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Generic FSAR Template Guidance for Life Cycle Minimization of Contamination

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Nuclear Energy Institute

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NOTICE

EXECUTIVE SUMMARY

NEI 08-08, *Generic FSAR Template Guidance for Life-Cycle Minimization of Contamination*, Revision 0, provides a complete generic program description for use in developing construction and operating license (COL) applications. The document reflects contemporary Nuclear Regulatory Commission (NRC) guidance, including Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants," and industry-NRC discussions regarding the applicable standard review plan section. A main objective of this program description is to assist in expediting NRC review and issuance of the combined license.

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GENERIC FSAR TEMPLATE GUIDANCE FOR LIFE-CYCLE MINIMIZATION OF CONTAMINATION

1 INTRODUCTION

The nuclear power industry has long recognized the benefits and value of implementing sound radiation protection principles to achieve occupational and public doses that are as low as reasonably achievable (ALARA) and to minimize contamination and radioactive waste generation. The implementation of procedures, engineering controls, lessons learned and financial assurance requirements for decommissioning have been evident in the nuclear industry's efforts to minimizing contamination and the generation of radioactive waste. In addition, under the Industry Ground Water Protection Initiative (GPI), nuclear power plants developed and implement a site-specific/company ground water protection program to assure timely and effective management of situations involving inadvertent releases of licensed material to ground water. The GPI guidance was amended to include lessons learned and was published as "Industry Ground Water Protection Initiative – Final Guidance Document" (Reference 3). "Groundwater Protection Guidelines for Nuclear Power Plants," EPRI Report 1015118, dated November 2007 (Reference 4) provides one acceptable approach for an effective ground water protection program.

The new reactors general design consideration for the ALARA principles result in plants that minimize contamination and the generation of radioactive waste. Regulatory Guide 8.8 ALARA recognize that contaminated air and liquids present the potential for intake by inhalation and absorption and that contaminated surfaces present the potential for intake by ingestion The basic variables identified that can be controlled to limit dose from internal exposure include those that limit (1) the amount of contamination and (2) the dispersal of the contamination. Therefore the ALARA principles include elements of a contaminant management philosophy that is part of the nuclear industry's total life cycle consideration for a facility.

This document reflects consideration of NRC's Regulatory Guide 4.21, Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning (Reference 5).A Combined License (COL) applicant's program that is consistent with this guidance document is an acceptable alternative method to R.G.4.21

Each license's risk informed approach toward limiting leakage and/or controlling the spread of contamination is integrated in the design of the type facility selected and supplemented by the operating programs, processes and procedures. This template describes the content of operating programs/processes that will demonstrate compliance with 10 CFR 20.1406. Where specific site information is needed, that information is contained by double parentheses **(( ))** and will be provided by the applicant.

2 APPLICABILITY AND CONTROLS

This template applies to applicants for licenses whose applications are submitted after August 20, 1997 and provides an acceptable format and information that may be used by a Combined License (COL) applicant to meet 10 CFR 20.1406.

3 MINIMIZING FACILITY CONTAMINATION

3.1. MINIMIZATION OF LEAKS AND SPILLS AND PROVISION OF CONTAINMENT

3.1.1 The design for the **((**ABWR,EPR,AP-1000, ESBWR,US APWR**))**facility incorporates features, to the extent practicable, that ensure the integrity of systems, structures, and components (SSCs) to minimize leaks and spills, contain leaks/spills where they might occur, and include detection where industry experience indicates potential for leakage.

((Provide the section (s) of the Design Control Document (DCD) that describes, to the extent practicable, how, the facility design minimizes contamination of the facility and the environment, facilitates eventual decommissioning, and minimizes the generation of radioactive waste.**))**

NOTE: This information should consider as a minimum the items identified in Appendix A of this document.

3.1.2 The facility layout will include designated areas for maintenance of equipment, decontamination of equipment/tools, and the storage of radioactive material. Clean areas will be segregated from contaminated areas.

