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NUREG-2249

Generic Environmental Impact Statement for Licensing of New Nuclear Reactors

Final Report

Office of Nuclear Material Safety and Safeguards

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ABSTRACT

The U.S. Nuclear Regulatory Commission (NRC) staff prepared this generic environmental impact statement (GEIS) in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended, to address the NRC licensing of the building and operation of new nuclear reactors in the United States. In this GEIS, the NRC staff uses the values and assumptions in a technology-neutral plant parameter envelope (PPE) for a new nuclear reactor to evaluate the environmental impacts of constructing and operating a new nuclear reactor. In addition, this GEIS assumes that a new reactor might be built anywhere in the United States and territories that meets the requirements of the NRC's siting regulations. To accommodate this broad range of siting possibilities, the staff developed a site parameter envelope (SPE) that provides limiting values and assumptions related to the site.

The purpose and need for this GEIS is to present impact analyses for the environmental issues that are common to many new nuclear reactors that can be addressed generically, thereby eliminating the need to repeatedly reproduce the same analyses each time a licensing application is submitted and allowing applicants and NRC staff to focus future environmental review efforts on issues that can only be resolved once a site is identified. The results from this GEIS will be codified in Title 10 of the *Code of Federal Regulations* Part 51. Applicants submitting licensing applications for new nuclear reactors may cite the regulation for those issues bounded by the PPE and SPE and related values and assumptions rather than presenting application-specific analyses. The NRC staff performing environmental reviews may cite the analyses in this GEIS for those same issues instead of addressing the issues individually in application-specific documentation. By developing this GEIS, the NRC staff expects to streamline the time and effort needed to complete environmental reviews under NEPA for most new nuclear reactors.

This GEIS evaluates the potential environmental impacts of 119 issues relevant to building and operation of a new nuclear reactor. It identifies 100 issues as Category 1 issues. This number includes both issues for which potential environmental impacts have been generically determined to be SMALL and adverse provided that the project is bounded by relevant PPE and SPE values and assumptions, and issues for which the impacts are beneficial. The GEIS identifies 17 issues as Category 2 issues and concludes that an application-specific analysis considering site-specific conditions is necessary for those issues. Finally, as discussed in Section 1.3.3.3, there are two issues that are designated as N/A (i.e., impacts are Uncertain), which are neither Category 1 nor 2. Upon receipt of an application for a new nuclear reactor, the NRC staff would prepare a supplemental environmental impact statement or other supplemental NEPA documentation for the proposed project.

In general, an application for a new nuclear reactor can refer to the generic analysis in this GEIS for any Category 1 issue without further analysis, if it demonstrates that the relevant values and assumptions in the PPE and SPE are met and there is no new and significant information to change the conclusions in this GEIS. If the relevant parameters and assumptions for a Category 1 issue are not met, the applicant would have to supply the requisite information necessary for the staff to perform a site-specific analysis. Applicants addressing Category 2 issues, or other relevant issues not addressed in this GEIS, would have to provide all the information typically needed to perform a site-specific analysis.

The NRC staff also addresses a No-Action Alternative where the staff would not issue this GEIS and would instead prepare individualized NEPA documentation when reviewing each incoming new nuclear reactor licensing application. The NRC staff concluded that this alternative was not environmentally preferable to the proposed action (development of this GEIS).

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EXECUTIVE SUMMARY

In recent years, interest in developing and licensing new nuclear reactors, including advanced nuclear reactors (ANRs)[1], in the United States using new technologies has increased. The increased interest is demonstrated by the Nuclear Energy Innovation Capabilities Act of 2017 (Public Law 115-248) and the Nuclear Energy Innovation and Modernization Act of 2019 (Public Law 115-439). On November 15, 2019, the U.S. Nuclear Regulatory Commission (NRC) staff issued a *Federal Register* notice (84 FR 62559) announcing an exploratory process and soliciting comments to determine the possible utility of developing a generic environmental impact statement (GEIS) for licensing ANRs.

In a GEIS, the NRC staff evaluates environmental impacts common to a group of related future licensing actions, thereby allowing the staff to focus on impacts requiring consideration of project-specific and site-specific factors once applications are received. As part of the exploratory process, the staff considered its experience with previous GEIS documents developed by NRC staff for power reactor license renewals, in situ uranium recovery facilities, and decommissioning. The NRC issued a notice of intent to prepare the GEIS on April 30, 2020 (85 FR 24040), carried out a scoping process, and held a scoping meeting to receive public comments on the GEIS on May 28, 2020. After considering the comments received from interested stakeholders and the public during the scoping process, the NRC staff developed this GEIS as a document that would be applicable to ANRs only.

The GEIS was developed initially using a technology-neutral, performance-based approach to allow its use by a wide range of future ANR applicants. In Staff Requirements Memorandum (SRM) SECY-20-0020, dated September 21, 2020, (NRC 2020-TN6492), the Commission approved the development of a GEIS for the construction and operation of ANRs using a technology-neutral, performance-based approach, and directed staff to codify results in the *Code of Federal Regulations* (CFR).

In SRM SECY-21-0098 (NRC 2024-TN10164), dated April 17, 2024, the Commission directed the NRC staff to change the limited applicability of this GEIS from solely “advanced nuclear reactors” to any new nuclear reactor licensing application, provided the application meets the values and the assumptions of the plant parameter envelopes and the site parameter envelopes used to develop the GEIS. The term “nuclear reactor,” as it is used in this GEIS, is defined in 10 CFR 50.2 (TN249) as “an apparatus, other than an atomic weapon, designed or used to sustain nuclear fission in a self-supporting chain reaction.”

In SRM SECY-23-0001, dated April 13, 2023, the Commission directed the staff to regulate near-term fusion systems under the 10 CFR Part 30 byproduct material framework. Therefore, this GEIS does not address the environmental impacts of fusion systems.

ES.1 Purpose and Need for this GEIS

The purpose and need for this GEIS is to present impact analyses for the environmental issues common to many new nuclear reactors that can be addressed generically, thereby eliminating the need to repeatedly reproduce the same analyses each time a licensing application is

[1] A definition for an ANR is provided in the Nuclear Energy Innovation and Modernization Act of 2019 (Public Law 115-439). ANRs are a subset of the broader range of new nuclear reactors addressed by this GEIS.

submitted and allowing applicants and NRC staff to focus future environmental review efforts on issues that can only be resolved once a site is identified. This GEIS is intended to improve the efficiency of licensing new nuclear reactors by (1) identifying the possible types of environmental impacts of constructing and operating a nuclear reactor, (2) assessing impacts that are expected to be generic (the same or similar) for many nuclear reactors, and (3) defining the environmental issues that will need to be addressed in project-specific supplemental environmental impact statements (SEISs) addressing specific projects.

ES.2 Proposed Action

The proposed action is for the NRC staff to use a technology-neutral approach to issue a GEIS that identifies and analyzes environmental issues, common to building and operation of a nuclear reactor, for which a generic determination that impacts would not be environmentally significant is possible as long as specific reasonable and practicable values and assumptions are met. Values and assumptions regarding the design of the plant are termed the plant parameter envelope (PPE) and values and assumptions regarding site conditions are termed the site parameter envelope (SPE). The results of this GEIS will be codified in 10 CFR Part 51.

To develop this GEIS, the NRC established an interdisciplinary team of environmental subject matter experts (SMEs) from the NRC and from contractor Pacific Northwest National Laboratory—all of whom have extensive experience in evaluating the environmental impacts of new reactors. In the GEIS, the interdisciplinary team is collectively referred to as the NRC staff. The SMEs included individuals who have expertise in nuclear technology, radiation protection, land use, aquatic and terrestrial ecology, hydrology and water use, socioeconomics, meteorology and air quality, and human health.

Because new nuclear reactors are likely to include a range of reactor designs and could be sited anywhere in the United States and territories that meets NRC siting requirements, the NRC pursued a technology-neutral approach using assumptions contained in the PPE and SPE (Appendix G). The PPE consists of bounding values or parameters for reactor design features regardless of the site. In addition, the staff developed an SPE table of site conditions and assumptions. The table includes the site size, size of water bodies supplying water to the reactor, as well as specific assumptions related to the condition of the affected environment, such as the extent and occurrence of wetlands and floodplains, site position relative to aquatic features, and its proximity to sensitive noise receptors. This GEIS presents generic analyses that evaluate the possible impacts of a reactor that fits within the bounds of the PPE on a site that fits within the bounds of the SPE for those issues for which a generic conclusion was possible (referred to as Category 1 issues).

The environmental issues are organized into 15 environmental resources. Each issue corresponds to a specific type of environmental impact determined by the interdisciplinary team of SMEs to potentially result from building or operation of a nuclear reactor. This GEIS will allow licensing applications for new nuclear reactors to reference the generic analysis for each Category 1 environmental issue for which it can demonstrate that the project is bounded by the applicable assumptions in the PPE and SPE and for which there is no new and significant information affecting the evaluation. The NRC staff would have to prepare a SEIS or other supplemental National Environmental Policy Act of 1969, as amended (NEPA) documentation for the licensing of a new nuclear reactor, if using this GEIS. The SEIS would briefly describe how the project meets the PPE and SPE values and assumptions for the appropriate Category 1 issues. The SEIS would also evaluate the environmental impacts of any issues for

which an application cannot demonstrate that the relevant assumptions in the PPE and SPE are met, as well as issues that the staff could not address generically in this GEIS.

ES.3 Impact Significance Levels and Categorization of Issues

For each issue, the SMEs identified each value or assumption in the PPE and SPE that could effectively bound a meaningful generic analysis. The SMEs performed and described generic analyses for each issue for a hypothetical reactor that falls within the bounding values of the PPE on a site that falls within the bounding values of the SPE. The SMEs drew conclusions about each analysis using one of the three significance levels that the NRC staff typically uses in environmental impact statements (EISs) for new reactors:

- SMALL – Environmental effects that are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered SMALL.
- MODERATE – Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
- LARGE – Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

These significance levels follow the definitions presented in the footnotes to Table B-1 in Appendix B to Subpart A of 10 CFR Part 51.

The SMEs assigned each issue to one of two categories depending on the potential utility of the generic analysis to applicants preparing specific new nuclear reactor licensing applications and to the NRC staff when completing environmental reviews of those applications. The categories are as follows:

- Category 1 issues – environmental issues for which a generic analysis concluding SMALL adverse environmental impacts is possible, provided that relevant values and assumptions in the PPE and SPE are met, or beneficial impacts;
- Category 2 issues – environmental issues for which a meaningful generic analysis of environmental impacts is not possible because the issue requires consideration of project-specific information.

In addition, as discussed in Section 1.3.3.3, there are two issues that are designated as N/A (i.e., impacts are Uncertain), which are neither Category 1 nor 2.

An applicant addressing a Category 1 issue in its environmental report (ER) that accompanies an application may refer to the generic analysis in this GEIS for that issue without further analysis, provided that it demonstrates that the relevant assumptions in the PPE and SPE are met and there is no new and significant information to change the conclusions in this GEIS. If the relevant parameters and assumptions for a Category 1 issue are not met, the applicant would have to supply the requisite information necessary for the staff to perform a site-specific analysis. All applicants would have to individually address each Category 2 issue without reference to this GEIS, in addition to any other issues that may be relevant to an application that were not considered in this GEIS.

This GEIS also identifies other elements of environmental documentation that must be addressed individually, including sections addressing the purpose and need, need for power (or project), and alternatives to the proposed action.

ES.4 Alternatives

In addition to the proposed action of preparing a GEIS for new nuclear reactors, the NRC staff analyzed a No-Action Alternative in which the NRC does not issue this GEIS. Without the availability of this GEIS, applicants for licensing new nuclear reactors would have to address all relevant environmental issues individually in their ERs, and staff would have to prepare individual EISs for each application received that address all relevant environmental issues (including all Category 1 and Category 2 issues). The processes for an applicant to prepare an ER and for the NRC staff to prepare an EIS would remain those used in the past for new reactor licensing applications. Conclusions in this GEIS regarding potential environmental impacts could not be referenced. However, the No-Action Alternative would accomplish none of the benefits intended by the preparation of this GEIS, which would include (1) reducing the time and resources for the applicant's preparation of the environmental report, (2) reducing the time and resources for the NRC staff's preparation of the EIS and (3) focusing the resources of the applicant, NRC staff, and decision-makers on issues where there is truly a potential for significant environmental impacts. The NRC staff therefore concludes that the No-Action Alternative is not preferable to the proposed action.

Prior to scoping, the NRC staff contemplated preparing a GEIS that would analyze the potential environmental impacts of a hypothetical reactor that would have a power level of approximately 30 megawatts thermal or less on a hypothetical site. The analytical approach to developing this GEIS would have been similar to that used under the proposed action, but the PPE/SPE would have been developed based on a typical reactor of 30 megawatts thermal, limiting the range of reactors for which this GEIS would have been useful. Use of the power-level–based GEIS by applicants for small reactors and NRC staff would have been the same as for the environmental performance-based GEIS called for in the proposed action. During scoping, multiple commenters suggested that the parameters used in the generic analyses should be tied to the potential for environmental impacts rather than to an arbitrary power level. After reviewing the comments, the staff agreed that a GEIS developed using technology-neutral performance-based values and assumptions tied to environmental impacts might help streamline environmental reviews even for some larger ANRs that have a low potential for significant environmental impacts with respect to some environmental issues. Because of the limited utility of a GEIS based on a limited power level, the staff decided not to evaluate this alternative approach in detail.

The NRC staff initially developed this GEIS as a document that would be applicable to only ANRs. See SECY-21-0098, *Proposed Rule: Advanced Nuclear Reactor Generic Environmental Impact Statement*, dated November 29, 2021. However, in SRM SECY-21-0098 (NRC 2024-TN10164), dated April 17, 2024, the Commission directed the NRC staff to change the limited applicability of this GEIS from solely "advanced nuclear reactors" to any new nuclear reactor licensing application, provided the application meets the values and the assumptions of the plant parameter envelopes and the site parameter envelopes used to develop the GEIS. Based on the direction from the Commission, the alternative of developing a GEIS that would be applicable to only advanced nuclear reactors will not be considered further.

The staff also considered whether it would be possible to develop a GEIS that could serve as the sole technical documentation of potential environmental impacts for any new nuclear reactor. However, the staff concluded that it is not technically possible to develop generic analyses addressing all potentially significant environmental impacts from any new nuclear reactor without consideration of project-specific and site-specific conditions. It is also unrealistic to assume that a GEIS would be able to fully comply with other environmental laws such as the Endangered Species Act (16 U.S.C. §§ 1531 et seq.) or the National Historic Preservation Act (54 U.S.C. §§ 300101 et seq.). Therefore, the staff decided not to evaluate this alternative approach in detail.

ES.5 Affected Environment and Environmental Consequences

The baseline condition described as the "affected environment" in this GEIS is the environment that exists at a site proposed for building and operation of a nuclear reactor. The site could be anywhere in the United States or its territories that meets the NRC reactor siting criteria in 10 CFR Part 100. The affected environment reflects the existing condition of environmental resources, as influenced by natural physical conditions and by past human activities such as agriculture, forestry, mining, urbanization, and industrial and non-industrial development. The range of existing environmental conditions that might possibly occur at a proposed site located anywhere in the United States is too broad to characterize. To address this, the NRC staff developed the PPE, SPE, and related assumptions presented in Appendix G. The PPE and SPE contain assumptions regarding the absence of, or limited presence of, sensitive environmental resources such as sensitive habitats, wetlands, floodplains, and residences on or near the site. The PPE and SPE also contain assumptions regarding the size and condition of resources near the site, including water sources and air.

The NRC staff evaluated the potential environmental impacts from 119 issues in 15 environmental resources in this GEIS (note that between the Draft and Final GEIS, the total number of issues and environmental resources changed as a result of public comments and changes in NRC policy). Of these, the staff identified 100 issues as Category 1 issues and 17 issues as Category 2 issues (Table 4-1). In addition, as discussed in Section 1.3.3.3, there are two issues that are designated as N/A (i.e., impacts are Uncertain), which are neither Category 1 nor 2. The NRC staff determined that the potential environmental impacts for each Category 1 issue would be of SMALL significance, as long as the applicable assumptions in the PPE and SPE are met. The basis for identifying an issue as a Category 1 issue is whether a generic analysis of the issue is sufficient for decision-makers and the public when licensing a new nuclear reactor that meets the assumptions in the PPE and SPE.

The NRC staff determined that it is not possible to evaluate the significance of environmental impacts from the Category 2 issues without application-specific evaluation after receiving a licensing application that identifies specific design parameters and site conditions. The staff identified certain issues as Category 2 issues because they require project-specific consultation with outside agencies to comply with statutes other than NEPA. Examples include issues related to threatened or endangered species regulated under the Endangered Species Act, essential fish habitat regulated under the Magnuson-Stevens Fishery Conservation and Management Act, and historic properties regulated under the National Historic Preservation Act. The staff is unable to evaluate the significance of impacts on those resources without receiving technical input from the consultations. The staff identified certain other issues as Category 2 issues because it was not possible to set realistic assumptions that could underlie a conclusion that the impacts would necessarily be SMALL at any hypothetical site in the United States. However, the fact that an individualized analysis is necessary does not mean that the

supplemental NEPA documentation will lead the NRC staff to conclude that impacts pertaining to the issue will be greater than SMALL; it only means that more than a generic analysis is necessary to reach a conclusion. Although it would theoretically be possible to constrain the assumptions to the extent that impacts on almost any environmental impact would be SMALL, the NRC staff intends for this GEIS to be a practicable, usable document for different types of new reactor projects.

ABBREVIATIONS AND ACRONYMS

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
^{235}U	uranium-235
ABWR	Advanced Boiling Water Reactor
ac	acre(s)
ACHP	Advisory Council on Historic Preservation
ADAMS	Agencywide Documents Access and Management System
ADU	ammonium diuranate
ALARA	as low as is reasonably achievable
AEC	Atomic Energy Commission
ANO	Arkansas Nuclear
ANR	advanced nuclear reactor
ANS	American Nuclear Society
APE	area of potential effect
APLIC	Avian Power Line Interaction Committee
APWR	Advanced Pressurized-Water Reactor
ARE	Aircraft Reactor Experiment
ASME	The American Society of Mechanical Engineers
ATF	accident tolerant fuel
BDBE	beyond design basis event
BMP	best management practice
Bq	becquerel(s)
BWR	boiling water reactor
BWXT	BWX Technologies, Inc.
CAA	Clean Air Act
CDF	core damage frequency
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
CFR	*Code of Federal Regulations*
CH_4	methane
Ci	curie(s)
CISF	Consolidated Interim Storage Facility
CO	carbon monoxide
CO_2	carbon dioxide
$CO_2(e)$	CO_2 equivalent

COL	combined construction permit and operating license or combined license
CP	construction permit
CPA	construction permit application
CWA	Clean Water Act (aka Federal Water Pollution Control Act)
CZMA	Coastal Zone Management Act
d	day(s)
dBA	decibel(s) on the A-weighted scale
DBA	design basis accident
DBE	design basis event
DC	design certification
DCD	design control document
DCP	dry conversion process
DCR	design certification rule
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DTS	dry transfer system
EA	environmental assessment
EBR-II	Experimental Breeder Reactor-II
EDO	Executive Director for Operation
EIS	environmental impact statement
EMF	electromagnetic field
EPA	U.S. Environmental Protection Agency
EPR	U.S. Evolutionary Power Reactor
EPZ	Emergency Planning Zone
EPCRA	Emergency Planning and Community Right-to-Know Act
ER	environmental report
ESA	Endangered Species Act of 1973, as amended
ESBWR	Economic Simplified Boiling-Water Reactor
ESP	early site permit
FAST	Fixing America's Surface Transportation Act
FDA	final design approval
FEIS	final environmental impact statement
FES	final environmental statement
Flibe	lithium tetrafluoroberyllate, Li_2BeF_4
FPPA	Farmland Protection Policy Act
FSAR	final safety analysis report
FSER	final safety evaluation report
ft	foot or feet

ft^2	square foot or feet
ft^3	cubic foot or feet
FWS	U.S. Fish and Wildlife Service
g	gram(s)
gal	gallon(s)
GEH	GE-Hitachi Nuclear Energy Americas, LLC
GEIS	generic environmental impact statement
GHG	greenhouse gas
gpd	gallon(s) per day
gpm	gallon(s) per minute
GTCC	greater than Class C
GWd	gigawatt day(s)
Gy	gray(s)
ha	hectare(s)
HALEU	high-assay low- enriched uranium
HAP	hazardous air pollutant
HEU	highly enriched uranium
HLW	high-level waste
hr	hour(s)
Hz	hertz
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
in.	inch(es)
Indian Point	Indian Point Energy Center
INL	Idaho National Laboratory
IPCC	Intergovernmental Panel on Climate Change
ISFSI	independent spent fuel storage installation
ISG	Interim Staff Guidance
KEPCO	Korea Electric Power Corporation
kg	kilogram(s)
KHNP	Korea Hydro & Nuclear Power Co., Ltd.
km	kilometer(s)
km^2	square kilometer(s)
KP-FHR	Kairos Power Fluoride Salt-Cooled, High Temperature Reactor
kV	kilovolt(s)
kWh	kilowatt-hour(s)

L	liter(s)
lb	pound(s)
LEU	low-enriched uranium
LERF	large early release frequency
LLC	Limited Liability Company
LLRW	low-level radioactive waste
LMP	Licensing Modernization Project
LOS	level of service
LPZ	low population zone
LR	license renewal
LR GEIS	license renewal generic environmental impact statement
LWR	light-water reactor
m	meter(s)
m^3	cubic meter(s)
MEI	maximally exposed individual
mGy	milligray(s)
MHA	Maximum Hypothetical Accident
mi	mile(s)
mi^2	square mile(s)
MIMS	Manifest Information Management System
M	million
MMT	million metric tons
mo	month(s)
mrad	millirad(s)
mrem	millirem(s)
MSR	molten-salt reactor
MSRE	Molten-Salt Reactor Experiment
mSv	millisievert(s)
MT	metric ton(nes)
MTU	metric ton(nes) uranium
MW	megawatt(s)
MWe	megawatt(s) electrical
MWt	megawatt(s) thermal
MWd	megawatt-day(s)
MWd/MTU	megawatt-day(s) per metric ton of uranium
MWh	megawatt-hour(s)
N/A	not applicable
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standard

NCP	Non-Concurrence Process
NCRP	National Council on Radiation Protection and Measurements
NEI	Nuclear Electric Institute
NEIMA	Nuclear Energy Innovation and Modernization Act of 2019
NEPA	National Environmental Policy Act of 1969, as amended
NFPA	National Fire Protection Association
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NNSR	Nonattainment New Source Review
NO_x	oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System
NPP	nuclear power plant
NR GEIS	*Generic Environmental Impact Statement for Licensing New Nuclear Reactors*
NRC or Commission	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NRIC	National Reactor Innovation Center
NSR	New Source Review
NTTF	Near-Term Task Force
NUREG	U.S. Nuclear Regulatory Commission technical document
NWP	Nation Wide Permit
OSHA	Occupational Safety and Health Administration
PDR	population dose risk
PER	pyrochemical/electrochemical reprocessing
PFSF	Private Fuel Storage Facility
PM	particulate matter
PM_{10}	particulate matter with a mean aerodynamic diameter of 10 µm or less
$PM_{2.5}$	particulate matter with a mean aerodynamic diameter of 2.5 µm or less
PNNL	Pacific Northwest National Laboratory
PPE	plant parameter envelope
ppsm	person(s) per square mile
ppt	part(s) per thousand
PRA	probabilistic risk assessment
PSD	Prevention of Significant Deterioration
PSAR	preliminary safety analysis report
PSDAR	post-shutdown decommissioning activity report
PSEG	Public Service Enterprise Group
PUREX	plutonium uranium extraction
PWR	pressurized water reactor

RCRA	Resource Conservation and Recovery Act of 1976, as amended
rem	roentgen equivalent man
REMP	Radiological Environmental Monitoring Program
RG	Regulatory Guide
ROW	right-of-way
RRY	reference reactor-year
Ryr	reactor-year(s)
s or sec	second(s)
SAFSTOR	SAFe STORage
SAG	Severe Accident Guideline
SAMA	severe accident mitigation alternative
SAMDA	severe accident mitigation design alternative
SAMG	Severe Accident Management Guideline
SDWA	Safe Drinking Water Act
SEIS	supplemental environmental impact statement
SER	Safety Evaluation Report
SFPI	spent fuel pool instrumentation
SFR	sodium-cooled fast reactor
SHPO	State Historic Preservation Office
SLR	subsequent license renewal
SME	subject matter expert
SMR	small modular reactor
SNF	spent nuclear fuel
SNM	special nuclear material
SO_x	oxides of sulfur
SPE	site parameter envelope
SRM	Staff Requirements Memorandum
SSA	Sole Source Aquifer
SWU	separative work unit
T	ton(nes)
TCP	traditional cultural properties
TDS	total dissolved solids
TEDE	total effective dose equivalent
Th-232	thorium-232
THPO	Tribal Historic Preservation Office
TMI	Three Mile Island
TPQ	Threshold Planning Quantity
TQ	threshold quantity
TRISO	TRi-structural ISOtropic

TRU	transuranic
U-235	uranium-235
U-238	uranium-238
UCB	upper confidence bound
UF_6	uranium hexafluoride
U.S.	United States of America
UO_2	uranium dioxide
USACE	U.S. Army Corps of Engineers
U.S.C.	*United States Code*
USNC	Ultra Safe Nuclear Corporation
VOC	volatile organic compound
WCS	Waste Control Specialists, LLC
WNA	World Nuclear Association
yd^3	cubic yard(s)
yr	year(s)

1 INTRODUCTION

In recent years, interest in developing and licensing new nuclear reactors, including advanced nuclear reactors (ANRs), in the United States using new technologies has increased. The increased interest is demonstrated by the Nuclear Energy Innovation Capabilities Act of 2017 (Public Law 115-248; TN6468) and the Nuclear Energy Innovation and Modernization Act of 2019 (NEIMA), Public Law 115-439; TN6469). One purpose of NEIMA is to provide a program for developing "the expertise and regulatory processes necessary to allow innovation and commercialization of advanced nuclear reactors." A strategic nonprofit organization dedicated to advancing nuclear development in the United States, ClearPath, sent a letter, dated February 19, 2019, to the U.S. Nuclear Regulatory Commission (NRC) recommending that it develop a generic environmental impact statement (GEIS) for construction and operation of ANRs (ClearPath 2019-TN6466). Multiple representatives of Congress also expressed interest in having the NRC develop such a GEIS. On June 25, 2019, Senators Barrasso and Braun sent a letter to the Chairman of the NRC requesting that the NRC initiate a process to develop a GEIS for ANRs (Barrasso and Braun 2019-TN6465). The Chairman responded on July 29, 2019 (NRC 2019-TN6467) that the NRC would explore whether development of a GEIS would beneficially streamline environmental reviews for ANRs while still fulfilling NRC's responsibilities to protect the environment and comply with the National Environmental Policy Act of 1969 (NEPA) (42 *United States Code* [U.S.C.] §§ 4321 et seq.*;* TN661).

On November 15, 2019, the NRC staff issued a *Federal Register* notice (84 FR 62559-TN6470) announcing an exploratory process and soliciting comments to determine the possible utility of developing a GEIS for licensing ANRs. The exploratory process included two public meetings, a comprehensive public workshop attended by multiple stakeholders, and a site visit to the Idaho National Laboratory, one location that is being contemplated for some ANRs. As part of the exploratory process, the staff considered its experience with previous NRC GEIS documents that support power reactor license renewals, in situ uranium recovery facilities, and decommissioning. The staff gathered information to determine whether a GEIS for construction and operation of ANRs might be viable. The exploratory process concluded with an information paper to the Commission concluding that the staff decided to pursue a GEIS using a technology-neutral approach, and that a GEIS would generically resolve many environmental issues, saving resources and providing predictability for potential applicants.

In Staff Requirements Memorandum (SRM) SECY-20-0020, dated September 21, 2020, (NRC 2020-TN6492), the Commission approved the development of a GEIS for the construction and operation of ANRs using a technology-neutral, performance-based approach, and directed staff to codify results in the *Code of Federal Regulations*. Details of this approach are discussed in Section 1.3. The NRC issued a notice of intent to prepare the GEIS on April 30, 2020 (85 FR 24040), carried out a scoping process, and held a scoping meeting to receive public comments on the GEIS on May 28, 2020. After considering the comments received from various sources during the scoping process, the NRC staff initially developed this GEIS as a document that would be applicable to only ANRs.

Because this GEIS was initially developed using a technology-neutral, performance-based approach, its analyses can be used by any reactor. In SRM SECY-21-0098 (NRC 2024-TN10164), dated April 17, 2024, the Commission directed the NRC staff to change the limited applicability of the GEIS from solely "advanced nuclear reactors" to any new nuclear reactor licensing application, provided the application meets the values and the assumptions of the plant parameter envelopes and the site parameter envelopes used to develop the GEIS.

1.1 Purpose and Need for this GEIS

The purpose and need for this GEIS is to present impact analyses for the environmental issues common to licensing actions for many new nuclear reactors[1] that can be addressed generically, thereby eliminating the need to repeatedly reproduce the same analyses each time a licensing application is submitted and allowing applicants and NRC staff to focus future environmental review efforts on issues that can only be resolved once a site is identified. This GEIS is intended to improve the efficiency of licensing new nuclear reactors by (1) identifying the types of potential environmental impacts[2] of constructing and operating a nuclear reactor, (2) assessing impacts that are expected to be generic (the same or similar) for many new nuclear reactors, and (3) defining the environmental issues that will need to be addressed in project-specific supplemental EISs (SEISs) addressing specific projects.

1.2 NEPA Process

After completing the exploratory process, the NRC established an interdisciplinary team of environmental subject matter experts (SMEs) to develop this GEIS. The team comprised experts from the NRC staff and from contractors, including Pacific Northwest National Laboratory, possessing extensive experience in evaluating the environmental impacts of new reactors. The SMEs included individuals who have expertise in nuclear technology, radiation protection, land use, aquatic and terrestrial ecology, hydrology and water use, socioeconomics, meteorology and air quality, and human health. A complete list of SMEs, their credentials, and their roles in preparing this GEIS is provided in Appendix A of this GEIS.

1.2.1 Public Scoping

On April 30, 2020, the NRC issued a *Federal Register* notice informing the public of its intent to develop an ANR GEIS and to conduct a scoping process to gather the information necessary to prepare an ANR GEIS for small-scale ANRs (85 FR 24040-TN6458). The NRC held a webinar on May 28, 2020, to receive comments from the public on the scope of this GEIS (NRC 2020-TN6459).

The *Federal Register* notice stated that the NRC intended to develop a GEIS for ANRs that have a small generating output and correspondingly small environmental footprint in order to streamline the environmental review process for future small-scale ANR environmental reviews (85 FR 24040-TN6458). At the time of scoping, the NRC staff considered a “small-scale” ANR to be one that has the potential to generate up to approximately 30 megawatts thermal (MWt) per unit and has a correspondingly small environmental footprint. The staff indicated that the actual bounding thermal power level and environmental footprint used in this GEIS were topics to be determined during the scoping process.

The NRC received a number of comments about the scope of this GEIS during the May 28, 2020, webinar and throughout the scoping comment period. A summary of the scoping comments was issued on September 25, 2020 (NRC 2020-TN6593). A number of commenters questioned the utility of a GEIS for ANRs, given that the NRC did not know the type of reactor or the site where the reactor would be located. Others agreed with the technology-neutral

[1] Relevant licensing actions are construction permits, operating licenses, combined licenses, early site permits, and limited work authorizations.

[2] This GEIS documents the potential impacts of construction, operation and decommissioning of new nuclear reactors. Accordingly, any impacts discussed in this GEIS are potential impacts.

approach but recommended a performance-based approach without limiting this GEIS to small-scale reactors. Based on the comments received during scoping, the NRC determined to use a technology-neutral, performance-based approach with specified values and assumptions. "Performance" reflects the ability of an applicant to design a nuclear reactor that minimizes environmental impacts while still meeting the reactor's objectives. The approach outlined above constitutes a technology-neutral, performance-based approach whereby the efficiencies gained through use of this GEIS increase as the potential for environmental impacts decreases.

1.2.2 Issuance of the Draft Generic Environmental Impact Statement for Licensing New Nuclear Reactors and Proposed Rule

The Commission, in SRM SECY-21-0098 (NRC 2024-TN10164), dated April 17, 2024, directed the NRC staff to change the limited applicability of the GEIS initially developed from solely "advanced nuclear reactors" to any new nuclear reactor licensing application, provided the application meets the values and the assumptions of the plant parameter envelopes and the site parameter envelopes used to develop the GEIS. Therefore, this document is referred to as the NR GEIS throughout.

The Notice of Availability of the Draft NR GEIS and Proposed Rule was published in the *Federal Register* on October 4, 2024 (89 FR 80797-TN11914), initiating a 75-day public comment period that closed on December 18, 2024.

1.2.3 Public Comments on the Draft NR GEIS and Proposed Rule

The public comment process for the Draft NR GEIS was similar to that used for other NRC NEPA documents. NRC distributed the Draft NR GEIS to Federal, State, and local government agencies, Federally-recognized Indian Tribes, environmental interest groups, and members of the public who requested copies. As part of the process to solicit public comments on the Draft NR GEIS, the NRC:

- Updated its public website to consolidate pertinent rulemaking information (NRC 2025-TN11953).
- Published the proposed rule, Draft NR GEIS, and associated guidance for public comment in the *Federal Register* (89 FR 80797-TN11914).
- Issued press releases and social media posts regarding the issuance of the Draft NR GEIS, associated guidance, and proposed rule; announcing public meetings; and providing instructions on how to provide comments.
- Notified the public of three public meetings to receive comments on the Draft NR GEIS and proposed rule.
- Conducted an in-person public meeting in Rockville, Maryland, on November 7, 2024, and two virtual public meetings on November 13 and November 14, 2024.
- Conducted an informational meeting with Federally recognized Tribes on December 3, 2024, to provide an overview of the Draft NR GEIS and proposed rule and afford Tribal representatives an opportunity to discuss the GEIS and rule with NRC staff.

Approximately 122 people attended the in-person and virtual meetings. During the public comment period, the NRC received a total of 39 comment submissions, including those captured in public meeting transcripts, comment letters, and emails, which have been referenced and incorporated by reference in this NR GEIS (see Appendix E.2). The public

comment documents received are available online in the Agencywide Documents Access and Management System and on the Federal rulemaking website (Regulations.gov) under Docket ID# NRC-2020-0101. The NRC considered all comments received when developing the Final NR GEIS. NRC responses to all comments received are included in Appendix E.2 of this NR GEIS.

Changes made in response to comments in this Final NR GEIS, as well as changes made to include updated information, corrections, and substantial editorial revisions are marked with a change bar (vertical line) on the side margin of the page where the changes or additions were made. Minor editorial revisions and those limited to formatting are not marked.

1.2.4 Changes Between the Draft and Final GEIS

1.2.4.1 Limited Work Authorizations.

Based on input received during the public comment period, the staff proposes to add rule language allowing for use of the NR GEIS with limited work authorizations.

1.2.4.2 Executive Order 14154 and Rescinding of Council on Environmental Quality (CEQ) NEPA Regulations.

The staff removed references to the CEQ NEPA regulations in the Final GEIS based on the CEQ's interim final rule removing the CEQ NEPA regulations effective on April 11, 2025. This interim rule was issued in response to Executive Order 14154, dated January 28, 2025.

1.2.4.3 Withdrawal of Environmental Justice.

Effective April 30, 2025, the Commission withdrew its *Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions (Environmental Justice Policy Statement)* and its *Environmental Justice Strategy* (90 FR 17887). This action was taken in response to Executive Order 14173, which rescinded Executive Order 12898. In Staff Requirements Memorandum COMSECY-25-0007 (NRC 2025-TN11710), "Withdrawing the Environmental Justice Policy Statement and Environmental Justice Strategy," signed April 10, 2025, the Commission directed the staff to "take a comprehensive review of the NRC's environmental regulations, guidance, and training materials to remove references to Environmental Justice (EJ) ...." and "... to refrain from explicitly addressing EJ in its [NEPA] reviews ...." (NRC 2025-TN11710)

Therefore, the NRC is no longer considering environmental justice as an issue needing to be addressed in new reactor environmental reviews and removed the two Category 2 issues identified in the Draft GEIS and proposed rule.

1.2.4.4 Severe Accidents and Mitigation

The staff updated Severe Accidents to a Category 1 issue and developed PPE/SPE values based on available information since the publication of the draft NR GEIS and proposed rule in 2021. The NRC staff also eliminated the Severe Accident Mitigation Design Alternatives category as a separate issue. The staff developed a new Appendix I to the NR GEIS explaining the context for these changes and made changes in Section 3.11.2.3 of the NR GEIS.

1.2.4.5 Tribal/Historic Resources Consultation

The staff added a new Section 1.4.7 in Chapter 1 of the NR GEIS and a new section on the Commission's Tribal Policy Statement in COL-ISG-030 to reference consultations conducted under ESA and NHPA, as well as the NRC's Tribal Policy Statement.

1.2.4.6 Climate Change Impacts on Environmental Resources

The staff revised the name of the Category 2 issue 'Climate Change' to 'Climate Change Impacts on Environmental Resources' to clarify that this issue addresses changes to the affected environment independent of a new nuclear reactor project and how the project's environmental impacts would increase, decrease, or remain the same under a baseline that is altered by climate change.

1.3 Analytical Approach Used in this GEIS

1.3.1 Methodology

This section discusses the methodology the NRC staff used to develop this GEIS. This GEIS evaluates the impacts of building, operating, and decommissioning a new nuclear reactor sited within the United States and its territories that is bounded by the values and assumptions in Appendix G and the analyses in this GEIS. In addition, this GEIS considered fuel cycle impacts and the impacts from continued storage of spent fuel after operations. The term building, as used in this GEIS, includes the full range of preconstruction (building activities not within the NRC's regulatory authority), and construction and installation activities (building activities within the NRC's regulatory authority). The term construction worker includes any worker engaged in building activities and the term construction equipment includes any equipment used for building activities. For the purposes of this GEIS, the staff assumed that the U.S. Army Corps of Engineers (USACE) would be a cooperating agency, in accordance with the Memorandum of Understanding between the two agencies (USACE and NRC 2008-TN637). Based on this assumption, preconstruction activities are addressed in Chapter 3 along with the impacts of NRC-authorized construction.

Because new nuclear reactors are not specific to only one reactor design and could be sited anywhere in the United States and its territories that meets NRC siting requirements as set forth in Title 10 of the *Code of Federal Regulations* Part 100 (TN282), the NRC decided to pursue a technology-neutral, performance-based approach using a plant parameter envelope (PPE). The PPE consists of parameters for specific reactor design features regardless of the site. Examples of parameters include the site footprint size, building height, water use, air emissions, employment levels, and noise generation levels. For each PPE parameter, the staff developed a set of bounding values and assumptions.

In addition, the staff developed a set of site-related parameters termed the site parameter envelope (SPE). Examples of parameters include site size and size of water bodies supplying water to the reactor. For each SPE parameter, the staff developed a set of bounding values and assumptions related to the condition of the affected environment, such as the extent and occurrence of wetlands and floodplains, position near aquatic features, and proximity to sensitive noise receptors. The GEIS presents generic analyses that evaluate the possible impacts of a reactor that fits within the bounds of the PPE on a site that fits within the bounds of the SPE.

The PPE and SPE are presented in Appendix G. The PPE and SPE values and assumptions were developed by the interdisciplinary team of SMEs assigned to prepare this GEIS. The SMEs developed the values and assumptions based on one or more of the following:

- regulatory limits and permitting requirements relevant to the resource as established by Federal, State, or local agencies;
- relevant information obtained from other NRC GEISs, including the 1996, 2013, and 2024 versions of the LR GEIS (NRC 1996-TN288, NRC 2013-TN2654, NRC 2024-TN10161) and the Continued Storage GEIS (NRC 2014-TN4117);
- empirical knowledge gained from conducting evaluations and analyses for past new reactor environmental impact statements (EISs) and operating reactor license renewal SEISs;
- values and assumptions derived from other documents applying a PPE/SPE approach (such as the National Reactor Innovation Center [NRIC] PPE Report; NRIC 2021-TN6940); and
- subject matter expertise and/or development of calculations and formulas based upon education and experience with the resource.

The SMEs strove to ensure that the PPE and SPE were set broadly enough to make this GEIS a useful licensing tool, while still ensuring that enough project-specific analysis would be completed upon receipt of an application to document significant environmental impacts for the public and decision-makers.

The NRC staff presented preliminary tables outlining the PPE and SPE at the March 28, 2020, scoping meeting. The PPE and SPE presented in Appendix G reflect the staff's consideration of comments received during the scoping process and subsequent research conducted by the SMEs to prepare the Draft GEIS.

The SMEs started their analysis by identifying specific types of impacts relevant to each of 15 environmental resource areas. Each type of impact is termed an issue. Each issue corresponds to a specific type of environmental impact determined by the interdisciplinary team of SMEs that could potentially result from construction or operation of a nuclear reactor. The SMEs identified 119 specific issues. For each issue, the SMEs then determined whether it would be possible to identify values and assumptions in the PPE and SPE that could effectively bound a meaningful generic analysis and provided the basis for each value and assumption. The SMEs then performed and described their generic analyses for each issue, for a hypothetical reactor/site that meets the PPE and SPE values and assumptions. For this GEIS, the values and assumptions were set such that the SMEs could reach a generic conclusion of SMALL adverse impacts, which are designated as Category 1 issues (i.e., issues for which a generic analysis was possible). Issues for which the impacts are beneficial are also designated as Category 1.

After considering potential values and assumptions for the PPE and SPE for some environmental impact issues, the staff could not reach a generic conclusion. In some cases, this was due to requirements of other statutes, such as the National Historic Preservation Act (NHPA) (54 U.S.C. §§ 300101 et seq.; TN4157) and the Endangered Species Act (ESA; 16 U.S.C. §§ 1531 et seq.; TN1010). In other cases, the wide range of potential reactor designs and potential site locations made it impossible for the staff to reach a generic conclusion. These issues are designated as Category 2 issues, which require site- or project-specific analysis in an NRC EIS.

The SMEs drew conclusions about each analysis using one of the three significance levels that the NRC staff typically uses in EISs for new reactors, including the following:

- SMALL – Environmental effects that are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered SMALL.
- MODERATE – Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
- LARGE – Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

These significance levels follow the definitions presented in the footnotes in Table B-1 in Appendix B of Subpart A of 10 CFR Part 51 (TN250). These are the same environmental significance levels and definitions used in the LR GEIS (NRC 2024-TN10161) and in recent EISs prepared by the NRC staff for combined licenses and early site permits for new light-water reactors (LWRs). The discussion of each Category 1 environmental impact issue in this GEIS includes an explanation of how the significance category of SMALL was determined. For issues for which the probability of occurrence is a key consideration (i.e., postulated accidents), the probability of occurrence has been factored into the determination of significance. Possible mitigation measures that could be used to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse impacts are discussed where appropriate.

- The SMEs assigned each issue to one of the two categories depending on the potential utility of the generic analysis to applicants preparing specific new nuclear reactor licensing applications and to the NRC staff when completing environmental reviews of those applications. In summary, the categories are as follows:
- Category 1 issues – environmental issues for which a generic analysis concluding SMALL adverse environmental impacts is possible, provided that relevant values and assumptions in the PPE and SPE are met, or beneficial impacts;
- Category 2 issues – environmental issues for which a meaningful generic analysis of environmental impacts is not possible because the issue requires consideration of project-specific information.

In addition, as discussed in Section 1.3.3.3, there are two issues that are designated as not applicable (N/A) (i.e., impacts are Uncertain), which are neither Category 1 nor 2.

Category 1 issues include one or more PPE/SPE parameters with associated values and assumptions; these values and assumptions are set to define a SMALL impact. This GEIS provides generic analyses for these Category 1 environmental issues, organized under the 15 environmental resources described in Chapter 3 of this GEIS.

An applicant addressing a Category 1 issue in its environmental report (ER) may refer to the generic analysis in this GEIS for that issue without further analysis, provided that it demonstrates that the relevant values and assumptions of the PPE and SPE used in the resource analysis are met and there is no new and significant information that would require project-specific analysis. The applicant will have to document how the values and assumptions are met, unless this is made clear in other information provided in the application package. The extent of the information necessary to demonstrate that a value or assumption is met will vary. In some cases, the demonstration may only require showing that the project falls within a

parameter value or assumption (e.g., building height). But in other cases, analysis may be required to demonstrate that a value or assumption has been met (e.g., building- or operations-related noise levels).

If the relevant values and assumptions for a Category 1 issue are not met, the applicant would have to supply the requisite information necessary for the staff to perform a project-specific analysis. One place for guidance for applicants providing information to the staff in an ER is available in the latest version of Regulatory Guide (RG) 4.2.[3] The applicant may, however, be able to incorporate by reference all or part of the generic analysis provided in this GEIS and focus on providing the additional project-specific information needed. Applicants addressing Category 2 issues in an ER would have to provide all the information typically needed by the staff to perform a project-specific analysis and may rely on guidance available in RG 4.2 (NRC 2026-TN11915). The staff expects that applicants may be able to rely on the generic conclusions for certain Category 1 issues, but not all Category 1 issues.

When addressing Category 1 issues in SEISs, the NRC staff may likewise refer to the generic analysis in this GEIS for that issue without further analysis, provided that the relevant values and assumptions in the PPE and SPE are met and there is no new and significant information that changes the conclusions in this GEIS. Staff may also have to briefly document how the values and assumptions are met. If the relevant values and assumptions are not met, staff would have to complete a project-specific analysis in accordance with the latest version of the Environmental Standard Review Plan or related guidance (such as any relevant Interim Staff Guidance). Staff may however be able to streamline the effort by incorporating all or a portion of the generic analysis in this GEIS and expanding it to account for project-specific information.

It is possible that applicants for certain new nuclear reactors carefully designed to minimize environmental impacts may be able to demonstrate that their projects fall within all or most of the values and assumptions and may be able to reference generic analyses in this GEIS for all or most of the Category 1 environmental issues. In such a case, the NRC staff's SEIS would likely be shorter than an EIS has been in the past for a typical new reactor application. Also, as has always been the case, if the design of a project is such that an environmental issue (or group of environmental issues) is not applicable, then the applicant need not analyze the issue(s). For example, if the nuclear reactor design does not use cooling water then the impact issues associated with the use of cooling water do not need to be analyzed. However, the applicant must briefly describe its basis for concluding that the issue(s) is/are not applicable.

The NRC cannot rely on this GEIS alone to analyze the environmental impacts of construction or operation of any nuclear reactors. For example, the staff would still have to conduct the consultations required by Section 106 of the NHPA (54 U.S.C. §§ 300101 et seq.; TN4157) and Section 7 of the ESA (16 U.S.C. §§ 1531 et seq.; TN1010) and include the documentation in the SEIS for each application using this GEIS. Therefore, these consultations will not be part of this GEIS. The NRC staff will still have to complete other project-specific analyses upon receiving a new nuclear reactor application.

The NRC staff has evaluated fuel cycle impacts for LWRs, as documented in 10 CFR 51.51 (TN250), Table S-3, Table of Uranium Fuel Cycle Environmental Data. However, in accordance with 10 CFR 51.51, only an ER for LWRs can include Table S-3. For reactors other than LWRs, the application must contain the basis for evaluating the contribution of the environmental

[3] Unless stated otherwise, references to RG 4.2 in this document refer to Revision 4 to Regulatory Guide 4.2, which is being published at the same time as this Final GEIS.

effects of fuel cycle activities for the reactor (10 CFR 51.50(b)(3) and 10 CFR 51.50(c)). Section 3.14 of this NR GEIS evaluated the fuel cycle impacts for nuclear reactor fuel and determined that data from Table S-3 could bound the impacts of the fuel cycle for certain advanced non-LWRs. An applicant for an advanced non-LWR license could meet the requirements of 10 CFR 51.50(b)(3) and 10 CFR 51.50(c) by demonstrating that their fuel falls within the fuel cycle analysis in this GEIS. If the fuel cycle or parts of the fuel cycle do not fall within the analysis in this GEIS, then the applicant would need to provide the analysis of the parts of the fuel cycle that are not bounded.

This GEIS incorporates by reference NUREG-2157, *Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel* (NRC 2014-TN4117), in which the NRC evaluated the environmental impacts of the continued storage of spent nuclear fuel beyond the licensed life for the operation of LWRs. In 10 CFR 51.23 (TN250), "Environmental impacts of continued storage of spent nuclear fuel beyond the licensed life for operation of a reactor," the NRC specifies that NUREG-2157 is deemed to be incorporated into the EIS for a new reactor. However, NUREG-2157 did not evaluate the storage of spent nuclear fuel from non-LWRs. The staff expects that many new nuclear reactors will not be LWRs. Section 3.14.2.6 of this NR GEIS therefore evaluates the applicability of NUREG-2157 and determines that the findings were applicable to non-LWR fuel, provided that the non-LWR fuel is stored in a manner that meets the regulatory requirements for spent fuel storage cask approval and fabrication in accordance with 10 CFR Part 72 (TN4884), Subpart L – "Approval of Spent Fuel Storage Casks," as was the LWR spent fuel evaluated in NUREG-2157 (NRC 2014-TN4117).

The NRC has generically evaluated the environmental impacts of the transportation of fuel and waste in 10 CFR 51.52 (TN250), "Environmental effects of transportation of fuel and waste – Table S-4," Table S-4, Environmental Impact of Transportation of Fuel and Waste to and from One Light Water Cooled Nuclear Power Reactor, for LWR fuel that meets certain entry conditions specified in 10 CFR 51.52(a). The staff evaluated the impacts of transportation of non-LWR fuel and waste in Section 3.15 of this GEIS and determined that the shipment of unirradiated and irradiated non-LWR fuel and radioactive waste would be a Category 1 issue. The applicant can rely on the generic analysis as long as the PPE values and assumptions are met.

This GEIS incorporates by reference NUREG-0586, Supplement 1 (NRC 2002-TN665), in which the NRC evaluated the environmental impacts of the decommissioning of nuclear power reactors. The NRC staff's evaluation of the environmental impacts of decommissioning presented in NUREG-0586, Supplement 1, considered environmental issues for LWRs and three permanently shutdown facilities that included a fast breeder reactor and two high-temperature gas-cooled reactors (NRC 2002-TN665). NUREG-0586, Supplement 1, identified whether the environmental issues were considered generic to all decommissioning sites or project-specific. While most issues were considered generic to all decommissioning sites, two issues were determined to require a project-specific review and four issues were considered to be conditionally project-specific. Therefore, in Section 3.16.2 of this GEIS, the NRC staff evaluated the applicability of NUREG-0586, Supplement 1, and determined that the findings for the issues considered generic to all decommissioning sites are expected to be applicable to any new nuclear reactor, provided that the impacts from decommissioning can be shown to be within the bounds described in the Decommissioning GEIS, and that regulatory requirements for decommissioning in 10 CFR 50.82 (TN249) or 10 CFR 52.110 (TN251) are met. Additional analysis would be required for the identified project-specific issues.

In summary, the general analytical approach used by the NRC staff in this GEIS to evaluate environmental impacts was to (1) describe each environmental issue relevant to each of the 15 environmental resources considered; (2) categorize each issue as Category 1 or Category 2; (3) identify for each Category 1 issue the relevant values and assumptions in the PPE and SPE; and (4) assess the significance of the environmental impact on the Category 1 issue.

1.3.2 Primary Documents Used to Develop this GEIS

The NRC staff drew information from a broad range of sources while developing this GEIS, including the following more prominent written sources:

- Results of Exploratory Process for Developing a Generic Environmental Impact Statement for the Construction and Operation of Advanced Nuclear Reactors (SECY-20-0020, NRC 2020-TN6493)
- Staff Requirements – SECY-20-0020 – Results of Exploratory Process for Developing a Generic Environmental Impact Statement for the Construction and Operation of Advanced Nuclear Reactors (SRM-SECY-20-0020, NRC 2020-TN6492)
- Staff Requirements – SECY-21-0098 – Proposed Rule: Advanced Nuclear Reactor Generic Environmental Impact Statement (SRM SECY-21-0098, NRC 2021-TN10127)
- Staff Requirements – SECY-23-0001 – Options for Licensing and Regulating Fusion Energy Systems (SRM SECY-23-0001, NRC 2023-TN10128)
- *Standard Review Plans for Environmental Reviews for Nuclear Power Plants* (NUREG-1555, NRC 2000-TN614)
- *Preparation of Environmental Reports for Nuclear Power Stations* (RG 4.2, NRC 2018-TN6006)
- *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NUREG-1437, NRC 2024-TN10161)
- *Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities* (NUREG-1910, NRC 2009-TN2559)
- *Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel: Final Report, Volumes 1 and 2* (NUREG-2157, NRC 2014-TN4117)
- Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors (NUREG-0586, Supplement 1, NRC 2002-TN665)
- Environmental Considerations Associated with Micro-Reactors (COL-ISG-029, NRC 2019-TN6523)
- Final Environmental Assessment for the Use of Department of Energy-Owned High-Assay Low-Enriched Uranium Stored at Idaho National Laboratory (DOE/EA-2087; DOE 2019-TN6757)
- *Advanced Nuclear Reactor Plant Parameter Envelope and Guidance* (NRIC-21-ENG-0001; PNNL-30992, NRIC 2021-TN6940)
- *Advances in Small Modular Reactor Technology Developments; A Supplement to IAEA Advanced Reactors Information System (ARIS)*, 2020 Edition (IAEA 2020-TN6953)
- *Manifest Information Management System* (DOE 2024-TN10120).

1.3.3 Issue Categories

1.3.3.1 Category 1 Issues – Generic Analysis

This GEIS identifies 100 environmental issues as Category 1 issues. Chapter 3 of this GEIS provides generic analyses for each Category 1 issue and indicates the relevant values and assumptions in the PPE and SPE underlying the analyses. Applicants and NRC staff may rely on the generic analysis for each Category 1 issue provided that the relevant values and assumptions are met and there is no new and significant information that changes the conclusions in this GEIS.

These issues and a list of the sections where they are discussed in this GEIS are listed in Table 1-1.

1.3.3.2 Category 2 Issues – Project-Specific Analysis

This GEIS identifies 17 environmental issues as Category 2 issues. These issues cannot be evaluated generically and must be evaluated in the ER and SEIS using project-specific information. For example, the ESA requires every Federal agency to document its consideration of the impacts of its actions on threatened and endangered species and critical habitats. This ESA Section 7 consultation requirement is required in addition to NEPA; however, the impacts on threatened and endangered species and critical habitat are considered in the NEPA documents.

These issues and a list of the sections where they are discussed in this GEIS are listed in Table 1-1.

1.3.3.2.1 Resource-Specific Category 2 Issues

Category 2 issues specific to a given environmental resource are described in the applicable section of Chapter 3.

1.3.3.2.2 Category 2 Issues Applying Across Resources

Certain Category 2 issues apply across all resources and are summarized below.

Climate Change Impacts on Environmental Resources

Climate change is a subject of national and international interest that causes changes to the affected environment. Commission Order CLI-09-21 (NRC 2009-TN6406) provides the current direction to the NRC staff to include the consideration of the impacts of the emissions of carbon dioxide and other greenhouse gases (GHGs) in its environmental reviews for major licensing actions. GHGs are "[g]aseous constituents of the atmosphere...that absorb and emit radiation at specific wavelengths within the spectrum of radiation emitted by the Earth's surface, by the atmosphere itself, and by clouds. This property causes the greenhouse effect" (IPCC 2023-TN10123). The effect of a proposed action on climate change is evaluated by quantifying the proposed action's GHG emissions, as described in Section 3.3.2 of the NR GEIS. The NRC staff generically determined this issue to be SMALL for both construction and operation.

However, the NRC staff also recognize that future changes in climate have broader implications for environmental resources. Climate change is an environmental trend that could result in

changes to the affected environment independent of the new nuclear reactor project. Possible climate-related changes that could occur at a proposed reactor site include rising temperatures and sea levels; increased frequency and intensity of extreme weather (e.g., heavy downpours, floods, or droughts); earlier snowmelts and associated frequent wildfires; and reduced snow cover, glaciers, permafrost, and sea ice.

The NRC staff has considered the impacts of climate change in its recent new reactor EISs. Climate change can lead to changes in the affected environment around a new reactor project, potentially influencing the level of impacts on resources affected by the project. The NRC staff's consideration of climate change therefore also includes an evaluation of how the project's environmental impacts would increase, decrease, or remain the same under a baseline that is altered by climate change. For climate change to impact an environmental resource, the proposed action must have an incremental new, additive, or increased physical effect or impact on the resource or environmental condition beyond that under the baseline conditions unaltered by climate change. The goal of the analysis for this issue is to describe reasonably foreseeable climate change impacts in proportion to their significance on environmental resource areas that are incrementally affected by the proposed action. Because the effects of climate change are location-specific, they cannot be evaluated generically. For example, while climate change may cause many areas to receive less average annual precipitation, other areas may see an increase in average annual precipitation. Therefore, applicants and the NRC staff will address the effects of climate change impacts on environmental resources in the environmental documents for new nuclear reactor licensing. For additional information, see RG 4.2 (NRC 2026-TN11915) and Interim Staff Guidance (ISG), COL/ESP-ISG-026 (NRC 2014-TN3767).

Cumulative Effects

Cumulative effects are the effects on the environment that result from the incremental effects of the proposed action when added to the effects of other past, present, and reasonably foreseeable actions, regardless of which agency (Federal or non-Federal) or person undertakes such other actions. Evaluating cumulative effects without knowing specific site locations or the time frame for evaluating reasonably foreseeable actions is not possible generically. The cumulative effects of building and operating a nuclear reactor must be considered on a project-specific basis. Effects would depend on regional resource characteristics, the resource-specific impacts of the proposed project, and the cumulative significance of other factors affecting the resource. This is a Category 2 issue.

1.3.3.2.3 Non-Resource Related Category 2 Issues

This GEIS addresses the environmental impact issues associated with building and operating a nuclear reactor. However, the ER and the staff's SEIS must also include other information, as required by the regulations and discussed in regulatory guidance. These are not resource-specific issues. Rather, they are project-specific issues, not tied to any specific environmental resource, that are necessary to support the NRC staff's completion of its environmental review in accordance with NEPA. These issues cannot be evaluated generically and must be addressed in the ER and SEIS using project-specific information. Because of their unique nature, some of these issues are discussed further below, and are summarized in Table 4-1 (in Chapter 4). This list is not all-inclusive. NRC regulations at 10 CFR Part 51 (TN250) and guidance such as RG 4.2 (NRC 2026-TN11915) describe information not included in this list that must be included as part of an application.

Purpose and Need

The applicant must describe in its ER the purpose and need for its proposed action, i.e., the reasons for developing the project (10 CFR 51.45(b); TN250). The NRC staff will use this information to inform its development of the NRC's purpose and need in the SEIS. Properly defining the purpose and need is a critical step in the development of an environmental document for the purposes of meeting NEPA requirements because it establishes the need for the action and the range of reasonable alternatives that must be considered. In NRC licensing actions under 10 CFR Parts 50 (TN249) and 52 (TN251) for large LWRs, the purpose and need have typically been described in terms of providing a specific quantity of electricity (typically baseload) to a defined service area within a defined time period. However, neither NEPA nor NRC regulations require the purpose and need statement to be restricted to electricity generation. If there are other proposed purposes for the new reactor's power, such as area heating or desalinating water, the applicant should demonstrate those needs in sufficient detail for the NRC staff to determine whether the needs serve the public interest. The applicant may also describe ancillary benefits associated with the proposed project, such as meeting GHG emission goals, enhancing energy diversity, or meeting State energy policies. The NRC staff would consider such benefits in its benefit-cost balancing. For additional information, see RG 4.2 (NRC 2026-TN11915), ISG COL/ESP-ISG-026 (NRC 2014-TN3767), COL-ISG-029 (NRC 2019-TN6523), and ISG COL-ISG-030 (NRC 2026-TN11922).

Need for Power

The Atomic Energy Act requires the social and environmental consequences of the civilian use of nuclear materials be weighed against the benefits that their use would provide. Historically, the primary benefit of nuclear power generation projects has been to provide electrical power to the grid. Therefore, the NRC staff has evaluated the need for power in its new reactor EISs. Any new nuclear reactor that uses this GEIS may also provide power to the grid, and if so, may require the same type of need for power evaluation in both the ER and SEIS. However, some nuclear reactors may be built for other purposes (e.g., to generate process heat, to desalinate water, or as a research and demonstration project). In such cases, the applicant will need to present, and the NRC staff will have to evaluate, the need for the project (10 CFR 51.45(b); TN250).

Alternatives

The applicant's ER must address alternatives to the proposed action (10 CFR 51.45(b)(3) and (c); TN250). Identification and evaluation of alternatives for any proposed action are inherently project-specific. The NRC staff is unable to generically evaluate alternatives universally applicable to licensing of new nuclear reactors. This GEIS therefore does not consider any alternatives to the action of constructing and operating a nuclear reactor. Identification of a range of reasonable alternatives[4] requires consideration of information about a specific project and site. The staff will have to individually consider the range of reasonable alternatives that meet the purpose and need behind each incoming new nuclear reactor licensing application.

Most new reactor EISs prepared by the NRC staff have evaluated alternatives with respect to the proposed reactor site (site alternatives), with respect to fuel used to generate the requisite

[4] Changes to the NEPA statute (42 U.S.C. § 4321 et seq.) from the Fiscal Responsibility Act of 2023 (Public Law No. 118-5, 137 Stat. 10) included adding a new Section 102(2)(F) directing agencies to "…study, develop, and describe technically and economically feasible alternatives."

power (energy alternatives), and with respect to cooling system use (system design alternatives). Each of these broad types of alternatives is briefly discussed in the sections below. The staff expects that the range of reasonable alternatives will differ for each incoming new nuclear reactor licensing application and may include alternatives from one or more of these groupings of possible alternatives. Other types of alternatives might also be possible.

Site Alternatives

New reactor EISs prepared by NRC staff have evaluated in detail situating the proposed reactor at three or four alternative sites as well as the proposed site (unless siting has been previously addressed, as in the case of a combined license referencing an early site permit). For any site to be a reasonable alternative, it must meet all of the NRC siting criteria established in 10 CFR Part 100 (TN282). Applicants typically consider many other factors as well when determining whether sites are reasonable alternatives—factors such as proximity to customers, proximity to existing transmission lines, availability of water sources, land ownership, avoidance of sensitive features such as wetlands and historic sites, accessibility to workers, and considerations of local residents and government officials. Applicants often favor sites on or adjacent to existing nuclear plant sites or sites containing other energy generation facilities. The advantages of such sites include the availability of existing transmission lines, pipelines, highways, and other facilities that do not have to be newly built, thereby reducing construction costs and disturbance to non-industrial landscapes and environmentally sensitive lands.

Applicants commonly follow systematic approaches to narrowing a field of potential sites such as that developed by the Electric Power Research Institute (EPRI 2015-TN5285). However, use of any specific siting guidance is not mandatory. The NRC offers additional guidance in RG 4.7 (NRC 2014-TN3550).

The geographical area that must be considered for site alternatives will be determined based on the purpose and need for the proposed action. ISG COL/ESP-027 (NRC 2014-TN3774) contains some insights regarding this aspect in its discussion of Chapter 9.

According to ISG-027, an applicant may request construction at a specific location to meet its purpose and need for a light-water small modular reactor (SMR) facility (NRC 2014-TN3774). For example, an applicant may propose to use excess heat for industrial processes or station heating. A proposed SMR may be used to provide a secure energy source for military, government, or critical industrial facilities. In these cases, the applicant must still submit and the staff must review alternative sites. However, the region of interest used for the site selection process may be much smaller than is typical for large LWRs (e.g., within the confines of a military installation).

Although the ISG was written specifically for SMRs, the fundamental concept is informative for most other new nuclear reactors as well. The range of alternatives that must be considered is a direct product of the purpose and need for the proposed action. The proposed and alternative sites can be adjacent to each other.

This GEIS can be used for both the proposed and alternative sites for the evaluation of resource impacts. However, the application must compare the differences between the proposed and alternative sites, so that a determination can be made about whether an alternative site is environmentally preferable or obviously superior to the proposed site.

Energy Alternatives

A reasonable alternative must meet the purpose and need for the project. For example, new reactor EISs recently have evaluated alternatives that could meet the purpose and need for the project to supply baseload power. The EISs have evaluated alternatives such as coal, natural gas, and mixtures of natural gas and renewable energy sources that could supply baseload power. Energy sources such as wind and solar by themselves were not considered reasonable alternatives because they could not supply baseload power.

The range of alternative energy sources constituting reasonable alternatives for each proposed new nuclear reactor project may differ. For example, if the purpose and need statement was "to demonstrate a specific type of advanced reactor technology to supply power," then coal, natural gas, wind, or solar would not be reasonable alternatives because they do not demonstrate the specific type of nuclear reactor technology and therefore the EIS would not evaluate them. Other potential purposes of new reactors include desalinating water, providing process heat, or aiding States in meeting carbon emission goals. Because the purpose and need for each project is likely to be different, applicants and the NRC staff would have to individually identify reasonable alternatives suited to each specific application.

System Design Alternatives

Because operation of water-based cooling systems to discharge waste heat from large nuclear reactors has the potential to significantly affect the water bodies from which water is taken, and into which it is discharged, new reactor EISs recently prepared by NRC staff have evaluated alternative system designs that use different cooling processes. Possible cooling systems considered have included (1) once-through cooling, in which water is withdrawn from a source such as a river or lake and run through the system once to absorb waste heat before being returned to the source; (2) recirculating cooling-water systems, in which water is withdrawn and recirculated through cooling towers multiple times (cycles of concentration) before being discharged; (3) air cooling that does not involve water; and (4) use of multiple cooling approaches. Different types of cooling towers are also possible, such as natural draft cooling towers comprising tall hyperbolic structures that direct air upward on a pressure gradient to cool water, or lower mechanical draft cooling towers that use electrically driven fans to cool water. Consideration of system design alternatives involving cooling systems may not be appropriate for nuclear reactors designed for air cooling or for which smaller volumes of cooling water may be used. If the design of the project does not use cooling water, then an evaluation of alternative cooling systems is not required. Because of the wide range of possible new nuclear reactor technologies, the NRC staff is not able to anticipate all possible alternative design approaches that might be reasonable.

1.3.3.3 Uncertain Issues

The GEIS identifies the impacts of two issues as Uncertain, and therefore the determination of Category 1 or Category 2 is N/A. These issues relate to exposure to electromagnetic fields (EMFs). Studies of 60 hertz (Hz) EMFs have not uncovered consistent evidence linking harmful effects with field exposures. Because the state of the science is currently uncertain, no generic conclusion on human health impacts is possible. If, in the future, the Commission finds scientific information sufficient to draw conclusions about potential human health impacts, the Commission may require applicants to submit plant-specific reviews of these health effects as part of their application. Until such time, applicants are not required to submit information on this issue.

Table 1-1 Issues Discussed in the Generic Environmental Impact Statement

Issue	Section	Category
Land Use		
Construction		
Onsite Land Use	3.1.2.1.1	1
Offsite Land Use	3.1.2.1.2	1
Impacts to Prime and Unique Farmland	3.1.2.1.3	1
Coastal Zone and Compliance with the Coastal Zone Management Act	3.1.2.1.4	1
Operation		
Onsite Land Use	3.1.2.2.1	1
Offsite Land Use	3.1.2.2.2	1
Visual		
Construction		
Visual Impacts in Site and Vicinity	3.2.2.1.1	1
Visual Impacts from Transmission Lines	3.2.2.1.2	1
Operation		
Visual Impacts During Operations	3.2.2.2.1	1
Air Quality		
Construction		
Emissions of Criteria Pollutants and Dust During Construction	3.3.2.1.1	1
Greenhouse Gas Emissions During Construction	3.3.2.1.2	1
Operation		
Emissions of Criteria and Hazardous Air Pollutants during Operation	3.3.2.2.1	1
Greenhouse Gas Emissions During Operation	3.3.2.2.2	1
Cooling-System Emissions	3.3.2.2.3	1
Emissions of Ozone and oxides of nitrogen during Transmission Line Operation	3.3.2.2.4	1
Water Resource		
Construction		
Surface Water Use Conflicts during Construction	3.4.2.1.1	1
Groundwater Use Conflicts due to Excavation Dewatering	3.4.2.1.2	1
Groundwater Use Conflicts due to Construction-Related Groundwater Withdrawals	3.4.2.1.3	1
Water Quality Degradation due to Construction-Related Discharges	3.4.2.1.4	1
Water Quality Degradation due to Inadvertent Spills during Construction	3.4.2.1.5	1
Water Quality Degradation due to Groundwater Withdrawal	3.4.2.1.6	1
Water Quality Degradation due to Offshore or In-Water Construction Activities	3.4.2.1.7	1
Water Use Conflict Due to Plant Municipal Water Demand	3.4.2.1.8	1
Degradation of Water Quality from Plant Effluent Discharges to Municipal Systems	3.4.2.1.9	1
Operation		
Surface Water Use Conflicts during Operation due to Water Withdrawal from Flowing Water Bodies	3.4.2.2.1	1

Table 1-1 Issues Discussed in the Generic Environmental Impact Statement (Continued)

Issue	Section	Category
Surface Water Use Conflicts during Operation due to Water Withdrawal from Non-flowing Water Bodies	3.4.2.2.2	1
Groundwater Use Conflicts Due to Building Foundation Dewatering	3.4.2.2.3	1
Groundwater Use Conflicts Due to Groundwater Withdrawals for Plant Uses	3.4.2.2.4	1
Surface Water Quality Degradation Due to Physical Effects from Operation of Intake and Discharge Structures	3.4.2.2.5	1
Surface Water Quality Degradation Due to Changes in Salinity Gradients Resulting from Withdrawals	3.4.2.2.6	1
Surface Water Quality Degradation Due to Chemical and Thermal Discharges	3.4.2.2.7	2
Groundwater Quality Degradation Due to Plant Discharges	3.4.2.2.8	1
Water Quality Degradation due to Inadvertent Spills and Leaks during Operation	3.4.2.2.9	1
Water Quality Degradation due to Groundwater Withdrawals	3.4.2.2.10	1
Water Use Conflict from Plant Municipal Water Demand	3.4.2.2.11	1
Degradation of Water Quality from Plant Effluent Discharges to Municipal Systems	3.4.2.2.12	1
Terrestrial Ecology		
Construction		
Permanent and Temporary Loss, Conversion, Fragmentation, and Degradation of Habitats	3.5.2.1.1	1
Permanent and Temporary Loss and Degradation of Wetlands	3.5.2.1.2	1
Effects of Building Noise on Wildlife	3.5.2.1.3	1
Effects of Vehicular Collisions on Wildlife	3.5.2.1.4	1
Bird Collisions and Injury from Structures and Transmission Lines	3.5.2.1.5	1
Important Species and Habitats – Resources Regulated under the Endangered Species Act of 1973	3.5.2.1.6	2
Important Species and Habitats – Other Important Species and Habitats	3.5.2.1.6	1
Operation		
Permanent and Temporary Loss or Disturbance of Habitats	3.5.2.2.1	1
Effects of Operational Noise on Wildlife	3.5.2.2.2	1
Effects of Vehicular Collisions on Wildlife	3.5.2.2.2	1
Exposure of Terrestrial Organisms to Radionuclides	3.5.2.2.3	1
Cooling-Tower Operational Impacts on Vegetation	3.5.2.2.4	1
Bird Collisions and Injury from Structures and Transmission Lines	3.5.2.2.5	1
Bird Electrocutions from Transmission Lines	3.5.2.2.6	1
Water Use Conflicts with Terrestrial Resources	3.5.2.2.7	1
Effects of Transmission Line ROW Management on Terrestrial Resources	3.5.2.2.8	1
Effects of Electromagnetic Fields on Flora and Fauna	3.5.2.2.9	1

Table 1-1 Issues Discussed in the Generic Environmental Impact Statement (Continued)

Issue	Section	Category
Important Species and Habitats – Resources Regulated under the ESA of 1973	3.5.2.2.10	2
Important Species and Habitats – Other Important Species and Habitats	3.5.2.2.10	1
Aquatic Ecology		
Construction		
Runoff and Sedimentation from Construction Areas	3.6.2.1.1	1
Dredging and Filling Aquatic Habitats to Build Intake and Discharge Structures	3.6.2.1.2	1
Building Transmission Lines, Pipelines, and Access Roads Across Surface Waterbodies	3.6.2.1.3	1
Important Species and Habitats – Resources Regulated under the ESA and Magnuson-Stevens Fishery Conservation and Management Act	3.6.2.1.4	2
Important species and habitats – Other Important Species and Habitats	3.6.2.1.4	1
Operation		
Stormwater Runoff	3.6.2.2.1	1
Exposure of Aquatic Organisms to Radionuclides	3.6.2.2.2	1
Effects of Refurbishment on Aquatic Biota	3.6.2.2.3	1
Effects of Maintenance Dredging on Aquatic Biota	3.6.2.2.4	1
Impacts of Transmission Line ROW Management on Aquatic Resources	3.6.2.2.5	1
Impingement and Entrainment of Aquatic Organisms	3.6.2.2.6	1
Thermal Impacts on Aquatic Biota	3.6.2.2.7	2
Other Effects of Cooling-Water Discharges on Aquatic Biota	3.6.2.2.8	2
Water Use Conflicts with Aquatic Resources	3.6.2.2.9	1
Important Species and Habitats – Resources Regulated under the ESA and Magnuson-Stevens Act	3.6.2.2.10	2
Important species and habitats – Other Important Species and Habitats	3.6.2.2.10	1
Historic and Cultural Resources		
Construction		
Construction Impacts on Historic and Cultural Resources	3.7.2	2
Operation		
Operation Impacts on Historic and Cultural Resources	3.7.2	2
Radiological Environment		
Construction		
Radiological Dose to Construction Workers	3.8.1.2.1	1
Operation		
Occupational Doses to Workers	3.8.1.2.2	1
Maximally Exposed Individual Annual Doses	3.8.1.2.2	1
Total Population Annual Doses	3.8.1.2.2	1
Nonhuman Biota Doses	3.8.1.2.2	1

Table 1-1 Issues Discussed in the Generic Environmental Impact Statement (Continued)

Issue	Section	Category
Nonradiological Environment		
Construction		
Building Impacts of Chemical, Biological, and Physical Nonradiological Hazards	3.8.2.2.1	1
Building Impacts of EMFs	3.8.2.2.1	N/A
Operation		
Operation Impacts of Chemical, Biological, and Physical Nonradiological Hazards	3.8.2.2.2	1
Operation impacts of EMFs	3.8.2.2.2	N/A
Noise		
Construction		
Construction-Related Noise	3.9.2.1	1
Operation		
Operation-Related Noise	3.9.2.2	1
Radiological Waste Management		
Operation		
Low-Level Radioactive Waste	3.10.1.2.1	1
Onsite Spent Nuclear Fuel and High-Level Waste Management	3.10.1.2.2	1
Mixed Waste	3.10.1.2.3	1
Nonradiological Waste Management		
Construction		
Construction Nonradiological Waste	3.10.2.2.1	1
Operation		
Operation Nonradiological Waste	3.10.2.2.2	1
Postulated Accidents		
Operation		
Design Basis Accidents Involving Radiological Releases	3.11.2.1	1
Accidents Involving Releases of Hazardous Chemicals	3.11.2.2	1
Severe Accidents	3.11.2.3	1
Acts of Terrorism	3.11.2.4	1
Socioeconomics		
Construction		
Community Services and Infrastructure	3.12.2.1.1	1
Transportation Systems and Traffic	3.12.2.1.2	1
Economic Impacts	3.12.2.1.3	1
Tax Revenue Impacts	3.12.2.1.4	1
Operation		
Community Services and Infrastructure	3.12.2.2.1	1
Transportation Systems and Traffic	3.12.2.2.2	1
Economic Impacts	3.12.2.2.3	1
Tax Revenue Impacts	3.12.2.2.4	1

Table 1-1 Issues Discussed in the Generic Environmental Impact Statement (Continued)

Issue	Section	Category
Fuel Cycle		
Operation		
Uranium Recovery	3.14.2.1	1
Uranium Conversion	3.14.2.2	1
Enrichment	3.14.2.3	1
Fuel Fabrication[(a)]	3.14.2.4	1
Reprocessing	3.14.2.5	1
Storage and Disposal of Radiological Wastes	3.14.2.6	1
Transportation of Fuel and Waste		
Operation		
Transportation of Unirradiated New Reactor Fuel	3.15.2.1	1
Transportation of Radioactive Waste from New Reactors	3.15.2.2	1
Transportation of Irradiated Fuel from New Reactors	3.15.2.3	1
Decommissioning		
Decommissioning Impacts (generically addressed issues in NUREG-0586)	3.16.2	1
Decommissioning Impacts (site-specific and/or conditionally site-specific issues in NUREG-0586)	3.16.2	2
Issues Applying Across All Resources		
Climate Change Impacts on Environmental Resources	1.3.3.2.2	2
Cumulative Impacts	1.3.3.2.2	2
Non-Resource Related Issues		
Purpose and Need	1.3.3.2.3	2
Need for Power	1.3.3.2.3	2
Site Alternatives	1.3.3.2.3	2
Energy Alternatives	1.3.3.2.3	2
System Design Alternatives	1.3.3.2.3	2

EMF = electromagnetic field; ESA = Endangered Species Act of 1973; N/A = not applicable; ROW = right-of-way.
(a) Fuel fabrication impacts for metal fuel and liquid fueled molten salt are not included in the NRC staff's generic analysis.

1.4 Implementation of the Rule (10 CFR Part 51)

Applicants and the NRC staff will use this GEIS as a tool to increase the efficiency and effectiveness of environmental reviews for constructing and operating new nuclear reactors, while at the same time ensuring that NRC's NEPA requirements are met. This GEIS presents generic analyses of environmental impacts that the staff expects will be common to most new nuclear reactors meeting a set of design conditions (termed the PPE) built on a hypothetical site meeting a set of site conditions (termed the SPE) (see Appendix G). Applicants will be able to streamline ERs by referring to the generic analyses in this GEIS codified in 10 CFR Part 51 (TN250) whenever possible and focus on providing the project-specific information needed for the staff to complete environmental reviews of issues that cannot be addressed generically.

The staff will be able to streamline environmental reviews by referring to the generic analyses in this GEIS whenever possible and focus their review efforts on environmental issues where a consideration of project-specific information is needed to ascertain the potential for significant environmental impacts. Upon receipt of specific new nuclear reactor licensing applications, the staff will prepare SEISs tiered from this GEIS, in accordance with the associated rule, that briefly identify the environmental issues that can be addressed through this GEIS and then cover the remaining issues in more detail using project-specific information. The staff expects that use of this GEIS along with the SEIS will reduce the time and resources needed to complete environmental reviews, while still providing decision-makers and the public with a complete and robust analysis of potential environmental impacts and meeting all NEPA requirements.

Applicants for a construction permit and operating license or a combined license for a nuclear reactor, or an early site permit or a limited work authorization, are required as part of their application to submit a safety analysis report and an ER. The NRC then performs a safety review which results in a safety evaluation report and an environmental review that results in an EIS. This GEIS does not evaluate the safety of a reactor design; that is a separate review done when an application is submitted.

Every 10 years, the Commission intends to review the material in this NR GEIS and the associated rule and update it if necessary. A scoping notice will be published in the *Federal Register* inviting public comments and proposals for other areas that should be updated and indicating the results of the NRC's review.

The implementation of the rule is described in more detail below.

1.4.1 General Requirements

The regulatory requirements for conducting a NEPA review for a new nuclear reactor are the same as the requirements for other plant licensing actions. Consistent with the current NEPA practice for plant licensing actions, an applicant will be required to submit an ER that assesses the environmental impacts associated with the proposed action, consider alternatives to the proposed action, and evaluate any alternatives for reducing adverse environmental effects. For a new nuclear reactor license using this NR GEIS, the NRC will prepare a draft SEIS to this GEIS for public comment and issue a final SEIS after considering public comments on the draft.

1.4.2 Applicant's Environmental Report

The applicant's ER must contain an assessment of the environmental impacts of constructing and operating a nuclear reactor and alternatives that meet the purpose and need. In preparing the analysis of environmental impacts contained in the ER, the applicant should refer to the information provided in Table C-1 of 10 CFR Part 51 (TN250). The applicant is not required to assess the environmental impacts of Category 1 issues listed in Table C-1 if (1) the applicant has demonstrated that its project is bounded by the applicable PPE and SPE values and assumptions in Table C-1, and (2) the applicant has not identified any new and significant information that would change the conclusions in this GEIS. If a value or assumption is not met, then the applicant may be able to limit its analysis to just the impact of not meeting the value or assumption. Similarly, if the applicant identifies new and significant information that would change the conclusions in this GEIS, then the applicant may be able to limit its analysis to just the impact of the new and significant information. For Category 2 issues listed in

Table C-1 or other relevant issues not addressed in this GEIS, the applicant must provide a project-specific assessment of the impacts.

1.4.3 The NRC's SEIS

As required by 10 CFR 51.20(b)(2) (TN250), the NRC will be required to prepare a SEIS to this GEIS for each new nuclear reactor application using this NR GEIS. The SEIS will serve as the NRC's analysis of the environmental impacts of issuing a new nuclear reactor license and will compare those impacts to the environmental impacts of the alternatives. This document will also present the NRC's recommendation to approve or deny the proposed action.

1.4.4 Public Scoping and Public Comments

For a SEIS, the NRC will conduct scoping to inform the public about the licensing process, and typically will hold public scoping meetings to receive comments about the scope of the NRC's plant-specific environmental review. At the conclusion of the scoping period, the NRC will review and address public comments in a scoping summary report. In addition, the draft SEIS will be issued for public comment (see 10 CFR 51.73; TN250). In both the scoping and the SEIS public comment process, the NRC will consider comments and will determine whether the comments provide any information that is new and significant compared to information previously considered in this GEIS (for Category 1 issues). If the comments are determined to provide new and significant information that could change the conclusions in this GEIS, these comments will be considered and addressed in the SEIS.

1.4.5 The NRC's Draft SEIS

The NRC's draft SEIS will include its analysis of the environmental impacts of the proposed action and the environmental impacts of the alternatives to the proposed action. The NRC will use and integrate (1) the environmental impacts of the proposed action as provided in Table C-1 of 10 CFR Part 51 (TN250) for Category 1 issues, (2) the appropriate plant-specific analyses of Category 2 issues, (3) other project-specific information necessary to support the analyses (see Section 1.3.3), and (4) any new and significant information identified in the applicant's ER or during the scoping and public comment process, to arrive at a conclusion regarding the environmental impacts of issuing a new nuclear reactor license. These impacts will be compared to the environmental impacts of the alternatives presented in the SEIS.

1.4.6 The NRC's Final SEIS

The NRC will issue a final SEIS in accordance with 10 CFR 51.91 and 51.93 (10 CFR Part 51-TN250) after considering (1) the public comments, (2) the analysis of Category 2 issues, and (3) any new and significant information involving Category 1 issues. The NRC will provide a record of its decision regarding the environmental impacts of the proposed action (see 10 CFR 51.102 and 51.103). All comments on the draft SEIS will be addressed by the NRC in the final SEIS in accordance with 10 CFR 51.91(a)(1).

1.4.7 Consultations

Project-specific environmental reviews may require consultation with other Federal, State, regional and local agencies, and Tribes. For new reactor reviews, the NRC staff must consider the effects of its actions on ecological resources protected under Federal statutes, including the Endangered Species Act (TN1010), Magnuson-Stevens Fishery Conservation and Management

Act (MSA) (TN1061), and National Marine Sanctuaries Act (TN7197). Section 106 of the NHPA (TN4157) requires Federal agencies to take into account the effects of their undertakings on historic properties. For further information about these consultations, see Sections 3.5.2.1.6, 3.6.2.1.4, 3.6.2.2.10, and 3.7.1.1 of this GEIS.

Federal Trust Relationship and the NRC's Tribal Policy Statement

The NRC shares the Federal government's unique Trust Relationship with, and Trust Responsibility to, Federally recognized Indian Tribes. Under the Federal Trust Doctrine, the United States—and the individual agencies of the Federal government—owe a fiduciary duty to Federally recognized Indian Tribes. The nature of that duty depends on the underlying substantive laws (i.e., treaties, statutes, agreements) creating the duty (82 FR 2402-TN5500). Many Federally recognized Indian Tribes have an interest in public health and safety and environmental protection associated with NRC regulatory activities, including licensing of nuclear power plants. The NRC exercises its Trust Responsibility in the context of its authorizing statutes including the Atomic Energy Act (TN663), the Energy Reorganization Act of 1974 (TN4466), the Nuclear Waste Policy Act of 1982 (Nuclear Waste Policy Act of 1982-TN740), the Low-Level Radioactive Waste Policy Act of 1985 (TN6606), and the Uranium Mill Tailings Radiation Control Act of 1978 (TN7221, as amended (82 FR 2402-TN5500).

Other statutory provisions such as the NHPA can require Tribal consultation as part of the NRC's evaluation of agency activities during licensing actions (e.g., new reactor licensing), rulemaking, or policy development. The NRC complies with statutory provisions and NRC regulatory provisions that require Tribal consultation and interacts with Tribal governments on a government-to-government basis accordingly (82 FR 2402-TN5500).

On January 9, 2017, the NRC published its Tribal Policy Statement of principles to guide the agency's interactions with American Indian and Alaska Native Tribes (82 FR 2402-TN5500). The policy statement is intended to encourage and facilitate Tribal involvement in activities under NRC jurisdiction. The policy statement also underscores the NRC's commitments to conducting outreach to Tribes and engaging in timely consultation, and to coordinate with other Federal agencies. The policy statement is based on the United States Constitution, treaties, statutes, executive orders, judicial decisions, and the unique relationship between Indian Tribes and the Federal government (82 FR 2402-TN5500).[5]

As an independent regulatory agency that does not hold in trust Tribal lands or assets or provide services to Federally recognized Tribes, the NRC fulfills its Trust Responsibility through implementation of the principles of the Tribal Policy Statement, by providing protections under its implementing regulations, and through recognition of additional obligations consistent with other applicable treaties and statutory authorities (82 FR 2402-TN5500).

[5] This Tribal Policy Statement is not intended to, and does not, grant, expand, create, or diminish any rights, benefits, or trust responsibilities, substantive or procedural, enforceable at law or in equity in any cause of action by any party against the United States, the Commission, or any person. This Tribal Policy Statement does not alter, amend, repeal, interpret, or modify Tribal sovereignty, any treaty rights of any Indian Tribes, or preempt, modify, or limit the exercise of such rights. Nothing in this Tribal Policy Statement shall be interpreted as amending or changing the Commission's regulations.

2 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

The term “alternatives” is used two ways in this GEIS. The first use refers to alternatives to the proposed action of issuing the GEIS. Only those alternatives, outlined below in Section 2.1, are compared in the GEIS and considered in the record of decision for the GEIS. The other use refers to alternatives to building and operation of a specific nuclear reactor. It is possible to identify those alternatives only after identification of a specific project on a specific site. The NRC staff will evaluate and compare such alternatives in a SEIS issued following receipt of each individual new nuclear reactor licensing application.

2.1 Proposed Action and Alternatives to the GEIS

The staff developed the following proposed action and alternatives in response to the purpose and need outlined in Section 1.1. These alternatives were developed and informed by an exploratory process completed in January 2020, involving interested stakeholders and through the public scoping process that concluded in May 2020.

2.1.1 Proposed Action: Issue Technology-Neutral GEIS Based on Performance-Based Assumptions

The proposed action is for the NRC to issue a GEIS containing generic analyses of the environmental impacts of building and operation of a hypothetical nuclear reactor on a hypothetical site. The generic analyses for each Category 1 issue would be bounded by the plant design values and assumptions in the PPE and by the site condition values and assumptions in the SPE presented in Appendix G. The values and assumptions in Appendix G are performance-based, where performance reflects minimization of potential environmental impacts by the applicant when choosing a plant design and site prior to submitting an application. The values and assumptions are based on environmental conditions and impact levels below which the staff believes that they may rely on a generic analysis to confidently conclude that environmental impacts would be SMALL for any location within the United States.

This GEIS presents generic analyses for Category 1 issues, for which a meaningful impact assessment is possible based on reasonable values and assumptions in the PPE and SPE. Category 2 issues include those environmental issues for which a meaningful generic analysis of environmental impacts is not possible without consideration of project-specific information. As such, analysis of Category 2 issues is not included in this GEIS.

Once this GEIS is issued, applicants will be able to rely on and reference the generic analyses for each Category 1 issue for which the proposed project is bounded by the PPE and SPE values and assumptions, thereby streamlining the environmental reviews associated with a new nuclear reactor application. The NRC staff will likewise be able to reference the generic analyses when it prepares a SEIS in response to an application, thereby simplifying and streamlining the environmental reviews. Instead of developing individual analyses specific to all environmental issues in any proposed new nuclear reactor ER or SEIS, applicants and NRC staff may focus their efforts on the environmental issues that require individualized consideration of project-specific information (Category 1 issues where the proposed project is not bounded by the PPE and SPE values and assumptions, and Category 2 issues) to address the potential for significant environmental impacts. The shorter, more focused ERs and SEISs will help NRC staff and decision-makers concentrate on issues for which there is potential for significant environmental impacts.

2.1.2 No-Action Alternative: No GEIS – Project-Specific National Environmental Policy Act Review Only

Under the No-Action Alternative, the NRC staff would not develop a GEIS for new nuclear reactors. Without the availability of a GEIS, applicants for licensing new nuclear reactors would have to address all relevant environmental issues individually in their ERs, and staff would have to prepare individual EISs for each application received that address all relevant environmental issues (including all Category 1 and Category 2 issues). The processes for an applicant to prepare an ER and for the NRC staff to prepare an EIS would remain similar to those used in the past for new reactor licensing applications. Regardless of whether the licensing review process uses a GEIS or not, the actual environmental impacts of the project are the same. However, the No-Action Alternative would accomplish none of the benefits intended by the preparation of this GEIS, which would include (1) reducing the time and resources for the applicant's preparation of the ER, (2) reducing the time and resources for the NRC staff's preparation of the EIS, and (3) focusing the effort of applicant, NRC staff, and decision-makers on issues that involve a potential for significant environmental impacts. Because the No-Action Alternative would result in the same level of project-specific impacts without the benefit of streamlining provided by the GEIS, the NRC staff concludes that the No-Action Alternative is not environmentally preferable to the proposed action.

2.1.3 Other Alternatives Considered but Not Analyzed in Detail

2.1.3.1 Limiting the GEIS to Reactors Less than 30 MWt

Prior to scoping, the NRC staff contemplated preparing a GEIS that would analyze the potential environmental impacts of a hypothetical reactor that has a power level of approximately 30 MWt or less on a hypothetical site. The analytical approach to developing the GEIS would have been similar to that used under the proposed action, but the PPE/SPE would have been developed based on a typical reactor of 30 MWt, thereby limiting the range of reactors for which the GEIS would have been useful. Use of the power-level–based GEIS by applicants for small reactors and NRC staff would have been the same as for the environmental performance-based GEIS called for in the proposed action. During the scoping process, multiple commenters suggested that the parameters used in the generic analyses should be tied to the potential for environmental impacts rather than to an arbitrary power level. After reviewing the comments, the staff agreed that a GEIS developed using performance-based values and assumptions tied to environmental impacts might help streamline environmental reviews even for some larger advanced nuclear reactors that would still have a low potential for significant environmental impacts with respect to some environmental issues.

2.1.3.2 GEIS for Advanced Nuclear Reactors Only

The NRC staff initially developed this GEIS as a document that would be applicable to only advanced nuclear reactors. See SECY-21-0098, *Proposed Rule: Advanced Nuclear Reactor Generic Environmental Impact Statement*, dated November 29, 2021. However, in SRM SECY-21-0098 (NRC 2024-TN10164), dated April 17, 2024, the Commission directed the NRC staff to change the limited applicability of this GEIS from solely "advanced nuclear reactors" to any new nuclear reactor licensing application, provided the application meets the values and the assumptions of the plant parameter envelopes and the site parameter envelopes used to develop the GEIS. Based on the direction from the Commission, the alternative of developing a GEIS that would be applicable to only advanced nuclear reactors will not be considered further.

2.1.3.3 GEIS Analyzing All Potential Environmental Impacts

The staff also considered whether it would be possible to develop a GEIS that could serve as the sole technical documentation of potential environmental impacts for any new nuclear reactor. However, the staff concluded that it is not technically possible to develop generic analyses addressing all potentially significant environmental impacts from any new nuclear reactor without consideration of site-specific and project-specific conditions. Reliance on such a GEIS would not meet the NRC's regulations in Title 10 of the *Code of Federal Regulations* Part 51 (TN250) for compliance with the National Environmental Policy Act of 1969 (42 U.S.C. §§ 4321 et seq.; TN661). The GEIS would also not meet the requirements of other environmental laws, such as the Endangered Species Act (16 U.S.C. §§ 1531 et seq.; TN1010) or the NHPA (54 U.S.C. §§ 300101 et seq.; TN4157).

3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter of the GEIS describes the affected environment and environmental consequences resulting from building and operation of a nuclear reactor. This introduction describes the concept and background behind the development and analysis of the baseline, the values and assumptions bounding the PPE and SPE and impacts from building and operation on the environmental resources. This chapter is organized into subsections that address each of 15 relevant environmental resources that the NRC staff identified following the scoping process outlined in Chapter 1.

- **Overview of Affected Environment.** The baseline condition described as the "affected environment" in this GEIS is the environment that exists at and around a site proposed for building and operation of a nuclear reactor. A site could be anywhere in the United States or its territories that meets NRC reactor siting criteria in Title 10 of the *Code of Federal Regulations* Part 100 (TN282). The affected environment reflects the existing condition of environmental resources, as influenced by natural physical conditions and by past human activities such as agriculture, forestry, mining, urbanization, and industrial and non-industrial development. The site might be situated at an existing nuclear power plant property, and, if so, the generalized description of the affected environment at an existing nuclear power generation site presented in the LR GEIS (NRC 2024-TN10161) might be informative. However, new nuclear reactors might also be proposed for sites not previously used for nuclear power generation. New nuclear reactors might be proposed for sites that have a history of industrial use or other development, or they might be proposed for greenfield sites that have not been previously developed other than for agricultural, forestry, or conservation purposes. New nuclear reactors might be proposed for sites on government-owned or managed installations such as military bases or national laboratories, or they might be proposed for privately owned sites.

The range of existing environmental conditions that might possibly occur at any possible proposed site is too broad to characterize. The NRC staff instead developed the PPE and SPE values and assumptions presented in Appendix G. An application for a license that references this GEIS and for which the reactor and site meet the PPE and SPE values and assumptions for a Category 1 issue will be able to rely on the generic environmental impact analyses and conclusions for that issue in this GEIS. If the PPE or SPE values and assumptions relevant to an environmental impact are not met, the applicant will have to perform an analysis of that impact in the ER using project-specific environmental information. Relevant project-specific information would be presented in an application for a license that references the GEIS and in the NRC's supplemental environmental review documentation.

Each resource-specific section that follows discusses the affected environment in terms of baseline conditions and the PPE and SPE values and assumptions as they relate to that resource.

- **Overview of Environmental Consequences.** This chapter also evaluates the potential environmental consequences of building, operation, fuel cycle, and decommissioning of a nuclear reactor that meet the values and assumptions for the parameters in the PPE and SPE. Each subsection identifies specific environmental issues involving the possible impacts of a new nuclear reactor on the subject resource. Each subsection then presents generic analyses of potential environmental impacts for each issue for which a generic

analysis is possible (i.e., Category 1 issues), assuming that all of the PPE and SPE values and assumptions for that issue are met. Each environmental issue is defined as either a Category 1 or a Category 2 issue.

The basis for identifying an issue as being a Category 1 issue is whether a generic analysis of the issue is sufficient for decision-makers and the public when licensing a new nuclear reactor that meets the values and assumptions in the PPE and SPE. The generic analyses for all issues identified by the NRC staff as Category 1 issues support determinations of SMALL impacts. In general, however, individualized analyses that consider project-specific information are necessary for impacts of greater than SMALL significance. In addition, the fact that an individualized analysis is necessary does not mean that the supplemental environmental documentation will conclude that impacts pertaining to the issue will be greater than SMALL; it only means that more than a generic analysis is necessary to reach that conclusion.

The generic analyses presented in this chapter assume possible mitigation measures on a resource-specific basis developed on a generic basis to reduce adverse environmental impacts. If a proposed new nuclear reactor application meets the PPE and SPE values and assumptions, including mitigation, pertaining to an environmental issue, then the generic assessment can be relied upon in the SEIS. The staff will always individually consider the possible mitigation measures for Category 2 issues.

3.1 Land Use

3.1.1 Baseline Conditions and PPE/SPE Values and Assumptions

Baseline conditions influencing potential land use impacts associated with construction and operation of a new nuclear reactor include past and present land uses and land cover on and surrounding the site, applicable zoning regulations, and relevant planning documents such as comprehensive land use plans or installation land use plans. Land use conditions relevant to the environmental analysis include the plant site and surroundings but also offsite land (and surroundings) for affiliated uses such as construction laydown and intake and discharge structures, and any offsite rights-of-way (ROWs) for transmission lines, pipelines, or heavy-haul roads.

In developing the values and assumptions in the PPE and SPE pertaining to land use, the staff relied upon the information and analyses contained in multiple new reactor EISs prepared since 2005, the LR GEIS (NRC 2024-TN10161), other past NRC EISs, and common elements of State and local land use regulation. Some assumptions made in this section of the GEIS involve parameters and values that are developed based on previous staff environmental reviews or are the subject of Federal and State regulations; some have been appropriately scaled down to account for the size and technology differences between large LWRs and potential smaller new nuclear reactors. In every case, the NRC staff has selected a value or parameter that will ensure a minimal impact on land use from construction and operation of a nuclear reactor after considering all available information and leveraging professional judgment and expertise. The NRC staff's assumptions that support the PPE and SPE are described below.

In addition to assuming that any proposed facilities would comply with NRC siting regulations in 10 CFR Part 100 (TN282), the staff assumes that the proposed plant site would be no larger than 100 ac, within which site disturbance would affect no more than 30 ac of land permanently and no more than 20 ac of additional land temporarily. The staff also assumes that the site would be at least 0.5 mi from the nearest existing residence. The staff established these values

to ensure that dedication and disturbance of land in most settings could not substantially interfere with nearby land uses or alter regional land use characteristics and trends. The staff also assumes that construction and operation of a power plant would be consistent with applicable zoning and with the objectives of any local land use plans (typically prepared for counties or multi-county planning areas). Reliance on zoning compliance and compatibility with land use plans underlie conclusions regarding minimal land use impacts in all recent new reactor EISs, as well as most EISs prepared for other major land development projects. The staff assumes that any cooling towers built on the site would be mechanical draft towers under 100 ft in height rather than the taller natural draft cooling towers. Taller cooling towers can generate drift capable of affecting sensitive land uses, such as residential uses, at greater distances from the towers. Taller towers could also pose a collision risk to birds and other flying wildlife (see Section 3.5.2.1.5). The staff also assumes that a project would not include salt evaporation ponds, whose use could potentially result in significant salt deposition in surrounding residential lands (NRC 2011-TN6437).

The staff assumes that new offsite ROWs for transmission lines, pipelines, access roads, or other new linear facilities would be no longer than 1 mi and have a maximum ROW width of 100 ft. However, the assumptions allow for unlimited additional mileage for building new linear facilities within existing ROWs or adjacent to existing ROWs or public highways, unless in residential areas. As for the assumed site area values, the staff established the ROW values to ensure that the offsite ROWs could not substantially interfere with other land uses or alter regional land use characteristics or trends. For similar reasons, the staff assumes that the site and ROWs would not be situated closer than 0.5 mi to residential areas or 1 mi to sensitive land uses such as Federal, State, or local parks, wildlife refuges, conservation lands, Wild and Scenic Rivers, or Natural Heritage Rivers. The staff also assumes that the land disturbed by building activities (footprint of disturbance) could be accommodated within the site but still avoid impacts on more than 0.5 ac of wetlands and other waters of the United States (project wide), and avoid any encroachment into floodplains, shoreline, or riparian lands that may be within the site boundaries (although the SPE allows for offsite ROWs to traverse such features). The 0.5 ac limit is based on the fact that many Nationwide Permits under Section 404 of the Clean Water Act (CWA) (33 U.S.C. § 1344-TN1019) include a project-wide limitation of 0.5 acres (ac) of wetland loss. The staff also assumes that the site and ROWs do not have a history of past industrial use capable of leaving a legacy of contamination requiring cleanup to protect human health or the environment.

The staff further assumes that projects would comply with NRC siting regulations in 10 CFR Part 100 (TN282) (including 10 CFR 100.20 – Factors to be considered when evaluating sites; 10 CFR 100.21 – Non-seismic siting criteria; and 10 CFR 100.23 – Geologic and seismic siting criteria), the Coastal Zone Management Act of 1972 (CZMA; 16 U.S.C. §§ 1451 et seq.; TN1243) and the Farmland Protection Policy Act (FPPA; 7 U.S.C. §§ 4201 et seq.; TN708), including implementation of any mitigation measures necessary for compliance with these statutes and regulations. The staff will include the findings made and the data gathered as a result of this compliance in its evaluation of land use impacts, as applicable (NRC 2000-TN614). Under the CZMA, each State bordering the tidal waters of the oceans or the Great Lakes has the opportunity to identify its coastal zone and issue a plan for managing land use in that zone that balances the objectives of conservation and economic development. The CZMA is a voluntary program for States (16 U.S.C. § 1451(i) and 1452(2) and (4)). If a State has decided to participate in the CZMA program, then compliance with the CZMA is necessary for all reactor licensing projects sited in that State's coastal zone, in accordance with the State's coastal management program (16 U.S.C. § 1456(c)). Additionally, if an applicant proposes to construct and operate a reactor outside of the State's coastal zone, compliance with the CZMA may still

be required to the extent that the proposed project may have a reasonably foreseeable effect upon offsite coastal zone land uses or resources (15 CFR 930.33(a)(1); TN4475). The State's coastal management program is approved by the National Oceanic and Atmospheric Administration, of the U.S. Department of Commerce.

The staff assumes there is no prime or unique farmland, or other farmland of statewide or local importance within the footprint of disturbance, unless the site does not abut other agricultural areas and is situated in a predominantly agricultural setting. The purpose of the FPPA is to minimize the extent that Federal programs contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses. The FPPA defines three categories of regulated farmland namely, prime farmland, unique farmland, and farmland of State or local importance. Prime farmland means "land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion," as determined by the Secretary of the U.S. Department of Agriculture (7 U.S.C. 4201(c)(1)(A)). Prime farmland includes land that possesses the above characteristics but is being used currently to produce livestock and timber. Prime farmland does not include land already in or committed to urban development or water storage. Unique farmland means "land other than prime farmland that is used for production of specific high-value food and fiber crops, as determined by the Secretary. It has the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality or high yields of specific crops when treated and managed according to acceptable farming methods" (7 U.S.C. § 4201(c)(1)(B); TN708). Examples of crops grown on unique farmland include citrus fruits, olives, and cranberries. The third category is farmland, other than prime or unique farmland, which is determined to be of State or local significance as determined by the appropriate State or local agency with the concurrence of the U.S. Department of Agriculture Secretary (7 U.S.C. § 4201(c)(1)(C)).

The FPPA does not apply to Federal permitting and licensing (7 U.S.C. § 4208(a); TN708), including the issuance of an NRC license for a reactor, unless the reactor is to be constructed or installed on federally owned or leased land that falls under one of the above-described FPPA categories. If the reactor is to be located on such federally owned or leased land, then the NRC must consider the impacts of its proposed action in accordance with the FPPA. Even if the FPPA does not apply to an action, impacts on farmland still constitute an environmental consideration in the context of NEPA. The FPPA definitions include land mapped by the Natural Resources Conservation Service that feature soils possessing optimal physical and climatic properties for food and fiber production, even if the soils are not actually in agricultural use. Soils with a past history of disturbance for urban development are excluded from the farmland designations used in the FPPA.

3.1.2 Land Use Impacts

Most land use impacts from new nuclear reactors would take place during the preconstruction and construction phases of the project. Evaluation requires consideration of the proposed safety-related facilities such as the nuclear island as well as non-safety-related facilities such as cooling towers, administration buildings, parking lots, switchyards, and any onsite and offsite pipelines, access roads, and transmission lines. Many smaller nuclear reactors may be housed in one or a few small buildings on a site of less than a few acres and may lack cooling towers, switchyards, or offsite pipelines or transmission lines. Larger nuclear reactors may require some or all of these support facilities and hence larger sites exceeding the site and disturbance area assumptions. Land uses are unlikely to substantially change during operation of a nuclear

reactor, although minor land use changes could be necessary to refurbish or upgrade a nuclear reactor during its operational life (NRC 2024-TN10161).

3.1.2.1 Environmental Consequences of Construction

The staff's evaluation of land use impacts for building a nuclear reactor focused on land use changes being consistent with potentially applicable zoning and land use plans. The NRC staff identified four land use issues for analysis of the building of a nuclear reactor:

- onsite land use, especially the compliance of onsite land uses with zoning and land use plans and compatibility with adjacent and nearby land uses
- offsite land use, especially the compatibility of offsite linear facilities such as pipelines and transmission lines with adjacent land uses
- potential impacts on prime farmland, unique farmland, and farmland of State or local significance
- CZMA compliance for a nuclear reactor to be constructed or installed at a site within a designated coastal zone or at a site outside of a coastal zone but the construction or the installation of the reactor may have a reasonably foreseeable effect upon a coastal zone use or resource

3.1.2.1.1 Onsite Land Use

The PPE and SPE assume that the new nuclear reactor would require the dedication of a site no larger than 100 ac in area, within which site disturbance would affect no more than 30 ac of land permanently and no more than 20 ac of land temporarily. A site of that size would likely be large enough to accommodate any exclusion areas required under 10 CFR Part 100 (TN282). Use of a site of that size is unlikely to noticeably affect the availability of land for other purposes in most settings that are rural enough to meet the NRC siting criteria for a nuclear reactor in 10 CFR Part 100. Existing land use within the 30 ac of permanently disturbed land would be converted to industrial land use. The remainder of the site would be available for management as buffer land surrounding the new facilities and could be left in existing natural vegetation, agricultural land uses, or other uses that do not encroach on the exclusion area defined in 10 CFR Part 100 or interfere with reactor operations. As required by 10 CFR Part 100, no land uses unrelated to operation of the reactor would be allowed within the exclusion area, although conservation and management of natural vegetation would be allowed. The staff assumes that the 20 ac of temporarily disturbed land would be restored to regionally indigenous vegetation and then be available for other allowable land uses (if it is outside of the exclusion area defined in 10 CFR Part 100). The analysis recognizes that the entire 100 ac site would be unavailable for other industrial, commercial, residential, or recreational land uses until after the reactor is fully decommissioned.

The assumptions in Section 3.1.1 include compliance with applicable zoning ordinances and compatibility with any comprehensive land use plans adopted by local governments or planning agencies for the affected area. Zoning ordinances and land use plans are prepared to ensure that future development projects are compatible with other existing and reasonably foreseeable land uses in the area. The ordinances and plans also strive to ensure that adequate land is available for reasonably foreseeable competing land use demands. Land use plans are also often prepared by government agencies or contractors for national laboratory properties or military bases. These plans help ensure that new land uses are compatible with the facility's mission and conservation objectives. The assumption in Section 3.1.1 that the site is at least

0.5 mi from existing residential areas further reduces the risk that the proposed new facilities might interfere with nearby residential properties. Constructing or installing a reactor of a size encompassed by the PPE and fitting onto a site featuring the size and disturbance limitations noted above would attract only a limited construction workforce for a temporary period of time, which should not noticeably alter land use patterns in the surrounding landscape.

The NRC staff has determined that onsite land use during the building of a nuclear reactor is a Category 1 issue. The staff concludes that as long as the assumptions outlined in Section 3.1.1 for the site are met, then impacts from building a nuclear reactor can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- The proposed project, including any associated land uses, complies with NRC siting regulations in 10 CFR Part 100 (TN282).
- The site size is 100 ac or less.
- The permanent footprint of disturbance includes 30 ac or less of vegetated lands, and the temporary footprint of disturbance includes no more than an additional 20 ac or less of vegetated lands.
- The proposed project complies with the site's zoning and is consistent with any relevant land use plans or comprehensive plans.
- The site would not be situated closer than 0.5 mi to existing residential areas or 1.0 mi to sensitive land uses such as Federal, State, or local parks; wildlife refuges; conservation lands; Wild and Scenic Rivers; or Natural Heritage Rivers.
- The site does not have a history of past industrial use capable of leaving a legacy of contamination requiring cleanup to protect human health and the environment.
- The total wetland loss from use of the site, including use of any offsite ROWs, would be no more than 0.5 ac.
- Best management practices (BMPs) for erosion, sediment control, and stormwater management would be used.
- Compliance with any mitigation measures established through zoning ordinances, local building permits, site use permits, or other land use authorizations.

3.1.2.1.2 Offsite Land Use

A project meeting the assumptions outlined in Section 3.1.1 would establish no more than 1 mi of new offsite ROW that is no more than 100 ft in width, although unlimited offsite linear development within or adjacent to existing ROWs or roadway is assumed. Any required acquisition of land or easements is also assumed to be obtained from willing landowners without resorting to use of eminent domain.[1] Development of 1 mi of ROW that is no more than 100 ft in width would result in conversion of approximately 12.1 ac of existing land cover to land managed for a utility ROW. Forest cover, whether natural or managed, would be removed and converted to managed grassland, scrubland, or other land cover compatible with management of the ROW. It might be possible to continue the current use of some land in the ROW during and after the utility line construction or installation for cropland, pasture, orchards, or range, or

[1] The NRC would not engage in eminent domain on behalf of an applicant or licensee.

for outdoor recreation or conservation, although some land uses would be permanently converted to build access roads, transmission towers, or other facilities.

Establishment of new ROWs across existing land uses could fragment properties and interfere with existing or potential uses, but those effects would be minimized in most settings by the 1 mi limitation on new ROW length not co-located with or adjoining existing ROWs or roadways. The presence of ROWs and especially overhead transmission conductors could interfere with some agricultural operations such as aerial pesticide spraying and pivot irrigation. The presence of the ROW would not likely interfere with abutting or nearby land uses, although it could be perceived as undesirable when abutting or close to residential, recreational, or educational land uses.

Other than in residential areas, use of existing ROWs has little potential for the types of land use impacts described above for establishing new ROWs. Building utilities such as transmission lines within existing ROWs, including existing roadway ROWs, would not expose additional existing land uses to the presence of a ROW. Widening existing ROWs to accommodate new offsite utilities would also not fragment other land uses and is much less likely to interfere with other land uses or be perceived as incompatible. Additional land might be affected by widening existing ROWs, but the widened ROWs would not fragment additional land uses or expose new land uses to the presence of adjacent transmission lines or other linear utilities. However, the staff recognizes that widening an existing ROW, or even new work within an existing ROW, could have impacts in residential areas, where a consideration of site-specific conditions could be necessary to determine potential effects on residential properties.

The NRC staff has determined that offsite land use during construction of a nuclear reactor is a Category 1 issue. The staff concludes that as long as the PPE and SPE values and assumptions outlined in Section 3.1.1 for the offsite ROWs are met, the impacts of building offsite linear features associated with a nuclear reactor can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- New offsite ROWs for transmission lines, pipelines, or access roads would be no more than 100 ft in width and total no more than 1 mi in length.
- No new offsite ROW would be situated closer than 0.5 mi to existing residential areas or sensitive land uses such as Federal, State, or local parks; wildlife refuges; conservation lands; Wild and Scenic Rivers; or Natural Heritage Rivers.
- No existing ROWs in residential areas would be used or widened to accommodate project features.
- No ROW has a history of past industrial use capable of leaving a legacy of contamination requiring cleanup to protect human health and the environment.
- The total wetland loss from use of the entire project, including use of the site and any offsite ROWs, would be no more than 0.5 ac.
- BMPs for erosion, sediment control, and stormwater management would be used.
- Compliance with any mitigation measures established through zoning ordinances, local building permits, site use permits, or other land use authorizations.

3.1.2.1.3 Impacts on Prime and Unique Farmland

The PPE and SPE assume that the site is no larger than 100 ac and does not contain any prime or unique farmland, or other farmland of statewide or local importance, as defined in the FPPA (7 U.S.C. §§ 4201 et seq.; TN708). The assumptions do, however, allow for the presence of prime or unique farmland on the site as long as the site does not abut other land actively managed for agricultural purposes and does not occur in a predominantly agricultural landscape.

Loss of less than 100 ac of land optimal for agricultural use is unlikely to substantially affect regional agricultural production if the affected land is not positioned close to other agricultural land. Building transmission lines and other structures bounded by the PPE and SPE in offsite ROWs is also unlikely to adversely affect the use of farmland, including farmland regulated under the FPPA. Establishing up to 1 mi of new offsite ROW would affect no more than approximately 12.1 ac of farmland. Additional farmland could be affected by widening ROWs but would not experience the effects of fragmentation by the presence of new utility structures. Not all of the affected land would necessarily be excluded from agricultural use, because farming could continue under transmission conductors and over the top of backfilled pipeline and buried utility trenches. Some of the soils in the ROW could be disturbed to excavate trenches or build towers or access roads, thereby permanently altering the physical properties of the soils that make them optimal for agricultural use. However, the small area of disturbance allowed within the PPE and SPE ensures that the agricultural effects would be low.

The NRC staff has determined that prime and unique farmland during construction of a nuclear reactor is a Category 1 issue. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- The site size is 100 ac or less.

The site does not contain any prime or unique farmland or other farmland of statewide or local importance; or the site does not abut any agricultural land and is not situated in a predominantly agricultural landscape. The generic analysis can be relied on without conducting any mitigation measures. If the site includes any federally owned land (or if the applicant is itself a Federal agency), however, the agency charged with managing the land must demonstrate compliance with the FPPA by consulting with the Natural Resources Conservation Service, which may specify mitigation measures. However, the FPPA exempts actions not affecting federally owned land, even if the actions require permits or involve the acceptance of funding from Federal agencies.

3.1.2.1.4 Coastal Zone and Compliance with the Coastal Zone Management Act

The NRC staff has determined that impacts on the coastal zone during the construction or installation of a nuclear reactor is a Category 1 issue. The NRC cannot license an activity affecting the designated coastal zone without the applicant documenting that it has received a consistency determination from the applicable State agency. The State agency will not issue a consistency determination under the Act unless the potential impacts from the activity on the coastal zone are shown to be minimal or otherwise appropriately mitigated. The staff expects that only minimal impacts on the coastal zone will result from the construction/installation and operation of a reactor meeting the PPE criteria on a site meeting the SPE criteria. The staff concludes that any potential impacts on the coastal zone would be SMALL provided the applicant receives a CZMA consistency determination from the applicable State agency. The staff relied on the following PPE and SPE assumption to reach this conclusion:

- The site is not situated in any designated coastal zone, or the applicant can demonstrate that the affected state(s) have or will issue a consistency determination or other indication that the project complies with the Coastal Zone Management Act.

3.1.2.2 Environmental Consequences of Operation

The NRC staff recognizes that the greatest potential for adverse land use impacts is during construction, when existing land cover at the site is altered to build the reactor and supporting facilities. Nevertheless, the staff identified two environmental issues for analysis of land use impacts from operation of a nuclear reactor:

- onsite land use, especially possible land use changes on the site during operation of a reactor; and
- offsite land use, especially land use changes within ROWs during operation of offsite linear facilities such as pipelines and transmission lines.

Once the project has been built, further impacts on prime and unique farmland or the coastal zone are not a potential concern.

3.1.2.2.1 Onsite Land Use

Once a site has been developed with a nuclear reactor, onsite land use would not substantially change over the course of operations. It is possible that small areas of land cover within the site could be temporarily or permanently disturbed as facilities are maintained or refurbished or to accommodate additional support facilities such as expanded parking lots. However, the entire site would still be dedicated to the reactor throughout its operational life and the overall character of the site would remain unchanged. Land use restrictions in the exclusion areas would remain restricted in accordance with 10 CFR Part 100 (TN282) throughout operations. The licensee may initiate new uses of other land within the site, such as management of undeveloped land for agriculture or conservation or for other land uses not regulated by the NRC, but those actions would not constitute substantial land use changes within a site not exceeding the PPE of 100 ac. If the licensee has obtained permission from the NRC to build and operate an onsite storage facility on the site, the NRC staff has already determined in the Continued Storage GEIS that land use impacts from building and operating additional onsite short-term and long-term nuclear fuel storage facilities during the operational life of the reactor would be SMALL (NRC 2014-TN4117). The continued storage GEIS recognized that only small areas of land would be needed to build and operate the facilities and could be accommodated within previously disturbed lands on operating reactor sites. The analysis presented above is also corroborated by the License Renewal GEIS where the staff concluded that onsite land use impacts from operation of the existing large LWRs would be SMALL (NRC 2024-TN10161).

The NRC staff has determined that onsite land use during operation of a nuclear reactor is a Category 1 issue. The staff concludes that, as long as the PPE and SPE values and assumptions outlined in Section 3.1.1 for the site are met, the land use impacts from operating a nuclear reactor can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- The proposed project, including any associated land uses, complies with NRC siting regulations in 10 CFR Part 100.
- The site size is 100 ac or less.

- If needed, cooling towers would be mechanical draft, not natural draft; less than 100 ft in height; and equipped with drift eliminators.
- Any makeup water for the cooling towers would be fresh water (less than 1 part(s) per thousand [ppt] salinity).
- BMPs for erosion, sediment control, and stormwater management would be used.

3.1.2.2.2 Offsite Land Use

Once a nuclear reactor is built and begins operation, substantial new offsite land use changes are unlikely. The staff has determined that the potential for offsite land use impacts from continued operation of already-built reactors is minimal (NRC 2024-TN10161). It would be possible to continue use of some land in offsite ROWs for cropland, pasture, orchards, or range, or for outdoor recreation or conservation. The 2013 LR GEIS described studies in which the presence of overhead electrical transmission conductors somewhat depressed the yield of cotton, but not rice or soybeans, planted underneath, and attributed the effects either to the presence of EMFs or physical interference by the conductors with aerial pesticide spraying (NRC 2013-TN2654). Landowners are, however, compensated for utility easements crossing their land (unless the utility buys the land underlying the ROW outright), and the indicated yield suppressions would not limit economically viable agriculture.

Operation of cooling towers can result in fogging, icing, and salt drift that interfere with offsite land uses, including agricultural and residential uses. As reported in the 1996 LR GEIS, a review for possible visible vegetation damage from operation of natural draft cooling towers at eight nuclear plants across the United States revealed no damage, and a review for possible visible vegetation damage from 10 nuclear plants that have mechanical draft cooling towers revealed no damage more than 500 ft from the towers (NRC 1996-TN288). The PPE and SPE assume that natural draft cooling towers, which are taller and hence capable of depositing drift farther away from the towers, would not be used; however, the fact that even they have been shown to result in minimal drift effects supports an assertion that drift impacts have only minimal potential to affect land outside of a power plant site. Furthermore, the PPE and SPE assume that there are no existing (at the time of licensing) residential properties within 0.5 mi of the site, including any cooling towers, thereby ensuring conservatism with respect to the potential for drift-related impacts. The analysis presented above is also corroborated by the current LR GEIS in which the staff concluded that onsite land use impacts from operation of the existing large LWRs would be SMALL (NRC 2024-TN10161).

Operation of any new nuclear reactor would result in increased employment in the surrounding region, possibly requiring the use of land to provide additional housing and services. However, accommodating any increase in regional population growth for operation of a nuclear reactor, as outlined in the PPE and SPE for the socioeconomic analysis in Section 3.12, is unlikely to result in enough increased regional development by housing and support services to lead to noticeable adverse competition for offsite land resources in most economic regions.

The staff has determined that offsite land use during operations of a nuclear reactor is a Category 1 issue. The staff concludes that as long as the PPE and SPE values and assumptions outlined in Section 3.1.1 for the offsite ROWs are met, the impacts can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- New offsite ROWs for transmission lines, pipelines, or access roads would be no more than 100 ft in width and total no more than 1 mi in length.
- BMPs for erosion, sediment control, and stormwater management would be used (wherever land is disturbed during the course of ROW management).

3.2 Visual Resources

3.2.1 Baseline Conditions and PPE/SPE Values and Assumptions

Baseline conditions influencing visual impacts include land cover and topography on the proposed site and surrounding landscape, weather patterns and conditions, the height of any existing structures and vegetation on the property, the proximity to other uses of the site, the extent of viewsheds (the area visible from a location sensitive to visual impacts, such as a residence or a park), and other landscape characteristics. Visual effects depend greatly on the setting. A nuclear power plant that might be visually obtrusive in residential or tourist settings might not raise any visual objections in areas where industrial or power generation facilities are common. Among the various visual impact assessment methodologies developed by Federal agencies, one of the best known is the Visual Contrast Rating process, which emphasizes the visual contrast between development actions and their surroundings (BLM 1986-TN6403).

In developing the values and assumptions in the PPE and SPE pertaining to visual resources, the staff relied upon the information and analyses contained in multiple new reactor EISs prepared since 2005, the LR GEIS (NUREG-1437; NRC 2024-TN10161), other past NRC EISs, and common elements of State and local land use regulation. In each case, staff has selected a value or parameter that will ensure a minimal visual impact from construction and operation of a nuclear reactor after considering all available information and leveraging professional judgment and expertise. The staff's assumptions that support the PPE and SPE are described below.

Most of the assumptions relevant to visual impacts are also ones outlined in Section 3.1.1 for land use. In addition, the staff assumes a maximum building and structure height of 50 ft (except 200 ft for meteorological towers and 100 ft for transmission poles/towers and mechanical draft cooling towers). The staff assumes that projects would not include natural draft cooling towers, which are typically several hundred feet in height and therefore visible from considerable distances away from the site in most settings, depending on factors such as vegetation and topography. The staff also assumes that project structures would not be visible from Federal or State parks or wilderness areas designated as Class 1 under Section 162 of the Clean Air Act (42 U.S.C. § 7472; TN6954) or a Wild and Scenic River, a Natural Heritage River, or a river of similar State designation. The staff acknowledges that many proposed facilities may not be completely invisible at all times from all sensitive locations such as residences or parks, even if meeting all of the values and assumptions noted above. The visibility of structures from places on or eligible for listing on the National Register of Historic Places (NRHP) is addressed in Section 3.9.

3.2.2 Visual Resources Impacts

Context plays a key role in the evaluation of visual impacts; the appearance of industrial structures in established industrial settings is generally better tolerated than the same structures in pastoral or residential settings. Taller or larger structures, especially structures of a type not previously occurring on the landscape, tend to affect the visual properties of landscapes more than other structures. For example, for the proposed Greene County Nuclear Power Plant,

cancelled in the 1980s because of opposition due to aesthetic concerns, greater opposition was recorded among members of the public to a natural draft cooling tower than to a cement plant, an industrial feature already existing in the generally rural landscape (Petrich 1982-TN6810). Evaluators of visual impacts often speak of effects in terms of viewsheds, defined as the landscape that can be directly seen under favorable atmospheric conditions, from a viewpoint or along a transportation corridor (BLM 1984-TN5536). Many smaller nuclear reactors meeting the assumptions in the PPE and SPE may consist only of, or be housed in, smaller, lower structures compared to the larger, commercial reactors that have been previously licensed by the NRC. Such smaller, lower structures meeting the values and assumptions would have little potential for visual impacts on viewsheds, whether or not those viewsheds contain existing nuclear facilities or other power generation or industrial facilities.

3.2.2.1 Environmental Consequences of Construction

The NRC staff identified two environmental issues related to visual resources for building a nuclear reactor:

- visual impacts from structures on and in the vicinity of the site, and
- visual impacts from transmission lines.

3.2.2.1.1 Visual Impacts in Site and Vicinity

Projects meeting the values and assumptions outlined in Section 3.2.1 would not likely be visually obtrusive, even from sensitive features such as residences, parks, and areas designated for conservation. Not being visually obtrusive does not necessarily imply incapable of being seen, especially from a distance. Power generation facilities are however industrial in appearance and would therefore contrast strongly with most natural settings found on greenfield (previously undeveloped) sites, although they would not likely contrast markedly if built in close proximity to existing nuclear or other power plants or other industrial facilities. In landscapes that feature substantial forest cover, structures would likely only be visible close to the site. The structures might be visible from distant high points or ridges but not be a prominent visual feature. The structures would be visible for greater distances in open landscapes characterized predominantly as agricultural, grassland, or scrub cover, but their visual prevalence would decrease with distance. In a completely open landscape such as the ocean or a grassland with no trees, the horizon visible to a standing person 6 ft in height would be approximately 3 mi away; even at distances of only 1 mi, structures would be visible although not prominent. Most landscapes, however, contain hills, trees, and other features that soften the appearance of structures relative to a completely open, flat landscape. Little or no change in the overall visual character of most landscapes would occur if structures meeting the assumed building height values noted in Section 3.2.1 were built close to existing industrial facilities such as existing nuclear generation facilities or other power plants, or in industrial parks or industrially developed areas of military bases. The structures could be aesthetically detrimental to residences or parks situated close to the site, but the structures would not likely alter the aesthetic quality of residences or parks more than 1 mi from the site.

The staff has determined that visual impacts on the site and vicinity are a Category 1 issue. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- The site size is 100 ac or less.

- The site would not be situated closer than 0.5 mi to existing residential areas or 1 mi to sensitive land uses such as Federal, State, or local parks; wildlife refuges; conservation lands; Wild and Scenic Rivers; or Natural Heritage Rivers.
- The maximum proposed building and structure height is no more than 50 ft, except that the maximum height is 200 ft for proposed meteorological towers and 100 ft for transmission line poles/towers and mechanical draft cooling towers.
- The proposed project structures would not be visible from Federal or State parks or wilderness areas designated as Class 1 under Section 162 of the Clean Air Act (42 U.S.C. § 7472; TN6954); or as a Wild and Scenic River, a Natural Heritage River, or a river of similar State designation.

Note that the generic analysis assumes both that the site and ROWs are not within 1 mi of exceptionally sensitive areas such as wilderness areas and special-status rivers and that the proposed new structures would not be visible from these sensitive areas. No visual simulation or other projection of visual effects is needed to corroborate this conclusion as long as the relevant PPE and SPE values and assumptions are met. If the PPE and SPE values and assumptions are met, the applicant does not need to submit visual simulations (such as an artistic rendering) or other projections of visual effects. Optional mitigation measures that might be considered include planting trees, earthen berms, walls, or other landscaping activities around any part of the perimeter of the site.

3.2.2.1.2 Visual Impacts from Transmission Lines

The assumptions in the PPE and SPE regarding transmission line ROWs and structures (poles or towers) ensure that the visual effects of any new transmission lines serving a nuclear reactor project would be minimal and that the visual integrity of sensitive features such as parks, wilderness areas, conservation lands, Wild and Scenic Rivers, and American Heritage Rivers would not be compromised. Transmission towers, poles, and conductors are visually prominent features that can contrast with and detract from the aesthetic beauty of most non-industrial landscapes. Using Bureau of Land Management terminology (BLM 1986-TN6403), these features can have “moderate” contrast with most natural landscapes. In certain cases, larger steel-lattice transmission towers or tall steel poles may have “strong” contrast relative to some natural landscapes.

However, overhead electric lines, including overhead transmission lines carried on various types of towers and poles, are a common feature in all but the most pristine of landscapes. In many landscapes, new transmission lines may be routed to follow existing transmission line ROWs and thereby avoid introducing such structures to pristine areas. Overhead electric lines on the sides of roadways are a common visual occurrence expected by most drivers. The clearing of new ROWs across forested landscapes can create a visually noticeable notch or strip that breaks the lines of the forest canopy and can be visible from substantial distances, but the limited length of new ROWs assumed under the PPE limits the extent of any such visual effects.

The NRC staff has determined that visual impacts from building transmission lines are a Category 1 issue. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- New offsite ROWs for transmission lines, pipelines, or access roads would be no more than 100 ft in width and total no more than 1 mi in length.
- No transmission line structures (poles or towers) would be over 100 ft in height.

- The new offsite ROWs would not be situated closer than 1 mi to existing residential areas or sensitive land uses such as Federal, State, or local parks; wildlife refuges; conservation lands; Wild and Scenic Rivers; or Natural Heritage Rivers.
- Any proposed new structures on offsite ROWs would not be visible from Federal or State parks or wilderness areas designated as Class 1 under Section 162 of the Clean Air Act (42 U.S.C. § 7472; TN6954); or as a Wild and Scenic River, a Natural Heritage River, or a river of similar State designation.

If the PPE and SPE values and assumptions are met, the applicant does not need to submit visual simulations (such as an artistic rendering) or other projections of visual effects. The generic analysis can be relied on without conducting any mitigation measures, but possible mitigation measures to consider might include preserving or establishing tree screens at road crossings or along the edges of ROWs, or painting steel towers or poles brown or dark green.

3.2.2.2 Environmental Consequences of Operation

The NRC staff identified one environmental issue related to visual resources for operation of a nuclear reactor:

- visual impacts during operations.

3.2.2.2.1 Visual Impacts During Operations

Once structures are built, whether onsite or offsite, they are established features of the landscape. Operation of the structures for their intended purpose once built does not substantially alter their appearance. If there is a need during the operational life to refurbish structures or build new support structures on the site, those changes would most likely not substantially contrast with the already-developed industrial appearance of the site. Operating cooling towers release visible fog-like plumes, but any such plumes from mechanical draft cooling towers meeting the values and assumptions in Section 3.2.1 would likely only be visible from areas close to the site. A nuclear reactor that meets the values and assumptions would not include the tall hyperbolic natural draft cooling towers whose plumes can be visible from substantial distances. Section 3.5.2.2.4 analyzes the potential for drift from cooling towers from nuclear reactors to injure vegetation and concludes that possible effects are localized to the immediate location of the cooling towers and would be minimal. The staff has determined that visual impacts from building transmission lines are a Category 1 issue. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- The site would not be situated closer than 1 mi to existing residential areas or sensitive land uses such as Federal, State, or local parks; wildlife refuges; conservation lands; Wild and Scenic Rivers; or Natural Heritage Rivers.
- The maximum proposed building and structure height would be no more than 50 ft, except that the maximum height would be 200 ft for proposed meteorological towers and 100 ft for proposed transmission line poles/towers and proposed mechanical draft cooling towers.
- The proposed project structures would not be visible from Federal or State parks or wilderness areas designated as Class 1 under Section 162 of the Clean Air Act (42 U.S.C. § 7472; TN6954); or as a Wild and Scenic River, a Natural Heritage River, or a river of similar State designation.
- If needed, cooling towers would be mechanical draft, not natural draft; less than 100 ft in height; and equipped with drift eliminators.

- Any makeup water for the cooling towers would be fresh water (less than 1 ppt salinity).

3.3 Meteorology and Air Quality

3.3.1 Baseline Conditions and PPE/SPE Values and Assumptions

Baseline conditions influencing potential air quality impacts associated with construction and operation of a new nuclear reactor include climatology, regional meteorology, atmospheric stability, the potential for severe weather events, and regional air quality. The atmospheric processes that occur as a result of these baseline conditions determine the transport of routine air emissions during construction and routine air emissions or accidental releases during operation, and their effects on regional air quality. Impacts on regional air quality may result not only from construction and operation at the plant site but also from construction and operations at offsite land, which could include construction of intake and discharge structures and transmission lines, pipelines, or heavy-haul roads. Activities that could potentially cause air emissions include the following:

- land clearing and material processing, handling, and removal
- excavation for structures, utilities, access roads and other infrastructure, including transmission lines
- material replacement (e.g., subsurface preparation and concrete pouring and paving)
- driving piles and erecting structures
- construction machinery operation and maintenance
- truck deliveries of reactor modules, supplies, and materials
- soil transport and temporary stockpiling
- workforce vehicle use during daily commuting to and around the site and during refueling outages
- periodic testing of standby power generators and other support equipment
- operation of cooling towers and auxiliary systems
- operation of transmission lines
- refurbishments activities.

In developing the values and assumptions in the PPE and SPE pertaining to air quality, the staff relied upon the information and analyses contained in multiple new reactor EISs prepared since 2005, the LR GEIS (NRC 2024-TN10161), and common elements of State and local regulations. Some values and assumptions made in this section of the GEIS involve parameters and values that are developed based on previous staff environmental reviews or are the subject of Federal and State regulations and some have been appropriately scaled down to account for the size and technology differences between large LWRs and potentially smaller new nuclear reactors. In every case, the staff has selected a value or parameter that will ensure a minimal impact on local meteorology and air quality from construction and operation of a nuclear reactor after considering all available information and leveraging professional judgment and expertise.

The PPE and SPE values relevant to air quality assume that the proposed plant site would be no larger than 100 ac, within which site disturbance would affect no more than 30 ac of land

permanently and no more than 20 ac of additional land temporarily, and offsite ROWs for transmission lines, pipelines, or access roads would be no longer than 1 mi; however, these values and assumptions allow for unlimited additional mileage for linear features built within existing ROWs or directly adjacent to existing ROWs or public highways. The staff has concluded that the values stated above used for the land use analysis (as discussed in Section 3.1) will also apply for the analysis of air quality for determining impacts during building activities. The PPE and SPE values assume the construction and operation workforce traffic would not change the level of service (LOS) determination for local road systems, which is discussed in Section 3.12. The staff has concluded that this PPE/SPE value used for socioeconomics would also apply for the analysis of air quality for determining impacts from traffic during building and operation. The PPE and SPE values assume plant cooling would be accomplished by mechanical draft cooling towers, if needed, which are equipped with drift eliminators, and are 100 ft in height or less, and the makeup water would be fresh (with a salinity less than 1 ppt). These values are based on previous license renewal and new reactor environmental reviews, as discussed in Section 3.5, and will be used to determine the air quality impacts from the operation of cooling towers. Lastly, for plants using cooling towers, the air quality section also relies on an assumption that there are no existing residential areas within 0.5 mi of site. This assumption is based on previous new reactor reviews analyses.

New reactor siting also includes consideration of mandatory Class I Federal areas where visibility is an important value (40 CFR Part 81-TN7226). Although there is little likelihood that activities at a nuclear reactor site could adversely affect air quality and air quality-related values (e.g., visibility or acid deposition) in Class I areas, the PPE and SPE assumes that completed structures would not be located within 1 mi of areas designated as Class I under Section 162 of the Clean Air Act (42 U.S.C. § 7472-TN6954).

Air quality is generally measured by the amount of pollution present in the atmosphere. The U.S. Environmental Protection Agency (EPA) has set National Ambient Air Quality Standards (NAAQSs) for six criteria pollutants, including sulfur dioxide, nitrogen dioxide, carbon monoxide (CO), ozone, particulate matter with a mean aerodynamic diameter of 10 μm or less (PM_{10}), particulate matter with a mean aerodynamic diameter of 2.5 μm or less ($PM_{2.5}$), and lead, as shown in Table 3-1. Primary NAAQSs specify maximum ambient (outdoor air) concentration levels of the criteria pollutants with the aim of protecting public health with an adequate margin of safety. Secondary NAAQSs specify maximum concentration levels with the aim of protecting public welfare. States can have their own State Ambient Air Quality Standards. State Ambient Air Quality Standards must be at least as stringent as the NAAQSs and can include standards for additional pollutants. If a State has no standard corresponding to one of the NAAQSs, the NAAQSs apply (40 CFR Part 50-TN1089).

An area where criteria air pollutants are within NAAQS levels is referred to as an attainment area, and an area where criteria air pollutants exceed NAAQS levels is called a nonattainment area (40 CFR Part 81-TN7226). In some cases, the EPA is not able to determine an area's status after evaluating the available information and those areas are designated as "unclassifiable" (EPA 2020-TN6772). Previous nonattainment areas where air quality has been improved to meet the NAAQSs are redesignated maintenance areas and are subject to an air quality maintenance plan. Locations of EPA-Designated Nonattainment and Maintenance Areas for each criteria pollutant are routinely updated, and are available at https://www3.epa.gov/airquality/greenbook/ancl.html (EPA 2024-TN10122).

Table 3-1 National Ambient Air Quality Standards for Six Criteria Pollutants[a]

Pollutant	Averaging Time	NAAQS Value[b]	NAAQS Type[c]
SO_2	1-hour	75 ppb	P
SO_2	Annual	10 ppb	S
NO_2	1-hour	100 ppb	P
NO_2	Annual	0.053 ppm (53 ppb)	P, S
CO	1-hour	35 ppm	P
CO	8-hour	9 ppm	P
O_3	8-hour	0.070 ppm	P, S
PM_{10}	24-hour	150 µg/m^3	P, S
$PM_{2.5}$	24-hour	35 µg/m^3	P, S
$PM_{2.5}$	Annual	15 µg/m^3	S
$PM_{2.5}$	Annual	9 µg/m^3	P
Pb	Rolling 3-month	0.15 µg/m^3	P, S

CFR = *Code of Federal* Regulations.

(a) CO = carbon monoxide; NAAQS = National Ambient Air Quality Standards; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; $PM_{2.5}$ = particulate matter ≤2.5 µm; PM_{10} = particulate matter ≤10 µm; ppb = parts per billion; ppm = parts per million; SO_2 = sulfur dioxide.

(b) Refer to 40 CFR Part 50 or EPA 2024-TN11955 for detailed information about attainment determination and reference method for monitoring.

(c) P = Primary standard whose limits were set to protect public health; S = secondary standard whose limits were set to protect public welfare.

Source: EPA 2024-TN11955.

If a proposed project is in a nonattainment or maintenance area, the General Conformity Rule (40 CFR Part 93-TN2495) ensures that Federal actions comply with the NAAQSs (EPA 2020-TN6773). In accordance with Section 176(c) of the Clean Air Act (42 U.S.C. § 7506-TN4856) and the General Conformity Rule, the NRC must analyze the proposed permit action for conformity applicability; therefore, the NRC must demonstrate that the air emissions associated with activities within its authority would conform to the appropriate State implementation plans, which are developed to improve or maintain air quality in designated nonattainment and maintenance areas. The EPA has established *de minimis* levels for each criteria pollutant (EPA 2020-TN6774). The *de minimis* levels for air emissions vary depending on air quality conditions in the area where the plant is located. In most cases, the *de minimis* levels are established at 100 T/yr. Exceptions include:

- NO_x or volatile organic compound (VOC) emissions of 10, 25, and 50 T/yr in extreme, severe, and serious ozone nonattainment areas, respectively
- VOC emissions of 50 T/yr in ozone nonattainment areas inside an ozone transport region stretching from Virginia to Maine
- Lead emissions of 25 T/yr in lead nonattainment areas
- PM_{10} emissions of 70 T/yr in serious PM_{10} nonattainment areas
- $PM_{2.5}$, SO_2, NO_x, VOC, and ammonia emissions of 70 T/yr in serious $PM_{2.5}$ nonattainment areas and 100 T/yr in moderate $PM_{2.5}$ nonattainment areas

In maintenance areas, the *de minimis* levels are 100 T/yr for all pollutants, except for 50 T/yr for VOCs inside the ozone transport region and 25 T/yr for lead.

The PPE and SPE assume the proposed plant could be located in either attainment, nonattainment, or maintenance areas, but if located in a nonattainment or maintenance area the criteria pollutant(s) emitted would be less than the *de minimis* levels set by the EPA or State. If a project is located in a nonattainment or maintenance area and the project's emissions are estimated to exceed the *de minimis* levels for any criteria pollutant as demonstrated in an applicability analysis, a conformity determination must be completed. A conformity determination, if needed, must be completed before the action is taken and documented in the project-specific review. The NRC would conduct a conformity determination in accordance with NRC guidance (NRC 2023-TN12145)

New sources that emit air pollutants could also be subject to Federal and State permitting programs. The New Source Review (NSR) regulations are broken down into two separate programs: Prevention of Significant Deterioration (PSD) and Nonattainment New Source Review (NNSR). PSD is a Federal permitting program that applies to sources classified as major sources (as defined in 40 CFR 52.21-TN4498) under the PSD program and located in attainment areas. The purpose of the program is to prevent degradation of air quality in areas where air quality is good. New or modified sources of criteria pollutants that exceed *de minimis* emission rates are subject to the program. For a proposed new facility, the need for an NSR permit—and the level of air pollution control potentially required by the permit—depends on the source's potential to emit NSR-regulated pollutants and the attainment status of the location for the proposed facility.

A new or modified "major" stationary source is required to obtain a nonattainment NSR permit (NNSR) or PSD permit. A new source may be treated as "major" if it emits pollutants in amounts equal to, or greater than the established major source threshold levels. The emission thresholds for a major source subject to NNSR are similar to *de minimis* levels for general conformity applicability analysis and are listed in 40 CFR 51.165. A PSD permit is required for construction of a major source in an attainment area. The PSD criteria for a major source is listed in 40 CFR 52.21, including 250 T/yr of any regulated pollutant, or 100 T/yr of any pollutant for one of the 28 listed source categories (e.g., cement plants, fuel conversion plant, petroleum refineries, steel mills, fossil fuel boilers >250 MMBTU/hour heat input). A new nuclear power plant is most likely to have air emissions less than these "major" emission thresholds and therefore should not require an NSR or PSD permit. Minor New Source Reviews are for pollutants from stationary sources that do not require PSD or NNSR permits. A minor source is a facility that has potential emissions less than these major NSR or PSD thresholds, but greater than State, Tribal or local regulatory requirements. A new minor source may require a State permit depending on the State and/or local regulations. These minor source permit standards are developed by States as part of their State Implementation Plans. State air permit applications require air quality modeling analyses and use of control technologies to demonstrate that new emissions would not violate NAAQS and PSD increments set to prevent deterioration of air quality to levels set by the NAAQs.

Title V of the Clean Air Act (TN1141) requires a Federally enforceable operating permit program that applies to large, new, and existing sources of air pollution. Any facility with the potential to emit 100 TPY or more of any criteria pollutant, 10 TPY of any hazardous air pollutant (HAP), or 25 TPY of any combination of HAPs is required to obtain a valid Title V permit and is considered a major air emission source.

Sources at operating nuclear power plants that contribute to criteria air pollutants include backup diesel generators, boilers, fire pump engines, and cooling towers. The emissions from these sources (and, if applicable, emissions from the incineration of any waste products) must

comply with State and local regulatory air quality permitting requirements. Because nuclear power plant ancillary equipment are generally low emitters of criteria air pollutants and VOCs, the impact of these emissions on potential ambient air quality is minimal. However, special permit conditions may be applicable under various regulatory jurisdictions for facilities located in EPA designated nonattainment areas. Diesel generators, pumps, fossil fuel boilers, and cooling towers typically require State or local operating permits. Operating permits specify conditions that limit air emissions, hours of operation, fuel content, or fuel consumption. Most State air pollution regulations provide air permit exemptions for air pollution sources that are not routinely operated, which can be defined as sources with insignificant activity meeting specified operating criteria (e.g., so many hours of continuous operation over specified periods or so many hours of operation per year). Some plant equipment such as diesel generators and cooling towers may emit some HAPs during operation. The EPA coordinates with State, local, and Tribal governments to reduce the air emissions of toxic air pollutants to the environment. The PPE assumes that these HAPs operational emissions are within limits established by the EPA or State.

Gases found in the Earth's atmosphere that trap heat and play a role in the Earth's climate are collectively termed GHGs. GHGs include carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); water vapor; and fluorinated gases, such as hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Climate change research indicates that the cause of the Earth's warming over the last 50 years is the buildup of GHGs in the atmosphere, resulting from human activities (IPCC 2023-TN10123). The EPA has determined that GHGs "may reasonably be anticipated both to endanger public health and to endanger public welfare" (74 FR 66496-TN245). Climate change is a subject of national and international interest because of how it changes the affected environment. Commission Order CLI-09-21 (NRC 2009-TN6406) provides the current direction to the NRC staff to include the consideration of the impacts of the emissions of CO_2 and other GHGs that drive climate change in its environmental reviews for major licensing actions.[2] Estimates of GHG emissions from a reference 1,000 megawatts electrical (MWe) reactor were developed using the approach in Interim Staff Guidance COL/ESP-ISG-026 (NRC 2014-TN3767) and the Interim Staff Guidance on Environmental Issues Associated with New Reactors.

GHGs are emitted from equipment and vehicles used during building, operation, the uranium fuel cycle, transportation of fuel and waste, and decommissioning including extended SAFe STORage (SAFSTOR). Appendix H estimates GHG emissions for life-cycle phases for a reference 1,000 MWe reactor with an 80 percent capacity factor. The calculation of GHG emissions for a new nuclear reactor assumes two 1,000 MW(e) nuclear reactors could be installed on the same site, based on previous applications for sites with two or more new LWRs (NRC 2015-TN6438, NRC 2016-TN6434, NRC 2019-TN6136). GHG emission estimates for building, operation, decommissioning, including extended SAFSTOR, for a two-unit nuclear plant would be based on the plant's physical size, and the estimates for these stages are assumed to be twice the value of the reference 1,000 MWe reactor emission estimates in Appendix H. However, GHG emission estimates for the uranium fuel cycle and transportation of fuel and waste would be based on the anticipated efficiency of the proposed plant. For example, the Final EIS for Turkey Point Units 6 and 7 scaled GHG emissions from the fuel cycle upward by a factor of 2.6, and the Final EIS for the Public Service Enterprise Group (PSEG) scaled GHG emissions from the fuel cycle upward by a factor of 3, based on plant efficiencies greater than the 80 percent assumption in Appendix H (NRC 2016-TN6434, NRC 2015-TN6438). To

[2] The Commission stated that "the Staff's analysis for reactor applications should encompass emissions from the uranium fuel cycle as well as from construction and operation of the facility to be licensed." (CLI-09-21, at 6)

provide bounding values, the estimates for GHG emissions for uranium fuel cycle activities and fuel and waste transport associated with a new nuclear reactor in this GEIS were calculated using three times the values for the reference 1,000 MWe reactor in Appendix H.

Based on the Interim Staff Guidance COL/ESP-ISG-026 approach used in several new reactor EISs, the reference 1,000 MWe reactor emissions described Appendix H, and the scaling factors discussed above, the PPE/SPE value for GHGs emitted by equipment and vehicles during the 97-year GHG life-cycle period for a nuclear reactor would be equal to or less than 2,534,000 metric tonnes (MT) of CO_2 equivalent (CO_2(e)),[3] as shown in Table 3-2.

3.3.2 Air Quality Impacts

Most air quality impacts from new nuclear reactors would take place during the building of the project. Impacts would occur primarily during site preparation and the building of facility components such as the nuclear island and facilities such as cooling towers, administration buildings, parking lots, switchyards, and any onsite and offsite pipelines, access roads, and transmission lines. Air emissions from vehicles and stationary support equipment, such as auxiliary equipment, would occur during operation and would increase periodically during equipment testing and during refueling outages, depending on the plant design. Air emissions also result from operation of the cooling towers. Small amounts of ozone and NOx are produced by transmission lines during operation.

Table 3-2 Plant Parameter Envelope Values for Greenhouse Gas Emissions

Source	Total Emissions (reference 1,000 MW reactor) (MT CO_2(e))	Activity Duration (yr)	Scaling Factor	PPE Emission Values (two 1,000 MW reactors) (MT CO_2(e))
Construction Equipment[a]	39,000	7	2	78,000
Construction Workforce[a]	43,000	7	2	86,000
Plant Operations[b]	181,000	40	2	362,000
Operations Workforce[b]	136,000	40	2	272,000
Uranium Fuel Cycle[b]	540,000	40	3	1,620,000
Fuel and Waste Transportation[b]	14,000	40	3	42,000
Decommissioning Equipment[c]	19,000	10	2	38,000
Decommissioning Workforce[c]	8,000	10	2	16,000
SAFSTOR Workforce	10,000	40	2	20,000
TOTAL[d]	990,000	97	-	2,534,000

CO_2(e) = CO_2 equivalent; SAFSTOR = SAFe STORage.
(a) Activities are assumed to occur over the same time frame.
(b) Activities are assumed to occur over the same time frame.
(c) Activities are assumed to occur over the same time frame.
(d) Results are rounded to the nearest 1,000 MT CO_2(e).

[3] A measure to compare the emissions from various GHGs on the basis of their global warming potential (GWP), defined as the ratio of heat trapped by one unit mass of the GHG to that of one unit mass of CO_2 over a specific time period.

The NRC staff evaluated the total GHG emissions for a nuclear reactor. Equipment and vehicles used during building, operation, uranium fuel cycle, transportation of fuel and waste, and decommissioning activities would emit a total of 2,534,000 MT of CO_2(e) over the assumed 97-year GHG life-cycle of the plant (see Table 3-2). The NRC staff's life-cycle GHG estimate in Appendix H places the estimate at the lower end of the estimates presented in Table A.II.4 of the Intergovernmental Panel on Climate Change report (IPCC 2012-TN2648).

The NRC staff has determined that the contribution of GHG emissions from total plant life-cycle activities to national emissions is a Category 1 issue. The staff concludes that, as long as the PPE assumption associated with GHG emissions is met, the GHG impacts from building, operating, conducting the fuel cycle, transporting fuel and waste, and decommissioning of a nuclear reactor can be generically determined to be SMALL. The staff relied on the following PPE assumption to reach this conclusion:

- GHGs emitted by equipment and vehicles during the 97-year reactor GHG life-cycle period would be equal to or less than 2,534,000 MT of CO_2(e). Appendix H of this GEIS contains the staff's methodology for developing this value, which includes emissions from construction, operation, and decommissioning. As long as this total value is met, the impacts for the life-cycle of the project and the individual phases of the project are determined to be SMALL.

GHG impacts associated with building and operation (including the fuel cycle and transportation of fuel and waste) are discussed below. Air quality impacts including GHG emissions for decommissioning are evaluated in Section 3.16 of this GEIS.

3.3.2.1 Environmental Consequences of Construction

The staff's evaluation of impacts on air quality during building activities focused on emissions from construction equipment and vehicles, and fugitive dust generation. Major activities include earthmoving, open burning, placement of land fill, concrete batch plant operation, facility construction, operation of temporary boilers, and emission of vehicular exhaust. Emissions from these activities would include PM, CO, NOx, sulfur dioxide, and VOCs. Building activities at the site of a new nuclear reactor would result in temporary impacts on local air quality.

The NRC staff identified two air quality issues for analysis of construction of a nuclear reactor:

- emissions of criteria pollutants and fugitive dust to the atmosphere in relation to regional air quality conditions and NAAQSs for criteria pollutants; and
- emissions of GHGs.

3.3.2.1.1 Emissions of Criteria Pollutants and Dust during Construction

Equipment and vehicle emissions from building activities including passenger cars and light duty trucks of the construction workforce, delivery trucks, and heavy equipment (e.g., excavators, bulldozers, heavy-haul trucks, cranes) would contain CO, NOx, VOCs, and oxides of sulfur (SOx) to a lesser extent. Fugitive dust (such as PM_{10} and $PM_{2.5}$) would be generated during windy periods, earthmoving, concrete batch plant operation, and movement of vehicular traffic over recently disturbed or cleared areas or unpaved roads. Painting, coating, and similar operations would generate emissions of VOCs. Typically, the construction workforce would be divided into two or three shifts and the increased traffic would be distributed over the day, with periodic and short-term increases at shift changes. Construction activities are typically subject to

air permits under State and Federal laws that address the impact of air emissions on any local sensitive receptors. Air emission mitigation measures that may be used to reduce potential impacts include the following:

- phasing activities and equipment use
- minimizing the idling time of vehicles
- using properly maintained equipment in compliance with applicable regulations
- minimizing speeds on unpaved roads
- watering unpaved roads and exposed areas
- minimizing soil storage piles
- locating stationary equipment (e.g., generators, temporary boilers, and compressors) away from sensitive receptors
- minimizing dust-generating activities during high winds.

Emissions of fugitive dust and construction equipment engine exhaust are generally limited in duration, infrequent, mostly localized to the project area, and would vary based on the level and duration of a specific activity throughout the building phase of the facility. The PPE/SPE assumes the total site size is 100 ac or less, the permanent disturbed vegetated areas is 30 ac or less, and the additional vegetated area disturbed by temporary activities is 20 ac or less, and that new offsite ROWs for transmission lines, pipelines, or access roads would be no longer than 1 mi and have a maximum ROW width of 100 ft. The air quality impacts are therefore expected to be temporary and limited to the area within 6 mi of the plant construction site. The PPE/SPE assumes the plant is located in an attainment area or that criteria pollutants emitted from construction activities are less than Clean Air Act *de minimis* levels set by the EPA if the project/action is located in a nonattainment or maintenance area and, therefore, would not be subject to a conformity determination. If the plant is located adjacent to a nonattainment or maintenance area, the total emissions from criteria pollutants should be less than Clean Air Act *de minimis* levels. The PPE/SPE assumes the site is not located within 1 mi of a mandatory Class I Federal area where visibility is an important value.

Some communities located near the construction site may experience increases in traffic and associated increases in the amount of particulate and gaseous emissions. The impact of emissions from additional workforce and other construction traffic would be localized and temporary and have little impact on the regional air quality (NRC 2021-TN7037). Under the PPE and SPE assumption that the LOS determination associated with anticipated peak construction would not change, traffic bottlenecks that could significantly increase localized emissions from idling vehicles are not expected to occur.

The staff has determined that emissions of criteria pollutants during construction of a nuclear reactor are a Category 1 issue. The staff concludes that as long as the applicable PPE and SPE values and assumptions are met, the air quality impacts from building a nuclear reactor can be generically determined to be SMALL. The staff relied on the following PPE values and assumptions to reach this conclusion:

- The site size is 100 ac or less.
- The permanent footprint of disturbance is 30 ac or less of vegetated lands and the temporary footprint of disturbance is an additional 20 ac or less of vegetated land.
- New offsite ROWs for transmission lines, pipelines, or access roads would be no longer than 1 mi and have a maximum ROW width of 100 ft.

- Criteria pollutants emitted from construction activities are less than Clean Air Act *de minimis* levels set by the EPA if the site is located in a nonattainment or maintenance area or adjacent to these areas, or the site is located in an attainment area.
- The site is not located within 1 mi of a mandatory Class I Federal area where visibility is an important value.
- The LOS determination for affected roadways does not change.
- Mitigation necessary to rely on the generic analysis includes implementation of BMPs for dust control.
- Compliance with air permits under State and Federal laws that address the impact of air emissions during construction.

3.3.2.1.2 GHG Emissions during Construction

Equipment and vehicles used during building activities, including construction worker vehicles and delivery trucks, would emit GHGs, principally CO_2. Combining the PPE values for GHG emissions for these two stages listed in Table 3-2 above, 164,000 MT CO_2(e) would be emitted during a 7-year construction period of two 1,000 MW reactors, or less than 24,000 MT/yr CO_2(e) on average.

As noted in Section 3.3.2 above, the NRC staff has determined that the contribution of plant life-cycle GHG emissions is a Category 1 issue. The NRC staff concludes that, as long as the PPE and SPE assumptions associated with the life-cycle GHG emissions are met, the GHG impacts from building a nuclear reactor can also be generically determined to be SMALL. The staff relied on the following PPE values and assumptions to reach this conclusion:

- GHGs emitted by equipment and vehicles during the 97 year reactor GHG life-cycle period would be equal to or less than 2,534,000 MT of CO_2(e). Appendix H of this GEIS contains the staff's methodology for developing this value, which includes emissions from construction, operation, and decommissioning. As long as this total value is met, the impacts for the life-cycle of the project and the individual phases of the project are determined to be SMALL.

3.3.2.2 Environmental Consequences of Operation

The NRC staff identified four air quality issues for analysis of the operation of a nuclear reactor:

- emissions of criteria and HAPs to the atmosphere during operation activities in relation to regional air quality conditions and thresholds for NAAQSs for criteria pollutants and HAPs;
- cooling-system impacts such as ground-level fogging/icing, plume shadowing, drift deposition from dissolved salts and chemicals found in the cooling water, and ground-level temperature and humidity increases;
- emissions to the atmosphere of ozone and NOx from transmission line operation; and
- GHG emissions during operations.

These air quality impacts would be expected to continue during the operational life of the reactor.

3.3.2.2.1 Emissions of Criteria and Hazardous Air Pollutants during Operation

The principal air emission sources for criteria pollutants during operation would be auxiliary equipment, such as boilers for heating and startup, engine-driven emergency equipment, emergency power supply system diesel generators and/or gas turbines, depending on the plant design, and refurbishment activities. Emissions would include NOx, CO, SOx, CO_2, CH_4, N_2O, hydrocarbons in the form of VOCs, and $PM_{2.5}$ and PM_{10}.

Impacts on air quality during normal plant operations can result from operations of fossil-fuel-fired equipment needed for various plant functions, although these types of operations may be reduced, limited, or not present for smaller reactor designs. Each licensed plant typically employs emergency diesel generators for use as a backup power source. Emergency generators would be used on an infrequent basis and therefore pollutants discharged (e.g., particulates, SOx, CO, hydrocarbons, and NOx) would be released infrequently. Emergency diesel generators and fire pumps typically require State or local operating permits for routine (typically monthly) testing. These monthly tests have several test burns of various durations (e.g., 1 to several hours). In addition to these maintenance tests, longer-running endurance tests are typically conducted at each plant. Each generator is typically tested for 24 hours on a staggered test schedule (e.g., once every refueling outage) (NRC 2024-TN10161). Plants with nonelectric fire pumps, typically also diesel-fired, usually employ test protocols identical or similar to those used for emergency generators. Many State air pollution regulations provide exemptions for air pollution sources that are not routinely operated, which can be defined as sources that have insignificant activity, meeting specified operating criteria (e.g., so many hours of continuous operation over specified periods or so many hours of operation per year) (NRC 2024-TN10161). In addition to the emergency diesel generators, fossil-fueled (i.e., diesel-, oil-, or natural-gas-fired) boilers can be used primarily for evaporator heating, plant space heating, and/or feed water purification. Again, depending on the simplicity of the reactor design, this equipment may be reduced or eliminated.

Air emission sources associated with nuclear power plant operation would be managed in accordance with Federal, State, and local air quality control laws and regulations. A new plant at any U.S. site would comply with all regulatory requirements of the Clean Air Act, as well as any relevant State requirements to minimize impacts on State and regional air quality. When an applicant selects a project design, modeling, as required, will be conducted to demonstrate the project emissions will not result in exceedances of the NAAQS. The evaluation will include a determination of whether the project is in an attainment area for all NAAQS criteria pollutants (Clean Air Act, Part D-TN6972), and whether the proposed project is subject to a Nonattainment New Source Review (EPA 2016-TN6970). A PPE for this GEIS assumes that all operational emissions of criteria pollutants are below *de minimis* levels for NAAQSs if the project/action is located in a nonattainment or maintenance area or adjacent to these areas.

Operations-related traffic would also result in vehicular air emissions. Some communities located near the construction site may experience increases in traffic and associated increases in the amount of particulate and gaseous emissions. The impact of emissions from additional workforce traffic would be localized and have little impact on the regional air quality (NRC 2021-TN7037). Nominal localized increases in emissions would occur as a result of the increased numbers of cars, trucks, and delivery vehicles that would travel to and from the plant site. Emission impacts for operation assume that LOS values can be maintained with the increased traffic volumes.

In addition to criteria pollutants, fuel oil for the diesel generators is a source of HAPs. To be considered a major source of HAPs by EPA, a facility must have the potential to emit 10 T/yr of an individual HAP or 25 T/yr or more total for all HAPs (Clean Air Act; 42 U.S.C. §§ 7401 et seq.; TN1141). Because diesel generators operate on a limited basis (typically monthly), the staff does not expect that HAPs for diesel generators associated with a nuclear reactor would meet the 10 T/yr threshold. The PPE assumes that HAPs emissions will be within regulatory limits.

The staff has determined that air quality during operation of a nuclear reactor is a Category 1 issue. The potential impact from emergency generators and boilers on air quality, given the infrequency and short duration of maintenance testing, would not be an air quality concern. The staff concludes that air quality impacts from operating a nuclear reactor can be generically determined to be SMALL. The staff relied on the following PPE values and assumptions to reach this conclusion:

- Criteria pollutants emitted from vehicles and standby power equipment during operations are less than Clean Air Act *de minimis* levels set by the EPA if located in a nonattainment or maintenance area.
- The site is not located within 1 mi of a mandatory Class I Federal area where visibility is an important value.
- The LOS determination for affected roadways does not change.
- Compliance with air permits under State and Federal laws that address the impact of air emissions.
- HAP emissions will be within regulatory limits.

3.3.2.2.2 GHG Emissions during Operation

Equipment and vehicles used during plant operations, the uranium fuel cycle, and fuel and waste transport would emit GHGs, principally CO_2. Combining the PPE values for GHG emissions for these stages listed in Section 3.3.1 above, 2,296,000 MT would be emitted during a 40-year operation period for two 1,000 MW reactors, or about 57,400 MT/yr on average. As noted in Section 3.3.2 above, the staff has determined that the contribution of plant life-cycle GHG emissions is a Category 1 issue. The staff concludes that, as long as the PPE assumption associated with GHG emissions is met, the GHG impacts from operating a nuclear reactor can also be generically determined to be SMALL. The staff relied on the following PPE values and assumptions to reach this conclusion:

- GHGs emitted by equipment and vehicles during the 97-year reactor GHG life-cycle period would be equal to or less than 2,534,000 MT of CO_2(e). Appendix H of this GEIS contains the staff's methodology for developing this value, which includes emissions from construction, operation, and decommissioning. As long as this total value is met, the impacts for the life-cycle of the project and the individual phases of the project are determined to be SMALL.

3.3.2.2.3 Cooling-System Emissions

The primary impacts of operating a new nuclear power plant on local meteorology would be from releases to the environment of heat and moisture from the primary cooling system. Cooling towers, if used, would remove excess heat by evaporating water. Upon exiting the tower, water vapor would mix with the surrounding air, and this process would generally lead to condensation

and formation of a visible plume, which would have aesthetic impacts. Cooling towers would also produce drift. Drift is composed of small water droplets that are carried out of the cooling tower. These droplets evaporate, leaving particles that contain residual salts and chemicals from the cooling water. Drift from mechanical draft cooling towers is deposited near the cooling tower, and drift from natural draft towers is deposited farther downwind (NRC 2024-TN10161). Wet cooling towers at existing nuclear power plants generally have drift eliminators to reduce drift (NRC 2013-TN2654). Other meteorological and atmospheric impacts from cooling towers include ground-level fogging/icing, plume shadowing, and ground-level temperature and humidity increases. In addition, plumes from the cooling towers could interact cumulatively with emissions from other sources on the site.

The PPE includes an assumption of a maximum height of 100 ft for mechanical draft cooling towers that have drift eliminators. The PPE also assumes that the site is not located within 1 mi of a mandatory Class I Federal area where visibility is an important value. The SPE assumes there will be no existing residential areas within 0.5 mi of the site.

The LR GEIS (NRC 2024-TN10161) and SEISs for individual plant relicensing evaluated the impact of the continued operation of cooling towers, including natural draft cooling towers, at existing power plants for an additional 20 years and found the impacts to be SMALL. For these license renewal reactor EISs, most of the impacts occurred within 1 mi of the cooling towers. The staff evaluated the impact of continued operation of cooling towers, including natural draft cooling towers, at existing power plants for an additional 20 years and found the impacts to be SMALL. In the 1996 LR GEIS (NRC 1996-TN288) the staff reviewed the distances and impacts from deposition of salt drift from nuclear power plants, which states the "...measurements indicate that, beyond about 1.5 km (1 mi) from nuclear plant cooling towers, salt deposition is not significantly above natural background levels." In addition, the NRC staff reviewed the recent new reactor EIS reviews for cooling-tower impacts and the impacts were found to be SMALL for ground-level fogging/icing, plume shadowing, drift deposition from dissolved salts and chemicals found in the cooling water, and ground-level temperature and humidity increases (NRC 2021-TN7037). For these new reactor EISs, most of the impacts occurred within 1 mi of the cooling towers except for the longest plumes which occurred typically within 5 mi of the cooling towers, but these plume lengths were infrequent, occurring a small percentage of the time during certain times of the year. Icing impacts were infrequent and in more southern areas of the U.S. were not likely to occur (i.e., Florida, Texas, South Carolina) as compared to more northern areas of the United States.

In addition to emissions of criteria pollutants, releases of HAP could be expected from chemical additives used in the cooling-tower water. Some examples of these chemical additives are sodium hypochlorite (NaOCl), sodium hydroxide (NaOH), hydroxyethylidine diphosphonic acid (HEDP), and petroleum distillate. Chemical additives added to cooling-tower water are within State regulatory limits or would be within the releases of HAPs listed in Section 112 of the Clean Air Act (42 U.S.C. § 7412-TN7014). The PPE assumes that the emissions of HAPs from the cooling tower will meet the regulatory limits set by EPA or the State.

The staff has determined that air quality during operation of cooling towers associated with a nuclear reactor is a Category 1 issue. The staff concludes that air quality impacts from operating cooling towers associated with a nuclear reactor can be generically determined to be SMALL. The staff relied on the following PPE values and assumptions to reach this conclusion:

- If needed, cooling towers would be mechanical draft, not natural draft.
- Cooling towers would be equipped with drift eliminators.

- The site is not located within 1 mi of a mandatory Class I Federal area where visibility is an important value.
- Mechanical draft cooling towers would be less than 100 ft tall.
- Makeup water would be fresh (with a salinity less than 1 ppt).
- Operation of cooling towers is assumed to be subject to State permitting requirements.
- HAP emissions would be within regulatory limits.
- No existing residential areas within 0.5 mi of the site.

3.3.2.2.4 Emissions of Ozone and NOx during Transmission Line Operation

Small amounts of ozone and even smaller amounts of NOx are produced by transmission lines and associated equipment. The impacts of existing transmission lines on air quality are addressed in the LR GEIS (NRC 2024-TN10161). The staff found the production of ozone and NOx to be insignificant for 765 kilovolts (kV) transmission lines (the largest lines in operation) and for a prototype 1,200 kV transmission line (NRC 2024-TN10161). In addition, it was determined that potential mitigation measures, such as burying transmission lines, would be very costly and would not be warranted.

The staff has determined that air quality during operation of transmission lines is a Category 1 issue. The staff concludes that based on the LR GEIS (NRC 2024-TN10161) and more recent new reactor EIS findings, impacts from emissions of ozone and NOx can be generically determined to be SMALL without relying on mitigation. The staff relied on the following PPE value to reach this conclusion:

- The transmission line voltage would be no higher than 1,200 kV.

3.4 Water Resources

3.4.1 Baseline Conditions and PPE/SPE Values and Assumptions

Water resources comprise surface water bodies (e.g., rivers, streams, lakes, ponds, estuaries, oceans, and manufactured reservoirs) and groundwater aquifers (including unconfined, water table aquifers, deeper confined aquifers, and perched saturated zones). Exchange between surface water bodies and groundwater systems is common (e.g., groundwater discharge to, or recharge from, abovementioned surface water bodies). Water may be used for many purposes including public and domestic supplies, industrial (including cooling) processes, building-related activities, agriculture, hydropower production, recreation, and general ecosystems support. An assessment of baseline conditions for water resources includes a description of the surface water bodies and groundwater aquifers potentially affected by the building and operation of a proposed plant, the existing and planned uses of the affected water bodies, trends in water quality, and any regulatory restrictions on water use or on discharges affecting water quality.

Nuclear power plants use water during both construction and operation. However, impacts on water resources are typically greatest during plant operations, which require water over an operating period that could last for 40 or more years. In the current fleet of power plants with large LWRs, the predominant use for water during operations is for removing excess heat generated in the reactor by condenser cooling. Some new nuclear reactor designs may not use water for cooling purposes. If cooling water is not used, then the impacts from the use of cooling water does not need to be analyzed. In addition to removing heat from the reactor, cooling water

is also provided to the service water system and to the auxiliary cooling-water system. However, the amount of water used by these systems is small compared to the amount of water typically required for the condenser cooling system. Nuclear power plants may also require water for other plant systems (e.g., fire suppression) and for sanitary or potable uses. During operations, nuclear power plants typically discharge warm water to a receiving water body. This discharge can contain blowdown from cooling systems, process water from other plant systems, and sanitary system discharges. Reduction or elimination of water use and discharge will increase the number of potential sites at which a new nuclear reactor may be located and decrease the potential for impacts on water resources in the vicinity of the corresponding location.

Construction activities and nuclear power plant operations may contribute to changes in water quality conditions. Removal of vegetation and construction of buildings, parking lots, and other impervious surfaces can increase runoff from a site and result in the entrainment of sediments and pollutants in the runoff that ultimately discharges to nearby water bodies. Building of intake and discharge structures may temporarily disturb natural water flows similar to dredging or fill placement in waterways. Water withdrawal for plant use may affect the quality of the groundwater or surface water source. Discharge of cooling water and other plant wastewaters introduces chemical constituents of plant operations (e.g., cooling-water treatment chemicals) and thermal pollution to the receiving water body. In addition, inadvertent chemical spills or releases that are transported with runoff may contaminate surface water and groundwater resources.

During both construction and operation of a nuclear power plant, water from municipal sources may be needed to support the potable and sanitary needs of plant personnel. The potential municipal water demand is expected to be relatively small compared to a plant's cooling-water needs. However, this water demand may affect the ability of nearby municipal water systems to meet their planned obligations. Nuclear power plants may also discharge plant effluents (e.g., sanitary and sewage discharges) to municipal wastewater systems that may affect the municipal systems' ability to meet their planned obligations.

Applicants seeking to construct and operate a nuclear reactor must obtain and comply with all applicable permits and authorizations that regulate alterations and limit impacts on the hydrologic environment. Federal regulations for water quality, use, and withdrawal stem from the CWA (codified as the Federal Water Pollution Control Act of 1972; 33 U.S.C. §§ 1251 et seq.; TN662).[4] Dredging and construction-related activities are regulated by provisions of the CWA Section 404 (33 U.S.C. § 1344-TN1019) and Section 10 of the Rivers and Harbors Appropriation Act of 1899 (33 U.S.C. §§ 401 et seq.; TN660). Federal regulations may be administered through a State permitting program, which may institute more restrictive criteria based on the unique regional or local environment or environmental issues. In addition, local or regional water boards or river authorities may require registration, notification, and permitting of the use of water from rivers, reservoirs, and aquifers. Descriptions of applicable laws, regulations, and other authorizations are provided in Appendix F.

For each potential resource impact described in the following sections, the level of information provided should be related to the amount of use and the degree of anticipated impacts.

[4] The CWA includes Sections 401 (Water Quality Certification; 33 U.S.C. § 1341-TN4764), 402 (National Pollutant Discharge Elimination System, or NPDES, permit; 33 U.S.C. § 1342-TN4765), and Sections 316(a) and 316(b) (for cooling-water discharges and withdrawals, respectively; 33 U.S.C. § 1326-TN4823). Applicable regulations also include U.S. Environmental Protection Agency measures for spill prevention and response (40 CFR Part 112 [TN1041]).

Applicants should provide a description of communications with relevant Federal, State, regional, and local authorities and agencies related to obtaining applicable permits and authorizations governing water use and quality. Compliance with environmental quality standards and permit requirements does not satisfy the need for NRC staff to evaluate environmental impacts. However, any assessment that supports the permit may be considered as part of the evaluation of environmental impacts. See footnote 3 to 10 CFR 51.71(d) (TN250).

Monitoring programs should be developed to identify potential adverse impacts and to formulate associated water resource mitigation strategies related to operation. Monitoring programs, which are required as part of Federal and State permits, should include identification of alternatives or engineering measures that could be implemented to mitigate impacts, if needed.

3.4.1.1 Surface Water Resources

3.4.1.1.1 Surface Water Use

Operating large LWR nuclear power plants typically withdraw large volumes of surface water to meet a variety of plant needs related primarily to use in cooling systems. Nuclear reactors could be either “dry” cooled, “wet” cooled, or use a combination of both (“hybrid”). Dry-cooled systems use no water and can significantly decrease the total water consumption of a power plant. Wet-cooled systems rely on water for cooling and use systems that interface significantly with water resources. With one exception, the current fleet of operating large LWR nuclear plants rely on surface water sources for cooling. These sources include flowing water bodies (e.g., stream, canal, or river) and non-flowing water bodies (e.g., oceans, gulfs, intertidal zones, estuaries, lakes, ponds, and reservoirs)[5] and use a variety of cooling systems. Currently, the Palo Verde Nuclear Generating Station is the only operating plant that uses treated wastewater for cooling purposes. Proposed new large LWRs may also plan to withdraw water from a variety of surface water sources to supply the cooling-water system with makeup water. Once-through systems are used for most operating units. The remaining units employ closed-cycle systems, which rely on cooling ponds, lakes, canals, and mechanical and natural draft cooling towers to transfer waste heat to the atmosphere. Compared to the large LWRs mentioned above, it is anticipated that smaller nuclear reactors may use cooling technologies that reduce or eliminate reliance on water for cooling purposes or for reactor shutdown.

In environmental reviews for large LWRs, the NRC staff evaluates the effects that plant water use may have on the availability of surface water resources and the impacts of uses and users of these resources. For this GEIS, the staff developed plant and site parameters for water demand and available supply to provide guidance for evaluating issues arising from water use conflicts between the proposed plant and other uses and users. These parameters are presented and explained in the PPE/SPE table in Appendix G. The total plant water demand PPE was developed by the NRC staff after considering the bounding value for water requirements presented in the NRIC PPE report for advanced nuclear reactor designs (NRIC 2021-TN6940). This NRIC bounding value includes water use by all advanced nuclear reactor plant systems. The NRC staff increased this value to the nearest 1,000 gpm to derive the PPE for this GEIS, which specifies that the total plant water demand does not exceed a daily

[5] Flowing and non-flowing water bodies are distinguished primarily based on the mechanism that provides water availability. Water availability in flowing water bodies (e.g., stream, canal, or river) is primarily provided by the water body’s discharge rate and storage effects are minor. In non-flowing water bodies (e.g., oceans, gulfs, intertidal zones, estuaries, lakes, ponds, and reservoirs), water availability is primarily provided by the volume of stored water.

average of 6,000 gpm. The NRC staff assumed that the total plant water demand accounts for the maximum amount of water supply required for all plant needs and may include water from multiple sources.

Based on this PPE value, the total surface water use by plant systems would be less than or equal to 6,000 gpm. Because the NRIC PPE report covers a wide range of reactor types and power outputs, the staff expects that the 6,000 gpm limit would not be overly restrictive of new reactor designs addressed by this GEIS. This limit also provides staff with confidence that conclusions reached in this GEIS will be valid given the wide range of site characteristics and settings to which this GEIS might be applicable.

The staff separated potential surface water sources into two broad categories in the generic analysis: (1) flowing surface water bodies (e.g., stream, canal, or river) and (2) non-flowing surface water bodies. The staff differentiated non-flowing surface water bodies into two categories that are based on water body size and correspond to the potential for hydrologic and aquatic impacts from plant water usage at the PPE withdrawal rate discussed above. The categories are large water bodies (specifically the Great Lakes, the Gulf of America, estuaries, intertidal zones, and oceans) and smaller water bodies (e.g., inland lakes, ponds, and reservoirs).

To minimize the impact on flowing surface water bodies, the SPE specifies that plant withdrawals from water bodies be limited to no more than 3 percent of the 95 percent exceedance daily flow of the source. The staff developed this SPE criterion for water withdrawal by evaluating the impacts related to plant use of flowing surface water bodies in EISs for new reactors and the LR GEIS for operating reactors. Based on the evaluations provided in these recent EISs and the LR GEIS, the staff determined that the impacts would be SMALL for withdrawal rates at or below 3 percent of the water available during low flow conditions. EPA regulations specified in 40 CFR Part 125, Subpart I codify requirements applicable to cooling water intake structures for new facilities (40 CFR Part 125 Subpart I-TN4818). The total plant water demand PPE of 6,000 gpm (8.64 MGD) for the new reactors addressed in this GEIS would place the facilities in Tracks I or II (40 CFR 125.84(a)-TN254). For both Tracks, the total design intake flow from cooling water intake structures located in freshwater rivers and streams must be no greater than 5 percent of source water annual mean flow (40 CFR 125.84(c)(2)(i) or 40 CFR 125.84(d)(2)(i)) (TN254). The SPE value (3 percent of the 95 percent exceedance daily flow) is bounded by the proportional flow limitation, which specifies that total design intake flow must be no greater than 5 percent of the source water annual mean flow. The staff assumed that the 95 percent exceedance daily flow is estimated accounting for all existing withdrawals and instream flow requirements.

For large non-flowing surface water bodies, the staff recognize that project-specific conditions could result in noticeable impacts on water resources at sufficiently large withdrawal rates. However, water bodies the staff expects that the total plant water demand PPE value of 6,000 gpm would not result in water use conflicts in the Great Lakes, the Gulf of America, estuaries, intertidal zones, and oceans, because the plant demand would be negligible compared to water availability. For smaller non-flowing water bodies (e.g., inland lakes, ponds, and reservoirs), the impacts from competing water uses could manifest in different ways (e.g., reduction in downstream discharge from the water body, reduction in water surface elevation of the water body, and reduction in nearshore habitat suitability) that depend on site-specific hydrologic conditions. Therefore, these smaller water bodies fall outside the SPE value for Surface Water Availability—Non-flowing in Appendix G.

For both flowing and non-flowing sources, corresponding assumptions stated in Appendix G should be met. If water is supplied by municipal systems, the staff assumes that the amounts will be within the available capacity of the system. This is reflected in the PPE value for municipal water availability.

3.4.1.1.2 Surface Water Quality

In environmental reviews for large LWRs, the NRC staff typically evaluates the effects on surface water quality from both construction and operation activities in terms of the degradation of the ambient conditions of the water source and the resulting impacts on uses and users of that source. During operations, surface water quality can be affected by the numerous nonradioactive liquid effluents discharged from nuclear power plants. Discharges from the cooling system usually account for the largest volumes of water and the greatest potential impacts on water quality and aquatic systems, although other systems may contribute heat and contaminants to the effluent. Operation of these cooling systems may alter current patterns at intake and discharge structures, salinity gradients, and thermal attributes of the receiving water bodies. Water quality could be affected by temperature effects, sediment discharge, scouring, eutrophication, and the discharge of water containing biocides, sanitary wastes, heavy metals, and higher total dissolved solids (TDS) concentrations than those in the receiving water bodies. During construction, surface water quality in nearby water bodies can be affected by runoff containing sediments and other contaminants from industrial sites including any inadvertent spills that ultimately reach these water bodies.

Plant discharges must meet limits set forth in the CWA and specified in the applicable Federal, State, and local permits received for the site. Discharge criteria are determined and implemented by Federal and State agencies responsible for protection of resources based on various project-specific conditions. As a result, criteria may vary among States and among water body uses and types. To mitigate the effects of thermal discharges a mixing zone may be established in the receiving water body such that changes from ambient temperatures outside of the mixing zone are considered minor. The establishment of a mixing zone is highly project-specific, as discussed in Section 3.4.2.2.7.

The PPE/SPE specifies that if discharge water is sent to a municipal wastewater treatment facility, the available capacity of the municipal system to treat effluents will exceed the expected amount of plant effluent.

3.4.1.2 Groundwater Resources

3.4.1.2.1 Groundwater Use

Groundwater has typically been used for non-cooling-water supplies at proposed and operating nuclear power plants. Groundwater has been used for common construction activities such as dust abatement, soil compaction, and as a supply for concrete batch plants. Excavations of plant foundations may also require dewatering or groundwater removal during construction-related activities. Plants may continue dewatering during operations to maintain low water levels near buildings and foundations. During construction and operation, groundwater has also been used for systems that require a higher degree of water quality such as potable and sanitary systems, service water, fire protection water, and plant systems that require demineralized water. Applications for new large LWR nuclear power plants or early site permits (ESPs) in the past have proposed to use groundwater for construction and/or operation.

Nuclear plants that withdraw groundwater may affect the availability of groundwater for other nearby users. Impacts could occur as a direct effect of withdrawing groundwater by lowering the water table or indirectly by inducing the movement of lower quality water (e.g., saline water) toward existing well users. Nearby groundwater users could also be affected indirectly if construction or operation of the power plant were to disrupt the normal recharge of the groundwater aquifer. The impacts of large groundwater withdrawal rates are likely to be more significant for users located close to the plant boundary, and in areas where available water resources are stressed. The magnitude of impacts from groundwater withdrawals is also dependent on the site conditions and the hydrogeologic characteristics of the affected aquifer. For example, groundwater pumping from confined aquifers tends to affect larger areas than does pumping from unconfined aquifers for a given pumping rate, and for aquifers that are less transmissive.

A permit from the State or other local/regional governing body is typically required to withdraw groundwater. Permitting criteria may include the effects on water rights, availability of water, interference with other beneficial uses, lowering groundwater levels (drawdown), and water quality. The effects on connected surface water bodies (e.g., reductions in streamflow resulting from groundwater withdrawals) may be a consideration. A permit exemption may be available in areas when the withdrawal is less than a threshold value (e.g., 100,000 gpd or about equivalent to a constant pumping rate of about 70 gpm), consistent with the expectation that lower withdrawal rates would typically result in fewer impacts.

For operating plants, the NRC staff has found that groundwater withdrawals of 100 gpm or less created negligible or small impacts at operating nuclear power plants because this use rate would not generally lower groundwater levels beyond the site boundary (NUREG-1437; NRC 2024-TN10161). Operating plant site areas are significantly larger than the site area SPE value of 100 ac considered in this GEIS. Because some new nuclear reactor sites would be smaller than large LWR sites, groundwater wells could be closer to the site boundary. As a result, the NRC staff determined that the GEIS PPE/SPE should include a maximum groundwater withdrawal rate less than 100 gpm, the rate used in the LR GEIS (NRC 2024-TN10161). In addition, the staff determined that the GEIS SPE should include limits on the effects of withdrawals and dewatering on groundwater levels at the site boundary.

