Abstract

This document is a supplement to the U.S. Nuclear Regulatory Commission (NRC) document *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities* issued in 1988 (NUREG-0586, referred to here as the 1988 Generic Environmental Impact Statement [GEIS]). This Supplement was prepared because of the technological advances in decommissioning operations, experience gained by licensees, and changes made to NRC regulations since the 1988 GEIS.

This Supplement updates the information provided in the 1988 GEIS. It is intended to be used to evaluate environmental impacts during the decommissioning of nuclear power reactors as residual radioactivity at the site is reduced to levels that allow for termination of the NRC license. This Supplement addresses only the decommissioning of nuclear power reactors licensed by the NRC. It updates the sections of the 1988 GEIS relating to pressurized water reactors, boiling water reactors, and multiple reactor stations. It goes beyond the 1988 GEIS to consider high-temperature gas-cooled reactors and the fast breeder reactors. This document can be considered a stand-alone document such that readers should not need to refer back to the 1988 GEIS. The environmental impacts described in this Supplement supercede those described in the 1988 GEIS.

The scope of this Supplement is based on the decommissioning activities performed to remove radioactive materials from structures, systems, and components from the time that the licensee certifies that they have permanently ceased power operations until the license is terminated. The scope of the document was determined through public scoping meetings and meetings with other Federal agencies and the nuclear industry. An evaluation process was then developed to determine environmental impacts from nuclear power reactor facilities that are being decommissioned. The evaluation process involved determining the specific activities that occur during reactor decommissioning and obtaining data from site visits and from licensees at reactor facilities currently being decommissioned. The data obtained from the sites were analyzed and then evaluated against a list of variables that defined the parameters for facilities that are currently operating but which will one day be decommissioned. This evaluation resulted in a range of impacts for each environmental issue that may be used for comparison by licensees that are or will be decommissioning their facilities.

Contents

1

Contents

Contents

Contents

Figures

Tables

Executive Summary

This document is a supplement to the U.S. Nuclear Regulatory Commission (NRC) document *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities,* issued in 1988 (NUREG-0586, referred to here as the 1988 Generic Environmental Impact Statement [GEIS]).[(a)] As a supplement, this document considers the technological advances in decommissioning, the experience gained by licensees, and the changes in NRC regulations since the 1988 GEIS. The information from the 1988 GEIS that is still current and applicable to permanently shutdown and currently operating commercial nuclear power reactors is included here. This Supplement is intended to be used to evaluate environmental impacts during the decommissioning of nuclear power reactors as residual radioactivity at the site is reduced to levels that allow for termination of the NRC license.

The NRC elected to supplement the GEIS:

(1) to further the purposes of the National Environmental Policy Act (NEPA)

(2) to update the information in the GEIS

(3) to provide additional information to the public on decommissioning activities

(2) to establish an envelope of environmental impacts that could be associated with decommissioning activities.

Unlike the 1988 GEIS, which took a broad look at decommissioning of a variety of sites and activities, this Supplement addresses only nuclear power reactors licensed by the NRC. It updates the sections of the 1988 GEIS relating to pressurized water reactors, boiling water reactors, and multiple reactor stations. It goes beyond the 1988 GEIS and considers the existing permanently shut down high-temperature gas-cooled reactor and the fast breeder reactor. It does not include research and test reactors or the decommissioning of reactors that have been involved in accidents. It also does not include other types of fuel-cycle facilities, such as fuel-reprocessing plants or small mixed oxide fuel-fabrication plants.

The intent of this Supplement is to consider in a comprehensive manner all aspects related to the radiological decommissioning of nuclear reactor facilities by incorporating updated information, regulations, and analyses. Since the 1988 GEIS was written, the NRC and the industry have gained substantially more nuclear power facility decommissioning experience. Based on the number of reactors shut down and the date that they permanently ceased operations, over 200 facility-years' worth of decommissioning experience have accumulated since the NRC published the 1988 GEIS. Currently, there are 19 commercial power reactors undergoing some phase of the decommissioning process. This includes nine that permanently ceased operations after the NRC published the 1988 GEIS. Since the 1988 GEIS, there are

(a) The GEIS is considered "generic" in that it evaluates environmental impacts from decommissioning activities common to a number of nuclear power facilities.

three facilities that have completed decommissioning and terminated their licenses. There are also new technologies and approaches applicable to decommissioning that the 1988 GEIS does not address. The regulations for decommissioning reactors have also undergone significant changes since the 1988 GEIS.