3.1.3 Radiologically significant leaks and spills are addressed and contained to ensure compliance with 10 CFR Part 20, and to minimize contamination to the extent practicable and cost effective.

3.1.4 Evaluate all systems, structures, or components (SSCs) that contain or could contain licensed material and for which there is a credible mechanism for the licensed material to reach ground water. Work practices that involve licensed material and for which there is a credible mechanism for the licensed material to reach ground water will also be evaluated. (Reference 3, Objective 1.2)

a. Identify each SSC and work practice that involves or could reasonably be expected to involve licensed material and for which there is a credible mechanism for the licensed material to reach ground water. Examples of SSCs of interest include: refueling water storage tanks, if outdoors; spent fuel pools; spent fuel pool leak detection systems; outdoor tanks; outdoor storage of contaminated equipment; buried piping; retention ponds or basins or reservoirs; lines carrying steam

((Identify design features that are incorporated into specific plant systems that minimize the contamination of the facility, environment, and the generation of

radioactive waste based on the risk of the plant system potential for contamination of the facility and the environment.**))**

NOTE: Consider the systems identified in Appendix B, as a minimum.

b. Identify existing (included in the design)leak detection methods for each SSC and work practice that involves or could involve licensed material and for which there is a credible potential for inadvertent releases to ground water. These may include ground water monitoring, operator rounds, engineering walk downs or inspections, leak-detection systems, or periodic integrity testing

c. Identify potential enhancements to leak detection systems or programs. These may include additional or increased frequency of rounds or walk downs or inspections, or integrity testing

d. Identify potential enhancements to prevent spills or leaks from reaching ground water. These may include resealing or paving surfaces or installing spill containment measures

e. Establish long term programs to perform preventative maintenance or surveillance activities to minimize the potential for inadvertent releases of licensed materials due to equipment failure.

f. Establish the frequency for periodic reviews of SSCs to update site risk to ground water contamination.

3.2. PROMPT DETECTION OF LEAKAGE

3.2.1 Evaluate the facility to identify the leak detection capability of systems with the potential for leakage and for which there is a credible mechanism for the licensed material to reach groundwater. The leak detection system should be capable of detecting minor leaks that could potentially cause significant environmental contamination. (Reference 3, Objective 1.3)

((Provide a list of potential leak sources and identify whether early detection of leaks is accomplished by leak detection or monitoring**))**

NOTE: The potential leak sources identified in Appendix C, as a minimum should be addressed.

3.2.2 The on-site groundwater monitoring program will ensure timely detection of inadvertent radiological releases to ground water by implementing the following:

a. Using the hydrology and geology studies developed under 4.1.below, consider placement of ground water monitoring wells down gradient from the plant but within the boundary defined by the final safety analysis report.

b. Consider, as appropriate, placing sentinel wells closer to SSCs that have the highest potential for inadvertent releases that could reach ground water or SSCs where leak detection capability is limited.

c. Establish sampling and analysis protocols and frequencies, including analytical sensitivity requirements, for ground water and soil. Sampling for tritium in the vadose or unsaturated zone may not be practicable and may require additional evaluation. For split or duplicate samples, analytical sensitivity levels should be discussed with and agreed to by those external stakeholders responsible for the analyses to preclude future disputes.

d. Establish a formal, written program for long-term ground water monitoring.

e. Periodically review existing station or contract lab(s) analytical capabilities. An important consideration is the time needed to obtain results.

f. Establish a long-term program for preventative maintenance of ground water wells.

g. Establish the frequency for periodic review of the ground water monitoring program.