The PPE and SPE parameter table in Appendix G specifies that groundwater withdrawals for all plant uses (excluding dewatering withdrawals) be less than or equal to 50 gpm for a new nuclear reactor. Based on simplified modeling, the NRC staff determined that effects on groundwater levels at the site boundary from pumping 50 gpm on a 100 ac site would approximate the effects from pumping 100 gpm on a larger site the size of a typical large LWR. In addition, the staff assumed that the hydrogeologic properties of the aquifer are such that groundwater withdrawals for plant uses would reasonably result in less than a 1 ft reduction in groundwater levels at the site boundary. The threshold of 1 ft was selected as a *de minimis* value likely to be less than the natural annual fluctuations in groundwater levels at most sites. The groundwater withdrawal parameter also includes the assumption that plant groundwater withdrawals would not occur in an aquifer designated by the EPA as a Sole Source Aquifer (SSA), or in any aquifer designated by a State, Tribe, or regional authority to have special protections to limit drawdown. Groundwater withdrawals are also assumed to meet the permitting requirements of applicable State and local agencies.

The PPE/SPE specifies that groundwater withdrawals for dewatering also be no more than 50 gpm. The staff assumed the value of 50 gpm represents the long-term, steady dewatering rate; the initial rate of dewatering may be larger. Based on simplified modeling, the NRC staff

determined that, relative to the plant site area, the effects on groundwater levels caused by dewatering withdrawals of 50 gpm at a 100 ac site would be similar to the effects caused be dewatering withdrawals of 100 gpm on a larger site the size of a typical large LWR. Consistent with the site area used in this NR GEIS, the staff assumed in this simplified modeling that the area to be dewatered and the depth of groundwater drawdown at the excavation/foundation would be smaller for new nuclear reactors than for a typical large LWR. The PPE/SPE dewatering parameter also includes assumptions that the hydrogeologic characteristics of the site are such that dewatering has a negligible effect on groundwater levels at the site boundary and that dewatering discharge does not affect the quality of the receiving water body.

Because groundwater withdrawals could affect wetlands on or near the site, the SPE includes assumptions that any changes in wetland water levels and hydroperiod caused by groundwater use or dewatering are within historical annual or seasonal fluctuations to avoid adverse impacts on wetlands. Potential groundwater use impacts on wetlands are discussed in Sections 3.5.2.1.2 and 3.5.2.2.7 of this GEIS.

3.4.1.2.2 Groundwater Quality

When conducting environmental reviews for large LWRs, the staff evaluates the potential effects of plant construction and operation on current groundwater quality conditions. Groundwater withdrawals could impair groundwater quality if they result in the movement of lower quality groundwater. For example, long-term pumping of groundwater from coastal plain aquifers by industrial and municipal facilities has contributed to saltwater intrusion in areas of nearly every Atlantic and Gulf Coast State (Trapp and Horn 1997-TN1865; USGS 1990-TN6648). Groundwater quality could also be impaired at inland sites where groundwater may be replaced by poorer quality surface water through induced infiltration, or where groundwater has been previously contaminated. Groundwater quality impacts are considered to be of small significance when the plant does not contribute to changes in groundwater quality that would preclude current and future uses of the groundwater. As with water use impacts, these types of groundwater quality impacts are likely to be most significant when a plant withdrawal rate is large.

Groundwater quality may be affected by releases of potential contaminants to the subsurface. Any intentional discharge of wastewaters to the subsurface would be regulated by the EPA as required by 40 CFR Part 144 (Underground Injection Control Program) and/or State underground injection control requirements. Spills or leaks from nuclear power plant facilities can also impair groundwater quality. Nonradioactive materials such as fuels, solvents, and other chemicals are typically stored and used at the nuclear power plants as part of general industrial activities. Spills of these materials can occur during their use, and leaks from storage containers and associated transfer lines can occur above and below the ground surface. Storage and handling of fuels and chemicals are regulated by EPA and State requirements, and typically require that spill prevention and response procedures be considered.

NRC licensees are required to document and report the hazard of known releases of radionuclides. However, inadvertent releases of radionuclides to groundwater may not be easily detected and have resulted in groundwater contamination at operating nuclear power plants. Operating plants have implemented a voluntary groundwater protection program to detect and respond to inadvertent releases of radionuclides to groundwater (NEI 2019-TN6775). This program includes characterization of site geology and hydrology, risk assessment for releases, groundwater monitoring, establishment of a remediation protocol to prevent offsite migration of radionuclides, and reporting of leaks/spills and groundwater monitoring results. Appendix I

to 10 CFR Part 50 provides the framework for the radiological environmental monitoring program (REMP) by directing licensees to establish surveillance and monitoring programs, including groundwater monitoring, for release of radionuclides. Guidance related to the REMP is provided in RG 4.1 (NRC 2009-TN3802). In addition, 10 CFR 50.36a (TN249) requires that licensees establish Technical Specifications to keep releases of radioactive materials as low as reasonably achievable or ALARA.

To minimize the potential groundwater quality impacts, the PPE and SPE parameter table in Appendix G specifies that the plant will not be located in the recharge area for an EPA-designated SSA, or in the recharge area for any aquifer designated by a State, Tribe, or regional authority to have special protections. Under the provisions of the Safe Drinking Water Act (SDWA), States must establish demonstration programs for protection of critical aquifers. In addition, the groundwater quality parameter in Appendix G specifies that the plant will not be located in a wellhead protection area or designated groundwater recharge area for a public water supply well. It is also assumed that there are no planned plant discharges to the subsurface, that applicable requirements and guidance on spill prevention and control are followed, and that a groundwater protection program to detect and monitor inadvertent releases is established and followed. If a new nuclear reactor is proposed for a site that does not conform to these groundwater quality parameters and assumptions, a project-specific evaluation would be required, and the NRC would consult with the jurisdictional authority and responsible agencies when evaluating impacts.

3.4.2 Water Resources Impacts

The NRC staff took four steps to develop a basis for determining values and assumptions for a PPE and SPE for new nuclear reactors in order to determine which issues related to water resources might be dispositioned generically (Category 1) and which would require a project-specific evaluation (Category 2). First, the staff reviewed all EISs published since 2006 for new reactor projects that have received NRC permits and licenses to evaluate the corresponding water use and summarize the resultant impact determinations.[6] Second, the staff reviewed the LR GEIS (NRC 2024-TN10161) to understand the key factors and assumptions used to determine the impact level and category designation for water resource issues. Third, the staff evaluated criteria for water withdrawal and discharge from three states (Tennessee, Idaho, and Alaska), which are representative of variable regions and climates where a new nuclear reactor might be sited, to develop a bounding set of PPE and SPE parameters that are independent of a potential design or power rating. Lastly, the NRC staff reviewed the applicable Federal and State regulations and permit requirements related to water resources.

Applicants for a new nuclear reactor license would be expected to obtain and comply with all applicable permits and authorizations that regulate and limit impacts on the hydrologic environment. Federal regulations administered by a State may be more restrictive than the corresponding Federal regulations in order to account for unique regional or local environment or environmental issues. As a result, the water-related authorizations may include, but not be

[6] Combined license EISs reviewed were those for Fermi Unit 3 (NRC 2013-TN6436), Levy Units 1 and 2 (NRC 2012-TN1976), North Anna Unit 3 (NRC 2010-TN6), South Texas Project Units 3 and 4 (NRC 2011-TN1722), V.C. Summer Units 2 and 3 (NRC 2011-TN1723), Vogtle Units 3 and 4 (NRC 2011-TN6439), W.S. Lee Units 1 and 2 (NRC 2013-TN6435), and Turkey Points Units 6 and 7 (NRC 2016-TN6434). ESP EISs reviewed were those for Clinton (NRC 2006-TN672), Grand Gulf (NRC 2006-TN674), North Anna (NRC 2006-TN7), Vogtle (NRC 2008-TN673), PSEG (NRC 2015-TN6438) and Clinch River NRC 2019-TN6136).

limited to, those listed in Appendix F of this GEIS. The applicant would also comply with other applicable regional, State, tribal, and local regulations, which may include the following:

- Water withdrawal registration and notification. Some States may require notification and water withdrawal registration for amounts that exceed State-specified limits to aid in water resource management during drought conditions.
- Water and sewer connection permits. Typically issued by a city, county, or municipal district.

3.4.2.1 Environmental Consequences of Construction

Construction activities that may result in impacts on water quality, availability, and designated use include the following:

- land clearing, grading, and placement of fill and spoils associated with site preparation
- construction of drainage and detention/retention features
- construction of features at, in, or near-surface water bodies, which may include intake and outfall structures, cofferdams, bulkheads, piers, jetties, and basins
- water channel modifications, including filling or dredging
- alteration of floodplains, natural drainage features or waterways near site
- development of infrastructure such as roads, parking lots, laydown areas, and surface and subsurface transmission lines (above and below ground)
- inadvertent spills of liquids (e.g., oil, fuel, diesel, solvents, wastewater)
- excavations and dewatering of building foundations
- surface water, groundwater, or municipal water use for construction-related purposes (e.g., dust suppression, concrete batch plant, potable and sanitary water)
- discharges from stormwater runoff and sanitary systems.

These construction activities may affect the quality and availability of surface water and groundwater resources in the vicinity of the proposed site. The NRC staff identified and evaluated the following environmental issues related to water use and quality, which may arise from the construction activities listed above:

- surface water use conflicts during construction
- groundwater use conflicts due to excavation dewatering
- groundwater use conflicts due to construction-related groundwater withdrawals
- water quality degradation due to construction-related discharges
- water quality degradation due to inadvertent spills during construction
- water quality degradation due to groundwater withdrawal
- water quality degradation due to offshore or in-water construction activities
- water use conflicts due to plant municipal water demand
- degradation of water quality due to plant effluent discharges to municipal systems.

Each of the above environmental issues is discussed in more detail in the subsequent sections.

3.4.2.1.1 Surface Water Use Conflicts during Construction

During construction, surface water may be used for activities such as dust abatement, concrete mixing, and potable water needs. Construction-related water use is usually a small portion of the amount of water needed for operation of a plant that has a water-cooled heat dissipation system and because timeframes for construction are shorter. As a result, construction-related surface water use impacts on water resources are typically less than operational impacts and, as such, construction uses would be bounded by the total plant water demand limitation of 6,000 gpm (a daily average) included in the PPE and SPE table (see Appendix G).

No EIS for a plant licensed since 2006 has concluded that the impacts of surface water use during construction would be greater than SMALL, even when surface water was the only source of construction-related water. An example is the EIS for VC Summer Units 2 and 3, in which the staff determined that construction-related surface water use would be about 1 percent of the average makeup water withdrawn during operations (NRC 2011-TN1723); if a plant used a mix of surface and groundwater resources for construction, then this percentage of surface water use would be expected to be less.

Acquiring water withdrawal permits and/or water rights for construction-related use has not resulted in water use conflicts at large LWR sites. In addition, some new nuclear reactor technologies are anticipated to require a smaller site footprint with a correspondingly reduced reliance on water resources for construction than large LWR sites. Based on the preceding discussion, the staff assumes that any applicable water withdrawal permits can be obtained, and water rights can be acquired to support construction-related use at new nuclear reactor sites. Therefore, the staff determined that the impacts on surface water use from construction of a new nuclear reactor is a Category 1 issue. The staff concludes that, as long as the relevant PPE and SPE criteria and assumptions are met for the applicable water body type, the impacts on surface water use from building a new nuclear reactor can be generically determined to be SMALL. This conclusion relies on the following PPE/SPE parameter and the associated value and assumptions:

- Total Plant Water Demand
  - Less than or equal to a daily average of 6,000 gpm.

If water is obtained from a flowing water body, then the following PPE/SPE parameter and associated assumptions also apply:

- Surface Water Availability – Flowing
  - Average plant water withdrawals do not reduce discharge from the flowing water body by more than 3 percent of the 95 percent exceedance daily flow and do not prevent the maintenance of applicable instream flow requirements.
  - The 95 percent exceedance flow accounts for existing and planned future withdrawals.
  - Water availability is demonstrated by the ability to obtain a withdrawal permit issued by State, regional, or tribal governing authorities.
  - Water rights for the withdrawal amount are obtainable, if needed.

If water is obtained from a non-flowing water body, then the following PPE/SPE parameter and associated value and assumptions also apply:

- Surface Water Availability – Non-flowing
  - Water availability of the Great Lakes, the Gulf of America, oceans, estuaries, and intertidal zones exceeds the amount of water required by the plant.
  - Water availability is demonstrated by the ability to obtain a withdrawal permit issued by State, regional, or Tribal governing authorities.
  - Water rights for the withdrawal amount are obtainable, if needed.
  - CZMA consistency determination is obtainable, if applicable, for the non-flowing water body.

3.4.2.1.2 Groundwater Use Conflicts Due to Excavation Dewatering

Excavation dewatering during construction of building foundations may be required for any new nuclear reactor project. Dewatering lowers groundwater levels adjacent to and beneath an excavation to facilitate construction and increase the stability of excavation slopes (DOD 2004-TN6814). Groundwater levels in the region surrounding the excavation will also be affected, and the magnitude of the affected area will depend on the hydrogeologic conditions of the site, the duration of dewatering, and the methods used to mitigate the effects of dewatering. Changes in groundwater levels may locally affect the direction of groundwater flow, and may alter groundwater recharge or discharge rates, including discharge to wetlands.

The impacts of dewatering have been evaluated in the EIS for each of the licensed new reactor sites. At these sites, dewatering rates were expected to be minimized by using engineering practices to limit groundwater inflow to the excavations. In instances where dewatering impacts were modeled, drawdown at the site boundary was typically less than the amount of seasonal fluctuation in the surficial aquifer and water elevations were expected to rebound quickly when dewatering ceased. With a single exception (i.e., the Grand Gulf ESP), impacts were expected to be SMALL. In the Grand Gulf ESP EIS, the staff concluded that the impacts of water use, including dewatering, on the underlying EPA SSA could not be determined because of uncertainty in the plant design, planned pumping rates, and site characterization (NRC 2006-TN674). Groundwater use conflicts, including the impacts of dewatering, were evaluated in the LR GEIS (NRC 2024-TN10161) and determined to be a Category 2 issue (SMALL, MODERATE, or LARGE impacts depending on project-specific characteristics) for plants that withdraw more than 100 gpm. Groundwater withdrawals of less than 100 gpm were determined to have SMALL impacts because the effects on groundwater levels typically do not extend beyond the site boundary (NRC 2024-TN10161).

A dewatering rate of 50 gpm is specified in the PPE/SPE table (Appendix G) of this GEIS, as discussed in Section 3.4.1.2.1. While this dewatering rate is less than the rate determined to have SMALL impacts in the LR GEIS, the staff determined that the 50 gpm value is appropriate for the site size (100 ac) specified in the PPE/SPE table. The actual impacts of dewatering at any particular site will depend on the size of the site, the area and depth of the excavation, and the hydrogeologic characteristics of the site. In evaluating the impacts of dewatering for this generic analysis, staff considered that excavations for some new nuclear reactor sites are expected to be smaller, and the depth of groundwater drawdown at the excavation are expected to be less, than those for the licensed fleet of large LWRs. With these expectations, the staff used simplified modeling to determine that, relative to the plant site area, the effects on groundwater levels caused by dewatering withdrawals of 50 gpm at a 100 ac site would be

similar to the effects caused by dewatering withdrawals of 100 gpm on a larger site the size of a typical large LWR. Accepted methods for the design of dewatering systems (DOD 2004-TN6814) were used by staff in this impact evaluation. As specified in the PPE/SPE table, dewatering is assumed to result in negligible drawdown at the site boundary. This indicates that the radius of influence of the dewatering activities, (the distance beyond which pumping of a dewatering system has no significant effect on ambient groundwater levels), does not extend beyond the site boundary. With these specifications and assumptions, the staff determined that the impacts of dewatering are likely to be localized at sites where the effective saturated hydraulic conductivity of the surficial aquifer is no more transmissive than that represented by a silty or very fine sand, or fractured/permeable rock. At smaller sites and sites that have more transmissive aquifers, the staff assumed that additional engineering controls would be used to avoid dewatering impacts beyond the site boundary.

The staff has determined that groundwater use conflicts due to excavation dewatering during construction of a new nuclear reactor is a Category 1 issue. The staff concludes that the effects of dewatering activities related to the construction of new nuclear reactors would be localized and temporary, and groundwater use conflicts from dewatering can be generically determined to have a SMALL impact for this GEIS. This conclusion relies on the following PPE/SPE parameter and the associated value and assumptions:

- Groundwater Withdrawal for Excavation or Foundation Dewatering
  - The long-term dewatering withdrawal rate is less than or equal to 50 gpm (the initial rate may be larger).
  - Dewatering results in negligible groundwater level drawdown at the site boundary.

Because wetlands located on or adjacent to the site may be affected by groundwater withdrawals for excavation dewatering, the PPE/SPE includes the assumption that changes in wetland water levels and hydroperiod resulting from groundwater use are within historical annual or seasonal fluctuations, to avoid adverse impacts on nearby wetlands. Potential groundwater use impacts on wetlands are discussed in Sections 3.5.2.1.2 and 3.5.2.2.7 of this GEIS.

Engineering controls may be required to achieve the limit on drawdown. As described in Chapter 1, the staff anticipates that an application for a new nuclear reactor license will include the appropriate data and analysis to establish with reasonable assurance that the proposed project meets the conditions of the PPE/SPE with respect to dewatering, including the limitation on drawdown at the site boundary. If the PPE/SPE conditions cannot be met, a project-specific evaluation of the impacts of excavation dewatering is required.

3.4.2.1.3 Groundwater Use Conflicts Due to Construction-Related Groundwater Withdrawals

During construction, groundwater may be used for activities such as dust abatement, concrete mixing, and potable water needs. Groundwater withdrawals from one or more wells located on the plant site will lower groundwater hydraulic head levels in the aquifer around the well(s). The magnitude of the drawdown in hydraulic head and the extent of the affected area depend on the withdrawal rate, the hydrogeologic conditions of the site, and the duration of withdrawal. Changes in groundwater levels may locally affect the direction of groundwater flow, and may alter groundwater recharge or discharge rates, including discharge to wetlands and streams.

Construction-related groundwater withdrawal rates proposed for the licensed new reactor plant and ESP sites planning to use only groundwater for construction (i.e., South Texas Project,

PSEG ESP, Vogtle, and Levy) ranged from 119 gpm to 420 gpm. In the final EIS (FEIS) for each of these proposed plants, the staff determined these pumping rates would have a SMALL impact on groundwater resources, in part due to the limited duration of construction and typical associated withdrawal rates that are less than those proposed for plant operations.

The withdrawal associated with construction use of groundwater would be subject to the limitation of 50 gpm included in the PPE/SPE table (Appendix G), as discussed in Section 3.4.1.2.1. This withdrawal limitation is more restrictive than the construction-related groundwater withdrawal rates proposed for the four licensed sites referenced above. In addition, the PPE/SPE assumes that withdrawals for plant use reduce groundwater heads at the site boundary by no more than 1 ft, as discussed in Section 3.4.1.2.1. The 1 ft limit includes the potential cumulative effect of simultaneous excavation or foundation dewatering and groundwater withdrawal for plant use because dewatering is assumed to contribute negligible drawdown at the site boundary, as specified in Appendix G. The impacts of groundwater withdrawals during operation are evaluated in Section 3.4.2.2.4 and found to be SMALL when the specifications and assumptions of the PPE/SPE are met. Because the duration of groundwater withdrawal would be shorter during construction than during operation, the staff determined that the operational impacts bound those during construction for this issue. The staff therefore concludes that this is a Category 1 issue. If actions required by appropriate permits are implemented and applicable assumptions in the PPE and SPE are met (as described in Section 3.4.2.2.4), water use conflicts related to groundwater withdrawals during construction of a nuclear reactor will be minor, and impacts can be generically determined to be SMALL for this GEIS.

3.4.2.1.4 Water Quality Degradation Due to Construction-Related Discharges

During construction-related activities, runoff from disturbed and laydown areas can potentially carry sediments to nearby surface water bodies. Because engineering controls (BMPs, silt fences, detention basins, etc.) regulated by a combination of National Pollutant Discharge Elimination System (NPDES) and USACE permitting are required during these activities, construction-related impacts on surface water quality would be controlled, localized, and temporary. Shallow groundwater withdrawn during dewatering of foundations during construction could be discharged to surface water bodies on or near the site. The discharge rate is limited to 50 gpm by the PPE/SPE value for groundwater excavation dewatering, as discussed in Section 3.4.1.2.1. These discharges would be subject to the limits of an NPDES permit designed to avoid adverse impacts on the receiving water body.

The impacts on surface water quality from construction-related discharges were determined to be SMALL in each of the EIS evaluations for new reactors because of adherence to the conditions of the NPDES permit and because of the temporary nature of the discharge. The staff expects that these impacts would be bounding for new nuclear reactors because adherence to NPDES requirements would similarly be required and because of the PPE assumption that the area disturbed would be relatively small (PPE values of 30 ac permanently disturbed and 20 ac temporarily disturbed). Accordingly, the staff has determined that water quality degradation due to construction-related discharges of a nuclear reactor is a Category 1 issue. The staff concludes that the effects of discharges related to the construction of new nuclear reactors would be localized and temporary and impacts can be generically determined to be SMALL. This conclusion relies on the following PPE/SPE parameters and the associated values and assumptions:

- Permanent Footprint of Disturbance – and Temporary Footprint of Disturbance
  - The permanent footprint of disturbance includes 30 ac or less of vegetated lands, and the temporary footprint of disturbance includes no more than an additional 20 ac or less of vegetated lands.
- Impacts on Aquatic Biota
  - Adherence to requirements in NPDES permits issued by the EPA or State permitting program, and any other applicable permits.
- Groundwater Withdrawal for Excavation or Foundation Dewatering
  - The long-term groundwater dewatering withdrawal rate is less than or equal to 50 gpm.
  - Dewatering discharge has minimal effects on the quality of the receiving water body (e.g., as demonstrated by conformance with NPDES permit requirements).

The staff also concludes that water quality impacts on groundwater can be generically determined to be SMALL. This conclusion relies on the following PPE/SPE parameter and the associated value and assumptions:

- Groundwater Quality
  - There are no planned discharges to the subsurface (by infiltration or injection), including stormwater discharge.

3.4.2.1.5 Water Quality Degradation Due to Inadvertent Spills during Construction

During construction, inadvertent spills of gasoline, diesel fuel, hydraulic fluid, lubricants, solvents, and wastewater used for construction equipment could affect both surface water and groundwater resources. Pursuant to 40 CFR Part 112 (TN1041), applicants would be required to use BMPs and implement a Spill Prevention, Control, and Countermeasure (SPCC) to minimize the occurrence of spills and limit their effects. Impacts on water quality from inadvertent spills during construction were determined to be SMALL in the EIS evaluations for new reactors because of adherence to these spill prevention and pollution control measures.

Building any nuclear reactor is expected to involve activities and methods similar to those for building a large LWR. The associated BMPs and SPCC implementation are also expected to be similar. Therefore, the staff has determined that water quality degradation due to inadvertent spills during construction of a nuclear reactor is a Category 1 issue. The staff concludes that the impacts of inadvertent spills on water quality during construction of a nuclear reactor can generically be determined to be SMALL. This conclusion relies on the following PPE/SPE parameters and the associated values and assumptions. This conclusion relies on the following assumptions:

- Site Size and Location
  - The site size is 100 ac or less

- Permanent Footprint of Disturbance and Temporary Footprint of Disturbance
  - The permanent footprint of disturbance includes 30 ac or less of vegetated lands, and the temporary footprint of disturbance includes no more than an additional 20 ac or less of vegetated lands.
- Groundwater Quality
  - Applicable requirements and guidance on spill prevention and control are followed, including relevant BMPs and SPCCs.

3.4.2.1.6 Water Quality Degradation Due to Groundwater Withdrawal

Degradation of groundwater resources may occur when dewatering or withdrawal of groundwater for plant uses induces the flow of lower quality water from the surrounding aquifers or connected surface water bodies. This could result from pumping of deep confined aquifers and dewatering of shallow, unconfined surficial aquifers.

Groundwater withdrawals may induce infiltration from surface water (e.g., rivers, ponds, or lakes), or contribute to saltwater intrusion from oceans and estuaries in aquifers near the coast. In the LR GEIS (NRC 2024-TN10161) the staff determined that pumping of confined groundwater at operating plants in estuary or coastal sites had a small impact on groundwater quality. The pumping rates considered in the LR GEIS greatly exceed the PPE/SPE limits for groundwater withdrawals.

In EISs for new reactors, the staff has generally determined that the impacts of dewatering of the surficial aquifer would not extend far beyond the site boundary. At sites located near water bodies of lower quality, such as PSEG, the surficial aquifer can be impacted. In that case, the impacts were due to hydraulic connections with brackish Delaware River water limiting the private use of groundwater in the area and the potential for further degradation (NRC 2015-TN6438).

The PPE/SPE table limits groundwater withdrawals for excavation dewatering and plant uses to 50 gpm each and assumes that groundwater withdrawals will result in no more than a 1 ft lowering of groundwater levels at the site boundary, as discussed in Section 3.4.1.2.1. The 1 ft limit includes the potential cumulative effect of simultaneous excavation dewatering and groundwater withdrawal for plant uses because dewatering is assumed to contribute negligible drawdown at the site boundary, as specified in the PPE/SPE table (Appendix G). In areas that have exploitable groundwater resources, the PPE/SPE withdrawal rate is expected to be a small fraction of the total withdrawal rate by other users (typically agricultural or municipal uses in rural and urban areas, respectively). With no more than a 1 ft change in groundwater levels at the site boundary, the potential for PPE/SPE withdrawals to induce flow from adjacent water bodies is unlikely to be noticeable. In addition, the effects of groundwater withdrawals would be limited to the period of construction.

The staff has determined that water quality degradation due to groundwater withdrawals is a Category 1 issue. The staff concludes that water quality impacts resulting from groundwater withdrawals during construction of any new nuclear reactors would be localized and temporary and can be generically determined to be SMALL for this GEIS. This conclusion relies on the following PPE/SPE parameters and the associated values and assumptions:

- Groundwater Withdrawal for Excavation or Foundation Dewatering
  - The long-term dewatering withdrawal rate is less than or equal to 50 gpm (the initial rate may be larger).
  - Dewatering results in negligible groundwater level drawdown at the site boundary.
- Groundwater Withdrawal for Plant Uses
  - Groundwater withdrawal for all plant uses (excluding dewatering) is less than or equal to 50 gpm.
  - Withdrawal results in no more than 1 ft of groundwater level drawdown at the site boundary.
  - Withdrawals are not derived from an EPA-designated SSA, or from any aquifer designated by a State, Tribe, or regional authority to have special protections to limit drawdown.
  - Withdrawals meet any applicable State or local permit requirements.

3.4.2.1.7 Water Quality Degradation Due to Offshore or In-Water Construction Activities

Activities that may be associated with water quality degradation in lakes, rivers, and marine environments include offshore or in-water construction of cofferdams; dredging operations; placement of fill material into the water; creation of shoreside facilities involving bulkheads, piers, jetties, basins, or other structures or activities with potential to alter existing shoreline processes; construction of intake and outfall structures; water channel modifications; and bridge or culvert construction. Activities related to in-water building are localized and temporary, lasting for the duration of the construction. These in-water building activities are regulated by provisions of the CWA Section 404 (33 U.S.C. § 1344-TN1019) and Section 10 of the Rivers and Harbors Appropriation Act of 1899 (33 U.S.C. §§ 401 et seq.; TN660). Adverse effects of these building activities are traditionally controlled using BMPs like installation of turbidity curtains or installation of cofferdams.

As such, the staff has determined that water quality degradation due to offshore or in-water construction activities is a Category 1 issue and that the impacts could be generically determined to be SMALL. This conclusion relies on the following PPE/SPE parameter and the associated values and assumptions:

- In-Water Structures (including intake and discharge structures)
  - Constructed in compliance with provisions of the CWA Section 404 (33 U.S.C. § 1344-TN1019) and Section 10 of the Rivers and Harbors Appropriation Act of 1899 (33 U.S.C. §§ 401 et seq.; TN660).
  - Adverse effects of building activities controlled and localized using BMPs such as installation of turbidity curtains or installation of cofferdams.
  - Construction duration would be less than 7 years.

3.4.2.1.8 Water Use Conflicts Due to Plant Municipal Water Demand

Municipal water supply used to support construction-related water use (e.g., potable and sanitary needs) may affect the municipal systems' ability to meet their planned obligation to other users. This plant need would only exist during the period of plant construction. To generically assess the potential impact on municipal systems from the plant's

construction-related water use, the staff assumed that the needed amount of municipal water would be available and within the existing capacity of the municipal systems, thereby accounting for all existing and planned future uses. If these assumptions are satisfied, the staff determined that the plant's construction-related municipal water use would not unduly stress the municipal systems' ability to meet their existing and planned obligations.

The staff has determined that the effect of water supply from municipal systems is a Category 1 issue. The staff concludes that, as long as the relevant PPE and SPE are met the impacts on municipal systems from building a nuclear reactor can be generically determined to be SMALL. This conclusion relies on the following PPE/SPE parameter and the associated value and assumptions:

- Municipal Water Availability
  - The amount available from municipal water systems exceeds the amount of municipal water required by the plant.
  - Municipal Water Availability accounts for all existing and planned future uses.
  - An agreement or permit for the usage amount can be obtained from the municipality.

3.4.2.1.9 Degradation of Water Quality Due to Plant Effluent Discharges to Municipal Systems

During construction, certain plant effluents (e.g., sanitary and sewer discharges) could be discharged to a municipal wastewater treatment system. This plant effluent discharge would only exist during the period of plant construction. To generically assess the potential impact on the municipal wastewater system, the staff assumed that the municipal system has an existing or planned capacity to treat all plant effluents while accounting for all existing and planned future discharges. The staff further assumed that the plant effluent constituents can be treated by the receiving system and therefore a permit can be obtained for construction-related plant effluent discharge to the municipal systems.

The staff has determined that the degradation of water quality from plant effluent discharges to municipal systems is a Category 1 issue. The staff concludes that, as long as the relevant PPE and SPE criteria are met the impacts on water quality from plant effluent discharges to municipal systems related to building a nuclear reactor can be generically determined to be SMALL. This conclusion relies on the following PPE/SPE parameter and the associated values and assumptions:

- Municipal Systems' Available Capacity to Receive and Treat Plant Effluent
  - Municipal Systems' Available Capacity to Receive and Treat Plant Effluent accounts for all existing and reasonably foreseeable future discharges.
  - Agreement to discharge to a municipal treatment system is obtainable.

3.4.2.2 Environmental Consequences of Operation

If the plant is water-cooled, the primary water-related impact would be associated with withdrawals and discharges related to the cooling-water system. Potential impacts on water quality, availability, and designated use may occur as a result of operations-related activities that may include the following:

- maintenance dredging and disposal of dredged spoils
- groundwater dewatering of site structures to support plant operations

- surface water withdrawal at intake structures
- surface water discharge of plant blowdown and effluents to discharge structures
- groundwater withdrawal for plant use
- inadvertent spills of chemicals, fuels, solvents, and oils
- water supply from and discharges to municipal systems.

As described in the following sections, the NRC staff identified the following environmental issues related to water use, which may arise during operation:

- surface water use conflicts during operations due to water withdrawal from flowing water bodies
- surface water use conflicts during operation due to water withdrawal from non-flowing water bodies
- groundwater use conflicts due to building foundation dewatering
- groundwater use conflicts due to groundwater withdrawals for plant uses
- surface water quality degradation due to operation of intake and discharge structures
- surface water quality degradation due to changes in salinity gradients resulting from withdrawals
- surface water quality degradation due to chemical and thermal discharges
- groundwater quality degradation due to plant discharges
- water quality degradation due to inadvertent spills and leaks during operation
- water quality degradation due to groundwater withdrawals
- water use conflict due to plant municipal water demand
- degradation of water quality due to plant effluent discharges to municipal systems.

The potential impacts related to water use conflicts and water quality degradation are discussed in the following sections.

3.4.2.2.1 Surface Water Use Conflicts during Operation Due to Water Withdrawal from Flowing Water Bodies

The staff used a performance-based approach to identify a conservative and defensible SPE criterion based on water availability at the new nuclear reactor site. The SPE criteria and assumptions were developed for flowing (e.g., stream, canal, or river) and non-flowing (e.g., oceans, gulfs, intertidal zones, estuaries, lakes, ponds, and reservoirs) water bodies because withdrawals affect each of these types of water bodies differently (see Appendix G). The SPE criteria and assumptions for flowing water bodies are discussed in this section. SPE criteria and assumptions for non-flowing water bodies are discussed in Section 3.4.2.2.2. Using these performance-based criteria and assumptions potentially allows a larger number of sites in a variety of hydrologic settings to fall within Category 1 under this GEIS.

As discussed in Section 3.4.1.1, the staff determined that the total amount of surface water withdrawn from surface water bodies for use by the nuclear reactor would be less than or equal

to 6,000 gpm, which is the PPE related to total plant water demand. This PPE value was derived by considering the water needs of currently known ANR technologies. During operations, some of this water would be consumed through evaporative loss or by other plant systems. It is expected that operation-related water needs of some new nuclear reactors will be much lower if the plant does not use water for cooling. The PPE limit includes water withdrawn from surface water sources for use by all plant systems (cooling water, service water, fire protection, potable, and sanitary) but does not include water from a municipal provider even if the municipal provider obtained the water from a surface water source, because the impacts of withdrawal by a municipal provider would have been considered in the provider's withdrawal permit. The staff estimated that the total plant water demand PPE is 5 to 10 times less than the average surface water withdrawal rate proposed by the recently licensed large LWRs that planned to rely predominately on flowing surface water bodies during operations (e.g., VC Summer, WS Lee, and Clinch River). In each recently licensed large LWR, the impacts of water withdrawal on surface water resources were determined to be SMALL, in part due to the comparatively large amount of water available for use at each site. As a result of these factors, the NRC staff determined that the PPE for total plant water demand conservatively supports a generic impact determination when neither the design nor the site are currently known.

The SPE criteria for surface water availability of a flowing water body was determined by identifying the following:

- An appropriate low flow characteristic to be used in the water impact assessment for flowing surface water bodies. The staff chose to use the 95 percent exceedance flow of the flowing surface water body as the flow characteristic for the impact assessment because this characteristic is statistically representative of low flow conditions for that water body.
- A conservative impact measure of the low flow characteristic, which could be used to relate withdrawal to the impact and category designation. Based on the evaluation described below, the staff determined that plant withdrawals of 3 percent or less of the 95 percent exceedance flow of the flowing surface water body would result in a SMALL impact and Category 1 designation.
- Constraints on the applicability of the Category 1 determination. These constraints were developed by evaluating the previous EISs for circumstances that led to impacts that were greater than SMALL and are included as assumptions for the SPE criteria.

The staff developed the SPE criteria for water withdrawal (i.e., 3 percent of the 95 percent exceedance flow) by evaluating the impacts related to plant use of flowing surface water bodies in EISs for new reactors and the LR GEIS for operating reactors (NRC 1996-TN288 and NRC 2024-TN10161). In each recent EIS for new large LWRs withdrawing from flowing surface water bodies, the staff determined that the impacts would be SMALL even though maximum withdrawal rates were above 3 percent of the water available during low flow conditions. The only exceptions to this were the proposed Grand Gulf and PSEG sites, where the ratio of maximum plant withdrawal to availability during low flow conditions was much smaller because of the size of the adjacent river resulting in SMALL impact determinations (NRC 2006-TN674). The LR GEIS discusses two plants where plant withdrawals from flowing surface water bodies that exceeded 10 percent of minimum flows could result in future water use conflicts (Limerick and Duane Arnold; NRC 1996-TN288). In both cases, reducing the withdrawal to a much smaller percentage of the minimum flow, such as the SPE value of 3 percent or less, would reduce the chances of future water use conflicts and minimize impacts on other users. The SPE value of 3 percent would also comply with the EPA 316(b) Proportional Flow Limitation

(40 CFR 125.84(b)(3)(i) [TN254]), which specifies that plants not withdraw more than 5 percent of the source water body annual mean flow.

The staff's generic analysis for water use impacts on flowing surface water bodies is described here. The impact of water withdrawals on the resource is expected to be SMALL when the plant withdrawal from a flowing surface water body is less than 3 percent of the 95 percent exceedance flow and when assumptions stated in Appendix G are met. The criterion may be described using the following equation:

$$Q_w \leq 0.03 \times Q_{95\%}$$

where Q_w is the plant water withdrawal rate and $Q_{95\%}$ i is the 95 percent exceedance flow (rate) of the flowing surface water body.

Using this relationship, a plant withdrawing water at the 6,000 gpm (the PPE limit) would need to be sited on a flowing surface water body with a 95 percent exceedance flow of at least 200,000 gpm (approximately 450 cubic feet per second). Plants with lower withdrawal rates could be sited on smaller flowing surface water bodies and be included in this generic analysis, as illustrated by the shaded region in Figure 3-1. If this relationship is met, the staff has determined that surface water use conflicts during operations due to water withdrawal from flowing surface water bodies is a Category 1 issue. This conclusion relies on the following PPE/SPE parameters and the associated values and assumptions for the following parameters:

- Total Plant Water Demand
  - Less than or equal to a daily average 6,000 gpm.
- Surface Water Availability – Flowing
  - Average plant water withdrawals do not reduce discharge from the flowing water body by more than 3 percent of the 95 percent exceedance daily flow and do not prevent the maintenance of applicable instream flow requirements.
  - The 95 percent exceedance flow accounts for existing and planned future withdrawals.
  - Water availability is demonstrated by the ability to obtain a withdrawal permit issued by State, regional, or tribal governing authorities.
  - Water rights for the withdrawal amount are obtainable, if needed.

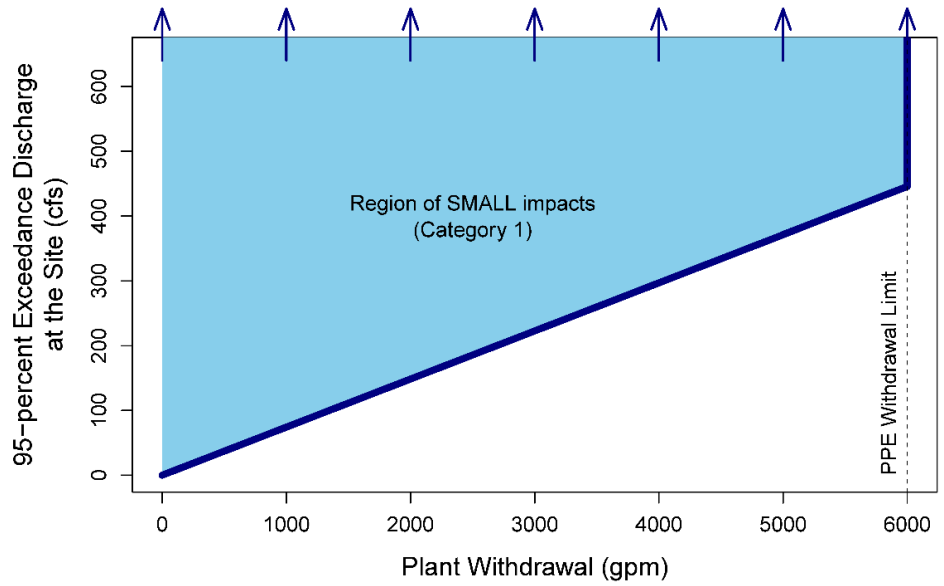

Figure 3-1 SMALL Surface Water Use Impacts for Plant Withdrawals of 6,000 gpm or Less Compared to the 95 Percent Exceedance Discharge in the Flowing Surface Water Body

If the assumptions are not met or the plant water demand exceeds the PPE, assessing surface water use impacts would require a project-specific evaluation in the SEIS.

Radial (Ranney©) collector wells have been proposed for some new reactor sites and may be proposed to supply water for future nuclear reactors. Radial collector wells are installed within an aquifer and have a direct, productive connection to a surface water body so that they can withdraw water from the surface water body that is of better quality, due to bank filtration, while minimizing impacts such as sedimentation and scouring in the surface water body. Because these wells either directly pump surface water or are removing groundwater that is discharging to a surface water body, the PPE/SPE values and assumptions for surface water availability and the evaluation of surface water use conflicts above also apply to withdrawals from radial collector wells.

3.4.2.2.2 Surface Water Use Conflicts during Operation Due to Water Withdrawal from Non-flowing Water Bodies

The staff considers the water availability of some non-flowing surface water bodies, i.e., the Great Lakes, the Gulf of America, estuaries, intertidal zones, bays, and oceans, to be large water bodies compared to the total plant water demand PPE value of 6,000 gpm. For example, in the EIS for Fermi (NRC 2013-TN6436), the staff determined that the annual water withdrawal amounted to an inconsequential amount (0.0014 percent) of the volume of Lake Erie.

The staff considers that smaller non-flowing surface water bodies (e.g., inland lakes, manufactured ponds, and reservoirs) have limited water availability. These water bodies are not included in the staff's generic analysis. The water availability in these smaller non-flowing surface water bodies may be allocated or planned for multiple uses. Therefore, withdrawing water for use from these smaller non-flowing surface water bodies is more likely to result in surface water use conflicts. The impacts from the competing water use could manifest in different ways (e.g., reduction in downstream discharge from the water body, reduction in water

surface elevation of the water body, and reduction in nearshore habitat suitability) that depend on site-specific hydrologic conditions. The staff has determined that impacts of plant water withdrawal from these smaller non-flowing surface water bodies on surface water resources will be assessed in a project-specific analysis in the SEIS.

As a result, the staff determined that the impact of surface water use from these large non-flowing surface water bodies is a Category 1 issue. The staff concludes that if the conditions and assumptions of the PPE and SPE are met the impact on surface water resources from plant water withdrawal from these large non-flowing surface water bodies would be negligible and can be generically determined to be SMALL. This conclusion relies on the following PPE/SPE parameters and the associated values and assumptions for the following parameters:

- Total Plant Water Demand
  - Less than or equal to a daily average of 6,000 gpm.
- Surface Water Availability – Non-flowing
  - Water availability of the Great Lakes, the Gulf of America, oceans, estuaries, and intertidal zones exceeds the amount of water required by the plant.
  - Water availability is demonstrated by the ability to obtain a withdrawal permit issued by State, regional, or tribal governing authorities.
  - Water rights for the withdrawal amount are obtainable, if needed.
  - Coastal Zone Management Act of 1972 (16 U.S.C. §§ 1451 et seq.; TN1243) consistency determination is obtainable, if applicable.

The discussion related to radial collector wells that withdraw water from flowing surface water bodies in Section 3.4.2.2.1 is also relevant if water were withdrawn using radial collector wells from a non-flowing surface water body.

3.4.2.2.3 Groundwater Use Conflicts Due to Building Foundation Dewatering

The potential impacts of excavation dewatering are described in Section 3.4.2.1.2, in which the staff concluded that dewatering during construction is expected to result in a SMALL impact on groundwater resources. This conclusion relied on the PPE/SPE specification that the dewatering rate is less than 50 gpm and the assumption that dewatering results in negligible alterations in groundwater levels at the site boundary. The basis for the PPE/SPE values and assumptions are discussed in Section 3.4.1.2.1. The effects of dewatering building foundations during plant operation would be similar to those occurring during construction, but the magnitude of the effects may increase because of the longer period of operation.

The combined impact of operational dewatering and plant groundwater use for large LWRs was evaluated in the LR GEIS (NRC 2024-TN10161). Based on a review of operating plants, the staff concluded in the LR GEIS that plants withdrawing less than 100 gpm (for operational dewatering or for plant uses) would have SMALL impacts. However, the staff also determined that plants withdrawing more than 100 gpm have the potential to create conflicts with other local groundwater users if groundwater levels are lowered beyond the site boundary. For these plants, the staff concluded that the impacts of groundwater withdrawals cannot be determined generically.

When evaluating the impacts of dewatering in Section 3.4.2.1.2, the staff noted that although the PPE/SPE dewatering rate of 50 gpm is less than the rate determined to have SMALL

impacts in the LR GEIS, the actual impacts of dewatering at any particular site will depend on the size of the site, the area dewatered, the depth of groundwater drawdown at the dewatering location (i.e., the building foundations), and the hydrogeologic conditions of the site. As a result, the actual effects of dewatering on groundwater levels are uncertain and this uncertainty increases with the duration of the projected need for dewatering. The staff relied on the temporary nature of dewatering during construction in concluding that the impacts of dewatering during construction would be SMALL. Because dewatering of building foundations could occur for the duration of operations, the potential impacts of operational dewatering could be larger than those of the relatively shorter period of construction.

The effects of dewatering on groundwater levels would be monitored, and appropriated mitigation would be used with the PPE/SPE conditions met, the effects of dewatering will be localized to the plant site and therefore unlikely to result in groundwater use conflicts. On this basis, the staff has determined that groundwater use conflicts due to building foundation dewatering during operation of a nuclear reactor are a Category 1 issue. The staff concludes that the effects of dewatering activities related to the operation of nuclear reactors would be localized to the plant site, and groundwater use conflicts from dewatering can be generically determined to have a SMALL impact for this GEIS. This conclusion relies on the following PPE/SPE parameter and the associated values and assumptions.

- Groundwater Withdrawal for Excavation or Foundation Dewatering
  - The long-term dewatering withdrawal rate is less than or equal to 50 gpm (the initial rate may be larger).
  - Dewatering results in negligible groundwater level drawdown at the site boundary.

Because wetlands located on or adjacent to the site may be affected by building foundation dewatering during operations, the PPE/SPE includes the assumption that changes in wetland water levels and hydroperiod resulting from groundwater use are within historical annual or seasonal fluctuations, to avoid adverse impacts on nearby wetlands. Potential groundwater use impacts on wetlands are discussed in Sections 3.5.2.1.2 and 3.5.2.2.7 of this GEIS.

As discussed in Chapter 1, the staff anticipates that an application for a new nuclear reactor license will include the appropriate data and analysis to establish with reasonable assurance that the proposed project meets the conditions of the PPE/SPE with respect to dewatering, including the limitations on groundwater withdrawal rate and on drawdown at the site boundary. If the PPE/SPE conditions cannot be met, a project-specific evaluation of the impacts of excavation dewatering is required.

3.4.2.2.4 Groundwater Use Conflicts Due to Groundwater Withdrawals for Plant Uses

Construction use of groundwater is discussed in Section 3.4.2.1.3. Groundwater may be used during operations for various plant purposes, including potable, sanitary, process, and cooling uses. The operational effects of groundwater use would be similar to those described for construction, with the principal difference being that the duration of pumping for operations would be significantly longer. When evaluating impacts, the staff considered an operational period of 40 years. Groundwater withdrawals from one or more wells located on the plant site will lower groundwater hydraulic head levels in the aquifer around the well(s), and the magnitude of the drawdown in hydraulic head and the extent of the affected area tend to increase with the duration of the withdrawal. As noted previously, changes in groundwater levels may locally affect the direction of groundwater flow, and may alter groundwater recharge or discharge rates, including discharge to wetlands and streams.

The staff reviewed recent new reactor EISs and found that the proposed groundwater pumping rates exceeding 100 gpm were determined to have a SMALL impact on groundwater resources. In each case, this conclusion was made, in part, because the site locations and specific pumping rates were known and could be fully evaluated. In one instance (Grand Gulf), where the plant design and groundwater withdrawal rate were uncertain, and where withdrawals would be from an EPA-designated SSA, the staff concluded that a MODERATE impact was possible (NRC 2006-TN674).

Based on a review of groundwater withdrawals for operational purposes at existing plants, the staff reported in the LR GEIS (NRC 2024-TN10161) that impacts on water resources could vary based on geographic location, especially if pumping rates exceeded 100 gpm. As a result, the staff determined that groundwater use conflicts are a Category 2 issue (SMALL, MODERATE, or LARGE impacts depending on project-specific characteristics) for plants that withdraw more than 100 gpm. For plants that withdraw less than 100 gpm, the staff determined that groundwater use conflicts were a Category 1 issue and concluded that these plants would have SMALL impacts because the effects on groundwater levels do not usually extend beyond the site boundary (NRC 2024-TN10161).

A groundwater withdrawal rate of 50 gpm is specified in the PPE/SPE table (Appendix G), as discussed in Section 3.4.1.2.1. While this withdrawal rate is less than the rate determined to have SMALL impacts in the LR GEIS, the actual impacts of groundwater withdrawals at any particular site will depend on the size of the site. The site size (100 ac) specified in the PPE/SPE table is much smaller than the areas of operating plants and licensed new reactors (e.g., the Clinch River site proposed for a small modular reactor is more than 900 ac). In evaluating the impacts of groundwater use for this generic analysis, the staff considered the 100-ac size specified in the PPE for reactor sites and used a distance between the pumped well and the site boundary of about 1,000 ft (the distance of a well located at the center of a square 100 ac site). As noted below, mitigation to prevent significant impacts may be required if the well is closer to the site boundary. The staff's analysis used a single well, screened over the entire depth of an infinite (in area), homogeneous aquifer, and withdrawing 50 gpm for 40 years. As specified in the PPE/SPE table, and discussed in Section 3.4.1.2.1, groundwater withdrawals are assumed to result in no more than 1 ft of drawdown at the site boundary.

Given the specifications and assumptions described above, groundwater drawdown at any distance from the pumped well can be estimated with an analytical approach for radial flow to a well (e.g., Freeze and Cherry 1979-TN3275). Because drawdown depends on the hydrogeological properties of the aquifer (which is unknown for a generic site), the staff evaluated the effects of groundwater use for a representative range of aquifer properties. The staff determined that the impacts of groundwater withdrawals are likely to be localized (i.e., groundwater drawdown beyond the site boundary is less than 1 ft) at sites where the effective transmissivity is greater than about 5,000 ft^2/d for withdrawals from an unconfined aquifer and greater than 10,000 ft^2/d for withdrawals from a confined aquifer. These transmissivity values imply aquifers that are productive sources of groundwater, with well-specific capacities in the range of 25 to 40 gpm/ft of drawdown (Driscoll 1986-TN6823). At smaller sites or sites where the pumped well is located closer to the site boundary, and at sites with less transmissive aquifers, additional mitigation may be needed to avoid groundwater use conflicts (e.g., reducing the withdrawal rate or altering the location of the well with respect to other groundwater users).

The staff determined that groundwater use conflicts due to groundwater withdrawals during operation of a nuclear reactor is a Category 1 issue. The staff concludes that the effects of groundwater use related to the operation of nuclear reactors would be localized to the site area

and groundwater use conflicts from withdrawals for plants uses can be generically determined to have a SMALL impact for this GEIS. This conclusion relies on the following PPE/SPE parameter and the associated value and assumptions:

- Groundwater Withdrawal for Plant Uses
  - Groundwater withdrawal for all plant uses (excluding dewatering) is less than or equal to 50 gpm.
  - Withdrawal results in no more than 1 ft of groundwater level drawdown at the site boundary.
  - Withdrawals are not derived from an EPA-designated SSA, or from any aquifer designated by a State, Tribe, or regional authority to have special protections to limit drawdown.
  - Withdrawals meet any applicable State or local permit requirements.

Because wetlands located on or adjacent to the site may be affected by building foundation dewatering during operations, the PPE/SPE includes the assumption that changes in wetland water levels and hydroperiod resulting from groundwater use are within historical annual or seasonal fluctuations, to avoid adverse impacts on nearby wetlands. Potential groundwater use impacts on wetlands are discussed in Sections 3.5.2.1.2 and 3.5.2.2.7 of this GEIS.

As described in Chapter 1, the staff anticipates that an application for a new nuclear reactor license will include the appropriate data and analysis to establish with reasonable assurance that the proposed project meets the conditions of the PPE/SPE with respect to groundwater withdrawals for plant use. If the PPE/SPE conditions cannot be met, a project-specific evaluation of the impacts of groundwater withdrawal is required.

3.4.2.2.5 Surface Water Quality Degradation Due to Physical Effects from Operation of Intake and Discharge Structures

Cooling-water intake and discharge structures have the potential to create localized impacts on surface water quality through physical effects such as alterations of current patterns, scouring, sediment transport, and increased turbidity. The LR GEIS reports that (NRC 2024-TN10161) these impacts have typically been small for operating reactors, in part due to adherence to Section 316 of the CWA (33 U.S.C. § 1326; TN4823) and because effects are limited to the area of the intake and discharge structure. Section 316(b) of the CWA requires that the "best technology available for minimizing adverse environmental impact" be used for cooling-water intake structure. This has made the use of once-through cooling-water systems unlikely for new power plants. Any applicant for a new nuclear reactor license that uses intake or discharge structures as part of the cooling or water supply system would also need to comply with the same requirements of Section 316(b) of the CWA and the conditions of the NPDES permit that would be required for the site.

Because the effects of intake and discharge structures are dependent on water withdrawal and discharge rates, the staff expects that the plant discharge rate would be less than the withdrawal rate. The withdrawal rate is based on the PPE limit for total plant water demand and any applicable SPE values and assumptions for the selected water source (Surface Water Availability for Flowing or Non-flowing water bodies). For flowing water bodies, withdrawals would be limited to the total plant water demand PPE/SPE value of 6,000 gpm and be 3 percent or less of the 95 percent low flow value for the water body as explained in Section 3.4.2.2.1. For

non-flowing water bodies, withdrawals would also be limited to the total plant water demand PPE/SPE value of 6,000 gpm and be subject to SPE values and assumptions.

The staff has determined that degradation of surface water quality due to operation of intake and discharge structures is a Category 1 issue. The staff concludes that the impacts on the aquatic environment from the alteration of current patterns, scouring, sediment transport, and increased turbidity would be localized to the vicinity of these structures, and therefore the impact on surface water quality can be generically determined to be SMALL. This conclusion relies on the following PPE/SPE parameters and the associated values and assumptions for the following parameters:

- Total Plant Water Demand
  - Less than or equal to a daily average of 6,000 gpm.
- Intake and Discharge Structures
  - Adhere to best available technology requirements of CWA 316(b) (33 U.S.C. § 1326-TN4823).
  - Operated in compliance with CWA Section 316 (b) and 40 CFR 125.83, including compliance with monitoring and recordkeeping requirements in 40 CFR 125.87 and 40 CFR 125.88, respectively (40 CFR Part 125-TN254).
  - Best available technologies are employed in the design and operation of intake and discharge structures to minimize alterations due to scouring, sediment transport, increased turbidity and erosion.
  - Adherence to requirements in NPDES permits issued by the EPA or a given State.
- If water is obtained from a flowing water body, then the following PPE/SPE parameter and associated value also applies.
- Surface Water Availability – Flowing
  - The average rate of plant withdrawal does not exceed 3 percent of the 95 percent exceedance daily flow for the water body.

If water is obtained from a non-flowing water body, then the following PPE/SPE parameters and associated values and assumptions also apply:

- Surface Water Availability – Non-flowing
  - Water availability of the Great Lakes, the Gulf of America, oceans, estuaries, and intertidal zones exceeds the amount of water required by the plant.

3.4.2.2.6 Surface Water Quality Degradation Due to Changes in Salinity Gradients Resulting from Withdrawals

Power plant withdrawals may cause alterations to salinity concentrations and salinity gradients if the source water body is an estuary or intertidal zone. As a result, States with estuaries or intertidal zones typically require consideration of the effect of power plant withdrawals on the alteration of salinity regimes as part of the development of permits.

The impacts of water withdrawal and discharge on salinity gradients near operating nuclear power plants, including those located on estuaries or intertidal zones, were evaluated by the staff for the 2013 LR GEIS (NRC 2013-TN2654). The 2013 LR GEIS drew upon project-specific

examples provided in the 1996 LR GEIS (NRC 1996-TN288) to conclude that altered salinity gradients were expected to be noticeable only in the immediate vicinity of the intake and discharge structures. The 1996 LR GEIS considered the impacts to be SMALL and designated this a Category 1 issue. To develop this GEIS, the staff considered the conclusions and examples provided in both the 1996 LR GEIS and the 2013 revision. In one example shared in the 1996 GEIS, the staff noted that a fossil-fuel plant located on the same large estuary as a nuclear plant, was found to have altered natural salinity patterns because it was sited in a shallower area. This illustrates that, even in large estuaries, the degree of impact is somewhat dependent on the location of the plant. Siting may be an even more important factor when a smaller water body is involved. In addition, the 1996 GEIS noted that impacts were also dependent on whether alterations to salinity gradient were, "…within the normal tidal or seasonal movements of salinity gradients that characterize estuaries" (NRC 1996-TN288).

For this GEIS, the staff recognizes that for water bodies other than estuaries and intertidal zones, maintaining the natural salinity regime is not a critical issue and is not typically included in water quality criteria for that water body. As noted above, in sensitive water bodies such as estuaries or intertidal zones, factors that affect the magnitude of potential impacts include the size of the water body, the placement of the plant intake structures in relation to the water body, and any changes in the normal range and movement of the salinity gradients that characterize that water body. These factors are project-specific and are considered important in the development of the impact level for nuclear reactors that may be sited in a variety of locations and water body types.

For this GEIS, the staff has determined that degradation of surface water quality due to changes in salinity gradients resulting from withdrawal is a Category 1 issue that can be generically determined to be SMALL. This conclusion relies on the following PPE/SPE parameter and the associated values:

- Total Plant Water Demand
  - Less than or equal to a daily average 6,000 gpm.

If water is obtained from a flowing water body, then the following PPE/SPE parameter and associated assumptions also apply:

- Surface Water Availability – Flowing
  - Average plant water withdrawals do not reduce discharge from the flowing water body by more than 3 percent of the 95 percent exceedance daily flow and do not prevent the maintenance of applicable instream flow requirements.
  - The 95 percent exceedance flow accounts for existing and planned future withdrawals.
  - Water availability is demonstrated by the ability to obtain a withdrawal permit issued by State, regional, or tribal governing authorities.
  - Water rights for the withdrawal amount are obtainable, if needed.
  - If withdrawals are from an estuary or intertidal zone, then changes to salinity gradients are within the normal tidal or seasonal movements that characterize the water body.

If water is obtained from a non-flowing water body, then the following PPE/SPE parameter and associated values and assumptions also apply:

- Surface Water Availability – Non-flowing
  - Water availability of the Great Lakes, the Gulf of America, oceans, estuaries, and intertidal zones exceeds the amount of water required by the plant.
  - Water availability is demonstrated by the ability to obtain a withdrawal permit issued by State, regional, or tribal governing authorities.
  - Water rights for the withdrawal amount are obtainable, if needed.
  - If withdrawals are from an estuary or intertidal zone, then changes to salinity gradients are within the normal tidal or seasonal movements that characterize the water body.

The Coastal Zone Management Act of 1972 (16 U.S.C. §§ 1451 et seq.; TN1243) consistency determination is obtainable, if applicable. The finding applies to all water bodies. However, based on the discussion above, for estuaries and intertidal zones, the staff's impact conclusion relies on the SPE assumption, adopted from the LR GEIS, that changes to salinity gradients be localized near the intake of the power plant and remain within the normal tidal or seasonal movements of salinity gradients that characterize the water body. If PPE and SPE values and assumptions are not met, then a project-specific evaluation will be required.

3.4.2.2.7 Surface Water Quality Degradation Due to Chemical and Thermal Discharges

During operations, nuclear plants may discharge water from the cooling, service, and sanitary water system to surface water bodies near the plant. If the plant is water-cooled, the largest volume of discharge and the greatest potential impacts on water quality are associated with the heat and chemical constituents in the effluent discharged from the cooling-water system. Discharges typically contain increased TDS, salinity, biocides, heavy metals, and other contaminants that may have been included in the withdrawn cooling water but become concentrated due to evaporative loss during the cooling process. Some chemicals may also be added to the withdrawn water before it is discharged (e.g., biocides). Impacts on surface water from plant discharge may vary based on the quality and rate of the plant discharge and the characteristics of the receiving water body, some of which are related to location. These location-dependent characteristics may include natural variations in temperature, salinity levels, or normal tidal or seasonal movements of salinity gradients.

To operate, power plants must obtain an NPDES permit under Section 402 of the CWA (33 U.S.C. § 1342-TN4765). The permit specifies discharge standards and monitoring requirements, and licensees are required to be in compliance with the limits set by the permit. NPDES permits are issued by the EPA or, more commonly, a designated State water quality regulatory agency.

The staff performed a review of the historical impacts of discharges from known plant discharge designs on well-understood sites and determined that the impacts were determined to be of small significance (NRC 2024-TN10161). The staff also reviewed EISs for licensed new reactors and determined that the impacts of discharges during operations on surface water quality would be SMALL, with one exception. This exception occurred in the Grand Gulf ESP EIS, where the staff concluded that the impacts of plant discharges on the Mississippi River water quality were not able to be determined because "…the bounds of concentrations of chemical effluents" for all waste streams had not been provided in the PPE or ER (NRC 2006-TN674). For both operating and proposed sites, the conclusion that impacts on water quality would be SMALL was reached

after a project-specific review. These project-specific reviews included an estimation of the extents of the mixing zones in the receiving water bodies and how the mixing zone may affect aquatic resources under site-specific conditions (e.g., geometry, ambient discharge characteristics, ambient water quality characteristics, aquatic habitat, and designated uses of the water body).

During the evaluation conducted for this GEIS, the staff sought to develop a comprehensive bounding set of water quality criteria, including both thermal and chemical criteria, for use in the PPE and SPE. The staff found this to be impractical and determined that it would not ultimately be beneficial to the GEIS. Development of a bounding list for the PPE was complicated by uncertainties in how a new, advanced plant design might affect cooling systems, and the thermal and chemical characteristics of the discharges.

Development of a bounding set of characteristics for the SPE was challenging for the reasons presented below.

First, a State with delegated permitting authority may impose limitations on temperature and effluent that are tailored to the conditions of the State and they may be more stringent than those required by the EPA. These State-specific conditions include characteristics of the receiving water body such as type (e.g., ocean, lake, river), designated use (e.g., water supply, agricultural use, recreational), ambient temperature, ambient water quality and assimilative capacity, and the significance of the aquatic habitat (e.g., spawning zones). For example, contaminant concentration standards for domestic water supplies prescribed by the States of Tennessee (TN 0400-40-03-TN7038) and Alaska (18 AAC 70-TN7039) are more restrictive than the legally enforceable standards required by the National Primary Drinking Water Regulations of the SDWA.

Second, the more stringent criteria developed by States may vary. The staff reviewed the acceptable temperature ranges in discharges and the resulting thermal impacts on receiving water bodies for Tennessee, Alaska, and Idaho and found them to vary (TN 0400-40-03-TN7038; 18 AAC 70-TN7039; IDAPA 58.01.02-TN7040). This variance between States results primarily from the difference in the ambient temperature of the water bodies caused by the regional climate as well as the tolerance for temperature variations of the aquatic species present in the water bodies. In addition, States with estuaries or intertidal zones (e.g., Maryland) typically require consideration of the effect of power plant discharges on the alteration of salinity regimes at the discharge site as part of the NPDES permits. State with these zones may set more restrictive limits on salinity and require greater evaluation of potential impacts of the discharge on salinity gradients than States without these zones.

Third, if permits establish effluent limits that exceed water quality criteria a regulatory mixing zone may be determined, for which individual requirements can be established on a case-by-case basis. In theory, impacts could be negligible if the potential for significant dilution of effluent discharge and minimization of thermal and salinity impacts in the receiving water body exists. However, computation of an acceptable dilution factor for permits often factors in limits on mixing zone sizes set by States for specific water bodies, making the dilution factor project-specific.

Lastly, development of a bounding set of plant parameters for the PPE or site parameters for the SPE was not considered beneficial for this GEIS, because compliance with water quality standards set forth in the NPDES permit does not necessarily equate to a SMALL impact (i.e., indicating no noticeable impact on surface water quality of the resource; see 10 CFR

51.71(d), footnote 3 [TN250]). Therefore, a project-specific evaluation would be necessary to develop the impact determination as part of a SEIS.

As a result, the staff determined that degradation of surface water quality from chemical and thermal discharges requires consideration of project-specific information on a case-by-case basis. Therefore, the staff determined that the degradation of surface water quality due to chemical and thermal discharges is a Category 2 issue (SMALL, MODERATE, or LARGE impacts depending on project-specific characteristics). The staff concludes that the impact on surface water quality due to chemical and thermal discharges should be determined on a case-by-case basis using project-specific information in a SEIS.

3.4.2.2.8 Groundwater Quality Degradation Due to Plant Discharges

Based on reviews of proposed large LWRs and existing plants, the staff has determined that the discharge to surface water bodies during operation would not noticeably impact groundwater resources. However, some existing and proposed plants discharge, or plan to discharge, plant effluents directly to groundwater via deep well injection or indirectly to groundwater via infiltration from ponds or canals. Water discharged to a cooling pond has elevated concentrations of TDS and other constituents and could infiltrate into the underlying groundwater system. The significance of the groundwater quality impacts would depend on cooling pond water quality, site hydrogeologic conditions, and the location, depth, and pumping rate of offsite wells. The potential for impacts is decreased in areas that have poorer groundwater quality, such as coastal areas and salt marshes (NRC 2024-TN10161), but all plant discharges to the subsurface have the potential to degrade groundwater quality. At the Turkey Point site, in-depth, project-specific analysis of the potential effects of discharge from an operating plant located above an EPA-designated SSA has also been conducted. The staff evaluated the impacts of infiltration of hypersaline water from the operation of Units 3 and 4 discharged into the cooling-canal system (NRC 2019-TN6824). The staff found that infiltration of plant effluents into the shallow aquifer underlying the canal has had a significant impact on groundwater quality on and off the plant site. In the Turkey Point Units 6 and 7 EIS (NRC 2016-TN6434), the staff also evaluated the potential impact of injection of plant discharge into a deep aquifer. The staff ultimately determined that deep well injection would lead to a SMALL impact. However, this determination relied upon a detailed project-specific evaluation.

Because the potential impacts on groundwater can be significant, the PPE/SPE groundwater quality parameter specifies that a new nuclear plant be located outside the recharge area for any aquifer designated to have special protections. In addition, the PPE/SPE specifies that the plant be outside the designated contributing area for any public water supply well. Because any discharge of plant effluents to the subsurface would have significant potential impacts on groundwater quality, the PPE/SPE also assumes that there would be no planned discharges to the subsurface via either direct injection or via infiltration from ponds or canals. Based on these PPE/SPE values and assumptions, the staff has determined that groundwater quality degradation due to plant discharges during operation of a nuclear reactor is a Category 1 issue. The staff concludes that the discharges can be generically determined to have a SMALL impact on groundwater quality. This conclusion relies on the following PPE/SPE parameter and the associated values and assumptions:

- Groundwater Quality
  - The plant is outside the recharge area for any EPA-designated SSA or any aquifer designated to have special protections by a State, tribal, or regional authority.

- The plant is outside the wellhead protection area or designated contributing area for any public water supply well.
- There are no planned discharges to the subsurface (by infiltration or injection).

If these PPE/SPE values and assumptions are not met, a project-specific evaluation of the impacts of groundwater withdrawal is required.

3.4.2.2.9 Water Quality Degradation Due to Inadvertent Spills and Leaks during Operation

During operation, inadvertent spills of gasoline, diesel fuel, hydraulic fluid, lubricants, solvents and wastewater used for construction equipment could impact both surface water and groundwater resources. Pursuant to 40 CFR Part 112 (TN1041), applicants would be required to use BMPs and implement a SPCC to minimize the occurrence of spills and limit their effects. While not necessarily uncommon at operating nuclear power plants, minor chemical spills have not constituted widespread, consistent water quality impacts because they are readily amenable to correction (NRC 1996-TN288).

During operation, features of the stormwater discharge system, such as retention basins, may increase infiltration over the area of the basin and increase local recharge to groundwater, thereby potentially affecting groundwater quality. Stormwater discharge would be regulated under the NPDES permit and it would conform to the terms of the NPDES permit, including monitoring of discharge water quality for potential inadvertent releases. In recent EISs for proposed large LWRs the NRC staff has assumed that the system would be designed to preclude discharge to groundwater during operations and, as a result, plant runoff during operations would not affect groundwater quality.

Radionuclide leaks from plant components and pipes have occurred at numerous plants (NRC 2023-TN10129). Groundwater protection programs have been established at all operating nuclear power plants to minimize potential impacts from inadvertent releases (NEI 2019-TN6775). The LR GEIS evaluated the impacts from leaks occurring at operating reactor sites and determined that that if leaks were to occur, the magnitude of impacts would be dependent on project-specific characteristics (NRC 2024-TN10161). The staff concluded in the LR GEIS that, because the impacts of radionuclide leaks to groundwater could be greater than SMALL and must be based on a project-specific analysis, this is a Category 2 issue.

While contamination from inadvertent leaks have occurred at operating plants, the staff determined that this operating experience is not sufficient to preclude a generic determination on this issue for the operation of new nuclear reactors. As a result, the staff has determined that water quality degradation due to inadvertent spills during operation of a nuclear reactor is a Category 1 issue. The staff concludes that the impacts of inadvertent spills on water quality during operation of a nuclear reactor site would be SMALL. This conclusion relies on the following PPE/SPE parameters and the associated values and assumptions:

- Groundwater Quality
  - Applicable requirements and guidance on spill prevention and control are followed, including relevant BMPs and SPCCs.
  - There are no planned discharges to the subsurface (by infiltration or injection), including stormwater discharge.
  - A groundwater protection program conforming to NEI 07-07 (NEI 2019-TN6775) is established and followed.

- Site Size and Location
  - The site size is 100 ac or less.
- Permanent Footprint of Disturbance
  - Use of BMPs for soil erosion, sediment control, and stormwater management.
- Impacts on Aquatic Biota
  - Adherence to requirements in NPDES permits issued by the EPA or a given State, and any other applicable permits.

If the PPE/SPE conditions are not met, a project-specific evaluation of the impacts of inadvertent spills and leaks is required.

3.4.2.2.10 Water Quality Degradation Due to Groundwater Withdrawals

Water quality degradation due to groundwater withdrawals during construction is discussed in Section 3.4.2.1.6. Degradation of groundwater resources may occur when dewatering or withdrawal of groundwater for plant uses induces the flow of lower quality water from the surrounding aquifers or connected surface water bodies. Groundwater withdrawals may induce infiltration from surface water (e.g., rivers) or contribute to increased saltwater intrusion from nearby oceans and estuaries in aquifers already impacted by saltwater intrusion. The effects of groundwater withdrawals during operation of a nuclear reactor would be similar to those during construction, but they would occur over a longer duration.

In the 1996 LR GEIS (NRC 1996-TN288) the staff reported that operating plants in estuary or coastal sites that pumped groundwater from confined aquifers at rates between 400 gpm and 1,000 gpm had a small effect on groundwater quality, especially when the plant's withdrawal rate was a small fraction of the regional total groundwater use. In the EISs for new large LWRs, groundwater pumping during operation was determined to have a SMALL impact on groundwater resources at all sites except for Grand Gulf. In the Grand Gulf ESP EIS (NRC 2006-TN674) the staff evaluated a range of potential pumping rates because the estimates of the pumping rate were not provided. The staff determined that high groundwater withdrawal rates (from radial collector wells) could induce flow of lower quality groundwater from deeper aquifers upward into the Catahoula (an EPA-designated SSA) and significantly degrade water quality.

The PPE/SPE table limits groundwater withdrawals for building foundation dewatering and plant uses to 50 gpm and assumes that groundwater withdrawals will result in no more than a 1 ft lowering of groundwater levels at the site boundary. The basis for the PPE/SPE values and assumptions is discussed in Section 3.4.1.2.1. The 1 ft limit includes the potential cumulative effect of simultaneous dewatering and groundwater withdrawal for plant uses because dewatering is assumed to contribute negligible drawdown at the site boundary, as specified in the PPE/SPE table (Appendix G). In areas that have exploitable groundwater resources, the PPE/SPE withdrawal rate is expected to be a small fraction of the total withdrawal rate by other users (typically agricultural or municipal uses in rural and urban areas, respectively). With minimal changes in groundwater levels at the site boundary, the potential for PPE/SPE withdrawals to induce flow from adjacent water bodies is unlikely to be noticeable.

The staff has determined that water quality degradation due to groundwater withdrawals is a Category 1 issue. The staff concludes that water quality impacts resulting from groundwater withdrawals during operation of any nuclear reactors would be localized and can be generically

determined to be SMALL for this GEIS. This conclusion relies on the following PPE/SPE parameters and the associated values and assumptions:

- Groundwater Withdrawal for Excavation or Foundation Dewatering
  - The long-term dewatering withdrawal rate is less than or equal to 50 gpm (the initial rate may be larger).
  - Dewatering results in negligible groundwater level drawdown at the site boundary.
- Groundwater Withdrawal for Plant Uses
  - Groundwater withdrawal for all plant uses (excluding dewatering) is less than or equal to 50 gpm.
  - Withdrawal results in no more than 1 ft of groundwater level drawdown at the site boundary.
  - Withdrawals are not derived from an EPA-designated SSA, or from any aquifer designated by a State, Tribe, or regional authority to have special protections to limit drawdown.
  - Withdrawals meet any applicable State or local permit requirements.

If any of the PPE/SPE conditions are not met, a project-specific evaluation of the water quality impacts of groundwater withdrawals is required. For example, use of a radial collector well during operation is likely to involve withdrawals that exceed the 50 gpm PPE/SPE value, which will require a project-specific evaluation of potential water quality degradation.

3.4.2.2.11 Water Use Conflict Due to Plant Municipal Water Demand

Municipal water supply used to support water use (e.g., potable and sanitary needs) during plant operations may affect the municipal systems' ability to meet their planned obligation to other users. To generically assess the potential impact on municipal systems from the plant's operation-related water use, the staff assumed that the needed amount of municipal water is available and within the existing or planned capacity of the municipal systems while accounting for all existing and planned future uses. If these assumptions are satisfied, the staff determined that the plant's operation-related municipal water use will not unduly stress the municipal systems' ability to meet their existing and planned obligations.

The staff has determined that the effect of water supply from municipal systems is a Category 1 issue. The staff concludes that, as long as the relevant PPE and SPE are met, the impacts on municipal systems from operating a nuclear reactor can be generically determined to be SMALL. This conclusion relies on the following PPE/SPE parameter and the associated values and assumptions:

- Municipal Water Availability
  - Usage amount is within the existing capacity of the system(s), accounting for all existing and planned future uses.
  - An agreement or permit for the usage amount can be obtained from the municipality.

3.4.2.2.12 Degradation of Water Quality Due to Plant Effluent Discharges to Municipal Systems

During operation of a plant, certain plant effluents (e.g., sanitary and sewer discharges) could be discharged to a municipal wastewater treatment system. To generically assess the potential

impact on the municipal wastewater system, the staff assumed that the municipal system has an existing or planned capacity to treat all plant effluent while accounting for all existing and planned future discharges. The staff further assumed that the plant effluent constituents can be treated by the receiving system and therefore a permit can be obtained for operation-related plant effluent discharge to the municipal systems.

The staff has determined that the degradation of water quality from plant effluent discharges to municipal systems is a Category 1 issue. The staff concludes that, as long as the relevant PPE and SPE are met (e.g., the plant effluent discharge is bounded by municipal wastewater systems' capacity) and appropriate permits can be obtained, the impacts on water quality from plant effluent discharges to municipal systems from operating a nuclear reactor can be generically determined to be SMALL. This conclusion relies on the following PPE/SPE parameter and the associated values and assumptions:

- Municipal Systems' Available Capacity to Receive and Treat Plant Effluent
  - Municipal systems' available capacity to receive and treat plant effluent accounts for all existing and reasonably foreseeable future discharges.
  - Agreement to discharge to a municipal treatment system is obtainable.

3.5 Terrestrial Ecology

3.5.1 Baseline Conditions and PPE/SPE Values and Assumptions

Any site proposed for a new reactor would contain terrestrial habitat of some type. Even land areas with past industrial or urban development provide habitat for terrestrial species. The NRC staff expects that most proposed new reactor sites would contain some naturally vegetated land such as forest, scrub, grassland, or wetlands; landscaped land such as lawns or mowed areas; or agricultural land such as cropland, pasture, and orchard. Sites may also contain active or abandoned structures, pavement, rubble, borrow pits, or strip-mined lands. In natural habitats, the vegetation present may be the climax vegetation featuring species composition typical for the landscape position after long periods without human or natural disturbance, or it may be successional vegetation influenced by more recent disturbance. Sites may be greenfield, without a history of nonagricultural development, or all or part of a proposed site may contain operating or abandoned power generation facilities or other industrial facilities. More information about how the NRC staff defines and characterizes terrestrial habitats is available in RG 4.11 (NRC 2012-TN1967).

Vegetation varies greatly across the United States. Vegetation is typically forest in humid settings receiving high rainfall but may be grassland (prairie), shrubland, or desert vegetation in drier or rockier settings or areas subject to past disturbance, or taiga (boreal forest) or tundra in permafrost settings. Wetlands are intermediate between terrestrial and aquatic habitat types. Wetlands are delineated using the *Corps of Engineers Wetlands Delineation Manual* (USACE 1987-TN2066) and regional supplemental guidance recognized by the USACE and may or may not be under the jurisdiction of the CWA protecting wetlands and threatened and endangered species, and relevant scientific literature. Some assumptions made in this section of this GEIS involve parameters and values adapted from previous staff environmental reviews or are the subject of Federal regulations; some have been appropriately scaled down to account for the size and technology differences between large LWRs and smaller reactors. In every case, the staff has selected a value or parameter that will ensure a SMALL impact on terrestrial resources from building and operation of a reactor after considering all available information and leveraging professional judgment and expertise.

Based on information contained in past new reactor EISs and the staff's ability to scale that information to smaller reactors, the staff includes an assumption in the PPE and SPE that calls for the permanent disturbance of no more than 30 ac of vegetated (unpaved) terrestrial habitat, and temporary disturbance of an additional 20 ac of vegetated terrestrial habitat. However, the PPE and SPE assume that any temporarily disturbed habitat would be restored using regionally indigenous vegetation once the new facilities are built. The staff reasons that disturbance to larger areas could potentially result in substantial effects on regional ecosystems. The assumptions also recognize limitations on the type and quality of terrestrial habitat disturbed. There can be no ecologically sensitive features within the disturbed areas (footprint of disturbance), such as floodplains, shorelines, riparian vegetation, late-successional vegetation, land specifically designated for conservation, or habitat known to be potentially suitable for one or more Federal or State threatened or endangered species. In addition, the PPE assumes that there can be no more than 0.5 ac of wetlands or other surface waters impacted by the entire project. This value is based on the fact that many Nation Wide Permits (NWPs) established under the CWA (33 CFR Part 330-TN4318) allow up to 0.5 ac of project-wide disturbance to wetlands and other waters of the United States. Additionally, drawing from analyses in past new reactor EISs, the staff included an assumption in the PPE and SPE of a maximum building height of 50 ft, except for 200 ft for meteorological towers and 100 ft for transmission line poles/towers and mechanical draft cooling towers. The PPE assumes new meteorological towers will have non-red, flashing lights. The Federal Aviation Administration recommends voluntary marking of meteorological towers <200 ft AGL and does not permit red non-flashing lights on any new tower above 150 ft AGL to reduce the number of migratory bird collisions (FAA 2020-TN10130; FCC 2017-TN10131). The PPE and SPE likewise assume no noise generation greater than 85 decibel(s) on the A-weighted scale (dBA) at a point 50 ft from the source. The assumptions in the PPE and SPE regarding site employment (Section 3.12.2) also apply to the staff's evaluation of potential impacts on wildlife from vehicular traffic.

As presented in Section 3.1, the staff assumes that offsite ROWs for transmission lines, pipelines, and access roads are not more than 1 mi in length or 100 ft in width, but may be unlimited in mileage for linear features built within existing ROWs or in widened ROWs directly adjacent to existing ROWs or public highways. The staff recognizes that these values would effectively minimize disturbance to terrestrial habitats and wildlife in most surrounding landscapes. Additionally, the NRC staff assumes that the total disturbance to any wetlands (as delineated using the *Corps of Engineers Wetlands Delineation Manual* [USACE 1987-TN2066] and regional supplements) and other surface waters from the entire project (including onsite and offsite activities) would not exceed 0.5 ac (based on criteria underlying many NWPs). Otherwise, the staff does not assume other qualitative limitations on other habitats that may be present in proposed offsite ROWs, because only a small fraction of the area would be disturbed by support foundations and most of the ROW area would be spanned by overhead power lines. In addition, the staff assumes there would be no physical disturbance to streams greater than 10 ft in width below the ordinary high-water mark. While the potential impacts on most such narrow streams would be localized, physical disturbance to larger streams could potentially affect more distant connected wetland and shoreline habitats.

The staff assumes that licensees would comply with State and local regulatory requirements for implementing BMPs for soil erosion, sediment control, and stormwater management whenever ground-disturbing activities take place either onsite or offsite. Even if a project is proposed for somewhere lacking such regulatory requirements, the staff assumes for purposes of its generic analyses that licensees would voluntarily implement BMPs similar to those commonly required by most States and local jurisdictions. The staff also assumes that any impacts on wetlands or

other waters of the United States can be permitted through general permits rather than individual permits, and that licensees would implement any mitigation called for in the permits.

The NRC staff typically evaluates effects on terrestrial resources in terms of habitats and broad groupings of wildlife, as well as on the individual species and habitats that meet the definition of "important" species and habitats outlined in RG 4.2 (NRC 2026-TN11915). Determining which species and habitats potentially affected by a project meet the criteria for "important" is not possible until a specific site and ROWs are identified. While the analysis in Section 3.5.2 is able to consider the potential effects on many types of important species generically, it reserves consideration of potential effects on federally listed threatened or endangered species until after receipt of an application. Several available mapping tools and databases contain relevant information about potential important species for sites anywhere in the United States. The U.S. Fish and Wildlife Service (FWS) maintains online mapping tools and databases regarding the potential occurrence of threatened, endangered, proposed, or candidate species and critical habitats designated under the Federal ESA (16 U.S.C. §§ 1531 et seq.; TN1010). As of 2024, the FWS mapping tool is termed Information for Planning and Consulting (IPaC). Users can enter an action area (potentially affected area) polygon into IPaC which then generates a list of potentially occurring listed species and habitats as well as other ecologically useful information. Users can also use IPaC to automatically generate an official species letter that serves the same function as the official species letters that agencies formerly used to request from the FWS in writing. The FWS also continues to add automated features that help in assessing potential impacts to certain listed species. Most States have Natural Heritage Programs with databases containing known locations of species and habitats with Federal or State special designations.

3.5.2 Terrestrial Ecology Impacts

For most new reactors, terrestrial ecology impacts related to loss, conversion, and fragmentation of upland and wetland habitats and habitats for threatened or endangered species would primarily take place during preconstruction, especially during site preparation work such as clearing, grubbing, and grading. Potential impacts related to exposure of wildlife to noise or the potential for collision of birds and bats with structures and transmission lines could continue throughout the building period and extend into operations. Issues related to the exposure of flora and fauna to cooling-tower drift, radiological releases, EMFs, or the risk of avian electrocution on powerlines are more of a concern during operations.

3.5.2.1 Environmental Consequences of Construction

The NRC staff identified the following environmental issues for analysis for the building of a new reactor:

- permanent and temporary loss, conversion, fragmentation, and degradation of habitats;
- permanent and temporary loss, conversion, and degradation of wetlands;
- effects of building noise on wildlife;
- effects of vehicular collisions on wildlife; and
- bird collisions with structures.

In addition to evaluating the issues noted above, the NRC staff addressed as a separate issue any impacts on important species and habitats as defined for NRC environmental reviews in RG 4.2 (NRC 2026-TN11915).

3.5.2.1.1 Permanent and Temporary Loss, Conversion, Fragmentation, and Degradation of Habitats

Because of the assumptions in the PPE and SPE outlined in Section 3.5.1, building a new reactor would not require permanent disturbance of more than 30 ac of land or temporary disturbance of more than 20 ac of additional land, within a site no larger than 100 ac. The assumptions also limit impacts on wetlands (addressed further in Section 3.5.2.1.2) and exclude impacts on floodplains, riparian land, late-successional vegetation, land specifically designated for conservation, or habitat potentially suitable for one or more Federal or State threatened or endangered species. These assumptions are conservative regarding parameters related to terrestrial ecology and recognize the high degree of variability in the sensitivity of various habitats and species in various landscape settings. Habitat that is permanently lost to build a reactor would no longer provide food or cover for terrestrial flora or fauna. However, loss of 50 ac of habitat not situated in sensitive settings is unlikely to noticeably reduce the overall availability of such habitat for most species in the surrounding landscape. Many of the EISs for new LWRs over the last 10 years have identified noticeable impacts on terrestrial habitats (e.g., those for Levy and Turkey Point; NRC 2012-TN1976 and NRC 2016-TN6434, respectively), but these proposed reactors have each encompassed hundreds of acres of habitat loss, substantially exceeding the PPE used in this GEIS. Much of the terrestrial habitat outside of sensitive settings consists of current or former agricultural land, pasture or degraded range land, forest monocultures, or ruderal habitat compromising the presence of invasive plant species such as cheatgrass (*Bromus tectorum*), red brome (*Bromus rubens*), garlic mustard (*Alliaria petiolata*), stiltgrass (*Microstegium vimineum*), or ailanthus (*Ailanthus altissima*). Losses of such degraded habitat on new reactor sites are unlikely to noticeably limit resources for most species in the surrounding landscape. Even for higher-quality habitats such as late-successional forest, scrub, or prairie vegetation, the loss of only 50 ac is unlikely to result in a noticeable decline in the ecological quality of the surrounding landscape.

However, the staff recognizes the typically long time horizon following past disturbance that is necessary for late-successional vegetation to develop, particularly in arid regions where vegetation recovery and succession are poorly understood (Abella 2010-TN6722; Engel and Abella 2011-TN6721; McAuliffe 1988-TN6723). Thus, project-specific review of the plans would be necessary to evaluate the value of late-successional habitats and the consequences of losing the ecological services they provide. In many settings, the individualized review may reveal that impacts from losses of those habitats might be minimal, but the staff considers individualized review to be necessary. The assumptions in the PPE and SPE therefore exclude late-successional vegetation from the onsite footprint of disturbance. Applicants would likely select sites located in areas of relatively low habitat value.

Habitat conversion involves changing habitat to a different habitat type. Habitat conversion typically involves a change from a more mature to a less mature vegetational stage (Abella 2010-TN6722) that may be then maintained indefinitely (e.g., from forest to shrub or grassland within a ROW). Habitat conversion may also include the cutting of forest near new reactors to open sightlines for security purposes. Unlike habitat loss, converted habitat continues to provide food or cover for terrestrial flora or fauna, but food or cover that is different from and perhaps inferior to that provided by the original habitat. When habitat changes, basic elements of an ecosystem upon which a species relies for shelter, food, and reproduction may be altered or may no longer be available. Habitat generalists may be able to adapt more readily to such changes than habitat specialists. Habitat conversion may result in a shift in species dominance and composition (Abella 2010-TN6722). Disturbance to convert habitats may also provide an

opportunity for increased establishment of invasive species. Habitat conversion over small parcels is unlikely to noticeably limit resources for most species in the surrounding landscape.

Fragmentation of mature forests or rangeland habitats, and other high-quality terrestrial habitats can be as harmful to wildlife as habitat losses, because it can limit wildlife movement and migration and limit access to food, water, and other resources, as well as increase the amount of edge habitat and invasive species resulting in habitat degradation and increased predation. Fragmentation can result from new clearings or the establishment of new features such as roads or fences that can interfere with the movement of wildlife. Fragmentation of natural habitats by human activity is recognized as being a key contributor to biodiversity losses over five continents (Haddad et al. 2015-TN6563). In North America, forest fragmentation has been shown to have adverse effects on neotropical migratory birds (birds that nest in the tropics and migrate north to breed in summer) through small forest-patch size, reduced proximity of patches, more edge, and negative interactions with non-forest species, in addition to those from habitat loss (Boulinier et al. 2001-TN6724, Critical Area Commission 2000-TN6564). Lynch (1987-TN6726) described the negative insular effects of forest fragmentation on neotropical migrants in terms of reduced patch size and isolation in the eastern United States. Yahner (2000-TN6565) demonstrated that the probability of four neotropical migratory bird species favoring forest interiors in the eastern United States declined sharply in forest tracts of less than 100 ha (247 ac). Initially, forest fragmentation triggers effects on a local scale, resulting in a range retraction of populations to less fragmented parts of a region (Rolstad 2008-TN6725). Similar effects have been shown to result from fragmentation of rangeland vegetation in the Midwest and Western North America. Schoerlbel (2003-TN6727) and Knick and Rotenberry (1995-TN6728, 2002-TN6729) demonstrated the effects of shrub-steppe fragmentation on songbirds requiring sagebrush (*Artemisia* spp.) habitat. Smith (2016-TN6730) demonstrated that the fragmentation of 1 mi^2 of shrub-steppe habitat for agricultural development can reduce sage-grouse (*Centrocercus urophasianus*) population persistence within an area 12 times that size. The FWS highlighted similar implications of fragmentation by energy development to sage-grouse, other sagebrush-dependent species, and the greater sagebrush ecosystem (FWS 2014-TN6731).

The assumptions in the PPE and SPE would effectively ensure minimization of losses and fragmentation of late-successional vegetation. Technical guidance on minimization of loss and fragmentation of habitats is available for most habitat types. Most call for locating new infrastructure on the periphery of already-developed areas and clustering or sharing ROWs for new infrastructure to avoid affecting late-successional habitats where possible (Critical Area Commission 2000-TN6564; Paige and Ritter 1999-TN6802).

Clearing new offsite ROWs, even those under 100 ft in width, can fragment large blocks of forest and rangeland, reduce the availability of habitat to forest-interior and area-sensitive wildlife to an extent greater than suggested by the acreage of clearing. Rich et al. (1994-TN6732) demonstrated that narrow forest-dividing corridors as small as 8 m (26 ft) can substantially reduce the abundance of forest-interior neotropical migrant birds. Creating new offsite ROWs with upright structures such as poles and towers increases perching habitat for predators and can increase predation for populations of at-risk species in sagebrush ecosystems (e.g., sage-grouse) (Manier et al. 2014-TN6746). However, the PPE limits the length of new offsite ROWs not co-located with or adjacent to existing utilities or roads to less than 1 mi, ensuring that the potential fragmentation of habitat and associated indirect risks to wildlife (e.g., predation) would be minimal. The NRC staff anticipates (but does not assume, for purposes of this analysis) that applicants would strive to locate new offsite ROWs whenever

possible in areas of low extant habitat value and sufficiently distant from any seasonal habitats (e.g., nesting areas) to minimize predation risk.

The staff has determined that permanent or temporary loss, conversion, fragmentation, or degradation of nonsensitive habitats is a Category 1 issue. The staff concludes that, as long as the applicable assumptions in the PPE and SPE are met, impacts from building a new reactor can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- The permanent footprint of disturbance would include 30 ac or less of vegetated lands, and the temporary footprint of disturbance would include no more than an additional 20 ac or less of vegetated lands.
- Temporarily disturbed lands would be revegetated using regionally indigenous vegetation once the lands are no longer needed to support building activities.
- New offsite ROWs for transmission lines, pipelines, or access roads would be no more than 100 ft in width and total no more than 1 mi in length.
- The footprint of disturbance (permanent and temporary) would contain no ecologically sensitive features such as floodplains, shorelines, riparian vegetation, late-successional vegetation, land specifically designated for conservation, or habitat known to be potentially suitable for one or more Federal or State threatened or endangered species.
- Total wetland impacts from use of the site and any offsite ROWs would be no more than 0.5 ac (see Section 3.5.2.1.2 below).
- Applicants would demonstrate an effort to minimize fragmentation of terrestrial habitats by using existing ROWs, or widening existing ROWs, to the extent practicable.
- BMPs would be used for erosion, sediment control, and stormwater management.

3.5.2.1.2 Permanent and Temporary Loss and Degradation of Wetlands

The assumptions would ensure that there would be no more than 0.5 ac of wetlands within the footprint of disturbance, and hence subject to filling, on the site and in the offsite ROWs (except for building intake and discharge structures if needed). A project meeting the assumptions would most likely not require an Individual Permit under Section 404 of the CWA; 33 U.S.C. § 1344-TN1019).

Wetlands for purposes of the analyses contained in this NR GEIS include the lands that meet the criteria for delineation as wetlands as established in the USACE Wetlands Delineation Manual (USACE 1987-TN2066) and applicable regional supplementary wetland delineation guidance, regardless of whether they meet other criteria required for jurisdiction under the CWA (33 CFR Part 328-TN1683). Many wetlands not meeting the criteria for jurisdiction under the CWA, sometimes termed “isolated wetlands” or “non-jurisdictional wetlands,” can still provide beneficial ecological services such as contributing to groundwater recharge, attenuating overland surface runoff thereby reducing flooding potential, and providing specialized habitat for many wetland-dependent wildlife species. Many depressional features such as vernal pools, prairie potholes, Carolina bays, and playa lakes play key roles in flood control and groundwater recharge, and provide specialized habitat required by many wildlife species that are declining rapidly in many regions, yet are isolated from navigable waterways and surface tributary systems and hence not under the jurisdiction of the CWA. Because the functions and values of wetlands are not dependent on whether the wetland is under CWA jurisdiction, the staff

established the 0.5 ac assumed limit on wetland disturbance to be inclusive of impacts on any wetlands regardless of jurisdictional status under the CWA.

The 0.5 ac of wetlands might be physically lost or disturbed by site preparation work, commonly referred to as “discharge of dredged or fill material,” or by other types of disturbances. The hydrology of wetlands, and hence biota that rely on the hydrological properties of wetlands, can also be altered by changes in landscape drainage patterns and overland runoff. Wetlands are also subject to sedimentation from upgradient soil disturbances. Wetland losses and disturbances cause the loss or reduction of multiple hydrological functions such as groundwater recharge and discharge, flood flow abatement, and shoreline stabilization; ecological functions such as fish and wildlife habitat, production export, and providing specialized habitat for many threatened or endangered species; and societal values such as recreation and aesthetics (USACE 1999-TN1793).

Excavations to build a reactor can cause temporary drawdowns of the water table, thereby influencing the hydrology and hence the water levels, hydroperiod (number and timing of days per year that soils remain saturated or covered with water), spatial extent and function of nearby wetlands. Even for large reactors, however, analyses in recent EISs have indicated that some hydrological effects on wetlands might be brief and localized. A conservative analysis of the drawdown effects of excavating 56 ft deep to build a large pond component for the proposed Bell Bend nuclear power plant in Pennsylvania, and pumping groundwater at a rate of 235 to 310 gpm, estimated that the effects of water table drawdown on nearby wetlands would last only as much as 24 months and not extend more than about 1,200 ft from the excavation (NRC and USACE 2016-TN6562). Analysis of water table drawdowns during excavations for the proposed Levy Units 1 and 2 in a landscape in north-central Florida containing extensive wetlands concluded that the drawdown effects on adjoining wetlands would be temporary and within the range of expected seasonal water table fluctuations to which the wetlands are adapted (NRC 2012-TN1976). Both analyses assumed, however, that nearby wetlands would be monitored over the period of excavation and action would be taken to restore water levels as necessary. Based on these analyses, for a new reactor bounded by the assumptions for groundwater withdrawals and dewatering in the SPE (50 gpm with negligible effect on groundwater levels at the site boundary), onsite wetlands with a groundwater connection could be affected, but similar wetlands offsite would not be affected. Temporary adverse impacts on onsite wetlands can result if groundwater dewatering causes changes in water levels or hydroperiod that exceed historical annual or seasonal fluctuations. This applies to all onsite wetlands with a groundwater connection, and the effects may be accentuated in wetlands that only have a surface water connection. The staff expects that applicants relying on the generic analysis would demonstrate that the assumption regarding the influence of groundwater withdrawal for dewatering on connected wetlands (changes in wetland water levels and hydroperiod are within historical annual or seasonal fluctuations) in the SPE are met. If this assumption is not met, then project-specific analysis would be necessary to demonstrate that impacts are minimal.

Wetlands may also be affected by habitat conversion. One of the most notable types of habitat changes in wetland water levels and hydroperiod within historical annual or seasonal fluctuation conversions that may occur in association with new reactors is forest clearing for the purpose of spanning wetlands with transmission lines (EPA 2018-TN6747). The removal of vertical habitat structure reduces the diversity of species and creates corridors that fragment forests (addressed in previous section) (EPA 1994-TN6748). Canopy and subcanopy trees are typically removed, eliminating nesting habitat for forest-interior bird species. Extant shade-tolerant forest understory vegetation may change to herbaceous and/or shrub species adapted to full-sun

conditions. Amphibian breeding pools may become unsuitable because of increased solar exposure and change to an unsuitable temperature regime. The amount of edge habitat would increase, thereby increasing the risk of invasive species establishment and habitat degradation. Ultimately, early successional plants and wildlife could become established in the converted area, which subsequently could be maintained over the long term as an emergent or scrub-shrub wetland in order to avoid vegetation interference with overhead transmission lines. There would be a net reduction in wetland functions and values due to conversion of forested wetland to emergent or scrub-shrub wetland (DOE 2019-TN6749; NextEra Energy 2020-TN11987). However, the 0.5 ac limit on wetland disturbance renders minimal the potential effects of wetland habitat conversion, degradation, or fragmentation.

The staff recognizes that up to 0.5 ac of wetlands can be disturbed by building utility lines in NWP 12 under the CWA, which the USACE recognizes as not having a significant impact on waters of the United States (33 CFR 330.1(b)-TN4318). The staff assumes that the applicant would implement any mitigation required by the USACE under the CWA or required by State agencies that have similar wetland regulatory authority. Even if a project may not require a permit under the CWA or State wetland protection regulations, the staff expects that applicants relying on the generic analysis would provide a wetland delineation demonstrating that assumptions regarding wetlands in the PPE are met. The PPE includes assumptions, based on information contained in most recent new reactor EISs, that applicants would be required by State or local governments to implement BMPs as mitigation to minimize sedimentation and erosion of nearby wetlands. Additionally, because hydrology is one of the most important factors in the establishment and maintenance of wetlands and wetland processes (SFWMD 1995-TN6799), the PPE includes an assumption that licensees relying on the generic analysis would demonstrate that the assumption regarding the influence of groundwater withdrawal for dewatering on connected wetlands in the SPE (changes in wetland water levels and hydroperiod are within historical annual or seasonal fluctuations) is met. If this assumption is not met, then project-specific analysis would be necessary to demonstrate that impacts would be minimal. The staff developed this assumption in the PPE based on experience from past reviews supporting EISs for proposed new reactors in Levy County, Florida (NUREG-1941; NRC 2012-TN1976) and Berwick, Pennsylvania (NUREG 2179; NRC and USACE 2016-TN6562).

The staff has determined that permanent or temporary loss or degradation of wetlands during building of a new reactor is a Category 1 issue. The staff concludes that as long as the relevant assumptions in the PPE and SPE are met, the impacts from building a new reactor can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- Applicant would provide a delineation of potentially impacted wetlands, including wetlands not under CWA jurisdiction.
- Total wetland impacts from use of the site and any offsite ROWs would be no more than 0.5 ac.
- If activities regulated under the CWA are performed, those activities would receive approval under one or more NWPs (33 CFR Part 330) or other general permits recognized by the USACE.
- Temporary groundwater withdrawals for excavation or foundation dewatering would not exceed a long-term rate of 50 gpm.

- Applicants would be able to demonstrate that the temporary groundwater withdrawals would not substantially alter the hydrology of wetlands connected to the same groundwater resource.
- Any required State or local permits for wetland impacts would be obtained.
- Any mitigation measures indicated in the NWPs or other permits would be implemented.
- BMPs would be used for erosion, sediment control, and stormwater management.

3.5.2.1.3 Effects of Building Noise on Wildlife

Activities to build reactor facilities are usually performed in a series of steps or phases, and noise associated with different phases can vary greatly depending on the type of equipment used. Average maximum noise levels of typical building equipment 50 ft from the source may range from about 73 to 101 dBA for non-impact heavy equipment (earthmoving equipment such as bulldozers), 79 to 110 dBA for impact equipment (jackhammers, pile drivers, etc.), and 68 to 88 dBA for stationary equipment (pumps, etc.) (WSDOT 2017-TN5313), but an overall noise level of approximately 85 dBA at 50 ft from the source is typical (DOT 2017-TN5383). Noise from operating construction equipment can startle and interfere with the behavior and movement of wildlife. The effects can be exacerbated by the fact that some building noise occurs episodically rather than continuously over extended periods, and hence wildlife may be less capable of habituating to it (Shannon et al. 2016-TN6566). A comprehensive literature review of wildlife responses to anthropogenic noise indicated that some species adversely respond to noise levels as low as 40 dBA, but 20 percent of the literature documented responses only above 50 dBA (Shannon et al. 2016-TN6566). Restrictions have been placed on noise at similar levels within the habitat of sensitive wildlife species. For example, the U.S. Department of Energy (DOE) considers an increase in noise levels greater than 6 dBA above ambient to constitute a disturbance to the Mexican spotted owl (*Strix occidentalis lucida*) on the Los Alamos Site in New Mexico (Hathcock et al. 2017-TN6789).

The assumptions in the PPE and SPE include no noise generation greater than 85 dBA at a point 50 ft from the source. However, noise levels decrease by approximately 6 dBA per doubling of distance over hard site conditions (i.e., substrate such as concrete or open water) in accordance with the inverse square law (DOT 2017-TN6567), and by an additional 1.5 dBA decrease if soft site conditions (e.g., unpacked earth) are present (WSDOT 2017-TN5313). Therefore, typical building noise of 85 dBA at a distance of only 50 ft from the source may diminish to only around 50 dBA at about 1,200 ft from the source (assuming soft ground conditions). This noise level would not generally disturb most wildlife. Furthermore, this value is conservative because it likely overestimates the actual noise level because the calculation does not take into account additional noise attenuation by vegetation and topography (WSDOT 2017-TN5313), which are difficult to consider without project-specific analysis.

The staff therefore expects that potential noise impacts would extend over a sufficiently small part of the landscape and that any effects on wildlife would be minor and thus be a Category 1 issue. The staff concludes that as long as the assumption in the PPE regarding a maximum noise generation of 85 dBA 50 ft from the source is met, the impacts can be generically determined to be SMALL. Effects on wildlife from building noise over 85 dBA would extend over a greater distance and area and thus require project-specific evaluation. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- Noise generation would not exceed 85 dBA 50 ft from the source.

3.5.2.1.4 Effects of Vehicular Collisions on Wildlife

Wildlife can also be killed or injured through collisions with vehicles, although the low number of construction workers needed to build a reactor of a size fitting the assumptions in the PPE and SPE suggests that vehicular usage, and hence the potential for collisions, would be minimal. While roadkill may increase somewhat during the building period, except for special situations (e.g., ponds and wetlands crossed by roads where large numbers of migrating amphibians would be susceptible), traffic mortality rates rarely limit population size (Forman and Alexander 1998-TN2250). The potential for significant vehicular collisions with wildlife is limited by the assumptions in the PPE and SPE regarding site size, size of the footprint of disturbance, and by limitations on traffic growth, as evidenced by traffic LOSs on roads near the site.

Federal and State wildlife conservation agencies commonly suggest practices to reduce the potential for vehicular collisions with wildlife species regarded as regionally sensitive or desirable. For example, an EIS prepared by the NRC (NRC 2013-TN6436 │ NUREG-2105, Fermi Unit 3 COL EIS, p. 4-37│) acknowledged the potential for injury and mortality of eastern fox snakes, a rare (and State-listed) species known to occur near the site, related to construction equipment while building a proposed reactor, but it also concluded that readily implemented mitigation measures suggested by the State could prevent noticeable impacts on the regional population of that species. Some specific mitigation measures proposed included signage along roads, worker education, and reduced speed limits. Another NRC EIS (NRC 2016-TN6434) recognized the potential for mortality of American crocodiles (a federally listed threatened species known to inhabit the site and surrounding landscape) by construction vehicle collisions, but concluded that easily implemented mitigation measures recommended by the FWS, such as signage and speed limits, could prevent substantial population effects.

The staff has therefore determined that traffic effects on wildlife are a Category 1 issue. The staff concludes that as long as the project fits within the PPE regarding site size (no more than 100 ac, with a permanent building footprint of no more than 30 ac and a temporary footprint of no more than 20 ac) and site employment, the impacts can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- The site size would be 100 ac or less.
- The permanent footprint of disturbance would include 30 ac or less of vegetated lands, and the temporary footprint of disturbance would include no more than an additional 20 ac or less of vegetated lands.
- There would be no decreases in the LOS designation for affected roadways.
- The licensee would communicate with Federal and State wildlife agencies and implement mitigation actions recommended by those agencies to reduce potential for vehicular injury to wildlife.

Mitigation measures that Federal and State wildlife agencies might recommend include the use of signage, worker education, reduced speed limits where construction equipment crosses habitat potentially containing regionally rare or declining wildlife, and discussion of these and other possible mitigation measures with relevant Federal, State, and local conservation offices.

3.5.2.1.5 Bird Collisions and Injury from Structures and Transmission Lines

Birds and other flying wildlife such as bats can be injured and killed when colliding with tall structures such as buildings, towers, and transmission lines. The assumptions in the PPE and SPE are that the tallest building or structure height would be no more than 50 ft, although the PPE and SPE allow for taller meteorological or communications towers or mechanical draft cooling towers. Additionally, during construction, cranes that are taller than the structures they are being used to build may be in place temporarily. It is possible that some birds or bats could be injured or killed by flying into and colliding with buildings, towers, transmission lines, or cranes. In the LR GEIS, the NRC reviewed the scientific literature about bird collisions with buildings and indicated that collisions with buildings and windows account for the vast majority of annual avian collision mortality in the United States (NRC 2024-TN10161). Researchers have estimated that the annual mortality rate for each building 1 to 3 stories tall (approximately 42 ft in height) is about 2 birds and about 16 birds for each building 4 to 11 stories tall (approximately 56 to 154 ft in height) (Loss et al. 2014-TN6568). The PPE assumes, based on the staff's experience from recent new reactor EISs and on the scientific literature cited above, that most buildings and structures developed on smaller new reactor sites would be less than 50 ft in height, and only a few would be over 50 ft in height (mechanical draft cooling towers). The low per-building mortality rate for buildings 1 to 3 stories tall plus the 100 ac bound on the size of the site, which limits and localizes the number of 50 ft or less tall structures, render negligible the potential for building collision injury and mortality. Although the mortality rate for each mechanical draft cooling tower is expected to be somewhat higher because of its greater height (typically 50–100 ft), in the LR GEIS the NRC considered avian collision mortality from mechanical draft cooling towers to be negligible (NRC 2024-TN10161). The staff has determined this conclusion to also be appropriate for mechanical draft cooling towers on new reactor sites.

The LR GEIS reviewed the scientific literature about bird collisions with structures, including nuclear power plant structures, transmission lines, and communication towers, and evaluated the potential for bird collisions with several operating large LWRs containing natural draft cooling towers and concluded that the effects on bird populations were minimal (NRC 2024-TN10161). The GEIS found the overall effect from operating these plants constitutes a small fraction of annual avian collision mortality from all sources nationwide. The onsite plant structures and communication towers would all be clustered within the 100 ac site fitting the PPE. For new reactors that meet the assumptions listed below, the only new transmission lines would likely be those needed to connect the plant to the regional power distribution system. The assumptions in the PPE and SPE limit the length of new transmission lines and other offsite linear facilities to less than 1 mi of new ROW not adjoining existing utilities or roads, and they limit the height of transmission structures (poles or towers) to no more than 100 ft. The PPE allows for additional co-located transmission line ROWs, but co-location would not introduce the potential for collisions to new areas of the landscape. The transmission lines at such new reactor sites would constitute both a very low fraction of transmission lines nationwide as well as related collision mortality. Loss et al. (TN9396) estimated median annual collision rate of about 29.6 birds/km (47.7 birds/mi) of powerline using strict study inclusion criteria and 23.2 birds/km (37.4 birds/mi) relaxed study inclusion criteria.

A new reactor facility within the bounds of the assumptions would have only one or a few towers or other tall structures clustered on a site of less than 100 ac. Meteorological towers could be about 197 ft (60 m) aboveground level (the prescribed height at which wind speed and direction should be measured), and could be guyed (NRC 2007-TN278). The PPE allows for a single meteorological tower of any height on a site, with non-red, flashing lights if lit. Meteorological

towers (Kerlinger et al. 2012-TN4401), as well as other types of towers such as communication towers (Longcore et al. 2008-TN4398, Longcore et al. 2013-TN4399), have been implicated in avian collision mortality of predominantly neotropical night-migrating songbirds being affected (Longcore et al. 2013-TN4399). Estimated rates of avian fatality from collision with ten 50 m (164 ft) and eight 60 m (197 ft) temporary meteorological towers supported by guy wires near wind turbines in central California were about seven total birds per tower per year, including night-migrating songbirds (Kerlinger et al. 2012-TN4401). Collision mortality increases with increasing tower height; the highest rate of collision mortality is associated with towers taller than 1,000 ft that use guy wires, and the use of continuously (as opposed to intermittently) illuminated lights (Longcore et al. 2008-TN4398; Gehring et al. 2011-TN6581). Meteorological towers at new reactor sites, regardless of whether they are guyed or whether or how they may be lit, would cause only negligible avian collision mortality due to their relatively low height. It is also possible that communication towers could be present on new reactor sites. Any communication towers would make up only a very minute fraction of all such towers nationwide and of the collision mortality posed by such towers noted above. The 100 ac maximum size of the site assumed in the PPE limits the possible number of communication towers.

Any effects from buildings, towers, and transmission lines would be localized and not likely to noticeably contribute to bird mortality in the surrounding landscape. The staff has therefore determined that bird collisions with structures and transmission lines during building are a Category 1 issue. The staff concludes that as long as the applicable assumptions in the PPE and SPE regarding site size and building and structure height are met, the impacts can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- The site size would be 100 ac or less.
- New offsite ROWs for transmission lines, pipelines, or access roads would be no more than 100 ft in width and total no more than 1 mi in length.
- No transmission line structures (poles or towers) would be more than 100 ft in height.
- Licensees would implement common mitigation measures such as those provided by the American Bird Conservancy (ABC 2015-TN6763) for buildings, by FWS (2013-TN6764) for towers, and by the Avian Power Line Interaction Committee (APLIC) for transmission lines (APLIC 2012-TN6779).

Examples of possible mitigation measures include using building designs that use less glass, screens and shutters that partly obscure glass, and two-dimensional patterns that birds perceive as barriers (ABC 2015-TN6763); using unguyed lattice or monopole structures where possible, keeping towers unlit if the Federal Aviation Administration regulations permit but otherwise using flashing (as opposed to steady) lights (FWS 2013-TN6764); marking devices to enhance the visibility of existing power lines; and considering migratory patterns and high-use areas when planning new power lines (APLIC 2012-TN6779).

3.5.2.1.6 Important Species and Habitats

Species and habitats meeting the NRC criteria (NRC 2026-TN11915) for a given site can only be determined once an application is received that identifies the site boundaries. Because of differing regulations and sensitivities to impacts, two separate issues are analyzed below regarding important species and habitats: (1) resources regulated under the ESA (16 U.S.C. §§ 1531 et seq.; TN1010), and (2) other important species and habitats.

Resources Regulated under the Endangered Species Act of 1973

The FWS has developed online databases and mapping tools that identify threatened, endangered, proposed, and candidate species under the ESA, as well as critical habitats designated and proposed under the Act. Because these federally regulated resources occur in the same setting and are subject to the same types of impacts as those considered in Sections 3.5.2.1.1 through 3.5.2.1.5, the limitations placed upon the extent and intensity of ecological impacts by meeting the assumptions in the PPE and SPE would likewise limit the potential for impacts on these resources. However, the staff would need to consult individually with the FWS under ESA Section 7 regarding the potential effects of each specific licensing action. Furthermore, the criteria for listing species under the ESA are based on the potential for the most severe of potential ecological impacts: extinction of species, subspecies, or distinct population segments. Species that have experienced previous impacts so severe that they are now, or could imminently become, in danger of extinction may also be substantially more sensitive to impacts that might only pose minimal threat to other species. The staff has therefore determined that building impacts on resources regulated under the ESA is a Category 2 issue. Because of their potential for future regulation over the course of a licensing action, the Category 2 designation extends also to proposed and candidate species and critical habitat proposed under the Act. Even if the assumptions in the PPE and SPE that are referenced in Section 3.5.1 are met, the NRC staff is unable to determine the significance of potential impacts without consideration of project-specific factors, including the specific species and habitats affected and the types of ecological changes potentially resulting from each specific licensing action. Furthermore, completing the required consultation requires individualized action by the staff for each application.

Other Important Species and Habitats

Most States maintain natural heritage databases that identify known occurrences of species and habitats receiving various categories of State regulation or recognition. Many species and habitats that do not display the potential for extinction necessary for regulation under the ESA are still recognized by States because of declining numbers within State boundaries. However, extirpation from a State is not as severe an impact as range-wide extinction. Regarding other types of important species and habitats, most sites containing undeveloped land may support commercially or recreationally valuable species such as whitetail deer (*Odocoileus virginianus*), wild turkey (*Meleagris gallopavo*), and ring-necked pheasant (*Phasianus colchicus*), and nuisance or invasive species such as Canada thistle (*Cirsium arvense*), johnsongrass (*Sorghum halepense*), cheatgrass (*Bromus tectorum*), European starlings (*Sturnus vulgaris*), Burmese pythons (*Python bivittatus*), and nutria (*Myocastor coypus*). Research of and communication with State and local agencies, private conservation organizations, and other stakeholders would be necessary to determine other important species and habitats potentially present on a site, such as species with monitoring requirements, State threatened or endangered species, other State status species, protected habitats, habitats with high priority for protection, or other habitats of interest such as nesting or nursery grounds.

The analyses presented above regarding impacts on terrestrial habitats and wildlife from specific terrestrial ecological issues suggest that the potential impacts on many important species and habitats (NRC 2026-TN11915) from building of a new reactor meeting the PPE and SPE assumptions discussed in Section 3.5.1 would likely be minimal regardless of site location and the important species specifically present on a given site. The assumptions in the PPE and SPE limit the potential for adverse impacts, especially limitations on the size of

the footprint of disturbance and the assumed absence of sensitive habitat types potentially containing rare species within the footprint.

The staff has therefore determined that building impacts on important species and habitats other than those regulated under the ESA is a Category 1 issue. The staff concludes that as long as the assumptions regarding the size and habitat quality within the building footprint, wetlands, building height, noise generation, and employment in the PPE and SPE are met, the impacts can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- Applicants would communicate with State natural resource or conservation agencies regarding wildlife and plants and implement mitigation recommendation of those agencies.

3.5.2.2 Environmental Consequences of Operation

The NRC staff identified the following environmental issues for analysis for operation of a new reactor:

- permanent and temporary loss or disturbance of habitats;
- effects of operational noise and traffic on wildlife;
- exposure of terrestrial organisms to radionuclides;
- cooling-tower operational impacts on vegetation;
- bird injury and mortality related to collisions with structures and transmission lines;
- bird electrocutions by transmission lines;
- water use conflicts with terrestrial resources;
- effects of transmission line ROW management on terrestrial resources; and
- effects of EMFs on flora and fauna.

In addition to evaluating the issues noted above, the NRC staff addressed as a separate issue any impacts on important species and habitats as defined for NRC environmental reviews (NRC 2026-TN11915).

3.5.2.2.1 Permanent and Temporary Loss or Disturbance of Habitats

Substantial losses or changes in habitats on new reactor sites are unlikely during operations, although small areas of vegetated land might have to be disturbed to maintain, upgrade, or expand structures or add support structures. In reviewing the environmental effects of operating large LWRs, the NRC staff explained that most unpaved lands in the developed areas on nuclear sites are maintained as modified habitats with lawns and other landscaped areas or may contain early successional habitats (NRC 2024-TN10161). Even if other habitats are present in developed areas, they can be expected to be small, fragmented, and heavily influenced by noise and human activity associated with reactor operations. Based on the LR GEIS (NRC 2024-TN10161), the NRC staff expects that there would be no wetlands in such areas, or that any wetland disturbances (except for intake and discharge structures [Section 3.6.2.1]) would not cause total wetland impacts for the project to exceed the PPE value of 0.5 ac (Section 3.5.2.1.2). Wetland impacts for projects within the PPE value of 0.5 ac would most likely not require an Individual Permit under CWA Section 404 (33 U.S.C. § 1344-TN1019) and may result from “discharge of dredged or fill material” or other types of disturbances. The LR GEIS explains that habitats in such settings are generally tolerant of disturbance (NRC 2024-TN10161), as are associated populations of birds, mammals, and lizards (Samia et al. 2015-TN6790). Small areas of such habitats could be lost or disturbed as facilities on the site are refurbished, upgraded, or expanded, although the ecological effects of any losses on the

surrounding landscape are likely to be minimal. Not only would the effects be minimized because of the limited spatial extent of facilities meeting the PPE, but also because of the previously altered character of the affected areas.

The staff has determined that this is a Category 1 issue. The staff concludes that the impacts can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- Temporarily disturbed lands would be revegetated using regionally indigenous vegetation once the lands are no longer needed to support building activities.
- The total wetland loss from site disturbance over the operational life of the plant would be no more than 0.5 ac.
- Any State or local permits for wetland impacts would be obtained.
- Any mitigation measures indicated in the NWPs or other wetland permits would be implemented.
- BMPs would be used for erosion, sediment control, and stormwater management.

3.5.2.2.2 Effects of Operational Noise and Vehicular Collisions on Wildlife

The effects of operational noise and traffic on wildlife would be as described above for building in Sections 3.5.2.1.3 and 3.5.2.1.4, respectively, but the effects would occur over an extended period of time covering the operational lifespan of the reactor. Operational noise would tend to be lower in intensity and steadier than building noise, and wildlife may therefore be better able to habituate to and tolerate the noise. As for during construction, the potential for injury or mortality of wildlife caused by vehicular collisions would be limited by the low employment at the reactor established in the PPE. Furthermore, it is unlikely that new roads would be constructed through substantial blocks of natural habitat thereby exposing additional wildlife to noise or collision threats during operations. The staff has therefore determined that operational noise and traffic are Category 1 issues. The staff concludes that as long as the applicable assumptions in the PPE and SPE regarding noise generation and employment are met, the impacts can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- Noise generation would not exceed 85 dBA 50 ft from the source.
- There would be no decreases in the LOS designation for affected roadways.
- The licensee would communicate with Federal and State wildlife agencies and implement mitigation actions recommended by those agencies to reduce potential for vehicular injury to wildlife.

3.5.2.2.3 Exposure of Terrestrial Organisms to Radionuclides

The NRC staff recognizes that small amounts of radioactive particulates can be vented to the exterior environment during operation of LWRs and evaluated the potential effects of those releases on terrestrial ecological receptors in the LR GEIS (NRC 2024-TN10161). Section 3.8.1.2.2 of this GEIS concludes that the impact of routine radiological releases from past and current operations on terrestrial biota would be SMALL. To support that conclusion, Table 3-7 (in Section 3.8.1 in this GEIS) presents radiological exposure estimates for two mammal and two bird species modeled using NRCDose code, as presented in 15 EISs for proposed new LWRs published between 2006 and 2019. All estimates were substantially

lower than exposure levels considered protective of terrestrial animal populations by the International Atomic Energy Agency (IAEA).

In the 2013 and 2024 LR GEIS (NRC 2013-TN2654, NRC 2024-TN10161), the staff also used the RESRAD-BIOTA dose evaluation model developed by DOE (DOE 2004-TN6460) to calculate estimated dose rates to terrestrial biota receptors using REMP reports submitted by licensees for 15 operating LWRs in the United States. RESRAD-BIOTA accounts for bioaccumulation of radionuclides in the tissues of biological organisms and biomagnification, whereby radionuclides become concentrated at higher levels in organisms occupying higher positions in the food chain. The staff calculated estimated doses for three terrestrial ecological receptors: riparian animals (animals estimated to spend approximately half their time in aquatic environments and half in terrestrial environments), terrestrial animals, and terrestrial plants. None of the estimated doses exceeded levels recognized by DOE as being protective of riparian or terrestrial animals (0.1 rad/d [0.001Gy/d]) or terrestrial plants (1.0 rad/d [0.01 Gy/d]) (DOE 2002-TN4551).

- While many new reactors may use fuels containing different compositions of radionuclides than the LWRs considered in the analyses presented above, a reactor meeting the PPE for Radiological Environmental Hazards in Appendix G would not be likely to result in greater releases of radioactivity. The staff has determined that this is a Category 1 issue. The staff concludes that as long as the assumptions in the PPE underlying the analysis in Section 3.8 are met, the impacts can be generically determined to be SMALL without mitigation. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:
- Applicants would demonstrate in their application that any radiological nonhuman biota doses would be below IAEA (1992-TN712) and National Council on Radiation Protection and Measurements (NCRP) (1991-TN729) guidelines.

3.5.2.2.4 Cooling-Tower Operational Impacts on Vegetation

The PPE assumes that a new reactor would use only fresh makeup water that has a salinity of under 1 ppt for operation of any cooling towers. The staff has found in past new reactor EISs that salt drift modeling sometimes indicates potentially significant impacts on vegetation when brackish water is used as makeup water (NRC 2012-TN1976, NRC 2016-TN6434, NRC 2016-TN6840). The PPE also assumes that any cooling towers would be the mechanical draft type rather than natural draft cooling towers and under 100 ft in height. While mechanical draft cooling towers are typically under 100 ft in height, natural draft cooling towers can be more than 400 ft in height. Natural draft towers release drift higher into the atmosphere and therefore can spread drift farther across the landscape than can mechanical draft towers. Drift from mechanical draft towers tends to affect only vegetation in close proximity to the towers, which is mostly limited to disturbed lawns and other successional vegetation typical of existing industrially developed areas. The PPE also assumes that any cooling towers would be equipped with drift eliminators to minimize the amount of drift.

The NRC staff recognizes that salt deposition rates between 1 and 2 kg/ha/mo are generally not damaging to plants, while rates approaching or exceeding 10 kg/ha/mo in any month during the growing season could cause leaf damage in many species (NRC 2000-TN614). Even 10 kg/ha/mo is a conservative estimate representing documented acute injury only of the most sensitive of crop and native vegetation plant species (NRC 1996-TN288). It is reasonable to expect that substantially higher deposition rates would be needed to cause noticeable injury to vegetation consisting of a mixture of plant species of differing sensitivities.

Estimates for TDS (total dissolved solids, referred to hereafter as “salt”) deposition rates were less than 10 kg/ha/mo for several recently completed new reactor EISs where mechanical draft cooling towers were to be operated using fresh makeup water. Estimates for maximum salt drift deposition from operation of four mechanical draft cooling towers serving the proposed Comanche Peak Units 3 and 4 in inland Texas were approximately 3.49 kg/ha/mo, at a point 100 m (328 ft) north of the towers (NRC 2011-TN6437). Estimates for maximum salt drift deposition from operation of four mechanical draft cooling towers serving the proposed William States Lee Units 1 and 2 in western South Carolina were 0.0103 kg/ha/mo, at a point 200 m (656 ft) north of the towers (NRC 2013-TN6435). The estimates for building SMRs of unspecified technology at the Clinch River site in Oak Ridge, Tennessee, were as high as 112.7 kg/ha/mo at a point approximately 100 m (328 ft) from the towers but were less than 10 kg/ha/mo at 300 m (984 ft) from the towers. Even though the Clinch River data suggest possible vegetation damage in close proximity to operating mechanical draft cooling towers, such close-in areas to a nuclear power plant are usually industrial in character and any vegetation present would likely be ruderal or highly disturbed vegetation of low ecological value. The low estimated drift rate for areas 1,000 ft from the towers suggests that the potential effects of vegetation damage on the surrounding landscape would be low.

There is less of a record to draw from for cooling towers operated using brackish water or seawater makeup sources. The maximum deposition for the proposed Turkey Point Units 6 and 7, which were modeled using mechanical draft cooling towers with makeup water as salty as seawater, was estimated to be as high a 105 kg/ha/mo close to the towers (NRC 2016-TN6434) but to diminish rapidly with distance to under 10 kg/ha/mo within 1 mi from the towers (NRC 2016-TN6434). Although the Turkey Point EIS concluded that the effects would be minimal, the proposed site was situated on an island with an existing nuclear plant where the nearest high-quality natural habitat was nearly 1 mi distant (NRC 2016-TN6434). Had high-quality natural habitats been present close to those reactors, habitat function could have been noticeably compromised due to leaf injury. The maximum deposition for the proposed Levy Units 1 and 2 in north-central Florida, which was to use natural draft cooling towers with brackish makeup water of about 24 ppt, was estimated to be 10.75 kg/ha/mo (NRC 2012-TN1976). Such deposition suggests the possibility of noticeable leaf damage in terrestrial habitats close to the site. The Levy plant, however, was designed with natural draft cooling towers, which tend to disburse drift farther from the towers than mechanical draft towers.

The NRC staff recognizes that damage to forested habitats can result from icing of cooling-tower drift but recognizes such damage as being “rare, minor, and localized” (NRC 2024-TN10161). The recently completed new reactor EISs discussed above dismiss the effects of icing on terrestrial habitats from cooling-tower operation as being minimal. Even in arctic or very cold habitats, the existing vegetation would have to already be adapted to heavy snow and ice accumulation.

The staff has determined that cooling-tower effects on vegetation are a Category 1 issue. The staff concludes that as long as the applicable assumptions regarding cooling towers in the PPE and SPE are met, including that the source of makeup water is fresh (salinity of less than 1 ppt), the impacts can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- If needed, cooling towers would be mechanical draft, not natural draft; less than 100 ft in height; and equipped with drift eliminators.
- Any makeup water for the cooling towers would be fresh water (less than 1 ppt salinity).

The staff recognizes that vegetation damage from the operation of cooling towers using brackish water or seawater as makeup water may also have a low probability of noticeable adverse effects on terrestrial habitats, but less evidence is available to support high confidence in that conclusion without completion of project-specific analysis.

3.5.2.2.5 Bird Collisions and Injury from Structures and Transmission Lines

The structures and transmission lines discussed in Section 3.5.2.1 for building would continue to be present during operations, and no new structures or transmission lines would be introduced during operations that were not previously considered. Thus, the analyses in Section 3.5.2.1 also apply during operations. As for construction, the staff has determined that bird collisions with structures and transmission lines during operations are a Category 1 issue. The staff concludes that as long as the assumptions regarding structure heights and transmission lines are met, the impacts can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- The site size would be 100 ac or less.
- New offsite ROWs for transmission lines, pipelines, or access roads would be no more than 100 ft in width and total no more than 1 mi in length.
- No transmission line structures (poles or towers) would be more than 100 ft in height.
- Licensees would implement common mitigation measures such as those provided by the American Bird Conservancy (ABC 2015-TN6763) for buildings, by FWS (2013-TN6764) for towers, and by the APLIC for transmission lines (APLIC 2012-TN6779).

See Section 3.5.2.1.5 for a brief discussion of the types of possible mitigation measures.

3.5.2.2.6 Bird Electrocutions from Transmission Lines

The potential for avian electrocutions from energized transmission conductors depends on a combination of biological, environmental, and electrical design factors (APLIC 2006-TN794). Biological and environmental factors include proximate habitat, bird species (body size, behavior, distribution, and abundance), and prey availability. The key electrical design factor is the physical separation between energized conductors (wires). If the distance between energized conductors is less than that of the head-to-foot or wrist-to-wrist distance of a bird, electrocution may occur. APLIC (2006-TN794) recommends that conductors be spaced a minimum of 60 in. apart horizontally and 40 in. apart vertically, with 60 in. vertical separation recommended near sensitive avian habitats. Contact between a single conductor and a bird does not generally result in electrocution, but simultaneous contact by a bird with more than one conductor (or air space very close to a conductor) can cause electrocution because of the phase differences in voltage. Most electrocutions are of birds that have large wingspans, such as eagles, hawks, vultures, ravens, and large waterbirds. Of particular concern are bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*), which are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. §§ 668 et seq.*;* TN1447) (APLIC and EEI 2018-TN6809). Although collisions occur at both distribution lines and transmission lines, electrocutions mostly occur at distribution lines, with voltages between 2.4 and 60 kV (Loss et al. 2014-TN9396). Electrocution mortality is not known to have been a concern at existing nuclear power plants in the United States; thus, the NRC did not address the subject in its LR GEIS (NRC 2024-TN10161).

The staff expects the likelihood of avian electrocution mortality, up to and including population level effects, would be low for new reactor transmission lines in any environmental setting and has concluded this is a Category 1 issue. As long as the assumptions regarding transmission lines in the PPE and SPE are met, the impacts can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- New offsite ROWs for transmission lines, pipelines, or access roads would be no more than 100 ft in width and total no more than 1 mi in length.
- Common mitigation measures, such as those recommended by APLIC (2006-TN794), would be implemented.

The potential for electrocutions is limited by the PPE that assumes a maximum of 1 mi of ROW not co-located with existing ROWs or roads. APLIC (2006-TN794) recognizes that co-location of new power lines with existing power lines reduces the potential for electrocutions. The greatest potential for electrocutions is where power lines cross open treeless areas (APLIC and EEI 2018-TN6809), but even in these areas the limitations assumed under the PPE are expected to keep impacts at low significance. Examples of mitigation measures recommended by APLIC include separation of phase conductors and grounded hardware, and installation of covers on phases or grounds where adequate separation is not feasible (APLIC 2006-TN794). Moreover, most electrocutions are on distribution lines, not transmission lines (Loss et al. 2014).

3.5.2.2.7 Water Use Conflicts with Terrestrial Resources

Water levels and hydroperiod are important factors in determining the composition of wetland plant and animal species present (EPA 1996-TN6800; SFWMD 1995-TN6799). Through physiological stress and habitat alteration, water-level fluctuations create temporal and spatial heterogeneity that shapes littoral zone (shoreline and nearshore) habitats. Freshwater littoral zones typically harbor diverse ecological communities that serve numerous ecosystem functions that are influenced, in part, by water-level fluctuations (Carmignani and Roy 2017-TN6795). For example, some native plants and animals have adapted to the range of hydrologic conditions that occur in natural wetlands (SFWMD 1995-TN6799).

Large anthropogenic water withdrawals can influence the water levels and hydroperiod in wetlands, floodplains, riparian, and other terrestrial habitats connected to flowing water bodies; non-flowing freshwater, brackish, and marine water bodies; and groundwater sources supplying water to meet the demands. Adverse effects on these habitats can occur when the water levels or hydroperiod are changed beyond historical annual or seasonal fluctuations. In the LR GEIS, which addresses large LWRs that typically use water-based cooling systems requiring large quantities of water, the NRC staff concluded that project-specific analyses were necessary to characterize the potential impacts from water use conflicts on terrestrial habitats (NRC 2024-TN10161).

Flowing Water Bodies

The staff's assumption regarding surface water availability for flowing systems (i.e., withdrawals from rivers under low flow conditions of less than or equal to 3 percent of the 95 percent exceedance flow, or extreme low flow conditions) would result in the loss of an even much smaller percentage of the full or out-of-bank flows typically required to maintain riparian habitats and connected wetlands, floodplains, and riparian areas (Hill et al. 1991-TN6791; Navratil 2006-TN6792; Poff et al. 1997-TN6794; Kendy et al. 2012-TN6793). The 95 percent exceedance flow accounts for cumulative hydrologic impacts because it includes existing withdrawals and

planned future withdrawals. Although there are no standard metrics for determining the flow quantity or duration needed to maintain wetland, floodplain, and riparian habitats (Hill et al. 1991-TN6791), a minor water withdrawal such as 3 percent of the 95 percent exceedance flow is unlikely to reduce water levels or alter hydroperiods in such habitats enough to cause noticeable adverse effects, even when added to existing or planned water withdrawals. If the low flow withdrawal assumption is not met, project-specific analysis would be required to determine potential impacts on connected wetland, floodplain, and riparian habitats.

Non-flowing Water Bodies

Human activities that reduce lake water levels and hydroperiods below historical annual or seasonal fluctuations may threaten littoral zone ecological integrity (Carmignani and Roy 2017-TN6795; SFWMD 1995-TN6799) as described above for withdrawals from flowing water bodies. Freezing or drying out of root systems and compaction of sediment may stress emergent and aquatic plants. Reduced plant productivity, cover, and food supplies may result in a decrease in dependent microorganisms, invertebrates, fish, and wildlife. Forage species that supply food for birds and other wildlife might be replaced by species more tolerant of desiccation and/or freezing, thereby having detrimental ecological effects on existing communities. For example, a U.S. Bureau of Reclamation EIS (USBR 2004-TN6796) evaluated a proposed 5 ft drawdown of Banks Lake in eastern Washington State lasting up to 2 months and concluded that there would be adverse impacts on the distribution of vegetation, fish, and wildlife; prompting the U.S. Bureau of Reclamation to propose vegetation mitigation and further investigate potential effects on wildlife. Flat, shallow habitats are anticipated to incur greater areal exposure than steeper habitats during a given drawdown.

The staff assumes a maximum surface water use rate of 6,000 gpm (Section 3.4.1) for total plant water demand, applying to non-flowing water bodies such as the Great Lakes, the Gulf of America, oceans, estuaries, and intertidal zones. The staff assumes for the generic analysis that the quantity of surface water withdrawn from these water bodies would not result in a reduction in water levels or hydroperiod that could adversely affect connected wetlands, floodplains, or riparian or other habitats. However, for other non-flowing bodies of freshwater (e.g., inland lakes, ponds, and reservoirs) the staff assumes that applicants relying on the generic analysis would demonstrate that the assumption regarding connected wetlands, floodplains, or riparian habitats (changes in water levels and hydroperiod are within historical annual or seasonal fluctuations) is met. If the applicant cannot so demonstrate, project-specific analysis would be necessary to determine potential impacts on connected wetland, floodplain, and riparian habitats. Such a demonstration would only be necessary if the site contains more than just low value wetlands or other terrestrial habitats, such as drainage ditches or manufactured depressions within uplands, or dominated by invasive vegetation.

Estuaries and Intertidal Zones

Water withdrawals from brackish non-flowing water bodies such as estuaries (partially enclosed, coastal water body where freshwater mixes with marine water) could affect connected terrestrial habitats and wildlife due to potential changes in water quality. Many different terrestrial habitat types are found in estuaries, including freshwater and saltwater tidal marshes, tidal swamps, sandy beaches, mud and sand flats, rocky shores, mangrove forests, and river deltas. The most influential gradient in estuaries is salinity because it structures the spatial patterns of physical properties, biogeochemical processes, and plants and wildlife with species-specific adaptations to different salinity ranges (Cloern et al. 2017-TN6967). The salinity gradient in such settings depends on the relative exchanges of both fresh and marine water, which may be altered

beyond historical annual or seasonal fluctuations by withdrawal of either fresh or marine water (40 CFR 230.25; TN427). Water withdrawals in estuaries may alter both the physical extent of saltwater influence and salinity levels and thereby affect populations of salinity-dependent food sources that could in turn affect the survival of dependent wildlife. The staff therefore assumes that applicants relying on the generic analysis would demonstrate that the assumption for estuaries regarding connected terrestrial habitats (changes in the physical extent of saltwater influence and salinity gradients are within historical annual or seasonal fluctuations) is met. If the assumption is not met, further project-specific analysis would be necessary to determine potential impacts on the physical extent of saltwater influence and salinity gradients as well as associated food chain effects.

Water withdrawals from marine or brackish non-flowing water bodies such intertidal zones (area of shoreline between low and high tides) could affect habitat and wildlife due to potential changes in water quality. Intertidal zones can encompass terrestrial habitats such as sandy beaches, mud and sand flats, and rocky shores. Intertidal zones are characterized by unique environmental conditions, including variable temperatures (depending on the status of the tide), microclimates, and ecological factors that provide habitat for a wide variety of plant and animal species. The vulnerability of intertidal zones to water withdrawals depends to a large extent on the degree of enclosure from the open ocean. Partially enclosed intertidal zones with little connectivity or current exchange with the open ocean would be more susceptible to water withdrawals affecting salinity gradients than intertidal zones that are more open and connected to the ocean. The irregularity in the geomorphology of coastal environments in terms of the vertical and horizontal degree of enclosure from the open ocean varies widely, as does the degree of vulnerability of intertidal zones to the effects of water withdrawal on changes in salinity levels. The staff therefore assumes that applicants relying on the generic analysis would demonstrate that the assumption for intertidal zones (changes in salinity levels are within historical annual or seasonal fluctuations) is met. If the assumption is not met, further project-specific analysis would be required to determine potential impacts on salinity gradients as well as associated habitat and food chain effects.

Groundwater

The water use assumptions established in the PPE and SPE for surficial groundwater depletion that could influence terrestrial habitats include withdrawal of less than or equal to 50 gpm resulting in drawdown of no more than 1 ft at the site boundary. Withdrawals of surficial groundwater during plant operations would be continual and thus have the potential for permanent impacts on connected terrestrial habitats. Localized shoreline habitats throughout the United States and internationally have undergone changes consistent with a loss or reduction of groundwater discharge (EPA 1996-TN6800). High-risk hydrologic settings include groundwater-fed wetlands without a surface water connection (EPA 1996-TN6800; MBWSR 2016-TN6801), such as many prairie potholes, pocosins, peat bogs, fens, and Carolina bays. Long-term lowering of groundwater levels may impact groundwater-fed isolated wetlands in much the same way as surface water withdrawals (described above for flowing and non-flowing water bodies), but very few studies provide quantitative analysis. Some data suggest that chronic reductions of groundwater levels result in a reduction in hydroperiod and can have significant effects on plant community structure in wetlands (SFWMD 1995-TN6799). A less than 1 ft modeled drawdown of groundwater has been shown to be associated with actual drawdowns of several feet in isolated wetlands, and an extended modeled drawdown of groundwater from 0.6 to 1.0 ft, within seasonally to semi-permanently flooded isolated wetlands, has been shown to correspond with significant changes in plant community composition and structure (SFWMD 1995-TN6799). Thus, there was ample evidence that a drawdown criterion of

less than 1 ft may be appropriate in some areas of Florida (SFWMD 1995-TN6799). However, most of the studies reviewed by the South Florida Water Management District (SFWMD 1995-TN6799) did not establish a threshold of harm corresponding to specific groundwater drawdown level (modeled or actual).

Desert springs, often the sole sources of water for some wildlife in the arid west, often support wetland and wetland/upland transition ecosystems including rare and endemic species. Groundwater withdrawal may lower the local water table, reducing the areal cover of wetland and wetland/upland transition vegetation and reduce the amount of upland phreatophytic vegetation (deep-rooted plants that obtain water from the water table or the layer of soil just above it) by causing water levels to drop below plant rooting depths. Percolation of salts to surface soils may be reduced, eventually altering desert shrub cover from halophytes (plants adapted to growing in saline conditions) to nonhalophytes. The extent of these effects will vary among springs, based on their distance from groundwater extraction sites and location relative to regional groundwater flow paths (Patten et al. 2007-TN6968). For example, outflow distance at springs that have low discharge rates generally may not be more than 200 m, while outflow distance at springs that have large discharges can be many kilometers (Patten et al. 2007-TN6968).

Based on the above information related to the extraction of surficial groundwater, the staff has no assurance that relying on assumed PPE/SPE values of groundwater drawdown of no more than 50 gpm and no more than 1 ft at the site boundary, would adequately protect wetlands with a groundwater connection, either within or outside of the site boundary. Based on these analyses, even for a new reactor bounded by the assumptions for groundwater withdrawals for dewatering in the PPE and SPE (50 gpm with no more than a 1 ft drawdown of groundwater levels at the site boundary), some onsite and offsite wetlands in certain settings with a groundwater connection could be affected. Adverse impacts on onsite and offsite wetlands could result if groundwater dewatering causes changes in water levels or hydroperiod that exceed historical annual or seasonal fluctuations. This applies to wetlands with a groundwater connection but may be accentuated in such wetlands without a surface water connection. The staff expects that applicants relying on the generic analysis would demonstrate that the terrestrial resources assumption regarding wetlands (changes in water levels and hydroperiod are within historical annual or seasonal fluctuations) in the SPE is met. It might be possible to demonstrate that there are no wetlands, or only wetlands of minimal value, present on or in the immediate vicinity of the site. Or it might be possible to demonstrate that the only wetlands on or near the site belong to hydrogeomorphic classes not typically influenced by groundwater, such as the hydrogeomorphic classes of riverine wetlands or tidal or lacustrine fringe wetlands (Brinson et al. 1995-TN6969). Other tools might be available from various regulatory agencies or other institutions and could be used. Such a demonstration would also have to provide evidence that the maximum depth to groundwater lay substantially below the surface. If this assumption is not met, further project-specific analysis would be required.

Conclusion

The staff has determined that water use conflicts with terrestrial resources are a Category 1 issue under the assumptions discussed above for flowing water bodies, non-flowing water bodies (including freshwater, brackish, and marine), and surficial groundwater. If the applicable assumptions for terrestrial resources in the relevant water body type are not met, project-specific analyses would be necessary to characterize potential impacts on habitats connected to such water bodies as well as on dependent wildlife. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- Total plant water demand would be less than or equal to a daily average of 6,000 gpm.
- If water is withdrawn from flowing water bodies, average plant water withdrawals would not reduce flow by more than 3 percent of the 95 percent exceedance daily flow, and would not prevent maintenance of applicable instream flow requirements.
- Any water withdrawals would be in compliance with any EPA or State permitting requirements.
- Applicants would be able to demonstrate that hydroperiod changes are within historical or seasonal fluctuations.

3.5.2.2.8 Effects of Transmission Line ROW Management on Terrestrial Resources

Once a transmission line is built, ROWs in potential forest habitat will require routine maintenance to keep them free of trees tall enough to cause electrical current to arc through vegetation to the ground, which may ignite fires and cause power outages. It may also be necessary to trim or remove trees growing near the edge of the ROW that are capable of falling too close to the conductors (commonly termed “danger trees”). Trimming or removing individual danger trees is unlikely to substantially alter the ecological properties of terrestrial habitats adjoining the ROW. Some utilities also maintain “screens” of low trees under transmission line conductors where they cross aesthetically sensitive suburban roadways; those tree screens require frequent maintenance. The ecological properties of the screens are unlikely to be substantially altered by trimming the entire screen or by removal of individual trees. Sometimes relatively level upland areas on transmission line ROWs, especially in aesthetically sensitive residential areas, are periodically mowed. But the most common techniques used in managing transmission line ROWs involve the use of herbicides. Herbicides can be applied directly to vegetation in the ROW, or herbicides can be applied to cut stump surfaces once trees are felled.

The NRC staff performed a comprehensive literature review of the potential effects of transmission line ROW management on terrestrial resources as part of the LR GEIS (NRC 2024-TN10161). The analysis considered various common ROW management practices including tree trimming and clearing, mowing, and herbicide application and concluded that the overall ecological effects were neither substantially adverse nor beneficial. Limitations on the length and routing of transmission lines in the PPE further reduce the potential for adverse impacts.

The staff has determined that this is a Category 1 issue. The staff concludes that as long as the assumptions regarding transmission lines in the PPE and SPE are met, the impacts can be generically determined to be SMALL. The PPE includes an assumption that licensees would implement integrated vegetation management practices to maintain ROWs in areas where vegetation growth may interfere with power lines. Mitigation measures necessary to rely on the generic analysis include ensuring that all work is performed in compliance with all applicable laws and regulations and that herbicides are applied only by licensed applicators in compliance with the applicable manufacturer label instructions. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- Vegetation in transmission line ROWs would be managed following a plan consisting of integrated vegetation management practices.
- All ROW maintenance work would be performed in compliance with all applicable laws and regulations.

- Herbicides would be applied by licensed applicators, and only if in compliance with applicable manufacturer label instructions.

3.5.2.2.9 Effects of Electromagnetic Fields on Flora and Fauna

Electric current moving through transmission lines generates an EMF in the surrounding airspace. The NRC staff performed a comprehensive literature review of the potential effects of EMFs on terrestrial resources, including flora, honeybees, and wildlife and livestock and identified no significant impacts (NRC 2024-TN10161). Based on the literature review in the LR GEIS, the staff determined that this is a Category 1 issue and impacts would be SMALL regardless of the length, location, or size of the transmission lines. The staff did not recommend any mitigation in the LR GEIS (NRC 2024-TN10161); hence, none is needed here. The staff did not rely on any PPE and SPE values or assumptions in reaching this conclusion.

3.5.2.2.10 Important Species and Habitats

As noted for building, important species and habitats meeting the NRC criteria (NRC 2026-TN11915) for a given site can only be determined once the site is identified. Because of different regulations and sensitivities to impacts, two separate issues are analyzed below regarding important species and habitats: (1) resources regulated under the ESA (16 U.S.C. §§ 1531 et seq.; TN1010), and (2) other important species and habitats.

Resources Regulated under the Endangered Species Act of 1973

For the same reasons noted for building in Section 3.5.2.1.6, the staff has determined that operational impacts on resources regulated under the ESA are a Category 2 issue. Because of their potential for future regulation over the course of a licensing action, the Category 2 designation extends also to candidate species and species and critical habitat proposed for designation under the Act. Even if the applicable assumptions in the PPE and SPE outlined in Section 3.5.1 are met, the NRC staff is unable to determine the significance of potential impacts without consideration of project-specific factors, including the specific species and habitats affected and the types of ecological changes potentially resulting from each specific licensing action. Furthermore, completing the required consultation requires individualized action by the staff for each application.

Other Important Species and Habitats

The analyses presented in Section 3.5.2.1.6 also apply to operations and suggest that the potential impacts on other important species and habitats as defined in RG 4.2 (NRC 2026-TN11915) from operating a new reactor that meets the PPE and SPE would likely be minimal regardless of site location and the important species specifically present on a given site. The assumptions in the PPE and SPE limit the potential for adverse impacts, especially limiting the size of the disturbance footprint and the assumed absence of sensitive habitat types potentially containing rare species within the footprint. The staff has therefore determined that operational impacts on important species and habitats other than those regulated under the ESA are a Category 1 issue. The staff concludes that as long as the applicable assumptions regarding the size and habitat quality of the building footprint, wetlands, building height, noise generation, and employment in the PPE and SPE are met, the impacts can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- Applicants would communicate with State natural resource or conservation agencies regarding wildlife and plants and implement mitigation recommendation of those agencies.

3.6 Aquatic Ecology

3.6.1 Baseline Conditions and PPE/SPE Values and Assumptions

Some sites proposed for a new reactor may include (or be adjacent to) aquatic habitats in streams, rivers, ponds, lakes, or other surface water features. Other sites may lack aquatic habitats within their perimeters, but activities there could still affect aquatic habitats because the sites lie in the watershed, thereby contributing overland runoff to down-gradient surface water features containing aquatic habitats. Some watersheds may drain directly to large bodies of waters such as oceans, estuaries, or large lakes; while others may instead drain into tributary systems that flow into the larger bodies of water. In some landscapes, sites may drain into depressions where the accumulated water forms permanent or temporary lakes or ponds, or ephemeral features such as playas and vernal pools, from which it evaporates to the atmosphere or leaches into the groundwater. In landscapes overlying limestone (karst landscapes), sites may drain into streams whose flow disappears into the underlying groundwater and may emerge at springs elsewhere in the landscape.

The separation between aquatic and terrestrial habitats is not always sharp; the edges of some aquatic habitats are clearly bounded by an ordinary high-water mark, while elsewhere the transition is gradual and may include interim zones of wetlands. The NRC staff typically considers wetlands that contain persistent emergent vegetation, including most swamps and marshes, to be terrestrial habitats (addressed in Section 3.5), while considering wetlands dominated only by submerged aquatic vegetation to be aquatic habitats (NRC 2026-TN11915). More information about how the NRC staff defines and characterizes aquatic habitats is available in RG 4.24 (NRC 2017-TN6720).

Aquatic habitats may be marine, estuarine, or freshwater. Marine habitats in oceans or bays broadly open to the ocean generally are saltwater, with a typical seawater salinity of approximately 35–37 ppt. Seawater that accumulates in depressions may attain higher salinities due to partial evaporation. Estuaries are surface water areas where freshwater entering through tributaries or runoff mixes with seawater carried by the tides, resulting in brackish water between 0.5 ppt and less than 35 ppt. Estuarine habitats are typically in continuous flux in response to changing tides, freshwater inflow, and freshwater runoff. Freshwater habitats, with salinities generally 0.5 ppt or less, are sometimes characterized as either lotic, situated in portions of streams or rivers containing running water; or lentic, situated in ponds, lakes, or portions of streams or rivers containing standing water. Biota at the base of aquatic food chains are photosynthetic (capable of using sunlight to produce biomass); including photosynthetic bacteria, phytoplankton (free-floating microscopic algae), larger floating algae or algae fixed to solid substrates by holdfasts or rooted submerged vascular plants. Other components of the aquatic food chain can include zooplankton (free-floating microscopic animal-like biota), benthic organisms (generally larval insects or other fauna that attach to rocks and other solid underwater substrates), fish, crustaceans, and shellfish. Many fish and shellfish include microscopic life stages that behave more like plankton than the independently mobile adults. The aquatic food chain is intimately connected to the terrestrial food chain and can be influenced by terrestrial organisms such as birds, mammals, reptiles, amphibians, and insects.

The NRC staff developed the values and assumptions in the PPE and SPE pertaining to aquatic ecology based on the information and analyses contained in multiple new reactor EISs prepared

since 2005, the LR GEIS (NRC 2024-TN10161), other past NRC EISs, and Federal and State regulations protecting waters of the United States and threatened and endangered species.

Based on experience gained from preparing past new reactor EISs, the NRC staff included an assumption in the PPE and SPE that permanent disturbance would encompass no more than 30 ac of vegetated land, with temporary disturbance of as much as an additional 20 ac of vegetated land. The NRC staff also assumes the temporarily disturbed land will be restored once it is no longer needed using regionally indigenous vegetation. Disturbances to land in the watershed of surface water bodies can result in sedimentation and stormwater runoff reaching habitats of aquatic flora and fauna. The NRC staff would have to consider project-specific factors if greater disturbances were necessary. Also, based on the staff's experience with past new reactor EISs, the PPE and SPE additionally assume that the footprint of disturbance (other than for building intake or discharge structures) would not encompass aquatic habitats. However, as explained in Section 3.5.1, the assumptions in the PPE and SPE allow for impacts on as much as 0.5 ac of wetlands or other waters of the United States, based on disturbance area limits built into several NWPs established by the USACE under Section 404 of the CWA (33 U.S.C. § 1344-TN1019). The PPE and SPE also recognize that transmission lines, pipelines, and access roads might extend across or under streams or small surface water features (as long as the project's total impact on wetlands and other surface water bodies is less than 0.5 ac).

Recognizing that the evaluation of aquatic impacts in the LR GEIS (NRC 2024-TN10161) and past new reactor EISs identified substantial impacts from certain types of plant cooling systems, the staff included an assumption in the PPE and SPE that allows for use of recirculated-water cooling towers, but not once-through cooling systems, cooling ponds, or new cooling-water reservoirs. However, the assumptions still recognize that any cooling towers would have to be mechanical draft type rather than natural draft type, and that any makeup water for cooling would have to be fresh (salinity less than 1 ppt). EISs for proposed new reactors in Levy County, Florida (NRC 2012-TN1976) and Homestead, Florida (NRC 2016-TN6434) identified potentially damaging salt drift at certain locations close to cooling towers using brackish makeup water. The PPE and SPE also assume that any intake would meet the requirements established by the EPA in 40 CFR 125.83 (TN254) for protection of aquatic biota from entrainment or impingement. Because of the potential for contamination by dissolved metals in cooling-system blowdown water that are toxic to aquatic biota, the PPE also assumes no use of copper alloy tubes in cooling systems. Based on information in past new reactor EISs, the staff established assumptions in the PPE and SPE regarding features such as transmission lines and other linear utilities. The PPE and SPE assume that any new poles or towers would be built outside of wetlands and floodplains and that any pipelines would be directionally drilled under surface water features such as streams without disturbance to shorelines or bottom substrates. Finally, the PPE and SPE assumptions relevant to aquatic ecology include all of the assumptions developed for Hydrology (Section 3.4.1) with respect to withdrawal of surface water and groundwater.

The NRC staff typically evaluates impacts on aquatic habitats, as well as on the individual species and habitats that meet the definition of "important," as outlined in RG 4.2 (NRC 2026-TN11915). Determining which species and habitats potentially affected by a project meet the criteria for "important" is not possible until a specific site is identified. While the analysis in Section 3.6.2 is able to consider the potential impacts on many types of important species generically, it reserves a consideration of potential impacts on federally listed threatened or endangered species and species regulated under the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act; 16 U.S.C. §§ 1801 et seq.; TN1061) until after

receipt of an application. The generic analyses of environmental consequences presented below therefore address potential impacts on aquatic habitats, food chains, and groupings of biota, while reserving consideration of potential impacts on federally listed threatened or endangered species and species regulated under the Magnuson-Stevens Act for project-specific documentation for the review of a specific license application.

A number of available databases contain relevant information about aquatic biota for sites anywhere in the United States. The FWS and National Marine Fisheries Service (NMFS) maintain online databases regarding the potential occurrence of threatened, endangered, proposed, or candidate species and critical habitats designated under the Federal ESA (16 U.S.C. §§ 1531 et seq.; TN1010); and the NMFS maintains maps depicting the geographic extent of essential fish habitat regulated under the Magnuson-Stevens Act (16 U.S.C. §§ 1801 et seq.; TN1061). Most States have Natural Heritage Programs with databases that contain information about the locations of species and habitats that have Federal or State special designations.

3.6.2 Aquatic Ecology Impacts

For a nuclear plant meeting the assumptions in the PPE and SPE, the potential for significant impacts on aquatic ecological resources would generally be minor. There would be a potential for runoff and sedimentation to affect aquatic habitats during preconstruction and construction, but the PPE and SPE assume BMPs would be used to minimize adverse effects. There would also be a potential for limited impacts on wetlands and other shallow surface waters, although the potential impacts would be limited by the assumptions in the PPE and SPE. It may be necessary to build transmission lines, pipelines, or access roads spanning rivers, streams, or other surface waters; and the assumptions in the PPE and SPE allow for limited occurrence of such encroachments. For plants operated using water-based cooling, operational impacts on aquatic resources could also result from entrainment and impingement or thermal discharges. The evaluation below also considers the potential for impacts on aquatic resources from releases of radionuclides or nonradiological contamination during operations. The evaluation also considers the possible impacts on aquatic habitats from operation and maintenance of transmission lines and other facilities on offsite ROWs.

3.6.2.1 Environmental Consequences of Construction

The NRC staff considered the following environmental issues related to aquatic resources for the building of a new reactor meeting the PPE and SPE:

- runoff and sedimentation from building areas;
- dredging and filling aquatic habitats to build intake and discharge structures;
- building transmission lines, pipelines, and access roads across surface water bodies; and
- impacts on important species and habitats.

The NRC staff addressed as a separate issue any impacts on important species as defined for NRC environmental reviews (NRC 2026-TN11915).

3.6.2.1.1 Runoff and Sedimentation from Construction Areas

Even though the PPE and SPE assume no more than 0.5 ac of disturbance of aquatic habitats (including wetlands delineated using the *Corps of Engineers Wetlands Delineation Manual* [USACE 1987-TN2066] and regional supplements), physical disturbance of surface soils could

cause runoff and sediment to enter nearby streams, rivers, lakes, and other surface water features. Precipitation can dislodge soil particles from surface soils exposed by clearing, grubbing, and grading; and those dislodged particles can become suspended in surface runoff and be carried overland into nearby surface water features. Upon entering surface waters, sediment can settle onto the bottom substrate and smother benthic (substrate-borne) flora and fauna. Runoff and sediment can also block sunlight needed by photosynthetic organisms that form the base of the aquatic food chain, and runoff can carry soil-borne nutrients such as phosphorus and nitrogen to surface waters where they can cause rapid growth of algae, plants, or microorganisms in a process termed eutrophication. These “blooms” of aquatic organisms can rapidly deplete oxygen carried in the water (dissolved oxygen) needed by fish and other aquatic organisms, causing suffocation. Runoff and sediment can also carry pesticides and other chemical contaminants from terrestrial to aquatic settings. The entry of large volumes of runoff can increase currents and scour bottom sediments, dislodging benthic biota and increasing sedimentation of downstream habitats. As soil is compacted by building equipment and structures are built, soil permeability is reduced, and precipitation is prevented from slowly entering the soil column and is instead directed overland toward aquatic habitats. Rapid flushes of stormwater following intense precipitation can generate flood flows capable of carrying large volumes of nutrients or contaminants into aquatic habitats and scouring benthic biota (biota attached to underwater surfaces).

Significant erosion and sedimentation of aquatic habitats caused by construction could be effectively prevented by implementing BMPs. Common BMPs for sedimentation and erosion control include, but are not limited to, placing silt fences at the perimeter of areas prior to soil disturbance, installing sediment traps to catch sediment, and temporarily and permanently stabilizing exposed soil using straw or fast-growing vegetation. Stormwater runoff from impervious surfaces could be managed by building basins to detain runoff so that more ultimately moves into the soil column rather than overland to surface waters. Many States or localities require developers to implement detailed plans for soil erosion and sediment control and stormwater management.

Because of the widespread availability of effective BMPs, the staff has determined that runoff and sedimentation from building areas is a Category 1 issue. The staff concludes that as long as the applicable PPE and SPE assumptions regarding the permanent and temporary areas of disturbance are met, the impacts from building a new reactor can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- BMPs would be used for erosion and sediment control.
- Temporarily disturbed lands would be revegetated using regionally indigenous vegetation once the lands are no longer needed to support building activities.

Applicants relying on the generic determination would prepare and implement a soil erosion and sediment control plan and a stormwater management plan that have been approved by all applicable State and local authorities. If a project involves building in an area where there are no requirements for regulatory approval of those plans, the PPE and SPE still assume that for purposes of relying on the generic conclusions in this GEIS, applicants would develop and implement BMPs commonly recognized as being effective.

3.6.2.1.2 Dredging and Filling Aquatic Habitats to Build Intake and Discharge Structures

Based on recent license applications for new reactors, building intake and discharge structures for cooling typically require disturbing no more than 200 linear feet of shoreline and affect less than 1–2 ac of aquatic habitat per structure. The Tennessee Valley Authority recently estimated that it would have to build an intake structure measuring approximately 50 ft by 50 ft and a discharge structure containing two 3 ft pipes to support mechanical draft cooling towers for a future SMR project in Tennessee (NRC 2019-TN6136). Building those structures would likely disturb less than 200 ft of shoreline on the reservoir and less than 1 ac of bottom sediment in the reservoir. An application for a new reactor in Pennsylvania proposed disturbing approximately 0.61 ac within a river to build an intake structure and approximately 0.46 ac in the river to build a discharge structure (NRC and USACE 2016-TN6562). Positioning excavation and building equipment may also require temporarily disturbing a small area of adjoining riparian habitat, likely under 0.5 ac per structure. The structures are typically built in the same river, lake, or other source water body but usually have to be established at separate locations so discharges do not interfere with intakes. The staff has typically concluded that the impacts of building the intakes and discharges would be minimal as long as the structures qualify for a NWP 7 under the CWA Section 404 (33 CFR Part 330-TN4318), BMPs are followed, and any mitigation measures required by the USACE under CWA permits are implemented.

The PPE does not assume any limitations on the extent of land, shoreline, and riparian disturbance because of the ability to perform mitigation. Excavation to build the intake and discharge structures would disturb a small area of aquatic habitat as well as a small area of adjoining riparian vegetation, thereby influencing the quality of aquatic habitat. The resulting habitat losses or disturbance would not substantially alter the overall aquatic ecosystem in most surface water features large enough to function as sources of makeup water. Excavation would briefly generate plumes of sediment capable of being carried by currents to distant aquatic habitats; however, it is usually possible to construct small temporary cofferdams around excavation locations to limit the escape of sediment. Cofferdams temporarily surround the excavation area with a physical structure that blocks movement of suspended sediment into adjoining waters. Most surface water bodies large enough to serve as makeup water sources are navigable or situated on tributary systems and would therefore be regulated as waters of the United States under the CWA (33 U.S.C. §§ 1251 et seq.*;* codified as the Federal Water Pollution Control Act of 1972-TN662). Work to build intake and discharge structures would therefore require a permit from the USACE under CWA Section 404 but would be covered in most instances by one or more NWPs (33 CFR Part 330-TN4318).

The staff has determined that this is a Category 1 issue. The staff concludes that as long as the assumptions in the PPE and SPE regarding the intake structure are met, the impacts from this issue can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- Applicant would obtain approval, if required, under NWP 7 in 33 CFR Part 330.
- Applicant would implement any mitigation required under NWP 7 in 33 CFR Part 330.
- Applicant would minimize any temporarily disturbed shoreline and riparian lands needed to build the intake and discharge structures and restore those areas with regionally indigenous vegetation suited to those landscape settings once the disturbances are no longer needed.
- BMPs would be used for erosion and sediment control.

3.6.2.1.3 Building Transmission Lines, Pipelines, and Access Roads across Surface Water Bodies

Transmission conductors of any voltage can be built to span rivers, streams, and narrow lakes without physically disturbing shorelines, sediments, or other components of the channel or basin. The conductors would not cast a substantial shadow capable of reducing sunlight reaching the water surface or otherwise altering the condition of the aquatic habitat. The PPE and SPE assume that conductors would be mounted on towers situated only in uplands and that no new towers would be built within surface water bodies or adjacent wetlands or floodplains. Pipelines can typically be built under waterways using directional horizontal drilling, thereby avoiding physical disturbance of overlying surface water bodies. The PPE and SPE assume that pipelines would be extended under (or over) surface water bodies through directional drilling (or aboveground placement) without physically disturbing shorelines or bottom substrate.

Access roads can be built across smaller streams using a bridge or ford. It is usually possible to place matting over shallow water areas to facilitate fording with minimal physical disturbance of shorelines and bottom substrate. Building the bridge abutments or a ford would temporarily disturb small areas of shoreline and bottom substrate and use of a ford could disturb substrate each time a vehicle passes. Fish and other mobile aquatic biota may briefly disperse from areas near a crossing each time the crossing is used due to noise and vibrations caused by the vehicles. A bridge could also limit the occurrence of aquatic plants and other photosynthetic organisms because of shading. The assumptions in the PPE and SPE regarding the length of offsite ROW and the 0.5 ac limit on impacts on wetlands and surface waters function to limit the number of possible crossings by access roads. Another assumption is that no access roads would be extended across stream channels over 10 ft in width (at ordinary high water). Crossing wider streams would likely require building fords or bridges that involve a potential for aquatic resource impacts and would require project-specific analysis to assess their significance. The PPE and SPE also assume that no more than 0.5 ac of surface waters or wetlands would be disturbed. Limiting crossings to streams of that width would limit the potential for habitat disturbance, disturbance of mobile biota, or generation of sediment.

No impacts on aquatic resources would likely result from spanning or horizontal drilling under a surface water body. Extending roadways across waters of the United States typically qualifies under one or more NWPs (33 CFR Part 330-TN4318), the availability of which supports the staff's conclusions. The USACE issues NWPs only for classes of activity determined to generally not result in significant adverse impacts on aquatic resources and are subject to public review every 5 years. NWP 12 (temporarily vacated at the present time) applies to utility lines such as pipelines or transmission lines and NWP 14 applies to linear transportation projects associated with any project. Both NWPs limit the total disturbance to waters of the United States and adjacent wetlands to 0.5 ac; additional limitations apply to tidal areas. Applicants relying on the generic determination would be expected to demonstrate that the USACE has approved any impacts on waters of the United States under one or more NWPs or that the crossings meet the criteria for approval. Applicants would also be expected to implement BMPs as mitigation to minimize runoff and sedimentation to surface water features from building transmission lines, access roads, or pipelines.

Like other CWA permitting requirements, the need for approval under a NWP applies only to wetlands under CWA jurisdiction. Building transmission lines, pipelines, and access roads could impact both jurisdictional and non-jurisdictional wetlands or surface water features. The PPE and SPE therefore includes an assumption that access roads crossing non-jurisdictional surface water features meet the substantive requirements of NWPs 12 or 14 regarding limits on

disturbance and requirements for mitigation. Both permits limit the cumulative disturbance from a “single and complete project” to no more than 0.5 ac of jurisdictional surface water features that can serve as an equivalent benchmark for non-jurisdictional surface water features as well. While greater impacts on non-jurisdictional surface waters might not be significant, the staff can only make that determination after review of project-specific information.

The staff has determined that this is a Category 1 issue. The staff concludes that as long as the PPE and SPE assumptions established for offsite ROWs are met, the impacts from this issue can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- If activities regulated under the Clean Water Act are performed, they would receive approval under one or more NWPs (33 CFR Part 330-TN4318) or other general permits recognized by the USACE.
- Pipelines would be extended under (or over) surface through directional drilling without physically disturbing shorelines or bottom substrate.
- Access roads would span streams and other surface waterbodies with a bridge or ford, and any fords would include placement and maintenance of matting to minimize physical disturbance of shorelines and bottom substrates.
- No access roads would be extended across stream channels over 10 ft in width (at ordinary high water).
- Any bridges or fords would be removed once no longer needed, and any exposed soils or substrate would be revegetated using regionally indigenous vegetation appropriate to the landscape setting.
- Any mitigation measures indicated in the NWPs or other permits would be implemented.
- BMPs would be used for erosion and sediment control.

3.6.2.1.4 Important Species and Habitats

Important species and habitats meeting the NRC criteria (NRC 2026-TN11915) for a given site can only be determined once the site is identified. Because of differing regulations and sensitivities to impacts, two separate issues are analyzed below regarding important species and habitats: (1) resources regulated under the ESA (16 U.S.C. §§ 1531 et seq.; TN1010) and the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act; 16 U.S.C. §§ 1801 et seq.; TN1061), and (2) other important species and habitats.

Resources Regulated under the Endangered Species Act and Magnuson-Stevens Act

The FWS has developed online databases and mapping tools that identify threatened, endangered, proposed, and candidate species under the ESA (16 U.S.C. §§ 1531 et seq.; TN1010), as well as critical habitats designated under the Act. The NMFS maintains similar information for marine or anadromous species protected under the Act. NMFS also maintains maps and other information about essential fish habitats regulated under the Magnuson-Stevens Act.

Because these federally regulated resources occur in the same setting and are subject to the same types of impacts as those considered in Sections 3.5.2.1.1 through 3.5.2.1.5, the limitations placed upon the extent and intensity of ecological impacts by meeting the

assumptions in the PPE and SPE would likewise limit the potential for impacts on these resources. However, the staff would need to consult individually with the FWS and/or NMFS (depending on the specific setting) under the ESA and Magnuson-Stevens Act regarding the potential impacts from each specific licensing action. Furthermore, with respect to the ESA, the criteria for listing species are based upon the potential for the most severe of potential ecological impacts: extinction of species, subspecies, or distinct population segments. Species that have experienced previous impacts so severe that they are now, or could imminently become, in danger of extinction may also be substantially more sensitive to impacts that might only pose minimal threat to other species.

The staff has therefore determined that building impacts on resources regulated under the ESA and Magnuson-Stevens Act are a Category 2 issue. Because of their potential for future regulation over the course of a licensing action, the Category 2 designation extends also to proposed and candidate species designated under the ESA. Even if the assumptions in the PPE and SPE discussed in Sections 3.6.2.1.1 through 3.6.2.1.3 are met, the NRC staff is unable to determine the significance of potential impacts without consideration of project-specific factors, including the specific species and habitats affected and the types of ecological changes potentially resulting from each specific licensing action. Furthermore, the ESA and Magnuson-Stevens Act require consultations for each licensing action that may affect regulated resources.

Other Important Species and Habitats

Most States maintain natural heritage databases that identify known occurrences of species and habitats receiving various categories of State regulation or recognition. Many species and habitats that do not display the potential for extinction necessary for regulation under the ESA are still recognized by States because of declining numbers within State boundaries. However, extirpation from a State is not as severe an impact as complete extinction. Regarding other types of important species and habitats, most sites containing aquatic habitats may support commercially or recreationally valuable fisheries, as well as nuisance or invasive species such as zebra mussels (*Dreissena polymorpha*), Asiatic clams (*Corbicula fluminea*), northern snakehead fish (*Channa argus*), and invasive aquatic vegetation such as common water hyacinth (*Pontederia crassipes*) and Eurasian watermilfoil (*Myriophyllum spicatum*). Invasive aquatic species not only adversely affect native aquatic species but can also interfere with navigation and recreational use of waterways. The NRC staff expects that applicants will communicate with State and local agencies, private conservation organizations, and other stakeholders as necessary to determine what other important species and habitats are potentially present on a site, such as species that have a Federal or State monitoring requirement or other species of known interest, protected habitats, habitats identified by Federal or State agencies as being of high priority for protection, or other habitats of interest such as nesting or nursery grounds.

The analyses presented above regarding impacts on aquatic resources from specific ecological issues suggest that the potential impacts on many important species and habitats (NRC 2026-TN11915) from building of a new reactor that meets the PPE and SPE would likely be minimal regardless of site location. The NRC staff is confident in this conclusion for any site meeting the assumptions in the PPE and SPE discussed in Sections 3.6.2.1.1 through 3.6.2.1.3, even without identifying the important species specifically present on a given site. The assumptions in the PPE and SPE limit the potential for adverse impacts, especially limitations on the size of the footprint of disturbance and the assumed absence of sensitive habitat types potentially containing rare species. The staff has therefore determined that building impacts on important

species and habitats other than those regulated under the ESA and Magnuson-Stevens Act are a Category 1 issue. The staff concludes that as long as the assumptions in the PPE and SPE discussed in Sections 3.6.2.1.1 through 3.6.2.1.3 are met, the impacts can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- Applicants would communicate with State natural resource or conservation agencies regarding aquatic fish, wildlife, and plants and implement mitigation recommendation of those agencies.

3.6.2.2 Environmental Consequences of Operation

The NRC staff considered the following environmental issues related to aquatic resources for building of a new reactor meeting the PPE and SPE assumptions:

- stormwater runoff,
- exposure of aquatic organisms to radionuclides,
- impacts of refurbishment on aquatic biota,
- impacts of maintenance dredging on aquatic biota,
- impacts of transmission line ROW management on aquatic resources,
- impingement and entrainment of aquatic organisms,
- thermal impacts on aquatic biota,
- other impacts of cooling-water discharges on aquatic biota,
- water use conflicts with aquatic resources, and
- impacts on important species and habitats.

The list of issues considered is similar to that presented for operations in the LR GEIS (NRC 2024-TN10161). However, the PPE assumes there will be no use of once-through cooling systems, cooling ponds, or building of new reservoirs. The PPE also assumes limits on the quantities of water taken in and discharged for new reactors with dry or water-cooled cooling towers. The LR GEIS addresses losses from predation, parasitism, and disease among organisms exposed to sublethal stresses (NRC 2024-TN10161), but those impacts are encompassed herein as part of the interrelated issues noted above. Any possible impacts from cooling-tower drift falling on aquatic habitats are addressed as part of the same issue in Section 3.5.2.

3.6.2.2.1 Stormwater Runoff

Stormwater runoff generated by impervious surfaces during building is addressed above in Section 3.6.2.1.1. The potential for stormwater runoff continues as long as impervious surfaces remain on the site. Typical impervious surfaces at a reactor site include the tops of buildings and other structures, roads and parking lots, exterior paved areas, walkways and other exterior “hardscaping” areas. Unpaved but heavily compacted soils can also function as mostly impervious surfaces and generate substantial quantities of runoff. Chemicals such as pesticides, paints, and petroleum products are sometimes stored or handled on impervious surfaces and contribute chemical contamination to runoff. Runoff from roads and parking lots can contain oil and grease leaked from vehicles. Exterior areas, including landscaped areas, can also contribute pesticides to runoff potentially reaching aquatic habitats. The potential for stormwater runoff reaching aquatic habitats is typically minimized through implementation of stormwater management plans as explained in Section 3.6.2.1.1. As noted in Section 3.10.2.1, the PPE assumes that licensees would comply with any additional requirements established

through permits for the storage and use of hazardous materials issued by Federal and State agencies under the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. §§ 6901 et seq.-TN1281). The staff has determined that stormwater runoff during operations is a Category 1 issue. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- Preparation, approval by applicable regulatory agencies, and implementation of a stormwater management plan.
- Obtaining and complying with any required permits for the storage and use of hazardous materials issued by Federal and State agencies under RCRA.
- BMPs would be used for stormwater management.

3.6.2.2.2 Exposure of Aquatic Organisms to Radionuclides

The NRC staff recognizes that small amounts of radioactive particulates can be released to the exterior environment during operation of LWRs and evaluated the potential impacts of those releases on aquatic ecological receptors in the LR GEIS (NRC 2024-TN10161). Section 3.8.1.2.2 of this GEIS concludes that the impact of routine radiological releases from past and current operations on aquatic biota would be SMALL. To support that conclusion, Table 3-6 (in Section 3.8.1 of this GEIS) presents radiological exposure estimates for fish, invertebrates, and algae modeled using the NRCDose code, as presented in 15 EISs for proposed new LWRs published between 2006 and 2019. All estimates were substantially lower than exposure levels considered protective of terrestrial animal populations by the IAEA.

Additionally, in the LR GEIS (NRC 2024-TN10161), the NRC staff used the RESRAD-BIOTA dose evaluation model developed by DOE (2004-TN6460) to calculate estimated dose rates to aquatic biota receptors using REMP reports submitted by licensees for 15 operating LWRs in the United States. RESRAD-BIOTA accounts for possible bioaccumulation of radionuclides in biological organisms and biomagnification, whereby radionuclides become concentrated at higher levels in organisms occupying higher positions in the food chain. The total estimated doses for aquatic biota were all less than 0.2 rad/d (0.002 Gy/d), considerably less than the guideline value of 1 rad/d (0.01 Gy/d) recognized by DOE as being protective (DOE 2002-TN4551).

While many new reactors may use fuels containing differing distributions of radionuclides than the LWRs considered in the analyses presented above, a reactor meeting the PPE and SPE would not be likely to result in greater releases of radioactivity. The staff has determined that exposure of aquatic organisms to radionuclides is a Category 1 issue. The staff concludes that as long as the project meets the assumptions in the PPE and SPE underlying the analysis in Section 3.8, the impacts can be generically determined to be SMALL, and mitigation would not be warranted. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- Applicants would demonstrate in their application that any radiological nonhuman biota doses would be below IAEA (1992-TN712) and NCRP (1991-TN729) guidelines.

3.6.2.2.3 Effects of Refurbishment on Aquatic Biota

Refurbishment constitutes the replacement, improvement, or addition of new facilities within the site of a new reactor throughout its operating life. Examples of possible new facilities might include additional or expanded storage buildings, parking lots, administration buildings, or

independent spent fuel storage installation. Existing facilities might be demolished or rebuilt in part. The SPE assumes that there are no surface water features on a site prior to the building of a new reactor, although it is possible that developers of a new facility might build artificial ponds or ditches as part of the stormwater management system for the site. These would be the only possible locations for aquatic habitats on a site that meets the SPE. Any aquatic habitats that form in these artificial features over time would be simpler and of lower ecological value than most natural aquatic habitats and because they were generated after development of the site, they would be easily replaceable. Loss or degradation of these artificial habitats to accommodate refurbishment would not constitute a noticeable loss of aquatic habitat function in the landscape. It is possible that over the operational lifetime of a new reactor that work in or near natural aquatic habitats may be necessary to maintain or replace intake or discharge structures or pipelines. The impacts would be bounded by the analyses presented above for the building of those facilities.

The staff has determined that the impacts of refurbishment on aquatic organisms at an operating reactor are a Category 1 issue. Impacts can be generically determined to be SMALL as long as assumptions in the PPE regarding the area of disturbance and the SPE regarding features within the area of disturbance are met. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- BMPs would be used for erosion, sediment control, and stormwater management.
- Exposed soils would be restored as soon as possible with regionally indigenous vegetation.

3.6.2.2.4 Effects of Maintenance Dredging on Aquatic Biota

The NRC staff recognizes that maintenance dredging of sediment is sometimes necessary during the operational life of a nuclear power plant, for purposes such as keeping intake screens free of sediment or removing sediment from areas where boats are used (NRC 2024-TN10161). As explained in the LR GEIS, accumulation of sediment in standing or slow-moving waters over time is a natural and unavoidable process that requires attention in order to maintain facilities or navigational capabilities. The LR GEIS describes the potential impacts on aquatic biota from maintenance dredging at a LWR and concludes that the impacts would be minimal because of its infrequency and the small areas affected. The extent of the effects is not likely to be increased by the fuels or technologies of future new reactors. Dredging of any type is considered under the CWA to constitute “discharge of dredged or fill material” requiring a permit from the USACE under Section 404 (33 U.S.C. § 1344-TN1019); however, dredging for the purpose of maintaining existing navigation capabilities such as marina basins or boat slips is covered under NWP 35. There are no area or volume limitations established for NWP 35, although certain conditions regarding the presence of sensitive resources such as threatened or endangered species or wild and scenic rivers must be met, and specific mitigation must be implemented. By issuing this NWP, the USACE acknowledges that such maintenance dredging has minimal potential for having significant environmental impacts on aquatic resources.

The staff has determined that the impacts on aquatic organisms of maintenance dredging of any type at an operating reactor are a Category 1 issue. Impacts can be generically determined to be SMALL as long as relevant assumptions in the PPE and the SPE are met. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- If activities regulated under the Clean Water Act are performed, those activities would receive approval under one or more NWPs (33 CFR Part 330-TN4318) or other general permits recognized by the USACE.
- Any mitigation measures indicated in the NWPs or other permits would be implemented.

- BMPs would be used for erosion and sediment control.

3.6.2.2.5 Impacts of Transmission Line ROW Management on Aquatic Resources

Once a transmission line is built, the ROW requires routine maintenance to keep it free of trees tall enough to cause electrical current to arc through vegetation to the ground. It may also be necessary to remove or trim trees growing near the edge of the ROW capable of falling too close to the conductors (commonly termed “danger trees”). Some utilities also maintain “screens” of low trees under transmission line conductors where they cross aesthetically sensitive suburban roadways; such tree screens require frequent maintenance. Sometimes relatively level upland areas on transmission line ROWs, especially in aesthetically sensitive residential areas, are periodically mowed. But the most common techniques in managing transmission line ROWs involve use of herbicides. Herbicides can be applied directly to vegetation in the ROW, or to cut stump surfaces once trees are felled. Even when applied in uplands, herbicides can be carried in overland runoff to streams or other surface water features. Herbicides can also leach into groundwater under application sites and be carried to surface waters. Herbicides entering aquatic habitats vary in their lethality to aquatic organisms depending on their active ingredient but also on how they are formulated. For example, formulations of the nonselective herbicide glyphosate labeled for use in upland settings are more lethal to aquatic biota than are glyphosate formulations labeled for use in wetlands or near aquatic features (Langeland and Gettys 2015-TN6461).

Operation of spray equipment or mowers on ROWs can physically disturb soils, thereby generating small amounts of sedimentation that can enter aquatic habitats (see Section 3.6.2.1.1 for an explanation of the impacts of sedimentation on aquatic biota). Maintenance of service roads on the ROW can also cause small amounts of sedimentation. Heavy equipment traversing streams or wetlands can physically damage aquatic biota and the soils and sediment supporting aquatic biota. The potential for noticeable adverse impacts on aquatic habitats from sedimentation can be readily prevented using BMPs. Physical disturbance of soils and sediments in aquatic habitats by fording equipment can be prevented by use of temporary matting that can be removed once it is longer needed. The NRC staff considered possible impacts of transmission line ROW maintenance on aquatic habitats associated with relicensing of existing LWRs and concluded that impacts would be minimal because they would be infrequent, localized, and temporary (NRC 2013-TN2654).

The staff has determined that the impacts of transmission line maintenance on aquatic biota are a Category 1 issue. The staff concludes that as long as the assumptions in the PPE and SPE regarding work in offsite ROWs are met, the impacts can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- Vegetation in transmission line ROWs would be managed following a plan consisting of integrated vegetation management practices.
- All ROW maintenance work would be performed in compliance with all applicable laws and regulations.
- Herbicides would be applied by licensed applicators, and only if in compliance with applicable manufacturer label instructions.
- BMPs would be used for erosion and sediment control.

3.6.2.2.6 Impingement and Entrainment of Aquatic Organisms

Impingement and entrainment of aquatic organisms is a consideration only for facilities whose operation involves use of intake structures for cooling water. The PPE assumes recirculating cooling-water systems using cooling towers but not using once-through cooling systems that require intake of substantially larger volumes of water. The potential for impingement or entrainment generally increases with the volume of water withdrawn and the velocity of movement through the intake screen. For purposes of regulation under CWA Section 316(b), the EPA defines impingement as the entrapment of all life stages of fish and shellfish on the outer part of an intake structure or against a screening device during periods of water withdrawal (40 CFR 125.83; TN254). The EPA defines entrainment as incorporation of all life stages of fish and shellfish with intake water flow entering and passing through a cooling-water intake structure and into a cooling-water system (40 CFR 125.83). Impingement can immobilize organisms rendering them subject to starvation or predation. Organisms that are entrained may pass through the cooling system and emerge in the discharge but are usually killed or substantially injured in the process. Although the EPA regulatory definitions address only fish and shellfish, plankton, comprising both faunal (zooplankton) and floral (phytoplankton) organisms carried by water currents, may also be entrained. Impacts on plankton can harm fish and shellfish by altering supportive food chains.