Scope of the Supplement

The content of this Supplement was initially defined by the scope of the 1988 GEIS and was modified based on current decommissioning regulations, input received during four public scoping meetings, letters and comments received during the scoping period, and meetings between the NRC and the U.S. Environmental Protection Agency (EPA) and the Council on Environmental Quality (CEQ).

The scope of this Supplement is based on the decommissioning activities performed to remove radioactive materials from structures, systems, and components (SSCs) from the time that the licensee certifies that they have permanently ceased power operations until the license is terminated. As a result, the activities performed before permanent cessation of operations (except for decommissioning planning) or impacts that are related to the decision to permanently cease operations (for example, the impact from the loss of generation capacity) are outside the scope of this document.

The Commission defines decommissioning as “to remove a facility or site safely from service and reduce residual radioactivity to a level that permits (1) Release of the property for unrestricted use and termination of the license; or (2) Release of the property under restricted conditions and termination of the license.” The staff has included activities that are directly related to the removal of radioactive material from the facility or that must be performed in order to facilitate the removal of contaminated SSCs, as well as the activities and impacts related to the removal of uncontaminated SSCs (such as the intake structure or cooling towers) that were required for the operation of the reactor.

The decommissioning process continues until the licensee requests termination of the license and demonstrates that radioactive material has been removed to the levels that permit termination of the NRC license. At that point, the NRC no longer has jurisdiction over the site and the owner of the site is no longer subject to NRC regulations. As a result, activities performed after license termination and the resulting impacts are outside the scope of this Supplement. These activities may include any non-NRC required monitoring, site restoration (grading, planting of vegetation, etc.), continued dismantlement (removal of uncontaminated structures or those that have been radiologically decontaminated), or continued use of the site for activities such as power production using natural gas, oil, or coal.

Any potential radiological impacts following license termination that are related to activities performed during the decommissioning period are not considered in this Supplement. Those impacts are covered by the *Generic Environmental Impact Statement in Support of Rulemaking*

on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities (NUREG-1496). Nonradiological impacts following license termination that are related to activities performed during the decommissioning period are considered in this Supplement.

Levels of Significance and Applicability of Environmental Impacts

This Supplement provides a measure of (a) the significance and severity of potential environmental impacts and (b) the applicability of these impacts to a variety of plants both permanently shut down and operating. The significance of the environmental impacts is described as either SMALL, MODERATE or LARGE. The applicability of these impacts to a variety of plants is categorized as either generic or site-specific.

Levels of Significance: The NRC's standard of significance was established using the CEQ terminology for "significantly" (40 CFR 1508.27, which considers "context" and "intensity"). Using the CEQ terminology, the NRC established three significance levels: SMALL, MODERATE, or LARGE.

> SMALL - Environmental impacts 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 in this Supplement, the NRC has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small.
>
> MODERATE - Environmental impacts are sufficient to alter noticeably but not to destabilize important attributes of the resource.
>
> LARGE - Environmental impacts are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The discussion of each environmental issue in this Supplement includes an explanation of how the significance level was determined. In determining a significance level, the NRC staff assumed that ongoing mitigation measures would continue (including those mitigation measures implemented during plant construction and/or operation) during decommissioning, as appropriate. Benefits of additional mitigation measures during or after decommissioning are not considered in determining significance levels.

Applicability: In addition to determining the significance of environmental impacts, this Supplement includes a determination of whether the analysis of the environmental issues could be applied to all plants, and whether additional mitigation measures would be warranted. An environmental issue may be assigned to one of two categories:

- Generic - For each environmental issue, the analysis reported in this Supplement shows the following:

  (1) Environmental impacts associated with the issue have been determined to apply either to all plants, or for some issues to plants of a specific size, specific location or having a specific type of cooling system or site characteristics, and

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts, and

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

- Site-specific - For each environmental issue, the analysis reported in this Supplement has shown that one or more of the generic criteria was not met. Therefore, additional plant-specific review is required. Examples of site-specific issues are threatened and endangered species, and environmental justice.