3.3. AVOIDANCE OF THE RELEASE OF CONTAMINATION FROM UNDETECTED LEAKS

3.3.1 The leak detection program objective is to identify minor leaks that over an extended period of time could result in accumulation of subsurface residual contamination. Example of SSCs of interest includes buried pipes with radioactive liquids, tanks/pools embedded in concrete, or in contact with soil that are susceptible to undetected leakage.(Reference 5, Section A-1)

3.3.2 Establish a remediation protocol to prevent migration of licensed material off-site and to minimize decommissioning impacts. The protocol will include the following: (Reference 3, Objective 1.4)

a. Written procedures outlining the decision making process for remediation of leaks and spills or other instances of inadvertent releases. This process is site specific and shall consider migration pathways.

b. Evaluations of the potential for detectible levels of licensed material resulting from planned releases of liquids and/or airborne materials.

c. Evaluate and document, as appropriate, decommissioning impacts resulting from remediation activities or the absence thereof.

3.4. REDUCING DECONTAMINATION OF EQUIPMENT AND STRUCTURES

3.4.1 The facility design for components containing radioactive liquids considers the selection of materials; minimization of buried components; improved protection of buried components; the use of industry consensus codes and standards for repair and/or replacement of components; periodic inspection or testing; and quality control and quality assurance in the procurement specifications and during installation of components based on their potential for leakage and importance to radiation safety.**((** Provide the sections of the Design Control Document (DCD) that describe, to the extent practicable, how these features meet this.**))**

3.4.2 The facility ventilation design for areas containing radioactive contamination includes provisions for ensuring that air flow moves from the areas of no or minor contamination to areas with greater contamination. **((**Provide the sections of the Design Control Document (DCD) that describe, to the extent practicable, how, these feature meet this.**))**

3.4.3 The operational ALARA program decreases the probability of a release, the amount released, and the spread of a contaminant by considering: temporary or supplemental ventilation systems; treating the exhaust from vents and overflows, and using techniques to control releases of radioactive liquids and steam.

3.5. REVIEW OF OPERATIONAL PRACTICES

3.5.1 Establish a frequency for the review of worker practices that involve licensed material and for which there is a credible mechanism for the licensed material to reach ground water.(Reference 3, Objective 1.2, Acceptance Criterion g)

3.5.2 Events that result in leaks and spills of radioactive materials will be documented in the applicants' corrective action program. The level of analysis and evaluation will be specified and based on the significance of the event.(Reference 3, Objective 1.2, Acceptance Criterion e)

4 GUIDES FOR MINIMIZING CONTAMINATION OF THE ENVIRONMENT

4.1. SITE CONCEPTUAL MODEL DEVELOPMENT

4.1.1 The applicant will ensure that the site characterization of geology and hydrology provide an understanding of predominant ground water gradients based upon current site conditions. (Reference 3, Objective 1.1,and Reference 4)

NOTE: FSAR Section 2.4 Hydrologic Engineering contains the data for site

characterization.**((**Define the timing for development and implementation of the Site Conceptual Model**))**

4.1.2 Perform hydrogeologic and geologic studies to determine predominant ground water flow characteristics and gradients.

4.1.3 As appropriate, review existing hydrogeologic and geologic studies, historical environmental studies, and permit or license related reports.

4.1.4 Identify potential pathways for ground water migration from on-site locations to off-site locations through ground water.

4.1.5 Establish the frequency for periodic reviews of site hydrogeologic studies. As a minimum, reviews should be performed whenever any of the following occurs.

a. Substantial on-site construction,

b. Substantial disturbance of site property,

c. Substantial changes in on-site or nearby off-site use of water, or

d. Substantial changes in on-site or nearby off-site pumping rates of ground water.

e. Based on this review, update the site's Final Safety Analysis Report as appropriate with changes to the characterization of hydrology and/or geology.

4.1.6 The applicant's site characterization, facility design, construction, potential release mechanisms, release scenarios and location of contaminant provides an understanding of the interface with environmental systems and the features that will control movement of contamination in the environment.

4.2 EARLY DETECTION OF LEAKAGE AND CONTAMINANT MIGRATION

Leak detection measures, programs for preventative maintenance and surveillance, on-site ground water monitoring program, and periodic evaluation of potential flow paths from buried SSCs or those in contact with the ground to minimize contamination of the environment will be implemented in site procedures.