The PPE includes limits on flow rates at intake structures based on regulatory limits established by EPA in 40 CFR 125.84 (TN254) to protect fish and shellfish. The regulations establish a maximum through-screen velocity of 0.5 ft/s. The total design intake flow must generally be no more than 5 percent of the mean annual flow of rivers or streams and low enough to not disturb natural thermal stratification or turnover in lakes or reservoirs. Thermal stratification is the formation of layers of water of differing temperatures in standing water bodies due to temperature-related differences in water density. Turnover is the shifting of layers in the water column in response to seasonal changes in temperature. Both the stratification and seasonal turnover can be highly influential on the development and survival of aquatic biota. For intakes in tidal water bodies, the regulations limit intake to less than 1 percent of the volume of the water column centered around the opening to the intake structure. The regulations establish additional requirements, including monitoring requirements, to ensure that these rates of intake are protective of fish and shellfish.

The NRC staff included a description of the potential impacts of impingement and entrainment of aquatic biota from operation of large LWRs in Section 4.6.1.2 of the LR GEIS (NRC 2024-TN10161). Even though the staff identified potentially significant impacts from impingement and entrainment for operating plants with once-through cooling systems (NRC 2024-TN10161), they also noted that substantial reductions of aquatic biota populations did not occur during operation of plants that have cooling towers because of the smaller volume of water intake (NRC 2024-TN10161). Cooling towers require less water intake because they recirculate the same water for multiple cycles of cooling before discharge and replacement. Cooling systems for nuclear as well as non-nuclear power plants operate independently of the fuel or power generation technology; hence, the minimal impacts observed with large LWRs suggest that similarly minimal impacts would result from operation of new reactors using any fuel or technology.

The staff has determined that impingement and entrainment of aquatic biota is a Category 1 issue. The staff concludes that as long relevant PPE and SPE are met, the impacts can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- Intakes would comply with regulatory requirements established by EPA in 40 CFR 125.84 (TN254) to be protective of fish and shellfish.
- Best available control technology would be employed in the design of intakes to minimize entrainment and impingement, such as use of screens and intake rates recognized to minimize effects.

3.6.2.2.7 Thermal Impacts on Aquatic Biota

Operation of power plants requires the disposition of excess heat generated by the fuel but not converted into electricity. Although some new reactors may be air-cooled, whereby the waste heat is transferred to air, others, like most large LWRs, may be water-cooled, whereby the waste heat is transferred to water. The PPE assumes no use of once-through cooling systems, whereby makeup water is withdrawn and passed over-heat exchangers only once before being discharged. New reactors within the PPE may however use recirculated-water cooling systems where makeup water is passed over the heat exchangers and run through a cooling tower to dissipate most of its heat content to the air before being recirculated to dissipate more heat in the same way. After recirculation for a specified number of passes (cycles of concentration), the cooling water is discharged as blowdown to a river, lake, or other surface water body (usually the same body that provided the makeup water). The thermal quality of discharges is regulated under CWA Section 316(a), under which the EPA and States can issue thermal variances as part of NPDES permits.

If water is discharged at a temperature higher than that of the receiving water, the discharges can affect aquatic biota. Aquatic biota are adapted to seasonal patterns of water temperatures, including seasonal turnover of stratified water column layers. A particularly serious problem is heat shock: fish and other aquatic biota favoring warmer water temperatures congregate in the vicinity of heated water discharges that persist only as long as a power plant is in operation, but are faced with suddenly colder water whenever operations cease for maintenance or refueling. Increased water temperatures can also encourage growth of invasive aquatic species such as hydrilla (*Hydrilla verticillata*) and Eurasian watermilfoil (*Myriophyllum spicatum*).

The NRC staff included a description of the potential thermal impacts on aquatic biota from operation of large LWRs in Section 4.6.1.2 of the LR GEIS (NRC 2024-TN10161). Even though staff identified potentially significant impacts from thermal impacts for operating nuclear plants with once-through cooling systems (NRC 2024-TN10161), the staff also concluded that the impacts were minimal from nuclear plants using cooling towers because of the smaller discharge plumes resulting from the reduced volume of water being discharged (NRC 2024-TN10161). Cooling systems operate independently of the fuel or power generation technology; hence, the minimal impacts observed with large LWRs provide evidence that similarly minimal impacts would result from operation of new reactors using any fuel or technology. However, the conclusion in the LR GEIS that impacts would be minimal was reached after a review of a series of existing reactors under known conditions. As discussed in Section 3.4.2.2.7, project-specific reviews included an estimation of the extents of the mixing zones in the receiving water bodies and how the mixing zone may affect aquatic resources under project-specific conditions.

The staff concludes that the impact of thermal impacts on aquatic biota is a Category 2 issue. The staff concludes that it is not possible to generically evaluate the potential impacts of the thermal impacts on aquatic ecosystems without first considering project-specific factors. The staff would have to first review the discharge plume analysis (as described in Section 3.4.2.2.7) and the aquatic biota potentially present before being able to reach a conclusion regarding the possible significance of impacts on that biota.

However, this issue is relevant only to nuclear power plants that will have discharges (other than stormwater discharges) to surface water during operations. In general, nuclear power plants that do not use water for cooling do not have discharges capable of adversely affecting aquatic biota. For such plants, detailed analysis of thermal impacts on aquatic biota are not necessary.

3.6.2.2.8 Other Effects of Cooling-Water Discharges on Aquatic Biota

The NRC staff recognizes that discharges of cooling-tower blowdown water from operating nuclear power plants can release nonradiological contaminants to aquatic habitats (NRC 2024-TN10161). The LR GEIS discusses copper introduced into cooling water when it passes over copper alloy tubes used in a few existing LWRs but notes that those tubes have been replaced by tubes made of other metals such as titanium as mitigation. The PPE therefore assumes that copper alloy tubes would not be used in new reactors. Operators of nuclear power plants that use cooling towers typically add biocides to the cooling water to prevent the buildup of microorganisms, algae, and invasive species such as zebra mussels and Asiatic clams that can interfere with water conveyance. As explained in the LR GEIS (NRC 2024-TN10161), NPDES permits include restrictions on biocide use to protect non-target organisms in receiving waters such as indigenous mussels and fish. Various methods are available to minimize biocide use in order to comply with NPDES permits. Cooling water can also affect dissolved oxygen levels and cause eutrophication in receiving waters, and discharges can cause localized areas of gas supersaturation (gas bubbles) that are detrimental to aquatic biota, but the staff has concluded in the LR GEIS that the impacts would be minor (NRC 2024-TN10161). However, development of a bounding set of plant parameters for the PPE or site parameters for the SPE that are adequately protective of aquatic biota is not possible, because compliance with standards set forth in an NPDES permit would not necessarily result in only minimal impacts on aquatic biota in all settings. This is especially true for discharges to waters not under the CWA jurisdiction and hence not requiring an NPDES permit.

The staff therefore concludes that the impact of cooling-water discharges on aquatic biota is a Category 2 issue. The staff concludes that it is not possible to generically evaluate the potential impacts of the discharges on aquatic ecosystems without first considering project-specific factors. The staff would have to first review the discharge plume analysis (as described in Section 3.4.2.2.7) and the aquatic biota potentially present before being able to reach a conclusion regarding the possible significance of impacts on that biota.

However, this issue is relevant only to nuclear power plants that will have discharges (other than stormwater discharges) to surface water during operations. In general, nuclear power plants that do not use water for cooling do not have discharges capable of adversely affecting aquatic biota. For such nuclear power plants, detailed analysis of cooling water discharges on aquatic biota is not necessary.

3.6.2.2.9 Water Use Conflicts with Aquatic Resources

The water demands for operating a nuclear reactor are typically low unless water is used for cooling purposes. The more substantive demands for cooling water could however reduce water levels in some aquatic habitats. Recirculating cooling-water systems withdraw water and repeatedly cycle it through multiple passes over the heat exchangers, evaporating a portion of the water in each cycle. Substantially less water is therefore discharged back to the source water body than is withdrawn. The reduced water availability can reduce flow in streams and rivers, reduce water elevations in lakes and reservoirs, contract shorelines, and periodically dry out shallow areas and wetlands. As discussed in Section 3.5.2.2.7, the assumption in the SPE

regarding water use and surface water availability applies to flowing systems. Water withdrawals from streams or rivers would constitute less than 3 percent of the 95 percent exceedance daily flow (essentially, extreme low flow conditions), which would ensure that aquatic fauna and flora in riverine habitats would not experience adverse effects caused by hydrological changes during droughts.

The staff recognizes that it is not as easy to estimate the potential impacts of water withdrawals on non-flowing surface water bodies. The PPE value of 6,000 gpm (Section 3.4.1) for total plant water demand applies to non-flowing water bodies such as the Great Lakes, the Gulf of America, oceans, estuaries, and intertidal zones. The staff recognizes that the quantity of water withdrawals for new reactors from very large water bodies such as oceans, the Great Lakes, and the Gulf of America would not result in a reduction in water levels or hydroperiod that could adversely affect the ecological integrity of aquatic habitats or biota. However, water withdrawals from smaller or more sensitive non-flowing fresh water bodies such as inland lakes and reservoirs, estuaries, and intertidal zones could require project-specific review of the potential impacts of changes in water level and hydroperiod (Section 3.5.2.2.7). The staff assumes that applicants relying on the generic analysis can demonstrate that hydroperiod changes are within historical annual or seasonal fluctuations. If the applicant cannot so demonstrate, project-specific analysis would be needed to determine potential impacts on aquatic habitats.

The water losses resulting from operation of cooling-water systems for power plants are unlikely to result in substantial changes to most aquatic ecosystems under normal conditions but could be noticeable during times of extended drought. In the LR GEIS, the NRC staff determined that evaluating the potential impacts of water use conflicts with aquatic biota requires a project-specific analysis for the individual reactor undergoing relicensing (NRC 2024-TN10161). However, for this GEIS (unlike in the LR GEIS), the staff relies on assumptions in the PPE and SPE regarding water use that the staff developed to limit potential adverse effects on aquatic habitats. The staff has therefore determined that water use conflicts with aquatic biota are a Category 1 issue. The staff concludes that as long as relevant values and assumptions in the PPE and SPE regarding cooling systems (Section 3.6.1) and assumptions regarding surface water withdrawal (Section 3.4.1) are met, including that it is possible to demonstrate that hydroperiod changes are within historical or seasonal fluctuations, the impacts can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- If needed, cooling towers would be mechanical draft, not natural draft; less than 100 ft in height; and equipped with drift eliminators.
- Any makeup water for the cooling towers would be fresh water (less than 1 ppt salinity).
- Total plant water demand would be less than or equal to a daily average of 6,000 gpm.
- If water is withdrawn from flowing waterbodies, average plant water withdrawals would not reduce flow by more than 3 percent of the 95 percent exceedance daily flow and would not prevent maintenance of applicable instream flow requirements.
- Any water withdrawals would be in compliance with any EPA or State permitting requirements.
- Applicants would be able to demonstrate that hydroperiod changes are within historical or seasonal fluctuations.

3.6.2.2.10 Important Species and Habitats

As noted for building, important species and habitats that meet the NRC criteria (NRC 2026-TN11915) on a given site can only be determined once the site is identified. Because of differing regulations and sensitivities to impacts, two separate issues are analyzed below regarding important species and habitats: (1) resources regulated under the ESA (16 U.S.C. §§ 1531 et seq.; TN1010) and the Magnuson-Stevens Act (16 U.S.C. §§ 1801 et seq.; TN1061), and (2) other important species and habitats.

Resources Regulated under the Endangered Species Act and Magnuson-Stevens Act

For the same reasons noted for building in Section 3.6.2.1.4, the staff has determined that operational impacts on resources regulated under the ESA and Magnuson-Stevens Act are a Category 2 issue. Because of their potential for future regulation over the course of a licensing action, the Category 2 designation extends also to proposed and candidate species designated under the ESA. Even if the applicable assumptions in the PPE and SPE are met, the NRC staff is unable to determine the significance of potential impacts without consideration of project-specific factors, including the specific species and habitats affected and the types of ecological changes potentially resulting from each specific licensing action. Furthermore, the ESA and Magnuson-Stevens Act require consultations for each licensing action that may affect regulated resources.

Other Important Species and Habitats

The analyses presented in Section 3.6.2.1.4 also apply to operations and suggest that the potential impacts on other important species and habitats from operation of a new reactor that meets the PPE and SPE would likely be minimal regardless of site location. The NRC staff is confident in this conclusion for any site that meets the assumptions in the PPE and SPE associated with cooling systems and meets the regulatory limits in 40 CFR 125.84 (TN254) and requirements associated with applicable NPDES permits, even without identifying the important species specifically present on a given site. The assumptions in the PPE and SPE limit the potential for adverse impacts, especially limitations on the amount of water used and the assumed absence of sensitive habitat types potentially containing rare species. Licensees would also likely communicate with multiple State and local authorities, who may recommend following routine BMPs to prevent the introduction of invasive species to affected water bodies.

The staff has therefore determined that operational impacts on important species and habitats other than those regulated under the ESA and Magnuson-Stevens Act are a Category 1 issue. The staff concludes that as long as the applicable assumptions in the PPE and SPE are met, the impacts can be generically determined to be SMALL. The staff relied on the following PPE and SPE values and assumptions to reach this conclusion:

- Applicants would communicate with State natural resource or conservation agencies regarding aquatic fish, wildlife, and plants and implement mitigation recommendation of those agencies.

3.7 Historic and Cultural Resources

3.7.1 Baseline Conditions

Historic and cultural resources are the remains of past human activities and include precontact (i.e., prehistoric) and historic era archaeological sites, districts, buildings, structures, and

objects. Precontact era archaeological sites pre-date the arrival of Europeans in North America and may include small temporary camps, larger seasonal camps, large village sites, or specialized-use areas associated with fishing or hunting or with tool and pottery manufacture. Historic era archaeological sites post-date European contact with Indian Tribes and may include farmsteads, mills, forts, residences, industrial sites, and shipwrecks. Architectural resources include buildings and structures. Historic and cultural resources also include elements of the cultural environment such as landscapes, sacred sites, and other resources that are of religious and cultural importance to Indian Tribes, such as traditional cultural properties (TCPs) important to a living community of people for maintaining its culture.[7]

Within the scope of the NHPA (54 U.S.C. §§ 300101 et seq.-TN4157), a historic or a cultural resource is considered a historic property if it has met at least one of the four criteria for listing or is listed on the NRHP.[8] The NRHP is the Nation's official list recognizing buildings, structures, objects, sites, and districts of national, State, or local places that are historically significant and worthy of preservation. The list is maintained by the U.S. National Park Service in accordance with its regulations in 36 CFR Part 60 (TN1682). The NRHP criteria to evaluate the eligibility of a property are set forth in 36 CFR 60.4.[9] In this regard, a historic property is at least 50 years old, although exceptions can be made for properties determined to be of "exceptional significance."[10]

3.7.1.1 National Historic Preservation Act and NEPA

NEPA (42 U.S.C. §§ 4321 et seq.; TN661) requires Federal agencies to consider the potential effects of their actions on the affected human environment, which includes aesthetic, historic, and cultural resources as these terms are commonly understood, including such resources as sacred sites. For NEPA compliance, impacts on cultural resources that are not eligible for or listed on the National Register would also need to be considered.

Section 106 of the NHPA (54 U.S.C. §§ 300101 et seq.; TN4157) requires Federal agencies to take into account the effects of their undertakings[11] on historic properties and consult with the appropriate consulting parties as defined in 36 CFR 800.2 (TN513). Consulting parties consist of the State Historic Preservation Officer (SHPO), Advisory Council on Historic Preservation (ACHP), Tribal Historic Preservation Officer (THPO), Indian Tribes that attach cultural and religious significance to historic properties on a government-to-government basis, and other

[7] According to U.S. National Park Service (NPS) guidance, a "traditional cultural property" is associated "with the cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" (Parker and King 1998-TN5840).

[8] Historic property is defined in 36 CFR 800.16(l)(1) (TN513) as "... any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the [NRHP] maintained by the Secretary of Interior. This term includes artifacts, records, and remains that are related to and located within such properties." As defined in 36 CFR 800.16(l)(2), "The term eligible for inclusion in the National Register includes both properties formally determined as such in accordance with regulations of the Secretary of the Interior and all other properties that meet National Register listing criteria."

[9] The eligibility of a resource for listing on the NRHP is evaluated based on four criteria and is articulated in 36 CFR 60.4 (TN1682), as follows: Criterion a: Associated with events that have made a significant contribution to broad patterns of our history; Criterion b: Associated with the lives of persons significant in our past; or Criterion c: Embodies the distinctive characteristics of a type, period, or method of construction, or represents the work of a master, or that possesses high artistic values, or that represents a significant and distinguishable entity whose components may lack individual distinction; and Criterion d: Has yielded, or is likely to yield, information important to prehistory and history.

[10] 36 CFR 60.4(g).

[11] An undertaking is defined as "a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency, including those carried out by or on behalf of a Federal agency; those carried out with Federal financial assistance; and those requiring a Federal permit, license, or approval" (see CFR 800.16(y); TN513).

parties that have a demonstrated interest in the effects of the undertaking, including local governments and the public, as applicable. The ACHP is an independent Federal agency that oversees the NHPA Section 106 review process in accordance with its implementing regulations in 36 CFR Part 800, *Protection of Historic Properties* (TN513). Issuing a license for a new reactor is an undertaking that requires compliance with NHPA Section 106.

Historic and cultural resources vary widely from site to site; there is no generic way of determining their existence or significance. Historic and cultural resource impacts must be analyzed on a project-specific basis, and the NRC is required to complete a NEPA and NHPA Section 106 review (NRC 2026-TN11915) prior to issuing a license.[12]

For a specific application, in accordance with 36 CFR Part 800 (TN513), the NRC would establish the undertaking, identify consulting parties, and determine the scope of potential effects from the undertaking by defining the area of potential effect (APE). The APE for a new reactor is the area that may be directly or indirectly affected by activities during construction or plant operations. The APE typically encompasses the nuclear power plant site where onsite ground-disturbing activities may occur, its immediate environs including viewshed, and in-scope transmission lines. The APE may extend beyond the nuclear plant site and transmission lines when building and operation activities may affect historic properties at offsite locations. The NRC will rely on cultural resource investigations of the APE and NRHP-eligibility evaluations completed by qualified professionals, who meet the Secretary of Interior's standards at 36 CFR Part 61 (TN4848), in consultation with the SHPO and other consulting parties to determine whether historic properties are present in the APE.

When preparing project-specific supplements to this GEIS (see 36 CFR 800.8(c); TN513), the NRC's practice is to fulfill the requirements of NHPA Section 106 through the NEPA review process. Additional historic and cultural resource laws could apply, for example, if a proposed project is located on Federal lands or is subject to State-specific preservation laws (see Appendix F).

3.7.2 Historic and Cultural Resources Impacts

The NRC considers impacts on historic and cultural resources in this GEIS through its NEPA requirements in 10 CFR Part 51 (TN250). Impacts may be direct, indirect, visual, or auditory. Any new construction activity, including the building and operation of a new reactor, parking areas, access roads, or transmission lines, is particularly important to an analysis of impacts on historic and cultural resources. Building and operation-related ground-disturbing activities or alterations to buildings or structures that are NRHP-eligible can result in direct effects on archaeological sites, aboveground resources, and TCPs. Introduction of noise or visual intrusions (i.e., use of reflective materials, tall structures, building design that is inconsistent with surrounding environment) that are either temporary or permanent in nature can result in both direct and indirect effects on aboveground resources and TCPs. For new reactor projects, consultation with Indian Tribes will seek to identify and incorporate indigenous knowledge in the NRC's environmental review.

The NRC staff will rely on preliminary recommendations made by qualified professionals, who meet the Secretary of Interior's standards at 36 CFR Part 61 (TN4848), in its determination of whether historic properties will be or will not be adversely affected. For a historic or cultural resource that does not meet the criteria to be considered a historic

[12] The NRC is required to comply with the NHPA including the anticipatory demolition clause, Section 110(k) of the NHPA (54 U.S.C. 306113). See Section 4.6 of RG 4.2 (NRC 2026-TN11915).

property under the NHPA, the NRC will assess whether there are any potential significant impacts on this resource through the NEPA process.

If historic and cultural resource investigations do not identify historic properties within the APE, the NRC will conclude a finding of *no historic properties affected* in accordance with 36 CFR 800.4(d)(1) (TN513). The NRC will provide documentation of these findings for review and concurrence to SHPO/THPO, Indian Tribes, and interested members of the public in accordance with documentation standards set forth in 36 CFR 800.11(d).

If historic properties have been identified but would not be impacted by the proposed construction and operation activities, or if the impacts can be either minimized or avoided, the NRC staff will apply the criteria of *no adverse effect* on historic properties outlined in 36 CFR 800.5(b). The NRC will provide documentation of these findings for review and concurrence to SHPO/THPO, Indian Tribes, and interested members of the public in accordance with documentation standards set forth in 36 CFR 800.11(e).

If historic properties have been identified and cannot be avoided by the proposed construction and operation activities, the NRC staff will apply the criteria of *adverse effect* to historic properties outlined in 36 CFR 800.5(a) (TN513). Adverse effects result when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion on the NRHP in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. These include physical destruction or alteration of a property's characteristics that contribute to its historic significance. Examples of adverse effects are described in 36 CFR 800.5(a)(2).

The NRC staff will provide documentation of this finding to the ACHP, SHPO/THPO, Indian Tribes, and interested members of the public for review and concurrence in accordance with documentation standards set forth in 36 CFR 800.11(e) (TN513). The NRC will consult with the same parties regarding the resolution of adverse effects and develop measures to avoid, minimize, or mitigate the adverse effects. Such measures to address adverse effects are typically documented in a Memorandum of Agreement or a Programmatic Agreement.

3.7.2.1 Environmental Consequences of Construction

The NRC staff identified one environmental issue:

- construction impacts on historic and cultural resources

Most impacts on historic and cultural resources would occur during the construction phase. Impacts would occur primarily from both onsite and offsite preparation-related ground-disturbing activities (e.g., land clearing, grading and excavation, and road work) and the construction of safety-related facilities such as the nuclear island and non-safety-related facilities such as cooling towers, administration buildings, parking lots, switchyards, pipelines, access roads, and transmission lines. Archaeological sites are sensitive to disturbance and even a small amount of ground disturbance (e.g., ground clearing and grading) could affect a significant resource. Much of the information contained in an archaeological site is derived from the spatial relationships between soil layers and associated artifacts. Once these spatial relationships are altered, they can never be reclaimed (NRC 2024-TN10161). Alterations to the visual setting, whether temporary or permanent, could also affect other types of historic and cultural resources such as cultural landscapes, architectural resources, or TCPs.

Direct and indirect impacts from construction on historic and cultural resources and historic properties can be avoided or minimized if the undertaking is modified or if the applicant takes the appropriate mitigation measures. Impacts on archaeological resources can typically be

avoided by re-siting ground-disturbing activities. Minimization efforts can include but are not limited to use of geomembranes or geotextile fabric to protect and/or stabilize archaeological deposits, construction monitoring, and development of inadvertent discovery plans. Direct impacts on aboveground resources can be avoided by not altering any of the exterior or interior physical components of the building that contribute to its NRHP eligibility. Indirect impacts can be avoided by existing natural topography or vegetation screening. Minimization efforts for aboveground resources can include but are not limited to vegetation restoration, creative landscaping, integration of structures with the surrounding environment, minimization of the use of bright flashy surfaces, and other considerations related to overall design. Adaptive reuse of an aboveground resource is often viewed as a beneficial effect depending on the scope of modifications necessary.

If impacts on a historic property cannot be avoided or minimized, they can be mitigated through the development of mitigation measures that are formalized in a Memorandum of Agreement or a Programmatic Agreement. Historic and cultural resources are nonrenewable, hence certain activities depending upon the resource and its significance can result in an irretrievable loss of the resource. Mitigation efforts for archaeological sites typically entail data recovery and controlled excavation if in situ stabilization is not possible. Despite being a form of mitigation, archaeological data recovery results in an irretrievable loss of the historic and archaeological information. Mitigation efforts for aboveground resources can include but are not limited to formal documentation in a Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER) study and public education activities. Development of avoidance, minimization, and mitigation measures for adverse effects on TCPs must be done in consultation with the Tribe or community that has an interest in that TCP.

This GEIS does not identify any specific sites for NRC licensing actions that would trigger NHPA Section 106 consultation requirements that are normally conducted during project-specific licensing reviews. Development of this GEIS is not a licensing action; it does not authorize the building or operation of any new reactor. Because the analysis requires project-specific information, the impact of building a new reactor on historic and cultural resources is a Category 2 issue.

3.7.2.2 Environmental Consequences of Operation

The NRC staff identified one environmental issue:

- operation impacts on historic and cultural resources

Continued operations can affect historic and cultural resources through ground-disturbing activities associated with plant operations and ongoing maintenance of existing onsite and offsite facilities, roads, and transmission lines; and changes to the appearance of the nuclear power plant and transmission lines. Impacts from operation and maintenance activities on historic and cultural resources and historic properties can be avoided or minimized through the development of historic and cultural resource protection procedures. These procedures outline stop work and notification protocols in the event that archaeological materials or human remains are inadvertently discovered during building, operation, or maintenance activities. The procedures should follow State burial laws if the new reactor is sited on non-Federal land or the Native American Graves Protection and Repatriation Act (25 U.S.C. §§ 3001 et seq.; TN1686) if it is sited on Federal land. Development of avoidance, minimization, and mitigation measures (i.e., stop work and notification procedures) for addressing adverse effects on historic properties must be done in consultation with SHPO/THPO and Indian Tribes.

NHPA Section 106 consultation requirements are normally conducted during project-specific licensing reviews. This GEIS is not a licensing action; it does not authorize the construction or operation of any new reactor. Because the analysis requires project-specific information, the impact of operating a new reactor on historic and cultural resources is a Category 2 issue.

3.8 Environmental Hazards

3.8.1 Radiological Environment

3.8.1.1 Baseline Conditions and PPE/SPE Values and Assumptions

Radiological exposures from nuclear power plants include offsite doses to members of the public and onsite doses to the workforce. Each of these impacts is common to all commercial U.S. reactors. The Atomic Energy Act of 1954 (42 U.S.C. §§ 2011 et seq.; TN663) requires the NRC to promulgate, inspect, and enforce standards that provide an adequate level of protection for public health and safety and the environment. The NRC continuously evaluates the latest radiation protection recommendations from international and national scientific bodies to establish the requirements for nuclear power plant licensees. The NRC has established multiple layers of radiation protection limits to protect the public from potential health risks related to exposure to radioactive materials effluent discharges from nuclear power plant operations. If the licensees exceed a certain fraction of these dose levels in a calendar quarter, they are required to notify the NRC, investigate the cause, and initiate corrective actions within the specified time frame.

An assessment of the radiological environment for a proposed site on which to build and operate a nuclear power plant would depend on the characteristics of the site relative to prior and adjacent activities. If the site has not been used for any prior industrial activities, i.e., it is a greenfield site, then the environment is only affected by natural radioactive background. However, if the footprint of the proposed nuclear power plant is within an existing licensed nuclear facility's property, there is an adjacent or nearby nuclear facility (e.g., nuclear power plant, nuclear fuel cycle facility, or another NRC-licensed, Agreement State-licensed, or Federal nuclear facility), or the site was a former nuclear facility, then radiological effects from such nuclear facilities, such as direct radiation or residual radionuclides in the soil on the proposed site, should already have been assessed for their impacts with respect to regulatory requirements (10 CFR 20.1101, CFR 20.1201, 10 CFR 20.1301, 10 CFR Part 20 Appendix B [10 CFR Part 20-TN283]).

Existing licensed nuclear facilities have a REMP. The limits for all radiological releases are specified in a nuclear power plant's Offsite Dose Calculation Manual, and these limits are designed to meet Federal standards and requirements. The REMP includes monitoring of the aquatic environment (fish, invertebrates, and shoreline sediment), atmospheric environment (airborne radioiodine, gross beta, and gamma), terrestrial environment (vegetation), and direct radiation. These reports have shown that doses to individuals around the nuclear site were a small fraction of the limits specified in Federal environmental radiation standards (10 CFR Part 20 [TN283], 10 CFR Part 50 [TN249], Appendix I, and 40 CFR Part 190 [TN739]).

In an Atomic Safety Licensing Board initial decision for the North Anna ESPs (ASLB 2007-TN6826) it was ruled that the limits in 40 CFR 190.10 (TN739)—and hence 10 CFR 20.1301(e) (TN283)—do not apply to non-LWRs. EPA's radiation protection standard applies to operations within the "uranium fuel cycle," which it defines as the processes involved in the production of uranium fuel, "generation of electricity by a light-water cooled nuclear power plant using uranium

fuel," and reprocessing spent uranium fuel. This definition excludes gas-cooled, molten salt-cooled, liquid metal-cooled, and heat pipe-cooled nuclear power reactors, regardless of fuel composition. Therefore, under the current regulatory scheme, non-LWR nuclear power reactors would not be subject to the dose limits of 10 CFR 20.1301(e) for the applicable environmental radiation standards in 40 CFR 190.10. In addition, 10 CFR Part 50 (TN249), Appendix I, provides "numerical guidance on design objectives for [LWRs] to meet the requirements that radioactive material in effluents released to unrestricted areas be kept [ALARA]." No similar specific numerical guidance on design objectives currently exists for non-LWRs. However, the staff assumes that the ALARA design objective requirements in 10 CFR 50.34a (see below) and radiation protection programs under 10 CFR 20.1101 (TN283), which are applicable to non-LWR licensees, will ensure that radioactive effluent releases from non-LWRs should remain below applicable regulatory limits. The use of 40 CFR Part 190 (TN739) limits and the results in Table 3-3 to Table 3-7 are provided as examples for demonstrating small impacts.

3.8.1.1.1 Regulatory Requirements and Guidance

Nuclear power reactors in the United States must be licensed by the NRC and must comply with NRC regulations and conditions specified in the license in order to operate. The application must provide assurance that the limits on the release of radioactive liquid and gaseous effluents during normal operation (including expected operational occurrences) will meet the requirements in 10 CFR Part 20 (TN283), Subpart B, "Radiation Protection Programs," Subpart C, "Occupational Dose Limits for Adults," and Subpart D, "Radiation Dose Limits for Individual Members of the Public." In addition, a new reactor applicant would need to meet the following 10 CFR Part 20 and 10 CFR Part 50 (TN249) regulations concerning radioactive effluent releases:

- applicable 10 CFR Part 20, Appendix B (TN283) regulatory standards for discharge radioactive effluents;
- the requirements in 10 CFR 50.34a, "Design objectives for equipment to control releases of radioactive material in effluents—nuclear power reactors" (TN249); and
- the special license conditions a reactor design shall meet to minimize the radiological impacts associated with plant operations, as provided in 10 CFR 50.36a, "Technical specifications on effluents from nuclear power reactors" (TN249).

Additional details and discussion of the radiation protection regulatory requirements to be addressed in a new reactor application, excluding Appendix I to 10 CFR Part 50 (TN249), which only applies to LWRs, can be found in Section 3.9.1.1, Regulatory Requirements, of Revision 2 to NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NRC 2024-TN10161), which is incorporated by reference.

The PPE assumes that the application contains sufficient technical information, both in scope and depth, for the NRC staff to complete the detailed technical review and render an independent assessment with regard to applicable regulatory requirements and the protection of public health, safety, and security. The level of detail provided in each section of the Final Safety Analysis Report/Preliminary Safety Analysis Report is expected to be commensurate with the safety significance of the topic. The PPE also assumes that the staff will find the application to be in compliance with the above regulations that will ensure that effluent release limits will be met during normal operations for the life of the plant.

3.8.1.1.2 Radiological Exposure Pathways

There are various environmental pathways by which radiation and radioactive effluents can be transmitted from a reactor to living organisms, assuming there are radiological effluent releases. The scope of this radiological health evaluation for the dose to the maximally exposed individual (MEI) and to the population includes consideration of (1) the pathways by which gaseous and liquid radioactive effluents can be transported to individual receptors (MEI, construction workers, and occupational workers) along with the surrounding population, and (2) the location of these receptors.

For the radiological gaseous effluent releases, the following exposure pathways may exist:

- immersion in airborne activity in the plume;
- inhalation of airborne activity in the plume;
- direct radiation exposure from deposited activity on the ground; and
- ingestion of locally grown meats, fruits, vegetables, and milk from the absorption of the released radionuclides into the production of major types of foods within 80 km (50 mi) of the plant.

The radiological liquid effluent exposure pathways may include the following:

- ingestion of water from downstream sources;
- ingestion of aquatic organisms as food (i.e., fish and invertebrates);
- ingestion of locally grown meats, fruits, vegetables, and milk within 80 km (50 mi) of the plant that is irrigated by water drawn from a body of water into which the liquid effluent is discharged; and
- radiation exposure from swimming and boating activities in the same body of water.

Similar pathways exist to expose nonhuman biota to the radiological effluent releases from a reactor. Radiological exposure for construction and occupational workers is expected to be from inhalation of the airborne plume, direct radiation from deposited plume activity on the ground or from radiation sources due to byproduct material devices used during construction, and from the plant or other co-located nuclear facility operations. In addition, there is the potential for these receptors to be exposed to radionuclides via the ingestion of water from downstream sources if they are the plant's potable water source.

Representative diagrams of the radiological exposure pathways to be considered are provided in Figure 3-2 for human exposure and Figure 3-3 for nonhuman exposure.

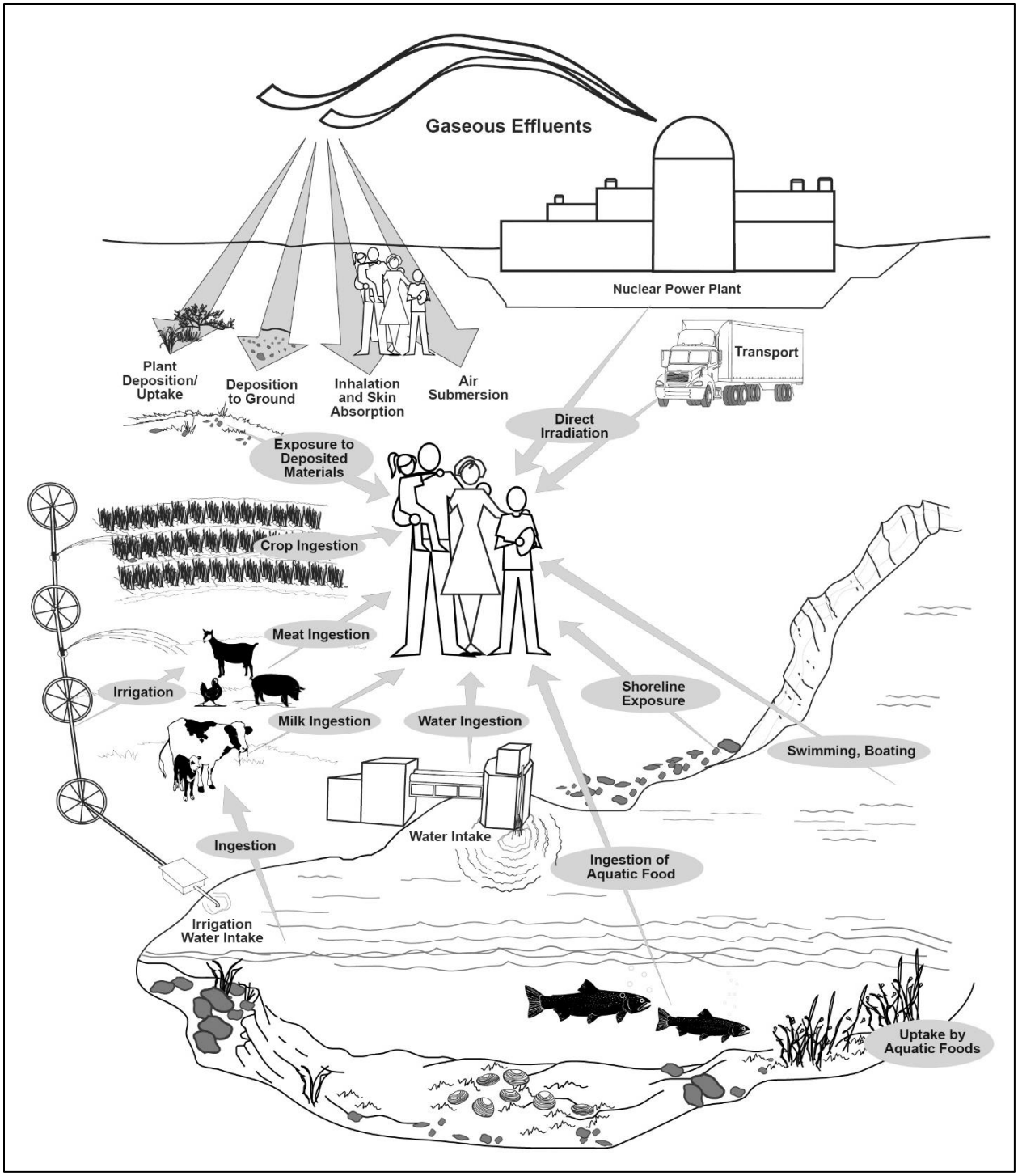

Figure 3-2 Representative Radiological Exposure Pathways to Human. Source: Modified from Soldat et al. 1974-TN710.

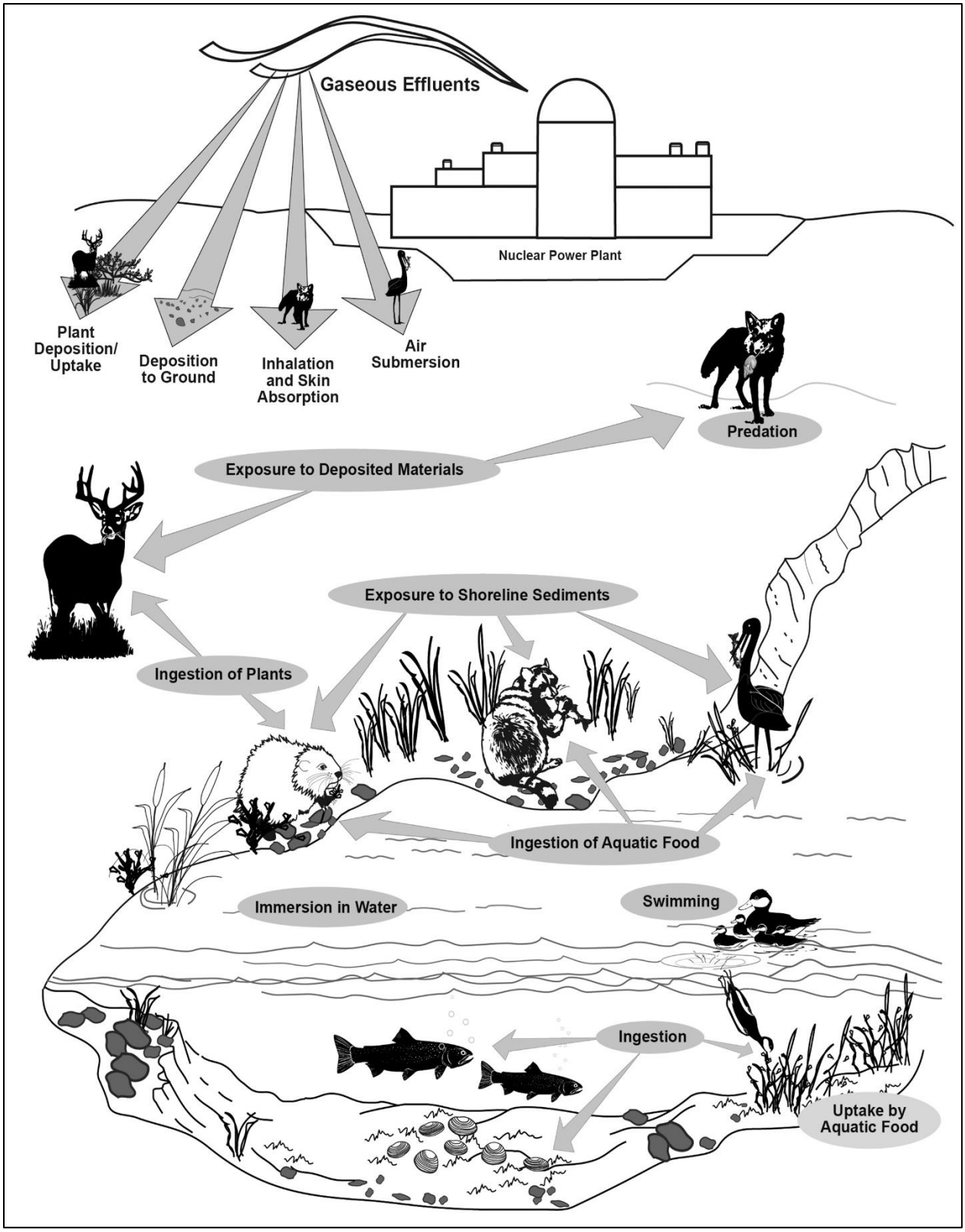

Figure 3-3 Representative Radiological Exposure Pathways to Nonhuman Biota. Source: Modified from Soldat et al. 1974-TN710.

3.8.1.2 Radiological Environment Impacts

This section characterizes the environmental impacts of the liquid and gaseous effluent releases, the onsite radiological waste management systems, solid low-level radioactive waste management (LLRW), and onsite storage of spent fuel. This analysis includes assessing potential radiological impacts on construction workers as well as radiological impacts on humans (occupational workers and members of the public) and nonhuman biota from operation of a new reactor. Building a nuclear power station is a project that may affect construction workers as a result of direct radiation and radiological releases from co-located operating nuclear facilities. Radiological health impacts on occupational workers can occur from operation of the radioactive waste systems, onsite storage of waste, and from operation of the nuclear power station. The impacts on members of the public and nonhuman biota can come from the ingestion of food and water, external exposure from water immersion, inhalation of airborne radionuclides, and external exposure to immersion in gaseous effluent plume.

3.8.1.2.1 Environmental Consequences of Construction

The NRC staff identified one environmental issue associated with construction:

- radiological dose to construction workers.

If the site for the new reactor is a greenfield site (i.e., no adjacent or nearby nuclear facilities), then there are no potential radiation exposure pathways and no analysis of construction worker dose is necessary. For sites that have adjacent nuclear facilities (LWRs, other reactors, independent spent fuel storage installation [ISFSIs], nuclear research facilities, nuclear fuel cycle facilities, etc.) that are already operational, potential sources of radiation exist that will expose construction workers to radiation during the site preparation and construction phases of building. Similarly, if the site for the new reactor is a brownfield site (i.e., a site characterized by the potential presence of hazardous substances, pollutants, or contaminants; EPA 2021-TN6848) potential sources of radiation exist that could expose construction workers to radiation during the site preparation and construction phases of building. If a reactor building could hold multiple cores, it is also assumed that once the first reactor core became critical, construction on any other modules would be performed by properly trained and qualified radiation workers whose radiation exposure would be controlled under the regulatory limits of 10 CFR 20.1201 (TN283).

New reactors could be manufactured at an offsite location and either major components or, if small enough, the complete reactor system with a fueled subcritical core, could be delivered to the site. Thus, the onsite time required for construction and installation of a packaged reactor system is expected to be noticeably less than that for a large LWR employing traditional construction methods. This offsite manufacturing process reduces radiation exposures to construction workers by reducing the amount of time they would be working near operating units.

Construction worker radiation doses must remain below the radiation dose limit for individual members of the public (100 millirems/year [mrem/yr] [10 CFR 20.1301; TN283]) pursuant to 10 CFR Part 20, Subpart D (TN283), “Radiation Dose Limits for Individual Members of the Public”, including from exposure to uranium fuel cycle activities as defined by 40 CFR Part 190, “Environmental Radiation Protection Standards for Nuclear Power Operations” (TN739). Because of the variability in new reactor designs, power levels, and timeframes for the construction stage, the potential radiation exposure levels could range from not measurable to close to the 100 mrem/yr regulatory limit. It is also expected that the applicant, if issued a

license, would mitigate the construction worker radiation exposures by following radiation protection best practices to maintain radiation dose ALARA standards in accordance with 10 CFR 20.1101 (TN283), “Radiation Protection Programs.”

New reactor licensing actions for LWRs have shown that the anticipated radiological doses to construction workers would be within regulatory limits for members of the public, as shown in Table 3-3. These results show that even for sites with co-located nuclear power plants, dose levels are generally significantly below 100 millirems/year (mrem/yr). The only exception is for the Fermi 3 licensing action, which involved an anticipated dose slightly less than 100 mrem/yr, and this was in part due to the type of reactor in operation at Fermi 2 and having an ISFSI adjacent to the Fermi 3 construction site that would have a number of storage casks in place during the construction time frame (see Section 4.9 of NRC 2013-TN6436). Therefore, it is important that exposure pathways from any adjacent or nearby nuclear facility, whether licensed by the NRC, an Agreement State, or if next to another Federal nuclear facility, be properly accounted for when assessing annual doses to construction workers. If it is identified that construction workers could be exposed to radiation levels from licensed activities that could result in a dose that may exceed limits to members of the public set forth in 10 CFR 20.1301, then they should be trained as radiation workers.

Table 3-3 Construction Worker Individual and Collective Doses

Site Name	Worker Population	Individual Construction Worker Dose (mrem/yr)	Cumulative Construction Worker Dose (person-rem/yr)
Clinton Exelon ESP (NRC 2006-TN672)	3,150	25	80
Grand Gulf ESP (NRC 2006-TN674)	3,150	36	112
North Anna Power Station Unit 3 ESP (NRC 2010-TN6)	3,500	29	102
Calvert Cliffs Unit 3 COL (NRC 2011-TN1980)	3,950	38.81	4.6
South Texas Units 3 and 4 COL (NRC 2011-TN1722)	5,950	19	-
Virgil C. Summer Units 2 and 3 COL (NRC 2011-TN1723)	3,600	1.2	4.7
Levy Units 1 and 2 COL (NRC 2012-TN1976)	3,300	2.7	-
Comanche Peak Units 3 and 4 COL (NRC 2011-TN6437)	4,953	2.5	-
Vogtle Units 3 and 4 ESP (NRC 2008-TN673)	3,500	26.3	92
Enrico Fermi Unit 3 COL (NRC 2013-TN6436)	2,900	96.6	-
William States Lee Units 1 and 2 COL (NRC 2013-TN6435)	2,100	0.4	0.83
PSEG ESP (NRC 2015-TN6438)	4,100	18.7	77
Turkey Point Units 6 and 7 COL (NRC 2016-TN6434)	2,800	6	17
Bell Bend COL (NRC and USACE 2016-TN6562)	3,950	16.4	10.3
Clinch River ESP (NRC 2019-TN6136)	3,300	53	170

COL = combined license; ESP = early site permit; PSEG = Public Service Enterprise Group.

Based on these considerations, the NRC concludes that radiological impacts during construction would be SMALL for all new reactors independent of power level or design and the doses would be less than the regulatory limits, which will be demonstrated in the application. This is a Category 1 issue. The staff relied on the following PPE assumptions to reach this conclusion:

- For protection against radiation, the applicant must meet the regulatory requirements of:
  - 10 CFR 20.1101 Radiation Protection Programs (10 CFR Part 20-TN283) if issued a license
  - 10 CFR 20.1201 Occupational dose limits for adults
  - 10 CFR 20.1301 Dose limits for individual members of the public
  - Appendix B of 10 CFR Part 20 Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage
  - 10 CFR 50.34a (10 CFR Part 50-TN249) Design objectives for equipment to control releases of radioactive material in effluents—nuclear power reactors
  - 10 CFR 50.36a Technical specifications on effluents from nuclear power reactors.
- Application contains sufficient technical information for the staff to complete the detailed technical safety review.
- Application will be found to be in compliance by the staff with the above regulations through a radiation protection program and an effluent release monitoring program.

3.8.1.2.2 Environmental Consequences of Operation

If the new reactor design does not have radiological gaseous and liquid effluent releases and no significant quantities of solid radioactive waste are being stored onsite, then there are no potential offsite radiation exposure pathways and no environmental analysis of offsite radiological dose is necessary. To receive an NRC license, the applicant must provide assurances that the new reactor's operations would not exceed regulatory limits for occupational doses and doses to individual members of the public, as set forth in 10 CFR Part 20 (TN283). Under the safety review, the staff would review and confirm in the Final Safety Evaluation Report that the application demonstrates adequate protection of the public's health and safety by meeting the appropriate regulatory limits through all operational phases. The application's safety analysis does not assess the collective dose to the surrounding population or doses to nonhuman biota.

The NRC staff identified four environmental issues related to radiological environment impacts for operation of a new reactor:

- occupational doses to workers
- MEI annual doses
- total population annual doses
- nonhuman biota doses.

Variability in radiological waste management systems between new reactor designs is expected. Some new reactors may be designed to have no radiological effluent releases and very small quantities of onsite solid radioactive waste. Other new reactors, such as liquid-fueled molten-salt reactors, may have industrial processes for removing fission products from the nuclear fuel as part of their normal operating procedures with accompanying releases of noble and volatile radioactive gases, and liquid waste from processing stream(s). This would necessitate an appropriately designed and approved 10 CFR Part 50 (TN249) or Part 52 (TN251) radioactive waste management system and an associated processing and storage facility to support plant operations. It is also expected that the various new reactor designs with

lower power levels and inherent design features, while satisfying the regulatory limits for effluent releases of 10 CFR Part 20 (TN283), would not necessarily have the same level of effluent releases as the LWRs previously assessed in the new reactor ESP and COL EISs. Thus, based on the assumption that new reactors will meet regulatory effluent release limits, the previous new reactor environmental impacts for LWRs would provide bounding impacts for new reactors with radioactive waste streams leading to offsite doses.

Occupational Doses to Workers

The licensee of a new plant would need to maintain individual doses to workers to within 5 rem annually as specified in 10 CFR 20.1201 (TN283) and incorporate provisions to maintain doses ALARA. Section 3.9.1.2, "Occupational Radiological Exposures," of Revision 2 to NUREG-1437 (NRC 2024-TN10161) provides a detailed analysis of occupational doses to workers at LWR nuclear power plants. This analysis shows improvements have been implemented over the years of operational experience to reduce occupational doses to workers and that the average annual doses are well within regulatory limits, and Revision 2 to NUREG-1437 (NRC 2024-TN10161) is incorporated by reference.

New reactor applicants' radiation protection programs should be able to build upon and apply the lessons learned through LWR operational experience to maintain their workers' occupational doses well below regulatory limits and would ensure that occupational exposures are maintained ALARA. In addition, new reactor applicants could establish plans for worker training, monitoring, and radiation safety programs.

The staff concludes that the health impacts from occupational radiation exposure would be SMALL based on individual worker doses being maintained within 10 CFR 20.1201 (TN283) limits and collective occupational doses for new reactors should be in line with the radiation protection practices at current operating LWRs. Additional mitigation would not be warranted because the operating plant would be required to maintain doses ALARA. This is a Category 1 issue. The staff relied on the following PPE assumptions to reach this conclusion:

- For protection against radiation, the applicant must meet the regulatory requirements of:
  - 10 CFR 20.1101 Radiation Protection Programs (10 CFR Part 20-TN283) if issued a license
  - 10 CFR 20.1201 Occupational dose limits for adults
  - Appendix B of 10 CFR Part 20 Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage
  - 10 CFR 50.34a (10 CFR Part 50-TN249) Design objectives for equipment to control releases of radioactive material in effluents—nuclear power reactors
  - 10 CFR 50.36a Technical specifications on effluents from nuclear power reactors.
- Application contains sufficient technical information for the staff to complete the detailed technical safety review.
- Application will be found to be in compliance by the staff with the above regulations through a radiation protection program and an effluent release monitoring program.

Maximally Exposed Individual Annual Doses

Prior new reactor EISs have assessed the total dose to the MEI as part of meeting the requirements of the 10 CFR Part 20 (TN283) based on the methodology provided in RG 1.109, *Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I* (NRC 1977-TN90). The MEI total dose is usually assessed from the nuclear power plant to the nearest resident assuming all appropriate exposure pathways are at that location. This assumption provides for a conservative or bounding analysis for demonstrating compliance with regulatory dose limits. Prior LWR new reactor ESP and COL MEI annual doses are provided in Table 3-4 along with two non-LWRs, namely the Kairos Hermes test reactor and the Abilene Christian University Molten Salt Research Reactor. The table demonstrates that the MEI annual dose assessed not only met the regulatory limit of 100 mrem/yr in 10 CFR 20.1301(a) (TN283) but also met the lower regulatory limits in 40 CFR Part 190 (TN739), which is incorporated into NRC regulations under 10 CFR 20.1301(e) (TN283), even for sites with co-located nuclear power plants.

Table 3-4 Maximally Exposed Individual Doses[a]

Site Name	Total Body (mrem/yr)[b]	Thyroid (mrem/yr)	Organ (mrem/yr)
Clinton Exelon ESP (NRC 2006-TN672)	3.21	9.47	5.04
Grand Gulf ESP (NRC 2006-TN674)	8.9	17.0	21.0
North Anna Power Station Unit 3 ESP (NRC 2010-TN6)	6.9	18.0	14.0
Calvert Cliffs Unit 3 COL (NRC 2011-TN1980)	0.458	0.88	1.3
South Texas Units 3 and 4 COL (NRC 2011-TN1722)	5.71	4.55	1.94
Virgil C. Summer Units 2 and 3 COL (NRC 2011-TN1723)	2.2	14.0	3.5
Levy Units 1 and 2 COL (NRC 2012-TN1976)	5.5	12.9	19.5
Comanche Peak Units 3 and 4 COL (NRC 2011-TN6437)	3.7	3.1	7.8
Vogtle Units 3 and 4 ESP (NRC 2011-TN6439)	2.36	12.39	8.88
Enrico Fermi Unit 3 COL (NRC 2013-TN6436)	5.66	13.99	2.32
William States Lee Units 1 and 2 COL (NRC 2013-TN6435)	3.74	20.0	9.05
PSEG ESP (NRC 2015-TN6438)	2.94	6.86	3.97
Turkey Point Units 6 and 7 COL (NRC 2016-TN6434)	7.8	15.0	8.4
Bell Bend COL (NRC and USACE 2016-TN6562)	4.52	6.80	7.32
Clinch River ESP (NRC 2019-TN6136)	11	25.0	24.0
Kairos Hermes CP (NRC 2023-TN9771)	2.4	1.7	1.5
Abilene Christian University Molten Salt Research Reactor CP (NRC 2024-TN10337)	<0.5	-	-

COL = combined license; CP = construction permit; ESP = early site permit; PSEG = Public Service Enterprise Group.

(a) 40 CFR 190.10 (a) (TN739) states "the annual dose equivalent does not exceed 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public as the result of exposures to planned discharges of radioactive materials, radon and its daughters excepted, to the general environment from uranium fuel cycle operations and to radiation from these operations."

(b) These values meet the restrictions stated in 40 CFR 190 (a) (TN739) as well as the restrictions in 10 CFR 20.1301(a)(1) (TN283) Dose Limits.

A new reactor applicant must provide the necessary information on the docket for the staff to reach a regulatory finding that the regulatory requirements have been met, such as annual dose limits to members of the public provided in 10 CFR 20.1301 (TN283). Additionally, 10 CFR

Parts20 (TN283) and 50 (TN249) require that a REMP be established to provide data about measurable levels of radiation and radioactive materials in the site environs. Licensees would rely on the REMP or a similar program to satisfy the requirements of Criterion 64, "Monitoring Radioactivity Releases," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, *Domestic Licensing of Production and Utilization Facilities* (NRC 2016-TN6463) or applicant-developed plant-specific Principal Design Criteria for non-LWRs (NRC 2018-TN7066). Therefore, the environmental impacts on the MEI are expected to be SMALL where new reactor applicants demonstrate in their application that any radiological effluent releases and annual doses would be within regulatory limits, or where the staff during their safety review finds the applicant would be in compliance with the applicable 10 CFR Part 20 regulations. This is a Category 1 issue. The staff relied on the following PPE assumptions to reach this conclusion:

- For protection against radiation, the applicant must meet the regulatory requirements of:
  - 10 CFR 20.1101 Radiation Protection Programs (10 CFR Part 20-TN283) if issued a license
  - 10 CFR 20.1301 Dose limits for individual members of the public
  - Appendix B of 10 CFR Part 20 Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage
  - 10 CFR 50.34a (10 CFR Part 50-TN249) Design objectives for equipment to control releases of radioactive material in effluents—nuclear power reactors
  - 10 CFR 50.36a Technical specifications on effluents from nuclear power reactors.
- Application contains sufficient technical information for the staff to complete the detailed technical safety review.
- Application will be found to be in compliance by the staff with the above regulations through a radiation protection program and an effluent release monitoring program.

Total Population Annual Doses

If there are radiological effluent releases, they will move beyond the site into the surrounding area exposing the surrounding population, and the impacts from such releases need to be assessed under NRC's NEPA obligations. For the past new reactor ESP and COL application reviews, this analysis of total population doses was provided using the NRCDose code, which was also applied as part of the safety analysis and was evaluated out to a distance of 80 km (50 mi). These total population dose results from the various ESPs and COLs approved by the NRC are provided in Table 3-5. As part of these reviews, the staff compared the total population dose associated with the licensing action to the collective dose from natural background radiation based on an average annual individual natural background dose of 310 mrem/yr. The results from the various ESP and COL radiological assessments show that the surrounding population would receive a very small fraction of what would be expected from natural background.

Both the NCRP and the International Council on Radiation Protection and Measurements (ICRP) suggest that when the collective effective dose is smaller than the reciprocal of the relevant risk detriment (i.e., less than 1/0.00057, which is less than 1,754 person-rem), the assessment should find that the most likely number of excess health effects is zero (NCRP 1995-TN728; ICRP 2007-TN422). As noted above, all of the ESP and COL total population

doses are significantly less than the 1,754 person-rem value that both ICRP and NCRP suggest would most likely result in zero excess health effects (NCRP 1995-TN728; ICRP 2007-TN422).

Table 3-5 Total Population and Collective Natural Background Doses in 50 mi Radius[(a)]

Site Name	50 mi Population	50 mi Population Collective Dose (person-rem/yr)	Collective Dose from Natural Background Radiation (person-rem/yr)
Clinton Exelon ESP (NRC 2006-TN672)	800,000	1.83	230,000
Grand Gulf ESP (NRC 2006-TN674)	332,369	3.20	102,000
North Anna Power Station Unit 3 ESP (NRC 2010-TN6)	2,800,000	8.70	840,000
Calvert Cliffs Unit 3 COL (NRC 2011-TN1980)	6,418,570	3.9	2,000,000
South Texas Units 3 and 4 COL (NRC 2011-TN1722)	514,000	0.58	160,000
Virgil C. Summer Units 2 and 3 COL (NRC 2011-TN1723)	2,131,394	34.50	663,000
Levy Units 1 and 2 COL (NRC 2012-TN1976)	1,440,000	13.8[(a)]	520,000
Comanche Peak Units 3 and 4 COL (NRC 2011-TN6437)	3,490,000	8.00	985,000
Vogtle Units 3 and 4 ESP (NRC 2011-TN6439)	674,101	1.84	243,000
Enrico Fermi Unit 3 COL (NRC 2013-TN6436)	7,710,000	21.60	2,400,000
William States Lee Units 1 and 2 COL (NRC 2013-TN6435)	4,195,000	10.6	1,305,000
PSEG ESP (NRC 2015-TN6438)	8,138,635	65.90	2,531,000
Turkey Point Units 6 and 7 COL (NRC 2016-TN6434)	7,500,000	8.00	2,500,000
Bell Bend COL (NRC and USACE 2016-TN6562)	2,640,368	8.54	821,154
Clinch River ESP (NRC 2019-TN6136)	2,658,157	68.00	830,000

COL = combined license; ESP = early site permit; PSEG = Public Service Enterprise Group.
(a) The 50 mi population collective dose for one unit was multiplied by 2 to account for a two-unit site.

The combination of these radiological impacts demonstrates a low MEI dose correlates to a small total population dose, even out to 80 km (50 mi.), where zero excess health effect in the general population would be expected. Therefore, the environmental impacts on the surrounding population are expected to be SMALL where new reactor applicants demonstrate in their application that any radiological effluent releases and annual doses to the population would be within regulatory limits of 10 CFR Part 20 (TN283). This is a Category 1 issue. The staff relied on the following PPE assumptions to reach this conclusion:

- For protection against radiation, the applicant must meet the regulatory requirements of:
  - 10 CFR 20.1101 Radiation Protection Programs (10 CFR Part 20-TN283) if issued a license
  - 10 CFR 20.1301 Dose limits for individual members of the public
  - Appendix B of 10 CFR Part 20 Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage
  - 10 CFR 50.34a (10 CFR Part 50-TN249) Design objectives for equipment to control releases of radioactive material in effluents—nuclear power reactors
  - 10 CFR 50.36a Technical specifications on effluents from nuclear power reactors.

- Application contains sufficient technical information for the staff to complete the detailed technical safety review.

Application will be found to be in compliance by the staff with the above regulations through a radiation protection program and an effluent release monitoring program.

Nonhuman Biota Doses

The Commission position on nonhuman biota doses is that the current set of radiation protection controls is protective of the environment. Therefore, the NRC radiation protection regulations, by protecting members of the public, also protect nonhuman biota and there is no need to have separate radiation protection regulations for plant and animal species (SECY-04-0223 [NRC 2004-TN6431], SECY-06-0168 [NRC 2006-TN6430], SECY-08-0197 [NRC 2008-TN6432], SECY-04-0055 [NRC 2004-TN7100], and related Staff Requirements Memorandums SRM-SECY-04-0223 [NRC 2005-TN6649], SRM-SECY-06-0168 [NRC 2005-TN6650], SRM-SECY-08-0197 [NRC 2009-TN6651]), SRM-SECY-04-0055 [NRC 2004-TN7101]. The IAEA (1992-TN712) and the NCRP (1991-TN729) report that a chronic dose rate of no greater than 10 milligrays/day (mGy/d) (1,000 millirads/day [mrad/d]) to the MEI in a population of aquatic organisms would ensure protection of the population. The IAEA (IAEA 1992-TN712) also concluded that chronic dose rates of 1 mGy/d (100 mrad/d) or less do not appear to cause observable changes in terrestrial animal populations. These two guidelines (1,000 mrad/d for aquatic biota, 100 mrad/d for terrestrial biota) have been applied in various NRC environmental reviews. For example, the impact of radionuclides on aquatic organisms has been raised as an issue by the public for several of the nuclear plants that have undergone license renewal. The LR GEIS (NRC 2024-TN10161) concludes that the impact of routine radionuclide releases from past and current operations on aquatic and terrestrial biota would be SMALL for all nuclear plants and would not be expected to appreciably change during the renewal period.

Nonhuman biota doses have also been assessed in the new reactor ESP and COL FEISs. The results from the new reactor reviews for the seven surrogate species (three aquatic species and four terrestrial species analyzed within the NRCDose code) are shown in Table 3-6 and Table 3-7. These tables clearly show the absorbed dose rates for all surrogate species were much lower than the IAEA and NCRP guidelines (IAEA 1992-TN712; NCRP 1991-TN729). Thus, the conclusion in all of the new reactor environmental reviews was the radiological impact on nonhuman biota from a new nuclear power plant at the selected site would be SMALL. Therefore, the environmental impacts on nonhuman biota are expected to be SMALL where new reactor applicants demonstrate in their application that any radiological effluent releases and annual doses would be within regulatory limits. This is a Category 1 issue. The staff relied on the following PPE assumption to reach this conclusion:

- Applicants would demonstrate in their application that any radiological nonhuman biota doses would be below IAEA (1992-TN712) and NCRP (1991-TN729) guidelines.

Table 3-6 Aquatic Nonhuman Biota Doses[a]

Site Name	Fish (mrad/d)	Invertebrate (mrad/d)	Algae (mrad/d)
Clinton Exelon ESP (NRC 2006-TN672)	0.0171	0.0376	0.0762
Grand Gulf ESP (NRC 2006-TN674)	0.068[b]	0.452[b]	0.405[b]
North Anna Power Station Unit 3 ESP (NRC 2010-TN6)	0.009[b]	0.033[b]	0.047[b]
Calvert Cliffs Unit 3 COL (NRC 2011-TN1980)	0.00077	0.0064	0.015
South Texas Units 3 and 4 COL (NRC 2011-TN1722)	0.0068	0.015	0.0015
Virgil C. Summer Units 2 and 3 COL (NRC 2011-TN1723)	0.0022	0.0063	0.018
Levy Units 1 and 2 COL (NRC 2012-TN1976)	0.01	0.02	0.03
Comanche Peak Units 3 and 4 COL (NRC 2011-TN6437)	0.052	0.088	0.11
Vogtle Units 3 and 4 ESP (NRC 2011-TN6439)	0.00044[c]	0.0012[c]	0.0036[c]
Enrico Fermi Unit 3 COL (NRC 2013-TN6436)	0.0063	0.021	0.033
William States Lee Units 1 and 2 COL (NRC 2013-TN6435)	0.0016	0.0044	0.013
PSEG ESP (NRC 2015-TN6438)	0.0045	0.0161	0.0225
Turkey Point Units 6 and 7 COL (NRC 2016-TN6434)	0.00	0.00	0.00
Bell Bend COL (NRC and USACE 2016-TN6562)	0.00052	0.0018	0.0058
Clinch River ESP (NRC 2019-TN6136)	0.0045	0.021	0.0067

COL = combined license; ESP = early site permit; PSEG = Public Service Enterprise Group.
(a) The IAEA and NCRP reported a chronic absorbed dose rate of no greater than 1,000 mrad/d would ensure protection of aquatic organism populations (IAEA 1992-TN712; NCRP 1991-TN729).
(b) Dose converted from mGy/yr to mrad/d.
(c) Dose converted from mGy/d to mrad/d.

Table 3-7 Terrestrial Nonhuman Biota Doses[a]

Site Name	Muskrat (mrad/d)	Raccoon (mrad/d)	Heron (mrad/d)	Duck (mrad/d)
Clinton Exelon ESP (NRC 2006-TN672)	0.0471	0.0222	0.191	0.0470
Grand Gulf ESP (NRC 2006-TN674)	0.227[b]	0.058[b]	0.534[b]	0.227[b]
North Anna Power Station Unit 3 ESP (NRC 2010-TN6)	0.112[b]	0.056[b]	0.082[b]	0.112[b]
Calvert Cliffs Unit 3 COL (NRC 2011-TN1980)	0.0038	0.00075	0.0011	0.0038
South Texas Units 3 and 4 COL (NRC 2011-TN1722)	0.03	0.031	0.03	0.036
Virgil C. Summer Units 2 and 3 COL (NRC 2011-TN1723)	0.020	0.023	0.044	0.027
Levy Units 1 and 2 COL (NRC 2012-TN1976)	0.02	0.01	0.01	0.02
Comanche Peak Units 3 and 4 COL (NRC 2011-TN6437)	0.19	0.060	0.55	0.19
Vogtle Units 3 and 4 ESP (NRC 2011-TN6439)	0.0055[c]	0.0066[c]	0.01[c]	0.0071[c]
Enrico Fermi Unit 3 COL (NRC 2013-TN6436)	0.071	0.032	0.049	0.071
William States Lee Units 1 and 2 COL (NRC 2013-TN6435)	0.016	0.011	0.030	0.015
PSEG ESP (NRC 2015-TN6438)	0.0199	0.0170	0.0203	0.0206
Turkey Point Units 6 and 7 COL (NRC 2016-TN6434)	0.14	0.14	0.14	0.14
Bell Bend COL (NRC and USACE 2016-TN6562)	0.010	0.0090	0.013	0.010
Clinch River ESP (NRC 2019-TN6136)	0.24	0.23	0.25	0.24

COL = combined license; ESP = early site permit; PSEG = Public Service Enterprise Group.
(a) The IAEA concluded that a chronic absorbed dose rate of 100 mrad/d or less does not appear to cause observable changes in terrestrial animal populations (IAEA 1992-TN712).
(b) Dose converted from mGy/yr to mrad/d.
(c) Dose converted from mGy/d to mrad/d.

3.8.2 Nonradiological Environment

3.8.2.1 Baseline Conditions and PPE/SPE Values and Assumptions

Baseline conditions influencing potential public and occupational health impacts associated with the building and operation of a new reactor include consideration of nonradiological chemical hazards, biological hazards, EMFs, the distance to receptors (occupational workers or a member of the public), the number of people potentially exposed, and other industrial physical concerns, such as falls, burns from high temperature, shock, or asphyxiation. Relevant public and occupational health conditions involve not only industrial processes at the plant itself, but also consider other sources of public and occupational exposure, such a neighboring chemical facilities and current road conditions. Section 3.3 includes information about air quality. Section 3.4 includes information about water resources. Section 3.9 includes information about noise. Section 3.11 includes information about postulated accidents. Section 3.12 includes information about traffic impacts. Section 3.15 includes information about transportation of fuel and waste, while Section 3.10 includes information about waste impacts. The overall well-being of these resource areas is important to maintaining the quality of public and occupational health.

The assumption of the PPE/SPE developed for this GEIS is that the applicant must adhere to applicable Federal, State, local and tribal public and occupational health regulatory limits and BMPs regarding chemical hazards, biological hazards, EMFs, and physical hazards.

3.8.2.1.1 Chemical Hazards

A chemical hazard occurs when workers or members of the public are exposed to a nonradiological hazardous substance by inhalation, skin absorption, or ingestion. Chemical hazards can have immediate effects (nausea, vomiting, acid burns, asphyxiation—also known as acute hazards) or the effects might take time to develop (dermatitis, asthma, liver damage, cancer—also known as chronic hazards). Figure 3-2 shows the exposure pathways for radiological hazards to humans. Those same exposure pathways also apply to nonradiological chemical hazards to humans.

For large LWRs, there are multiple pathways by which humans can be exposed to pollutants from a plant. For example, a direct pathway would be a human breathing in a gaseous effluent or swimming in water that was contaminated by a liquid effluent. An indirect pathway would be a human eating a fish that had absorbed a pollutant into its body or eating crops that had been irrigated with water contaminated by a liquid effluent. One advantage of a new reactor is that pathways for exposure could be limited based on the design.

The Occupational Safety and Health Administration is responsible for developing and enforcing workplace safety regulations. Congress created the Occupational Safety and Health Administration by enacting the Occupational Safety and Health Act of 1970, as amended (29 U.S.C. 651 et seq.) to safeguard the health of workers. Nuclear power plant conditions that result in an occupational risk, but do not affect the safety of licensed radioactive materials, are under the statutory authority of the Occupational Safety and Health Administration rather than the NRC as set forth in a memorandum of understanding (NRC 2013-TN10165) between the two agencies. The Occupational Safety and Health Administration rather than the NRC as set forth in a memorandum of understanding (NRC 2013-TN10165) between the two agencies. The Occupational Safety and Health Administration sets enforceable permissible exposure limits for about 500 hazardous chemicals to protect workers against the health effects of exposure to hazardous substances, including limits on the airborne concentrations of hazardous chemicals

in the air and skin contact. Most permissible exposure limits are 8-hour time-weighted averages, although there are also ceiling and peak limits. Regulatory limits for chemical hazards are found in 29 CFR Part 1910 (TN654).

The EPA is responsible for the regulation of most chemicals that can enter the environment through the following Federal Acts: the Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. §§ 136 et seq.; TN4535); Toxic Substances Control Act (15 U.S.C. §§ 2601 et seq.; TN4454); RCRA (42 U.S.C. §§ 6901 et seq.; TN1281); Clean Water Act (codified as the Federal Water Pollution Control Act of 1972; 33 U.S.C. §§ 1251 et seq.; TN662); SDWA (42 U.S.C. §§ 300f et seq.; TN1337); Clean Air Act (42 U.S.C. §§ 7401 et seq.; TN1141); and the Comprehensive Environmental Response Compensation and Liability Act (42 U.S.C. §§ 9601 et seq.; TN6592). Discharged biocides, liquid wastes, chemicals, and heavy metals are regulated by the NPDES permitting system.

3.8.2.1.2 Biological Hazards

Biological hazards are organic substances that pose a threat to the health of humans and other organisms. Biological hazards include pathogenic microorganisms, insects, animals, viruses, toxins, spores, and fungi. Biological hazards, such as mosquitos, bees, and ticks could be present at any industrial site, either while building the facility itself or while the facility is in operation. Microbiological hazards occur when workers or members of the public come into contact with disease-causing microorganisms, also referred to as etiological agents. Examples of etiological agents are Salmonella spp., Shigella spp., Legionella spp., Pseudomonas aeruginosa, or thermophilic fungi. The 2013 and 2024 LR GEIS (NRC 2013-TN2654, NRC 2024-TN10161) provide further background information about microorganisms of concern at large LWRs and a description of studies of microorganisms in cooling towers.

3.8.2.1.3 Electromagnetic Fields

An EMF is caused by a combination of electric and magnetic fields of force or moving electric charges. The strength of the EMF will increase with an increase in voltage. EMFs are generated by natural phenomena (for example the Earth's magnetic field) or any electrical equipment (WHO 2020-TN6561). There are no U.S. Federal standards limiting residential or occupational exposure to EMFs from power lines, but some States, such as Florida, Minnesota, Montana, New Jersey, New York, and Oregon, have set electric field and magnetic field standards for transmission lines (NIEHS 2002-TN6560). EMFs resulting from a 60 Hz power transmission line falls under the category of non-ionizing radiation. A voluntary occupational standard has been set for EMFs by the International Commission on Non-Ionizing Radiation Protection. For occupational workers who are exposed to 60 Hz (power lines), the electric field standard is 8.3 kV/m and the magnetic field standard is 4,200 milligauss, while for the general public who are exposed to 60 Hz, the electrical field standard is 4.2 kV/m and the magnetic field standard is 833 milligauss (ICNIRP 1998-TN6591). The National Institute of Occupational Safety and Health does not consider EMFs to be a proven health hazard (NIOSH 1996-TN6766). NUREG-1437, Volume 1 (NRC 2024-TN10161), provides further background information about EMFs at large LWRs.

In 1996, the World Health Organization began a multidisciplinary research study regarding the possible health effects from exposure to EMF sources (WHO 2020-TN6561) and concluded current evidence does not support the existence of any health consequences from exposure to low-level EMFs. Two additional reports, one from the U.S. National Academy of Science

(National Research Council 1997-TN6595), and another from the National Institute of Environmental Health Sciences, concluded similar findings (NIEHS 2002-TN6560).

3.8.2.1.4 Physical Hazards

A physical hazard is an action, agent, or condition that can cause harm upon contact. Physical hazards include actions such as slips, trips, and falls. Physical hazards from agents include noise (see Section 3.9), shock, vibration, ionizing radiation, and ergonomic factors from heavy lifting and repetitive motion. Physical conditions could include high heat, cold, pressure, or confined space. A new reactor is an industrial facility and will have many of the typical occupational hazards found at other electric power generation utilities. Physical hazards such as ladder safety, fall protection, noise exposure, non-ionizing radiation, and personal protective equipment are regulated by 29 CFR Part 1910 (TN654).

If a new reactor were to be a power-producing facility, transmission lines to support the power grid would be necessary. Occupational workers and members of the public could be exposed to acute electric shock from transmission lines or electrical equipment needed to support the facility. Secondary shock currents are also produced when humans make contact with (1) capacitively charged bodies, such as a vehicle parked near a transmission line, or (2) magnetically linked metallic structures, such as fences near transmission lines. The National Electrical Safety Code contains the basic provisions that are considered necessary for the safety of employees and the public under specific conditions. 29 CFR 1926 Subpart V (TN4455) contains safety regulations related to electrical power transmission and distribution. NUREG-1437, Volume 1 (NRC 2024-TN10161), provides further information about electric shock.

3.8.2.2 Nonradiological Environment Impacts

The NRC has assessed the impacts on nonradiological public and occupational health from the existing operating reactor fleet during license renewal assessments and from proposed new reactors as part of the COL and ESP process under 10 CFR Part 52 (TN251). Impacts on nonradiological public and occupational health from the continued operation and refurbishment of typical large LWRs in the existing U.S. fleet are evaluated in the LR GEIS (NRC 2024-TN10161). Impacts from the building and operation of new reactors have been evaluated in several EISs. The NRC staff assumes that the impacts on nonradiological public and occupational health from the construction and operation of new reactors would generally be bounded by the large LWRs.

3.8.2.2.1 Environmental Consequences of Construction

The NRC staff identified two environmental issues:

- building impacts of chemical, biological, and physical nonradiological hazards, and
- building impacts of EMFs.

The primary impacts of constructing a new reactor on nonradiological public and occupational health would be from building activities. Potential occupational worker impacts would come from chemical hazards, biological hazards, EMFs, and physical hazards typical of large-scale building construction. This would include exposure to the following:

- equipment engine exhaust

- heavy metals in solder or welding fumes
- solvent vapors
- fugitive dust
- plant toxins, insects, and other biological hazards
- vibration
- slips, trips, falls from scaffolding
- heat or cold stress, burns, frost-bite
- noise (see Section 3.9 regarding information about this subject)
- heat stress
- non-ionizing radiation from welding
- shock from electrical equipment
- repetitive motion (ergonomic concerns), strains, and sprains
- traffic-related impacts from construction worker and supply transportation (see Section 3.12 regarding information about this subject).

Building Impacts of Chemical, Biological, and Physical Nonradiological Hazards

Chemical exposure would exist in the form of dust, fumes, fibers (solids), liquids, mists, gases, or vapors. Examples of chemical hazards found in construction work could include lead, silica, cadmium, carbon monoxide, oxides of nitrogen, VOCs, welding fumes, spray paints, cutting oil mists, solvents, and hexavalent chromium. Fugitive emissions of dust in particular would be generated during windy periods, earthmoving, and movement of vehicular traffic over recently disturbed areas. Exposure to plant and insect toxins could occur during earthmoving activities. Physical impacts common to any large-scale industrial project would also occur.

Potential impacts on members of the public during building would be from chemical hazards and physical hazards typical of large-scale building construction. This would include exposure to some of the hazards that occupational workers would face, such as equipment engine exhaust, fugitive dust, vibration, noise, and traffic-related impacts from construction worker and supply transportation. Members of the public could be exposed to building impacts due to the proximity of their house, work, school, recreational site, or via a water source. Applicable liquid and air permits and regulations would also regulate impacts on members of the public, similar to the regulation for occupational workers.

Occupational and public health mitigation measures that may be used to reduce potential impacts during building, include phasing activities and equipment use; BMPs such as proper equipment maintenance and use; and watering and stabilizing roads and spoils.

Building activities are typically subject to air permits under State and Federal laws to address impacts of air emissions on any local sensitive receptors. Mitigation could also consist of providing administrative and engineering design features, such as dikes around large liquid chemical tanks.

The staff has determined that nonradiological public and occupational health impacts associated with chemical, biological, and physical hazards during construction of a new reactor are a

Category 1 issue. The staff concluded that as long as the applicable PPE and SPE values and assumptions are met, the nonradiological public and occupational health impact from building a new reactor can be generically determined to be SMALL. Any planned exposure or release over the regulatory limit would require project-specific analysis. The staff relied on the following PPE values and assumptions to reach this conclusion:

- The applicant must adhere to all applicable Federal, State, local or Tribal regulatory limits and permit conditions for chemical hazards, biological hazards, and physical hazards.
- The applicant will follow nonradiological public and occupational health BMPs and mitigation measures, as appropriate.

Building Impacts of EMFs

Occupational workers would be exposed to EMFs during the use of any electronic tool or equipment. However, the staff has determined that nonradiological public and occupational health impacts from EMFs during construction are uncertain.

Studies of 60 Hz EMFs have not uncovered consistent evidence linking harmful effects with field exposures. Because the state of the science is currently uncertain, no generic conclusion on human health impacts is possible. If, in the future, the Commission finds scientific information sufficient to draw conclusions about potential human health impacts, the Commission may require applicants to submit plant-specific reviews of these health effects as part of their application. Until such time, applicants are not required to submit information about this issue.

3.8.2.2.2 Environmental Consequences of Operation

The NRC staff identified two environmental issues:

- operation impacts of chemical, biological, and physical nonradiological hazards, and
- operation impacts of EMFs.

The primary impacts of operating a new reactor on nonradiological public and occupational health would be from chemical hazards, biological hazards, EMFs, and physical hazards. Hazards present during operation for occupational workers would be the same as those listed for construction.

Operation Impacts of Chemical, Biological, and Physical Nonradiological Hazards

For new reactors, operations-related chemical hazards could result from the releases of liquid effluents or gaseous emissions from industrial operations, sanitary discharges, leaching of heavy metals from tanks or pipes, and improper storage or handling of chemicals. Various reactor operational systems may require treatment using chemicals or biocides to avoid scaling. The rate of flow into water systems would be managed, while facility discharges that may contain low-level concentrations of chemicals or biocides, would be managed through engineering and administrative controls necessary to maintain requirements of an NPDES permit or other standards. Industrial processes at a new reactor could also use backup diesel generators, boilers, cooling condensers, or cooling towers. Impacts on occupational workers can result from operations of engine-driven equipment, although these types of operations may be reduced, limited, or not present for some new reactor designs. The regulations in 10 CFR Part 50 (TN249) dictate that safety-related diesel generators and other emission-releasing equipment be tested throughout the year for various durations. Diesel generators that function

as standby equipment would also typically be tested throughout the year for various durations. Primary cooling systems, operation of process equipment, mobile emissions, and emergency power supply systems would all release either a liquid effluent or gaseous emission. Emissions could include nitrogen oxide, carbon monoxide, sulfur dioxide, VOCs, and particulate matter, depending upon the plant design. Additionally, new reactors would either have a stand-alone sanitary system or connect to a municipal sanitary system.

Chemical effects could also be caused by the improper storage or handling of chemicals or waste. For example, improper storage of acids and bases, chemicals commonly used in onsite laboratories for testing of effluents, could cause an explosion. In addition, there could be impacts from accidental chemical spills either in the laboratory or when chemistries of the primary and secondary coolant systems are being adjusted, if multiple coolant systems are part of the reactor design.

Occupational workers would be exposed to biological hazards at a new reactor, as workers at any industrial facility would be. The staff assumes the applicant to employ industry BMPs to minimize biological hazards to occupational workers.

Conditions at cooling towers, spent fuel pools, and other thermal discharges could provide ideal living conditions for etiological agents unless those conditions are managed properly. Occupational workers could come into contact with microbiological hazards when cleaning condenser tubes or cooling towers. Management of microbiological hazards could include the use of engineering and administrative controls, such as PPE. NUREG-1437, Volume 1, provides an impact description of microorganisms of concern at large LWRs (NRC 2024-TN10161). The impacts of microbiological hazards would be expected to be similar at a new reactor if the reactor design operates with similar conditions (cooling ponds, lakes, canals or discharge to a river). However, the NRC staff assumes that some new reactor designs will minimize the use of cooling ponds, lakes, canals or discharges to rivers and will adhere to a NPDES permit.

Physical hazards from actions such as slips, trips, falls from ladders, forklift operation, burns from high temperatures, and electrical shock would be present for occupational workers. Physical agents, such as noise (see Section 3.9), vibration, and ionizing radiation, and ergonomic factors from heavy lifting and repetitive motion would also be expected. Occupational workers could face potentially hazardous physical conditions, such as high heat, cold, pressure, or performing work in confined spaces or using electrical equipment. Regulations in 29 CFR Part 1910 (TN654) have been set in place to minimize physical hazards. The staff assumes BMPs will be put in place by the applicant, and that the applicant will adhere to the regulations in 29 CFR Part 1910 for nonradiological occupational health.

Potential impacts on members of the public during operation from chemical hazards, biological hazards, and physical hazards at a new reactor would be those typical of large LWRs and electric power generating facilities. Hazards present during operation for members of the public are the same as those listed for building, with the addition of planned or accidental chemical releases from industrial processes.

Members of the public could be exposed to operation impacts due to the proximity of their house, work, school, recreational site, or via a water source. Applicable liquid and air permits and regulations would also regulate impacts on members of the public, similar to the regulation for occupational workers. The staff assumes that proper emergency management procedures will be put in place.

Members of the public could come into contact with microbiological hazards if in contact with a water body that receives runoff or discharge from a new reactor or air deposition from gaseous releases. Changes in microbial populations and in the public use of water bodies might be caused by the operation of a new reactor that uses water as a coolant or a moderator. The staff assumes an applicant would use advanced system designs, distance, dilution, and security measures to minimize microbiological hazards to the public and adhere to NPDES permit limitations.

The scope of the transmission line review is from the plant to the first interconnecting point or points on the existing high-voltage transmission system (NRC 2000-TN3549). The greatest hazard from a transmission line is direct contact with the conductors. There is a potential for members of the public to be exposed to acute electrical shock from these lines. The issue of electrical shock is generic to all electrical power plants. Tower designs preclude direct public access to the conductors. However, electrical contact can be made without physical contact between a grounded object and the conductor. A person who contacts a metallic structure or a charged object could receive a secondary shock and experience a painful sensation at the point of contact. The staff assumes the applicant would construct and operate transmission lines in adherence with the National Electrical Safety Code criteria (IEEE 2023-TN10132).

Occupational and public health mitigation measures that may be used to reduce potential impacts during operation, include adherence to industrial hygiene and safety practices and locating noisy equipment away from sensitive receptors.

The staff has determined that the impacts of nonradiological public and occupational health impacts associated with chemical, biological, and physical hazards during operation is a Category 1 issue. The staff concluded that as long as the applicable PPE and SPE values and assumptions are met, the nonradiological public and occupational health impact from operating a new reactor can be generically determined to be SMALL. Any planned exposure or release over the regulatory limit would require project-specific analysis. The staff relied on the following PPE values and assumptions to reach this conclusion:

- The applicant must adhere to all applicable Federal, State, local or Tribal regulatory limits and permit conditions for chemical hazards, biological hazards, and physical hazards.
- The applicant will follow nonradiological public and occupational health BMPs and mitigation measures, as appropriate.

Operation Impacts of EMFs

Occupational workers would be expected to be exposed to low-frequency EMFs at a new reactor if the primary purpose of the facility is to produce electrical power and electrical equipment would be present. The median magnetic field measurement during a workday for a distribution substation worker at an electric utility is 7.2 milligauss (NIEHS 2002-TN6560). The staff assumes that occupational workers at a new reactor would experience similar fields. Distance and shielding have been shown to be effective mitigation tools for EMFs. Members of the public could also be exposed to EMFs from powerlines associated with the reactor. However, the staff has determined that nonradiological public and occupational health impacts from EMFs during operation are uncertain.

Studies of 60 Hz EMFs have not uncovered consistent evidence linking harmful effects with field exposures. Because the state of the science is currently uncertain, no generic conclusion on human health impacts is possible. If, in the future, the Commission finds scientific information

sufficient to draw conclusions about potential human health impacts, the Commission may require applicants to submit plant-specific reviews of these health effects as part of their application. Until such time, applicants are not required to submit information on this issue.

3.9 Noise

This section describes the baseline conditions, PPE/SPE values, and environmental consequences associated with noise, as heard by humans. Wildlife-related noise impacts are described in Section 3.5.

3.9.1 Baseline Conditions and PPE/SPE Values and Assumptions

Noise levels associated with the building and operation of a new reactor (and associated transmission line ROWs) that may influence human health include the volume and duration of the noise, the distance to receptors (where dwelling units or other sites of frequent human use exist), and landscape characteristics such as topography and foliage. Noise from nuclear plant building and operations can often be detected offsite relatively close to the plant site boundary. Major sources of noise during building include earthmoving activities and building of safety- and non-safety-related facilities. Major sources of noise at operating nuclear power plants are cooling towers, turbines, transformers, large pumps, and cooling-water system motors.

Sound pressure levels are typically measured by using the logarithmic decibel scale. To assess potential noise impacts on humans, a special weighting scale was developed to account for human sensitivities to certain frequencies and duration of sounds. The dBA is widely used in environmental noise assessments because it correlates well with a human's subjective reaction to sound (Cowan 1994-TN3905).

U.S. Department of Housing and Urban Development regulations for exterior noise standards (24 CFR 51.101(a)(8); TN1016), Section 5.3.4 of NUREG-1555 (NRC 2000-TN614) states noise levels are acceptable (i.e., SMALL) if the day-night average sound level outside a residence is less than 65 dBA. Threshold noise levels from industrial sites are subject to threshold values from the National Institute for Occupational Safety and Health under the Occupational Safety and Health Act of 1970 (Public Law 91-596; 29 U.S.C. §§ 651 et seq.; TN4453). Noise abatement issues are also handled by State and local governments because there is no overarching Federal noise abatement program.[13] The assumption underlying the PPE is that the new reactor will not exceed a 65 dBA threshold at the site boundary, unless a relevant State or local noise abatement law or ordinance sets a different threshold, which would then be the presumptive threshold for PPE purposes. If an applicant cannot meet the 65 dBA threshold through mitigation, then the applicant must obtain a variance or exception from the relevant State or local regulator. Based upon the NRC's past experience reviewing new reactor and license renewal applications for large LWRs, noise impacts during both building and operation have generally not exceeded 65 dBA (except for very short periods of time such as alarm and equipment testing) or these impacts have been successfully mitigated (e.g., through the implementation of BMPs, including modeling, foliage planting, building of noise buffers, and the timing of construction activities). Therefore, the PPE assumes that applicable BMPs and potential mitigation measures would be applied to reduce noise impacts to below a 65 dBA threshold on applicable receptors, particularly during building.

[13] In the 1970s, the EPA coordinated all Federal noise control activities pursuant to the Noise Control Act of 1972 (42 U.S.C. §§ 4901 et seq.; TN4294), as amended by the Quiet Communities Act of 1978 (TN7029). The EPA's implementing regulations are at 40 CFR Parts 201 to 211 (TN7030). The EPA phased out the program's funding in 1982 and transferred the primary responsibility of regulating noise to State and local governments.

3.9.2 Noise Impacts

Noise impacts associated with new reactors and associated transmission line ROWs would take place during the building and operation phases of the project. The mitigation measures that could be conducted to be able to rely on the generic analysis may include implementation of BMPs, such as modeling, foliage planting, building noise buffers, and the timing of building and/or operation activities.

3.9.2.1 Environmental Consequences of Construction

Impacts would occur during site preparation and the building of both safety-related and non-safety-related facilities. Some smaller new reactor designs can be placed in one or a few small buildings on a small site and may lack structures such as cooling towers, switchyards, or offsite pipelines. As a result, the noise associated with building new reactors could produce lower overall noise impacts relative to what has been typical for a large LWR. Larger new reactors may require the building of facilities similar to those associated with a large LWR and most likely have noise levels similar to those of a large LWR.

In certain cases, sound modeling in accordance with industry standards may be necessary to estimate noise levels associated with the building of the reactor. While post-mitigated noise associated with construction may exceed the noise thresholds during certain activities, these impacts are expected to be temporary and short in duration. As part of the ER, the applicant should conduct a noise survey in the relevant area, identify the peak day and night noise levels in dBA at each survey point, and establish the likely source of that noise level (e.g., road traffic, industrial and construction noises, etc.). Therefore, the NRC staff concludes that building-related human noise impacts from a new reactor would be SMALL and a Category 1 issue. The staff relied upon the following PPE assumptions to reach this determination:

- The noise level would be no more than 65 dBA at site boundary, unless a relevant State or local noise abatement law or ordinance sets a different threshold, which would then be the presumptive threshold for PPE purposes.
- If an applicant cannot meet the 65 dBA threshold through mitigation, then the applicant must obtain a variance or exception with the relevant State or local regulator.
- The project would implement BMPs, such as modeling, foliage planting, construction of noise buffers, and the timing of construction and/or operation activities.

3.9.2.2 Environmental Consequences of Operation

Impacts associated with the operation of the new reactor would also occur. However, the noise associated with the operation of the reactor, while longer in duration, is expected to be generated at a lower level than during building. Therefore, building-generated noise impacts establish the upper bound for operations-related noise.

The NRC staff assumes that the noise associated with the operation of a new reactor would be mitigated and would not routinely exceed 65 dBA at the site boundary. Therefore, the NRC staff concludes that operation-related human noise impacts from a new reactor would be SMALL and a Category 1 issue. The NRC staff assumes that any mitigation necessary to achieve the noise thresholds from construction would remain in place and that no additional mitigation would be needed to maintain those thresholds for the duration of operations. The staff relied upon the following PPE assumptions to reach this determination:

- The noise level would be no more than 65 dBA at site boundary, unless a relevant State or local noise abatement law or ordinance sets a different threshold, which would then be the presumptive threshold for PPE purposes.
- If an applicant cannot meet the 65 dBA threshold through mitigation, then the applicant must obtain a variance or exception with the relevant State or local regulator.
- The project would implement BMPs, such as modeling, foliage planting, construction of noise buffers, and the timing of construction and/or operation activities.

3.10 Waste Management

3.10.1 Radiological Waste Management

3.10.1.1 Baseline Conditions and PPE/SPE Values and Assumptions

There are three types of radiological wastes that could be associated with a new reactor: LLRW (low-level radioactive waste), high-level radioactive waste, and mixed wastes. Regulations regarding the how a licensee shall dispose of licensed materials is regulated in accordance with 10 CFR Part 20 (TN283) Subpart K. These wastes are described in the sections below.

The NRC staff assumes that a new reactor could be installed at an existing licensed facility. The new reactor could be a physically separate nuclear facility or, if there is adequate land, it could be integrated within the boundaries of an existing nuclear power plant or other nuclear facility. If the new reactor is a stand-alone facility, the space needed to store onsite radiological wastes would be within the planned footprint of the facility. If the new reactor is sited at an existing nuclear facility, the existing radiological waste infrastructure and management program could likely support the additional radiological wastes generated by the new reactor. For an existing site, information should be available about the radiological waste management facilities onsite, such as the information developed for that facility's NRC licensing activities and documented, for example, in annual environmental monitoring reports. This and other applicable documentation can be incorporated by reference into the SEIS.

3.10.1.1.1 Low-Level Radioactive Wastes

The Commission's licensing requirements for the land disposal of LLRW are set forth in 10 CFR Part 61 (TN252), *Licensing Requirements for Land Disposal of Radioactive Waste*. Part 61 defines LLRW as "radioactive waste not classified as high-level radioactive waste [HLRW], transuranic [TRU] waste, spent nuclear fuel, or byproduct material as defined in paragraphs (2), (3), and (4) of the definition of byproduct material set forth in § 20.1003 of this chapter."[14] The NRC's regulation 10 CFR 61.55 (TN252) established a classification system that categorizes LLRW as Class A, B, C, or greater than Class C (GTCC). Class A wastes contain radionuclides at relatively low concentrations, whereas the half-lives and concentrations of radionuclides in the Class B and C wastes are progressively higher. In addition, Class B wastes must meet more rigorous requirements with regard to their form to ensure their stability after disposal (e.g., by adding chemical stabilizing agents such as cement to the waste or placing the waste in a disposal container or structure that provides stability after disposal). Class C wastes must not only meet the more rigorous requirements above but also require the implementation of additional measures at the disposal facility to protect against inadvertent intrusion (e.g., by increasing the thickness and hardness of the cover over the waste disposal cell). GTCC is

[14] 10 CFR 61.2 (TN252) (definition of "waste").

LLRW with concentrations of radionuclides that exceed the limits established by the Commission for Class C LLRW (NRC 2019-TN6440). Under the NRC's current regulations, GTCC waste is considered to be generally unacceptable for near-surface disposal and must be disposed of in a geologic repository unless the Commission approves, on a case-by-case basis, disposal of such waste in a disposal site licensed pursuant to 10 CFR 61.55(a)(2)(iv) (TN252). These regulations form the basis for the PPE guidance in Appendix G of this GEIS.

For this GEIS, the NRC staff assumes that the quantities of LLRW generated at a new reactor would be less than the quantities of LLRW generated at existing nuclear power plants, which generate an average of 21,200 ft^3 (600 m^3) and 2,000 curies (Ci) (7.4×10^{13} becquerel [Bq]) per year for boiling water reactors and half that amount for pressurized water reactors (NRC 2024-TN10161). The LLRW generated at a new reactor would likely be similar to LLRW wastes from existing facilities: these wastes typically consist of contaminated protective shoe covers and clothing, wiping rags, mops, filters, equipment and tools, and other contaminated objects depending on the nuclear application (NRC 2017-TN6545). The radioactivity can range from just above the background levels found in nature to very highly radioactive. LLRW that contains radionuclides that have shorter decay times can be stored onsite by licensees until it can be released in accordance with 10 CFR Part 20, Subpart K (TN283). LLRW that contains radionuclides that have longer decay times can be stored onsite until material inventory amounts are large enough for shipment to a low-level waste disposal site. Applicable regulations from the NRC (10 CFR Part 71-TN301, "Packaging and Transportation of Radioactive Material") and/or the U.S. Department of Transportation (49 CFR-TN7054) must be used when offering licensed material for transport.

The NRC requires that all licensees implement measures to minimize, to the extent practicable, the generation of radioactive waste (10 CFR 20.1406 [TN283]). Additionally, the new reactor licensee could do the following:

- Build additional temporary radiological storage facilities on the site.
- Enter into an agreement with a third-party contractor to process, store, own, and ultimately dispose of LLRW from the new reactor site.

The Low-Level Radioactive Waste Policy Amendments Act of 1985 (Public Law 99-240; TN6517)[15] gave States the responsibility for disposal of the LLRW generated at commercial facilities within their States. States are encouraged to enter into compacts that allow them to dispose of the waste at a common disposal facility shared by multiple States. Depending on the location of the new reactor site, the reactor licensee could contract with one or more licensed LLRW disposal sites. There are currently four operating disposal facilities in the United States that are licensed to accept LLRW from commercial facilities (including nuclear power plants) (NRC 2020-TN6516). They are located at Clive, Utah; Andrews County, Texas; Barnwell, South Carolina; and near Richland, Washington. The Energy*Solutions* disposal facility at Clive, Utah, is licensed by the State of Utah to accept Class A LLRW from all regions of the United States. The Waste Control Specialists LLC (WCS) site in Andrews County, Texas, is licensed to accept Class A, B, and C LLRW from the Texas Compact generators (Texas and Vermont) and from outside generators with permission from the Texas Compact. Energy*Solutions* Barnwell Operations located near Barnwell, South Carolina, accepts waste from the Atlantic Compact States (Connecticut, New Jersey, and South Carolina) and is licensed by the State of South Carolina to dispose of Class A, B, and C LLRW. U.S. Ecology, located near Richland,

[15] The Low-Level Radioactive Waste Policy Amendments Act superseded, in its entirety, an earlier law, the Low-Level Radioactive Waste Policy Act of 1980 (Public Law 96-573; TN6606).

Washington, accepts LLRW from the Northwest and Rocky Mountain Compact States (Washington, Alaska, Hawaii, Idaho, Montana, Oregon, Utah, Wyoming, Colorado, Nevada, and New Mexico) and is licensed by the State of Washington to dispose of Class A, B, and C waste. A new reactor licensee would likely have to choose one or a combination of these options. Section 3.10.1.2 addresses the potential environmental impacts of using LLRW disposal facilities. The NRC staff anticipates that a new reactor licensee would enter into an agreement with one of the four above facilities or make alternative arrangements in accordance with 10 CFR Part 20 Subpart K (TN283).

3.10.1.1.2 High-Level Waste

The only two types of high-level waste (HLW) generated at new reactors would be spent nuclear fuel and, potentially, waste from fuel reprocessing (e.g., removal of fission products during operation from liquid-fueled molten-salt reactors) (NRC 2020-TN6955). The regulations for the storage of HLW are found in 10 CFR Part 72 (TN4884) and apply to the proper storage and handling of spent nuclear fuel in an ISFSI. Section 3.14.2.6 provides more information about the storage and disposal of spent nuclear fuel.

New reactor designs may not require onsite spent nuclear fuel storage, for example, in cases where the depleted core would be shipped offsite after a short period after shutdown (see Section 3.14 for away-from-reactor impacts during continued storage).

If spent nuclear fuel or any treated, reprocessed waste needs to be stored temporarily at a new reactor facility, it would be stored either in a spent fuel pool or in non-water-based spent nuclear fuel storage. After an appropriate holding period, it would be transferred to dry cask storage in an at-reactor ISFSI under a general license or a stand-alone ISFSI under specific license.

3.10.1.1.3 Mixed Wastes

Mixed waste, regulated under the RCRA (TN1281) and the Atomic Energy Act of 1954 (42 U.S.C. §§ 2011 et seq.; TN663), is waste that is both radioactive and hazardous (EPA 2019-TN6956). These wastes are subject to dual regulation by the EPA or an authorized State for their hazardous component, and by the NRC or an Agreement State for the radioactive component. Nuclear power plants generate small quantities of mixed waste, typically accounting for less than 3 percent by volume of the annual LLRW (NRC 1996-TN288). The NRC staff assumes that new reactors would be similar small-quantity generators and generate mixed wastes similar to those wastes generated at currently operating nuclear power plants. If any new reactor would generate more mixed wastes than is assumed in this GEIS, the associated impacts would need to be assessed in the site-specific environmental report developed for the licensing of that facility.

The types of mixed wastes generated at nuclear power plants include organics (e.g., liquid scintillation fluids, waste oils, halogenated organics), metals (e.g., lead, mercury, chromium, and cadmium), solvents, paints, cutting fluids, cleaning and refrigeration effluents, and corrosives from acids. The quantity of mixed waste generated varies considerably from plant to plant (NRC 1996-TN288). The EIS for the Fermi Unit 3 COL (NUREG-2105; NRC 2013-TN6436) states that 0.416 m^3/yr (0.544 yd^3/yr) of mixed waste would be generated during operation. Overall, the quantities generated during operations are generally relatively small, but because of the added complexity of dual regulation, it is more problematic for plant owners to manage and dispose of mixed wastes than the other types of wastes. Similar to hazardous waste, mixed waste is generally accumulated onsite in designated areas as authorized under RCRA, then shipped

offsite for treatment as appropriate and for disposal. The only disposal facilities that are authorized to receive mixed LLRW for disposal at present are the Energy*Solutions* and the WCS facilities (NRC 2024-TN10161).

The NRC staff assumes that a new reactor licensee would manage mixed waste in accordance with appropriate regulations and BMPs. In addition, the NRC staff assumes that a licensee for a new reactor would produce waste in quantities that would allow classification as a small-quantity generator of hazardous waste, based on the design features of new reactors and the fact that other large LWRs can meet the classification.

3.10.1.2 Radiological Waste Impacts

The NRC staff identified three environmental issues for analysis of waste management associated with a new reactor:

- LLRW
- onsite spent nuclear fuel management
- mixed waste.

3.10.1.2.1 Low-Level Radioactive Waste

The NRC staff assumes the new reactor site would have sufficient storage for LLRW. The NRC dose limitations (10 CFR Part 20-TN283) would apply for both public and occupational radiation exposure for any onsite facilities (see Section 3.8.1). The radiological environmental monitoring programs around nuclear power plants that operate such LLRW storage facilities show that the increase in radiation dose at the site boundary is not significant (NRC 2024-TN10161). The NRC staff has concluded that doses to members of the public from the operation of onsite LLRW storage facilities would have a minimal impact.

In addition, the NRC staff assessed in the LR GEIS the impacts of onsite LLRW storage at currently operating nuclear power plants and concluded that the radiation doses to offsite individuals from onsite LLRW storage are not significant (NRC 2024-TN10161). The expected types of LLRW generated by new reactors would be very similar to those generated by currently operating nuclear power plants (i.e., LLRW in the form of contaminated protective shoe covers and clothing, wiping rags, mops, filters, equipment and tools, etc.), although the amount is expected to be less because some new reactor designs involve sealed reactor systems (e.g., microreactors) and other designs could have fewer operational maintenance activities, which include only typical sources of LLRW (listed above). The building and operation activities for these onsite LLRW storage facilities for a new reactor would be similar to those of LLRW storage facilities for existing nuclear power plants. However, the magnitude of the impact is expected to be less for many designs, based on factors such as lower power levels, less complex reactor systems, remote maintenance operations, and reduced maintenance activities generating reduced volumes of LLRW.

For the shipment of LLRW offsite to a licensed disposal site (as discussed in Section 3.10.1.1.1), the NRC staff assumes that the quantities shipped and associated impacts would be bounded by the impact assessment provided in Section 4.11.1.1 and by the data in Tables 3.11-1 and 3.11-2 of the LR GEIS (NRC 2024-TN10161) related to the volume and activity of LLRW shipped offsite in 2021 for 11 power plant sites. This information is incorporated here by reference.

The NRC staff concluded that there should be no significant issues or environmental impacts associated with onsite storage of LLRW generated by nuclear power plants, including new reactors. Onsite storage facilities would be used until the wastes could be safely shipped to licensed LLRW disposal facilities as previously discussed. The NRC staff considers impacts of LLRW management to be SMALL and a Category 1 issue, because of expected compliance with regulations and policies governing radiological waste management. The staff relied on the following PPE assumptions to reach this conclusion:

- Applicants must meet the regulatory requirements of 10 CFR Part 20 (TN283) (e.g., 20.1406 and Subpart K), 10 CFR Part 61 (TN252), 10 CFR Part 71 (TN301), and 10 CFR Part 72 (TN4884).
- Quantities of LLRW generated at many new reactors would be less than the quantities of LLRW generated at existing nuclear power plants, which generate an average of 21,200 ft^3 (600 m^3) and 2,000 Ci (7.4×10^{13} Bq) per year for boiling water reactors and half that amount for pressurized water reactors (NRC 2024-TN10161).

As discussed above, in previous assessments the NRC staff concluded that there would be no significant environmental impacts associated with onsite storage of LLRW generated by nuclear power plants, and this conclusion can be applied to new reactors addressed in this GEIS. Onsite storage facilities would likely be used at new reactors until these wastes could be safely shipped to licensed LLRW disposal facilities as previously discussed. Currently operating LLRW disposal facilities have adequate capacity to accommodate the increased demand from new reactors. The NRC staff considers impacts of LLRW management to be SMALL and a Category 1 issue based on the information already available about LLRW management for currently operating nuclear facilities and because of expected compliance with regulations and policies governing radiological waste management.

3.10.1.2.2 Onsite Spent Nuclear Fuel and High-Level Waste Management

Because a new reactor is assumed to generate less spent nuclear fuel than currently operating reactors in the United States (i.e., due to smaller cores and longer core lifetimes), the NRC staff assumes that the impacts of onsite spent nuclear fuel management at new reactor facilities would be bounded by the impacts of spent nuclear fuel storage at current nuclear power plants. The environmental impacts of storage are assessed for current nuclear power plants in the context of operating license renewal in Section 4.11.1.2 of the LR GEIS (NRC 2024-TN10161). Current and potential environmental impacts from spent nuclear fuel storage onsite at the reactor sites are well understood and the environmental impacts during the license renewal term were found to be small (NRC 2024-TN10161). Offsite spent nuclear fuel storage and disposal impacts are addressed in Section 3.14.2.6 of this GEIS. During the operational lifetime of the new reactor, appropriate handling and storage of spent nuclear fuel must be performed in accordance with NRC regulations (e.g., 10 CFR Part 72-TN4884). While liquid-fuel molten-salt reactors (MSRs) could process the molten salt to remove fission products and other radionuclides, the resulting high-level and TRU waste must be handled and stored in accordance with NRC regulations (see Section 3.14.2.5 for discussion of reprocessing).

Assuming an appropriate decay time, new reactor management of spent nuclear fuel would be similar to current reactor sites and use similar ISFSIs, with a currently approved cask design or a specially designed spent nuclear fuel storage facility or dry cask storage system. The NRC staff assumes that radiological impacts would be within regulatory limits; thus, the environmental impacts of onsite storage during operations would be SMALL. The NRC staff's overall conclusion about onsite management of spent nuclear fuel, high-level waste, and TRU waste during the licensed lifetime of operations for new reactors is that the environmental impacts would be minor. This is a Category 1 issue. The staff relied on the following PPE assumptions to reach this conclusion:

- Compliance with 10 CFR Part 72 (TN4884).

3.10.1.2.3 Mixed Waste

New reactors could also be expected to generate small quantities of mixed waste. The waste at the new reactor site would either be treated onsite or sent offsite for treatment followed by disposal at a permitted landfill licensed to accept mixed waste. The comprehensive regulatory controls and the facilities and procedures that are in place at nuclear power plants ensure that the mixed waste is properly handled and stored. The NRC staff assumes that the radioactive dose and exposure to toxic materials from mixed waste should have a small contribution to LLRW impacts based on existing impacts at current LWRs, as was assessed in the LR GEIS (NRC 2024-TN10161 [see Section 4.11.1.4, Mixed Waste Storage and Disposal]). Therefore, the radiological and nonradiological environmental impacts from the long-term disposal of mixed waste for any individual new reactor is considered SMALL. This is a Category 1 issue. The staff relied on the following PPE assumptions to reach this conclusion:

- RCRA Small Quantity Generator (EPA 2020-TN6590) for Mixed Waste.

3.10.2 Nonradiological Waste Management

3.10.2.1 Baseline Conditions and PPE/SPE Values

Baseline conditions influencing nonradiological waste impacts associated with building and operation of a new reactor include consideration of waste forms, classifications, and exposure pathways. Nonradiological waste can exist in a gaseous, liquid, or solid form. Nonradiological waste can further be classified as hazardous or nonhazardous. When hazardous waste is combined with radiological waste it is referred to as mixed waste. Mixed waste is addressed in Section 3.10.1.2.3. Exposure pathways to nonradiological waste can be either through inhalation, ingestion, or absorption. See Section 3.3.1 for information regarding air quality, Section 3.4.1 for water resources, Section 3.8.1 for public and occupational health information, Section 3.11.1 for postulated accidents, and Section 3.15.1 for transportation of fuel and waste.

The assumption of the PPE/SPE developed for this GEIS is that the licensee must meet all applicable permit conditions and regulations, and perform all appropriate BMPs related to solid, liquid, and gaseous waste. The NRC staff also assumes that licensees would implement mitigation measures, such as recycling, along with using the least hazardous substance in its operations, as appropriate.

Hazardous waste is defined by the EPA in 40 CFR Part 261 (TN5092). Hazardous wastes may be wastes that are specifically listed as known hazardous wastes or wastes that have one or more characteristics of ignitability, corrosivity, reactivity, or toxicity. Types of hazardous wastes common to new reactors or electric power generation facilities include waste paints, lab packs,

and solvents. Per the LR GEIS (NRC 2024-TN10161), most LWRs accumulate their hazardous waste onsite as authorized under RCRA (42 U.S.C. §§ 6901 et seq.; TN1281) and transport it to treatment facilities for processing (NRC 2024-TN10161). The remaining residues are sent to permanent disposal facilities. A class of hazardous waste called universal waste is handled differently than hazardous waste, and includes batteries, pesticides, mercury-containing equipment, light bulbs, and aerosol cans. Federal universal waste regulations can be found in 40 CFR Part 273 (TN6587). All aspects of hazardous waste, such as generation, treatment, transportation, and disposal, are regulated by the EPA or by States under agreements with the EPA per the regulations set forth under RCRA.

RCRA also defines categories of hazardous waste generators (EPA 2020-TN6590). These types include large-quantity generators, small-quantity generators, and very small-quantity generators. Very small-quantity hazardous waste generators create 100 kg or less per month of hazardous waste or 1 kg or less per month of acutely hazardous waste. Small-quantity hazardous waste generators create more than 100 kg but less than 1,000 kg of hazardous waste per month. Large-quantity hazardous waste generators create 1,000 kg per month or more of hazardous waste or more than 1 kg per month of acutely hazardous waste. The ESP application for the Clinch River small modular reactor expected the facility to qualify as a small-quantity generator (TVA 2019-TN6589). The ESPs application for the Public Service Enterprise Group stated that it maintains the program required of a small-quantity generator (PSEG 2014-TN3452). The assumption of the PPE/SPE developed for this GEIS is that the proposed plant would conform to RCRA regulations.

Nonhazardous waste is waste that is not contaminated with either radionuclides or hazardous chemicals. These wastes include office trash, paper, wood, oils not mixed with hazardous waste or radiological waste, and sewage. Solid wastes, defined as nonhazardous by 40 CFR Part 261 (TN5092) are collected and disposed of in a landfill. Sanitary wastes defined as nonhazardous by 40 CFR Part 261 are treated either at an onsite sewage treatment plant (as in the case of many large-scale industrial facilities), discharged directly to a municipal sewage system for treatment, or discharged to onsite septic tanks. The assumptions of the PPE/SPE developed for this GEIS is that the quantity of water discharged to a municipal system would be within the receiving system's capacity, as noted in Appendix G.

Large LWRs have nonradioactive waste management systems in place that manage both hazardous and nonhazardous wastes. For example, boiler blowdown, water treatment wastes, boiler metal cleaning wastes, laboratory and sampling wastes, floor and yard drains, and stormwater runoff are all managed by these systems and are regulated by an NPDES permit, with the exception of wastes in solid form (NRC 2024-TN10161). See Section 3.4 for further discussion of water resources. The NRC staff assumes that new reactors would have some of the same systems as a large LWR, although new reactor designs may vary.

3.10.2.2 Nonradiological Waste Impacts

The NRC has assessed nonradiological waste impacts arising from the existing operating fleet during license renewal assessments and from proposed new reactors as part of the COL and ESP process under 10 CFR Part 52 (TN251). Nonradiological waste impacts resulting from the refurbishment and operation of typical large LWRs in the existing U.S. fleet are evaluated in the LR GEIS (NRC 2024-TN10161). Nonradiological waste impacts from building and operating LWRs have been evaluated in several EISs and the impacts were found to be SMALL. Impacts of nonradiological waste from building and operating a new reactor would generally be bounded by the impacts associated with large LWRs. See Section 3.3.2 for impacts on air quality,

Section 3.4.2 for impacts on water resources, Section 3.8.2 for impacts on public and occupational health impacts, Section 3.11.2 for impacts of postulated accidents, and Section 3.15.2 for impacts of the transportation of fuel and waste.

3.10.2.2.1 Environmental Consequences of Construction

The primary nonradiological waste impacts of building a new reactor would be those associated with building activities. Impacts would include the generation, handling, and disposal of waste and would be bounded by those of any large-scale construction project. Building waste impacts would depend on whether the new reactor was built at a greenfield (undeveloped land), brownfield (previously developed land available for redevelopment), or currently industrialized site. Potential types of nonradioactive wastes expected from building a new reactor would include construction debris, spoils, stormwater runoffs, municipal and sanitary waste, dust, hazardous waste from construction equipment maintenance (e.g., oils and solvents), and air emissions. Impacts are categorized into one of three waste types: solid, liquid, and gaseous.

Building a new reactor could result in solid waste materials such as construction debris from excavation, land clearing, and municipal waste. Debris could either be shipped to a local construction debris landfill or the licensee could construct and operate its own onsite landfill. For example, the Tennessee Valley Authority proposed to construct and operate an onsite landfill in its application for an ESP (TVA 2019-TN5854). The NRC staff assumes municipal and hazardous solid waste would be handled and shipped to the appropriate licensed disposal facility in accordance with applicable regulations. If a licensee were to construct an onsite landfill, those impacts would be considered in a project-specific EIS.

Building activities related to building a new reactor could result in liquid waste, such as stormwater runoffs. Surface water and groundwater have the potential to be affected by building activities. The NRC staff assumes the applicant for a new reactor would obtain an NPDES permit for stormwater discharges and maintain a Stormwater Pollution Prevention Plan to minimize potential impacts. The NRC staff also assumes that an erosion and sediment control plan would be implemented as part of the NPDES permit. In addition, the NRC staff assumes sanitary wastes would be handled and shipped to the appropriate licensed disposal facility, such as a local municipal sanitary waste facility. Mitigation for stormwater runoff could include creation of berms around temporary spoils areas, trenching, drainpipes, culverts, and swales to direct runoff to retention ponds. Dewatering at the construction site could be expected for the nuclear island area if the design of the new reactor calls for subsurface installation of major components. Mitigation could include use of horizontal drains to direct water to sumps, grouting to prevent inflow of groundwater, and pumping water from sumps to construction-stormwater management systems. Impacts of dewatering are discussed in Section 3.4.

In addition, building activities could result in gaseous waste. Examples of gaseous waste include construction equipment and vehicle emissions and fugitive dust from earthmoving activities. Air permits are required for construction activities. In addition, the NRC staff assumes licensees would use BMPs, such as stabilizing construction roads and spoil piles, covering haul trucks, watering unpaved construction roads, and maintaining equipment in proper working order, as discussed in Section 3.3.

The staff has determined that nonradiological waste impacts during construction of a new reactor are a Category 1 issue. The staff concluded that as long as the applicable PPE and SPE values and assumptions are met, the nonradiological waste impacts from building a new reactor can be generically determined to be SMALL. The staff relied on the following PPE values and assumptions to reach this conclusion:

- The applicant must meet all the applicable permit conditions, regulations, and BMPs related to solid, liquid, and gaseous waste management.
- For hazardous waste generation, applicants must meet conformity with hazardous waste quantity generation levels in accordance with RCRA.
- For sanitary waste, applicants must dispose of sanitary waste in a permitted process.
- For mitigation measures, the applicant would perform mitigation measures to the extent practicable, such as recycling, process improvements, or the use of a less hazardous substance.

3.10.2.2.2 Environmental Consequences of Operation

The NRC staff assumes the nonradiological waste impacts of operating a new reactor would be smaller than those experienced during building and would depend on the design of the new reactor. Impacts would result from the generation, handling, and disposal of nonradiological waste. Such waste can be classified as either hazardous or nonhazardous and found in solid, liquid, or gaseous forms. Depending on the new reactor design, some waste streams may be reduced or eliminated relative to a large LWR. For instance, reactors moderated by substances other than water may not have a significant water footprint.

New reactor operational activities could result in solid waste materials such as office waste, cardboard, wood, metal, sewage treatment sludge, and resins. The NRC staff assumes municipal (office trash) and hazardous solid waste would be handled and shipped to the appropriate licensed disposal facility in accordance with the applicable regulations, while cardboard, paper, wood pallets, and metal would be recycled, as appropriate. BMPs regarding solid waste for a new reactor would be similar to those already in use for large LWRs.

The operation of a new reactor could result in liquid waste materials such as chemicals, biocides (for control of algae), and stormwater runoff. These discharges would be from cooling or other operations of the reactor and would be managed in accordance with Federal, State, local or tribal regulations. Sanitary waste would either be discharged to a permitted municipal sanitary system or treated in an onsite sanitary system. The NRC staff assumes the licensee would comply with all applicable permits and use BMPs to control liquid waste materials.

Gaseous waste materials would come from operation of diesel generators, fossil-fuel boilers, and from the coolant system (i.e., if the new reactor was a gas-cooled reactor). Section 3.3 contains further information about air quality impacts. Gaseous wastes include CO, NO_x, CO_2, CH_4, N_2O, PM, and VOCs for diesel-, natural-gas-, and oil-fired units. Gaseous waste materials associated with a new reactor would be managed in accordance with Federal, State, local, or tribal regulations. In addition, the NRC staff assumes the licensee would comply with all applicable permits and use BMPs for these wastes.

Mitigation for waste management could include recycling, improving an operational process, or using a less hazardous chemical, such as using aqueous ammonium versus anhydrous ammonia.

The staff has determined that nonradiological waste impacts during operation of a new reactor are a Category 1 issue. The staff concluded that as long as the applicable PPE and SPE values and assumptions are met, the nonradiological public and occupational health impact from operating a new reactor can be generically determined to be SMALL. The staff relied on the following PPE values and assumptions to reach this conclusion:

- The applicant must meet all the applicable permit conditions, regulations, and BMPs related to solid, liquid, and gaseous waste management.
- For hazardous waste generation, applicants must meet conformity with hazardous waste quantity generation levels in accordance with RCRA.
- For sanitary waste, applicants must dispose of sanitary waste in a permitted process.
- For mitigation measures, the applicant would perform mitigation measures to the extent practicable, such as recycling, process improvements, or the use of a less hazardous substance.

3.11 Postulated Accidents

3.11.1 Baseline Conditions and PPE/SPE Values and Assumptions

3.11.1.1 Design Basis Accidents Involving Radiological Releases[16]

Radiological effects from a postulated accident from such nuclear facilities are considered for their impacts with respect to the following regulatory requirements:

- 10 CFR 50.34(a)(1) (TN249), “Contents of applications; technical information.”
- 10 CFR 52.79(a)(1)(A) (TN251), “Contents of applications; technical information in final safety analysis report.”

Based on the regulations, whether it is a non-LWR or LWR design, the new reactor design basis accident (DBA) analysis must satisfy the following:

- For the exclusion area boundary, the maximum total effective dose equivalent (TEDE) for any 2-hour period during the radioactivity release should be calculated.
- For the low-population zone, the TEDE should be calculated for the duration of the accident release (i.e., 30 days, or other duration as justified).
- Comparison of the DBA doses with the dose criteria given in regulations related to the application (e.g., 10 CFR 50.34(a)(1) [TN249], 10 CFR 52.17(a)(1) and 10 CFR 52.79(a)(1) [10 CFR Part 52-TN251]), standard review plans (SRPs) (e.g., SRP criteria, Table 1 in SRP Section 15.0.3 of NUREG-0800 [NRC 2007/2019-TN6221]), and RGs, (e.g., RG 1.183 [NRC 2000-TN517]), as applicable.

[16] For the purposes of this GEIS, “Design Basis Accidents” are related to a spectrum of accidents that will be evaluated for satisfying siting requirements (e.g., 10 CFR Part 100) and the safety analysis requirements (e.g., 10 CFR Part 50, Part 52) or the applicable NRC safety and siting regulations in place at the time the application is docketed).

3.11.1.2 Accidents Involving Releases of Hazardous Chemicals

The effects of hazardous chemical releases from nearby facilities have traditionally been reviewed as part of safety reviews for their effects on control room habitability (see NUREG-0800, Section 2.2.1–2.2.2, Identification of Potential Hazards in Site Vicinity, and Section 6.4, Control Room Habitability System; NRC 2007-TN613).

EPA also regulates hazardous chemicals. For example, the Risk Management Plan Rule (40 CFR Part 68-TN5494) requires facilities that produce, process, or store extremely hazardous substances to identify hazards associated with an accidental release, design and maintain a safe facility, prepare a Risk Management Plan and minimize consequences of accidental releases that occur. Facilities holding more than a threshold quantity (TQ) of a regulated substance in a process are required to comply with 40 CFR Part 68 (TN5494). As provided in 40 CFR 68.130, Tables 1, 2, 3, and 4 list the regulated substances and their TQs.

The Emergency Planning and Community Right-to-Know Act requires that if an extremely hazardous substance (EHS) in quantities at or above the Threshold Planning Quantity (TPQ) is present at a facility, then certain emergency planning activities must be conducted. For example, Local Emergency Planning Committees (LEPCs) must develop emergency response plans and the facility owner or operator must notify the State Emergency Response Commission or Tribal Emergency Response Commission and their LEPC if any of the EHS is present at the facility or above its TPQ. The EHSs and their TPQs are listed in 40 CFR Part 355, Appendices A and B (40 CFR Part 355-TN5493).

Because of the potential for the use of hazardous chemicals in the operation of a new reactor, there is also the potential for releases of hazardous chemicals as a result of postulated accidents. In developing the PPE values and assumptions pertaining to accidents involving releases of hazardous chemicals, the staff assumed that if a regulated substance or EHS is present at a new reactor facility in quantities less than the requirement for establishing a Risk Management Plan and offsite emergency planning, then the consequences of releases of these hazardous chemicals would be small. To establish the PPE, the staff is applying the list of regulated substances and TQs contained in 40 CFR 68.130, and the list of EHSs and TPQs contained in 40 CFR Part 355, Appendices A and B (TN5493). The PPE assumptions are as follows:

- new reactor inventory of a regulated substance is less than its TQ. TQs are found in 40 CFR 68.130, Tables 1, 2, 3, and 4 (TN5494); and
- new reactor inventory of an EHS is less than its TPQ. TPQs are found in 40 CFR Part 355, Appendices A and B (TN5493).

If the PPE above is exceeded and a new reactor facility has the potential to release hazardous chemicals from licensed operations, the applicant should provide an analysis in the ER that estimates the consequences to members of the public in the event of such a release. Generally available information or protective emergency guidelines can be useful when characterizing the consequences (e.g., Acute Exposure Guideline Levels, [17] Emergency Response Planning

[17] Acute Exposure Guideline Levels s are guidelines designed to help responders deal with emergencies involving chemical spills or other catastrophic events during which members of the general public are exposed to a hazardous airborne chemical (NOAA ORR 2019-TN7023).

Guidelines,[18] Temporary Emergency Exposure Limits,[19] or Protective Action Criteria for Chemicals.[20] Relevant analysis prepared for compliance with other State or Federal regulations (e.g., a Risk Management Plan submitted under 40 CFR Part 68 [TN5494]) should be provided as applicable.

3.11.1.3 Severe Accidents

The Commission provided direction to the staff for the environmental assessment of severe accidents in their policy statement entitled "Nuclear Power Plant Accident Considerations Under the National Environmental Policy Act of 1969," which includes the following statements (45 FR 40101-TN4270):

> It is the position of the Commission that its Environmental Impact Statements, pursuant to Section 102(c)(i) of the National Environmental Policy Act of 1969 [42 U.S.C. §§ 4321 et seq.; TN661], shall include a reasoned consideration of the environmental risks (impacts) attributable to accidents at the particular facility or facilities within the scope of each such statement. In the analysis and discussion of such risks, approximately equal attention shall be given to the probability of occurrence of releases and to the probability of occurrence of the environmental consequences of those releases. Releases refer to radiation and/or radioactive materials entering environmental exposure pathways, including air, water, and groundwater.

and

> The environmental consequences of releases whose probability of occurrence has been estimated shall also be discussed in probabilistic terms. Such consequences shall be characterized in terms of potential radiological exposures to individuals, to population groups, and, where applicable, to biota. Health and safety risks that may be associated with exposures to people shall be discussed in a manner that fairly reflects the current state of knowledge regarding such risks. Socioeconomic impacts that might be associated with emergency measures during or following an accident should also be discussed. The environmental risk of accidents should also be compared to and contrasted with radiological risks associated with normal and anticipated operational releases.

This subsection provides the Severe Accidents category issue bounding PPE values based on leveraging the analyses necessary to demonstrate compliance with safety regulations for severe accidents. Appendix I of this GEIS provides the detailed technical rationale and discussion for the environmental evaluation of severe accidents and technical bases for these PPE values. To establish PPE values, the NRC staff applied information from several sources. The primary sources apply parameters such as the PDR, core damage frequency, Exposure Index risk-metrics contained in the 1996, 2013, and 2024 license renewal generic environmental impact

[18] Emergency Response Planning Guidelines are guidelines designed to anticipate the health effects from exposure to certain airborne chemical concentrations (NOAA ORR 2019-TN7024).

[19] Temporary Emergency Exposure Limits are guidelines designed to predict the response of members of the general public to different concentrations of a chemical during an emergency response incident (NOAA ORR 2020-TN7025).

[20] The Protective Action Criteria for Chemicals data set is a hierarchy-based system of the three common public exposure guideline systems (AEGLs, ERPGs, and Temporary Emergency Exposure Limits) (NOAA ORR 2020-TN7026).

statements (LR GEISs) (NRC 1996-TN288, NRC 2013-TN2654, NRC 2024-TN10161), and applicable safety regulations that specify a maximum health effect. Other sources include various risk-informed and performance-based regulations that assess severe accidents and mitigation. A NEPA impact determination in an environmental review includes two essential components: impact assessment and mitigation measures. The following bullets describe the alternative methodologies for a NEPA Category 1 impact determination of SMALL as well as mitigation methodologies. To utilize the Category 1 impact determination in this GEIS, an applicant must resolve impacts using one of these four impact assessment methodologies and mitigation as noted below.

Impact Methodologies:

- The population-dose risk PPE value is based on the 1996 LR GEIS analysis of severe accidents, as augmented and updated by the 2013 and 2024 LR GEISs (NRC 1996-TN288, NRC 2013-TN2654, NRC 2024-TN10161), for bounding the frequency-weighted consequences of postulated severe accidents for new reactors when demonstrating compliance with the applicable Commission's regulations. Applicants may utilize 10 CFR 50.155 or FLEX (NEI 2016-TN10640) to address mitigation of beyond-design-basis events, or the applicant may demonstrate that the health effects are shown not to be significant, and therefore that no further mitigation is warranted (TN249).
- For an Exposure Index, the PPE value is based on the 1996 LR GEIS analysis of severe accidents, as augmented and updated by the 2013 and 2024 LR GEISs, bound the frequency-weighted consequences of postulated severe accidents for new reactors when demonstrating compliance with the applicable Commission regulations. Applicants may utilize 10 CFR 50.155 or FLEX to address mitigation of beyond-design-basis events, or the applicant may demonstrate that the health effects are shown not to be significant, and therefore that no further mitigation is warranted.
- The dose PPE value is based on applying the source term specified in 10 CFR 50.34(a)(1)(ii)(D), or the equivalent 10 CFR Part 52 regulation, with a non-intact containment or confinement, which is based primarily on the applicant or licensee utilizing RG 4.7, Appendix A, when assessing alternative approaches to addressing population-related siting considerations (NRC 1998-TN1008).[21] A new reactor that is co-located with an existing LWR may compare source terms to demonstrate that the LWR's severe accident risks bounds the new reactor's risks.
- Applicants may utilize 10 CFR 50.33(g)(2) (TN249) to demonstrate there is no plume exposure pathway Emergency Planning Zone, based primarily on meeting the Emergency Planning Zone (EPZ) regulations at the site boundary. The analysis required by 10 CFR 50.33(g)(2) could demonstrate that a spectrum of severe accidents have acceptable levels of offsite risk of health effects from radiation exposure in an emergency situation, while weighing costs and risks associated with any protective action (EPA 2017-TN5977).[22] Applicants may utilize 10 CFR 50.155 or FLEX to address mitigation of beyond-design-basis events, or the applicant may demonstrate that the health effects are shown not to be significant, and therefore that no further mitigation is warranted.

[21] NRC, Regulatory Guide 4.7, Rev. 2, General Site Suitability Criteria for Nuclear Power Stations, February 2024, Nuclear Regulatory Commission.
[22] EPA, "PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents EPA-400/R-17/001," January 2017, Environmental Protection Agency.

Mitigation Methodologies

- Utilizing 10 CFR 50.155 or FLEX addresses mitigation of beyond-design-basis events or applicant demonstrates that the health effects are shown not to be significant, and no further mitigation is warranted.
- The NRC staff may perform a cost-screening confirmatory spreadsheet evaluation as another measure of the low risk when population dose risk and offsite economic damage risk information are provided in the applicant's environmental report. This cost-screening applies the cost-benefit methodology and formulas under the current NRC cost-benefit regulatory analysis guidance to confirm no further mitigation is warranted due to a very low maximum benefit monetary value.

A severe accident mitigation analysis "in the most basic sense, is a cost-benefit analysis that addresses whether the expense of implementing a mitigation measure not mandated by the NRC is outweighed by the expected reduction in environmental cost it would provide in a core damage event."[23] Mitigation analyses are not meant to prevent an accident but rather to mitigate the severity should one occur.

If the Severe Accidents category is determined to be SMALL, then detailed mitigation analyses may not be needed, given that the definition of SMALL environmental impacts reads:

> SMALL – Environmental effects that are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. **For the purposes of assessing radiological impacts**, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered SMALL. [emphasis added]

This finding of SMALL radiological impacts is appropriate for large LWRs based on the analysis in the 2024 LR GEIS (NRC 2024-TN10161). All existing nuclear reactors have undergone at least one severe accident and a severe accident mitigation alternative (SAMA) review where the SAMA analysis accounts for societal and economic impacts. As also presented in the 2024 LR GEIS, a full SAMA analysis found that further mitigation was not warranted. The resulting severe accidents category finding for severe accidents and SAMAs in the 2024 LR GEIS therefore states:

> The probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and **societal and economic impacts** from severe accidents are small for all plants. Severe accident mitigation alternatives do not warrant further plant-specific analysis because the demonstrated reductions in population dose risk and continued severe accident regulatory improvements substantially reduce the likelihood of finding cost-effective significant plant improvements. [emphasis added]

Of specific note for evaluating new reactors, societal and economic impacts noted in the above 2024 LR GEIS (NRC 2024-TN10161) statement are impacts beyond radiological health impacts. As stated in 10 CFR 51.45(c) and 10 CFR 51.71(d) (TN250), the environmental analysis also needs to assess "alternatives available for reducing or avoiding adverse environmental effects." Thus, mitigation alternatives addressing adverse environmental effects need to not only assess radiological impacts but also would reduce or avoid societal and economic impacts of a severe

[23] Massachusetts v. NRC, 708 F.3d 63, 68 (1st Cir. 2013)

accident. Therefore, new and advanced reactors, given their design and potential siting differences from the nuclear reactors analyzed in the 2024 LR GEIS, would demonstrate that radiological impacts from severe accidents are SMALL and that further mitigation for avoiding or reducing societal and economic impacts is not warranted. The demonstration of such severe accident mitigation can be based on safety requirements of 10 CFR 50.155 (TN249), by committing to implement the nuclear industry's FLEX program, or that the health effects are shown not to be significant. Appendix I provides the NRC staff's detailed analysis for the development of the alternative PPE values. Since the NEPA process is the responsibility of the NRC, the NRC staff may perform a confirmatory and simple cost-screening analysis to assess the maximum benefit monetary value by leveraging the severe accident data (e.g., total release frequency or core damage frequency, population dose risk and offsite economic damage risk values) when available in the above PPE values.

Addressing Severe Accidents and Mitigation in a Construction Permit without a Probabilistic Risk Assessment

The issue of a construction permit application (CPA) lacking a probabilistic risk assessment (PRA) to support the environmental review was raised to the Commission in January 2015 by Enclosure 1 of SECY-15-0002, "Proposed Updates of Licensing Policies, Rules, and Guidance for Future Reactor Applications" (NRC 2015-TN6489). As noted in SECY-15-0002, there is not a regulatory requirement in 10 CFR Part 50 for the preliminary safety report (PSAR) submitted in the CPA to include a PRA. However, the basis for whether there would be enough information submitted in a CPA to allow an environmental assessment of severe accident risk and related mitigation will depend in a large part on the selection of and use of the PSAR guidance being applied by the construction permit (CP) applicant. This would depend on whether the PSAR that relies on a PRA follows RG 1.233 (NRC 2020-TN6441) and RG 1.253 (NRC 2024-TN12019) or applies the guidance and allowance for not including a PRA at the CP stage based on NUREG-0800, RG 1.70 (NRC 1978-TN4541), RG 4.7 (NRC 2014-TN3550), or other safety guidance.

Ultimately, the NRC safety staff will make the determination as to whether the PSAR submitted in the CPA is adequate or not when an initial PRA is not included. The CP applicant's environmental report should be addressing radiological issues, such as severe accidents and mitigation, consistent with the information in the PSAR. Therefore, the information in the PSAR will dictate how the NRC environmental staff can or cannot address environmental risks from severe accidents and mitigation at the CP stage. The CPA's PSAR and ER may note that a PRA would be developed with the necessary risk-information to support an environmental review of severe accidents and mitigation at the operating licensing (OL) stage under 10 CFR Part 50. In such a case, the severe accident and mitigation assessment by the NRC staff would be deferred to the OL stage. Alternatively, the ER, applying information from the PSAR, may apply one of the other PPE methodologies to demonstrate the severe accident health effects are not significant. Therefore, any prospective applicant for a CP should engage with the NRC staff during pre-application activities regarding the extent to which it plans to address severe accidents in the PSAR and ER at the CP and OL stages.

3.11.1.4 Acts of Terrorism

Previous U.S. Courts of Appeals decisions addressed the circumstances under which the NRC must assess the environmental impacts of potential acts of terrorism and sabotage. The U.S. Court of Appeals for the Ninth Circuit held that the NRC could not categorically refuse

to consider the consequences of a terrorist attack in an analysis under NEPA.[24] The Commission thereafter stated it would adhere to the Ninth Circuit's decision by considering the potential impacts of a terrorist attack in making licensing decisions for facilities located within the Ninth Circuit's jurisdiction but it would not consider terrorist attacks in licensing decisions outside of that court's jurisdiction.[25]

The U.S. Court of Appeals for the Third Circuit disagreed with the Ninth Circuit's analysis of NEPA case law.[26] Instead, as the Commission had originally held, the Third Circuit concluded that the issuance of a facility license would not be the "proximate cause" of a terrorist attack on the facility.[27] Moreover, the Third Circuit noted that the LR GEIS (NRC 1996-TN288) had reviewed the possible impacts of a sabotage event, which is a form of terrorism. The LR GEIS found that the consequences of a sabotage event would be no worse than those expected from an internally initiated severe accident. As a result, the Third Circuit found that, even if the Commission were required to analyze the impacts of a terrorist attack, the NRC could not have evaluated the risks more meaningfully than it had already done for internally initiated severe accidents.[28]

These court decisions related to NEPA evaluations of terrorist attacks and the NRC staff's subsequent evaluations to address them are discussed in Section E.3, Accident Risk and Impact Assessment, of Appendix E, Environmental Impact of Postulated Accidents, to the LR GEIS (NRC 2024-TN10161), and in Section 4.19, Potential Acts of Sabotage or Terrorism, of NUREG-2157 (NRC 2014-TN4117), which are incorporated herein by reference.

As a result of these court decisions, the NEPA evaluation of an application for a new reactor to be located at a site within the Ninth Circuit's jurisdiction would need to address acts of terrorism. For sites not within the jurisdiction of the Ninth Circuit, the NEPA evaluation would not address acts of terrorism.

As described in Appendix E of the LR GEIS (NRC 2024-TN10161) and in Section 4.19 of NUREG-2157 (NRC 2014-TN4117), the NRC will continue to address facility physical security measures, including the prevention of and response to terrorist attacks, through its ongoing regulatory and inspection processes. The NRC routinely assesses threats and other information provided by a variety of Federal agencies and sources. The NRC also ensures that licensees meet appropriate security-level requirements. In this regard, the NRC views facility physical security measures as a current, ongoing, and generic regulatory issue that affects all nuclear facilities.

3.11.2 Postulated Accidents Impacts

New reactor designs could be water-cooled large nuclear power plants (e.g., LWRs like the AP1000), water-cooled small modular reactors (e.g., the NuScale SMR), or non-LWRs (e.g., high temperature gas, molten salt, and liquid sodium cooled nuclear power plants). The risks from new reactor accidents may be limited. A major emphasis for the development of new

[24] *San Luis Obispo Mothers for Peace v. NRC*, 449 F.3d 1016 (9th Cir. 2006) (San Luis Obispo Peace v. Nuclear Regulatory 2006-TN6959).
[25] *AmerGen Energy Co. LLC* (Oyster Creek Nuclear Generating Station), CLI-07-8, 65 NRC 124, 126, 128 (NRC 2007-TN6957).
[26] *New Jersey Dept of Environmental Protection v. NRC*, 561 F.3d 132 (3rd Cir. 2009) (NJ Dept. of Environmental Protection v. NRC-TN6958).
[27] *Id.*, 561 F.3d at 140.
[28] *Id.*, 561 F.3d at 134, 136, 143-44.

reactors is the minimization (i.e., a very low probability of an accident with an offsite radiological or hazardous chemical release) or the elimination of radioactive or hazardous chemical releases from accidents. Thus, the risks from new reactor accidents may be limited as presented in the final safety analysis report (FSAR)/PSAR of the new reactor application. However, the NRC staff cannot prejudge the level of safety of a new reactor design a priori and, therefore, cannot rule out the need for a postulated accident analysis in future license applications. To this end, this section also incorporates the related guidance on postulated accidents and SAMAs from ISG-029, "Environmental Considerations Associated with Micro-reactors" (NRC 2020-TN6710).

To support the licensing of non-LWR designs, the staff developed and published 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* (NRC 2020-TN6441). The selection of licensing-basis events; classification and special treatments of structures, systems, and components; and assessment of defense-in-depth are fundamental to the safe design of non-LWRs. The guidance provided in RG 1.233 may assist in the development of the new reactor applicant's accident analysis in the FSAR/PSAR. Regardless of whether or not a new reactor applicant chooses to conform to RG 1.233, the applicant is required to provide an evaluation of events including accident analyses, and for Part 52 applicants, a description and the results of the project-specific probabilistic risk assessment in the FSAR/PSAR, which may be incorporated by reference in the new reactor application's ER in order to meet the PPE assumptions.

This section addresses all design types of new reactors because the accident analysis is tied to possible radioactive releases from postulated accidents and not for a specific type of new reactor design.

Based on the analyses in Section 3.11.1, the following five environmental issues related to impacts from postulated accidents associated with a new reactor are discussed:

- design basis accidents involving radiological releases
- design basis accidents involving releases of hazardous chemicals
- severe accidents
- severe accident mitigation design alternatives
- acts of terrorism.

3.11.2.1 Design Basis Accidents Involving Radiological Releases

The environmental guidance for LWR DBA evaluations is provided in the current versions of RG 4.2 (NRC 2026-TN11915) and Section 7.1 of NUREG-1555 (NRC 2013-TN3547). Prior LWR DBA environmental evaluations were slightly different than the DBA analysis considered in the safety reviews. Specifically, the environmental review of DBAs was based on applying dispersion coefficients based on 50th percentile weather data (i.e., "realistic" weather conditions) versus the 95th percentile weather data applied in the applicant's DBA analysis in Chapter 15 of the FSAR/PSAR. All other factors, such as accident categories and timeframes, were the same for the two assessments. At the conclusion of the staff's safety review, the applicant's DBA analysis would have to demonstrate to the staff that no regulatory limits were exceeded, in part, for the NRC to issue the license. This also meant that 50th percentile weather conditions used in the environmental DBA evaluation would also meet the same regulatory limits, resulting in an environmental finding of SMALL. However, given that the safety evaluation must reach a safety determination for DBAs for a license to be issued, it is reasonable to conclude that the staff can also reach an environmental finding of SMALL (i.e., by meeting

regulatory requirements for safety) by relying on the DBA analysis in the applicant's FSAR/PSAR. Therefore, in future new reactor applications, the staff should be able to incorporate by reference into the environmental evaluation the DBA analysis from the FSAR/PSAR and the staff's safety evaluation of DBAs.

DBAs involving radiological releases are a Category 1 issue. The FSAR/PSAR must demonstrate that the reactor falls within the regulatory limits discussed in Section 3.11.1; with incorporation by reference to the ER, the PPE values would be met, and the impacts would be SMALL. The staff relied on the following PPE assumptions to reach this conclusion:

- For the exclusion area boundary, the maximum TEDE for any 2-hour period during the radioactivity release should be calculated.
- For the low-population zone, the TEDE should be calculated for the duration of the accident release (i.e., 30 days, or other duration as justified).

The above calculations would compare the DBA doses with the dose criteria given in regulations related to the application (e.g., 10 CFR 50.34(a)(1) [TN249], 10 CFR 52.17(a)(1) and 10 CFR 52.79(a)(1) [10 CFR Part 52-TN251]), SRPs (e.g., SRP criteria, Table 1 in SRP Section 15.0.3 of NUREG-0800 [NRC 2007/2019-TN6221]), and RGs, (e.g., RG 1.183 [NRC 2000-TN517]), as applicable.

3.11.2.2 Accidents Involving Releases of Hazardous Chemicals

Accidents involving releases of hazardous chemicals are a Category 1 issue. The applicant can rely on the on the generic analysis in this GEIS if the new reactor inventories of regulated substances and EHSs are less than their TQs and TPQs, respectively, and the impacts would be SMALL. The staff relied on the following PPE assumptions to reach this conclusion:

- new reactor inventory of a regulated substance is less than its TQ. TQs are found in 40 CFR 68.130, Tables 1, 2, 3, and 4 (TN5494)
- new reactor inventory of an EHS is less than its TPQ. TPQs are found in 40 CFR Part 355, Appendices A and B (TN5493)

3.11.2.3 Severe Accidents

Severe accidents are a Category 1 issue based on PPE values provided below which meet the applicable permissible dose-base and risk-based acceptance criteria and requirements for mitigation within the Commission's regulations. To provide flexibility to a new reactor applicant, the NRC staff provide several alternative PPE values based on the accident analysis methodology selected to be presented in the FSAR/PSAR along with meeting the requirements of 10 CFR 50.155 (TN249) for mitigation. Applicants and licensees can implement further severe accident mitigation measures by adapting the voluntary FLEX program that provides additional resources to avoid or reduce impacts from beyond design basis events (NEI 2016-TN10640). The specific PPE values are as follows:

- Within the maximum PDR 95th confidence bounding value of 9.727×10^3 person-rem per reactor year (i.e., Indian Point Energy Center [Indian Point] Units 2 and 3) specified in the 1996 LR GEIS (NRC 1996-TN288) and demonstrating the utilization of 10 CFR 50.155 or FLEX to address mitigation of beyond-design-basis events. or
- Within the maximum 10 and 150 mi (16 and 240 km) Exposure Index at the 95th confidence bounding value of 1.896×10^4 and 2.864×10^6, respectively (i.e., Indian Point Units 2 and 3)

specified in the 1996 LR GEIS and demonstrating the utilization of 10 CFR 50.155 or FLEX to address mitigation of beyond-design-basis events. or

- Utilizing the source term from 10 CFR 50.34(a)(1)(ii)(D) (TN249), or the equivalent 10 CFR Part 52 regulation, with a non-intact containment or confinement for population density assessments under 10 CFR 100.21(h) (TN282) demonstrating a calculated TEDE of no greater than 1 rem over a period of 30 days wherein no further mitigation is necessary due to the health effects being shown not to be significant or a new reactor that is co-located with an existing LWR may compare its source terms to demonstrate that the LWR's severe accident risks bounds the new reactor's risks. or
- Utilizing 10 CFR 50.33(g)(2) to demonstrate there is no plume exposure pathway Emergency Planning Zone where the projected TEDE exceeds 1 rem over 96 hours (i.e., 10 CFR 50.33(g)(2)(i)(A)) and no further mitigation is necessary due to the health effects being shown not to be significant.

Applicants also have the option of performing a cost-screening analysis based on the regulatory analysis guidance to determine that the maximum benefit monetary value of avoiding an accident is so small that mitigation is not justified. The NRC staff may also perform such a cost screening as a confirmatory calculation.

3.11.2.4 Acts of Terrorism

The NRC staff has determined that the environmental impacts of acts of terrorism and sabotage only need to be addressed if a new reactor facility is subject to the jurisdiction of the U.S. Court of Appeals for the Ninth Circuit. Because the environmental impacts of a facility subject to the jurisdiction of this court cannot be determined without the consideration of project-specific factors, the potential impacts of terrorism and sabotage for these facilities would require a project-specific analysis. The necessary environmental evaluation would be performed based on the design features that provide for physical protection of the new reactor from acts of terrorism and sabotage. The impacts of acts of terrorism can be mitigated by complying with the physical protection requirements under 10 CFR Part 73 (TN423), *Physical Protection of Plants and Materials*, that provide reasonable assurance that the risk from sabotage is small. If a facility is not subject to the jurisdiction of the U.S. Court of Appeals for the Ninth Circuit, then this would be a Category 1 issue, since no other jurisdiction currently requires consideration of the consequences of a terrorist attack in an analysis under NEPA.

3.12 Socioeconomics

3.12.1 Baseline Conditions and PPE/SPE Values and Assumptions

Baseline conditions influencing potential socioeconomic resources associated with the building and operation of a new nuclear reactor include the economic and social service conditions found currently in the vicinity of the site. The analysis will depend on information supplied by the applicant. The applicable NRC guidance is Section 4.4 of RG 4.2, Revision 3, *Preparation of Environmental Reports for Nuclear Power Stations* (NRC 2026-TN11915).

The NRC's Environmental Standard Review Plan (NRC 2000, 2007-TN614) suggests beginning an analysis of the economic and demographic impacts of building and operating a nuclear power reactor on an area within a 50-mile radius from the proposed plant. Depending on the size and inherent safety features of new reactor designs, the radius of the analytical areas may be reduced from that starting point. The demographic region is the geographic area within

a defined radius from the site for which demographic data are analyzed. Facility sites are located within economic regions defined by the local labor market. The economic region for any facility is based on the geographic area from which the facility will draw its workforce—typically a grouping of counties surrounding the site. The economic region and the demographic region may not be the same size or shape.

The socioeconomic characteristics of potential sites for new reactors can vary widely, from sparsely populated remote outposts to industrial facilities located in major metropolitan centers. Thus, the staff adopted PPE/SPE values that are proportional metrics based on percentage changes from baseline conditions, rather than absolute values.

The PPE and SPE assume that most socioeconomic impacts are driven by changes in the local workforce employed as a result of the proposed action. The in-migration of workers and their families into an economic region for project building and operations, including outage activities, imposes new demands on local infrastructure and community services. Previous new reactor reviews also have shown that traffic impacts on local access routes may be greater than minor, but not typically destabilizing. Beneficial impacts from increased tax revenues associated with the increased assessed value of new reactor projects also tend to be noticeable within the affected economic region or local taxing jurisdiction.

Based on staff experience with new license applications for large LWRs, the NRC staff has developed PPE/SPE values for each socioeconomic resource, which, if met, allow the staff to reach a generic conclusion of beneficial or SMALL adverse impacts for that resource. The principal assumption is that the project-related workforce together with associated families would not result in a net increase in the population of the economic region that would be greater than the planned growth for that region by local agencies over the same time period. Based on workforce migration into the economic region, staff determined demand increases for infrastructure (e.g., housing availability) and services (e.g., public schools) would not result in specific thresholds being crossed. Similarly, the staff assumes that the LOS values for the affected roadways would not change as a result of the added traffic pressure from the project workforce traffic.

In summary, the NRC staff provides the following PPE/SPE values (also summarized in Appendix G):

- The peak project-related in-migrating workforce including families does not exceed established local planning and growth projections for infrastructure and service demands.
- The housing vacancy rate in the affected economic region does not change by more than 5 percent, or at least 5 percent of the housing stock remains available.
- The student:teacher ratios in the affected economic region’s classrooms do not exceed locally mandated levels after including the school age children of the in-migrating worker families.
- The LOS determination for affected roadways does not change with the addition of the commuting patterns of the building or operations workforce.

3.12.2 Socioeconomic Impacts

Socioeconomic impacts from new reactors would occur during the building and operations phases of the project. Impacts are linked to the size of the local workforce during site preparation and the construction of safety-related facilities such as the nuclear island and non-

safety-related facilities such as cooling towers, administration buildings, parking lots, switchyards, and any onsite and offsite pipelines, access roads, and transmission lines. Many smaller new reactors may lack cooling towers, switchyards, or offsite pipelines or transmission lines and may require a site of only a few acres. Larger new reactors may require some or all of these support facilities and hence require larger sites. During operations, the principal socioeconomic impacts would be from employment of the operations workforce and tax revenue generated based on the assessed value of the project.

3.12.2.1 Socioeconomic Consequences of Construction

Historically, the staff's evaluation of socioeconomic impacts for building a new reactor primarily focused on the in-migration of construction workers and their resulting impacts on local community resources and infrastructure, and related economic impacts. These impacts can vary considerably from site to site and between building and operations. The NRC staff identified four socioeconomic issues for analysis of building a new reactor:

- community services and infrastructure demands (specifically, housing and schools) altered by construction workers and families migrating to the local economic region; traffic impacts on local site access roadways and associated road networks; economic impacts such as employment, economic output, and local labor income; and
- tax revenue impacts, such as sales and property taxes.

3.12.2.1.1 Community Services and Infrastructure

To the degree that the size of the construction project requires the acquisition of workers from outside the economic region, impacts related to worker migration would be expected. These impacts occur as workers, including families, relocate temporarily or permanently to be closer to the site. Impacts from local workers already residing within the economic region are assumed to result in no net changes in service demands across the economic region, except as a part of traffic impacts.

The impacts of migration from outside the economic region are found by obtaining the applicant's estimate of the peak construction workforce anticipated to come from outside the economic region. In recent new reactor reviews, the NRC staff evaluated the impacts from in-migrating workers and their families in the context of the local planning authority's estimate of population growth in the economic region. If the percentage of in-migrating construction workers and their families relative to the total population of the economic region is less than the planned rate of population growth in the economic region during the construction period, the reviewer can determine the construction-related impact on housing, community services, and infrastructure are within the planning authority's management capabilities and, therefore, would be minor.

Recent new reactor reviews have shown that the principal community service affected by building a new reactor is public school systems. As families migrate into the economic region, local schools may observe increased class sizes at all levels. The PPE value of student:teacher ratio is the principal metric used to assess classroom crowding impacts. The NRC staff assumes that the impact of the new students would be minor as long as the addition of new students from in-migrating worker's families does not increase the student:teacher ratio beyond the locally mandated level.

Based on recent reviews of new reactors, the key infrastructure impact metric is housing availability. This metric is assessed in terms of the proportion of the housing stock that is available for residency. The staff assumes that the combination of available unoccupied single-family dwellings and rental housing should remain greater than 5 percent in a healthy housing market with relatively stable prices. The impact on housing would be minor, if the addition of the in-migrating workers does not change the housing supply by 5 or more percent, or if the available number of rental units in the economic region is 5 percent or more after accounting for the rental units needed for the in-migrating construction workers.

Experience reviewing new reactors has shown that other community service and infrastructure impacts are generally minor. These include impacts on first-responder resources, public utilities including potable water resources, health care resources, and other public services (e.g., community aid providers).

The staff has determined that the public school system and housing availability are the most likely places where impacts on community services and infrastructure can be observed during building of a new reactor. The staff concludes that, as long as the applicable PPE and SPE assumptions are met, the community services and infrastructure impacts from building a new reactor can be generically determined to be SMALL and mitigation would not be warranted. Therefore, the socioeconomic impacts from building a new reactor are a Category 1 issue. The staff relied upon the following PPE assumptions to reach this determination:

- The housing vacancy rate in the affected economic region does not change by more than 5 percent, or at least 5 percent of the housing stock remains available after accounting for in-migrating construction workers.
- Student:teacher ratios in the affected economic region do not exceed locally mandated levels after including the school age children of the in-migrating worker families.

3.12.2.1.2 Transportation Systems and Traffic

Facility building activities result in physical impacts on two aspects of local transportation systems in the vicinity of the site: improvements and repairs to roads in anticipation of the project, and traffic-related impacts (the decline in road service quality from construction worker commutes). Transporting materials and equipment to the proposed site may require the applicant to build or refurbish access roads, heavy-haul roads, rail spurs, and barge landing facilities. Local road access routes also may see increased wear from building-related traffic associated with the workforce commuting and deliveries. Experience from previous NEPA reviews of large nuclear power plant construction shows the adverse impacts of making road improvements are typically minor and temporary.

Construction-related traffic impacts occur as construction-related truck traffic and the workforce travel to and from the site in competition with the baseline local traffic. At the peak of building employment, these impacts can be substantial, depending on the characteristics of the access route(s). To give context to any expected traffic impacts affecting the site and local vicinity, the NRC staff uses baseline traffic statistics for the principal roadway access routes to and from the site. State and County transportation departments typically publish annual average daily traffic counts (FHWA 2018-TN6584) at key points of principal roads and highways. In addition, the NRC staff analyzes LOS information (FHWA 2017-TN6585) used by transportation planners for principal road access routes. Table 3-8 provides a summary of LOS values.

Table 3-8 Level of Service Value Descriptions

Level of Service	General Operating Conditions
A	Free flow, with low volumes and high speeds.
B	Reasonably free flow, but speeds beginning to be restricted by traffic conditions.
C	Stable flow, but most drivers are restricted in the freedom to select their own speeds.
D	Approaching unstable flow; drivers have little freedom to select their own speeds.
E	Unstable flow; may be short stoppages.
F	Forced or breakdown flow; unacceptable congestion; stop-and-go.

One indicator of a noticeable impact would be a change in a LOS value for a specific roadway. The PPE and SPE values and assumptions analyzed in this GEIS assume no change in a LOS value as a result of increased traffic during peak building activities. The staff assumes such impacts would be of temporary duration (months) and limited to typical day-shift commuting patterns for the affected roadways. Section 4.4 of RG 4.2, *Preparation of Environmental Reports for Nuclear Power Stations* (NRC 2026-TN11915) regarding traffic studies and the timing of peak building activities recommends that the applicant use LOS studies to demonstrate that its project falls within the PPE value.

The NRC staff has determined that as long as the applicable PPE and SPE values and assumptions are met, the traffic impacts and impacts on the local transportation systems from building a new reactor can be generically determined to be SMALL and a Category 1 issue. The staff relied upon the following PPE assumptions to reach this determination:

- The LOS determination for affected roadways does not change. Mitigation measures may include implementation of traffic flow management, management of shift-change timing, and encouragement of ride-sharing and use of public transportation options, such that LOS values can be maintained with the increased volumes.

3.12.2.1.3 Economic Impacts

Building new reactor projects has financial and economic impacts on the economic region. These impacts include construction-related expenditures expected to be made by the applicant in the local economy, wages and salaries to be paid to construction workers, and the associated economic activity enabled by these expenditures. Depending on the size of the local economy, these beneficial impacts may range from substantial in small rural economies to minimal in large metropolitan economies, when viewed in the context of the overall economic activity in the region.

The NRC staff has assessed the economic impacts of building new nuclear reactors since 2005. To estimate the economic impacts of anticipated construction-related expenditures made in the local economy, the NRC relies upon simple economic input-output modeling of those expenditures to reveal the economic multiplier effect, which estimates the gross output, employment, and income effects of the direct local expenditures. Economic multiplier effects depend on several factors including the size of the initial annual expenditures and the diversity of the local economy. Economic diversity refers to how fast local expenditures leak from the economy as various rounds of economic activity occur. The more diverse the structure of the local economy, the longer direct expenditures will circulate in the economy, generating a higher multiplier effect and greater total impact on output, employment, and income. Because sites can be located in widely varying local economies, economic multiplier values range widely—typically

between 1.5 and 4. For example, in the case of an employment multiplier of 3, this indicates that for each direct job created by the construction expenditures, an additional two jobs are also added as a result of the economic activity generated by the one direct construction job. The economic impacts of construction and operation of a new reactor are expected to be beneficial; therefore, this is a Category 1 issue. If, during the project-specific environmental review, the NRC staff determines that detailed analysis of economic costs and benefits is needed for analysis of the range of alternatives considered or relevant to mitigation, the staff may require further information from the applicant.

3.12.2.1.4 Tax Revenue Impacts

While the greatest tax revenue impacts are generally associated with plant operations, some revenue impacts would be expected during the building of a plant. These include any local sales and use taxes paid on local or in-State purchases, service fees from local regulatory bodies (local licenses and permits, etc.), any local taxes paid by in-migrating workers and their families, or payments in lieu of taxes arranged by agreement between the applicant and the jurisdiction. Each site will have differing conditions and agreements with applicants and their contractors and thus revenue impacts during building must be considered site by site. For example, some States and local governments may offer incentives for new industrial construction projects, such as deferred property taxes or sales tax exemptions, which might minimize State and local tax revenues compared to other sites where such incentives are not offered.

As with economic impacts, the scale of construction-related tax revenue impacts attributable to the proposed action may range from substantial in small rural economies to minimal in large metropolitan economies, when viewed in the context of baseline revenues of the affected taxing jurisdiction(s) and the size of the proposed action. The staff concludes that if the new reactor project would not generate tax revenues exceeding 5 percent of the revenue of any affected jurisdiction or taxing authority during building, then the impacts would be minor and may be offset by other year-to-year changes in local revenues.

The tax revenue impacts of construction and operation of a new reactor are expected to be beneficial; therefore, this is a Category 1 issue. If, during the project-specific environmental review, the NRC staff determines detailed analysis of tax revenue costs and benefits is needed for analysis of the range of alternatives considered or relevant to mitigation, the staff may require further information from the applicant.

3.12.2.2 Socioeconomic Consequences of Operations

The staff's evaluation of socioeconomic impacts for operating a new reactor focused on workforce-induced migration, the resulting impacts on local community resources and infrastructure, and related economic impacts. Tax revenue impacts from an operating reactor facility also provide beneficial impacts on local taxing jurisdictions. These impacts can vary considerably from site to site and between building and operations. The NRC staff identified four environmental issues for analysis of operation of a new reactor:

- community services and infrastructure demands (e.g., housing, schools) altered by operations workers and families migrating into the local economic region; and
- traffic impacts on local site access roadways and associated road networks.
- economic impacts such as employment, economic output, and local labor income; and
- tax revenue impacts, such as sales and property taxes.

3.12.2.2.1 Community Services and Infrastructure

Based on experience with large LWRs in the current fleet, the staff assumes that a new reactor's operations workforce is smaller than its construction workforce, but their presence would be more permanent. The increased number of workers at nuclear power plants during regularly scheduled plant refueling and maintenance outages creates a short-term increase in the demand for temporary housing units in the region around each plant, generally in local hotels and motels, but also in campgrounds and recreational vehicle parks. However, because of the short duration and the repeated nature of these scheduled outages, as well as the general availability of rental housing units (including portable trailers) in the vicinity of nuclear power plants, employment-related housing impacts would have little or no long-term impact on the price and availability of rental housing. Refurbishment or unit replacement impacts would be similar to what is experienced during routine plant refueling and maintenance outages. Consequently, the staff determined that if the PPE assumption holds, the building-related impacts on housing are a Category 1 issue. The staff relied upon the following PPE assumption to reach this determination:

- The housing vacancy rate in the affected economic region does not change by more than 5 percent, or at least 5 percent of the housing stock remains available after accounting for in-migrating operations workers.

Experience reviewing new reactors has shown that the operations-related impacts of other community service and infrastructure resources are bounded by the building-related impacts and are generally minor. These include impacts on first-responder resources, public utilities including potable water resources, health care resources, and other public services (e.g., community financial aid providers, etc. Minor impacts on public school systems might be expected because of the addition of children of the operations workforce, as families migrate into the economic region. However, because much of the building workforce would leave the area once operation begins, the impacts of the in-migrating operations workforce would be bounded by the size of the construction workforce's impact on the school system. If the building impacts on schools met the criteria for a Category 1 issue, then the operations impacts on housing and schools, being bounded by that, must also be Category 1 issue. The staff concludes that, as long as the applicable PPE and SPE assumptions are met, the community services and infrastructure impacts from operating a new reactor can be generically determined to be SMALL and mitigation would not be warranted. Therefore, the socioeconomic impacts from operating a new reactor are a Category 1 issue. The staff relied upon the following PPE assumptions to reach this determination:

- Student:teacher ratios in the affected economic region do not exceed locally mandated levels after including the school age children of the in-migrating worker families.

3.12.2.2.2 Transportation Systems and Traffic

Transportation impacts depend on the size of the workforce, the capacity of the local road network, traffic patterns, and the availability of alternate commuting routes to and from the plant. Because most sites have only a single access road, there is often congestion on these roads during shift changes. Because rail and barge facilities would only be used intermittently during operations, only minimal physical impacts on transportation systems, apart from roadways (e.g., rail or barge facilities), would be expected during operations.

The transportation impact of plant operations would be bounded by the peak construction employment-related impacts and is not likely to result in degradation of LOS values.

Operations-related transportation impacts continue for the life of the plant and become well established within the affected communities for all nuclear power plants. The increased number of workers at nuclear power plants during outage activities including unit replacement creates a short-term increase in traffic volumes, and this impact would vary based on the site location and size of the plant. Refurbishment impacts including unit replacement would be similar to what has been experienced during routine plant refueling and maintenance outages. However, because of the relative short duration of these outages, increased traffic volumes have had little or no lasting impact. Therefore, as long as LOS values for affected roadways do not degrade, there would be minor traffic impacts during operations.

The staff has determined that transportation system and traffic impacts during operations of a new reactor are a Category 1 issue, as long as the applicable PPE and SPE assumptions are met. The staff assumes any mitigation measures needed to be able to rely on this GEIS for construction impacts would be continued during operations, such that LOS values can be maintained with expected volumes during operations. The staff relied upon the following PPE assumptions to reach this determination:

- The LOS determination for affected roadways does not change. Mitigation measures may include implementation of traffic flow management, management of shift-change timing, and encouragement of ride-sharing and use of public transportation options, such that LOS values can be maintained with the increased volumes.

3.12.2.2.3 Economic Impacts

Economic multiplier effects during operations, including outages or unit replacement activities, would be bounded by peak construction-related economic impacts, and the staff assumes that at least minor beneficial economic impacts, such as induced increases in local employment, labor income, and output, would result. The magnitude of these impacts would depend on the size and diversity of the local economy. For most anticipated new reactor projects covered by this GEIS, these impacts would be minor in the context of the economic region in which they would occur.

The economic impacts of construction and operation of a new reactor are expected to be beneficial; therefore, this is a Category 1 issue. If, during the project-specific environmental review, the NRC staff determines the need for detailed analysis of economic costs and benefits is needed for analysis of the range of alternatives considered or relevant to mitigation, the staff may require further information from the applicant.

3.12.2.2.4 Tax Revenue Impacts

Nuclear power plants and the workers who operate them are an important source of tax revenue for many local governments and public school systems. Tax revenues from nuclear power plants mostly come from property tax payments or other forms of payments such as payments in lieu of (property) taxes, or payments in lieu of taxes payments, although taxes on energy production have also been collected from a number of nuclear power plants. County and municipal governments and public school districts receive tax revenue either directly or indirectly through State tax and revenue-sharing programs.

In addition to the potentially substantial contribution of property tax revenues, County and municipal governments in the vicinity of an operating nuclear power plant also receive tax revenue from sales taxes and service fees from the power plant and its employees. Changes in the number of workers and the amount of taxes paid to counties, municipal governments, and public schools can affect socioeconomic conditions in the counties and communities around the nuclear power plant.

Outage activities including unit replacement are not expected to have a noticeable effect on the assessed value of nuclear plants, thus only minimal changes in tax revenues would be anticipated from future refurbishment activities. Refurbishment activities involving the one-for-one replacement of existing components and equipment are generally not considered a taxable improvement. The addition of any nuclear reactor units beyond the scope of the license may result in increased assessed value but would be considered under separate licensing actions. Also, property tax assessments; proprietary payments in lieu of taxes stipulations, settlements, and agreements; and State tax laws are continually changing the amount of taxes paid to taxing jurisdictions by nuclear plant owners. These changes are independent of operations activities.

The tax revenue impacts of construction and operation of a new reactor are expected to be beneficial; therefore, this is a Category 1 issue. If, during the project-specific environmental review, the NRC staff determines the need for detailed analysis of tax revenue costs and benefits is needed for analysis of the range of alternatives considered or relevant to mitigation, the staff may require further information from the applicant.

3.13 (Withdrawn)

3.14 Fuel Cycle

3.14.1 Baseline Conditions and PPE/SPE Values and Assumptions

3.14.1.1 Uranium Fuel Cycle Environmental Data

As discussed in Section 3.12.1.1, Uranium Fuel Cycle, of the LR GEIS NRC 2024-TN10161), the NRC evaluated the environmental impacts that would be associated with operating uranium fuel cycle facilities other than reactors in two NRC documents: WASH-1248 (AEC 1974-TN23) and NUREG-0116 (NRC 1976-TN292). The types of facilities and their environmental impacts considered in these two documents include:

- uranium mining – facilities in which the uranium ore is mined;
- uranium milling – facilities in which the uranium ore is refined to produce uranium concentrates in the form of triuranium octaoxide;
- uranium hexafluoride (UF_6) production – facilities in which the uranium concentrates are converted to UF_6;
- isotopic enrichment – facilities in which the isotopic ratio of the uranium-235 (U-235) isotope in natural uranium is increased to meet the requirements of LWRs;
- fuel fabrication – facilities in which the enriched UF_6 is converted to uranium dioxide (UO_2) and made into sintered UO_2 pellets. The pellets are subsequently encapsulated in fuel rods, and the rods are assembled into fuel assemblies ready to be inserted into the reactors;

- reprocessing – facilities that disassemble the spent fuel assemblies, chop up the fuel rods into small sections, chemically dissolve the spent fuel out of sectioned fuel rod pieces, and chemically separate the uranium in spent fuel from the plutonium for reuse and other radionuclides (primarily fission products and actinides); and
- disposal – facilities in which the radioactive wastes generated at all fuel cycle facilities, including the reactors, are buried. Spent nuclear fuel (SNF) that is removed from the reactors and not reprocessed was also assumed to be disposed of at a geologic repository.

In addition to impacts occurring at the above facilities, the impacts associated with the transportation of radioactive materials among these facilities, including the transportation of wastes to disposal facilities, were evaluated. The results were summarized in a table and promulgated as Table S-3 in 10 CFR 51.51(b) (TN250). The analysis in WASH-1248 is based on the principal environmental considerations for each component of the nuclear fuel cycle, and the aggregate considerations, normalized to the annual fuel requirement of a 1,000 MWe (3,000 MWt) model LWR are summarized for the nuclear fuel cycle in Table S-3 (AEC 1974-TN23). This normalization is called the “annual model LWR fuel requirement” throughout WASH-1248 (AEC 1974-TN23).

Figure 3-4 displays the uranium fuel cycle for the majority of pathways. Table S-3 addresses their environmental impacts related to the uranium fuel cycle, but this does not include mixed oxide fuel, as shown in the figure. Additional details about the nuclear fuel cycle are provided in Section 1.1, Uranium Fuel Cycle, of a Pacific Northwest National Laboratory (PNNL) report prepared for the NRC (Napier 2020-TN6443). The assumption applied for Table S-3 regarding plutonium recovered from recycling was that the recovered plutonium would be placed into storage for future use (see Figure S-1 of WASH-1248 [AEC 1974-TN23]).

The 1996 version of the LR GEIS (NRC 1996-TN288) found the once-through, low-enriched uranium (LEU) fuel cycle to be a Category 1 issue with environmental findings of SMALL. This result was codified into regulations and the findings are provided in 10 CFR Part 51 (TN250), Appendix B, Table B-1, *Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants*. The 2013 LR GEIS (NRC 2013-TN2654) reassessed the environmental effects listed in Table S-3 and concluded that no new information has been identified that would alter the conclusion in the 1996 version of the LR GEIS. The analyses provided in the 2013 LR GEIS are incorporated by reference into this analysis. There are potential fuel cycle options regarding fast spectrum MSRs, as described by Holcomb et al. (e.g., LWR-derived TRU burner) (Holcomb et al. 2011-TN6943), but they are not considered in this GEIS because of the continuing development of the related technology bases.

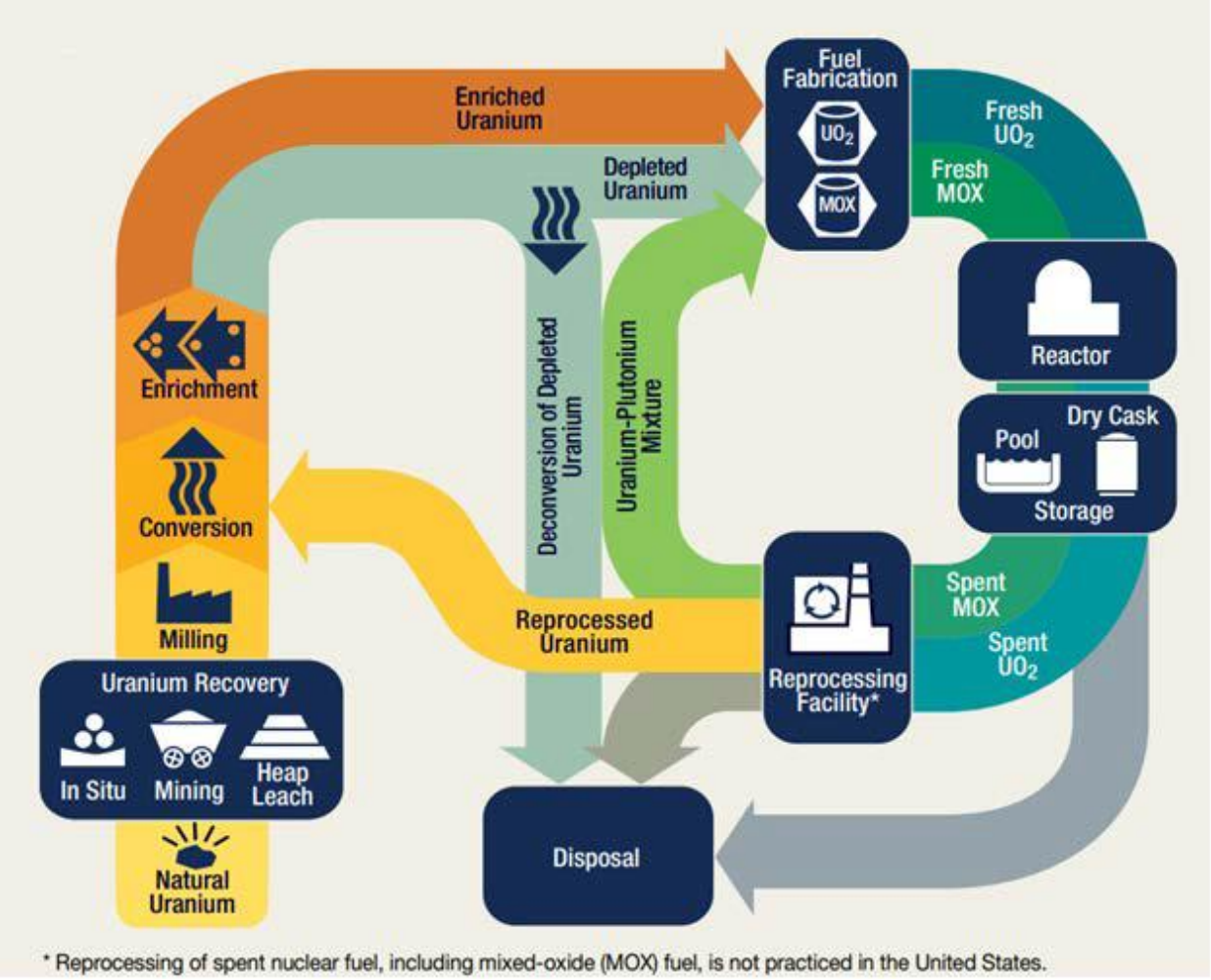

Figure 3-4 Options of the Current Fuel Cycle which Includes the Table S-3 Uranium Fuel Cycle. Source: NRC 2019-TN6652.

3.14.1.2 Other Fissile Fuel Cycles

Fuel cycles based on fissile or fertile materials other than uranium are possible, such as a thorium fuel cycle in which thorium is irradiated to create fissile uranium-233 (U-233). This fuel cycle thus would start with mining of thorium, rather than uranium, and would require irradiation of the thorium in a reactor using U-235–based fuel to generate the necessary U-233. Thorium is a commercially available material already mined and processed for use in a variety of commercial products, such as an alloying element in magnesium and in the manufacturing of lenses for cameras and scientific instruments (RSC 2020-TN6442). Because this fuel cycle requires neutron transmutation of thorium-232 (Th-232) to U-233 (typically considered to be from fission of U-235 but could also be from fission of plutonium-239 [Pu-239]), it can be considered to be partially part of the uranium cycle of Figure 3-4 and partially a separate cycle. The processes associated with thorium mining, milling, fuel fabrication, reactor use, storage, reprocessing, and waste disposal should be similar to, but distinct from, those for the uranium fuel cycle. Enrichment of thorium is unnecessary; however, irradiated thorium requires processing to obtain the U-233 necessary to this fuel cycle (WNA 2017-TN6668). Thus, a thorium fuel cycle should only significantly differ from uranium in that conversion of uranium to a gas (UF_6) and subsequent enrichment processes are omitted after initial thorium fuel cycle

startup; however, reprocessing would be an additional step currently not seen in the once-through uranium fuel cycle. The NRC staff assumes that the thorium fuel cycle will not be significantly different than the uranium fuel cycle, therefore the uranium fuel cycle impacts should bound the thorium fuel cycle impacts.

3.14.1.3 DOE High-Assay Low-Enriched Uranium Availability Program

The High-Assay Low-Enriched Uranium (HALEU) Availability Program by DOE was developed to secure a domestic supply of HALEU fuel following the Energy Act of 2020 (DOE 2024-TN9790).

> The HALEU Availability Program will acquire HALEU through purchase agreements with domestic industry partners and produce limited initial amounts of material from DOE-owned assets. The HALEU Availability Program is intended to spur demand for additional HALEU production and private investment in the nation's nuclear fuel supply infrastructure – ultimately removing the federal government's initial role as a supplier. (DOE 2024-TN9790)

As of the writing of this NR GEIS, DOE has identified and contracted with partners for enrichment services for the production of HALEU as uranium hexafluoride (DOE 2025-TN11939). Additionally, DOE has identified and contracted with partners for deconversion of HALEU stored as uranium hexafluoride to other chemical forms (i.e., metal or oxide) for fuel fabrication purposes (DOE 2025-TN11941). Finally, DOE has awarded contracts for HALEU criticality benchmarks to assist in the transport package licensing and certification process (DOE 2024-TN11956). The development of criticality benchmarks is intended to support further DOE funding opportunities that would result in an NRC Certified HALEU transportation package.

DOE has established a HALEU Consortium to further these efforts. The purposes of the consortium are to:

- Identify demand estimates for domestic commercial use.
- Purchase HALEU made available to members for commercial use.
- Conduct HALEU demonstration projects.
- Identify HALEU supply chain improvements and reliability.

The environmental impacts of the DOE HALEU program have been assessed in DOE/EIS-0559, *Draft Environmental Impact Statement for Department of Energy Activities in Support of Commercial Production of High-Assay Low-Enriched Uranium (HALEU)* (DOE 2024-TN11957). At the time of writing, DOE has established a HALEU Consortium to inform the DOE on future HALEU fuel requirements, complete demonstration projects using HALEU fuel, purchase HALEU for distribution to members for commercial use and identify actionable steps to improve the HALEU supply chain. Purchased HALEU will be distributed through the HALEU Availability Program to members of the consortium (DOE 2025-TN11671).

3.14.1.4 Nuclear Fuel Cycle Regulatory Requirements for New Reactors

As provided in 10 CFR 51.51(a) (TN250), the environmental data of Table S-3 only apply to CP, operating license (OL), ESP, or COL applications for light-water-cooled nuclear power reactors. However, as required in 10 CFR 51.50(b)(3) and 51.50(c) for other than light-water-cooled nuclear power reactors (i.e., non-LWRs), an ER for an ESP or a COL shall contain the basis for

evaluating the contribution of the environmental effects of fuel cycle activities for the nuclear power reactor. Any new reactor SNF container (i.e., a storage cask or a transportation container or package) or an ISFSI and dry transfer system (DTS) facilities for the reactor's SNF must satisfy the regulatory requirements of 10 CFR Part 71 (TN301), *Packaging and Transportation of Radioactive Material*, 10 CFR Part 72 (TN4884), *Licensing Requirements for the Independent Storage of Spent Fuel, High-Level Radioactive Waste, and Reactor-related Greater Than Class C Waste*, and 10 CFR Part 73 (TN423), *Physical Protection of Plants and Materials.* Any fuel cycle facility must satisfy the regulatory requirements of 10 CFR Part 40 (TN4882), *Domestic Licensing of Source Material,* and 10 CFR Part 70 (TN4883), *Domestic Licensing of Special Nuclear Material*. Any fuel cycle reprocessing must meet the regulatory requirements of 10 CFR Part 50 (TN249), *Domestic Licensing of Production and Utilization Facilities*.

3.14.1.5 Changes in the Nuclear Fuel Cycle since WASH-1248

Many of the nuclear fuel cycle facilities and processes assessed for Table S-3 still exist today. However, some have undergone several industrial developments and technological advances that have significantly reduced their environmental effects. As discussed in NUREG-2226, the Clinch River ESP FEIS (NRC 2019-TN6136), recent changes in the uranium fuel cycle may have some bearing on environmental impacts. As discussed below, the staff is confident that the contemporary normalized uranium fuel cycle impacts for LWRs are less than those identified in Table S-3. This assertion is true in light of the following recent uranium fuel cycle trends in the United States:

- Increasing use of in situ leach uranium mining, which does not produce mine tailings and would lower the release of radon gas. A discussion of this subject is provided in Section 3.14.2.1.
- Transitioning of U.S. uranium enrichment technology from gaseous diffusion to gas centrifugation. The latter process uses only a fraction of the electrical energy per separation unit compared to gaseous diffusion and U.S. gaseous-diffusion plants that relied on electricity derived mainly from the burning of coal. A discussion of this subject is provided in Section 3.14.2.3.
- Current LWRs are using nuclear fuel more efficiently because of higher levels of fuel burnup. Thus, less uranium fuel per year of reactor operation is required than in the past to generate the same amount of electricity (an increase in the time for refueling (from 12 months to 18 months or greater) as applied for Table S-3).

The values in Table S-3 were calculated from industry averages for the performance of each type of facility or operation within the fuel cycle. Recognizing that this approach meant that there would be a range of reasonable values for each estimate, the staff chose the assumptions or factors to be applied so that the calculated values would not be underestimated. This approach was intended to make sure that the actual environmental impacts would be less than the quantities shown in Table S-3 for all LWR nuclear power plants within the widest range of operating conditions. The staff recognizes that many of the fuel cycle parameters and interactions vary in small ways from the estimates in Table S-3 and concludes that these variations would have no impacts on the Table S-3 calculations. For example, to determine the quantity of fuel required for a year's operation of a nuclear power plant in Table S-3, the staff defined the reference reactor as a 1,000 MW LWR operating at 80 percent capacity with a 12-month fuel-reloading cycle and an average fuel burnup of 33,000 megawatt-day(s) per metric ton of uranium (MWd/MTU). The current LWR fleet is operating with an average factor

approximately 95 percent capacity for peak fuel rod burnup of up to 62,000 MWd/MTU with refueling occurring at approximately 2-year intervals (NRC 2019-TN6136).