Use and Development of this Supplement

This Supplement can be used by the public to understand the decommissioning process, the activities performed during decommissioning, and the potential environmental impacts of these activities. It identifies activities that can be bounded by a generic evaluation. Licensees can rely on the information in this Supplement as a basis for meeting the requirements in 10 CFR 50.82(a)(6)(ii). This requirement states that the licensee must not perform any decommissioning activity that causes any significant environmental impact not previously reviewed. The NRC staff will also rely on this Supplement as a basis for determining if anticipated decommissioning impacts require an additional review.

The staff first created an initial list of environmental issues and activities that this Supplement should address. The initial list of environmental issues was developed from issues (such as air quality, aquatic ecology, and radiological impacts) identified in the 1988 GEIS and in the list specified in 10 CFR Part 51, Subpart A, Appendix B, for license renewal. This list was used because it represents the potential impacts associated with nuclear power facilities. The initial list of decommissioning activities was modified based on experience, the scoping process, site visits to six facilities currently being decommissioned, and meetings with EPA and CEQ.

After compiling the issue and activity lists, the staff assessed which activities might have environmental impacts for each of the issues. The next step was to identify the variables that might affect the decommissioning impact for a specific issue and activity. For example, the proximity of the plant to a barge slip or railroad might affect the licensee's decision to remove the steam generator or other large components intact and ship them to a waste site. If the barge slip needs additional dredging, or an additional railroad line needs to be installed, then the environmental impacts may change.

The analyses in this Supplement include data from both operating and decommissioning facilities in order to appropriately span the range of impacts that could be expected. Data from

decommissioning facilities was used to determine whether the potential impacts from decommissioning activities for the various issues are generic or site-specific. Data from operating facilities were used to ensure that this Supplement will be valid for all commercial nuclear power reactors.

Alternatives

The alternative to the action of decommissioning is not to decommission the facility. The option to restart the reactor is not considered to be an alternative to decommissioning because the decision to permanently cease operation prevents the licensee from operating the reactor without a significant safety and environmental review by the NRC staff.

The alternative to decommissioning at the end of the licensing period is a "no action" alternative, implying that a licensee would simply abandon or leave a facility after ceasing operations. NRC regulations do not allow the option of not decommissioning. Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for an additional 20 years if NRC requirements are met. However, at the end of the licensing period (whether it has been extended or not), the regulations require that the facility be decommissioned. Once the facility permanently ceases operation, if the licensee does not conduct decommissioning activities to an extent that meets the license termination criteria in 10 CFR Part 20, Subpart E, then the license will not be terminated (although the licensee will not be authorized to operate the reactor). The licensee will be required to comply with the necessary requirements for the operating license. As a result, the environmental impacts for maintaining the nuclear reactor facility will be considered to be in the bounds of the appropriate, previously issued Environmental Impact Statements.

Conclusions

Table ES-1 presents each evaluated environmental issue and identifies whether the issue is considered generic or site-specific. If the issue is considered generic, then it is assigned a significance level of either SMALL, MODERATE or LARGE. Of the environmental issues assessed, most of the impacts are generic and SMALL for all plants regardless of the activities and identified variables (see Appendix E for a list of the variables). The two issues determined to be site-specific are threatened and endangered species and environmental justice. Four additional issues are conditionally site-specific. Land use activities requiring major transportation upgrades, aquatic and terrestrial ecology, and cultural and historic resources are site-specific for activities occurring outside the disturbed areas in which there is no recent environmental assessment.