4.3. FINAL SITE CONFIGURATION

4.3.1 The site conceptual model will be updated with the final "as-built" site configuration following construction.

4.3.2 The site characterization of geology and hydrology will be reviewed to ensure an understanding of predominant groundwater gradients based upon this final site configuration.

4.3.3 The protocol for responding to the detection of leaks and spills is identified in sections 3.3.2 and 3.5.2 of this document.

5. FACILITATION OF DECOMMISSIONING

5.1. DESIGN AND OPERATIONAL FEATURES THAT FACILITATE DECOMMISSIONING

5.1.1 The means for facilitating decommissioning begins at the design stage and should be incorporated into the procedures and operations. The objective is to ensure that throughout the life of the facility, the design and operating procedures minimize the amounts of residual radioactivity that will require remediation at the time of decommissioning. **((**Provide the sections of the Design Control Document (DCD) that describe, to the extent practicable, how design features facilitate decommissioning to reduce the spread of radioactive material.**))**

5.2 DECOMMISSIONING RECORDS

5.2.1 Records of instances of facility and environmental contamination and operational events that are of interest for decommissioning or that result in residual contamination will be documented over the lifetime of the plant. The records of leaks, spills, and the remediation of any leak with the potential to contaminate groundwater are retained and retrievable to meet the record keeping practices and retention periods to comply with 10 CFR 50.75(g), 10 CFR 30.35 (g), 10 CFR 40.63 (f), 10 CFR 70.25 (g) and 10 CFR 72.30 (g).

5.2.2 The above documented events will assist in developing a historical assessment of the site and facility reducing the time, effort, and hazard to personnel during decommissioning activities. These records should also be used to determine an area's classification for purposes of performing surveys during decommissioning.(see NRC Regulatory Issue Summary 2002-02 Lessons Learned Related to Recently Submitted Decommissioning Plans and License Termination Plans).(Reference 3, Objective 1.5,Acceptance Criterion a)

6 MINIMIZING THE GENERATION OF WASTE

6.1 LIFE CYCLE WASTE MANAGEMENT

6.1.1 The approach used to identify significant radioactive components used in the facility and the waste that will result from operations and processing will be documented.

6.1.2 The program will consider options to implement measures that minimize waste generation and radioactivity levels over the life cycle of the facility, including decommissioning

6.2 ONSITE STORAGE OF RADIOACTIVE WASTE

6.2.1 The waste management program should include additional onsite storage when other disposal or treatment outlets are not available. Provisions for the decontamination and decommissioning of the storage facility should be considered.

6.2.2 Periodic assessments of the waste stored onsite should also be performed.

7. DEFINITIONS

Radiologically Significant –refers to the presence of radioactive materials at levels which could result in radiation exposures and doses in excess of the 10 CFR Part 20 requirements for radiation workers and members of the public, or in excess of liquid and airborne effluent concentration limits and releases to sewers under Appendix B to Part 20.

Ground water as used in this document, means any subsurface water, whether in the unsaturated or vadose zone, or in the saturated zone of the earth.

Leak or Spill: The terms “leak” or “spill” refers to an inadvertent event or perturbation in a system or component’s performance that results in contamination escaping from its intended confinement or container.

Licensed material (from 10 CFR 20.1003) means source material, special nuclear material, or byproduct material received, possessed, used, transferred or disposed of under a general or specific license issued by the Commission.

Minor Leakage A small leakage rates (e.g., several gallons per week) originating from an independent zone, such as a spent fuel pool and its associated piping would be a clearly defined independent zone

8. REFERENCES

1. 10 CFR Part 20.1406 “Minimization of Contamination”

2. Regulatory Guide 8.8, Information Relevant To Ensuring That Occupational Radiation Exposures At Nuclear Power Stations Will Be As Low As Is Reasonably Achievable
3. NEI 07-07 “Industry Ground Water Protection Initiative – Final Guidance Document”, August 2007
4. EPRI –TR-1015118, Groundwater Protection Guidelines for Nuclear Power Plants, November 2007 (Non-proprietary)
5. Regulatory Guide 4.21, Minimization of Contamination and Radioactive Waste Generation : Life-Cycle Planning