The Table S-3 analysis from the 1970s was also based on most of the electricity generated in the United States being produced in plants that burn fossil fuels and coal composing the bulk of fossil-fuel utilization (AEC 1974-TN23). However, today the energy sources for utility-scale electrical generation are very diverse with (DOE/EIA-TN10133):

- only 19.5 percent from coal;
- 39.8 percent from natural gas, for which air emissions are much less than those from coal;
- 18.2 percent from nuclear power plants;
- 21.5 percent from renewables (15.3 percent from non-hydroelectric renewables and 6.2 percent from hydroelectric); and
- Less than 1 percent from petroleum and other sources.

Therefore, environmental impacts related to air emissions, associated pollutants, and water/thermal impacts from today's electrical generation contribution to the nuclear fuel cycle are clearly less and are bounded by the coal-electrical generation data assessed by WASH-1248 (AEC 1974-TN23) and found in Table S-3. This trend of decreasing reliance on fossil fuels for electrical generation will continue, spurred by actions to combat climate change (DOE/EIA 2020-TN6653). Additional information concerning GHG emission from the fuel cycle is discussed in Section 3.3.2.2.2.

Based on several of the items discussed above, the 2013 revision of the LR GEIS states:

> It was concluded that even though certain fuel cycle operations and fuel management practices have changed over the years, the assumptions and methodology used in preparing Table S-3 were conservative enough that the impacts described by the use of Table S-3 would still be bounding.

With Table S-3 still bounding for particular parts of the LWR nuclear fuel cycle, the following sections provide a brief background on the components of the nuclear fuel cycle and discuss their current situation with respect to Table S-3 regarding the advanced nuclear fuel cycle since the publication of the 2013 revision to the LR GEIS (NRC 2013-TN2654).

3.14.1.6 PPE Assumptions

As discussed above, a review of past LWR projects has revealed a number of trends, which the staff assumes will continue for the fuel cycle for new reactors. Therefore, the following assumptions are made regarding these trends for establishing the PPE for the various new reactor fuel cycle components and are discussed in Section 3.14.2, Fuel Cycle Impacts:

- increasing use of in situ leach uranium mining,
- transitioning of U.S. uranium enrichment technology from gaseous diffusion to gas centrifugation for enrichment levels of up to 20 percent,
- using fuel more efficiently in the current LWRs due to higher levels of fuel burnup,
- discharging of fewer spent fuel assemblies per reactor-year, and
- relying less on coal-fired electrical generation plants.

In addition, the following are not part of the above-listed current once-through uranium fuel cycle trends, but could be applicable to new reactor fuel cycles:

- Sources of enriched lithium would be from U.S. stockpiles or from foreign sources (Napier 2020-TN6443; GAO 2013-TN6960).
- The reprocessing capacity would be up to 900 MTU/yr based on analysis in WASH-1248 (AEC 1974-TN23).
- Uranium fuel cycle impacts will bound the thorium fuel cycle impacts.

The PPE also assumes that the regulatory requirements of 10 CFR Part 40 (TN4882), *Domestic Licensing of Source Material*; 10 CFR Part 50 (TN249), *Domestic Licensing of Production and Utilization Facilities*; 10 CFR Part 70 (TN4883), *Domestic Licensing of Special Nuclear Material*; 10 CFR Part 71 (TN301), *Packaging and Transportation of Radioactive Material*; 10 CFR Part 72 (TN4884), *Licensing Requirements for the Independent Storage of Spent Fuel, High-Level Radioactive Waste, and Reactor-related Greater Than Class C Waste*; and 10 CFR Part 73 (TN423), *Physical Protection of Plants and Materials,* are also met.

3.14.2 Fuel Cycle Impacts

The NRC must still evaluate nuclear fuel cycle impacts of the non-LWR fuels to meet its obligations under NEPA, as has been done for UO_2 fuels for LWRs. The NRC has generically evaluated the environmental effects of the nuclear fuel cycle[30] for LWRs that use uranium fuel. The results of the evaluation are presented in 10 CFR 51.51 (TN250), Table S-3, Table of Uranium Fuel Cycle Environmental Data. However, the environmental data of Table S-3 can only be applied to LWRs that use UO_2 fuel. New reactor developers are expected to predominately still use enriched uranium fuel with close to 20 percent by weight enrichment, also known as high-assay low-enriched uranium or HALEU. Several of the potential non-LWR designs are expected to deploy non-UO_2 fuels (e.g., uranium metal, uranium carbide, uranium in a molten salt, etc.) or rely on recycled fissile material. Some new reactor developers intend to build on a thorium/U-233 fuel cycle. To the extent practicable, this section assesses the nuclear fuel cycle for new reactors for the expected environmental effects compared to the environmental data provided in Table S-3 where possible.

The NRC staff identified six environmental issues for analysis of fuel cycle impacts associated with a new reactor:

- uranium recovery,
- uranium conversion,
- enrichment,
- fuel fabrication,
- reprocessing, and
- storage and disposal of radiological wastes.

[30] In the United States, all currently operating commercial plants are LWRs that use uranium for fuel. Therefore, in this section the term “uranium fuel cycle” is used to describe the current use of nuclear fuel where the principal fissile material is U-235. The term “nuclear fuel cycle” includes the use of other fissile nuclides, such as U-233 applied in a thorium-based fuel cycle.

3.14.2.1 Uranium Recovery

As indicated on the NRC's public website, uranium recovery focuses on extracting (or mining) natural uranium ore from the Earth and concentrating (or milling) that ore (NRC 2020-TN6444). These recovery operations produce a product, called "yellowcake," which is then transported to a fuel cycle facility. There, the yellowcake is transformed into fuel for nuclear power reactors. In addition to yellowcake, uranium recovery operations generate waste products, called byproduct materials, that contain low levels of radioactivity.

For mining activities, the regulatory responsibility depends on the extraction method that the given facility uses. Specifically, conventional mining (where uranium ore is removed from deep underground shafts or shallow open pits) is regulated by the Office of Surface Mining, the U.S. Department of the Interior, and the individual States in which the mines are located. By contrast, the NRC regulates in situ recovery (formerly known as in situ leach recovery), where the uranium ore is chemically altered underground before being pumped to the surface for further processing. Currently, the NRC regulates active uranium recovery operations in New Mexico and Nebraska, but does not directly regulate the active uranium recovery operations in Wyoming, Texas, Colorado, and Utah, because they are Agreement States, meaning that they have entered into strict agreements with the NRC to exercise regulatory authority over this type of material (NRC 2023-TN10135). In situ leach recovery is also subject to the EPA Underground Injection (UIC) program as a class III injection activity (40 CFR Part 144-TN11921, 40 CFR Part 146-TN7203).

The NRC has provided information about the past and current practices for uranium recovery on the NRC's public website (NRC 2020-TN6827). The table provided on the public website compares the features of the three main types of uranium recovery facilities, namely conventional uranium mills, heap leach/ion-exchange facilities, and in situ recovery facilities.

In general, the primary industrial hazards associated with uranium milling are the occupational hazards found in any metal milling operation that uses chemical extraction, as well as the chemical toxicity of the uranium itself (NRC 2020-TN6444). Because the uranium produced at these facilities is not enriched, there is no criticality hazard and little fire or explosive hazard. Radiological hazards are also low at these facilities, because uranium has little penetrating radiation and only moderate non-penetrating radiation. The primary radiological hazard is attributable to the presence of radium in the waste byproduct material (known as "mill tailings").

To facilitate the agency's review of in situ recovery applications, in May 2009 the NRC staff published the *Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities* (NUREG-1910; NRC 2009-TN2559), which addresses common environmental issues associated with the construction, operation, and decommissioning of facilities, as well as the groundwater restoration at such in situ recovery facilities, if they are located in particular regions of the western United States (NRC 2020-TN6828). In addressing environmental issues common to the in situ recovery process, the NRC staff applied the generic environmental impact statement for In Situ Leach Uranium Milling Facilities (In Situ Recovery GEIS) as the starting point for its project-specific environmental review of license applications for new in situ recovery facilities. Completed project-specific environmental reviews of new in situ recovery facilities can be found at https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1910/ (NRC 2020-TN6829). The analysis of the In Situ Recovery GEIS is incorporated by reference.

The Prohibiting Russian Uranium Imports Act, H.R. 1042, bans the import of Russian uranium (DOE 2024-TN10150). H.R. 1042 passed in the U.S. House of Representatives in December

2023 and the U.S. Senate in April of 2024 and was signed by the U.S. President in May 2024 (NuclearNews 2024-TN10151). The law will allow short-term waivers for Russian imports through 2027 subject to limitations (NuclearNews 2024-TN10151), which should reduce but may not fully eliminate the importation of uranium from Russia. Once fully in effect, it is reasonable to expect uranium recovery operations to increase in the United States. This ban does not preclude import of uranium from other international sources, such as Kazakhstan, Canada, Namibia, or Australia.

The analyses for Table S-3 regarding uranium recovery were predicated on active uranium mining, heap leaching, and large industrial milling facilities (see Appendix C of the In Situ Recovery GEIS [NRC 2020-TN6828]). There were no active heap leaching sites, 1 active underground uranium mining site, and 7 active in-situ leaching uranium mining sites in 2024 (DOE/EIA 2025-TN12425). As indicated in the In Situ Recovery GEIS, in situ recovery has removed many of the causes of harmful uranium recovery impacts because this process does not directly remove the uranium ore from a site, transport the uranium ore to a large milling facility, and process large volumes of uranium ore that produce tailing piles and leachate ponds and the associated release of radon gas. Thus, the in situ recovery process avoids many of the environmental impacts of these past uranium recovery processing steps. Therefore, the environmental impacts for in situ recovery are expected to be less than those listed in Table S-3 for uranium recovery facilities and the impacts would be SMALL. This is a Category 1 issue. The staff relied on the following PPE assumptions to reach this conclusion:

- Table S-3 is expected to bound the impacts for new reactor fuels, because of uranium fuel cycle changes since WASH-1248 (AEC 1974-TN23), including:
  - Increasing use of in situ leach uranium mining has lower environmental impacts than traditional mining and milling methods.
  - Current LWRs are using nuclear fuel more efficiently due to higher levels of fuel burnup resulting in less demand for mining and milling activities.
  - Less reliance on coal-fired electrical generation plants resulting in less gaseous effluent releases from electrical generation sources supporting mining and milling activities.
- Must satisfy the regulatory requirements of 10 CFR Part 40 (TN4882) Domestic Licensing of Source Material and 10 CFR Part 71 (TN301), Packaging and Transportation of Radioactive Material

3.14.2.2 Uranium Conversion

The processing involved in converting triuranium octaoxide, (also called “yellowcake”) into UF_6 for ease of use in uranium enrichment facilities remains the same as that analyzed for Table S-3. The only UF_6 conversion facility in the United States—the Metropolis Works uranium conversion facility operated by Honeywell International Inc.—is in Metropolis, Illinois (NRC 2020-TN6837), and is currently in “Operational/idle-ready” status (NRC 2023-TN10140). Honeywell believes they will be ready to support HALEU demand in the future (DOE 2024-TN11957).

Accident tolerant fuel (ATF) deployment and use with increased enrichment levels would result in greater amount of yellowcake being processed during uranium conversion to UF_6 to support increased enrichments. By applying the UxC Fuel Cost Calculator (UxC 2023-TN8086), increasing enrichment to 8 wt% U-235 would need approximately 2.1 times more yellowcake feedstock than the 4 wt% U-235 that underscores Table S-3 environmental data. Increasing

enrichment to 10 wt% U-235 would require approximately 2.6 times more yellowcake for UF_6 conversion than for 4 wt% U-235. Furthermore, increasing enrichment to 20 wt% U-235 would require approximately 5.2 times more yellowcake for UF_6 conversion than for 4 wt% U-235 (UxC 2023-TN8086).

The NRC staff assumes that environmental and process control improvements along with new or amended Federal or State environmental regulations since the publication of WASH-1248 in 1974 would reduce operating uranium conversion facility environmental impacts, maintaining them within those listed in Table S-3. For example, the RCRA (42 U.S.C. §§ 6901 et seq.; TN1281) was passed into law in 1976 (EPA 2020-TN6963). Additionally, Honeywell has completed treatment upgrades to the environmental protection facility to provide enhancements to meet new fluoride discharge limits (NRC 2019-TN6964). Therefore, NRC staff assumes Table S-3 will still bound the environmental impacts of a uranium conversion facility operating today and would be SMALL. This is a Category 1 issue. The staff relied on the following PPE assumptions to reach this conclusion:

- Table S-3 is expected to bound the impacts for new reactor fuels, because of uranium fuel cycle changes since WASH-1248 (AEC 1974-TN23), including:
  - Current LWRs are using nuclear fuel more efficiently due to higher levels of fuel burnup resulting in less demand for conversion activities.
  - Less reliance on coal-fired electrical generation plants resulting in fewer gaseous effluent releases from electrical generation sources supporting conversion activities.
- Must satisfy the regulatory requirements of 10 CFR Part 40 (TN4882) *Domestic Licensing of Source Material* and 10 CFR Part 71 (TN301), *Packaging and Transportation of Radioactive Material*, and 10 CFR Part 73 (TN423), *Physical Protection of Plants and Materials.*

3.14.2.3 Enrichment

The uranium enrichment process has undergone significant changes since the analysis of Table S-3 provided in WASH-1248 (AEC 1974-TN23) and NUREG-0116 (NRC 1976-TN292). That analysis was based on gaseous-diffusion enrichment, which had large energy requirements and the electricity needed to run the process was produced by coal-electrical generation plants that featured large air emissions and other environmental conditions, as noted in Table S-3.

Gaseous-diffusion enrichment was the first commercial process used in the United States to enrich uranium. The enrichment facilities used massive amounts of electricity and as the centrifuge enrichment technology matured the existing gaseous-diffusion plants became obsolete (NRC 2020-TN6836). Worldwide they have all been replaced by second-generation technology, i.e., centrifuge enrichment technology, which requires far less electric power to produce equivalent amounts of separated uranium. One such nuclear power plant with centrifuge enrichment technology is the Centrus Energy Corp nuclear power plant located on a DOE reservation in Piketon, Ohio (NRC 2023-TN10142); Centrus Energy Corp has successfully demonstrated its HALEU production process and is expanding HALEU production to the rate of 900 kg per year (CEC 2023-TN10144). Another gas centrifuge enrichment facility is the Louisiana Energy Services (LES) facility in Eunice, New Mexico (NRC 2024-TN10145) which has been enriching up to 5 wt% Uranium-235 since 2010 (Urenco 2024-TN10146) and has submitted a license amendment request to enrich up to 10 wt% (Urenco 2024-TN10147). Historically, there were two gaseous-diffusion plants under NRC purview in the United States which have been shutdown, namely the facilities at Paducah, Kentucky, and Portsmouth, Ohio

(NRC 2020-TN10162). DOE now holds the certificates for these plants and is in charge of the safe decommissioning (SAFSTOR) of these gaseous-diffusion plants (DOE Undated-TN10148, DOE Undated-TN10149).

There is a significant difference in energy use between gaseous-diffusion and centrifuge enrichment technologies. Separative work unit, or SWU, is the standard measure of the effort required to separate isotopes of uranium (U-235 and uranium-238 [U-238]) during an enrichment process and is independent of the enrichment process (either gaseous or centrifuge). Using a SWU calculator (UxC 2023-TN8086) to obtain 1,000 kg of 4 percent by weight enriched uranium, assuming 0.25 wt% of U-235 in the tails, from a related amount of natural uranium requires 5,832 SWUs, and to obtain 1,000 kg of 20 percent by weight enriched uranium (HALEU) requires 41,576 SWUs. The gaseous-diffusion process consumes about 2,500 kilowatt-hour (kWh) per SWU, while modern gas centrifuge plants require only about 50 kWh per SWU (WNA 2020-TN6661). Thus, a centrifuge enrichment facility would consume approximately 2,100,000 kWh to reach 20 wt% uranium enrichment, while a gaseous-diffusion plant would need approximately 14,600,000 kWh to reach the 4 wt% uranium enrichment analyzed in WASH-1248 (AEC 1974-TN23) and assessed in Table S-3. Therefore, for the enrichment of uranium, Table S-3 would bound the environmental impacts from a centrifuge enrichment facility to produce HALEU and the impact would be SMALL. This is a Category 1 issue. The staff relied on the following PPE assumptions to reach this conclusion:

- Table S-3 is expected to bound the impacts for new reactor fuels, because of uranium fuel cycle changes since WASH-1248 (AEC 1974-TN23), including:
  - Transitioning of U.S. uranium enrichment technology from gaseous diffusion to gas centrifugation which requires less electrical usage per SWU.
  - Current LWRs are using nuclear fuel more efficiently due to higher levels of fuel burnup resulting in less demand for enrichment activities.
  - Less reliance on coal-fired electrical generation plants resulting in fewer gaseous effluent releases from electrical generation sources supporting enrichment activities.
- Must satisfy the regulatory requirements of 10 CFR Part 40 (TN4882) *Domestic Licensing of Source Material*, 10 CFR Part 70 (TN4883), *Domestic Licensing of Special Nuclear Material*, 10 CFR Part 71 (TN301), *Packaging and Transportation of Radioactive Material*, and 10 CFR Part 73 (TN423), *Physical Protection of Plants and Materials.*

3.14.2.4 Fuel Fabrication

Fuel fabrication facilities will need to be licensed, constructed, and operated to produce the necessary new reactor fuel types. The NRC currently regulates several different types of nuclear fuel fabrication operations. For commercial nuclear power plant fuel, three fuel fabrication plants processing LEU (up to 5 percent by weight enrichment of U-235) are currently licensed by the NRC (2020-TN6835):

- Global Nuclear Fuel-Americas in Wilmington, North Carolina;
- Westinghouse Columbia Fuel Fabrication Facility in Columbia, South Carolina; and
- Framatome, Inc. (Framatome), in Richland, Washington.

Two other fuel fabrication plants licensed by the NRC produce nuclear fuel for the U.S. Navy and can downblend highly enriched uranium (HEU) with other uranium to create LEU reactor fuel for commercial nuclear power plants. These are the Nuclear Fuel Services plant in Erwin, Tennessee, and the BWX Technologies, Inc. (BWXT) Nuclear Operations Group plant in

Lynchburg, Virginia. All five of the abovementioned fuel fabrication facilities were in operation at the time of the WASH-1248 study, as were five other fuel fabrication facilities (AEC 1974-TN23).

In Appendix E of WASH-1248 (AEC 1974-TN23), a model fuel fabrication plant that had a capacity of 3 MTU per day and operated 300 days per year was used to assess environmental impacts. The model plant lifetime was taken to be 20 years. WASH-1248 also assumed that the electricity used in fuel fabrication facilities came from coal power plants; some natural gas was used for process heat and other external resources involved land use and water. At the time of WASH-1248, fuel fabrication facilities applied a wet process method for UF_6 to UO_2 conversion, which involves the use of ammonium hydroxide to form an intermediate ammonium diuranate (ADU) compound prior to final conversion to UO_2.

While WASH-1248 notes that a dry conversion process (DCP) was under development at that time, several of the above mentioned fuel fabrication facilities now apply a dry process (AEC 1974-TN23). The ADU process was recognized as creating greater waste management problems than the dry process. The Global Nuclear Fuel-Americas facility converted to DCP in 1997 (NRC 2009-TN6663) and the Framatome facility converted in 1998 (NRC 2009-TN6664). The BWXT facility currently only packages customer-provided uranium fuel material into fuel assemblies (NRC 2003-TN6665). The Nuclear Fuel Services facility could provide a variety of nuclear fuel services such as converting HEU into LEU or HALEU for use in commercial nuclear power plants (NRC 2011-TN6666). Only the Westinghouse Columbia Fuel Fabrication Facility currently applies the ADU process for final conversion to commercial nuclear fuel (NRC 2019-TN6472). Available capacity information for the three commercial nuclear fuel fabricators is provided in Table 3-9. Note that the rod and assembly capacity number may not be similar to the conversion and pelletizing capacity because UO_2 pellets could be provided from an outside source and the fuel fabricator is only inserting these outside source fuel pellets into cladding pins and then combining them into fuel assemblies.

Table 3-9 Light-Water Reactor Fuel Fabrication Capacity

Fabricator	Location	Conversion		Pelletizing		Rod/Assembly	
		MTU/yr[(a)]	MTU/d[(b)]	MTU/yr[(a)]	MTU/d[(b)]	MTU/yr[(a)]	MTU/d[(b)]
Framatome, Inc.	Richland, Washington	1,200	3.4	1,200	3.4	1,200	3.4
Global Nuclear Fuel – Americas	Wilmington, North Carolina	1,200	3.4	1,000	2.9	1,000	2.9
Westinghouse	Columbia, South Carolina	1,600	4.6	1,594	4.6	2,154	6.2

(a) WNA 2021-TN10153.
(b) The metric tons of uranium per day (MTU/d) value is based on a current fuel fabrication facility operating schedule of 350 days per year as opposed to the 300 days assumed in WASH-1248 (AEC 1974-TN23).

WASH-1248 states that most of the airborne chemical effluents result from the combustion of fossil fuels to produce electricity to operate the fabrication plant (AEC 1974-TN23). As previously described, a large percentage of electricity production today is from generation sources other than coal. Thus, existing and any new fuel fabrication facilities would have lower air emissions than those assessed in WASH-1248. The level of environmental impacts for other aspects of fuel fabrication, as presented in Appendix E of WASH-1248, are provided in Table 3-10.

The establishment of commercial fuel fabrication process lines for new reactor designs has yet to occur (at the time of publishing this GEIS). It is expected that the majority of new reactor fuel

will use HALEU, but it might not be in the form of UO_2 sintered pellets. New reactor fuel forms could be TRi-structural ISOtropic (TRISO) fuel, uranium metal, uranium compound in a molten salt, or in another yet unidentified form. In addition, there is the potential for a new reactor, likely a MSR design, to be designed with a thorium-based fuel cycle using fissile U-233 (WNA 2017-TN6668).

Table 3-10 WASH-1248 Fuel Fabrication Environmental Impacts (AEC 1974-TN23)

Environmental Impact	Value	WASH-1248 Comments
Site Size (acres)	A few acres up to a few thousand acres	Less than 5 percent of that committed by the rest of the fuel cycle
Building Size (ft^2)	100,000	-
Annual Water Consumption (gal)	5,200,000	About 0.05 percent of that used by the model LWR evaluated by WASH-1248
Power Required (MW and megawatt-hour [MWh])	6 MWe and 1,700 MWe-hr	About 0.5 percent of the electricity of the enrichment plant evaluated by WASH-1248
Annual Natural Gas Usage for Process Heat (ft^3)	3,600,000	About 4 percent of that consumed by the total nuclear fuel cycle
Liquid Waste Stream Volume (gpd)	25,000	Combined with about 425,000 gpd of process cooling water in the holding ponds prior to release offsite
Annual Solid Waste Volume (MT)	680	Calcium fluoride precipitate from the liquid waste stream for retaining on site (11 yd^3)
Annual Gaseous Airborne Activity Released (Ci)	0.005	Less than 0.1 percent of the applicable 10 CFR Part 20 (TN283) limit
Annual Liquid Activity Released (mCi)	40	Less than 10 percent of 10 CFR Part 20 (TN283) limits for release to an unrestricted area
Annual Solid Activity for Disposal (mCi)	25	Activity shipped per annual fuel requirement

"-" denotes no data in table cell.

3.14.2.4.1 TRISO Fuel Fabrication

As described in the previously mentioned PNNL report (Napier 2020-TN6443), TRISO fuel is composed of fuel particles or seeds less than 1 mm in diameter. Each has a kernel (ca. 0.5 mm) of uranium oxycarbide (or UO_2), and the uranium is likely to be enriched up to 20 wt% of U-235. This kernel is surrounded by layers of carbon and silicon carbide, giving a containment for fission products that is expected to be stable up to very high temperatures (up to 1,600°C (Napier 2020-TN6443). There are two ways in which these particles can be arranged: either in blocks—hexagonal "prisms" of graphite; or in billiard ball-sized pebbles of graphite encased in silicon carbide, each with about 15,000 fuel particles and 9 g of uranium. Either way, the moderator is graphite. A description of a TRISO fuel fabrication process is also provided in PNNL-29367 and includes the related environmental emissions (Napier 2020-TN6443).

In the United States, BWXT is making HALEU TRISO fuel on an engineering scale, funded by DOE, and in October 2019 the company announced a planned expansion to commercial scale within 3 years (WNA 2021-TN10153). As presented in a DOE categorical exclusion document supporting this work (DOE 2020-TN6735), HEU material would be shipped from the Y-12 National Security Complex in Oak Ridge, Tennessee, to the BWXT facility in Erwin, Tennessee, for conversion from HEU metal to HEU oxide. BWXT would then ship the HEU oxide to the

BWXT fuel fabrication plant in Lynchburg, Virginia, for downblending and TRISO fabrication. BWXT was tasked with producing 100 kg of TRISO HALEU fuel. In November 2020, BWXT announced it had completed its TRISO nuclear fuel line restart project and is actively producing fuel at its Lynchburg facility (BW 2020-TN6756). Test samples of the BWXT TRISO fuel have been irradiated and examined at the Idaho National Laboratory (INL) Advanced Test Reactor (Nagley 2020-TN6739). In 2022 the Department of Defense Strategic Capabilities Office selected BWXT for creation of the Project Pele microreactor. The reactor core will use TRISO produced by BWXT (BWXT 2022-TN10154). The production of this TRISO fuel is being conducted under existing NRC special nuclear material (SNM) licenses and associated environmental assessments (EAs). For the BWXT Lynchburg facility, the license renewal EA, issued in 2006 for a 20-year period under Materials License SNM-42, concluded the BWXT operations would not result in a significant impact on the environment where airborne and liquid effluent releases along with public and occupational doses are below regulatory limits (71 FR 16348-TN6785). Therefore, this EA covers the environmental impact of producing 100 kg of TRISO HALEU fuel under DOE funding.

A potential new fuel fabricator for TRISO is X-Energy LLC (X-Energy 2020-TN6736). X-Energy has also been producing TRISO fuel on an engineering scale and announced irradiation testing in May 2020 to be performed at the Massachusetts Institute of Technology Nuclear Reactor Laboratory's 6 MW Massachusetts Institute of Technology reactor (WNN 2020-TN6740). X-Energy developed a pilot TRISO fuel fabrication process and presented an overview of this process to the NRC and during a national HALEU webinar (Pappano 2018-TN6738, Pappano 2020-TN6737). In 2022, TRISO-X LLC, a subsidiary of X-Energy LLC, applied for an NRC license for a HALEU fuel fabrication facility in Oak Ridge, Tennessee; development of an EIS for this facility is ongoing (87 FR 77146-TN11958).

In 2023, Ultra Safe Nuclear Corporation (USNC) and Framatome established a joint venture to produce TRISO (Framatome 2023-TN10158). USNC has constructed a pilot fuel fabrication facility for production of TRISO fuel. USNC has produced TRISO for the National Aeronautics and Space Administration, though for use as a nuclear propulsion technology for spacecraft (USNC 2023-TN10159). The production of this TRISO fuel is being conducted under existing NRC SNM licenses and associated EAs. Operation of the facility is covered by the Framatome license SNM-1227 and its associated EAs.

A direct comparison of existing ADU and DCP fabrication and industry-level TRISO fuel fabrication processes cannot be made at this time. The BWXT TRISO work is being conducted under an existing NRC SNM license but production quantity is limited. Based on the available public information, once the UF_6 feedstock is converted to a solid form, the X-Energy TRISO-X process and NRC's experience with BWXT TRISO fuel fabrication licensing both have similar steps that feature environmental impacts comparable to or less than those of the ADU (the fuel fabrication process associated with Table S-3) and the current DCP fuel fabrication processes (Pappano 2020-TN6737).

3.14.2.4.2 Metallic Uranium Fuel Fabrication

It is anticipated that several new reactor designs, such as microreactors and liquid sodium-cooled reactors, could use a form of metal uranium alloy fuel. Such a fuel type has been employed in a variety of research and test reactors. Supplies of metallic HALEU could become available to commercial developers, at least initially, from DOE's surplus HEU stockpiles. One initial source of metallic uranium is recycled material from the Experimental Breeder Reactor-II (EBR-II) at INL, but it could also be provided by DOE if surplus HEU from the U.S. government's

nuclear weapons program is made available for commercial nuclear fuels. The uranium material from EBR-II, up to 10 MT, will be melted into ingots and could be cast into reactor components (DOE 2019-TN6757). INL has developed the Hybrid Zirconium Extraction process, which is used to remove cladding from the fuel, thereby allowing downblending of metallic HEU into HALEU casting (INL 2019-TN6758). The first castings for a new reactor were made in late 2019 (Morning Consult 2019-TN6759). INL is also prepared to recover up to 10 MT of former EBR-II fuel for transition into appropriate fuel forms for new reactor fuel developers (DOE 2023-TN10160). INL awarded 5 MT of the former EBR II fuel to Oklo Inc. for recycling and repurposing for Oklo's design (DOE 2023-TN10160).

For the case where the initial supply of metallic uranium fuel for a new reactor is supplied from DOE's surplus HEU stock, all of the environmental impacts prior to fuel fabrication already occurred during U.S. government processes years ago. HALEU fuel could use processed spent EBR-II fuel (DOE/EA-2087; DOE 2019-TN6757). Thus, any environmental impacts from the processing of metallic fuel from DOE sources for new reactors related to past mining, milling, enrichment, and conversion have been accounted for in the WASH-1248 analysis (AEC 1974-TN23) and are provided in Table S-3. If the HALEU feedstock is taken from unprocessed irradiated fuel (i.e., EBR-II or spent Navy fuel), then there will be an environmental impact associated with reprocessing the irradiated fuel, likely similar to the impacts associated with previously processed irradiated EBR-II fuel, as described in DOE/EA-2087 (DOE 2019-TN6757). Thus, future commercial production of metallic HALEU fuel would have environmental impacts similar to those previously discussed for all steps prior to fuel fabrication.

An overall fuel fabrication process is presented in Section 1.1 of the PNNL report entitled *Metal Fuel Fabrication Safety and Hazards* (LaHaye and Burkes 2019-TN6961). The metal fuel fabrication steps, as provided by LaHaye and Burkes (2019-TN6961), are as follows:

1. Feedstock must be prepared from ore. This includes dissolution, purification, and chemical conversion to the desired chemical state for the next step. Feedstock can also be prepared from used fuel through reprocessing. Enrichment will typically take place between purification and conversion to the final chemical state for reduction but is outside the scope of this effort. (These steps are addressed previously in this section of this GEIS.)
2. Feedstock must then be reduced to metal. This is traditionally achieved by bomb/metallothermic reduction, but other means can also be employed to convert feedstock to metal.
3. The metal is alloyed with the desired alloying agent(s) to create a binary, ternary, or other alloy.
4. The alloy is cast to form a fuel billet.
5. The fuel billet is machined and/or thermomechanically processed to get it into a desired form.
6. The formed fuel billet is clad and collected into fuel assemblies.

Each of the above metal fuel fabrication process steps is described in detail in subsequent sections by LaHaye and Burkes (2019-TN6961) and is incorporated by reference.

For assessing the environmental impacts of metal fuel fabrication, the level of impacts is likely to vary with the source of metal fuel feedstock. If the fuel material is being supplied directly from the enrichment facility or was from downblended HEU, the only radiological hazard would be from the uranium itself. Such a feedstock source should also not need any further purification.

For recycled or reprocessed used fuel, the purification to remove fission products and TRU elements could be an initial step in the metal fuel fabrication facility. The effectiveness of this purification process in removing the highly radioactive non-fuel nuclides could affect the kind of processing protections (e.g., remote operations in a highly shielded hot cell versus a glovebox) necessary in the subsequent fabrication steps.

Outside of the expected radiological impacts, the effluent releases and wastes streams from the above process steps are not expected to be significantly different than those of most metal fabrication facilities. As described by the European Bank for Reconstruction and Development (EBRD Undated-TN6941) and by LaHaye and Burkes (2019-TN6961), there are likely to be a number of waste streams from metal fabrication. Air emissions from volatile chemicals, fumes, and dust/particulates would be generated from various process steps involving melting, degreasing, cleaning, welding, and grinding operations. Solid waste in the form of chips and scrap metal could be generated from machining, milling, and thermomechanical treatments. Wastewater could also be generated containing various chemical wastes due to the mentioned degreasing, cleaning, treatments, and grinding operations.

The NRC staff assumes a metal fuel fabrication facility would have the appropriate process controls (e.g., glove boxes and hot cells as appropriate), ventilation filters (e.g., high-efficiency particulate air [HEPA] and charcoal filter beds), and monitoring to minimize the amount of waste generated and associated environmental impacts. Environmental impacts could be bounded by current fuel fabrication processes. However, there could be noticeable waste streams from casting and from stabilizing uranium scraps (LaHaye and Burkes 2019-TN6961). Therefore, due to the lack of environmental impact information for new reactor metal fuel fabrication, the NRC staff cannot readily assess an environmental impact for such fuel fabrication in relationship to WASH-1248 and Table S-3.

3.14.2.4.3 Nuclear Fuel in Molten-Salt Reactors

A new reactor classified as a MSR is one where a molten salt is used as the working fluid for heat, transferring the energy from the nuclear core to an industrial process, such as electrical generation or industrial heat processes. The nuclear fuel could be in a form described above in the MSR's own fuel channel. There are also proposed MSR designs in which the nuclear fuel will be mixed in the molten salt and the reactor will be specifically designed so that the reactor vessel's configuration is such that the nuclear core physics support criticality (i.e., a liquid-fuel MSR). As indicated by the World Nuclear Association (WNA), "in the normal or basic MSR concept, the fuel is a molten mixture of lithium and beryllium fluoride salts with dissolved LEU (U-235 or U-233) fluorides (UF_4)" (WNA 2021-TN7072). As further indicated by the WNA, "chloride salts have some attractive features compared with fluorides, in particular the actinide trichlorides form lower melting point solutions and have higher solubility for actinides so can contain significant amounts of transuranic elements" (WNA 2021-TN7072). The type of nuclear fuel could be based on any of the fissile isotopes in the form of HALEU U-235, a mixture of uranium and plutonium (TRU mixture with U-235, Pu-239, and U-238 in a fast neutron spectrum), or thorium-based U-233. A number of MSR developers are examining a variety of molten-salt types (Flanagan 2017-TN6742). Discussions of nuclear fuel salts likely to be employed in MSRs (chloride- and fluoride-based salts) and the general characteristics of reactors that would use those types of salts are provided in Chapter 2 of McFarlane et al. (2019-TN6741).

Two prior productions of liquid-fuel MSRs could be used as an indication of the fuel preparation impacts for this type of nuclear fuel (McFarlane et al. 2019-TN6741): the Aircraft Reactor Experiment (ARE) in 1954, and the Molten-Salt Reactor Experiment (MSRE). McFarlane et al. (2019-TN6741) provide a description of the processing of the ARE fuel in Section 2.2.1 of their report, Fuel Loading at ARE:

> At the ARE, Na_2UF_6 was added to an initially barren mixture of sodium and zirconium fluorides. The procedure to add the ARE fuel involved the successive connection of numerous small concentrate containers to an intermediate transfer pot. The pot was then connected to the fuel system, which injected the concentrate into the pump tank above the liquid level. Since the ARE was not optimized for breeding, its fuel salt contained a higher concentration of uranium. The ARE final fuel mixture consisted of 53.09 mole percent NaF, 40.73 mole percent ZrF_4, and 6.18 mole percent UF_4, with ^{235}U enriched to 93.4 weight percent. The ARE fuel salt ^{235}U concentration was increased 8.8 percent over the course of operations (from 0.383 g/cc to 0.416 g/cc) as operational power was increased.

McFarlane et al. (2019-TN6741) provide the following description of the MSRE fuel in Section 2.2.2 of their report, Fuel Loading at MSRE:

> The MSRE reactor fuel mixture nominally consisted of 65 ^{7}LiF, 29.1 BeF_2, 5 ZrF_4, and 0.9 UF_4 (mole percent). At MSRE, ^{7}LiF-UF_4 (73-27 mole %) was separately synthesized and incrementally dissolved into barren carrier salt to start and maintain nuclear operation. Both the MSRE coolant and the flush salt were a binary mixture of 66 mole percent LiF in BeF_2. Initial operation employed 33 weight percent enriched uranium. The operational fuel salt volume was roughly 2,067 liters. All of the lithium used was assayed to be at least 99.99 percent ^{7}Li. In 1968, the uranium was removed from the fuel salt and replaced with nearly pure ^{233}U. The last few refueling capsules in 1969 contained PuF_3 (94 weight percent ^{239}Pu).

McFarlane et al. (2019-TN6741) discuss the processes for synthesizing the carrier salt and related chemical hazards in Chapter 3 of their report. In addition, it is expected there would be onsite processing to add fissile material and to remove certain fission products to maintain MSR operations. While these processes would be like other industrial hazards associated with producing chloride- and fluoride-based compounds, they were not part of the analysis in WASH-1248 (AEC 1974-TN23) and are not addressed in Table S-3.

An additional consideration for the liquid-fuel MSRs is that the fission products dissolved in the fuel salt could be continuously removed in an adjacent online reprocessing loop and replaced with fissile uranium, plutonium and other actinides, or, potentially, fertile Th-232 or U-238 (WNA 2021-TN7072). Because this is a series of actions that would occur during operations, it is not a fuel fabrication process. For this situation, once the MSR begins operation, only the manufacturing of the chemical form of the fissile material being produced to be compatible with the respective chemistry of the molten salt to be delivered to the MSR is part of the fuel preparation process. Potential waste processing and waste forms associated with MSRs are documented by Riley et al. (2018-TN6942).

If the MSR design has a separate fuel channel from the molten-salt coolant then NRC staff assumes the fuel fabrication environmental impacts as described above to be similar to the

nuclear fuel form being employed in the reactor design (i.e., oxides, TRISO, and metal). However, due to the lack of environmental impact information about generating liquid-fuel molten salt, the NRC staff cannot readily assess an environmental impact of such fuel fabrication in relationship to WASH-1248 (AEC 1974-TN23) and Table S-3.

3.14.2.4.4 Fuel Fabrication Conclusions

For the assessment of environmental impacts, Table S-3 is expected to bound the impacts for new reactors that rely on uranium oxycarbide/UO_2 fuels if such fuel fabrication is applying the existing processes of the NRC-licensed fuel fabrication facilities resulting in SMALL impacts. If not, the impacts from new reactor fuel fabrication would need to be bounded by the values provided in Appendix E of WASH-1248 (AEC 1974-TN23), as listed in Table 3-10. Based on the assumption of meeting these values, fuel fabrication is a Category 1 issue. The staff relied on the following PPE assumptions to reach this conclusion:

- Table S-3 is expected to bound the impacts for new reactor fuels, because of uranium fuel cycle changes since WASH-1248 (AEC 1974-TN23), including:
  - Current LWRs are using nuclear fuel more efficiently due to higher levels of fuel burnup resulting in fewer discharged fuel assemblies to be fabricated each year and due to longer time periods between refueling
  - Less reliance on coal-fired electrical generation plants resulting in less gaseous effluent releases from electrical generation sources supporting fabrication
- Must satisfy the regulatory requirements of 10 CFR Part 40 (TN4882) *Domestic Licensing of Source Material*, 10 CFR Part 70 (TN4883), *Domestic Licensing of Special Nuclear Material*, 10 CFR Part 71 (TN301), *Packaging and Transportation of Radioactive Material*, and 10 CFR Part 73 (TN423), *Physical Protection of Plants and Materials.*

Any new reactor fuel fabrication that cannot be bounded by WASH-1248 (AEC 1974-TN23), namely metallic fuel and liquid-fuel MSRs, requires a discussion of the anticipated fuel fabrication process and environmental impacts in the project-specific application. New reactor applications in these cases must include enough information to support the staff's review for reaching an environmental finding. The information needs identified in the PNNL report (Napier 2020-TN6443) should be provided in the new reactor application.

3.14.2.5 Reprocessing

As discussed in Section 1.6.1 of SECY-2011-0163 (NRC 2011-TN6830), the NRC staff considers reprocessing to be defined as the separation of SNF into its constituent components of isotopes of uranium, fission products, and TRU nuclides by aqueous and nonaqueous chemical processing of irradiated fuel for the purpose of recovering reusable fuel material. This definition encompasses the types of materials that would be produced in reprocessing and the various methods of separation that have been proposed. Reprocessing of SNF could occur for some types of new reactor fuels (e.g., fissile material circulating in the molten-salt coolant or a new reactor designed to use reprocessed SNF) and could be internal to the operation of the reactor at the site or could be conducted externally at a remote reprocessing facility. Therefore, the environmental impacts of reprocessing new reactor fuel are addressed in this section.

At the time WASH-1248 was published, only U.S. government reprocessing facilities were in operation and applying the plutonium uranium reduction extraction (PUREX) process.[31] There were no operational commercial SNF reprocessing facilities. Three U.S. commercial reprocessing facilities were anticipated to be operational later in the 1970s (AEC 1974-TN23). Thus, WASH-1248 and related reports in support of Table S-3 evaluated the environmental impacts of PUREX reprocessing as being maximized for either of the two fuel cycles: uranium only and full recycle. Based on a court decision, the Commission directed the staff to prepare a supplement to WASH-1248 to establish a basis for identifying environmental impacts associated with fuel reprocessing and waste management activities that are attributable to the licensing of a model LWR. These environmental impacts were documented in NUREG-0116, *Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle* (NRC 1976-TN292). No U.S. commercial SNF reprocessing facilities are in operation as of today, and there are no licensing actions to construct and operate such a nuclear facility at the time of this GEIS; however, DOE and a group composed of commercial entities, universities, and national laboratories are evaluating the potential for recycling and reprocessing spent nuclear fuel (ARPA-E 2022-TN10126).

WASH-1248 Table F-1 provides a summary of environmental considerations for irradiated fuel reprocessing normalized to the model LWR annual fuel requirement (AEC 1974-TN23). The table is based on the collective operation of the three anticipated reprocessing facilities, normalized to an annual capacity of 900 MTU/yr, to serve as the selected model reprocessing plant. This capacity is equivalent to the annual fuel requirements of approximately 26 model LWRs at 1,000 MWe each, or 3.46×10^{-2} MTU/yr-MWe.

The level of impacts of reprocessing in WASH-1248 (AEC 1974-TN23) correspond to approximately a quarter of the current nuclear operating fleet. This amount of reprocessing capability could support a large number of new reactors. Thus, it is likely that the capacity of an offsite reprocessing process related to one new reactor would be significantly under 900 MTU/yr. Therefore, this is a Category 1 issue based on the bounding assumption that the reprocessing capacity for the new reactor, if pursued as an integral part of its fuel cycle, would be less than 900 MTU/yr, and that the contents of Table S-3 would bound the environmental impacts.

Table 2-10 in the *Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle* (NUREG-0116) provides a summary of the impacts of reprocessing and waste management per reference reactor-year (RRY) for a 1,000 MWe reactor (assumed to be operating at 80 percent of its maximum capacity for 1 year) (NRC 1976-TN292). Based on the best available information applied in NUREG-0116, the impacts as summarized in Table 2.10 of this NUREG are slightly different from those in WASH-1248 (AEC 1974-TN23). When these impacts are included in the total impacts of the uranium fuel cycle attributable to a single reactor (see new Total column in Table 2.10 of NUREG-0116), the total values are not substantially different from those in WASH-1248; the difference in values is not sufficient to affect the NRC staff's impact determination in this GEIS.

Under the Integral Fast Reactor program (ANL 2017-TN6832), a form of pyroprocessing (ANL 2016-TN6831), a pyrochemical/electrochemical reprocessing (PER) method, was developed and tested using the EBR-II fuel and facilities. Pyroprocessing is a nonaqueous

[31] PUREX involves the dissolution of irradiated nuclear fuel in nitric acid, followed by separation of the uranium, plutonium, and fission products by solvent extraction using a mixture of tributyl phosphate in an organic diluent.

reprocessing process in which spent fuel is subjected to high temperatures (typically over 600°C [equivalent])] to facilitate physical or chemical processes for the purpose of separating and recovering fissile and fertile materials (NRC 2011-TN6830). PER is a pyroprocessing operation involving selective reduction and oxidation in molten salts or metals to recover nuclear fuel materials, and management of the resulting waste (NRC 2011-TN6830). However, the Integral Fast Reactor program was cancelled, and further development of PER has been limited since then (Frank et al. 2015-TN6833). Renewed interest in applying PER for reprocessing new reactor fuel has been expressed, so the environmental impacts of a potential PER method are considered in this GEIS. In support of the treatment of sodium-bonded SNF, DOE has evaluated several methods of reprocessing including a PUREX-based and a PER-based treatment (DOE 2000-TN6834). As provided in Table S-4 of DOE/EIS-0306 (DOE 2000-TN6834), the PER environmental impacts were shown to be less than those associated with a PUREX treatment process with one exception where there is a small difference in the volume of high-level waste generated (18 m^3 for PER vs. 5.6 m^3 for PUREX) (DOE 2000-TN6834).

The NRC staff finds the above conclusions provided in NUREG-0116 support the conclusions in WASH-1248 resulting in SMALL impacts. Additionally, for the same mass of spent fuel processed as in the PUREX process described in WASH-1248 (AEC 1974-TN23) and NUREG-0116 (NRC 1976-TN292), these environmental impacts should bound or be similar to a PER-based treatment process. This is a Category 1 issue. The staff relied on the following PPE assumptions to reach this conclusion:

- Table S-3 is expected to bound the impacts for new reactor fuels, because of uranium fuel cycle changes since WASH-1248 (AEC 1974-TN23), including:
  - Current LWRs are using nuclear fuel more efficiently due to higher levels of fuel burnup resulting in fewer discharged fuel assemblies to be reprocessed each year
  - Less reliance on coal-fired electrical generation plants resulting in less gaseous effluent releases from electrical generation sources supporting reprocessing
- Reprocessing capacity up to 900 MTU/yr
- Must satisfy the regulatory requirements of 10 CFR Part 40 (TN4882) “Domestic Licensing of Source Material,” 10 CFR Part 50 (TN249), “Domestic Licensing of Production and Utilization Facilities,”10 CFR Part 70 (TN4883), “Domestic Licensing of Special Nuclear Material,” 10 CFR Part 71 (TN301),” Packaging and Transportation of Radioactive Material,” 10 CFR Part 72 (TN4884),” Licensing Requirements for the Independent Storage of Spent Fuel, High-Level Radioactive Waste, and Reactor-related Greater Than Class C Waste,” and 10 CFR Part 73 (TN423), “Physical Protection of Plants and Materials.”

3.14.2.6 Storage and Disposal of Radiological Wastes

As with previous LWRs, the NRC must analyze the environmental impacts of the generation of radioactive wastes by a new reactor and their safe storage and ultimate disposal. Appendix G of WASH-1248 presents the analysis of the environmental impacts of managing radioactive wastes from the nuclear fuel cycle activities (AEC 1974-TN23). The analysis is for radioactive wastes that can be categorized as HLWs and other than high-level, or LLRWs. HLWs, generated at fuel reprocessing plants, contain fission products separated from fissile material recovered from irradiated fuel. LLRWs result from operations involving UF_6 production, fuel fabrication, and fuel reprocessing. These include all wastes, regardless of concentration or specific activity, that are not designated as HLWs.

While WASH-1248 states the LLRW, which is generated during fuel cycle operations, is variable and difficult to estimate, the total waste volume is estimated to be approximately 14,000 ft^3 (AEC 1974-TN23). This analysis also assumes that, with no further compaction of the waste, the final volume of packages containing the waste could approximate 20,000 ft^3 per annual model LWR fuel requirement. As discussed in Section 3.15, Transportation of Fuel and Waste, in this GEIS, this is a fraction of the annual LLRW from all U.S. sources shipped to the four Agreement State-licensed LLRW disposal facilities.

The analysis in WASH-1248 (AEC 1974-TN23) was based on lower burnup levels than are currently allowed for the current fleet of LWRs. The higher burnup levels result in greater utilization of the uranium fuel along with corresponding greater efficiency in extracting energy from the fuel. This has also resulted in extended time between refueling and the removal of fewer fuel assemblies per reactor-year.

WASH-1248, while recognizing that a HLW disposal facility, which includes disposal of SNF, did not yet exist, did state that the U.S. Atomic Energy Commission (AEC) was proceeding on a program to design, construct, and operate a surface (or near-surface) facility in which the solidified commercial HLW in sealed canisters would be stored (AEC 1974-TN23). However, this program was never completed. Rather, in the late 1970s, the NRC reexamined an underlying assumption used in licensing reactors up to that time, namely that a repository could be secured for the ultimate disposal of spent fuel generated by nuclear reactors, and that spent fuel could be safely stored in the interim (NRC 2014-TN4117). This analysis was later codified into NRC regulations under 10 CFR 51.23 (TN250), “Temporary storage of spent fuel after cessation of reactor operation – Generic determination of no significant environmental impact” (49 FR 34658-TN3370), or the Waste Confidence decision.

3.14.2.6.1 Waste Confidence and the Evaluation of Continued Storage

The complete history of the Waste Confidence decision is provided in Section 1.1, History of Waste Confidence, of NUREG-2157, *Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel* (NRC 2014-TN4117) and is incorporated by reference. As a result of legal actions involving the unknown timing of an operational geologic repository for the permanent disposal of SNF, the NRC developed and published NUREG-2157 and revised 10 CFR 51.23 (TN250), which became “Environmental impacts of continued storage of SNF beyond the licensed life for operation of a reactor” (79 FR 56238-TN4104).

NUREG-2157 analyzes the environmental impacts of continued storage of spent fuel (NRC 2014-TN4117). In it, the NRC analyzed the direct, indirect, and cumulative effects of continued storage for three timeframes:

- short-term – 60 years beyond licensed life for reactor operations;
- long-term – 100 years beyond the short-term storage time frame; and
- indefinite – indefinite storage and handling of spent fuel.

These timeframes are discussed in more detail in Section 1.8.2 of NUREG-2157 (NRC 2014-TN4117). The locations of the storage sites related to these impacts were assessed for at-reactor storage, away-from-reactor storage, and cumulative impacts when added to other past, present, and reasonably foreseeable activities. The analyses contained in NUREG-2157 provide the regulatory basis for the revisions to 10 CFR 51.23 (TN250), in which 10 CFR 51.23(a) states:

> The Commission has generically determined that the environmental impacts of continued storage of SNF beyond the licensed life for operation of a reactor are those impacts identified in NUREG–2157, “Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel.”

The impact levels determined in NUREG-2157 of at-reactor storage, away-from-reactor storage, and cumulative impacts of continued storage when added to other past, present, and reasonably foreseeable activities are summarized in Table 6-4 of NUREG-2157 (NRC 2014-TN4117). The impact levels are denoted as SMALL, MODERATE, and LARGE as a measure of their expected adverse environmental impacts. Most impacts were found to be SMALL and SMALL to MODERATE. For some resource areas, the impact determination language is specific to the authorizing regulation, Executive Order, or guidance. Impact determinations that include a range of impacts reflect uncertainty related to both geographic variability and the temporal scale of the analysis. As a result, based on analyses performed in NUREG-2157, the NRC assumes that further project-specific analysis would be unlikely to result in impact conclusions with different ranges. The analyses of NUREG-2157 were codified into 10 CFR 51.23 (79 FR 56238-TN4104).

Many of the assumptions provided in Section 1.8.3, Analysis Assumptions, and subsequent analysis in NUREG-2157 are independent of the fuel type because they involve onsite impacts related to the siting, operation, and maintenance of the ISFSI and DTS facilities over all timeframes during continued storage (NRC 2014-TN4117). For example, the waste management resource area involves radioactive and chemical wastes generated by the operation of the ISFSI itself and does not directly involve the SNF in the storage casks. Only a select few topics considered in NUREG-2157 have a connection with the SNF itself and how it could result in offsite environmental impacts, namely related to “Transportation,” “Public and Occupational Health,” “Postulated Accidents,” and “Potential Acts of Terrorism.”

For the transportation of SNF and for public and occupational health, the staff concluded in NUREG-2157 that the radiological doses would be expected to continue to remain below the regulatory dose limits during continued storage and all of the related activities would have small environmental impacts (NRC 2014-TN4117). The staff reached this conclusion in Sections 4.16 and 4.17 of NUREG-2157 because the operations during continued storage would have a smaller workforce, lower volume of traffic and shipment activities, and continued storage represents a fraction of the activities occurring during reactor operations, as previously analyzed in the LR GEIS (NRC 2024-TN10161) and in other NRC studies.

Regarding the analysis of postulated accidents in NUREG-2157 (NRC 2014-TN4117), any SNF must be safely stored and decay heat must be appropriately removed once the SNF is removed from the reactor. This includes the protection from and the mitigation of severe accidents, or beyond-design-basis accidents, which are accidents that may challenge safety systems at a level higher than that for which they were designed.

The concerns about severe accidents within an ISFSI, whether involving at-reactor or away-from-reactor storage, were analyzed in NUREG-2157 (NRC 2014-TN4117). The lowest consequences events with any radiological release involved dropping a cask. The highest consequences were associated with an impact on the storage cask followed by a fire, such as could occur after an aircraft impact. In all cases, the staff determined the likelihood of the event would be very low and the environmental risk of an accident would be small. The consequences described for cask drops at an ISFSI also provided some insight into the consequences of severe accidents in a DTS. Compliance with NRC regulations for spent fuel handling and

storage would likely make the risk of severe accidents in a DTS small. In addition, the consequences of any severe accident in a DTS would likely be comparable to or less than that for the cask drop accident described above. This resulted in the staff concluding in NUREG-2157 that the likely impacts from activities in a DTS also would be small.

An assessment of the risks that could potentially result from acts of terrorism or radiological sabotage was also provided in NUREG-2157 (NRC 2014-TN4117). The assessment was based, in part, on the analysis provided in the licensing of the Diablo Canyon ISFSI and accounted for the security and protective measures required by NRC regulations (see Section 4.19 of NUREG-2157). The staff determined that the potential for theft or diversion of LWR spent fuel from the ISFSI with the intent of using the contained SNM for nuclear explosives is not considered credible because of the following:

- the inherent protection afforded by the massive reinforced concrete storage module and the steel storage canister;
- the unattractive form of the contained SNM, which is not readily separable from the radioactive fission products; and
- the immediate hazard posed by the high radiation levels of the spent fuel to persons not provided with radiation protection.

The staff concluded in NUREG-2157 (NRC 2014-TN4117) that for acts of terrorism, even though the environmental consequences of a successful attack could be large, the very low probability of a successful attack ensures that the environmental risk would be small for operational ISFSIs and DTSs during continued storage.

Finally, the Commission, in the Continued Storage rulemaking, reclassified the offsite radiological impacts of SNF and HLW disposal as a Category 1 issue; no impact level was assigned and the finding column entry was revised to address the existing radiation standards (79 FR 56238-TN4104). Thus, the Commission has concluded that the impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 (TN4878) should be eliminated (see Table B-1 in 10 CFR Part 51 [TN250]).

3.14.2.6.2 Continued Storage of Spent Advanced Fuel

Many of the new reactor designs currently under development were not part of the analysis of NUREG-2157 (NRC 2014-TN4117), as noted in Section 1.8.6, Issues Eliminated from Review in this GEIS. This is likely due to information provided in a report to Congress in August 2012 (NRC 2012-TN6670), which stated:

> Spent nuclear fuel storage regulations in 10 CFR Part 72 are generally broad enough to address new types of fuel associated with advanced reactor designs. However, minor modifications may be necessary to address new design features from any new class of cask storage technologies associated with advanced reactor fuels. The NRC would need to evaluate the adequacy of new storage cask designs for onsite storage of advanced LWR and non-LWR fuel designs and any other radioactive components not previously reviewed as part of the current LWR technology. The NRC would consider how cask designs may be affected by different discharge and loading operations, since discharged fuel may not be housed in traditional spent fuel pools. Other challenges may involve

stacking spent fuel for non-LWRs during refueling operations, as well as detecting, segregating, and processing damaged fuel.

Thus, with only limited information about SNFs concerning high-temperature gas-cooled reactors or liquid metal fast reactors, NUREG-2157 designated SNF from these types of advanced reactors as being out of scope (NRC 2014-TN4117). However, if these technologies should become viable and the NRC reviews one or more license applications for an out of scope advanced reactor, then the environmental impacts of continued storage of that spent fuel will be considered in individual licensing proceedings unless the NRC updates NUREG-2157 and the corresponding rule to include the environmental impacts of storing this type of fuel after a reactor's licensed life for operation (NRC 2014-TN4117).

The same requirements for the shipment of spent fuel to and storage at an offsite ISFSI with respect to NRC and the U.S. Department of Transportation (DOT) regulations would apply to new reactor SNF. Thus, the analysis of NUREG-2157 (NRC 2014-TN4117) for the safe handling, storage, and management of SNF could also apply to any type of new reactor SNF, regardless of its chemical form, and is incorporated here by reference. Several assumptions can be made simply because any such SNF container (i.e., a storage cask or a transportation container or cask) or an ISFSI and DTS facilities for new reactor SNF must satisfy the regulatory requirements of 10 CFR Part 71 (TN301), "Packaging and Transportation of Radioactive Material," 10 CFR Part 72 (TN4884), "Licensing Requirements for the Independent Storage of Spent Fuel, High-Level Radioactive Waste, and Reactor-related Greater Than Class C Waste," and 10 CFR Part 73 (TN423), "Physical Protection of Plants and Materials."

Any new reactor spent fuel storage or shipping containers must demonstrate that the associated fuels can always be safely managed (see 10 CFR Part 71 Subpart E (TN301), *Package Approval Standards*, for shipping containers and 10 CFR Part 72 Subpart L (TN4884), *Approval of Spent Fuel Storage Casks, for spent fuel storage casks*).

Radionuclide inventories and thermal loading limits should not be a significant departure from the performance of currently certified spent fuel shipping and storage containers. For example, the radionuclide inventory and related container shielding for any type of new reactor SNF must meet the regulatory requirements of 10 CFR 71.47 (TN301), *External radiation standards for all packages* and 10 CFR 72.236 (TN4884), *Specific requirements for spent fuel storage cask approval and fabrication*.

If new reactor SNF is not encased in a zirconium alloy, then the highly exothermic chemical reaction called a runaway zirconium oxidation reaction or autocatalytic ignition as assessed in NUREG-2157 (NRC 2014-TN4117) is not possible. Metallic fuels could be encased in a type of stainless steel (e.g., stainless steel [SS] 316, HT9, and D9) rather than a zirconium alloy cladding (FRWG 2018-TN6696). TRISO fuels are encapsulated in ceramic and carbon-based materials, and "are structurally more resistant to neutron irradiation, corrosion, oxidation, and high temperatures (the factors that most impact fuel performance) than traditional reactor fuels" (DOE 2019-TN6786). Several suitable non-zirconium alloys may exist, including high-temperature nickel-based alloys and modified Hastelloy N variants, for showing acceptable compatibility in MSRs (Busby et al. 2019-TN6695).

In addition, any shipping or storage container for SNF, including SNF from new reactors, would have to satisfy the regulatory requirements of 10 CFR 71.55 (TN301), "General requirements for fissile material packages," and 10 CFR 72.236 (TN4884), "Specific requirements for spent fuel storage cask approval and fabrication," which include the following:

- Confine fuel to a known volume.
- Ensure compliance with criticality safety.
- Meet specific structural testing requirements.
- Permit normal handling and retrieval.

Because the ISFSI infrastructure and the required physical protection is no different for LWR SNF than for non-LWR SNF, the same considerations provided in NUREG-2157 (NRC 2014-TN4117) of a very low probability of an accident or of a successful terrorist attack with the resulting small environmental risk would apply during continued storage of any new reactor SNF. The one difference identified in NUREG-2157 was that for non-LWR SNF, the period of self-protection from acts of terrorism may be shorter than that of LWR SNF, depending on the burnup level and the isotopic composition of the SNM (i.e., the attractiveness of the material for diversion).

Therefore, if the new reactor SNF conforms with the above analysis for this Category 1 issue, then the analysis of NUREG-2157 (NRC 2014-TN4117) would bound the environmental impacts and impacts would be SMALL. The staff relied on the following PPE assumptions to reach this conclusion:

- Table S-3 is expected to bound the impacts for new reactor fuels, because of uranium fuel cycle changes since WASH-1248 (AEC 1974-TN23), including:
  - Current LWRs are using nuclear fuel more efficiently due to higher levels of fuel burnup resulting in fewer discharged fuel assemblies to be stored and disposed.
  - Less reliance on coal-fired electrical generation plants resulting in less gaseous effluent releases from electrical generation sources supporting storage and disposal.
- Waste and spent fuel inventories, as well as their associated certified spent fuel shipping and storage containers, are not significantly different from what has been considered for LWR evaluations in NUREG-2157 (NRC 2014-TN4117)
- Must satisfy the regulatory requirements of 10 CFR Part 40 (TN4882) *Domestic Licensing of Source Material*, 10 CFR Part 70 (TN4883), *Domestic Licensing of Special Nuclear Material*, 10 CFR Part 71 (TN301), *Packaging and Transportation of Radioactive Material*, 10 CFR Part 72 (TN4884), *Licensing Requirements for the Independent Storage of Spent Fuel, High-Level Radioactive Waste, and Reactor-related Greater Than Class C Waste*, and 10 CFR Part 73 (TN423), *Physical Protection of Plants and Materials.*

However, if conditions, such as fuel stability within the uranium spent fuel (ORNL 1970-TN6754, ORNL 1998-TN6755) and the site conditions for construction and operation of an ISFSI including fuel transfers, go beyond what is in NUREG-2157, then a project-specific analysis would be necessary to demonstrate continued safe storage (ORNL 1970-TN6754, ORNL 1998-TN6755).

Disposal of new reactor SNF in a deep geological repository would need to demonstrate compliance with radiation standards that are expected to be comparable, if not the same, as the existing radiation standards in Table B-1 in 10 CFR Part 51 (TN250) (e.g., a dose limit of 0.15 millisieverts [15 mrem]). Therefore, the offsite radiological impacts of new reactor SNF could be expected to be classified as a Category 1 issue with no impact level assigned.

3.14.3 Staff Conclusions about the Environmental Impacts of a New Reactor Fuel Cycle

It is important to acknowledge that the determinations arrived in this GEIS are based on the staff's current understanding of the proposed plans and designs for the activities associated with new reactor fuel and facilities. The staff reviewed the general literature containing information about expected new reactor (LWR and non-LWR) fuel cycles. The review examined expected uranium and uranium-plutonium fuel forms (oxide, metal, TRISO, salt). The staff review examined available information about uranium extraction, uranium conversion, uranium enrichment, fuel processing/fabrication, nuclear material transportation, irradiated fuel processing, spent fuel management, and radioactive waste management as it is related to expected new reactor systems. The NRC staff assumes that the thorium fuel cycle will not be significantly different from the uranium fuel cycle, therefore the uranium fuel cycle impacts should bound the thorium fuel cycle impacts.

Based on its review of the available, general information, the staff believes that new reactor fuel cycles will have SMALL environmental impacts (i.e., impacts that are less than or comparable to those of current LWRs and those discussed in Table S-3), particularly for once-through fuel cycle options. The lower fuel cycle impacts are the result of improved fuel cycle technologies (reduced environmental impact), improved reactor technologies, and waste and spent fuel inventories that are not significantly different from what has been considered for LWR evaluations (e.g., as in Continued Storage Rulemaking) with respect to hazardous radionuclides.

A new reactor applicant would have to demonstrate in its ER that the impacts of its fuel cycle fall within the values and assumptions of the PPE for the Category 1 issues above (see Section 1.3.1 of this GEIS). The NRC staff expects the new reactor applicants to describe their planned fuel cycle designs, plans, and activities. The applicant's analysis needs to discuss and analyze any new processes (ones not considered in this NR GEIS) that will be part of their fuel cycle.

3.15 Transportation of Fuel and Waste

3.15.1 Baseline Conditions and PPE/SPE Values and Assumptions

The NRC has generically evaluated the environmental effects of the transportation of fuel and waste to and from LWRs in 10 CFR 51.52 Table S-4, Environmental effects of transportation of fuel and waste (TN250). However, the environmental data in Table S-4 is only applicable to LWRs that use uranium oxide, or UO_2, fuel that meets specific criteria in 10 CFR 51.52(a) as expanded in Addendum 1 of NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants Addendum to Main Report* (NRC 1999-TN289) and as discussed in Revision 2 of NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NRC 2024-TN10161). Some new reactor developers are expected to use uranium fuel with enrichment levels of up to 20 percent enrichment, known as HALEU. In addition, as discussed in Section 3.14 of this GEIS, several of the potential non-LWR designs are expected to deploy non-UO_2 fuels (e.g., uranium metal, uranium carbide, uranium in a molten salt, etc.) or deploy new reactors based on a Th-232/U-233 fuel cycle. While Table S-4 does not apply to new reactors and non-UO_2 fuels, the transportation of fuel and waste is a connected action under NEPA regulations, guidance, and case law. Therefore, the NRC must still evaluate transportation impacts for the non-LWR fuel and waste to meet its obligations under NEPA as has been done for large LWR UO_2 fuels. This section addresses both the radiological and nonradiological environmental impacts from incident-free and accident

conditions resulting from (1) shipment of unirradiated fuel to the new reactor site, (2) shipment of LLRW and mixed waste to offsite disposal facilities, and (3) shipment of spent fuel to an interim storage facility or a permanent geologic repository. Air emissions from the transportation of fuel and waste, specifically for greenhouse gases or GHGs, are discussed in Section 3.3 of this GEIS.

3.15.1.1 Table S-4 on the Transportation of Fuel and Waste

The NRC performed a generic analysis of the environmental effects of the transportation of fuel and waste to and from LWRs in the *Environmental Survey of Transportation of Radioactive Materials To and From Nuclear Power Plants*, WASH-1238 (AEC 1972-TN22) and in a supplement to WASH-1238, NUREG-75/038 (NRC 1975-TN216), and found the impact to be small. These documents provided the basis for Table S-4 in 10 CFR 51.52 (TN250) that summarizes the environmental impacts of transportation of fuel and waste to and from one LWR of 3,000 to 5,000 MW(t) (1,000 to 1,500 MW(e)). Impacts are provided for normal conditions of transport and accidents in transport for a reference 1,100 MW(e) LWR.[32] Dose to transportation workers during normal transportation operations was estimated to result in a collective dose of 4 person-rem per RRY. The combined dose to the public along the route and the dose to onlookers were estimated to result in a collective dose of 3 person-rem per RRY.

Based on public comments on the 1996 version of the LR GEIS (NRC 1996-TN288), the NRC reevaluated the transportation issues and the adequacy of Table S-4 for license renewal application reviews. In 1999, the NRC issued an addendum to the 1996 LR GEIS (NRC 1999-TN289) in which the agency evaluated the applicability of Table S-4 to future license renewal proceedings, given that the spent fuel is likely to be shipped to a single repository (as opposed to several destinations, as originally assumed in the preparation of Table S-4) and given that shipments of spent fuel are likely to involve more highly enriched fresh fuel (more than 4 percent as assumed in Table S-4) and higher-burnup spent fuel (higher than 33,000 MWd/MTU as assumed in Table S-4). In the addendum, the NRC evaluated the impacts of transporting the spent fuel from reactor sites to the candidate repository at Yucca Mountain and the impacts of shipping more highly enriched fresh fuel and higher-burnup spent fuel. On the basis of the evaluations, the NRC concluded that the values given in Table S-4 would still be bounding, as long as the (1) enrichment of the fresh fuel was 5 percent or less, (2) burnup of the spent fuel was 62,000 MWd/MTU or less, and (3) higher-burnup spent fuel (higher than 33,000 MWd/MTU) was cooled for at least 5 years before being shipped offsite. A later study found that the impacts presented in Table S-4 would bound the potential environmental impacts that would be associated with transportation of SNF with up to 75,000 MWd/MTU burnup, provided that the fuel is cooled for at least 5 years before shipment (Ramsdell et al. 2001-TN4545).

3.15.1.2 Additional NRC Studies of the Risk from the Transportation of SNF

Since the publication of WASH-1238 (AEC 1972-TN22) and NUREG-75/038 (NRC 1975-TN216), the NRC has undertaken four studies regarding the risk from the transportation of SNF. Each study improved upon the assumptions and analysis techniques from the prior study for assessing these risks.

[32] Note that the basis for Table S-4 is a 1,100 MW(e) LWR at an 80 percent capacity factor (AEC 1972-TN22; NRC 1975-TN216).

In September 1977, the NRC published NUREG-0170, *Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes*, which assessed the adequacy of the regulations in 10 CFR Part 71 (TN301), then entitled *Packaging and Transportation of Radioactive Waste* (NRC 1977-TN417, NRC 1977-TN6497). In that assessment, the measure of safety was the risk associated with radiation doses to the public under routine and accident transport conditions, and the risk was found to be acceptable. Since that time, there have been two affirmations of this conclusion for SNF transportation, each using improved tools and information.

A 1987 study applied actual accident statistics to projected spent fuel transportation (Fischer et al. 1987-TN4105). This study, known as the "Modal Study," recognized that accidents could be described in terms of the strains they produced in transportation packages (for impacts) and the increase in package temperature (for fires). Like NUREG-0170 (NRC 1977-TN417, NRC 1977-TN6497), the 1987 study based risk estimates on models because the limited number of accidents that had occurred involving spent fuel shipments was not sufficient to support projections or predictions. The Modal Study's refinement of modeling techniques and use of accident frequency data resulted in smaller assessed risks than had been projected in NUREG-0170.

In 2000, a study of two generic truck packages and two generic rail packages analyzed the package structures and response to accidents by using computer modeling techniques (Sprung et al. 2000-TN222). The study used semi-trailer truck and rail accident statistics for general freight shipments because, even though more than 1,000 spent fuel shipments had been completed in the United States by the year 2000 and many thousands more had been completed safely internationally, there had been too few accidents involving spent fuel shipments to provide statistically valid accident rates. Sprung et al. 2000 (TN222) used improved technology to analyze the ability of containers to withstand an accident. This study concluded that the risk from the increased number of spent fuel shipments that could occur in the first half of this century would be even smaller than originally estimated in NUREG-0170 (NRC 1977-TN417, NRC 1977-TN6497).

NUREG-2125, published in January 2014, presented the results of a fourth investigation into the safety of SNF transportation (NRC 2014-TN3231). The selected routes included the origins and destinations analyzed in NUREG/CR-6672 (Sprung et al. 2000-TN222), thereby permitting the results of the studies to be compared. This investigation showed that the risk from the radiation emitted from the packages is a small fraction of naturally occurring background radiation and the risk from accidental release of radioactive material is several orders of magnitude less. Because there have been only minor changes to the radioactive material transportation regulations in NUREG-0170 (NRC 1977-TN417, NRC 1977-TN6497) and NUREG-2125, the calculated dose from the external radiation from the package under routine transport conditions is similar to what was found in earlier studies. The improved analysis tools and techniques, improved data availability, and a reduction in uncertainty have made the estimate of accident risk from the release of radioactive material in NUREG-2125 approximately five orders of magnitude less than what was estimated in NUREG-0170. The results from NUREG-2125 (NRC 2014-TN3231) demonstrate that NRC regulations continue to provide adequate protection of public health and safety during the transportation of SNF.

The NRC published NUREG-2266, "Environmental Evaluation of Accident Tolerant Fuels with Increased Enrichment and Higher Burnup Levels," in July 2024 to support efficient and effective licensing reviews of ATFs and to reduce the need for a complex site-specific environmental review for each ATF LAR (NRC 2024-TN10333). NUREG-2266 evaluated the reasonably

foreseeable impacts of near-term ATF technologies with increased enrichment and higher burnup levels on the uranium fuel cycle, transportation of fuel and waste, and decommissioning for LWRs (i.e., a bounding analysis). To this end, the NRC staff assessed and applied available near-term ATF technology performance analyses, data, and studies; information from prior NRC environmental analyses; and the assessment of other publicly available data sources and studies to complete an evaluation of ATF with increased enrichment and higher burnup levels. Based on the evaluations in this study, the NRC staff determined that Table S-4 of 10 CFR 51.52(c) would bound the deployment and use of near-term ATF for up to 8 wt% U-235 and 80 GWd/MTU average assembly burnup. This study also indicates there would be no significant adverse environmental impacts for the uranium fuel cycle, transportation of fuel and wastes, and decommissioning associated with deploying near-term ATF.

For the assessment of the potential generic impacts of transporting SNF in this GEIS, NUREG-2125 (NRC 2014-TN3231) is examined for environmental impacts because it is the most recent study that applies the latest knowledge and analytical tools.

3.15.1.3 Additional NRC Information Sources

Several NRC EISs regarding the construction and operation of new reactors contain an analysis of the potential environmental impacts due to the transportation of LWR fuel and waste. These transportation assessments were performed by the new reactor applicants to meet the regulatory requirements of 10 CFR 51.52 (TN250). The NRC staff then reviewed the applicant's analyses and made a final assessment of the impacts, normalized with respect to power level and the amount of radioactive material per shipment, to allow for comparison to the results presented in Table S-4 of 10 CFR 51.52. While 10 CFR 51.52 applies only to LWRs, these assessments may help inform the staff's assessment in this GEIS because of the similarities in transportation modes (e.g., packaging, routing, and distances) and the quantities of radioactive material per shipment.

In addition to the new reactor EISs, the NRC has published two EISs regarding the proposed licensing of two interim storage facilities (NRC 2021-TN10124, NRC 2022-TN10171). The transportation assessments of these EISs will also be examined for informing the transportation assessments in this GEIS.

3.15.1.4 U.S. Department of Energy Transportation Risk Assessments

The DOE routinely ships radioactive material between their various national laboratories and other nuclear facilities. Examples of these shipments include shipments of LLRW and transuranic wastes to DOE disposal sites at the Nevada Test Site and the Waste Isolation Pilot Plant, respectively. Some DOE LLRW has also been shipped to commercial disposal sites. DOE has also transported SNF as part of various national programs, such as shipments of research quantities of commercial SNF to the INL (INL 2020-TN6500). Hence, DOE developed a transportation risk assessment handbook to provide a methodology for DOE staff and DOE contractors to apply when conducting necessary NEPA analysis related to DOE programs involving shipments of radioactive material (DOE 2002-TN1236). The methodology presented in the DOE handbook is the preferred analytical method for assessing the environmental impacts of the transportation of fuel and waste.

DOE has also published a number of reports that include transportation risk assessments as a component of their NEPA analysis in support of a number of DOE program decisions. A majority of these are for specific situations and for a limited number of radioactive material shipments.

There are two transportation risk assessments that are more comprehensive with respect to potentially large shipping campaigns. The first of these two assessments is the transportation analysis in support of the licensing of the Yucca Mountain geologic repository (DOE 2002-TN1236). The second study is a series of reports (Monette et al. 1995-TN6505, Monette et al. 1995-TN6506; Biwer et al. 1996-TN6502; Monette et al. 1996-TN6501, Monette et al. 1996-TN6503) concerning the transportation of radioactive wastes as part of the production of the DOE Waste Management Programmatic Environmental Impact Statement (DOE 1997-TN6752). Information from these assessments will be used in this evaluation of the environmental impacts of non-LWR waste shipments.

3.15.1.5 Issues for the Transportation of Non-LWR Fuel and Wastes

There is limited information regarding the transportation of several forms of non-LWR fuel due to the expected higher enrichment levels (i.e., HALEU fuel) and the physical form of the non-LWR fuel being shipped. This limited information has been identified in several reports and conference/seminar/workshop presentations and principally involves suitable transportation packages to support the economic use of HALEU materials (Jarrell 2018-TN6508; Eidelpes et al. 2019-TN6507; Reardon et al. 2019-TN6952).

Principal issues involve the lack of certified transport packages for unirradiated and irradiated HALEU fuel and radioactive waste. Items being considered for non-LWR fuel and waste transport packages include the following:

- non-LWR fresh fuel shipments likely to be similar to those for LWRs (except for molten salt);
- processing operations and transportation for MSRs and sodium fast reactors are significantly different than for the current reactor fleet; and
- uncertainty in the post irradiation forms for transport and storage.

Another potential departure from current transportation practices for LWR unirradiated, or fresh, fuel and SNF is the fuel loading in one transport package. Currently, multiple shipments must be made to fuel the LWR core and to remove the SNF from the LWR site. There are non-LWR developers whose relatively small size of the reactor core may lead them to consider transporting the entire and completely assembled reactor core or reactor vessel with the core to and from the reactor site. These are all factors that must be considered in this evaluation to determine if the environmental impacts from the transportation of non-LWR fuel and waste can be generically addressed.

3.15.1.6 Development of the Transportation Plant Parameter Envelope

The effects of incident-free and accident transportation are proportional to the total shipment distance associated with the unirradiated fuel, radioactive waste, or irradiated fuel, i.e., as the number of shipments and the shipping distance increase, the effects from transporting the unirradiated fuel, radioactive waste, or irradiated fuel also increase. For this reason, the total shipment distance was used as the metric for the transportation PPE. The total shipment distance is quantified in terms of the annual one-way shipment distance or the annual round-trip shipment distance.

The annual one-way shipment distance is calculated using the formula:

- Annual One-Way Shipment Distance (km) = Annual Number of Normalized Shipments × One-Way Shipping Distance (km)

The annual round-trip shipment distance is calculated using the formula:

- Annual Round-Trip Shipment Distance (km) = 2 × Annual Number of Normalized Shipments × One-Way Shipping Distance (km)

In order to develop the transportation PPE, NRC staff examined WASH-1238 and past new reactor EISs to determine the total shipment distances evaluated in these EISs for unirradiated fuel, radioactive waste, or irradiated fuel. The NRC staff also identified factors that could affect the relationship between the effects of incident-free and accident transportation and the total shipment distance.

Factors identified by the NRC staff included:

- The use of different versions of RADTRAN to estimate the effects of transporting unirradiated fuel, radioactive waste, and irradiated fuel: The radiation doses and risks discussed in Sections 3.15.1.7, 3.15.1.8, and 3.15.1.9 below were estimated using the RADTRAN computer code. RADTRAN has changed over time, with Version 5 (Neuhauser et al. 2000-TN6990; Neuhauser and Kanipe 2003-TN6989) being used in EISs published in the period 2006-2008, Version 5.6 (Weiner et al. 2008-TN302) being used in EISs published in the period 2011-2016, and Version 6 being the current version (Weiner et al. 2013-TN3390, Weiner et al. 2014-TN3389). A specific example of how RADTRAN has changed over time is in how it estimates long-term doses after a transportation accident, where RADTRAN 5 and 5.6 estimated a 50-year long-term dose from transportation accidents, while RADTRAN 6 no longer provides 50-year long-term dose estimates (see page 66 and equation 75 in Weiner et al. 2014-TN3389).
- The use of different census data to estimate the effects of transporting unirradiated fuel, radioactive waste, and irradiated fuel: The radiation doses and risks discussed in Sections 3.15.1.7, 3.15.1.8, and 3.15.1.9 below were estimated using 2000 census and 2010 census data; earlier EISs used 2000 census data and later EISs used 2010 census data to estimate transportation impacts. The use of different census data can affect the estimates of the effects of transporting unirradiated fuel, radioactive waste, and irradiated fuel for a transportation route, even if the route remains the same.
- The use of different sources of transportation accident, injury, and fatality rate data to estimate the effects of transporting unirradiated fuel, radioactive waste, and irradiated fuel: In general, the radiological and nonradiological effects discussed in Sections 3.15.1.7, 3.15.1.8, and 3.15.1.9 below were estimated using State-level accident, injury, and fatality rate data from Saricks and Tompkins (1999-TN81). However, other sources of transportation accident, injury, and fatality rate data have been used (e.g., DOT 2013-TN3930). The use of different accident, injury, and fatality rate data can affect the estimates of the effects of transporting unirradiated fuel, radioactive waste, and irradiated fuel.
- The number of exposed persons along different transportation routes: Lower transportation effects would be estimated for routes through more sparsely populated areas (rural) than for routes through more highly populated areas (urban and suburban), where higher transportation effects would be estimated. The fraction of a route that is urban, suburban, and rural will vary for the same destination depending on the originating site's location and on the States traversed by a transportation route.

- Differences in the accident, injury, and fatality rates in the various States traversed by a transportation route: The transportation accident effects discussed in Sections 3.15.1.7, 3.15.1.8, and 3.15.1.9 below were typically estimated using State-level accident, injury, and fatality rate data (see Saricks and Tompkins 1999-TN81). These rates differ by State, which can yield higher or lower estimates of effects depending on the States traversed by a transportation route.
- Differences in parameters such as source-to-receptor distances, shielding factors, transportation cask dimensions, etc. used to estimate the effects of transporting unirradiated fuel, radioactive waste, and irradiated fuel: The radiological effects discussed in Sections 3.15.1.7, 3.15.1.8, and 3.15.1.9 below were estimated using specific values of parameters deemed appropriate at the time of the analysis, such as source-to-receptor distances, shielding factors, and transportation cask dimensions. These specific parameter values would affect the calculated values in the tables below.
- Differences in the radionuclide inventory contained in a transportation cask due to the irradiated fuel having higher or lower burnup: The radiological effects associated with transportation accidents involving irradiated fuel discussed in Section 3.15.1.9 were estimated using a transportation cask with a capacity of 0.5 MTU. However, the burnup associated with the irradiated fuel would be reactor-specific. The burnup affects the radionuclide inventory, which in turn affects the estimates of the estimated radiation doses from transportation accidents involving irradiated fuel.
- Use of an updated stop model for unirradiated fuel shipments: The transportation effects in the North Anna (NRC 2006-TN7), Clinton (NRC 2006-TN672), and Grand Gulf (NRC 2006-TN674) EISs were estimated using a stop model with a population density of 64,300 people/km^2 in a 1 to 10 m annular ring around the vehicle. In addition, the exposure time was estimated to be 4.5 hours and no shielding was assumed. In later EISs, transportation effects were estimated using the updated stop model described by Griego et al. (1996-TN69).

NRC staff found that these factors do not affect the use of the total shipment distance as the metric for the transportation PPE but account for the variations in the calculated values in the subsequent tables.

3.15.1.7 Transportation of Unirradiated New Reactor Fuel

Unirradiated nuclear fuel assemblies, or fresh fuel elements, are transported to the nuclear reactor in protective outer packages designed to prevent damage to the fuel elements in transit (Rhoads 1977-TN6572). Typically, one pressurized water reactor (PWR) or two boiling water reactor fuel elements are placed in a protective overpack designed to protect the valuable fuel element from damage during transport (NRC 2019-TN6511, NRC 2019-TN6512, NRC 2019-TN6513). These overpacks are usually shipped to the nuclear reactor site by truck. Ten containers of PWR fuel (Table B-2 of WEC 2019-TN6510) each containing one assembly or six containers of boiling water reactor fuel each containing two assemblies are typically placed on a standard truck semi-trailer with a current maximum Federal gross vehicle weight limit of 80,000 pounds (DOT 2015-TN6753).[33] The overpack dimensions appear to be the limiting factor for the number of overpacks in one shipment and not the maximum Federal gross vehicle weight limit.

[33] 10 CFR 51.52 (TN250) Table S–4 includes a condition that the truck shipments not exceed 73,000 lb as governed by Federal or State gross vehicle weight restrictions.

The necessary NRC-certified transport packages for unirradiated new reactor fuel at HALEU enrichment levels are being developed (Jarrell 2018-TN6508; Eidelpes et al. 2019-TN6507; Jarrell and Eidelpes 2020-TN6694). For example, in Section 4, Review and Application of Existing Packaging Designs, in the paper by Eidelpes et al. (2019-TN6507), the authors note that two promising packaging designs were identified that could be adapted for HALEU transportation, and could be readily transported by truck. These are the Transnuclear Americas Long Cask (TN-LC) (NRC 2017-TN6684) and the NAC International Inc. (NAC) International Optimal Modular Universal Shipping for low-activity contents (OPTIMUS™-L) packaging. In addition, review of the NRC-certified transport packages listed on DOE's Radioactive Material Packaging website reveals a small number of transportation packages that are currently certified for shipping HALEU material, such as the VP-55 package (Hennebach and Langston 2020-TN6693; NRC 2020-TN6686). The VP-55 package is also certified for various forms of unirradiated TRISO fuel in the form of uranium kernels and TRISO particles, which may be loose or mixed in a graphite matrix and pressed into compacts of various fuel forms (e.g., annular cylinders, planks, right circular cylinders, spheres, etc.).

There are also DOE-certified transport packages that potentially could be applied for shipping HALEU fuel (Jarrell 2018-TN6508). The higher enriched material approved for such certified packages could be in the form of UF_6, TRISO, and research reactor plate fuel. Given the nature of liquid-fueled MSRs where the HALEU material is mixed with the chloride- or fluoride-based molten salt, it should be expected that the HALEU material would be shipped from the enrichment site to the MSR site in the form of UF_6 (McFarlane et al. 2019-TN6741).

3.15.1.7.1 Normal Conditions

Normal conditions, sometimes referred to as "incident-free" transportation, are transportation activities during which shipments reach their destination without releasing any radioactive material to the environment (i.e., not being involved in a vehicular accident). Impacts from these shipments would be from the low levels of radiation that penetrate the shielding provided by unirradiated fuel shipping containers. In the case of unirradiated fuel, the radiation would be from the natural decay of the uranium isotopes. Past studies have determined the largest impacts would occur for shipments made by trucks due to a larger number of shipments that would occur versus rail shipments, and these impacts would also have a larger exposure population due to existing travel densities on U.S. roadways.

The number of unirradiated fuel shipments for WASH-1238 (AEC 1972-TN22) and new reactor LWR licensing actions are provided in Table 3-11. This table is broken down by shipments for an initial core loading, the number of annual shipments to support core reloading, and the total number of shipments over the lifetime of the operating license (assumed to be 40 years). For example, the Advanced Passive 1000 (AP1000) fuel shipments would have approximately seven PWR overpacks for each truck shipment.[34] This results in a mass loading of approximately 3.8 MTU per truck shipment. It is anticipated that for an MSR, unirradiated fuel would be shipped in the form of UF_6. For low-enriched UF_6, a standard truck loading is six Type 30B cylinders per truck (USEC 1999-TN6515) for approximately 9.3 MTU per truck. To have the equivalent MTU as the PWR unirradiated fuel shipment would require about three Type 30B cylinders per truck. Assuming equal uranium requirements, this would reduce the number of unirradiated fuel shipments required for an MSR by about 50 percent compared to a large LWR.

[34] There are 157 fuel assemblies per core loading and 23 initial core loading shipments; therefore, 157/23 ≈ 6.8 rounded to 7 fuel assemblies per shipment.

The radiological impacts provided in WASH-1238 (AEC 1972-TN22) and the previous new reactor EISs, as shown in Table 3-12, were based on annual exposures from the expected number of shipments over a year as normalized to 1,100 MW(e) (or 880 MW(e) net electrical output). Another factor to consider when extending this analysis to new reactors is the assumption applied in WASH-1238 and in the staff's analysis of new reactor unirradiated fuel shipments that the radiation dose rate at 3.3 ft from the transport vehicle is about 0.1 mrem/hr. This assumption should also be reasonable for new reactors that use HALEU fuel because the HALEU materials would still be low-dose-rate uranium radionuclides and would likely be packaged similarly to those described in WASH-1238 (i.e., inside a metal container that provides little radiation shielding).

Table 3-11 Number of Truck Shipments and One-Way Shipping Distances for Unirradiated Fuel

Site Name	Number of Shipments Per Site: Initial Core	Number of Shipments Per Site: Total Reload[a]	Number of Shipments Per Site: Total[a]	Number of Shipments Per Site: Normalized Annual Shipments[b]	Number of Shipments Per Site: One-Way Shipping Distance (km)
WASH-1238 (NRC 2006-TN7)	18	234	252	6.3	3,200
North Anna Power Station Unit 3 ESP (NRC 2006-TN7)	51	780	831	18.2	3,200
Clinton Exelon ESP (NRC 2006-TN672)	51	780	831	18.2	3,200
Grand Gulf ESP (NRC 2006-TN674)	51	780	831	18.2	3,200
Vogtle Units 3 and 4 ESP (NRC 2008-TN673)	23	210	233	5	3,200
Calvert Cliffs Unit 3 COL (NRC 2011-TN1980)	-	-	298	4.4	3,200
South Texas Units 3 and 4 COL (NRC 2011-TN1722)	-	-	372	6.6	3,200
Virgil C. Summer Units 2 and 3 COL (NRC 2011-TN1723)	-	-	233	5	3,200
Levy Units 1 and 2 COL (NRC 2012-TN1976)	23	210	233	5	1,166
Comanche Peak Units 3 and 4 COL (NRC 2011-TN6437)	-	-	100	1.5	3,200
Enrico Fermi Unit 3 COL (NRC 2013-TN6436)	38	323	361	5.3	3,600
William States Lee Units 1 and 2 COL (NRC 2013-TN6435)	23	234	257	6.1	3,200
PSEG ESP (NRC 2015-TN6438)	45	300	345	4.9	4,400
Turkey Point Units 6 and 7 COL (NRC 2016-TN6434)	-	-	209	5	3,200
Bell Bend COL (NRC and USACE 2016-TN6562)	-	-	298	4.3	4,247

Table 3-11 Number of Truck Shipments and One-Way Shipping Distances for Unirradiated Fuel (Continued)

Site Name	Number of Shipments Per Site: Initial Core	Number of Shipments Per Site: Total Reload[a]	Number of Shipments Per Site: Total[a]	Number of Shipments Per Site: Normalized Annual Shipments[b]	Number of Shipments Per Site: One-Way Shipping Distance (km)
Clinch River ESP (NRC 2019-TN6136)	36	456	492	15	3,944
NUREG-2266 (NRC 2024-TN10333)[c]	-	-	-	5	5,129

COL = combined license; ESP = early site permit; IAEA = International Atomic Energy Agency; PSEG = Public Service Enterprise Group.
"-" denotes no data in table cell.
(a) Total shipments of unirradiated fuel over a 40-year plant lifetime.
(b) Normalized to Reference LWR (880 MW(e) net).
(c) Largest annual impact for an existing LWR from NUREG-2266, Table 3-6 (NRC 2024-TN10333).

Table 3-12 Radiological Impacts Under Normal Conditions of Transporting Unirradiated Fuel from WASH-1238 and New Reactor Sites

Site Name	Annual Total One-Way Shipment Distance[a] (km)	Population Impacts (person-rem/yr)[b]: Workers	Population Impacts (person-rem/yr)[b]: Public Onlookers	Population Impacts (person-rem/yr)[b]: Public Along Route
WASH-1238 (NRC 2006-TN7)	20,160	0.011	0.042	0.0010
North Anna Power Station Unit 3 ESP (NRC 2006-TN7)	58,240	0.031	0.12	0.0029
Clinton Exelon ESP (NRC 2006-TN672)	58,240	0.031	0.12	0.0029
Grand Gulf ESP (NRC 2006-TN674)	58,240	0.031	0.12	0.0029
Vogtle Units 3 and 4 ESP (NRC 2008-TN673)	16,000	0.0085	0.015	0.00021
Calvert Cliffs Unit 3 COL (NRC 2011-TN1980)	14,080	0.0076	0.016	0.00023
South Texas Units 3 and 4 COL (NRC 2011-TN1722)	21,120	0.011	0.024	0.00033
Virgil C. Summer Units 2 and 3 COL (NRC 2011-TN1723)	16,000	0.0085	0.018	0.00025
Levy Units 1 and 2 COL (NRC 2012-TN1976)	5,830	0.0031	0.0076	0.00029
Comanche Peak Units 3 and 4 COL (NRC 2011-TN6437)	4,800	0.0041	0.0071	0.000043
Enrico Fermi Unit 3 COL (NRC 2013-TN6436)	19,080	0.010	0.018	0.00018
William States Lee Units 1 and 2 COL (NRC 2013-TN6435)	19,520	0.012	0.021	0.00029
PSEG ESP (NRC 2015-TN6438)	21,560	0.0071	0.016	0.00047
Turkey Point Units 6 and 7 COL (NRC 2016-TN6434)	16,000	0.0090	0.018	0.00025

Table 3-12 Radiological Impacts Under Normal Conditions of Transporting Unirradiated Fuel from WASH-1238 and New Reactor Sites (Continued)

Site Name	Annual Total One-Way Shipment Distance[a] (km)	Population Impacts (person-rem/yr)[b] Workers	Population Impacts (person-rem/yr)[b] Public Onlookers	Population Impacts (person-rem/yr)[b] Public Along Route
Bell Bend COL (NRC and USACE 2016-TN6562)	18,262	0.0098	0.038	0.00067
Clinch River ESP (NRC 2019-TN6136)	59,160	0.0078	0.044	0.0012
NUREG-2266 (NRC 2024-TN10333) [c]	25,645	0.0634	0.340	0.0013
Maximum Estimate	59,160	0.0634	0.340	0.0029

COL = combined license; ESP = early site permit; IAEA = International Atomic Energy Agency; PSEG = Public Service Enterprise Group.
(a) The total shipment distance is based on the number of annual shipments multiplied by the shipping distance.
(b) Normalized to Reference LWR (880 MW(e) net).
(c) Largest annual impact for an existing LWR from NUREG-2266, Table 3-6 (NRC 2024-TN10333).

The one-way distances should also be bounding for unirradiated HALEU fuel shipments because the existing fuel fabrication facility locations would still be expected to fabricate HALEU fuel. Additionally, the distances from enrichment facilities to an MSR site for HALEU UF_6 shipments should also be within these one-way distances.

3.15.1.7.2 Transportation Accidents

Accident risks are a combination of accident frequency and consequence. Accident frequencies for transportation of unirradiated fuel are expected to be lower than those used in the analysis in WASH-1238 (AEC 1972-TN22). This is based on the NRC staff evaluations in previous new reactor EISs where the NRC staff identified the trends in improvements in highway safety and security, and an overall reduction in traffic accident, injury, and fatality rates since WASH-1238 was published. Although packages for all types of new reactor unirradiated fuel have not been designed or certified by the NRC, these packages must comply with the packaging requirements contained in 10 CFR Part 71 (TN301) and, for this reason, the impacts of radiological accidents during transport of unirradiated fuel to a new reactor are expected to be smaller than those listed in Table S-4 in 10 CFR 51.52 (TN250).

Nonradiological impacts are the human health impacts projected to result from traffic accidents involving shipments of unirradiated fuel to the new reactor site (i.e., the analysis does not consider the radiological or hazardous characteristics of the cargo). Nonradiological impacts include the projected number of traffic accidents, injuries, and fatalities that could result from shipments of unirradiated fuel to the site and return shipments of empty containers from the site. The methodology for determining the nonradiological impacts can be found in any of the new reactor EISs, such as in Section 6.2.1.3, Nonradiological Impacts of Transportation Accidents, of the Clinch River ESP Final EIS (NRC 2019-TN6136). This methodology is incorporated by reference in this GEIS. The nonradiological impacts for unirradiated fuel shipment accidents from WASH-1238 (AEC 1972-TN22) and the new reactor EISs are provided in Table 3-13.

3.15.1.7.3 Summary of PPE Values for Transport of Unirradiated New Reactor Fuel

Based on the above information, Table 3-12 and Table 3-13 present the PPE for transport of unirradiated new reactor fuel. This PPE consists of two components:

- The maximum annual one-way shipment distance (59,160 km) presented in Table 3-12. The annual shipments associated with the one-way shipment distance have been normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor from WASH-1238.
- The maximum annual round-trip shipment distance (118,320 km) presented in Table 3-13. The annual shipments associated with the round-trip shipment distance have been normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor from WASH-1238.

The PPE applies to situations where the enrichment of the unirradiated new reactor fuel is 20 percent or less, based on the unlimited A_2 value in Table A-1 in 10 CFR Part 71 for unirradiated uranium enriched to 20 percent or less (10 CFR Part 71-TN301). This PPE does not apply to situations in which a new reactor applicant proposes to ship the unirradiated reactor fuel by air, ship, or barge; or in which a new reactor applicant proposes that an unirradiated fuel transportation package for the new reactor be approved using the provisions of 10 CFR 71.12, 10 CFR 71.41(c), or 10 CFR 71.41(d), such as might be applied for when shipping a complete unirradiated reactor core.

Table 3-13 Nonradiological Impacts of Transporting Unirradiated Fuel

Site Name	Annual Total Round-Trip Shipment Distance[a] (km)	Accidents per Year[b]	Injuries per Year[b]	Fatalities per Year[b]
WASH-1238 (NRC 2006-TN7)	40,320	-[c]	-[c]	-[c]
North Anna Power Station Unit 3 ESP (NRC 2006-TN7)	116,480	-[c]	-[c]	-[c]
Clinton Exelon ESP (NRC 2006-TN672)	116,480	-[c]	-[c]	-[c]
Grand Gulf ESP (NRC 2006-TN674)	116,480	-[c]	-[c]	-[c]
Vogtle Units 3 and 4 ESP (NRC 2008-TN673)	32,000	0.0090	0.0061	0.00029
Calvert Cliffs Unit 3 COL (NRC 2011-TN1980)	28,160	0.013	0.0066	0.00041
South Texas Units 3 and 4 COL (NRC 2011-TN1722)	42,240	0.020	0.0098	0.00061
Virgil C. Summer Units 2 and 3 COL (NRC 2011-TN1723)	32,000	0.015	0.0074	0.00046
Levy Units 1 and 2 COL (NRC 2012-TN1976)	11,660	0.0069	0.0038	0.00031
Comanche Peak Units 3 and 4 COL (NRC 2011-TN6437)	9,600	0.0026	0.0013	0.000087
Enrico Fermi Unit 3 COL (NRC 2013-TN6436)	38,160	0.018	0.0089	0.00055
William States Lee Units 1 and 2 COL (NRC 2013-TN6435)	39,040	0.018	0.0090	0.00056
PSEG ESP (NRC 2015-TN6438)	43,120	0.024	0.012	0.00072
Turkey Point Units 6 and 7 COL (NRC 2016-TN6434)	32,000	0.015	0.0074	0.00046

Table 3-13 Nonradiological Impacts of Transporting Unirradiated Fuel (Continued)

Site Name	Annual Total Round-Trip Shipment Distance[(a)] (km)	Accidents per Year[(b)]	Injuries per Year[(b)]	Fatalities per Year[(b)]
Bell Bend COL (NRC and USACE 2016-TN6562)	36,524	0.14	0.0086	0.00030
Clinch River ESP (NRC 2019-TN6136)	118,320	0.069	0.035	0.0018
NUREG-2266 (NRC 2024-TN10333)	51,290	0.0138	0.00534	0.00046
Maximum Estimate	118,320	0.14	0.035	0.0018

COL = combined license; ESP = early site permit; IAEA = International Atomic Energy Agency; PSEG = Public Service Enterprise Group.
"-" denotes no data in table cell.
(a) The total shipment distance is based on the number of annual shipments multiplied by the round-trip shipping distance. The round-trip distance is used because nonradiological vehicle accident impacts could occur on the return trip.
(b) Normalized to Reference LWR (880 MW(e) net).
(c) Not analyzed.
Largest annual impact for an existing LWR from NUREG-2266, Table 3-8 (NRC 2024-TN10333).

3.15.1.8 Transportation of Radioactive Waste from New Reactors

As discussed in Section 3.10 of this GEIS, radioactive waste can consist of a variety of materials with radioactivity levels from just above background radiation levels found in nature to very high radioactivity in certain cases. While SNF is also radioactive waste, it is classified as high-level radioactive waste, or HLW, and will be discussed in Section 3.15.1.8. This section assesses the LLRW generated at a new reactor site that would be stored onsite, either until it has decayed away and can be disposed of as ordinary trash, or until amounts are large enough for shipment to a LLRW disposal site in packages authorized by the DOT (e.g., Type A packages) or approved by the NRC (e.g., Type B transport packages).

The characteristics of radioactive waste from new reactors are expected to be the same as those of the radioactive waste generated by the current LWR fleet. Because of the design, size, and the nature of the potential operations at a new reactor, the amount of LLRW likely to be generated annually by a new reactor could be noticeably less than that generated by the current LWRs.

The staff has assessed LLRW shipment impacts as part of the environmental review of new reactor ESP and COL applications relative to the annual LLRW shipments shown in Table 3-14. As noted on the NRC website for LLRW disposal (NRC 2020-TN6516), there are four existing commercial LLRW disposal facilities in the United States that accept various classes of LLRW.[35] All are in Agreement States. The Low-Level Radioactive Waste Policy Amendments Act of 1985 (Public Law 99–240, 99 Stat. 1842; TN6517) gave the States responsibility for the disposal of their LLRW. The Act encouraged the States to enter into compacts that would allow them to dispose of waste at a common disposal facility. Two LLRW disposal facilities only accept wastes from within their Compact. Two other LLRW disposal facilities could accept LLRW regardless of the location of the LLRW generator. One LLRW disposal site will accept Class A LLRW and another LLRW disposal site will accept Class A, B, and C LLRW. Energy*Solutions* Clive Operations, located in Clive, Utah, accepts waste from all regions of the United States. Clive is

[35] The classes of LLRW are defined under 10 CFR 61.55, "Waste classification" (10 CFR Part 61-TN252).

licensed by the State of Utah for Class A waste only (NRC 2017-TN6518). WCS LLC, located near Andrews, Texas, accepts waste from the Texas Compact generators and outside generators with permission from the Compact. WCS is licensed by the State of Texas to dispose of Class A, B, and C waste. For the new reactor LLRW transportation impacts, the staff selected the Energy*Solutions* or the WCS LLRW disposal facility if the location was not in a Compact with one of the other two LLRW disposal facilities.

The DOE's Manifest Information Management System (MIMS) is a database used to monitor the management of commercial LLRW in the United States (DOE 2024-TN10120). The LLRW information in MIMS is derived from manifests for waste shipments to one closed and four operating commercial LLRW disposal facilities. MIMS information for the most recent five years for available data (i.e., 2019 to 2023) was compiled for the four commercial LLRW disposal facilities by the different classes of LLRW. Table 3-15 provides the breakdown to each LLRW disposal facility by volume and Table 3-16 does so by activity.

As can be seen in a comparison of annual waste volumes in Table 3-14 and Table 3-15, all of the LWR waste streams are a small fraction of the median annual total volumes for the last 5 years of data. The annual curie content of the LLRW from new reactors is also expected to be small fraction of the median annual total as provided in Table 3-16.

Table 3-14 Summary of Radioactive Waste Shipments and One-Way Shipping Distances

Site Name	Annual Waste Generation per Unit (m^3/yr-unit)	Number of Radioactive Waste Shipments[(a)]	One-Way Shipping Distance (km)
WASH-1238 (NRC 2006-TN7)	108	46	-[(b)]
North Anna Power Station Unit 3 ESP (NRC 2006-TN7)	168	51	-[(b)]
Clinton Exelon ESP (NRC 2006-TN672)	168	51	-[(b)]
Grand Gulf ESP (NRC 2006-TN674)	168	51	-[(b)]
Vogtle Units 3 and 4 ESP (NRC 2008-TN673)	56	21	800
Calvert Cliffs COL (NRC 2011-TN1980)	208	9	800
South Texas Units 3 and 4 COL (NRC 2011-TN1722)	99	31	800
Virgil C. Summer Units 2 and 3 COL (NRC 2011-TN1723)	56	21	800
Levy Units 1 and 2 COL (NRC 2012-TN1976)	56	21	800
Comanche Peak Units 3 and 4 COL (NRC 2011-TN6437)	433	109	800
Enrico Fermi Unit 3 COL (NRC 2013-TN6436)	449	114	800
William States Lee Units 1 and 2 COL (NRC 2013-TN6435)	56	21	800
PSEG ESP (NRC 2015-TN6438)	432.7	105.4	1110
Turkey Point Units 6 and 7 COL (NRC 2016-TN6434)	56	23	800
Bell Bend COL (NRC and USACE 2016-TN6562)	208	52	800
Clinch River ESP (NRC 2019-TN6136)	142	75	1954.3

COL = combined license; ESP = early site permit; PSEG = Public Service Enterprise Group.
"-" denotes no data in table cell.
(a) The number of shipments was calculated assuming the average waste shipment capacity of 2.34 m^3 (82.6ft^3) per shipment applied in WASH-1238 (AEC 1972-TN22) (108 m^3/yr divided by 46 shipments/year yields 2.34 m^3 per shipment). The number of shipments was also normalized to 880 MW(e).
(b) Not analyzed.

Table 3-15 Low-Level Radioactive Waste by Volume

Year	Class A Volume (m^3)	Class B Volume (m^3)	Class C Volume (m^3)	Total Volume (m^3)
Barnwell				
2023	236.9	34.1	23.5	294.5
2022	156.9	23.8	18.4	199.1
2021	397.0	21.1	10.2	428.3
2020	836.1	48.4	6.8	891.4
2019	246.5	39.3	19.1	305.0
Median	246.5	34.1	18.4	305.0
Energy*Solutions*				
2023	91,823.0	0.0	0.0	91,823.0
2022	63,994.8	0.0	0.0	63,994.8
2021	25,185.5	0.0	0.0	25,185.5
2020	27,805.3	0.0	0.0	27,805.3
2019	118,516.4	0.0	0.0	118,516.4
Median	63,994.8	0.0	0.0	63,994.8
Richland				
2023	334.7	3.8	0.0	399.0
2022	734.4	3.4	0.0	755.5
2021	512.9	6.0	0.0	566.4
2020	371.2	3.6	0.0	433.0
2019	493.1	0.0	0.0	592.3
Median	493.1	3.6	0.0	566.4
Waste Control Specialists				
2023	769.7	140.3	47.5	957.4
2022	706.1	113.5	66.4	886.0
2021	624.8	123.8	47.0	795.6
2020	803.1	57.9	32.7	893.7
2019	756.6	104.2	49.7	910.4
Median	756.6	113.5	47.5	893.7
Annual Total				
2023	93,164.2	178.2	70.9	93,473.9
2022	65,592.2	140.8	84.8	65,835.4
2021	26,720.2	150.9	57.2	26,975.9
2020	29,815.7	110.0	39.5	30,023.3
2019	120,012.6	143.5	68.8	120,324.3
Median	65,592.2	143.5	68.8	65,835.4

Note: Original units were cubic feet. Cubic feet were converted to cubic meters by multiplying by 0.0283 m^3/ft^3.
Source: DOE 2024-TN10120.

Table 3-16 Low-Level Radioactive Waste by Activity

Year	Activity Class A (curies)	Activity Class B (curies)	Activity Class C (curies)	Total Activity (curies)
Barnwell				
2023	187.46	475.31	12,870.47	13,533.24
2022	114.58	499.60	29,134.89	29,749.07
2021	133.27	743.96	46.57	923.80
2020	160.02	464.81	18.28	643.11
2019	251.90	3,315.23	26,986.16	30,553.29
Median	160.02	499.60	12,870.47	13,533.24
Energy*Solutions*				
2023	6,339.55	0.00	0.00	6,339.55
2022	6,969.43	0.00	0.00	6,969.43
2021	6,368.76	0.00	0.00	6,368.76
2020	15,608.41	0.00	0.00	15,608.41
2019	9,553.56	0.00	0.00	9,553.56
Median	6,969.43	0.00	0.00	6,969.43
Richland				
2023	407.34	604.93	0.00	1,017.40
2022	324.16	724.76	0.00	1,048.93
2021	265.51	6,321.28	0.00	6,589.54
2020	999.90	7,861.04	0.00	9,235.54
2019	658.32	0.00	0.00	669.66
Median	407.34	724.76	0.00	1,048.93
Waste Control Specialists				
2023	888.36	3,711.31	147,140.44	151,740.11
2022	979.88	4,953.42	110,591.00	116,524.30
2021	806.38	7,681.52	98,842.64	107,330.54
2020	1,156.49	3,081.13	19,695.26	23,932.89
2019	723.33	4,935.57	88,333.14	93,992.05
Median	888.36	4,935.57	98,842.64	107,330.54
Annual Total				
2023	7,822.71	4,791.54	160,010.91	172,630.29
2022	8,388.05	6,177.78	139,725.89	154,291.74
2021	7,573.93	14,746.76	98,889.21	121,212.65
2020	17,924.83	11,406.99	19,713.54	49,419.95
2019	11,187.11	8,250.80	115,319.30	134,768.56
Median	8,388.05	8,250.81	115,319.30	134,768.55

Source: DOE 2024-TN10120.

3.15.1.8.1 Summary of PPE Values for Transport of Radioactive Waste from New Reactors

In NUREG-0170, *Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes* (NRC 1977-TN417, NRC 1977-TN6497), the NRC evaluated the shipment of radioactive material, including shipments of unirradiated fuel, SNF, and radioactive waste to and from nuclear power plants. The NRC concluded in NUREG-0170 that the average radiation dose to the population at risk from normal transportation is a small fraction of the limits recommended for members of the general public from all sources of radiation other than natural and medical sources and is a small fraction of the natural background dose. In addition, the NRC determined that the radiological risk from accidents in transportation is small, amounting to about 0.5 percent of the normal transportation risk on an annual basis. The NRC also determined in NUREG-0170 that the environmental impacts of normal transportation of radioactive materials and the risks attendant to accidents involving radioactive material shipments are sufficiently small to allow continued shipments by all modes. The doses from radioactive waste accidents were negligible when compared to the doses from accidents involving spent fuel shipments.

Previous LWR ESP and COL environmental analyses of the nonradiological impacts from accidents involving the transportation of LLRW (injuries and death from physical collisions involving truck LLRW shipments) have shown the risks to be low and the environmental impact finding was SMALL. The results from these environmental analyses are shown in Table 3-17. There is uncertainty as to the design of new reactors and how that relates to the generation of LLRW; most designs are expected to generate lower volumes of LLRW than LWRs due to their having less complex systems, structures, and components. This should result in a much lower number of annual LLRW shipments but will depend on the capacity of the onsite radiological waste storage building.

Based on the above information, Table 3-17 presents the PPE for transport of radioactive waste from new reactors. This PPE consists of one component:

The maximum annual round-trip shipment distance (293,145 km) presented below in Table 3-17. The annual shipments associated with the round-trip shipment distance have been normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor and a shipment volume of 2.34 m^3/shipment from WASH-1238.

This PPE does not apply to situations where a new reactor applicant proposes shipping the reactor's radioactive waste by air, ship, or barge; or where a new reactor applicant proposes that a radioactive waste transportation package for the new reactor be approved using the provisions of 10 CFR 71.12, 10 CFR 71.41(c), or 10 CFR 71.41(d) (10 CFR Part 71-TN301).

Table 3-17 Annual Nonradiological Impacts of Transporting Waste from the Site

Site Name	Annual Total Round-Trip Shipment Distance[a,b] (km)	Accidents per Year[b]	Injuries per Year[b]	Fatalities per Year[b]
WASH-1238 (NRC 2006-TN7)	-[c]	-[c]	-[c]	-[c]
North Anna Power Station Unit 3 ESP (NRC 2006-TN7)	-[c]	-[c]	-[c]	-[c]
Clinton Exelon ESP (NRC 2006-TN672)	-[c]	-[c]	-[c]	-[c]
Grand Gulf ESP (NRC 2006-TN674)	-[c]	-[c]	-[c]	-[c]
Vogtle Units 3 and 4 ESP (NRC 2008-TN673)	33,600	0.0095	0.0065	0.00031
Calvert Cliffs COL (NRC 2011-TN1980)	14,400	0.0067	0.0033	0.00021
South Texas Units 3 and 4 COL (NRC 2011-TN1722)	49,600	0.023	0.011	0.00072
Virgil C. Summer Units 2 and 3 COL (NRC 2011-TN1723)	33,600	0.016	0.0078	0.00049
Levy Units 1 and 2 COL (NRC 2012-TN1976)	33,600	0.016	0.0078	0.00049
Comanche Peak Units 3 and 4 COL (NRC 2011-TN6437)	174,400	0.077	0.040	0.0026
Enrico Fermi Unit 3 COL (NRC 2013-TN6436)	182,400	0.085	0.042	0.0026
William States Lee Units 1 and 2 COL (NRC 2013-TN6435)	33,600	0.016	0.0078	0.00049
PSEG ESP (NRC 2015-TN6438)	233,988	0.17	0.097	0.0060
Turkey Point Units 6 and 7 COL (NRC 2016-TN6434)	36,800	0.017	0.0085	0.00053
Bell Bend COL (NRC and USACE 2016-TN6562)	83,200	0.076	0.0045	0.00016
Clinch River ESP (NRC 2019-TN6136)	293,145	0.17	0.11	0.0049
Maximum Estimate	293,145	0.17	0.11	0.0060

COL = combined license; ESP = early site permit; PSEG = Public Service Enterprise Group.
"-" denotes no data in table cell.

(a) The total shipment distance is based on the number of annual shipments multiplied by the round-trip shipping distance. The round-trip distance is used because nonradiological vehicle accident impacts could occur on the return trip.

(b) In determining the round-trip shipment-km, accidents per year, injuries per year, and fatalities per year, the number of shipments was calculated assuming the average waste shipment capacity of 2.34 m^3 (82.6 ft^3) per shipment applied in WASH-1238 (AEC 1972-TN22) (108 m^3/yr divided by 46 shipments/year yields 2.34 m^3 per shipment). The number of shipments was also normalized to 880 MW(e).

(c) Not analyzed.

3.15.1.9 Transportation of SNF from New Reactors

This section discusses the radiological and nonradiological environmental impacts from the potential shipments of SNF for normal operating, or incident-free conditions and transportation accidents. For the previous new reactor EISs, the staff performed an independent analysis of the environmental impacts of transporting spent fuel from the proposed and alternative sites to a spent fuel disposal repository. The staff has also performed an independent analysis for the transportation of SNF to a private ISFSI and two Consolidated Interim Storage Facilities (CISFs) for SNF and HLW, as published in three EISs (NRC 2001-TN6514, NRC 2021-TN10124, NRC 2022-TN10125).

For the purposes of these new reactor transportation analyses, the NRC staff considered the proposed Yucca Mountain site in Nevada as a surrogate destination. The NRC has not made a licensing decision about the DOE application for the proposed geologic repository at Yucca Mountain. However, the NRC staff considers an estimate of the impacts of the transportation of spent fuel to a possible repository in Nevada to be a reasonable bounding estimate of the transportation impacts on a spent fuel interim storage or disposal facility because of the distances involved and the representativeness of the distribution of members of the public in urban, suburban, and rural areas (i.e., population distributions) along the shipping routes. In addition, as noted in Section 3.15.1.3, Additional NRC Information Sources, the new reactor transportation analyses using truck shipments of 0.5 MTU were normalized with respect to power level and shipment quantities to allow a comparison to the results presented in Table S-4 of 10 CFR 51.52 (TN250). The results of the new reactor transportation analyses for SNF as normalized for comparison to Table S-4 are provided in Table 3-18, Table 3-19, and Table 3-20, for incident-free SNF impacts, radiological accident SNF impacts, and nonradiological accident SNF impacts, respectively.

For the licensing action of the Private Fuel Storage Facility (PFSF) ISFSI, the staff analyzed the human health impacts from the transportation of SNF in NUREG-1714, (NRC 2001-TN6514). Section 5.7, Human Health Impacts of SNF Transportation, discusses the radiological and nonradiological human health impacts associated with transportation of SNF from nuclear power plants to the PFSF. For cross-country transportation to the proposed PFSF, only shipments by rail are analyzed because Private Fuel Storage planned to receive only rail transportation packages under its NRC license with the potential for short travel distances by heavy-haul trucks or by barges when necessary. Based on the results of the transportation analysis, the staff found that annual and cumulative radiological impacts of transporting SNF to the proposed PFSF would be small. Also, the analytical results for transportation of SNF to and from the proposed PFSF are consistent with earlier analyses of SNF risks reported in NUREG-0170 (NRC 1977-TN417, NRC 1977-TN6497).

In the CISF EISs, the staff estimated the potential radiological impacts on workers and the public from the proposed rail transportation of SNF from nuclear power plants and ISFSIs to the proposed CISF based on prior NRC transportation risk estimates in NUREG-2125, *Spent Fuel Transportation Risk Assessment* (NRC 2014-TN3231). In the NUREG-2125 analysis, the staff performed a transportation risk assessment to calculate worker and public doses and risks from the transportation of SNF along various representative national routes under incident-free and accident conditions. In that analysis, the staff calculated occupational doses for groups of workers, including rail crew, escorts in transit, and railyard workers, as well as crew and escorts at stops. Because the resulting dose estimates provided in NUREG-2125 were presented for single shipments and for each kilometer traveled and for each hour of transportation, the staff scaled the results by these variables (e.g., number of shipments, distance, and time) to generate estimates that were applicable to the proposed CISF projects. The staff selected a representative route that was bounding for the proposed shipments of SNF to the proposed CISF and scaled the calculated doses to match the number of proposed shipments and, as applicable, the shipment distance and time.

Table 3-18 Incident-Free Radiological Impacts for Shipping Spent Nuclear Fuel to the Yucca Mountain Site

Site Name	Annual Shipments[a]	Shipping Distance (km)	Annual Total One-Way Shipment Distance[a] (km)	Population Impacts (person-rem/yr)[b]		
				Workers	Public Onlookers	Public Along Route
North Anna Power Station Unit 3 ESP (NRC 2006-TN7)	90	4,410	396,900	9.2	32	0.82
Clinton Exelon ESP (NRC 2006-TN672)	90	3,076	276,840	6.4	22	0.41
Grand Gulf ESP (NRC 2006-TN674)	90	3,718	334,620	7.8	25	0.62
Vogtle Units 3 and 4 ESP (NRC 2008-TN673)	40	4,091	163,640	7.3	13	0.38
Calvert Cliffs Unit 3 COL (NRC 2011-TN1980)	46	4,568	210,128	9.4	19	0.53
South Texas Units 3 and 4 COL (NRC 2011-TN1722)	60	2,922	175,320	8.0	17	0.37
Virgil C. Summer Units 2 and 3 COL (NRC 2011-TN1723)	46	4,096	188,416	7.4	15	0.35
Levy Units 1 and 2 COL (NRC 2012-TN1976)	40	4,520	180,800	8.2	20	0.42
Comanche Peak Units 3 and 4 COL (NRC 2011-TN6437)	9.5	2,568	24,396	2.0	0.37	0.11
Enrico Fermi Unit 3 COL (NRC 2013-TN6436)	40.3	3,481	140,284	6.4	13	0.25
William States Lee Units 1 and 2 COL (NRC 2013-TN6435)	39	4,041	157,599	7.5	13	0.37
PSEG ESP (NRC 2015-TN6438)	54.5	4,470	243,615	11	23	0.63
Turkey Point Units 6 and 7 COL (NRC 2016-TN6434)	60	4,977	298,620	9.9	18	0.59
Bell Bend COL (NRC and USACE 2016-TN6562)	44	4,090	179,960	4.3	14	0.35
Clinch River ESP (NRC 2019-TN6136)	137	3,689	505,393	2.8	50	0.97
NUREG-2266 (NRC 2024-TN10333)[c]	78	4,458	347,724	4.4	11.4	0.637
Maximum Estimate	-	-	505,393	11	50	0.97

COL = combined license; ESP = early site permit; IAEA = International Atomic Energy Agency; PSEG = Public Service Enterprise Group.
"-" denotes no data in table cell.
(a) The total shipment distance is based on the number of annual shipments multiplied by the shipping distance.
(b) Normalized to Reference LWR (880 MW(e) net).
(c) Largest annual impact for an existing LWR from NUREG-2266, Table 3-10 (NRC 2024-TN10333).

Table 3-19 Radiological Accident Impacts for Shipping Spent Nuclear Fuel to the Yucca Mountain Site

Site Name	Annual Shipments[a]	Shipping Distance (km)	Annual Total One-Way Shipment Distance[a] (km)	Population Impacts (person-rem/yr)[b]	Burnup (GWd/MTU)
North Anna Power Station Unit 3 ESP (NRC 2006-TN7)	90	4,410	396,900	5.00×10^{-4}[c]	62 (LWRs)[d] 133 (TRISO)
Clinton Exelon ESP (NRC 2006-TN672)	90	3,076	276,840	2.30×10^{-4}[c]	62 (LWRs)[d] 133 (TRISO)
Grand Gulf ESP (NRC 2006-TN674)	90	3,718	334,620	4.10×10^{-4}[c]	62 (LWRs)[d] 133 (TRISO)
Vogtle Units 3 and 4 ESP (NRC 2008-TN673)	40	4,091	163,640	2.20×10^{-5}	62 (LWR)[d]
Calvert Cliffs Unit 3 COL (NRC 2011-TN1980)	46	4,568	210,128	8.40×10^{-5}	52 (LWR)
South Texas Units 3 and 4 COL (NRC 2011-TN1722)	60	2,922	175,320	1.50×10^{-4}	32.3 (LWR)
Virgil C. Summer Units 2 and 3 COL (NRC 2011-TN1723)	46	4,096	188,416	1.80×10^{-5}	50.5 (LWR)
Levy Units 1 and 2 COL (NRC 2012-TN1976)	40	4,520	180,800	9.20×10^{-5}	62 (LWR)[d]
Comanche Peak Units 3 and 4 COL (NRC 2011-TN6437)	9.5	2,568	24,396	5.90×10^{-5}	46.2 (LWR)
Enrico Fermi Unit 3 COL (NRC 2013-TN6436)	40.3	3,481	140,284	3.10×10^{-6}	46 (LWR)
William States Lee Units 1 and 2 COL (NRC 2013-TN6435)	39	4,041	157,599	7.10×10^{-5}	62 (LWR)
PSEG ESP (NRC 2015-TN6438)	54.5	4,470	243,615	2.00×10^{-4}	54.2 (LWR)
Turkey Point Units 6 and 7 COL (NRC 2016-TN6434)	60	4,977	298,620	5.20×10^{-5}	50.5 (LWR)
Bell Bend COL (NRC and USACE 2016-TN6562)	44	4,090	179,960	1.28×10^{-4}	52 (LWR)
Clinch River ESP (NRC 2019-TN6136)	137	3,689	505,393	7.50×10^{-6}	51 (LWR)
NUREG-2266 (NRC 2024-TN10333)[e]	45	4,252	191,340	2.96×10^{-5}	80 (LWR)[f]
Maximum Estimate	-	-	505,393	5.00×10^{-4}	80 (LWRs)[f] 133 (TRISO)

COL = combined license; ESP = early site permit; IAEA = International Atomic Energy Agency; LWR = light-water reactor; PSEG = Public Service Enterprise Group; TRISO = TRi-structural ISOtropic.
"-" denotes no data in table cell.
(a) The total shipment distance is based on the number of annual shipments multiplied by the shipping distance.
(b) Normalized to Reference LWR (880 MW(e) net).
(c) Maximum population impact if multiple reactor types are evaluated.
(d) Peak rod burnup.
(e) Largest annual impact for an existing LWR from NUREG-2266, Table 3-14 (NRC 2024-TN10333).
(f) Assembly averaged burnup.

Table 3-20 Nonradiological Accident Impacts for Shipping Spent Nuclear Fuel to the Yucca Mountain Site

Site Name	Annual Shipments[a]	Shipping Distance (km)	Annual Total Round-Trip Shipment Distance (km)[a]	Accidents per Year[b]	Injuries per Year[b]	Fatalities per Year[b]
North Anna Power Station Unit 3 ESP (NRC 2006-TN7)	90	4,410	793,800	-[c]	-[c]	-[c]
Clinton Exelon ESP (NRC 2006-TN672)	90	3,076	553,680	-[c]	-[c]	-[c]
Grand Gulf ESP (NRC 2006-TN674)	90	3,718	669,240	-[c]	-[c]	-[c]
Vogtle Units 3 and 4 ESP (NRC 2008-TN673)	40	4,091	327,280	0.081	0.067	0.0036
Calvert Cliffs Unit 3 COL (NRC 2011-TN1980)	46	4,568	420,256	0.16	0.099	0.0076
South Texas Units 3 and 4 COL (NRC 2011-TN1722)	60	2,922	350,640	0.20	0.13	0.0062
Virgil C. Summer Units 2 and 3 COL (NRC 2011-TN1723)	46	4,096	376,832	0.11	0.071	0.0056
Levy Units 1 and 2 COL (NRC 2012-TN1976)	40	4,520	361,600	0.15	0.087	0.0062
Comanche Peak Units 3 and 4 COL (NRC 2011-TN6437)	9.5	2,568	48,792	0.011	0.062	0.0042
Enrico Fermi Unit 3 COL (NRC 2013-TN6436)	40.3	3,481	280,569	0.15	0.068	0.0046
William States Lee Units 1 and 2 COL (NRC 2013-TN6435)	39	4,041	315,198	0.11	0.072	0.0056
PSEG ESP (NRC 2015-TN6438)	54.5	4,470	487,230	0.28	0.13	0.0080
Turkey Point Units 6 and 7 COL (NRC 2016-TN6434)	60	4,977	597,240	0.15	0.098	0.0068
Bell Bend COL (NRC and USACE 2016-TN6562)	44	4,090	359,920	0.33	0.019	0.00067
Clinch River ESP (NRC 2019-TN6136)	137	3,689	1,010,786	0.32	0.21	0.016
NUREG-2266 (NRC 2024-TN10333)[c]	78	4,252	331,656	0.211	0.093	0.0077
Maximum Estimate	-	-	1,010,786	0.33	0.21	0.016

COL = combined license; ESP = early site permit; IAEA = International Atomic Energy Agency; PSEG = Public Service Enterprise Group.
"-" denotes no data in table cell.
(a) The total shipment distance is based on the number of annual shipments multiplied by the round-trip shipping distance. The round-trip distance is used because nonradiological vehicle accident impacts could occur on the return trip.
(b) Normalized to Reference LWR (880 MW(e) net).
(c) Not analyzed.
(d) Largest annual impact for an existing LWR from NUREG-2266, Table 3-16 (NRC 2024-TN10333).

3.15.1.9.1 Differences between Truck and Rail Transportation Modes

Several differences between the truck and rail transportation modes should be considered when selecting the transportation mode for assessing the impacts of transporting new reactor SNF. First, there is a significant difference in the MTU load that can be carried by each. Truck shipments are likely not to contain more than approximately 2 MTU (e.g., 4 PWR SNF assemblies) where 0.5 MTU has been applied in previous staff analyses for a comparison to Table S-4. Rail transportation packages could contain upwards of approximately 18.5 MTU (e.g., 37 PWR SNF assemblies) (NRC 2020-TN6683, NRC 2018-TN6685). Thus, for a set MTU quantity of new reactor SNF, fewer numbers of shipments are necessary for the rail mode.

The rail mode would likely involve less radiation exposure to members of the public because people traveling on roads would be next to truck shipments and there is generally a buffer zone on each side of the rail right-of-way going through residential neighborhoods. There are also access limitations for the shipment of SNF by rail. It is not certain that all new reactor sites would have rail access. Thus, some portion of the transportation route may have to be performed using heavy-haul trucks for rail shipments. Such heavy-haul truck shipments are expected to be heavily monitored and controlled resulting in low to negligible impacts on members of the public.

Therefore, it is expected that truck shipments would have larger incident-free impacts than rail shipments due to the larger number of shipments (e.g., as much as 37 times—0.5 MTU versus 18.5 MTU) and due to the greater potential for radiation exposure to members of the public. In addition, 49 CFR 397.101 (49 CFR Part 397-TN6621) requires that placarded radioactive material shipments made by truck are operated on routes that minimize radiological risks. Similarly, 49 CFR 172.820 requires that rail routes for highway-route–controlled quantities of radioactive material consider factors that would also serve to minimize radiological risks (see 49 CFR Part 172-TN6616, Appendix D).

When considering impacts from transportation accidents, both rail and truck packages have a very low probability of a radioactive release. As stated in the summary for Chapter 3, Cask Response to Impact Accidents, of NUREG-2125 (NRC 2014-TN3231):

> Detailed FE [finite element] analyses performed for two spent fuel transportation rail casks indicate that casks are very robust structures capable of withstanding almost all impact accidents without release of radioactive material. In fact, when spent fuel is transported within an inner welded canister or in a truck cask, no impacts result in release. Even the rail cask without an inner welded canister can withstand impacts much more severe than the regulatory impact without releasing any material.

And with respect to truck packages:

> Assessment of previous analyses performed for spent fuel truck transportation casks, including impacts onto flat rigid targets, into cylindrical rigid targets, by locomotives, and by falling bridge structures, indicate that truck casks will not release their contents in any impact accidents.

Chapter 5, Transportation Accidents, of NUREG-2125 (NRC 2014-TN3231) concluded the overall collective dose risks are very small to negligible for the two types of extra-regulatory accidents (accidents involving a release of radioactive material and loss-of-lead-shielding accidents).

For transportation accidents involving severe fires, NUREG/CR-7209 (Fort et al. 2017-TN6692) evaluated four severe roadway and railway fires for their potential impact on spent fuel transportation packages. The analyses found that NRC regulations and packaging standards provide a high degree of protection of public health and safety against releases of radioactive material in real-world transportation accidents involving fires.

3.15.1.9.2 Summary of PPE Values for Transport of Irradiated New Reactor Fuel

Based on the above information, Table 3-18 and Table 3-20 present the PPE for transport of irradiated new reactor fuel. This PPE consists of two components:

- The maximum annual one-way shipment distance (505,393 km) presented below in Table 3-18. The annual shipments associated with the one-way shipment distance have been normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor and a shipment capacity of 0.5 MTU/shipment from WASH-1238.
- The maximum annual round-trip shipment distance (1,010,786 km) presented below in Table 3-20. The annual shipments associated with the round-trip shipment distance have been normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor and a shipment capacity of 0.5 MTU/shipment from WASH-1238.

Based on the radiological accident impacts presented below in Table 3-19, an additional component is established for the PPE:

- A maximum assembly averaged burnup of 80 GWd/MTU for UO_2 fuel and peak pellet burnup of 133 GWd/MTU for TRISO fuel.

This PPE does not apply to situations where a new reactor applicant proposes shipping the irradiated fuel by air, ship, or barge; or where a new reactor applicant proposes that an irradiated fuel transportation package for the new reactor be approved using the provisions of 10 CFR 71.12, 10 CFR 71.41(c), or 10 CFR 71.41(d) (10 CFR Part 71-TN301), such as might be applied for when shipping an entire irradiated reactor core. In addition, the irradiated new reactor fuel must be shipped in a transportation package that meets all of the applicable NRC regulations.

3.15.2 Transportation Impacts

The NRC staff identified the following three environmental issues associated with the radiological and nonradiological environmental impacts from incident-free transportation and transportation accident conditions:

- shipment of unirradiated fuel to the new reactor site,
- shipment of LLRW and mixed waste to offsite disposal facilities, and
- shipment of SNF to an interim storage facility or a permanent geologic repository.

This assessment will draw upon previous analyses for their assumptions, shipment parameters, and routing information and provide a basis that a new reactor applicant could apply for

bounding the potential environmental impacts for their non-LWR fuel and waste, given there is a certain amount of uncertainty in transport packaging and processing.

A couple of notable conditions in this analysis can be accepted without specific new reactor design information. First, it is likely that new reactor developers will use HALEU fuel with resulting longer refueling cycling times than the 2-year refueling frequencies of LWRs that were assessed in the new reactor EISs. Thus, the number of shipments of fresh fuel to the new reactor site and the potential number of SNF shipments from the site could be significantly less than previously assessed for new reactor LWRs. The previous analyses, whether they used existing certified transport packages or not, were based on a specific quantity of nuclear fuel in each shipment. For example, WASH-1238 (AEC 1972-TN22) assumed a 0.5 MTU per SNF truck shipment. Thus, this is another shipment parameter that could be applied as a bounding value for new reactor fuel shipments.

Second, there are a number of unknowns or questions related to several aspects of non-LWR fuel shipments. Prior transportation risk assessments were reviewed for their applicability to support resolution of new reactor fuel transportation issues. In addition, PNNL has prepared a report for the NRC regarding transportation analysis for non-LWR reactor designs (Maheras 2020-TN6509). While Section 6.2 in NRC RG 4.2 (NRC 2026-TN11915) provides detailed guidance for how to estimate transportation-related impacts for LWRs, the PNNL report provides additional guidance for estimating transportation-related impacts for non-LWRs in the following areas:

- applicability of NRC and DOT regulations to the shipment of non-LWR fuel and waste;
- absence of certified packages for shipping the unirradiated fuel, spent fuel, and radioactive waste associated with non-LWRs;
- external dose rates associated with the shipment of non-LWR unirradiated fuel, spent fuel, and radioactive waste;
- transportation routing for non-LWR shipments;
- chemical and physical forms associated with the non-LWR unirradiated fuel, spent fuel, and radioactive waste;
- number of shipments associated with unirradiated fuel, spent fuel, and radioactive waste shipments;
- radionuclide inventory per shipment for non-LWR unirradiated fuel, spent fuel, and radioactive waste;
- conditional probabilities and release fractions associated with transportation accidents involving non-LWR fuel and waste shipments; and
- comparison of transportation risk assessment results to various criteria.

In addition to the PNNL report (Maheras 2020-TN6509), other transportation analysis documents are discussed for their usefulness to support the environmental conclusions in Section 3.15.1.

3.15.2.1 Transportation of Unirradiated New Reactor Fuel

The staff's evaluation of the transport of unirradiated new reactor fuel focused on incident-free radiological impacts and the nonradiological impacts of transportation accidents. This is a

Category 1 issue. If the values and assumptions of the PPE that the transport of unirradiated new reactor fuel will fit within the bounds outlined in Table 3-12 and Table 3-13 in Section 3.15.1.7.1 are met, the impacts can be generically determined to be SMALL and the maximum transportation estimates are as listed in Table 3-12 and Table 3-13. The staff relied on the following PPE values and assumptions to reach this conclusion:

- The maximum annual one-way shipment distance (59,160 km) presented in Table 3-12. The annual shipments associated with the one-way shipment distance have been normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor from WASH-1238 (AEC 1972-TN22).
- The maximum annual round-trip shipment distance (118,320 km) presented in Table 3-13. The annual shipments associated with the round-trip shipment distance have been normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor from WASH-1238.

This requires that the unirradiated new reactor fuel shipments be normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor from WASH-1238. The PPE applies to situations where the enrichment of the unirradiated new reactor fuel is 20 percent or less, based on the unlimited A_2 value in Table A-1 in 10 CFR Part 71 (TN301) for unirradiated uranium enriched to 20 percent or less. In addition, the PPE does not apply to situations in which a new reactor applicant proposes shipping the unirradiated fuel by air, ship, or barge; or in which a new reactor applicant proposes that an unirradiated fuel transportation package for the new reactor be approved using the provisions of 10 CFR 71.12, 10 CFR 71.41(c), or 10 CFR 71.41(d) (10 CFR Part 71-TN301). If these assumptions are not met, a project-specific transportation impact analysis must be performed as part of the new reactor application.

Some new reactor designs are anticipated to ship a fully loaded but unirradiated reactor core from a manufacturing facility to an appropriately licensed reactor site. In the case of shipping a new reactor core and its unirradiated contents or any other new reactor unirradiated fuel, in which any of the above conditions are not met, then a project-specific transportation impact analysis must be performed as part of the new reactor application.

3.15.2.2 Transportation of Radioactive Waste from New Reactors

The staff's evaluation of the transport of radioactive waste from new reactors focused on the nonradiological impacts of transportation accidents. This is a Category 1 issue. If the values and assumptions of the PPE that the transport of radioactive waste from a new reactor will fit within the bounds outlined in Table 3-17 in Section 3.15.1.8.1 are met, the impacts can be generically determined to be SMALL and the maximum transportation estimates are as listed in Table 3-17. The staff relied on the following PPE value and assumptions to reach this conclusion:

The maximum annual round-trip shipment distance (293,145 km) presented in Table 3-17. The annual shipments associated with the round-trip shipment distance have been normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor and a shipment volume of 2.34 m^3/shipment from WASH-1238 (AEC 1972-TN22).

This requires that the radioactive waste shipments from new reactors be normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor and a shipment volume of 2.34 m^3/shipment from WASH-1238 (AEC 1972-TN22). In addition, the PPE does not apply to situations in which a new reactor applicant proposes shipping the radioactive

waste by air, ship, or barge; or in which a new reactor applicant proposes that a radioactive waste transportation package for the new reactor be approved using the provisions of 10 CFR 71.12, 10 CFR 71.41(c), or 10 CFR 71.41(d) (10 CFR Part 71-TN301). If these assumptions are not met, a project-specific transportation impact analysis must be performed as part of the new reactor application.

3.15.2.3 Transportation of Irradiated Fuel from New Reactors

The staff's evaluation of the transport of irradiated fuel from new reactors focused on incident-free radiological impacts and the radiological and nonradiological impacts of transportation accidents. This is a Category 1 issue. If the values and assumptions of the PPE that the transport of irradiated new reactor fuel will fit within the bounds outlined in Table 3-18 and Table 3-20 are met, the impacts can be generically determined to be SMALL and the maximum transportation estimates are as listed in Table 3-18, Table 3-19, and Table 3-20. The staff relied on the following PPE values and assumptions to reach this conclusion:

- The maximum annual one-way shipment distance (505,393 km) presented in Table 3-18. The annual shipments associated with the one-way shipment distance have been normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor and a shipment capacity of 0.5 MTU/shipment from WASH-1238.
- The maximum annual round-trip shipment distance (1,010,786 km) presented in Table 3-20. The annual shipments associated with the round-trip shipment distance have been normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor and a shipment capacity of 0.5 MTU/shipment from WASH-1238.
- A maximum assembly averaged burnup of 80 GWd/MTU for UO_2 fuel and peak pellet burnup of 133 GWd/MTU for TRISO fuel (see Table 3-19).

This requires that the irradiated fuel shipments from new reactors be normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor and a shipment capacity of 0.5 MTU/shipment from WASH-1238. The PPE also does not apply to situations in which a new reactor applicant proposes shipping the irradiated fuel by air, ship, or barge; or in which a new reactor applicant proposes that an irradiated fuel transportation package for the new reactor be approved using the provisions of 10 CFR 71.12, 10 CFR 71.41(c), or 10 CFR 71.41(d) (10 CFR Part 71-TN301). In addition, the irradiated new reactor fuel must be shipped in a transportation package that meets all of the applicable NRC regulations. If these assumptions are not met, a project-specific transportation impact analysis must be performed as part of the new reactor application.

It is recommended that the transportation analysis be performed in manner to the practicable extent possible to apply impact results from previous NRC or DOE analysis. The basis for applying these prior results must be justified to show that the new reactor SNF characteristics fit within the parameters and assumptions applied in the prior transportation analysis, such as was done for the two CISF EIS transportation analyses (NRC 2021-TN10124, NRC 2022-TN10125).

3.16 Decommissioning

3.16.1 Baseline Conditions and PPE/SPE Values and Assumptions

At the end of the operating life of a power reactor, NRC regulations require that the nuclear facility undergo decommissioning. The NRC defines decommissioning as the safe removal of a facility from service and the reduction of residual radioactivity to a level that permits termination of the NRC license. The regulations governing decommissioning of power reactors are found in 10 CFR 50.75 (TN249), 10 CFR 50.82 (TN249), and 10 CFR 52.110 (TN251). The radiological criteria for termination of the NRC license are in 10 CFR Part 20 (TN283), Subpart E. The requirements for the minimization of contamination and generation of radioactive waste for facility design and procedures for operation are addressed in 10 CFR 20.1406 (TN283).

If a new reactor applicant submits an application for an operating license or a COL, or applies for a license to construct a new nuclear power plant, there is a requirement in 10 CFR 50.33 (TN249) to provide a report (discussed in 10 CFR 50.75 (TN249), and 10 CFR 52.77 refers back to 10 CFR 50.33) that contains a certification indicating how reasonable assurance will be provided that funds will be available to complete decommissioning of the facility. In addition, the regulations for termination of the license in 10 CFR 50.82(a)(4)(i) (TN249) and 10 CFR 52.110(d)(1) (TN251) require the licensee to submit a post-shutdown decommissioning activity report (PSDAR) to the NRC and a copy to the affected State(s) either before or not later than 2 years after permanent cessation of operations.

The PSDAR must include a description of the licensee's planned decommissioning activities, a schedule for the accomplishment of significant milestones, and an estimate of all expected costs for radiological decommissioning (this does not include site restoration). The PSDAR is sometimes referred to as the licensee's decommissioning plan that provides the decommissioning strategy for the reactor. The PSDAR must contain, among other things, a discussion that provides the reasons for concluding that the environmental impacts associated with project-specific decommissioning activities will be bounded by appropriate previously issued EISs.

The PSDAR should also document the results of the licensee's evaluation of the environmental impacts associated with project-specific decommissioning activities. The evaluation should include a comparison of the project-specific environmental impacts of the proposed decommissioning to the impacts identified in previously issued environmental statements, that is, NUREG-0586, Supplement 1, *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities Regarding the Decommissioning of Nuclear Power Reactors* (the Decommissioning GEIS) (NRC 2002-TN665), NUREG-1496, Volume 1, *Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities* (NRC 1997-TN5455), and any previous project-specific environmental NEPA licensing documents. The NRC will determine whether the licensee's PSDAR contains the information required by the regulation. Although the NRC's approval of the PSDAR is not required, if the NRC determines that the information provided by the licensee in the PSDAR does not comply with the regulatory requirements, it will inform the licensee in writing of the additional information required by the regulations and request a response. The licensee is required to provide updates to the NRC for review if there are any significant changes to the PSDAR.

The licensee is required to submit a License Termination Plan application with its final status survey strategy to the NRC at least 2 years before they intend to terminate the license. Before

the completion of decommissioning, the licensee conducts a final status survey to demonstrate compliance with criteria established in the License Termination Plan; the License Termination Plan is sometimes referred to in layman's terms as the approved decommissioning plan for power reactors. The NRC may verify the survey by one or more of the following: a quality assurance/quality control review, side-by-side or split sampling of a radiological survey of selected areas, and independent confirmatory surveys. When the NRC confirms that the criteria in the License Termination Plan and all other NRC regulatory requirements have been met, the NRC either terminates or amends the license, depending on the licensee's decision to use the licensed area.

The Decommissioning GEIS (NRC 2002-TN665) determined the environmental impacts would be SMALL for the following resource areas, would be limited to operational areas, would not be detectable or destabilizing and are expected to have a negligible effect on the impacts of terminating operations and decommissioning:

- Onsite Land Use
- Water Use
- Water Quality
- Air Quality
- Aquatic Ecology within the operational area
- Terrestrial Ecology within the operational area
- Radiological
- Radiological Accidents (non-spent-fuel-related)
- Occupational Issues
- Socioeconomic
- Onsite Cultural and Historic Resources for plants where the disturbance of lands beyond the operational areas is not anticipated
- Aesthetics
- Noise
- Transportation
- Irretrievable Resource

Threatened and endangered species is a site-specific issue in the Decommissioning GEIS where a generic environmental impact determination could not be reached. In addition, four other issues also do not have generic environmental impact determinations in the Decommissioning GEIS, including offsite land use and aquatic ecology, terrestrial ecology, and historic and cultural resource activities beyond the operational area.

The following two environmental issues were not identified in the Decommissioning GEIS and are assessed in the next section:

- Nonradiological waste
- Greenhouse gases

3.16.2 Decommissioning Impacts

This section addresses the potential environmental impacts of the decommissioning of the new reactor facility and the management of SNF that may remain at the site until it is removed and the license is terminated. The continued storage of spent fuel during the period of time past permanent cessation of reactor operations is discussed in Section 3.14.2.6, Storage and Disposal of Radiological Wastes.

The NRC staff evaluated the environmental impacts during the decommissioning of nuclear power reactors. This evaluation was documented in the Decommissioning GEIS (NUREG-0586, Supplement 1; NRC 2002-TN665). NUREG-0586, Supplement 1, is incorporated here by reference. The 2013 and 2024 LR GEIS (NRC 2013-TN2654, NRC 2024-TN10161) reference the Decommissioning GEIS and describes the impacts associated with decommissioning existing LWRs (a nuclear facility with a large footprint). They also describe and discuss the environmental consequences of terminating nuclear power plant operations and decommissioning, but the only impacts attributable to the proposed action (license renewal) are the effects of an additional 20 years of operations on the impacts of decommissioning. The majority of the impacts associated with plant operations would cease with reactor shutdown; however, some impacts would remain unchanged, while others would continue at reduced or altered levels. Some new impacts might also result directly from terminating nuclear power plant operations. The 2013 and 2024 LR GEIS discuss the various impacts by resource area; some could be quantified as having small impacts, such as radiological impacts, while others could have higher impacts, such as socioeconomics (NRC 2013-TN2654, NRC 2024-TN10161). The LR GEIS concluded that the effects of license renewal on impacts of terminating nuclear power plant operations and decommissioning are considered a single environmental issue. Because the impacts are expected to be SMALL at all plants and for all environmental resources, it is considered a Category 1 issue.

The LR GEIS discussion above informs the impacts expected for decommissioning a new reactor and are incorporated here by reference.

At the initial licensing stage, new reactor applicants are not required to submit information regarding the specific method chosen for decommissioning or the schedule, but financial planning is required per 10 CFR 50.75 “Reporting and recordkeeping for decommissioning planning” and 10 CFR 50.82(a)(8) “Termination of license” (10 CFR Part 50-TN249). However, a new reactor applicant should provide a discussion in the application’s ER that demonstrates whether the environmental impacts of decommissioning discussed in NUREG-0586, Supplement 1 (NRC 2002-TN665) would bound those for the new reactor design.

The NRC staff’s evaluation of the environmental impacts of decommissioning presented in NUREG-0586, Supplement 1, considered environmental issues for LWRs and three permanently shutdown facilities that included a fast breeder reactor and two high-temperature gas-cooled reactors (NRC 2002-TN665). The Decommissioning GEIS identified whether the environmental issues were considered generic to all decommissioning sites or project-specific. If the issue was considered generic, then it was assigned a significance level of either SMALL, MODERATE or LARGE. For the environmental issues assessed in the Decommissioning GEIS, most impacts were considered generic and SMALL for all plants, regardless of the activities and identified variables. This is because the impacts would be limited to operational areas, would not be detectable or destabilizing, and are expected to have a negligible effect on the impacts of terminating operations and decommissioning. Threatened and endangered species was the one

issue that was determined to require a project-specific review. Four issues in the Decommissioning GEIS were considered to be conditionally project-specific:

- land use involving offsite areas to support decommissioning activities,
- aquatic ecology for activities beyond the licensed operational area,
- terrestrial ecology for activities beyond the licensed operational area, and
- historic and cultural resources (archaeological, architectural, structural, historic) for activities within and beyond the licensed operational area with no current (i.e., at the time of decommissioning) evaluation of resources for NRHP eligibility.[36]

Table 3-21 provides a summary of the impacts and findings for each of the Decommissioning GEIS's evaluated environmental issues.

Table 3-21 Summary of the Environmental Impacts from Decommissioning Nuclear Power Facilities (NRC 2002-TN665)

Environmental Issue	NUREG-0586 S1 Section No.	Generic	NUREG-0586 S1 Finding	Summary of NUREG-0586 S1
Onsite Land Use • Onsite land use activities • Offsite land use activities	4.3.1	Yes No	SMALL Site-specific	Decommissioning utilizes areas used during construction. Decommissioning activities that affect offsite land use are not expected unless major upgrades to transportation links are required.
Water Use	4.3.2	Yes	SMALL	Significantly smaller than water use during operation.
Water Quality • Surface Water • Groundwater	4.3.3	Yes	SMALL SMALL	Application of common BMP's; NPDES permits regulate intentional releases of hazardous materials; considerable attention is placed on minimizing spills
Air Quality	4.3.4	Yes	SMALL	Activities extend over years and BMPs can be used to minimize fugitive dust

[36] In some cases, the nuclear power plant itself may be considered a historic property for its unique design or contribution to a significant historic or engineering achievement. Ultimately, historic and cultural resources at each site can be quite different and must be assessed at a plant-specific level and in consultation with SHPOs, Tribal representatives, and other interested parties.

Table 3-21 Summary of the Environmental Impacts from Decommissioning Nuclear Power Facilities (NRC 2002-TN665) (Continued)

Environmental Issue	NUREG-0586 S1 Section No.	Generic	NUREG-0586 S1 Finding	Summary of NUREG-0586 S1
Aquatic Ecology • Activities within the operational area • Activities beyond the operational area	4.3.5	Yes No	SMALL Site-specific	If decommissioning does not include removal of shoreline or in-water structures, very little aquatic habitat is expected to be disturbed during decommissioning. When there is a decommissioning activity outside the operational area, the significance of the potential impacts is more difficult to define and will depend on site-specific considerations.
Terrestrial Ecology • Activities within the operational area • Activities beyond the operational area	4.3.6	Yes No	SMALL Site-specific	There is a relatively distinct/small operational area where most or all site activities occur. Some sites will require the reconstruction or installation of new transportation links, such as railroad spurs, road upgrades, or barge slips.
Threatened and Endangered Species	4.3.7	No	Site-specific	The likelihood of impacts to threatened and endangered species is related to their presence or absence

Table 3-21 Summary of the Environmental Impacts from Decommissioning Nuclear Power Facilities (NRC 2002-TN665) (Continued)

Environmental Issue	NUREG-0586 S1 Section No.	Generic	NUREG-0586 S1 Finding	Summary of NUREG-0586 S1
Radiological • Occupational dose • Dose to the public	4.3.8	 Yes Yes	 SMALL SMALL	Radiological impacts of decommissioning, including demolition debris that is LLRW, will remain within regulatory limits for both occupational exposures and to members of the public.
Radiological Accidents	4.3.9	Yes	SMALL	Emergency plans and procedures will remain in place to protect health and safety while the possibility of significant spent fuel pool accidents exists.
Occupational Issues	4.3.10	Yes	SMALL	Strict adherence to NRC, Occupational Safety and Health Administration, and State safety standards, practices, and procedures during decommissioning.
Cost	4.3.11	N/A	N/A	Evaluation of decommissioning cost is not a NEPA requirement.
Socioeconomic	4.3.12	Yes	SMALL	Impacts of plant closure are those that are observed by the community, rather than the impacts from decommissioning activities because they occur at about the same time

Table 3-21 Summary of the Environmental Impacts from Decommissioning Nuclear Power Facilities (NRC 2002-TN665) (Continued)

Environmental Issue	NUREG-0586 S1 Section No.	Generic	NUREG-0586 S1 Finding	Summary of NUREG-0586 S1
Cultural and Historic Resources • Activities within the operational area • Activities beyond the operational area	4.3.14	Yes No	SMALL Site-specific	The amount of land required to support the decommissioning process is relatively small and is a small portion of the overall plant site. Some sites will require the reconstruction or installation of new transportation links, such as railroad spurs, road upgrades, or barge slips
Aesthetics	4.3.15	Yes	SMALL	BMPs to control many of the potentially adverse impacts of decommissioning activities on aesthetics (e.g., dust and noise)
Noise	4.3.16	Yes	SMALL	The sources of noise would be sufficiently distant from critical receptors outside the plant boundaries that the noise would be attenuated to nearly. ambient levels and would be scarcely noticeable.
Transportation	4.3.17	Yes	SMALL	Licensees are expected to comply with all applicable regulations when shipping radioactive waste from decommissioning.

Table 3-21 Summary of the Environmental Impacts from Decommissioning Nuclear Power Facilities (NRC 2002-TN665) (Continued)

Environmental Issue	NUREG-0586 S1 Section No.	Generic	NUREG-0586 S1 Finding	Summary of NUREG-0586 S1
Irretrievable Resources	4.3.18	Yes	SMALL	If the license is terminated for unrestricted use, then the land will be available for other uses and other irretrievable resources are minor.

BMP = best management practices; LLRW = low-level radioactive waste; N/A = not applicable; NEPA = National Environmental Policy Act of 1969, as amended; NPDES = National Pollutant Discharge Elimination System; NRC = U.S. Nuclear Regulatory Commission.

The NRC staff believes the above impacts, as discussed in Decommissioning GEIS (NRC 2002-TN665), are bounding for large LWRs deployed after 2002. The expected methods and processes for decommissioning new reactors are expected to be similar to existing decommissioning methods and processes for large LWRs. Regulations specified in § 50.82(a)(4)(i) and § 52.110(d)(1) require that PSDARs provide the reasons for concluding that appropriate previously issued EISs will bound the environmental impacts from site-specific decommissioning activities. After the PSDAR is submitted, the licensee must remain in compliance with § 50.82(a)(6)(ii) or § 52.110(f)(2), as applicable. The staff assumes the decommissioning of new reactors would likely have no greater impacts than large LWR decommissioning impacts given that the two project-specific and four conditionally project-specific issues would be evaluated and addressed at the time of either early decommissioning (submittal and review of the PSDAR for acceptability) or later (during License Termination Plan NEPA review). In addition, 10 CFR 50.82 (TN249) or 10 CFR 52.110 (TN251), as applicable, provide that a licensee shall not perform any decommissioning activities that result in significant environmental impacts not bounded by previously issued environmental review documents, such as the Decommissioning GEIS. Licensees that are considering decommissioning activities that could result in significant environmental impacts and would otherwise be prohibited by § 50.82(a)(6)(ii) or § 52.110(f)(2), to modify the decommissioning activity so that the impacts would be bounded, decide not to perform the proposed activity, or seek NRC approval of a license amendment or exemption request. If the licensee decides to pursue a license amendment or exemption, its request will trigger an NRC review of the site-specific environmental impacts of the decommissioning activity under NEPA.

Regarding nonradiological waste, waste minimization and pollution prevention are important elements of operations at all nuclear power plants (NRC 2024-TN10161. Nonradiological waste can include hazardous waste and nonhazardous waste (see Section 3.10.2 for details on nonradiological waste information). Licensees are required to consider pollution prevention measures as dictated by the Pollution Prevention Act (Public Law 101 5084; TN6607) and the Resource Conservation and Recovery Act of 1976, as amended (Public Law 94 580; TN1281). In addition, licensees have waste minimization programs in place that are aimed at minimizing the quantities of waste sent offsite for treatment or disposal. Waste minimization techniques employed by the licensees may include (1) source reduction, which includes (a) changes in input materials (e.g., using materials that are not hazardous or are less hazardous), (b) changes

in technology, and (c) changes in operating practices and (2) recycling of materials either onsite or offsite. The establishment of a waste minimization program is also a requirement for managing hazardous wastes under RCRA. Nonradiological waste will need to be handled in accordance with applicable Federal and State regulations. It is assumed that licensees would continue to adhere to all applicable State and Federal laws and pollution prevention plans as well as applying waste minimization techniques. The staff concludes that, as long as the PPE assumptions associated with decommissioning and waste management (Section 3.10 of this NR GEIS) are met, the nonradiological waste impacts from decommissioning a new reactor can also be generically determined to be SMALL.

The Decommissioning GEIS (NRC 2002-TN665) does not specifically address the GHG footprint of decommissioning activities. However, it does list the decommissioning activities and states that the decommissioning workforce would be expected to be smaller than the operational workforce, and that the decontamination and demolition activities could take up to 10 years to complete. Finally, it discusses SAFSTOR (also called the SAFSTOR decommissioning option), in which decontamination and dismantlement are delayed for a number of years (within a cumulative time period of a 50-year time frame (6–10 years is equivalent to 50 years for SAFSTOR). Equipment and vehicles used during decommissioning and SAFSTOR activities would emit GHGs, principally CO_2. Combining the PPE values for GHG emissions for these stages listed in Table 3-2 in Section 3.3.1, 74,000 MT CO_2(e) would be emitted during a 10-year decommissioning period and 40-year SAFSTOR period of two 1,000 MW reactors, or less than 1,500 MT CO_2(e)/yr on average. For comparison, in 2022, total gross annual U.S. GHG emissions were 6,343.2 MMT of CO_2(e), of which 5,199.8 MMT CO_2(e) were from the energy sector (EPA 2024-TN10121). Estimated annual GHGs emissions from equipment used during decommissioning are about 0.00003 percent of the 2019 GHG emissions from the U.S. energy sector.

As noted in Section 3.3.2.2.2, the staff has determined that the contribution of plant life-cycle GHG emissions to national emissions is a Category 1 issue. The staff concludes that, as long as the PPE assumptions associated with GHG emissions are met, the GHG impacts from decommissioning a new reactor can also be generically determined to be SMALL. The generic analysis for GHG emissions for decommissioning can be relied on without applying any mitigation measures.

Assuming that the decommissioning of a new reactor is similar to current decommissioning practices, the impacts from decommissioning should be within the bounds described in the Decommissioning GEIS (NRC 2002-TN665). Based on the above information, the Decommissioning GEIS can be relied upon for new reactor decommissioning generic or Category 1 issues with SMALL impacts as presented in Table 3-21. Six site specific or conditionally project-specific issues along with climate change and cumulative impacts are Category 2 and their impacts remain undetermined (see Table 3-21 for the environmental issues marked as Category 2 environmental issues). The Category 2 issues will need to be addressed within the site-specific environmental review for each application utilizing this NR GEIS.

4 SUMMARY OF FINDINGS

Table 4-1 summarizes the findings of this GEIS, for which 119 environmental issues were analyzed. The table identifies issues as Category 1, Category 2, or N/A. A Category 1 designation means that the NRC has determined that a generic analysis of environmental impacts is possible, provided that relevant values and assumptions in the PPE and SPE are met. Issues for which the impacts are beneficial are also designated as Category 1. A Category 2 designation means that NRC has determined that a meaningful generic analysis of environmental impacts is not possible without consideration of project-specific information. The two N/A issues relate to exposure to EMFs and do not have a national scientific agreement regarding adverse health effects (i.e., Uncertain impacts).

For Category 1 issues involving adverse impacts, the NRC staff will evaluate the applicant's ER as part of the staff's determination of whether the proposed reactor project meets the PPE and SPE for the issue. In its project-specific SEIS, the NRC will set forth its analysis and determination about whether the project meets the PPE and SPE for the issue and will identify whether the NRC staff considered any additional information not provided in the applicant's ER. If the NRC staff finds that the project meets the PPE and SPE for that Category 1 issue, then the environmental impact will be considered SMALL for that issue. The NRC defines SMALL impacts as impacts that are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that the impacts that do not exceed permissible levels in the Commission's regulations are considered SMALL.

For Category 2 issues, the GEIS does not include either PPE or SPE values or assumptions because a meaningful generic analysis of Category 2 issues is not possible. The applicant will be required to provide a project-specific analysis for each Category 2 issue in its ER. The project-specific analysis for a Category 2 issue may lead to a conclusion of SMALL, MODERATE or LARGE impacts. Because the NRC staff cannot reach a conclusion regarding the impacts for these issues, the impacts are stated as being "Undetermined" in Table 4-1.

For the N/A (Uncertain) issues, the staff will continue to monitor research initiatives to evaluate the potential human health effects of EMFs. If, in the future, the Commission finds scientific information sufficient to draw conclusions about potential human health impacts, the NRC will determine what to require of all new nuclear reactor license applicants.

Assumptions including mitigation measures were considered in the analysis of each environmental issue and are discussed in the appropriate sections of Chapter 3 and are summarized in Table 4-1. The staff's generic conclusion for a Category 1 issue may rely on one or more of the values and assumptions for a parameter. However, the Category 1 issue may not use all of the values and assumptions for the parameter. To determine which values and assumptions are applicable to an individual Category 1 issue, the reader should review the resource-specific evaluation section in Chapter 3.

Table 4-1 Summary of Findings and Mitigation[1]

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
Land Use				
Construction				
Onsite Land Use	3.1.2.1.1	1	SMALL	• The proposed project, including any associated land uses, complies with NRC siting regulations in 10 CFR Part 100 (TN282). • The site size is 100 ac or less. • The permanent footprint of disturbance includes 30 ac or less of vegetated lands, and the temporary footprint of disturbance includes no more than an additional 20 ac or less of vegetated lands. • The proposed project complies with the site's zoning and is consistent with any relevant land use plans or comprehensive plans. • The site would not be situated closer than 0.5 mi to existing residential areas or 1.0 mi to sensitive land uses such as Federal, State, or local parks; wildlife refuges; conservation lands; Wild and Scenic Rivers; or Natural Heritage Rivers. • The site does not have a history of past industrial use capable of leaving a legacy of contamination requiring cleanup to protect human health and the environment. • The total wetland loss from use of the site, including use of any offsite ROWs, would be no more than 0.5 ac. • BMPs for erosion, sediment control, and stormwater management would be used. • Compliance with any mitigation measures established through zoning ordinances, local building permits, site use permits, or other land use authorizations.
Offsite Land Use	3.1.2.1.2	1	SMALL	• New offsite ROWs for transmission lines, pipelines, or access roads would be no more than 100 ft in width and total no more than 1 mi in length. • No new offsite ROW would be situated closer than 0.5 mi to existing residential areas or sensitive land uses such as Federal, State, or local parks; wildlife refuges; conservation lands; Wild and Scenic Rivers; or Natural Heritage Rivers. • No existing ROWs in residential areas would be used or widened to accommodate project features. • No ROW has a history of past industrial use capable of leaving a legacy of contamination requiring cleanup to protect human health and the environment. • The total wetland loss from use of the entire project, including use of the site and any offsite ROWs, would be no more than 0.5 ac. • BMPs for erosion, sediment control, and stormwater management would be used. • Compliance with any mitigation measures established through zoning ordinances, local building permits, site use permits, or other land use authorizations.