Licensees undergoing or planning decommissioning of a commercial nuclear power reactor can use this Supplement in support of their evaluation of the environmental consequences from decommissioning. The impacts identified in this Supplement are designed to span the range of impacts from all plants that are currently permanently shutdown as well as the plants that are currently operating, including the plants that have or may renew their licenses beyond the original 40-year license; a renewed license can be issued for a period not to exceed 20 years

beyond the expiration of the operating license. When planning a specific decommissioning activity, licensees that fall within the bounds of the impacts, as described in Chapter 4, may proceed with the activity with no further analysis. However, if a site falls outside the bounds of the identified environmental impacts, then the activity cannot be performed until the licensee performs a site-specific analysis of the activity. Depending on the results of the site-specific evaluation, the staff may determine that it is appropriate to consult with another agency (such as the U.S. Fish and Wildlife Service or a State Historic Preservation Office). If the activity would result in an impact that is outside the bounds of the GEIS or other environmental assessments, the licensee would be required to submit a license-amendment request.

Table ES-1. Summary of the Environmental Impacts from Decommissioning Nuclear Power Facilities

Issue	Generic	Impact
Onsite/Offsite Land Use		
- onsite land use activities	Yes	SMALL
- offsite land use activities	Yes	SMALL
- offsite activities that require major transportation upgrades	No	Site-specific
Water Use	Yes	SMALL
Water Quality		
- Surface water	Yes	SMALL
- Groundwater	Yes	SMALL
Air Quality	Yes	SMALL
Aquatic Ecology		
- Activities within the boundaries of previously disturbed areas or outside the disturbed areas with a current ecological assessment	Yes	SMALL
- Activities outside the boundaries of previously disturbed areas and no recent ecological assessment	No	Site-specific
Terrestrial Ecology		
- Activities within the boundaries of previously disturbed areas or outside the disturbed areas with a current ecological assessment	Yes	SMALL
- Activities outside the boundaries of previously disturbed areas and no recent ecological assessment	No	Site-specific
Threatened and Endangered Species	No	Site-specific
Radiological		
- Activities resulting in occupational dose to workers	Yes	SMALL
- Activities resulting in dose to the public	Yes	SMALL
Radiological Accidents	Yes	SMALL, or MODERATE, or LARGE
Occupational Issues		
- Noise, temperature, ergonomic, and biological hazards	Yes	SMALL
- Physical hazards from construction activities, electrical shock, and accidental falls	Yes	MODERATE
Cost	NA[(a)]	NA
Socioeconomic		
- Population change <3%	Yes	SMALL
- Population change between 3% and 5%	Yes	MODERATE
- Population change >5%	Yes	LARGE
- Annual tax revenue loss <10%	Yes	SMALL
- Annual tax revenue loss between 10% and 20%	Yes	MODERATE
- Annual tax revenue loss >20%	Yes	LARGE
Environmental Justice	No	Site-specific

Table ES-1. (contd)

Issue	Generic	Impact
Cultural and Historic Resource Impacts		
- Activities within the boundaries of previously disturbed areas or activities outside the boundaries of previously disturbed areas with a current cultural resource survey available	Yes	SMALL
- Activities outside the boundaries of previously disturbed areas with no current cultural resource assessment	No	Site-specific
Aesthetics	Yes	SMALL
Noise	Yes	SMALL
Transportation	Yes	SMALL
Irretrievable Resources	Yes	SMALL
(a) A decommissioning cost assessment is not a specific National Environmental Policy Act (NEPA) requirement. However, an accurate decommissioning cost estimate is necessary for a safe and timely plant decommissioning. Therefore, this Supplement includes a decommissioning cost evaluation, but the cost is not evaluated using the environmental significance levels nor identified as a generic or site-specific issue.		

Abbreviations/Acronyms

µGy	microGray(s)
µSv	microSieverts
ac	acre(s)
AEA	Atomic Energy Act of 1954
AEC	U.S. Atomic Energy Commission
ALI	annual limits on intake
ALARA	as low as reasonably achievable
ANPR	advanced notice of proposed rulemaking
BLM	Bureau of Land Management
Bq	Bequerel(s)
BWR	boiling water reactor
C	Celsius
CAA	Clean Air Act
CDE	committed dose equivalent
CEDE	committed effective dose equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
Ci	Curie
CWA	Clean Water Act
DAC	derived air concentration
dBA	decibel
DBA	design-basis accident
DDREF	dose or dose rate effectiveness factor
DE	dose equivalent
DNL	day-night average sound level
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EA	environmental assessment
EDE	effective dose equivalent
EIS	environmental impact statement
EJ	environmental justice