APPENDIX A

FACILITY DESIGN AND OPERATIONAL IMPLEMENTATION OF 10 CFR 20.1406						
		DCD REFERENCE				
	Design Items	AP-1000	ESBWR	EPR	ABWR	US-APWR
	Minimize leaks and spills and provide containment in areas where such events may occur,					
	Provide for adequate leak detection capability to provide prompt detection of leakage for any structure, system, or component which has the potential for leakage,					
	Use leak detection instrumentation capable of detecting minor leaks in areas where it is difficult or impossible to conduct regular inspections (such as for spent fuel pools, tanks that are in contact with the ground, and buried, embedded, or subterranean piping) to avoid release of contamination from undetected leaks,					
	Reduce the need to decontaminate equipment and structures by decreasing the probability of any release, reducing any amounts released, and decreasing the spread of the contaminant from the source,					
	Provide for early detection of leakage and contamination migration to minimize contamination of the environment,					
	Facilitate decommissioning by …b) minimizing embedded and buried piping,					
	Facilitate decommissioning by...c) designing the facility to facilitate the removal of any equipment					

	and/or components that may require removal and/or replacement during facility operation or decommissioning,					
	Minimize the generation and volume of radioactive waste both during operation and during decommissioning (by minimizing the volume of components and structures that become contaminated during plant operation)					
	Detect leakage from the piping in any radwaste trenches.					
	Verify that there are no piping runs containing contaminated fluids that will be buried in the ground and not routed through one of the radwaste trenches.					
	Isolate areas containing radioactive components and materials from areas containing non-radioactive components and minimize interfaces between them					
	Use designs and materials that facilitate maintenance, decontamination and eventual disposal					
	To the extent practical, ensure that SSC containing radioactive materials are separated from the environment by at least two impermeable barriers					
Operational and Procedural Items		**AP-1000**	**ESBWR**	**EPR**	**ABWR**	**US-APWR**
	Periodically review operational practices to ensure that, operating procedures are revised to reflect the installation of new or modified equipment, personnel qualification and training are kept current, and facility personnel are					

	following the operating procedures,					
	Facilitate decommissioning by maintenance of records relating to facility design and construction, facility design changes, changes to the facility during operation, site conditions before and after construction, onsite waste disposal and contamination and results of radiological surveys,					
	Develop a site conceptual model (based on site characterization and facility design and construction) which will aid in the understanding of the interface with environmental systems and the features that will control the movement of contamination in the environment,					
	Evaluate the final site configuration after construction to assist in preventing the migration of radionuclides offsite via unmonitored pathways,					
	Describe the criteria that govern the frequency of performing periodic visual inspections of the piping in the radwaste pipe trenches to check for leaks and of the floor/wall expansion joints in the radwaste pipe trenches to ensure that no spills or leaks on the floors enter unmonitored areas beneath the floors and foundations.					

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APPENDIX B

SPECIFIC DESIGN FEATURE INCORPORATED THAT SUPPORTS 10 CFR 20.1406					
	DCD REFERENCE				
SYSTEM	AP-1000	ESBWR	EPR	ABWR	US-APWR
Nuclear Steam Supply					
Fuel Storage and Handling					
Process Sampling System					
Equipment, Floor, Chemical, and Detergent Drain Systems					
Heating, ventilation and air conditioning systems used in buildings and rooms that contain radioactive materials or effluent streams					
Turbine Main Steam System					
Other Features of Steam and Power Conversion System					

APPENDIX C

PROMPT DETECTION OF LEAKAGE					
	LEAK DETECTION SYSTEM / MONITORING				
Potential Leak Source	**AP-1000**	**ESBWR**	**EPR**	**ABWR**	**US-APWR**
Radwaste Trench					
Radwaste Discharge Line					
Outside Tanks					
Buried Pipes					