[1] For Category 2 issues, the impacts are stated as "Undetermined" because the NRC staff cannot reach a generic conclusion regarding the impacts for these issues.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
Impacts to Prime and Unique Farmland	3.1.2.1.3	1	SMALL	• The site size is 100 ac or less. • The site does not contain any prime or unique farmland or other farmland of statewide or local importance; or the site does not abut any agricultural land and is not situated in a predominantly agricultural landscape.
Coastal Zone and Compliance with the Coastal Zone Management Act (16 U.S.C. §§ 1451 et seq.; TN1243)	3.1.2.1.4	1	SMALL	• The site is not situated in any designated coastal zone, or the applicant can demonstrate that the affected State(s) have or will issue a consistency determination or other indication that the project complies with the Coastal Zone Management Act.
Operation				
Onsite Land Use	3.1.2.2.1	1	SMALL	• The proposed project, including any associated land uses, complies with NRC siting regulations in 10 CFR Part 100. • The site size is 100 ac or less. • If needed, cooling towers would be mechanical draft, not natural draft; less than 100 ft in height; and equipped with drift eliminators. • Any makeup water for the cooling towers would be fresh water (less than 1 ppt salinity). • BMPs for erosion, sediment control, and stormwater management would be used.
Offsite Land Use	3.1.2.2.2	1	SMALL	• New offsite ROWs for transmission lines, pipelines, or access roads would be no more than 100 ft in width and total no more than 1 mi in length. • BMPs for erosion, sediment control, and stormwater management would be used (wherever land is disturbed during the course of ROW management).
Visual Resources				
Construction				
Visual Impacts in Site and Vicinity	3.2.2.1.1	1	SMALL	• The site size is 100 ac or less. • The site would not be situated closer than 0.5 mi to existing residential areas or 1 mi to sensitive land uses such as Federal, State, or local parks; wildlife refuges; conservation lands; Wild and Scenic Rivers; or Natural Heritage Rivers. • The maximum proposed building and structure height is no more than 50 ft, except that the maximum height is 200 ft for proposed meteorological towers and 100 ft for transmission line poles/towers and mechanical draft cooling towers. • The proposed project structures would not be visible from Federal or State parks or wilderness areas designated as Class 1 under Section 162 of the Clean Air Act (42 U.S.C. § 7472; TN6954); or as a Wild and Scenic River, a Natural Heritage River, or a river of similar State designation.
Visual Impacts from	3.2.2.1.2	1	SMALL	• New offsite ROWs for transmission lines, pipelines, or access roads would be no more than 100 ft in width and total no more than 1 mi in length.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
Transmission Lines				• No transmission line structures (poles or towers) would be over 100 ft in height. • The new offsite ROWs would not be situated closer than 1 mi to existing residential areas or sensitive land uses such as Federal, State, or local parks; wildlife refuges; conservation lands; Wild and Scenic Rivers; or Natural Heritage Rivers. • Any proposed new structures on offsite ROWs would not be visible from Federal or State parks or wilderness areas designated as Class 1 under Section 162 of the Clean Air Act (42 U.S.C. § 7472; TN6954); or as a Wild and Scenic River, a Natural Heritage River, or a river of similar State designation.
Operation				
Visual Impacts During Operations	3.2.2.2.1	1	SMALL	• The site would not be situated closer than 1 mi to existing residential areas or sensitive land uses such as Federal, State, or local parks; wildlife refuges; conservation lands; Wild and Scenic Rivers; or Natural Heritage Rivers. • The maximum proposed building and structure height would be no more than 50 ft, except that the maximum height would be 200 ft for proposed meteorological towers and 100 ft for proposed transmission line poles/towers and proposed mechanical draft cooling towers. • The proposed project structures would not be visible from Federal or State parks or wilderness areas designated as Class 1 under Section 162 of the Clean Air Act (42 U.S.C. § 7472; TN6954); or as a Wild and Scenic River, a Natural Heritage River, or a river of similar State designation. • If needed, cooling towers would be mechanical draft, not natural draft; less than 100 ft in height; and equipped with drift eliminators. • Any makeup water for the cooling towers would be fresh water (less than 1 ppt salinity).
Meteorology and Air Quality				
Construction				
Emissions of Criteria Pollutants and Dust During Construction	3.3.2.1.1	1	SMALL	• The site size is 100 ac or less. • The permanent footprint of disturbance is 30 ac or less of vegetated lands and the temporary footprint of disturbance is an additional 20 ac or less of vegetated land. • New offsite ROWs for transmission lines, pipelines, or access roads would be no longer than 1 mi and have a maximum ROW width of 100 ft. • Criteria pollutants emitted from vehicles and standby power equipment during construction are less than Clean Air Act *de minimis* levels set by the EPA if the site is located in a nonattainment or maintenance area, or the site is located in an attainment area. • The site is not located within 1 mi of a mandatory Class I Federal area where visibility is an important value. • The LOS determination for affected roadways does not change. • Mitigation necessary to rely on the generic analysis includes implementation of BMPs for dust control.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
				• Compliance with air permits under State and Federal laws that address the impact of air emissions during construction.
Greenhouse Gas Emissions During Construction	3.3.2.1.2	1	SMALL	• GHGs emitted by equipment and vehicles during the 97-year GHG life-cycle period would be equal to or less than 2,534,000 MT of CO_2(e). Appendix H of this GEIS contains the NRC staff's methodology for developing this value, which includes emissions from construction, operation, and decommissioning. As long as this total value is met, the impacts for the life-cycle of the project and the individual phases of the project are determined to be SMALL.
Operation				
Emissions of Criteria and Hazardous Air Pollutants during Operation	3.3.2.2.1	1	SMALL	• Criteria pollutants emitted from vehicles and standby power equipment during operations are less than Clean Air Act *de minimis* levels set by the EPA if located in a nonattainment or maintenance area. • The site is not located within 1 mi of a mandatory Class I Federal area where visibility is an important value. • The LOS determination for affected roadways does not change. • Compliance with air permits under State and Federal laws that address the impact of air emissions. • HAP emissions will be within regulatory limits.
Greenhouse Gas Emissions During Operation	3.3.2.2.2	1	SMALL	• GHGs emitted by equipment and vehicles during the 97-year GHG life-cycle period would be equal to or less than 2,534,000 MT of CO_2(e). Appendix H of this GEIS contains the NRC staff's methodology for developing this value, which includes emissions from construction, operation, and decommissioning. As long as this total value is met, the impacts for the life-cycle of the project and the individual phases of the project are determined to be SMALL.
Cooling-System Emissions	3.3.2.2.3	1	SMALL	• If needed, cooling towers would be mechanical draft, not natural draft. • Cooling towers would be equipped with drift eliminators. • The site is not located within 1 mi of a mandatory Class I Federal area where visibility is an important value. • Mechanical draft cooling towers would be less than 100 ft tall. • Makeup water would be fresh (with a salinity less than 1 ppt). • Operation of cooling towers is assumed to be subject to State permitting requirements. • HAP emissions would be within regulatory limits. • No existing residential areas within 0.5 mi of the site.
Emissions of Ozone and NOx during Transmission Line Operation	3.3.2.2.4	1	SMALL	• The transmission line voltage would be no higher than 1,200 kilovolts.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
Water Resources				
Construction				
Surface Water Use Conflicts during Construction	3.4.2.1.1	1	SMALL	Total Plant Water Demand • Less than or equal to a daily average of 6,000 gpm. If water is obtained from a flowing water body, then the following PPE/SPE parameter and associated assumptions also apply: • Average plant water withdrawals do not reduce discharge from the flowing water body by more than 3 percent of the 95 percent exceedance daily flow and do not prevent the maintenance of applicable instream flow requirements. • The 95 percent exceedance flow accounts for existing and planned future withdrawals. • Water availability is demonstrated by the ability to obtain a withdrawal permit issued by State, regional, or tribal governing authorities. • Water rights for the withdrawal amount are obtainable, if needed. If water is obtained from a non-flowing water body, then the following PPE/SPE parameter and associated value and assumptions also apply: • Water availability of the Great Lakes, the Gulf of America, oceans, estuaries, and intertidal zones exceeds the amount of water required by the plant. • Water availability is demonstrated by the ability to obtain a withdrawal permit issued by State, regional, or tribal governing authorities. • Water rights for the withdrawal amount are obtainable, if needed. • The Coastal Zone Management Act consistency determination is obtainable, if applicable, for the non-flowing water body.
Groundwater Use Conflicts due to Excavation Dewatering	3.4.2.1.2	1	SMALL	• The long-term dewatering withdrawal rate is less than or equal to 50 gpm (the initial rate may be larger). • Dewatering results in negligible groundwater level drawdown at the site boundary.
Groundwater Use Conflicts due to Construction-Related Groundwater Withdrawals	3.4.2.1.3	1	SMALL	• Groundwater withdrawal for all plant uses (excluding dewatering) is less than or equal to 50 gpm. • Withdrawal results in no more than 1 ft of groundwater level drawdown at the site boundary. • Withdrawals are not derived from an EPA-designated SSA, or from any aquifer designated by a State, Tribe, or regional authority to have special protections to limit drawdown. • Withdrawals meet any applicable State or local permit requirements.
Water Quality Degradation due to Construction-Related Discharges	3.4.2.1.4	1	SMALL	• The permanent footprint of disturbance includes 30 ac or less of vegetated lands, and the temporary footprint of disturbance includes no more than an additional 20 ac or less of vegetated lands. • Adherence to requirements in NPDES permits issued by the EPA or State permitting program, and any other applicable permits.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
				• The long-term groundwater dewatering withdrawal rate is less than or equal to 50 gpm. • Dewatering discharge has minimal effects on the quality of the receiving water body (e.g., as demonstrated by conformance with NPDES permit requirements). • There are no planned discharges to the subsurface (by infiltration or injection), including stormwater discharge.
Water Quality Degradation due to Inadvertent Spills during Construction	3.4.2.1.5	1	SMALL	• The site size is 100 ac or less. • The permanent footprint of disturbance includes 30 ac or less of vegetated lands, and the temporary footprint of disturbance includes no more than an additional 20 ac or less of vegetated lands. • Applicable requirements and guidance on spill prevention and control are followed, including relevant BMPs and Integrated Pollution Prevention Plans.
Water Quality Degradation due to Groundwater Withdrawal	3.4.2.1.6	1	SMALL	Groundwater Withdrawal for Excavation or Foundation Dewatering • The long-term dewatering withdrawal rate is less than or equal to 50 gpm (the initial rate may be larger). • Dewatering results in negligible groundwater level drawdown at the site boundary. Groundwater Withdrawal for Plant Uses • Groundwater withdrawal for all plant uses (excluding dewatering) is less than or equal to 50 gpm. • Withdrawal results in no more than 1 ft of groundwater level drawdown at the site boundary. • Withdrawals are not derived from an EPA-designated SSA, or from any aquifer designated by a State, tribe, or regional authority to have special protections to limit drawdown. • Withdrawals meet any applicable State or local permit requirements.
Water Quality Degradation due to Offshore or In-Water Construction Activities	3.4.2.1.7	1	SMALL	• In-water structures (including intake and discharge structures) are constructed in compliance with provisions of the CWA Section 404 (33 U.S.C. § 1344; TN1019) and Section 10 of the Rivers and Harbors Appropriation Act of 1899 (33 U.S.C. §§ 401 et seq.; TN660). • Adverse effects of building activities controlled and localized using BMPs such as installation of turbidity curtains or installation of cofferdams. • Construction duration would be less than 7 years.
Water Use Conflict Due to Plant Municipal Water Demand	3.4.2.1.8	1	SMALL	• The amount available from municipal water systems exceeds the amount of municipal water required by the plant (gpm). • Municipal Water Availability accounts for all existing and planned future uses. • An agreement or permit for the usage amount can be obtained from the municipality.
Degradation of Water Quality from Plant Effluent Discharges to	3.4.2.1.9	1	SMALL	• Municipal Systems' Available Capacity to Receive and Treat Plant Effluent accounts for all existing and reasonably foreseeable future discharges. • Agreement to discharge to a municipal treatment system is obtainable.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
Municipal Systems				
Operation				
Surface Water Use Conflicts during Operation due to Water Withdrawal from Flowing Waterbodies	3.4.2.2.1	1	SMALL	• Total plant water demand is less than or equal to a daily average of 6,000 gpm. • Average plant water withdrawals do not reduce discharge from the flowing water body by more than 3 percent of the 95 percent exceedance daily flow and do not prevent the maintenance of applicable instream flow requirements. • The 95 percent exceedance flow accounts for existing and planned future withdrawals. • Water availability is demonstrated by the ability to obtain a withdrawal permit issued by State, regional, or tribal governing authorities. • Water rights for the withdrawal amount are obtainable, if needed.
Surface Water Use Conflicts during Operation due to Water Withdrawal from Non-flowing Waterbodies	3.4.2.2.2	1	SMALL	• Total plant water demand is less than or equal to a daily average of 6,000 gpm. • Water availability of the Great Lakes, the Gulf of America, oceans, estuaries, and intertidal zones exceeds the amount of water required by the plant. • Water availability is demonstrated by the ability to obtain a withdrawal permit issued by State, regional, or tribal governing authorities. • Water rights for the withdrawal amount are obtainable, if needed. • Coastal Zone Management Act of 1972 (16 U.S.C. §§ 1451 et seq.; TN1243) consistency determination is obtainable, if applicable.
Groundwater Use Conflicts Due to Building Foundation Dewatering	3.4.2.2.3	1	SMALL	• The long-term dewatering withdrawal rate is less than or equal to 50 gpm (the initial rate may be larger). • Dewatering results in negligible groundwater level drawdown at the site boundary.
Groundwater Use Conflicts Due to Groundwater Withdrawals for Plant Uses	3.4.2.2.4	1	SMALL	• Groundwater withdrawal for all plant uses (excluding dewatering) is less than or equal to 50 gpm. • Withdrawal results in no more than 1 ft of groundwater level drawdown at the site boundary. • Withdrawals are not derived from an EPA-designated SSA, or from any aquifer designated by a State, Tribe, or regional authority to have special protections to limit drawdown. • Withdrawals meet any applicable State or local permit requirements.
Surface Water Quality Degradation Due to Physical Effects from Operation of Intake and	3.4.2.2.5	1	SMALL	• Total plant water demand is less than or equal to a daily average of 6,000 gpm. • Adhere to best available technology requirements of CWA 316(b) (33 U.S.C. § 1326-TN4823). • Operated in compliance with CWA Section 316 (b) and 40 CFR 125.83, including compliance with monitoring and recordkeeping requirements in 40 CFR 125.87 and 40 CFR 125.88, respectively (40 CFR Part 125-TN254). • Best available technologies are employed in the design and operation of intake and discharge structures to minimize alterations due to scouring, sediment transport, increased turbidity and erosion.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
Discharge Structures				• Adherence to requirements in NPDES permits issued by the EPA or a given State. If water is obtained from a flowing water body, then the following PPE/SPE parameter and associated value also apply: • The average rate of plant withdrawal does not exceed 3 percent of the 95 percent exceedance daily flow for the water body. If water is obtained from a non-flowing water body, then the following PPE/SPE parameters and associated values and assumptions also apply: • Water availability of the Great Lakes, the Gulf of America, oceans, estuaries, and intertidal zones exceeds the amount of water required by the plant.
Surface Water Quality Degradation Due to Changes in Salinity Gradients Resulting from Withdrawals	3.4.2.2.6	1	SMALL	• Total plant water demand is less than or equal to a daily average of 6,000 gpm. If water is obtained from a flowing water body, then the following PPE/SPE parameter and associated assumptions also apply: • Average plant water withdrawals do not reduce discharge from the flowing water body by more than 3 percent of the 95 percent exceedance daily flow and do not prevent the maintenance of applicable instream flow requirements. • The 95 percent exceedance flow accounts for existing and planned future withdrawals. • Water availability is demonstrated by the ability to obtain a withdrawal permit issued by State, regional, or tribal governing authorities. • Water rights for the withdrawal amount are obtainable, if needed. • If withdrawals are from an estuary or intertidal zone, then changes to salinity gradients are within the normal tidal or seasonal movements that characterize the water body. If water is obtained from a non-flowing water body, then the following PPE/SPE parameter and associated values and assumptions also apply: • Water availability of the Great Lakes, the Gulf of America, oceans, estuaries, and intertidal zones exceeds the amount of water required by the plant. • Water availability is demonstrated by the ability to obtain a withdrawal permit issued by State, regional, or tribal governing authorities. • Water rights for the withdrawal amount are obtainable, if needed. • If withdrawals are from an estuary or intertidal zone, then changes to salinity gradients are within the normal tidal or seasonal movements that characterize the water body.
Surface Water Quality Degradation Due to Chemical and	3.4.2.2.7	2	Undetermined	The NRC staff determined that a generic analysis to determine operational impacts on surface water quality due to chemical and thermal discharges was not possible because (1) some States may impose effluent constituent limitations more stringent that those required by the EPA, (2) limitations imposed on effluent constituents may vary among States, and (3) the establishment of a mixing zone may be required. Because all of these issues related to degradation of surface water

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
Thermal Discharges				quality from chemical and thermal discharges require consideration of project-specific information, a project-specific assessment should be performed in the SEIS.
Groundwater Quality Degradation Due to Plant Discharges	3.4.2.2.8	1	SMALL	• The plant is outside the recharge area for any EPA-designated SSA or any aquifer designated to have special protections by a State, tribal, or regional authority. • The plant is outside the wellhead protection area or designated contributing area for any public water supply well. • There are no planned discharges to the subsurface (by infiltration or injection).
Water Quality Degradation due to Inadvertent Spills and Leaks during Operation	3.4.2.2.9	1	SMALL	• Applicable requirements and guidance on spill prevention and control are followed, including relevant BMPs and Integrated Pollution Prevention Plans. • There are no planned discharges to the subsurface (by infiltration or injection), including stormwater discharge. • A groundwater protection program conforming to NEI 07-07 (NEI 2019-TN6775) is established and followed. • The site size is 100 ac or less. • Use of BMPs for soil erosion, sediment control, and stormwater management. • Adherence to requirements in NPDES permits issued by the EPA or a given State, and any other applicable permits.
Water Quality Degradation due to Groundwater Withdrawals	3.4.2.2.10	1	SMALL	• The long-term dewatering withdrawal rate is less than or equal to 50 gpm (the initial rate may be larger). • Dewatering results in negligible groundwater level drawdown at the site boundary. • Groundwater withdrawal for all plant uses (excluding dewatering) is less than or equal to 50 gpm. • Withdrawal results in no more than 1 ft of groundwater level drawdown at the site boundary. • Withdrawals are not derived from an EPA-designated SSA, or from any aquifer designated by a State, Tribe, or regional authority to have special protections to limit drawdown. • Withdrawals meet any applicable State or local permit requirements.
Water Use Conflict from Plant Municipal Water Demand	3.4.2.2.11	1	SMALL	• Usage amount is within the existing capacity of the system(s), accounting for all existing and planned future uses. • An agreement or permit for the usage amount can be obtained from the municipality.
Degradation of Water Quality from Plant Effluent Discharges to Municipal Systems	3.4.2.2.12	1	SMALL	• Municipal Systems' Available Capacity to Receive and Treat Plant Effluent accounts for all existing and reasonably foreseeable future discharges. • Agreement to discharge to a municipal treatment system is obtainable.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
Terrestrial Ecology				
Construction				
Permanent and Temporary Loss, Conversion, Fragmentation, and Degradation of Habitats	3.5.2.1.1	1	SMALL	• The permanent footprint of disturbance would include 30 ac or less of vegetated lands, and the temporary footprint of disturbance would include no more than an additional 20 ac or less of vegetated lands. • Temporarily disturbed lands would be revegetated using regionally indigenous vegetation once the lands are no longer needed to support building activities. • New offsite ROWs for transmission lines, pipelines, or access roads would be no more than 100 ft in width and total no more than 1 mi in length. • The footprint of disturbance (permanent and temporary) would contain no ecologically sensitive features such as floodplains, shorelines, riparian vegetation, late-successional vegetation, land specifically designated for conservation, or habitat known to be potentially suitable for one or more Federal or State threatened or endangered species. • Total wetland impacts from use of the site and any offsite ROWs would be no more than 0.5 ac. • Applicants would demonstrate an effort to minimize fragmentation of terrestrial habitats by using existing ROWs, or widening existing ROWs, to the extent practicable. • BMPs would be used for erosion, sediment control, and stormwater management.
Permanent and Temporary Loss and Degradation of Wetlands	3.5.2.1.2	1	SMALL	• Applicant would provide a delineation of potentially impacted wetlands, including wetlands not under CWA jurisdiction. • Total wetland impacts from use of the site and any offsite ROWs would be no more than 0.5 ac. • If activities regulated under the CWA are performed, those activities would receive approval under one or more NWPs (33 CFR Part 330) or other general permits recognized by the USACE. • Temporary groundwater withdrawals for excavation or foundation dewatering would not exceed a long-term rate of 50 gpm. • Applicants would be able to demonstrate that the temporary groundwater withdrawals would not substantially alter the hydrology of wetlands connected to the same groundwater resource. • Any required State or local permits for wetland impacts would be obtained. • Any mitigation measures indicated in the NWPs or other permits would be implemented. • BMPs would be used for erosion, sediment control, and stormwater management.
Effects of Building Noise on Wildlife	3.5.2.1.3	1	SMALL	• Noise generation would not exceed 85 dBA 50 ft from the source.
Effects of Vehicular Collisions on Wildlife	3.5.2.1.4	1	SMALL	• The site size would be 100 ac or less. • The permanent footprint of disturbance would include 30 ac or less of vegetated lands, and the temporary footprint of disturbance would include no more than an additional 20 ac or less of vegetated lands. • There would be no decreases in the LOS designation for affected roadways.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
				• The licensee would communicate with Federal and State wildlife agencies and implement mitigation actions recommended by those agencies to reduce potential for vehicular injury to wildlife.
Bird Collisions and Injury from Structures and Transmission Lines	3.5.2.1.5	1	SMALL	• The site size would be 100 ac or less. • New offsite ROWs for transmission lines, pipelines, or access roads would be no more than 100 ft in width and total no more than 1 mi in length. • No transmission line structures (poles or towers) would be more than 100 ft in height. • Licensees would implement common mitigation measures such as those provided by the American Bird Conservancy (ABC 2015-TN6763) for buildings, by FWS (2013-TN6764) for towers, and by the APLIC for transmission lines (APLIC 2012-TN6779).
Important Species and Habitats – Resources Regulated under the Endangered Species Act of 1973 (ESA; 16 U.S.C. §§ 1531 et seq; TN1010)	3.5.2.1.6.1	2	Undetermined	The NRC staff is unable to determine the significance of potential impacts without consideration of project-specific factors, including the specific species and habitats affected and the types of ecological changes potentially resulting from each specific licensing action.
Important Species and Habitats – Other Important Species and Habitats	3.5.2.1.6.2	1	SMALL	• Applicants would communicate with State natural resource or conservation agencies regarding wildlife and plants and implement mitigation recommendations of those agencies.
Operation				
Permanent and Temporary Loss or Disturbance of Habitats	3.5.2.2.1	1	SMALL	• Temporarily disturbed lands would be revegetated using regionally indigenous vegetation once the lands are no longer needed to support building activities. • The total wetland loss from site disturbance over the operational life of the plant would be no more than 0.5 ac. • Any State or local permits for wetland impacts would be obtained. • Any mitigation measures indicated in the NWPs or other wetland permits would be implemented. • BMPs would be used for erosion, sediment control, and stormwater management.
Effects of Operational Noise on Wildlife	3.5.2.2.2	1	SMALL	• Noise generation would not exceed 85 dBA 50 ft from the source. • There would be no decreases in the LOS designation for affected roadways.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
				• The licensee would communicate with Federal and State wildlife agencies and implement mitigation actions recommended by those agencies to reduce potential for vehicular injury to wildlife.
Effects of Vehicular Collisions on Wildlife	3.5.2.2.2	1	SMALL	• Noise generation would not exceed 85 dBA 50 ft from the source. • There would be no decreases in the LOS designation for affected roadways. • The licensee would communicate with Federal and State wildlife agencies and implement mitigation actions recommended by those agencies to reduce potential for vehicular injury to wildlife.
Exposure of Terrestrial Organisms to Radionuclides	3.5.2.2.3	1	SMALL	• Applicants would demonstrate in their application that any radiological nonhuman biota doses would be below IAEA (1992-TN712) and NCRP (1991-TN729) guidelines.
Cooling-Tower Operational Impacts on Vegetation	3.5.2.2.4	1	SMALL	• If needed, cooling towers would be mechanical draft, not natural draft; less than 100 ft in height; and equipped with drift eliminators. • Any makeup water for the cooling towers would be fresh water (less than 1 ppt salinity).
Bird Collisions and Injury from Structures and Transmission Lines	3.5.2.2.5	1	SMALL	• The site size would be 100 ac or less. • New offsite ROWs for transmission lines, pipelines, or access roads would be no more than 100 ft in width and total no more than 1 mi in length. • No transmission line structures (poles or towers) would be more than 100 ft in height. • Licensees would implement common mitigation measures such as those provided by the American Bird Conservancy (ABC 2015-TN6763) for buildings, by FWS (2013-TN6764) for towers, and by the APLIC for transmission lines (APLIC 2012-TN6779).
Bird Electrocutions from Transmission Lines	3.5.2.2.6	1	SMALL	• New offsite ROWs for transmission lines, pipelines, or access roads would be no more than 100 ft in width and total no more than 1 mi in length. • Common mitigation measures, such as those recommended by APLIC (2006-TN794), would be implemented.
Water Use Conflicts with Terrestrial Resources	3.5.2.2.7	1	SMALL	• Total plant water demand would be less than or equal to a daily average of 6,000 gpm. • If water is withdrawn from flowing water bodies, average plant water withdrawals would not reduce flow by more than 3 percent of the 95 percent exceedance daily flow and would not prevent maintenance of applicable instream flow requirements. • Any water withdrawals would be in compliance with any EPA or State permitting requirements. • Applicants would be able to demonstrate that hydroperiod changes are within historical or seasonal fluctuations.
Effects of Transmission Line ROW	3.5.2.2.8	1	SMALL	• Vegetation in transmission line ROWs would be managed following a plan consisting of integrated vegetation management practices.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
Management on Terrestrial Resources				• All ROW maintenance work would be performed in compliance with all applicable laws and regulations. • Herbicides would be applied by licensed applicators, and only if in compliance with applicable manufacturer label instructions.
Effects of Electromagnetic Fields on Flora and Fauna	3.5.2.2.9	1	SMALL	• Based on the literature review in the LR GEIS, the NRC staff determined that this is a Category 1 issue and impacts would be SMALL regardless of the length, location, or size of the transmission lines. The NRC staff did not recommend any mitigation in the LR GEIS (NRC 2024-TN10161); hence, none is needed here. The NRC staff did not rely on any PPE and SPE values or assumptions in reaching this conclusion.
Important Species and Habitats – Resources Regulated under the ESA of 1973	3.5.2.2.10.1	2	Undetermined	The NRC staff is unable to determine the significance of potential impacts without consideration of project-specific factors, including the specific species and habitats affected and the types of ecological changes potentially resulting from each specific licensing action.
Important Species and Habitats – Other Important Species and Habitats	3.5.2.2.10.2	1	SMALL	• Applicants would communicate with State natural resource or conservation agencies regarding wildlife and plants and implement mitigation recommendations of those agencies.
Aquatic Ecology				
Construction				
Runoff and sedimentation from construction areas	3.6.2.1.1	1	SMALL	• BMPs would be used for erosion and sediment control. • Temporarily disturbed lands would be revegetated using regionally indigenous vegetation once the lands are no longer needed to support building activities.
Dredging and filling aquatic habitats to build intake and discharge structures	3.6.2.1.2	1	SMALL	• Applicant would obtain approval, if required, under NWP 7 in 33 CFR Part 330. • Applicant would implement any mitigation required under NWP 7 in 33 CFR Part 330. • Applicant would minimize any temporarily disturbed shoreline and riparian lands needed to build the intake and discharge structures and restore those areas with regionally indigenous vegetation suited to those landscape settings once the disturbances are no longer needed. • BMPs would be used for erosion and sediment control.
Building transmission lines, pipelines, and access roads	3.6.2.1.3	1	SMALL	• If activities regulated under the Clean Water Act are performed, they would receive approval under one or more NWPs (33 CFR Part 330-TN4318) or other general permits recognized by the USACE. • Pipelines would be extended under (or over) surface through directional drilling without physically disturbing shorelines or bottom substrate.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
across surface waterbodies				• Access roads would span streams and other surface waterbodies with a bridge or ford, and any fords would include placement and maintenance of matting to minimize physical disturbance of shorelines and bottom substrates. • No access roads would be extended across stream channels over 10 ft in width (at ordinary high water). • Any bridges or fords would be removed once no longer needed, and any exposed soils or substrate would be revegetated using regionally indigenous vegetation appropriate to the landscape setting. • Any mitigation measures indicated in the NWPs or other permits would be implemented. • BMPs would be used for erosion and sediment control.
Important Species and Habitats – Resources Regulated under the ESA and Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §§ 1801 et seq.; TN1061)	3.6.2.1.4.1	2	Undetermined	The NRC staff is unable to determine the significance of potential impacts without consideration of project-specific factors, including the specific species and habitats affected and the types of ecological changes potentially resulting from each specific licensing action. Furthermore, the Endangered Species Act (16 U.S.C. §§ 1531 et seq.; TN1010) and Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §§ 1801 et seq.; TN1061) require consultations for each licensing action that may affect regulated resources.
Important species and habitats – Other Important Species and Habitats	3.6.2.1.4.2	1	SMALL	• Applicants would communicate with State natural resource or conservation agencies regarding aquatic fish, wildlife, and plants and implement mitigation recommendation of those agencies.
Operation				
Stormwater runoff	3.6.2.2.1	1	SMALL	• Preparation, approval by applicable regulatory agencies, and implementation of a stormwater management plan. • Obtaining and compliance with any required permits for the storage and use of hazardous materials issued by Federal and State agencies under RCRA. • BMPs would be used for stormwater management.
Exposure of aquatic organisms to radionuclides	3.6.2.2.2	1	SMALL	• Applicants would demonstrate in their application that any radiological nonhuman biota doses would be below IAEA (1992-TN712) and NCRP (1991-TN729) guidelines.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
Effects of refurbishment on aquatic biota	3.6.2.2.3	1	SMALL	• BMPs would be used for erosion, sediment control, and stormwater management. • Exposed soils would be restored as soon as possible with regionally indigenous vegetation.
Effects of maintenance dredging on aquatic biota	3.6.2.2.4	1	SMALL	• If activities regulated under the Clean Water Act are performed, those activities would receive approval under one or more NWPs (33 CFR Part 330) or other general permits recognized by the USACE. • Any mitigation measures indicated in the NWPs or other permits would be implemented. • BMPs would be used for erosion and sediment control.
Impacts of transmission line ROW management on aquatic resources	3.6.2.2.5	1	SMALL	• Vegetation in transmission line ROWs would be managed following a plan consisting of integrated vegetation management practices. • All ROW maintenance work would be performed in compliance with all applicable laws and regulations. • Herbicides would be applied by licensed applicators, and only if in compliance with applicable manufacturer label instructions. • BMPs would be used for erosion and sediment control.
Impingement and entrainment of aquatic organisms	3.6.2.2.6	1	SMALL	• Intakes would comply with regulatory requirements established by EPA in 40 CFR 125.84 (TN254) to be protective of fish and shellfish. • Best available control technology would be employed in the design of intakes to minimize entrainment and impingement, such as use of screens and intake rates recognized to minimize effects.
Thermal impacts on aquatic biota	3.6.2.2.7	2	Undetermined	The NRC staff would have to first review the discharge plume analysis (as described in Section 3.4) and the aquatic biota potentially present before being able to reach a conclusion regarding the possible significance of impacts to that biota.
Other effects of cooling-water discharges on aquatic biota	3.6.2.2.8	2	Undetermined	The NRC staff would have to first review the discharge plume analysis (as described in Section 3.4) and the aquatic biota potentially present before being able to reach a conclusion regarding the possible significance of impacts to that biota.
Water use conflicts with aquatic resources	3.6.2.2.9	1	SMALL	• If needed, cooling towers would be mechanical draft, not natural draft; less than 100 ft in height; and equipped with drift eliminators. • Any makeup water for the cooling towers would be fresh water (less than 1 ppt salinity). • Total plant water demand would be less than or equal to a daily average of 6,000 gpm. • If water is withdrawn from flowing waterbodies, average plant water withdrawals would not reduce flow by more than 3 percent of the 95 percent exceedance daily flow, and would not prevent maintenance of applicable instream flow requirements. • Any water withdrawals would be in compliance with any EPA or State permitting requirements. • Applicants would be able to demonstrate that hydroperiod changes are within historical or seasonal fluctuations.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
Important Species and Habitats – Resources Regulated under the ESA and Magnuson-Stevens Act	3.6.2.2.10.1	2	Undetermined	The NRC staff is unable to determine the significance of potential impacts without consideration of project-specific factors, including the specific species and habitats affected and the types of ecological changes potentially resulting from each specific licensing action. Furthermore, the Endangered Species Act (16 U.S.C. §§ 1531 et seq.; TN1010) and Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §§ 1801 et seq.; TN1061) require consultations for each licensing action that may affect regulated resources.
Important species and habitats – Other Important Species and Habitats	3.6.2.2.10.2	1	SMALL	• Applicants would communicate with State natural resource or conservation agencies regarding aquatic fish, wildlife, and plants and implement mitigation recommendations of those agencies.
Historic and Cultural Resources				
Construction				
Construction impacts on historic and cultural resources	3.7.2	2	Undetermined	Impacts on historic and cultural resources are analyzed on a project-specific basis. The NRC will perform a NEPA analysis and a NHPA Section 106 consultation, as required, in accordance with 36 CFR Part 800, including consultation with the State and Tribal Historic Preservation Officers, Indian Tribes, and other interested parties.
Operation				
Operation impacts on historic and cultural resources	3.7.2	2	Undetermined	Impacts on historic and cultural resources are analyzed on a project-specific basis. The NRC will perform a NEPA analysis and a NHPA Section 106 consultation, as required, in accordance with 36 CFR Part 800, including consultation with the State and Tribal Historic Preservation Officers, Indian Tribes, and other interested parties.
Environmental Hazards – Radiological Environment				
Construction				
Radiological dose to construction workers	3.8.1.2.1	1	SMALL	• For protection against radiation, the applicant must meet the regulatory requirements of: – 10 CFR 20.1101 Radiation Protection Programs (10 CFR Part 20-TN283) if issued a license – 10 CFR 20.1201 Occupational dose limits for adults – 10 CFR 20.1301 Dose limits for individual members of the public – Appendix B of 10 CFR Part 20 *Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage* – 10 CFR 50.34a (10 CFR Part 50-TN249) Design objectives for equipment to control releases of radioactive material in effluents—nuclear power reactors – 10 CFR 50.36a Technical specifications on effluents from nuclear power reactors

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
				– Application contains sufficient technical information for the NRC staff to complete the detailed technical safety review. – Application will be found to be in compliance by the staff with the above regulations through a radiation protection program and an effluent release monitoring program.
Operation				
Occupational doses to workers	3.8.1.2.2.1	1	SMALL	• For protection against radiation, the applicant must meet the regulatory requirements of: − 10 CFR 20.1101 Radiation Protection Programs (10 CFR Part 20-TN283) if issued a license − 10 CFR 20.1201 Occupational dose limits for adults − Appendix B of 10 CFR Part 20 *Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage* − 10 CFR 50.34a (10 CFR Part 50-TN249) Design objectives for equipment to control releases of radioactive material in effluents—nuclear power reactors − 10 CFR 50.36a Technical specifications on effluents from nuclear power reactors • Application contains sufficient technical information for the staff to complete the detailed technical safety review • Application will be found to be in compliance by the NRC staff with the above regulations through a radiation protection program and an effluent release monitoring program.
Maximally exposed individual annual doses	3.8.1.2.2.2	1	SMALL	• For protection against radiation, the applicant must meet the regulatory requirements of: − 10 CFR 20.1101 Radiation Protection Programs (10 CFR Part 20-TN283) if issued a license − 10 CFR 20.1301 Dose limits for individual members of the public − Appendix B of 10 CFR Part 20 *Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage* − 10 CFR 50.34a (10 CFR Part 50-TN249) Design objectives for equipment to control releases of radioactive material in effluents—nuclear power reactors − 10 CFR 50.36a Technical specifications on effluents from nuclear power reactors • Application contains sufficient technical information for the staff to complete the detailed technical safety review • Application will be found to be in compliance by the NRC staff with the above regulations through a radiation protection program and an effluent release monitoring program
Total population annual doses	3.8.1.2.2.3	1	SMALL	• For protection against radiation, the applicant must meet the regulatory requirements of: − 10 CFR 20.1101 Radiation Protection Programs (10 CFR Part 20-TN283) if issued a license − 10 CFR 20.1301 Dose limits for individual members of the public − Appendix B of 10 CFR Part 20 *Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage* − 10 CFR 50.34a (10 CFR Part 50-TN249) Design objectives for equipment to control releases of radioactive material in effluents—nuclear power reactors

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
				− 10 CFR 50.36a Technical specifications on effluents from nuclear power reactors • Application contains sufficient technical information for the staff to complete the detailed technical safety review • Application will be found to be in compliance by the NRC staff with the above regulations through a radiation protection program and an effluent release monitoring program.
Nonhuman biota doses	3.8.1.2.2.4	1	SMALL	• Applicants would demonstrate in their application that any radiological nonhuman biota doses would be below IAEA (1992-TN712) and NCRP (1991-TN729) guidelines.
Environmental Hazards – Nonradiological Environment				
Construction				
Building impacts of chemical, biological, and physical nonradiological hazards	3.8.2.2.1	1	SMALL	• The applicant must adhere to all applicable Federal, State, local or Tribal regulatory limits and permit conditions for chemical hazards, biological hazards, and physical hazards. • The applicant will follow nonradiological public and occupational health BMPs and mitigation measures, as appropriate.
Building impacts of EMFs	3.8.2.2.1	N/A	Uncertain	Studies of 60 Hz EMFs have not uncovered consistent evidence linking harmful effects with field exposures. Because the state of the science is currently uncertain, no generic conclusion on human health impacts is possible. If, in the future, the Commission finds scientific information sufficient to draw conclusions about potential human health impacts, the Commission may require applicants to submit plant-specific reviews of these health effects as part of their application. Until such time, applicants are not required to submit information about this issue.
Operation				
Operation impacts of chemical, biological, and physical nonradiological hazards	3.8.2.2.2	1	SMALL	• The applicant must adhere to all applicable Federal, State, local or Tribal regulatory limits and permit conditions for chemical hazards, biological hazards, and physical hazards. • The applicant will follow nonradiological public and occupational health BMPs and mitigation measures, as appropriate.
Operation impacts of EMFs	3.8.2.2.2	N/A	Uncertain	Studies of 60 Hz EMFs have not uncovered consistent evidence linking harmful effects with field exposures. Because the state of the science is currently uncertain, no generic conclusion on human health impacts is possible. If, in the future, the Commission finds scientific information sufficient to draw conclusions about potential human health impacts, the Commission may require applicants to submit plant-specific reviews of these health effects as part of their application. Until such time, applicants are not required to submit information about this issue.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
Noise				
Construction				
Construction-related noise	3.9.2.1	1	SMALL	• The noise level would be no more than 65 dBA at site boundary, unless a relevant State or local noise abatement law or ordinance sets a different threshold, which would then be the presumptive threshold for PPE purposes. • If an applicant cannot meet the 65 dBA threshold through mitigation, then the applicant must obtain a variance or exception with the relevant State or local regulator. • The project would implement BMPs, such as modeling, foliage planting, construction of noise buffers, and the timing of construction and/or operation activities.
Operation				
Operation-related noise	3.9.2.2	1	SMALL	• The noise level would be no more than 65 dBA at site boundary, unless a relevant State or local noise abatement law or ordinance sets a different threshold, which would then be the presumptive threshold for PPE purposes. • If an applicant cannot meet the 65 dBA threshold through mitigation, then the applicant must obtain a variance or exception with the relevant State or local regulator. • The project would implement BMPs, such as modeling, foliage planting, construction of noise buffers, and the timing of construction and/or operation activities.
Waste Management – Radiological Waste Management				
Operation				
LLRW	3.10.1.2.1	1	SMALL	• Applicants must meet the regulatory requirements of 10 CFR Part 20 (TN283) (e.g., 20.1406 and Subpart K), 10 CFR Part 61 (TN252), 10 CFR Part 71 (TN301), and 10 CFR Part 72 (TN4884). • Quantities of LLRW generated at a new nuclear reactor would be less than the quantities of LLRW generated at existing nuclear power plants, which generate an average of 21,200 ft^3 (600 m^3) and 2,000 Ci (7.4×10^{13} Bq) per year for boiling water reactors and half that amount for pressurized water reactors (NRC 2024-TN10161).
Onsite spent nuclear fuel management	3.10.1.2.2	1	SMALL	• Compliance with 10 CFR Part 72 (TN4884)
Mixed waste	3.10.1.2.3	1	SMALL	• RCRA Small Quantity Generator (EPA 2020-TN6590) for Mixed Waste.
Waste Management – Nonradiological Waste Management				
Construction				
Construction nonradiological waste	3.10.2.2.1	1	SMALL	• The applicant must meet all the applicable permit conditions, regulations, and BMPs related to solid, liquid, and gaseous waste management. • For hazardous waste generation, applicants must meet conformity with hazardous waste quantity generation levels in accordance with RCRA. • For sanitary waste, applicants must dispose of sanitary waste in a permitted process.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
				• For mitigation measures, the applicant would perform mitigation measures to the extent practicable, such as recycling, process improvements, or the use of a less hazardous substance.
Operation				
Operation nonradiological waste	3.10.2.2.2	1	SMALL	• The applicant must meet all the applicable permit conditions, regulations, and BMPs related to solid, liquid, and gaseous waste management. • For hazardous waste generation, applicants must meet conformity with hazardous waste quantity generation levels in accordance with RCRA. • For sanitary waste, applicants must dispose of sanitary waste in a permitted process. • For mitigation measures, the applicant would perform mitigation measures to the extent practicable, such as recycling, process improvements, or the use of a less hazardous substance.
Postulated Accidents				
Operation				
Design Basis Accidents Involving Radiological Releases	3.11.2.1	1	SMALL	• For the exclusion area boundary, the maximum TEDE for any 2-hour period during the radioactivity release should be calculated. • For the low-population zone, the TEDE should be calculated for the duration of the accident release (i.e., 30 days, or other duration as justified). The above calculations would compare the DBA doses with the dose criteria given in regulations related to the application (e.g., 10 CFR 50.34(a)(1) [TN249], 10 CFR 52.17(a)(1) and 10 CFR 52.79(a)(1) [10 CFR Part 52-TN251]), standard review plans (e.g., SRP criteria, Table 1 in SRP Section 15.0.3 of NUREG-0800 [NRC 2007/2019-TN6221]), and RGs, (e.g., RG 1.183 [NRC 2000-TN517]), as applicable.
Accidents Involving Releases of Hazardous Chemicals	3.11.2.2	1	SMALL	• Reactor inventory of a regulated substance is less than its TQ. TQs are found in 40 CFR 68.130, Tables 1, 2, 3, and 4 (TN5494); and • Reactor inventory of an EHS is less than its TPQ. TPQs are found in 40 CFR Part 355, Appendices A and B (TN5493).
Severe Accidents	3.11.2.3	1	SMALL	• Within the maximum Population Dose Risk 95th confidence bounding value of 9.727×10^3 person-rem per reactor year (i.e., Indian Point Units 2 and 3) specified in the 1996 LR GEIS (NRC 1996-TN288) and demonstrating the utilization of 10 CFR 50.155 or FLEX to address mitigation of beyond-design-basis events, or • Within the maximum 10 and 150 mi Exposure Index at the 95th confidence bounding value of 1.896×10^4 and 2.864×10^6, respectively (i.e., Indian Point Units 2 and 3) specified in the 1996 LR GEIS and demonstrating the utilization of 10 CFR 50.155 or FLEX to address mitigation of beyond-design-basis events, or

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
				• Utilizing the source term from 10 CFR 50.34(a)(1)(ii)(D) (TN249), or the equivalent 10 CFR Part 52 regulation, with a non-intact containment or confinement for population density assessments under 10 CFR 100.21(h) (TN282) demonstrating a calculated TEDE of no greater than 1 rem over a period of 30 days wherein no further mitigation is necessary due to the health effects being not to be significant or a new reactor that is co-located with an existing LWR may compare its source terms to demonstrate that the LWR's severe accident risks bounds the new reactor's risks, or Utilizing 10 CFR 50.33(g)(2) to demonstrate there is no plume exposure pathway Emergency Planning Zone where the projected TEDE exceeds 1 rem over 96 hours (i.e., 10 CFR 50.33(g)(2)(i)(A)) and no further mitigation is necessary due to the health effects being shown not to be significant.
Acts of Terrorism	3.11.2.5	1	SMALL	The environmental impacts of acts of terrorism and sabotage only need to be addressed if a reactor facility is subject to the jurisdiction of the U.S. Court of Appeals for the Ninth Circuit.
Socioeconomics				
Construction				
Community Services and Infrastructure	3.12.1.1.1	1	SMALL	• The housing vacancy rate in the affected economic region does not change by more than 5 percent, or at least 5 percent of the housing stock remains available after accounting for in-migrating construction workers. • Student:teacher ratios in the affected economic region do not exceed locally mandated levels after including the school age children of the in-migrating worker families.
Transportation Systems and Traffic	3.12.1.1.2	1	SMALL	The LOS determination for affected roadways does not change. Mitigation measures may include implementation of traffic flow management, management of shift-change timing, and encouragement of ride-sharing and use of public transportation options, such that LOS values can be maintained with the increased volumes.
Economic Impacts	3.12.1.1.3	1	Beneficial	The economic impacts of construction and operation of a new nuclear reactor are expected to be beneficial; therefore, this is a Category 1 issue. If, during the project-specific environmental review, the NRC staff determines a detailed analysis of economic costs and benefits is needed for analysis of the range of alternatives considered or relevant to mitigation, the NRC staff may require further information from the applicant.
Tax Revenue Impacts	3.12.1.1.4	1	Beneficial	The tax revenue impacts of construction and operation of a new nuclear reactor are expected to be beneficial; therefore, this is a Category 1 issue. If, during the project-specific environmental review, the NRC staff determines a detailed analysis of tax revenue costs and benefits is needed for analysis of the range of alternatives considered or relevant to mitigation, the NRC staff may require further information from the applicant.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
Operation				
Community Services and Infrastructure	3.12.1.2.1	1	SMALL	• The housing vacancy rate in the affected economic region does not change by more than 5 percent, or at least 5 percent of the housing stock remains available after accounting for in-migrating construction workers. • Student:teacher ratios in the affected economic region do not exceed locally mandated levels after including the school age children of the in-migrating worker families.
Transportation Systems and Traffic	3.12.1.2.2	1	SMALL	The LOS determination for affected roadways does not change. Mitigation measures may include implementation of traffic flow management, management of shift-change timing, and encouragement of ride-sharing and use of public transportation options, such that LOS values can be maintained with the increased volumes.
Economic Impacts	3.12.1.2.3	1	Beneficial	The economic impacts of construction and operation of a new nuclear reactor are expected to be beneficial; therefore, this is a Category 1 issue. If, during the project-specific environmental review, the NRC staff determines a detailed analysis of economic costs and benefits is needed for analysis of the range of alternatives considered or relevant to mitigation, the NRC staff may require further information from the applicant.
Tax Revenue Impacts	3.12.1.2.4	1	Beneficial	The tax revenue impacts of construction and operation of a new nuclear reactor are expected to be beneficial; therefore, this is a Category 1 issue. If, during the project-specific environmental review, the NRC staff determines a detailed analysis of tax revenue costs and benefits is needed for analysis of the range of alternatives considered or relevant to mitigation, the NRC staff may require further information from the applicant.
Fuel Cycle				
Operation				
Uranium Recovery	3.14.2.1	1	SMALL	• Table S–3 is expected to bound the impacts for new nuclear reactor fuels, because of uranium fuel cycle changes since WASH-1248 (AEC 1974-TN23), including: − Increasing use of in situ leach uranium mining has lower environmental impacts than traditional mining and milling methods. − Current light-water reactors are using nuclear fuel more efficiently due to higher levels of fuel burnup resulting in less demand for mining and milling activities. − Less reliance on coal-fired electrical generation plants is resulting in less gaseous effluent releases from electrical generation sources supporting mining and milling activities. • Must satisfy the regulatory requirements of 10 CFR Part 40 (TN4882) *Domestic Licensing of Source Material* and 10 CFR Part 71 (TN301), *Packaging and Transportation of Radioactive Material*.
Uranium Conversion	3.14.2.2	1	SMALL	• Table S–3 is expected to bound the impacts for new nuclear reactor fuels because of uranium fuel cycle changes since WASH-1248 (AEC 1974-TN23), including: − Current LWRs are using nuclear fuel more efficiently due to higher levels of fuel burnup resulting in less demand for conversion activities.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
				− Less reliance on coal-fired electrical generation plants is resulting in less gaseous effluent releases from electrical generation sources supporting conversion activities. • Must satisfy the regulatory requirements of 10 CFR Part 40 (TN4882) *Domestic Licensing of Source Material* and 10 CFR Part 71 (TN301), *Packaging and Transportation of Radioactive Material*, and 10 CFR Part 73 (TN423), *Physical Protection of Plants and Materials*.
Enrichment	3.14.2.3	1	SMALL	• Table S–3 is expected to bound the impacts for new nuclear reactor fuels, because of uranium fuel cycle changes since WASH-1248 (AEC 1974-TN23), including: • Transitioning of U.S. uranium enrichment technology from gaseous diffusion to gas centrifugation, which requires less electrical usage per separative work unit. • Current LWRs are using nuclear fuel more efficiently due to higher levels of fuel burnup resulting in less demand for enrichment activities. • Less reliance on coal-fired electrical generation plants is resulting in less gaseous effluent releases from electrical generation sources supporting enrichment activities. • Must satisfy the regulatory requirements of 10 CFR Part 40 (TN4882) *Domestic Licensing of Source Material*, 10 CFR Part 70 (TN4883), *Domestic Licensing of Special Nuclear Material*, 10 CFR Part 71 (TN301), *Packaging and Transportation of Radioactive Material*, and 10 CFR Part 73 (TN423), *Physical Protection of Plants and Materials*.
Fuel Fabrication[(a)]	3.14.2.4	1	SMALL	• Table S–3 is expected to bound the impacts for new nuclear reactor fuels, because of uranium fuel cycle changes since WASH-1248 (AEC 1974-TN23), including: − Current LWRs are using nuclear fuel more efficiently due to higher levels of fuel burnup resulting in fewer discharged fuel assemblies to be fabricated each year and due to longer time periods between refueling − Less reliance on coal-fired electrical generation plants is resulting in less gaseous effluent releases from electrical generation sources supporting fabrication. • Must satisfy the regulatory requirements of 10 CFR Part 40 (TN4882) *Domestic Licensing of Source Material*, 10 CFR Part 70 (TN4883), *Domestic Licensing of Special Nuclear Material*, 10 CFR Part 71 (TN301), *Packaging and Transportation of Radioactive Material*, and 10 CFR Part 73 (TN423), *Physical Protection of Plants and Materials*.
Reprocessing	3.14.2.5	1	SMALL	• Table S–3 is expected to bound the impacts for new nuclear reactor fuels, because of uranium fuel cycle changes since WASH-1248 (AEC 1974-TN23), including: − Current LWRs are using nuclear fuel more efficiently due to higher levels of fuel burnup resulting in fewer discharged fuel assemblies to be reprocessed each year. − Less reliance on coal-fired electrical generation plants is resulting in less gaseous effluent releases from electrical generation sources supporting reprocessing. • Reprocessing capacity up to 900 MTU/yr. • Must satisfy the regulatory requirements of 10 CFR Part 40 (TN4882) *Domestic Licensing of Source Material*, 10 CFR Part 50 (TN249) *Domestic Licensing of Production and Utilization Facilities*,10 CFR Part 70 (TN4883), *Domestic Licensing of Special Nuclear Material*, 10 CFR Part 71 (TN301), *Packaging and Transportation of Radioactive Material*, 10 CFR Part 72

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
				(TN4884), *Licensing Requirements for the Independent Storage of Spent Fuel, High-Level Radioactive Waste, and Reactor-related Greater Than Class C Waste*, and 10 CFR Part 73 (TN423), *Physical Protection of Plants and Materials*.
Storage and Disposal of Radiological Wastes	3.14.2.6	1	SMALL	• Table S–3 is expected to bound the impacts for new nuclear reactor fuels, because of uranium fuel cycle changes since WASH-1248 (AEC 1974-TN23), including: − Current LWRs are using nuclear fuel more efficiently due to higher levels of fuel burnup resulting in fewer discharged fuel assemblies to be stored and disposed. − Less reliance on coal-fired electrical generation plants is resulting in less gaseous effluent releases from electrical generation sources supporting storage and disposal. • Waste and spent fuel inventories, as well as their associated certified spent fuel shipping and storage containers, are not significantly different from what has been considered for LWR evaluations in NUREG-2157 (NRC 2014-TN4117). • Must satisfy the regulatory requirements of 10 CFR Part 40 (TN4882) *Domestic Licensing of Source Material*, 10 CFR Part 70 (TN4883), *Domestic Licensing of Special Nuclear Material*, 10 CFR Part 71 (TN301), *Packaging and Transportation of Radioactive Material*, 10 CFR Part 72 (TN4884), *Licensing Requirements for the Independent Storage of Spent Fuel, High-Level Radioactive Waste, and Reactor-related Greater Than Class C Waste*, and 10 CFR Part 73 (TN423), *Physical Protection of Plants and Materials.*
Transportation of Fuel and Waste				
Operation				
Transportation of Unirradiated Fuel	3.15.2.1	1	SMALL	• The maximum annual one-way shipment distance (59,160 km) presented in Table 3-12. The annual shipments associated with the one-way shipment distance have been normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor from WASH-1238 (AEC 1972-TN22). • The maximum annual round-trip shipment distance (118,320 km) presented in Table 3-13. The annual shipments associated with the round-trip shipment distance have been normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor from WASH-1238 (AEC 1972-TN22).
Transportation of Radioactive Waste	3.15.2.2	1	SMALL	• The maximum annual round-trip shipment distance (293,145 km) presented in Table 3-17. The annual shipments associated with the round-trip shipment distance have been normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor and a shipment volume of 2.34 m^3/shipment from WASH-1238 (AEC 1972-TN22).
Transportation of Irradiated Fuel	3.15.2.3	1	SMALL	• The maximum annual one-way shipment distance (505,393 km) presented in Table 3-18. The annual shipments associated with the one-way shipment distance have been normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor and a shipment capacity of 0.5 MTU/shipment from WASH-1238 (AEC 1972-TN22). • The maximum annual round-trip shipment distance (1,010,786 km) presented in Table 3-20. The annual shipments associated with the round-trip shipment distance have been normalized

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
				to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor and a shipment capacity of 0.5 MTU/shipment from WASH-1238 (AEC 1972-TN22). • A maximum assembly averaged burnup of 80 GWd/MTU for UO_2 fuel and peak pellet burnup of 133 GWd/MTU for TRISO fuel (see Table 3-19).
Decommissioning				
Decommissioning	3.16.2	1	SMALL	The environmental impacts for the following resource areas were generically addressed in NUREG-0586, Supplement 1, would be limited to operational areas, would not be detectable or destabilizing and are expected to have a negligible effect on the impacts of terminating operations and decommissioning: • Onsite land use • Water use • Water quality • Air quality • Aquatic ecology within the operational area • Terrestrial ecology within the operational area • Radiological • Radiological accidents (non-spent-fuel-related) • Occupational issues • Socioeconomic • Onsite cultural and historic resources for plants where the disturbance of lands beyond the operational areas is not anticipated • Aesthetics • Noise • Transportation • Irretrievable resource The following issues were not addressed in NUREG-0586, Supplement 1, but have been determined to be Category 1 issues: • Nonradiological waste • GHGs

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
Decommissioning	3.16.2	2	Undetermined	Threatened and endangered species was an issue identified in NUREG-0586, Supplement 1, as requiring a project-specific review. Four conditionally project-specific issues identified in NUREG-0586, Supplement 1, will require a project-specific review if present: • Land use involving offsite areas to support decommissioning activities • Aquatic ecology for activities beyond the licensed operational area • Terrestrial ecology for activities beyond the licensed operational area • Historic and cultural resources (archaeological, architectural, structural, historic) for activities within and beyond the licensed operational area with no current (i.e., at the time of decommissioning) evaluation of resources for NRHP eligibility Additionally, the following two environmental resource areas are additional decommissioning impacts that require project-specific review: • Climate change: the effects of climate change are location-specific and cannot, therefore, be evaluated generically (see Section 1.3.3.2.2, Category 2 Issues Applying Across Resources, of this NR GEIS) • Cumulative effects: must be considered on a project-specific basis where impacts would depend on regional resource characteristics, the resource specific impacts of the project, and the cumulative significance of other factors affecting the resource. (see Section 1.3.3.2.2, Category 2 Issues Applying Across Resources, of this NR GEIS)
Issues Applying Across Resources				
Climate Change Impacts on Environmental Resources	1.3.3.2.2	2	Undetermined	The effects of climate change on environmental resources are location-specific and cannot, therefore, be evaluated generically. For example, while climate change may cause many areas to receive less than average annual precipitation, other areas may see an increase in average annual precipitation. Therefore, applicants and the NRC staff would address the effects of climate change on environmental resources in the environmental documents for new nuclear reactor licensing.
Cumulative Impacts	1.3.2.2.2	2	Undetermined	Applications must individually consider the cumulative impacts from past, present, and reasonably foreseeable actions known to occur at specific sites for proposed new nuclear reactors, and briefly present those considerations in supplemental NEPA documentation. The staff would address whether these individualized evaluations of potential cumulative impacts alter any of the generic analyses and conclusions relied upon for Category 1 issues. The individualized cumulative impact analyses may also identify opportunities where NRC staff might rely upon the generic analyses for some Category 1 issues for which certain of the PPE or SPE values and assumptions might be exceeded.
Non-Resource Related Issues				
Purpose and Need	1.3.3.2.3	2	Undetermined	Must be described in the environmental report associated with a given application.
Need for Power	1.3.3.2.3	2	Undetermined	Must be described in the environmental report associated with a given application.

Table 4-1 Summary of Findings and Mitigation (Continued)

Issue	Section	Category	Finding	PPE/SPE Values and Assumptions
Site Alternatives	1.3.3.2.3	2	Undetermined	Must be described in the environmental report associated with a given application.
Energy Alternatives	1.3.3.2.3	2	Undetermined	Must be described in the environmental report associated with a given application.
System Design Alternatives	1.3.3.2.3	2	Undetermined	Must be described in the environmental report associated with a given application.

APLIC = Avian Power Line Interaction Committee; BMP = best management practice; CFR = *U.S. Code of Federal Regulation*; CO_2(e) = CO_2 equivalent; CWA = Clean Water Act; dBA = decibel(s) on the A-weighted scale; DBA = design basis accident; EHS = Extremely Hazardous Substances; EMF = electromagnetic field; EPA = U.S. Environmental Protection Agency; ESA = Endangered Species Act of 1973, as amended; FWS = U.S. Fish and Wildlife Service; GEIS = generic environmental impact statement; GHG = greenhouse gas; HAP = hazardous air pollutant; IAEA = International Atomic Energy Agency; LOS = level of service; LR GEIS = license renewal generic environmental impact statement; LWR = light-water reactor; NCRP = National Council on Radiation Protection and Measurements; NEI = Nuclear Electric Institute; NEPA = National Environmental Policy Act of 1969, as amended; NHPA = National Historic Preservation Act; NPDES = National Pollutant Discharge Elimination System; NR GEIS = *Generic Environmental Impact Statement for Licensing New Nuclear Reactors*; NRC = U.S. Nuclear Regulatory Commission; NRHP = National Register of Historic Places; NWP = Nation Wide Permit; PPE = plant parameter envelope; RCRA = Resource Conservation and Recovery Act of 1976, as amended; RG = Regulatory Guide; ROW = right-of-way; SEIS = supplemental environmental impact statement; SPE = site parameter envelope; SSA = Sole Source Aquifer; TEDE = total effective dose equivalent; TPQ = Threshold Planning Quantities; U.S.C. = *U.S. Code*; USACE = U.S. Army Corps of Engineers.

(a) Fuel fabrication impacts for metal fuel and liquid fueled molten salt are not included in the staff's generic analysis.

4.1 Unavoidable Adverse Environmental Impacts and Irreversible and Irretrievable Commitments of Resources

Unavoidable adverse environmental impacts are those potential impacts of the NRC proposed action that cannot be avoided and for which no practical means of mitigation are available. The term "irreversible and irretrievable commitments of resources" refers to environmental resources that would be irreparably changed by the activities authorized by the NRC, where the environmental resources could not be restored at some later time to the resource's state before the relevant activities.

Because the issuance of the NR GEIS would itself have no impacts and would not approve or license the construction and/or operation of any new nuclear reactor, there would be no unavoidable adverse environmental impacts or any irreversible or irretrievable commitments of resources from development of the NR GEIS.

Any project-specific SEIS developed for a proposed new nuclear reactor tiering to the GEIS would be required to analyze the impacts associated with construction and operation of such a facility. The unavoidable adverse environmental impacts associated with the granting of the license would include impacts of construction, preconstruction, and operation and would be described in the project-specific SEIS.

The irreversible and irretrievable commitments of resources during construction of the proposed new nuclear reactor generally would be similar to those of any major construction project and would be dependent on the size and scale of the proposed reactor. The NRC would prepare the project-specific SEIS, issue the requisite record of decision in accordance with 10 CFR 51.102 (TN250), and assuming approval of the project, describe any such irreversible and irretrievable commitments of resources in the SEIS before the issuance of any license, permit, or other authorization to construct or operate a new nuclear reactor.

The NRC staff expects that the use of construction materials in the quantities associated with those expected for new nuclear reactors tiering to the GEIS, while irreversible and irretrievable, would be of small consequence with respect to the availability of such resources. The main resource that would be irreversibly and irretrievably committed during operation of any new nuclear unit would be the fuel. If uranium is the fuel, the availability of uranium ore, existing stockpiles of highly enriched uranium in the United States, and other uranium sources identified through the DOE HALEU production program that could be processed into fuel is sufficient (OECD/NEA and IAEA 2008-TN3992) so that the irreversible and irretrievable commitment of this resource would be negligible. The irreversible and irretrievable commitment of resources would not be the same for all nuclear power plants and would depend on the specific characteristics of the power plant (e.g., thorium fuel cycle, lithium-based primary fluid, or other resource characteristic) and its resource needs.

4.2 Relationship between Short-Term Use of the Environment and Long-Term Productivity

NEPA Section 102(2)(C)(iv) (42 U.S.C. § 4332(C)(iv); TN4880) requires that an EIS include information about the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

Because the issuance of the NR GEIS would not approve or license the construction and/or operation of any new nuclear reactor, the GEIS itself would not result in either short-term or

long-term impacts. However, a project-specific SEIS tiering to the GEIS would consider the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

Nuclear power plant construction and operations would necessitate short-term use of the environment and commitments of resources. Certain resources (e.g., land and energy) will be committed indefinitely or permanently. Short-term use of the environment can affect long-term productivity of the ecosystem if that use alters the ability of the ecosystem to re-establish an equilibrium that is comparable to that of its original condition.

Air emissions from power plant operations would introduce small amounts of radiological and nonradiological constituents to the region around the plant site. Over time, these emissions could result in increased concentrations and exposure, but are not expected to affect air quality or radiation exposure to the extent that public health and long-term productivity of the environment would be impaired. Continued employment, expenditures, and tax revenues generated during power plant operations would directly benefit local, regional, and State economies during the short term. Local governments investing project-generated tax revenues into infrastructure and other required services could enhance economic productivity over the long term. The management and disposal of spent nuclear fuel, low-level waste, hazardous waste, and nonhazardous waste would require an increase in energy and would consume space at treatment, storage, or disposal facilities. Regardless of the location, the use of land to meet waste disposal needs would reduce the long-term productivity of the land. Power plant facilities would be committed to power production over the short term. After decommissioning these facilities and restoring the power plant site, the land would become available for other productive uses. The nature of the relationship between short-term use of the environment and long-term productivity would vary among plants and would depend on the specific characteristics of each plant and its interaction with the environment. This relationship is reactor-specific and would be analyzed in a project-specific SEIS.

4.3 No-Action Alternative Conclusion

Under the No-Action Alternative the NRC would not issue this GEIS. There are no environmental impacts associated with not issuing the GEIS. In this context, the No-Action Alternative would accomplish none of the benefits intended by the GEIS process, which would include (1) reducing the time and resources for the applicant's preparation of the ER, (2) reducing the time and resources for the NRC staff's preparation of the EIS, and (3) focusing the effort of applicant, NRC staff, and decision-makers on issues that involve a potential for significant environmental impacts.

Selection of the No-Action Alternative would likely lead to the same magnitude and level of environmental impacts associated with the licensing of new nuclear reactors; these impacts would be addressed in project-specific EISs rather than in supplemental analyses tiering to the NR GEIS. Mitigation measures associated with these projects would be developed on a case-by-case basis rather than comprehensively, as in the GEIS, potentially leading to increased inconsistency and potential greater impacts.

4.4 Cost Benefit

Section 102(B) of NEPA requires that all Federal agencies "identify and develop methods and procedures, in consultation with the Council on Environmental Quality established by Title II of this Act, which will ensure that presently unquantified environmental amenities and values

may be given appropriate consideration in decision-making along with economic and technical considerations" (42 U.S.C. § 4332(B); TN4880).

However, NEPA does not require the benefits and costs of a proposed action be quantified in dollars or any other common metric. The intent of this section is not to identify and quantify all of the potential societal benefits of the proposed activities and compare them to the potential costs of the proposed activities. Instead, this section focuses on only the benefits and costs of such magnitude or importance that their inclusion in this analysis can inform the decision-making process. This section summarizes the pertinent analytical conclusions reached in earlier chapters of this GEIS.

The proposed action of proceeding with the GEIS is expected to improve the efficiency of the environmental review process and avoid duplication of effort, compared to the No-Action Alternative of developing individual project-specific EISs for new nuclear reactor applications. The issues identified as Category 1 in this GEIS have been analyzed and resolved generically; therefore, the resources needed for subsequent staff reviews of environmental issues in individual new nuclear reactor applications would be reduced. In addition, by analyzing Category 1 issues generically, the GEIS would also enhance consistency across environmental reviews, thereby increasing efficiency and streamlining the environmental review process. Use of the GEIS would allow NRC staff and decision-makers to focus on issues that involve a potential for significant environmental impacts. Project-specific environmental reviews would be able to incorporate the GEIS findings by reference, thereby streamlining the review processes.

5 REFERENCES

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APPENDIX A

CONTRIBUTORS TO THE ENVIRONMENTAL IMPACT STATEMENT

Members of the U.S. Nuclear Regulatory Commission prepared this generic environmental impact statement with assistance and support from Pacific Northwest National Laboratory and a commercial contractor. The table below identifies each contributor's name, affiliation, and function or expertise.

Table A-1 U.S. Nuclear Regulatory Commission Preparers

Name	Affiliation	Review Area/Expertise
Jack Cushing[(a)]	Office of Nuclear Material Safety and Safeguards	Project Management, Historic and Cultural Resources, Cumulative Impacts
Stacey Imboden	Office of Nuclear Material Safety and Safeguards	Project Management, Meteorology and Air Quality, Nonradiological Environment
Laura Willingham	Office of Nuclear Material Safety and Safeguards	Project Management, Meteorology and Air Quality
Robert Hoffman	Office of Nuclear Material Safety and Safeguards	Project Management
Dan Barnhurst	Office of Nuclear Material Safety and Safeguards	Surface Water and Groundwater Resources, Project Management
Jennifer Davis	Office of Nuclear Material Safety and Safeguards	Historic and Cultural Resources
Elijah Dickson	Office of Nuclear Reactor Regulation	Accident Analysis
Peyton Doub	Office of Nuclear Material Safety and Safeguards	Land Use, Terrestrial Ecology, Aquatic Ecology, Visual Resources, Alternatives, Executive Summary
Jerry Dozier[(c)]	Office of Nuclear Reactor Regulation	Accident Analysis
Dan Mussatti[(b)]	Office of Nuclear Material Safety and Safeguards	Visual Resources, Noise, Socioeconomics, Need for Project
Donald Palmrose	Office of Nuclear Material Safety and Safeguards	Radiological Environment, Accident Analysis, Radiological Waste Management, Fuel Cycle, Transportation of Fuel and Waste, Decommissioning, Continued Storage
Jeffrey Rikhoff	Office of Nuclear Material Safety and Safeguards	Need for Project, Alternatives, Cost Benefits, Land Use
Marty Stutzke	Office of Nuclear Reactor Regulation	Accident Analysis

(a) Retired from the U.S. Nuclear Regulatory Commission in 2021.
(b) Retired from the U.S. Nuclear Regulatory Commission in 2023.
(c) Departed from the U.S. Nuclear Regulatory Commission in 2025.

Table A-2 Pacific Northwest National Laboratory[a] Preparers

Name	Review Area/Expertise
Bo Saulsbury[b]	Project Management
Dave Goodman	Project Management, Land Use, Visual Resources, Noise, Alternatives Analysis, Cumulative Impacts
Andrew Kugler	Project Management, Plant and Site Parameter Envelopes, Alternatives
Kirsten Chojnicki	Project Management
Terri Miley[b]/Sadie Montgomery	Comment Response
Bruce McDowell/Saikat Ghosh	Air Quality
Rajiv Prasad/Kazi Tamaddun	Surface Water Resources
Philip Meyer/Rebecka Iveson	Groundwater Resources
Stephanie Larson/Tracy Fuentes/Jim Becker[b]	Terrestrial Ecology
Ann Miracle/Stephanie Larson	Aquatic Ecology
Tara O'Neil/Lindsey Renaud/Ellen Kennedy[b]	Historic and Cultural Resources
Dave Anderson	Socioeconomics
Kim Leigh/Seema Verma	Nonradiological Environment
Caitlin Condon/Jon Napier/Steve Maheras	Radiological Environment, Waste Management, Fuel Cycle, Decommissioning, Accidents, Transportation of Fuel and Waste, Continued Storage

(a) Pacific Northwest National Laboratory (PNNL) is managed for the U.S. Department of Energy by Battelle Memorial Institute.
(b) Formerly of PNNL.

APPENDIX B

OUTREACH

This appendix provides a description of outreach activities and the Federal, State, and Tribal agencies and groups that the U.S. Nuclear Regulatory Commission (NRC) contacted during the preparation of this *Generic Environmental Impact Statement for Licensing New Nuclear Reactors* (NR GEIS). The NRC did not identify any cooperating agencies for the environmental review or receive any formal requests for cooperating agency status. The NRC staff conducted extensive outreach during preparation of the NR GEIS and rule.

B.1 Exploratory Process

On November 15, 2019, the NRC staff issued the following *Federal Register* Notices (84 FR 62559-TN6470, 84 FR 67299-TN7085, and 84 FR 68194-TN7084) announcing an exploratory process and soliciting comments to determine the possibility of developing a GEIS for licensing advanced nuclear reactors. The exploratory process included two public meetings, a comprehensive public workshop attended by multiple stakeholders, and a site visit to the Idaho National Laboratory, a location that is being contemplated for advanced reactors (NRC 2019-TN7087, NRC 2019-TN7086, NRC 2020-TN7088).

B.2 Public Meetings and Webinars

On May 28, 2020 from 1:00 p.m. to 4:00 p.m. the NRC staff held a webinar with the public as part of the scoping process to gather information necessary to prepare a GEIS for advanced nuclear reactors (85 FR 24040-TN6458).

The NRC staff held an in-person public meeting on the Draft NR GEIS and proposed rule on November 7, 2024, and two virtual meetings on November 13 and November 14, 2024. These meetings presented the results of the Draft NR GEIS and proposed rule and allowed the public to ask clarifying questions and provide comments (NRC 2024-TN11984, NRC 2024-TN11985, NRC 2024-TN11986).

B.3 Obtaining Comments

The staff collected comments from the public in three ways during the public comment period associated with the initial scoping process, held from April 30, 2020 to June 30, 2020 (85 FR 24040-TN6458).

- **Federal Rulemaking website:** The public submitted comments to the NRC staff through the Federal Rulemaking website at https://www.regulations.gov using Docket ID NRC-2020-0101.
- **Advanced Reactors-GEIS Email:** The NRC staff used an email account, AdvancedReactors-GEIS@nrc.gov, to receive comments from the public during the initial scoping process for the GEIS.
- **Mail:** The NRC staff requested that comments be sent by mail, if desired, to Office of Administration, Mail Stop TWFN-7-A60M, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555-0001.

- The NRC staff collected comments from the public in six different ways during the public comment period on the Draft NR GEIS and proposed rule, held from October 4, 2024 to December 18, 2024 (89 FR 80797-TN11914).
- **Public Meetings:** see Section B.2 above.
- **Federal Rulemaking website:** The public submitted comments to the NRC staff through the Federal Rulemaking website at https://www.regulations.gov, using Docket ID NRC-2020-0101.
- **Email:** the NRC staff accepted comments via email at Rulemaking.Comments@nrc.gov to receive comments from the public on the Draft NR GEIS and proposed rule.
- **Fax:** the NRC staff accepted comments via fax at 301-415-1101.
- **Mail:** the NRC staff accepted comments sent via mail to Secretary, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001, ATTN: Rulemakings and Adjudications Staff.
- **Hand-delivered:** the NRC staff accepted hand-delivered comments at 11555 Rockville Pike, Rockville, Maryland 20852.

B.4 Distribution of the Scoping Summary Report and Comment-Response Report

The NRC staff summarized the comments received during the scoping process and the staff's related responses in a report titled, *Environmental Impact Statement Scoping Process Summary Report: The Advanced Nuclear Reactor Generic Environmental Impact Statement Public Scoping Period* (NRC 2020-TN6593). This scoping report was issued in September 2020.

The NRC staff summarized and responded to comments received on the Draft NR GEIS and proposed rule. This Comment-Response Report is included in Appendix E to this Final NR GEIS.

B.5 NRC Website

Throughout the development of the NR GEIS and the rulemaking process, the NRC maintained a webpage at: https://www.nrc.gov/reactors/new-reactors/advanced/modernizing/rulemaking/advanced-reactor-generic-environmental-impact-statement-geis.html (NRC 2025-TN11953). The NRC regularly updated the website, which contained a description of the purpose of the GEIS and rulemaking, the history of the GEIS development and rulemaking, and the schedule for the GEIS and rule. The website also provided an overview of key communications between the staff and Commission (SECY-20-0020 [NRC 2020-TN6493] and SRM-SECY-20-0020 [NRC 2020-TN6492]) and the public. In addition there is a website for the rulemaking effort associated with the NR GEIS at https://www.nrc.gov/reading-rm/doc-collections/rulemaking-ruleforum/active/ruledetails.html?id=1139 (NRC 2021-TN7103). This website provides the public with rulemaking information such as the schedule, the NRC docket ID, and the rulemaking project manager information along with other information.

B.6 Advanced Reactor Stakeholder Meetings

On at least nine occasions, the NRC staff has taken part in the periodic Advanced Reactor Stakeholder Meetings to provide an overview of the GEIS development and answer questions.

All meetings were open to the public and associated slides may be found at https://www.nrc.gov/reactors/new-reactors/advanced/details.html#stakeholder (NRC 2021-TN7099).

B.7 Tribal Contact

The NRC staff contacted federally recognized Tribes via a State and Tribal Correspondence letter regarding scoping for the advanced nuclear reactor GEIS (NRC 2020-TN7095). The staff distributed the scoping summary report to Tribes via LYRIS distribution through the NRC Tribal liaison branch (NRC 2020-TN7094, NRC 2020-TN7093, NRC 2020-TN7092, NRC 2020-TN7091, NRC 2020-TN7090, NRC 2020-TN7089). Another State and Tribal Correspondence letter was sent to invite Tribes to attend the July 15, 2021 Advanced Reactors Stakeholder meeting (NRC 2021-TN7096).

On October 25, 2024, the NRC contacted federally recognized Tribes via a State and Tribal Correspondence letter regarding the publication of the Draft NR GEIS and proposed rule for comment and notification of a closed informational meeting (NRC 2024-TN11974). The informational meeting held on December 3, 2024, provided an overview of the Draft NR GEIS and proposed rule and afforded Tribal representatives an opportunity to discuss the rule with NRC staff.

B.8 Other Federal Agencies

On April 1, 2020, the NRC reached out to the Advisory Council on Historic Preservation and the U.S. Environmental Protection Agency via email to notify them of the NRC's intent to conduct a scoping process for the advanced nuclear reactor GEIS and to inform the agencies that the NRC would issue a *Federal Register* Notice (NRC 2021-TN7097, NRC 2021-TN7098).

On September 26, 2024, the NRC provided notice through the GovDelivery email subscriber management system that the Draft NR GEIS and related documents would be available for comment starting on October 4, 2024. This notice was provided to the public and various federal agencies, including the Advisory Council on Historic Preservation, the U.S. Environmental Protection Agency, and the Army Corps of Engineers.

B.9 References

84 FR 62559. November 15, 2019. "Agency Action Regarding the Exploratory Process for the Development of an Advanced Nuclear Reactor Generic Environmental Impact Statement." *Federal Register*, Nuclear Regulatory Commission. TN6470.

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85 FR 24040. April 30, 2020. "Notice To Conduct Scoping and Prepare an Advanced Nuclear Reactor Generic Environmental Impact Statement." *Federal Register*, Nuclear Regulatory Commission. TN6458.

89 FR 80797. October 4, 2024. "Generic Environmental Impact Statement for Licensing of New Nuclear Reactors." *Federal Register*, Nuclear Regulatory Commission. TN11914.

NRC (U.S. Nuclear Regulatory Commission). 2019. Memorandum from M.A. Sutton to B.G. Beasley, Office of Nuclear Reactor Regulation, dated December 10, 2019, regarding "Summary of November 15 and 20, 2019, Public Meetings to Discuss Exploratory Process for Developing an Advanced Nuclear Reactor Generic Environmental Impact Statement." Washington, D.C. ADAMS Accession No. ML19337C862. TN7086.

NRC (U.S. Nuclear Regulatory Commission). 2019. Public Meeting Announcement and Agenda, November 15 and 20, 2019, "Meeting to Discuss the Environmental Information Needed to Develop a Generic Environmental Impact Statement for Advanced Nuclear Reactors." Washington, D.C. ADAMS Accession No. ML19304B011. TN7087.

NRC (U.S. Nuclear Regulatory Commission). 2020. Email from J. Olmstead to NRC, dated November 17, 2020, regarding "Scoping Summary Report for the Advanced Reactor Generic Environmental Impact Statement." Washington, D.C. ADAMS Accession No. ML21224A280. TN7089.

NRC (U.S. Nuclear Regulatory Commission). 2020. Email from L. Willingham to the Hopi Tribe, dated November 17, 2020, regarding "U.S. Nuclear Regulatory Commission - Advanced Reactor Generic Environmental Impact Statement Scoping Summary Report." Washington, D.C. ADAMS Accession No. ML21224A293. TN7091.

NRC (U.S. Nuclear Regulatory Commission). 2020. Email from L. Willingham to the Miami Tribe of Oklahoma, dated November 17, 2020, regarding "U.S. Nuclear Regulatory Commission - Advanced Reactor Generic Environmental Impact Statement Scoping Summary Report." Washington, D.C. ADAMS Accession No. ML21224A296. TN7090.

NRC (U.S. Nuclear Regulatory Commission). 2020. Email from L. Willingham to the Navajo Nation, dated November 17, 2020, regarding "U.S. Nuclear Regulatory Commission - Advanced Reactor Generic Environmental Impact Statement Scoping Summary Report." Washington, D.C. ADAMS Accession No. ML21224A292. TN7092.

NRC (U.S. Nuclear Regulatory Commission). 2020. Email from L. Willingham to the San Manuel Band of Mission Indians, dated November 17, 2020, regarding "U.S. Nuclear Regulatory Commission - Advanced Reactor Generic Environmental Impact Statement Scoping Summary Report." Washington, D.C. ADAMS Accession No. ML21224A291. TN7093.

NRC (U.S. Nuclear Regulatory Commission). 2020. Email from L. Willingham to the Shoshone-Bannock Tribe, dated November 17, 2020, regarding "U.S. Nuclear Regulatory Commission - Advanced Reactor Generic Environmental Impact Statement Scoping Summary Report." Washington, D.C. ADAMS Accession No. ML21216A202. TN7094.

NRC (U.S. Nuclear Regulatory Commission). 2020. Letter from L.Y. Cuadrado to All Agreement and Non-Agreement States, State Liaison Officers, and All Federally Recognized Indian Tribes, dated April 30,2020, regarding "Notification of the Intent to Conduct a Scoping Process and Prepare a Generic Environmental Impact Statement for Advanced Nuclear Reactors." Washington, D.C. ADAMS Accession No. ML20114E140. TN7095.

NRC (U.S. Nuclear Regulatory Commission). 2020. Memorandum from A.L. Vietti-Cook to M.M. Doane, dated September 21, 2020, regarding Staff Requirements - SECY-20-0020 - Results of Exploratory Process for Developing a Generic Environmental Impact Statement for the Construction and Operation of Advanced Nuclear Reactors." SRM-SECY-20-0020, Washington, D.C. ADAMS Accession No. ML20265A112. TN6492.

NRC (U.S. Nuclear Regulatory Commission). 2020. *Policy Issue: Results of Exploratory Process for Developing a Generic Environmental Impact Statement for the Construction and Operation of Advanced Nuclear Reactors*. SECY-20-0020, Washington, D.C. ADAMS Accession No. ML20052D175. TN6493.

NRC (U.S. Nuclear Regulatory Commission). 2020. Public Meeting Announcement and Agenda, January 08, 2020, "Workshop to Discuss the Environmental Information Needed to Develop a Generic Environmental Impact Statement for Advanced Nuclear Reactors." Washington, D.C. ADAMS Accession No. ML19347A733. TN7088.

NRC (U.S. Nuclear Regulatory Commission). 2020. *Scoping Summary Report for the Advanced Nuclear Reactor Generic Environmental Impact Statement Public Scoping Period*. Washington, D.C. ADAMS Accession No. ML20269A317. TN6593.

NRC (U.S. Nuclear Regulatory Commission). 2021. "Advanced Reactors Details." Washington, D.C. ADAMS Accession No. ML21232A543. TN7099.

NRC (U.S. Nuclear Regulatory Commission). 2021. Email from NRC to ACHP, dated April 1, 2021. regarding "NRC Preparing an Advance Nuclear Reactor Generic Environmental Impact Statement (GEIS)." Washington, D.C. ADAMS Accession No. ML21219A001. TN7097.

NRC (U.S. Nuclear Regulatory Commission). 2021. Email from NRC to EPA, dated April 1, 2021. regarding "NRC Preparing an Advance Nuclear Reactor Generic Environmental Impact Statement (GEIS)." Washington, D.C. ADAMS Accession No. ML21218A186. TN7098.

NRC (U.S. Nuclear Regulatory Commission). 2021. Letter from M. Arribas-Colon to All Agreement States, Connecticut, Indiana, Non-Agreement States, State Liaison Officers, and Federally Recognized Indian Tribes, dated July 12, 2021, regarding "Opportunity to Observe the U.S. Nuclear Regulatory Commission Periodic Advanced Reactor Stakeholder Meeting (STC-21-044)." Washington, D.C. ADAMS Accession No. ML21190A285. TN7096.

NRC (U.S. Nuclear Regulatory Commission). 2021. "Planned Rulemaking Activities - Rule." Washington, D.C. ADAMS Accession No. ML21232A497. TN7103.

NRC (U.S. Nuclear Regulatory Commission). 2024. Letter from K. Williams, Director, Division of Materials Safety, Security, State, and Tribal Programs, Office of Nuclear Material Safety and Safeguards, to All Agreement and Non-Agreement States State Liaison Officers, dated October 25, 2024, regarding "Issuance of Proposed Rule and Notice of Availability of the Draft Generic Environmental Impact Statement for Licensing of New Nuclear Reactors (STC-24-058)." Washington, D.C. ADAMS Accession No. ML24200A089. TN11974.

NRC (U.S. Nuclear Regulatory Commission). 2024. Public Meeting Announcement, November 13, 2024, "Proposed Rule Generic Environmental Impact Statement for Licensing of New Nuclear Reactors." Washington, D.C. ADAMS Accession No. ML24284A347. TN11985.

NRC (U.S. Nuclear Regulatory Commission). 2024. Public Meeting Announcement, November 14, 2024, "Proposed Rule Generic Environmental Impact Statement for Licensing of New Nuclear Reactors." Washington, D.C. ADAMS Accession No. ML24284A353. TN11984.

NRC (U.S. Nuclear Regulatory Commission). 2024. Public Meeting Announcement, November 7, 2024, "Proposed Rule Generic Environmental Impact Statement for Licensing of New Nuclear Reactors." Washington, D.C. ADAMS Accession No. ML24284A341. TN11986.

NRC (U.S. Nuclear Regulatory Commission). 2025. "New Nuclear Reactor Generic Environmental Impact Statement (NR GEIS)." Washington D.C. Accessed June 2, 2025, at https://www.nrc.gov/reactors/new-reactors/advanced/modernizing/rulemaking/advanced-reactor-generic-environmental-impact-statement-geis.html. TN11953.

APPENDIX C

CHRONOLOGY OF NRC STAFF ENVIRONMENTAL REVIEW CORRESPONDENCE RELATED TO THE GENERIC ENVIRONMENTAL IMPACT STATEMENT FOR LICENSING NEW NUCLEAR REACTORS

This appendix contains a chronological listing of correspondence between the U.S. Nuclear Regulatory Commission (NRC) staff and external parties as part of its development of the *Generic Environmental Impact Statement for Licensing New Nuclear Reactors*.

All documents, with the exception of those containing proprietary information, are available electronically in the NRC's Library, which is found on the Internet at the following Web address: http://www.nrc.gov/reading-rm.html. From this site, the public can gain access to the NRC's Agencywide Documents Access and Management System (ADAMS), which provides text and image files of the NRC's public documents. The ADAMS accession number for each document is included below. If you need assistance in accessing or searching in ADAMS, contact the Public Document Room staff at 1-800-397-4209.

November 15, 2019	NRC *Federal Register* Notice (FRN) Announcing an Exploratory Process and Soliciting Comments on a Possible ANR GEIS (84 FR 62559) (Accession No. ML19302G126)
February 28, 2020	SECY-20-0020, Results of Exploratory Process for Developing a GEIS for the Construction and Operation of Advanced Nuclear Reactors (Package Accession No. ML20052D175)
April 1, 2020	Scoping email to NRC, from J. Eddins, Advisory Council on Historic Preservation, Regarding Preparation of a GEIS for Advanced Reactors (Accession No. ML21219A001)
April 1, 2020	Scoping email to M. Roundtree, Environmental Protection Agency, from NRC, Regarding Preparation of an Advance Nuclear Reactor GEIS (Accession No. ML21218A186)
April 21, 2020	NRC FRN Announcing an Exploratory Process, Public Meetings, and Soliciting Comments on an ANR GEIS (Accession No. ML20111A308)
April 30, 2020	NRC FRN Providing Notice of Intent to Conduct Scoping and Prepare an ANR GEIS (85 FR 24040) (Accession No. ML20111A308)
April 30, 2020	NRC Notification to All Agreement and Non-Agreement States, State Liaison Officers, and All Federally Recognized Indian Tribes, Regarding Notice of Intent to Conduct Scoping and Prepare an ANR GEIS (STC-20-036) (Accession No. ML20114E140)
April 30, 2020	Public Meeting Notice to Discuss the Scope of the GEIS for ANRs (Accession No. ML20148M245)

May 14, 2020	Email to NRC, from K. Jensen, The Yocha Dehe Wintun Nation, Regarding the Generic EIS for Small Scale ANR (Accession No. ML21220A000)
May 14, 2020	Email to L. Bill, The Yocha Dehe Wintun Nation, from NRC, Regarding Yocha Dehe Wintun Nation Notification Response (Accession No. ML21220A001)
May 27, 2020	Email to M. Bremer, The Pueblo de San Ildefonso Tribe, from NRC, Regarding the Generic EIS for ANR (Accession No. ML21220A003)
June 3, 2020	Email from A. McCleary, The San Manuel Band of Mission Indians, Regarding attending the scoping meeting (Accession No. ML21223A341)
June 10, 2020	Letter to D. True, Nuclear Energy Institute, from NRC, Regarding the Nuclear Energy Institute's March 5, 2020 letter "Recommendations for Streamlining Environmental Reviews for Advanced Reactors" (Accession No. ML20147A540)
July 2, 2020	NRC Memorandum: Scoping Meeting Summary (Package Accession No. ML20161A339)
July 23, 2020	Letter to NRC, from Senators J. Barrasso, M. Braun, and M. Crapo, Regarding the ANR GEIS (Accession No. ML20206K923)
August 19, 2020	Email to D. Hunter, The Miami Tribe of Oklahoma, from NRC, Regarding Notification of Intent to Review and update the Generic EIS (Accession No. ML20233A558)
August 27, 2020	Letter to Senator J. Barrasso, from NRC, Regarding the Senator's July 23, 202p letter on the ANR GEIS (Accession No. ML20225A074)
September 21, 2020	Staff Requirements Memorandum (SRM) 20-0020, Results of Exploratory Process for Developing a GEIS for the Construction and Operation of ANRs (Accession No. ML20265A112)
September 22, 2020	Email to Mr. Koyiyumptewa, The Hopi Tribe, from NRC, Regarding the Hopi Tribe Response to the NRC's April 30, 2020 letter (Accession No. ML21223A408)
September 25, 2020	ANR GEIS Scoping Summary Report (Package Accession No. ML20260H180)
November 17, 2020	Email to T. Martin, The Shoshone Bannock Tribe, from NRC, Regarding the ANR GEIS Scoping Summary Report (Accession No. ML21216A202)
November 17, 2020	Email to A. McCleary, The San Manuel Band of Mission Indians, transmitting the ANR GEIS Scoping Summary Report (Accession No. ML21224A291)

November 17, 2020	Email to Mr. Karr, Navajo Nation, Department of Justice, transmitting the ANR GEIS Scoping Summary Report (Accession No. ML21224A292)
November 17, 2020	Email to Mr. Koyiyumptewa, The Hopi Tribe, transmitting the ANR GEIS Scoping Summary Report (Accession No. ML21224A293)
November 17, 2020	Email to D. Hunter, The Miami Tribe of Oklahoma, transmitting the ANR GEIS Scoping Summary Report (Accession No. ML21224A296)
November 17, 2020	Email from Joan Olmstead transmitting the Scoping summary report to Tribal and State Liaison Contacts (Accession No. ML21224A280)
December 14, 2021	Submittal of Proposed Rule: Advanced Nuclear Reactor Generic Environmental Impact Statement (Accession No. ML21222A044)
April 18, 2024	Staff Requirements Memorandum – SECY-21-0098 – Proposed Rule: Advanced Nuclear Reactor Generic Environmental Impact Statement (Accession No. ML24108A200)
October 4, 2024	NRC *Federal Register* Notice of Availability of the Proposed Rule and Draft New Reactor GEIS (89 FR 80797) (Accession No. ML24176A216)
October 25, 2024	Issuance of Proposed Rule and Notice of Availability of the Draft Generic Environmental Impact Statement for Licensing of New Nuclear Reactors (STC-24-058) (Accession No. ML21274A151)
October 25, 2024	Issuance of Proposed Rule and Notice of Availability of the Draft Generic Environmental Impact Statement for Licensing of New Nuclear Reactors and Tribal Information Meeting (STC-24-062) (Accession No. ML24297A191)
December 3, 2024	11/07/2024 Public Meeting—Generic Environmental Impact Statement for Licensing of New Nuclear Reactors Proposed Rule—Presentation, Summary, and Transcript (Accession No. ML24284A341)
December 3, 2024	11/13/2024 Public Meeting—Generic Environmental Impact Statement for Licensing of New Nuclear Reactors Proposed Rule—Presentation, Summary, and Transcript (Accession No. ML24284A347)
December 3, 2024	11/14/2024 Public Meeting—Generic Environmental Impact Statement for Licensing of New Nuclear Reactors Proposed Rule—Presentation, Summary, and Transcript (Accession No. ML24284A353)

APPENDIX D

DISTRIBUTION LIST

The U.S. Nuclear Regulatory Commission (NRC) is providing copies of the *Generic Environmental Impact Statement for Licensing New Nuclear Reactors* (NR GEIS) to the organizations and individuals listed below. In addition, the NRC will issue a State and Tribal Correspondence letter to notify all federally recognized Tribes and State liaison contacts. The NRC will also send the NR GEIS to over 3,000 private citizens that provided scoping comments during the scoping period held for the GEIS from April to June 2020. The NRC will provide hard copies to other interested organizations and individuals upon request.

Table D-1 Distribution List

Name	Affiliation
	Federal Agencies
Bill Marzella	Advisory Council on Historic Preservation
William James	U.S. Army Corps of Engineers
Robert Tomiak	U.S. Environmental Protection Agency (EPA) Office of Federal Activities
	Other Organizations and Individuals
Bud Albright	U.S. Nuclear Industry Council
Peter Hastings	Kairos
Edwin Lyman	Union of Concerned Scientists
Nicholas McMurray	ClearPath
Marcus Nichol	Nuclear Energy Institute
Caleb Ward	U.S. Nuclear Industry Council

APPENDIX E

COMMENTS RECEIVED ON THE ENVIRONMENTAL REVIEW

E.1 Public Scoping

On April 30, 2020, the U.S. Nuclear Regulatory Commission (NRC) issued, for public comment, a notice of intent to prepare an advanced nuclear reactor generic environmental impact statement (GEIS) and to conduct a scoping process to gather the information necessary to prepare such a GEIS for small-scale advanced nuclear reactors (85 FR 24040-TN6458). The NRC held a webinar on May 28, 2020, to receive comments from the public on the scope of the GEIS (NRC 2020-TN6459).

The NRC received a number of comments about the scope of this GEIS both during the May 28, 2020, webinar and throughout the scoping comment period. The NRC staff and its contractor reviewed the transcript from the webinar and all written materials received during the public comment period. All comments were considered. The NRC staff issued a summary of the scoping comments, and the staff's responses to those comments, on September 25, 2020 (NRC 2020-TN6593).

In accordance with 10 CFR 51.29(b) (TN250), this scoping summary report has been made publicly available at the NRC Public Document Room, located at One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852, or from the Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible through the NRC's public website, www.nrc.gov. The accession number for the scoping summary report is ML20269A317 (NRC 2020-TN6593).

E.2 Comments on the Draft NR GEIS and Proposed Rule

The NRC published the Notice of Availability of the Draft GEIS for Licensing of New Nuclear Reactors (NR GEIS) and Proposed Rule in the *Federal Register* on October 4, 2024 (89 FR 80797-TN11914), initiating a 75-day public comment period that closed on December 18, 2024. The NRC held an in-person public meeting in Rockville, Maryland, on November 7, 2024, and two virtual public meetings on November 13 and November 14, 2024. Approximately 122 people attended the in-person and virtual meetings.

During the public comment period, the NRC received a total of 39 comment submissions. The public comment documents received are available on the Federal rulemaking website (Regulations.gov) under Docket ID# NRC-2020-0101. The NRC considered all comments received when developing the final NR GEIS and includes responses to comments received in this section.

Table E-1 Individuals Providing Comments on the Draft GEIS and/or Proposed Rule Package

Commenter	Affiliation (if stated)	Comment Source	ADAMS Accession Number	Correspondence ID
Adams, James C.	-	Regulations.gov	ML24351A225	19
Aguilar S., Kathya	-	Regulations.gov	ML24351A224	17
Anonymous	-	Regulations.gov	ML24296A467	6
Anonymous	-	Regulations.gov	ML24320A044	11
Anonymous	-	Regulations.gov	ML24351A227	18
Anonymous	-	Regulations.gov	ML24353A018	22
Austgen, Kati	Nuclear Energy Institute	Meeting Transcript	ML24284A344	12-1
Chumble, Prasad	United States Environmental Protection Agency	Letter	ML24353A239	23
Draffin, Cyril	United States Nuclear Industry Council	Letter	ML24355A173	27
Eo, Taeseon	-	Regulations.gov	ML24351A205	15
Gallagher, Michael	-	Regulations.gov	ML24312A233	9
Gallagher, Michael	-	Regulations.gov	ML24312A234	10
Grussing, Valerie J.	National Association of Tribal Historic Preservation Officers	Letter	ML24353A312	25
Guzman, Xachell	-	Regulations.gov	ML24353A240	35
Hastings, Peter S.	Kairos Power	Letter	ML24354A061	29
Hayes, Rose	-	Regulations.gov	ML24312A235	8
Johnson, John	-	Regulations.gov	ML24283A191	2
Johnson, John	-	Regulations.gov	ML24290A162	3
Johnston, Renee	Nuclear Matters	Email	ML24354A037	31
Keo, Callan	-	Regulations.gov	ML24304B000	7
Lee, Changki	-	Regulations.gov	ML24351A205	15
Lesofski, Emy	Utah Department of Natural Resources	Letter	ML24353A305	32
Lester, Jackson	-	Regulations.gov	ML24351A205	15
Mclovin, Dan	-	Regulations.gov	ML24290A154	5

Table E-1 Individuals Providing Comments on the Draft GEIS and/or Proposed Rule Package (Continued)

Commenter	Affiliation (if stated)	Comment Source	ADAMS Accession Number	Correspondence ID
McManus, Mark	United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry U.S./Canada	Regulations.gov	ML24353A022	26
McMurray, Nicholas	ClearPath	Letter	ML24354A039	36
McMurray, Nicholas	ClearPath	Meeting Transcript	ML24284A349	13-4
McRoberts, Sage	-	Regulations.gov	ML24355A163	28
McRoberts, Sage	-	Regulations.gov	ML24355A165	34
Merrifield, Jeff	-	Meeting Transcript	ML24284A349	13-3
O'Neill, Martin	Nuclear Energy Institute	Email	ML24354A067	38
O'Neill, Martin	Nuclear Energy Institute	Meeting Transcript	ML24284A349	13-1
Peterson, Alyse	New York State Energy Research and Development Authority	Letter	ML24354A051	37
Pond, Douglas	-	Regulations.gov	ML24353A312	21
Potter, Jack	-	Regulations.gov	ML24290A151	4
Ray, Paul	-	Regulations.gov	ML24351A214	20
Reynolds, Steven A.	Illinois Emergency Management Agency and Office of Homeland Security	Letter	ML25015A138	39
Schmidt, Trevor		Regulations.gov	ML24351A205	15
Schoedel, Anthony J.	Westinghouse Electric Company	Regulations.gov	ML24353A236	24
Tasoluk, Sofia		Regulations.gov	ML24353A312	16
Toohill, Spencer	The Breakthrough Institute	Letter	ML24355A170	30
Toohill, Spencer	The Breakthrough Institute	Meeting Transcript	ML24284A344	12-2
Toohill, Spencer	The Breakthrough Institute	Meeting Transcript	ML24284A349	13-2
Unknown, Eric	Amphibian Refuge	Regulations.gov	ML24283A184	1
Unknown	American Power Association	Letter	ML24354A059	33

Table E-1 Individuals Providing Comments on the Draft GEIS and/or Proposed Rule Package (Continued)

Commenter	Affiliation (if stated)	Comment Source	ADAMS Accession Number	Correspondence ID
Unknown	Edison Electric Institute	Letter	ML24354A059	33
Unknown	National Rural Electric Cooperative Association	Letter	ML24354A059	33

ADAMS = Agencywide Documents Access and Management System.

Table E-2 Comment Categories

E.2.1 Meteorology and Air Quality
E.2.2 Hydrology-Surface Water
E.2.3 Hydrology-Groundwater
E.2.4 Ecology-Terrestrial
E.2.5 Ecology-Aquatic
E.2.6 Historic and Cultural Resources
E.2.7 Health-Radiological
E.2.8 Radiological Waste
E.2.9 Postulated Accidents
E.2.10 Environmental Justice
E.2.11 Uranium Fuel Cycle
E.2.12 Climate Change
E.2.13 Cumulative Impacts
E.2.14 Purpose and Need
E.2.15 Non-Resource Related Issues
E.2.16 General Environmental Concerns
E.2.17 Rulemaking Process
E.2.18 Specific Requests for Comment - PPE and SPE Values and Assumptions
E.2.19 Specific Requests for Comment - Environmental Issues Evaluated
E.2.20 Specific Requests for Comment - Categorization of Issues
E.2.21 Specific Requests for Comment - Scope of Proposed Rule Changes and GEIS
E.2.22 Specific Requests for Comment - Guidance for Applicants
E.2.23 Specific Requests for Comment - Limited Work Authorizations
E.2.24 Process-NEPA
E.2.25 Public Participation
E.2.26 Relationship to Other Plans/Regulations/Processes
E.2.27 Monitoring and Adaptive Management
E.2.28 Regulatory Analysis
E.2.29 GHG White Paper
E.2.30 Energy and System Design Mitigation Alternatives White Paper
E.2.31 General Opposition
E.2.32 General Support
E.2.33 Outside Scope-Safety
E.2.34 Outside Scope-Security and Terrorism

E.2.1 Meteorology and Air Quality

Comment: Finally, to provide the public and decision makers with a more complete picture of net GHG emissions associated with nuclear reactors, the EPA recommends that the GEIS discuss the potential for reductions in GHG emissions due to the displacement of fossil fuel sources with nuclear energy. The existing mix of local electricity generation can have a significant impact on net emissions of the nuclear facility. Hence, the EPA recommends that the GEIS include a more robust discussion of this issue, which includes information and data on how the effects would vary across regions of the U.S. Furthermore, given the potential for net emission reductions when considering displacement of existing sources of fossil fuel, the EPA recommends that NRC consider GHG emissions a category 2 issue in the GEIS. (**23-13** [Chumble, Prasad])

Response:

The NRC acknowledges and agrees in part with the comment. The comment combined two issues that were considered separately in the NR GEIS, i.e., the impacts of greenhouse gas (GHG) emissions of a new reactor, and the impacts of energy alternatives. As discussed in Section 1.3.1 of the NR GEIS, the aim of the NR GEIS was to determine which impacts of building and operating a new nuclear reactor could be addressed generically (Category 1), and which could not (Category 2). Analysis of the GHG emissions for the life cycle of a reference reactor is discussed in Appendix H of the NR GEIS. Based on this analysis, the NRC determined in NR GEIS Sections 3.3.2.1.2 and 3.3.2.2.2 that the GHG impacts from building and operating two 1000 MW reactors can be generically determined to be SMALL, making GHG emissions from a new reactor a Category 1 issue. In contrast, the issue of energy alternatives is a Category 2 issue because the NRC could not reach a generic conclusion of SMALL impacts for that issue.

The NRC agrees that the potential reduction in GHG emissions due to the displacement of fossil fuel-based sources is relevant to the comparison of a specific proposed project with the energy alternatives. Because the net change in GHG emissions from a proposed project displacing fossil fuel-based energy alternatives depends on the purpose of the project, the project's location, and the nature of the potentially displaced energy alternatives, this analysis cannot be performed generically and is therefore not addressed in the NR GEIS. The potential reduction in GHG emissions from displacing fossil fuel sources would be evaluated as part of the Category 2 energy alternatives issue in a project-specific supplement to the NR GEIS when the NRC reviews a specific application. Existing guidance (e.g., RG 4.2, Section 9.2) (NRC 2026-TN11915) already addresses the consideration of GHG emissions for energy alternatives. Therefore, the NRC disagrees that the potential for net GHG emission reductions from the displacement of fossil fuel sources should be discussed in the NR GEIS, and that such a reduction requires that the GHG emissions issue be considered a Category 2 issue.

No changes to the NR GEIS, the final rule, or guidance documents were made in response to the comment.

Comment:

Air Quality

Existing Conditions

The Draft GEIS characterizes air quality impacts as a generic Category 1 issue to be addressed by the document. Because of the general applicability of the GEIS to any location within the U.S., at some unknown time in the future, it is not possible to characterize existing air quality. Existing air quality and air quality related values (AQRVs) provide the baseline from which the magnitude of additional impacts from future actions should be judged. Therefore, EPA recommends that future reactor specific NEPA documents disclose the existing air quality and AQRVs using the most recent and relevant monitoring data. If these assessments identify air quality or AQRV concerns, the EPA recommends considering whether a detailed analysis of air quality impacts is warranted (especially if a new reactor would create emissions within a nonattainment or maintenance area).

Air Quality and Air Quality Related Values (AQRVs) Impact Analysis

The Draft GEIS provides conclusions regarding air quality and AQRV impacts without providing supporting analysis. It asserts that impacts from air emissions from construction of a new reactor would be small, and further that emissions would be below de minimis rates (see 40 CFR 93.153(b)). The estimates are based on the installation of one 1,000 megawatt(s) electrical (MWe) output reactor and power generation unit assuming an 80 percent capacity factor, henceforth referred to as the reference 1,000 MWe reactor. It provides summaries of greenhouse gas (GHG) emission estimates for a new reference nuclear reactor and assumes two 1,000 MW(e) nuclear reactors could be installed on the same site, based on previous applications for sites with two or more new light water reactors. However, these emission estimates are only provided for GHGs. The EPA recommends providing emission estimates for other non-GHG pollutants in the GEIS to substantiate the conclusions that impacts regarding air quality and AQRVs would be small. The EPA recommends that a detailed emission inventory be included as an appendix so that the emission summary can be verified and reproduced. This will assist NRC when reactor specific NEPA documents must be prepared in the future so that the proposals can be clearly judged against what was considered for the GEIS.

(**23-3** [Chumble, Prasad])

Response:

The NRC acknowledges and agrees in part with the comment. As part of the project-specific review, the applicant must demonstrate that it meets the applicable plant parameter envelope (PPE)/site parameter envelope (SPE) values, including that criteria pollutants are less than National Ambient Air Quality Standards (NAAQS) de minimis levels if the site is located in a nonattainment or maintenance area, and compliance with air permits under Federal and State laws. The applicant should collect local and regional air quality data to establish baseline conditions prior to project construction and calculate potential emissions to demonstrate compliance. Project emissions can vary with scope of the project, and therefore, NRC staff will utilize the applicant's project emissions during project-specific review. If the PPE/SPE values are not met and the project emissions are above Federal and/or State thresholds, the applicant must provide additional air quality impact analyses as part of the project-specific review, which may involve the development of an emissions inventory.

Additionally, as part of the environmental review for a site-specific application, the NRC staff will determine whether there is any new and significant information that was not considered in the NR GEIS for Category 1 issues, including any changes in Federal and/or State air quality standards associated with individual pollutants.

In response to this comment, the NRC has added Table 3-1 in the NR GEIS of the NAAQS standards for criteria pollutants. In addition, text has been added in Section 3.3.1 of the NR GEIS discussing applicable air quality regulations and standards, including NAAQS de minimis levels, as well as a discussion of potential Federal, State, and/or local permitting requirements.

Comment: Additionally, Appendix H does not provide sufficient detail to understand the details of GHG emission estimates for reactor construction (see Table H-1, which does not include an equipment roster or document emission factors). (**23-4** [Chumble, Prasad])

Comment:
The EPA provided comments to NRC for the GEIS for License Renewal of Nuclear Plants. In those comments the EPA pointed out that General Conformity (40 CFR Part 93, Subpart B) is not a generic issue that can be addressed by a generic EIS. NRC corrected the final GEIS to acknowledge EPA's comments. However, it appears that this draft GEIS asserts that any future project that meets the assumptions of the analysis will be below the de minimis rates in the General Conformity rule. Since there are different rates in Section 93.153 based on the classification of the nonattainment or maintenance area it is again unclear which threshold rate is being referred to. Therefore, the EPA continues to recommend that the GEIS acknowledge that General Conformity is not a generic Category 1 issue but is rather a Category 2 application-specific issue that must be met in the future when a specific project is proposed. (**23-5** [Chumble, Prasad])

Comment: *Update for National Ambient Air Quality Standards (NAAQS) for PM*
On February 7, 2024, the EPA strengthened the National Ambient Air Quality Standards for Particulate Matter (PM NAAQS) by setting the level of the primary (health-based) annual PM2.5 standard at 9.0 micrograms per cubic meter ($\mu g/m^3$) to provide increased public health protection, consistent with the available health science. Section 3.3.1 of the draft GEIS discusses baseline conditions and plant parameter envelope (PPE)/site parameter envelope (SPE) values and assumptions and states that "in developing the values and assumptions in the PPE and SPE pertaining to air quality, the staff relied upon the information and analyses contained in multiple new reactor EISs prepared since 2005, the License Renewal GEIS, and common elements of State and local regulations." While the EPA appreciates this approach, we recommend that the values and assumptions consider the EPA's recent revision where the primary annual PM2.5 standard level was decreased from 12.0 µg/m3 to 9.0 $\mu g/m^3$. Analysis of project emissions and related impacts will therefore need to reflect this change that has been in effect since March 6, 2024.[1]

[1] https://www.federalregister.gov/documents/2024/03/06/2024-02637/reconsideration-of-the-national-ambient-air-quality-standards-for-particulate-matter. Accessed 11/18/2024.

(**23-6** [Chumble, Prasad])

Comment: *GHG Emissions*

The final GEIS should include all reasonably foreseeable impacts.[5] In the draft GEIS, emissions associated with construction focus on equipment and do not include emissions associated with

the materials. Construction materials have associated "embodied" or upstream emissions associated with extracting raw materials, manufacturing of materials, and their transport to the construction site. Tools, emissions factors, and methodologies such as the EPA's Compilations of Emissions Factors, AP-42 and EPA's Greenhouse Gas Reporting Rule, 40 CFR 98, can be used to quantify embodied GHG emissions in building materials. Tier 4 Calculation Methodology (https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98/subpart-H/section-98.83), Inventory U.S. of Greenhouse Gas Emissions and Sinks, Chapter 4.1 (https://www.epa.gov/system/files/documents/2022-04/us-ghg-inventory-2022-chapter-4-industrial-processes-and-product-use.pdf) and CO2 Accounting and Reporting Standard for the Cement Industry (https://www.wbcsd.org/Sector-Projects/Cement-Sustainability-Initiative/Resources/CO2-Accounting-and-Reporting-Standard-for-the-Cement-Industry) can be used to quantify embodied GHG emissions in cement and concrete. The Argonne National Laboratory Greenhouse gases, Regulated Emissions and Energy use in Technologies (GREET)[6] model can be used to quantify embodied GHG emissions in steel. By using these available tools, the EPA recommends that the GEIS discuss embodied materials emissions.

Appendix H assumes that decommissioning activities emit ½ the GHG emissions as construction. The EPA recommends the GEIS provide a more robust analysis of these decommissioning activities and their associated emissions.

Furthermore, Appendix H provides a useful estimation of fuel cycle related GHG emissions for a 1000 MWe light-water reactor (LWR). For this reason, the EPA also recommends the GEIS, and/or future project specific EISs, provide estimates for fuel cycle GHG emission impacts for advanced reactor designs that use high-assay low-enriched uranium (HALEU) fuels as appropriate. HALEU based reactors require higher levels of uranium enrichment, have different capacity factors, and may use fuel at different rates than LWRs. These differences are reasonably foreseeable and should be examined and explained in a manner similar to the 1000 MWe reference case.

When quantifying the GHG emissions from a project, the EPA recommends that the GEIS calculate separate annual emission estimates of metric tons of carbon dioxide, methane, nitrous oxide, and sulfur hexafluoride as applicable, to account for differences in the impacts of these pollutants in the atmosphere over time. Estimating annual emissions separately for each relevant GHG allows for better consideration of the different environmental impacts associated with emissions of each of the GHGs, including applying the estimated SC-GHG discussed below.

In addition, the draft GEIS uses emission factors that start with scaling CO to CO_2 and then uses a GHG equivalency factor to estimate CH_4 and N_2O emissions based on data from 2012. To provide estimates based on the most recent data, the EPA recommends NRC use emission modeling tools such as the EPA Motor Vehicle Emission Simulator (MOVES)[7]or GREET to estimate GHG emissions from transportation equipment used to construct, operate, and decommission a nuclear power site.

The EPA also recommends that the GEIS and any future project specific EISs present emission estimates in a more digestible format, such as annual emissions. For example, in many tables in Appendix H, GHG estimates are presented as total emissions for the duration of the activity, including a life-cycle footprint for 97 years. To improve transparency, the EPA recommends that direct and indirect GHG emissions also include annual emissions.

[5] See NEPA Section 102(2)(c).

[6] Argonne GREET R&D Model (https://greet.anl.gov/)

[7] MOVES and Mobile Source Emissions Research | US EPA (https://www.epa.gov/moves)

(**23-12** [Chumble, Prasad])

Response:

The NRC disagrees with the comments.

NRC disagrees that an updated GHG emissions inventory should be developed in the NR GEIS. The PPE/SPE values for greenhouse gas emissions were calculated from the installation of two 1,000 MW(e) reactors on the same site and are intended to be reasonably conservative and bounding for all phases of the project, including construction, operation, and decommissioning. NRC expects that the new reactors with advanced technologies and smaller size will have potential GHG emissions below this threshold. Voluntary guidance for demonstrating consistency with this PPE value is provided in the Recommendations for an Applicant to Calculate Activity Data for Greenhouse Gases Estimates White Paper that was published with the NR GEIS; additional guidance can be found in RG 4.2.

Estimates for the emissions for the reference 1,000 MW(e) reactor in Appendix H are based upon methods and data provided in Chapman et al. (2012) (TN2644) and Napier (2020) (TN6443). GHG data from various construction activities were obtained from UniStar's application documents for a 1,000 MW(e) power plant (UniStar 2007) (TN1564). UniStar compiled emission factors from various data sources including the U.S. Environmental Protection Agency's (EPA's) NONROAD model, which is currently incorporated within USEPA MOVES model. Indirect CO_2 emissions from electricity consumption by centrifuge plants and natural gas combustion for process heating during the uranium fuel cycle were developed in Napier (2020). Information from Napier (2020) can be used to adjust the GHG footprint associated with various fuel types, including high-assay low-enriched uranium (HALEU). Additionally, Chapman (2012) calculated GHG emissions from workforce vehicles, fuel, and waste transportation. While Appendix H provides a method for calculating GHG emissions in order to meet the PPE values, applicants may choose to apply other GHG calculation methods.

Regarding the request that embodied construction materials emissions should be included in the GHG emissions inventory, the GHG emissions inventory in Appendix H is sufficiently conservative in its estimates for each phase of the project life cycle. An increase in upstream emissions due to embodied emissions in construction materials is unlikely to change the conclusion of SMALL impacts due to project life-cycle GHG emissions.

Regarding the request to present annual emissions estimates, annual average emissions for construction and operations are already provided in NR GEIS as 24,000 MT/yr (see Section 3.3.2.1.2) and 57,400 MT/yr (see Section 3.3.2.2.2), respectively. The NRC disagrees that GHG should be broken out by pollutant to account for impacts and to apply the social cost of GHG. The staff's analysis accounts for all GHG pollutants in considering CO_2 equivalents, a measure to compare the emissions from various GHGs on the basis of their global warming potential. The NRC notes that Executive Order 13990, Executive Order 14008, and documents and guidance related to the social cost of carbon mentioned by the commenter have been rescinded by the January 20, 2025 Executive Order 14154, "Unleashing American Energy" (90 FR 8353-TN11916).

Lastly, the NRC disagrees with the comment that states that General Air Conformity is treated as a Category 1 Issue in the NR GEIS. The NR GEIS states that if a project is in a nonattainment or maintenance area that the applicant must provide air emission estimates and NRC would need to conduct an applicability analysis to determine if the emissions are de minimis and if a General Conformity Determination is required. Section 3.3.1 of the GEIS was revised to clarify these requirements.

No additional changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

Comment: *Mitigation*
The EPA appreciates NRC's discussion of general mitigation measures and encourages NRC to routinely adopt all practicable mitigation measures, even where these measures are not required by permits or regulations. EPA recommends the GEIS discuss methods to ensure mitigation is enforceable or achieved in practice and encourages future project approvals to be conditioned upon adoption all practicable mitigation measures.

For example, sulfur hexafluoride (SF_6), is a common pollutant at power facilities that can be mitigated and is not typically regulated through permitting. SF_6 is the most potent greenhouse gas with 26,000 times the global warming potential of carbon dioxide and a lifespan of over 3,000 years. Hence, small equipment leaks and replacement during servicing and repairs, as well as the lifecycle of SF_6, starting from manufacturing, can contribute to climate impacts. Although not mentioned in the draft GEIS, SF_6 is used extensively in switchgears and circuit breakers throughout the energy system, including at nuclear power facilities. Given that the life of a switchgear is typically over 30 years, and that installation, repairs, replacements, and decommissioning of SF_6 containing equipment occurs at all facilities, the GEIS presents an appropriate planning tool to evaluate SF_6 use and identify opportunities for nuclear power facilities to mitigate and transition away from the use of SF_6. SF_6-free circuit breakers are currently in use in the U.S. and have been in use in Europe for over 10 years, with reported higher reliability and lower operating and maintenance costs. This technology would represent reasonable mitigation. The EPA has partnered with power producers to reduce and phase out the use of this pollutant and can connect NRC with further resources on SF_6 free technology. (**23-16** [Chumble, Prasad])

Response:

The NRC staff acknowledges the comment.

The NRC acknowledges that SF_6 is one of the most potent GHGs known and is often used in electric power transmission and distribution systems. The PPE/SPE values for greenhouse gas emissions were calculated from the installation of two 1,000 MW(e) reactors on the same site and are intended to be reasonably conservative and bounding for all phases of the project, including construction, operation, and decommissioning.

As stated in Section 1.3.1 of the NR GEIS, an applicant may refer to the generic analysis in the NR GEIS for a Category 1 issue provided it demonstrates that relevant values and assumptions of the PPE and SPE used in the resource analysis are met and there is no new and significant information that would require project-specific analysis. If the relevant values and assumptions for a Category 1 issue are not met, the applicant would have to supply the requisite information necessary for the staff to perform a project-specific analysis.

Applicants should include mitigation of adverse impacts as part of their application as described in RG 4.2 Section V (Mitigation of Adverse Effects): Applicants are required to consider alternatives available for reducing or avoiding adverse effects as described in 10 CFR 51.45(c). This may include relevant mitigation. Therefore, the statement that states that "the generic analyses can be relied on without any mitigation measures" has been removed in Sections 3.3.2.2.1 and 3.3.2.2.2 of the NR GEIS because it was incomplete. Appropriate mitigation and potential enforcement mechanisms will be considered in site-specific applications.

Comment: Category 1 Environmental Issues
Greenhouse Gas Emissions

The current analysis for greenhouse gas (GHG) emissions during operation focuses on two 1,000 MW reactors, which is overly narrow for the wide spectrum of reactor designs envisioned for advanced nuclear technology.[11] This focus excludes designs like the AP1000, which exceeds the 1,000 MW threshold at 1,117 MWe, and advanced reactors with significantly smaller capacities, which could have distinct operational profiles affecting their life-cycle GHG emissions.

The Category 1 classification for GHG emissions is well-supported by the conclusion that operational emissions represent only 0.001% of 2019 U.S. energy sector emissions.[12] However, the scope of the analysis should extend beyond a single reactor size scenario to maintain credibility across all advanced designs. As advanced reactors evolve, GHG emission profiles may improve due to innovations in fuel cycles, transportation efficiencies, and operational systems. A performance-based framework, rather than static bounding assumptions, would allow the GEIS to remain relevant for future technologies..

While the PPE values for a 40-year operational period (57,400 MT/yr) may generically bound advanced reactor designs with similar or smaller footprints, they could underrepresent or misrepresent the emissions profile of larger designs like the AP1000. The NR GEIS should explicitly acknowledge and adapt to these variations.

Revisions should incorporate a more inclusive analysis of GHG emissions that considers a broader range of reactor sizes, technologies, and configurations. For example, designs like microreactors, small modular reactors (SMRs), and large advanced reactors all differ in their operational emissions and life-cycle GHG impacts. At a minimum, a larger 1,200 MW capacity should be used in the GEIS analysis to ensure that generic impacts are considered and appropriately determined to be SMALL for all new reactor designs. The current analysis that uses 1000 MW potentially limits the applicability of the GEIS.

[11] Draft NR GEIS, Section 3.3.2.2.2 GHG Emissions during Operation, Page 3-24.

[12] Ibid

(**30-6** [Toohill, Spencer])

Response:

The NRC disagrees with the comment.

The NRC has concluded that the contribution of GHG emissions from total plant life-cycle activities is a Category 1 issue, as shown in Section 3.3.2. The PPE/SPE values for greenhouse

gas emissions were calculated from the installation of two 1,000 MW(e) reactors on the same site and are intended to be reasonably conservative and bounding for all phases of the project, including construction, operation, and decommissioning. As presented in the comment, a 1,200 MW capacity reactor would fall within the PPE, which contains emissions for two 1,000 MW(e) reactors on the same site. NRC expects that the new reactors with advanced technologies and smaller size will have potential GHG emissions below this threshold, and will therefore be bounded by the PPE value.

If a proposed reactor does not meet the PPE values to rely on this Category 1 issue, the applicant would be required to provide a project-specific evaluation of GHG emissions. The Recommendations for an Applicant to Calculate Activity Data for Greenhouse Gases Estimates White Paper that was published with the NR GEIS and RG 4.2 provide methodologies for estimating and scaling GHG estimates.

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

Comment:

J. The NR GEIS Appropriately Classifies Greenhouse Gas Emissions as a Category 1 Issue

Given nuclear energy's net beneficial climate effects, and consistent with NEPA's rule of reason and the concept of proportionality, NEI contends that that applicants and the NRC should not need to devote inordinate resources to analyzing GHG emissions and climate change-related effects. As the CEQ notes in its 2023 GHG Guidance:

As with any NEPA review, the rule of reason should guide the agency's analysis and the level of effort can be proportionate to the scale of the net GHG effects and whether net effects are positive or negative, with actions resulting in very few or an overall reduction in GHG emissions generally requiring less detailed analysis than actions with large emissions.[82]

NEI agrees with the NRC staff's conclusion that the contribution of GHG emissions from total plant life-cycle activities to national emissions is a Category 1 issue. Specifically, the staff concluded that, as long as the PPE assumption associated with GHG emissions is met, the GHG impacts from building, operating, conducting the fuel cycle, transporting fuel and waste, and decommissioning of a nuclear reactor can be generically determined to be SMALL.[83] The generic analysis documented in Appendix H to the NR GEIS can be relied on without applying any mitigation measures.

[82] CEQ 2023 GHG Guidance, 88 Fed. Reg. at 1204-05.

[83] *See* Draft NR GEIS at 3-17 to 3-20, 4-5 (Table 4-1), G-6 to G-7 (Table G-1), Appendix H (Greenhouse Gas Emissions Estimate for a Reference 1,000 MWe Reactor). The staff relied on the following PPE assumption to reach this conclusion:
GHGs emitted by equipment and vehicles during the 97-year reactor GHG life-cycle period would be equal to or less than 2,534,000 MT of CO2(e). Appendix H of this GEIS contains the staff's methodology for developing this value, which includes emissions from construction, operation, and decommissioning. As long as this total value is met, the impacts for the life-cycle of the project and the individual phases of the project are determined to be SMALL.

(**38-2-8** [O'Neill, Martin])

Response:

The NRC agrees with the comment. However, the NRC notes that while the analysis in Appendix H can be relied on without mitigation measures, applicants are required under 10 CFR 51.45(c) to address alternatives to reduce or avoid adverse effects, which could include mitigation measures that reduce greenhouse gas emissions. No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

Comment: *Greenhouse Gas (GHG) Context, and Social Cost of GHGs (SC-GHG)*

Section 3.3.2 of the draft GEIS compares the cumulative GHG emissions impacts of a plant parameter limited project to those of the national energy sector inventory. As would be expected when GHG emissions from any single project are compared to a GHG national inventory, the result is a very small fraction. This approach inappropriately diminishes the significance of project level GHG emissions and the extent to which incremental emissions from individual projects collectively are causing climate change impacts. The EPA recommends that NRC instead include a detailed discussion of the project's GHG emissions in the context of national GHG emission reduction goals. In addition, NRC could contextualize the GHG emissions from the plant parameter project, as well as avoided emissions, using the social cost of greenhouse gases (SC-GHG).

To assist lead agencies in calculating SC-GHG, the EPA published the *Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances*, November 2023. This report provides updated estimates of the SC-GHGs that reflect advancements in the scientific literature on climate change and its economic impacts and incorporates recommendations made by the National Academies of Science, Engineering, and Medicine[8] (National Academies 2017). The updated SC-GHG estimates in this report have also undergone an expert peer review and a public comment process.

The EPA also released a Microsoft Excel "Workbook for Applying SC-GHG Estimates" spreadsheet to better assist lead agencies with the utilization of these updated estimates, and it can be accessed at https://www.epa.gov/environmental-economics/scghg. This workbook presents a straightforward tool for applying the updated SC-GHG values to monetize project SC-GHG emissions. To use this tool to properly apply the SC-GHG, emissions results are needed at the annual level, so that the full time-path of emissions can be valued. The EPA continues to recommend the use of these SC-GHG values, which reflect the best available science, to provide decision-makers and the public a complete picture of the scope of climate impacts of the project alternatives. These values are being used by many other federal agencies, including the Department of Transportation, the U.S. Department of Agriculture, and the Department of the Interior, among others, to value GHG emissions in their environmental impact statements and environmental assessments.

[8] Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide | The National Academies Press (https://nap.nationalacademies.org/catalog/24651/valuing-climate-damages-updating-estimation-of-the-social-cost-of) (**23-14** [Chumble, Prasad])

Response:

The NRC acknowledges and agrees in part with the comment. The NRC agrees that comparison of life-cycle GHGs emissions to national estimates is not a useful comparison and therefore has removed this discussion in Section 3.3.2 of the NR GEIS. Section 3.3.2 of the

NR GEIS has been updated to reflect that the Category 1 determination for GHG emissions was based on comparison to Intergovernmental Panel on Climate Change (IPCC) estimates assessing life-cycle GHG emissions for nuclear (IPCC 2012-TN2648).

The NRC notes that Executive Order 13990, Executive Order 14008, and documents and guidance related to the social cost of carbon mentioned by the commenter have been rescinded by the January 20, 2025 Executive Order 14154, "Unleashing American Energy."

E.2.2 Hydrology-Surface Water

Comment: *Provisions to Address Extreme Drought Conditions*

Section 3.4.1.1.1 Surface Water Use states "To minimize the impact on flowing surface water bodies, the SPE specifies that plant withdrawals from water bodies be limited to no more than 3 percent of the 95 percent exceedance daily low flow of the source. The staff developed this SPE criterion for water withdrawal by evaluating the impacts related to plant use of flowing surface water bodies in EISs for new reactors and the License Renewal GEIS for operating reactors. Based on the evaluations provided in these recent EISs and the License Renewal GEIS, the staff determined that the impacts would be SMALL for withdrawal rates at or below 3 percent of the water available during low flow conditions. In addition, this SPE value is bounded by the EPA 316(b) Proportional Flow Limitation (40 CFR 125.84(b)(3)(i), which specifies that the plants not withdraw more than 5 percent of the source water body annual mean flow. The staff assumed that the 95 percent exceedance daily flow is estimated accounting for all existing withdrawals and instream flow requirements."

The EPA recommends that NRC cite the main regulation for new facilities with cooling water intake structures located in a freshwater river or stream at 40 CFR 125.84 (https://www.ecfr.gov/current/title-40/section-125.84). In addition, the regulation states that the total design intake flow must be no greater than 5 percent of the source water annual mean flow. This is different than the language used by NRC (e.g., plants not withdrawal).

In addition, to assist in the calculations for low flow conditions, the EPA utilizes it's "Low Flow Statistics Tools Handbook[2]. It describes the low flow values "in terms of their averaging period (for example, a 4-day average flow or a 7-day average flow) and their recurrence frequency (generally once in 10 years for hydrologically based flows and once in 3 years for biologically based flows)." It also states "hydrologically based low flow is computed using the single lowest flow event from each year of record, followed by application of distributional models (typically the Log Pearson Type III distribution is assumed) to infer the low flow value. The 1Q10 is the lowest one-day average flow that occurs (on average) once every 10 years. The 7Q10 is the lowest 7-day average flow that occurs (on average) once every 10 years."

The draft GEIS states the 95th percentile flow is used as the extreme low flow. This flow is the same as the 7Q10 flow in most river systems. However, this flow level may not capture the most extreme low flow expected over the nuclear power plant's 30+ year life cycle. In addition, the draft GEIS implies that water quality models would not be required under certain flow regimes and receiving water body types.

The EPA recommends using long-term flow records to assess the lowest observed flow. Such a flow could be significantly less than the 7Q10 flow. For plants requiring cooling water, a reliable supply under extreme conditions is critical to ensure safety or develop protocols to shut down the reactors during such low-flow events. The EPA also recommends that all intertidal

waterbodies, such as the Savannah River power plants, can only be adequately assessed with three-dimensional water quality models. These models are necessary to assess the dissolved oxygen and salinity profiles in the river and estuary. Such models also can assist in running scenarios to capture changes in rainfall and temperature and other factors associated with climate change.

[2] Low Flow Statistical Tools Handbook | US EPA (https://www.epa.gov/npdes/low-flow-statistical-tools-handbook)
(**23-9** [Chumble, Prasad])

Response:

The NRC agrees in part and disagrees in part with the comment.

The NRC agrees with the recommendation that the main regulation for new facilities with cooling water intake structures located in a freshwater river or stream be cited, and therefore has updated Section 3.4.1.1.1 of the NR GEIS to cite the main regulation at 40 CFR 125.84.

The NRC disagrees with the suggestion that the 95 percent exceedance low flow may not be the most extreme low flow expected over a nuclear power plant's life cycle and recommended using long-term flow records to assess the lowest observed flow. EPA also suggested that a reliable supply under extreme conditions may be critical to ensure safety. The NRC agrees that the lowest observed flow would represent a more extreme flow condition than the 95 percent exceedance daily flow. However, the NR GEIS focuses on evaluating environmental impacts, not safety of the nuclear power plants. Typically, nuclear power plants have derating or shutdown procedures for extreme low-flow conditions that may limit cooling water availability. The plants also rely on emergency cooling systems (e.g., onsite or supplemental water sources, passive cooling) to maintain safe shutdown conditions. The safety issues are evaluated separately from the NRC's environmental impacts assessment.

No additional changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

Comment: *General Protection of Water Resources*
For protection of water resources at future reactor sites, the EPA recommends that NRC consider providing a discussion on the following areas in the Final GEIS as appropriate:

1. Working with States and Tribes to ensure that water resources are protected and used judiciously throughout reactor project construction and operation activities.

3. Green construction and management practices, consistent with the federal "green" requirements and opportunities that may apply to design, operation, and maintenance of project-related facilities and equipment.[4]

4. Zero or low impact development techniques in project design due to their potential to reduce storm water volumes, and mimic natural conditions. Examples include:
a. Minimizing creation of new impervious surface.
b. Use of recycled water.
c. Using pervious pavement and avoid building over groundwater recharge areas.
d. De-paving areas as mitigation for any new impervious surfaces needed for the project, to achieve no net increase in pollution generating impervious surface.

[4] https://www.epa.gov/green-infrastructure. Accessed 11/18/2024.

(**23-10** [Chumble, Prasad])

Response:

The NRC agrees with the comments but disagrees that changes are needed in the NR GEIS. The NRC works with Federal, State, local, and tribal agencies that may have jurisdiction over environmental matters related to permitting and licensing new nuclear power plants. Compliance with applicable regional, State, tribal, and local regulations, both during construction and operation, was considered for impacts to water resources in Section 3.4.2 of the NR GEIS. NRC considered use of best management practices (BMPs) during construction (see Section 3.4.2.1.4); use of spill prevention, control, and countermeasures plan (see Section 3.4.2.1.5); use of in-water construction BMPs (see Section 3.4.2.1.7); use of best available technologies for intake and discharge design and operation (see Section 3.4.2.2.5); and compliance with all applicable Federal, State, local, and tribal regulations. The construction and management practices mentioned in the comment are part of BMPs and may be required in some jurisdictions.

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

Comment: 2. Storm Water Runoff Requirements for projects under Section 438 of the Energy Independence and Security Act (EISA) of 2007 and related guidance[3]. In addition, include EISA among other Federal laws and regulations applicable to activities associated with licensing of new reactors in Appendix F, “Laws, Regulations, and other Authorizations.”

[3]http://www.epa.gov/polluted-runoff-nonpoint-source-pollution/stormwater-management-federal-facilities-under-section438. Accessed 11/18/2024.

(**23-11** [Chumble, Prasad])

Response:

The NRC disagrees with the comment. Section 438 of the Energy Independence and Security Act (EISA) of 2007 (TN11920) applies to the sponsor of any development or redevelopment project involving a Federal facility. However, under its authority to license new nuclear reactor projects, NRC is not regarded as a sponsor because it would neither own, operate, occupy, or be the primary user of the facility, nor would the agency have initiated a development or redevelopment project involving a Federal facility.

No changes were made to the NR GEIS, final rule, or guidance documents as a result of the comment.

E.2.3 Hydrology-Groundwater

Comment: Water Quality

Groundwater Quality / Underground Injection Control (UIC)

Section 3.4.1.2.2 Groundwater Quality states: "Groundwater quality may be affected by releases of potential contaminants to the subsurface. Any intentional discharge of wastewaters to the subsurface would be regulated by the EPA as required by 40 CFR Part 144 (Underground Injection Control Program) and/or State underground injection control requirements." The EPA recommends that the GEIS advises that for specific projects, an inventory of the potential constituents contained in wastewater be provided. For UIC purposes, the chemical makeup of injected wastewater generally categorizes injection well classes. For this reason, the EPA also recommends a full catalog of potential contaminants to be made available in case of an emergency release.

Please note that instances of groundwater removal should be specific enough with respect to volumes withdrawn to not negatively impact the local water table or, if the case exists, any existing wetlands. (**23-7** [Chumble, Prasad])

Response:

The NRC acknowledges the comment. With regard to the industry's implementation of and adherence to 40 CFR Part 144 (TN11921), these regulations do not specify requirements for recording constituents and potential contaminants within liquids injected to ground. However, as stated in the comment, any intentional discharge of wastewater to subsurface subject to the Underground Injection Control Program would be regulated by six classes of wells as set forth in 40 CFR 144.6, which are generally categorized by contaminants of concern. Section 3.4.1.1.2 of the NR GEIS also states that discharge criteria are determined and implemented by Federal and State agencies responsible for protection of resources based on various project-specific conditions. Additionally, the NRC requires licensees to conduct subsurface (i.e., subsurface soil and groundwater) monitoring in accordance with 10 CFR 20.1501 (TN283) to ensure compliance with radiation dose limits.

With regard to the impacts of groundwater removal on the local water table or existing wetlands, Section 3.4.1.2.1 states the magnitude of impact from groundwater withdrawals is dependent on the site conditions and hydrogeologic characteristics of the affected aquifer. A permit from the State or other local/regional governing body is typically required to withdraw groundwater, and permitting criteria may include effects on availability of water, drawdown, and effects on connected surface water bodies. The PPE and SPE table in Appendix G of the NR GEIS specifies that groundwater withdrawals for all plant uses (excluding dewatering withdrawals) be less than or equal to 50 gallons per minute (gpm) for a new nuclear reactor. Based on a 100-acre site, the NRC staff determined the effects on groundwater levels at the site boundary would result in less than a 1 foot reduction. The PPE/SPE specified groundwater withdrawals for dewatering would also be no more than 50 gpm and include the assumption that the hydrogeologic characteristics of the site are such that dewatering has a negligible effect on groundwater levels at the site boundary. Additionally, the potential groundwater use impact on wetlands is discussed in Sections 3.5.1.2 and 3.5.2.2.7 of the NR GEIS.

As stated in Section 1.3.1 of the NR GEIS, an applicant may refer to the generic analysis in the NR GEIS for a Category 1 issue provided it demonstrates that relevant values and assumptions

of the PPE and SPE used in the resource analysis are met and there is no new and significant information that would require project- specific analysis. If the relevant values and assumptions for a Category 1 issue are not met, the applicant would have to supply the requisite information necessary for the staff to perform a project-specific analysis.

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

E.2.4 Ecology-Terrestrial

Comment: Amphibian populations are declining worldwide, and amphibians are experiencing high extinction rates due to habitat loss, chytrid fungus, pollutants, pesticides, and climate change. Amphibians are the most threatened class of vertebrates.

Amphibian Refuge recommends that amphibians be considered in the evaluation of terrestrial ecology effects (Section 3.5). Nuclear reactor projects have the potential for habitat, wetland, noise, vehicle collision, cooling tower water discharge, and water use conflict effects on amphibians. (**1-1** [Unknown, Eric])

Response:

The NRC agrees with the comment. Amphibians should be considered in the evaluation of terrestrial ecology effects for nuclear reactor projects. Accordingly, the NRC considered amphibians as part of the terrestrial wildlife potentially present on or near sites affected by the issues evaluated in Sections 3.5.1 and 3.5.2 of the NR GEIS. For example, effects on amphibians are relevant to the habitat disturbance issue addressed in Section 3.5.2.1.1 and the wetland disturbance issue addressed in Section 3.5.2.1.2. The conclusions and assumptions presented for these and other terrestrial ecology issues reflect the possible presence of amphibians whenever relevant. Even though no issues in the NR GEIS are specific only to amphibians, the NR GEIS considers possible impacts to the broad spectrum of terrestrial biota present, including but not limited to amphibians. The NRC therefore expects that use of the NR GEIS, including observing requirements for project-specific responses for Category 2 issues and Category 1 issues for which relevant assumptions are not met, will ensure that potential impacts on amphibians are properly addressed. Additionally, some specific amphibian species and habitats may meet the definition of important terrestrial species, which are addressed in Sections 3.5.2.1.6 and 3.5.2.2.10 of the NR GEIS. NRC defines "important" terrestrial species and habitats as those outlined in RG 4.2 (Section 2.3.1).

As part of any project-specific analysis, the NRC would describe terrestrial and aquatic communities, determine important species and habitats, review proposed administrative controls and BMPs, and analyze effects of the proposed action and alternatives on species and habitats in terrestrial and aquatic systems. The NRC would consider possible effects on amphibians when evaluating ecological impacts and evaluate effects on any important amphibians and their habitats when preparing any project-specific reviews tiered from the NR GEIS.

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

E.2.5 Ecology-Aquatic

Comment: Another concern in the heavy water usage associated with nuclear reactors. Cooling systems in traditional nuclear plants require substantial amounts of water, potentially straining local resources and harming aquatic ecosystems. Thermal pollution from discharged cooling water can disrupt aquatic habitats and biodiversity. Alternative cooling methods, such as air cooling systems or modular reactors that require less water, should be prioritized to mitigate these risks. The environmental impacts of water usage must be carefully assessed during the licensing process to ensure ecosystem preservation. (**21-5** [Pond, Douglas])

Response:

The NRC acknowledges the comment. The environmental impacts of water usage were carefully considered during preparation of the NR GEIS and will be considered on a project-specific basis whenever necessary. The design of a proposed new nuclear reactor, including the choice and design of cooling system, is determined by the applicant rather than by NRC. However, NRC will evaluate the environmental impacts from the chosen reactor design for any new reactor licensing application received, including the proposed cooling system, and apply the assessment methodology in the NR GEIS, including for the need to perform a project-specific analysis. No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

E.2.6 Historic and Cultural Resources

Comment:

While this letter is specifically about the NR GEIS, that proposal does not exist in a vacuum. We would be remiss if I did not note the federal government's chronic underfunding of THPOs is both a violation of the federal government's trust responsibility to Tribal Nations and abrogation of its environmental justice commitments. We also urge the Administration to propose budgets and Congress to pass appropriations bills that reflect the important role that THPOs play in protecting the places that tell the stories of Tribal Nations. In Fiscal Year 2025, THPOs are receiving on average $104,000 from the Historic Preservation Fund (HPF). NATHPO strongly supports a reauthorization of the HPF that would require that:

• THPOs receive a minimum of 20 percent of the HPF each year, and;

• the National Park Service reviews if THPO funding is keeping pace with the annual increase in the number of THPOs and adjusts the funding to reflect that increase.

(**25-6** [Grussing, Valerie J.])

Comment: Tribal Coordination and Tribal Resources

Tribal Consultation Protocols and Process

The EPA is committed to enhancing and encouraging interagency coordination and collaboration to protect Tribal-reserved rights.[27] The siting of new nuclear reactors under the Preferred Alternative would include areas within territory ceded by Tribal nations to the United States where Tribes hold judicially affirmed reserved rights to hunt, fish, and gather. These reserved rights can be exercised on public lands and private lands upon those which public

hunting, fishing, and gathering are permitted. The draft GEIS was silent on proactive and early Tribal engagement outside of the responsibilities under the National Historic Preservation Act (NHPA). Additionally, it did not reference or discuss NRC's Tribal Protocol Manual[28] where Tribal consultation is expected throughout the entirety of NRC's decision-making processes (e.g., providing opportunities for Tribes to raise concerns regarding the effects that NRC licensing or regulatory activities may have on Tribal interests). It also did not reference the sovereignty of Tribal Nations nor explain Tribal Treaty Rights and their context in relation to the Preferred Alternative. Due to potential effects caused by the Preferred Alternative, EPA recommends NRC discuss how future project-specific documents may analyze and disclose potential direct, indirect, and cumulative effects to Tribes and Tribal resources, as described below. If applicable to the siting of a new nuclear reactor, such information could assist NRC and applicants in avoiding, minimizing, and mitigating adverse effects while performing a project-specific supplement. EPA recommends the final GEIS:

1. Provide a discussion of NRC's Tribal consultation protocols, including: (1) the extent to which Tribes would participate and engage in consultation; and (2) how verbal and written Tribal input would inform a project-specific supplement, protective measures, and/or other project decisions.

2. Explain NRC's process for identifying Federally-recognized Tribes that may have historic or cultural resources present in a project area, as Tribes with ties to a project-specific location under the Preferred Alternative may reside elsewhere. To identify additional Tribal groups that may have ties, consider using the U.S. Housing and Urban Development's Tribal Assessment Directory Tool[29] for screening, while also using other information.[30]

3. If applicable, commit to evaluating potential direct, indirect, and cumulative effects to Tribes and Tribal resources on a project-specific basis separate from a NHPA review. Effects would include access to land and waters to exercise Tribal-reserved rights.

[27] EPA is a signatory to the December 2021 Memorandum of Understanding Regarding Interagency Coordination and Collaboration for the Protection of Tribal Treaty Rights and Reserved Rights. See https://www.epa.gov/tribal/memorandum-understanding-regarding-interagency-coordination-and-collaboration-protection.

[28] To view NRC's Tribal Protocol Manual and other information on the agency's Tribal program, see https://www.nrc.gov/about-nrc/state-tribal/tpm.html.

[29] The Tribal Assessment Directory Tool is available at: https://egis.hud.gov/TDAT/.

[30] The U.S. Forest Service Tribal Connections Viewer may be of use to NRC. See: https://usfs.maps.arcgis.com/apps/webappviewer/index.html?id=fe311f69cb1d43558227d73bc34f3a32.

(**23-21** [Chumble, Prasad])

Response:

The NRC agrees in part and disagrees in part with the comments. In accordance with its Tribal Policy Statement (82 FR 2402) (TN5500), the NRC consults in good faith with Indian Tribes on agency actions that have substantial direct effects on one or more Indian Tribes as well as those agency actions for which Tribal consultation is required under Federal Statute. The NRC's Tribal Policy Statement established a set of principles to guide the agency's government-to-

government interactions with federally recognized Indian Tribes and Alaska Native Tribes, to promote effective government-to-government interactions with Indian Tribes, and to encourage and facilitate Tribal involvement in the areas over which the Commission has jurisdiction.

The NRC's Tribal Policy Statement, published in 2017, formally reflects the NRC's recognition of the Federal Trust Responsibility and NRC's commitment to a government-to-government relationship with federally recognized Tribes, which is distinct from interactions with members of the public. Under the Federal Trust Doctrine, the United States—and the individual agencies of the Federal government—owe a fiduciary duty to Indian Tribes. The nature of that duty depends on the underlying substantive laws (i.e., treaties, statutes, agreements) creating that duty. The NRC exercises its Trust Responsibility under its authorizing statutes including the Atomic Energy Act of 1954 (TN663), the Energy Reorganization Act of 1974 (TN4466), the Nuclear Waste Policy Act of 1982 (TN740), the Low-Level Radioactive Waste Policy Act of 1985 (TN6517), and the Uranium Mill Tailings Radiation Control Act of 1978 (TN7221), as amended.

The NRC is not subject to the requirements of certain executive orders (EOs), including EO 13175 (65 FR 67249). However, the NRC acts in a manner consistent with the fundamental precepts expressed in EO 13175, and the NRC's Tribal Policy Statement is consistent with the principles articulated in EO 13175. Similarly, the Presidential Memorandum on Tribal Consultation and Strengthening Nation-to-Nation Relationships does not apply to the NRC. However, the NRC remains committed to following the principles set forth in its Tribal Policy Statement. The purpose of the Tribal Policy Statement is to promote effective government-to-government interactions with federally recognized American Indian and Alaska Native Tribes, and to encourage and facilitate Tribal involvement in the areas for which the NRC has jurisdiction.

The development of the NR GEIS and the associated rulemaking does not authorize NRC licensing actions for the construction and operation of new reactors that would trigger National Historic Preservation Act (NHPA) Section 106 (TN4157) consultation requirements that are normally conducted during project-specific reviews. This rulemaking is not a licensing action; it does not authorize construction or operation of any nuclear power plant. In accordance with the Tribal Policy Statement, the NRC conducts pre-application outreach activities with potential consulting parties. For project-specific reviews, the NRC will continue to meet its NHPA Section 106 consultation requirements with consulting parties pursuant to 36 CFR 800.2 (TN513). The NRC will continue to meet its obligation to consult with Indian Tribes by engaging early and often and consult specifically with Indian Tribes to discuss any potential direct, indirect, and cumulative effects to potential natural and cultural resources.

The NRC agrees that the NR GEIS would benefit from a more detailed discussion of the NRC's Tribal Policy Statement. The NRC has added a discussion (Section 1.4.7, Consultations) to Chapter 1 of the NR GEIS and a new section (Tribal Policy Statement) to Section 3 of COL-ISG-30 "Environmental Considerations for New Nuclear Reactor Applications that Reference the Generic Environmental Impact Statement (NUREG–2249)" (NRC 2026-TN11922) as a result of the comments. Additionally, the NRC revised Section I.B and added two footnotes to the final rule to include reference to consultations conducted under the Endangered Species Act (ESA) and NHPA, which require interagency consultation with Federal agencies or Indian Tribes and added a reference to the NRC's Tribal Policy Statement.

The NRC disagrees that the NR GEIS should provide discussion of the NRC's Tribal consultation protocols, process for identifying federally recognized Tribes for project-specific reviews, and how future licensing reviews will analyze and disclose potential direct, indirect, and

cumulative effects to Tribes and Tribal resources. The purpose of the NR GEIS is to present impact analyses for the environmental issues common to licensing actions for many new nuclear reactors that can be addressed generically, thereby eliminating the need to repeatedly reproduce the same analyses each time a licensing application is submitted and allowing applicants and NRC staff to focus future environmental review efforts on issues that can only be resolved once a site is identified. It is not intended to be procedural guidance for conducting an environmental review or associated consultations required by statute. Procedural guidance is contained in other NRC documents, which guide the staff's review of an application.

Information pertaining to consultation protocols is contained in NUREG-2173, Revision 1 (NRC 2018-TN6447), "Tribal Protocol Manual." Guidance to NRC staff on how to prepare environmental assessments and environmental impact statements for new reactor licensing is provided in NUREG-1555 (NRC 2007-TN614), "Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan," and in COL–ISG–030, ''Environmental Considerations for New Nuclear Reactor Applications that Reference the Generic Environmental Impact Statement (NUREG–2249)."

No additional changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

Comment: *Area of Potential Effects (APE)*

The definition of area of potential effects (APE) in the draft GEIS[31] is slightly different from the definition used in Federal regulation under NHPA.[32] NRC's definition is unclear as to the extent of APE or what would occur if a State/Tribal Historic Preservation Office(s) disagreed with NRC's determination of a site-specific APE. Generally, the level of effort related to a determination of APE would be expected to be more intensive if there is potential for the APE to contain an archeological site of national significance or value to a *living community* (e.g., Tribes). Federal agencies should not confuse delineation of an APE with a site-specific project's construction footprint. Effects to archeological properties are not restricted solely to direct physical impacts. By consulting with Tribes, NRC can ensure due consideration is given to all aspects of an archeological site's National Register significance. This is especially important when APE may contain archaeological properties of traditional religious and cultural significance to Tribes. The EPA recommends the final GEIS:

1. Ensure the final GEIS is consistent with Federal regulation language regarding APE, to avoid any confusion.

2. Use a clearer definition of APE. NRC's Emergency Planning Zones[33] provide a clear model for what a typical APE would be while still allowing site-specific flexibility. Adapting components of this model to create APE would also better reflect the impact on historic and cultural resources such as agricultural resources from operational activities.

[31] Page 3-100

[32] See 36 CFR 800.16(d). The Advisory Council on Historic Preservation defines the area of potential effects as the geographic area where an undertaking may directly or indirectly cause alterations in the character or use of historic properties. For more information on APE, see https://www.achp.gov/Section_106_Archaeology_Guidance/Questions%20and%20Answers/Determining_which_archaeological_sites_are _significant_identification.

[33] NRC creates Emergency Planning Zones as a preplanned protective action strategy based on plant size and shape, specific site conditions, unique geographical features of the area, and demographic information.

(**23-22** [Chumble, Prasad])

Response:

The NRC disagrees with the comment. The comment states that the NRC should use the Emergency Planning Zones as a model for defining a typical area of potential effect (APE). The definition of the APE provided in the NR GEIS serves as a guide for future project-specific reviews, thereby allowing for site- and project-specific flexibility. The NRC strives to define an APE that encompasses potential impacts associated with a proposed undertaking. Per 36 CFR 800.16(d), the APE is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking. The APE for a new reactor is the area that may be directly or indirectly affected by activities during construction or plant operations. The APE typically encompasses the nuclear power plant site where onsite ground-disturbing activities may occur, its immediate environs including viewshed, and in-scope transmission lines. If applicable, and dependent upon site- and project-specific considerations, the APE may extend beyond the nuclear plant site and transmission lines when building and operation activities may affect historic properties at offsite locations.

For specific licensing reviews, the NRC will continue to fulfill the requirements of NHPA Section 106 through the NEPA review process, including consultation regarding the definition of the APE and assessment of effects to historic properties with State Historic Preservation Officers, Tribal Historic Preservation Officers, federally recognized Indian Tribes, and interested parties.

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

Comment: *Application of Historic and Cultural Resource Policies*

Page 3-100 includes the following statement: "*When preparing project-specific supplements to this GEIS, the NRC's practice is to fulfill the requirements of NHPA Section 106 through the NEPA review process. Additional historic and cultural resource laws could apply if a proposed project is located on Federal lands.*" It then referred readers to Appendix F ("Laws, Regulations, and other Authorizations") to provide a list of various laws, regulations, executive orders, and guidance that apply to construction on Federal lands. Several of these listed policies, such as the Bald and Golden Eagle Protection Act of 1940 and the Native American Repatriation Act of 1990, apply more broadly than just on Federal lands.[34] The EPA recommends that the Final GEIS clarify when additional historic and cultural resource policies could apply to a proposed site-specific project.

[34] 50 CFR 22.4(a) and 43 CFR 10.1

(**23-23** [Chumble, Prasad])

Response:

The NRC acknowledges the comment. The NR GEIS evaluates the impacts of building, operating, and decommissioning a new nuclear reactor sited within the United States and its territories. The intent of the statement was to acknowledge that there are different requirements for projects sited on Federal lands and to recognize that there could be other Federal or State laws and regulations that could apply to a project-specific review. The NRC has revised the text in Section 3.7.1.1 to reflect that additional historic and cultural resource laws could apply, for example, if a proposed project is located on Federal lands or is subject to State-specific preservation laws (see Appendix F).

Additionally, the list of applicable laws, regulations, and other authorizations contained in Appendix F of the NR GEIS is intended to provide a basic overview to assist the applicant in identifying environmental and natural resources laws that may affect the new nuclear reactor licensing process. The descriptions are general in nature and are not intended to provide a comprehensive analysis or explanation of any of the items listed. No additional changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

Comment: Beyond our overall objection to streamlining, NATHPO has a specific concern about the categorization of issues in the NR GEIS by resource area that was presented during the listening session. In the categorization of issues there is an artificial line drawn between Historic and Cultural issues and many other issues, such as "Land Use," "Visual Impacts," and "Surface Water." For Tribal Nations the land, the viewshed, and the surface water are cultural resources and the NRC's proposal to separate them is problematic. (**25-2** [Grussing, Valerie J.])

Comment: Subject one asked for comments on NRC's Plant Parameter Envelope and Site Parameter Envelope values and assumptions. NRC makes a false assumption about what is a cultural resource when it separates that issue area from land, viewshed, surface water, and other issue areas. (**25-3** [Grussing, Valerie J.])

Comment: Subject three asked for comments on the "categorization of the issues." Many of the issues, such as land use and viewshed, are included in "Category 1" issues that would have a "small impact," while "Historic and Cultural" are included in "Category 2" issues that would have an "undetermined impact." For Tribal Nations, the landscape, viewshed, surface water, and other areas are cultural resources and should also be included in "Category 2," because it cannot be determined, from a cultural standpoint, what impact building a nuclear power plant will have on them. (**25-4** [Grussing, Valerie J.])

Response:

NRC acknowledges the comments. The NRC recognizes that Tribal Nations consider the land, the viewshed, and the surface water as cultural resources. Potential impacts to resource areas such as land use, visual effects, and surface water are taken into consideration during the NRC's NEPA and associated NHPA Section 106 consultation for project-specific licensing reviews. During pre-application engagement and the project-specific NHPA Section 106 consultation, the NRC consults with any Indian Tribe or Native Hawaiian organization that attaches religious and cultural significance to historic properties that may be affected by an undertaking. While historic and cultural resources are a project-specific Category 2 issue, Category 1 issues are environmental issues for which a generic analysis concluding SMALL adverse environmental impacts is possible, provided that relevant values and assumptions in the PPE and SPE are met and there is no new and significant information that changes the

conclusions reached in the NR GEIS. However, if the relevant values and assumptions for a Category 1 issue are not met or there is new and significant information that would change the generic determination reached in the NR GEIS, then a project-specific analysis would be performed. No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

Comment: Besides the requested changes in categorization of issues, as the NR GEIS moves forward, NATHPO would strongly urge the following additions and clarifications outlined below. Namely, regarding the use of Indigenous Knowledge, application of the Native American Graves Protection and Repatriation Act (NAGPRA) to inadvertent discoveries, and compensation for work performed by Tribal Nations.

We ask that the NR GEIS be amended to include language unequivocally stating Indigenous Knowledge is a valid and self-supporting means for evaluating the impacts construction of new nuclear reactors will have on cultural resources and places. Such language would be consistent with the Advisory Council on Historic Preservation's policy on Indigenous Knowledge, and all Program Comments, NPAs, and Memoranda of Agreement should include this language.

NATHPO strongly recommends the inclusion of language saying, "The recipient shall be responsible for compliance with the requirements of NAGPRA (25 U.S.C. §§ 3001-3013) and its implementing regulations (43 CFR Part 10) for all Native American human remains or cultural items in its possession or control." This needs to be explicitly stated because receipt of Federal funds triggers NAGPRA's repatriation requirements for all Native American human remains and cultural items in the possession or control of the receiving institution, not just ones identified by the funded project.

We also urge language be added to the NR GEIS clearly stating when NRC or the recipients of NRC funds or permits request Tribal Nations' engage in work related to determining impacts of new nuclear power plants on Tribal Nations' cultural resources and sacred places, Tribal Nations be compensated for this work. Financial support for Tribal Nations work is particularly important because it is both time consuming and emotionally difficult work. (**25-5** [Grussing, Valerie J.])

Response:

The NRC agrees in part and disagrees in part with the comment. The NRC agrees that the NR GEIS should recognize the importance of indigenous knowledge as a means for identifying and assessing effects to historic and cultural resources. For project-specific license reviews, the NRC consults with Indian Tribes that attach religious and cultural significance to historic properties within the area of potential effects. As part of its NHPA Section 106 consultation, the NRC seeks to identify Indian Tribes that have ancestral ties to the proposed project area to identify, assess effects, and resolve any adverse effects to historic properties. The NRC has added language in Section 3.7.2 to note that for new reactor projects, consultation with Indian Tribes will seek to identify and incorporate indigenous knowledge in the NRC's environmental review.

The comment also recommends that the NRC include language stating that "The recipient shall be responsible for compliance with the requirements of Native American Graves Protection and Repatriation Act (NAGPRA) (25 U.S.C. §§ 3001-3013) (TN1686) and its implementing regulations (43 CFR Part 10) (TN4845) for all Native American human remains or cultural items in its possession or control." Further, the comment states that the receipt of Federal funds

triggers NAGPRA's repatriation requirements for all Native American human remains and cultural items in the possession or control of the receiving institution, not just ones identified by the funded project. NAGPRA applies to discoveries or excavations of human remains or cultural items on Federal or Tribal lands. For projects occurring on private or State lands, excavations or discoveries may be governed first by local or State laws, but human remains or cultural items removed from private or State land may be subject to repatriation, depending on who has control of them (e.g., any museum, Federal agency, or institution that receives Federal funds to implement NAGPRA). During project-specific reviews, the NRC complies with the requirements in NHPA Section 106 through the review and oversight of power plant procedures (i.e., procedures to identify and consider effects on historic properties and to address inadvertent discoveries, stop work and notification protocols pursuant to 36 CFR 800.13). For projects occurring on private lands, procedures would include notification of law enforcement (in accordance with applicable State or local laws), the NRC, appropriate State Historic Preservation Officer, and Indian Tribes that have ancestral ties to the project area.

The NRC disagrees that the NR GEIS should provide discussion regarding compensation for Tribal Nations' consulting on the impacts of new nuclear power plants or for conducting surveys to identify cultural resources and sacred places. Discussion of Federal government funding of Tribal Historic Preservation Offices and Tribal engagement on new nuclear power proposals are outside the scope of this analysis. The NHPA and Advisory Council on Historic Preservation's regulations at 36 CFR 800 authorize Federal agencies to contract with others to provide information for complying with Section 106. However, neither authority requires Federal agencies to pay for any aspect of consulting party participation in the Section 106 process. When an agency seeks to identify historic properties that may be significant to an Indian Tribe, the agency may ask for specific information and documentation regarding the location, nature, and condition of individual sites, or request that a survey be conducted by the Tribe. In that case, the agency is requesting the Tribe to fulfill the role of a consultant or contractor. In such cases, the Tribe would be justified in requiring payment for its services.

The purpose of the NR GEIS is to present impact analyses for the environmental issues common to licensing actions for many new nuclear reactors that can be addressed generically, thereby eliminating the need to repeatedly reproduce the same analyses each time a licensing application is submitted and allowing applicants and NRC staff to focus future environmental review efforts on issues that can only be resolved once a site is identified. Additionally, the NR GEIS is not intended to be procedural guidance for conducting an environmental review or associated consultations required by statute. No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

Comment: In line with the NRC's goals as directed by the ADVANCE Act, we recommend the NRC recategorize the "Historic and Cultural Resources" section of the NR GEIS to Category 1. The NRC should assume the impact of both construction and operation on historic and cultural resources is small, unless otherwise indicated during the notice and comment period for approval of the construction and operation applications. (**33-5** [Unknown] [Unknown] [Unknown])

Response:

The NRC disagrees with the comment. Historic and cultural resources vary widely from site to site; there is no generic way of determining their existence or significance. Therefore, historic and cultural resource impacts must be analyzed on a project-specific basis, and the NRC is required to complete a NEPA and NHPA Section 106 review prior to issuing a license. No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

E.2.7 Health-Radiological

Comment: Impacts on Health
In addition to mitigating environmental impacts, the regulation of nuclear reactors is vital to prevent nuclear catastrophes in case the reactor fails. Even though the issues covered by the NR GEIS are extensive including biodiversity, conservation of ecosystems and native species, transportation, fuel cycle, postulated accidents and decommissioning, there is a lack of emphasis on the importance of public health. To put more emphasis on public health, I suggest that the NR GEIS also take into account the potential health threats to communities that live near the nuclear reactor since they are the most vulnerable to exposure to radiation. It is crucial to ensure that local populations have the adequate information regarding these health threats as well as being protected by any potential exposure to radiation during the planT's operation and decommissioning phases. If protection and information are not provided, this could potentially violate human rights, environmental justice and create socio economic problems. (**17-1** [Aguilar S., Kathya])

Response:

The NRC disagrees with the comment. The NRC considered the potential human health impacts of ionizing radiation in Section 3.8.1. The NRC has established dose limits in 10 CFR 20.1301, the annual limits on intake for effluent concentrations in 10 CFR 20 Appendix B for members of the public, and 10 CFR Part 50 Appendix I (TN249) for light water reactor effluent to provide reasonable assurance of adequate protection of public health and safety. These regulations limit emissions to the environment and are sufficient to declare that radiological human health impacts from construction and operations are a Category 1 issue with SMALL impacts. Additionally, any license application for a new nuclear reactor, per 10 CFR 50.34, must contain a sufficient level of technical information for the staff to complete a detailed technical safety review and determine if the application is in compliance with regulations through a radiation protection program and an effluent release monitoring program to ensure adequate protection of public health and safety. Furthermore, 10 CFR Part 51 (TN251) describes the environmental protection regulations for domestic licensing and related regulatory functions including information on the implementation of the National Environmental Policy Act and the requirements for Environmental Reports.

The NRC requires licensees to monitor radioactive effluents (routine and inadvertent) discharged into the environment; thus, each nuclear power plant is required to have a Radiological Environmental Monitoring Program (REMP). The REMP quantifies the environmental impacts associated with radioactive effluent releases from the plant. The REMP requires monitoring the environment over time, starting before the plant operates to establish background radiation levels and continuing throughout its operating lifetime to monitor radioactivity in the local environment. The REMP provides a mechanism for determining the levels of radioactivity in the environment to ensure that any accumulation of radionuclides

released into the environment will not become significant as a result of plant operations. The REMP also measures radioactivity from other nuclear facilities that may be in the area (i.e., other nuclear power plants, hospitals using radioactive material, research facilities, or any other facility licensed to use radioactive material). Thus, the REMP monitors the cumulative impacts from all sources of radioactivity in the vicinity of the power plant. To obtain information about radioactivity around the plant, samples of environmental media (e.g., surface water; groundwater; drinking water; air; milk; locally grown crops; locally produced food products; river, ocean, or lake sediment; and fish and other aquatic biota) are collected from areas surrounding the plant to measure the amount of radioactivity, if any, in the samples. The media samples reflect the radiation exposure pathways to the public from radioactive effluents released by the nuclear power plant and from background radiation (i.e., cosmic sources and naturally occurring radioactive material, including radon and global fallout). The information obtained through the REMP verifies that measurable concentrations of radioactive materials and levels of radiation in the environment are not higher than expected when compared against data on the amount of radioactive effluent discharged from an operating nuclear power plant. The findings from the REMP are summarized in the Annual Radiological Environmental Operating Reports and the Annual Radioactive Effluent Release Reports issued for each operating nuclear power plant. As part of each project-specific environmental review, the NRC staff reviews REMP reports to look for adverse data or evidence of a buildup of radioactivity in the environment.

The NRC's regulatory limits for radiological protection are set to protect workers and the public from the harmful health effects of radiation on humans. The limits are based on the recommendations of standards-setting organizations. Radiation standards reflect extensive scientific study by national and international organizations (i.e., International Commission of Radiological Protection, National Council on Radiation Protection and Measurements, United Nations Scientific Committee on the Effects of Atomic Radiation, Health Physics Society, and the National Academy of Sciences) and are conservative to ensure that the public and workers at nuclear facilities are protected. The international community and Federal agencies (including the NRC in 10 CFR Part 20) follow International Commission of Radiological Protection's current guidelines that the overall annual dose to members of the public from all sources should not exceed 1 mSv (100 mrem), in order to be protective of all individuals and the environment. These guidelines also hold that the exposure from a single source should be limited to a fraction of this overall dose. The purpose of the public dose limit is to limit the lifetime risk from radiation to a member of the general public. The conversion factor used to equate dose into risk is based on data from various populations of various ages exposed to very high doses of radiation, such as the atomic bomb survivors. Therefore, even though the studies use the term reference man, the variation in the sensitivity to radiation given age and gender is built into the standards, which are based on lifetime exposure. A lifetime exposure includes all stages of life, from birth to old age. For ease of implementation, the radiation standards, which are developed to minimize the lifetime risk, limit the annual exposure that an individual may receive.

Radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and adverse impacts, such as incidents of cancer. The linear, no-threshold model assumes any increase in dose, no matter how small, results in an incremental increase in health risk. The NRC uses this model for estimating health risks from radiation exposure, recognizing that the model probably overestimates risks from low doses (below about 0.1 Sv [10 rem]). Based on this model, the NRC conservatively establishes radiation dose limits, in 10 CFR Part 20, to ensure adequate protection of workers and members of the public. The NRC's regulatory limits incorporate conservative assumptions and are

considered protective of adults and children. More information about these topics may be found at https://www.nrc.gov/about-nrc/radiation.html (NRC 2021-TN11934).

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

Comment:

Radiation Protection

Section 3.8.1.1 of the draft GEIS notes that the EPA's public dose and radionuclide release standards at 40 CFR part 190, which are implemented by reference in NRC's 10 CFR 20.1301(e), do not apply to non-light water-cooled reactors. This could potentially lead to the anomalous situation described in the referenced North Anna Early Site Permit decision, in which 10 CFR 20.1301(a) and 20.1301(e) apply to different reactors or other activities at the same site. The draft GEIS appropriately considers the current regulatory framework in evaluating impacts. However, it would be useful, and the EPA recommends, that the final GEIS note that the EPA recognizes this limitation and sought public comment on how to address this issue as it considers revisions to the rule (79 FR 6509, February 4, 2014). This would be particularly appropriate given that non-light water reactors are not likely to be operating much before 2030, if then.

Section 3.8.2.1 discusses radiation doses to construction workers and states that doses must remain below 100 mrem/yr, citing 10 CFR 20.1301 for limits to doses to the public. In fact, as described elsewhere in the draft GEIS, 10 CFR 20.1301 includes two different dose limits for members of the public. The 100 mrem/yr limit is given in §20.1301(a), while §20.1301(e) specifies the limit in 40 CFR part 190, which is 25 mrem/yr to the whole body, 75 mrem/yr to the thyroid, and 25 mrem/yr to any other organ. The EPA recommends that the final GEIS clarify why the 100 mrem/yr standard in §20.1301(a) should apply to construction workers and not the lower standard in §20.1301(e).

(**23-1** [Chumble, Prasad])

Response:

The NRC acknowledges and agrees in part with the comment. The NRC has added clarifying language to the NR GEIS regarding the EPA action of soliciting comments related to the applicability of 40 CFR Part 190 (TN739) to advanced reactors in 79 FR 6509 (TN11935). Changes were made to Section 3.8.1.1 of the NR GEIS as a result of the comment. The NRC also added clarifications to Section 3.8.1.2.1's discussion on radiation doses to construction workers to clarify the different definitions in 10 CFR 20.1301 and its connection to 40 CFR Part 190 as a result of the comment.

The dose limit for members of the public in 10 CFR 20.1301 is 100 mrem per year. This value is inclusive of all potential sources of anthropogenic radiation above what a person would receive from natural background and any required medical procedures. The dose limits in 40 CFR 190 are source specific, from any exposures to planned discharges of radioactive materials to the general environment from uranium fuel cycle operations and to radiation from these operations, radon and its daughters excepted. This 40 CFR 190 dose limit can be considered a subcomponent of the all- inclusive limits of 10 CFR 20.1301. In addition, 10 CFR 50 Appendix I identifies restrictions on dose from effluents related to operations from water cooled nuclear

power reactors. New reactor applicants may choose to compare their dose from effluents to 10 CFR 50 Appendix I to demonstrate low doses during operations. This would be a subcomponent of both 10 CFR 20.1301 and 40 CFR 190.

Workers who have received radiation protection training and would be under the occupational exposure limits of 10 CFR Part 20 Subpart C would not be regulated under 40 CFR 190.

When viewed individually, the regulations in 10 CFR 50 Appendix I, 10 CFR 20.1301, and 40 CFR 190 may appear to conflict, but when viewed together identify a layered approach to limiting emissions from individual sources, from collective processes, and to an individual from all sources. These regulations provide a comprehensive methodology to protect members of the public and the environment from harmful radiation doses.

Comment: Section 4.1 concludes that the irreversible and irretrievable commitment of uranium will be negligible because of availability of ore and stockpiles of enriched uranium in the United States and Russia. This appears to contradict the discussion in Section 3.14.2.1 of the Prohibiting Russian Uranium Imports Act that will severely curtail imports of uranium from Russia by the time new reactors are commissioned. EPA recommends that the final GEIS provides information that supports the conclusion in Section 4.1 and/or clarify the contradiction. (**23-2** [Chumble, Prasad])

Response:

The NRC agrees with the comment. The NRC acknowledges the Prohibiting Russian Uranium Imports Act (TN10152) and its effect on the uranium fuel cycle. The NR GEIS has been revised to reflect the status of the U.S. Department of Energy (DOE) HALEU Availability program. As part of this program, DOE has awarded several contracts for production of HALEU fuels. Companies, such as American Centrifuge Operating, General Matter, Louisiana Energy Services, and Orano Federal Services, have been awarded contracts for enrichment (https://www.energy.gov/ne/haleu-enrichment-services). DOE has awarded contracts for deconversion of enriched materials to BWXT, Centrus, Framatome, GE Verona, and Orano (https://www.energy.gov/ne/haleu-deconversion-services). Centrus has begun enriching uranium to HALEU levels at their Piketon facility and will be ramping up domestic production of HALEU (CEC 2025-TN11936; Urenco 2024-TN11937).

Changes were made to the NR GEIS in Section 3.14.1.3 to provide further information related to HALEU availability as well as the Prohibiting Russian Uranium Imports Act, and Section 4.1 was updated to include the availability of other uranium sources identified through the DOE HALEU production program.

E.2.8 Radiological Waste

Comment: New nuclear reactor licenses should include the requirement for disposing of the nuclear waste generated during the reactor's operating life. (**8-1** [Hayes, Rose])

Comment: Waste Management and Decommissioning

Managing radioactive waste is an extremely challenging aspect for nuclear reactors, which remains hazardous for thousands of years. It is concerning to think that in the majority of cases the current waste storage solutions are temporary, this includes dry cask storage and on-site storage pools. There is an expectation of increased nuclear energy

production, which is why bigger and more sustainable waste management strategies in the long-run are extremely necessary.

The NR GEIS should mandate that all nuclear projects incorporate plans for long-term waste disposal, possibly through advancements in deep geological repositories, which offer safer, more permanent waste storage solutions than current methods. The decommissioning phase of nuclear reactors is one of the most dangerous phases since it has high environmental and safety risks. To prevent radioactive contamination from negatively affecting future land use, the decommissioned area must be cleaned immediately, completely and most effectively. Therefore, I encourage the NR GEIS to include decommissioning protocols that are clear, rigorous and have built-in enforcement mechanisms to prevent environmental contamination and harm to surrounding communities. The Nuclear Regulatory Commission can ensure that the production of nuclear energy will remain responsible and sustainable as a key part of the transition to clean energy if these requirements are included in the NR GEIS. (**17-5** [Aguilar S., Kathya])

Comment: Finally, nuclear waste management is an issue that cannot be overlooked. Current storage solution, such as dry cask storage, and interim facilities, are only temporary measures and cannot accommodate the long term accumulation of radioactive waste, Studies have highlighted the need for advanced waste recycling technologies, such as fast neutron reactors, which can reuse spent fuel to significantly reduce waste volume and toxicity (Brook et al., 2014). In addition, the establishment of permanent geological repositories, like the proposed Yucca Mountain facility, is critical to ensuring the safe and secure disposal of nuclear waste over millennia, (**21-6** [Pond, Douglas])

Comment: Waste

The GEIS notes on page 3-127 that current NRC regulations require an applicant to minimize the generation of nuclear waste.2 As to high-level waste, the GEIS states that "new reactor designs may not require onsite spent nuclear fuel storage, for example, in cases where the depleted core would be shipped offsite after a short period after shutdown (see Section 3.14 for away-from-reactor impacts during continued storage)" and that "[i]f spent nuclear fuel or any treated, reprocessed waste needs to be stored temporarily at a new reactor facility, it would be stored either in a spent fuel pool or in non-water-based spent nuclear fuel storage. After an appropriate holding period, it would be transferred to dry cask storage in an at-reactor ISFSI under a general license or a stand-alone ISFSI under specific license" (GEIS at 3-128). The GEIS cites to 10 CFR Part 72, which relates to "requirements, procedures, and criteria for the issuance of licenses to the Department of Energy (DOE) to receive, transfer, package, and possess power reactor spent fuel, high-level radioactive waste, power reactor-related GTCC waste, and other radioactive materials associated with the storage of these materials in a monitored retrievable storage installation." But as the Commission is well aware, although federal law places the obligation to handle high-level waste on the federal government (42 U.S.C. §10101 et seq. (1982), there is currently no high-level waste repository available. Moreover, as of the date of this submission, federal courts have invalidated the Commission's ability to issue licenses to interim storage facilities such as those implicated by 10 CFR Part 72.3 Should the United States Supreme Court side with the petitioners in those cases, there will, as a practical matter, be no place to which the waste can be relocated as contemplated in the GEIS, and each advanced reactor site will become a de facto long term waste storage installation.

At the same time, the waste generated by advanced reactors has not been the subject of extensive academic study, and current waste characteristics and generation projections are unreliable as there are no licensed, operating advanced reactor facilities to look to for their actual waste profile. But one such study, published in the Proceedings of the National Academy of Sciences and co-authored by former NRC Commissioner Macfarlane, found that the spent nuclear fuel from small modular reactors will be generated in greater volumes per unit of energy extracted and that its composition can be far more complex than the spent fuel resulting from existing power plants.4 The authors evaluated nuclear fuel cycles for three distinct SMR designs, finding that "relative to a gigawatt-scale PWR, these reactors will increase the energy-equivalent volumes of SNF, long-lived LILW [low-and intermediate-level waste], and short-lived LILW by factors of up to 5.5, 30, and 35, respectively." Further, the authors found SMR waste streams will bear "significant (radio-)chemical differences" from those of existing reactors that will need costly treatment, conditioning and packaging to make them suitable for geologic disposal, introducing new pathways for radiation exposure. The authors conclude that similar neutron leakage characteristics inherent to most of the dozens of proposed SMR designs would render the waste "incompatible with existing nuclear waste disposal activities" and that future studies should assess "whether safe interim storage of reactive SMR waste streams is credible in the context of a continued delay in the development of a geologic repository in the United States" (n.3 at pl0). Yet for this GEIS, the NRC staff assumes that the quantities of LLRW generated at a new reactor would be less than the quantities of LLRW generated at existing nuclear power plants (GEIS at 3-127); while this may be true, this is only because the facilities are much smaller — the waste generated by certain advanced reactors appears to be higher per output than existing facilities, posing a problem for the aggregate collection of waste across the country should these facilities be built out in large numbers. In light of this credible information, we cannot agree with the GEIS's assertion that existing radiological waste infrastructure and management programs could "likely support the additional radiological wastes generated by a new reactor" (see 3-126) and request that the final GEIS acknowledge the findings of Krall et al. We also strongly encourage the Commission, pursuant to 10 CFR Part 1406, to require mitigation measures for adverse waste impacts in all environmental reviews, and condition licenses on the minimization of waste. But in light of this information, which has not been explored in the GEIS, we also request that waste management be changed from a Category 1 to a Category 2 issue, such that the treatment plans for waste generated from new/advanced reactors can be understood once such designs are available.

[2] See 10 C.F.R. 1406 ((a) Applicants for licenses ... shall describe in the application how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.").
[3] See, e.g., *U.S. Nuclear Regulatory Commission et al. v. State of Texas et al. and Interim Storage Partners LLC v. Texas et al.*, before the Supreme Court at the time of this writing as NRC v. Texas, No. 23-1300.

[4] Krall, et al., *Nuclear waste from small modular reactors*. Proceedings of the National Academy of Sciences: Vol. 119, No.23 (June 7, 2022). Available at https://doi.org/10.1073/pnas.2111833119

(**37-6** [Peterson, Alyse])

Response:

The NRC disagrees with the comments. The comments are concerned with the generation of spent fuel and the current management of such spent fuel without a geologic repository.

While a repository for final disposal of spent nuclear fuel has yet to be constructed, the Commission has, through rulemaking, considered the environmental impacts of spent fuel management in light of the current national policy while waiting for a geologic repository. Specifically, on August 26, 2014, the Commission issued a revised rule in 10 CFR 51.23 and an associated Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel (NUREG-2157 (NRC 2014-TN4117)). Continued Storage is defined as the storage of spent fuel after the end of the licensed life for operations of a nuclear reactor and before final disposal in a permanent repository. NUREG-2157 was incorporated into the NR GEIS by reference in Section 1.3.1.

The storage of spent nuclear fuel in dry cask storage must meet regulatory requirements, where the environmental impacts were analyzed in the Continued Storage GEIS (NUREG-2157). The Continued Storage GEIS reviewed three time periods, 60 years, an additional 100 years past the original 60 years, and indefinite storage. Under all time periods, the impacts of continued storage are small if effective management and institutional controls remain in place. As stated in Section 3.14.3 of the NR GEIS, if conditions, such as fuel stability within the uranium spent fuel and the site conditions for construction and operation of an independent spent fuel storage installation including fuel transfers, go beyond what is in NUREG-2157, then a project-specific analysis would be necessary to demonstrate continued safe storage. Related to disposal of advanced reactor fuels, as stated in Section 3.14.3 of the NR GEIS, disposal of new reactor spent nuclear fuel (SNF) in a deep geological repository would need to demonstrate compliance with radiation standards that are expected to be comparable, if not the same, as the existing radiation standards in Table B-1 in 10 CFR Part 51 (e.g., a dose limit of 0.15 millisieverts [15 mrem]).

Regarding commenter concerns related to reprocessing, there are no facilities that currently reprocess or recycle nuclear fuel for use in reactors. As stated in Section 3.14.2.5 of the NR GEIS, the impacts of reprocessing SNF from light-water reactors (LWRs) were evaluated in NUREG-0116, Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle (NRC 1976-TN292). Additionally, the staff made an initial impact assessment in Section 3.14.2.5 comparing pyrochemical reprocessing to the PUREX process evaluated in NUREG-0116. However, if an entity proposed to reprocess spent fuel, they would have to provide the appropriate environmental evaluation under that licensing action.

Regarding commenter concerns related to advanced nuclear fuels, to meet the PPE values associated with the NR GEIS for radiological waste management, applicants must meet the regulatory requirements of 10 CFR Part 20 (e.g., 20.1406 and Subpart K), 10 CFR Part 61 (TN252), 10 CFR Part 71 (TN301), and 10 CFR Part 72 (TN4884) as stated in Appendix G of the NR GEIS. Related to decommissioning, the regulations governing decommissioning of power reactors are found in 10 CFR 50.75, 10 CFR 50.82, and 10 CFR 52.110. As concluded in Section 3.16 of the NR GEIS, the Decommissioning GEIS can be relied upon for new reactor decommissioning generic or Category 1 issues with SMALL impacts as presented in Table 3-21. Six site-specific or conditionally project-specific issues along with climate change and cumulative impacts are Category 2 issues, and their impacts remain undetermined (see Table 3-21 for the environmental issues marked as Category 2 environmental issues). The Category 2

issues will need to be addressed within the project-specific environmental review for each application utilizing the NR GEIS.

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

E.2.9 Postulated Accidents

Comment: Comment #1: Section 3.11.2.3 Severe Accidents NUREG-2249 Generic Environmental Impact Statement for Licensing of New Nuclear Reactors Draft Report for Comment

Section 3.11.2.3 Severe Accidents should be Category 1 (instead of 2 as listed) and the finding impact should be SMALL (instead of Undetermined).

The following is the basis for this change:

1. Section 3.11.2.3 states that the probabilistic risk assessment provided in the safety analysis would have CDFs that would likely be substantially less than the CDFs associated with the current reactor fleet. If the probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are bounded by the existing fleet then the proposed new reactor could be generically evaluated as Category 1 with a SMALL impact.

2. The staff has not considered the approved new reactor design certifications as a basis for determining that Severe Accidents could be Category 1 with a SMALL impact. The 10 CFR Part 52 design certifications that should be considered are:

Appendix A to Part 52-design certification rule for the US Advanced Boiling Water Reactor

Appendix B to Part 52-design certification rule for the System 80+ design

Appendix C to Part 52-design certification rule for the AP600 design

Appendix D to Part 52-design certification rule for the AP1000 design

Appendix E to Part 52-design certification rule for the ESBWR design

Appendix F to Part 52-design certification rule for the APR1400 design

Appendix G to Part 52-design certification rule for NuScale

In summary, the staff should utilize the information from the existing reactor fleet and approved design certifications to conclude the severe accident issue is Category 1 and the impact is SMALL. I cannot imagine any new reactor developer would propose a design that would result in a Severe Accident impact greater than the existing reactor fleet.

In adopting this comment, NRC staff will be able to contribute to the fulfillment of *ADVANCE Act of 2024"* Section 506 "Modernization of Nuclear Reactor Environmental Reviews."[1]

[1] *"Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024" Title V Improving Commission Efficiencies*

(**9-1** [Gallagher, Michael])

Comment:

Comment 2 3.11.1.4 SAMDA

Comment #2: Section 3.11.2.3 Severe Accidents NUREG-2249 Generic Environmental Impact Statement for Licensing of New Nuclear Reactors Draft Report for Comment

Section 3.11.2.4 "Severe Accident Design Alternatives" (SAMDA) should be eliminated as a separate issue to be evaluated. Any mitigation, including SAMDA, should be driven by the 3.11.2.3 "Severe Accidents" Finding.

If issue 3.11.2.3 "Severe Accidents" is determined to be SMALL, then mitigation is not needed because of the definition of SMALL:

SMALL - Environmental effects that are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered SMALL. [1]

If issue 3.11.2.3 "Severe Accidents" is determined to be MODERATE or LARGE, then mitigation may be necessary. SAMDA could be one possible mitigation method.

The basis for this change is as follows:

1. NRC staff continues to rely upon Limerick Ecology Action vs. NRC [3rd Cir. 1989] when "its usefulness has passed."

The Limerick Ecology Action vs. NRC [3rd Cir. 1989] was procedural in nature because the NRC excluded SAMDA in an EIS because of a Policy Statement. Therefore, the 3rd Circuit also identified that the NRC staff did not comply with NEPA's requirement that the environmental impacts of agency action be given careful consideration and that the public be informed of them. The 3rd Circuit summarized the issue:

Summary of Severe Accident Mitigation Alternatives, The Commission's Decision[2]

We conclude that, contrary to the NRC's contention simply meeting the requirements of the AEA does not exempt the Commission from complying with NEPA's procedural requirements. NEPA requires that the environmental impacts of agency action be giving careful consideration and that the public be informed of them. Here, the NRC excluded consideration of design alternatives through a generic policy statement rather than through careful consideration. Because the action not to consider SAMDA's was promulgated as a policy statement, rather than a rule, and because it applies to an Issue that we find Is unlikely to be treated as generic, it does not meet the Baltimore Gas criteria for generic rule making and therefore SAMDAs must be given careful consideration. Moreover, we are unwilling to conclude that on the basis of record before us, that, if the Commission had not excluded consideration of severe accident mitigation design alternatives on the basis of the Final Policy Statement it would nevertheless have precluded their consideration on the ground that the underlying risks were remote and speculative. We therefore will grant the petition for review and remand for consideration of SAMDAs in light of this opinion.

Neither of the issues cited by the 3rd Circuit is true now. Today there is adequate basis to determine that SAMA (SAMDA) is not worth the effort. It is very clear that SAMAs are not needed for the existing fleet based on the 2024 GEIS:

"Moreover, the comprehensive improvements in severe accident risk outside of license renewal have exceeded the current process and scope of SAMA analysis for determining the need for additional mitigative measures."[3]

For new reactor technology this should also be the case because, why would there be a proposed reactor technology that has greater Severe Accident impact than the existing fleet? For the existing fleet, the Severe Accident impact is SMALL. Therefore, mitigation should not be necessary. In addition, in my Comment #1, the staff did not include the existing reactor fleet and the approved design certifications in determining the Category and impact of Section 3.11.2.3 Severe Accidents.

[1] ES.3-page xvii NUREG-2249 Generic Environmental Impact Statement for Licensing of New Nuclear Reactors Draft Report for Comment

[2] Limerick Ecology Action vs. NRC, 869 F.2d 719 [3rd Cir. 1989]

[3] 2024 LR GEIS page E-97

(**10-1** [Gallagher, Michael])

Comment:

2. Mitigation is necessary only to *"reduce the projected impacts of agency actions to below a threshold of significance."*

The Council on Environmental Quality (CEQ) issued guidance for Federal departments and agencies on establishing, implementing, and monitoring mitigation commitments identified and analyzed in Environmental Assessments, Environmental Impact Statements, and adopted in the final decision documents.

Mitigation Incorporated into Project Design[4]

Many Federal agencies rely on mitigation to reduce adverse environmental impacts as part of the planning process for a project, incorporating mitigation as integral components of a proposed project design before making a determination about the significance of the project's environmental impacts. Such mitigation can lead to an environmentally preferred outcome and in some cases reduce the projected impacts of agency actions to below a threshold of significance. An example of mitigation measures that are typically included as part of the proposed action are agency standardized best management practices such as those developed to prevent storm water runoff or fugitive dust emissions at a construction site.

Mitigation should be associated with the issue Severe Accidents, not itself an issue to be evaluated (SAMA/SAMDA). It does not make sense to evaluate for Mitigation on SAMA/SAMDA which is already a mitigation. SAMAs represent only a minor portion of the Commission's overall regulatory regime—separate and apart from its safety requirements. A SAMA is simply "a cost-benefit analysis that addresses whether the expense of implementing a mitigation measure not mandated by the NRC is outweighed by the expected reduction in environmental cost it would

provide in a core damage event."[5]. SAMAs are not meant to prevent an accident but rather to mitigate the severity should one occur. The Commission relies on a myriad of other safety mechanisms to prevent accidents.

If the staff insists that Section 3.11.2.4 "Severe Accident Design Alternatives" (SAMDA) remain then, since the issue is Category 1, additional criteria should be included to justify not performing a SAMDA. Section 3.11.2.4 should be revised as follows (addition criteria are in bold italics):

3.11.2.4 Severe Accident Mitigation Design Alternatives

It is expected that for severe accidents, although a Category 2 issue, the probabilistic risk assessment provided in the safety analysis would have CDFs that would likely be substantially less than the CDFs associated with the current reactor fleet. Therefore, any one of the three would be acceptable in determining that a SAMDA analysis is not needed.

1. If Section 3.11.2.3 "Severe Accidents" is determined to be SMALL, a SAMDA is not needed because, the Commission has concluded that radiological impacts meet permissible levels in the Commission's regulations.

2. If no PEP EPZ[6] is necessary utilizing §50.33(g)(2), then a SAMDA is not needed.

3. For non-LWR SAMA screening and assessments, event or release category frequency could be used in place of CDFs. A cost screening could determine that the maximum benefit of avoiding an accident is so small that a SAMDA is not justified based on the minimum cost to design an appropriate SAMDA.

This is a Category 1 issue. The staff relied on the following PPE assumption to reach this conclusion:

• If a cost-screening analysis determines that the maximum benefit for avoiding an accident is so small that a SAMDA analysis is not justified based on a minimum cost to design an appropriate SAMDA.

This cost-screening process would be based on the available risk information derived from the FSAR/PSAR and would apply the cost formulas from NUREG/BR-0058 (NRC 2004-TN670). If SAMDAs are not screened out, the bounding assumption is not met and a project-specific analysis is required. For example, the NuScale SMR 50 Mwe single module has eight accident release categories and seven out of eight accident release categories have release frequencies of 2.4 × 10-9 per reactor-year or smaller (NuScale 2020-TN6811). The total estimated maximum benefit of these seven low-probability release categories would be less than $100. It is unlikely that a design mitigation alternative could be developed costing less than $100, so there is no 24 need to develop potential mitigation strategies.

In adopting this comment, NRC staff will be able to contribute to the fulfillment of ADVANCE Act of 2024" Section 506 "Modernization of Nuclear Reactor Environmental Reviews."[7]

[4] CEQ memo, "Appropriate Use of Mitigation and Monitoring and Clarifying the Appropriate Use of Mitigated Findings of No Significant Impact", January 14,2011

[5] Massachusetts v. NRC, 708 F.3d 63, 68 (1st Cir. 2013)

[6] NEI 24-05, Rev 0, An Approach for Risk-Informed Performance-Based Emergency Planning June 2024

[7] "Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024" Title V Improving Commission Efficiencies

(**10-2** [Gallagher, Michael])

Comment: However, we do not support the categorization of Design Basis Accidents Involving Radiological Releases as a Category 1 with SMALL significance finding/adverse effects. With the diversity of the new advanced reactor technology designs and the differences between these new reactors and current light water technologies, this should be listed as a Category 2 and a larger analysis of potential releases should be explored in the site-specific context. (**37-4** [Peterson, Alyse])

Comment: • Severe Accidents should be classified as a Category 1 issue based on existing NRC bounding analyses of severe accidents prepared as part of the License Renewal GEIS. For related reasons, the NRC also should remove Severe Accident Mitigation Design Alternatives (SAMDAs) from the NR GEIS as a separate issue requiring evaluation by applicants. (**38-1-7** [O'Neill, Martin])

Comment: L. Severe Accidents Should Be Classified as a Category 1 Issue Based on Existing NRC Bounding Analyses of Severe Accidents

Section 3.11.2.3 of the draft NR GEIS identifies severe accidents as a Category 2 issue. It further states that "[b]ased on the analysis in the FSAR/PSAR regarding severe accidents and PRAs, if a new reactor design has severe accident progressions that involve radiological or hazardous chemical releases, then an environmental risk evaluation must be performed."

NEI requests that the NRC reconsider its designation of severe accidents as a Category 2 issue. As defined in the NR GEIS, a Category 2 issue is one "for which a meaningful generic analysis of environmental impacts is not possible because the issue requires consideration of project-specific information."[91] With regard to nuclear power reactor severe accidents, such an analysis does exist in Chapter 5 (Environmental Impacts of Postulated Accidents) of the1996 License Renewal GEIS (LR GEIS).[92] That analysis documents the NRC's assessment of the impacts of postulated accidents at nuclear power plants on the environment, including design-basis accidents and severe accidents (e.g., those with core damage). Based on that analysis, the NRC concluded that "[t]he probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are small for all plants."[93]

The 1996 LR GEIS analysis was a Level 3 probabilistic risk assessment (PRA), in which the NRC considered dose and health effects of accidents (population dose risk, latent fatality risk, and prompt fatality risk) (see sections 5.3.3.2 through 5.3.3.4), economic impacts of accidents (see section 5.3.3.5), and the impact of uncertainties on results (see section 5.3.4). The estimated impacts were based upon the analysis of severe accidents at 28 nuclear power plants, as reported in the EISs and/or final environmental statements prepared for each of the 28 plants in support of their operating licenses. To address uncertainties, the 1996 LR GEIS analysis used 95th percentile upper confidence bound (UCB) estimates whenever available. The 1996 LR GEIS analysis concluded that the probability-weighted consequences and impacts

were small compared to other risks to which the populations surrounding nuclear power plants are routinely exposed.[94]

[91] Draft NR GEIS at 1-5.

[92] NRC, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Final Report* (NUREG-1437, Vols. 1 and 2) (May 1996) (ML040690705 and ML040690738) (1996 LR GEIS).

[93] 1996 LR GEIS, Vol. 1 at 5-115.

[94] The "probability-weighted consequences" of a severe accident are equal to the population dose risk (PDR), which is the core damage frequency (CDF) multiplied by the population dose (PD). As noted in footnote 4 of Appendix E to the 2024 LR GEIS, the correct terminology is "frequency-weighted consequences" because the accident consequences are multiplied by the core damage frequency. Since the 1996 LR GEIS used the term "probability-weighted consequences", the 2024 LR GEIS uses these terms interchangeably.

(**38-2-11** [O'Neill, Martin])

Comment:

In Revision 2 of the LR GEIS, issued in August 2024, the NRC updated its assessment of postulated accident risk, as the NRC's understanding of accident risk has further evolved since the issuance of the 1996 LR GEIS and 2013 LR GEIS (Revision 1).[95] In Appendix E to the 2024 LR GEIS, the NRC considered current information about plant-specific PRA results and other relevant risk information to assess their potential impacts on the conclusions in Chapter 5 of the 1996 LR GEIS.[96] For example, the NRC considered new internal events information, new source term information, use of BEIR VII risk coefficients, external events, low power and shutdown events, power uprates, higher fuel burnup, and new information about spent fuel pool accidents. Appendix E, Table E.5-1 of the 2024 LR GEIS (pp. E-94 to E-96) summarizes NRC's findings on these issues, including the following:

• The environmental impacts estimated using more recent and realistic source term information are expected to be much lower than the impacts used as the basis for the 1996 LR GEIS (i.e., the frequency-weighted consequences). The early fatality risk is orders-of-magnitude less than the NRC safety goal, and the latent cancer fatality risk is well below the NRC safety goal.[97]

• The internal events CDF has decreased, on average, by a factor of 4 to 6. However, the reduction in environmental impact is substantial, ranging from a factor of 2 to 600 and, on average, is about a factor of 30 lower when compared to the expected PDR value reported in the 1996 LR GEIS.

• Explicit consideration of the risk from all hazards in the 2024 LR GEIS shows that the probability-weighted dose consequences are bounded by the 1996 LR GEIS estimates. Table E.3-1 in Appendix E of the 2024 LR GEIS (pp. E-9 to E-11) shows that the estimated total PDR, which accounts for severe accidents initiated by internal events and external events during at-power operation, for each plant that has performed a SAMA analysis, is bounded by the corresponding 95 percent UCB population dose reported in the 1996 LR GEIS for each plant.[98] The predicted 95 percent UCB population dose values from the 1996 LR GEIS are higher for each plant by factors ranging from 3 to over 1,000 and are on average a factor of 120

higher than the corresponding total PDR values from the license renewal SAMA analyses. The population-weighted consequences reported in the 1996 LR GEIS are the basis for the determination therein that the environmental impact of severe accident risks is SMALL.

• The 1996 LR GEIS 95 percent UCB predicted values for early fatalities and latent fatalities are derived from the estimated radiological doses to the population. Thus, those values also are very conservative based on the updated information from the license renewal SAMA analyses.

[95] NRC, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Final Report* (NUREG-1437, Rev. 2, Vols. 1-3) (Aug. 2024) (2024 LR GEIS) https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/r2/index.html.

[96] See 2024 LR GEIS, Vol. 3. Appendix E (Environmental Impact of Postulated Impacts).

[97] As shown by the NRC's SOARCA study, the environmental impacts estimated using more recent and realistic source term information are expected to be much lower than the impacts used as the basis for the 1996 LR GEIS (i.e., the frequency-weighted consequences). *See State-of-the-Art Reactor Consequence Analyses (SOARCA) Report* (NUREG-1935) (Nov. 2012) (ML12332A057).

[98] Table E.3-1 reflects plant-specific SAMA analyses, in which the external events multiplier is multiplied by the estimated PDR for internally initiated events to develop the license renewal SAMA total plant PDR. As indicated in footnote (b) to Table E.3-1, data were obtained from the applicable plant-specific supplement to NUREG-1437, unless otherwise noted. Where applicable, the SAMA PDR was adjusted using the external events multiplier, which was developed on a plant-specific basis using the best available information and guidance at the time of the plant-specific SAMA analysis. The NRC also considered newer information from plant-specific reviews that included updated estimates of external risk in Section E.3.2 of Appendix E.

(**38-2-12** [O'Neill, Martin])

Comment:

Based on the detailed analysis presented in Appendix E, the NRC determined that the probability-weighted consequences estimated in the 1996 LR GEIS remain bounding after consideration of new and applicable plant-specific information and other relevant information. In fact, using site-specific Level 3 PRAs performed as part of license renewal SAMA analyses, all of the evaluated plants demonstrated that the environmental probability-weighted consequences had decreased.[99]

NEI recognizes that the LR GEIS analysis of severe accident impacts considers large light-water reactors (LWRs) making up the current operating fleet. We further acknowledge the NRC staff's statement in the draft NR GEIS that it "cannot prejudge the level of safety of a new reactor design a priori and, therefore, cannot rule out the need for a postulated accident analysis in future license applications."[100] Nonetheless, from an environmental risk perspective, NEI contends that any new reactors licensed by the NRC, including light-water SMR and advanced non-LWR designs, would be bounded by the LR GEIS analysis of severe accident impacts. From a safety perspective, such reactors will be licensed to meet safety requirements that are at least as strict as those applicable to the current operating fleet, and provide reasonable assurance of adequate protection to public health and safety. Moreover, new reactor

applicants presumably will have developed plant-specific PRAs (or other appropriate accident analyses) and considered mitigation design alternatives consistent with applicable NRC safety requirements and related guidance. As such, NEI is not suggesting that the NRC "prejudge the level of safety of a new reactor design" or forego postulated accident analyses that are needed to support the NRC's safety findings under the AEA and related NRC safety regulations.

Notably, Section 3.11.2.4 of the draft NR GEIS notes that "[i]t is expected that for severe accidents ...the probabilistic risk assessment provided in the safety analysis would have CDFs that would likely be substantially less than the CDFs associated with the current reactor fleet," and that "for non-LWR SAMA screening and assessments, event or release category frequency could be used in place of CDFs."[101] Publicly available data corroborate these points. For example, Table 2-1 ("PRA-Related Information for Use in Preliminary Screening Analyses") of NUREG/BR-0058, Revision 5 provides PRA-related information (including Average Internal Events CDF per reactor year) compiled from SAMA analyses that were conducted for nuclear power plant license renewal environmental reviews.[102] For the PWR designs, the Average Internal Events CDF per reactor year values range from 2.1E-05 to 3.9E-05. For the BWR designs, the Average Internal Events CDF per reactor year values range from 2.9E-06 to 3.0E-05. Table 2-1 also includes At Power Internal Events CDF per reactor year values for the three NRC-certified designs for which an associated combined license (COL) to build and operate has also been issued by the NRC. Those values are 1.6E-07 (ABWR – GEH), 2.4E-07 (AP1000), and 1.7E-08 (ESBWR), which are roughly two orders of magnitude lower than those of current operating reactors.

[99] 2024 LR GEIS, Vol. 3, App. E at E-6, E-84.

[100] Draft NR GEIS at 3-140.

[101] Draft NR GEIS at 3-142 (emphasis added).

[102] NRC, *Regulatory Analysis Guidelines of the U.S. Nuclear Commission, Draft Report for Comment* (NUREG/BR-0058, Rev. 5) at 2-17 (Apr. 2017) (ML17100A480).

(**38-2-13** [O'Neill, Martin])

Comment: Table 5.11-22 from the Kemmerer Power Station Unit 1 Environmental Report (Rev. 0), as excerpted below, shows how the estimated Accident Frequency and Population Dose Risk for the proposed Natrium 840 megawatts thermal pool-type sodium fast reactor compare to those of Generation III and newer, large LWRs.[103] The Accident Frequency is bounded by these other LWR designs (which, in turn, are bounded by the CDFs for the current operating fleet), and Population Dose Risk is roughly two to three orders of magnitude lower. Based on the results of its Level 3 PRA, the applicant concluded that environmental impacts of severe accidents are anticipated to be SMALL.[104]

Table 5.11-22 Comparison of the Natrium Design's Severe Accident Impacts to Advanced Large LWRs

Plant: Kemmerer 1
Design: Natrium
Accident Frequency (per reactor-yr): 1.4×10^{-8}
Dose Risk (person-rem/reactor-yr): 1.5×10^{-4}
Plant: Turkey Point 6 & 7

Design: AP1000
Accident Frequency (per reactor-yr): 2.4 x 10^{-7}
Dose Risk (person-rem/reactor-yr): 2.7 x 10^{-1}
Plant: Fermi 3
Design: ESBWR
Accident Frequency (per reactor-yr): 1.7 x 10^{-8}
Dose Risk (person-rem/reactor-yr): 3.2 x 10^{-2}
Plant: Comanche Peak 3 & 4
Design: US APWR
Accident Frequency (per reactor-yr): 1.2 x 10^{-6}
Dose Risk (person-rem/reactor-yr): 3.0 x 10^{-1}
Plant: Calvert Cliffs 3
Design: US EPR
Accident Frequency (per reactor-yr): 5.3 x 10^{-7}
Dose Risk (person-rem/reactor-yr): 3.5 x 10^{-1}
Note: Data from other plants are from the respective combined license applications.

In view of the above discussion, NEI believes there is sufficient technical basis for treating severe accidents as a Category 1 issue in the NR GEIS. Namely, the 1996 LR GEIS analysis of severe accidents, as augmented and updated by the 2013 and 2024 LR GEISs, will bound the frequency-weighted consequences of postulated severe accidents for new reactors, thereby providing the "meaningful generic analysis" needed to support a Category 1 designation.

In stating that an environmental risk evaluation must be performed for new reactor designs with severe accident progressions that involve radiological or hazardous chemical releases, the draft NR GEIS quotes a June 13, 1980 interim Commission policy statement.[105] That interim policy statement, which was issued following the March 1979 accident at Three Mile Island Unit 2, expired on September 11, 1980.[106] It also has been rendered moot by numerous developments over the last 44 years, including subsequent NRC regulatory actions and technical studies on severe accident risks. Further, as discussed above, the federal courts have affirmed the NRC's authority under NEPA to generically analyze – including through the use of "conservative bounding assumptions" – risks or impacts that are essentially common to all plants and to codify those determinations.[107] Through the LR GEIS, the NRC has provided a thorough and comprehensive generic analysis that also supports the classification of severe accidents as a Category 1 issue for new reactors.