EPA	U.S. Environmental Protection Agency
ER	environmental report
ESA	Endangered Species Act of 1973
ES&H	environment, safety and health
F	Fahrenheit
FBR	fast breeder reactor
FES	final environmental statement
FHA	Federal Housing Administration
FR	Federal Register
FSAR	final safety analysis report
ft	foot/feet
FWPCA	Federal Water Pollution Control Act (also known as the Clean Water Act of 1977)
FWS	U.S. Fish and Wildlife Service
gal.	gallon(s)
GEIS	Generic Environmental Impact Statement
gpd	gallons per day
gpm	gallons per minute
GTCC	Greater than Class C (waste)
Gy	gray(s)
ha	hectare(s)
HDA	high decommissioning activity
HEPA	high-efficiency particulate air filter
HLW	high-level waste
h	hour
HTGR	high-temperature gas-cooled reactor
HUD	U.S. Department of Housing and Urban Development
HVAC	heating, ventilation, and air conditioning
IAEA	International Atomic Energy Agency
in.	inch(es)
I&C	instrumentation and control
ICRP	International Commission on Radiological Protection
ISFSI	independent spent fuel storage installation

kg	kilogram(s)
km	kilometer(s)
kV	kilovolt(s)
kWh	kilowatt hour(s)
L	liter(s)
LDA	low-decommissioning activity
LER	license event report
LET	linear energy transfer
LLW	low-level waste
LOS	level of service
LRA	license renewal application
LTP	license termination plan
LWR	light water reactor
m	meter(s)
m^3/d	cubic meters per day
m^3/s	cubic meters per second
MARSSIM	Multi-agency Radiation Survey and Site Investigation Manual, NUREG-1575
MBTA	Migratory Bird Treaty Act of 1918
mi	mile(s)
mGy	milliGray(s)
MPC	maximum permissible concentrations
mrad	millirad(s)
mrem	millirem(s)
mSv	milliSievert(s)
MTBA	Migrating Bird Treaty Act of 1918
MTHM	metric tonnes of heavy metal
MT	metric ton(s) (or tonne[s])
MTU	metric ton(s)-uranium
MW	megawatt(s)
MWd/MTU	megawatt-days per metric ton of uranium
MW(e)	megawatt(s) electric
MW(t)	megawatt(s) thermal
MWh	megawatt hour(s)
NA	not applicable
NAS	National Academy of Sciences
NBS	National Bureau of Standards
NCRP	National Council on Radiation Protection and Measurements

NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act of 1969
NHPA	National Historic Preservation Act
NIST	National Institute of Standards and Technology
NMFS	National Marine Fisheries Service
NO_x	nitrogen oxide(s)
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRR	Nuclear Reactor Regulation
NWPA	Nuclear Waste Policy Act of 1982
ODCM	Offsite Dose Calculation Manual
OSHA	Occupational Safety and Health Administration
PAG	protective action guide
PCBs	polychlorobiphenyls
PEL	permissible exposure limit
POL	possession-only license
PPE	personal protective equipment
PSDAR	post-shutdown decommissioning activities report
PV	pressure vessel
PWR	pressurized water reactor
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RCS	reactor coolant system
ROW	rights of way
RPV	reactor pressure vessel
SARA	Superfund Amendments and Reauthorization Act
SHPO	State Historic Preservation Officer
SI	Systeme Internationale (international system of units)
SO_2	sulfur dioxide
SO_x	sulfur oxide(s)
SSCs	structures, systems, and components
Sv	sievert(s)
TEDE	total effective dose equivalent
THPO	Tribal Historic Preservation Officer

UNSCEAR	United Nations Scientific Committee on The Effects of Atomic Radiation
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound
VRM	Visual Resource Management (system)
wk	week(s)
YNPS	Yankee Nuclear Power Station
yr	year(s)◦