[103] TerraPower, LCC, Kemmerer Power Station Unit 1 Environmental Report at 5.11-40 (Mar. 2024) (ML24088A072).

[104] Id. at 5.11-4.

[105] Draft NR GEIS at 3-137 (quoting Nuclear Power Plant Accident Considerations Under the National Environmental Policy Act of 1969; Statement of Interim Policy, 45 Fed. Reg. 40,101, 41,103 (June 13, 1980),

[106] Also, unlike statutory provisions, regulations, and orders, Commission policy statements generally do not impose legally binding requirements on the NRC staff or licensees. Although federal courts sometimes find agency policy statements to be tantamount to "legislative rules" that impose legally binding requirements (and thus subject to judicial review), general policy statements typically serve to advise the public about the manner in which the agency intends to exercise its discretionary authority. See, e.g., Brock v. Cathedral Bluffs Shale Oil Co., 796 F.2d

533, 537 (D.C. Cir. 1986) (“A general statement of policy … does not establish a ‘binding norm’ [and instead] announces the agency’s tentative intentions for the future.”).

[107] *New York v. NRC*, 824 F.3d 1012, 1019 (D.C. Cir. 2016).
(**38-2-14** [O'Neill, Martin])

Comment:

M. Severe Accident Mitigation Design Alternatives (SAMDAs) Should Be Removed From the NR GEIS as a Separate Issue Requiring Evaluation

NEI also recommends that the NRC remove SAMDAs from the NR GEIS as a separate issue requiring evaluation. In the draft NR GEIS, the NRC has classified SAMDAs as a Category 1 issue and established the following PPE value/assumption: "If a cost-screening analysis determines that the maximum benefit for avoiding an accident is so small that a SAMDA analysis is not justified based on a minimum cost to design an appropriate SAMDA."[108] For the reasons stated below, such an analysis is neither warranted nor an efficient use of applicant and agency resources.

As discussed in Section L above, the highly conservative, bounding analysis in the LR GEIS demonstrates that the frequency-weighted consequences of severe accidents are SMALL for all plants. Additionally, the numerous SAMA analyses performed by license renewal applicants have confirmed the Commission's expectation - as conveyed in the 1996 rulemaking codifying the license renewal SAMA analysis requirement - that SAMA analyses are unlikely to identify "major plant design changes or modifications that will prove to be cost-beneficial."[109] Indeed, as noted in the 2024 LR GEIS, none of the SAMA analyses performed by license renewal applicants to date has identified plant-specific "major" cost-beneficial SAMAs that significantly reduce the risk of a severe accident:

[P]lant-specific "major" cost-beneficial SAMAs that significantly reduce the risk ... have not been identified in SAMA analyses and almost all currently operating plants having performed a SAMA. This result included consideration of uncertainty, wherein estimated SAMA benefits, developed using the mean point estimate for internal events CDF, were multiplied by an uncertainty factor derived from the ratio of the 95th percentile to the mean point estimate for internal events CDF, which was compared to the estimated implementation cost of the SAMA for the determination of whether it was potentially cost-beneficial. However, as a result of the NRC's ongoing safety oversight, significant improvements in plant safety including reducing the risk of a severe accident initiated by internal or external events have been achieved as a result of processes separate from license renewal, such as post-Fukushima Orders for mitigation of beyond-design-basis events. Because these measures have provided additional severe accident mitigation and/or further reduced the risk profile of operating reactors, they decrease the possibility that further SAMA analyses would uncover cost-beneficial SAMAs ....[110]

In a 2016 decision arising from the *Limerick* license renewal proceeding, the D.C. Circuit made similar observations, noting that "SAMAs represent only a minor portion of the Commission's overall regulatory regime - separate and apart from its safety requirements," and that the NRC "relies on a myriad of other safety mechanisms to prevent accidents," including "ongoing safety oversight."[111]

The foregoing observations apply *a fortiori* to new reactor designs, which, in addition to being required to meet all current applicable NRC safety requirements, are expected to include

enhanced safety features that will reduce both the frequency and the consequences of core damage events (if not preclude such events altogether).[112] The draft NR GEIS acknowledges this in stating that "[t]he risks from new reactor accidents may be limited" because "[a] major emphasis for the development of new reactors is the minimization (i.e., a very low probability of an accident with an offsite radiological or hazardous chemical release) or the elimination of radioactive or hazardous chemical releases from accidents."[113] The draft NR GEIS further notes that for new reactors, "the probabilistic risk assessment provided in the safety analysis would have CDFs that would likely be substantially less than the CDFs associated with the current reactor fleet."[114]

As the Commission has noted, "[u]nder basic NEPA principles, it is reasonable to tailor the degree of mitigation analysis to the significance of the impact to be mitigated."[115] In this case, NEI contends that mitigation analysis in the form of cost-screening analysis for SAMDAs is not necessary given that the frequency-weighted consequences of postulated severe accidents for new reactors are expected to be SMALL (as they are bounded by the LR GEIS), and the unlikelihood that any cost-beneficial SAMDAs that significantly reduce the risk of a severe accident will be identified.

[108] Draft NR GEIS at 3-142, 4-21 (Table 4-1), Appendix G at G-13 (Table G-1).

[109] NRC, Environmental Review for Renewal of Nuclear Power Plant Operating Licenses; Final Rule, 61 Fed. Reg. 28,467, 28,481 (June 5, 1996) (noting that any additional plant enhancements identified by license renewal SAMA analyses as cost-beneficial "generally would be procedural and programmatic fixes, with any hardware changes being only minor in nature and few in number").

[110] 2024 LR GEIS, Vol. 3, App. E at E-86.

[111] *Natural Res. Def. Council v. NRC*, 823 F.3d 641, 650-51 (D.C. Cir. 2016).

[112] Such features include passive safety systems that rely on natural phenomena such as gravity, natural circulation, and inherent material properties rather than active systems or operator intervention. Advanced designs also may incorporate inherent reactivity control mechanisms to prevent criticality accidents. Lower operating pressures also help prevent damage to the reactor core or containment and limit the dispersal of radioactive materials. In addition, advanced reactors may have robust containment structures that can withstand extreme external events (e.g., earthquakes, floods) and/or use advanced fuels (e.g., TRISO) that can withstand extreme temperatures without degradation and contain fission products within the fuel itself. These features provide multiple layers of defense to contain radioactive materials and prevent the release of radionuclides to the environment, even under severe accident conditions.

[113] Draft NR GEIS at 3-140. As the NRC has noted with regard to micro-reactors, "[a] particular micro-reactor design may not have credible severe accidents associated with it. In such a case, the NRC staff will not need to assess the offsite environmental impacts from severe accidents or evaluate the benefits and costs of SAMAs." COL-ISG-029, *Environmental Considerations Associated with Micro-reactors* (Oct. 2020) (ML20252A076).

[114] Draft NR GEIS at 3-142.

[115] *Entergy Nuclear Operations, Inc.* (Indian Point, Units 2 and 3), CLI-16-7, 83 NRC 293, 323 n.156 (2016). Cf. See 10 CFR 51.45(b)(1) ("Impacts shall be discussed in proportion to their significance.").

(**38-2-15** [O'Neill, Martin])

Response:

The NRC staff agrees in part and disagrees in part with the comments. Based on the comments, the NRC staff has revised Severe Accidents to a Category 1 issue in the final rule and developed PPE/SPE values based on, among other things, leveraging severe accident and severe accident mitigation alternative analyses and data from the 2024 LR GEIS (NRC 2024-TN10161) as noted by two commenters. The NRC staff also agrees the Severe Accident Design Alternatives category should be merged with the Severe Accidents issue because, if the Severe Accident PPE/SPE values and assumptions are met, then mitigation is addressed and does not need to be separately assessed. The need to assess mitigation will be driven by the Severe Accidents Category 1 finding and PPE/SPE values based on the characteristics of the design and the site. However, the NRC staff disagrees that the 2024 LR GEIS analysis of severe accidents may be generically applied to all new reactor designs (e.g., non-light-water reactors and unique light-water small modular reactor designs) and sites, as is. The NRC staff also disagrees that the Limerick decision and the June 1, 1980, Commission Policy Statement entitled "Nuclear Power Plant Accident Considerations Under the National Environmental Policy Act of 1969" (45 FR 40101-TN4270) no longer apply. Providing clarification by updating the Severe Accident issue category would provide flexibility in the implementation of the NR GEIS when actual, on-the-ground circumstances for a specific reactor design, whether light-water, liquid sodium metal, molten salt, or high-temperature gas nuclear reactors, and power level may warrant a site-specific evaluation. To support these changes to the Rule, the NR GEIS has been updated to provide a fully developed technical basis as presented in Appendix I of the NR GEIS for designating the Severe Accident issue category as Category 1 with associated PPE/SPE values.

The NRC disagrees that design-basis accidents involving radiological releases should be a Category 2 issue. Design-basis accidents involving the release of radioactive material must meet safety regulatory requirements in either 10 CFR Part 50 or 10 CFR Part 52, and the PPE/SPE are based on these regulatory requirements. An applicant must demonstrate that the design of its proposed nuclear reactor and the parameters of the proposed site meet or are bounded by the values and assumptions of the NR GEIS analysis supporting that Category 1 finding. If the applicant cannot demonstrate that it meets the PPE/SPE, a project-specific analysis is needed.

Based on these comments, the NRC staff has added Appendix I to the NR GEIS, made changes to Section 3.11.2.3 of the NR GEIS, and made appropriate changes to Table C-1 of Appendix C to Subpart A of 10 CFR Part 51. (GEIS-NR-DR0036R)

E.2.10 Environmental Justice

Comment: 2. Environmental Justice

Historically, minority and low-income communities have borne a disproportionate share of the risks associated with nuclear facilities. Studies show that "communities of color and economically disadvantaged groups are more likely to live near hazardous waste sites and

nuclear facilities" (Cruz, 2023). The NRC must ensure that its regulatory updates explicitly address environmental justice to prevent further marginalization of vulnerable populations. While Environmental Justice is categorized in the site-specific Category 2 level of analysis, we believe that more analysis is needed to improve these reports and mitigate the damage from environmental injustices.

We propose the following actions to strengthen environmental justice considerations:

• Dedicated Environmental Justice Assessments: Incorporate detailed evaluations of how proposed actions may affect historically underserved communities.

• Early and Meaningful Involvement: Engage vulnerable populations at the earliest stages of the review process to address concerns proactively.

• Equity Audits: Conduct periodic equity audits to assess whether the proposed rules disproportionately impact specific demographic groups and mitigate those effects. Such measures will align the NRC's processes with Executive Order 12898, which mandates federal agencies to prioritize environmental justice in their actions. (**15-2** [Eo, Taeseon] [Lee, Changki] [Lester, Jackson] [Schmidt, Trevor])

Comment: Socioeconomic Issues and Environmental Justice
The location of nuclear reactors regularly has socio economic problems specifically for nearby communities. Even though there are positive economic impacts by creating jobs in those communities, nuclear plants bring threats to safety, land use, and most importantly environmental justice. It is well known that some of these plants have been located and constructed in the city suburbs, nearby marginalized communities with lower incomes. This is a violation of human rights and it raises questions regarding equal treatment. It is clear that these communities do not possess the ability to sue these companies due to their lower income, which is why they have been silenced and their rights have been abused. Their health and safety have been impacted in an extremely dangerous way making them more prone to cancer and other radiation-related diseases. This is why I consider that it is extremely important for the NR GEIS to include provisions in order to assess the socioeconomic impacts of nuclear projects on local marginalized communities. It must be ensured that no community is at risk and we have a fairer process for site selection. Environmental justice considerations should also be central to site selection, ensuring that no community bears a disproportionate burden of nuclear risks. (**17-4** [Aguilar S., Kathya])

Comment: *Environmental Justice*
NRC should consider including a broad discussion on how the Preferred Alternative will affect communities with environmental justice (EJ) concerns for each of the upcoming site-specific analyses.[9] Under NEPA, CEQ requires the lead Federal agency to analyze the disproportionate and adverse human health and environmental effects of a proposed action in communities with EJ concerns. If significant human health and environmental effects disproportionately and adversely affect communities with EJ concerns, CEQ regulations direct lead Federal agencies to, where relevant and appropriate, consider incorporating mitigation measures that address or reduce those effects.[10] NRC's own regulations and policies also direct the agency to evaluate effects related to EJ as part of its NEPA reviews.[11]

[9] Communities with environmental justice concerns are those that may not experience the just treatment and meaningful involvement of all people, regardless of income, race, color, national origin, Tribal affiliation, or disability in agency decision making so that the people are fully

protected from disproportionate and adverse human health and environmental effects (including risks) and hazards, including those related to climate change, the cumulative of environmental and other burdens, and the legacy of racism or other structural or systemic barrier, and have equitable access to a healthy, sustainable, and resilient environment. See 40 CFR § 1508.1(f) and (m); see also NEPA Section 102(2)(c).

[10] 40 CFR § 1505.3(b). EO 12898 and EO 14096 also direct Federal agencies, as appropriate and consistent with applicable law, to identify, analyze, and address disproportionate and adverse effects of Federal activities, including those related to climate change and cumulative effects, on communities with EJ concerns.

[11] See, e.g., 10 C.F.R. § 51.71(d); see also *Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions*, 69 FR 52040, 52044 (Aug. 24, 2004) ("It is the Commission's view that the obligation to consider and assess disproportionately high and adverse impacts on low-income and minority populations as part of its NEPA review was not created by the E.O. Rather, it is the Commission's view that the E.O. reminded agencies that such an analysis is appropriate in its normal and traditional NEPA review process.")

(**23-17** [Chumble, Prasad])

Comment: The following recommendations are provided for NRC's consideration as opportunities to analyze, disclose, and reduce effects to communities with EJ concerns in future NEPA documents.[12]

Direct, Indirect, and Cumulative Effects Analysis

The draft GEIS indicated that EJ analyses conducted for project-specific supplements must demonstrate an EJ population is both disproportionately high and adversely affected by the Preferred Alternative.[13] Under CEQ's NEPA Implementing Regulations[14] environmental justice is now evaluated based simply on disproportionate and adverse effects. The EPA recommends NRC consistently reference and evaluate environmental justice based on the adjusted language, "disproportionate and adverse," as outlined in CEQ regulations.

[12] For purposes of NEPA review, the EPA considers a project to be in an area of potential EJ concern when the area shows one or more of the thirteen EJ indices at or above 80th percentile in the nation/state on EJScreen. However, scores under the 80th percentile should not be interpreted to mean there are definitively no EJ concerns present.

[13] See Section 3.13.1, "*An EJ analysis is required to determine whether that population would experience any disproportionately high and adverse human health effects.*"

[14] 40 CFR § 1502.16(a)(13)

(**23-18** [Chumble, Prasad])

Comment: The draft GEIS indicated that the baseline conditions to evaluate EJ analyses in project-specific supplements would be limited to data on low-income and minority populations using only demographic characteristics.[15] The evaluation criteria are based on the 2004 "Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions."[16] Section 3.13.2 stated, "*project-specific factors include the presence, geographic location, and size of specific minority or low-income populations; impact pathways derived from*

the plant design, layout, or site characteristics; or other community characteristics [emphasis added] affecting specific minority or low-income populations."

EJ analyses should no longer be limited to only the effects on low-income and minority communities.[17] It is reasonable to assume that other community characteristics include existing pollution exposures, health vulnerabilities, and climate change-related effects. Federal agencies should analyze all human health and environmental effects based on the best available science and information on disproportionate effects arising from exposure to pollution and other environmental hazards, using information on race, national origin, age, and disability status, among others.[18] The EPA encourages the use of EJScreen when conducting an EJ analysis.[19] This tool provides information on environmental and socioeconomic indicators as well as pollution sources, health disparities, critical service gaps, and climate change data.[20] The EPA recommends that NRC commit to the following when performing a project-specific supplement, consistent with CEQ's NEPA Implementing Regulations:[21]

1. Disclose demographic information and identify the presence of communities with EJ concerns in and/or near the project area that could experience environmental effects from the proposed project.

2. Include an analysis and conclusion regarding whether the Preferred Alternative or any action alternatives, including the No Action Alternative, may have disproportionate and adverse effects on communities with EJ concerns, as specified in CEQ's NEPA Implementing Regulations.[22]

3. Consider any disproportionate, non-project-related pollution exposures that communities of EJ concern may already be experiencing, as well as any disproportionate non-pollution stressors that may make communities more susceptible to pollution, such as health conditions, other social health determinants, and disproportionate vulnerability to climate change.

4. Where relevant and appropriate, identify and commit to measures that will be taken to avoid, minimize, and mitigate effects identified above.

[15] Pages 3-150 through 3-151.

[16] 69 FR 52040, see https://www.federalregister.gov/d/04-19305.

[17] EO 14096, CEQ's NEPA Implementing Regulations, and the EPA all use an updated definition of environmental justice (EJ) that considers disproportionate and adverse human health and environment effects for all communities, not just those classified as low-income and minority. For more information on the EPA and EJ, see https://www.epa.gov/environmentaljustice/learn-about-environmental-justice.

[18] Research has supported the finding that underserved communities are exposed to higher pollution burdens and have higher rates of morbidity and mortality. To view these findings, see the following resources: Tessum, C.W., Paolella, D.A., Chambliss, S.E., Apte, J.S., Hill, J.D., & Marshall J.D. (2021). PM2.5 polluters disproportionately and systemically affect people of color in the United States, Science Advances 7(18), 10.1126/sciadv.abf4491; Ihab Mikati, Adam F. Benson, Thomas J. Luben, Jason D Sacks, and Jennifer Richmond Bryant, Disparities in Distribution of Particulate Matter Emission Sources by Race and Poverty Status, Am. J. Public Health. 2018 April; 108(4): 480– 485; Technical Guidance for Assessing Environmental Justice in Regulatory Analysis, Section 4, U.S. EPA; Catherine Jampel, Intersections of Disability Justice, Racial Justice, and Environmental Justice, Environmental Sociology (2018),

10.1080/23251042.2018.1424497; USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II, Chapter 19 (discussing rural communities) [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018, https://nca2018.globalchange.gov.

[19] Access the EPA's EJScreen here: https://www.epa.gov/ejscreen.

[20] EJScreen includes layers on the Justice40 Climate and Economic Justice Screening Tool (https://www.epa.gov/environmentaljustice/inflation-reduction-act-disadvantaged-communities-map) and the EPA Inflation Reduction Act Disadvantaged Communities map (https://screeningtool.geoplatform.gov/en/methodology).

[21] For CEQ's updated regulations on environmental justice and EJ analyses, see: 40 CFR § 1500.2(d-e) and 40 CFR § 1501.3(d)(vii).

[22] 40 CFR § 1502.16(a)(13).

(**23-19** [Chumble, Prasad])

Comment: *Meaningful Engagement and Public Participation*

EJScreen can inform EJ and community outreach to identify potential meeting locations and any language barriers by providing information on linguistic isolation, languages spoken, and places of community cohesion (e.g., schools, places of worship, etc.). The draft GEIS did not provide information or discuss NRC's approach to facilitate meaningful engagement and public participation for project-specific supplements to the GEIS. EPA recommends NRC consider and commit to the following:

1. Discuss the meaningful involvement and targeted outreach[23] to communities with EJ concerns to be undertaken by NRC in plain language and languages other than English spoken by residents in and/or near the project area when completing a project-specific supplement. Consider local and Indigenous knowledge, linguistically isolated populations within the project area, etc.[24]

[23] Consider engaging the public early and often, proactively seek full representation from the community, consider public comments and feedback, and incorporate feedback into the project.

[24] 40 CFR § 1501.9; 40 CFR § 1502.15(b); see also 10 CFR §§ 51.26, 51.73-74.

2. Utilize resources such as the Promising Practices for EJ Methodologies in NEPA Reviews Practices[25] and the Community Guide to EJ and NEPA Methods[26] to conduct an EJ analysis that appropriately engages in meaningful, targeted community outreach, analyzes effects, and advances EJ principles through NEPA implementation.

[25] https://www.epa.gov/sites/default/files/2016-08/documents/nepa_promising_practices_document_2016.pdf.

[26] https://www.energy.gov/sites/prod/files/2019/05/f63/NEPA%20Community%20Guide%202019.pdf.

(**23-20** [Chumble, Prasad])

Response:

The NRC disagrees with the comments. The comments relate to NRC's evaluation and analysis of environmental justice issues in the NR GEIS.

Effective April 30, 2025, the Commission withdrew its Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions (Environmental Justice Policy Statement) and its Environmental Justice Strategy (90 FR 17887-TN11684). This action was taken in response to Executive Order 14173 (90 FR 8633-TN11607), which rescinded Executive Order 12898. In Staff Requirements Memorandum COMSECY-25-0007 (NRC 2025-TN11710), "Withdrawing the Environmental Justice Policy Statement and Environmental Justice Strategy," signed April 10, 2025, the Commission directed the staff to "take a comprehensive review of the NRC's environmental regulations, guidance, and training materials to remove references to Environmental Justice (EJ) ...." and "... to refrain from explicitly addressing EJ in its [NEPA] reviews ...."

Therefore, the NRC is no longer considering environmental justice as an issue needing to be addressed in new reactor environmental reviews and removed the two Category 2 issues identified in the Draft NR GEIS and proposed rule. Section 1.4 of the NR GEIS discusses the process by which the NRC will implement this rule in subsequent project-specific reviews, including opportunities for public participation and consultation. No additional changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

E.2.11 Uranium Fuel Cycle

Comment: *Fuel Cycle Impacts / Uranium Recovery*

The NRC has identified six environmental issues for analysis of fuel cycle impacts associated with a new reactor. Uranium recovery is one of those issues and is discussed in section 3.14.2.1. It states "…the NRC regulates in situ recovery (formerly known as in situ leach recovery), where the uranium ore is chemically altered underground before being pumped to the surface for further processing. Currently, the NRC regulates active uranium recovery operations in New Mexico and Nebraska but does not directly regulate the active uranium recovery operations in Wyoming, Texas, Colorado, and Utah, because they are Agreement States, meaning that they have entered into strict agreements with the NRC to exercise regulatory authority over this type of material". The EPA recommends that this statement be clarified to convey that uranium in situ leaching is managed by the
EPA's UIC program as a Class III injection activity.

In addition, Table 4-1, Summary of Findings and Mitigation indicates that based on the PPE/SPE values and assumptions that a new reactor "Must satisfy the regulatory requirements of 10 CFR Part 40, Domestic Licensing of Source Material and 10 CFR Part 71, Packaging and Transportation of Radioactive Material.", the uranium recovery issue is small. The EPA recommends that this statement be clarified to indicate that it must satisfy UIC requirements of 40 CFR Part 144 and 146. (**23-8** [Chumble, Prasad])

Response:

The NRC agrees with the comment. The NRC acknowledges that fuel cycle facilities may be subject to both NRC and EPA regulations. Section 3.14.2.1 of the NR GEIS has been updated to indicate that in situ leach recovery is also subject to the EPA Underground Injection program as a class III injection activity.

Comment: N. The Final NR GEIS Should Reflect Current Advanced Reactor Fuel Cycle Developments

The NRC presumably will update the NR GEIS before its publication in final form to reflect significant technical, regulatory, and/or commercial developments that may inform the NRC staff's analyses. One area NEI wishes to highlight is the advanced reactor fuel cycle and the HALEU supply developments in particular. As indicated above, DOE issued its Final HALEU EIS in October 2024. That EIS evaluates the potential environmental impacts from activities associated with DOE's Proposed Action, which is to acquire, through procurement from commercial sources, HALEU enriched to at least 19.75 and less than 20 weight percent uranium-235 (U-235) over a 10-year period of performance, and to facilitate the establishment of commercial HALEU fuel production.[116] DOE also analyzed, to the extent feasible, the environmental impacts associated with the use of the HALEU that would occur after the Proposed Action activities, including fuel fabrication, use of HALEU in advanced reactors, and spent nuclear fuel storage and disposition. DOE based its bounding impact analyses largely on NEPA analyses for both existing and previously-proposed fuel cycle facilities licensed by the NRC, taking into account the possibility of using existing nuclear facility sites, other brownfield sites, and greenfield sites.

In October 2024, DOE also announced awards of multiple HALEU-related contracts under its HALEU Availability Program. They include contracts with six companies to perform HALEU deconversion and to transform enriched UF_6 to other chemical forms, including metal or oxide, for storage before it is fabricated into fuel for advanced reactors.[117] DOE also executed contracts with four companies to provide enrichment services for producing HALEU.[118] In November 2024, DOE announced a new HALEU transportation package funding opportunity to research, develop, and acquire NRC licensing for HALEU transportation packages.[119]

Given these developments, the NRC should update Section 3.14 (Fuel Cycle), and Section 3.14.2 (DOE High-Assay Low-Enriched Uranium Availability Program) in particular, of the NR GEIS. In doing so, the NRC should consider whether portions of DOE's Final HALEU EIS (which include discussion of the NRC's draft NR GEIS) might be incorporated by reference to the extent they are relevant to the NRC's assessment of new reactor fuel cycle impacts.

[116] Those activities include the extraction and recovery of uranium ore (from domestic and/or foreign in-situ recovery or conventional mining and milling sources); uranium conversion to uranium hexafluoride (UF6) for input to enrichment facilities; enrichment to HALEU of from 19.75 to less than 20 weight percent U-235 in an NRC-licensed Category II facility; HALEU deconversion from UF6 to uranium oxide, metal, and other forms suitable for use in fuel fabrication in an NRC Category II facility; storage in an NRC Category II facility or facilities of the converted HALEU; transportation of materials between facilities; and DOE acquisition of up to 290 MT of HALEU.

[117] *See* https://www.energy.gov/ne/articles/biden-harris-administration-announces-6-contracts-spur-americas-domestic-haleu-supply.

[118] *See* https://www.energy.gov/articles/biden-harris-administration-announces-four-contracts-boost-domestic-haleu-supply-and.

[119] *See* https://www.energy.gov/ne/articles/us-department-energy-issues-new-funding-opportunity-develop-haleu-transportation.

(**38-2-16** [O'Neill, Martin])

Response:

The NRC agrees with the comment. NRC staff recognizes that DOE is actively pursuing HALEU availability and that progress has been made since the issuance of the Draft NR GEIS. DOE has awarded contracts for production of HALEU fuels. Companies, such as American Centrifuge Operating, General Matter, Louisiana Energy Services, and Orano Federal Services, have been awarded contracts for enrichment (DOE 2025-TN11939). DOE has awarded contracts for deconversion of enriched materials to BWXT, Centrus, Framatome, GE Verona, and Orano (DOE 2025-TN11941). Centrus has begun producing enriched uranium to HALEU levels at their Piketon facility and will be ramping up domestic production of HALEU (CEC 2025-TN11936; Urenco 2024-TN11937). The text in Section 3.14.1.3 was revised to reflect the completion of DOE/EIS-0559 as well as to provide the current status of the HALEU Availability program.

E.2.12 Climate Change

Comment: On the other hand, I also want to highlight and agree with the NRC for identifying "climate change" as a Category 2 issue. Although nuclear reactors produce greenhouse-gas-free energy, they still face indirect effects from climate change that can impact their operations, causing other environmental issues. As mentioned before, most of the issues relating to the Turkey Point Nuclear Generator are due to climate change. Even though the Turkey Point Nuclear Generator is unique for its cooling canals, all nuclear reactors have some water cooling system, which will be and are currently impacted by increasing extreme weather conditions and temperature levels (Miami Waterkeeper, 2024). I would suggest that the NRC not only list climate change as a Category 2 issue but put it at the forefront of evaluations since it is ever-changing and very dangerous for the future of nuclear operations. (**16-4** [Tasoluk, Sofia])

Response:

The NRC agrees in part and disagrees in part with the comment. The NRC agrees that climate change should be a Category 2 issue. As described in Section 1.3.3 of the NR GEIS, climate change is recognized as one of 20 environmental issues that cannot be evaluated generically and must be evaluated using project-specific information (i.e., a Category 2 issue). Furthermore, the NR GEIS identifies climate change as an issue that applies across all environmental resource areas. The NRC disagrees that the issue of climate change should be highlighted in the NR GEIS more prominently than other Category 2 issues. Section 1.3.3.2.2 of the NR GEIS describes the basis for the determination that climate change is a Category 2 issue. This level of analysis is appropriate and similar to that of other Category 2 issues. Because climate change is a Category 2 issue, the NR GEIS and rule do not address how the staff would evaluate it and climate change's relative importance compared to other environmental issues.

No changes to the NR GEIS, final rule, or guidance were made in response to the comment.

Comment: *Climate Change Effects, Adaptation and Resilience*

The EPA concurs with NRC's proposal to include climate change considerations as a Category 2 issue. The EPA also recommends the GEIS discuss ongoing and projected climate resilience/adaption as related to planning future project design, outlining measures to be taken to ensure resilience/adaptation to protect the infrastructure investment from the effects of climate change. The long-lived nature of nuclear infrastructure makes consideration of the ongoing and projected impacts of climate change even more important. It is not sufficient to ensure resilience of the project to risks under current climate conditions. Considering potential climate change impacts helps ensure that investments made today continue to function and provide benefits, even as the climate changes. The EPA recommends that the GEIS specifically discuss how climate resiliency should be considered in the site selection and design of future proposed actions and alternatives. In addition, the required consideration of any relevant state, tribal, or local adaptation plans, would ensure the consideration of ongoing and projected regional and local climate impacts, including, but not limited to, rising sea levels, drought, high intensity precipitation events, at-risk areas not yet designated as flood zones, and increased fire risk. Consideration of these impacts could help avoid infrastructure investments in vulnerable locations, and unintended impacts on local communities. (**23-15** [Chumble, Prasad])

Response:

The NRC disagrees with the comment. The scope of the Category 2 climate change issue focuses on the impacts of climate change on environmental resources that are also affected by new reactor construction and operation during the license term. To the extent that communities potentially affected by the project could also be affected by climate change, the NRC's evaluation of the climate change issue would consider this. However, the scope of the Category 2 climate change issue does not include the climate change impacts on risks to power plant infrastructure and the safe operation of nuclear power plants. The effects of climate change on a plant's structures, systems, and components are outside the scope of the NRC's environmental review and the NR GEIS and rulemaking.

The NRC's environmental review documents the potential effects from new reactor construction and operation on the environment. In addition to the environmental review, the NRC will conduct a safety review and issue a safety evaluation report. Site-specific environmental conditions are considered for safety concerns when siting nuclear power plants. This includes the consideration of meteorological and hydrologic siting criteria, including maximum probable precipitation, as set forth in 10 CFR Part 100 (TN282), "Reactor Site Criteria." NRC regulations require that nuclear power plants operate within technical specifications in accordance with the NRC operating license, including coping with natural phenomenon hazards, such as flooding. Furthermore, NRC regulations require that plant structures, systems, and components important to safety be designed to withstand the effects of natural phenomena, such as flooding, intense precipitation, and drought, without loss of capability to perform safety functions.

Additionally, once the license is issued, the NRC evaluates nuclear power plant operating conditions and physical infrastructure to ensure ongoing safe operations under the plant's operating license(s) through the NRC's reactor oversight program. If new information about changing environmental conditions (such as rising sea levels that threaten safe operating conditions or challenge compliance with the plant's technical specifications) becomes available, the NRC will evaluate the new information to determine whether any safety-related changes are needed at licensed nuclear power plants. The NRC staff's safety evaluation process is separate and distinct from the NRC staff's new reactor environmental review that it conducts in

accordance with NEPA and the NRC's regulations for implementing NEPA in 10 CFR Part 51. No changes to the NR GEIS, final rule, or guidance were made in response to the comment.

Comment: Climate Change

The NRC's current classification of climate change as a Category 2 issue rests on the argument that its effects are location-specific and cannot be evaluated generically. However, this framing limits the utility of the NRC's environmental reviews and should be reconsidered based on the following rationale:

Environmental Impact Statements (EIS) assess the potential environmental effects of projects. These effects are feasible to quantify when they are direct, tangible, and local, like pollution going into a stream near the site of a project. Assessing the site-specific climate change impact from the project itself is much more challenging because carbon dioxide is a well-mixed greenhouse gas that disperses evenly throughout the Earth's atmosphere over time. This global mixing ensures that CO2 emissions contribute to the enhanced greenhouse effect regardless of their geographic origin, and thus, the impact of CO2 emissions on the climate is independent of where those emissions occur.[30] Further, CO2 accumulates in the atmosphere resulting in impacts that are the sum result of cumulative emissions over time. The global cumulative CO2 emissions since the late 1800s have been around 2,500 GtCO2.[31] There are many assessed impacts of those cumulative emissions[32] but the impacts attributable to any one source are necessarily small. For example, the carbon footprint of a large nuclear power plant over its lifetime might be on the order of 2.5 million metric tons of CO2.[33] This would only be 2x10-6 (0.0002%) of the global cumulative CO2 emissions since the late 1800s. Thus, any climate change-related impact (either at the location of the plant or elsewhere) attributable to the emissions of the plant itself would be scientifically indeterminable. Even if direct impacts could be causally determinable and attributable, it would be relatively negligible compared to cumulative emissions.

The primary impact of a nuclear reactor project related to climate change is its contribution to or reduction of greenhouse gas (GHG) emissions. The NR GEIS appropriately classifies GHG emissions as a Category 1 issue. This is inherently a global issue, not tied to specific locations, as GHG emissions from one site contribute to climate trends worldwide. The net positive impact of nuclear energy in reducing emissions is uniform across projects, making this aspect well-suited for Category 1 classification.

The current rationale that location-specific climate change impacts (e.g., changing precipitation patterns) cannot be generically evaluated creates inconsistencies. For instance, attributing specific climate outcomes (e.g., local rainfall changes) to emissions from a single plant is scientifically unsupported. Generic treatment could streamline reviews while maintaining scientific rigor.

Similar to other issues categorized as Category 1 where impacts are uniform across sites, the climate benefits of nuclear power—such as displacing fossil fuels—are well-documented and could be generically addressed.

Alternatively, climate change could be folded into cumulative effects evaluations. This approach acknowledges that climate-related changes, such as regional temperature or precipitation shifts, are part of broader environmental trends influenced by multiple actions (local and global). This aligns with NRC's definition of cumulative effects, which considers "past, present, and reasonably foreseeable actions."[34] Section 9.3.5 of DG-4032 describes this connection in

saying, "The potential impacts of climate change should be considered under cumulative impacts for alternative sites."[35]

The NR GEIS further explains cumulative effects as a Category 2 issue: "Effects would depend on regional resource characteristics, the resource-specific impacts of the proposed project, and the cumulative significance of other factors affecting the resource."[36] BTI contends that climate change is inextricably linked to that explanation. Combining climate change with cumulative effects reduces redundancy and confusion. For example, instead of addressing climate change impacts in isolation, applicants could integrate these analyses into cumulative effects, focusing on how proposed projects fit into broader trends and environmental baselines.

Recommendations

BTI recommends the NRC staff to take one of the following revisions:
1.Reclassify the climate change impacts from nuclear plants on GHG emissions as a Category 1 issue, reflecting the generic and uniformly positive nature of these impacts.
2.Alternatively, if the NRC Staff deems that climate change impacts remain a Category 2 issue, combine climate change into the related cumulative effects Category 2 issue to streamline the review process.

[30] See IPCC AR6 WG1 Ch. 7, https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-7/#Effective

[31] See IPCC SR15 Fig. 2.3, https://www.ipcc.ch/sr15/chapter/chapter-2/2-2/2-2-2/2-2-2-1/figure-2-3/

[32] See IPCC AR6 WG2 https://www.ipcc.ch/report/ar6/wg2/

[33] Draft NR GEIS, 3.3.1, Page 3-18, Line 31.

[34] Draft NR GEIS, page 1-10

[35] DG-4032, Page 157.

[36] Draft NR GEIS, page 1-10

(**30-13** [Toohill, Spencer])

Comment:

3. Categorization of Issues

Utah OED recommends that the following Category 2 issues be removed from the Generic EIS:

-Climate Change

The NRC's Generic EIS categorizes GHG emissions as a generic Category 1 issue, and fully analyzes the expected GHG emissions over the assumed life cycle of a new nuclear reactor. But the Generic EIS would also require site-specific analysis of the impacts on climate change under Category 2. Utah OED finds that a separate site-specific analysis for climate change is redundant and overly burdensome, and Utah OED recommends that climate change analysis be removed from the required Category 2 issues altogether. Analyzing the impacts of a new nuclear reactor on anthropogenic climate change, in addition to the generic analysis of GHG

emissions, would compel NRC to engage in fruitless speculation with no benefit to NRC decision makers.

The Generic EIS already estimates GHG emissions from construction and operation of future nuclear reactors in its plant parameter envelope values for GHG emissions.[3] The NRC estimates that emissions from equipment and vehicles used during building, operation, uranium fuel cycle, transportation of fuel and waste, and decommissioning activities would emit a total of 2,534,000 MT of CO2(e) over the assumed 97-year GHG life-cycle of a new nuclear plant. Based on these values and assumptions, estimated annual GHGs emissions from the plant life cycle would be about 0.0005 percent of GHG emissions from the U.S. energy sector over the same period. NRC staff used these findings to determine that "as long as the PPE assumption associated with GHG emissions is met, the GHG impacts from building, operating, conducting the fuel cycle, transporting fuel and waste, and decommissioning of a nuclear reactor can be generically determined to be SMALL."[4] Utah OED concurs with this finding that GHG impacts will be small and should be generically analyzed under Category 1. The insignificance of GHG impacts from a new plant are particularly stark when compared to global CO2 emissions, which in 2023 exceeded 36.8 billion metric tons.[5] Given the existing analysis of GHG emissions in the Generic EIS, further site-specific analysis of climate change impacts by the NRC for proposed reactors is not warranted.

The Generic EIS repeatedly justifies inclusion of climate change as a Category 2 issue by alleging that impacts of climate change are location-specific. The Generic EIS states: "The effects of climate change are location-specific and cannot, therefore, be evaluated generically. For example, while climate change may cause many areas to receive less than average annual precipitation, other areas may see an increase in average annual precipitation. Therefore, applicants and staff would address the effects of climate change in the environmental documents for new nuclear reactor licensing."[6]

Here, the NRC uses faulty reasoning. While the effects of climate change may indeed be location-specific, the impacts of a new nuclear reactor on climate change will not be location-specific, and will almost certainly be negligible. The example of precipitation used the Generic EIS does not fit; while climate-related changes to surrounding environmental conditions could occur because of global aggregate GHG emissions, those climatic changes will not have a causal relationship to the *de minimis* emissions from a new nuclear reactor.

While climate-related changes to things such as temperature or precipitation could theoretically alter the impacts of a new nuclear plant on certain Category 2 issues such as aquatic biota, surface water quality or important species habitat, asking NRC staff to account for these alterations would be wildly speculative. Performing this analysis would require NRC staff to predict how global anthropogenic climate change could impact the area around a new nuclear site, distinguish between climate change-related impacts and natural variations in weather patterns, and then account for how these climatic changes either exacerbate or mitigate the expected externalities of a new nuclear reactor. This exercise would be extremely complicated and far beyond the intended scope of NEPA.

Nuclear power will likely play a central role in America reducing its GHG emissions and thereby reducing its net contributions to global anthropogenic climate change. As acknowledged by the NRC, this Generic EIS is intended to speed the review process for new reactors and facilitate the development of low-GHG electrical generation in the United States. The NRC can better accomplish this mission if it removes the redundant and unnecessary climate change analysis

from the Category 2 issues, and better yet, removes any climate change analysis requirements altogether.

[3] Generic EIS, at Table 3-1 (Page 3-19).

[4] Generic EIS, at 3-19.

[5] See NOAA Research, Record carbon dioxide emissions impending progress on meeting climate goals (December 5, 2023). Available at https://research.noaa.gov/record-fossil-carbon-dioxide-emissions-impeding-progress-on-meeting-climate-goals-report/.

[6] Generic EIS, at Table 4-1.

(**32-4** [Lesofski, Emy])

Comment:

Recommendation 7: Reconsider Climate Change as a Category 1 issue

The effects of climate change are a long-term issue; however, a nuclear reactor needs to be designed to withstand external events, including some events impacted by climate change. To an extent, withstanding climate change effects are captured by a nuclear plant's safety review and maintained through its current licensing basis. Other effects, such as potential environmental impacts from thermal discharges, are considered by compliance with environmental laws and a reactor's license.

As set forth in ClearPath's recent submission to the NRC,[14] decarbonizing the electrical and industrial sectors will require unprecedented infrastructure investment, including gigawatts of new clean energy generation. In addition to scale, this infrastructure build-out must be done rapidly to meet U.S. decarbonization goals and electricity demand growth. Nuclear energy is critical to reduce emissions in both the electrical and industrial sectors. Furthermore, nuclear electricity and heat can be used for a wide suite of carbon dioxide removal technologies. Therefore, the operation of a nuclear energy plant has a positive impact, reduces emissions, and can reduce the negative impacts of climate change. Treating climate change in the environmental review as a Category 2 issue is counterintuitive when considering the net benefits of nuclear energy as well as that the impacts of climate change are considered through other aspects of a license review and during operation.

[14] ADAMS Accession Number ML24262A251

(**36-11** [McMurray, Nicholas])

Response:

The NRC disagrees with the comments. The comments state that the climate change Category 2 issue is unnecessary and should be removed from the NR GEIS. The NRC disagrees that the climate change issue can be evaluated generically and therefore resolved as a Category 1 issue. The NRC also disagrees that the Category 2 issue of climate change is duplicative of the NRC's cumulative effects analysis. Climate change is a subject of national and international interest and has been and continues to be a topic of broad public interest with respect to new reactor licensing. The implications of climate change and the high level of public interest have made this topic one that requires a "hard look" under NEPA. Section 1.3.3.2.2 of the NR GEIS was revised to clarify the two-part scope of the NRC's consideration of climate change. The first part is the effect of a proposed action on climate change, which is evaluated by quantifying the proposed action's greenhouse gas emissions, as described in Section 3.3.2 of the NR GEIS. The NRC generically determined this issue to be SMALL for both construction and operation.

However, the NRC also recognizes that future changes in climate have broader implications for environmental resources. Climate change is an environmental trend that can result in future changes to the affected environment. This is the second part of NRC's consideration of climate change. These changes potentially influence the magnitude of impacts on resources affected by the project. NRC's consideration of climate change thus also includes an evaluation of how the project's environmental impacts would increase, decrease, or remain the same under a baseline that is altered by climate change. This is the subject of the Category 2 issue described in Section 1.3.3.2.2 of the NR GEIS. The NRC has concluded that the impacts of climate change on environmental resources that are affected by new reactor construction and operations are location-specific, thus requiring a project-specific review.

Regarding the cumulative effect concerns provided in the comments, the NRC defines cumulative effects as the impacts on the environment that result from incremental effects of the proposed action when added to the effects of other past, present, and reasonably foreseeable actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Analyzing the cumulative effects requires that the environmental baseline and thresholds of environmental change be established. As discussed in the NR GEIS, the affected environment is the currently existing environment of the proposed new reactor and its surrounding area. The Category 2 climate change issue assesses the potential future baseline conditions (affected environment) as a result of climate change. Prior to developing the cumulative effects analysis and evaluating the effects on individual resources, the baseline conditions with respect to climate change trends will need to be established for resource areas impacted by climate change. Therefore, the NRC has determined that establishing climate change impacts on environmental resources as a separate Category 2 issue is appropriate and will facilitate a more focused and effective cumulative effects analysis.

Section 1.3.3.2.2 of the NR GEIS was revised to clarify that the Category 2 climate change issue considers those reasonably foreseeable effects on environmental resource conditions that may also be directly affected by construction and operation of new reactors during the license term. The title of this issue was revised from "Climate Change" to "Climate Change Impacts on Environmental Resources" to clarify its purpose and distinction from the Category 1 issue of greenhouse gas emissions.

Comment: • Consistent with recent modifications its license renewal-related guidance, the NRC should revise its NR GEIS implementing guidance to clarify that any site-specific discussion of

climate change impacts (a Category 2 issue) should address only reasonably foreseeable climate change impacts and do so in proportion to their significance, consistent with NEPA's "rule of reason." (**38-1-8** [O'Neill, Martin])

Comment:

K. Discussion of Climate Change Effects Must Be Governed by NEPA's "Rule of Reason"
In the NR GEIS, the NRC staff has classified climate change as a Category 2 issue. The staff's rationale is that climate change can cause changes in the affected environment around a new reactor project, potentially influencing the level of impacts on resources affected by the project. Therefore, the staff notes, climate change effects are location-specific and cannot be evaluated generically. [84]

NEI provided extensive comments on this issue in response to the NRC's draft GEIS for license renewal (NUREG-1437, Revision 2), which the NRC issued in final form earlier this year. We incorporate those comments by reference insofar as they are germane to new reactor licensing.[85] In short, we continue to believe that climate change is more appropriately considered as a cumulative impact (not its own Category 2 issue), or as part of the discussion of the affected environment used in evaluating the impacts of the proposed licensing action (to the extent climate change effects on the "environmental baseline" conditions described in an applicant's environmental report and the NRC's supplemental EIS may be reasonably discerned based on reliable data).

NEI recognizes that the NRC staff disagreed with the foregoing position and is unlikely to reach a different result in the context of new reactor licensing. Nonetheless, there are aspects of our prior comments with which the staff agreed, and which warrant mention here. The staff agreed that "the NRC's climate change impact analyses should and must be governed by NEPA's 'rule of reason,' use the best information reasonably available, recognize relevant scientific uncertainties, and be limited to reasonably foreseeable impacts or effects."[86] It further agreed that "clarity is needed in the NRC's guidance to applicants and staff with regard to the treatment of GHGs and climate change impacts."[87] In response to NEI's comments, the NRC staff indicated that it made the following changes to Section 4.12 ("Greenhouse Gas Emissions and Climate Change") of NUREG-1555, Supplement 1, Revision 2, the NRC's Environmental Standard Review Plan for License Renewal (ESRP-LR):

• Revised Section 4.12.5 to reiterate that climate change impact analyses prepared by the NRC staff "appropriately focus on and discuss reasonably foreseeable climate change impacts and that they be evaluated in proportion to their significance."[88]

• Revised Section 4.12.3 to provide an area of interest to be considered. Specifically, the staff added a geographic scope under "studies and monitoring programs." Regarding the list of climate change indicators, the staff noted that the list provides examples, and recognized that not all may apply to every nuclear power plant site. The NRC thus revised the list to include "and/or."[89]

• Revised Section 4.12.5 to clarify that climate change parameters can include those that are listed. The NRC also agreed with NEI's recommendation that the statement concerning climate change projections in Section 4.12 of should also reference the climate models used and thus made clarifying changes to Section 4.12.5.[90]

NEI requests that the NRC staff include these principles and clarifications/revisions in the NRC's

implementing guidance for the NR GEIS, including any future updates to NUREG-1555, *Environmental Standard Review Plan (ESRP) for New Site/Plant Applications.*

[84] *See* Draft NR GEIS at 1-9 to 1-10, 1-18 (Table 1-1), 4-27 (Table 4-1).

[85] *See* NEI Comments on NRC Proposed Rule - "Renewing Nuclear Power Plant Operating Licenses - Environmental Review," Attachment 1 at 7-17 (May 2, 2023) (ML23123A407)

[86] NUREG-1437, Rev. 2, Vol. 2, Appendix A (Comments Received on the Environmental Review) at A-259.
[87] *Id.* at A-256.[88] *Id.*

[89] *Id.*

[90] *Id.*

(**38-2-10** [O'Neill, Martin])

Response:

The NRC agrees with the comments. The comments express concern for inconsistency between the LR GEIS and the NR GEIS and associated rules and guidance. With consideration of differences in the licensing actions, the NRC agrees that its approach to the climate change issue described in Section 1.3.3.2.2 of the NR GEIS should be consistent with the same issue described in the LR GEIS (Section 4.12.2 of NUREG-1437 Rev. 2). Section 1.3.3.2.2 of the NR GEIS was revised to provide clarity on the treatment of GHG emissions and climate change impacts on environmental resources, consistent with the LR GEIS (NUREG-1437 Rev. 2). In addition, Section 3.17.1 of ISG-COL-30 was revised to include additional guidance consistent with Section 4.12.5 of the NRC's Environmental Standard Review Plan for License Renewal (ESRP-LR).

The NRC notes that the commenter lists changes made to Section 4.12 of NUREG-1555, Supplement 1, Revision 2, the NRC's ESRP-LR as part of the NRC's response to the comments on the Draft LR GEIS. The ESRP for new site/plant applications (NUREG-1555) is not being revised as part of this rulemaking.

E.2.13 Cumulative Impacts

Comment: Cumulative Impacts

The practice of analyzing cumulative impacts has its origins in the CEQ's November 1978 NEPA regulations.[7] These regulations, and all subsequent CEQ regulations further expanding on the idea of cumulative impacts analysis, have been invalidated by the Court of Appeals in *Marin County Audubon v. FAA*. Utah OED recommends that the NRC remove any cumulative impacts analysis requirements from the Generic EIS entirely.

The concept of analyzing cumulative impacts has expanded over the years and has led federal agencies to speculate on future impacts far removed in time and space from the actual projects being proposed. This type of speculation far exceeds the original intent of NEPA and has exacerbated the permitting delays that have hamstrung many essential infrastructure projects in the United States. With this recent ruling in *Marin County*

Audubon v. FAA, the NRC should seize the opportunity to remove this unnecessary and burdensome requirement from the Generic EIS.

Forgoing a cumulative impacts analysis would be particularly logical for a new nuclear plant, which will not emit GHGs into the atmosphere (other than incidental emissions associated with construction, transportation of fuels to and from the plant, and decommissioning). New nuclear reactors will not make any significant contribution to global climate change, the impetus for much of the CEQ's regulatory regime for cumulative impacts analysis. The NRC's Generic EIS will be a more effective tool and more successful in streamlining the permitting process if applications and NRC staff do not need to commit additional resources to a cumulative impacts analysis.

[7] 43 FR 55978. November 29, 1978. National Environmental Policy Act – Regulations. Council on Environmental Quality. Available at: https://ceq.doe.gov/docs/laws-regulations/FR-1978-11-29-43-FR-55978-CEQ-NEPA-Regulations-NOFR.pdf.

(**32-5** [Lesofski, Emy])

Comment: We support the Staff's decision to identify a large number of potential impacts as Category 2, where site-specific analyses are needed. In particular, we support the cumulative impacts analysis being categorized as a Category 2, because it appears likely that many SMRs may be sited on existing, operating nuclear reactor sites where analysis of complex scenarios would be important. (**37-3** [Peterson, Alyse])

Comment: We would also suggest that the final GEIS provide further clarity on how the draft GEIS takes into account the modular nature of Small Modular Reactors (SMRs) and the resulting potential cumulative impacts from multiple reactor modules being installed overtime at the same site. For example, it is not clear how the GEIS would evaluate multi-module reactor designs where additional modules may be added to the same site in the future without a new license and thus, without a new GEIS/cumulative impacts analysis. It would be our expectation that a subsequent SEIS would be performed, should the number of reactors (along with the accompanying volume of fuel and then waste) at any site change after the licensing decision. (**37-8** [Peterson, Alyse])

Response:

The NRC acknowledges and agrees in part with the comments. The NRC agrees with comments stating that cumulative impacts should be a Category 2 issue and disagrees with the comment that cumulative impacts analysis should not be required in project-specific supplemental environmental impact statements (SEISs). Analysis of cumulative impacts cannot be conducted generically without knowledge of the designs and locations of potential new reactor license applications, including potential multi-module reactor designs proposed on individual sites. As such, cumulative impacts are a Category 2 issue that requires project-specific analysis.

Since 1984, when the NRC first promulgated its NEPA-implementing regulations in 10 CFR Part 51, the NRC has taken a position that it will voluntarily take account of Council on Environmental Quality's (CEQ's) regulations subject to certain conditions (10 CFR 51.10(a)). As a result, the NRC has closely patterned its NEPA-implementing regulations on CEQ's regulations. The CEQ regulations have included requirements related to cumulative impacts since 1978 and, as a result, the NRC regulations in 10 CFR Part 51 also include requirements

related to cumulative impacts. The interim final rule removing the CEQ NEPA regulations (90 FR 10610-TN11722) does not change NRC's NEPA regulations and associated requirements. Executive Order 14300 , Ordering the Reform of the Nuclear Regulatory Commission, directs the NRC to "[r]evise, in consultation with the Council on Environmental Quality, NRC regulations governing NRC's compliance with the National Environmental Policy Act to reflect the Congress's 2023 amendments to that statute and the policies articulated in sections 2 and 5 of Executive Order 14154 of January 20, 2025 (Unleashing American Energy)." Those revisions are underway separate from this rulemaking and may result in changes to the NRC's regulations concerning consideration of cumulative effects.

One of the comments questioned how NRC would address multiple modular reactors built at a site. Every reactor requires a license issued by the NRC. Various licensing scenarios for small modular reactors are discussed in Interim Staff Guidance COL/ESP-027 (NRC 2014-TN3774), "Specific Environmental Guidance for Light Water Small Modular Reactor Reviews." Any proposed new small modular reactor that has not already been licensed by the NRC will have to proceed through the NRC licensing process before being built.

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

E.2.14 Purpose and Need of the NR GEIS

Comment: The Nuclear Energy Institute and our members appreciate that the NRC has opted to use a technology-neutral performance-based approach in the New Reactor GEIS. Specifically, the NRC staff developed plant parameter envelope, site parameter envelope, and related assumptions, as summarized in Appendix G of the NR GEIS.

The use of this bounding approach is important as it optimizes the NR GEIS and related rule's applicability to new reactor applications and reduces the scope of any necessary site or project specific analysis under NEPA. We agree with the need for and importance of the New Reactor GEIS. (**12-1-1** [Austgen, Kati])

Comment: Finally, we agree with the NRC's recognition in the proposed Rule that use of a New Reactor GEIS is consistent with NEPA requirements, related legal principles, and longstanding NRC regulatory practice. (**12-1-5** [Austgen, Kati])

Comment: we are very supportive and very appreciative of the inclusion of the plant parameter envelope and the site parameter envelope. (**12-2-1** [Toohill, Spencer])

Comment: And the courts have recognized that it is an appropriate method of NEPA analysis, you know, the generic analysis, and it really does serve to make the reviews more efficient, and we believe this is going to be critically important given the potential number of applications we could see submitted to the NRC in coming years. (**13-1-2** [O'Neill, Martin])

Comment: Categories of Impacts

It can be said that every scenario will vary. However, breaking down the impact of these issues caused by nuclear reactors into Category 1 and Category 2 is extremely helpful to better address the problem. Category 1 issues are generic to all nuclear reactors and Category 2 issues require project specific analysis. Because site-specific concerns that may vary from one location to another. Category 2 issues require an additional layer of research and approval by

the project-specific agency to ensure effectiveness. Variations might include the unique ecology of a site, the proximity it has to populated areas, and local geological risks such as earthquakes or floods.

The NR GEIS's approach in categorizing these issues ensures that localized risks are given specialized attention, fostering a balance between environmental protection and regulatory efficiency. The NR GEIS allows a streamlined review of processes by breaking down impacts into these categories, where general impacts are standardized, and unique issues need to receive more detailed examination, which demonstrates the sustainability and safety of nuclear energy's development. (**17-3** [Aguilar S., Kathya])

Comment: As detailed in our June 2020 scoping comments, NEI fully supports the NRC's use of bounding values or parameters for reactor design features and site conditions that are based on the numerous sources of information listed in Section 1.3 of the draft NR GEIS.[9] Importantly, those sources include, among others, other NRC GEISs (e.g., the License Renewal GEIS and Continued Storage GEIS) and prior new reactor-related EISs issued since 2006 (see, e.g., draft NR GEIS Table 3-3 (listing EISs reviewed by the NRC staff)).

[9] See Letter from Marc Nichol, NEI, to NRC, "NEI Comments on Scoping of an Advanced Nuclear Reactor Generic Environmental Impact Statement" (June 30, 2020) (ML20183A009).

(**38-1-12** [O'Neill, Martin])

Comment: C. NRC's Reliance on the NR GEIS and Rule Are Consistent with NEPA, the ADVANCE Act, Judicial Precedent, and Established NRC Regulatory Practice

The NRC's development of a GEIS that generically evaluates the environmental impacts associated with a broad range of new reactor designs is a permissible and pragmatic approach under NEPA. So, too, is the NRC's decision to optimize the NR GEIS's value by codifying its findings in Part 51 so that the GEIS can be consistently relied upon by applicants and the NRC staff. The FRA amendments to NEPA and Section 506 of the ADVANCE Act further support this conclusion, as they expressly call for the expanded use of "programmatic environmental documents" (NEPA Section 108) and "generic environmental impact statements" (ADVANCE Act Section 506(a)), respectively.

As noted in the proposed rule's SOC, "[t]he use of a GEIS for meeting the NRC's NEPA obligations and the concomitant codification of generic findings into an NRC regulation has been upheld by Federal courts."[12] Indeed, the U.S. Supreme Court has underscored the NRC's broad discretion to structure its NEPA inquiries, and found that when there are environmental effects that would be essentially similar for all or a commonly identifiable subcategory of nuclear plants, "[a]dministrative efficiency and consistency of decision are both furthered by a generic determination of these effects without needless repetition of the litigation in individual proceedings."[13] Multiple U.S. Courts of Appeals have applied the Supreme Court's *Baltimore Gas* holding. The First Circuit has noted, in the context of NRC license renewal, that the NRC's "divergent treatment of generic and site-specific issues is reasonable and consistent with the purpose of promoting efficiency in handling [its licensing] decisions."[14] The Third Circuit affirmed the NRC's License Renewal GEIS analysis of the risk of sabotage to nuclear power plants.[15] The D.C. Circuit also has affirmed the generic analysis method under NEPA in two separate contexts - license renewal and continued storage of spent nuclear fuel.[16]

As a practical matter the NRC's established use of GEISs and associated Part 51 rulemakings demonstrates the viability and efficacy of the generic analysis method under NEPA. To date, the NRC has prepared GEIS documents for at least five activities.[17] Collectively, these GEISs have substantially reduced applicant and NRC resource expenditures, consistent with NEPA's focus on providing "a reasonably thorough discussion of the significant aspects of the probable environmental consequences" of a proposed action."[18] The NRC's draft Regulatory Analysis indicates that the NRC's generic analysis of Category 1 issues and codification the resulting generic impact conclusions similarly will yield substantial cost savings and procedural efficiencies.[19] As discussed in the Proposed Rule's SOC, such efficiencies include, among others, enhancing stability and predictability of the licensing process, improving public understanding and confidence in the licensing process, and assisting the Commission in resolving recurring complex methodological and policy issues.[20]

[12] NRC, [GEIS] for Licensing of New Nuclear Reactors, 89 Fed. Reg. 80,797, 80,801 (Oct. 4, 2024) (Proposed Rule).

[13] *Balt. Gas & Elec. Co. v. NRDC*, 462 U.S. 87, 101 (1983) ("The generic method chosen by the agency is clearly an appropriate method of conducting the hard look required by NEPA.") (citations omitted).

[14] *Massachusetts v. United State*s, 522 F.3d 115, 119-20, 127 (1st Cir. 2008); *see also Massachusetts v. NRC*, 708 F.3d 63, 68 (1st Cir. 2013) ("As to the second mechanism for environmental impacts that are not plant-specific, but instead apply to all like plants, the Supreme Court has held that the NRC is permitted to make generic determinations to meet its NEPA obligations.") (citation omitted).

[15] *N.J. Dep't of Envt'l Prot. v. NRC*, 561 F.3d 132, 143 (3d Cir. 2009) ("The NRC rules codify these generic findings, and by regulation, license renewal applicants are excused from discussing generic issues in their environmental reports.").

[16] *See Natural Res. Def. Council v. NRC*, 823 F.3d 641, 645 (D.C. Cir. 2016) (noting that 10 CFR 51.53(c)(3)(ii)(L) "constitutes a generic determination, via rulemaking, that one SAMA per plant is sufficient to 'uncover most cost-beneficial measures to mitigate both the risk and the effects of severe accidents, thus satisfying [the Commission's] obligations under NEPA'"); *New York v. NRC*, 824 F.3d 1012, 1019 (D.C. Cir. 2016) (citing *New York v. NRC*, 681 F.3d 471, 480 (D.C. Cir. 2012) (stating that "the cornerstone of our holding was that the NRC may generically analyze risks that are 'essentially common' to all plants so long as that analysis is 'thorough and comprehensive', and that "[i]n this case, we are convinced that the NRC has met that standard").

[17] Those GEISs relate to (1) the relicensing of nuclear power plants, (2) the handling and storage of spent nuclear reactor fuel, (3) the decommissioning of nuclear facilities, (4) radiological criteria for license termination, and (5) in-situ uranium recovery facilities. *See* "NRC Guidance for NEPA Reviews," https://www.nrc.gov/about-nrc/regulatory/licensing/ecoe/nepa-environment-analysis/guidance.html.

[18] *WildEarth Guardians v. Mont. Snowmobile Ass'n*, 790 F.3d 920, 924 (9th Cir. 2015) (quoting City of Sausalito v. O'Neill, 386 F.3d 1186, 1206 (9th Cir. 2004)).

[19] NRC, *Draft Regulatory Analysis for the 10 CFR Part 51, Generic Environmental Impact Statement for Licensing of New Nuclear Reactors* Proposed Rule at xiii-ix, 4-1 to 4-2 (Sept. 2024) (ML24176A218) (Draft Regulatory Analysis).

[20] Proposed Rule, 89 Fed. at 80,800-01.

(**38-1-15** [O'Neill, Martin])

Response:

The NRC agrees with the comments. The NR GEIS's use of a technology-neutral, performance-based approach using bounding a PPE and SPE is intended to streamline the evaluation of environmental impacts of constructing and operating a new nuclear reactor. As stated in the Purpose and Need statement in Section 1.1 of the NR GEIS, presenting generic impact analyses for environmental issues common to many new nuclear reactors will potentially eliminate the need to repeatedly reproduce the same analyses each time a licensing application is submitted. This will allow applicants and NRC staff to focus future environmental review efforts on issues that can only be resolved once a site is identified. The intent of this approach is to streamline the time and effort needed to complete environmental reviews under NEPA for most new nuclear reactors.

The use of a GEIS is consistent with NRC practice, as is the application of the PPE and SPE approach. As stated in Section 1.3.1 of the NR GEIS, the PPE and SPE values were developed by an interdisciplinary team, which developed the values and assumptions based on a number of different sources.

Based on public input received during the comment period on the Draft NR GEIS, the NRC has updated the categorization of and PPE/SPE values for various issues. In particular, Severe Accidents was recategorized from a Category 2 issue to a Category 1 issue with appropriate new PPE/SPE values. Severe Accident Mitigation Design Alternatives was merged with the Severe Accidents issue because, if the Severe Accident PPE/SPE values and assumptions are met, then mitigation is addressed and does not need to be separately assessed. For more detail, please see the Postulated Accidents response in this appendix. In addition, the NRC is no longer considering environmental justice as an issue needing to be addressed in new reactor environmental reviews and removed the two Category 2 issues identified in the Draft NR GEIS and proposed rule.

As applicable, corresponding changes were made in the NR GEIS, final rule, and guidance documents as a result of the comments.

Comment: The NRC relies heavily on Baltimore Gas and Electric Co. v. NRDC, 462 U.S. 87 (1983), but the proposed rule goes beyond what the Supreme Court contemplated in that decision to uphold the NRC's use of generic findings in Table S-3. The generic findings in Baltimore Gas addressed a narrow and uniform area of environmental impact, the fuel cycle, while the generic findings at issue here are to be applied across an array of environmental issues, like air quality, water resources, and waste management. Further, the adoption of Table S-3 did not limit the avenues that affected parties to challenge the generic findings therein. (**19-5** [Adams, James C.])

Comment: Regarding technology neutrality

For the first time, this draft GEIS uses a technology-neutral framework (GEIS at iii) along with a set of plant parameters (called plant parameter envelope or PPE) and site parameters (called site parameter envelope or SPE) to determine potential environmental impacts from construction, operation, and decommissioning of new nuclear reactors. As long as the nuclear reactor — whatever kind it is, and none are discussed in detail in the GEIS — meets the SPE and PPE listed for each potential impact, the public would have no right to additional information or legal challenge as to these environmental impacts once the GEIS is finalized. We note that this is a novel approach to an emerging industry, with little operational history from which to draw. We also note that the characterization here of this technology neutral analysis as "performance based" where "performance reflects the ability of an applicant to design a nuclear reactor that minimizes environmental impacts while still meeting the reactor's objectives" (see GEIS at 1.2-1.3) is not consistent with NRC's standard use of the term "performance" as regarding nuclear facilities and wastes. See, e.g., NUREG-2150, Appendix D, which outlines NRC's risk informed and performance-based defense-in-depth regulatory approach for reactors, materials, waste, fuel cycle, and transportation,[1] and the performance objectives of 10 CFR 61. We suggest that the Final GEIS address this apparent inconsistency.

The GEIS fails to provide sufficient information for the public to determine whether the basis of each assumption is sufficient such that it should form the basis for a permanent bar (for Category 1 impacts) on any further stakeholder input or challenge. In the land use section, for example, the GEIS says only that "in developing the values and assumptions in the PPE and SPE pertaining to land use, the staff relied upon the information and analyses contained in multiple new [unspecified] reactor EISs prepared since 2005 [none of which were presumably for advanced reactors], the License Renewal GEIS [which did not evaluate advanced reactors], other past [unspecified] NRC EISs, and common elements of State and local land use regulation [which are also unspecified]." (bracketed text added). As such, it is not possible to ascertain the basis for these assumptions, which makes it difficult to comment on or evaluate the weakness or accuracy of the GEIS. We encourage the Staff to employ flexibility in the implementation of the GEIS when actual, on-the-ground circumstances may warrant the exploration of sufficient or additional information to enable host states, municipalities, and relevant stakeholders to understand potential impacts of even Category 1 issues once a specific design at a specific location is announced, even if the "new and significant" threshold cannot be met. We question how technology-agnostic criteria can be appropriate given the many differences among emerging technologies with a range of cooling options that spans light water, liquid sodium metal, molten salt, and high-temperature gas, and varying requirements for water consumption and discharge. Put simply, how can accurate accident or waste analyses be performed without specifying the reactor design?

[1] "A performance-based regulatory approach is one that establishes performance and results as the primary basis for regulatory decision making, and incorporates the following attributes: 1. measurable (or calculable) parameters (i.e., direct measurement of the physical parameter of interest or of related parameters that can be used to calculate the parameter of interest) exist to monitor system, including facility and licensee, performance, 2. objective criteria to assess performance are established based on risk insights, deterministic analyses, and/or performance history, 3. licensees have flexibility to determine how to meet the established performance criteria in ways that will encourage and reward improved outcomes, and 4. a framework exists in which the failure to meet a performance criterion, while undesirable, will not in and of itself constitute or result in an immediate safety concern."

(**37-2** [Peterson, Alyse])

Response:

The NRC disagrees with the comments. The NR GEIS and the NRC's environmental findings contained in Appendix C to Subpart A of 10 CFR Part 51 establish a robust and effective environmental evaluation process for new nuclear reactors. This approach is consistent with previous NRC environmental review processes, including those approved for license renewal as codified in Appendix B to Subpart A of 10 CFR Part 51. As stated in the proposed rule, the use of a GEIS for meeting the NRC's NEPA obligations and the concomitant codification of generic findings into an NRC regulation has been upheld by Federal courts, including for the NRC's reliance on NUREG-1437 for operating power reactor license renewal actions, consistent with the holding in Baltimore Gas and Electric Co. v. NRDC, 462 U.S. 87 (1983) (TN1054).

The NR GEIS is used to avoid duplication, ensure the most effective use of resources, and allow the NRC staff to focus specifically on those issues that are important for a particular nuclear plant (i.e., unique to that plant or exceptional in size and scope for those issues ordinarily assumed to be similar for all plants) in project-specific supplemental environmental impact statements (SEISs) to the NR GEIS for an application for a new nuclear reactor.

Section 1.3.1 describes the methodology for developing the NR GEIS's PPE and SPE values, including the use of technology-neutral, performance-based bounding values and assumptions. Appendix G of the NR GEIS describes each of the PPE and SPE values and assumptions along with the basis and methodology for deriving these values and assumptions. Additional details for each of these values and assumptions can be found in the applicable resource sections in Chapter 3 of the NR GEIS. To develop the NR GEIS and the PPE/SPE values, the NRC established an interdisciplinary team of environmental subject matter experts (SMEs) from the NRC and from contractor Pacific Northwest National Laboratory—all of whom have extensive experience in evaluating the environmental impacts of new reactors. In the NR GEIS, the interdisciplinary team is collectively referred to as the NRC staff. The SMEs included individuals who have expertise in nuclear technology, radiation protection, land use, aquatic and terrestrial ecology, hydrology and water use, socioeconomics, meteorology and air quality, and human health.

The final rule provides substantial flexibility to address site-specific issues when necessary. Namely, the regulations require the applicant to demonstrate and the NRC to find that the relevant values and assumptions in the PPE and SPE are met and there is no new and significant information that could change the conclusions in the NR GEIS. The environmental review process encourages public input, and members of the public can also identify potentially new and significant information.

The NRC disagrees with the comment relating to the NRC's performance-based regulatory approach. The NRC staff defined its use of the term "performance-based" in Section 1.2.1 of the NR GEIS. "Performance" in the NR GEIS "reflects the ability of an applicant to design a nuclear reactor that minimizes environmental impacts while still meeting the reactor's objectives." While this definition is different from other uses of the term "performance," such as that for defense-in-depth, the implementation of this performance-based approach is consistent with NRC's approach in related efforts.

Based on public input received during the comment period on the Draft NR GEIS, the NRC has updated the categorization of and PPE/SPE values for various issues. In particular, Severe

Accidents was recategorized from a Category 2 issue to a Category 1 issue with appropriate new PPE/SPE values. Severe Accident Mitigation Design Alternatives was merged with the Severe Accidents issue because, if the Severe Accident PPE/SPE values and assumptions are met, then mitigation is addressed and does not need to be separately assessed. For more detail, please see the Postulated Accidents response in this appendix. In addition, the NRC is no longer considering environmental justice as an issue needing to be addressed in new reactor environmental reviews and removed the two Category 2 issues identified in the Draft NR GEIS and proposed rule.

As applicable, changes to both Postulated Accidents and environmental justice were made in the NR GEIS, final rule, and guidance documents as a result of the comments.

E.2.15 Non-Resource Related Issues

Comment: A couple of areas that have been designed as Category 2 are need for power and alternative siting criteria, the origins of the need to address those issues dating back to the 70s and 80s when utilities were all regulated and there was a lot of over-building going on. I think there's a lot more flexibility that the NRC has within NEPA.

I would argue that these two categories should be potentially reclassified, principally because in terms of both need for power and alternative siting criteria, those are evaluated by states either as regulated utilities, and thus, you have an economic regulator at the state level that is making a determination about that need for power or where those sites should occur, or in the market today, no one would be building nuclear reactors without having an assurance that they've got a set of users who will be conducting an off take on that, and certainly those developers would also be considering alternative sites given the fact that many of these would only incorporate criteria that would really, you know, the release criteria at the fence line.

I think the need to impose these kind of requirements on licensees is outdated, and so as you are continuing to move forward on this effort, we certainly recommend a reassessment of both those criteria and the need for detailed assessment to be placed on potential applicants. (**13-3-2** [Merrifield, Jeff])

Comment: 3. Consistent with the comments provided by NEI, Westinghouse also recommends that the NRC eliminate the "need-for-power" as a separate Category 2 issue. Instead, information on this topic should be included in the purpose and need statement for the proposed action. Along with the many arguments provided by NEI to support this comment, Westinghouse would like to emphasize the point that a detailed need-for-power analysis is not required by either the Atomic Energy Act (AEA) or the National Environmental Policy Act (NEPA). (**24-3** [Schoedel, Anthony J.])

Comment: We endorse the detailed NR GEIS recommendations made by ClearPath in their December 18, 2024 submission. For instance, we support ClearPath's Recommendation 1 regarding Need for Power and four other Non-Resource Related Issues. (**27-2** [Draffin, Cyril])

Comment: 2. Kairos Power urges consideration of the points made by NEI regarding treatment and both Purpose and Need and Need for Power. There is substantive discussion in both NEI's letter and in related comments from ClearPath indicating current/past treatment of these issues is beyond what is needed for a meaningful NEPA analysis, particularly as clarified by the Fiscal Responsibility Act (FRA) direction that NEPA analyses include "a reasonable range of alternatives to the proposed agency action" (emphasis added). Further, it is not clear that NRC

staff's assessment of Purpose and Need or Need for Power would ever constitute a more compelling justification for a project than those considerations applied in policy or commercial decision making. (**29-2** [Hastings, Peter S.])

Comment: Additionally, the rulemaking package also discusses SECY-24-0046, "Implementation of the Fiscal Responsibility Act of 2023 National Environmental Policy Act Amendments" (ML24078A013). As reflected in NEI's comments,"…Commission approval and future staff implementation of certain recommendations contained in SECY-24-0046…could affect how the NRC analyzes energy alternatives and alternative sites for new reactor license applications." Citing SECY-24-0046, NEI reiterates:

"The staff would evaluate the reasonably foreseeable environmental effects of the agency's regulatory or licensing decision. In most cases, the reasonable range of alternatives to the regulatory or licensing decision would be defined as and limited to the no action alternative (i.e., not issuing the license) because not engaging in regulatory or licensing decisions is the only reasonable alternative to the agency action. The staff would analyze the reasonably foreseeable environmental effects of the no action alternative (including negative environmental impacts of not implementing the proposed agency action). The environmental effects of the no action alternative may include the environmental impacts from termination of operation and decommissioning, energy conservation, and energy imports, as well as replacement energy options and alternative nuclear material production, processing, and storage. Under this option, the staff would likely consider replacement energy options as reasonably foreseeable consequences of the no action alternative instead of as "alternatives to the proposed agency action." However, the NRC generally would not consider alternatives to the proposed action that the agency does not have the authority to implement (e.g., siting and energy alternatives)." [emphasis added by NEI] (**29-4** [Hastings, Peter S.])

Comment: Purpose and Need & Need for Power

The NR GEIS categorizes both Need for Power and Purpose and Need as Category 2 environmental issues, necessitating site-specific evaluations. While the intention of this categorization reflects the NRC's commitment to ensuring comprehensive and localized assessments, BTI recommends revisiting these classifications to ensure they align with modern reactor applications, legislative developments, and environmental review efficiency.

Atomic Energy Act Requirements

On these two environmental issues, the NR GEIS implies that the Atomic Energy Act (AEA) requires them to consider risks and impacts compared to benefits.[13] The AEA actually says they must manage consequences to public health and safety, protect the environment, and provide for common defense and security through regulations.[14] At the same time, while managing the consequences, they also must maximize the general welfare.[15] The text of the GEIS should be adjusted to consider that, as required by the AEA, contribution to the general welfare should be maximized, not weighed relative to the consequences. The consequences need to be separately managed through the regulations. There is no requirement to weigh one against the other, and doing so implies a zero-sum situation that does not exist - both consequences and benefits could be improved at the same time. NEPA reviews allow for that situation by considering, not weighing, both positive and negative impacts.[16]

[13] Draft NR GEIS, page 1-10

[14] Atomic Energy Act of 1954, 42 U.S.C. § 2011 et seq. (Hereinafter AEA)

[15] See "Considering Nuclear Energy's Benefits to Society," A. Stein, November 2024, ML24337A023 (https://www.nrc.gov/docs/ML2433/ML24337A023.pdf). ; NRC's mission to protect public safety and security remained in service to the policies Congress established in the AEA, e.g., "to make the maximum contribution to the general welfare ..."

[16] National Environmental Policy Act of 1969 § 102(2)(C)(iii), 42 U.S.C. § 4332.

(**30-7** [Toohill, Spencer])

Comment: That being said, see our following evaluation and recommendations:

Purpose and Need

BTI recognizes that the Purpose and Need issue is a foundational element in NEPA reviews. It helps define the scope of the environmental review and determines which alternatives are reasonable. A well-crafted Purpose and Need can align environmental considerations with regulatory and technological objectives.[17]

However, The NR GEIS approaches these issues very differently than the recently approved Generic Environmental Impact Statement for License Renewal of Nuclear Plants (LR GEIS).[18] In our opinion, the LR GEIS addresses this requirement more efficiently and effectively. It states that the purpose is to provide an option that allows for power if the energy system needs it, subject to meeting all other NRC regulations. This approach does not unnecessarily limit the potential benefits of nuclear energy to society.[19] In contrast, the NR GEIS imposes a stricter framework by requiring a Purpose and Need statement that the NRC uses to evaluate project justification. This can inadvertently limit innovative projects or non-traditional reactor use cases, such as those for process heat or water desalination, as applicants must frame these goals within a power-centric paradigm, or use a separate 'alternative' analysis. The draft NR GEIS currently states:

The applicant must describe in its ER the purpose and need for its proposed action, i.e., the reasons for developing the project (10 CFR 51.45(b)). The NRC staff will use this information to inform its development of the NRC's purpose and need in the SEIS. Properly defining the purpose and need is a critical step in the development of an environmental document for the purposes of meeting NEPA requirements because it establishes the need for the action and the range of reasonable alternatives that must be considered. For additional information, see RG 4.2, ISG COL/ESP-ISG-026, and COL-ISG-029.[20]

In comparison, the LR GEIS emphasizes flexibility and avoids weighing economic factors or justifying the need for power within the NRC's purview, reflecting a broader, systemic view: The purpose and need for the proposed action (license renewal) is to provide an option that allows for baseload power generation capability beyond the term of the current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, system, and, where authorized, Federal (other than NRC) decisionmakers. Except to the extent that findings in the safety review required by the Atomic Energy Act or in the environmental review could lead the NRC to not renew the operating license, the NRC has no role in the energy-planning decisions of power plant owners, State regulators, system operators, and, in some cases, other Federal agencies as to whether the nuclear power plant should continue to operate.[21]

[17] For instance, the Hermes 2 Environmental Assessment used this framework to reject alternatives that failed to support the stated purpose of testing new nuclear technologies. Environmental Assessment and Finding of No Significant Impact for the Construction Permits for the Kairos Hermes 2 Test Reactors, Draft Report for Comment, April 2024, https://www.nrc.gov/docs/ML2410/ML24103A002.pdf.

[18] NUREG-1437, Volume 1, Revision 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," August 2024, ML24086A526 (https://www.nrc.gov/docs/ML2408/ML24086A526.pdf). (Hereinafter LR GEIS)

[19] See ADVANCE Act § 501: the NRC Commission shall "update the mission statement of the Commission to include that licensing and regulation of the civilian use of radioactive materials and nuclear energy be conducted in a manner that is efficient and does not unnecessarily limit— (1) the civilian use of radioactive materials and deployment of nuclear energy; or (2) the benefits of civilian use of radioactive materials and nuclear energy technology to society."

[20] Draft NR GEIS, Page 1-10.

[21] LR GEIS, Page xxxiii.

(**30-8** [Toohill, Spencer])

Comment: *Need For Power*

The NR GEIS currently evaluates Need for Power as a deterministic Category 2 issue tied predominantly to grid electricity demands, stating:

The Atomic Energy Act requires the social and environmental consequences of the civilian use of nuclear materials be weighed against the benefits that their use would provide. Historically, the primary benefit of nuclear power generation projects has been to provide electrical power to the grid. Therefore, the NRC staff has evaluated the need for power in its new reactor EISs. Any new nuclear reactor that uses this GEIS may also provide power to the grid, and if so, may require the same type of need for power evaluation in both the ER and SEIS. However, some nuclear reactors may be built for other purposes (e.g., to generate process heat, to desalinate water, or as a research and demonstration project). In such cases, the applicant will need to present, and the NRC staff will have to evaluate, the need for the project (10 CFR 51.45(b)).[22]

BTI finds numerous challenges with the intent and description of Need for Power in the current draft. On a broad level, this perspective does not align with all modern applications of advanced nuclear reactors, such as microreactors or specialized industrial uses. The NRC's interpretation, anchored in DG-4032, ties Need for Power evaluations predominantly to electricity sales by utilities. DG-4032 states:

The need for electrical power analysis should be limited to the discussion of the supply and demand for electricity from the present to the end of the permit period. Any other primary commodities (e.g., desalinization of water, area or industrial heat) that would be produced by the proposed project should follow the guidance in Appendix C, Section C.2.8. Discussion of ancillary benefits (e.g., reduced greenhouse gas emissions, fuel diversity, or grid stability) should be addressed in the benefit-cost section of the ER.[23]

As such, Need for Power exclusively discusses the use of nuclear power for electricity. In these cases, the Need for Power and Purpose and Need often converge, making the traditional evaluation framework less applicable. Further, a deterministic delineation between power and non-power applications provides no additional value to protect the environment. The staff does acknowledge that there are other use cases (to generate process heat, to desalinate water, or as a research and demonstration project) but provides alternative requirements for showing need other than through power elsewhere. Appendix C Section C.2.8 of DG4032 also acknowledges non-electricity uses (e.g., process heat or desalination), but these applications are treated as ancillary and not fully integrated into the Need for Power analysis. A performance-based approach to Need for Power would allow flexibility in all new reactor applications and efficient environmental reviews.

The NRC posits its explanation in referencing a requirement in the AEA: "The Atomic Energy Act requires the social and environmental consequences of the civilian use of nuclear materials be weighed against the benefits that their use would provide."[24] As stated above, the AEA mandates that benefits and consequences be weighed independently. However, the NR GEIS deterministically applies a Need for Power metric to fulfill this requirement, potentially contravening the AEA's intent by precluding broader benefit considerations. AEA's directive to maximize contributions to general welfare suggests that benefits (e.g., energy security, technological advancement) should be weighed on their own merit, not solely against environmental or social impacts. The AEA does include a provision to consider the need for power, at the Commission's discretion, that is specifically in relation to antitrust provisions.[25]

Also note that the NR GEIS is incorrectly citing a regulatory requirement in § 51.45(b). There is no specific requirement in that section that there must be a need for power: "Environmental considerations. The environmental report shall contain a description of the proposed action, a statement of its purposes, a description of the environment affected, and discuss the following considerations" [emphasis added].[26] 10 CFR § 51.45 requires impacts to be discussed and considered with no analysis weighing impacts vs benefits to approve an EIS. 10 CFR § 51.45(b) does not explicitly nor implicitly require a *need for power*.

The ADVANCE Act also required the NRC to consider non-power applications for nuclear energy in Section 203.[27] The ADVANCE Act's goal of expanding nuclear energy deployment could be undermined by rigid interpretations of the Need for Power that limit projects serving diverse or localized needs. This is further evidenced by Chapter 8 of DG-4032. It provides detailed, prescriptive guidance to applicants on preparing a need-for-power analysis. DG-4032 states that "[t]he need-for-power analysis should fully describe and characterize the physical, geographic, regulatory, and administrative provisions and constraints which affect the current and forecast supply of and demand for power, and "be in sufficient detail to fully demonstrate how the proposed project would supply some or all of the service area's future need for power."[28]

[22] Draft NR GEIS, Page 1-10 - 1-11.

[23] DG-4032, Page 143.

[24] Draft NR GEIS, Page 1-10.

[25] The Atomic Energy Act of 1954, 42 U.S.C. § 105(c)(6)

[26] 10 CFR § 51.45(b)

[27] See ADVANCE Act § 203: "(a) IN GENERAL.—Not later than 270 days after the date of enactment of this Act, the Commission shall submit to the appropriate committees of Congress a report addressing any unique licensing issues or requirements relating to—(1) the flexible operation of advanced nuclear reactors, such as ramping power output and switching between electricity generation and nonelectric applications; (2) the use of advanced nuclear reactors exclusively for nonelectric applications; and (3) the colocation of nuclear reactors with industrial plants or other facilities."

[28] DG-4032, Page 143.

(**30-9** [Toohill, Spencer])

Comment: Furthermore, there are prominent divergences in precedent. Recent policies, such as those in the LR GEIS, adopt a more flexible approach that defers power justification to states or other federal bodies, avoiding unnecessary limitations on nuclear projects' societal benefits. BTI emphasizes the fact that the Commission approved the LR GEIS (and therefore approved the more flexible approach) more recently than the 2003 Commission that is cited in DG-4032. The relevant section of the LR GEIS NUREG-1437, Revision 2 10 CFR 51.95(c)(2) states, in part:

The supplemental environmental impact statement for license renewal is not required to include discussion of need for power or the economic costs and economic benefits of the proposed action or of alternatives to the proposed action except insofar as such benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation.[29]

[29] LR GEIS, Page 1-14 - 1-15.

(**30-10** [Toohill, Spencer])

Comment: *Recommendations*

BTI recommends refining the classifications of "Purpose and Need" and "Need for Power" to better align with the diverse applications of advanced reactors and the modern policy landscape. A more flexible and performance-based approach, consistent with the precedent set by the LR GEIS and directives from the ADVANCE Act, would streamline environmental reviews and avoid unnecessary restrictions on innovative reactor projects. These adjustments are vital to ensure the NRC framework supports the broader goals of maximizing societal benefits and expanding nuclear energy deployment efficiently and effectively. See the following:

1. Purpose and Need

a. Align the NR GEIS with the more effective precedent set by the LR GEIS:

i. Revise the Purpose and Need language to acknowledge non-power use cases in Section 1.3.3.2.3, Line 32-40 of the NR GEIS, ensuring the framework supports the diverse range of new reactor applications

ii. Incorporate greater flexibility to the NR GEIS and related supporting documents and analysis to acknowledge non-power use cases, ensuring the framework supports diverse reactor applications.

2. Need for Power

a. Revise related sections on Need for Power to address all concerns (not limited to any other revisions the NRC deems appropriate related to the concerns identified in this comment) and maintain Need for Power as its own Category 2 issue.

b. Alternatively, integrate the Need for Power into Purpose and Need as a unified environmental issue, emphasizing flexibility and performance-based approaches rather than deterministic forecasting. (**30-11** [Toohill, Spencer])

Comment: Site, Energy, and System Design Alternatives

The current regulatory framework for evaluating site, energy, and system design alternatives may unintentionally create barriers for advanced nuclear technologies, including microreactors, small modular reactors (SMRs), and co-located facilities. These technologies are often designed for specific contexts, such as remote areas, industrial integration, or grid support, where traditional alternatives are either unsuitable or irrelevant.

Challenges

-Site Alternatives: Microreactors and co-located facilities are often designed for specific load requirements or industrial integration. Requiring consideration of alternative sites for projects inherently tied to a specific location (e.g., proximity to data centers or chemical plants) adds unnecessary complexity and delays without meaningful environmental benefit.

-Energy Alternatives: Comparing advanced nuclear projects to other energy sources does not account for their unique contributions, such as carbon-free baseload power, grid resilience, and decarbonization of industrial sectors. These features are critical to meeting national and global climate goals but are not directly comparable to intermittent renewables or fossil fuels.

-System Design Alternatives: Mandating alternative designs for advanced reactors, especially modular systems optimized for specific applications, undermines the efficiency and standardization that these designs rely on. This could hinder the deployment of safe, cost-effective nuclear solutions.

Recommendations

The NRC should consolidate its approach to site, energy, and system design alternatives into either a combined Category 2 issue or designate them as individual Category 1 issues. This would better reflect the specific characteristics and deployment contexts of advanced nuclear technologies.

1. If Combined as a Category 2 Issue:

a. The NRC would be able to still conduct a more nuanced, context-specific analysis but integrate site, energy, and system design considerations. This approach would streamline reviews while ensuring that key environmental and safety impacts are appropriately addressed.

2. If Designated as Individual Category 1 Issues:

a. For projects that meet specified criteria (e.g., microreactors, co-located facilities, or advanced modular systems), establish clear guidance exempting them from extensive alternative analyses when their deployment context or design purpose inherently precludes viable alternatives. (**30-14** [Toohill, Spencer])

Comment:

Recommendation 1: Redesignate the five Non-Resource Related Issues as Category 1 issues

ClearPath reiterates its prior position that the "Purpose and Need," "Need for Power," "Site Alternatives," "Energy Alternatives," and "System Design Alternatives" are superfluous. In every case, the relevant license applicant will have done these analyses before approaching the NRC with their final project proposal. It is not the NRC's specialty or responsibility to understand the business case of the reactor for which they are performing an environmental review.

There are two basic types of project proponents: governmental authorities and private entities. Government authorities like public utility commissions and grid planners perform their own assessments to decide if additional generation is necessary. The NRG has no special competency in determining local grid requirements, so there is no benefit to an additional NRG analysis in these cases. Similarly, any public or private entity developing the project would have weighed the costs and benefits of alternative energy sources, site locations, and reactor designs before a license application is submitted to the NRG. In every instance, the NRG has no special expertise to assess the business case, so there is no benefit to having them reconsider these choices during an environmental review.

Moreso, Section 107(d) of the National Environmental Policy Act (NEPA), as added by the 2023 FRA amendments, states only that "[e]ach environmental document shall include a statement of purpose and need that briefly summarizes the underlying purpose and need for the proposed agency action" (emphasis added). This framing provides the justification to treat the "Purpose and Need" and "Need for Power" as generic Category 1 issues. First, an applicant is required to submit a purpose and need statement to comply *with NEPA*; the statute does not direct project applicants or the authorizing agency to conduct a detailed "Need for Power'' assessment. Instead, the NRG can view the statement of "Purpose and Need" as compliance with NEPA, not as a project-specific review.

Furthermore, as revised by the FRA, Section 102(2)(C) of NEPA states that an agency's EIS must include a discussion of "a reasonable range of alternatives to the proposed agency action, including an analysis of any negative environmental impacts of not implementing the proposed agency action in the case of a no action alternative, that are technically and economically feasible, and meet the purpose and need of the proposal (emphasis added)." As the NRG staff notes in SECY-24-0046[7] (Enclosure 1), the reasonable range of alternatives to the regulatory or licensing decision generally "would be defined as and limited to the no action alternative (i.e., not issuing the license) because not engaging in regulatory or licensing decisions is the only reasonable alternative to the agency action." As noted above, an applicant will have considered which siting and energy alternatives, if any, are technically and economically feasible and consistent with the applicant's identified "Purpose and Need" for the facility. Said another way, if the decision to seek a license is solely on the applicant, and the NRC's role is to issue a license or not, then there is no basis for the NR GEIS to treat the three Alternatives analyses as Category 2 items.

The "Purpose and Need," "Need for Power," and three "Alternatives" analyses are best determined by external public and private entities - not through NRG-led environmental reviews aimed at determining the environmental impact of a license decision. At a minimum, the NR GEIS should treat all of these items generically as Category 1 issues. Ideally, these items could all be treated as non-applicable due to their in-depth consideration by other external entities before submitting a license application to the NRC.

[7] ADAMS Accession Number ML24078A

(**36-5** [McMurray, Nicholas])

Comment: • The NRC proposes to treat Need for Power as a separate Category 2 issue requiring fairly detailed quantitative analysis. Such an analysis is not legally mandated by the Atomic Energy Act or NEPA; i.e., neither statute requires monetization and comparison of benefits and costs (i.e., cost-benefit analysis). Nor is it necessary given the clear need for new nuclear capacity in the U.S., related national policy objectives and congressional imperatives, and an applicant's need to describe the Purpose and Need for a proposed facility as its own Category 2 issue. (**38-1-5** [O'Neill, Martin])

Comment: • The NR GEIS and its implementing guidance should make clear that the No Action Alternative must include "an analysis of any negative environmental impacts of not implementing the proposed agency action." This analysis is required by Section 102(2)(C)(iii) of NEPA, as revised by the FRA. (**38-1-6** [O'Neill, Martin])

Comment:

G. The NRC Should Consider Removing "Need for Power" as a Separate Category 2 Issue Requiring Detailed Analysis of Power Market Conditions

The NR GEIS identifies multiple non-resource-related Category 2 issues, two of which are the (1) purpose and need for the proposed action and (2) the need for power that may be generated by a proposed new reactor.[36] Chapter 8 of Regulatory Guide DG-4032 (proposed Revision 4 to Regulatory Guide (RG) 4.2, *Preparation of Environmental Reports for Nuclear Power Reactors*) provides detailed, prescriptive guidance to applicants on preparing a need-for-power analysis. DG-4032 states that "[t]he need-for-power analysis should fully describe and characterize the physical, geographic, regulatory, and administrative provisions and constraints which affect the current and forecast supply of and demand for power, and "be in sufficient detail to fully demonstrate how the proposed project would supply some or all of the service area's future need for power."[37]

NEI requests that the NRC consider whether a separate and detailed need-for-power analysis is still needed in view of applicable legal requirements, the clear demand for new nuclear power nationwide, related national policy objectives, and an applicant's need to articulate the purpose and need for a proposed facility as its own Category 2 issue. We discuss each of these considerations below. Based on this discussion, we recommend that the NRC eliminate Need for Power as a separate Category 2 issue and include a more concise discussion of the need for power (as relevant to a specific project) in the Purpose and Need Statement for a proposed action.

1. <u>Neither the Atomic Energy Act Nor NEPA Requires Detailed Need-for-Power Analysis or a Quantitative Cost-Benefit Analysis</u>

In discussing the need for power issue, the draft NR GEIS states: "The Atomic Energy Act requires the social and environmental consequences of the civilian use of nuclear materials be weighed against the benefits that their use would provide."[38] The NR GEIS, however, does not cite any specific AEA section in support of this assertion. Section 8.0 of DG-4032, which provides guidance to applicants on analyzing the need for power in their environmental reports, quotes, in part, subparagraph (c)(6) of the AEA Section 105 ("Antitrust Provisions").[39] Section 105(c)(6) states in full:

In the event the Commission's findings under paragraph (5) is in the affirmative, the Commission shall also consider, in determining whether the license should be issued or continued, such other factors, including the need for power in the affected area, as the Commission in its judgment deems necessary to protect the public interest. On the basis of its findings, the Commission shall have the authority to issue or continue a license as applied for, to paragraph (5) of this subsection. Such advice shall include an explanatory statement as to the reasons or basis therefor.[40]

The NRC's reliance on this provision appears misplaced, insofar as Section 105(c)(6) relates to an antitrust review that the NRC was formerly required to conduct as part of the licensing of commercial reactors.[41] Section 625 of Energy Policy Act of 2005 (EPAct 2005) provided that the NRC's authority to conduct an antitrust review does **not** apply to an application for a license to construct or operate a nuclear power plant that is filed on or after the date of enactment.[42] Consequently, the NRC has no antitrust review authority or responsibility with respect to applications for new nuclear power plants. In an October 2005 final rule, the NRC eliminated its antitrust review requirements for new reactors.[43] Thus, AEA Section 105(c)(6) cannot reasonably be construed as requiring any need-for-power analysis, much less one performed for purposes of complying with NEPA.

NEPA itself does not require the NRC to perform a detailed need-for-power analysis for commercial reactors. In fact, Section 107(d) of NEPA, as added by the 2023 FRA amendments, states only that "[e]ach environmental document shall include a statement of purpose and need that briefly summarizes the underlying purpose and need for the proposed agency action."[44] CEQ's implementing regulation at 40 CFR 1502.13 contains the same language.

Historically, the NRC has attributed the need-for-power analysis requirement to "judicial interpretations" of NEPA concluding that "Federal agencies must balance environmental costs against the anticipated benefits of the action in the EIS."[45] In denying a 2002 NEI petition for rulemaking involving this issue, the Commission elaborated on this point:

In the past, the NRC equated the need for power with the benefits of the proposed action. "'Need for power' is a shorthand expression for the 'benefit' side of the cost-benefit balance, which NEPA mandates for a proceeding considering the licensing of a nuclear plant."[46]

The Commission further noted that "in the case of construction of a new nuclear power plant, the NRC must assess the need for power to accurately characterize the cost (i.e., environmental impact) and benefits associated with the proposed action."[47]

[36] *Id*. at 1-10 to 1-11, 1-18 (Table 1-1), 4-27 (Table 4-1). The NRC has provided guidance on these topics in several current and proposed new/revised guidance documents.

[37] DG-4032 at 143.

[38] Draft NR GEIS at 1-10.

[39] DG-4032 at 143 (quoting AEA Sec. 105(c)(6)).

[40] AEA Sec. 105(c)(6), 42 USC 2135.c.(6).

[41] See *Alabama Power Co. v NRC*, 692 F.2d 1362, cert. denied, 464 U.S. 816 (1983) for a description of the earlier scheme for antitrust review.

[42] Energy Policy Act of 2005, P.L. 109-58 (Aug. 8, 2005), 42 USC § 16005.

[43] Price-Anderson Act Financial Protection Regulations and Elimination of Antitrust Reviews, 70 Fed. Reg. 61,885 (Oct. 27, 2005) (to be codified at 10 C.F.R. pts. 2, 50, 52, and 140) ("The final rule's changes in the regulations remove all antitrust review requirements and references to the discontinued antitrust review.").

[44] 42 USC 4337(d) (emphasis added).

[45] NRC, Nuclear Energy Institute; Denial of Petition for Rulemaking, 68 Fed. Reg. 55,905, 55,909 (Sept. 29, 2003).

[46] *Id*. (citations omitted) (emphasis added).

[47] *Id*. at 55,910.

(**38-1-19** [O'Neill, Martin])

Comment: While NEPA is generally regarded as requiring a weighing or balancing of the environmental costs against the economic, technical, or other public benefits of a proposed action, an agency's EIS (or an applicant's environmental report) need not contain a formal or mathematical cost-benefit analysis.[48] NEPA contains no reference to cost-benefit analysis. In fact, the courts and the CEQ have distinguished between cost-benefit balancing and cost-benefit analysis. The latter is a quantitative analytic technique in which benefits and costs are monetized and a numerical ratio is obtained. The courts have not construed NEPA to require a cost-benefit analysis.[49] As one court noted, NEPA "permits, at most, a narrowly focused, indirect review of the economic assumptions underlying a federal project described in an impact statement."[50] The CEQ has stated that "NEPA does not require a cost-benefit analysis where all monetized benefits and costs are directly compared."[51]

With regard to cost-benefit balancing, the Commission has recognized that NEPA's "theme . . . is sounded by the adjective 'environmental': NEPA does not require the agency to assess every impact or effect of its proposed action, but only the impact or effect on the environment."[52] Thus, the "[d]etermination of economic benefits and costs that are tangential to environmental consequences are within [a] wide area of agency discretion."[53] In the case of economic benefits, "a key consideration . . . [is] whether the economic assumptions of the FEIS [or ER] 'were so distorted as to impair fair consideration of the' project's adverse environmental effects.'"[54] Accordingly, when it comes to the NEPA cost-benefit balance, the Commission's primary concern is that misleading information on economic benefits of a project "could skew an agency's overall assessment of a project's [environmental] costs and benefits, and potentially 'result in approval of a project that otherwise would not have been approved because of its adverse environmental effects.'"[55]

[48] *Idaho v. ICC*, 35 F.3d 585, 595 (D.C. Cir. 1994); *Trout Unlimited v. Morton*, 509 F.2d 1276 , 1286 (9th Cir. 1974) (noting that an EIS does not require "a formal and mathematically expressed cost-benefit analysis" in economic or monetary terms); *Sierra Club v. Stamm*, 507 F.2d 788 , 794 (10th Cir. 1974) (rejecting the view that an EIS requires "the fixing of a dollar figure to either environmental losses or benefits").

[49] See David R. Mandelker, NEPA Law and Litigation §§ 10.24 to 10.25 (2d ed. 1999 & 2008 Supp.).

[50] *S. La. Envtl. Council, Inc. v. Sand*, 629 F.2d 1005, 1011 (5th Cir. 1980) (emphasis added).

[51] CEQ, National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change; Notice of interim guidance; request for comments, 88 Fed. Reg. 1196, 1211 (Jan. 9, 2023) (CEQ 2023 GHG Guidance).

[52] *La. Energy Servs., L.P.* (Claiborne Enrichment Ctr.), CLI-98-3, 47 NRC 77, 88 (quoting *Metro. Edison Co. v. People Against Nuclear Energy,* 460 U.S. 766, 772 (1983)).

[53] *Id*. at 89 (quoting *S. La. Envtl. Council*, 629 F.2d at 1011).

[54] *Id*.

[55] *Id*. (citing *Hughes River Watershed Conservancy v. Glickman,* 81 F.3d 437, 446 (4th Cir. 1996))

(**38-1-20** [O'Neill, Martin])

Comment: 2. Numerous Studies Demonstrate the Clear Need for New Nuclear Capacity in the U.S.

As a clean, carbon-free, and highly reliable power source, new nuclear power is clearly needed to meeting rapidly growing electricity demand while simultaneously avoiding further carbon-intensive emissions. Indeed, the U.S. Department of Energy (DOE) has concluded that nuclear energy will "play a role in the transition to a clean energy economy by fundamentally enabling our nation's targets for clean, carbon-free electricity as well as non-electric energy markets," giving us "the potential to decarbonize many industrial sectors in the United States and abroad."[56] DOE's September 2024 *Advanced Nuclear Liftoff Report* notes that multiple system-level decarbonization modeling exercises have concluded that regardless of renewables deployment, "significant new nuclear power is required by 2050" - at least 200+ GWe or triple our current capacity - is needed to reach net-zero.[57] The White House's November 2024 *Nuclear Energy Deployment Framework* sets a target of 200 GW of net new capacity by 2050.[58] The need for nuclear generation is only increasing with the rapid buildout of datacenters, "clean tech" factories, and other electricity-intensive industrial facilities that by themselves will require the addition of many gigawatts of capacity to the U.S. grid.[59] Thus, the conclusion that substantial new nuclear generating capacity is needed is already well documented.

This growing recognition of nuclear power's value and benefits has prompted unprecedented bipartisan support for nuclear power at both the federal and state government levels. This support is evidenced by landmark federal legislation and billions of dollars of related appropriations, including NEICA, NEIMA, the Bipartisan Infrastructure Investment and Jobs Act

of 2021, the Inflation Reduction Act of 2022, the Consolidated Appropriations Act, 2024 (H.R. 4366), and the ADVANCE Act of 2024.[60] Many states also are pursuing legislative, regulatory, and policy initiatives aimed at deploying new advanced nuclear reactors. In short, the clear demand for new nuclear capacity, nuclear energy's proven environmental and other benefits, and widespread governmental support for nuclear energy suggest that there is little risk of "distorted" or "skewed" cost-benefit balancing by the NRC.

[56] DOE, Q&A: *Acting Assistant Secretary Dr. Kathryn Huff Shares Her Vision for the Future of Nuclear Energy* (June 24, 2021), https://www.energy.gov/ne/articles/qa-acting-assistant-secretary-dr-kathryn-huff-shares-her-vision-future-nuclear-energy.

[57] DOE, *Advanced Nuclear Liftoff Report* at 11.

[58] White House, *Safety and Responsibly Expanding U.S. Nuclear Energy: Deployment Targets and a Framework for Action* at 8-9 (Nov. 2024), https://www.whitehouse.gov/wp-content/uploads/2024/11/US-Nuclear-Energy-Deployment-Framework.pdf.

[59] *See, e.g.,* Halper, Evan, "Amid explosive demand, America is running out of power," *The Washington Post* (Mar. 7, 2024), https://www.washingtonpost.com/business/2024/03/07/ai-data-centers-power/; Kearney, Laila et al., "US electric utilities brace for surge in power demand from data centers," *Reuters* (Apr. 10, 2024), https://www.reuters.com/business/energy/us-electric-utilities-brace-surge-power-demand-data-centers-2024-04-10/#:~:text=Longer%20term%20power%20demand%20from,over%2035%20GW%20by%202030.

[60] Indeed, Section 501(a) of the ADVANCE Act directs the NRC to update its mission statement by July 9, 2025, to specify that the licensing and regulation of radioactive materials and nuclear energy for civilian purposes be "conducted in a manner that is efficient and does not unnecessarily limit - (1) the civilian use of radioactive materials and deployment of nuclear energy; or (2) the benefits of civilian use of radioactive materials and nuclear energy technology to society." (Emphasis added).

(**38-1-21** [O'Neill, Martin])

Comment:

3. Any Project-Specific Need-for-Power Considerations Can Be Addressed As Part of the Purpose and Need Statement for the Proposed Action

In view of the above, there appears to be no legal or practical need for the NRC to include a separate, detailed need-for-power analysis in its EISs (or EAs) for new reactors. Consistent with NEPA, the NR GEIS states that an applicant must describe in its environmental report the purpose and need for its proposed action - i.e., the reasons for developing the project.[61] The NRC staff uses that information to inform its development of the NRC's purpose and need in its supplement to the GEIS. As the NR GEIS further notes, "defining the purpose and need is a critical step in the development of an environmental document for the purposes of meeting NEPA requirements because it establishes the need for the action and the range of reasonable alternatives that must be considered."[62]

Furthermore, "[w]hen an agency is asked to sanction a specific plan[], the agency should take into account the needs and goals of the parties involved in the application."[63] In applying this

principle in NRC proceedings, the Commission has emphasized that "a federal agency may appropriately 'accord substantial weight to the preferences of the applicant and/or sponsor in the siting and design of the project,'" and "thus may take into account the 'economic goals of the project's sponsor.'"[64] If an applicant's economic goals include generating electricity for sale to various customers or end users, then its purpose and need statement will reflect that fact. An applicant will not seek to build and operate a plant unless it believes that there is a need for the electricity or other plant outputs (e.g., heat, steam), and that the electricity or other products can be sold at a competitive rate. Moreover, as the NRC has recognized, the regulatory authority over licensee economics (including the need for power) falls within the jurisdiction of the states and, to some extent, within the jurisdiction of the Federal Energy Regulatory Commission (FERC) or other federal agencies.[65]

Accordingly, NEI recommends that the NRC consider addressing the need for power as part of the agency's discussion of the purpose and need for the proposed action and doing so in a much more concise fashion, making use of incorporation by reference as appropriate. FERC, for example, has taken this approach in its hydropower licensing proceedings. FERC guidance allows for a "Purpose of Action and Need for Power" section and states:

This section presents the need (both project-specific and regional) - for the power the project would generate, including total energy and capacity needs, and fossil fuel displacement, and shows why providing that energy is important. Cite any plans or reports used to project future power demand and explain how the project satisfies or would help satisfy these power demands. If the applicant is not a utility, discuss only the regional need for power, and include the amount of power to be sold and, if known, identify the purchasers.[66]

NEI believes the NRC could take a similar approach by briefly describing and incorporating by reference recent demand for power reports or analyses (e.g., annual integrated resource plans), ISO or RTO power market analyses, state utility regulatory filings, other relevant regional reports or resource assessments. Like FERC, the NRC could devote 1-2 pages to the need-for-power discussion rather than an entire chapter of its site-specific EIS.

[61] Draft NR GEIS at 1-10.

[62] Id.

[63] *Citizens Against Burlington, Inc. v. Busey*, 938 F.2d 190, 196 (D.C. Cir. 1991) (citing *La. Wildlife Fed'n v. York*, 761 F.2d 1044, 1048 (5th Cir. 1985) (per curiam) ("[N]ot only is it permissible for the Corps to consider the applicant's object; the Corps has a duty to take into account the objectives of the applicant's project. Indeed, it would be bizarre if the Corps were to ignore the purpose for which the applicant seeks a permit and to substitute a purpose it deems more suitable."); *Roosevelt Campobello Int'l Park Comm'n v. EPA*, 684 F.2d 1041, 1046-47 (1st Cir. 1982) ("EPA's choice of alternative sites was focused by the primary objectives of the permit applicant.")).

[64] *Hydro Resources, Inc.* (P.O. Box 15910, Rio Rancho, NM 87174), CLI-01-4, 53 NRC 31, 55-56 (2001) (quoting *Citizens Against Burlington*, 938 F.2d at 197; *City of Grapevine v. Dep't of Transp*., 17 F.3d 1502, 1506 (D.C. Cir.), cert. denied, 513 US 1043 (1994)) (emphasis added). *See also Canyons v. U.S. Forest Serv*., 297 F.3d 1012, 1030 (10th Cir.2002) ("Where the action subject to NEPA review is triggered by a proposal or application from a private party, it is appropriate for the agency to give substantial weight to the goals and objectives of that private actor.").

[65] NRC, NUREG-1437, Vol. 1, Rev. 2, *Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants; Main Report, Final Report* at 1-15 (Aug. 2024) (ML24086A526).

[66] FERC, Office of Energy Projects Division of Hydropower Licensing, *Preparing Environmental Documents: Guidelines for Applicants, Contractors, and Staff* at 3 (Sept. 2008), https://www.ferc.gov/sites/default/files/2020-04/PreparingEnvironmentalDocuments.pdf. See, e.g., FERC, Office of Energy Projects Division of Hydropower Licensing, *Final Environmental Impact Statement for Hydropower License, Goldendale Energy Storage Project - FERC* Project No. 14861-002 (FERC/EIS-0331F) at 4 (Feb. 2024) (providing one-page discussion of the need for power), https://elibrary.ferc.gov/eLibrary/filelist?accession_number=20240208-3036.

(**38-2-1** [O'Neill, Martin])

Comment:

NEI notes that Commission approval and future staff implementation of certain recommendations contained in SECY-24-0046, "Implementation of the Fiscal Responsibility Act of 2023 National Environmental Policy Act Amendments" (May 30, 2024) (ML24078A013), could affect how the NRC analyzes energy alternatives and alternative sites for new reactor license applications. As revised by the FRA, Section 102(2)(C) of NEPA states that an agency's EIS must include discussion of:

(iii) a reasonable range of alternatives to the proposed agency action, including an analysis of any negative environmental impacts of not implementing the proposed agency action in the case of a no action alternative, that are technically and economically feasible, and meet the purpose and need of the proposal.[70]

As amended by the FRA, NEPA now generally refers to the "proposed agency action" (as distinguished from the phrase "proposed action" used in the pre-2023 version of NEPA) and includes the word "Federal" before "resources" in section 102(2)(C)(v).

As detailed in Enclosure 1 to SECY-24-0046, the staff has recommended, in Option 1.b, to generally limit the proposed agency action to the regulatory or licensing decision (e.g., whether to issue an operating license). Furthermore, the NRC's consideration and analysis of the "irreversible and irretrievable commitments" of resources involved in the proposed agency action would be limited to "Federal" resources.[71] As the staff notes, if approved by the Commission, this approach would improve the efficiency of NRC's NEPA reviews by narrowing the scope of those reviews to be consistent with the current text of NEPA and CEQ regulations. As SECY-24-0046 further explains:

The staff would evaluate the reasonably foreseeable environmental effects of the agency's regulatory or licensing decision. In most cases, the reasonable range of alternatives to the regulatory or licensing decision would be defined as and limited to the no action alternative (i.e., not issuing the license) because not engaging in regulatory or licensing decisions is the only reasonable alternative to the agency action. The staff would analyze the reasonably foreseeable environmental effects of the no action alternative (including negative environmental impacts of not implementing the proposed agency action). The environmental effects of the no action alternative may include the environmental impacts from termination of operation and decommissioning, energy conservation, and energy imports, as well as replacement energy options and alternative nuclear material production, processing, and storage. Under this option,

the staff would likely consider replacement energy options as reasonably foreseeable consequences of the no action alternative instead of as "alternatives to the proposed agency action." However, the NRC generally would not consider alternatives to the proposed action that the agency does not have the authority to implement (e.g., siting and energy alternatives).[72]

[70] 42 USC 4332(2)(C)(iii) (emphasis added).

[71] SECY-24-0046, Encl. 1 at 6.

[72] Id. at 6 (emphasis added). *See also id.*, Encl. 7 at 3 ("Other alternatives such as locating the proposed action at alternative sites would not be considered.").

(**38-2-4** [O'Neill, Martin])

Comment: As explained in SECY-24-0046, many proposed actions and alternatives thereto are currently analyzed under NEPA in terms of the applicant's and/or societal purpose and need rather than the NRC's purpose and need. For new nuclear power plant license applications, "this results in a purpose and need statement typically framed around a need for electrical power, with a resulting set of alternatives that would also achieve the stated need for additional electrical power, including other forms of power generation."[73] Thus, alternatives considered in new and advanced reactor licensing EISs have commonly included, as applicable, a no action alternative, site alternatives, energy generation alternatives, and system design alternatives. Commission approval and staff implementation of the approach recommended in SECY-24-0046, which is based on the staff's reading of NEPA Section 102(2)(C)(iii), would obviate discussion of energy and site alternatives and focus the NRC's analysis on the proposed action and no action alternative.[74] If this occurs, then the NRC would need to revise accordingly its Part 51 regulations, as well as any relevant discussion in the NR GEIS and implementing guidance.

[73] *Id.* at 1.

[74] Notably, even prior to its amendment in 2023, NEPA did foreclose an agency from analyzing in detail only two alternatives (i.e., one action alternative and the no action alternative, as NEPA "does not impose a numerical floor on alternatives to be considered." *Native Ecosystems Council v. U.S. Forest Serv.,* 428 F.3d 1233, 1246 (9th Cir. 2005) ("[T]o the extent that [plaintiff] is complaining that having only two final alternatives - no-action and a preferred alternative - violates the regulatory scheme, a plain reading of the regulations dooms that argument. So long as 'all reasonable alternatives' have been considered and an appropriate explanation is provided as to why an alternative was eliminated, the regulatory requirement is satisfied."). *See also N. Idaho Cmty. Action Network v. U.S. Dept. of Transp.*, 545 F.3d 1147 (9th Cir. 2008) ("Under these circumstances, we hold that the Agencies fulfilled their obligations under NEPA's alternatives provision when they considered and discussed only two alternatives in the 2005 EA."); *Citizens Against Burlington v. Busey,* 938 F.2d 190, 199 (D.C. Cir. 1991) (holding that the FAA, in approving a city's plan to expand an airport, complied with NEPA in publishing an EIS that discussed in depth only the two alternatives of approving the expansion and not approving it).

(**38-2-5** [O'Neill, Martin])

Comment: I. NRC Guidance Should Address the Need to Discuss the "Negative Environmental Impacts" of the No Action Alternative

As noted above, Section 102(2)(c)(iii) of NEPA provides that an agency must include "an analysis of any negative environmental impacts of not implementing the proposed agency action in the case of a no action alternative." In SECY-24-0046, the NRC staff states that it "is ensuring the analysis of the no-action alternative discusses reasonably foreseeable negative environmental impacts, per NEPA section 102(2)(C)(iii)."[75] Thus, NEI recommends that the NRC identify this new requirement in the NR GEIS and implementing guidance (i.e., RG 4.2 and COL-ISG-030). In addition, both applicants and the staff likely would benefit from some specific guidance on how to analyze reasonably foreseeable negative environmental impacts of the no-action alternative.

[75] SECY-24-0046, Encl. 1 at 5.

(**38-2-6** [O'Neill, Martin])

Comment:

As a general matter, nuclear power plants have net beneficial environmental effects. In 2023 alone, U.S. nuclear-generated electricity avoided approximately 439 million metric tons of carbon dioxide emissions that would otherwise have come from fossil fuel-fired generation units. It also emits no greenhouse gas or criteria air pollutants, such as nitrogen oxides, sulfur dioxide, particulate matter, and mercury, and has among the lowest overall life-cycle impacts of any electricity generation source.[76] Due to its high energy density, nuclear power also has a much smaller geographic footprint than other energy generation sources, including renewables.[77] As a result, nuclear power helps avoid adverse climate change, air quality, human health, land use, and ecological impacts that may disproportionately affect vulnerable communities. Thus, the no action alternative likely would entail the loss of these benefits, albeit on the scale of an individual plant.

DOE's October 2024 Final HALEU EIS provides some useful insights on this topic. Section 2.6.2 (No Action Alternative) states, in relevant part:

Under the status quo, existing electrical generation capacity would continue to operate. Traditional electricity generation sources, including LWRs, hydroelectric, solar, wind and fossil-fueled plants, would continue to be relied on to supply our nation's energy demand and energy security.

This could have adverse impacts on meeting [greenhouse gas (GHG)] reduction goals. The full-lifecycle GHG emissions of coal and natural gas-power generation sources are substantially higher than for nuclear power. For instance, coal generates 820 grams (g) of carbon dioxide equivalent (CO2e) per kilowatt-hour (g CO2e/kWh) of electricity, while natural gas produces 490 g CO2e/kWh. Even hydroelectric and solar produce lifecycle emissions at 24 g CO2e/kWh and 41 g CO2e/kWh, respectively. In contrast, nuclear power produces 12 g CO2e/kWh (Schlomer et al., 2014). Therefore, using coal or natural gas (and even hydroelectric and solar) to generate electricity would result in higher GHG emissions. Those higher GHG emissions from non-nuclear power could contribute to a greater rate of climate change.[78]

Notably, DOE also estimates that electrical power generated by HALEU-fueled advanced nuclear reactors could result in 94% to greater than 99% lower CO_2e emissions, compared to power generated from combinations of existing sources.[79] These emissions differences would be more pronounced where power generation introduced into a region by the HALEU program

displaces more higher-emitting fossil fuel generation sources than lower-emitting renewable generation sources.[80]

Finally, it bears emphasis that new nuclear power plants may have multiple benefits beyond providing electricity to the grid. Such benefits could include complying with environmental regulations (e.g., site remediation); replacing retired power plants; meeting Federal and/or State energy policy goals, including those aimed at decarbonization or GHG reduction; increasing diversity and reliability of U.S. electrical generation; bolstering energy independence and national security; demonstrating new technologies; and by-production of other commercial products (*e.g.,* hydrogen, steam, heat for use by industrial or chemical facilities).[81] Thus, the no action alternative could have direct and indirect negative environmental impacts associated with the loss of these benefits (e.g., due to continued heavy reliance on, or even increased use of, fossil fuel generation sources).

[76] *See* DOE, *Advanced Nuclear Liftoff Report* at 8; IAEA, *Nuclear Power and Sustainable Development*, at 50-51 (2016), http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1754web-26894285.pdf; *see also* National Renewable Energy Laboratory (NREL), *Life Cycle Assessment Harmonization*, https://www.nrel.gov/analysis/life-cycle-assessment.html.

[77] DOE, *Advanced Nuclear Liftoff Report* at 11 and Table 8.

[78] DOE, *Final Environmental Impact Statement for Department of Energy Activities in Support of Commercial Production of High-Assay Low-Enriched Uranium (HALEU)* (DOE/EIS-0559), Vol. 1 at 2-36 (Oct. 2024) (Final HALEU EIS), https://www.energy.gov/ne/haleu-environmental-impact-statement.

[79] *Id.* at 2-39, 4-5.

[80] *Id.* at 4-5. The expected benefits of using HALEU fuel include, for example, the ability to design smaller reactors that use different coolants and generate more power per unit of volume, improved fuel utilization due to higher burnup, improved thermal efficiency with higher operating temperatures, longer operating cycles, shorter refueling periods, inherent safety features, and reduced fuel waste volumes. *See id*. at 1-3; DOE, *Pros and Cons Analysis of HALEU Utilization in Example Fuel Cycles* (ANL/NSE-22/21) (June 2023), https://doi.org/10.2172/1985692.

[81] *See*, e.g., DG-4032 at 164.

(**38-2-7** [O'Neill, Martin])

Response:

The NRC agrees in part and disagrees in part with the comments.

The NRC disagrees with comments that proposed making changes to the NR GEIS, rule, and guidance to address issues related to the need for power and alternatives. Many of the commenters suggest changes such as eliminating the need for power analyses and the consideration of energy alternatives or making such issues Category 1. These matters relate to changes in the NRC's NEPA policy to align with the spirit of the Fiscal Responsibility Act of 2023 (TN9775) and the ADVANCE Act of 2024. Because the NRC's rulemakings in these areas remain under development, the suggested changes are outside the scope of the NR GEIS and rule. The suggested changes may be made in the future through other NRC actions.

The NRC agrees with comments that recommended changes to the NR GEIS and the guidance to indicate that there is flexibility to accommodate microreactors or novel uses of reactors (i.e., other than generating power for the electrical grid). The NRC has revised Section 1.3.3.2.3 of the NR GEIS; Regulatory Guide 4.2, Appendix C, Section C.2.8; and ISG-030, Section 3.18.1 to provide further clarification regarding the purpose and need.

The NRC disagrees with comments pointing to the License Renewal GEIS as a basis for not addressing the need for power in an application for a new reactor. License renewal is a special case that is distinct from licensing a new reactor. The NRC's treatment of need for power in the License Renewal GEIS is not a function of the greater flexibility of that GEIS compared to the NR GEIS; rather, the License Renewal GEIS does not consider the need for power for license renewal because the plant has already been built and is operating. The regulation at 10 CFR 51.53(c)(2) specifically exempts the license renewal applicant from discussing the need for power, but that is not a basis for not addressing the need for power for construction and operation of a new reactor.

The NRC disagrees with comments discussing the need for guidance to evaluate the negative environmental impacts of the no-action alternative. The existing guidance in Regulatory Guide 4.2, Section 9.1, already directs applicants to describe "the impacts of not implementing the proposed action." It also states that the environmental report "should discuss what other steps might be taken to address the need for power, and the associated environmental impacts." As a result, no changes to the guidance are needed.

The NRC agrees with the comment that pointed out that the discussion of the need for power in NR GEIS Section 1.3.3.2.3 incorrectly referenced 10 CFR 51.45(b). The reference should have been to 10 CFR 51.45(c), which includes a requirement to address "the economic, technical, and other benefits and costs of the proposed action and its alternatives." The text of the NR GEIS has been corrected.

The NR GEIS and guidance documents have been modified as discussed above. No changes were made to the final rule as a result of the comments.

E.2.16 General Environmental Concerns

Comment: I am writing to provide feedback on the Generic Environmental Impact Statement (GEIS) for the licensing of new nuclear reactors. the environmental risks associated with nuclear waste disposal, accidental releases, and long-term storage of radioactive materials are significant. I encourage the NRC to strengthen its assessment of these risks and ensure that robust, long-term containment and disposal plans are in place. In addition to environmental impacts, the GEIS should address the potential health risks for communities located near proposed nuclear reactor sites. It is crucial to ensure that local populations are adequately informed and protected from any potential exposure to radiation during the plant's operation and decommissioning phases. (**2-1** [Johnson, John])

Comment: Nuclear reactors play a vital role in making electricity that helps protect the air quality worldwide. While Nuclear reactors can produce a lot of electricity without polluting the air, they can also be harmful to the environment in several ways. When a nuclear reactor is at work, it creates dangerous radioactive waste, which can stay harmful for many years. If the waste is not handled properly it can contaminate the soil and air which could be harmful to plants, animals, and people. Nuclear reactors need the environment around them to continue working, they use a lot of water to cool down the reactors and keep everything running

smoothly. But they need a large amount of water so they tend to use the water from near rivers and lakes, which could also put plants and animals living in those ecosystems at risk. I recommend finding advanced and more environmentally friendly Nuclear reactors before building new establishments. (**11-1** [Anonymous])

Comment: I wanted to flag and comment and urge the NRC staff over next week, the two hybrid meetings that you'll be holding, as well as all the comments I'm sure that will be flooding in, just to shed light on that and remind everybody that the impacts the GEIS really is, impacts of the plant on the human environment.

And, I'm learning myself what that means, but not the other way around. Not the effects of the human environment on the plant.

And, I just wanted to bring attention to that as you all may be receiving comments of effects from the human environment on the plant and not the other way around. (**12-2-2** [Toohill, Spencer])

Comment: Nuclear power plants are a good energy source, considering that, unlike other energy sources, they do not directly produce CO2 (Ghosh, 2022). However, they still have negative environmental impacts, such as using large amounts of metal or producing radioactive waste (EIA, 2022). Additionally, the systems of the surrounding areas can be highly polluting to the environment depending on the local natural ecosystem. Whether it be the radioactive waste or accidents from the power plant, these hazards can enter nearby soil, if on land, or water, if next to a river, and impact its quality.

Turkey Point Nuclear Generator is a nuclear power plant in Miami-Dade County that exemplifies these situational issues. Two particular concerns for the generator are its impact on air and water quality. Specifically, climate change and rising sea levels have impacted the system's one-of-a-kind cooling canals, which has caused further concerns for Biscayne Bay (Miami Waterkeeper, 2023). Despite these concerns, the 1970s reactor was recently granted new operating licenses for the next 20 years. However, Miami has and will continue to face severe impacts from climate change, and these reactors have not seen improvements to consider these impacts. In the last decade, rising temperatures have caused the water in the canals to grow "saltier, fueling the underwater plume and pushing drink water wellfield"(Staletovich, 2024), creating an extreme health safety hazard to locals and the Bay itself. While NRC officials claim they have measures to address these increasing issues, nothing has been accomplished to show their measures. (**16-1** [Tasoluk, Sofia])

Comment: I have some concerns about the ways in which the rule proposes to codify findings that are being used to create a draft nuclear reactor generic environmental impact statement (NR GEIS). The reasoning appears to be in the name of efficiency, streamlining the process of approving new nuclear reactor applications by evaluating new projects based on these generic findings, and then using that data when conducting further site-specific environmental reviews. This rule marks an interesting dichotomy, where on one hand, using generic data to streamline a process could lead to overlooking real environment concerns, and allow for details to be missed or overlooked. On the other hand, there is a real argument that whatever negative site-specific environmental issues might exist pale in comparison to the amount of good that is done by phasing out other forms of energy in favor of nuclear, a relatively clean, environmentally friendly power source. (**18-2** [Anonymous])

Comment: However, it is important to address key issues surrounding operational safety, water resource management, and nuclear waste storage to ensure the safe and sustainable implementation of this technology. (**21-2** [Pond, Douglas])

Comment: Despite its promise, nuclear energy comes with significant challenges. Operation safely must remain a top priority as we develop and deploy advanced nuclear reactors. Past incidents such as the Fukushima, and Chernobyl disasters, and even the partial meltdown here in the United States at Three Mile Island, have underscored the catastrophic consequences of design flaws and inadequate risk management. Researchers have emphasized that advanced reactors must be rigorously tested and incorporate multiple fail safes to prevent such incidents (Ingersoll et al., 2014). Emergency preparedness plans should also be robust and regularly updated to address evolving risks. (**21-4** [Pond, Douglas])

Comment: However I urge the NRC to incorporate strong safeguards for operational safety, water resource management, and nuclear waste storage into the final rule to ensure the technology's long term sustainability and public acceptance. (**21-8** [Pond, Douglas])

Comment: I am hopeful that the "Generic Environmental Impact Statement for Licensing of New Nuclear Reactors" will help regulate nuclear reactors' impact on our environment in this age of climate change. This potential policy would be important as tracking data and understanding where the most negative effect is being done is important. (**28-1** [McRoberts, Sage])

Comment: However, it’s important to make sure unique site-specific issues aren't overlooked. (**34-2** [McRoberts, Sage])

Comment: It is important to consider both the pros and the cons of this issue. Although generalizing regulations for the construction and decommissioning of nuclear reactors would indeed speed up the process, safety issues are a concern. If the decommissioning of a nuclear reactor is too sped up because a "special case scenario" isn't recognized, it could lead to disaster in neighboring communities. However, nuclear energy is a renewable source of energy and it's vital in our fight against climate change. According to the World Nuclear Association, the rate of nuclear reactor accidents is relatively low and declining. This means that generalizing standards for construction and decommissioning of nuclear reactors isn't a bad idea, as it would not only speed up the process, but also save money and increase the amount of renewable energy used in the United States. Still, proper safety measures must be taken and discrepancies between a specific situation and the general guidelines must not be overlooked. If not, as stated before, this could pose significant risk to communities. Nuclear reactors are delicate, and must be dealt with as such, so while generalizing standards is a good idea for saving time, there are still many safety issues that must be considered and dealt with appropriately, including improved guidelines on how to respond in case of a nuclear accident or community exposure. The proposed rule touches on this, as it says that there will also be a list of unique situations and guidelines attached. Therefore, the Generic Environmental Impact Statement for Licensing of New Nuclear Reactors is overall a good rule that could easily be improved by guidelines in case of accidents, clean-up, and overall simply being extremely cautious with said guidelines. The generic guidelines on nuclear reactors contain more pros than cons, as they save money, are a source of renewable energy, and can overall improve the general state of the environment, however they must be dealt with cautiously and include even the most unique situations. (**35-1** [Guzman, Xachell])

Response:

The NRC agrees with the comments. The comments generally reference resource concerns associated with the construction, operation, and decommissioning of new reactors that should be considered in the NR GEIS. Chapter 3 of the NR GEIS includes the description of the affected environment and environmental consequences for all potentially affected resources, including:

- risks associated with nuclear waste disposal

- accidents

- long-term storage of radioactive materials

- human health impacts

- impacts on plants and animals

- water use

Additionally, Chapter 3 of the NR GEIS includes a description of the PPE and SPE values and assumptions used to reach generic conclusions, as applicable, for these resources, along with the rationale for how these values and assumptions were derived.

Site-specific conditions that may affect plant safety are considered as part of the safety review when siting nuclear power plants. This includes the consideration of seismic, meteorological, and hydrologic siting criteria, including maximum probable precipitation criteria, as set forth in 10 CFR Part 100, "Reactor Site Criteria." NRC regulations require that plant structures, systems, and components important to safety be designed to withstand the effects of natural phenomena, such as flooding, without loss of capability to perform safety functions. If new information about changing environmental conditions (such as rising sea levels that threaten safe operating conditions or challenge compliance with the plant's technical specifications) becomes available, the NRC will evaluate the new information to determine whether any safety-related changes are needed at licensed nuclear power plants. This is a separate and distinct process from the NRC staff's environmental review for licensing new reactors that it conducts in accordance with the NRC's regulations for implementing NEPA in 10 CFR Part 51. Additionally, once the license is issued, the NRC evaluates nuclear power plant operating conditions and physical infrastructure to ensure ongoing safe operations under the plant's operating license(s) through the NRC's reactor oversight program.

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

E.2.17 Rulemaking – Process and Authority

Comment: The proposed rule is overly restrictive in its approach to challenges to the generic findings and therefore seems to exceed agency authority. The fact that the proposed rule, after adoption, limits challenges to generic findings to petitions for rulemaking and a § 2.335(b) waiver raises a number of issues. In both cases the threshold for meaningful participation is high, both for applicants and the public. Petitions for rulemaking are resource-intensive

processes and are cumbersome for addressing singular issues. To petition for a new rule to contest a generic finding is analogous to using a sledgehammer to crack a nut.

And requesting a § 2.335(b) waiver before the Atomic Safety and Licensing Board (Board) requires the applicant to enter into administrative proceedings, which can be denied at the discretion of the Board. Again, this is a cumbersome, expensive, and illusive mechanism for allowing participation. The consolation of appeal to the NRC or further to the federal courts, per the Administrative Procedure Act, is of minimal comfort to the applicant. The cornerstones of NEPA are transparency and public participation. The NRC cannot issue regulations that contradict Congressional direction. Likewise, nowhere in the Atomic Energy Act is the authority given to the NRC to restrict public participation or skirt other statutory mandates. (**19-2** [Adams, James C.])

Response:

The NRC disagrees with the comment. Codifying the findings of the NR GEIS in 10 CFR Part 51 is consistent with the approach used for license renewal of nuclear power plants—a long-established approach that balances regulatory stability with the ability to raise new information. As codified, a direct challenge to any of the findings during the review of a specific project application would require a waiver of the rule through 10 CFR 2.335 (TN6204). However, built into the process for the review of each application is a requirement for the applicant and the staff to identify any new and significant information that would change a finding for a Category 1 issue in the NR GEIS. Likewise, members of the public can identify such information, for example through petition for rulemaking under 10 CFR 2.802. If new and significant information is identified for an issue, then an analysis of that issue is required (see 10 CFR 51.75(d)).

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

Comment: • Periodic Reviews of Impact Classifications: Regularly evaluate the effectiveness of the classification system to ensure it aligns with emerging scientific evidence and stakeholder feedback. Currently the process has a review of 10 years, which might be too long. 7 years might be better to ensure the effectiveness of the system. (**15-4** [Eo, Taeseon] [Lee, Changki] [Lester, Jackson] [Schmidt, Trevor])

Comment: A commitment to a process to reevaluate the generic findings at intervals, with opportunities for public participation, would, to some degree, ameliorate the concern that the public has with the restriction on challenges to the generic findings.

Nowhere in the proposed rule does the NRC commit to reevaluating the generic findings to account for inevitable scientific advancements and changing global circumstances. By codifying the findings of the NR GEIS, the NRC over-relies on the perseverance of existing circumstances. However, new scientific evidence and localized conditions across the country are both evolving rapidly. Beyond the bounds of fiscal considerations, the application of what will sooner or later be outdated generic findings to every new nuclear reactor strains credulity.

To provide one example, the proposed rule recognizes that two issues regarding exposure to electromagnetic fields (EMFs) are designated as non-applicable because their impacts are *uncertain*. Such designations may be unavoidable, but the NRC should assure the public that they will do everything possible to protect against effects on human health deemed uncertain by committing to a defined process to reevaluate the generic findings at intervals.

Such commitment to reevaluation would provide a more thorough and scientific process—again, a goal that the Nuclear Regulatory Commission should strive for when regulating some of the most dangerous sites in the country. A vague statement that "If, in the future, the Commission finds" adverse effects from an issue designated non-applicable, then the Commission act is again of minimal comfort to the public because it lacks clarity, guidance, and commitment. (**19-3** [Adams, James C.])

Comment: O. The Proposed 10-Year Review and Update Cycle for the GEIS and Rule Is Appropriate

The Commission intends to review the material in the NR GEIS and the associated rule and update them, as necessary, on a 10-year cycle.[120] NEI believes that 10 years is appropriate, notwithstanding the provisions of Section 108 of NEPA. Section 108(1) provides that an agency may rely on analysis in a "programmatic environmental document" for 5 years and without additional review "unless there are substantial new circumstances or information about the significance of adverse effects that bear on the analysis." Section 108(2) states that an agency may rely on the analysis after five years "so long as the agency reevaluates the analysis in the programmatic environmental document and any underlying assumption to ensure reliance on the analysis remains valid."

In SECY-24-0046, the NRC staff notes that its current reevaluation processes, including new and significant information reviews, meet the requirements of the substantial new circumstances and reevaluation requirements in Section 108 of NEPA.[121] NEI agrees. Specifically, the NRC already has specific procedures in place for evaluating new and significant information and/or the need to supplement an EIS. That evaluation may be documented on a case-by-case basis, e.g., as part of the agency's review of a specific licensing action. As noted in SECY-24-0046, "[p]roject-specific EAs and EISs already go through a reevaluation process each time they supplement a GEIS or incorporate previous environmental analyses by reference."[122]

[120] Notably, this 10-year interval is consistent with that specified in 10 CFR Part 51, Appendix B for NRC reviews of the License Renewal GEIS and Table B-1.

[121] See SECY-24-0046, Enclosure 5: Programmatic Environmental Documents.

[122] *Id.* at 4.

(**38-2-17** [O'Neill, Martin])

Response:

The NRC agrees in part and disagrees in part with the comments. The NRC agrees with the comment that a 10-year review interval is appropriate. The NRC disagrees with comments that indicate that the rule does not require any periodic review of the findings in the NR GEIS, or that a 10-year review interval is too long. If the rule associated with the NR GEIS is finalized, it will require a 10-year review and update of the NR GEIS to consider lessons learned, knowledge gained, and experience from new nuclear reactor environmental reviews; include changes to applicable laws and regulations; and factor in new information (emerging technologies and any operating experience) and new scientific data and methodologies with respect to the assessment of potential environmental impacts of licensing new nuclear power plants. This 10-year time frame is consistent with existing NRC practice, including that required for NRC's 2024 License Renewal GEIS. The NRC considers this interval to be appropriate based on its

experience with the License Renewal GEIS and rule. Relating to impact classifications for environmental resources, the NRC will consider new and significant information within the scope of any of the analyzed issues as a part of the development of every new reactor SEIS.

No changes were made in the NR GEIS, final rule, or guidance as a result of the comments.

Comment: Relatedly, the NRC reassures that a Category 1 issue may be reevaluated through a project-specific analysis if "new and significant information" becomes available, but, again, nowhere in the proposed rule does the NRC provide guidance for what this term means or where it is to be obtained. Perhaps, the applicant is obliged to provide such information in its environmental report. However, yet again, the proposed rule says nothing about ensuring the veracity of the applicant's reporting. (**19-4** [Adams, James C.])

Response:

The NRC disagrees with the comment. An applicant and the staff may rely on the generic analysis in the NR GEIS for any Category 1 issue for which the applicant can demonstrate that the relevant values and assumptions of the PPE and SPE have been met, and for which no new and significant information has been identified. The new NRC regulation at 10 CFR 51.50(d)(5) requires the applicant, in its environmental report, to provide any new and significant information of which it is aware. In addition, the new NRC regulation at 10 CFR 51.50(d)(6) requires the applicant, in its environmental report, to provide a description of the process used to identify new and significant information regarding the Category 1 issues on which it relies. Existing regulations at 10 CFR 50.9 and 52.6, among other things, require all information submitted as part of an application to be complete and accurate in all material respects. Finally, the new NRC regulations at 10 CFR 51.75(d) require the NRC staff to address any new and significant information that changes the conclusions for Category 1 issues in the NR GEIS. ISG-COL-030 associated with this rulemaking provides guidance for NRC's environmental reviewer on the identification of potential new and significant information, including review of the following:

- *the applicant's environmental report (ER)*
- *records of public meetings and correspondence related to the application, including scoping*
- *environmental quality standards and regulations*
- *technical literature*

For those issues in which the NRC reviewer's analysis changes the impacts of a Category 1 issue to greater than SMALL impacts, an impact assessment for inclusion in the appropriate section of the project-specific SEIS must be prepared. The assessment should include a concise description of the new environmental impact information (including the source of information) and how this information applies to the proposed new reactor. The assessment should also list any mitigation measures that would be considered appropriate. A summary statement and a list of references cited by the NRC in its impact assessment also should be provided. In addition, guidance regarding new and significant information is provided in the 2007 revision of the "Introduction" of the Environmental Standard Review Plan (NUREG-1555).

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

E.2.18 Specific Requests for Comment - PPE and SPE Values and Assumptions

If a commenter believes the NRC staff is using an inappropriate value to result in a SMALL impact (either too restrictive, or not restrictive enough), explain the basis for that position and provide an alternative proposed parameter value.

Comment: A brief comment addressing the agency's request for comments regarding the clarity and effectiveness of the language used to describe the bounding values of the plant parameter and site parameter envelopes—the proposed rule obscurely, if at all, explains the process the NRC used to develop such bounding values and how they are incorporated in the NR GEIS. This is another example of how this proposed rule would codify improper and nontransparent procedures. (**19-6** [Adams, James C.])

Comment: 1. PPE and SPE Values and Assumptions
a. Is NRC using an inappropriate value to result in a SMALL impact?

The Plant Parameter Envelope (PPE) and Site Parameter Envelope (SPE) establish design and site-specific assumptions, respectively, that determine whether an applicant can rely on generic findings in the NR GEIS for environmental reviews. By bounding key factors like reactor design, operation, and site characteristics, this approach streamlines environmental impact analyses, reducing redundancy and enabling targeted reviews for site-specific issues.

The PPE and SPE values and assumptions outlined in the GEIS are well-constructed to support a generic analysis of environmental impacts. The PPE and SPE approaches consolidate information on reactor and site designs to establish generic bounding values: The PPE represents the physical and operational characteristics of a hypothetical reactor design, including thermal output, water usage, and waste generation; The SPE includes environmental attributes of a site, such as topography, hydrology, and proximity to sensitive ecological areas. Both envelopes are based on a comprehensive review of regulatory limits, permitting requirements, historical data, and subject matter expertise.

BTI believes the NRC staff is using an appropriate value to result in a SMALL impact. The NRC defines a SMALL impact as: Effects that are not detectable or, if detected, are insignificant in altering any important resource attribute.[2] This is evaluated quantitatively (e.g., measurable criteria like air pollutant levels) and qualitatively (e.g., effects on visual aesthetics).

The PPE and SPE are intentionally designed to include conservative values, ensuring that even worst-case scenarios are unlikely to exceed SMALL impacts.[3] The NRC assumes adherence to well-established best practices. These measures are often enforced through permitting and regulatory compliance, ensuring their implementation.

There is consistent alignment with regulatory standards. For example, the values for air and water quality impacts are consistent with federal guidelines from the Environmental Protection Agency (EPA) and other agencies, ensuring a legally backed and scientifically grounded approach. The draft also complies with the Clean Water Act, the Clean Air Act, the Endangered Species Act, the National Historic Preservation Act, and many more regulatory standards. Additionally, the NRC incorporates cumulative effects into its impact assessments and provides opportunities for site-specific review during licensing. This dual-layered approach ensures that generic analyses are supplemented with detailed evaluations where warranted.

BTI supports this thorough evaluation to determine SMALL impacts and underscores the NRC's commitment to balancing environmental protection with efficient regulatory processes.

[2] Draft NUREG-2249, "Generic Environmental Impact Statement for Licensing of New Nuclear Reactors," dated September 2024, ML24176A220)https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML24176A220). (Hereinafter Draft NR GEIS) Page 1-4.

[3] An example in the draft that highlights this is limiting permanent land disturbance to 30 acres which provides a stringent cap that minimizes potential environmental degradation. Draft NR GEIS, Page 3-2.

(**30-3** [Toohill, Spencer])

Comment:

1. Plant parameter envelope and site parameter envelope values and assumptions

Utah OED does not disagree with the values used by NRC staff to determine whether an issue could be deemed to have a small environmental impact and thus benefit from generic analysis.

(**32-2** [Lesofski, Emy])

Response:

The NRC agrees in part and disagrees in part with the comments.

The NRC agrees that the use of the PPE/SPE assumptions and values presented in the NR GEIS establish an appropriate approach to support the generic findings of Category 1 impacts. Note that comments on PPE/SPE values for specific issues are discussed in the response for that issue within this appendix, as appropriate.

The NRC disagrees with the comment that the proposed rule does not explain how the bounding values were developed and how they are incorporated into the NR GEIS. The process used to develop the values is explained in Section 1.3.1 of the NR GEIS, with the details for a given value or assumption discussed for each resource area in Chapter 3 of the NR GEIS. The process used by the NRC staff for developing the NR GEIS is discussed in Section II of the Federal Register notice for the final rule.

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

E.2.19 Specific Requests for Comment - Environmental Issues Evaluated

Are there any environmental issues that the NRC staff did not include in the scope of the NR GEIS and the proposed rule that should be included? Commenters should provide the basis for considering any proposed environmental issues.

Comment: 2. Environmental Issues Evaluated
a. Are there any environmental issues that the NRC did not include in the scope of the NR GEIS and the proposed rule that should be included?

The final NR GEIS must accurately address the negative impacts of the no-action alternative and consider the replacement alternatives as a categorized environmental issue. The current draft of the NR GEIS fails to fully evaluate the broader environmental and societal implications of forgoing nuclear energy.[4] Section 9.1 of Draft Regulatory Guide DG-4032 (proposed Revision 4 to Regulatory Guide (RG) 4.2, Preparation of Environmental Reports for Nuclear Power Reactors)[5] addresses the no-action alternative briefly saying, "The discussion of alternatives in the ER should include the no-action alternative under which the requested license or permit is not granted by the NRC."[6]

However, the omission of the no-action alternative in the NR GEIS text undermines the purpose of the National Environmental Policy Act (NEPA), which requires agencies to assess all significant environmental effects of proposed actions and their alternatives, including the No-Action Alternative.[7] It is imperative for the NRC to include those aspects in the NR GEIS, not only because it is required by NEPA,[8] but also to improve how the it considers the negative environmental impacts of the no-action alternative for future reactors.

Furthermore, nuclear energy provides substantial environmental benefits compared to other energy sources. Unlike fossil fuel-based energy, nuclear reactors emit no greenhouse gases or harmful pollutants, making nuclear energy a critical tool in mitigating climate change. Due to its natural energy density, nuclear power requires significantly less land than most other energy sources, including wind and solar. This reality comparatively minimizes disruption to land use and ecological habitats, reducing impacts on biodiversity and avoiding risks that might disproportionately affect vulnerable communities. Beyond its advantages to the environment, nuclear energy also holds immense societal benefits, such as bolstering energy independence and reliability, local development and economic growth, and strengthening national security. Given this wide range of advantages, choosing not to utilize nuclear energy could lead to the loss of these environmental and public health benefits.

BTI recommends that the Staff revise the draft to incorporate this new requirement as a categorized environmental issue within the scope of the NR GEIS and expand upon this revision in relevant implementing guidance, even if the impact is observed on a plant-by-plant basis.

[4] Draft NR GEIS, Page xviii.

[5] Draft Regulatory Guide DG-4032, (RG 4.2 Rev 4), "Preparation Of Environmental Reports For Nuclear Power Station," ML24176A228 (https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML24176A228).

[6] DG-4032, Page 151.

[7] NEPA, as amended by the FRA, mandates consideration of the negative impacts of not implementing the proposed agency action, including the no-action alternative. In SECY-24-0046, the Staff states that it is "ensuring the analysis of the no-action alternative discusses reasonably foreseeable negative environmental impacts, per NEPA section 102(2)(C)(iii)."

[8] Section 102(2)(c)(iii) of NEPA directs that an agency must include "an analysis of any negative environmental impacts of not implementing the proposed agency action in the case of a no action alternative."

(**30-4** [Toohill, Spencer])

Comment:

2. Environmental issues evaluated

Utah OED has not identified any additional environmental issues that should have been included in the scope of the NRC's GEIS.

(**32-3** [Lesofski, Emy])

Response:

The NRC agrees in part and disagrees in part with the comments. The comments relate generally to environmental issues that should be analyzed in the NR GEIS. The NRC agrees with the comment that indicated that the proposed NR GEIS addressed the appropriate issues.

The NRC disagrees with the comment that states that the NR GEIS must address the negative impacts of the no-action alternative. The no-action alternative to this rulemaking (i.e., preparing the NR GEIS) is that the NRC would not issue the NR GEIS, which would require that a project-specific EIS addressing all relevant environmental issues would have to be prepared for each new nuclear reactor licensing application.

Regardless of whether the NR GEIS and associated rulemaking is approved, project-specific licensing applications must analyze, in both the applicant's environmental report and NRC's associated EIS or SEIS, the impacts associated with the no-action alternative, including the implications of forgoing nuclear energy. NRC's Regulatory Guide 4.2 provides guidance to applicants for the format and content of environmental reports submitted for licensing new nuclear power plants. Section 9.1 of Regulatory Guide 4.2 states that environmental reports should describe "the impacts of not implementing the proposed action," including considerations of the need for power and the electrical grid reliability. Similarly, Section 9.1 of the Environmental Standard Review Plan (NUREG-1555) directs the staff to include, in its EIS, "a concise description of the effects of no action."

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

E.2.20 Specific Requests for Comment - Categorization of Issues

Are the environmental issues categorized appropriately? In other words, are there Category 1 issues that should be Category 2, or Category 2 issues that should be Category 1? Provide a basis for such conclusions.

Comment: I think some of the strategies, recommendations that the staff's pursuing could even affect how Category 2 issues within the GEIS are ultimately analyzed by an applicant and the staff, so I think that's something that we can touch on in the written comments we submit. (**13-1-5** [O'Neill, Martin])

Comment: 3. Clarity in Categorization

The NRC's proposed approach to categorizing environmental impacts into generic (Category 1) and site-specific (Category 2) groups is a practical step toward streamlining reviews. However, this method risks underestimating significant localized impacts if categorization criteria are not rigorously defined. Misclassification can lead to inadequate mitigation measures and public skepticism of the regulatory process. Furthermore, issues from generic aspects can be amplified due to site-specific criteria. For example, aquatic ecology should be treated differently if there is a certain number of endangered animals in the ecosystem.

As highlighted in Zeitoun (1994) and Gauna (1995), "ambiguities in regulatory frameworks can lead to procedural inconsistencies and stakeholder dissatisfaction." To address this, we recommend the following:

• Clear Criteria for Categorization: Develop explicit, scientifically robust guidelines for determining whether an impact is generic or site-specific and what criteria can turn a generic issue into a site-specific issue. (**15-3** [Eo, Taeseon] [Lee, Changki] [Lester, Jackson] [Schmidt, Trevor])

Comment: • Transparency in Decision-Making: Publish detailed justifications for classification decisions to enhance accountability and public understanding.

By implementing these recommendations, the NRC can strike a balance between efficiency and thoroughness, ensuring that no significant impacts are overlooked. (**15-5** [Eo, Taeseon] [Lee, Changki] [Lester, Jackson] [Schmidt, Trevor])

Comment: The NRC is asking for comments regarding the categorization of proposed issues. While I agree that some factors can be generalized, such as the base construction of the reactor, everything relates to situational impact in some way. For example, socioeconomics is listed as a Category 1 issue, but I believe it should be in Category 2 for its specific relation to a location's community. Therefore, I recommend that the NRC shift some (about one-third) of the Category 1 issues into Category 2 to ensure that local impacts are fully accounted for.

As described through the Turkey Point Nuclear Generator, every nuclear reactor has very specific conditions based on its surrounding environment. The Turkey Point Nuclear Generator's unique cooling systems, proximity to Biscayne Bay, and sensitivity to climate change make it different from any other nuclear reactor. Therefore, the general assessment of Category 1 issues, such as ecology and socioeconomics, would be inapplicable for its conditions. (**16-2** [Tasoluk, Sofia])

Comment: However, the rulemaking mentions that, for these cases, "NRC staff will complete a project-specific analysis...for Category 1 issues for which the relevant values and assumptions are not met, or for which new and significant information was identified"(NRC, 2024). While I do like that the NRC addresses these special-case scenarios, the fact that their staff makes the judgment as to whether they should take the extra steps to complete individual analysis is too weak. For example, the NRC staff issued a new renewal for the Turkey Point Nuclear Generator without fully considering the current climate change issues the generator and surrounding area face (Staletovich, 2024), which demonstrates how the administration will not take the extra steps for environmental assessment when unmandated. Rather than leaving the judgment to staffers as to whether they should perform an individual assessment, more Category 1 issues should be in Category 2, to begin with. (**16-3** [Tasoluk, Sofia])

Comment: The NRC is also requesting comments on the current evaluations of the environmental issues of reactors. Currently, the NRC has determined that all identified Category 1 issues have "SMALL IMPACT," which slightly undermines the reality of its impact. For the NRC to generalize all issues as "SMALL IMPACT," when they may not be, is a red flag for the GEIS and hints that it weakens its assessment of impact.

For example, the EIS of the Turkey Point Nuclear Plant considered a decent amount of the described issues as "MODERATE IMPACT"(NRC, 2016). This includes land use, terrestrial ecology, and socioeconomic, all of which are listed as Category 1 issues with "SMALL IMPACT" in the GEIS. As previously discussed, the identified issues should be shifted so that more are listed as Category 2. This, in alignment with the determination of their impact, also contributes to the notion that even though the issues seem they could be generalized, in reality, they still have variations in every situation.

The rulemaking states that "the NRC staff has [only] preliminarily concluded in the draft NR GEIS that the potential environmental impacts will be beneficial or of a SMALL adverse significance level for Category 1 issues"(NRC, 2024). Considering that the current evaluation is only a preliminary assessment, I urge the NRC to do a more in-depth analysis and comparison against existing nuclear reactors to determine the amount of these issues that could potentially have a "MODERATE" impact depending on different scenarios. With these issues, I recommend they switch to Category 2 rather than Category 1. (**16-5** [Tasoluk, Sofia])

Comment: As the country shifts to increasing its use of renewable energy and nuclear reactors in particular, they must be constructed in a manner that does not damage the environment in other ways. While I agree that a Generic Environmental Impact Statement (GEIS) is efficient, cost-reductive, and beneficial in the acceleration of reactors in the country, I also believe it can be dangerous for the environmental implications of future reactor construction.

The Turkey Point Nuclear Generator is a perfect example of overlooked situational impacts during construction, which can occur again with a GEIS for nuclear reactors. Listing issues as Category 1, which have a clear situational impact, such as socioeconomics, and addressing those impacts as "SMALL IMPACT" overlooks the true environmental impact, which can cause more concerns in our ever-changing environment.

Simply shifting some of the Category 1 issues to Category 2, reevaluating the impact level, and continuing to emphasize the impact of climate change will significantly improve this rulemaking to be more accurately considerate of the environment. I thank the NRC for considering my public comment and hope the agency fully reviews it before finalizing this rulemaking for a GEIS. (**16-6** [Tasoluk, Sofia])

Comment: 3. Categorization of Issues
a. Are the environmental issues categorized appropriately (Category 1 versus Category 2)?

The categorization of environmental issues in the draft reflects a thoughtful division between those requiring generalized analysis (Category 1) and those necessitating site-specific evaluation (Category 2). Category 1 issues, which conclude SMALL adverse impacts, align well with the PPE/SPE methodology. Category 1 issues are those that have been comprehensively studied across a range of plausible scenarios, allowing for conclusions that apply uniformly to all or most reactor sites. Conversely, Category 2 issues require a more detailed, site-specific evaluation because their impacts are highly influenced by local conditions.[9]

While almost all of the 20 Category 2 issues listed in Table 1-1[10] accurately reflect issues that necessitate supplemental, site-specific analysis, BTI urges the NRC staff to provide additional clarity and, optimally, revise the classification of one Category 1 issue: *Greenhouse Gas Emissions; and six Category 2 issues: Need for Power, Purpose and Need, Climate Change, and the three non-resource related Alternatives.*

[9] Draft NR GEIS, Page xvii.

[10] Draft NR GEIS, Pages 1-13 - 1-18.

(**30-5** [Toohill, Spencer])

Comment: Furthermore, the staff should consider how additional Category 2 issues (or even all Category 2 issues in certain situations) could be treated as Category 1 issues for licensing actions, specific locations, and/or specific reactor technologies to achieve the efficiency gains called for by Congress. (**36-3** [McMurray, Nicholas])

Comment:

Recommendation 5: Allow site or technology-specific treatment of Category 1 issues

In lieu of an EA/FONSI or CATEX for a nuclear reactor, additional Category 2 issues could be considered Category 1 issues. This is discussed as it relates to several sections of the ADVANCE Act in Recommendation 3 and could depend on specific technologies and/or locations. Ultimately, it may be possible to treat all issues as Category 1 issues for a specific reactor technology on a specific location, like a brownfield or an existing nuclear plant site. This would facilitate the industry's and NRC's efforts to efficiently license microreactors, non-power reactors, and other larger power reactors safely.

(**36-9** [McMurray, Nicholas])

Response:

The NRC agrees in part and disagrees in part with the comments. The NRC agrees with comments that support the NRC's approach to and general classification of environmental issues as either Category 1 or Category 2. Note that comments specific to the categorization of a given issue are described within the response to that issue in this appendix.

Many comments state that various issues should be classified as Category 2, stating that the NRC has not fully determined that many of the Category 1 issues have SMALL impacts. Conversely, other comments stated that the NRC should reconsider the classification of many of the Category 2 issues. The NRC disagrees with the comments.

The NRC's justification for and determination of SMALL impacts for each Category 1 issue is contingent on an individual proposed reactor project meeting the PPE and SPE values identified for the issue; if the project cannot meet these values for a Category 1 issue or if new and significant impacts exist, then a project-specific analysis for that issue must be developed, similar to the process for Category 2 issues. As described in Section 1.3.1 of the NR GEIS, the PPE and SPE values and assumptions were developed by SMEs using various sources; the SMEs strove to ensure that the PPE and SPE were set broadly enough to make the NR GEIS a useful licensing tool, while still ensuring that enough project-specific analysis would

be completed upon receipt of an application to document significant environmental impacts for the public and decision-makers. However, the fundamental criterion, as discussed in the NR GEIS, is that if the NRC staff could develop a set of values and assumptions that would allow it to reach a generic conclusion of SMALL environmental impacts, then the issue is classified as Category 1. If the NRC could not reach a generic conclusion, the issue was identified as a Category 2 issue.

The NRC disagrees with comments that suggest that some or all of the Category 2 issues could become Category 1 issues for certain reactor designs or certain types of sites (e.g., brownfield). The impacts of the Category 2 issues are, by their nature, project and site specific. For example, even a brownfield site may contain endangered species or cultural and historic resources.

One commenter requested "explicit, scientifically robust guidelines for determining whether an impact is generic or site-specific." The nature and characteristics of the environmental issues covered by the NR GEIS vary widely, which required the staff to develop the values and assumptions on a resource-specific basis. Chapter 3 of the NR GEIS discusses how the PPE and SPE values and assumptions for each Category 1 issue were developed.

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

E.2.21 Specific Requests for Comment - Scope of Proposed Rule Changes and GEIS

Is the applicability of the GEIS to new reactors (which includes advanced nuclear reactors) clearly articulated? Do the proposed revisions adequately address all licensing scenarios associated with evaluating the environmental impacts of permitting and licensing new nuclear reactor construction and operation? For example, no changes are proposed to §51.53(b), ''Post-construction environmental report–operating license stage,'' because this provision already references the requirements of §51.50, ''Environmental report—construction permit, early site permit, or combined license stage,'' which is modified by the proposed rule. Commenters should clearly specify any proposed regulatory text additions or changes and provide the basis for such proposed changes.

Comment: In the executive summary, the proposed action states that the GEIS will be used to "prepare a SEIS or other supplemental National Environmental Policy Act of 1969, as amended (NEPA) documentation 42 for the licensing of a new nuclear reactor, if using this GEIS." However, the proposed action in Section 2.1 of the GEIS does not contain the same language that would allow for the preparation of supplement NEPA analyses. Further, the purpose and need for the GEIS states that it will be used to define "the environmental issues that will need to be addressed in project-specific supplemental EISs (SEISs) addressing specific projects." As a result, it is not clear whether the GEIS is intended to only support the preparation of site-specific SEISs, or whether it could be used to support other NEPA analyses, such as EAs. Because the smaller footprints and operational characteristics of many advanced reactor designs will likely not result in substantial impacts to the environment, the GEIS should be revised throughout to make clear that it can be used to support other types of environmental analyses besides just EISs. (**3-1** [Johnson, John])

Comment: While the NRC staff currently envisions issuing site-specific supplements to the New Reactor GEIS, that is supplemental EISs, it is conceivable that the New Reactor GEIS could be used to support the use of environmental assessments for certain new reactors, for example,

micro reactors via future changes to Part 51 and/or case specific exemption. We look forward to exploring these possibilities with the NRC staff. (**12-1-6** [Austgen, Kati])

Comment:

Recommendation 4: Apply findings from the NR GEIS to an Environmental Assessment (EA) or Categorical Exclusion (CATEX)

The NR GEIS is applicable to the development of an EIS; however, it is likely that a number of new reactors would only require an EA as directed by the FRA.[10] As the staff awaits Commission direction on SECY-24-0046 to satisfy the FRA, the staff should ensure that the technical findings in the NR GEIS can, to the extent needed, be used to accelerate the completion of an EA and the issuance of a FONSI. Furthermore, the findings in the NR GEIS could also be used to help justify a CATEX for a nuclear reactor. ClearPath comments on the ongoing CATEX rulemaking are dated July 20, 2021[11] and September 16, 2024.[12]

[10] This would include a separate but related rulemaking that revises 10 CFR 51.20, similar to the recommendation in Enclosure 2 of SECY-24-0046

[11] ClearPath Comments on Proposed Rule, "Categorical Exclusions From Environmental Review" [Regulation Identifier Number RIN-3150-AK54; Docket ID NRC-2018-0300], dated July 20, 2021 (ADAMS Accession Number ML21209A486)

[12] ClearPath Comments on Proposed Rule, "Categorical Exclusions From Environmental Review" [Regulation Identifier Number RIN-3150-AK54; Docket ID NRC-2018-0300], September 16, 2024 (ADAMS Accession Number ML24262A251)

(**36-8** [McMurray, Nicholas])

Response:

The NRC disagrees with the comments. Existing NRC regulations at 10 CFR 51.20(b)(1) require the preparation of an EIS for the types of new reactor licensing actions covered by the rule (i.e., issuance of a limited work authorization, construction permit, operating license, early site permit or combined license). Only if this regulation is revised or if an applicant obtains an exemption under 10 CFR 51.6, then an applicant could reference the analysis in the NR GEIS in its application, or the NRC staff could consider the NR GEIS in its evaluation of the impacts of a proposed new reactor in an environmental assessment or in the development of a new CATEX. However, while the analysis in the NR GEIS may be relevant to an environmental assessment or CATEX, the codified findings in 10 CFR Part 51, Appendix C, Table C-1 would not apply in an environmental assessment or CATEX in the way that they could for an EIS because a finding of SMALL is not necessarily the same as a finding of no significant impacts (FONSI), and additional analysis would be required to use the information in the NR GEIS to support a FONSI or CATEX. Revisions to 10 CFR 51.20 are beyond the scope of this rulemaking.

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

Comment: 1. Of particular interest to Kairos Power is the NEI comment to ensure the scope of the GEIS includes all new reactors, including research and test reactors and reactors located on non-traditional sites. (**29-1** [Hastings, Peter S.])

Comment: 4.Scope of Proposed Rule Changes and NR GEIS
a. Is the applicability of the NR GEIS clear? Do the proposed revisions adequately address all licensing scenarios associated with evaluating the environmental impacts of permitting and licensing new nuclear reactor construction and operation?

The NR GEIS aims to "improve the efficiency of the NRC staff's environmental review of a new nuclear reactor application by identifying those potential environmental issues that are expected to be common, or generic, to the construction, operation, and decommissioning of many new nuclear reactors."[37] Previously scoped as the "Advanced Nuclear Reactor GEIS," the rule would have been limited in applicability to reactors that fit the definition of "advanced reactor" in the rule. BTI appreciates the shift in scope to a technology-neutral and performance-based approach that leverages broad usability with specific values and assumptions. We support the change to expand the applicability of the GEIS, reflecting the Commission's intent to enhance flexibility and efficiency.[38] This is a significant step toward streamlining the environmental review process for nuclear reactor licensing.

If the draft were overly specific, then applicants would end up with the potential for less regulatory certainty and more regulatory costs as the rule may require applicants to seek exemptions, or the rule may need to be updated in the future to allow for new licensing pathways. Allowing the GEIS to be general in scope will facilitate greater use of the rule and avoid amendments in the long run if and when new rulemakings are finalized. BTI is pleased to see that the NRC has utilized this opportunity to address all new commercial nuclear plants in compliance with Commission direction.

Having said that, the NR GEIS has the opportunity to expand the scope past commercial applicants. The draft needs additional clarity to determine the applicability of non-power research and test reactors (RTRs). The Commission did not distinguish between commercial reactors and RTRs when referring to the staff to revise the limited applicability of this GEIS to "any new nuclear reactor application."[39] BTI argues that the NR GEIS should apply to both new commercial reactors and new RTRs. Should proposed RTR facilities and sites meet the determined PPE and SPE values and assumptions in the NR GEIS, the rule should not unnecessarily limit these non-power facilities from utilizing this comprehensive analysis for generic environmental issues. Note existing construction permits and environmental assessments for RTRs where impacts were concluded to be SMALL or displayed findings of no significant impact (FONSI).[40] It is probable that new non-power applications will be submitted to the NRC, and ensuring that the NR GEIS can be used would align with the overarching intent of the rule and expand the effort of performing efficient and consistent environmental reviews.

BTI recommends that the NRC staff make the appropriate revisions to expand the applicability of the draft NR GEIS. By broadening the scope of the GEIS to include RTRs, the NRC will be able to address common environmental issues, eliminate redundant analyses, improve regulatory efficiency, and ensure focused attention on site-specific considerations for new and advanced reactors.

[37] See Federal Register Notice, Supplementary Information A. "Purpose of the Regulatory Action," https://www.federalregister.gov/d/2024-22385/p-13

[38] Nuclear Regulatory Commission, Staff Requirements - SECY-21-0098 - Proposed Rule: Advanced Nuclear Reactor Generic Environmental Impact Statement, SRM SECY-21-0098, April 17, 2024, ML24108A200 (https://www.nrc.gov/docs/ML2410/ML24108A200.pdf)

[39] Nuclear Regulatory Commission, Staff Requirements - SECY-21-0098 - Proposed Rule: Advanced Nuclear Reactor Generic Environmental Impact Statement, SRM SECY-21-0098, April 17, 2024, ML24108A200 (https://www.nrc.gov/docs/ML2410/ML24108A200.pdf).

[40] Nuclear Regulatory Commission, Environmental Impact Statement for the Construction Permit for the Kairos Hermes Test Reactor; Final Report, NUREG-2263, August 2023, ML23214A269 (https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML23214A269); Nuclear Regulatory Commission, Environmental Assessment and Finding of No Significant Impact for the Construction Permits and Environmental Review Exemptions for the Kairos Hermes 2 Test Reactors; Final Report, August 2024, ML24284A191 (https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML24284A191); Nuclear Regulatory Commission, Environmental Assessment for the Construction Permit Application for the Abilene Christian University Molten Salt Research Reactor January 2024, ML23300A053 (https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML23300A053).

(**30-16** [Toohill, Spencer])

Comment: 4. Scope of Proposed Rule Changes and GEIS
Utah OED recommends that the NRC better articulate that the Generic EIS applies to all new nuclear reactors, including advanced reactors and small modular nuclear reactors. Tremendous differences in scale and ground disturbing activities between traditional nuclear reactors and advanced nuclear reactors will significantly change the scope of EISs for new nuclear reactors. A clearer statement in the Generic EIS that the Generic EIS will be used for all types of new nuclear reactors will benefit future applicants. (**32-6** [Lesofski, Emy])

Comment: Moving forward, the staff should consider near-term and long-term rule implementation and adhere to Commission recommendations and Congressional mandates.

In the near term, before the rule is finalized, the staff should consider how the findings in the NR GEIS can be applied to first-mover license applications and Early Site Permits. In the long term, the staff should ensure that the rule can accommodate the widest possible range of licensing actions and reactor technologies. (**36-2** [McMurray, Nicholas])

Comment: Given the importance of the NR GEIS, the NRC should seek to optimize its benefits by clarifying that it applies to all new reactors, including new research and test reactors and reactors located on non-traditional sites. (**38-1-3** [O'Neill, Martin])

Comment: E. The NR GEIS and Rule Should Apply to All New Reactors, Including New Research and Test Reactors and Reactors Located on Non-Traditional Sites
The NRC seeks feedback on whether it has clearly articulated the applicability of the NR GEIS to new reactors, and whether its proposed revisions "adequately address all licensing scenarios associated with evaluating the environmental impacts of permitting and licensing new nuclear reactor construction and operation."[25] As an initial matter, NEI supports the Commission's direction to the staff to make the GEIS applicable to "any new nuclear reactor application, provided the application meets the values and the assumptions of the plant parameter envelopes and the site parameter envelopes used to develop the GEIS."[26] This approach (in contrast to limiting the GEIS to "advanced nuclear reactors" as defined in NEIMA) will help optimize the utility and benefits of the NR GEIS.

In referring to "any new nuclear reactor application," the Commission did not distinguish between commercial reactors and non-power research and test reactors (RTRs). NEI believes that the NR GEIS should apply to both categories of new reactors – i.e., commercial and RTRs to fully leverage the information and analysis contained in the GEIS and maximize efficiency. Indeed, it is possible, if not likely, that a proposed RTR facility and site will meet or are bounded by the relevant PPE and SPE values and assumptions in the NR GEIS. Notably, in its EIS for the Kairos Hermes 1 test reactor CP application, the NRC concluded that impacts on all resources from construction, operation, and decommissioning of the Hermes facility at the proposed site would be SMALL.[27] Additionally, the NRC staff was able to prepare environmental assessments and findings of no significant impact (FONSI) for the Hermes 2 CP application and Abilene Christian University's (ACU) CP application for a proposed molten salt research reactor (MSRR).[28] The latter will be the first deployment of the Natura MSR-1, a 1-MW thermal graphite-moderated, molten fluoride salt research reactor. The draft NR GEIS, in fact, contains references to the Hermes 1 and ACU projects.

Looking forward, it is likely that additional new non-power reactor applications may be submitted to the NRC, as well as applications for new power reactors that may be licensed by the NRC but are located on non-traditional sites (e.g., on military installations, university-owned lands, retired fossil sites). Ensuring that the NR GEIS can be used by applicants and the NRC for these application types would further the NRC's goals of performing efficient and consistent environmental reviews. Thus, NEI recommends that the NRC make appropriate revisions to the draft NR GEIS, rule, and guidance to clarify that they apply to the full gamut of new reactor applications (power and non-power).

[25] Proposed Rule, 89 Fed. Reg. at 80,808.

[26] SRM-SECY-21-0098 at 1 (Apr. 17, 2024) (emphasis added).

[27] NRC, *Environmental Impact Statement for the Construction Permit for the Kairos Hermes Test Reactor; Final Report* (NUREG-2263) (Aug. 2023) (ML23214A269).

[28] NRC, *Environmental Assessment and Finding of No Significant Impact for the Construction Permits and Environmental Review Exemptions for the Kairos Hermes 2 Test Reactors; Final Report*" (Aug. 2024) (ML24284A191); NRC, *Environmental Assessment for the Construction Permit Application for the Abilene Christian University Molten Salt Research Reactor* (Jan. 2024) (ML23300A053).

(**38-1-17** [O'Neill, Martin])

Response:

The NRC disagrees with the comments. The new or modified regulations at 10 CFR 51.50(d) and 51.75(d) provide direction for using the codified findings from the NR GEIS for environmental reports and SEISs for construction permits, early site permits, and combined licenses for nuclear reactors. Revised regulations at 10 CFR 51.49 and 51.76 provide directions for using the codified findings from the NR GEIS for environmental reports and supplemental environmental impact statements for limited work authorizations. The NR GEIS and associated rule were written to support licensing actions for any new reactors that require an environmental impact statement.

Research and test reactors use licensing processes similar to those for power reactors (e.g., construction permits), except that the environmental review for research and test reactors is typically completed using an environmental assessment and a finding of no significant impact.

Changes to the regulations for environmental assessments are outside the scope of this rulemaking. A research and test reactor applicant could reference the findings in the NR GEIS in its application, and the NRC staff could consider the NR GEIS analysis in its evaluation of the impacts of the reactor. However, neither the applicant nor the NRC staff could rely on the codified findings in 10 CFR Part 51, Appendix C, Table C-1 for an environmental assessment in the way that they could for the types of applications covered by the rule for the NR GEIS. If, for some reason, the licensing review for a research and test reactor were to lead to the preparation of an environmental impact statement, then that application could rely on the findings codified in 10 CFR Part 51, Appendix C, Table C-1.

No additional changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

Comment: We encourage the NRC staff to rely on the NR GEIS in all applications, without requiring the applications to reference the NR GEIS, unless there are specific facts in the applications that indicate application of the NR GEIS would be inappropriate. The NRC should state this plainly and clearly in the rule. (**33-4** [Unknown] [Unknown] [Unknown])

Response:

The NRC disagrees with the comment. As stated in Section 1.1 of the NR GEIS, the purpose and need "is to present impact analyses for the environmental issues common to licensing actions for many new nuclear reactors that can be addressed generically, thereby eliminating the need to repeatedly reproduce the same analyses each time a licensing application is submitted and allowing applicants and NRC staff to focus future environmental review efforts on issues that can only be resolved once a site is identified," improving the efficiency of licensing new nuclear reactors. While most applicants are likely to find referencing the NR GEIS a useful tool, there may be some applicants that choose not to reference the NR GEIS. For example, an applicant for a large reactor may find that it can only meet the values and assumptions for a small number of Category 1 issues and may choose to prepare its environmental report without referencing the NR GEIS. For such reviews, the applicant would need to individually address each issue without reference to the NR GEIS, similar to the process for addressing Category 1 issues where the PPE and SPE values are not met and Category 2 issues. In such cases, preparation of the site-specific EIS will be based on the information in the environmental report, and while the NRC staff may reference the NR GEIS as relevant in that effort for efficiency, it is not feasible to determine generically what aspects of the GEIS will be relevant when an applicant chooses to depart from the process contemplated by this rulemaking.

No changes were made to the NR GEIS, final rule, or guidance documents as a result of the comment.

E.2.22 Specific Requests for Comment - Guidance for Applicants

Are the methods described in the draft revision to RG 4.2 for demonstrating values and assumptions appropriate? Describe and justify any methods that the commenter believes are not appropriate.

Comment: 3.DG-4032

a. Update DG-4032 to reflect the concerns laid out in the above commentary on modern reactor capabilities and ensure guidance aligns with the ADVANCE Act's legislative intent to expand nuclear applications. (**30-12** [Toohill, Spencer])

Comment: 5. Guidance for Applicants

a. Are the methods described in the draft revision to RG 4.2 for demonstrating values and assumptions appropriate?

At a high level, no, the methods described in the draft revision to RG 4.2 are not entirely appropriate. Changes need to be made to address the issues described in this comment. These changes include *(but are not limited to other potential revisions that may be appropriate depending on how comments on this rulemaking are dispositioned):*[41]

We believe that clear and practical methods for evaluating PPE and SPE values and assumptions are essential to ensure consistent and efficient licensing processes. Additionally, supporting guidance on the categorization of Category 1 and Category 2 issues must be accurate and aligned with the overarching objectives of the NR GEIS.

Finally, we emphasize that a collaborative, iterative process for refining this guidance based on stakeholder feedback will be critical. This will ensure the guidance is both robust and adaptable to the evolving landscape of nuclear energy deployment, while maintaining the efficiency and effectiveness that the NR GEIS aims to achieve.

[41] The NRC staff should also revise other relevant sections of RG 4.2 not listed here to adequately address the concerns and incorporate the recommendations outlined in this comment.
-Section C, VI. Implementation of the LWA Rule - Definition of Construction and Preconstruction
-Chapter 1, 1.2. Description of the Proposed Action and the Purpose and Need
-Chapter 2:
  2.7.2. Air Quality
  2.7.1. Climate
-Chapter 8. Need for Power
-Chapter 9:
  9.1. No-Action Alternative
  9.2. Energy Alternatives
  9.3.5. Proposed and Alternative Sites
  9.4. System Alternatives
-Table C-1-1. Guidance Related to Demonstrating That the Value or Assumption Has Been Met

(**30-17** [Toohill, Spencer])

Comment: 5. Guidance for Applicants

Utah OED finds that the draft revisions to RG 4.2 appropriately described the methods for demonstrating values and assumptions. (**32-7** [Lesofski, Emy])

Response:

The NRC agrees in part and disagrees in part with the comments. The NRC agrees with the comment that expresses general support for the revisions to Regulatory Guide 4.2.

The NRC disagrees with the comments requesting additional revisions to RG 4.2. The NRC staff reviewed RG 4.2 in response to these comments and generally determined that the methods described were appropriate for providing guidance on demonstrating PPE and SPE values and assumptions for Category 1 issues.

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

E.2.23 Specific Requests for Comment - Limited Work Authorizations

Should the NRC expand the NR GEIS and the rule to include NRC approval of limited work authorizations (LWAs) for new nuclear reactor applications? Specifically, should an LWA applicant that demonstrates that its proposed project meets or is bounded by the PPE and SPE values and assumptions for a given Category 1 issue be able to rely on the generic findings for that issue in preparing the environmental report that it will submit in support of its LWA application? Similarly, should the NRC be able to rely on the generic findings for that Category 1 issue in preparing its supplemental environmental impact statement? If the NRC were to expand the NR GEIS and the rule to include NRC approval of LWAs, the expansion would cover both LWAs submitted as a stand-alone application and an LWA request submitted in conjunction with an application for another form of NRC approval described in the NR GEIS and in the proposed rule (e.g., a construction permit application).

Comment: it certainly seems to me that we want to maximize the applicability of the GEIS to include limited work authorizations.

I mean, they are essentially a form of construction authorization, so, and the LWA process can take quite a while to get through, I think, when you look at the steps that are involved. So, I think it's fair to say we would certainly support use of the GEIS in that context as well. (**13-1-6** [O'Neill, Martin])

Comment:

I wanted to piggyback just a little bit off of Marty's comments in terms of the limited work authorization, and I just wanted to -- well, we are still diving into the document and we will provide more in-depth and detailed written comments, but just in terms of the limited work authorizations, our perception is if the limited work authorization is within the bounds and scope of the PPE and SPE, that LWA would, by definition, be part of the larger project impact and should not exceed it. If the project qualifies to use the GEIS, the LWA should as well. The LWA should be tied to a specific project to ensure it's part of the larger environmental review.

And overall, BTI is very supportive of the rule of the limited work authorization aspect as well, and I just wanted to share some thoughts, but definitely stay tuned for the written comments we'll provide.

(**13-2-1** [Toohill, Spencer])

Comment: 6. Limited Work Authorizations

a. Should the NR GEIS and the rule be expanded to include NRC approval of LWAs for new nuclear reactor applications? Specifically -
i. Should an LWA applicant that demonstrates that its proposed project meets or is bounded by the PPE and SPE values and assumptions for a given Category 1 issue be able to rely on the generic findings for that issue in preparing the environmental report?
ii. Should the NRC be able to rely on the generic findings for that Category 1 issue in preparing its supplemental environmental impact statement?

The inclusion of LWAs within the GEIS framework is a logical extension, provided that LWA applicants meet or remain within the PPE and SPE bounds. The LWA would, by definition, be a part of the larger project impact and therefore should not exceed it. If the project qualifies to use the NR GEIS, the LWA should as well. The LWA should be tied to a specific project to ensure it is part of the larger environmental review. Allowing LWA applicants to rely on Category 1 findings would reduce redundancies without compromising environmental protections. This approach enhances regulatory certainty and reduces costs, which is particularly valuable for applicants.

A primary concern with incorporating LWAs into the GEIS is that it could permit environmental impacts to occur before a full Environmental Impact Statement (EIS) is finalized—raising the question of whether activities tied to a project without full agency approval should proceed. The answer, in this case, should be yes, for three key reasons. First, sites eligible for LWAs are often already disturbed or permitted for grading and other preparatory activities; they do not need to be pristine, undisturbed greenfields. Second, because an LWA is a subset of the overall project, its environmental impacts are necessarily smaller in scale and remain bounded within those of the full application. Third, the activities and impacts associated with LWAs are well understood, as they align with long-standing practices in early-stage construction for major infrastructure projects.

The final rule should explicitly expand the scope of the NR GEIS to include LWAs, with a clear requirement that applicants demonstrate compliance with the PPE and SPE assumptions. This ensures that LWAs remain integrated into the broader project-specific environmental review and that their impacts are bounded by those already analyzed in the GEIS. Furthermore, where LWA activities align with the PPE and SPE assumptions, the NRC should extend the use of Category 1 findings to supplemental environmental impact statements for such applications. This clarification would not only align with the principles of NEPA but also provide applicants with a more predictable and efficient regulatory pathway. (**30-18** [Toohill, Spencer])

Comment: 6. Limited Work Authorizations

Utah OED supports expanding the applicability of the NR Generic EIS to include NRC approval of limited work authorizations (LWAs). The purpose for the Generic EIS – to streamline the process of completing environmental analysis for new nuclear reactors and reduce permitting times, should apply to work conducted under LWAs. Use of the Generic EIS in the authorization of LWAs should allow LWS applications to similarly benefit from the analysis performed by NRC staff for this Generic EIS, and limit unnecessary or duplicative analysis of Category 1 issues. (**32-8** [Lesofski, Emy])

Comment:

Recommendation 2: Include Limited Work Authorizations (LWAs) in the scope of the final rule

LWAs can be an important tool to accelerate the deployment of new reactors as many new designs have less safety-related or safety-significant systems, structures, and components. This would allow for a greater amount of site work to commence before the issuance of a Construction Permit of Combined License (COL) and the start of full-scale nuclear construction. An LWA may be a standalone application or included as part of an Early Site Permit, Construction Permit, or COL application. Since the NRG must perform an environmental review as part of an LWA review, it is practical to include a LWA review within the scope of the NR GEIS. Any type of pre-construction and early limited construction work included in an LWA often has well-understood and managed environmental impacts, making them a suitable subject for generic treatment. Applying the NR GEIS to this type of work would streamline project timelines while ensuring that all environmental protections remain intact. (**36-6** [McMurray, Nicholas])

Comment: In addition, we recommend that the NRC include limited work authorizations within the scope of licensing actions covered by the NR GEIS and rule. The NRC's use of bounding values and assumptions for reactor design features and site conditions (i.e. plant and site parameter envelopes) in the NR GEIS should be conducive to implementing these recommendations. (**38-1-4** [O'Neill, Martin])

Comment:

F. The NR GEIS and Final Rule Should Include Limited Work Authorizations

The NRC requests comments on whether it should expand the NR GEIS and the proposed rule to include NRC approval of LWAs for new nuclear reactor applications.[29] NEI believes that it would be beneficial to make the NR GEIS and rule applicable to LWA requests in addition to ESP, CP, and COL applications. Although the LWA is a discrete regulatory approval, there is a clear nexus between an LWA request and the other application types, including overlap in the types of environmental impacts considered in the NRC's associated EISs.

To understand this relationship, some regulatory background is helpful. The LWA process allows CP, ESP, and COL applicants to request approval to perform certain limited "construction" activities before the issuance of a CP or COL. An ESP applicant may include a request for an LWA as part of a complete ESP application in accordance with 10 CFR 2.101(a)(1)-(a)(4).[30] A CP or COL applicant may submit a request for an LWA either as part of a complete application under 10 CFR 2.101(a)(1)-(4) or as a partial application under 10 CFR 2.101(a)(9) (i.e., phased application).

Section 50.10 governs the issuance of LWAs and specifies the information to be included in an LWA application.[31] As relevant here, the LWA application must include an environmental report in accordance with the applicable section(s) of 10 CFR 51.49 ("Environmental Report-Limited Work Authorization"). Further, the LWA applicant must include a site redress plan that describes the scope of the actions to be taken following suspension of construction activities and addresses the mitigation of impacts resulting from the performance of construction activities. The primary purpose of the site redress plan is to address activities that were authorized under the LWA (e.g., the placement of piles and installation of foundations), in the event the LWA holder terminates construction, the NRC revokes the LWA, or the underlying COL or CP application is withdrawn or denied.

To issue an LWA, the NRC must prepare an EIS.[32] Depending of the LWA application pathway chosen by a CP, COL, or ESP applicant and the scope/contents of the supporting environmental report, 10 CFR 51.76 ("Draft environmental impact statement-limited work authorization") permits or directs the NRC staff to prepare an EIS for the larger licensing action (i.e., for the CP, COL, or ESP):

• Section 51.76(a) provides that if the LWA application is submitted as part of a complete CP or COL application, then the NRC may prepare a partial draft EIS that is limited to the activities proposed to be conducted under the LWA. Alternatively, the NRC "may prepare" a complete draft EIS for the CP or COL application, as applicable.

• Section 51.76(b) provides that if a phased application is submitted under 10 CFR 2.101(a)(9), then the draft EIS for part one of the application may be limited to consideration of the activities proposed to be conducted under the LWA and the proposed redress plan. It further provides, however, that if the environmental report contains the full set of information required to be submitted under section 51.50(a) or (c), then an [EIS] "must be prepared" for the CP or COL application, applicable.

• Section 51.76(c) provides that if the LWA application is submitted as part of an ESP application, then the NRC "will prepare" an EIS in accordance with section 51.75(b) for the ESP application, but also must address the activities proposed to be conducted under LWA.

In short, depending on the circumstances, NRC regulations allow, and in some cases require, the NRC's NEPA analysis for an LWA request to be combined with or subsumed within the EIS for the broader licensing action - i.e., CP, COL, or ESP issuance. It thus makes logical sense for the NRC to expand the NR GEIS and the proposed rule (and their associated efficiency and cost saving benefits) to include NRC approval of LWAs. That is, if an LWA applicant can demonstrate that its proposed project meets or is bounded by the PPE and SPE values and assumptions for a given Category 1 issue in the NR GEIS, then it should be able to rely on the generic findings for that issue in preparing the environmental report for the LWA application. Likewise, the NRC should be able to rely on the generic findings for that Category 1 issue in preparing its supplement to the NR GEIS. NEI agrees with the NRC that any decision to expand the NR GEIS and rule to include NRC approvals of LWAs should cover both "stand-alone" (i.e., partial or phased) LWA applications and LWAs request submitted as part of an CP, COL, or ESP application.[33]

It does not appear that the NRC would need to make major substantive changes to the NR GEIS to include LWA approvals. The NR GEIS uses a technology-neutral PPE and SPE to evaluate the environmental impacts of building, operating, and decommissioning a new reactor. As used in the NR GEIS, the term “building” is defined to include “the full range of preconstruction (building activities not within the NRC’s regulatory authority), and construction and installation activities (building activities within the NRC’s regulatory authority).”[34] The PPE and SPE values and assumptions do not differentiate between preconstruction and construction activities and include the impacts of both activity types. Moreover, as NR GEIS notes, certain land use, water quality, and ecological impacts from new nuclear reactors would occur principally during the preconstruction and construction phases of the project. The NR GEIS analyzes such impacts generically to the extent practicable and, in doing so, considers related mitigation measures and best management practices that “could be used to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse impacts.”[35]

[29] Proposed Rule, 89 Fed. Reg. at 80,808.

[30] Note that an ESP holder also may submit a request for an LWA as an application for an amendment to the ESP in accordance with 10 CFR 52.39(e).

[31] Section C.2.18 of RG 1.206 discusses the required contents of an LWA application in greater detail.

[32] The staff also must make positive findings on safety, compliance, and technical qualifications for the LWA activities, and the presiding officer must make environmental findings and find there are no unresolved safety issues relating to LWA activities that constitute good cause for withholding the LWA. The LWA process also includes a mandatory hearing and a contested hearing opportunity.

[33] Proposed Rule, 89 Fed. Reg. at 80,808.

[34] Draft NR GEIS at 1-3.

[35] *Id*. at 1-5.

(**38-1-18** [O'Neill, Martin])

Response:

The NRC agrees with the comments. The NRC has expanded the scope of the final NR GEIS and rule to clarify that the NR GEIS can be used for limited work authorizations (LWAs), to the extent applicable. Because LWAs authorize a limited set of activities and are a subset of the larger new nuclear reactor project application, the impacts of the LWA will necessarily be bounded by those of the full project. As such, Section 1.4 of the NR GEIS has been updated to include LWAs, and the rule language at 10 CFR 51.49 and 51.76 has been updated to permit the use of the NR GEIS for an LWA. In addition, the text in COL-ISG-030 and Regulatory Guide 4.2 has been modified to make clear that an LWA may rely on the findings in the NR GEIS and final rule.

E.2.24 NEPA Process

Comment:

Our organization greatly appreciates NRC's commitment to upholding its trust responsibility to Tribal Nations and its commitment to the nation-to-nation relationship between the federal government and Tribal Nations.

While NATHPO recognizes the value of finding efficiencies, we are always concerned about any proposed rule, like this one, which is explicitly intended to "streamline" the environmental review process. Far too often "streamlining" becomes a euphemism for speeding through the process and circumventing Tribal consultation. While Tribal Nations have no desire to unnecessarily delay a new nuclear reactor, or any other project, they also do not want to engage in a truncated consultation process based on the project applicant's timeline.

(**25-1** [Grussing, Valerie J.])

Comment:

Impact of *Marin County* Ruling on CEQ NEPA Regulations

The NRC should adapt its Generic EIS to reflect a recent ruling from the Court of Appeals for the D.C. Circuit in *Marin County Audubon v. FAA*. In this case, the Court of Appeals found that the Council on Environmental Quality ("CEQ") was established by Congress to act as an advisory body only, and therefore lacks the statutory authority to promulgate regulations for NEPA compliance. While the Court's ruling may still be subject to *en banc* review and a potential petition for certiorari to the U.S. Supreme Court, the NRC should nevertheless proceed with development of the Generic EIS without reliance on CEQ regulations or guidance documents. CEQ regulations and guidance documents are no longer binding on the NRC.

The following CEQ documents are referenced in the draft Generic EIS, and should removed since they are no longer binding on the NRC:

• 89 FR 35442. May 1, 2024. "National Environmental Policy Act Implementing Regulations Revisions Phase 2." Final Rule, Federal Register, CEQ. *Available at:* https://www.govinfo.gov/content/pkg/FR-2024-05-01/pdf/2024-08792.pdf.

• Memorandum from C. Goldfuss to Heads of Federal Departments and Agencies, dated August 1, 2016, regarding "Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews." *Available at*: https://ceq.doe.gov/docs/ceq-regulations-and-guidance/nepa_final_ghg_guidance.pdf.

• NEPA and NHPA: A Handbook for Integrating NEPA and Section 106. CEQ and NHPA. March 2013. Available at: https://ceq.doe.gov/docs/ceq-publications/NEPA_NHPA_Section_106_Handbook_Mar2013.pdf. (Potentially still binding due to joint issuance by CEQ and NHPA.)

• 88 FR 1196. January 9, 2023. "National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change." Notice of Interim Guidance, Federal Register, CEQ. *Available at*: https://www.govinfo.gov/content/pkg/FR-2023-01-09/pdf/2023-00158.pdf.

As explained in greater detail below, Utah OED also recommends that the NRC remove the climate change analysis from the Category 2 issues requiring site-specific analysis. The climate change analysis is not only redundant to the Category 1 analysis of GHG ("GHG") emissions, but also not required under existing regulations or guidance since the CEQ's 2016 Memorandum on Consideration of Greenhouse Gas Emissions, 2023 Interim Guidance on Consideration of Greenhouse Gas Emissions, and 2024 NEPA Phase 2 Implementing Regulations are no longer binding on federal agencies. Removing unnecessary analysis requirements from the Generic EIS will reduce regulatory burdens on applicants and allow the NRC to better accomplish its objective to streamline environmental reviews for new nuclear reactors.

(**32-1** [Lesofski, Emy])

Response:

The NRC agrees in part and disagrees in part with the comments. The NRC disagrees with the comment that streamlining environmental reviews through the NR GEIS and rule would possibly lead to circumventing Tribal consultation. Tribal consultation would continue to be conducted by the NRC under the issue of Historic and Cultural Resources, which is a Category 2 issue. As a Category 2 issue, the NRC's evaluation of the impacts to Historic and Cultural Resources, including Tribal consultations, will be unaffected by the issuance of the NR GEIS and the rule.

The NRC agrees with the comment that the NRC should remove references to CEQ's NEPA regulations in the NR GEIS and associated documents. Since 1984, when the NRC first promulgated its NEPA-implementing regulations in 10 CFR Part 51, the NRC has taken a position that it will voluntarily take account of CEQ's regulations subject to certain conditions (10 CFR 51.10(a)). As a result, the NRC has closely patterned its NEPA-implementing regulations on CEQ's regulations. While the NRC has removed references to the CEQ NEPA regulations in the NR GEIS and final rule, the interim final rule removing the CEQ NEPA regulations (90 FR 10610) does not change NRC's NEPA regulations and associated requirements. Executive Order 14154 directs agencies to review and potentially revise their NEPA procedures; any such revisions are beyond the scope of this rulemaking.

The NRC disagrees that the Category 2 issue of climate change is redundant to the Category 1 greenhouse gas issue. The Category 2 issue of climate change involves the applicant analyzing the impacts of climate change on the same resources in the affected environment that would be impacted by new reactor construction, operation, and decommissioning. The Category 1 issue of greenhouse gas emissions involves the applicant estimating the greenhouse gas emissions from the construction, operation, and decommissioning of the new reactor such that the contribution of the project's emissions to climate change can be quantified and put into context for decision-makers.

The NRC has added a discussion (Section 1.4.7, Consultations) to Chapter 1 of the NR GEIS and a new section (Tribal Policy Statement) to Section 3 of COL-ISG-30 "Environmental Considerations for New Nuclear Reactor Applications that Reference the Generic Environmental Impact Statement (NUREG–2249)" as a result of the comment. Additionally, the NRC revised Section I.B and added two footnotes to the final rule to include reference to consultations conducted under the ESA and NHPA, which require interagency consultation with Federal agencies or Indian Tribes and added a reference to the NRC's Tribal Policy Statement.

E.2.25 Public Participation

Comment:

1. Transparency and Public Engagement
The proposed rule risks reducing opportunities for meaningful public participation, particularly for local communities directly affected by nuclear facilities. The categorization of impacts into generic and site-specific groups may inadvertently limit discussions around localized concerns that do not fit neatly into predefined categories. This comes at the expense of generic issues as they will receive less attention from the public. As noted in previous case studies, "limiting public input creates an imbalance in stakeholder representation and weakens the regulatory process"(Zeitoun, 1994).

We recommend that the NRC implement additional measures to ensure transparency and robust public engagement:

• Expanded Public Comment Periods: Allow longer comment periods to ensure all stakeholders have sufficient time to review and respond to proposed changes.

• Community Outreach Programs: Host workshops or forums in affected areas to educate the public on the implications of the proposed rule and encourage participation.

• Online Accessibility: Provide clear, user-friendly online resources to facilitate easier access to documents and submission portals.

These steps will help maintain trust and ensure that diverse voices are included in the decision-making process.

(**15-1** [Eo, Taeseon] [Lee, Changki] [Lester, Jackson] [Schmidt, Trevor])

Comment: 4. Balancing Efficiency and Equity

The goal of regulatory efficiency should not come at the expense of equity or public safety. As noted in Burger (2010), "streamlining processes must not undermine the comprehensive evaluation of risks, particularly those affecting vulnerable populations." Additionally, Ramana (2011) emphasizes that public trust is critical for the acceptance of nuclear projects and that perceived inequities can erode this trust.

To achieve a balanced approach, we suggest the following:

• Stakeholder Impact Analysis: Conduct detailed analyses of how the proposed changes will affect various stakeholder groups, including communities, industries, and government agencies.

• Equity-Driven Metrics: Develop metrics to measure whether the benefits and burdens of the proposed rule are equitably distributed.

• Mitigation Plans for Disadvantaged Groups: Include provisions to mitigate any adverse impacts on communities that may face heightened risks or resource burdens due to the new rule.

Balancing efficiency with equity will ensure that the NRC's regulatory updates meet the needs of all stakeholders without compromising safety or fairness. (**15-6** [Eo, Taeseon] [Lee, Changki] [Lester, Jackson] [Schmidt, Trevor])

Comment: Additionally, we note that the high amount of necessary detail on so many factors in each site-specific supplemental EIS (SEIS) requires diligence and detail by the applicant and Staff, and we encourage the Staff to require meaningful stakeholder engagement by the applicant on each SEIS, including meetings with the host community. (**37-5** [Peterson, Alyse])

Response:

The NRC disagrees with the comments. Commenters expressed a concern that the use of the NR GEIS will reduce opportunities for public participation in the licensing of new nuclear reactors. The development of the NR GEIS will not change NRC's NEPA requirements to engage stakeholders and the public. The intent of the NR GEIS is to focus the NRC's review

efforts on environmental issues where consideration of project-specific information is needed to ascertain the potential for significant environmental impacts. The NRC regulations continue to require that the NRC conduct a complete and robust analysis of potential environmental impacts and meet all requirements relating to stakeholder engagement, public participation, and accessibility. No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

E.2.26 Relationship to Other Plans/Regulations/Processes

Comment: In Section 321 of the Fiscal Responsibility Act of 2023, or the FRA, Congress amended NEPA to streamline and expedite the federal NEPA review process by, among other things, setting page limits on environmental impact statements and environmental assessments, and establishing deadlines of two years for EISs and one year for EAs.

Issuance of the New Reactor GEIS would help the NRC meet these page limits and deadlines for its NEPA reviews of new reactor license applications.

In July 2024, President Biden signed into law the Advance Act, Section 506, Modernization of Nuclear Reactor Environmental Reviews. It directs the NRC to submit a report to Congress within 180-days that describes the NRC's efforts to facilitate efficient, timely, and predictable environmental reviews of nuclear reactor license applications.

Section 506 identifies numerous potential measures for achieving this objective, including, for example, the expanded use of categorical exclusions, environmental assessments, and generic environmental impact statements. The report also must describe how the NRC will implement the FRA amendments to NEPA.

Avoiding undue delays in the license licensing process, including the agency's NEPA review, is essential to fostering technological innovation in new nuclear reactors that have environmental benefits relative to other generation sources.

The New Reactor GEIS can play a pivotal role in this regard by leveraging PPEs that are as inclusive of as many new reactor technologies as possible. (**12-1-3** [Austgen, Kati])

Comment:

I guess one maybe question I have, and I don't know if the staff can answer this today, but there are a lot of parallel activities going on as you're aware. The staff is developing a response plan to address the Fiscal Responsibility Act amendments to NEPA. There was a SECY paper issued actually, 24-0046, I believe. The staff is putting together a report in response to Section 506 of the ADVANCE Act.

So, you know, among other things, I think whatever initiatives or rulemakings the staff ultimately pursues, you know, could impact potentially the content of this GEIS or the related guidance and how it's implemented in the future, and I guess a question to you is, is that something the staff is thinking about maybe? Does it intend to address that in the final rule?

(**13-1-4** [O'Neill, Martin])

Comment:
Accordingly, Westinghouse provides the following comments to the U.S. Nuclear Regulatory Commission (NRC) staff on this draft proposed rule:

1. Westinghouse fully endorses the industry comments provided by the Nuclear Energy Institute (NEI) in their December 2024 letter in response to the above draft proposed rule.

2. As discussed in the Executive Summary, Section ES.4 in the Draft GEIS[1], the NRC staff initially developed this GEIS as a document that would be applicable to only advanced nuclear reactors[2]. However, in SRM-SECY-21-0098[3], the Commission directed the NRC staff to change the limited applicability of this GEIS from solely advanced nuclear reactors to any new nuclear reactor licensing application, provided the application meets the values and the assumptions of the plant parameter envelopes and the site parameter envelopes used to develop the GEIS. In ES.4 of the draft GEIS, the NRC concludes that "Based on the direction from the Commission, the alternative of developing a GEIS that would be applicable to only advanced nuclear reactors will not be considered further."

During the same time that the draft proposed rule was issued for public comment, NRC staff also issued a draft white paper[4] on "Nth-of-a-Kind Micro-Reactor Licensing and Deployment Considerations" to support the development of strategies to provide for the predictable and efficient licensing and regulation of microreactors. Enclosure 2[5] of this draft white paper is focused on alternative environmental review options for Nth-of-a-kind microreactors. There are options in this enclosure that build upon the new reactor GEIS proposed rulemaking. In addition, the Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024 (ADVANCE Act)[6], signed into law in July 2024, includes provisions for NRC to enact more efficient and timely licensing reviews. Through the ADVANCE Act, Congress directs the NRC to take action for both environmental reviews and microreactor licensing.

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Based on the ongoing collective efforts related to microreactor licensing and environmental reviews for advanced reactors, Westinghouse encourages NRC to consider the inclusion of environmental review alternatives discussed in Enclosure 2 of the recently issued Nth-of-a-Kind draft white paper in the scope of the new reactor GEIS proposed rulemaking. Specifically, Westinghouse encourages the NRC to consider for inclusion in the new reactor GEIS proposed rulemaking, environmental review options that facilitate: 1) standard design environmental reviews and 2) fleet deployment environmental reviews for sites with similar conditions. Westinghouse views the opportunity to consolidate the development of these environmental review options in the new reactor GEIS proposed rulemaking as a means for efficiently achieving a significant element of the ADVANCE Act by providing a step towards the development of design-specific and fleet deployment GEIS options.

[1] NUREG-2249, Draft Report for Comment, "Generic Environmental Impact Statement for Licensing of New Nuclear Reactors." (ML24176A220) (https://www.nrc.gov/docs/ML2417/ML24176A220.pdf)

[2] SECY-21-0098, "Proposed Rule: Advanced Nuclear Reactor Generic Environmental Impact Statement (RIN 3150-AK55; NRC-2020-0101)," November 29, 2021. (ML21222A053) (https://www.nrc.gov/docs/ML2122/ML21222A053.pdf)

[3] SRM-SECY-21-0098, "Staff Requirements - SECY-21-0098 - Proposed Rule: Advanced Nuclear Reactor Generis Environmental Impact Statement (RIN 3150-AK55; NRC 2020 0101)," April 18, 2024. (ML24108A199) (https://www.nrc.gov/docs/ML2410/ML24108A199.html)

[4] NRC draft white paper, "Nth-of-a-Kind Micro-Reactor Licensing and Deployment Considerations," September 2024. (ML24268A310) (https://www.nrc.gov/docs/ML2426/ML24268A310.pdf)

[5] NRC draft white paper, Enclosure 2, "Environmental Reviews for Nth-of-a-Kind Micro-Reactors," October 2024. (ML24302A292). (https://www.nrc.gov/docs/ML2430/ML24302A292.pdf)

[6] Public Law 118-67, Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024, July 9, 2024. (https://www.congress.gov/118/plaws/publ67/PLAW-118publ67.pdf)

(**24-2** [Schoedel, Anthony J.])

Comment: 3. On a related note, Kairos Power suggests a more holistic treatment of both FRA and the Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy (ADVANCE) Act in the GEIS rulemaking activity. The rulemaking package includes a draft NRC staff white paper ("Energy and System Design Mitigation Alternatives White Paper," ML21225A754) and suggests its conclusions may be incorporated by reference into future applicant environmental reports. (**29-3** [Hastings, Peter S.])

Comment: Kairos Power agrees with NEI's comments, and further suggests it would be worthwhile to fully reflect FRA and ADVANCE requirements and expectations into the GEIS and rule. Recognizing the timelines for the GEIS and for FRA and ADVANCE were not originally coincident, while Kairos Power would not prefer a delay in completion of the GEIS rule, it seems sensible (and more efficient) to merge the efforts fully at this point. (**29-5** [Hastings, Peter S.])

Comment: Connection to Recent Legislation

The NR GEIS is increasingly salient in relation to recent direction from Congress. This stems from a national demand for reliable, clean, and affordable energy and the rising need to meet increasing electricity demand. Congress has explicitly recognized the role of nuclear energy in meeting the nation's energy needs and development goals, passing key legislation that emphasizes modernized frameworks for licensing and reviewing nuclear projects.

In 2019, the Nuclear Energy Innovation and Modernization Act (NIEMA) directed the NRC to develop a technology-inclusive framework for new and advanced reactors, resulting in the proposed 10 CFR Part 53. This framework is intended to streamline licensing while maintaining high safety and environmental standards, aligning with the intent and usability of the NR GEIS to ensure efficient and inclusive environmental reviews.

On June 3rd, 2023, President Joe Biden signed the Fiscal Responsibility Act (FRA) into law. This law, among other provisions, established time constraints and page limits on environmental impact statements and environmental assessments (EIS and EA, respectively), which all federal

agencies must comply with. This directive underscores the need for tools like the NR GEIS to support compliance with these regulatory and procedural efficiencies while maintaining rigorous environmental oversight.

On July 9th, 2024, President Biden signed the Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy (ADVANCE) Act into law, which includes provisions directly tied to the development and utility of the NR GEIS. Several sections of the ADVANCE Act are particularly relevant to the development and application of the NR GEIS:

-Section 204: The NR GEIS can broadly improve the efficiency of the NRC's review for additional locations by providing generic findings that expedite environmental evaluations.

-Section 206: This section focuses on licensing advanced reactors at existing brownfield sites. By recategorizing certain Category 2 issues for projects located in these areas, the NRC could streamline licensing processes by leveraging the NR GEIS.

-Section 207: The NRC must establish and implement expedited procedure timelines for issuing combined licenses (COLs) for applications that use reactor designs or sites previously approved by the NRC. Leveraging Category 1 findings, the NR GEIS could play a key role in accelerating environmental reviews in adherence to the requirements in Section 207.

-Section 208: The potential for microreactors to use streamlined environmental pathways, such as an EA/FONSI or even a categorical exclusion (CATEX), highlights the need for the NR GEIS to enable widespread deployment of standardized designs with well-understood impacts.

-Section 501: Section 501 requires the NRC to revise its mission statement and provide guidance to the staff on how to perform the revised mission effectively. The updated mission statement is required to indicate that regulation of civilian use of radioactive materials and nuclear energy must be conducted efficiently and not unnecessarily limit benefits to society.[1] The NR GEIS is directly related to this direction.

-Section 504 and Section 505: Performance metrics and milestones should guide the NRC's implementation of the NR GEIS to improve overall efficiency, aligning with the broader goals of modernized regulatory processes.

-Section 506: This section specifically references the expanded use of categorical exclusions, EAs, and GEISs. The NR GEIS is a critical component of implementing this directive, contributing to more efficient and comprehensive environmental reviews.

The NR GEIS is central to addressing the congressional direction outlined in these legislative measures. It helps the NRC meet the demands of modernized environmental reviews and facilitates the deployment of advanced nuclear technologies.

[1] BTI whitepaper on *Mission Statement Update Options Pursuant to Subsection 501(a) of the ADVANCE Act of 2024*, SECY-24-0083, ML24337A218.

(**30-2** [Toohill, Spencer])

Comment: We appreciate recent steps taken by Congress and the administration to expedite the regulatory process for new nuclear reactors, like the Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy (ADVANCE) Act [Public Law No. 118-67]. The ADVANCE

Act seeks to improve the efficiency and timeliness of licensing and regulatory timelines for the deployment of new nuclear technologies. The undersigned are particularly supportive of certain sections of the ADVANCE Act, such as Section 206, which will better facilitate the licensing of nuclear facilities at brownfield and retired fossil fuel sites. (**33-1** [Unknown] [Unknown] [Unknown])

Comment:

Since starting the development of the NR GEIS, there have been multiple Congressional, NRC, and industry activities related to the environmental review process. Relevant legislation includes the Nuclear Energy Innovation and Modernization Act (NEIMA), the Fiscal Responsibility Act (FRA), and the ADVANCE Act. The NRC is currently responding to these pieces of legislation, updating its list of Categorical Exclusions (CATEX), updating its emergency planning and siting rules, and responding to industry interest around the "rapid licensing" of microreactors.

The NR GEIS can accelerate the deployment of nuclear energy by ensuring that NRG staff resources are focused on the most important environmental review topics. Although the number of upcoming new reactor applications is uncertain, the staff's previous analysis that the NR GEIS "would reduce the costs of environmental reviews for licensing advanced nuclear reactors by at least 20 percent and potentially up to 45 percent" is a significant cost savings for even a small number of applications.[5] Furthermore, the staff's changes to the proposed rule have made it more performance-based and technology-inclusive. For example, the staff previously changed the NR GEIS to apply to all new reactors by using a performance-based, technology-neutral framework that utilizes a Plant Parameter Envelope (PPE) instead of a prescriptive MW-thermal limit. This aligns the proposed NR GEIS rule with prior ClearPath comments, Commission direction in SRM-SECY-21-0098, and Congressional mandates in NEIMA, the FRA, and the ADVANCE Act.

[5] https://www.nrc.gov/docs/ML2122/ML21222A053.pdf

(**36-4** [McMurray, Nicholas])

Comment:

Recommendation 3: Ensure applicability to provisions of the ADVANCE Act and FRA

ClearPath recommends ensuring that this rulemaking fully aligns with the Congressional mandate of the FRA and ADVANCE Act. There are multiple sections in the ADVANCE Act that relate to the development of the NR GEIS, including:

•Section 206 - The efficient licensing of new reactors at existing brownfield sites could be partially achieved by having additional Category 2 issues[8] be Category 1 issues on all projects sited in defined brownfield areas.

•Section 207 - The expedited procedure timelines for issuing COLs will likely require treating additional Category 2 issues as Category 1 issues by leveraging previous environmental reviews and/or using the findings in the NR GEIS to accelerate the review of an Environmental Assessment (EA) and an associated Finding of No Significant Impact (FONSI).

•Section 208 - Beyond the potential for an EA/FONSI or even a CATEX, the NR GEIS could be expanded to allow widespread deployment of standardized reactor designs with well-understood environmental impacts due to their smaller footprint and potentially novel use cases.

•Section 506 - This section specifically refers to the "expanded use of categorical exclusions, environmental assessments, and generic environmental impact statements." ClearPath provided comments[9] on the implementation of this section and the NR GEIS plays a key role in its implementation. The NR GEIS should be broadly viewed as one of many interconnected efforts to perform more efficient environmental reviews.

•Section 204 - The use of the NR GEIS can broadly improve the efficiency of the NRC's review of projects on additional locations, such as DOE sites.

•Section 504 and Section 505 - Taken together, performance metrics and milestones should also be considered as the NRG staff implements the NR GEIS and other related provisions to improve the Agency's overall efficiency.

Finally, the staff's recommendations in SECY-24-0046, which relate to implementing the FRA, would also directly affect the use of the NR GEIS.

[8] For example, "Surface Water Quality Degradation Due to Chemical and Thermal Discharges," "Construction Impacts on Historic and Cultural Resources," "Operation Impacts on Historic and Cultural Resources," "Construction Environmental Justice Impacts," "Operation Environmental Justice Impacts," and the five "Non-Resource Related Issues"

[9] ClearPath Comments on the ADVANCE Act Report to Congress on Efforts to Facilitate Efficient, Timely, and Predictable Environmental Reviews for Nuclear Reactor Applications, dated October 11, 2024 (ADAMS Accession Number ML24289A052)

(**36-7** [McMurray, Nicholas])

Comment: NEI supports both the NR GEIS rulemaking and the NRC's broader efforts to provide a stable, predictable, and efficient environmental review process for new reactor applications. Avoiding delays in the licensing process, including the agency's National Environmental Policy Act (NEPA) review, is essential to fostering technological innovation and expeditiously deploying new nuclear plants, consistent with multiple nuclear-related laws enacted over the last five years. Those laws include, for example, the Nuclear Energy Innovation and Modernization Act of 2019 (NEIMA) and the Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024 (ADVANCE Act).

Our detailed comments are provided in the Enclosure to this letter. They generally convey support for the NR GEIS and proposed rule. NEI believes the NR GEIS will be integral to efficient NRC reviews of many expected new reactor license applications and become a foundational document like the License Renewal GEIS and Continued Storage Rule GEIS. (**38-1-1** [O'Neill, Martin])

Comment: A. The New Reactor Generic Environmental Impact Statement (NR GEIS) and Rule Are Needed to Meet Key National Policy Objectives and Congressional Directives

As the demand for electricity continues to grow, the U.S. nuclear industry will play a crucial role in meeting the nation's energy security, grid reliability, economic development, and

environmental goals via the long-term operation of the current power reactor fleet and the deployment of new reactors. As such, Congress has sought to bolster both public and private sector efforts to develop, license, and commercialize new nuclear technologies. For example, the Nuclear Energy Innovation Capabilities Act of 2017 (NEICA) authorized testing and demonstration of advanced reactors with private and public funding and cost-share grants to help fund advanced reactor licensing activities.[1] The Nuclear Energy Innovation and Modernization Act (NEIMA) of 2019 directed the NRC to develop a "technology-inclusive" licensing framework (proposed 10 CFR Part 53).[2]

As noted in the draft NR GEIS, in a June 25, 2019, letter to the NRC Chair, Senators John Barrasso and Mike Braun urged the NRC to develop a GEIS as "a critical step to facilitate the deployment of new nuclear technologies" and to "demonstrate NRC's commitment to transform and innovate."[3] They noted that "[a] GEIS is another important action that aligns with NEIMA's advanced nuclear reactor requirements," and "will reduce cumbersome regulatory barriers, expedite the environmental review process, and enable market deployment of innovative nuclear technologies."[4] This is especially important given recent U.S. Department of Energy (DOE) and White House pronouncements that at least 200 GW of net new nuclear capacity is needed by 2050.

[1] Nuclear Energy Innovation Capabilities Act of 2017 (NEICA), P.L. 115-248 (Sept. 28, 2018), www.congress.gov/bill/115th-congress/senate-bill/97.

[2] Nuclear Energy Innovation and Modernization Act (NEIMA), P.L. 115-439 (Jan. 14, 2019), www.congress.gov/bill/115th-congress/senate-bill/512.

[3] Letter from U.S. Senators John Barrasso and Mike Braun to NRC Chairman Kristine Svinicki at 1-2 (June 25, 2019) (ML19176A444).

[4] Id. at 1.

(**38-1-9** [O'Neill, Martin])

Comment: Congress also has recognized the need to improve the efficiency of federal environmental reviews to support the development of domestic energy resources, including nuclear energy. On June 3, 2023, President Biden signed the Fiscal Responsibility Act of 2023 (FRA).[5] Section 321 ("Builder Act") of the FRA includes important amendments to NEPA that are intended to expedite the permitting process for infrastructure projects. Among other things, the FRA amendments established time and page limits for environmental impact statements (EIS) and environmental assessments (EA) with which all federal agencies must comply. The NR GEIS will be crucial to the NRC's ability to meet these page limits and deadlines for its NEPA reviews of new reactor license applications.

On July 9, 2024, the President signed into law the Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024 (ADVANCE Act), which includes provisions to modernize NRC regulations and reduce investment and deployment costs for new reactors.[6] Section 506 directs NRC to submit a report to Congress within 180 days that describes the NRC's efforts "to facilitate efficient, timely, and predictable environmental reviews" of nuclear reactor license applications." It identifies numerous potential measures for achieving this objective, including the "expanded use of ... generic environmental impact statements" (emphasis added).

Accordingly, NEI believes that the NRC's Purpose and Need Statement in Section 1.1 of the NR GEIS should reflect the foregoing national policy considerations and legislative directives. The NRC's ongoing and future implementation of the 2023 NEPA amendments and ADVANCE Act Section 506 directives also could influence the implementation of this proposed rule's requirements. Thus, at a minimum, we believe these considerations warrant meaningful discussion in the Statements of Consideration (SOC) and Regulatory Analysis for the final rule.

[5] Fiscal Responsibility Act of 2023, P.L. 118-5, § 321 (Builder Act) (amending 42 U.S.C. 4321 et seq.), https://www.congress.gov/118/plaws/publ5/PLAW-118publ5.pdf.

[6] Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024 (ADVANCE Act), Pub. L. 118-67, div. B (July 9, 2024), https://www.congress.gov/118/plaws/publ67/PLAW-118publ67.pdf. *See also* NRC, "Streamlining and Efficiencies - Additional Efficiency Considerations Directed by the ADVANCE Act," https://www.nrc.gov/about-nrc/regulatory/licensing/ecoe/modernizing/efficiencies.html#add.

(**38-1-10** [O'Neill, Martin])

Comment:

B. The NR GEIS Will Facilitate the NRC's Implementation of Multiple ADVANCE Act Provisions in Addition to Section 506

In finalizing the NR GEIS, proposed rule, and related guidance, the NRC should acknowledge the role those documents may play in implementing other sections of the ADVANCE Act in addition to Section 506. Given their nexus to the environmental review process, those sections include:

• Section 206, "Regulatory issues for nuclear facilities at brownfield sites," directs the NRC to identify and report on regulations, guidance, or policy necessary to license and oversee nuclear facilities at brownfield sites, including sites with retired fossil fuel facilities, and at retired fossil fuel sites where one or more electric generation facilities are retired or scheduled to retire. The NRC must consider how existing site infrastructure can be reused and how early site permits, plant parameter envelopes, or standardized applications for similar sites may be used for licensing. The NRC also must develop and implement strategies to enable and support licensing of nuclear facilities, considering matters relating to existing emergency planning, environmental data and reviews, decontamination and remediation, community engagement, and historical experience with energy use at the sites. (Emphasis added)

• Section 207, "Combined license review procedure," directs the Commission to establish and implement an expedited procedure for issuing COLs under 10 CFR Part 52 for applications that make use of reactor designs and sites previously approved by the NRC.[7] The NRC must, to "the maximum extent possible," complete the technical review and safety evaluation and the final EIS or EA within 18 months after the design is accepted for docketing. Within two years, the NRC must complete any necessary public hearings, and within 25 months, the agency must issue a final decision on the COL application. (Emphasis added)

• Section 208, "Regulatory requirements for micro-reactors," directs the NRC to, within 18 months, develop performance-based and risk-informed guidance and strategies for licensing and regulating micro-reactors, taking onto account their unique size, source terms, and simplified design characteristics. It further provides that, within three years, the NRC must

implement these strategies and guidance within its existing regulatory framework, via its proposed Part 53 licensing framework, or through another pending or new rulemaking. (Emphasis added)

• Section 505, "Nuclear licensing efficiency," directs the NRC to "establish techniques and guidance for evaluating applications for licenses for nuclear reactors to support efficient, timely, and predictable reviews of applications for those licenses to enable the safe and secure use of nuclear reactors." For applications for new facilities to be located at an NRC-licensed production facility or utilization facility site, "the Commission shall, to the extent practicable, use information that was part of the licensing basis of the licensed production facility or utilization facility." (Emphasis added)

The NR GEIS and rule should prove useful in meeting some, if not all, of these ADVANCE Act directives. Section 206, for example, refers explicitly to "environmental reviews" and the use of "plant parameter envelopes." Section 505 cites the need for tools that support "efficient, timely, and predictable" licensing reviews - one of the express purposes and expected benefits of the NR GEIS. With regard to Section 206, the use of plant and site parameter envelopes developed by NRC staff subject matter experts are fundamental to the NR GEIS. As summarized therein: In this GEIS, the NRC staff uses the values and assumptions in a technology-neutral plant parameter envelope (PPE) for a new nuclear reactor to evaluate the environmental impacts of constructing and operating a nuclear reactor. In addition, this GEIS assumes that a new reactor might be built anywhere in the United States and territories that meets the requirements of the NRC's siting regulations. To accommodate this broad range of siting possibilities, the staff developed a site parameter envelope (SPE) that provides limiting values and assumptions related to the site.[8]

[7] Specifically, the expedited procedure will apply to COL applications that reference (1) an NRC-certified design or a design that is substantially similar to a design of a nuclear reactor for which the NRC has issued a COL, an operating license, or a manufacturing license; and (2) sites on which a licensed commercial nuclear reactor operates or previously operated, or that is directly adjacent to a site on which a licensed commercial nuclear reactor operates or previously operated and has site characteristics that are substantially similar to that site.

[8] Draft NR GEIS at 3.

(**38-1-11** [O'Neill, Martin])

Comment: Notably, the NRC staff already has signaled its intent to leverage the NR GEIS (subject to further direction from the Commission) in performing environmental reviews for micro-reactors. In Enclosure 2 to its October 2024 preliminary white paper on "Nth-of-a-Kind Micro-Reactor Licensing and Deployment," the NRC staff has proposed a multi-option "timed-phased" approach to micro-reactor licensing that begins with a micro-reactor design-specific GEIS (Option 2a, Design-Specific Generic Environmental Impact Statement) that could be tiered from the NR GEIS. In implementing Option E3 (Generic Micro-Reactor Online Portal with a Streamlined NEPA Process), the NRC staff notes that it could develop a set of bounding micro-reactor PPE and SPE values derived from the NR GEIS.[11]

For these reasons, NEI recommends that the NRC include some discussion of the potential role and importance of the NRC GEIS in implementing multiple directives contained in the above-referenced sections of the ADVANCE Act. If this discussion is not included in the NR GEIS itself, then it should be included in the final rule's SOC, at a minimum. The ADVANCE Act also

should be added to Appendix F ("Laws, Regulations, and Other Authorizations") of the NR GEIS.

[11] NRC, Preliminary White Paper, "Nth-of-a-Kind Micro-Reactor Licensing and Deployment Considerations" at 19-21 (Sept. 2024) (ML24268A310).

(**38-1-14** [O'Neill, Martin])

Response:

The NRC acknowledges and agrees in part with the comments. The comments generally describe and/or request clarification of the relationship between the NR GEIS and relevant laws such as the Fiscal Responsibility Act (FRA) and the ADVANCE Act. The NRC agrees that development of the NR GEIS is consistent with the requirements of the ADVANCE Act, which is intended to facilitate efficient, timely, and predictable environmental reviews of nuclear reactor license applications. Similarly, the NR GEIS is intended to streamline and expedite the NEPA review process, as required by the FRA. Other ongoing processes, such as NRC's Nth-of-a-Kind Micro-Reactor Licensing and Deployment Considerations White Paper, are intended to support the development of strategies to provide for the predictable and efficient licensing and regulation of microreactors, and are also consistent with the process and approach described in the NR GEIS and rule.

Separate from the development of the NR GEIS, the NRC is currently working on rulemaking under Executive Order 14300 related to both the FRA and the ADVANCE Act and the recission of the CEQ NEPA-implementing regulations and associated direction in Executive Order 14154, which were issued after the close of the public comment period on the NR GEIS. However, these activities are outside the scope of this final rule. As referenced in many of the comments, SECY-24-0046 (NRC 2024-TN11945) provides the staff's review of the Fiscal Responsibility Act, including recommendations for future actions to enhance the NRC's implementing procedures. The NR GEIS is consistent with the requirements of these Acts Section II.B of the rule has been updated to reflect the NRC's determination that the NR GEIS is consistent with both the FRA and ADVANCE Act.

Comment:

Recommendation 6: Acknowledge compliance with the Endangered Species Act and other environmental laws

Projects are required to comply with environmental laws like the Endangered Species Act (ESA), Clean Water Act, and Clean Air Act. As such, the staff's Category 2 reviews related to the ESA should consider that compliance with the ESA is *required* irrespective of the environmental review.[13] While it may not be possible to treat these items as Category 1 issues, regulatory guidance should acknowledge the fact that compliance with these environmental laws and associated regulations is required, which is very likely to reduce the burden on both applicants and staff resources while still ensuring environmental compliance.

[13] https://www.thenewatlantis.com/publications/we-dont-need-this-much-permitting

(**36-10** [McMurray, Nicholas])

Response:

The NRC agrees in part and disagrees in part with the comment. As discussed in Section 1.3.1 of the NR GEIS, certain issues were identified as Category 2 issues specifically because the staff is unable to reach a generic conclusion. In some cases, this Category 2 classification is specifically due to requirements of other statutes such as the Endangered Species Act (TN1010) and National Historic Preservation Act. During project-specific environmental reviews, the analysis of these Category 2 issues must consider compliance with these and other applicable laws and regulations. Existing guidance already discusses compliance with consultation requirements. See, for example, Appendix B to RG 4.2.

The NRC has added a discussion (Section 1.4.7, Consultations) to Chapter 1 of the NR GEIS that discusses the NRC's consultation responsibilities, including under the Endangered Species Act, Magnuson-Stevens Fishery Conservation and Management Act (TN1061), National Marine Sanctuaries Act (TN7197), and National Historic Preservation Act. The NRC also added a new section (Tribal Policy Statement) to Section 3 of COL-ISG-30 "Environmental Considerations for New Nuclear Reactor Applications that Reference the Generic Environmental Impact Statement (NUREG–2249)" as a result of the comment. Additionally, the NRC revised Section I.B and added two footnotes to the final rule to include reference to consultations conducted under the ESA and NHPA, which require interagency consultation with Federal agencies or Indian Tribes and added a reference to the NRC's Tribal Policy Statement. No additional changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

Comment: It is the State's understanding that the GEIS for Licensing of New Nuclear Reactors cannot be relied upon by applicants seeking extension of existing nuclear facility licenses because the Commission has recently released its Revision 2 to NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," which is specifically targeted at license extension regardless of the reactor design. Yet applicants seeking to build new reactors of the same design may rely on the GEIS for Licensing of New Nuclear Reactors. This creates a paradox wherein licensees seeking to extend a reactor license or build a new reactor may rely on differing GEIS frameworks even if the reactor design and the reactor site are the same in both cases. We suggest that the Staff clarify in the Final GEIS why this distinction is appropriate and is not arbitrary. (**37-7** [Peterson, Alyse])

Comment: Finally, on page 3-1, the Staff write: "The site might be situated at an existing nuclear power plant property, and, if so, the generalized description of the affected environment at an existing nuclear power generation site presented in the License Renewal GEIS might be informative." Insofar as this comment suggests that licensees may be able to cross-reference back to the License Renewal GEIS instead of presenting the description of the affected environment in an SEIS, we strongly encourage Staff to require all applicants to provide a new description of the affected environment in all SEISs, even if repetitive of information in the License Renewal GEIS, and not to require stakeholder and site host states and municipalities to dig through dense prior NRC reports to obtain all information needed to understand the impacts of a proposed new reactor. (**37-9** [Peterson, Alyse])

Response:

The NRC disagrees with the comments. The License Renewal GEIS and associated rule were prepared to specifically address the renewal of the license of an operating reactor. In the case of renewing the license for an operating reactor, the impacts of building the plant have already occurred and the impacts of the proposed action of license renewal involve only the impacts

related to continued operation during the renewal term. In contrast, the NR GEIS and rule were prepared for the licensing of a new reactor and therefore consider all of the impacts of building the plant in addition to the impacts of operations. Licensing a new reactor and license renewal of an existing reactor are two fundamentally different actions that require separate GEISs and rules.

Even if a new plant is sited on the site of an existing reactor, the NR GEIS merely states that information from the License Renewal GEIS might be informative, as would information from any environmental document previously published for that site or vicinity. Regardless, the NRC would still have to determine the usefulness and applicability of the information from any previous review to the current new reactor review.

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

E.2.27 Monitoring and Adaptive Management

Comment: Monitoring and Adaptive Management

Nuclear reactor projects have the potential to impact a variety of resources for an extended period. The EPA expects that lessons learned from past practices and adaptive management efforts, combined with the need to account for new challenges, such as the impacts of climate change, will influence management of new reactors. For this reason, the EPA recommends that the Final GEIS include information on an environmental inspection program and mitigation-monitoring program to ensure compliance with all mitigation measures and assess their effectiveness. The EPA also recommends that NRC describes the monitoring program and how it will be used as an effective feedback mechanism so needed program adjustments are made to meet environmental objectives throughout the life of each reactor license. (**23-24** [Chumble, Prasad])

Response:

The NRC disagrees with the comment. In general, adaptive management and monitoring programs in the NEPA context are most appropriately applied when an agency directly manages natural resources. Resource-management agencies can monitor the environmental effects of the actions they take on the resources they manage and then modify management approaches to reach their desired aims if existing practices do not yield the results an agency sought or assumed at the time it conducted its NEPA analysis. Regulatory agencies, like the NRC, however, are typically less able to take advantage of adaptive management approaches because doing so would require the NRC to exercise additional licensing and oversight actions that may exceed NRC's regulatory authority. Nonetheless, aspects of NRC's existing oversight and regulatory processes are inherently adaptive insofar as the NRC's regulations often make use of performance standards that give licensees the flexibility to decide how they will meet the standard. Finally, the NRC's ongoing activities to protect public health and the environment also include a robust research program that regularly provides new information to support the NRC's regulatory mission.

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

E.2.28 Regulatory Analysis

Comment: According to DOE's September 2024 Pathways to Commercial Liftoff Advanced Nuclear Report, U.S. nuclear capacity has the potential to triple from approximately 100 gigawatts electric todato approximately 300 gigawatts electric by 2050.

The growing demand for electricity and need to decarbonize many sectors has led to a resurgence of interest in nuclear power.

There are dozens of companies designing advanced reactors and planning for their construction and operation. Some companies have filed applications with the NRC or are engaged in pre-application activities with the NRC.

While the NRC's estimated net benefit accounts for 20 applications by 2036, NEI's October 2024 Updated Member Survey on the future of nuclear power shows a significant increase in the number of applications anticipated to be prepared over the next ten years. We may see 20 applications in the next five years, with another 20 applications before 2035. (**12-1-2** [Austgen, Kati])

Comment: I noticed that the reg analysis cites 20 applications over the next decade. Based on an updated survey NEI did of its utility members last month, the number could actually be significantly larger than that potentially. So, in that regard, the reg analysis may even understate the potential benefits of the GEIS. (**13-1-3** [O'Neill, Martin])

Comment: In this regard, the NRC's draft regulatory analysis may substantially underestimate the potential benefits of the NR GEIS rulemaking. Moreover, use of the NR GEIS is consistent with recent laws aimed at streamlining and expediting the NEPA review process, including the Fiscal Responsibility Act of 2023 (FRA) amendments to NEPA and Section 506 of the ADVANCE Act. The NR GEIS will help the NRC meet numerous congressional directives in those laws. (**38-1-2** [O'Neill, Martin])

Comment:

D. The NRC's Draft Regulatory Analysis May Underestimate the Quantitative Benefits of the NR GEIS and Associated Rule

Although the NRC staff has prepared a detailed and robust regulatory analysis that considers both quantitative costs and benefits as well as qualitative factors, the analysis may significantly underestimate the quantitative benefits implementing the NR GEIS rule. Specifically, in its draft Regulatory Analysis, the NRC staff assumed that implementation activities would apply to 20 applications submitted under the rule during the first 10 years after the rule is issued (i.e., 2026 to 2036). Using this assumption, the staff determined that the proposed rule alternative and associated guidance would result in undiscounted total net savings for the NRC and applicants up to $40.1 million or $2.0 million per application if the NR GEIS is fully utilized.[21]

NEI believes the volume of new reactor license applications that may rely on the NR GEIS during the cited 10-year period could be more than double that assumed by the NRC staff. The demand signal for more nuclear power has been strong for several years. However, it has been greatly amplified by surging demand for electricity that is being driven by investments in new manufacturing, industrial, bitcoin mining, and artificial intelligence (AI), and data center facilities.

According to DOE's September 2024 *Advanced Nuclear Liftoff* report, U.S. nuclear capacity has the potential to triple from ~100 GW in 2024 to ~300 GW by 2050.[22]

The growing demand for electricity and need to decarbonize many sectors has led to a resurgence of interest in nuclear power. There are many dozens of companies designing advanced reactors in the U.S. and abroad. Some of these companies have filed applications with the NRC or are engaged in pre-application activities with the NRC. Notably, NEI recently issued an updated its "Futures" survey of member companies that operate the nation's 94 operating reactors and one company that is recommissioning a shutdown reactor, for a total of 95 units.[23] Among other things, the survey updated information on plans and interest in new nuclear, yielding the following key insights:

• The members surveyed continue to see the need for 100 GWe of new nuclear by the 2050s to support their reliability and decarbonization needs.[24] Nearly half of the companies surveyed indicated that interest in and planning for new nuclear plants have increased. No companies indicated a reduced level of interest.

• While the 2023 survey had mainly focused on small modular reactors, the 2024 survey indicated interest in large reactors. This interest is consistent with the significant increase in load projections in some regions. Two companies also identified plans for micro-reactors.

• The 2024 survey also showed a significant increase in the number of early site permits (ESP) and construction permits (CP) anticipated to be prepared by the end of this decade. Over a dozen ESPs and a roughly equivalent number of CPs were reported. This planning also extended into the first half of the 2030s with a similar level of interest. As shown in the table below, there is reported interest in pursuing approximately 23 ESPs, 18-19 CP and 8 combined licenses (COL) over the next 10 years.

Number of NRC Submittals
New Nuclear Activities: New ESP
2025-2029: 10-11
2030-2034: 10-11
New Nuclear Activities: Update ESP
2025-2029: 3
2030-2034:
New Nuclear Activities: Construction Permit
2025-2029: 9
2030-2034: 9-10
New Nuclear Activities: New COL
2025-2029: 2
2030-2034: 6

[21] Draft Regulatory Analysis at 3-4, 4-1. The NRC staff notes that the list of expected applications submitted in the 10 years following the issuance of the rule (through 2036) is based on the updated, proprietary information of expected applicants provided to the NRC.

[22] DOE, *Pathways to Commercial Liftoff: Advanced Nuclear* (Sept. 2024), https://liftoff.energy.gov/advanced-nuclear-2/.

[23] NEI, *The Future of Nuclear Power - 2024 Update Survey* (Oct. 2024), https://nei.org/www.nei.org/files/f9/f9922ae5-98cb-449c-a004-785ef37b8105.pdf.

[24] The NEI member companies included in the survey are responsible for less than half of the total power generation in the U.S., so the total U.S. need for new nuclear is likely far greater than 100 GWe.

(**38-1-16** [O'Neill, Martin])

Response:

The NRC agrees with the comments. These comments anticipate more applications than were estimated in the proposed rule regulatory analysis, and as a result, the NRC has increased the expected number of applications in the regulatory analysis for this final rule in response.

The NRC also agrees with the comment that there may be more benefits that were not quantified in the proposed rule regulatory analysis, including meeting directives for streamlining in the Fiscal Responsibility Act of 2023 (FRA) amendments to NEPA and Section 506 of the ADVANCE Act. The NRC reevaluated the quantified costs and benefits in the regulatory analysis for this final rule in accordance with the current NRC cost–benefit regulatory analysis guidance.

The regulatory analysis for this final rule has been revised in response to the comments.

E.2.29 GHG White Paper

Comment: NEI also supports applicant and staff use of the NRC's draft "Recommendations for an Applicant to Calculate Activity Data for Greenhouse Gases Estimates" (GHG Estimates) (ML21225A768), which provides guidance to nuclear reactor license applicants on estimating GHG emission for their proposed facilities. The GHG Estimates document provides a simpler method than the method described in RG 4.2 Rev. 3, which an applicant can use to meet the PPE value from the NR GEIS (which, as noted above, is based on the analysis contained in Appendix H of the NR GEIS). DG-4032 references the GHG Estimates documents as one acceptable means of demonstrating that a proposed new reactor facility meets the PPE value specified in the NR GEIS and Part 51. The use of the simplified method provided in the GHG Estimates document is consistent with the NRC staff's goal of enhancing the efficiency of its environmental reviews. (**38-2-9** [O'Neill, Martin])

Response:

The NRC agrees with the comment. The comment states that the approach presented in the NRC's "Recommendations for an Applicant to Calculate Activity Data for Greenhouse Gases Estimates" (GHG Estimates) white paper (Ghosh 2024-TN7079) is intended to enhance the efficiency of NRC's environmental review by providing a means for an applicant to demonstrate that its proposed new nuclear reactor meets the air quality PPE and SPE values described in the NR GEIS. No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comment.

E.2.30 Energy and System Design Mitigation Alternatives White Paper

Comment: H. The NRC's Draft White Paper Energy and System Design Alternatives Should Help to Streamline Applicant and NRC Discussions of These Topics
The NRC's rulemaking package includes a draft "Energy and System Design Mitigation Alternatives White Paper" (White Paper) (ML21225A754). The White Paper describes the

potential environmental impacts of various alternatives to the construction and operation of a new nuclear reactor, including energy alternatives requiring and not requiring new generation capacity. It also includes descriptions of potential system design mitigation alternatives that have the potential to reduce resource impacts associated with such projects, with a focus on cooling water system (heat dissipation) design mitigation alternatives for large light water reactors. The White Paper notes that much of analysis therein was developed using information in new reactor EISs prepared by the NRC staff, including NUREG-2179, *Environmental Impact Statement for the Combined License for the Bell Bend Nuclear Power Plant*, as well as NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, Rev. 0 (1996) and Rev. 1 (2013). Both DG-4032 and draft ISG-COL-030 reference the White Paper, and the Proposed Rule's SOC states that an applicant could rely upon the information provided in the White Paper, as appropriate, in preparing its environmental report.[67]

[67] Proposed Rule, 89 Fed. Reg. at 80,811.

(**38-2-2** [O'Neill, Martin])

Comment: NEI appreciates the NRC staff's development of the White Paper and supports its use by new reactor license applicants in preparing their environmental reports. As the NRC staff noted in a July 2023 report on alternatives analysis under NEPA, the discussion of energy alternatives in recent EISs had become lengthy and repetitive.[68] The draft NRC GEIS aptly notes that identifying a reasonable range of technically and economically feasible alternatives to a proposed new reactor facility is an inherently project-specific inquiry that requires consideration of information about a given facility. Nonetheless, the draft White Paper analyzes many of the more common energy alternatives, such as those involving the use of natural gas, renewables such as wind and solar, demand-side management, and various combinations of other fuel types and nuclear. Thus, for projects seeking to provide significant quantities of electricity, relevant portions of the White Paper may be incorporated by reference in applicants' environmental reports and NRC's NR GEIS supplements. This practice should increase efficiency and streamline the NRC's discussion of this Category 2 issue, thereby furthering its ability to comply with the page limits and deadlines in Section 107 of NEPA. It also is consistent with the ADVANCE Act's directive to identify "opportunities to streamline the Commission's analyses of alternatives, including the Commission's analysis of alternative sites."[69]

[68] NRC, *Evaluation of the NRC's Alternatives Analysis Process for National Environmental Policy Act Reviews* at 7 (July 21, 2023) (ML23180A265) (Enclosure 1 to SECY-23-0068 (ML23180A266)). The NRC's EISs for the numerous COL applications reviewed in the early to mid-2000s, for example, contained lengthy discussions of alternative energy sources and alternative sites, notwithstanding each applicant's clear intention to build and operate a new nuclear reactor(s) at a specific site, and the NRC's lack of regulatory authority over the alternative energy sources and sites.

[69] Section 506(b)(2)(G) of the ADVANCE Act explicitly directs the NRC to consider "opportunities to streamline the Commission's analyses of alternatives, including the Commission's analysis of alternative sites."

(**38-2-3** [O'Neill, Martin])

Response:

The NRC agrees with the comments. The comments provide perspectives on the NRC's Draft Energy and System Design Alternatives White Paper. Section 9.2 of RG 4.2 includes guidance on consideration of energy alternatives, noting the white paper as a potentially useful source of information regarding alternative energy sources. As described in the comments, one benefit of the white paper is to streamline environmental reviews by allowing applicants to rely upon the relevant information therein when preparing its environmental report. As appropriate, the findings in the white paper will be updated over time to address evolving technologies and changing environmental impacts.

No changes were made in the NR GEIS, final rule, or guidance as a result of the comments.

E.2.31 General Opposition

Comment: The proposed rule is contrary to NEPA's goals of transparency and public participation and does not reflect the cautionary respect due to some of the most dangerous sites in the United States. (**19-1** [Adams, James C.])

Comment: This proposed rule seeks to achieve greater efficiency while sacrificing the thoroughness, adaptability, transparency, and public participation required by NEPA. Accordingly, the agency should withdraw the proposed rule, or at the least rectify the procedural and transparency issues. (**19-7** [Adams, James C.])

Response:

The NRC disagrees with the comments. The NRC is dedicated to its mission of protecting public health and safety and advancing the nation's common defense and security by enabling the safe and secure use and deployment of civilian nuclear energy technologies and radioactive materials through efficient and reliable licensing, oversight, and regulation for the benefit of society and the environment. The NRC provides continuous oversight for the safe operation of nuclear power plants through its ongoing reactor oversight process to verify that the nuclear plants are being operated and maintained in accordance with NRC regulations. Members of the public may also petition the Commission, in accordance with the provisions of 10 CFR 2.206, for consideration of safety issues during current operation and the period of extended operation of the plant.

The purpose of the NR GEIS and associated rulemaking is to present impact analyses for the environmental issues common to many new nuclear reactors that can be addressed generically, thereby eliminating the need to repeatedly reproduce the same analyses each time a licensing application is submitted and allowing applicants and NRC staff to focus future environmental review efforts on issues that can only be resolved once a site is identified. The methodology used in the NR GEIS for categorizing issues as generic or project-specific is an appropriate and effective use of the concept of tiering addressed in the NRC's regulations for implementing NEPA in 10 CFR Part 51.

As stated in Section 1.4 of the NR GEIS, the staff will be able to streamline environmental reviews by referring to the generic analyses in the NR GEIS whenever possible and focus its review efforts on environmental issues where a consideration of project-specific information is needed to ascertain the potential for significant environmental impacts. Upon receipt of specific new nuclear reactor licensing applications, the staff will prepare SEISs tiered from the NR GEIS,

in accordance with the associated rule, that briefly identify the environmental issues that can be addressed through the findings in the NR GEIS and then evaluate the remaining issues in more detail using project-specific information. The staff expects that use of the NR GEIS along with the SEIS will reduce the time and resources needed to complete an environmental review, while still providing decision-makers and the public with a complete and robust analysis of potential environmental impacts and allow the NRC to meet all NEPA requirements. The SEISs tiered from the NR GEIS will be prepared in accordance with NEPA requirements and will adhere to transparency and public participation requirements.

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

E.2.32 General Support

Comment: Having thoroughly researched this proposed rule, I would like to state that I support this proposed rule.

I am a customer of Dominion Energy in Virginia, and I believe that this rule would benefit me by making it easier for Dominion Energy to gradually transition to cleaner sources of power without damaging the environment. The cause of nuclear energy and environmental protection are both important to me, and in my opinion both causes are served well by this rule. (**4-1** [Potter, Jack])

Comment:

Nuclear power is a major renewable energy source, accounting for about 18% of electricity in the US. As a zero-emission energy source, it is an alternative to fossil fuels that contribute to global warming. However, the operation of nuclear reactors is high-risk, not only because of the potential environmental impacts, but also the potential for catastrophic disaster if the reactor fails. Thus, the regulation of nuclear reactors is of utmost importance is order to prevent nuclear disasters.

The codification of the Nuclear Regulatory Commission's Generic Environmental Impact Statement (NR GEIS) is a beneficial step for the further regulation of nuclear reactors. Using the NR GEIS as a standard for applicants would increase the efficiency of the application process because they will not have to complete project-specific analysis for information that would be repeated across different cases. Furthermore, this will set clear standards for future construction of nuclear reactors, which do not exist currently. As the data has already been collected, it is logical for applicants to have access to this data for their application.

While it can be said that the each application is a different scenario, and thus there should not be such broad standards in construction, the breakdown of impacts into Category 1 and Category 2 issues well addresses this problem. There is an important distinction between issues that are generic to every nuclear reactor (Category 1) and issues that are project-specific (Category 2). The requirement of project-specific analysis for Category 2 issues, extending past the NR GEIS standards, adds a key layer to this policy, strengthening its effectiveness. It is important to distinguish that the NR GEIS is not the sole standard for the construction of nuclear reactors, but instead an addition that makes the regulatory process easier for applicants.

Furthermore, the issues covered by the NR GEIS are extensive, including biodiversity, the conservation of ecosystems and indigenous species, human health, air quality, and water quality, among others. The majority of the standards listed are clear, and where they are not as

specific, the issue is listed as Category 2, meaning that project-specific analysis is required. This addresses potential loopholes where the regulations may not be clear because of a lack of adequate data.

Lastly, the economic benefits of this policy cannot be ignored, with an estimated total net savings of $40.1 million. The saved funds could then be reinvested into the further development of nuclear energy. Thus, I strongly recommend codification of NR GEIS to further assist the prevention of the potential environmental consequences of nuclear reactors.

(**6-1** [Anonymous])

Comment: Nuclear energy is an excellent energy source that offers a more sustainable alternative to fossil fuels. With the use of fossil fuels being the primary source of power in the US we must seek other alternatives to finding sources of renewable energy in order to prevent the further use of fossil fuels. Although nuclear energy has components of danger, such as reactor meltdowns, the risk of a reactor meltdown is far less common now than in the past and we see that nuclear power is becoming a safer way to produce clean energy. The revising of regulations for environmental impact statements is necessary to bring new nuclear energy policy to light.

This change from the Nuclear Regulatory Commission's Generic Environmental Impact Statement (NR GEIS) would create a change in this policy that would allow for more projects like this to occur around the country. Furthering the use of carbon free renewable energy, building more clear requirements. The construction of nuclear power plants and reactors benefit the environmentalist groups and people that are supplied the power. Although there can be issues with where plants are placed based on distance to nearby cities, we can better plan where the plants are placed and how they affect the natural area.

There is an estimated net savings of $40.1 million expected in savings for the Nuclear Regulatory Commission (NRC) if the NR GEIS is fully utilized. Regulatory analysis is also considered qualitative factors to be considered in the NRC's rulemaking decision. The NR GEIS has considered several factors in order to determine the safety of these nuclear power tools. The conservation of local ecosystems, and biogeography, effects on native species, water quality, air quality, public health and other environmental factors.

I am strongly in favor of the standardization of these new policies for the NR GEIS for the future of renewable energy resources. These implementations benefit the future of clean energy in the US. (**7-1** [Keo, Callan])

Comment: We agree that a rulemaking codifying generic findings in the New Reactor GEIS should result in greater transparency, predictability, clarity, and reliability in both the review and hearing process.

NRC's regulatory analysis for the draft New Reactor GEIS and proposed Rule states "the New Reactor GEIS and the issues and findings in Table C-1 of 10 CFR Part 51, will improve the efficiency of the environmental review.

Improving the clarity and efficiency of the regulatory provisions reduces the cost to industry to prepare environmental reports for new nuclear reactor applications and permits the NRC to focus resources on project-specific issues of importance, i.e., project-specific analysis, which also reduces the cost to the NRC. (**12-1-4** [Austgen, Kati])

Comment:

NEI is very supportive of the staff's efforts to develop the advanced, excuse me, new reactor GEIS. You know, it's been some time in the making and, you know, I think that the staff has put together an excellent document.

We're certainly reviewing it still and putting together some written comments for submittal to the NRC, but I just want to underscore how important the use of GEISs has been in NRC practice to date, you know, especially in the license renewal context.

(**13-1-1** [O'Neill, Martin])

Comment: Appreciate the work that's being done today and all the hard work that went into this proposed rule. I think there's a lot that you've done which is quite good and many of the elements that are designated as Category 1, I think, are very positive. (**13-3-1** [Merrifield, Jeff])

Comment: I just want to say thank you to the NRC staff for all of the work that's gone into developing the new reactor GEIS. I know it's been many years, and I do also really appreciate the staff being open to feedback on broadening the applicability beyond just a certain megawatt limit or megawatt thermal limit, as well as really trying to look at how to make it as broadly applicable as possible.

I think this is a really great example for the NRC looking at making a performance-based, technology neutral, and risk-informed regulation, and so I just wanted to make sure I shared my appreciation for the staff to really take this effort five years ago at this point and really continue to drive it towards completion, so thank you all. (**13-4-1** [McMurray, Nicholas])

Comment: I actively encourage the codification of the NR GEIS because it is vital for preventing future environmental impacts by nuclear reactors. It is important to understand that the NR GEIS is not the only standard taken into account for the construction of nuclear reactors, but a component that will facilitate the overall regulation process for applicants applying to construct and operate nuclear power plants. In this way, we will maximize efficiency when regulating nuclear reactors by strengthening the application process and giving significant information to applicants to avoid any environmental damage whether the potential issue is considered Category 1 or Category 2. Nuclear energy is a significant step into leaving fossil fuels behind and shifting to zero-emission energy. Which is why the codification of the NR GEIS and approval of this policy will be a significant step in turning nuclear power plants into a completely sustainable energy source and preventing any additional environmental damage. (**17-6** [Aguilar S., Kathya])

Comment: There is no denying that nuclear power generation has the potential to be a driving force in the fight against fossil fuels and the resulting anthropogenic climate change. I believe this proposed rule to be an important step in the direction of governmental support in the streamlining and efficiency needed to create sweeping changes in the ways we acquire our energy here in the United States. (**18-1** [Anonymous])

Comment: I applaud the Nuclear Regulatory Commission's plan to rely on generic environmental impact statements to resolve consideration of environmental matters that remain the same across licensing decisions. As the Commission is well aware, the process for evaluating environmental impacts under the National Environmental Policy Act, while laudable in intention, is broken. Too often the NEPA process results in years of needless administrative

delay and litigation. Reforming the NEPA process is critical to enable the United States to invest in the infrastructure necessary to compete and thrive in the twenty-first century. While such reforms will require important work on the part of Congress and the White House, there is much that agencies can do on their own, as the Commission's important proposal makes clear. I encourage the Commission to explain to its sister agencies the benefits of using generic environmental impact statements; I hope that other agencies follow the Commission's good example. (**20-1** [Ray, Paul])

Comment: As a geography student who's core studies revolve around climate change and water/energy resources, this proposal in my opinion is a vital step toward addressing the growing energy demands of critical infrastructure, such as data centers, and transitioning the country away from fossil fuels. (**21-1** [Pond, Douglas])

Comment: One of the primary reasons to support this rule is the increasing demand for reliable energy sources, particularly with the rise of energy intensive infrastructure like data centers and hyper centers. Research shows that global data centers consume approximately 1% of the world's electricity, with usage projected to grow rapidly as digitalization and the further implementation of AI accelerates. (Masanet et al., 2020). Advanced nuclear reactions, which provide consistent and scalable power, can fill the gap left by intermittent renewable sources like solar and wind. Unlike fossil fuels, nuclear power is a carbon free energy source, and its adoption can help meet climate targets by reducing greenhouse gas emissions. Studies have also demonstrated that nuclear energy, when deployed at scale, is among the most energy dense and environmentally sustainable options available (Brook et al., 2014). (**21-3** [Pond, Douglas])

Comment: In conclusion, I support the NRC's proposed rule to establish an advanced licensing framework for nuclear reactors, as it offers a path toward meeting growing energy demands while reducing reliance on fossil fuels. (**21-7** [Pond, Douglas])

Comment: The GEIS should be enacted because it will help simplify the frankly unnecessarily complicated regulations. In its current state, the various regulations make it difficult for nuclear power operators to comply with industry regulations. However, if the GEIS is enacted these various excessive regulations would be streamlined into one set of regulations, instead of many different regulatory standards. The GEIS, although its environmental regulation may be somewhat of a hindrance to industry, will simplify the process and make companies more likely to comply with these regulations. (**22-1** [Anonymous])

Comment: Westinghouse Electric Company LLC (Westinghouse) appreciates the opportunity to comment on the draft proposed rule for a generic environmental impact statement (GEIS) for new reactors. Resolution of this issue, ideally resulting in implementation of a GEIS for new reactors, has been one of the top policy issues for Westinghouse to support efficient licensing and deployment of the **eVinci™** microreactor. Westinghouse supports the continued effort towards finalization and implementation of this rulemaking. (**24-1** [Schoedel, Anthony J.])

Comment: The United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada (United Association or UA), representing more than 383,000 highly skilled workers in the plumbing and pipe fitting trades, strongly supports the proposed rule as an important, necessary step to expand nuclear capacity. Further, given the importance of this energy source, the NRC's initiative should be applauded for promoting a common sense, pragmatic revision to national nuclear policy. (**26-1** [McManus, Mark])

Comment: I. Striking a Proper Balance Between National Energy and Environmental Interests

In this rulemaking, the NRC is specifically proposing to "codify the generic findings of the NRC's draft Generic Environmental Impact Statement for Licensing of New Nuclear Reactors." This amendment to current regulations would help streamline the NEPA review process by incorporating "a technology-neutral framework and a set of plant and site parameters," which would facilitate an informed, more expedited assessment of potential environmental impacts "common to the construction, operation, and decommissioning of many new nuclear reactors."

This is precisely the type of change that is needed in our country's environmental/energy policy right now. While the NEPA is needed to ensure the protection of our environment and natural resources, its policy goals must be balanced with important countervailing goals in developing a substantial amount of new, clean, reliable generation capacity while also promoting strong economic development.

In addition, NEPA regulations, as well as numerous other regulatory review and permitting requirements have become increasingly arduous in construction generally and in nuclear projects specifically. The collective impact of such regulations can deter needed investments in energy sources in many cases while imposing excessive delays and undue burdens on project development in all cases.

There are several compelling reasons for addressing such challenges to expand nuclear generating capacity. For example, taxpayers and ratepayers, including our members, have a direct stake in cultivating a broad-based energy policy that promotes reliable, sufficient power supply to meet our nation's rapidly expanding demand for electricity and other power needs. Moreover, in the power generation arena, nuclear projects are the leading option for creating major economic benefits for any given project area because they create substantial employment and high-skill training opportunities in both plant construction and operations. (**26-2** [McManus, Mark])

Comment: II. A Major Buildout of Nuclear Capacity is Vitally Needed to Meet the Surging Demand for Clean Power

As the NRC is aware, our country's energy needs are critical, colossal, and urgent. First, there is a nationwide drive to decarbonize the economy and transform our energy infrastructure from fossil-based sources to renewable and other clean sources, especially nuclear. Second, developments in the power generation market, namely a surge in electricity consumption-driven by a massive buildout of data centers due to meeting the needs of exploding Artificial Intelligence technologies-is projected to double electric power demand by 2030.[1]

While the federal government's *All of the Above* strategy to clean energy, which seeks to promote all viable, clean power sources, is the correct approach, nuclear energy offers one of the most promising sources to meet growing demand. It is the single cleanest form of power generation, extremely reliable, and relatively cost-effective when compared to in-place costs of other generation sources. Moreover, next-generation nuclear technologies, including small modular reactors (SMRs) and other advanced systems, are showing considerable benefits over existing sources because they are significantly safer and easier to build, making them increasingly attractive generation sources worth their investment. For example, according to the U.S. Department of Energy:

Advanced SMRs offer many advantages, such as relatively small physical footprints, reduced capital investment, the ability to be sited in locations not possible for larger nuclear plants, and provisions for incremental power additions. SMRs also offer distinct safeguards, security, and nonproliferation advantages.

Expansion of nuclear capacity is also urgent due to the restrictions limiting other energy sources. For example, wind and solar energy have inherent limitations due to their intermittent nature. Hydrogen power, fusion, wave technology, and other renewable sources are still in the early stages of development.

For these reasons, nuclear power has been attracting increasing attention from both government and private industry. Federal and state governments are actively promoting new nuclear programs to facilitate decarbonization, while private corporations are finding nuclear plants the leading go-to solution for meeting their growing power needs.[2]

[1] Robert Walton, *US data center electricity demand could double by 2030, driven by artificial intelligence: EPRI,* Utility Dive (May 30, 2024), US data center electricity demand could double by 2030, driven by artificial intelligence: EPRI |Utility Dive (last visited December 17, 2024). (https://www.utilitydive.com/news/artificial-intelligence-doubles-data-center-demand-2030-EPRI/717467/)

[2] *See e.g.*, U.S. Department of Energy, *Advanced Small Reactors (SMRs*), Advanced Small Modular Reactors (SMRs) | Department of Energy (last visited December 17, 2024) (https://www.energy.gov/ne/advanced-small-modular-reactors-smrs); U.S. Energy Information Administration, *Data center owners turn to nuclear as potential electricity source* (https://www.eia.gov/todayinenergy/detail.php?id=63304), Data center owners turn to nuclear as potential electricity source - U.S. Energy Information Administration (EIA) (https://www.eia.gov/todayinenergy/detail.php?id=63304), (last visited December 17, 2024).

(**26-3** [McManus, Mark])

Comment: III. Major, Irrefutable Economic Benefits of Nuclear Power
While there are ample grounds under both energy and environmental policy to justify the NRC's proposed rule in this matter, these grounds are bolstered by substantial, undeniable economic benefits created by nuclear investments. This fact is extremely important for ensuring public support for the nation's clean energy agenda and facilitating needed investments in energy infrastructure generally.

For the next several decades, the federal and state governments will provide billions of dollars in taxpayer monies to foster the development of clean and renewable energy sources. This scope of publicly assisted construction should give extra weight to the voice of taxpayers and ratepayers, who will ultimately foot the bill for the lion's share of our new energy infrastructure.

Therefore, if new nuclear capacity can help meet our energy and environmental needs, and the use of this particular source yields substantially greater economic advantages over competing energy sources, this factor should drive the adoption of policies that facilitate nuclear power development. In short, nuclear generation facilities are uniquely capable of successfully advancing our nation's energy, environmental, and economic goals.

Research in this area shows that, in terms of job creation impact alone, nuclear projects (as well as bioenergy plants) *create OVER 1,000 percent more jobs* than wind and solar

projects.[3] Further, the jobs impact of nuclear investments is likely the leading reason driving exceptionally strong public support for this leading clean energy source. Indeed, it is difficult to show such support for any other energy sources. National research shows that there is uniquely strong, broad-based public support for existing and advanced nuclear systems for these reasons, as demonstrated by recent polls on this issue:

"NATIONAL" Population Survey[4]
89% Support License Renewal of Existing Nuclear Plants
87% Support Developing Advanced Nuclear Projects
86% Nuclear Important for Nation's Future Power Needs

"LOCAL" Communities Survey[5]
91% Favorable Impression of Local Plant
86% Support New Small Modular Reactor
78% Support New Reactors at Existing Sites

We submit that the data and information provided herein offer convincing support for NRC's proposed rule and other agency actions designed to facilitate nuclear power development. Thank you for your attention to this matter. Please let me know if you have any questions regarding these comments.

[3] *See* Attachment 1 hereto, Energy Jobs Impact Chart. (This research is based on employment data from the energy sector obtained from publicly accessible sources).

[4]Ann S. Bisconti, 2023 National Nuclear Energy Public Opinion Survey: Public Support for Nuclear Energy Stays at Record Level For Third Year in a Row, *Bisconti Research Inc.* (April – May 2024).

[5]Ann S. Bisconti, *Record High Public Support for Nuclear Energy, 2022 National Nuclear Energy Public Opinion Survey Finds Bisconti Research Inc. (June 3, 2022)*.

(**26-4** [McManus, Mark])

Comment: Advancing the United States' efforts to maintain leadership in the development of advanced nuclear technologies is vital to U.S. security. The U.S. must license and demonstrate the most promising advanced reactor technologies, and assure environmental reviews are done efficiently, and are focused on key issues. We think the NR GEIS is a helpful step to address environmental issues.
(**27-1** [Draffin, Cyril])

Comment: It is important to emphasize the significance of a generic environmental impact statement (GEIS) in the NRC's regulatory practice. Historically, a GEIS has proven to be an effective tool, particularly in the context of license renewals, where its use has been upheld by courts as an appropriate method of analysis to comply with the National Environmental Policy Act (NEPA). Generic analyses streamline the review process, improving efficiency while maintaining robust environmental protection. This efficiency will be especially critical in the coming years, given the potential volume of applications that the NRC may receive for new reactors. By enabling consistent, technology-neutral evaluations of common environmental impacts, the NR GEIS positions the NRC to meet this anticipated demand effectively and responsibly. (**30-1** [Toohill, Spencer])

Comment: By addressing common issues generically while reserving detailed analysis for site-specific concerns, the NRC achieves a balance between efficient licensing processes and thorough environmental protection. BTI appreciates that the division also undergoes periodic reassessment to incorporate advances in technology and evolving environmental and societal priorities. (**30-15** [Toohill, Spencer])

Comment: Nuclear Matters applauds the NRC's determination that, "The NR GEIS and the issues and findings in Table C-1 [of 10 CFR Part 51] will improve the efficiency of the environmental review. Improving the clarity and efficiency of the regulatory provisions reduces the cost to industry to prepare environmental reports for new nuclear reactor applications and permits the NRC to focus resources on project-specific issues of importance (i.e., project-specific analyses), which also reduces the cost to the NRC." The NR GEIS is testament to the NRC's efforts, which ensure that the letter and spirit of the laws protecting the environment are met in the most efficient manner possible, to the benefit of the environment and the public.

The secure deployment of advanced reactors is crucial to meeting our nation's carbon reduction goals and strengthening national energy security, as well as solidifying the U.S.'s global leadership on advanced nuclear technology. In addition, the advancement of new reactor technologies provides a career pathway for the next generation of nuclear industry professionals. Nuclear Matters encourages the NRC to fully recognize these positive environmental and economic impacts, plus the long safety record of the commercial nuclear power sector, in the final NR GEIS.

Nuclear Matters appreciates the opportunity to provide comments on the proposed rule and draft NR GEIS. Our advocates are enthusiastic about and supportive of the next generation of nuclear technology, including advanced reactor designs. New reactor technologies offer a clean source of carbon-free energy that can be deployed safely and affordably and will play a key role in securing America's clean energy future. (**31-1** [Johnston, Renee])

Comment: We applaud the NRC's efforts to reform environmental impact statement (EIS) procedures via the proposed amendments to 10 CFR part 51. As the NRC notes in the proposed rule, these are the most complex and resource-intensive environmental reviews the agency performs. We believe these proposed reforms will significantly reduce regulatory and licensing timelines for new nuclear reactors, supporting the availability of an affordable energy source for American consumers. (**33-2** [Unknown] [Unknown] [Unknown])

Comment: We also encourage the NRC to codify the generic conclusions of the draft NR GEIS. As noted in the proposed rule, applying the Category 1 issues identified in the NR GEIS to new nuclear reactor applications that will have a small environmental impact will allow for generic impact analyses for the environmental issues common to many new reactors, reducing extensive and potentially redundant review processes for new nuclear reactors. We believe this will be vital in helping many of our members, especially those with limited staffing resources, address regulatory requirements and embrace new nuclear technologies to help their communities reduce emissions and provide affordable and reliable energy. (**33-3** [Unknown] [Unknown] [Unknown])

Comment: This proposal could help speed up reviews for new nuclear reactors, which is a good thing. (**34-1** [McRoberts, Sage])

Comment: ClearPath commends the staff's efforts to date to develop the now-titled Generic Environmental Impact Statement (GEIS) for Licensing of New Nuclear Reactors (NR GEIS) as

an example of developing a rule that is performance-based, technology-inclusive, and able to accommodate the widest variety of nuclear reactor technologies possible. (**36-1** [McMurray, Nicholas])

Comment: As an initial matter, we support the idea of a generic approach to generic issues, where robust and thorough analysis is performed at the GEIS stage with sufficient basis such that all stakeholders can understand, and opine on, such impacts, knowing that it may be years before such a facility is proposed in any specific community. (**37-1** [Peterson, Alyse])

Comment: While brownfield sites may present some unique, site-specific issues, including the possible presence of legacy contamination and ongoing remediation activities, the NR GEIS should still prove useful. That is, the proposed facility and brownfield site may meet or be bounded by the relevant values and assumptions in the PPE and SPE that support the generic finding for certain Category 1 issues, thereby reducing the scope of any necessary site-specific analysis.[10]

[10] Importantly the draft NR GEIS notes that an applicant may be able to incorporate by reference all or part of the generic analysis provided in the GEIS and focus on providing the additional project-specific information needed, both for Category 1 issues that are not bounded by the PPE/SPE and Category 2 issues. The NRC's draft Regulatory Analysis reflects some consideration of brownfield site scenarios as part of the NRC staff's uncertainty analysis.

(**38-1-13** [O'Neill, Martin])

Comment: The Illinois Emergency Management Agency and Office of Homeland Security (IEMAOHS) appreciates the opportunity to comment on the proposed rulemaking, draft guidance, and draft Generic Environmental Impact Statement (GEIS) for licensing new reactors. IEMA-OHS acknowledges that the generic impact statement uses a technology-neutral framework and plant/site parameters to identify environmental issues common to new reactors, including those issues that would need project-specific analysis. IEMA-OHS acknowledges that the proposed rule and the GEIS for licensing new reactors in combination with the project-specific analysis for an individual plant/site would adequately provide decision-makers with a clear understanding of the new reactor's environmental implications to inform the decision-making process, including whether to proceed with the new reactor and under what conditions.

Additionally, IEMA-OHS recognizes that the draft GEIS is an effort to conservatively streamline the current environmental impact process by identifying and evaluating common issues within defined plant and site envelope boundaries, allowing for additional time and resources to be applied to site-specific concerns. Based on our review of the draft GEIS, IEMA-OHS considers it adequate to ensure the environmental impacts of construction, operation, and decommissioning any new nuclear reactors are properly evaluated, allowing the licensee and NRC flexibility to streamline the environmental review process for future nuclear reactor applicants. (**39-1** [Reynolds, Steven A.])

Response:

The NRC acknowledges the comments. Several comments are supportive of nuclear power and/or the NRC's licensing process for new nuclear reactors. The comments are general in nature and, therefore, will not be evaluated further. No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

E.2.33 Outside Scope-Safety

Comment: Also, As climate change accelerates, extreme weather events pose a growing risk to nuclear reactor infrastructure. I recommend that the GEIS include enhanced guidelines for ensuring nuclear facilities can withstand extreme weather events, such as floods, hurricanes, and heatwaves, without compromising safety or functionality. (**2-2** [Johnson, John])

Comment: Extreme Weather and Climate Change Preparedness
On the other hand, nuclear catastrophes are often started by extreme weather events.[1] As climate change rises, extreme weather events bring a growing risk to nuclear reactor infrastructure, which is why I also recommend that the NR GEIS includes enhanced guidelines to ensure nuclear facilities are able to withstand extreme weather events such as hurricanes, floods, and heat waves without compromising functionality and safety to its workers and nearby communities. The resilience of nuclear power plants against extreme weather events has become an alarming concern as we face the effects of climate change. A clear example of this problem is the 2011 Fukushima Daiichi disaster which showed the potential risks of inadequate preparation of nuclear power plants for natural disasters. A magnitude 9.0 earthquake triggered a massive tsunami, overwhelming the plant's seawall. [2]The tsunami flooded backup power generators, which disabled cooling systems and led to core meltdowns in the reactors. Several people were killed by the earthquake and tsunami that triggered the accident at the plant, and some workers later died from radiation-related illnesses due to their exposure during cleanup efforts.[3] Climate change impacts such as rising sea levels, increased frequency of hurricanes, and intense heat waves have significant risks to nuclear infrastructure. Which is why I suggest that the NR GEIS should make a bigger, more explicit emphasis on the requirements for enhanced resilience measures for all nuclear infrastructure. This includes reinforced structures, but most importantly the effectiveness of emergency response systems that are designed for extreme weather conditions.

The NR GEIS would play a pivotal role in mandating that nuclear plants should be constructed and designed in order to mitigate these climate-related challenges. This protects the quality of life of workers by ensuring their protections as well as surrounding communities.
This would also provide long-term stability for nuclear power as a reliable clean energy source amid increasingly volatile environmental conditions. Ensuring that nuclear facilities can withstand these changes is crucial for public safety and for the long-term sustainability of nuclear power in the face of a changing climate.

[1] Greenfield, A., & Martinez, C. (2022). *Reevaluating the Risk Assessment of Nuclear Facilities in Climate Change Scenarios.* International Journal of Climate and Energy, 12(6), 375-389.

[2] Smithsonian Institution. (2021). *The Fukushima Nuclear Disaster: How a Tsunami Triggered a Global Nuclear Crisis*. Smithsonian Magazine. Retrieved from https://www.smithsonianmag.com/science-nature/fukushima-tsunami-nuclear-disaster-180973489/

[3] Boice, J.D., Jr. (2000). Cancer Risk from Radiation Exposure. Journal of the National Cancer Institute, 92(12), 973-974. https://doi.org/10.1093/jnci/92.12.973.

(**17-2** [Aguilar S., Kathya])

Comment: I believe there also to be a temporal consideration, namely that this data may not accurately reflect the changing environmental concerns as climate change worsens globally.

With natural disasters occurring with a heightened frequency, and extremities in day-to-day weather growing more prevalent every year, this could reflect a blindspot in the generic readings which may not catch these concerns. As these concerns will generally reflect abnormalities in the day-to-day operations of these potential nuclear reactors, perhaps there should be an additional set of criteria that explores how these sites would respond to disaster. (**18-3** [Anonymous])

Response:

The NRC disagrees with the comments. The comments expressed concerns related to safety issues, including the effects of climate change and extreme weather events on operation of nuclear power plants, and indicated that these issues should be addressed in the NR GEIS. As detailed in Section 1.4 of the NR GEIS, the NRC's new nuclear reactor licensing process requires preparation of both a safety evaluation report and an environmental review. The NR GEIS does not evaluate the safety of a reactor design; that is a separate review done when an application is submitted. The impacts of extreme weather events and climate change on the plant would be considered during this safety review. Nuclear power plant operational safety issues are outside the scope of the NRC's environmental reviews conducted under 10 CFR Part 51 as well as the NR GEIS and rulemaking.

No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

E.2.34 Outside Scope-Security and Terrorism

Comment: From my perspective of making newer and looser regulations seems rather unsafe but reasonable. My reasoning is mostly from situations where anybody can take actions on nuclear areas with malicious intent posses unsafe levels to everybody. It would also allow more specific statements to be added to the application for specific clarification. (**5-1** [Mclovin, Dan])

Response:

The NRC disagrees with the comment. Security-related issues are addressed within project-specific safety reviews for reactor licensing and are outside the scope of the NR GEIS and this rulemaking. The NRC routinely assesses threats and other information provided by a variety of Federal agencies and sources. The NRC also ensures that reactor licensees meet appropriate security-level requirements. The staff will continue to address prevention of terrorist acts through the ongoing regulatory process as a current and generic regulatory issue that affects all nuclear facilities and many of the activities conducted at nuclear facilities. With regard to malevolent acts or sabotage resulting in a nuclear accident, it is the NRC's position that malevolent acts or sabotage are speculative and beyond the scope of a National Environmental Policy Act environmental review and, therefore, outside the scope of the NR GEIS and rulemaking. Nonetheless, the NRC has also considered the environmental impacts of severe accidents in Section 3.11 of the NR GEIS. No changes were made in the NR GEIS, final rule, or guidance documents as a result of the comments.

E.3 References

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10 CFR Part 20. *Code of Federal Regulations*, Title 10, *Energy*, Part 20, “Standards for Protection Against Radiation.” TN283.

10 CFR Part 40. *Code of Federal Regulations*, Title 10, *Energy*, Part 40, “Domestic Licensing of Source Material.” TN4882.

10 CFR Part 50. *Code of Federal Regulations*, Title 10, *Energy*, Part 50, “Domestic Licensing of Production and Utilization Facilities.” TN249.

10 CFR Part 51. *Code of Federal Regulations*, Title 10, *Energy*, Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions.” TN250.

10 CFR Part 52. *Code of Federal Regulations*, Title 10, *Energy*, Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants.” TN251.

10 CFR Part 61. *Code of Federal Regulations*, Title 10, *Energy*, Part 61, “Licensing Requirements for Land Disposal of Radioactive Waste.” TN252.

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APPENDIX F

LAWS, REGULATIONS, AND OTHER AUTHORIZATIONS

F.1 Introduction

This appendix presents a brief discussion of Federal and State laws, regulations, and other requirements that may affect the application for and issuance of a license for a new nuclear reactor. The Federal and State laws, regulations, and other requirements listed herein are designed to protect the environment and address the following topics: land and water use, air quality, aquatic resources, terrestrial resources, radiological impacts, waste management, chemical impacts, and socioeconomic conditions. Title 10 of the *Code of Federal Regulations* (10 CFR) 51.45(d) (TN250), "Status of compliance," states:

> The environmental report shall list all Federal permits, licenses, approvals, and other entitlements which must be obtained in connection with the proposed action and shall describe the status of compliance with these requirements. The environmental report shall also include a discussion of the status of compliance with applicable environmental quality standards and requirements including, but not limited to, applicable zoning and land-use regulations, and thermal and other water pollution limitations or requirements which have been imposed by Federal, State, regional, and local agencies having responsibility for environmental protection. The discussion of alternatives in the report shall include a discussion of whether the alternatives will comply with such applicable environmental quality standards and requirements.

The U.S. Nuclear Regulatory Commission (NRC) uses compliance with other laws and regulations designed to protect the environment in the assessment of environmental impacts in its environmental impact statement (EIS).

This appendix is intended to provide a basic overview to assist the applicant in identifying environmental and natural resources laws that may affect the new nuclear reactor licensing process. The descriptions of the laws, regulations, Executive Orders, and other directives are general in nature and are not intended to provide a comprehensive analysis or explanation of any of the items listed. In addition, the list itself is not intended to be comprehensive, and an applicant for a new nuclear reactor license is reminded that a variety of additional Federal, State, or local requirements may apply to their application.

Section F.2 identifies Federal laws and regulations that may be applicable to the new nuclear reactor licensing process. Section F.3 discusses relevant environmental Executive Orders, and Section F.4 identifies applicable NRC regulations. Section F.5 discusses State laws, regulations, and agreements, and Section F.5.1 discusses emergency management and response laws, regulations, and Executive Orders. Section F.6 0discusses laws that contain requirements for consultation with agencies and federally recognized Indian Nations.

F.2 Federal Laws and Regulations

The Federal laws and regulations that are identified and briefly discussed in this section are presented in alphabetical order.

Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024 (ADVANCE Act) (PL 118-67) – The ADVANCE Act is intended to facilitate efficient, timely, and predictable environmental reviews of nuclear reactor license applications.

American Indian Religious Freedom Act of 1978 (42 *United States Code* [U.S.C.] § 1996; TN5281**)** – The American Indian Religious Freedom Act protects Native Americans' rights of freedom to believe, express, and exercise traditional religions.

Antiquities Act of 1906, as amended (54 U.S.C. §§ 320301–320303 and 18 U.S.C. § 1866(b); TN6602) – The Antiquities Act protects historic and prehistoric ruins, monuments, and antiquities, including paleontological resources, on federally controlled lands from appropriation, excavation, injury, and destruction without permission.

Archeological and Historic Preservation Act of 1974, as amended (54 U.S.C. §§ 312501 et seq.; TN4844**)** – The Archeological and Historic Preservation Act establishes procedures for preserving historical and archaeological resources. Analysis of environmental compliance included assessing the energy alternatives for possible impacts on prehistoric, historic, and traditional cultural resources.

Archaeological Resources Protection Act of 1979, as amended (54 U.S.C. §§ 302101 et seq.; TN1687) – The Archaeological Resources Protection Act requires a permit for any excavation or removal of archaeological resources from Federal or Indian lands. Excavations must be undertaken for the purpose of furthering archaeological knowledge in the public interest, and resources removed are to remain the property of the United States. Consent must be obtained from the Indian Tribe or the Federal agency that has authority over the land, on which a resource is located, before issuance of a permit. The permit must contain terms and conditions requested by the Tribe or Federal agency.

Atomic Energy Act of 1954 (42 U.S.C. §§ 2011 et seq.; TN663) – The 1954 Atomic Energy Act (AEA), as amended, and the Energy Reorganization Act of 1974 (42 U.S.C. § 5801 et seq.; TN4466) gives the NRC the licensing and regulatory authority for nuclear energy uses within the commercial sector. It gives the NRC responsibility for licensing and regulating commercial uses of atomic energy and allows the NRC to establish dose and concentration limits for protection of workers and the public for activities under NRC jurisdiction. The NRC implements its responsibilities under the AEA through regulations set forth in 10 CFR.

Bald and Golden Eagle Protection Act of 1940, as amended (16 U.S.C. §§ 668–668d; TN1447) – The Bald and Golden Eagle Protection Act makes it unlawful to take, pursue, molest, or disturb bald and golden eagles, their nests, or their eggs anywhere in the United States. The U.S. Fish and Wildlife Service (FWS) may issue take permits to individuals, government agencies, or other organizations to authorize limited, non-purposeful disturbance of eagles, in the course of conducting lawful activities such as operating utilities or conducting scientific research.

Clean Air Act of 1970, as amended (42 U.S.C. §§ 7401 et seq.*;* TN1141) – The Clean Air Act (CAA) is intended to "protect and enhance the quality of the nation's air resources so as to promote the public health and welfare and the productive capacity of its population." The CAA establishes regulations to ensure maintenance of air quality standards and authorizes individual States to manage permits. Section 118 of the CAA requires each Federal agency, with jurisdiction over properties or facilities engaged in any activity that might result in the discharge of air pollutants, to comply with all Federal, State, interstate, and local requirements with regard

to the control and abatement of air pollution. Section 109 of the CAA directs the U.S. Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQSs) for criteria pollutants. The EPA has identified and set NAAQSs for the following criteria pollutants: particulate matter, sulfur dioxide, carbon monoxide, ozone, nitrogen dioxide, and lead. Section 111 of the CAA requires establishment of national performance standards for new or modified stationary sources of atmospheric pollutants. Section 160 of the CAA requires that specific emission increases must be evaluated prior to permit approval in order to prevent significant deterioration of air quality. Section 112 requires specific standards for release of hazardous air pollutants (including radionuclides). These standards are implemented through plans developed by each State and approved by the EPA. The CAA requires sources to meet standards and obtain permits to satisfy those standards. Nuclear power plants may be required to comply with the CAA Title V, Sections 501–507, for sources subject to new source performance standards or sources subject to National Emission Standards for Hazardous Air Pollutants. Emissions of air pollutants are regulated by the EPA in 40 CFR Parts 50 to 99 (TN5264).

Clean Water Act (33 U.S.C. §§ 1251 et seq.; **TN662)** – The Clean Water Act (CWA; formerly the Federal Water Pollution Control Act of 1972) was enacted to "restore and maintain the chemical, physical, and biological integrity of the Nation's water." The Act requires all branches of the Federal government, with jurisdiction over properties or facilities engaged in any activity that might result in a discharge or runoff of pollutants to surface waters, to comply with Federal, State, interstate, and local requirements.

As authorized by the CWA, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. The NPDES program requires that all facilities that discharge pollutants from any point source into waters of the United States obtain an NPDES permit. An NPDES permit is developed with two levels of controls: technology-based limits and water quality-based limits. NPDES permit terms may not exceed 5 years, and the applicant must reapply at least 180 days prior to the permit expiration date. A nuclear power plant may also participate in the NPDES General Permit for Industrial Stormwater due to stormwater runoff from industrial or commercial facilities to waters of the United States. The EPA is authorized under the CWA to directly implement the NPDES program; however, the EPA has authorized many States to implement all or parts of the national program. Section 401 of the CWA requires that an applicant for a Federal license or permit, whose activities may cause a discharge of regulated pollutants into navigable waters, provide the Federal licensing or permitting agency with a certification from the State or appropriate water pollution control agency in which the discharge originates or will originate. This water quality certification implies that discharges from the activity or project to be licensed or permitted will comply with CWA requirements, as applicable, including that the discharge will not cause or contribute to a violation of applicable water quality standards.

The U.S. Army Corps of Engineers (USACE) is the lead agency for enforcement of CWA wetland requirements (33 CFR Part 320-TN424). Under Section 401 of the CWA, the EPA or a delegated State agency has the authority to review and approve, condition, or deny all permits or licenses that might result in a discharge to waters of the State, including wetlands. CWA Section 401 [33 U.S.C. 1341(a)(1)] states: "No license or permit shall be granted until the certification required by this section has been obtained or has been waived as provided in the preceding sentence. No license or permit shall be granted if certification has been denied by the State, inter-State agency, or the Administrator, as the case may be." Therefore, the NRC cannot issue its license without a 401 certification or an NRC determination that a waiver has occurred,

in accordance with 40 CFR 121.9(c) (TN6718). In accordance with 10 CFR 50.54(aa) (TN249), conditions in the 401 Certification become a condition of the NRC's license.

A Section 404 permit would need to be obtained from the USACE before implementing any action, such as earthmoving activities and certain erosion controls, which could disturb wetlands. Federal and State permits/certifications are obtained using the same form and permit applications for activities affecting waterways, and wetlands are reviewed by the USACE in consultation with the FWS, the Soil Conservation Service, the EPA, and the delegated State agency.

Coastal Zone Management Act of 1972, as amended (16 U.S.C. §§ 1451 et seq.; TN1243) – Congress enacted the Coastal Zone Management Act in 1972 to address the increasing pressures of over-development upon the nation's coastal resources. The National Oceanic and Atmospheric Administration administers the Act. The Coastal Zone Management Act encourages States to preserve, protect, develop, and, where possible, restore or enhance valuable natural coastal resources such as wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as the fish and wildlife using those habitats. Participation by States is voluntary. To encourage States to participate, the Coastal Zone Management Act makes Federal financial assistance available to any coastal State or territory, including those on the Great Lakes, that are willing to develop and implement a comprehensive coastal management program.

Comprehensive Environmental Response, Compensation, and Liability Act as amended by the Superfund Amendments and Reauthorization Act (42 U.S.C. §§ 9601 et seq.; TN6592) – The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) includes an emergency response program to respond to a release of a hazardous substance to the environment. Releases of source, byproduct, or special nuclear material from a nuclear incident are excluded from CERCLA requirements if the releases are subject to the financial protection requirements of the AEA. CERCLA is intended to provide a response to, and cleanup of, environmental problems that are not covered adequately by the permit programs of the many other environmental laws, including the CAA; CWA; Safe Drinking Water Act (SDWA); Marine Protection, Research, and Sanctuaries Act (33 U.S.C. §§ 1401 et seq.; TN4479); Resource Conservation and Recovery Act (RCRA); and AEA. Under Section 120 of CERCLA, each department, agency, and instrumentality (e.g., a municipality) of the United States is subject to, and must comply with, CERCLA in the same manner as any nongovernmental entity (except for requirements for bonding, insurance, financial responsibility, or applicable time period). Under CERCLA, the EPA would have the authority to regulate hazardous substances at a facility in the event of a release or a "substantial threat of a release" of those materials. Releases greater than reportable quantities would be reported to the National Response Center. Assessment of alternatives for environmental compliance includes consideration of whether hazardous substances, in reportable quantity amounts, could be present at power plants during the license term.

Emergency Planning and Community Right-to-Know Act of 1986 (42 U.S.C. §§ 11001 et seq.; TN6603**) (also known as "SARA Title III")** – The Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA), which is the major amendment to CERCLA (42 U.S.C. § 9601; TN6592), establishes the requirements for Federal, State, and local governments, Indian Tribes, and industry regarding emergency planning and "Community Right-to-Know" reporting on hazardous and toxic chemicals. The "Community Right-to-Know" provisions increase the public's knowledge and access to information about chemicals at individual facilities, their uses, and releases into the environment. States and communities

working with facilities can use the information to improve chemical safety and protect public health and the environment. This Act requires emergency planning and notice to communities and government agencies concerning the presence and release of specific chemicals. The EPA implements this Act under regulations found in 40 CFR Part 355 (TN5493), Part 370 (TN6612), and Part 372 (TN6613).

Endangered Species Act of 1973 (16 U.S.C. § 1531–1544; TN1010**)** – The Endangered Species Act was enacted to prevent the further decline of endangered and threatened species and to restore those species and their critical habitats. Section 7 of the Act requires Federal agencies to consult with the FWS or the National Marine Fisheries Service (NMFS) for Federal actions that may affect listed species or designated critical habitats.

Environmental Standards for Uranium Fuel Cycle (40 CFR Part 190, Subpart B; TN739**)** – These regulations establish maximum doses to the body or organs of members of the public as a result of normal operational releases from uranium fuel cycle activities, including uranium enrichment. These regulations were promulgated by the EPA under the authority of the AEA, as amended, and have been incorporated by reference in the NRC regulations in 10 CFR 20.1301(e) (TN283).

Federal Insecticide, Fungicide, and Rodenticide Act, as amended (7 U.S.C. §§ 136 et seq.; TN4535**)** – The Federal Insecticide, Fungicide, and Rodenticide Act, as amended, by the Federal Environmental Pesticide Control Act and subsequent amendments, requires the registration of all new pesticides with the EPA before they are used in the United States. Manufacturers are required to develop toxicity data for their pesticide products. Toxicity data may be used to determine permissible discharge concentrations for an NPDES permit.

Fiscal Responsibility Act of 2023 (Public Law 118-5) – The Fiscal Responsibility Act enacted amendments to the National Environmental Policy Act (NEPA), aimed at streamlining the decision-making process and codifying existing structures for cooperation between Federal agencies. The Act established page and time limits for the environmental review process. Environmental assessments are limited to 75 pages, not including citations or appendices, while EISs are limited to 150 pages, with a 300-page limit for EISs that address an agency action of "extraordinary complexity," not including citations or appendices. The environmental assessment are required to take no more than 1 year to complete, while EISs are limited to 2 years. The Act also allows for common categorical exclusions to be used between agencies and codifies agency use of programmatic environmental documents to facilitate the NEPA review process.

Fish and Wildlife Conservation Act of 1980 (16 U.S.C. §§ 2901 et seq.; TN6604**)** – The Fish and Wildlife Conservation Act provides Federal technical and financial assistance to States for the development of conservation plans and programs for nongame fish and wildlife. Fish and Wildlife Conservation Act conservation plans identify significant problems that may adversely affect nongame fish and wildlife species and their habitats and appropriate conservation actions to protect the identified species. The Act also encourages Federal agencies to conserve and promote the conservation of nongame fish and wildlife and their habitats.

Fish and Wildlife Coordination Act of 1934, as amended (16 U.S.C. §§ 661–666e; TN4467**)** – The Fish and Wildlife Coordination Act requires Federal agencies that construct, license, or permit water resource development projects to consult with the FWS (or NMFS, when applicable) and State wildlife resource agencies for any project that involves an impoundment of more than 10 ac (4 ha), diversion, channel deepening, or other

waterbody modification regarding the impacts of that action to fish and wildlife and any mitigative measures to reduce adverse impacts.

Fixing America's Surface Transportation Act (42 U.S.C. §§ 4370m et seq.; TN6392**)** – Title 41 of the Fixing America's Surface Transportation Act (FAST-41) established new coordination and oversight procedures for infrastructure projects being reviewed by Federal agencies. FAST-41 is intended to accomplish the following:

- Increase predictability
  - through the publication of project-specific permitting timetables and
  - clear processes to modify permitting timetables and resolve issues.
- Increase transparency and accountability over the
  - Federal environmental review and
  - authorization process.
- Improve early coordination of agencies' schedules and synchronization of environmental reviews and authorizations.

FAST-41 established the Federal Permitting Improvement Steering Council, which is composed of agency representatives from various Federal agencies.

To be eligible for FAST-41, a proposal must meet the definition of a "covered project" under the statute. A covered project is one that: (1) is subject to the NEPA; (2) is likely to require a total investment of more than $200,000,000; and (3) does not qualify for abbreviated authorization or environmental review processes under any applicable law. A covered project can also be one that is subject to NEPA and is of the size and complexity which, in the opinion of Federal Permitting Improvement Steering Council, make the project likely to benefit from enhanced oversight and coordination, including a project likely to require (1) authorization from or environmental review involving more than two Federal agencies; or (2) the preparation of an EIS under NEPA."

Hazardous Materials Transportation Act, as amended (49 U.S.C. §§ 5101 et seq.; TN6605**)** – The Hazardous Materials Transportation Act regulates the transportation of hazardous material (including radioactive material) in and between States. According to the Act, States may regulate the transport of hazardous material as long as their regulation is consistent with the Act or the U.S. Department of Transportation regulations provided in 49 CFR Parts 171 through 177 (TN5466). Other regulations regarding packaging for transportation of radionuclides are contained in 49 CFR Part 173, Subpart I (TN298).

Low-Level Radioactive Waste Policy Act of 1980, as amended (42 U.S.C. §§ 2021b et seq.; TN6606**)** – The Low-Level Radioactive Waste Policy Act amended the AEA to improve the procedures for the implementation of compacts providing for the establishment and operation of regional low-level radioactive waste disposal facilities. It also allows for Congress to grant consent for certain inter-State compacts. The amended Act sets forth the responsibilities for disposal of low-level waste by States or inter-State compacts. The Act states the amount of waste that certain low-level waste recipients can receive over a set time period. The amount of low-level radioactive waste generated from both pressurized and boiling water reactor types is allocated over a transition period until a local waste facility is operational.

Magnuson-Stevens Fishery Conservation and Management Act, as amended (16 U.S.C. §§ 1801–1884; TN1061**)** – The Magnuson-Stevens Fishery Conservation and Management Act governs marine fisheries management in U.S. Federal waters. The Act created eight regional fishery management councils and includes measures to rebuild overfished fisheries, protect essential fish habitat, and reduce bycatch. Under Section 305 of the Act, Federal agencies are required to consult with NMFS for any Federal actions that may adversely affect essential fish habitat.

Marine Mammal Protection Act of 1972 (16 U.S.C. §§ 1361 et seq.; TN4478**)** – The Marine Mammal Protection Act (MMPA) was enacted to protect and manage marine mammals and their products (e.g., the use of hides and meat). The primary authority for implementing the Act belongs to the FWS and NMFS. The FWS manages walruses, polar bears, sea otters, dugongs, marine otters, and the West Indian, Amazonian, and West African manatees. The NMFS manages whales, porpoises, seals, and sea lions. The two agencies may issue permits under MMPA Section 104 (16 U.S.C. § 1374) to persons, including Federal agencies, that authorize the taking or importing of specific species of marine mammals.

After the Secretary of the Interior or the Secretary of Commerce approves a State's program, the State can take over responsibility for managing one or more marine mammals. The MMPA also established a Marine Mammal Commission whose duties include reviewing laws and international conventions related to marine mammals, studying the condition of these mammals, and recommending steps to Federal officials (e.g., listing a species as endangered) that should be taken to protect marine mammals. Federal agencies are directed by MMPA Section 205 (16 U.S.C. § 1405) to cooperate with the Commission by permitting it to use their facilities or services.

Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§ 703 et seq.; TN3331**)** – The Migratory Bird Treaty Act is intended to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia. The Act stipulates that, except as permitted by regulations, it is unlawful at any time, by any means, or in any manner to pursue, hunt, take, capture, or kill any migratory bird.

National Environmental Policy Act of 1969, as amended (42 U.S.C. § 4321 et seq.) – NEPA requires, in part, that Federal agencies integrate environmental values into their decision-making process by considering the reasonably foreseeable environmental effects (impacts) of proposed Federal actions and a reasonable range of alternatives to those actions. NEPA establishes policy, sets goals (in Section 101), and provides means (in Section 102) for carrying out the policy. Section 102(2) contains action-forcing provisions to ensure that Federal agencies follow the letter and spirit of the Act. For major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of NEPA, consistent with the provisions of NEPA except where compliance would be inconsistent with other statutory requirements, requires Federal agencies to prepare a detailed statement that includes the reasonably foreseeable environmental effects of the proposed action and other specified information. This generic environmental impact statement (GEIS) has been prepared in accordance with NEPA requirements and NRC regulations (10 CFR Part 51) for implementing NEPA to ensure compliance with Section 102(2).

National Historic Preservation Act of 1966, as amended (54 U.S.C. §§ 300101 et seq.; TN4157**)** – The National Historic Preservation Act (NHPA) was enacted to create a national historic preservation program, including the National Register of Historic Places and the Advisory Council on Historic Preservation. Section 106 of the Act requires Federal agencies

to take into account the effects of their undertakings on historic properties. The Advisory Council on Historic Preservation regulations implementing Section 106 of the Act are found in 36 CFR Part 800 (TN513). The regulations call for public involvement in the Section 106 consultation process, including Indian Tribes and other interested members of the public, as applicable.

Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. § 3001; TN1686**)** – The Native American Graves Protection and Repatriation Act establishes provisions for the treatment of inadvertent discoveries of Indian remains and cultural objects. When discoveries are made during ground-disturbing activities, the activity in the area must immediately stop, and reasonable protective efforts, proper notifications, and appropriate disposition of the discovered items must be pursued.

Noise Control Act of 1972 (42 U.S.C. §§ 4901 et seq.*;* TN4294**)** – The Noise Control Act delegates the responsibility of noise control to State and local governments. Commercial facilities are required to comply with Federal, State, interstate, and local requirements regarding noise control. Section 4 of the Noise Control Act directs Federal agencies to carry out programs in their jurisdictions "to the fullest extent within their authority" and in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health and welfare.

Nuclear Energy Innovation and Modernization Act of 2019 (NEIMA, Public Law 115-439; TN6469**)** – NEIMA's purpose is to establish transparency and accountability measures on the NRC's budget and fee recovery programs as well as to require the Commission to develop the regulatory framework necessary to enable the licensing of ANRs. The Act enables the licensing of ANRs by, among other things, requiring the Commission to develop and implement risk-informed, performance-based licensing policies and guidance. The Act also defines the term "advanced nuclear reactor." The Act authorizes appropriations sums necessary for the Commission to carry out the requirements of Section 103 of NEIMA.

Nuclear Regulatory Commission License Termination Rule (10 CFR Part 20, Subpart E; TN283**)** – The AEA assigns NRC the responsibility for licensing and regulating commercial uses of atomic energy. When a licensed facility has completed its mission, the facility must meet standards for cleanup in order to terminate its license. The License Termination Rule establishes that the NRC will consider a site acceptable for unrestricted use if (1) the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent to an average member of the critical group that does not exceed 25 mrem per year, including that from groundwater sources of drinking water, and (2) the residual radioactivity has been reduced to levels that are as low as reasonably achievable. The critical group is the group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances.

The License Termination Rule also provides for land-use restrictions or other types of institutional controls to allow for the termination of NRC licenses and the release of sites under restricted conditions if decommissioning criteria for unrestricted use cannot be met. Plus, the License Termination Rule establishes alternate criteria for license termination if the licensee provides assurance that public health and safety would continue to be protected, and that it is unlikely that the dose from all manufactured sources combined, other than medical, would be more than 100 mrem per year.

Nuclear Waste Policy Act of 1982 (42 U.S.C. §§ 10101 et seq.; TN740**)** – The Nuclear Waste Policy Act provides for the research and development of repositories for the disposal of

high-level radioactive waste, spent nuclear fuel, and low-level radioactive waste. Title I includes the provisions for the disposal and storage of high-level radioactive waste and spent nuclear fuel. Subtitle A of Title I delineates the requirements for site characterization and construction of the repository and the participation of States and other local governments in the selection process. Subtitles B, C, and D of Title I deal with the specific issues for interim storage, monitored retrievable storage, and low-level radioactive waste.

Occupational Safety and Health Act of 1970 (29 U.S.C. §§ 651 et seq.; TN4453**)** – The Occupational Safety and Health Act establishes standards to enhance safe and healthy working conditions in places of employment throughout the United States. The Act is administered and enforced by the Occupational Safety and Health Administration (OSHA), a U.S. Department of Labor agency. Employers who fail to comply with OSHA standards can be penalized by the Federal government. The Act allows States to develop and enforce OSHA standards if such programs have been approved by the Secretary of Labor.

Pollution Prevention Act of 1990 (42 U.S.C. §§ 13101 et seq.; TN6607**)** – The Pollution Prevention Act establishes a national policy for waste management and pollution control that focuses first on source reduction, then on environmental issues, safe recycling, treatment, and disposal.

Resource Conservation and Recovery Act as amended by the Hazardous and Solid Waste Amendments (42 U.S.C. §§ 6901 et seq.; TN1281**)** – The RCRA requires the EPA to define and identify hazardous waste; establish standards for its transportation, treatment, storage, and disposal; and require permits for persons engaged in hazardous waste activities. Section 3006 (42 U.S.C. § 6926) allows States to establish and administer these permit programs with EPA approval. EPA regulations implementing the RCRA are found in 40 CFR Parts 239 through 283 (TN6618). Regulations imposed on a generator or on a treatment, storage, and/or disposal facility vary according to the type and quantity of material or waste generated, treated, stored, and/or disposed. The method of treatment, storage, and/or disposal also affects the extent and complexity of the requirements.

Rivers and Harbors Act of 1899, Section 10 (33 U.S.C. § 403) – The Rivers and Harbors Act of 1899 (33 U.S.C. §§ 401 et seq.) requires USACE authorization in order to protect navigable waters in the development of harbors and other construction and excavation. Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. § 403) prohibits the unauthorized obstruction or alteration of any navigable water of the United States. That section provides that the construction of any structure in or over any navigable water of the United States, or the accomplishment of any other work affecting the course, location, condition, or physical capacity of such waters is unlawful unless the work has been authorized by the Secretary of the Army through the USACE. Activities requiring Section 10 permits include structures (e.g., piers, wharfs, breakwaters, bulkheads, jetties, weirs, transmission lines) and work such as dredging or disposal of dredged material, or excavation, filling, or other modifications to the navigable waters of the United States.

Safe Drinking Water Act of 1974 (42 U.S.C. §§ 300(f) et seq.; TN1337**)** – The SDWA was enacted to protect the quality of public water supplies and sources of drinking water and establishes minimum national standards for public water supply systems in the form of maximum contaminant levels for pollutants, including radionuclides. Other programs established by the SDWA include the Sole Source Aquifer Program, the Wellhead Protection Program, and the Underground Injection Control Program. In addition, the Act provides underground sources of drinking water with protection from contaminated releases and spills.

If a nuclear power plant is located within an area designated as being a Sole Source Aquifer pursuant to Section 1424(e) of the SDWA, the supplemental EIS would be subject to EPA review. If the EPA review raises concerns that plant operations are not protective of groundwater quality, specific mitigation recommendations or additional pollution prevention requirements may be required.

Toxic Substances Control Act (15 U.S.C. §§ 2601 et seq.; TN4454**)** – The Toxic Substances Control Act (TSCA) regulates the manufacture, processing, distribution, and use of certain chemicals not regulated by RCRA or other statutes, including asbestos-containing material and polychlorinated biphenyls. Any TSCA-regulated waste removed from structures (e.g., polychlorinated biphenyls-contaminated capacitors or asbestos) or discovered during the implementation phase (e.g., contaminated media) would be managed in compliance with TSCA requirements in 40 CFR Part 761 (TN6610).

F.3 Environmental Executive Orders

Executive Orders establish policies and requirements for Federal agencies. Executive Orders do not have the force of law or regulation. Generally, Executive Orders are applicable to most Federal agencies, although they may or may not be binding upon independent regulatory agencies such as the NRC.

Executive Order 11593, *Protection and Enhancement of the Cultural Environment* **(**36 FR 8921-TN6609**)** – This Order directs Federal agencies to locate, inventory, and nominate qualified properties under their jurisdiction or control to the National Register of Historic Places.

Executive Order 11988, *Floodplain Management* (42 FR 26951-TN270**)** – This Order requires Federal agencies to avoid direct or indirect support of floodplain development whenever there is a practicable alternative. A Federal agency is required to evaluate the potential effects of any actions it may take in a floodplain. Federal agencies are also required to encourage and provide appropriate guidance to applicants to evaluate the effects of their proposals on floodplains prior to submitting applications for Federal licenses, permits, loans, or grants.

Executive Order 11990, *Protection of Wetlands* (42 FR 26961-TN269**)** – This Order requires Federal agencies to avoid any short- or long-term adverse impacts on wetlands, whenever there is a practicable alternative and to provide opportunity for early public review of any plans or proposals for new construction in wetlands. Federal agencies are required to evaluate the potential effects of any actions they may take on wetlands when carrying out their responsibilities (e.g., planning, regulating, and licensing activities). However, this Executive Order does not apply to the issuance by Federal agencies of permits, licenses, or allocations to private parties for activities involving wetlands on non-Federal property.

Executive Order 12088, *Federal Compliance with Pollution Control Standards* (43 FR 47707-TN6623**), as amended by Executive Order 12580, *Superfund Implementation* (**52 FR 2923-TN6624**)** – This Order directs Federal agencies to comply with applicable administrative and procedural pollution controls standards established by, but not limited to, the CAA, the Noise Control Act, the CWA, the SDWA, the TSCA, and the RCRA.

Executive Order 12148, *Federal Emergency Management* (44 FR 43239-TN6614**)** – This Order transfers functions and responsibilities associated with Federal emergency management to the Director of the Federal Emergency Management Agency. The Order assigns the Director

the responsibility to establish Federal policies for, and to coordinate all civil defense and civil emergency planning, management, mitigation, and assistance functions of, Executive agencies.

Executive Order 12580, *Superfund Implementation* (52 FR 2923-TN6624**), as amended by Executive Order 13308 (**68 FR 37691-TN6625**)** – This Order delegates to the heads of Executive Departments and agencies the responsibility of undertaking remedial actions for releases or threatened releases that are not on the National Priorities List, and removal actions, other than emergencies, where the release is from any facility under the jurisdiction or control of Executive Departments and agencies.

Executive Order 12656, *Assignment of Emergency Preparedness Responsibilities* (53 FR 47491-TN6626**)** – This Order assigns emergency preparedness responsibilities to Federal departments and agencies.

Executive Order 13007, Indian Sacred Sites (61 FR 26771-TN6629**)** – This Order directs Federal agencies, to the extent permitted by law and not inconsistent with agency missions, to avoid adverse effects on sacred sites and to provide access to those sites to Native Americans for religious practices. The Order directs agencies to plan projects and provide protection of and access to sacred sites to the extent compatible with the project.

Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks (62 FR 19885-TN6630**), as amended by Executive Order 13229 (**66 FR 52013-TN6631**), as amended by Executive Order 13296 (**68 FR 19931-TN6632**)** – This Order requires Federal Executive branch agencies to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children and to ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health or safety risks.

Executive Order 13112, Invasive Species (64 FR 6183-TN4477**)** – This Order directs Federal agencies to act to prevent the introduction of or to monitor and control, invasive (non-native) species, to provide for restoration of native species, to conduct research, to promote educational activities, and to exercise care in taking actions that could promote the introduction or spread of invasive species. During the implementation phase, rehabilitation of disturbed areas would be accomplished by reseeding or revegetating areas with native plants and trees.

Executive Order 13123, Greening the Government through Efficient Energy Management (64 FR 30851-TN6634**)** – This Order sets goals for agencies to reduce greenhouse gas emissions from facility energy use, reduce energy consumption per gross square foot of facilities, reduce energy consumption per gross square foot or unit of production, expand use of renewable energy, reduce the use of petroleum within facilities, reduce source energy use, and reduce water consumption and associated energy use.

Executive Order 13175, Consultation and Coordination with Indian Tribal Governments (65 FR 67249-TN4846**)** – This Order directs Federal agencies to establish regular and meaningful consultation and collaboration with tribal governments in the development of Federal policies that have tribal implications, to strengthen U.S. government-to-government relationships with Indian Tribes, and to reduce the imposition of unfunded mandates on tribal governments. On January 9, 2017, the NRC published its Tribal Policy Statement, which describes best practices and principles in conducting the agency's government-to-government interactions with American Indian and Alaska Native Tribes (82 FR 2402-TN5500).

Executive Order 14154, Unleashing American Energy (90 FR 8353**)** – This Order requires that Federal agencies review all existing regulations, orders, guidance documents, policies, settlements, consent orders, and other agency actions to identify those agency actions imposing an undue burden on the identification, development, or use of domestic energy resources. It revokes various executive orders, including Executive Orders 13990 and 14008. It also revokes Executive Order 11991, which ordered the Council on Environmental Quality to issue regulations to Federal agencies for the implementation of the procedural provisions of NEPA. It ordered that the Chairman of the Council on Environmental Quality propose rescinding these regulations and provide guidance on implementing NEPA.

Executive Order 14173, Ending Illegal Discrimination and Restoring Merit-Based Opportunity (90 FR 8633**)** – This Order rescinds various executive orders, including Executive Order 12898, which called for Federal agencies to address environmental justice in minority populations and low-income populations, and directs Federal agencies to identify and address, as appropriate, disproportionately high and adverse health or environmental effects of their programs, policies, and activities on minority and low-income populations. It instructs Federal agencies not to issue contracts to private companies that include frameworks for diversity, equity, inclusion, and accessibility.

Executive Order 14300, Ordering the Reform of the Nuclear Regulatory Commission (90 FR 22587**)** – This Order requires that the NRC undertake a review and revision of its regulations and guidance documents, including revisions to NRC's NEPA regulations consistent with Executive Order 14154. It also requires that the NRC establish deadlines for evaluating and approving reactor licenses.

F.4 U.S. Nuclear Regulatory Commission Regulations and Guidance

The AEA, as amended, allows the NRC to issue licenses for commercial power reactors to operate up to 40 years. This license is based on adherence of the licensee to the NRC's regulations that are set forth in Chapter 1 of Title 10 of the CFR.

The new nuclear reactor license process includes two reviews: an environmental review and a safety review. The reviews are based on the regulations published in 10 CFR Part 51 (TN250) for the environmental review and 10 CFR Part 50 (TN249) or Part 52 (TN251) for the safety review. These regulations prescribe the format and content of license applications, as well as, the methods and criteria used by NRC staff in evaluating these applications.

The environmental review relies upon the following regulations and guidance:

- *Code of Federal Regulations* – The scope of the environmental review is based on the regulations provided in 10 CFR Part 51 (TN250), *Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions*.
- *Preparation of Environmental Reports for Nuclear Power Stations* (Regulatory Guide 4.2; NRC 2026-TN11915) – This document outlines the format and content to be used by the applicant to discuss the environmental aspects of its license application. It also defines the information and analyses the applicant must include in its environmental report submitted as part of the application.
- *Standard Review Plan for Environmental Reviews for Nuclear Power Plants* (NUREG-1555) – This document provides guidance to the staff in implementing provisions of 10 CFR

Part 51 (TN250), *Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions*, related to new site/plant applications.

- "Interim Staff Guidance Environmental Considerations Associated with Micro-reactors" (COL-ISG-029; NRC 2020-TN6710) – This document provides supplemental guidance to assist the NRC staff in determining the scope and scale of environmental reviews of microreactor applications.
- *Generic Environmental Impact Statement for Licensing New Nuclear Reactors (NR GEIS)* (NUREG-2249; NRC 2021-TN7080) – This document discusses the environmental impacts from new nuclear reactor licensing that are common to all or most nuclear power facilities. The GEIS allows the applicant and the NRC to focus on environmental issues specific to each site seeking a renewed operating license. The staff's review results in a project-specific supplement to the GEIS for each plant site.

F.5 State Laws, Regulations, and Other Requirements

The AEA authorizes States to establish programs to assume NRC regulatory authority for certain activities (the NRC's Agreement State Program). The New York State Department of Labor and Department of Environmental Conservation, for example, have established requirements under this Agreement State Program. New York State Department of Labor has jurisdiction in New York over commercial and industrial uses of radioactive material. Under the New York Agreement State Program, New York State Department of Labor and Department of Environmental Conservation has jurisdiction over discharges of radioactive material to the environment, including releases to the air and water, and the disposal of radioactive wastes in the ground. In addition, States have enacted their own laws to protect public health and safety, and the environment. State laws may supplement or implement various Federal laws for protection of air, water quality, and groundwater. State laws may also address solid waste management programs, locally rare or endangered species, and historic and cultural resources.

In addition, the CWA allows for primary enforcement and administration through State agencies, provided the State program (1) is at least as stringent as the Federal program and (2) conforms to the CWA. The primary CWA mechanism for controlling water pollution is the requirement that direct dischargers obtain an NPDES permit or, in the case of States in which the authority has been delegated from the EPA, a State permit.

One important difference between Federal regulations and certain State regulations is the definition of "waters" regulated by the State. Certain State regulations may include underground waters, while the CWA only regulates the navigable waters of the United States. For example, a State permit is required under New York State law for all discharges to both surface waters and groundwater.

F.5.1 State Environmental Requirements

Certain environmental requirements, including some discussed earlier, may have been delegated to State authorities for implementation, enforcement, or oversight. Table F-1 provides a list of representative State environmental requirements that may affect new nuclear reactor applications for nuclear power plants.

Table F-1 State Environmental Requirements

Law/Regulation	Requirements
Air Quality Protection	
Title V Permit Rules	Establishes the policies and procedures by which a State will administer the Title V permit program under the CAA. Requires Title V sources to apply for and obtain a Title V permit prior to operation of the source facility.
Permits to Install New Sources of Pollution	Requires a permit prior to the installation of a new source of air pollutants or the modification of an air contaminant source. Discusses exemptions and conditions under which approval will be granted. Also requires an impact analysis to determine if the air contaminant source will cause or contribute to violations of the NAAQSs.
Air Permits to Operate and Variances	Requires a permit prior to the operation or use of any air contaminant source in violation of any applicable air pollution control law, unless a variance has been applied for and obtained from the State agency.
Accidental Release Prevention Program	Requires the owner or operator of a stationary source, that has more than a threshold quantity of a regulated substance, to comply with all the provisions of the rule, including creating a hazard assessment, risk management plan, a prevention program, and an emergency response program.
General Conformity Rules	Rules on “general conformity” are mandated by the CAA to ensure that Federal actions do not contribute to air quality violations within the State. Discusses which Federal actions are subject to the conformity requirements, the procedures for conformity analysis, public participation/consultation, and the final conformity determination.
Water Resources Protection	
National Pollutant Discharge Elimination System Permits	Requires a permit prior to the discharge of pollutants from any point source into waters of the United States. Each permit holder must comply with authorized discharge levels, monitoring requirements, and other appropriate requirements in the permit.
Permits to Install New Sources of Pollution	Requires a permit prior to the installation of a new source of water pollutants or the modification of any pollutant discharge source.
Water Quality Standards	Establishes water quality standards for surface waters in the State, including beneficial use designations, numeric water quality criteria, and the anti-degradation waterbody classification system. Water quality standards are enforced through the NPDES permit.
Section 401 Water Quality Certifications	Requires a Section 401 water quality certification and payment of applicable fees before the issuance of any Federal permit or license to conduct any activity that may result in discharges to waters of the State.
Public Water Systems Licenses to Operate	Requires a public water system license prior to operating or maintaining a public water system.
Design, Construction, Installation, and Upgrading for Underground Storage Tank Systems	Establishes performance standards and upgrading requirements for underground storage tanks containing petroleum (e.g., diesel fuel) or other regulated substances. Requires an installation or upgrading permit for each location where such installation or upgrading is to occur prior to beginning either an installation or upgrading of a tank or piping comprising an underground storage tank system.

Table F-1 State Environmental Requirements (Continued)

Law/Regulation	Requirements
Registration of Underground Storage Tank System	Establishes annual registration requirements for underground storage tanks containing petroleum or other regulated substances.
Flammable and Combustible Liquids	Requires a permit to install, remove, repair, or alter a stationary tank for the storage of flammable or combustible liquids or modify or replace any line or dispensing device.
Waste Management and Pollution Prevention	
Generator Standards	Requires any person who generates waste to determine if that waste is hazardous. Requires a generator identification number from the EPA or State agency prior to treatment, storage, disposal, transport, or offer for transport of hazardous waste.
Licensing Requirements for Solid Waste, Construction, and Demolition Debris Facilities	Requires an annual license for any municipal solid waste landfill, industrial solid waste landfill, residual solid waste landfill, compost facility, transfer facility, infectious waste treatment facility, or solid waste incineration facility prior to operation. New facilities must obtain a permit to install, prior to construction. Also, requires a license to establish, modify, operate, or maintain a construction and demolition debris facility.
Radiation Generator and Broker Reporting Requirements	Requires completion of a low-level radioactive waste generator report within 60 days of beginning to generate low-level waste. Also requires each generator to submit an annual report about the State of low-level waste activities in their facility and pay applicable fees.
Hazardous Waste Management System Permits	Requires operation permits for any new or existing hazardous waste facility.
Emergency Planning and Response	
Hazardous Chemical Reporting	Requires the submission of Material Safety Data Sheets and an annual Emergency and Hazardous Chemical Inventory to local emergency response officials for any hazardous chemicals that are produced, used, or stored at the facility in an amount that equals or exceeds the threshold quantity.
Emergency Planning Requirements of Subject Facilities	Requires any facility that has an extremely hazardous substance present in an amount equal to, or exceeding the threshold planning quantity, to notify the emergency response commission and the local emergency planning committee within 60 days after onsite storage begins. Also requires the designation of a facility representative who will participate in the local emergency planning process as a facility emergency coordinator.
Toxic Chemical Release Reporting	Establishes reporting requirements and a schedule for each toxic chemical known to be manufactured (including imported), processed, or otherwise used in excess of an applicable threshold quantity. Applies only to facilities of a certain classification.
Biotic Resources Protection	
State Endangered Plant Species Protection	Establishes criteria for identifying threatened or endangered species of native plants and prohibits injuring or removing endangered species without permission.
State Endangered Fish and Wildlife Species Protection	Establishes and requires periodic updates to a State list of endangered fish and wildlife species.
Permits for Impacts on Isolated Wetlands	Requires a general or individual isolated wetland permit prior to engaging in an activity that involves the filling of an isolated wetland.

Table F-1 State Environmental Requirements (Continued)

Law/Regulation	Requirements
Cultural Resources Protection	
State Registry of Archaeological Landmarks	Establishes a State registry of archaeological landmarks. Prohibits any person from excavating or destroying such land, or from removing skeletal remains or artifacts from any land, placed on the registry without first notifying the State Historic Preservation Office.
Survey and Salvage; Discoveries; Preservation	Directs State departments, agencies, and political subdivisions to cooperate in the preservation of archaeological and historic sites and the recovery of scientific information from such sites. Also, requires State agencies and contractors performing work on public improvements to cooperate with archaeological and historic survey and salvage efforts and to notify the State historic preservation office about archaeological discoveries.

CAA = Clean Air Act; EPA = U.S. Environmental Protection Agency; NAAQS = National Ambient Air Quality Standard; NPDES = National Pollutant Discharge Elimination System.

F.6 Operating Permits and Other Requirements

Several operating permit applications may be prepared and submitted, and regulatory approval and/or permits would be received, prior to license approval by the NRC. Table F-2 lists representative Federal, State, and local permits.

Table F-2 Federal, State, and Local Permits and Other Requirements

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
Air Quality Protection			
Title V Operating Permit: Required for sources that are not exempt and are major sources, affected sources subject to the Acid Rain Program, sources subject to new source performance standards, or sources subject to National Emission Standards for Hazardous Air Pollutants.	EPA or State agency	CAA, Title V, Sections 501–507 (U.S.C., Title 42, §§ 7661–7661f [42 U.S.C. §§ 7661–7661f; TN1141])	Nuclear power plants are subject to 40 CFR Part 61, Subpart H (TN3289), "National Emissions Standards for Emissions of Radionuclides," which is included in the terms and conditions of the Title V Operating Permit.
Risk Management Plan: Required for any stationary source that has a regulated substance (e.g., chlorine, hydrogen fluoride, nitric acid) in any process (including storage) in a quantity that is over the threshold level.	EPA or State agency	CAA, Title 1, Section 112(R)(7) (42 U.S.C. § 7412-TN7014)	These regulated substances stored in quantities that exceed the threshold levels would require a risk management plan.

Table F-2 Federal, State, and Local Permits and Other Requirements (Continued)

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
CAA Conformity Determination: Required for each criteria pollutant (i.e., sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead) where the total of direct and indirect emissions in a nonattainment or maintenance area caused by a Federal action would equal or exceed threshold rates.	EPA or State agency	CAA, Title 1, Section 176(c) (42 U.S.C. § 7506-TN4856)	CAA conformity determination would be required at nuclear power plants located in nonattainment areas with NAAQSs for criteria pollutants or maintenance areas for any criteria pollutant that would be emitted as a result of new nuclear reactor licensing.
Water Resources Protection			
NPDES Permit: Construction Site Stormwater: Required before making point source discharges of stormwater from a construction project that disturbs more than 2 hectares (5 acres) of land.	EPA or State agency	CWA (33 U.S.C. §§ 1251 et seq.; TN662); 40 CFR Part 122 (TN2769)	Any plant refurbishment involving construction of more than 2 hectares (5 acres) of land would require a Stormwater Pollution Prevention Plan and construction site stormwater discharge permit.
NPDES Permit: Industrial Facility Stormwater: Required before making point source discharges of stormwater from an industrial site.	EPA or State agency	CWA (33 U.S.C. §§ 1251 et seq.; TN662); 40 CFR Part 122 (TN2769)	Stormwater would be discharged from the nuclear power plants during operations. Stormwater would discharge through existing outfalls covered by a permit.
NPDES Permit: Process Water Discharge: Required before making point source discharges of industrial process wastewater.	EPA or State agency	CWA (33 U.S.C. §§ 1251 et seq.; TN662); 40 CFR Part 122 (TN2769)	Process industrial wastewater would be discharged through existing outfalls covered by the permit.
Spill Prevention Control and Countermeasures Plan: Required for any facility that could discharge diesel fuel in harmful quantities into navigable waters or onto adjoining shorelines.	EPA or State agency	CWA (33 U.S.C. §§ 1251 et seq.; TN662); 40 CFR Part 112 (TN1041)	A Spill Prevention Control and Countermeasures Plan is required at nuclear power plants storing large volumes of diesel fuel and/or other petroleum products.
CWA Section 401 Water Quality Certification: Required to be submitted to the agency responsible for issuing any Federal	EPA or State agency	CWA, Section 401 (33 U.S.C. § 1341-TN4764); Chapters 119 and 6111	Certification for operation of a nuclear power plant may require a Federal license or permit (e.g., a

Table F-2 Federal, State, and Local Permits and Other Requirements (Continued)

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
license or permit to conduct an activity that may result in a discharge of pollutants into waters of a State.			CWA Section 404 Permit).
New Underground Storage Tanks System Registration: Required within 30 days of bringing a new underground storage tank system into service.	EPA or State agency	RCRA, as amended, Subtitle I (42 U.S.C. §§ 6991a–6991i; TN1281); 40 CFR 280.22 (TN6619)	Required if new underground storage tank systems would be installed at a nuclear power plant.
Aboveground Storage Tank: A permit is required to install, remove, repair, or alter any stationary tank for the storage of flammable or combustible liquids.	State Fire Marshal		Required if new aboveground diesel fuel storage tanks would be installed at a nuclear power plant.
Waste Management and Pollution Prevention			
Registration and Hazardous Waste Generator Identification Number: Required before a person who generates over 100 kg (220 lb) per calendar month of hazardous waste ships the hazardous waste offsite.	EPA or State agency	RCRA, as amended (42 U.S.C. §§ 6901 et seq.; TN1281), Subtitle C	Generators of hazardous waste must notify the EPA that the wastes exist and require management in compliance with RCRA.
Hazardous Waste Facility Permit: Required if hazardous waste will undergo nonexempt treatment by the generator, be stored onsite for longer than 90 days by the generator of 1,000 kg (2,205 lb) or more of hazardous waste per month, be stored onsite for longer than 180 days by the generator of between 100 and 1,000 kg (220 and 2,205 lb) of hazardous waste per month, disposed of onsite, or be received from offsite for treatment or disposal.	EPA or State agency	RCRA, as amended (42 U.S.C. §§ 6901 et seq.; TN1281), Subtitle C	Hazardous wastes are usually not disposed of onsite at nuclear power plants. Hazardous wastes generated onsite are not generally stored for more than 90 days. However, should a nuclear power plant store waste onsite for greater than 90 days for characterization, profiling, or scheduling for treatment or disposal, a Hazardous Waste Facility Permit would be required.

Table F-2 Federal, State, and Local Permits and Other Requirements (Continued)

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
Emergency Planning and Response			
List of Material Safety Data Sheets: Submission of a list of Material Safety Data Sheets is required for hazardous chemicals (as defined in 29 CFR Part 1910-TN654) that are stored onsite in excess of their threshold quantities.	State and local emergency planning agencies	EPCRA, Section 311 (42 U.S.C. § 11021; TN6603); 40 CFR 370.20 (TN6612)	Nuclear power plant operators are required to submit a list of Material Safety Data Sheets to State and local emergency planning agencies.
Annual Hazardous Chemical Inventory Report: The report must be submitted when hazardous chemicals have been stored at a facility during the preceding year in amounts that exceed threshold quantities.	State and local emergency response agencies; local fire department	EPCRA, Section 312 (42 U.S.C. § 11022; TN6603); 40 CFR 370.25 (TN6612)	If hazardous chemicals have been stored at a nuclear power plant during the preceding year in amounts that exceed threshold quantities, then plant operators would be required to submit an annual Hazardous Chemical Inventory Report.
List of Material Safety Data Sheets: Submission of a list of Material Safety Data Sheets is required for hazardous chemicals (as defined in 29 CFR Part 1910-TN654) that are stored onsite in excess of their threshold quantities.	State and local emergency planning agencies	EPCRA, Section 311 (42 U.S.C. § 11021; TN6603); 40 CFR 370.20 (TN6612)	Nuclear power plant operators are required to submit a list of Material Safety Data Sheets to State and local emergency planning agencies.
Annual Hazardous Chemical Inventory Report: The report must be submitted when hazardous chemicals have been stored at a facility during the preceding year in amounts that exceed threshold quantities.	State and local emergency response agencies; local fire department	EPCRA, Section 312 (42 U.S.C. § 11022; TN6603); 40 CFR 370.25 (TN6612)	If hazardous chemicals have been stored at a nuclear power plant during the preceding year in amounts that exceed threshold quantities, then plant operators would be required to submit an annual Hazardous Chemical Inventory Report.
Annual Hazardous Chemical Inventory Report: The report must be submitted when hazardous chemicals have been stored at a facility during the preceding year in amounts that exceed threshold quantities.	State and local emergency response agencies; local fire department	EPCRA, Section 312 (42 U.S.C. § 11022; TN6603); 40 CFR 370.25 (TN6612)	If hazardous chemicals have been stored at a nuclear power plant during the preceding year in amounts that exceed threshold quantities, then plant operators would be required to submit an annual Hazardous Chemical Inventory Report.

Table F-2 Federal, State, and Local Permits and Other Requirements (Continued)

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
Notification of Onsite Storage of an Extremely Hazardous Substance: Submission of the notification is required within 60 days after onsite storage begins of an extremely hazardous substance in a quantity greater than the threshold planning quantity.	State and local emergency response agencies	EPCRA, Section 304 (42 U.S.C. § 11004; TN6603); 40 CFR 355.30 (TN5493)	If an extremely hazardous substance will be stored at a nuclear power plant in a quantity greater than the threshold planning quantity, plant operators would prepare and submit the Notification of Onsite Storage of an Extremely Hazardous Substance.
Annual Toxics Release Inventory Report: Required for facilities that have 10 or more full-time employees and are assigned certain Standard Industrial Classification Codes.	EPA or State agency	EPCRA, Section 313 (42 U.S.C. § 11023; TN6603); 40 CFR Part 372 (TN6613)	If required, nuclear power plant operators would prepare and submit a Toxics Release Inventory Report to the EPA.
Transportation of Radioactive Wastes and Conversion Products Packaging, Labeling, and Routing Requirements for Radioactive Materials: Required for packages containing radioactive materials that will be shipped by truck or rail.	U.S. Department of Transportation	Hazardous Materials Transportation Act (49 U.S.C. §§ 5101 et seq.; TN6605); AEA, as amended (42 U.S.C. §§ 2011 et seq.; TN663); 49 CFR Part 172 (TN6616), Part 173 (TN298), Part 174 (TN6622), Part 177 (TN6620), and Part 397 (TN6621)	When shipments of radioactive materials are made, nuclear power plant operators would comply with U.S. Department of Transportation packaging, labeling, and routing requirements.
Biotic Resource Protection			
Threatened and Endangered Species Consultation: Required between the responsible Federal agencies and FWS and/or NMFS to ensure that the project is not likely to: (1) jeopardize the continued existence of any species listed at the Federal or State level as endangered or threatened, or (2) result in destruction of critical habitat of such species.	FWS and NMFS	ESA of 1973, as amended (16 U.S.C. §§ 1531 et seq.; TN1010)	For actions that may affect listed species or designated critical habitat, the NRC would consult with the FWS and/or NMFS under Section 7 of the ESA.
Essential Fish Habitat Consultation: Required between the responsible Federal agency and NMFS to ensure that Federal actions authorized, funded, or	NMFS	Magnuson-Stevens Fishery Conservation and Management Act, as amended (16 U.S.C. §§ 1801–1884; TN1061)	For actions that may adversely affect essential fish habitat, the NRC would consult with NMFS in accordance with 50 CFR Part 600, Subpart J (TN1342).

Table F-2 Federal, State, and Local Permits and Other Requirements (Continued)

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
undertaken do not adversely affect essential fish habitat.			
CWA Section 404 (Dredge and Fill) Permit: Required to place dredged or fill material into waters of the United States, including areas designated as wetlands, unless such placement is exempt or authorized by a nationwide permit or a regional permit; a notice must be filed if a nationwide or regional permit applies.	USACE	CWA (33 U.S.C. §§ 1251 et seq.; TN662); 33 CFR Part 323 (TN4827) and Part 330 (TN4318)	Dredging or placement of fill material into wetlands within the jurisdiction of the USACE at a nuclear power plant would require a Section 404 permit.
Cultural Resources Protection			
Archaeological and Historical Resources Consultation: Required before a Federal agency approves a project in an area where archaeological or historic resources might be located.	State Historic Preservation Officer and/or Tribal Historic Preservation Officer	NHPA of 1966, as amended (54 U.S.C. §§ 300101 et seq.; TN4157); Archeological and Historical Preservation Act of 1974 (54 U.S.C. §§ 312501 et seq.; TN4844); Antiquities Act of 1906 (54 U.S.C. §§ 320301–320303 and 18 U.S.C. § 1866(b); TN6602); Archaeological Resources Protection Act of 1979, as amended (16 U.S.C. §§ 470aa–mm; TN1687)	The NRC would consult with the State and/or Tribal Historic Preservation Officers and representative Indian Tribes regarding the impacts of licensing new nuclear reactors and the results of archaeological and architectural surveys of nuclear power plant sites.

CAA = Clean Air Act; CFR = *U.S. Code of Federal Regulations;* CWA = Clean Water Act; EPA = U.S. Environmental Protection Agency; EPCRA = Emergency Planning and Community Right-to-Know Act; ESA = Endangered Species Act of 1973, as amended; FWS = U.S. Fish and Wildlife Service; NAAQS = National Ambient Air Quality Standard; NHPA = National Historic Preservation Act; NMFS = National Marine Fisheries Service; NPDES = National Pollutant Discharge Elimination System; NRC = U.S. Nuclear Regulatory Commission; RCRA = Resource Conservation and Recovery Act of 1976, as amended; U.S.C. = *U.S. Code*; USACE = U.S. Army Corps of Engineers.

F.7 Emergency Management and Response Laws, Regulations, and Executive Orders

This section discusses the response laws, regulations, and Executive Orders that address the protection of public health and worker safety and require the establishment of emergency plans. These laws, regulations, and Executive Orders relate to the operation of nuclear power plants. To make things easier for readers, certain items are repeated from previous sections in this appendix.

F.7.1 Federal Emergency Management Response Laws

Emergency Planning and Community Right-to-Know Act of 1986 (42 U.S.C. §§ 11001 et seq.; TN6603**) (also known as "SARA Title III")** – EPCRA, which is the major amendment to CERCLA (42 U.S.C. § 9601; TN6592*)*, establishes the requirements for Federal, State, and local governments, Indian Tribes, and industry regarding emergency planning and "Community Right-to-Know" reporting on hazardous and toxic chemicals. The "Community Right-to-Know" provisions increase the public's knowledge and access to information about chemicals at individual facilities, their uses, and releases into the environment. States and communities working with facilities can use the information to improve chemical safety and protect public health and the environment. This Act requires emergency planning and notice to communities and government agencies concerning the presence and release of specific chemicals. The EPA implements this Act under regulations found in 40 CFR Part 355 (TN5493), Part 370 (TN6612), and Part 372 (TN6613).

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. § 9604(I); TN6592 **(also known as "Superfund")** – This Act provides authority for Federal and State governments to respond directly to hazardous substance incidents. The Act requires reporting of spills, including radioactive spills, to the National Response Center.

Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (42 U.S.C. § 5121; TN6638**)** – This Act, as amended, provides an orderly, continuing means of providing Federal government assistance to State and local governments in managing their responsibilities to alleviate suffering and damage resulting from disasters. The President, in response to a State governor's request, may declare an "emergency" or "major disaster" to provide Federal assistance under this Act. The President, in Executive Order 12148 (44 FR 43239-TN6614), delegated all functions except those in Sections 301, 401, and 409 to the Director of the Federal Emergency Management Agency. The Act provides for the appointment of a Federal coordinating officer who will operate in the designated area with a State coordinating officer for the purpose of coordinating State and local disaster assistance efforts with those of the Federal government.

Justice Assistance Act of 1984 (42 U.S.C. § 3701–3799; TN6639**)** – This Act establishes emergency Federal law enforcement assistance to State and local governments in responding to a law enforcement emergency. The Act defines the term "law enforcement emergency" as an uncommon situation that requires law enforcement, that is or threatens to become of serious or epidemic proportions, and with respect to which State and local resources are inadequate to protect the lives and property of citizens or to enforce the criminal law. Emergencies that are not of an ongoing or chronic nature (for example, the Mount St. Helens volcanic eruption) are eligible for Federal law enforcement assistance including funds, equipment, training, intelligence information, and personnel.

Price-Anderson Act (42 U.S.C. § 2210; TN4522**)** – The Price-Anderson Act provides insurance protection to victims of a nuclear accident. The main purpose of the Act is to partially indemnify the nuclear industry against liability claims arising from nuclear incidents, while still ensuring compensation coverage for the general public. The Act establishes a no-fault insurance-type system in which the first $12.6 billion (as of 2011) is industry-funded as described in the Act (any claims above the $12.6 billion would be covered by the Federal government).

The Act requires NRC licensees and U.S. Department of Energy contractors to enter into agreements of indemnification to cover personal injury and property damage to those harmed

by a nuclear or radiological incident, including the costs of incident response or precautionary evacuation, costs of investigating and defending claims, and settling suits for such damages.

F.7.2 Federal Emergency Management and Response Regulations

Quantities of Radioactive Materials Requiring Consideration of the Need for an Emergency Plan for Responding to a Release (10 CFR 30.72, Schedule C; TN4881**)** – This section of the regulations provides a list that is the basis for both the public and private sector to determine whether the radiological materials they handle must have an emergency response plan for unscheduled releases.

Occupational Safety and Health Administration Emergency Response, Hazardous Waste Operations, and Worker Right-to-Know (29 CFR Part 1910; TN654**)** – This regulation establishes OSHA requirements for employee safety in a variety of working environments. It addresses employee emergency and fire prevention plans (Section 1910.38), hazardous waste operations and emergency response (Section 1920.120), and hazards communication (Section 1910.1200) to make employees aware of the dangers they face from hazardous materials in their workplace. These regulations do not directly apply to Federal agencies. However, Section 19 of the Occupational Safety and Health Act (29 U.S.C. § 668) requires all Federal agencies to have occupational safety programs "consistent" with Occupational Safety and Health Act standards. There is a Memorandum of Understanding between the NRC and OSHA (NRC 2013-TN10165). The memorandum states its purpose is to "to delineate the general areas of responsibility of each agency, to describe generally the efforts of the agencies to achieve worker protection at facilities licensed by the NRC, and to provide guidelines for coordination of activities between the two agencies regarding occupational safety and health.

Emergency Management and Assistance (44 CFR Section 1.1; TN6615**)** – This regulation contains the policies and procedures for the Federal Emergency Management Act, National Flood Insurance Program, Federal Crime Insurance Program, Fire Prevention and Control Program, Disaster Assistance Program, and Preparedness Program, including radiological planning and preparedness.

Hazardous Materials Tables and Communications, Emergency Response Information Requirements (49 CFR Part 172; TN6616**)** – This regulation defines the regulatory requirements for marking, labeling, placarding, and documenting hazardous material shipments. The regulation also specifies the requirements for providing hazardous material information and training.

F.7.3 Emergency Management and Response Executive Orders

Executive Order 12148, Federal Emergency Management (44 FR 43239-TN6614**)** – This Order transfers functions and responsibilities associated with Federal emergency management to the Director of the Federal Emergency Management Agency. The Order assigns the Director the responsibility to establish Federal policies and to coordinate all civil defense and civil emergency planning for the management, mitigation, and assistance functions of Executive agencies.

Executive Order 12656, Assignment of Emergency Preparedness Responsibilities (53 FR 47491-TN6626**)** – This Order assigns emergency preparedness responsibilities to Federal departments and agencies.

Executive Order 12938, Proliferation of Weapons of Mass Destruction (59 FR 59099-TN6640**)** – This Order states that the proliferation of nuclear, biological, and chemical weapons ("weapons of mass destruction") and the means of delivering such weapons constitutes an unusual and extraordinary threat to the national security, foreign policy, and economy of the United States, and that a national emergency would be declared to deal with that threat.

F.8 Consultations with Agencies and Federally Recognized Indian Nations

Certain laws, such as the Endangered Species Act, as amended (16 U.S.C. §§ 1531 et seq.; TN1010), the Fish and Wildlife Coordination Act (16 U.S.C. §§ 661 et seq.; TN4467), and the NHPA (54 U.S.C. §§ 300101 et seq.; TN4157), require consultation and coordination by the NRC with other governmental entities, including other Federal, State, and local agencies and federally recognized Indian Tribes. These consultations must occur on a timely basis and are generally required before any land disturbance can begin. Most of these consultations are related to biotic resources, historic properties, cultural resources, and recognizes NRC's Federal trust responsibility to Indian Tribes. The biotic resource consultations generally pertain to the potential for activities to disturb sensitive species or habitats. Cultural resource consultations relate to the potential for disruption of important cultural resources and archaeological sites. Consultations with Indian Tribes are conducted on a government-to-government basis.

F.9 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, *Energy*, Part 20, "Standards for Protection Against Radiation." TN283.

10 CFR Part 30. *Code of Federal Regulations*, Title 10, *Energy*, Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material." TN4881.

10 CFR Part 50. *Code of Federal Regulations*, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities." TN249.

10 CFR Part 51. *Code of Federal Regulations*, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." TN250.

10 CFR Part 52. *Code of Federal Regulations*, Title 10, *Energy*, Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." TN251.

29 CFR Part 1910. *Code of Federal Regulations*, Title 29, *Labor*, Part 1910, "Occupational Safety and Health Standards." TN654.

33 CFR Part 320. *Code of Federal Regulations*, Title 33, *Navigation and Navigable Waters*, Part 320, "General Regulatory Policies." TN424.

33 CFR Part 323. *Code of Federal Regulations*, Title 33, *Navigation and Navigable Waters,* Part 323, "Permits for Discharge of Dredged or Fill Material into Waters of the United States." TN4827.

33 CFR Part 330. *Code of Federal Regulations*, Title 33, *Navigation and Navigable Waters*, Part 330, "Nationwide Permit Program." TN4318.

36 CFR Part 800. *Code of Federal Regulations*, Title 36, *Parks, Forests, and Public Property*, Part 800, "Protection of Historic Properties." TN513.

40 CFR Part 61. *Code of Federal Regulations,* Title 40, *Protection of Environment,* Part 61, "National Emission Standards for Hazardous Air Pollutants." TN3289.

40 CFR Part 112. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 112, "Oil Pollution Prevention." TN1041.

40 CFR Part 121. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 121, "State Certification of Activities Requiring a Federal License or Permit." TN6718.

40 CFR Part 122. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 122, "EPA Administered Permit Programs: The National Pollutant Discharge Elimination System." TN2769.

40 CFR Part 190. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations." TN739.

40 CFR Part 280. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 280, "Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)." TN6619.

40 CFR Part 355. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 302, "Emergency Planning and Notification." TN5493.

40 CFR Part 370. *Code of Federal Regulations*, Title 40, *Protection of Environmen*t, Part 370, "Hazardous Chemical Reporting: Community Right-To-Know." TN6612.

40 CFR Part 372. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 372, "Toxic Chemical Release Reporting: Community Right-To-Know." TN6613.

40 CFR Part 761. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions." TN6610.

40 CFR Parts 239–283. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Parts 239–283, EPA Regulations Implementing RCRA. TN6618.

40 CFR Parts 50-99. *Code of Federal Regulations*, Title 40, *Protection of the Environment*, Subchapter C, Parts 50-99, "Air Programs." TN5264.

44 CFR Part 1. *Code of Federal Regulations*, Title 44, *Emergency Management and Assistance*, Part 1, "Rulemaking, Policy, and Procedures." TN6615.

49 CFR Part 172. *Code of Federal Regulations*, Title 49, *Transportation*, Part 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans." TN6616.

49 CFR Part 173. *Code of Federal Regulations*, Title 49, *Transportation*, Part 173, "Shippers—General Requirements for Shipments and Packagings." TN298.

49 CFR Part 174. *Code of Federal Regulation*s, Title 49, *Transportation*, Part 174, "Carriage by Rail." TN6622.

49 CFR Part 177. *Code of Federal Regulation*s, Title 49, *Transportation*, Part 177, "Carriage by Public Highway." TN6620.

49 CFR Part 397. *Code of Federal Regulation*s, Title 49, *Transportation*, Part 397, "Transportation of Hazardous Materials; Driving and Parking Rules." TN6621.

49 CFR Parts 171-177. *Code of Federal Regulations*, Title 49, *Transportation*, Subchapter C, "Hazardous Materials Regulations (49 CFR Parts 171-177)." TN5466.

50 CFR Part 600. *Code of Federal Regulations*. Title 50, *Wildlife and Fisheries*, Part 600, "Magnuson-Stevens Act Provisions." TN1342.

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42 FR 26961. May 25, 1977. "Executive Order 11990 of May 24, 1977: Protection of Wetlands." *Federal Register*, Office of the President. TN269.

43 FR 47707. October 17, 1978. "Executive Order 12088 of October 13, 1978: Federal Compliance with Pollution Control Standards." *Federal Register*, Office of the President. TN6623.

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68 FR 19931. April 23, 2003. "Executive Order 13296 of April 18, 2003: Amendments to Executive Order 13045, Protection of Children From Environmental Health Risks and Safety Risks.” *Federal Register*, Office of the President. TN6632.

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Archeological and Historic Preservation Act of 1974, as amended. 54 U.S.C. § 312501 et seq. TN4844.

Atomic Energy Act of 1954. 42 U.S.C. § 2011 et seq. Public Law 112-239, as amended. TN663.

Bald and Golden Eagle Protection Act. 16 U.S.C. § 668-668d et seq. TN1447.

Clean Air Act. 42 U.S.C. § 7401 et seq. TN1141.

Coastal Zone Management Act of 1972. 16 U.S.C. § 1451 et seq. TN1243.

Comprehensive Environmental Response, Compensation, and Liability Act, as amended. 42 U.S.C. § 9601 et seq. TN6592.

Emergency Planning and Community Right-to-Know Act of 1986. 42 U.S.C. § 11001 et seq. TN6603.

Endangered Species Act of 1973. 16 U.S.C. § 1531 et seq. TN1010.

Energy Reorganization Act of 1974, as amended. 42 U.S.C. § 5801 et seq. TN4466.

Federal Insecticide, Fungicide, and Rodenticide Act, as amended. 7 U.S.C. § 136 et seq. TN4535.

Federal Water Pollution Control Act of 1972 (commonly referred to as the Clean Water Act). 33 U.S.C. § 1251 et seq. TN662.

Fish and Wildlife Conservation Act of 1980. 16 U.S.C. § 2901 et seq. TN6604.

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Migratory Bird Treaty Act of 1918. 16 U.S.C. § 703 et seq. TN3331.

National Historic Preservation Act. 54 U.S.C. § 300101 et seq. TN4157.

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Nuclear Waste Policy Act of 1982. 42 U.S.C. § 10101 et seq. TN740.

Occupational Safety and Health Act of 1970, as amended. 29 U.S.C. § 651 et seq. TN4453.

Pollution Prevention Act of 1990. 42 U.S.C. § 13101 et seq. TN6607.

Price-Anderson Act of 1957, as amended. 42 U.S.C. § 2210 et seq. TN4522.

Resource Conservation and Recovery Act of 1976. 42 U.S.C § 6901 et seq. Public Law 94-580, 90 Stat. 2795. TN1281.

Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988. 42 U.S.C. § 5121 et seq. TN6638.

Safe Drinking Water Act of 1974, as amended. 42 U.S.C. § 300f et seq. TN1337.

Toxic Substances Control Act, as amended. 15 U.S.C. § 2601 et seq. TN4454.

APPENDIX G

PLANT PARAMETER ENVELOPE AND SITE PARAMETER ENVELOPE

The interdisciplinary team of subject matter experts assigned to prepare the new nuclear reactor generic environmental impact statement (GEIS) used the following methodology to develop the plant parameter envelope (PPE) and site parameter envelope (SPE) values and assumptions in this appendix:

- regulatory limits and permitting requirements relevant to the resource as established by Federal, State, or local agencies
- relevant information obtained from other U.S. Nuclear Regulatory Commission (NRC) GEISs, including the License Renewal GEIS (NRC 2024-TN10161) and the Continued Storage GEIS (NRC 2014-TN4117)
- empirical knowledge gained from conducting evaluations and analyses for past new nuclear reactor environmental impact statements
- values and assumptions derived from other documents applying a PPE/SPE approach (such as the National Reactor Innovation Center PPE Report [NRIC 2021-TN6940])
- subject matter expertise and/or development of calculations and formulas based upon education and experience with the resource

For details about the PPE and SPE values and assumptions, see the applicable resource section in Chapter 3. The PPE and SPE values and assumptions are used only to support the findings for Category 1 issues. Category 2 issues do not have PPE and SPE values and assumptions.

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors

Parameter	Values and Assumptions	Basis/Methodology
Reactor Site Criteria	10 CFR Part 100 (TN282) Subpart B Evaluation Factors for Stationary Power Reactor Site Applications on or After January 10, 1997 Reactor siting factors to be considered by the applicant shall include: 1. 10 CFR 100.20 Factors to be considered when evaluating sites 2. 10 CFR 100.21 Non-seismic siting criteria 3. 10 CFR 100.23 Geologic and seismic siting criteria	Adherence to siting criteria regulations has been determined to minimize impacts associated with environmental review evaluations.
Site Size and Location	1. 100 ac 2. Complies with applicable zoning 3. Consistent with the objectives of any relevant land use plans 4. Complies with the Coastal Zone Management Act of 1972 (16 U.S.C. § 1451 et seq; TN1243) and the Farmland Protection Policy Act of 1981 (7 U.S.C. §§ 4201 et seq.; TN708), if applicable 5. Completed structures would not be sited within 1 mi of and would not be visible from Federal or State parks or wilderness areas, areas designated as Class I under Section 162 of the Clean Air Act (42 U.S.C. § 7472-TN6954), or a Wild and Scenic River or a National Heritage River, or a river of similar State designation 6. No existing residential areas within 0.5 mi of site	The NRC staff recognizes that, without a detailed consideration of specific land use conditions, as much as 100 ac of land can be dedicated to a project within a feasible setting without noticeably influencing the availability of land for other purposes. The NRC staff assumes any proposed project would meet NRC siting regulations in 10 CFR Part 100 (TN282), or the applicable NRC siting regulations in place at the time the application is docketed. Establishing industrial facilities close to residences can affect the use and enjoyment of residents who desire home environments that are less influenced by the sights, noise, odors, and other parameters acceptable to industrial and commercial workplace settings. A minimum distance of 0.5 mi bounds a generic determination that potential conflicts with residences would be SMALL, although a consideration of specific site conditions could indicate that closer distances could still be SMALL. An even greater distance (1 mi) is needed to bound a generic determination that a project would have only a SMALL potential for adversely affecting features such as Federal or State parks and conservation areas, whose qualities are even more sensitive to industrial influences.

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
Permanent Footprint of Disturbance	1. 30 ac of vegetated lands 2. Counts only land that supports vegetation as of project baseline 3. No prime or unique farmland, or other farmland of statewide or local importance (see Section 3.1.1 for definitions); or site does not abut actively managed agricultural land and is not situated in a predominantly agricultural landscape 4. No floodplains, surface water features, riparian habitat, late-successional vegetation, or dedicated conservation land 5. No more than 0.5 ac of wetlands in permanent or temporary disturbance on the site or ROWs 6. The site and any existing ROWs do not have legacy contamination requiring cleanup to protect human health or the environment 7. No Individual Permits required under Section 404 of the Clean Water Act (33 U.S.C. § 1344-TN1019) 8. Use of BMPs for soil erosion, sediment control, and stormwater management 9. Implementation of mitigation specified in Clean Water Act permits 10. Habitat is not known to be potentially suitable for one or more Federal or State threatened or endangered species	The total footprint of disturbance within areas of existing vegetation (30 ac permanent plus an additional 20 ac of temporary for a total of 50 ac) constitutes an estimate by NRC staff of how much natural habitat excluding unusually sensitive habitats can be disturbed, regardless of geometric shape, in almost any landscape without noticeably altering wildlife numbers or behavior. The value of 0.5 ac of wetlands corresponds to the upper ceiling for project-wide impacts on wetlands under many Nationwide Permits (33 CFR Part 330; TN4318) determined by the U.S. Army Corps of Engineers to constitute minimal impact.
Temporary Footprint of Disturbance	1. Additional 20 ac of vegetated land 2. Counts only land that supports vegetation as of project baseline 3. Meets assumptions for permanent footprint 4. Restored to original grade and seeded or planted with indigenous vegetation once construction is complete	This additional temporary disturbance is factored together with the assumption of no more than 30 ac permanent disturbance into the overall disturbance area of 50 ac (see above). Temporary disturbance of most natural habitats followed by restoration constitutes less impact per acre than permanent or long-term disturbance. The limit of 0.5 ac of wetland impacts in most Nationwide Permits (33 CFR Part 330; TN4318) is a project-wide limit, inclusive of all associated permanent and temporary impacts.
Offsite rights-of-way (ROW)	1. No longer than 1 mi and no wider than 100 ft, but allows for unlimited additional mileage for linear features built within existing ROWs or directly adjacent to existing ROWs or public highways 2. Does not cause the total project-wide wetland fill to exceed 0.5 ac	Dimensions of up to 1 mi long and 100 ft wide constitutes an upper estimate by the NRC staff as to how much new ROW can be established anywhere in most rural landscapes without noticeably affecting fragmented land uses or natural habitats, without consideration of project-specific factors. The staff, based on its experience

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
	3. Would not involve ground disturbance to streams greater than 10 ft in width 4. Does not cross or pass within 0.5 mi of parks, wildlife refuges, or conservation lands 5. Is not visible from Federal or State parks or wilderness areas, areas designated as Class I under Section 162 of the Clean Air Act (42 U.S.C. § 7472-TN6954), or a Wild and Scenic River or a National Heritage River, or a river of similar State designation 6. May span wetlands, waters of the United States, floodplains, shoreline, or riparian lands 7. Any new transmission poles or towers would be constructed outside of wetlands and floodplains 8. Pipelines or buried utilities would be directionally drilled under surface waters to avoid physical disturbance of shorelines or bottom substrates 9. Use of BMPs for soil erosion, sediment control, and stormwater management 10. Implementation of mitigation specified in Clean Water Act permits 11. No physical disturbance to streams greater than 10 ft in width below the ordinary high-water mark 12. Access roads crossing non-jurisdictional surface water features meet the substantive requirements of Nationwide Permits 12 or 14 regarding limits on disturbance and requirements for mitigation	conducting environmental reviews, concludes that co-location of new facilities within existing ROWs or in new ROWs immediately adjacent to existing ROWs or along existing roadways results in minimal land use or ecological impacts. Such ROWs do not fragment existing land uses or natural habitats or introduce utility structures to settings previously lacking such facilities. Additional assumptions address sensitive facilities, which, if present, would necessitate a project-specific analysis to assess the significance of impacts. The limit of 0.5 ac of wetland impacts in most Nationwide Permits (33 CFR Part 330; TN4318) is a project-wide limit, inclusive of impacts from all project elements, including offsite features.
Maximum Building and Structure Height	1. 50 ft, except 200 ft for meteorological towers and 100 feet for mechanical draft cooling towers 2. None of the structures would be built within or be visible from Federal or State parks or wilderness areas, other areas designated as Class I under Section 162 of the Clean Air Act (42 U.S.C. § 7472-TN6954), or designated Wild and Scenic Rivers 3. No transmission poles/towers over 100 ft	Fifty feet constitutes a conservative estimate of building heights that would not likely result in significant visual intrusion or wildlife collision mortality in most settings. This conclusion is based upon NRC reviews in past reactor EISs. The staff recognizes that meteorological towers must be taller to function, and that there would be no need for more than one or two meteorological towers per site. A transmission line with poles or towers taller than 100 ft would be visible in a forested area and would be highly visible in an open area. Most poles shorter than 100 ft are not highly distinct visually from the distribution poles for lower voltage electric lines that are common

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
		visual features in most settings. Mechanical draft cooling towers are typically 50–100 ft in height based on previous new nuclear reactor EIS analyses.
Intake and Discharge	1. Adhere to the best available technology requirements of CWA 316(b) (33 U.S.C. § 1326-TN4823) 2. Operated in compliance with CWA Section 316 (b) and 40 CFR 125.83 (TN254), including compliance with monitoring and recordkeeping requirements in 40 CFR 125.87 and 40 CFR 125.88, respectively 3. Best available technologies are employed in the design and operation of intake and discharge structures to minimize alterations due to scouring, sediment transport, increased turbidity, and erosion 4. Adherence to requirements in NPDES permits issued by the EPA or a given State	Requirements established in the subject regulations have been developed to be protective of aquatic biota, including protection of aquatic biota from excessive impingement or entrainment.
In-Water Structures (including intake and discharge structures)	1. Constructed in compliance with provisions of the CWA Section 404 (33 U.S.C. § 1344-TN1019) and Section 10 of the Rivers and Harbors Appropriation Act of 1899 (33 U.S.C. §§ 401 et seq.; TN660) 2. Adverse effects of building activities controlled and localized using BMPs such as installation of turbidity curtains or installation of cofferdams 3. Any shorelines or other areas temporarily disturbed to build intake and discharge structures would be restored using regionally indigenous vegetation 4. Construction duration would be less than 7 years	Requirements of existing regulations related to in-water construction are protective of aquatic resources and have been found to keep the adverse impacts of building activities localized and temporary.
Cooling Towers	1. No natural draft cooling towers 2. Would be equipped with drift eliminators 3. Makeup water would be fresh (salinity less than 1 ppt)	Various past new nuclear reactor EISs indicate that natural draft cooling towers are tall structures over 200 ft in height that may be visible from substantial distances and from which salt drift and fogging may affect substantial areas of offsite land.

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
Other Cooling Features	1. No once-through cooling 2. No new cooling ponds 3. No new reservoirs 4. No spray irrigation ponds	Once-through cooling systems have a substantial potential for significant impacts on aquatic biota from entrainment and impingement and are essentially not possible due to Section 316(b) of the Clean Water Act (33 U.S.C. § 1326-TN4823). Operation of cooling ponds can have potentially significant effects on aquatic and terrestrial biota. Building reservoirs can affect large areas of aquatic and terrestrial habitats, including sensitive wetland, floodplain, and riparian habitats.
Copper Alloy Tubes	1. No use of copper alloy tubes	According to the License Renewal GEIS, copper alloy tubes can introduce metal contaminants into discharged blowdown water that can be harmful to aquatic biota.
Criteria Pollutant and Hazardous Air Pollutant Emissions	1. Criteria pollutants emitted from vehicles and standby power equipment during construction and operations are less than Clean Air Act *de minimis* levels set by the EPA if located in a nonattainment or maintenance area 2. Hazardous Air Pollutant emissions will be within regulatory limits 3. Construction and operation activities meet the permitting requirements of applicable State and local agencies 4. Use of BMPs for dust control	Requirements of existing regulations related to air emissions have been found to be protective of human health and the environment.
Greenhouse Gas Emissions	New reactor construction and operation, including uranium fuel cycle activities, transportation of fuel and waste, and decommissioning will emit no more than 2,534,000 MT CO_2(e) for the lifespan of the project of 97 years	Appendix H provides estimates of emissions of greenhouse gases associated with building, operation, fuel cycle, transportation of fuel and waste, and decommissioning. Estimates of uranium fuel cycle emissions are based on 5% enrichment. Construction equipment would emit 78,000 MT CO_2(e) during a 7-year construction period Construction workforce would emit 86,000 MT CO_2(e) during a 7-year construction period Plant operations would emit 362,000 MT CO_2(e) during a 40- year period Plant workforce would emit 272,000 MT CO_2(e) during a 40- year period The uranium fuel cycle would emit 1,620,000 MT CO_2(e) during a 40-year period. Transportation of Fuel and Waste would emit 42,000 MT CO_2(e) during a 40-year period

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
		Decommissioning equipment would emit 38,000 MT CO_2(e) during a 10-year period Decommissioning workforce would emit 16,000 MT CO_2(e) during a 10-year period SAFe STORage workforce would emit 20,000 MT CO_2(e) during a 40-year period Previous new nuclear reactor reviews which have a larger fuel cycle contribution based on Table S–3 have concluded that the impact of the contribution of greenhouse gases is SMALL.
Cooling-System Air Quality	1. Hazardous Air Pollutant emissions will be within regulatory limits 2. Subject to State permitting requirements	The License Renewal GEIS (NRC 2024-TN10161) and supplemental EISs for individual plant relicensing evaluated the impact of continued operation of cooling towers, including natural draft cooling towers, at existing power plants for an additional 20 years and found the impacts to be SMALL.
Ozone and Nitrogen Oxide (NOx) Emissions	Transmission line voltage no higher than 1200 kilovolt(s)	Impacts of existing transmission lines on air quality are addressed in the License Renewal GEIS (NRC 2024-TN10161) and Supplemental EISs for individual plant relicensing, which have found impacts to be SMALL. The License Renewal GEIS evaluated lines up to 1,200 kilovolts.
Total Plant Water Demand	1. Less than or equal to a daily average 6,000 gpm 2. The total plant water demand accounts for the maximum amount of water supply required for all plant needs 3. The total plant water demand may include water from multiple sources (e.g., surface water, groundwater, and/or municipal water sources to meet certain water quality criteria)	The NRC staff developed the total plant water demand PPE by considering water requirements for all plant systems from the set of currently known advanced nuclear reactor designs considered by National Reactor Innovation Center (2021-TN6940). The NRC staff rounded this value up to the nearest 1,000 gpm to derive the PPE.
Municipal Water Availability	The amount available from municipal water systems exceeds the amount of municipal water required by the plant (gpm) If municipal water is used for plant water supply: 1. Municipal Water Availability accounts for all existing and planned future uses 2. An agreement or permit for the usage amount can be obtained from the municipality	Municipal water availability at a site is the amount of excess capacity in the municipal systems that is available after accounting for all existing and planned future uses. The NRC staff can generically conclude that the proposed project's municipal water requirements would not noticeably affect water resources at the site, if bounded by municipal water availability and the capacity of the municipal systems.

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
Surface Water Availability – Flowing (Stream or River) (not applicable if plant does not use cooling water)	1. The average rate of plant withdrawal does not exceed 3% of the 95% exceedance daily flow for the waterbody (cubic feet per second) 2. Average plant water withdrawals do not reduce discharge from the flowing waterbody by more than 3% of the 95% exceedance daily flow and do not prevent the maintenance of applicable instream flow requirements 3. The 95% exceedance daily flow accounts for existing and planned future withdrawals 4. Water availability is demonstrated by the ability to obtain a withdrawal permit issued by State, regional or tribal governing authorities 5. Water rights for the withdrawal amount are obtainable, if needed 6. Changes in littoral zone water levels and hydroperiod resulting from surface water withdrawals are within historical annual or seasonal fluctuations 7. If withdrawals are from an estuary or intertidal zone, then changes to salinity gradients are within the normal tidal or seasonal movements that characterize the waterbody	The staff reviewed surface water withdrawals from and related impacts on flowing waterbodies versus low-flow metrics at the of currently operating and newly licensed large LWRs. In the reviews of previous analyses, the staff found that water withdrawal rates at or below 3% of the water available during low flow conditions did not result in noticeable impacts. Therefore, the NRC staff generically concluded that plant surface water withdrawals that do not exceed 3 percent of the 95 percent exceedance daily flow in the flowing waterbody used as the source, while accounting for all existing and planned withdrawals, would not noticeably affect surface water resources at the site. Plant water withdrawal may alter salinity gradients in flowing water bodies. The License Renewal GEIS (NRC 1996-TN288 and NRC 2024-TN10161) evaluated the impact of plant withdrawals on altering salinity gradients at operating plants and found the impacts to be SMALL if they are localized and are within the normal tidal or seasonal movements of salinity gradients that characterize the waterbody.
Surface Water Availability – Non-Flowing (not applicable if plant does not use cooling water)	1. Water availability of the Great Lakes, the Gulf of America, oceans, estuaries, and intertidal zones exceeds the amount of water required by the plant 2. Water availability is demonstrated by the ability to obtain a withdrawal permit issued by State, regional or tribal governing authorities 3. Water rights for the withdrawal amount are obtainable, if needed 4. Changes in littoral zone water levels and hydroperiod resulting from surface water withdrawals are within historical annual or seasonal fluctuations 5. If withdrawals are from an estuary or intertidal zone, then changes to salinity gradients are within the normal tidal or seasonal movements that characterize the waterbody	The staff can generally conclude that the total plant water demand of 6,000 gpm would not result in water use conflicts in the Great Lakes, the Gulf of America, oceans, estuaries, and intertidal zones, because the plant demand would be negligible as compared to water availability. The staff acknowledges, however, that smaller non-flowing surface waterbodies (e.g., inland lakes, man-made ponds, and reservoirs) have limited water availability. These waterbodies are not included in the staff's generic analysis. Plant water withdrawal may alter salinity gradients in non-flowing waterbodies. The License Renewal GEIS (NRC 1996-TN288 and NRC 2024-TN10161) evaluated the impact of plant withdrawals on altering salinity gradients at operating plants and found the impacts to be SMALL if

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
	6. Coastal Zone Management Act of 1972 (16 U.S.C. §§ 1451 et seq.; TN1243) consistency determination is obtainable, if applicable	they are localized and are within the normal tidal or seasonal movements of salinity gradients that characterize the waterbody.
Municipal Systems' Available Capacity to Receive and Treat Plant Effluent	1. The available capacity of the municipal systems to treat effluent exceeds the expected amount of plant effluent (gpm) 2. Municipal Systems' Available Capacity to Receive and Treat Plant Effluent accounts for all existing and planned future discharges 3. Agreement to discharge to a municipal treatment system is obtainable	Municipal systems' available receiving and treatment capacity is determined while accounting for all existing and reasonably foreseeable future discharges. The NRC staff can generically conclude that plant effluent treated by a municipal system would not noticeably affect water resources at the site, if bounded by the municipal systems' available capacity. The constituents present in plant effluent are addressed in the municipal systems' discharge permits.
Groundwater Withdrawal for Plant Uses	1. Less than or equal to 50 gpm 2. Withdrawal results in no more than 1 ft of drawdown at the site boundary 3. Withdrawals are not derived from an EPA-designated Sole Source Aquifer, or from any aquifer designated by a State, Tribe, or regional authority to have special protections to limit drawdown 4. Withdrawals meet the permitting requirements of applicable State and local agencies 5. Changes in wetland water levels and hydroperiod resulting from groundwater use are within historical annual or seasonal fluctuations 6. Parameter value of 50 gpm is the total withdrawal for all plant uses (excluding dewatering)	This site parameter was based on the staff's determination in the License Renewal GEIS that ≤100 gpm groundwater withdrawal creates negligible or small impacts at operating nuclear power plants because this use rate would not generally lower groundwater levels beyond the site boundary. The groundwater withdrawal rate parameter was adjusted lower based on simplified modeling showing that effects on groundwater levels at the site boundary from pumping 50 gpm on a 100 ac site would approximate the effects from pumping 100 gpm on a larger site the size of a typical large LWR. The staff assumed that groundwater withdrawals for plant uses would result in less than a 1 ft reduction in groundwater levels at the site boundary. The threshold of 1 ft was selected as a *de minimis* value likely to be less than the natural annual fluctuations in groundwater levels at most sites.
Groundwater Withdrawal for Excavation or Foundation Dewatering	1. Dewatering rate less than or equal to 50 gpm 2. Dewatering results in negligible drawdown at the site boundary 3. Dewatering discharge has minimal effects on the quality of the receiving waterbody (e.g., as demonstrated by conformance with NPDES permit requirements) 4. Changes in wetland water levels and hydroperiod resulting from dewatering are within historical annual or seasonal fluctuations	The groundwater dewatering parameter was based on the staff's determination that impacts would be small if dewatering would not lower groundwater levels beyond the site boundary, which is consistent with the License Renewal GEIS. Based on simplified modeling, the staff determined that, relative to the plant site area, the effects on groundwater levels caused by dewatering withdrawals of 50 gpm at a 100 ac site would be similar to the effects caused by dewatering withdrawals of 100 gpm on a larger

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
	5. Parameter value of 50 gpm represents the long-term dewatering rate (the initial rate may be larger)	site the size of a typical large LWR. Consistent with the site area for the new nuclear reactor, the staff assumed in this simplified modeling that the area to be dewatered and the depth of groundwater drawdown at the excavation/foundation would be smaller than for a typical large LWR.
Groundwater Quality	1. The plant is outside the recharge area for any EPA-designated Sole Source Aquifer or any aquifer designated to have special protections by a State, tribal, or regional authority 2. The plant is outside the wellhead protection area or designated contributing area for any public water supply well 3. No planned plant discharges to the subsurface (by infiltration or injection), including stormwater discharge 4. Applicable requirements and guidance on spill prevention and control are followed, including relevant BMPs and Integrated Pollution Prevention Plan 5. A groundwater protection program conforming to NEI 07-07 (NEI 2019-TN6775) is established and followed	Because groundwater quality degradation would have the greatest effects on other users of the resource when groundwater at the plant site contributes to the source water for other users, the potential impacts on groundwater quality from plant construction and operation will be minimized when the plant is located outside the recharge areas for critical groundwater supplies and when there are no planned discharges to the subsurface. In addition, spill prevention/control requirements and a groundwater protection program help prevent releases of contaminants to groundwater and to minimize the impacts of any releases that inadvertently occur.
Impacts on Aquatic Biota	1. Adherence to regulatory limits in 40 CFR 125.84 (TN254) 2. Adherence to requirements in NPDES permits issued by the EPA or a given State	Requirements of existing regulations related to aquatic biota impacts are protective of aquatic resources and have been found to keep adverse impacts localized and temporary.
Radiological Environmental Hazards	For protection against radiation, the applicant must meet the regulatory requirements of: • 10 CFR 20.1101 Radiation Protection Programs (10 CFR Part 20-TN283) if issued a license • 10 CFR 20.1201 Occupational dose limits for adults • 10 CFR 20.1301 Dose limits for individual members of the public • Appendix B of 10 CFR Part 20 Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage • 10 CFR 50.34a (10 CFR Part 50-TN249) Design objectives for equipment to control releases of radioactive material in effluents—nuclear power reactors	Requirements of existing regulations related to radiological health have been found to be protective of workers and members of the public and are minimized through a radiation protection program that implements ALARA.

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
	• 10 CFR 50.36a Technical specifications on effluents from nuclear power reactors Applicants would demonstrate in their application that any radiological nonhuman biota doses would be below IAEA (1992-TN712) and NCRP (1991-TN729) guidelines Application contains sufficient technical information for the staff to complete the detailed technical safety review Application will be found to be in compliance by the staff with the above regulations through a radiation protection program and an effluent release monitoring program	
Nonradiological Environmental Hazards	1. The applicant must adhere to all applicable Federal, State, local, or tribal regulatory limits and permit conditions for chemical hazards, biological hazards, and physical hazards from a proposed advanced reactor 2. The applicant will follow nonradiological public and occupational health BMPs and mitigation measures, as appropriate, to govern building and operations-related activities	Requirements of existing regulations related to nonradiological environmental hazards are protective of human health and have been found to keep the adverse impacts of building and operations-related activities localized and temporary.
Wildlife-Related Noise Generation	85 dBA 50 ft from the source	NRC staff has historically relied upon the *Federal Highway Administration Construction Noise Handbook* (WSDOT 2017-TN5313) to determine that a noise level of 85 dBA 50 ft from the source is typical.
Human-Related Noise Generation	1. 65 dBA at site boundary, unless a relevant State or local noise abatement law or ordinance sets a different threshold, which would then be the presumptive threshold for PPE purposes. 2. If an applicant cannot meet the 65 dBA threshold through mitigation, then the applicant must obtain a variance or exception with the relevant State or local regulator. 3. Project will implement BMPs, such as modeling, foliage planting, construction of noise buffers, and the timing of construction and/or operation activities.	The License Renewal GEIS (NUREG-1437; NRC 2024-TN10161) determined that noise levels are considered acceptable if the day-night average sound level outside a residence is less than 65 dBA. This limit is also included in the NRC Environmental Standard Review Plans (NUREG-1555; NRC 2000-TN614).
Radiological Waste Management	Applicants must meet the regulatory requirements of 10 CFR Part 20 (TN283) (e.g., 20.1406 and Subpart K), 10 CFR Part 61 (TN252), 10 CFR Part 71 (TN301), and 10 CFR Part 72 (TN4884)	Requirements of existing regulations related to radiological waste management have been found to be protective of human health and the environment.

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
	LLRWs at existing nuclear power plants generate an average of 21,200 ft^3 (600 m^3) and 2,000 Ci (7.4×10^{13} Bq) per year for boiling water reactors and half that amount for pressurized water reactors (NRC 2024-TN10161) RCRA Small Quantity Generator (EPA 2020-TN6590) for Mixed Waste	
Nonradiological Waste Management	1. Applicants must meet all applicable permit conditions, regulations, and BMPs related to solid, liquid, and gaseous waste management 2. For hazardous waste generation, applicants must meet the conformity with the appropriate hazardous waste quantity generation level in accordance with RCRA (EPA 2020-TN6590) 3. For sanitary waste, applicants must treat sanitary waste in a permitted process 4. Perform mitigation measures, to the extent practicable, such as recycling, process improvements, or using a less hazardous substance	Requirements of existing regulations and applicable permits related to nonradiological waste management have been found to be protective of human health and the environment and have been found to keep the adverse impacts of building and operation activities localized and temporary.
Postulated Accidents	For design basis accidents,[1] the exclusion area boundary maximum total effective dose equivalent for any 2-hour period and the low-population zone maximum total effective dose equivalent for the duration of the accident release For accidents involving releases of hazardous chemicals: • New reactor inventory of a regulated substance is less than its TQ. TQs are found in 40 CFR 68.130, Tables 1, 2, 3, and 4 (TN5494); and • New reactor inventory of an EHS is less than its TPQ. TPQs are found in 40 CFR Part 355, Appendices A and B (TN5493).	Requirements of existing regulations related to postulated accidents are protective of human health. The applicant would have to demonstrate meeting the dose requirements contained in 10 CFR 50.34(a)(1) (TN249) Design objectives for equipment to control releases of radioactive material in effluents – nuclear power reactors, or 10 CFR 52.17(a)(1) (TN251), Contents of applications; technical information, or 10 CFR 52.79(a)(1)(A), Contents of applications; technical information in Final Safety Analysis Report, as applicable. For hazardous chemical accidents, the applicant would make a comparison of hazardous chemical inventories to the TQs found in 40 CFR 68.130, Tables 1, 2, 3, and 4

[1] For the purposes of this GEIS, "Design Basis Accidents" are related to a spectrum of accidents that will be evaluated for satisfying siting requirements (e.g., 10 CFR Part 100-TN282) and the safety analysis requirements (e.g., 10 CFR Part 50-TN249, 10 CFR Part 52-TN251) or the applicable NRC safety and siting regulations in place at the time the application is docketed).

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
	For severe accidents that release radioactive material the following are applicable: • Within the maximum Population Dose Risk 95th confidence bounding value of 9.727×10^3 person-rem per reactor year (i.e., Indian Point 2 and 3) specified in the 1996 LR GEIS (NRC 1996-TN288) and demonstrating the utilization of 10 CFR 50.155 or FLEX to address mitigation of beyond-design-basis events; or • Within the maximum 10 and 150 mi Exposure Index at the 95th confidence bounding value of 1.896×10^4 and 2.864×10^6, respectively (i.e., Indian Point 2 and 3) specified in the 1996 LR GEIS and demonstrating the utilization of 10 CFR 50.155 or FLEX to address mitigation of beyond-design-basis events; or • Utilizing the source term from 10 CFR 50.34(a)(1)(ii)(D) (TN249), or the equivalent 10 CFR Part 52 (TN251) regulation, with a non-intact containment or confinement for population density assessments under 10 CFR 100.21(h) (TN282) demonstrating a calculated TEDE of no greater than 1 rem over a period of 30 days and no further mitigation is necessary due to the health effects are shown not to be significant or a new reactor that is co-located with an existing LWR may compare its source terms to demonstrate that the LWR's severe accident risks bounds the new reactor's risks; or • Utilizing 10 CFR 50.33(g)(2) to demonstrate there is no plume exposure pathway Emergency Planning Zone where the projected TEDE exceeds 1 rem over 96 hours (i.e., 10 CFR 50.33(g)(2)(i)(A)) and no further mitigation is necessary due to the health effects being shown not to be significant. The proposed site is not within the jurisdiction of the United States Court of Appeals for the Ninth Circuit.	(TN5494); and the TPQs in 40 CFR Part 355, Appendices A and B (TN5493). For severe accidents: • The population-dose risk PPE value is based on the 1996 LR GEIS analysis of severe accidents, as augmented and updated by the 2013 and 2024 LR GEISs (NRC 1996-TN288, NRC 2013-TN2654, NRC 2024-TN10161), for bounding the frequency-weighted consequences of postulated severe accidents for new reactors when demonstrating compliance with the applicable Commission's regulations. • For an Exposure Index, the PPE value is based on the 1996 LR GEIS analysis of severe accidents, as augmented and updated by the 2013 and 2024 LR GEISs, bound the frequency-weighted consequences of postulated severe accidents for new reactors when demonstrating compliance with the applicable Commission regulations. • The dose PPE value is based on applying the source term specified in 10 CFR 50.34(a)(1)(ii)(D), or the equivalent 10 CFR Part 52 regulation, with a non-intact containment or confinement, which is based primarily on the applicant or licensee utilizing RG 4.7, Appendix A, when assessing alternative approaches to addressing population-related siting considerations (NRC 1998-TN1008). • Applicants may utilize 10 CFR 50.33(g)(2) (TN249) to demonstrate there is no plume exposure pathway Emergency Planning Zone, based primarily on meeting the Emergency Planning Zone (EPZ) regulations at the site boundary. The analysis required by 10 CFR 50.33(g)(2) could demonstrate that a spectrum of severe accidents have acceptable levels of

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
		offsite risk of health effects from radiation exposure in an emergency situation, while weighing costs and risks associated with any protective action. Acts of terrorism: If within the jurisdiction of the United States Court of Appeals for the Ninth Circuit, appropriate staff analysis would be performed based in part on the physical protection requirements under 10 CFR Part 73 (TN423).
Site Employment	Peak project-related in-migrating workforce including families does not exceed established local planning and growth projections for infrastructure and service demands	Some construction and operations workers and their families are assumed to relocate to the economic region of the proposed project. Staff assumes growth planning for the affected infrastructure and services would factor these changes into baseline service demand projections. This assumption is based on staff experience since 2005 for more than 20 license application reviews. Peak project-related workforce increases are assumed to cause minimal effects on most services and infrastructure as long as increases are within local government planning projections.
Community Services and Infrastructure (e.g., housing availability; school capacities)	1. The housing vacancy rate in the affected economic region remains at least 5% of the housing stock after removing sufficient rental units to accommodate the in-migrating construction workers. 2. Student:teacher ratios in the affected economic region do not decline below the locally mandated levels after including the school age children of the in-migrating construction worker families housing and education resources would be the only resource areas where noticeable impacts might occur.	This assumption is based on staff experience since 2005 with more than 20 license application reviews. Staff experience indicates a healthy housing market maintains a vacancy rate of 5% of the total housing stock, and any local, regional, or State mandated threshold (e.g., a student:teacher ratio) establishes the point of inflection from a SMALL impact to a MODERATE impact.
Transportation Systems and Traffic	LOS determination for affected roadways does not change	Movement between LOS classes (A, B, C, D, E, F) would be noticeable to drivers. Increased traffic that does not trigger a movement between these classes would be a minor impact. This assumption is based on the industry-standard LOS approach that has been used in previous NRC NEPA assessments since 2005.

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
Fuel Cycle	Table S–3 bounds the impacts for the proposed reactor, because of uranium fuel cycle changes since WASH-1248 (AEC 1974-TN23), including: • Increasing use of in situ leach uranium mining • Transitioning of U.S. uranium enrichment technology from gaseous diffusion to gas centrifugation. • Current LWRs are using nuclear fuel more efficiently due to higher levels of fuel burnup • Less reliance on coal-fired electrical generation plants Reprocessing capacity up to 900 MTU/yr Uranium fuel cycle impacts will bound the thorium fuel cycle impacts Waste and spent fuel inventories, as well as their associated certified spent fuel shipping and storage containers, are not significantly different from what has been considered for LWR evaluations in NUREG-2157 (NRC 2014-TN4117) Must satisfy the regulatory requirements of 10 CFR Part 40 (TN4882) *Domestic Licensing of Source Material*, 10 CFR Part 50 (TN249) *Domestic Licensing of Production and Utilization Facilities*, 10 CFR Part 70 (TN4883), *Domestic Licensing of Special Nuclear Material*, 10 CFR Part 71 (TN301), *Packaging and Transportation of Radioactive Material*, 10 CFR Part 72 (TN4884), *Licensing Requirements for the Independent Storage of Spent Fuel, High-Level Radioactive Waste, and Reactor-related Greater Than Class C Waste*, and 10 CFR Part 73 (TN423), *Physical Protection of Plants and Materials.*	Advances in the uranium fuel cycle (as noted in the values and assumptions columns) have reduced the various impacts of the fuel cycle from what is presented in Table S–3. For example, higher burnup levels allow for longer periods of time between refueling thus reducing the annual number of fuel assemblies discharged from a reactor. Requirements of existing regulations related to the safe processing, storage, transportation, and security of nuclear material have been found to be protective of workers and members of the public. Fuel fabrication impacts for metal fuel and liquid fueled molten salt are not included in the staff's generic analysis.
Transportation of Unirradiated Fuel	Consistency with thresholds for the maximum shipment distances in Table 3-12 and Table 3-13, 59,160 km and 118,320 km respectively. The shipments are normalized to a net electrical output of 880 MW(e), i.e., 1,100 MW(e) with an 80 percent capacity factor from WASH-1238 (AEC 1972-TN22)	Accident frequencies for transportation of unirradiated fuel are expected to be lower than those used in the analysis in WASH-1238 (AEC 1972-TN22). This is based on the NRC staff review of the trends in improvements in highway safety and security, and an overall reduction in traffic accident, injury, and fatality rates since WASH-1238 was published. Although packages for all types of

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
	The parameter does not apply to situations where a new nuclear reactor applicant proposes shipping the unirradiated fuel by air, ship or barge; or where an applicant proposes that an unirradiated fuel transportation package be approved using the provisions of 10 CFR 71.12, 10 CFR 71.41(c), or 10 CFR 71.41(d) (10 CFR Part 71-TN301)	unirradiated fuel have not been designed or certified by the NRC, these packages must comply with the packaging requirements contained in 10 CFR Part 71 (TN301) and for this reason, the impacts of radiological accidents during transport of unirradiated fuel are expected to be smaller than those listed in Table S-4 in 10 CFR 51.52 (TN250). The PPE applies to situations where the enrichment of the unirradiated fuel is 20 percent or less, based on the unlimited A_2 value in Table A-1 in 10 CFR Part 71 for unirradiated uranium enriched to 20 percent or less (10 CFR Part 71-TN301).
Transportation of Radioactive Waste	Consistency with thresholds for the maximum shipment distance in Table 3-17, 293,145 km. The shipments are normalized to a net electrical output of 880 MWe, i.e., 1,100 MWe with an 80% capacity factor and a shipment volume of 2.34 m^3/shipment from WASH-1238 (AEC 1972-TN22). This PPE does not apply to situations where a new nuclear reactor applicant proposes shipping the radioactive waste by air, ship or barge; or where an applicant proposes that a radioactive waste transportation package be approved using the provisions of 10 CFR 71.12, 10 CFR 71.41(c), or 10 CFR 71.41(d) (10 CFR Part 71-TN301)	Reviewed impacts from previous LWR ESP and COL environmental analyses, which have concluded that the impacts of transportation of radioactive waste were SMALL.
Transportation of Irradiated Fuel	Consistency with the thresholds for the maximum shipment distances, and burnup included in Table 3-18 through Table 3-20, 505,393 km and 1,010,786 km. The shipments are normalized to a net electrical output of 880 MWe, i.e., 1,100 MWe with an 80 percent capacity factor and a shipment capacity of 0.5 MTU/shipment from WASH-1238 (AEC 1972-TN22)	Reviewed impacts from previous LWR ESP and COL environmental analyses, which have concluded that the impacts of transportation of irradiated fuel were SMALL.

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
	This PPE is based on a maximum assembly averaged burnup of 80 GWd/MTU for uranium oxide fuel and 133 GWd/MTU for TRi-structural ISOtropic fuel This PPE does not apply to situations where a new nuclear reactor applicant proposes shipping the irradiated fuel by air, ship or barge; or where a new nuclear reactor applicant proposes that an irradiated fuel transportation package be approved using the provisions of 10 CFR 71.12, 10 CFR 71.41(c), or 10 CFR 71.41(d) (10 CFR Part 71-TN301) such as might be applied for when shipping a complete irradiated reactor core In addition, the irradiated fuel must be shipped in a transportation package that meets all of the applicable NRC regulations	
Decommissioning	The environmental impacts for the following resource areas were generically addressed in NUREG-0586, Supplement 1, would be limited to operational areas, would not be detectable or destabilizing and are expected to have a negligible effect on the impacts of terminating operations and decommissioning: • Onsite land use • Water use • Water quality • Air quality • Aquatic ecology within the operational area • Terrestrial ecology within the operational area • Radiological • Radiological accidents (non-spent-fuel-related) • Occupational issues • Socioeconomic • Onsite cultural and historic resources for plants where the disturbance of lands beyond the operational areas is not anticipated • Aesthetics • Noise • Transportation • Irretrievable resource	NUREG-0586 Supplement 1 Decommissioning GEIS (NRC 2002-TN665) Requirements of existing regulations related to decommissioning activities have been found to be protective of workers, members of the public, and the environment.

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
	The following issues were not addressed in NUREG-0586, Supplement 1, but have been determined to be Category 1 issues: • Nonradiological waste • Greenhouse gases Threatened and endangered species was an issue identified in NUREG-0586, Supplement 1, as requiring a project-specific review. Four conditionally project-specific issues identified in NUREG-0586, Supplement 1, will require a project-specific review if present: • Land use involving offsite areas to support decommissioning activities • Aquatic ecology for activities beyond the licensed operational area • Terrestrial ecology for activities beyond the licensed operational area • Historic and cultural resources (archaeological, architectural, structural, historic) for activities within and beyond the licensed operational area with no current (i.e., at the time of decommissioning) evaluation of resources for NRHP eligibility Additionally, the following two environmental resource areas are additional decommissioning impacts that require project-specific review: • Climate change: the effects of climate change are location-specific and cannot, therefore, be evaluated generically (see Section 1.3.3.2.2, Category 2 Issues Applying Across Resources, of this NR GEIS) Cumulative effects: must be considered on a project-specific basis where impacts would depend on regional resource characteristics, the resource specific impacts of the project, and the cumulative significance of other factors affecting the resource. (see Section 1.3.3.2.2, Category 2 Issues Applying Across Resources, of this NR GEIS)	

Table G-1 Plant Parameter Envelope and Site Parameter Envelope for New Reactors (Continued)

Parameter	Values and Assumptions	Basis/Methodology
Operational Life of the Plant	40-year operational life, assuming a 40-year license	10 CFR 50.51(a) (TN249) and 52.104 (TN251).
Construction Phase of the Plant	7-year construction life to complete construction activities	Based off previous new nuclear reactor EIS reviews.

ALARA = as low as is reasonably achievable; BMP = best management practice; CFR = *U.S. Code of Federal Regulations*; $CO_2(e)$ = CO_2 equivalent; COL = combined license; CWA = Clean Water Act; dBA = decibel(s) on the A-weighted scale; EHS = Extremely Hazardous Substance; EIS = environmental impact statement; EPA = U.S. Environmental Protection Agency; ESP = early site permit; GEIS = generic environmental impact statement; IAEA = International Atomic Energy Agency; LLRW = low-level radioactive waste; LOS = level of service; LR = license renewal; LWR = light-water reactor; MT = metric tonnes; NCRP = National Council on Radiation Protection and Measurements; NEI = Nuclear Electric Institute; NEPA = National Environmental Policy Act of 1969, as amended; NPDES = National Pollutant Discharge Elimination System; NR GEIS = *Generic Environmental Impact Statement for Licensing New Nuclear Reactors;* NRC = U.S. Nuclear Regulatory Commission; NRHP = National Register of Historic Places; PPE = plant parameter envelope; RCRA = Resource Conservation and Recovery Act; ROW = right-of-way; TEDE = total effective dose equivalent; TPQ = Threshold Planning Quantity; TQ = Threshold Quantity; U.S.C. = *United States Code*.

G.1 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, *Energy*, Part 20, “Standards for Protection Against Radiation.” TN283.

10 CFR Part 40. *Code of Federal Regulations*, Title 10, *Energy*, Part 40, “Domestic Licensing of Source Material.” TN4882.

10 CFR Part 50. *Code of Federal Regulations*, Title 10, *Energy*, Part 50, “Domestic Licensing of Production and Utilization Facilities.” TN249.

10 CFR Part 51. *Code of Federal Regulations*, Title 10, *Energy*, Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions.” TN250.

10 CFR Part 52. *Code of Federal Regulations*, Title 10, *Energy*, Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants.” TN251.

10 CFR Part 61. *Code of Federal Regulations*, Title 10, *Energy*, Part 61, “Licensing Requirements for Land Disposal of Radioactive Waste.” TN252.

10 CFR Part 70. *Code of Federal Regulations*, Title 10, *Energy*, Part 70, “Domestic Licensing of Special Nuclear Material.” TN4883.

10 CFR Part 71. *Code of Federal Regulations*, Title 10, *Energy*, Part 71, “Packaging and Transportation of Radioactive Material.” TN301.

10 CFR Part 72. *Code of Federal Regulations*, Title 10, *Energy*, Part 72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste.” TN4884.

10 CFR Part 73. *Code of Federal Regulations*, Title 10, *Energy*, Part 73, “Physical Protection of Plants and Materials.” TN423.

10 CFR Part 100. *Code of Federal Regulations*, Title 10, *Energy*, Part 100, “Reactor Site Criteria.” TN282.

33 CFR Part 330. *Code of Federal Regulations*, Title 33, *Navigation and Navigable Waters*, Part 330, “Nationwide Permit Program.” TN4318.

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40 CFR Part 125. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 125, “Criteria and Standards for the National Pollutant Discharge Elimination System.” TN254.

40 CFR Part 355. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 302, “Emergency Planning and Notification.” TN5493.

33 U.S.C. § 1326. U.S. Code Title 33, *Navigation and Navigable Waters*, Section 1326, “Thermal Discharges.” TN4823.

33 U.S.C. § 1344. U.S. Code Title 33, *Navigation and Navigable Waters*, Chapter 26, "Water Pollution Prevention and Control," Subchapter IV, Permits and Licenses, Section 404 "Permits for Dredged or Fill Material." TN1019.

42 U.S.C. § 7472. Clean Air Act Section 162, "Initial Classifications." TN6954.

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APPENDIX H

GREENHOUSE GAS EMISSIONS ESTIMATES FOR A REFERENCE 1,000 MWE REACTOR

The U.S. Nuclear Regulatory Commission (NRC) staff estimated the greenhouse gas (GHG) emissions of various activities associated with the building, operation, and decommissioning of nuclear power plants. The GHG emission estimates include direct emissions from the nuclear facility and indirect emissions from workforce and fuel transportation, decommissioning, and the uranium fuel cycle. The estimates are based on a single installation of 1,000 megawatt(s) electrical (MWe) output with an 80 percent capacity factor henceforth referred to as the reference 1,000 MWe reactor. The estimates may be roughly linearly scaled from the reference 1,000 MWe reactor for other reactor outputs[1] This appendix discusses the calculation of GHG emission estimates for the reference 1,000 MWe reactor.

The estimated emissions from equipment used to build a nuclear power plant listed in Table H-1 are based on hours of equipment use estimated for a single nuclear power plant at a site requiring a moderate amount of terrain modification (UniStar 2007-TN1564). Construction equipment carbon monoxide (CO) emission estimates were derived from the hours of equipment use, and carbon dioxide (CO_2) emissions were then estimated from the CO emissions using a scaling factor of 172 tons of CO_2 per ton of CO (Chapman et al. 2012-TN2644). The scaling factor is based on the ratio of CO_2 to CO emission factors for diesel fuel industrial engines as reported in Table 3.3-1 of AP-42 *Compilation of Air Pollutant Emission Factors* (EPA 2012-TN2647). A CO_2 to total GHG equivalency factor of 0.991 is used to account for the emissions from other GHGs, such as methane (CH_4) and nitrous oxide (N_2O) (Chapman et al. 2012-TN2644). The equivalency factor is based on non-road/construction equipment in accordance with relevant guidance (NRC 2014-TN3768; Chapman et al. 2012-TN2644). Equipment emissions estimates for decommissioning are assumed to be one-half of those for construction equipment. Data on equipment emissions for decommissioning are not available; the one-half factor is based on the assumption that decommissioning would involve less earthmoving and hauling of material, as well as fewer labor hours, compared to those involved in building activities (Chapman et al. 2012-TN2644).

Table H-2 lists the NRC staff's estimates of the $CO_2(e)$[2] emissions associated with workforce transportation. Construction workforce estimates for the reference 1,000 MWe reactor are conservatively based on estimates in various combined license (COL) applications (Chapman et al. 2012-TN2644), and the operational and decommissioning workforce estimates are based on Supplement 1 to NUREG–0586 (NRC 2002-TN665). Table H-2 lists the assumptions used to estimate total miles traveled by each workforce and the factors used to convert total miles to metric tons of $CO_2(e)$. The workers are assumed to travel in gasoline-powered passenger vehicles (cars, trucks, vans, and sport utility vehicles) that get an average of 21.6 mi/gal of

[1] The term "model LWR" has also been used to describe a 1,000 MWe light water reactor for the purpose of evaluating the environmental considerations of the supporting fuel cycle to the annual reactor operations (WASH-1248, AEC 1974-TN23). It is assumed there are no significant differences between the 1,000 MWe reactor evaluated in WASH-1248 and the 1,000 MWe reference reactor evaluated in this appendix.

[2] A measure to compare the emissions from various GHGs on the basis of their global warming potential (GWP), defined as the ratio of heat trapped by one unit mass of the GHG to that of one unit mass of CO_2 over a specific time period.

gasoline (FHWA 2012-TN2645). Conversion from gallons of gasoline burned to CO_2(e) is based on U.S. Environmental Protection Agency emission factors (EPA 2012-TN2643).

Table H-1 Green House Gas Emissions from Equipment Used in Building and Decommissioning (MT CO_2(e))

Equipment	Building Total[(a)]	Decommissioning Total[(b)]
Earthwork and dewatering	12,000	6,000
Batch plant operations	3,400	1,700
Concrete	5,400	2,700
Lifting and rigging	5,600	2,800
Shop fabrication	1,000	500
Warehouse operations	1,400	700
Equipment maintenance	10,000	5,000
Total[(c)]	39,000	19,000

(a) Based on hours of equipment usage over a 7-year period.
(b) Based on equipment usage over a 10-year period.
(c) Results are rounded to the nearest 1,000 metric tonnes (MT) CO_2 equivalent (CO_2(e)).

Table H-2 Workforce Green House Gas Footprint Estimates

	Construction Workforce	Operational Workforce	Decommissioning Workforce	SAFe STORage Workforce
Commuting Trips (round trips per day)	1,000	550	200	40
Commute Distance (miles per round-trip)	40	40	40	40
Commuting Days (days per year)	365	365	250	365
Duration (years)	7	40	10	40
Total Distance Traveled (miles)[(a)]	102,000,000	321,000,000	20,000,000	23,000,000
Average Vehicle Fuel Efficiency[(b)] (miles per gallon)	21.6	21.6	21.6	21.6
Total Fuel Burned[(a)] (gallons)	4,700,000	14,900,000	900,000	1,100,000
CO_2 Emitted Per Gallon[(c)] (MT CO_2)	0.00892	0.00892	0.00892	0.00892
Total CO_2 Emitted[(a)] (MT CO_2)	42,000	133,000	8,000	10,000
CO_2 Equivalency Factor[(c)] (MT CO_2/MT CO_2(e))	0.977	0.977	0.977	0.977
Total GHG Emitted[(a)] (MT CO_2(e))	43,000	136,000	8,000	10,000

GHG = greenhouse gas.
(a) Results are rounded.
(b) Source: FHWA 2012-TN2645.
(c) Source: EPA 2012-TN2643.

Title 10 of the *Code of Federal Regulations* (10 CFR) 51.51(a); TN250) states that every environmental report[3] prepared for an early site permit or COL stage of a light-water-cooled nuclear power reactor shall use Table S–3, Table of Uranium Fuel Cycle Environmental Data, as set forth in 10 CFR 51.51(b) (TN250) as the basis for evaluating the contribution of the environmental effects of uranium fuel-cycle activities to the environmental costs of licensing the nuclear power reactor. Section 51.51(a) (TN250) further states that Table S–3 shall be included in the environmental report and may be supplemented by a discussion of the environmental significance of the data set forth in the table as weighted in the project-specific analysis for the proposed facility.

Table S–3 of 10 CFR 51.51(b) (TN250) does not directly apply to non-light-water reactors (LWRs), nor does it provide an estimate of GHG emissions associated with the uranium fuel cycle; it only addresses pollutants that were of concern when the table was promulgated in the 1970s. However, Table S–3 states that 323,000 MWh is the assumed annual electric energy use for the Table S–3 reference 1,000 MWe nuclear power plant and that this 323,000 MWh of annual electric energy is assumed to be generated by a 45 MWe coal-fired power plant burning 118,000 MT of coal. These assumptions are based upon 1970s uranium enrichment technology, which has changed substantially since then. The older, energy-intensive gaseous-diffusion plants have been replaced with more efficient centrifuge-based systems. The current operating gas centrifuge uranium enrichment facility in the United States is URENCO-USA (Louisiana Energy Services), which is located in Eunice, New Mexico. The URENCO-USA facility does not rely solely upon coal as an energy source (Napier 2020-TN6443). If a 1,000 MWe plant is assumed to operate at 35 percent thermal efficiency and use uranium fuel enriched to 5 percent in uranium-235 (U-235) with an average burnup of 40,000 megawatt-day/metric tonnes (MWd/MT) for 40 years, then it will require about 1,043 tons of enriched uranium for fuel. To produce 1 ton of 5 percent enriched uranium with 0.25 percent U-235 in the depleted uranium stream requires extraction of 10.3 tons of natural uranium and 7,923 separative work units, or SWUs (Napier 2020-TN6443). The 1,043 tons of uranium enriched to 5 percent U-235 required over the 40-year life of the 1,000 MWe plant would then require 8,264,000 SWUs. Because a centrifuge enrichment facility requires about 50 kWh per SWU (WNA 2020-TN6661), a total of 413,200 MWh is needed to produce 40 years' worth of uranium enriched to 5 percent U-235 for fuel for the lifetime operation of the 1,000 MWe plant. For the existing U.S. centrifuge enrichment plant, the regional average CO_2 emission factor is 1,248 lb/MWh,[4] and the total CO_2 emission is about 243,000 MT.

Table S–3 also assumes that approximately 135,000,000 standard cubic feet of natural gas is required per year to generate process heat for certain portions of the uranium fuel cycle. The NRC staff estimates that burning 135,000,000 standard cubic feet of natural gas per year results in approximately 7,440 MT of CO_2(e) being emitted into the atmosphere per year because of the process heat requirements of the uranium fuel cycle.[5] For a 40-year operational life, this is 298,000 MT of CO_2(e). This amount is in addition to the CO_2(e) emissions from the enrichment process.

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[3] The NRC requires most applicants, including all reactor applicants, to submit an environmental report as part of the application. 10 CFR 51.45 and 10 CFR 51.50 (10 CFR Part 51-TN250).

[4] The EPA provides estimates of emissions from electricity production for different regions in the United States at https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid for CO_2 in units of pounds per kilowatt-hour (lb/kWh). The value for southeastern New Mexico has been applied here.

[5] The conversion is 0.0551 (metric tons CO_2/thousand standard cubic feet (https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references).

The NRC staff estimated GHG emissions related to plant operations from the typical usage of various onsite diesel generators (UniStar 2007-TN1564). CO emission estimates were derived assuming an average of 600 hours of emergency diesel generator operation per year (four generators, each operating 150 hr/yr) and 200 hours of station blackout diesel generator operation per year (two generators, each operating 100 hr/yr) (Chapman et al. 2012-TN2644). A scaling factor of 172 was then applied to convert the CO emissions to CO_2 emissions, and a CO_2 to total GHG equivalency factor of 0.991 was used to account for the emissions from other GHGs such CH_4 and N_2O (Chapman et al. 2012-TN2644).

The number of shipments and shipping distances for transport of fresh nuclear fuel to and spent nuclear fuel and radioactive wastes are presented in Table S-5 of Supplement 1 to WASH-1238 [NRC 1975-TN216], for a 1,100 MWe LWR with an 80 percent capacity factor. WASH-1248 (AEC 1974-TN23) assumes that truck casks weigh 50,000 lb (23 MT) and rail casks weigh 100 T (91 MT). For this analysis, emission rates of CO_2 for trucks are taken to be 64.7 g/T-mi (44.2 g/MT-km) and for rail are taken to be 32.2 g/T-mi (22 g/MT-km) (Cefic and ECTA 2011-TN6966). For the calculation, it is also assumed that return trips with empty casks double the total miles traveled by truck or rail. Table H-3 presents estimated annual CO_2e emissions from shipments associated with the reference 1,000 MWe reactor.

Table H-3 Annual Number of Shipments for the Reference 1,000 MWe Reactor

Material	Annual Number of Shipments for the Reference 1,000 MWe Reactor[1]	Typical Distance, mi[(a)]	Annual CO_2(e) Emissions[(b)]
Unirradiated fuel (truck)	6	1,000	19
Spent fuel (truck)	60	1,000	194
Spent fuel (rail)	10	1,000	64
Radioactive waste (truck)	46	500	74

(a) Source: NRC (1975-TN216), Table S-5.
(b) Results are rounded to the nearest 1000 MT CO_2(e).

The total GHG emissions for fuel and waste transportation are approximately 352 MT per reference reactor-year from Table H-3. Over a 40-year operating life for the reference 1,000 MWe reactor, the total is approximately 14,000 MT of CO_2(e) emitted.

Given the various sources of GHG emissions discussed above, the NRC staff estimated the total lifetime GHG footprint for the reference 1,000 MWe reactor to be about 990,000 MT CO_2(e), with a 7-year building phase, 40 years of operation, and 10 years of active decommissioning.[6] These components of the GHG emissions footprint are summarized in Table H-4. The uranium fuel cycle component of the footprint is the largest portion of the overall estimated GHG emissions and is directly related to the assumed power generated by the plant. The GHG emission estimates for the uranium fuel cycle are

[6] Under the NRC's regulations, a reactor licensee has up to 60 years to complete the decommissioning of a reactor facility commencing with the licensee's certification that it has permanently ceased reactor operations (10 CFR 50.82(a)(3); TN249). The 60-year decommissioning period may be exceeded subject to NRC approval if necessary to protect "public health and safety." *Id*. The estimated 10-year decommissioning period is a subset of the 60-year decommissioning period, during which significant demolition and earth-moving activities may occur (e.g., deployment and operation of equipment at the decommissioning site and shipments by truck or rail to remove irradiated soil, rubble, and debris from the site), as discussed in Supplement 1 to NUREG–0586 (NRC 2002-TN665).

based on newer enrichment technology, assuming that the energy required for enrichment is provided by modern regional electric systems.

Table H-4 Nuclear Power Plant Life-Cycle Green House Footprint

Source	Activity Duration (yr)[(a)]	Total Emissions (MT CO_2(e))
Construction equipment	7	39,000
Construction workforce	7	43,000
Plant operations	40	181,000
Operations workforce	40	136,000
Uranium fuel cycle	40	540,000
Fuel and waste transportation	40	14,000
Decommissioning equipment	10	19,000
Decommissioning workforce	10	8,000
SAFe STORage workforce	40	10,000
TOTAL[(b)]		990,000

(a) Nuclear power plant life-cycle for estimating GHG is assumed to be 97 years which includes construction (7 years), operations (40 years), and decommissioning (50 years).
(b) Results are rounded to the nearest 1,000 MT CO_2e.

The Intergovernmental Panel on Climate Change (IPCC) released a special report about renewable energy sources and climate change mitigation in 2012 (IPCC 2012-TN2648). Annex II of the IPCC report includes an assessment of previously published works on life-cycle GHG emissions from various electric generation technologies, including nuclear energy. The IPCC report included only reference material that passes certain screening criteria for quality and relevance in its assessment. The IPCC screening yielded 125 estimates of nuclear energy life-cycle GHG emissions from 32 separate references. The IPCC-screened estimates of the life-cycle GHG emissions associated with nuclear energy, as shown in Table A.II.4 of the IPCC report, ranged from 1 to 220 g of CO_2(e)/kWh, with 25th percentile, 50th percentile, and 75th percentile values of 8 g CO_2(e)/kWh, 16 g CO_2(e)/kWh, and 45 g CO_2(e)/kWh, respectively. The range of the IPCC estimates is due, in part, to assumptions regarding the type of enrichment technology employed, how the electricity used for enrichment is generated, the grade of mined uranium ore, the degree of processing and enrichment required, and the assumed operating lifetime of a nuclear power plant. The NRC staff's life-cycle GHG estimate of approximately 990,000 MT CO_2(e) for the reference 1,000 MWe reactor is equal to about 3.5 g CO_2(e)/kWh, which places the NRC staff's estimate at the lower end of the IPCC estimates in Table A.II.4 of the IPCC report. This placement is primarily because the IPCC estimates were for LWRs that used enrichment technologies that were based on the use of coal-fired generation as the electricity source.

The GHG emissions presented in Chapter 3 of this generic environmental impact statement use the values presented in this appendix but are scaled based on previous new nuclear reactor reviews. The GHG emissions for building and operation (including the fuel waste and transportation of fuel and waste) are discussed in Section 3.3, and in Section 3.16 for decommissioning.

H.1 References

10 CFR Part 50. *Code of Federal Regulations*, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities." TN249.

10 CFR Part 51. *Code of Federal Regulations*, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." TN250.

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APPENDIX I

SEVERE ACCIDENTS

This appendix provides discussions on several topics that were considered by the staff in determining whether the Severe Accidents issue should be a Category 1 or Category 2 issue in response to public comments. These discussions provide a meaningful generic analysis for designating the Severe Accident issue as Category 1. Discussions include:

1. Commission Implementation of National Environmental Policy Act of 1969, as amended (NEPA), Requirements for Severe Accidents
2. Commission Policy on Severe Accidents and Evolution of Regulations and Guidance from a Deterministic to a Risk-Informed and Performance-Based Framework
3. Recent New Reactor Reviews and Severe Accidents
4. Assessment of Generic Environmental Impact Statement for Licensing New Nuclear Reactors (NR GEIS) plant parameter envelope (PPE) values

This discussion provides an overview of the Commission's policies on addressing severe accidents within NEPA and in the agency's larger regulatory process. These policies generally reflect the safety goal that severe accidents should not pose an appreciable health and safety risk to members of the public. Next, this appendix describes how those policies have informed the U.S. Nuclear Regulatory Commission's (NRC's or Commission's) approach to ensuring safe operation of new and existing reactors. The appendix then provides a summary of prior NRC severe accident analyses under NEPA for reactors. These analyses have found that reactors licensed under the NRC's rigorous safety framework have a severe accident risk profile that presents very small probability-weighted environmental consequences. Finally, this appendix leverages those prior analyses to develop a set of PPE values for severe accidents to support a generic finding.

I.1 Commission Implementation of NEPA Requirements for Severe Accidents

The Commission provided direction to the staff for the NEPA assessment of severe accidents in their policy statement entitled "Nuclear Power Plant Accident Considerations Under the National Environmental Policy Act of 1969," which includes the following statements (45 FR 40101-TN4270):

> It is the position of the Commission that its Environmental Impact Statements, pursuant to Section 102(c)(i) of the National Environmental Policy Act of 1969 (TN661), shall include a reasoned consideration of the environmental risks (impacts) attributable to accidents at the particular facility or facilities within the scope of each such statement. In the analysis and discussion of such risks, approximately equal attention shall be given to the probability of occurrence of releases and to the probability of occurrence of the environmental consequences of those releases. Releases refer to radiation and/or radioactive materials entering environmental exposure pathways, including air, water, and groundwater.
>
> and

> The environmental consequences of releases whose probability of occurrence has been estimated shall also be discussed in probabilistic terms. Such consequences shall be characterized in terms of potential radiological exposures to individuals, to population groups, and, where applicable, to biota. Health and safety risks that may be associated with exposures to people shall be discussed in a manner that fairly reflects the current state of knowledge regarding such risks. Socioeconomic impacts that might be associated with emergency measures during or following an accident should also be discussed. The environmental risk of accidents should also be compared to and contrasted with radiological risks associated with normal and anticipated operational releases.

The technical rationale for evaluation of the applicant's severe accident analysis is discussed in Section 7.2 of the *Environmental Standard Review Plan* (NRC 2007-TN5141) as follows:

> The Commission has determined that the evaluation of events or accident sequences that lead to releases shall include, but not be limited to, those events or sequences that can reasonably be expected to occur. It has also stated that the environmental consequences of releases whose probability of occurrence has been estimated shall be discussed in probability terms. The consequences of the accidents that can reasonably be expected to occur are expressed in terms of potential exposure to individuals; the consequences of severe accidents referred to as probabilistic accidents in the policy statements (50 FR 32138-TN4519, 51 FR 30028-TN594) are characterized in terms of exposure to population groups.
>
> Releases refer to radiation or radioactive materials or both entering environmental exposure pathways, including air, water, and groundwater. In-plant accident sequences that can lead to a spectrum of releases shall be discussed and shall include sequences that can result in inadequate cooling of reactor fuel and melting of the reactor core. The events arising from causes external to the plant that are considered possible contributors to the risk associated with the plant should be discussed. Socioeconomic impacts associated with emergency measures during or following an accident should also be discussed, and the environmental risks compared to and contrasted with radiological risks should be associated with normal and anticipated operational releases.

The Commission also takes the position that detailed quantitative considerations that form the basis of probabilistic estimates of releases do not need to be incorporated into the environmental impact statement (EIS), but may be referenced, including references to safety evaluation reports (SERs).

I.2 Commission Policy on Severe Accidents

Outside of NEPA, Title 10, Part 50 and Part 52, of the *Code of Federal Regulations* (10 CFR Part 50, 10 CFR Part 52) defines the Federal regulations for the design, construction, licensing, and operation of commercial nuclear power plants (NPPs). The NRC evaluates the design of the nuclear facilities against these regulations and documents the staff's findings in various regulatory reports. Compliance with the Commission's regulations ensures adequate protection of the public health and safety during the operation of an NPP. The applicant's or licensee's preliminary or final safety analysis report (PSAR or FSAR, respectively) demonstrates compliance with these regulations and establishes the design basis of the plant. Under this framework, the Commission has developed guidance and goals, as well as regulatory requirements, for addressing those safety issues related to reactor accidents that are more

severe than the design-basis accidents (DBAs). These “severe accidents” are those in which substantial damage is done to the reactor core, regardless of whether serious offsite consequences occur.

Following the 1979 accident at the Three Mile Island (TMI) Nuclear Plant, Unit 2, it was recognized that severe accidents needed further attention. The NRC evaluated, generically, the capability of existing plants to tolerate a severe accident. The NRC found that the design-basis approach contained significant safety margins for the analyzed events. These margins permitted operating plants to accommodate a large spectrum of severe accidents. Based on this information, the Commission, in the Severe Accident Policy Statement, “Policy Statement on Severe Accidents Regarding Future Designs and Existing Plants,” (50 FR 32138, August 8, 1985), concluded that existing plants posed no undue risk to public health and safety, and that no basis existed for immediate action on generic rulemaking or other regulatory changes affecting these plants because of the risk posed by a severe accident. Thus, at that time, the Commission declined to undertake a specific rulemaking to address severe accidents. To address this issue for operating plants in the long term, the NRC issued SECY-88-147, “Integration Plan for Closure of Severe Accident Issues,” dated May 25, 1988 (NRC 1988-TN12036). This document identified the following necessary elements for closure of severe accidents:

- performance of an individual plant examination
- assessment of generic containment performance improvements
- improved plant operations
- a severe accident research program
- an external events program
- an accident management program

The Commission has made significant progress in these areas for operating plants and for new reactors, and many of these activities are completed.

The Commission expects that new reactor designs will achieve a higher standard of severe accident safety performance than previous designs. In an effort to provide this additional level of safety in the design of advanced NPPs, the staff has developed guidance and goals to accommodate events that are beyond the design basis of the plant. New reactor designers should strive to meet these goals.

For new reactors, including both the evolutionary and passive designs, the Commission has long concluded that designers should address severe accidents during the design stage. Designers can take full advantage of the insights gained from such input as probabilistic risk assessments (PRAs), operating experience, severe accident research, and accident analysis by designing features to reduce the likelihood that severe accidents will occur and, in the unlikely occurrence of a severe accident, to mitigate the consequences of such an accident. Incorporating insights and design features during the design phase is much more cost effective than modifying the design during operation.

I.2.1 Commission Policy Papers on Severe Accidents

The Commission has issued several policy papers for addressing severe accidents:

- NRC Policy Statement, “Severe Reactor Accidents Regarding Future Designs and Existing Plants” (Volume 50, page 32138, of the *Federal Register* (50 FR 32138-TN4519) dated August 8, 1985)

- NRC Policy Statement, “Safety Goals for the Operations of Nuclear Power Plants” (51 FR 28044-TN12078) dated August 4, 1986
- NRC Policy Statement, “Nuclear Power Plant Standardization” (52 FR 34884-TN12079) dated September 15, 1987
- NRC Policy Statement, “The Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities” (60 FR 42622-TN6278) dated August 16, 1995
- NRC Policy Statement, “Policy Statement on the Regulation of Advanced Reactors” (73 FR 60612-TN12083) dated October 14, 2008
- SECY-90-016 (NRC 1990-TN524), “Evolutionary Light-Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements,” issued January 12, 1990, and the corresponding staff requirements memorandum (SRM), issued June 26, 1990 (NRC 1990-TN6366)
- SECY-93-087 (NRC 1993-TN6212), “Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs,” issued April 2, 1993, and the corresponding SRM, issued July 21, 1993 (NRC 1993-TN12041)
- SECY-96-128 (NRC 1996-TN12042), “Policy and Key Technical Issues Pertaining to the Westinghouse AP600 Standardized Passive Reactor Design,” issued June 12, 1996, and the corresponding SRM, issued January 15, 1997 (NRC 1997-TN12043)
- SECY-97-044 (NRC 1997-TN12084), “Policy and Key Technical Issues Pertaining to the Westinghouse AP600 Standardized Passive Reactor Design,” issued February 19, 1997, and the corresponding SRM (NRC 1997-TN12085), issued June 30, 1997

The first four documents provide guidance as to the appropriate course for addressing severe accidents and the use of PRA. Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” of 10 CFR contains general requirements for addressing severe accidents (10 CFR 52.47), and the SRMs relating to SECY-90-016, SECY-93-087, SECY-96-128, and SECY-97-044 provide Commission-approved guidance for implementing features in new designs to prevent severe accidents and to mitigate their effects, should they occur.

I.2.2 Commission Severe Accident Policy Statement

The Commission issued its policy statement entitled, “Severe Reactor Accidents Regarding Future Designs and Existing Plants,” on August 8, 1985 (50 FR 32138-TN4519). This policy statement was prompted by the NRC’s judgment that severe accidents, which are beyond the traditional design-basis events (DBEs), constitute the major remaining risk to the public associated with radioactive releases from NPP accidents. A fundamental objective of the Commission’s severe accident policy is to take all reasonable steps to reduce the chances that a severe accident involving substantial damage to the reactor core will occur and to mitigate the consequences of such an accident, should one occur. This policy statement describes the policy that the Commission uses to resolve safety issues related to reactor accidents more severe than the design basis of the facility. The statement focuses on the guidance and procedures the Commission intends to use to certify new designs for NPPs. Regarding the decision process for certifying a new standard plant design, a process the Commission strongly encouraged for future plants, this policy statement affirms the Commission’s belief that a new design for an NPP can be shown to adequately address severe accident concerns if it meets the following guidance:

- demonstration of compliance with the requirements of current Commission regulations, including the TMI requirements for new plants, as reflected in 10 CFR 50.34(f) (TN249).
- demonstration of technical resolution of all applicable unresolved safety issues and the medium- and high-priority generic safety issues, including a special focus on assuring the reliability of decay heat removal systems and the reliability of both alternating current and direct current electrical supply systems.
- completion of a PRA and consideration of the severe accident vulnerabilities exposed by the PRA, along with the insights that it may add to providing assurance of no undue risk to public health and safety.
- completion of an NRC review of the design with a conclusion of safety acceptability using an approach that stresses deterministic engineering analyses and judgment, complemented by PRA.

At the time it issued the Severe Accident Policy Statement, the Commission determined that an adequate basis existed to establish appropriate guidance. This determination was supported by the current operating reactor experience, ongoing severe accident research, and insights from a variety of risk analyses. The Commission recognized the need to strike a balance between accident prevention and consequence mitigation, and in doing so, expected designers engaged in designing new standard plants to achieve a higher standard of severe accident safety performance than was achieved in previous designs.

I.2.3 Commission Safety Goals Policy Statement

The Commission issued its policy statement entitled, “Safety Goals for the Operation of Nuclear Power Plants,” on August 4, 1986 (51 FR 28044-TN12078). This policy statement focused on the risks to the public from NPP operations with the objective of establishing goals that broadly define an acceptable level of radiological risk that might be imposed on the public as a result of NPP operation. These risks are associated with the release of radioactive material from the reactor to the environment during normal operations, as well as from accidents. The Commission established the following two qualitative safety goals:

1. Individual members of the public should be provided a level of protection from the consequences of NPP operation such that individuals bear no significant additional risk to life and health.
2. Societal risks to life and health from NPP operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.

These two qualitative objectives are supported by the following two quantitative objectives that determine achievement of the above safety goals:

1. The risk to an average individual in the vicinity of an NPP of a prompt fatality that might result from reactor accidents should not exceed one-tenth of one percent (0.1 percent) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed.
2. The risk to the population in the area near an NPP of cancer fatalities that might result from NPP operation should not exceed one-tenth of one percent (0.1 percent) of the sum of cancer fatality risks resulting from all other causes.

This statement of the NRC safety policy expresses the Commission's views on the level of risk to public health and safety that the industry should strive for in its NPPs. The Commission recognizes the importance of mitigating the consequences of a core melt accident and continues to emphasize such features as the containment, siting in less populated areas, and emergency planning as integral parts of the defense-in-depth concept associated with its accident prevention and mitigation philosophy. The Commission approves the use of the qualitative safety goals, including use of the quantitative health effects objectives, in the regulatory decision-making process. Historically, the NRC has relied on the quantitative health objectives to evaluate the acceptability of severe accident analyses under NEPA, for example, as provided in several new reactor combined license (COL) final EISs.

I.2.4 Commission Standardization Policy Statement

The Commission issued its policy statement entitled, "Nuclear Power Plant Standardization," on September 15, 1987. This policy statement encourages the use of standard plant designs and contains information concerning the certification of plant designs that are essentially complete in terms of scope and level of detail. The intent of these actions was to improve the licensing process and to reduce the complexity and uncertainty in the regulatory process for standardized plants. With respect to severe accidents, the NRC expects applicants for a design certification (DC) to address the guidance for new plant designs provided in the Commission's Severe Accident Policy Statement.

I.2.5 Commission Use of PRA Methods in Nuclear Regulatory Activities Policy Statement

The Commission issued its policy statement entitled, "Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities," on August 16, 1995 (60 FR 42622-TN6278). This statement outlines the policy that the NRC will follow for using PRA methods in nuclear regulatory matters.

The Commission established this policy so that the many potential applications of PRA methods could be implemented in a consistent and predictable manner to promote regulatory stability and efficiency. The Commission adopted the following policy statement regarding the expanded NRC use of PRA:

- The use of PRA technology should be increased in all regulatory matters to the extent supported by the state-of-the-art in PRA methods and data and in a manner that complements the NRC's deterministic approach and supports the NRC's traditional defense-in-depth philosophy.
- PRA and associated analyses (e.g., sensitivity studies, uncertainty analyses, and importance measures) should be used in regulatory matters, where practical within the bounds of the state-of-the-art, to reduce unnecessary conservatism associated with current regulatory requirements, regulatory guides, license commitments, and staff practices. Where appropriate, PRA should be used to support the proposal for additional regulatory requirements, in accordance with 10 CFR 50.109 (TN249) (Backfit Rule). Appropriate procedures for including PRA in the process for changing regulatory requirements should be developed and followed. It is, of course, understood that the intent of this policy is that existing rules and regulations shall be complied with unless these rules and regulations are revised.

- PRA evaluations in support of regulatory decisions should be as realistic as practicable, and appropriate supporting data should be publicly available for review.
- The Commission's safety goals for NPPs and subsidiary numerical objectives are to be used with appropriate consideration of uncertainties in making regulatory judgments on the need for proposing and backfitting new generic requirements on NPP licensees.

In its approval of the policy statement, the Commission stated its expectation that implementation of the policy statement will improve the regulatory process in three ways: (1) foremost, through safety decision-making enhanced by the use of PRA insights, (2) through more efficient use of agency resources, and (3) through a reduction in unnecessary burdens on licensees.

SECY-00-0162 (NRC 2000-TN12086), "Addressing PRA Quality in Risk-Informed Activities," issued July 28, 2000, describes an approach for addressing PRA quality in risk-informed activities, including identification of the scope and minimal functional attributes of a technically acceptable PRA.

In SECY-04-0118 (NRC 2004-TN12087), "Plan for the Implementation of the Commission's Phased Approach to PRA Quality," issued July 13, 2004, presents the staff's approach to defining the needed PRA quality for current or anticipated applications, as well as the process for achieving this quality, while allowing risk-informed decisions to be made using currently available methods until all of the necessary guidance documents are developed and implemented.

In SECY-07-0042 (NRC 2007-TN12088), "Status of the Plan for the Implementation of the Commission's Phased Approach to Probabilistic Risk Assessment Quality," issued March 7, 2007, provides an update to the staff plan for the phased approach to PRA quality.

Relevant PRA-related guidance includes:

- NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," provides guidance to the NRC staff in performing safety reviews of construction permit (CP) or operating license applications (including requests for amendments) under 10 CFR Part 50 (TN249) and early site permit, DC, COL, standard design approval, or manufacturing license applications under 10 CFR Part 52 (TN251) (including requests for amendments). NUREG-0800, Section 19.1, titled "Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," is designed to guide the NRC staff in its evaluations of licensee requests for changes to the licensing basis that apply risk insights. Guidance developed in selected application-specific Regulatory Guides (RGs) and the corresponding chapters of NUREG-0800 also applies to these types of licensing basis changes. Furthermore, NUREG-0800, Section 19.0, titled "Probabilistic Risk Assessment and Severe Accident Evaluation for New Reactors," pertains to the staff review of the design-specific PRA for a DC and plant-specific PRA for a COL application.
- NUREG-1855, Revision 1, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decisionmaking" (NRC 2009-TN12089), provides guidance on how to treat uncertainties associated with PRA in risk-informed decision-making. This guidance is intended to foster an understanding of the uncertainties associated with PRA and their impact on the results of PRA.

- RG 1.174, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis” (NRC 2018-TN6335), provides guidance on an acceptable approach for developing risk-informed applications for a licensing basis change that considers engineering issues and applies risk insights.
- RG 1.175, “Plant-Specific, Risk-Informed Decisionmaking: Inservice Testing” (NRC 2021-TN12090), provides guidance on acceptable methods for using PRA information with established traditional engineering information in the development of risk-informed inservice testing programs.
- RG 1.177, “Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications” NRC 2021-TN12092), provides guidance on acceptable methods for using risk information to evaluate changes to NPP technical specification completion times and surveillance frequencies.
- RG 1.178, “Plant-Specific, Risk-Informed Decisionmaking for Inservice Inspection of Piping” (NRC 2021-TN12091), provides guidance on acceptable approaches for meeting the existing requirements in Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, as referenced by 10 CFR 50.55a, “Codes and Standards” (TN249), for the scope and frequency of inspection of inservice inspection programs, including the application of risk-informed inservice inspection programs.
- RG 1.200, “An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities” (NRC 2009-TN6211), provides an approach for determining whether the base PRA, in total or the parts that are used to support an application, is acceptable for use in regulatory decision-making for light-water reactors (LWRs). RG 1.200 currently endorses a PRA standard developed by the ASME and the American Nuclear Society (ANS) ASME/ANS RA-Sa-2009, “Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications,” (ASME/ANS 2024-TN12093) which addresses PRA for core damage frequency (CDF) and large early release frequency (LERF) for internal and external hazard groups during at-power operations.
- RG 1.201, “Guidelines for Categorizing Structures, Systems, and Components in Nuclear Power Plants According to Their Safety Significance” (NRC 2006-TN6279), provides guidance on an acceptable method for use in complying with the Commission’s requirements in 10 CFR 50.69, “Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors” (TN249), with respect to the categorization of structures, systems, and components that are considered in risk-informing special treatment requirements.
- RG 1.205, “Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants” (NRC 2006-TN12094), provides guidance for use in complying with the requirements for risk-informed, performance-based fire protection programs that comply with 10 CFR 50.48(c), “National Fire Protection Association Standard NFPA 805” (TN249), and the referenced 2001 Edition of the National Fire Protection Association (NFPA) standard, NFPA 805, “Performance-Based Standard for Fire Protection for Light-Water Reactor Electric Generating Plants” (NFPA 2025-TN12095).
- RG 1.206, “Applications for Nuclear Power Plants” (NRC 2007-TN12096), provides guidance on the information contained in and submitted with a COL application. This RG discusses the requirements in 10 CFR Part 52 for a COL applicant to conduct a plant-specific PRA and to describe the plant-specific PRA and its results within its FSAR. As required by 10 CFR 50.71, COL holders shall maintain and upgrade the PRA periodically

throughout the life of the plant, and the RG provides guidance on demonstrating PRA technical adequacy (i.e., PRA acceptability).

- 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" (NRC 2020-TN6441), provides guidance on using a technology-inclusive, risk-informed, and performance-based methodology to inform the licensing basis and content of applications for non-LWRs, including, but not limited to, molten salt reactors, high-temperature gas-cooled reactors, and a variety of fast reactors at different thermal capacities. RG 1.233 endorses methodology developed by the Nuclear Energy Institute (NEI) in NEI 18-01, Revision 1, "Risk-Informed Performance-Based Guidance for Non-Light Water Reactor Licensing Basis Development" (NEI 2019-TN12097). This methodology, commonly known as the Licensing Modernization Project (LMP) methodology, presents a technology-inclusive, risk-informed, and performance-based process for selection of Licensing Basis Events; safety classification of structures, systems, and components and associated risk-informed special treatments; and determination of defense-in-depth adequacy for non-LWRs. It should be noted that Licensing Basis Events include anticipated operational occurrences, DBEs, and beyond-design-basis events (BDBEs, including severe accidents) as well as DBAs that are derived from the DBEs by prescriptively assuming that only safety related systems, structures, and components are available to mitigate postulated accident consequences. The Commission approved the staff's endorsement of the LMP methodology in SRM-SECY-19-0117 (NRC 2020-TN12098) and stated:

  > In its work on the regulatory framework for advanced reactors, the staff should continue to recognize that the Commission's established policy on the application of the safety goals and safety performance expectations provides an acceptable minimum safety standard for new reactors while taking into account the need to adapt the aspects of our current regulatory framework for reactors that provide operational flexibility based on risk assessment…

- RG 1.247, "Acceptability of Probabilistic Risk Assessment Results for Non-Light Water Reactor Risk-Informed Activities" (NRC 2021-TN12099), describes one acceptable approach for determining whether a design-specific or plant-specific PRA used to support an application is sufficient to provide confidence in the results, such that the PRA can be used in regulatory decision-making for non-LWRs. RG 1.247 endorses the national consensus PRA standard ASME/ANS RA-S-1.4-2021, "Probabilistic Risk Assessment Standard for Advanced Non-Light Water Reactor Nuclear Power Plants" (ASME/ANS 2021-TN12100), which applies to a diverse set of reactor designs such as modular high-temperature gas-cooled reactors, liquid metal-cooled fast reactors, molten salt reactors, micro-reactors and small modular reactors (SMRs) based on non-LWR technology, and other advanced non-LWRs. RG 1.247 addresses (1) all radiological sources at the plant (e.g., reactor cores, spent fuel, fuel reprocessing facilities for molten salt reactors), including accident scenarios that lead to a radioactive release from multiple radiological sources; (2) all internal and external hazards; (3) all plant operating states (e.g., at-power, low-power, and shutdown operations); and (4) all levels of analysis (e.g., from initiating event to radiological consequence).

- DC/COL-ISG-020, "Seismic Margins Analysis for New Reactors Based on Probabilistic Risk Assessment" (NRC 2009-TN12101). In accordance with the Commission direction provided in SRM-SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light Water Reactor (LWR) Designs" (NRC 1993-TN12041), DC and COL

applicants may perform a seismic margins analysis to assess seismic risk. DC/COL-ISG-020 provides guidance for developing an acceptable PRA-based seismic margins analysis.

- DC/COL-ISG-028, “Interim Staff Guidance on Assessing the Technical Adequacy of the Advanced Light-Water Reactor Probabilistic Risk Assessment for the Design Certification Application and Combined License Application” (NRC 2014-TN12102). This guidance is needed because the ASME and ANS PRA standard ASME/ANS RA-Sa-2009, “Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications” (ASME/ANS 2024-TN12093), was developed for currently operating reactors. As a result, for PRAs developed for the DC and COL application stages, some supporting requirements in the ASME/ANS Level 1/LERF PRA Standard are not applicable or cannot be achieved as written, while other supporting requirements need some clarification to understand how they can be achieved. The staff position on the acceptability of PRA for advanced LWR applicants under 10 CFR Part 52 is currently under revision. DC/COL-ISG-028 provides guidance to DC and COL applicants that supplements the endorsement of ASME/ANS RA-Sa-2009 provided in Appendix A of this regulatory guide.

Figure I-1, which is taken from RG 1.200 (NRC 2009-TN6211), illustrates the relationship of some of these regulatory guides to certain risk-informed activities, other application-specific guidance, consensus PRA standards, and industry programs.

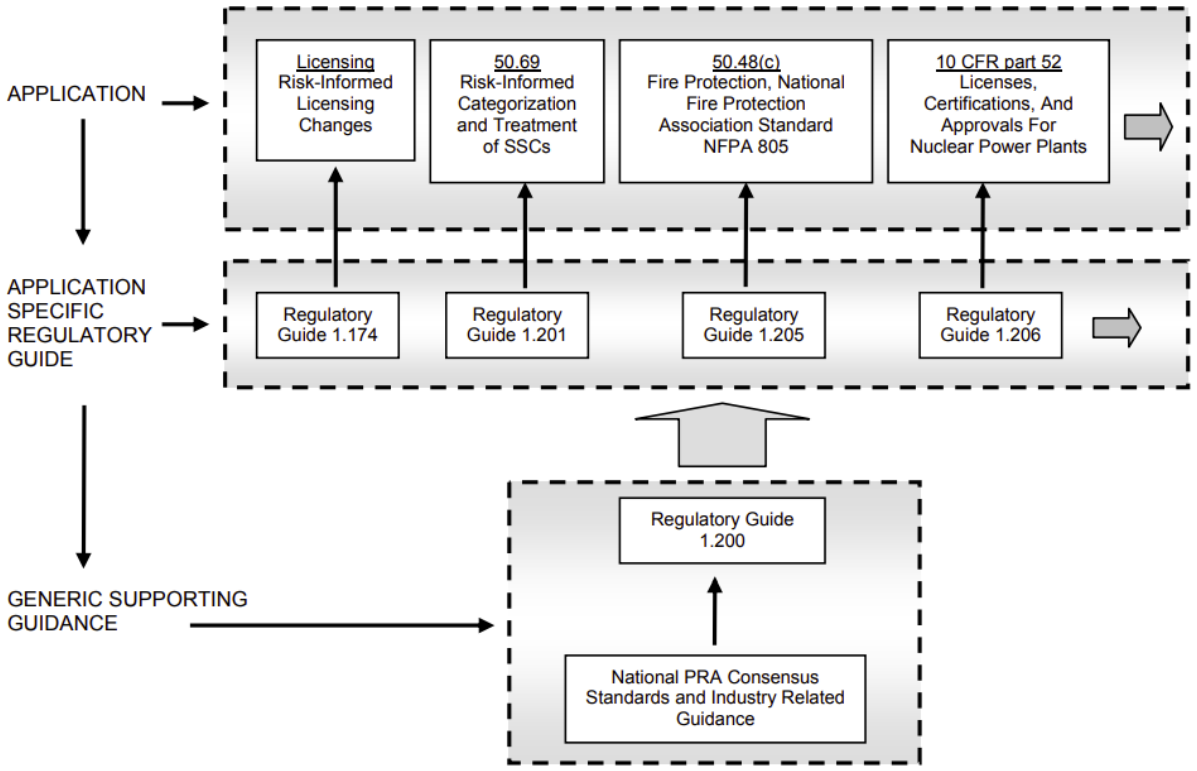

Figure I-1 Relationship Between Various Risk-Informed Guidance Documents. Source: NRC 2009-TN6211.

In SECY-90-016 (NRC 1990-TN524), issued January 12, 1990, the staff requested Commission approval for staff recommendations concerning proposed departures from current regulations for the evolutionary LWRs. The issues in SECY-90-016 were significant to reactor safety and

fundamental to the NRC decision on the acceptability of evolutionary LWR designs. The positions in SECY-90-016 were developed as a result of the following activities:

- NRC reviews of current-generation reactor designs and evolutionary LWRs
- consideration of operating experience, including the TMI accident
- results of PRAs of current-generation reactor designs and the evolutionary LWRs
- early efforts conducted in support of severe accident rulemaking
- research to address previously identified safety issues

The Commission approved some of the staff positions stated in SECY-90-016 (NR 1990-TN524) and provided additional guidance regarding others in an SRM dated June 26, 1990 (NRC 1990-TN6366).

I.2.6 Commission Advanced Reactor Policy Statement

The Commission revised its policy statement entitled, "Policy Statement on the Regulation of Advanced Reactors," (NRC 2008-TN12103) on October 7, 2008. Regarding advanced reactors, the Commission expects, as a minimum, at least the same degree of protection of the environment and public health and safety and the common defense and security that is required for current generation LWRs licensed before 1997. Furthermore, the Commission expects that advanced reactors will provide enhanced margins of safety and/or use simplified, inherent, passive, or other innovative means to accomplish their safety and security functions. This policy statement identifies attributes that could assist in establishing the acceptability or licensability of a proposed advanced reactor design, and therefore should be considered in advanced designs including, but not limited to, the following:

- Designs that minimize the potential for severe accidents and their consequences by providing sufficient inherent safety, reliability, redundancy, diversity, and independence in safety systems, with an emphasis on minimizing the potential for accidents over minimizing the consequences of such accidents.
- Designs that incorporate the defense-in-depth philosophy by maintaining multiple barriers against radiation release, and by reducing the potential for, and consequences of, severe accidents.

The Commission's advanced reactor policy statement indicates that the Commission policies on severe accidents, safety goals, and the use of PRA methods apply to advanced reactors.

I.2.7 Post Fukushima and the Creation of 10 CFR 50.155

Following the Fukushima Dai-ichi nuclear accident in March 2011, the Commission undertook a comprehensive evaluation of domestic nuclear safety measures to determine potential vulnerabilities in the U.S. reactor fleet. This response was spearheaded by the NRC's Near-Term Task Force (NTTF), which was established immediately after the accident to provide a systematic and expedited review of NRC processes and regulations. The NTTF issued a report in July 2011 that identified 12 recommendations to enhance safety in the areas of natural hazards, station blackout, spent fuel pools, emergency preparedness, and severe accident management (NRC 2011-TN684). Based on the NTTF recommendations, the NRC issued three major Orders in March 2012:

- Order EA-12-049: Required mitigation strategies (FLEX) for beyond-design-basis external events, ensuring key safety functions such as core cooling and containment integrity could be maintained (77 FR 16091-TN2476).

- Order EA-12-050: Required installation of reliable spent fuel pool instrumentation (SFPI) to monitor water levels during extended emergencies (77 FR 16098-TN2477).
- Order EA-12-051 (issued later): Required improvements to the capabilities of hardened vents in boiling water reactors (BWRs) with Mark I and II containments to reduce containment pressure and release risk during severe accidents (NRC 2013-TN12153).

Additionally, the NRC directed licensees to perform external hazard reevaluations, including updated analyses of seismic and flooding hazards based on the latest methodologies and data. This effort sought to identify vulnerabilities and required licensees to take appropriate actions if their existing designs were found to be insufficient.

To evaluate broader regulatory and economic implications, the NRC staff submitted SECY-12-0110 (NRC 2012-TN12104), "Consideration of Economic Consequences Within the U.S. Nuclear Regulatory Commission's Regulatory Framework," which explored whether economic consequences of severe accidents should play a greater role in NRC decision-making. The analysis considered whether current cost-benefit methodologies and emergency preparedness frameworks remained sufficient. Ultimately, the Commission concluded that safety-focused regulation should remain the priority and declined to integrate economic consequences as a formal component of its safety framework. The Commission also directed the staff to identify the potential changes to current methodologies and tools that would enhance the regulatory analysis framework in a paper describing the staff's plan for updating cost-benefit guidance. For example, the staff should provide to the Commission any cost-benefit model developed for use in guidance documents to address offsite property damage costs including changing the calculated value of averted dose referenced in NUREG-1530.

The NRC also conducted a Containment Protection and Release Reduction (NRC 2018-TN7804) study, which explored whether additional containment venting or filtration strategies were necessary, particularly for BWRs with Mark I and II containments. While some safety enhancements were implemented, the NRC decided against mandating filtered vents, choosing instead to rely on the broader FLEX (Diverse and Flexible Coping Strategies) and other mitigation measures.

The FLEX program was developed by the U.S. nuclear industry in response to the 2011 Fukushima Dai-ichi accident. Spearheaded by the NEI, the FLEX program aimed to enhance the ability of NPPs to respond to extreme events that involve a loss of offsite power and loss of ultimate heat sink, including beyond-design-basis external events such as earthquakes, floods, or severe storms. FLEX was designed to do the following:

- Maintain or restore key safety functions—core cooling, containment integrity, and spent fuel pool cooling.
- Provide additional layers of defense-in-depth by using portable, diverse, and redundant equipment.
- Ensure site independence through onsite and offsite equipment staging.

Core aspects of FLEX were to have (1) portable equipment, (2) multiple staging locations across the U.S., (3) several mitigation strategies, and (4) training and procedures. The FLEX portable equipment includes deployment of portable pumps, generators, batteries, cables, and other gear that can be transported and connected to existing plant systems to sustain safety functions. These are protected against site-specific hazards and stored both onsite and offsite. For each plant, multiple staging locations are identified. In general, FLEX equipment is located

in two protected onsite storage areas and with access to offsite regional response centers. These regional response centers, located in Memphis, TN, and Phoenix, AZ, are capable of delivering backup equipment within 24 hours to any U.S. plant. For each plant, site-specific FLEX strategies for mitigation take into account the unique layout, hazards, and design of each facility. These strategies are layered onto existing safety systems and emergency procedures. Lastly, plant personnel receive training and drills on FLEX deployment procedures, ensuring readiness and integration with existing emergency operating procedures and Severe Accident Management Guidelines (SAMGs). The NRC endorsed FLEX as a viable mitigation strategy and formalized its implementation through Order EA-12-049 in 2012 (77 FR 16091-TN2476). Later, the NRC included FLEX requirements in its rulemaking under 10 CFR 50.155 (TN249), ensuring permanent regulatory basis and inspection oversight. The outcome of the FLEX initiative is that all U.S. operating reactors successfully implemented FLEX strategies.

- The FLEX program significantly enhanced the resilience and flexibility of nuclear plants to cope with extreme events, without relying on external power or cooling sources.
- The approach demonstrated a cooperative and proactive industry response, setting a global example for post-Fukushima safety improvements.

Industry, in parallel, voluntarily committed to updating SAMGs and Severe Accident Guidelines (SAGs). These guidelines are key components of accident response strategies designed to mitigate the consequences of beyond-design-basis and severe accidents, particularly those involving core damage and potential containment failure. The purpose and scope are plant-specific procedures developed to guide operators and technical support staff in managing severe accident conditions once core damage is imminent or has occurred. They focus on strategies to preserve or restore critical safety functions during severe accidents, often dealing with containment protection, heat removal, and fission product mitigation. These guidelines are not rule-based operating procedures, but rather high-level, goal-oriented strategies to support decision-making when normal and emergency operating procedures are no longer applicable. Although the SAMGs and SAGs were initially voluntary, post-Fukushima initiatives led to greater regulatory attention. The NRC reviewed and monitored the industry's SAMG/SAG update commitments but stopped short of issuing binding requirements. However, the NRC has updated inspection procedures to verify SAMG/SAG implementation. Licensees also committed to maintaining and periodically reviewing SAMGs/SAGs, ensuring personnel training and procedural alignment with evolving plant configurations and hazard assessments. In summary, the SAMG/SAG programs provide a defense-in-depth layer in the nuclear industry's safety framework, helping manage and mitigate the most severe accident scenarios. Strengthened after Fukushima, they continue to play an important role in maintaining public safety and confidence in nuclear operations. Figure I-2 illustrates the typical role of accident management procedures and guidelines through the Commission's integrated emergency response framework. The left side of the slide presents the various Procedures and Guidelines, having been stacked in order of severity. The right side illustrates how these procedures are implemented during various plant states. This framework is implemented in such a way that procedures and guidelines work together to utilize the best available strategy for preventing or mitigating fuel damage and limiting radiological releases of a BDBE and severe accident.

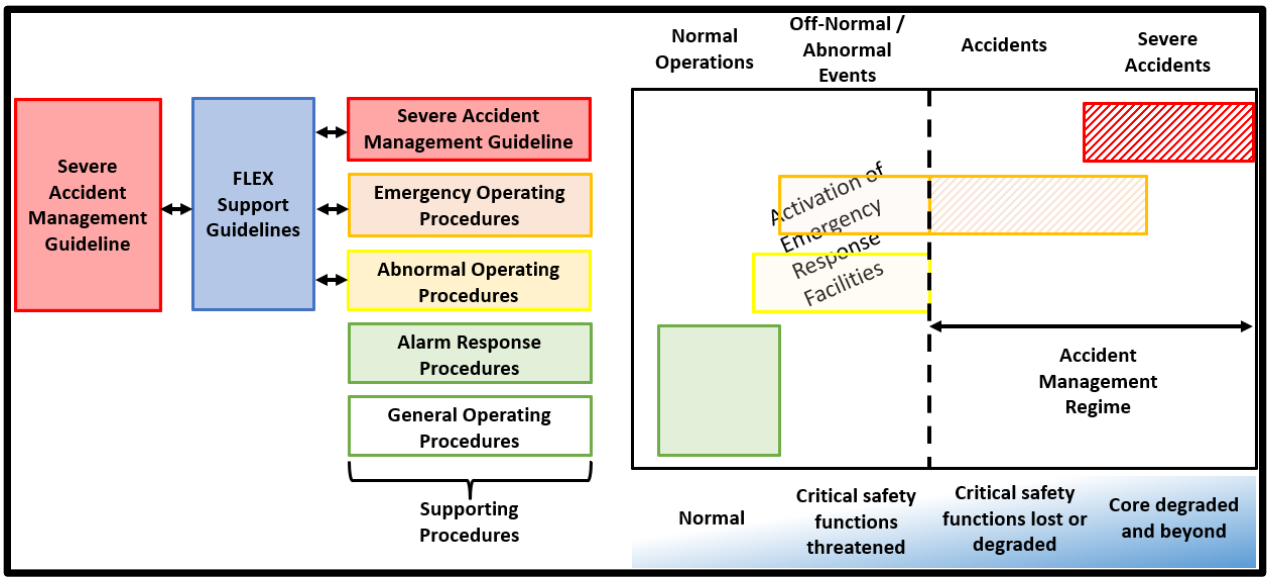

Figure I-2 Typical Role of Accident Management Procedures and Guidelines (NRC 2024-TN12156)

These cumulative efforts in response to the Fukushima Dai-ichi accident culminated in the creation of 10 CFR 50.155 (TN249), a new regulation finalized in 2019. This rule codifies key post-Fukushima requirements, including strategies for maintaining or restoring core cooling, spent fuel pool cooling, and containment integrity during BDBEs. It replaced the earlier Orders (EA-12-049: 77 FR 16091-TN2476 and EA-12-051: 77 FR 16082-TN1424), ensuring long-term regulatory clarity and consistency. It institutionalizes the FLEX approach and emergency response enhancements, ensuring long-term safety and resilience of U.S. NPPs against extreme events.

I.2.8 Evolution of Regulations from a Deterministic to a Risk-Informed and Performance-Based Framework

In light of the regulatory developments described above, the Commission's modern regulatory framework has evolved to incorporate direct assessment of severe accidents and their mitigation strategies, moving beyond the traditional deterministic approach for the current Generation II nuclear reactors.[1] Generation II-type reactors were designed and sited with traditional defense-in-depth and safety-margin principles rather than directly assessing severe accidents and mitigation. The assessment of severe accidents and mitigation for Generation II-type reactors later came from lessons learned due to events like the TMI and Fukushima accidents and other events, reactor oversight, and various severe accident analysis studies. This information contributed to the Commission updating its regulatory framework to specifically assess severe accidents and mitigation strategies for the current operating fleet as well as for new reactors before an operating license is granted. These regulations focus on accident prevention, risk assessment, and response measures. In general, the entire operating large light water reactor fleet has been licensed through 10 CFR Part 100 (TN282), "Reactor Site Criteria," and 10 CFR Part 50 (TN249), "Domestic Licensing of Production and Utilization Facilities," and several new reactors have been licensed through 10 CFR Part 52, "Early Site Permits; Standard

[1] Generation II nuclear reactors are a class of commercial nuclear power reactors developed primarily between the 1970s and 1990s, characterized by their use of proven light-water reactor technology and design focus on safety through defense-in-depth and conservative engineering margins.

Design Certifications; and Combined Licenses for Nuclear Power Plants." Discussion of how these regulations assess severe accidents and mitigation is provided below.

I.2.8.1 10 CFR Part 100 and 10 CFR Part 50

The 10 CFR Part 100 (TN282) reactor site criteria were initially issued by the Atomic Energy Commission (AEC) on April 12, 1962. The purpose of this regulation was to establish basic criteria for the siting of nuclear reactors. The focus was to ensure radiological consequences of postulated accidents at a nuclear facility would not result in unacceptable public exposure, considering population density, meteorology, hydrology, and geology. Through the 1970s and 1980s, minor updates were made to reflect improved understandings of seismic hazards and Emergency Planning Zones (EPZs). However, in 1996, a major rulemaking modernized the seismic and geological siting criteria to address uncertainties through appropriate analyses such as a probabilistic seismic hazard analysis.

The 10 CFR Part 50 (TN249) regulations were initially issued by the AEC on January 19,1956. The purpose of this regulation was to establish licensing procedures and safety requirements for nuclear reactors. The scope covered design, construction, and operations, including technical specifications and quality assurance. Following the TMI accident, several enhanced requirements were made in operational procedures, training, and human factors. Through the 1990s, regulation began to transition to a performance-based and risk-informed framework. Some key safety regulations and their subsequent analyses that can now be factored into the environmental review are listed as follows:

- 10 CFR 50.44, "Combustible gas control for nuclear power reactors," as they apply to combustible gas control for water-cooled reactor designs with characteristics (e.g., type and quantity of cladding materials) such that the potential for production of combustible gases is comparable to light water reactor designs (TN249).
- 10 CFR 50.155, "Mitigation of beyond-design-basis events," requires mitigation strategies for beyond-design-basis external events from natural phenomena that are developed assuming a loss of all alternating current power concurrent with either a loss of normal access to the ultimate heat sink or, for passive reactor designs, a loss of normal access to the normal heat sink (TN249).
- 10 CFR 50.34(a)(1)(ii) requires a description and safety assessment of the site and a safety assessment of the facility where it is expected that reactors will reflect through their design, construction, and operation an extremely low probability for accidents that could result in the release of significant quantities of radioactive fission products (TN249).
- 10 CFR 50.34(f) outlines additional safety requirements in response to lessons learned from the TMI accident in 1979, with the aim of preventing similar events and mitigating their consequences (TN249).
- 10 CFR 50.62, "Requirements for reduction of risk from anticipated transients without scram events for light-water-cooled nuclear power plants," applies to all commercial light-water-cooled NPPs to reduce the risk of anticipated transients without scram events (TN249).
- 10 CFR 50.63, "Loss of all alternating current power," requires light water-cooled nuclear reactors to be able to withstand for a specified duration, and recover from, a station blackout (TN249).
- 10 CFR 50.150, "Aircraft impact assessment," requires a design-specific assessment of the effects on the facility of the impact of a large, commercial aircraft (TN249).

- 10 CFR 50.160, “Emergency preparedness for small modular reactors, non-light-water reactors, and non-power production or utilization facilities,” requires a performance-based framework to demonstrate effective response in drills and exercises for emergency and accident conditions (TN249).

I.2.8.2 10 CFR Part 52

The Commission issued 10 CFR Part 52 (TN251), “Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants,” on April 18, 1989. This rule provides for issuing early site permits, standard DCs, and COLs with conditions for nuclear power reactors. It states the review procedures and licensing requirements for applications for these new licenses and certifications and was intended to achieve the early resolution of licensing issues, as well as to enhance the safety and reliability of NPPs. With regard to severe accidents, 10 CFR Part 52 codifies some parts of the guidance in the Severe Accident Policy Statement and the Standardization Policy Statement. Specifically, 10 CFR 52.47 requires an application for DC to do the following:

- Demonstrate compliance with any technically relevant portion of the TMI requirements set forth in 10 CFR 50.34(f) (TN249).
- Propose technical resolutions of those unresolved safety issues and medium- and high-priority generic safety issues, which are identified in the version of NUREG-0933 (NRC 2011-TN7816), “A Prioritization of Generic Safety Issues,” current on the date 6 months prior to application, and which are technically relevant to the design.
- Contain a design-specific PRA.

The NRC revised the rule on August 28, 2007. Specifically, 10 CFR 52.47, “Contents of applications; technical information,” now requires an application for a DC to describe the design-specific PRA and its results. 10 CFR 52.79, “Contents of applications; technical information in final safety analysis report,” now requires each COL applicant to describe the plant-specific PRA and its results.

As discussed below, the NRC has certified, or is currently reviewing, several new reactor designs under the Part 52 framework. Results of these DCs can be found in Appendix A to Part 52.

I.3 Recent New Reactor Reviews and Severe Accidents

The NRC staff conducts a comprehensive review of new reactor designs under the 10 CFR Part 50 (TN249) and 52 (TN251) frameworks, evaluating them against a combination of regulatory requirements, Commission policies, and detailed guidance documents such as the *Standard Review Plan*, NUREG-0800 (NRC 2007-TN613), which, as described above, have evolved to include a more direct assessment of severe accidents. Specifically, Chapter 19 of the standard review plan focuses on the assessment of severe accident risks and mitigation strategies. This includes PRAs and design features intended to prevent or mitigate core damage and containment failure. The staff’s review ensures that the applicant has appropriately identified potential severe accident scenarios, evaluated their consequences, and incorporated design provisions or operational strategies to minimize public health and safety risks. The evaluation also considers consistency with Commission policy statements—such as the 1985 Severe Accident Policy Statement (50 FR 32138-TN12105)—and ensures the design reflects a

sufficient safety margin and defense-in-depth approach, thereby supporting a risk-informed, performance-based regulatory framework.

The NRC has certified, or is currently reviewing, several new reactor designs under the 10 CFR Part 50 and 52 frameworks. Each certification includes a comprehensive evaluation of the applicant's final safety evaluation report (FSER) on severe accidents. This evaluation is documented in the staff's SER. Additionally, those reviews have included NEPA reviews of severe accidents and severe accident mitigation. Below, the staff have provided a synopsis of several approved DCs for new reactors. This synopsis focuses on the NRC's staff assessments of severe accidents with references to the Commission's resolution regarding environmental issues concerning severe accident mitigation design alternatives (SAMDAs). New reactor DC synopses include:

- Appendix A to Part 52—Design Certification Rule for the U.S. Advanced Boiling Water Reactor;
- Appendix B to Part 52—Design Certification Rule for the System 80 + Design;
- Appendix C to Part 52—Design Certification Rule for the AP600 Design;
- Appendix D to Part 52—Design Certification Rule for the AP1000 Design;
- Appendix E to Part 52—Design Certification Rule for the ESBWR Design;
- Appendix F to Part 52—Design Certification Rule for the APR1400 Design; and
- Appendix G to Part 52—Design Certification Rule for NuScale.

I.3.1 Appendix A to Part 52—Design Certification Rule for the U.S. Advanced Boiling Water Reactor

The certified U.S. Advanced Boiling Water Reactor (U.S. ABWR) is codified in Appendix A to 10 CFR Part 52 (TN251). The U.S. ABWR is a single-cycle, forced-circulation BWR, with a rated power of 3926 megawatts thermal (MWt), designed by GE Nuclear Energy. The design incorporates features of the BWR designs in Europe, Japan, and the United States, and uses improved electronics, computer, turbine, and fuel technology. Improvements include the use of internal recirculation pumps, control rod drives that can be controlled by a screw mechanism (rather than a step process), microprocessor-based digital control and logic systems, and digital safety systems. The design also includes safety enhancements, such as protection against over pressurizing the containment, passive core debris flooding capability, an independent water makeup system, three emergency diesels, and a combustion turbine as an alternative power source. The U.S. ABWR design is similar to the international ABWR design, which was built at the Kashiwazaki Kariwa Nuclear Power Generation Station, Units 6 and 7 (K-6/7), by the Tokyo Electric Power Company, Inc.

The staff's formal review of the application was initiated on March 31, 1989, when GE submitted its application for final design approval (FDA) and standard DC for the U.S. ABWR design. The NRC staff issued the FDA, along with the "Final Safety Evaluation Report [FSER] Related to Certification of the Advanced Boiling Water Reactor Design" (NRC 2008-TN12106: NUREG-1503), on July 13, 1994. The agency then published the proposed design certification rule (DCR) in the *Federal Register* on April 7, 1995 (60 FR 17902-TN12107). Subsequently, GE submitted changes to the ABWR design information in Revision 4 to the design control document (DCD). The NRC staff evaluated those changes in a supplement to the FSER (NUREG-1503, Supplement 1). The Executive Director for Operations (EDO) transmitted the

final DCR to the Commission on April 15, 1996 (NRC 1996-TN12108: SECY-96-077, "Certification of Two Evolutionary Designs"). Then, on December 6, 1996, the Commission voted to approve the final DCR for the U.S. ABWR standard plant design, and the Secretary of the Commission signed the final rule on May 2, 1997, after approval of the information collection requirements by the Office of Management and Budget. On May 12, 1997, the NRC issued the U.S. ABWR final DCR in the *Federal Register* (62 FR 25800-TN12109). Applicants or licensees intending to construct and operate a plant based on the U.S. ABWR design may do so by referencing its DCR, as set forth in Appendix A to 10 CFR Part 52. On August 8, 1997, the NRC issued a revised FDA based on the updated standard safety analysis report (62 FR 44152-TN12157).

The staff's final SER related to certification of the U.S. ABWR Standard Design can be found at NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design," and NUREG-1503, Supplement 1, "Final Safety Evaluation Report Related to Certification of the Advanced Boiling Water Reactor Design."

Appendix A to 10 CFR Part 52 VI.B presents matters resolved within the meaning of 10 CFR 52.63(a)(5) in subsequent proceedings for issuance of a COL, amendment of a COL, or renewal of a COL; proceedings held under 10 CFR 52.103; and enforcement proceedings involving plants referencing Appendix A. Appendix A to 10 CFR Part 52 VI.B.7 states that

> All environmental issues concerning severe accident mitigation design alternatives associated with the information in the NRC's environmental assessment for the U.S. ABWR design (ADAMS [Agencywide Documents Access and Management System] Accession No. ML21147A381) and GEH's supplemental evaluation of various severe accident mitigation design alternatives to prevent and mitigate severe accidents in "Amendment to Technical Support Document for the ABWR" (ADAMS Accession No. ML110040178), which updates information in the original "Technical Support Document for the ABWR" (ADAMS Accession No. ML100210563) for plants referencing this appendix whose averted risk person-rem value for each severe accident mitigation design alternative is less than or equal to the averted risk person-rem value for that severe accident mitigation design alternative provided in Table 5 of the original technical support document.

The staff reviewed the original U.S. ABWR DC environmental assessment (EA). The staff found that the original (1996) SAMDA EA (NRC 1996-TN6271) evaluated the initial 1994 SAMDA analysis as provided in the original "Technical Support Document for the ABWR" (GE 1997-TN12110) against guidance provided in NUREG/BR-0058, Revision 2, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission" (NRC 1995-TN12111). The NRC staff's 1996 SAMDA evaluation determined that the U.S. ABWR design already included numerous plant features to reduce CDF and risk and found significant margins in the results of the cost-benefit analysis of the original SAMDAs; therefore, additional plant improvements would not significantly reduce the risk of either internally or externally initiated events. The NRC staff further determined that any other design modifications would be unlikely to be justifiable on the basis of population exposure considerations due to estimated CDFs and risk estimates remaining very low on an absolute scale.

The staff also reviewed the updated EA by the Commission related to the renewal of the U.S. ABWR standard DC and associated submittals (NRC 2021-TN12112). After a review of GE-Hitachi Nuclear Energy Americas, LLC (GEH) responses to the NRC staff's request for additional information (GE Hitachi 2017-TN12113) and the staff's independent confirmatory

analysis, the staff determined that none of the design changes evaluated affect the U.S. ABWR PRA and that no design changes as described in GEH's recent submittal (NRC 2020-TN12114) impact the results of the SAMDA analysis provided in the original SAMDA EA (NRC 1996-TN6271). For SAMDA finality in a future U.S. ABWR application, an applicant should demonstrate that the proposed site would have an averted risk person-rem value for each SAMDA that is less than or equal to the averted risk person-rem value for that SAMDA in Table 5 of the amendment to the original GENE SAMDA analysis (GE 1997-TN12110). For any future U.S. ABWR application, the consideration of inflation of cost parameters and revised cost-benefit guidance in the intervening time from this analysis using 2016 dollars should be considered in determining the significance of the SAMDA conclusions described above.

I.3.2 Appendix B to Part 52—Design Certification Rule for the System 80 + Design

The certified System 80+ design, addressed in Appendix B to 10 CFR Part 52 (TN251), is a pressurized water reactor (PWR) with a rated power of 3914 MWt and a design power of 3992 MWt at which accidents are analyzed. Many features of the System 80+ design are similar to those of ABB-CE's System 80 design from which it evolved. As stated in NUREG-1462, the staff approved the System 80 design in NUREG-0852, "Safety Evaluation Report Related to the Final Design of the Standard Nuclear Steam Supply Reference System CESSAR System 80," dated November 1981, and in supplements thereto (NRC 1994-TN12072). Unique features of the System 80+ design include a large spherical, steel containment; an in-containment refueling water storage tank; a reactor cavity flooding system, hydrogen ignitors, and a safety depressurization system for severe accident mitigation; a combustion gas turbine for an alternate ac source; and an advanced digitally based control room.

The staff's final SER related to certification of the System 80+ Standard Design can be found at NUREG-1462 (NRC 1994-TN12072), "Final Safety Evaluation Report Related to the Certification of the System 80+ Design."

Appendix B to 10 CFR Part 52 VI.B presents matters resolved within the meaning of 10 CFR 52.63(a)(5) in subsequent proceedings for issuance of a COL, amendment of a COL, or renewal of a COL; proceedings held under 10 CFR 52.103; and enforcement proceedings involving plants referencing Appendix B. Appendix B to 10 CFR Part 52 VI.B.7 states,

> All environmental issues concerning severe accident mitigation design alternatives associated with the information in the NRC's final environmental assessment for the System 80 + design and the technical support document for the System 80 + design, dated January 1995, for plants referencing this appendix whose site parameters are within those specified in the technical support document.

The Commission found that the System 80+ design not only meets the Commission's safety goals for internal events but also offers a substantial overall enhancement in safety as compared, generally, with the current generation of operating power reactors. The basis for resolution of severe accident issues for the System 80+ is 10 CFR Part 52 (TN251), SECY-90-016 (NRC 1990-TN524), and SECY-93-087 (NRC 1993-TN6212). Part 52 of 10 CFR requires (1) compliance with the TMI requirements in 10 CFR 50.34(f), (2) resolution of unresolved safety issues and generic safety issues, and (3) completion of a design-specific PRA. The staff evaluated these criteria in NUREG-1462, Volume 2, "Final Safety Evaluation Report Related to the Certification of the System 80+ Design" (NRC 1994-TN12072).

I.3.3 Appendix C to Part 52—Design Certification Rule for the AP600 Design

The certified AP600 design, addressed in Appendix C to 10 CFR Part 52 (TN251), is a PWR with a power rating of 1933 MWt with an electrical output of at least 600 megawatts electric (MWe). The AP600 design contains many features that are not found in current operating reactor designs. For example, a variety of engineering and operational improvements provide additional safety margins and address the Commission's severe accident, safety goal, and standardization policy statements. The most significant improvement to the design is the use of safety systems that use passive means (such as gravity, natural circulation, condensation and evaporation, and stored energy) for accident prevention and mitigation. These passive safety systems perform safety injection, residual heat removal, and containment cooling functions.

Unique features of the AP600 design include an enhanced reactor core design, a larger reactor vessel, a larger pressurizer, an in-containment refueling water storage tank, an automatic depressurization system, a revised main control room design with a digital microprocessor-based instrumentation and control system, hermetically sealed canned reactor coolant pump motors mounted to the steam generator, and an increased battery capacity. In addition, the facility is designed for a 60-year life and employs modular construction techniques in its design.

The staff's final SER related to certification of the AP600 Standard Design can be found in NUREG-1512 (NRC 2025-TN12073), "Final Safety Evaluation Report Related to Certification of the AP600 Standard Design."

Appendix C to 10 CFR Part 52 VI.B presents matters resolved within the meaning of 10 CFR 52.63(a)(5) in subsequent proceedings for issuance of a COL, amendment of a COL, or renewal of a COL; proceedings held under 10 CFR 52.103; and enforcement proceedings involving plants referencing Appendix C. Appendix C to 10 CFR Part 52 VI.B.7 states that

> All environmental issues concerning severe accident mitigation design alternatives associated with the information in the NRC's environmental assessment for the AP600 design and appendix 1B of the generic DCD, for plants referencing this appendix whose site parameters are within those specified in the severe accident mitigation design alternatives evaluation.

The staff reviewed the AP600 DC document Appendix 1B (WEC 2000-TN12074). The staff found that the applicant performed an evaluation of candidate SAMDAs from previously assessed plants as well as identified 15 others based upon results of the PRA. The staff concluded that because of the small initial risk associated with the AP600, none of the SAMDAs were cost beneficial.

I.3.4 Appendix D to Part 52—Design Certification Rule for the AP1000 Design

The certified AP1000 design, addressed in Appendix D to 10 CFR Part 52 (TN251), is a PWR with a power rating of 3,415 MWt, with an electrical output of at least 1,000 MWe. The staff issued the FDA, along with the FSER related to certification of the AP1000 Standard Design in NUREG-1793, on September 13, 2004 with several supplements. The NRC issued its final SER on August 5, 2011. This report was subsequently published as Supplement 2 to NUREG-1793 in September 2011 (NRC 2011-TN2479). The AP1000 standard design includes many features that are not found in the designs of currently operating reactors. For example, a variety of engineering and operational improvements provide additional safety margins and address Commission policy statements regarding severe accidents, safety goals, and standardization.

The most significant improvement to the design is the use of safety systems for accident prevention and mitigation that rely on passive means, such as gravity, natural circulation, condensation and evaporation, and stored energy.

On March 28, 2002, the NRC staff initiated its formal review of the AP1000 when Westinghouse Electric Company submitted its application for FDA and standard DC for the AP1000 design. The staff issued the FDA, along with the "Final Safety Evaluation Report [FSER] Related to Certification of the AP1000 Standard Design" (NUREG-1793), on September 13, 2004. The proposed DCR was published in the *Federal Register* on April 18, 2005 (70 FR 20062-TN12075). Subsequently, Westinghouse submitted changes to the AP1000 design information in Revision 15 to the DCD. The NRC staff evaluated those changes in a supplement to the FSER (NUREG-1793, Supplement 1). The EDO transmitted the final DCR to the Commission on December 14, 2005 (SECY-05-0227, "Final Rule - AP1000 Design Certification") (NRC 2005-TN12076). Then, on December 30, 2005, the Commission voted to approve the final DCR for the AP1000 standard plant design, and the Secretary of the Commission signed the final rule on January 23, 2006, after approval of the information collection requirements by the Office of Management and Budget. On January 27, 2006, the NRC issued the AP1000 final DCR in the *Federal Register* (71 FR 4464-TN258). On March 10, 2006, the NRC issued a revised FDA based on Revision 15 of the Westinghouse DCD.

By letter dated May 26, 2007, Westinghouse submitted an application to amend the AP1000 DCR and Revision 16 of the AP1000 DCD (NRC 2007-TN12151).

On September 22, 2008, Westinghouse updated its application to amend the AP1000 DCD. The update, Revision 17, contains changes from those submitted in Revision 16. The changes are summarized in the September 22nd letter. On October 14, 2008, Westinghouse provided a corrected set of the Revision 17 DCD electronic files to update portions of the Revision change roadmap and include additional change bars in the margins that had inadvertently been omitted in the initial submittal (Westinghouse 2008-TN496).

On December 1, 2010, Westinghouse submitted Revision 18 to the AP1000 DCD (Westinghouse 2010-TN3251).

On June 13, 2011, Westinghouse submitted Revision 19 to the AP1000 DCD.

NRC completed its review of the AP1000 DCD, Revision 19, on August 5, 2011. NUREG-1793, Supplement 2, "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design" was issued in September 2011. On December 30, 2011, the AP1000 DC Amendment final rule was published in the *Federal Register* (76 FR 82079-TN248).

By letter dated December 10, 2010, Westinghouse requested that the NRC "retire" the FDA, which was based on Revision 15 of the Westinghouse DCD (Westinghouse 2010-TN12152).

The AP1000 DC Amendment final rule was published in the *Federal Register* on December 30, 2011. Based on the certification of the amended AP1000 design, which has superseded the previous AP1000 DCR in 10 CFR Part 52, Appendix D, the NRC staff agreed that the AP1000 FDA can be "retired" (i.e., withdrawn by the NRC) as Westinghouse has voluntarily requested (NRC 2012-TN6238).

By letter dated December 2, 2016 (Westinghouse 2016-TN6297), Westinghouse requested exemptions that would have extended the validity of the AP1000 DC for an additional 5 years

beyond the current expiration date, from February 27, 2021, to February 27, 2026, and allow Westinghouse to submit a DC renewal application between February 27, 2023 and February 27, 2025. In a letter dated February 14, 2018 (NRC 2018-TN6296), the NRC subsequently granted the request in part and denied it in part. Under the decision, the time period during which Westinghouse could submit and the staff could accept Westinghouse's renewal application for the AP1000 DC was deferred by 5 years. The NRC staff denied the exemption requests from 10 CFR 52.55(a) and 10 CFR Part 52, Appendix D, Part VII, "Duration of this Appendix," that would have generically extended the period during which the current AP1000 DC could be referenced by future COL applicants. The 15-year duration of a DC established by 10 CFR 52.55(a) and 10 CFR Part 52, Appendix D, Part VII, address when a COL applicant may reference the AP1000 design. These regulations pertain to future COL applicants' ability to reference the AP1000 design certified by NRC rulemaking, and exemptions from the regulations require consideration of the particular special circumstances of the "interested person" (i.e., the COL applicant), pursuant to the provisions of 10 CFR 50.12(a).

Applicants or licensees intending to construct and operate a plant based on the AP1000 design should do so by referencing its DCR in lieu of the FDA, as set forth in Appendix D to 10 CFR Part 52.

The staff's final SER related to certification of the AP1000 Standard Design can be found at NUREG-1793 (NRC 2004-TN7796), "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Plant Design," and NUREG-1793, Supplement 2 (NRC 2025-TN12115), "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Plant Design."

Appendix D to 10 CFR Part 52 VI.B presents matters resolved within the meaning of 10 CFR 52.63(a)(5) in subsequent proceedings for issuance of a COL, amendment of a COL, or renewal of a COL; proceedings held under 10 CFR 52.103; and enforcement proceedings involving plants referencing Appendix D. Appendix D to 10 CFR Part 52 VI.B.7 states that

> All environmental issues concerning severe accident mitigation design alternatives associated with the information in the NRC's EA for the AP1000 design, Appendix 1B of Revision 15 of the generic DCD, the NRC's final EA for Amendment 1 to the AP1000 design, Appendix 1B of Revision 19 of the generic DCD, and the NRC's final EA relating to the extension of the AP1000 standard design certification, for plants referencing this appendix whose site parameters are within those specified in the severe accident mitigation design alternatives evaluation.

The staff reviewed the AP1000 DC EA (NRC 2006-TN12071, NRC 2011-TN12154). The staff assessed Westinghouse's prior assessment of SAMDAs. The SAMDA analysis in Appendix 1B to Tier 2, Chapter 1, of the AP1000 DCD, Revision 15, dated December 8, 2005 (NRC 2005-TN12117), as originally certified, concluded that there were no cost-beneficial SAMDAs for the AP1000 design. In Westinghouse's technical report APP-PRA-GER-001, "AP1000 Design Change Proposal Review for PRA and Severe Accident Impact," dated September 21, 2007 (WEC 2007-TN12118), Westinghouse assessed the impacts of proposed design changes on the PRA and the SAMDA analysis for the certified AP1000 design as part of a May 26, 2007, request to amend the certified design (WEC 2007-TN12119).

The SAMDA analysis in Appendix 1B to Tier 2, Chapter 1, of the AP1000 DCD, Revision 19, which supported the 2011 amendment to the certified design in response to the May 26, 2007, application, as supplemented by subsequent letters, concluded that the proposed design changes did not significantly affect the applicability of the previous PRA. Therefore,

Westinghouse concluded that it could be inferred that the "AP1000 PRA revision will not impact the AP1000 SAMDA." Westinghouse further noted that it did not identify any new SAMDAs to incorporate that had not been considered previously. Therefore, Westinghouse concluded the design changes would not result in a change to the applicability of the certified AP1000 PRA, and the AP1000 SAMDA assessment in the original design remained valid. As a result, Westinghouse concluded that the SAMDAs that were considered and rejected as not being cost beneficial in the original (Revision 15) SAMDA assessment did not become cost beneficial due to the proposed (Revision 19) design changes. In its March 19, 2021, submittal, Westinghouse did not modify the prior SAMDA assessment.

The NRC staff reviewed the information in Appendix 1B to Tier 2, Chapter 1, of the AP1000 DCD, Revision 19, and in the EAs issued for the original AP1000 DCR (NRC 2006-TN12071) and for the amendment to the AP1000 DC (NRC 2011-TN12120). The NRC staff evaluated new cost information on updates to the dollar-per-person-rem value consistent with guidance in NUREG-1530, "Reassessment of NRC's Dollar Per Person-Rem Conversion Factor Policy, Report for Comment," Revision 1, issued August 2015 (NRC 2015-TN12121), and inflated to 2020 dollars the previously undiscounted cost parameters used in the maximum benefit valuation formulas of NUREG/BR-0184 (NRC 1997-TN676), "Regulatory Analysis Technical Evaluation Handbook," issued January 1997. Based on the updated maximum benefit valuation with sensitivity analyses, the NRC staff concluded that the new cost information would not change the conclusions reached in the EAs issued for the original and amended AP1000 DCRs.

I.3.5 Appendix E to Part 52—Design Certification Rule for the ESBWR Design

The certified Economic Simplified Boiling-Water Reactor (ESBWR) design, addressed in Appendix E to 10 CFR Part 52 (TN251), is designed by GEH and is a single-cycle BWR, with a rated power of 4,500 MWt. The containment vessel is a cylindrical steel-lined reinforced concrete structure integrated with the reactor building. Based on the reference design, the plant operates at an estimated gross electrical power output at a rated power of 1,594 MWe and a net estimated electrical power output of approximately 1,535 MWe. These electrical output numbers can vary by as much as 50 MWe, depending on the turbine island design and site-specific conditions. The ESBWR design provides a low-leakage containment vessel, which comprises the drywell and wetwell. The ESBWR uses a direct-cycle, natural circulation BWR for normal operation and has passive safety features. Within the containment structure are the reactor, elevated gravity-driven cooling system water pools to passively provide an emergency core cooling system, and a raised suppression pool. The ESBWR standard plant includes buildings dedicated exclusively or primarily to housing systems and equipment related to the nuclear system or controlled access to these systems and equipment.

GEH submitted an application for FDA and standard DC for the ESBWR on August 24, 2005 (NRC 2005-TN12122). By letter dated December 1, 2005 (NRC 2005-TN12123), the NRC accepted the application for docketing and assigned Docket No. 52-010. The staff's formal review of the application was initiated in December 2005. The NRC staff issued the FDA (NRC 2011-TN12124) and an FSER (NRC 2014-TN12125) for the ESBWR design in March 2011. The NRC published a proposed rule in the *Federal Register* on March 24, 2011 (76 FR 16549-TN12126) to certify the ESBWR design. The FSER and the proposed rule were based on the NRC's review of Revision 9 of the ESBWR DCD (NRC 2010-TN12127).

In late 2011, while the NRC staff was preparing the final rule, issues were identified with the ESBWR steam dryer, a nonsafety-related component. These issues called into question certain conclusions in the staff's safety review. Publication of the FSER as a NUREG was delayed

while the steam dryer design methodology was under review. On April 1, 2014, GEH submitted changes to the ESBWR design information in Revision 10 of the ESBWR DCD (NRC 2014-TN12128). The NRC staff evaluated those changes in a Supplemental FSER issued on September 24, 2014 (NRC 2014-TN12129). The March 2011 FSER was published as NUREG-1966 in April 2014 (NRC 2014-TN12125). The Supplemental FSER was published as NUREG-1966, Supplement 1 in September 2014 (NRC 2014-TN12130).

The NRC's EDO transmitted the final rule to the Commission on August 1, 2014 (SECY-14-0081, "Final Rule: Economic Simplified Boiling-Water Reactor Design Certification") (NRC 2014-TN12131). On September 16, 2014, the Commission voted to approve the final DCR for the ESBWR standard plant design, and the Secretary of the Commission signed the final rule on October 6, 2014. On October 15, 2014, the NRC issued the ESBWR final rule in the *Federal Register* (79 FR 61944). Applicants or licensees intending to construct and operate a plant based on the U.S. ESBWR design may do so by referencing the final rule, as set forth in Appendix E to 10 CFR Part 52. The NRC staff agreed that the ESBWR FDA can be "retired" (i.e., withdrawn by the NRC) as GEH has voluntarily requested on June 3, 2014 (GE Hitachi 2014-TN6239).

The staff's final SER related to certification of the ESBWR Standard Design can be found at NUREG-1966, "Final Safety Evaluation Report Related to the Certification of the Economic Simplified Boiling-Water Reactor Design," and NUREG-1966, Supplement 1, "Final Safety Evaluation Report Related to Certification of the Economic Simplified Boiling-Water Reactor Design, Supplement 1."

Appendix E to 10 CFR Part-52 VI.B presents matters resolved within the meaning of § 52.63(a)(5) in subsequent proceedings for issuance of a COL, amendment of a COL, or renewal of a COL; proceedings held under § 52.103; and enforcement proceedings involving plants referencing Appendix E. Appendix E to 10 CFR Part 52 VI.B.7 states that

> All environmental issues concerning severe accident mitigation design alternatives associated with the information in the NRC's Environmental Assessment for the ESBWR design (ADAMS Accession No. ML111730382) and NEDO-33306, Revision 4, "ESBWR Severe Accident Mitigation Design Alternatives" (ADAMS Accession No. ML102990433), for plants referencing this appendix whose site characteristics fall within those site parameters specified in NEDO-33306.

The staff reviewed the ESBWR DC EA (NRC 2014-TN12132). In NEDO-33306 (GE Hitachi 2010-TN12133), Revision 4, Licensing Topical Report, "ESBWR Severe Accident Mitigation Design Alternatives," issued October 2010, the applicant identified 177 candidate design alternatives based on a review of design alternatives for other plant designs, including the license renewal (LR) environmental reports and the GEH ABWR SAMDA study. The staff found that the applicant made extensive use of the results of the PRA to arrive at a final ESBWR design. As a result, the estimated CDF and risk calculated for the ESBWR design are very low. The low CDF and risk for the ESBWR design are a reflection of the applicant's efforts to systematically minimize the effect of initiators/sequences that have been important contributors to CDF in previous BWR PRAs. This minimization has been done largely through the incorporation of a number of hardware improvements in the ESBWR design. Because the ESBWR design already contains numerous plant features directed toward reducing CDF and risk, the benefits and risk reduction potential of additional plant improvements is significantly reduced. This reduction is true for both internally and externally initiated events. Moreover, with the features already incorporated in the ESBWR design, the ability to estimate CDF and risk

approaches the limitations of probabilistic techniques. The NRC concluded that none of the potential design modifications evaluated is justified on the basis of cost-benefit considerations. The NRC further concludes that it is unlikely that any other design changes would be justified in the future on the basis of person-rem exposure because the estimated CDFs are very low on an absolute scale.

I.3.6 Appendix F to Part 52—Design Certification Rule for the APR1400 Design

The certified APR1400 design, addressed in Appendix F to 10 CFR Part 52 (TN251), was submitted by Korea Electric Power Corporation (KEPCO) and Korea Hydro & Nuclear Power Co., Ltd. (KHNP) The APR1400 design is a two-loop, evolutionary design, PWR based on the System 80+ design by Combustion Engineering (now owned by Westinghouse Electric Company LLC [Westinghouse hereon]). KEPCO and KHNP submitted on December 23, 2014, their application for certification of the APR1400 standard design. The NRC certified the System 80+ design under 10 CFR Part 52, Subpart B, on June 20, 1997. The APR1400 net electrical power output is approximately 1,400 MWe, depending on site conditions. The Nuclear Steam Supply System rated thermal power is 4,000 MWt with a core thermal power of 3,983 MWt. The major design features of the APR1400 that are different from System 80+ include: pre-stressed concrete cylindrical containment, fluidic device in the safety injection tank to further enhance safety injection system performance, improved digital instrumentation and controls and advanced control room design, PLUS7 fuel, use of passive autocatalytic recombiners/igniters for hydrogen mitigation, and design enhancements to better execute severe accident management strategies such as external reactor vessel cooling.

The staff's final SERs related to certification of the APR1400 Standard Design can be found at https://www.nrc.gov/reactors/new-reactors/large-lwr/design-cert/apr1400/ser-final.html.

Appendix F to 10 CFR Part 52 VI.B presents matters resolved within the meaning of 10 CFR 52.63(a)(5) in subsequent proceedings for issuance of a COL, amendment of a COL, or renewal of a COL; proceedings held under 10 CFR 52.103; and enforcement proceedings involving plants referencing Appendix F. Appendix F to 10 CFR Part 52 VI.B.7 states that

> All environmental issues concerning severe accident mitigation design alternatives associated with the information in the NRC's environmental assessment for the APR1400 design (ADAMS Accession No. ML18306A607) and APR1400-E-P-NR-14006, Revision 2, "Severe Accident Mitigation Design Alternatives (SAMDAs) for the APR1400" (ML18235A158), for plants referencing this appendix whose site characteristics fall within those site parameters specified in APR1400-E-P-NR-14006.

The staff reviewed the APR1400 DC EA (NRC 2019-TN12134). The applicant identified 153 candidate design alternatives or design improvements. The staff found that KEPCO/KHNP adequately considered an appropriate set of SAMDAs and that none met the cost beneficial criteria. Although KEPCO/KHNP made no design changes as a result of considering SAMDAs, KEPCO/KHNP had already incorporated certain features in the APR1400 standard plant design on the basis of PRA results. These design features relate to severe accident prevention and mitigation but were not considered in the SAMDA evaluation because they were already part of the APR1400 standard plant design.

I.3.7 Appendix G to Part 52—Design Certification Rule for NuScale

The certified US600, addressed in Appendix G to 10 CFR Part 52 (TN251), was submitted by NuScale Power, LLC. The NuScale US600 SMR is an integral pressurized-water reactor, designed by NuScale Power, LLC. The design is based on Multi-Application Small Light Water Reactor developed at Oregon State University in the early 2000s. NuScale is a natural circulation light water reactor with the reactor core and helical coil steam generators located in a common reactor vessel in a cylindrical steel containment. The reactor vessel containment module is almost entirely submerged in water in the reactor building safety related pool, which is also the ultimate heat sink for the reactor. The pool portion of the reactor building is located below grade. The reactor building is designed to hold up to 12 SMRs. Each NuScale US600 SMR has a rated thermal output of 160 MWt and electrical output of 50 MWe, yielding a total capacity of 600 MWe for 12 SMRs.

The NRC's Safety Evaluations with Open Items (Review Phase 2) in conjunction with its review of the NuScale DC application submitted by NuScale Power, LLC can be accessed in the Agencywide Documents Access and Management System (ADAMS) via Accession No. ML19191A196 (NRC 2019-TN12135).

The NRC's Advanced Safety Evaluations with No Open Items (Review Phase 4) can be accessed in ADAMS via Accession No. ML19192A011 (NRC 2021-TN12136). A staff Non-Concurrence Process (NCP) for Phase 4 can be accessed in ADAMS via Accession No. ML20049A058 (NRC 2019-TN12146).

The NRC approved NuScale topical reports, along with NRC staff's safety evaluations, can be accessed in ADAMS via Accession No. ML20197A370 (NRC 2020-TN12137).

The NRC's Final Safety Evaluations Reports (Review Phase 6) can be accessed in ADAMS via package Accession No. ML20023A318 (NRC 2020-TN12138), which also contains documents for a staff NCP.

Appendix G to 10 CFR Part 52 VI.B presents matters resolved within the meaning of 10 CFR 52.63(a)(5) in subsequent proceedings for issuance of a COL, amendment of a COL, or renewal of a COL; proceedings held under 10 CFR 52.103; and enforcement proceedings involving plants referencing Appendix G. Appendix G to 10 CFR Part 52 VI.B.7 states,

> All environmental issues concerning severe accident mitigation design alternatives associated with the information in the NRC's environmental assessment for NuScale (ADAMS Accession No. ML22004A006) and DCD Part 3, "Applicant's Environmental Report—Standard Design Certification," Revision 5, dated July 2020 (ADAMS Accession No. ML20224A512), for plants referencing this appendix whose site characteristics fall within the site parameters of the representative site specified in the NuScale environmental report.

The staff reviewed the NuScale US600 DC EA (NRC 2022-TN12139). The applicant identified 199 candidate design alternatives or design improvements. The staff found the results of the NuScale Power risk and maximum benefit analyses for the single reactor to be reasonable, with no potentially cost-beneficial SAMDAs. The staff found the applicant's analysis to be limited to those SAMDAs evaluated as part of this DC and do not include SAMDAs that address procedures, training, or Reactor Building Crane design element details (this is in relationship to the dropped module accident release category with approximately 98 percent of NuScale's

standard DC accident risks); multi-unit aspects; and other procedural and training issues that would be included in an application referencing the NuScale certified design. These SAMDAs are considered outside the scope of the NuScale certified design. Therefore, the 37 SAMDAs associated with procedures and training, a multi-unit site, or the design element details of the Reactor Building Crane are not resolved within the meaning of 10 CFR 52.63(a)(5). In particular, an applicant that references the NuScale DC rule will need to provide further SAMDA analyses after addressing the design element after more information on procedures and training becomes available.

I.3.8 TerraPower Natrium Sodium-Cooled Fast Reactor Construction Permit

On March 28, 2024, TerraPower LLC, on behalf of US SFR Owner, LLC, submitted a construction permit application (CPA) in accordance with 10 CFR Part 50 (TN249) to construct a Natrium™ Reactor Plant No. 1, Kemmerer Power Station Unit 1, in Lincoln County, Wyoming, as part of participation in the U.S. Department of Energy's Advanced Reactor Demonstration Program (TerraPower 2024-TN10896). The CPA was accepted by the NRC on May 21, 2024. The notable design feature of this CPA is not only that the design is a sodium-cooled fast reactor (SFR), but rather that there are separate and distinct nuclear and energy islands, with their own respective systems, structures, and components. The SFR is part of the nuclear island that only provides thermal energy to a salt-based heat storage system under the energy island via an intermediate salt loop. The energy island contains all of the systems, structures, and components necessary to transfer the thermal energy from the heat storage system to a traditional steam cycle/steam turbine electrical generator system. The Natrium SFR–heat storage–electrical generation systems could allow the SFR to operate continuously at 100 percent power, while the energy island can generate 300 MWe continuously and load follow with peak short-term electrical output of up to 500 MWe.

The severe accident analysis in the Kemmerer Power Station CPA Environmental Report (Kemmerer ER) (TerraPower 2024-TN10896) is based on a PRA as discussed in Section 3.1 of the PSAR (TerraPower 2024-TN10896). The CPA implemented the NEI 18-04 framework as endorsed by RG 1.233. Section 5.11.2 of the Kemmerer ER asserts the site-specific environmental risks of severe accidents are based on initiated internal events considered in the PSAR and applied in a severe accident offsite analysis for two source terms that result in activity releases to the environment. The severe accident risk impacts, for a rural site with a low population density in southwestern Wyoming, were a 50-mile population dose risk (PDR) of approximately 1.5×10^{-4} person-rem per reactor year and an offsite economic cost risk of approximately 2.62×10^{-2} dollars per reactor year after applying a total accident frequency of 1.4×10^{-8} per reactor year to the consequence results. The resulting maximum benefit comes to very low values of $430 at a 7 percent discount rate and $1,100 at a 3 percent discount rate. These results suggest no severe accident mitigation alternative (SAMA) implementation will be cost-effective. However, the SAMDA analysis at the CP stage will need to be re-assessed at the operating license stage for the as-built plant conditions and the related final PRA that accounts for internal and external events.

I.3.9 Research and Test Reactor Construction Permits

As of the beginning of 2025, the NRC has issued three research and test reactor CPs. These CPs were issued for the Kairos Hermes 1 test reactor on December 14, 2023 (NRC 2023-TN12140), Abilene Christian University molten salt research reactor on September 16, 2024 (NRC 2024-TN12141), and the Kairos Hermes 2 test reactor on November 21, 2024 (NRC 2024-TN12142, NRC 2024-TN12143). NUREG-1537, as augmented, was the applicant's (Part

1) and NRC staff's (Part 2) (NRC 1996-TN8775) guidance for these CPs (NRC 2012-TN5527, NRC 2012-TN5528).

The Kairos Hermes 1 project would test and demonstrate key technologies, design features, and safety functions of the Kairos Power Fluoride Salt-Cooled, High Temperature Reactor (KP-FHR) technology, and it would provide data that may be used for validation of safety analysis tools and computational methodologies used for designing and licensing future reactors using the technology (NRC 2023-TN12140). This test reactor would demonstrate an advanced nuclear reactor technology that leverages TRI-structural ISOtropic particle fuel in pebble form with a low-pressure fluoride salt coolant. The core configuration would consist of a pebble bed core, graphite moderator/reflector, and a lithium tetrafluoroberyllate (Li_2BeF_4, or Flibe) molten salt coolant. Flibe has several important properties for use in a nuclear reactor, such as neutronic factors and stability at high temperatures. The potential offsite radiological consequences of the Maximum Hypothetical Accident (MHA) could only occur during operations. The results of the analysis are compared to the NRC's dose reference values for test reactor siting given in 10 CFR 100.11 (TN282), "Determination of exclusion area, LPZ [low population zone], and population center distance." The MHA is a conservative evaluation and represents the bounding consequences for potential DBAs at Kairos's proposed Hermes facilities. The calculated dose of 227 millirems (mrem) (2.27 millisieverts [mSv]) at the exclusion area boundary at a distance of 250 meters (m), and the LPZ dose of 59 mrem (0.59 mSv) at distance of 800 m would be well below the dose reference values specified for DBAs in 10 CFR 100.11(a)(2) (TN282). Therefore, since the MHA would not result in a significant health effect, the NRC staff concluded that the environmental impacts from potential radiological accidents would be SMALL, and further mitigation would not be warranted. For the Hermes 2 CPA, the two Hermes 2 reactors would be similar in size and design to the Hermes 1 reactor with postulated events for Hermes 2 that are within the design basis of the Hermes 1 reactor. The Hermes 1 MHA also bounds the radiological consequences of the postulated accident for the Hermes 2 reactor facility.

The Abilene Christian University molten salt research reactor would be a high-temperature research reactor that uses a molten fluoride-based uranium fuel salt, designed as only a 1 MWt reactor. The molten salt research reactor is accommodated within an academic research building on the Abilene Christian University campus. The calculated dose from the MHA for a release of liquid fuel molten salt to the MEI staying at the site boundary (a distance of 100 m) full time for 60 days would be less than 81 mrem (0.81 mSv). This MHA dose would be in compliance with the dose limits in 10 CFR Part 20, Subpart D, specifically the 100 mrem limit for an individual member of the public of 10 CFR 20.1301 (10 CFR Part 20-TN283). Therefore, because this low dose would not result in a significant health effect, the NRC staff concludes that the environmental impacts from potential radiological accidents would be SMALL and that further mitigation would not be warranted.

I.4 Assessment of NR GEIS PPE Values

This section provides a brief background on each of the selected PPE values relevant to the Severe Accident category issue in the NR GEIS. These PPE values are informed by the NRC's previous considerations of the probability-weighted consequences of severe accidents, described above. The intent is to describe how each PPE supports conclusions regarding the environmental impacts of severe accidents, based on previously established regulatory decisions, methodologies, and risk insights. Discussions for each PPE value are as follows:

1. The first set of PPE values draws from the 1996 License Renewal Generic Environmental Impact Statement (LR GEIS) (NRC 1996-TN288) using the PDR 95th percentile confidence bounds, where the Commission previously concluded these values are acceptable; these PPE values rely on PRA methods.
2. The second set of PPE values is based on the 1996 LR GEIS 10- and 150-mile Exposure Index approach, which also resulted in a Commission determination that the values were acceptable, and allows for either deterministic or probabilistic methodologies.
3. The third set of PPE values demonstrates compliance with 10 CFR 50.34(a)(1)(ii)(D) (TN249) while also addressing scenarios involving a non-intact containment or confinement structure, consistent with the assumptions in RG 4.7 (NRC 2014-TN3550), Appendix A, for population density assessments under 10 CFR 100.21(h) (TN282), and supports both deterministic and probabilistic analyses.
4. The fourth set of PPE values demonstrates compliance with 10 CFR 50.33(g)(2) to justify the absence of a plume exposure pathway EPZ, relying on a health effect criterion that is compatible with U.S. Environmental Protection Agency-established risk thresholds for emergency radiation exposure, and balancing health risks with protective action costs—again using either deterministic or probabilistic approaches.
5. The fifth set of PPE values demonstrates compliance with 10 CFR 50.155, which requires licensees to develop and maintain strategies for beyond-design-basis external events, forming the basis for the associated severe accident conclusion.
6. Finally, all of the PPE approaches would rely upon 10 CFR 50.155 for mitigative actions for addressing any residual severe accident risks that the SAMA process, such as presented in NEI 05-01A (NEI 2005-TN1978), was intended to address. The NRC staff, applicants, and licensees can still apply a cost-screening analysis to show that the potential maximum benefit monetary value of avoiding a severe accident is so minimal that additional design mitigation alternatives are not economically justified, with conclusions grounded in minimum cost estimates for implementing such alternatives.

I.4.1 The 1996, 2013, and 2024 LR GEISs and the Core Damage Frequency and Population Dose Risk Risk-Metrics

The NRC staff concluded that the Severe Accidents issue should be designated as Category 1 with a SMALL impact finding. The need to assess mitigation will be driven by the Severe Accidents category finding. The basis for this conclusion is due to the Commission's evolving regulatory framework for assessing severe accidents and their mitigation strategies. This discussion can be found in the 2024 LR GEIS (NRC 2024-TN10161), Chapter 4, Section 4.9.1.2 and Appendix E. The 2024 LR GEIS finding for the Severe Accident issue is the following:

> The probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are small for all plants. Severe accident mitigation alternatives do not warrant further plant-specific analysis because the demonstrated reductions in population dose risk and continued severe accident regulatory improvements substantially reduce the likelihood of finding cost-effective significant plant improvements.

The NR GEIS definition of Category 1 is as follows:

> Category 1 issues – environmental issues for which a generic analysis concluding SMALL adverse environmental impacts is possible, **provided that relevant values and assumptions in the PPE and SPE are met**, or beneficial impacts;

Therefore, 2024 LR GEIS issue designation of Severe Accidents as a Category 1 issue can support, when appropriate, this conclusion for the NR GEIS.

The applicability of the 2024 LR GEIS to new reactors is provided in Section D.4.8.2 of the LR GEIS, "New Nuclear Alternatives." Before a license is granted, the application for a new reactor would undergo a detailed safety review to make sure that the plant, if constructed, would operate in accordance with all applicable NRC rules and regulations. Section D.4.8.2 states, in part, that:

> A detailed analysis of postulated accidents in currently operating reactors (affected by initial LR or SLR) is provided in Chapter 4, Section 4.9.1.2 and Appendix E of this LR GEIS. Although the analysis is specific to initial LR and SLR, the impacts are representative of the impacts expected for new reactors. New reactor designs incorporate additional safety features not found in currently operating reactors. As a result, the risks associated with the new reactors are expected to be comparable to or less than the risks associated with current operating reactors. Before a license is granted, the application for a new reactor would undergo a detailed safety and environmental review to make sure that the plant, if constructed, would operate in accordance with all applicable NRC rules and regulations.

To leverage the 2024 LR GEIS approach, a new reactor design should develop the same risk metrics as the current large LWR fleet. The underpinnings of the large light water reactor severe accident mitigation stem from the Commission's regulatory framework for assessing severe accidents and their mitigation strategies. Demonstrating compliance with these regulations typically employs all three levels of PRA. First, a Level 1 PRA estimates CDF by analyzing equipment failures and initiating events. Next, a Level 2 PRA assesses containment performance and radioactive release probabilities. Finally, an appropriate Level 3 PRA for environmental evaluations of offsite consequences, including public health, environmental impact, and economic costs, ensures a comprehensive risk-informed approach to nuclear safety. Results of these analyses can be extended to compute design- and site-specific values to be compared to the NR GEIS PPE values that are based on the LR GEIS.

For LR and subsequent license renewal (SLR) of nuclear power reactors, the NRC staff uses various figures-of-merit such as CDF (or a total release frequency), PDR, and the Exposure Index, to assess continued safety over extended operating periods. These metrics, rooted in PRA methods, help the staff evaluate whether the plant maintains an acceptably low risk of severe accidents and radiological consequences to the public. While these figures are not absolute licensing thresholds, they serve as benchmarks to ensure that aging-related degradation does not significantly increase the likelihood or consequences of core damage events. The NRC's guidance emphasizes that continued plant operation beyond the initial 40 year license term—and into subsequent renewal periods—must demonstrate that risk remains within the Commission's established safety goals, including a qualitative defense-in-depth framework and a quantitative expectation that the risk of severe accidents remains as low as reasonably achievable.

The CDF is an expression of the likelihood that, given the way a reactor is designed and operated, an accident could cause the fuel in the reactor to be damaged. The PDR is a technology neutral probability-weighted consequence expression that considers information from the Level 1-, 2-, and 3 PRAs to assess risk consequences. Information included when assessing the PDR for a particular design or site includes site-specific population distributions and meteorology, containment integrity, source term release fractions and timings, and emergency planning, among others. Therefore, the PDR provides a comprehensive consideration of risk for health and safety of the public when assessing severe accidents. The Exposure Index is a function of population surrounding the plant weighted by the site-specific wind direction frequency and, thus, is a site-specific parameter. Since meteorological patterns, including wind direction frequency, tend to remain constant over time, Exposure Index changes as populations change or become redistributed.

Chapter 5 of the 1996 LR GEIS, NUREG-1437, Volumes 1 and 2 (NRC 1996-TN288, NRC 1999-TN289)[2] assessed the impacts of postulated accidents at NPPs on the environment. The estimated impacts were based on the analysis of postulated severe accidents at 28 NPP sites[3] as reported in the EISs and/or final environmental statements (FESs) prepared for each of the 28 plants in support of their operating licenses. With few exceptions, the severe accident analyses were limited to consideration of reactor accidents caused by internal events. The 1996 LR GEIS addressed the impacts of external events qualitatively.[4] The severe accident analysis for the 28 sites was extended to the remainder of plants whose EISs did not consider severe accidents (because such analyses were not required at the time the other plants' EISs were prepared). The estimates of environmental impact contained in the 1996 LR GEIS used PDR 95th percentile upper confidence bound (UCB) estimates whenever available. This approach provides conservatism to cover uncertainties, as described in Section 5.3.3.2.2 of the 1996 LR GEIS. The 1996 LR GEIS concluded that the probability-weighted consequences[5] were small compared to other risks to which the populations surrounding NPPs are routinely exposed. Specifically, in Section 5.5.2.5 of the 1996 LR GEIS, the NRC staff concluded that the generic analysis "applies to all plants and that the probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts of severe accidents are of small significance for all plants."

The focus of the 2013 LR GEIS (NRC 2013-TN2654) was on severe accidents because the impacts of DBAs are SMALL and, as stated in Section E.3 of the 2013 LR GEIS, the NRC's assessment remains unchanged for LRs. Similarly, the 2024 LR GEIS revision focuses on

[2] The LR GEIS was originally issued in 1996. Any reference in this document to the 1996 LR GEIS includes the two-volume set published in May 1996 (NRC 1996) and Addendum 1 to the LR GEIS published in August 1999 (NRC 1999).

[3] The 28 sites are listed in Table 5.1 of the 1996 LR GEIS. A total of 44 units are included in the list (at the 28 sites), but four of them never operated (Grand Gulf 2, Harris 2, Perry 2, and Seabrook 2). For the purpose of this appendix, the list is referred to as containing 28 nuclear power plants, but when mean values are calculated for this subset of nuclear power plants, all 40 units that operated are considered.

[4] Section 5.3.3.1 of the 1996 LR GEIS includes a brief discussion of the external event risk assessments conducted by the NRC staff prior to 1996, which included assessments for Zion 1 and 2, Indian Point 2 and 3, Limerick 1 and 2, Surry 1, Peach Bottom 2, and Millstone 3.

[5] The correct terminology is "frequency-weighted consequences" because the accident consequences are multiplied by the core damage frequency. However, the 1996 LR GEIS used the term "probability-weighted consequences" when referring to frequency-weighted consequences. To avoid confusion, this NR GEIS continues use of the 1996 LR GEIS terminology but also uses these two terms interchangeably.

severe accidents, because the 2024 LR GEIS also concludes that the impacts of DBAs are unchanged as discussed below and therefore would be SMALL for both an initial LR and SLR term.

The 2024 LR GEIS assessed additional information and updated the analysis presented in Chapter 4.9 and Appendix E regarding severe accidents. The update was possible since the NRC's understanding of severe accident risk had evolved since the issuance of the 1996 and 2013 LR GEISs due in part to improvements in plant safety, improved plant operational performance, and lessons learned and knowledge gained from the completion of a significant number of LRs by 2024. The 2024 LR GEIS revision considered how these developments would affect the Chapter 5 conclusions in the 1996 LR GEIS and provides comparative data where appropriate. The staff concluded that the reduction in environmental impacts from the use of new information (since the 1996 LR GEIS analysis) outweighs any increases resulting from this same information. As a result, the findings in the 1996 LR GEIS remain valid.

Assessment of Core Damage Frequency and Population Dose Risk

The NRC staff gathered results from various regulatory initiatives, including risk-informed reviews, new reactor design reviews, and severe accident research to compile comprehensive datasets that reflect plant and system performance across technologies. These datasets are analyzed to identify trends in safety performance, quantify improvements in reactor design, and evaluate the effectiveness of safety enhancements over time. This information supports the development of the NR GEIS PPE values, which provides bounding values for key safety-related parameters and helps streamline the safety assessment process for future reactor applications. Sources of information include:

- 1996 LR GEIS
- NUREG-1150 (NRC 1990-TN525)
- Early Site Permitting
- Combined Licensing for New Reactors
- 2024 LR GEIS
- Non-LWR reviews

Each dataset reflects a different generation of nuclear reactor designs, capturing the evolution of safety features from early plants with limited passive safety to modern designs emphasizing defense-in-depth and inherent safety characteristics. Figure I-3 present a simple comparative plot of calculated severe accident analysis results of PDR versus CDF. Each dataset is differently color-coded to easily visually differentiate between each.

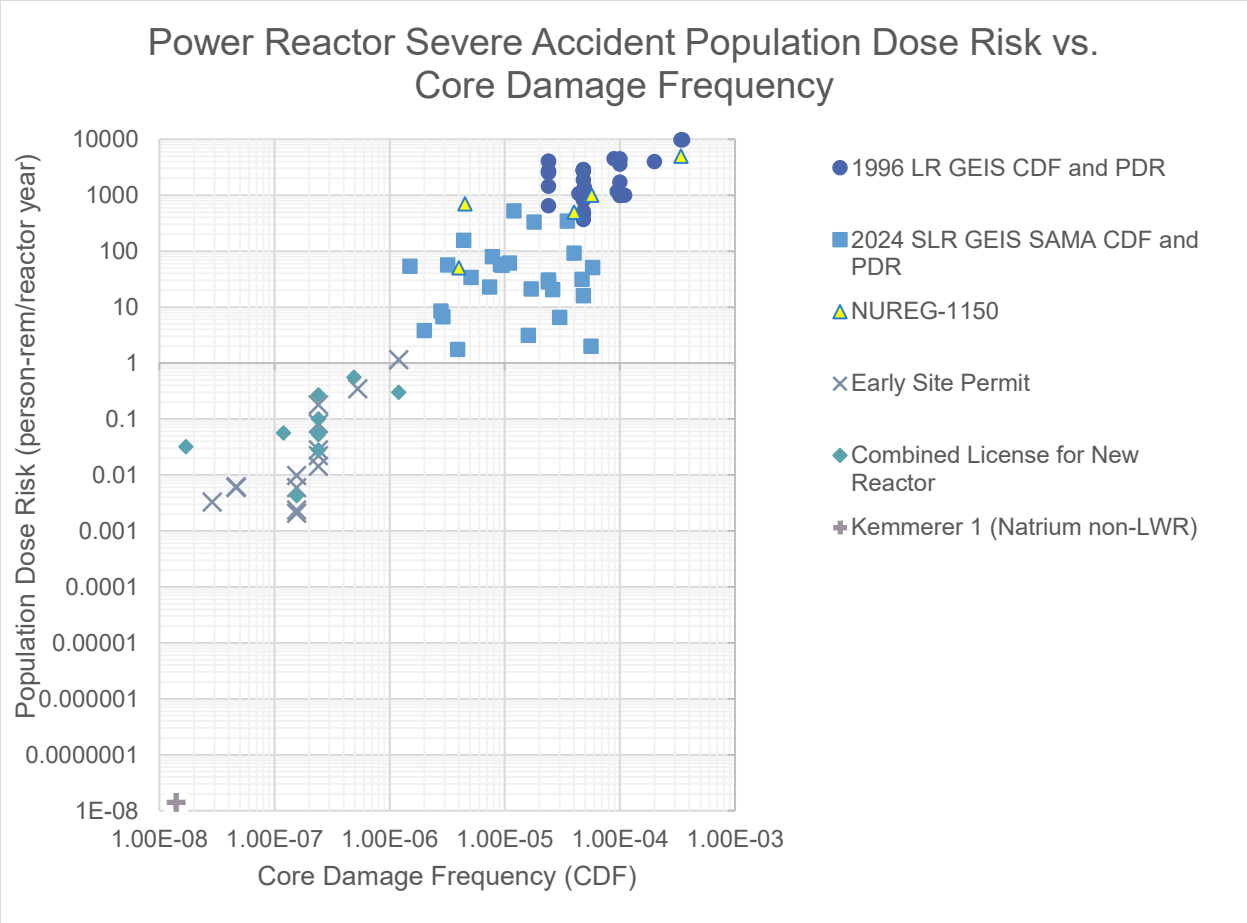

Figure I-3 Power Reactor Severe Accident Analysis Results of Population Dose Risk Versus Core Damage Frequency (Note: At the time of writing, the NRC has not completed its environmental review for the Kemmerer 1 project; as such, this information comes from the Kemmerer ER (TerraPower 2024-TN10896) and is provided for illustrative purposes only)

A visual assessment and trend analysis was performed to better understand the progression of severe accident risk over time. By doing so, the staff can identify relationships within and among each dataset across different reactor designs and licensing stages. Through this assessment, consistent patterns are observed in how safety improvements have been implemented across generations of nuclear reactors. The visual analysis also enabled the NRC staff to draw conclusions about the impact of regulatory expectations, technological advancements, and site-specific variables on overall plant safety.

- Each dataset forms coherent clusters that reflect the design generation and regulatory framework under which the plant was evaluated.
- The overall data show a clear downward trend in estimated severe accident risk, moving from higher values typical of Generation II reactors to much lower estimates for Generation III+ designs, which incorporate severe accident prevention and mitigation features directly into their safety basis.
- ESP and COL datasets reveal differences between sites referencing the same standardized design, indicating the influence of local site conditions on risk assessment outcomes.

- Importantly, the results for Generation III+ designs remain well within the bounding conclusions of the NRC's 1996 GEIS, which categorized the environmental impacts of severe accidents during LR as "SMALL".

Exposure Index

Population, which changes over time, defines the number of people within a given distance from the plant. Wind direction, which is assumed not to change from year to year, helps determine what proportion of the population is at risk in a given direction, because radionuclides are carried by the wind. Therefore, the 1996 LR GEIS (NRC 1996-TN288) developed an Exposure Index relationship by multiplying the wind direction frequency (fraction of the time per year) for 16 (22.5°) compass sectors by the population in that sector for a given distance from the plant and summing all products.[6] The Exposure Index value can be considered to be the expected population at risk for a particular year out to a distance of 10 miles from the NPP. Population varies with population growth and movement and with the distance from any given plant. As the population changes for that plant, the Exposure Index also changes (the larger the Exposure Index, the larger the number of people at risk). Thus, the Exposure Index is proportional to risk, and an Exposure Index for a site for a future year can be used to predict the risk to the population around that site in that future year.

The 1996 LR GEIS developed several relationships between the Exposure Index and various radiological health risk metrics. These relationships were developed by regressing total early fatality, normalized total latent fatality, and normalized total dose values on various Exposure Index values (see Appendix G of the 1996 LR GEIS). The Exposure Index values at 10 miles were found to best correlate with early fatalities, which is to be expected because early fatalities tend to be clustered close to the plant. The Exposure Index values at 150 miles (241 kilometers) were found to best correlate with latent fatalities and total dose. This finding is to be expected because the magnitudes of these risk values are largely influenced by the exposure of large populations around the plant.

Table 5.5 of the 1996 LR GEIS summarizes the information for 28 nuclear plant sites that were used to develop the relationship between Exposure Index and consequences of severe accidents analysis for both PWRs and BWRs. Because of fundamental design differences between PWRs and BWRs, separate regression analyses were performed for each to better account for the BWR–PWR differences in plant failure modes and source terms. Accordingly, the PWR regression was used to determine the best fit relationship for PWR risk values, and the BWR regression was used to determine the best fit relationship for FES BWR risk values. As can be seen in Figures 5.2–5.7 of the 1996 LR GEIS, two lines (representing average and UCB values) result from the regression analyses for total early fatalities, total latent fatalities, and total dose. The 95 percent UCB (dashed line) was developed based on the scatter in the data.

Using the UCB results of the regression analysis, the values for total early fatalities, total latent fatalities, and total dose were then predicted for each site at their middle year of LR period, rounded up to the nearest year for which projected population data are available (2010, 2030, 2050). The results of the UCB projections for early fatalities, latent fatalities, and total dose are shown in Table 5.6 of the 1996 LR GEIS. The effects on risk due to factors such as emergency planning, meteorology (other than the frequency of wind direction, e.g., rainfall), and topography

[6] An example calculation for an Exposure Index value for 1990 at 10 mi (16 km) is shown in the 1996 GEIS, Table 5.4, "Example calculation for exposure index (EI) value with 1990 population at 10-mile radius from plant."

were accounted for in the FES analyses of severe accidents and are consequently incorporated into the FES risk values. Any variation in risk resulting from variation of these secondary parameters among FES plants is reflected in the UCB calculated by the regressions. As discussed in Section 5.3.3.2.1 of the 1996 LR GEIS, the FES plants reasonably envelop these secondary effects. If the future risks for all plants are then estimated using the appropriate (BWR or PWR) regression and the middle year of relicense Exposure Index, the resulting UCB values are estimated future risks that are not expected to be exceeded.

Section 5.3.4.5, "Exposure Index," of the 1996 LR GEIS discusses identified uncertainty with the Exposure Index methodology—specifically, how the regression analysis for early fatalities were only performed for large plants having thermal power levels greater than about 3025 MWt. Although there is some relationship between plant size and predicted early fatalities (all other factors being held constant), the relationship is not linear because of the threshold effects for early fatalities. Therefore, normalization for plant size for the early fatality regression process was not considered appropriate; rather, early fatalities were predicted based only on the data for large plants. As explained by the 1996 LR GEIS, this approach should generally provide overpredictions for plants less than 3025 MWt, resulting in most of the uncertainty being in the direction of smaller predicted effects. For plants equal to or greater than 3025 MWt, small uncertainty in the calculated values may be present. However, the use of UCBs for predicting risk values should minimize the possibility of underprediction.

As discussed in Section 5.3.3.2.4, "Conclusion," of the 1996 LR GEIS, as can be seen from the data in Tables 5.10 and 5.11, the risk of early and latent fatalities from individual NPPs is small. It represents only a small fraction of the risk to which the public is exposed from other sources. Even if the predicted early and latent fatalities from all 118 plants (at the time of the 1996 LR GEIS was published) were considered (that is, the risk to the population of the United States from all 118 NPPs), this would only result in a predicted risk of approximately one additional early fatality per year and approximately 30 additional latent fatalities per year, which is still a small fraction of the approximately 100,000 early and 500,000 latent cancer fatalities per year from other sources.

Figure I-4 presents the 1996 LR GEIS Exposure Index values at 10 and 150 miles versus reactor power as a reference.

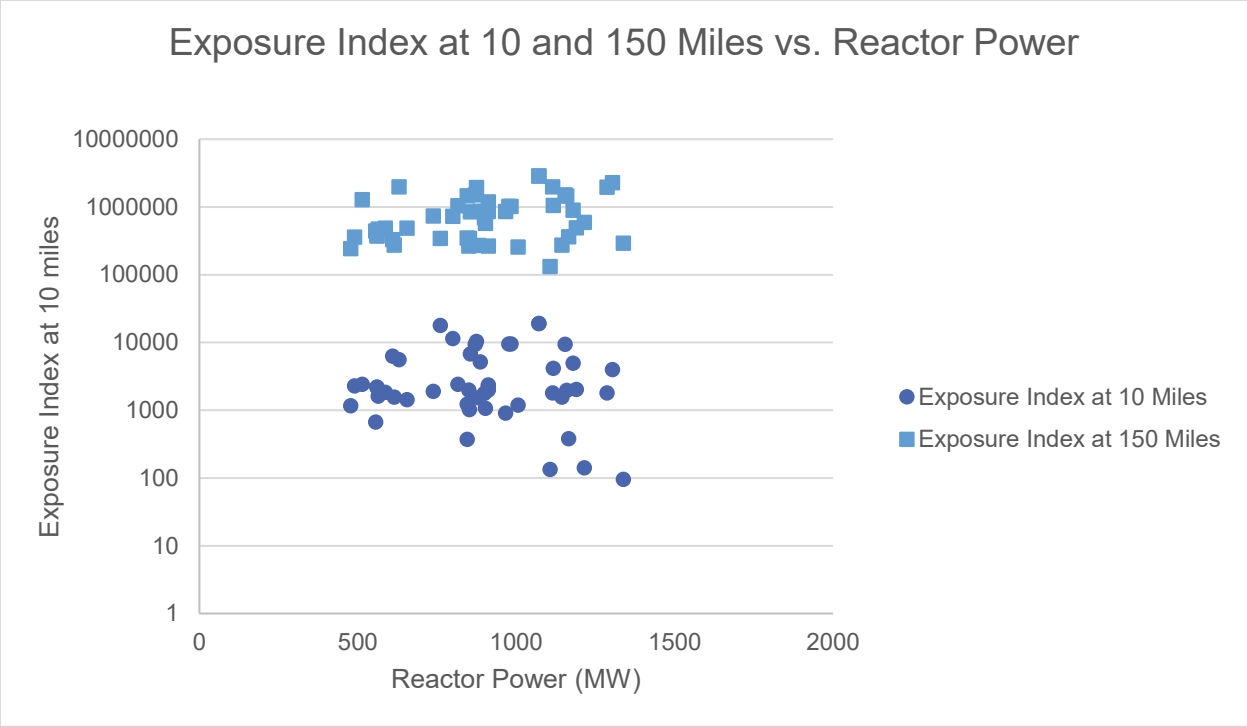

Figure I-4 The 1996 LR GEIS Exposure Index Values at 10 mi and 150 mi Versus Reactor Power. Source: NRC 1996-TN288.

I.4.2 Utilizing 10 CFR 50.34(a)(1)(ii)(D), or the Equivalent 10 CFR 52 Regulation, and Demonstrating Compliance with a Non-intact Containment or Confinement

Revision 4 to RG 4.7 (NRC 2024-TN12081), "General Site Suitability Criteria for Nuclear Power Stations," issued February 2024, describes the major site characteristics related to public health and safety and environmental issues that the staff consider in determining the suitability of sites for commercial nuclear power stations in Appendix A, "Alternative Approaches to Population-Related Siting Considerations." To demonstrate compliance with the regulatory requirements in 10 CFR 100.21, 10 CFR 50.34(a)(1), 10 CFR 52.17(a)(1)(ix), and 10 CFR 52.79(a)(1)(vi), as applicable, commercial nuclear power reactor siting analyses should account for the potential for radiological releases due to possible accident conditions (NRC 2023-TN12082). Historically, analyses for such releases have been based on regulatory guidance developed for large LWR technology (e.g., RG 1.183 (NRC 2023-TN9587), "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors"), which may not be applicable for many of the advanced reactor (e.g., non-LWR technologies and light-water SMR) designs being developed. Because of the wide variety of potential advanced reactor designs and safety approaches, the spectrum of accident conditions does not lend itself to prescriptive guidance similar to that developed for LWR designs (e.g., RG 1.183). Rather, the guidance in Revision 4 of RG 4.7, Appendix A, identifies a set of attributes that should be addressed as part of proposing an alternative approach in the siting analysis for advanced reactors. This section of the appendix provides guidance for three different approaches to estimating offsite consequences to inform the alternative population-related siting considerations for advanced reactors. The three approaches are as follows:

1. Regulatory Guide 1.233 Approach (non-LWRs)[7]

   For an applicant using a methodology like that described in RG 1.233 (NRC 2020-TN6441), the results from the DBA analyses are used to determine or confirm the boundaries of the exclusion area and LPZ by comparing the calculated consequences against the requirements in 10 CFR 50.34(a)(1)(ii)(D) (TN249) or the corresponding requirements in 10 CFR Part 52 (10 CFR 52.17(a)(1)(ix) (TN251) for early site permits or 10 CFR 52.79(a)(1)(vi) for COLs). An applicant using this approach may need to request an exemption from the regulations in 10 CFR 50.34, "Contents of applications; technical information," 10 CFR 52.17, "Contents of applications; technical information," or 10 CFR 52.79, "Contents of applications; technical information in final safety analysis report," if the DBA does not involve the equivalent of significant core damage such as that resulting from a major accident. Those regulations require an assumed "major accident"[8] for demonstrating the adequacy of traditional containment structures to confirm that doses at the boundaries of the exclusion area and LPZ are below the siting reference values provided in the regulations, a dose of 25 roentgen equivalent man (rem) total effective dose equivalent (TEDE).

   Applicants using a methodology like that described in RG 1.233 would use the licensing-basis events categorized as DBEs and BDBEs to estimate potential offsite doses for use in determining the distance out to which the population density should be less than 500 persons per square mile (ppsm).[9] The estimated doses from DBEs and BDBEs are calculated for the 30-day period following the initiation of the release to determine the distance at which the dose to a hypothetical individual would exceed 1 rem TEDE. The calculation of offsite doses should be in accordance with NRC-accepted methodologies, including associated computer models for the plant response to an accident, the performance of various barriers to the release of radioactive materials, and the atmospheric dispersion of any released radioactive materials to areas surrounding the plant.[10] Demonstrating that the population density for a subject site does not exceed 500 ppsm within the circular area defined by a radius of twice the distance at which the 1 rem TEDE is estimated for potential DBEs and BDBEs is sufficient to meet the requirements of 10 CFR 100.21(h) (TN282). If an applicant can show that no DBEs or BDBEs result in an offsite dose exceeding 1 rem TEDE for the 30-day exposure period, the siting of a reactor might not be determined by population-density considerations but would instead be governed by the regulatory requirement in 10 CFR 100.21(b) for reactors to be located distant from densely populated centers with more than about 25,000 residents. However, an advanced reactor with estimated doses below 1 rem at the site boundary over the month following the

[7] The scope of RG 1.233 is limited to non-LWRs. In the future, the staff may expand the applicability of RG 1.233 to LWRs as part of the guidance development for ongoing rulemakings.

[8] The term "major accident" is described in 10 CFR 50.34(a)(1)(ii)(D), footnote 6 as follows: "The fission product release assumed for this evaluation should be based upon a major accident, hypothesized for purposes of site analysis or postulated from considerations of possible accidental events. Such accidents have generally been assumed to result in substantial meltdown of the core with subsequent release into the containment of appreciable quantities of fission products."

[9] The methodology endorsed in RG 1.233 also includes specific steps to assess defense in depth provided by the combination of plant design, siting, and programmatic controls.

[10] The NRC can accept methodologies and computer models via endorsement of generally accepted methods, standards, and practices (e.g., regulatory guide for a consensus standard or approval of generic topical report) or as part of specific applications. Such acceptances can be for broad methodologies such as RG 1.247, "TRIAL—Acceptability of Probabilistic Risk Assessment Results for Non-Light-Water Reactor Risk-Informed Activities," or combinations of individual computer codes and related simulations.

assumed postulated accident could be sited within towns with populations of no more than approximately 25,000 residents.

2. Regulatory Guide 1.183 Plus Severe Accidents Approach (LWRs)

   In the event of a postulated accident at a commercial nuclear power station, radiological consequences for individual members of the public outside the station must be acceptably low. Defining exclusion areas and LPZ around the station is integral in achieving this goal. A reactor licensee is required to designate an exclusion area and to have authority to determine all activities within that area, including removal of personnel and property. In selecting a site for a commercial nuclear power station, it is necessary to provide an exclusion area in which the applicant has such authority. A reactor licensee is also required to designate an area immediately surrounding the exclusion area as an LPZ. The site selection process should account for this as well.

   The siting assessments and determination or confirmation of the boundaries of the exclusion area and LPZ are based on the assumption of a major accident, the performance of containment and other systems included in a design to limit fission product release, and the characteristics of the subject site. An applicant may also use the analyses of a major accident using guidance such as RG 1.183 (NRC 2023-TN9587) plus the evaluation of potential severe accidents that challenge the containment to evaluate an alternative to the assumed 20-mile distance from the plant for which population density is not to exceed 500 ppsm.

   LWR applicants using this method would evaluate the radiological consequences of DBAs described in RG 1.183 and severe accidents that challenge containment to estimate the distance at which a hypothetical individual would experience a dose of 1 rem TEDE over the 30-day period following the initiation of a release. The radiological source term from RG 1.183 can be used along with insights from generic or design-specific analyses to address the performance of containment and other systems included to limit the release of radionuclides from severe accidents. At a minimum, the containment leakage will be assumed to be the same as that used for the evaluation of the exclusion area boundary and LPZ. The magnitude and timing of possibly greater releases to the environment should be assumed based on the analyses of accident progression and containment performance from the assessment of severe accidents for the as-designed plant (including potential severe accident design features). Demonstrating that the population density for a subject site does not exceed 500 ppsm out to twice the calculated distance at which the 1 rem TEDE is estimated for a major accident with consideration of containment performance during severe accidents is sufficient to meet the requirements of 10 CFR 100.21(h) (TN282). In the case that an applicant can show that the calculated offsite dose does not exceed 1 rem TEDE for the 30-day exposure period, the siting of a reactor might not be determined by population-density considerations but would instead be governed by the regulatory requirement in 10 CFR 100.21(b) for reactors to be located distant from densely populated centers with more than about 25,000 residents. However, an advanced reactor with estimated doses below 1 rem at the site boundary over the month following the assumed postulated accident could be sited within towns with populations of no more than approximately 25,000 residents.

3. For Non-LWRs Not Using RG 1.233 and Using Traditional Analysis of a Containment-Type Barrier

   Non-LWR applicants choosing not to use a methodology like that in RG 1.233 (NRC 2020-TN6441) and the related event-specific modeling of mechanistic source terms may use a traditional or deterministic approach to establish the requirements for a containment-type barrier for limiting the release of radionuclides.[11] Since this approach will be seen as limiting for the required safety analyses compared to a more fully developed mechanistic source term for a range of event sequences, the applicant would need to develop a conservative, design-specific bounding core damage accident source term like that given in RG 1.183 (NRC 2023-TN9587) for LWRs. The source term based on an estimate of a mixture of radionuclides breaching barriers upstream of the containment, along with associated energy additions (e.g., accounting for increased temperatures and pressures) from DBAs, is used to confirm or establish performance requirements, including maximum leak rates, for the containment features using the existing criteria for doses at the exclusion area boundary and LPZ. (See for example, the discussion in RG 1.183, Section C.2, "Attributes of an Acceptable AST [alternative source term].") The non-LWR source term for the traditional siting analyses should be expressed in terms of times and rates of appearance of radioactive fission products released into the containment-type feature, the types and quantities of the radioactive species released, and the chemical forms for those radionuclides expected to significantly influence the public dose.

   Similar to the traditional approach described above for LWRs (Approach 2), the conservative source term introduced to the interior of a containment-type feature should also be used in combination with an assessment of containment performance under severe accidents. Demonstrating that the population density for a subject site does not exceed 500 ppsm out to twice the calculated distance at which the 1 rem TEDE is estimated for a major accident with consideration of containment performance during severe accidents is sufficient to meet the requirements of 10 CFR 100.21(h) (TN282). If an applicant can show that the calculated offsite dose does not exceed 1 rem TEDE for the 30-day exposure period, the siting of a reactor might not be determined by population-density considerations but would instead be governed by the regulatory requirement in 10 CFR 100.21(b) for reactors to be located distant from densely populated centers with more than about 25,000 residents. However, an advanced reactor with estimated doses below 1 rem at the site boundary over the month following the assumed postulated accident could be sited within towns with populations of no more than approximately 25,000 residents.

I.4.3 Utilizing 10 CFR 50.33(g)(2) and Demonstrating There Is No Plume Exposure Pathway Emergency Planning Zone

In 10 CFR 50.33(g)(2) (TN249), SMRs and other nuclear technologies take a consequence-oriented approach for determining the size of the plume exposure pathway EPZ. This final rule acknowledges technological advancements and other differences from large LWRs that are inherent in SMRs and other new technologies. The primary purpose of the plume exposure pathway EPZ is to define the area where predetermined, prompt protective measures are necessary, which results in dose savings and a reduction in early health effects.

[11] This approach is provided to address non-LWRs using a containment-type barrier that encloses other barriers similar to the essentially leak tight structures used for LWRs. The consideration of multiple barriers and event-specific mechanistic source terms are supported in the LMP methodology (see Section A-3.1). Hybrid approaches may be justified but are outside the scope of this guidance.

The 10 CFR 50.33 rule requires applicants and licensees choosing to comply with 10 CFR 50.160 to describe in their emergency plan the information that demonstrates compliance with the elements set forth in 10 CFR 50.160(b). This includes the capability to assess and classify emergency events, establish and maintain effective communications, assess radiological conditions in and around the facility, and recommend protective measures to offsite authorities as conditions warrant. If an applicant or licensee determines under 10 CFR 50.33(g)(2)(i)(B) that pre-determined, prompt protective measures are warranted, which would occur only if § 50.33(g)(2)(i)(A) is also met, then an EPZ is required. The need for pre-determined, prompt protective measures is assumed to exist unless an applicant can demonstrate that the timing of accidents in relation to the proposed capabilities for assessment and notification is such that predetermined, prompt protective measures are not warranted. That is, the applicant must demonstrate that plant condition-based, predetermined, prompt protective measures are not required because sufficient time is available, and the capability exists, to initiate appropriate response actions offsite as conditions warrant. RG 1.242 (NRC 2023-TN12144) provides guidance for the EPZ functional criterion.

The NRC establishes in 10 CFR 50.33(g)(2)(i) (TN249) two criteria for determining a plume exposure pathway EPZ size. The first criterion is that the plume exposure pathway EPZ is the area within which public dose, as defined in 10 CFR § 20.1003, "Definitions," is projected to exceed 1 rem TEDE over 96 hours from the release of radioactive materials from the facility considering accident likelihood and source term, timing of the accident sequence, and meteorology (10 CFR Part 20-TN283). The second criterion is that the plume exposure pathway EPZ is the area where predetermined, prompt protective measures are necessary.

By utilizing 10 CFR 50.33(g)(2) and demonstrating there is no plume exposure pathway EPZ, an applicant demonstrates that the impacts of severe accidents are consistent with the U.S. Environmental Protection Agency's determination concerning acceptable levels of risk of health effects from radiation exposure in an emergency situation, while weighing costs and risks associated with any protective action.[12]

Appendix A, "General Methodology for Establishing Plume Exposure Pathway Emergency Planning Zone Size," of RG 1.242 provides a sample methodology acceptable to the NRC for the analysis to establish EPZ size, as required under 10 CFR 50.33(g)(2). As described in RG 1.242, the analysis of the EPZ size required in 10 CFR 50.33(g)(2) may be preliminary for CPs consistent with the preliminary design of the facility as described in the PSAR. The applicant should describe its EPZ sizing analysis methodology and the preliminary analysis results, including the radius of the plume exposure pathway EPZ. Paragraph 50.33(g) of 10 CFR requires that applicants referencing an early site permit must meet the terms of the permit, including the radius of the plume exposure pathway EPZ if that is determined in the early site permit, or request a variance under 10 CFR 52.39(d).

I.4.4 Utilizing 50.155 to Mitigate Beyond-Design-Basis Events

On March 11, 2011, the Great East Japan Earthquake, rated a magnitude 9.0, occurred off the coast of Honshu Island, resulting in the automatic shutdown of 11 NPPs at four sites along the northeast coast of Japan, including three of six reactors at the Fukushima Dai-ichi NPP (the three remaining plants were shut down for maintenance). The earthquake caused a large tsunami that is estimated to have exceeded 14 meters in height at the Fukushima Dai-ichi NPP.

[12] EPA, *"PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents EPA-400/R-17/001," January 2017, Environmental Protection Agency* (TN5977)

The earthquake and tsunami produced widespread devastation across northeastern Japan, significantly impacting the infrastructure and industry in the northeastern coastal areas of Japan. The earthquake and tsunami disabled the majority of the external and internal electrical power systems at the Fukushima Dai-ichi NPP, creating a significant challenge for operators in responding to the event. In addition, the combination of severe events challenged the implementation of emergency plans and procedures.

In 10 CFR 50.155 (TN249), the Commission established regulatory requirements for nuclear power reactor applicants and licensees to mitigate BDBEs following the March 2011 Fukushima Dai-ichi event. This rule is applicable to power reactor licenses and power reactor license applicants. This rule made generically applicable the requirements in several Commission orders for mitigation of BDBEs and for reliable SFPI. These orders include Order EA-12-049 (77 FR 16091-TN2476), “Order Modifying Licenses With Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events” (Mitigation Strategies Order), and Order EA-12-051, “Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation” (SFPI Order), generically applicable (77 FR 16082-TN1424).

Paragraph 50.155(b) of 10 CFR requires each applicant or licensee to develop, implement, and maintain mitigation strategies for beyond-design-basis external events and extensive damage mitigation guidelines.

- The mitigation strategies for beyond-design-basis external events are designed to mitigate beyond-design-basis external events from natural phenomena. These strategies are developed assuming a loss of all alternating current power concurrent with either a loss of normal access to the ultimate heat sink or, for passive reactor designs, a loss of normal access to the normal heat sink. These strategies and guidelines must be capable of being implemented site-wide and must include the following: (1) maintaining or restoring core cooling, containment, and spent fuel pool cooling capabilities and (2) the acquisition and use of offsite assistance and resources to support the functions required by 10 CFR 50.155(b)(1)(i) indefinitely, or until sufficient site functional capabilities can be maintained without the need for the mitigation strategies.
- The extensive damage mitigation guidelines are strategies and guidelines to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities under the circumstances associated with loss of large areas of the plant impacted by the event, due to explosions or fire, to include strategies and guidelines for firefighting, operations to mitigate fuel damage, and actions to minimize radiological release.
- While 10 CFR 50.155 and FLEX were developed to mitigate beyond-design-basis external hazards, the equipment and training under both would nevertheless be useful for responding to other severe accidents.

Paragraph 50.155(c) of 10 CFR requires equipment relied on for the mitigation strategies and guidelines required by 10 CFR 50.155(b)(1) to have sufficient capacity and capability to perform the functions. The equipment relied on for the mitigation strategies and guidelines must be reasonably protected from the effects of natural phenomena that are equivalent in magnitude to the phenomena assumed for developing the design basis of the facility.

Section 50.155 of 10 CFR requires each licensee to provide for the training of personnel that perform activities in accordance with the capabilities required by 10 CFR 50.155(b)(1) and 10 CFR 50.155(b)(2).

Paragraph 50.155(e) of 10 CFR requires spent fuel pool monitoring in order to support effective prioritization of event mitigation and recovery actions. Each licensee is required to provide reliable means to remotely monitor wide-range water level for each spent fuel pool at its site until 5 years have elapsed since all of the fuel within that spent fuel pool was last used in a reactor vessel for power generation.

Paragraph 50.155(f) of 10 CFR requires documentation of changes in the implementation of the requirements, without NRC approval, provided that before implementing each such change, the licensee demonstrates that the provisions of this section continue to be met and maintains documentation of changes until the requirements of this section no longer apply. Changes in the implementation of requirements subject to change control processes in addition to 10 CFR 50.155(f) must be processed via their respective change control processes, unless the changes being evaluated impact only the implementation of 10 CFR 50.155.

Collectively, all paragraphs under 10 CFR 50.155 clarify and strengthen NRC's regulatory framework for protection against severe natural phenomena, mitigation of the effects of such events, coping with emergencies, and improving the effectiveness of NRC programs. Therefore, the regulation provides additional mitigation strategies that can be considered in the NRC staff's NEPA evaluation of SAMAs.

I.4.5 Perform a Cost-Screening Analysis to Determine That the Maximum Benefit of Avoiding an Accident Is So Small That Design Mitigation Alternatives Are Not Justified

The Commission employs cost-benefit analyses to systematically evaluate regulatory decisions, manufacturing licenses (10 CFR 51.54), standard DC (10 CFR 51.55), and LR and COL applications for NPPs (TN250). A critical aspect of these evaluations is the assessment of the Severe Accident Impact category, which addresses the potential consequences of low-probability but high-consequence events. As part of the assessment process, applicants must conduct a mitigation analysis, which identifies and evaluates potential upgrades or procedural changes that could reduce the risk or consequences of severe accidents. Otherwise, applicants must provide the basis for not incorporating SAMAs. NRC cost-benefit regulatory analysis guidance documents aid the agency's regulatory decision-making process when performing these analyses. NUREG/BR-0058 (NRC 2004-TN8977), entitled "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," provides the overall policy framework and high-level guidance for conducting regulatory analyses, including when and why such analyses are required. It outlines the principles and objectives of cost-benefit analysis in support of NRC rulemakings, licensing decisions, and other regulatory actions. In contrast, NUREG/BR-0184 (NRC 1997-TN676), entitled "Regulatory Analysis Technical Evaluation Handbook," serves as a detailed companion to NUREG/BR-0058 by providing the technical methodology and step-by-step procedures for performing cost-benefit evaluations. While NUREG/BR-0058 sets the "what" and "why," NUREG/BR-0184 provides the "how," including practical methods, default values, and calculation techniques for estimating costs and benefits in regulatory analysis. Together, these documents ensure that NRC decisions are both technically sound and aligned with the agency's policy objectives. Future cost screening analysis should apply the current NRC cost-benefit regulatory analysis guidance.

In performing and reviewing severe accident mitigation analyses, both the applicant and NRC staff may identify alternatives that are potentially cost-beneficial based on the criteria set forth in current cost-benefit regulatory analysis guidance documents. When such alternatives are

identified, applicants are expected to further evaluate their feasibility, considering site-specific factors such as implementation complexity, engineering challenges, and operational impacts.

For LR applications, NEI developed, and the NRC accepted, the SAMA guidance in NEI 05-01A, "Severe Accident Mitigation Alternatives (SAMA) Analysis: Guidance Document" (NEI 2005-TN1978). If the SAMA analysis determines that an aging related SAMA is potentially cost-beneficial, the plant is under no obligation to implement the SAMA immediately. Typically, these SAMAs are submitted to internal decision-making organizations that will consider them for implementation in accordance with an established plant procedural process. Lessons learned from LR found that SAMAs are likely limited to procedure changes and minimal hardware changes. The NRC staff reviews these evaluations to ensure consistency with regulatory expectations and confirms that safety enhancements are appropriately considered. This collaborative process helps maintain a high level of nuclear safety while ensuring that investments in safety improvements are justified and practical.

For standard DC applications, the PRA risk insights generally have determined that the designs already include numerous plant features to reduce CDF and risk. The results of these analysis, in all but one DC, have found that significant margins in the results of the cost-benefit analysis have informed that additional plant improvements would not significantly reduce the risk of either internally or externally initiated events. The NRC staff have further determined that any other design modifications would be unlikely to be justifiable on the basis of population exposure considerations due to estimated CDFs and risk estimates remaining very low on an absolute scale.

A Severe Accident category mitigation analysis "in the most basic sense, is a cost-benefit analysis that addresses whether the expense of implementing a mitigation measure not mandated by the NRC is outweighed by the expected reduction in environmental cost it would provide in a core damage event."[13] Mitigation analyses are not meant to prevent an accident but rather to mitigate the severity should one occur. The NRC cost-benefit methodologies outlined in NUREG/BR-0184 (NRC 1997-TN676) (or current NRC cost-benefit regulatory analysis guidance) are integral to determining the "maximum benefit" value used in evaluating alternatives. The maximum benefit value represents the estimated monetary benefit of implementing a specific mitigation measure, based on the reduction in risk to public health, safety, and the environment. Using PRA results, an applicant calculates the change in CDF or LERF associated with a SAMA/SAMDA and then applies conversion factors to monetize the avoided consequences—such as potential offsite economic impacts, radiation doses, and latent health effects. NUREG/BR-0184 provides the technical framework and standardized parameters, such as the value of a statistical life and discount rates, to ensure consistency and transparency in these calculations. The resulting "maximum benefit" is then compared to the cost of implementing the SAMA/SAMDA to determine whether it is cost-beneficial, guiding regulatory and operational decisions in LR reviews.

The NRC staff gathered results from licensing experience documented in NUREG-1437, and its supplements, to compile a comprehensive dataset that reflects estimated maximum benefit value for the operating power reactor fleet. Table I-1 presented at the end of this appendix, provides this dataset. Figure I-5 presents this dataset, by NUREG-1437 supplement number, for illustration purposes. This information was then leveraged to develop the NR GEIS PPE for performing a cost-screening analysis that can determine the maximum benefit of avoiding an accident being so small that design mitigation alternatives are not justified.

[13] Massachusetts v. NRC, 708 F.3d 63, 68 (1st Cir. 2013)

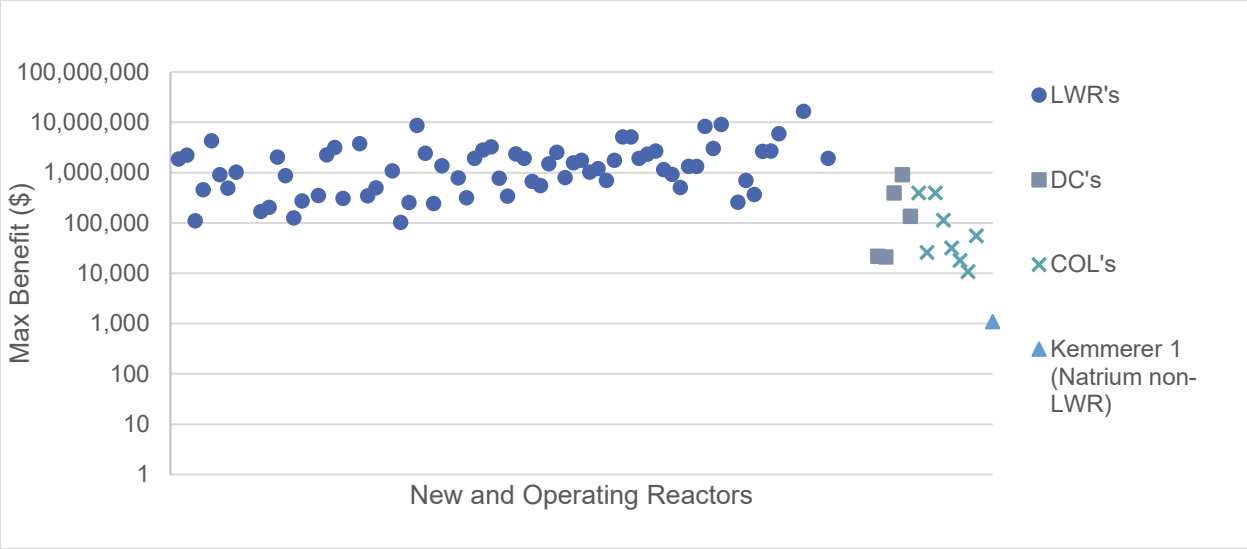

Figure I-5 SAMA Mitigation Maximum Benefit Estimates in Environmental Impact Statements for New and Operating Reactors (Note: At the time of writing, the NRC has not completed its environmental review for the Kemmerer 1 project; as such, this information comes from the Kemmerer ER (TerraPower 2024-TN10896) and is provided for illustrative purposes only)

When assessing the costs of a mitigation measure, in general, site-specific cost estimates are based on engineering judgement of project engineers experienced in performing design changes at the facility. The detailed cost estimates should consider engineering, labor, materials, and support functions, such as planning, scheduling, health physics, quality assurance, security, safety, and fire watch. The estimates can also include additional increases in cost due to unforeseen design- and installation costs, inflation adjustments, replacement power during extended outages for implementation, or increased maintenance or operational cost. Mitigation type-changes to the facility and their associated estimated cost range can be but are not limited to the following:

- procedural only, $25K to $50K
- procedural change with engineering or training required, $50K to $200K
- procedural change with engineering and testing or training required, $200K to $300K
- hardware modification, $100K to >$1,000K for PWRs and BWRs, and $33,000 for AP1000

The cost-screening process would be based on the available risk information derived from the safety analysis methodology (e.g., NUREG-0800 Chapter 19, RG 1.233 or RG 4.7) applied in the application's FSAR/PSAR extended to 50 miles for the selected site and would apply the cost formulas from current NRC cost-benefit regulatory analysis guidance. If the mitigation alternative is not screened out, the bounding assumption is not met, and a project-specific analysis is required.

For example, an SMR single module with an overall very low risk profile can have eight accident release categories. Seven out of eight accident release categories can have release frequencies of 2.4×10^{-9} per reactor-year or smaller. The total estimated maximum benefit of these seven low probability release categories could be less than $100. It is therefore unlikely that a design mitigation alternative could be developed costing less than $100, so there is no need to develop potential mitigation strategies for these seven release categories. Another

example is a new reactor applicant applies the RG 1.233 methodology with a release frequency of approximately 1.4×10^{-8}. The environmental severe accident analysis then leverages the consequence analysis for the frequency-consequence data point by extending the consequence analysis out to 50 miles to generate the PDR and offsite economic damage risks. The resulting estimated maximum benefit with a release frequence of approximately 1.4×10^{-8} per reactor-year can be shown to be a very low value, likely less than $1,000 for a rural site. Thus, as these two examples show, a new rector cost-screening could clearly demonstrate not only the low radiological risks but also the very low economic cost risks via a maximum benefit value.

I.5 Conclusion

The activities and regulations discussed in this appendix describe the agency's move to a more risk-informed and performance-based regulatory approach, as described in Staff Requirements Memorandum - SECY-98-144 - *White Paper on Risk-Informed and Performance-based Regulation* (NRC 1999-TN12070). While much of the above discussion in this appendix is related to nuclear reactor safety, this discussion along with past environmental review results described in Section I.3 and the associated PPE/SPE values described in Section I.4 and summarized in Table G-1, supports the NRC staff's Category 1 determination regarding severe accidents and mitigation in future new and advanced reactor licensing actions.

I.6 Appendix I Tables

Table I-1 1996 License Renewal Generic Environmental Impact Statement Core Damage Frequency and Population Dose Risk Value 1996 License Renewal Generic Environmental Impact Statement Core Damage Frequency and Population Dose Risk Values

Plant	1996 LR GEIS Estimated CDF	1996 GEIS Nonnormalized Predicted Total Dose (person-rem/reactor year) (95% UCB)
Indian Point 2	3.50×10^{-4}	9,727
Indian Point 3	3.40×10^{-4}	9,727
Millstone 3	2.00×10^{-4}	3,988
Nine Mile Point 2	1.10×10^{-4}	996
Vogtle 1 and 2	1.00×10^{-4}	983
Beaver Valley 2	1.00×10^{-4}	1,720
Hope Creek	1.00×10^{-4}	3,604
Braidwood 1 and 2	1.00×10^{-4}	4,418
River Bend	9.50×10^{-5}	1,168
Limerick 1 and 2	8.90×10^{-5}	4,461
Summer	4.90×10^{-5}	1,381
Catawba 1 and 2	4.80×10^{-5}	1,880
St. Lucie 2	4.80×10^{-5}	1,063
Wolf Creek	4.80×10^{-5}	466
Harris	4.80×10^{-5}	1,001
Palo Verde 1, 2, and 3	4.80×10^{-5}	369
Seabrook	4.80×10^{-5}	819
Callaway	4.80×10^{-5}	509
Byron 1 and 2	4.80×10^{-5}	2,867
Waterford 3	4.80×10^{-5}	477
Comanche Peak 1 and 2	4.80×10^{-5}	466
San Onofre 2 and 3	4.80×10^{-5}	3,099
South Texas 1 and 2	4.40×10^{-5}	1,065
Susquehanna 1 and 2	2.40×10^{-5}	4,010
Columbia (WNP-2)	2.40×10^{-5}	649
Grand Gulf	2.40×10^{-5}	1,441
Fermi 2	2.40×10^{-5}	2,722
Clinton	2.40×10^{-5}	2,549
Perry	2.40×10^{-5}	2,544

CDF = core damage frequency; LR GEIS = License Renewal Generic Environmental Impact Statement; UCB = upper confidence bound.

Table I-2 2024 Subsequent License Renewal Generic Environmental Impact Statement Severe Accident Mitigation Alternative Core Damage Frequency and Population Dose Risk Values

Plant	SAMA CDF	License Renewal SAMA Total Population Dose Risk (person-rem/Ryr)
Nine Mile Point 2	5.80×10^{-5}	50.9
Summer	5.60×10^{-5}	2.0
Comanche Peak 1 and 2	4.80×10^{-5}	16.0
Catawba 1 and 2	4.70×10^{-5}	31.4
Byron 1	4.00×10^{-5}	92.3
Byron 2	3.80×10^{-5}	92.3
Braidwood 1	3.60×10^{-5}	342
Braidwood 2	3.50×10^{-5}	342
Wolf Creek	3.00×10^{-5}	6.5
Millstone 3	2.60×10^{-5}	20.5
St. Lucie 2	2.40×10^{-5}	28
Indian Point 2	1.80×10^{-5}	332
Callaway	1.70×10^{-5}	21.0
Vogtle 1 and 2	1.60×10^{-5}	3.1
Indian Point 3	1.20×10^{-5}	521
Waterford 3	1.10×10^{-5}	61.0
Beaver Valley 2	9.50×10^{-6}	55.8
Harris	9.20×10^{-6}	58.0
Seabrook	7.80×10^{-6}	79.4
Columbia (WNP-2)	7.40×10^{-6}	25.9
Palo Verde 1, 2, and 3	5.10×10^{-6}	34.0
Hope Creek	4.40×10^{-6}	156
South Texas 1 and 2	3.90×10^{-6}	1.74
Limerick	3.20×10^{-6}	56.4
Grand Gulf	2.90×10^{-6}	6.7
River Bend	2.80×10^{-6}	8.5
Susquehanna 1	2.00×10^{-6}	3.8
Susquehanna 2	1.90×10^{-6}	3.8
Fermi 2	1.50×10^{-6}	54.0

CDF = core damage frequency; Ryr = reactor-year; SAMA = severe accident mitigation alternative.

Table I-3 NUREG-1150 Core Damage Frequency and Population Dose Risk Values

Plant	CDF	Population Dose Risk (person-rem/Ryr)
Grand Gulf	4.00×10^{-6}	≈0.5
Peach Bottom	4.50×10^{-6}	≈7
Sequoyah	5.70×10^{-5}	≈10
Surry	4.00×10^{-5}	≈6
Zion	3.40×10^{-4}	≈50

CDF = core damage frequency; Ryr = reactor-year.

Table I-4 Early Site Permits Core Damage Frequency and Population Dose Risk Values

Plant	CDF	Population Dose Risk (person-rem/Ryr)
Clinton—ABWR	1.56×10^{-7}	2.35×10^{-3}
Clinton—AP1000	2.40×10^{-7}	2.21×10^{-2}
Grand Gulf—ABWR	1.56×10^{-7}	2.08×10^{-3}
Grand Gulf—AP1000	2.40×10^{-7}	1.43×10^{-2}
North Anna—ABWR	1.56×10^{-7}	5.93×10^{-3}
North Anna—AP1000	2.40×10^{-7}	8.28×10^{-2}
North Anna—ESBWR	2.88×10^{-8}	3.29×10^{-3}
Vogtle—AP1000	2.40×10^{-7}	2.80×10^{-2}
PSEG—US-APWR	1.20×10^{-6}	1.15
PSEG—AP1000	2.40×10^{-7}	1.79×10^{-1}
PSEG—US-EPR	5.30×10^{-7}	3.48×10^{-1}
PSEG—ABWR	1.56×10^{-7}	9.83×10^{-3}
Clinch River—Site Boundary	4.65×10^{-8}	6.19×10^{-3}
Clinch River—2 miles	4.65×10^{-8}	6.03×10^{-3}
Clinch River—10 miles	4.65×10^{-8}	5.97×10^{-3}

ABWR = Advanced Boiling Water Reactor; CDF = core damage frequency; EPR = U.S. Evolutionary Power Reactor; ESBWR = Economic Simplified Boiling Water Reactor; PSEG = Public Service Enterprise Group; Ryr = reactor-year.

Table I-5 License for New Reactor Core Damage Frequency and Population Dose Risk Values

Plant	CDF	Population Dose Risk (person-rem/Ryr)
Turkey Point—AP1000	2.40×10^{-7}	2.70×10^{-1}
Lee—AP1000	2.40×10^{-7}	5.30×10^{-2}
Vogtle—AP1000	2.40×10^{-7}	2.80×10^{-2}
Summer AP1000	2.40×10^{-7}	1.00×10^{-1}
South Texas—ABWR	1.56×10^{-7}	4.24×10^{-3}
Levy—AP1000	2.40×10^{-7}	5.60×10^{-2}
Fermi—ESBWR—Internal Events	1.70×10^{-8}	3.20×10^{-2}

Table I-5 License for New Reactor Core Damage Frequency and Population Dose Risk Values (Continued)

Plant	CDF	Population Dose Risk (person-rem/Ryr)
Fermi—ESBWR—Total (All Hazards)	1.20×10^{-7}	2.30
Bell Bend—U.S. EPR	4.90×10^{-7}	5.60×10^{-1}
Comanche Peak—U.S. APWR	1.20×10^{-6}	3.00×10^{-1}

ABWR = Advanced Boiling Water Reactor; APWR = Advanced Pressurized-Water Reactor; CDF = core damage frequency; EPR = U.S. Evolutionary Power Reactor; ESBWR = Economic Simplified Boiling Water Reactor; Ryr = reactor-year.

Table I-6 Non-Light-water Reactors Core Damage Frequency and Population Dose Risk Values

Plant	CDF	Population Dose Risk (person-rem/Ryr)
Kemmerer 1 (Natrium)	1.40×10^{-8}	1.50×10^{-4}

CDF = core damage frequency; Ryr = reactor-year.

Table I-7 Maximum Benefit Estimates (per unit)

Plant	Maximum Benefit ($)
Nine Mile Point 1	1,880,000
Oyster Creek	2,230,000
Quad Cities 1 and 2	110,000
Dresden 2 and 3	456,000
Monticello	4,320,000
Pilgrim	914,000
Hatch 1 and 2	493,000
Peach Bottom 2 and 3	1,020,000
Browns Ferry 1 and 2	168,000
Browns Ferry 3	206,000
Brunswick 1 and 2	2,031,000
Vermont Yankee	877,000
FitzPatrick	126,000
Susquehanna 1 and 2	274,000
Cooper	351,000
Duane Arnold	2,261,000
Hope Creek	3,144,000
Fermi 2	306,300
Nine Mile Point 2	3,800,000
Columbia	500,000
LaSalle 1 and 2	1,087,000
Grand Gulf	102,000
River Bend	255,700
Calvert Cliffs 1 and 2	8,666,000

Table I-7 Maximum Benefit Estimates (per unit) (Continued)

Plant	Maximum Benefit ($)
Oconee 1, 2, and 3	2,430,000
ANO 1	245,000
St. Lucie 1 and 2	1,380,000
Fort Calhoun	784,000
ANO 2	316,000
Millstone 2	1,922,000
Palisades	2,814,000
TMI 1	3,270,000
Palo Verde 1, 2, and 3	777,000
Crystal River	340,000
Waterford 3	2,354,000
Ginna	1,928,000
Point Beach 1 and 2	673,000
Prairie Island 1	557,000
Prairie Island 2	1,490,000
Kewaunee	2,540,000
Turkey Point 3 and 4	801,000
Surry 1 and 2	1,570,000
North Anna 1 and 2	1,770,000
Robinson	1,030,000
Summer	1,200,000
Farley 1 and 2	702,000
Harris	1,755,000
Beaver Valley 1	5,130,000
Beaver Valley 2	5,098,000
McGuire 1 and 2	1,920,000
Catawba 1 and 2	2,322,000
Cook 1 and 2	2,690,000
Millstone 3	1,145,000
Wolf Creek	926,000
Vogtle 1 and 2	508,000
Indian Point 2	1,338,000
Indian Point 3	1,340,000
Salem 1 and 2	8,281,000
Seabrook	3,048,500
Diablo Canyon 1 and 2	14,350,000
South Texas 1 and 2	259,000
Callaway	698,000
Davis Besse	367,000
Sequoyah 1	2,662,000
Sequoyah 2	2,710,000
Byron 1 and 2	5,979,000

Table I-7 Maximum Benefit Estimates (per unit) (Continued)

Plant	Maximum Benefit ($)
Braidwood 1 and 2	16,576,000
Comanche Peak 1 and 2 SAMDA	(a)
Watts Bar 1 SAMDA	1,373,000
Watts Bar 2 SAMDA	1,930,000
Limerick	(a)
ABWR	21,600
US APWR	47,100
AP1000	21,000
ESBWR	397,900
APR1400	909,200
US-EPR	218,400
NuScale	136,000
Fermi Unit 3	282,500
Levy Units 1 and 2	26,000
North Anna Unit 3	397,900
South Texas Project Units 3 and 4	113,900
Summer Units 2 and 3	32,000
Vogtle Units 3 and 4	18,000
Lee Units 1 and 2	10,700
Turkey Point Units 6 and 7	56,000
Comanche Peak 3 and 4	786,700
Bell Bend	217,100
Kemmerer 1 (Natrium)	1,100

ABWR = Advanced Boiling Water Reactor; ANO = Arkansas Nuclear; APWR = Advanced Pressurized-Water Reactor; EPR = U.S. Evolutionary Power Reactor; ESBWR = Economic Simplified Boiling Water Reactor; SAMDA = severe accident mitigation design alternative; TMI = Three Mile Island.
(a) Value not available.

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10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)

The U.S. Nuclear Regulatory Commission (NRC) staff prepared this generic environmental impact statement (GEIS) in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended, to address the NRC licensing of the building and operation of new nuclear reactors in the United States. In this GEIS, the NRC staff uses the values and assumptions in a technology-neutral plant parameter envelope (PPE) for a new nuclear reactor to evaluate the environmental impacts of constructing and operating a nuclear reactor. In addition, this GEIS assumes that a new reactor might be built anywhere in the United States that meets the requirements of the NRC's siting regulations. To accommodate this broad range of siting possibilities, the staff developed a site parameter envelope (SPE) that provides limiting values and assumptions related to the site. The results from this GEIS will be codified in Title 10 of the Code of Federal Regulations Part 51.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)

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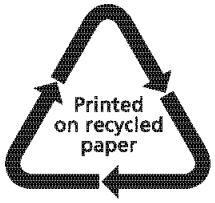

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