Implementation of 10 CFR 20.1406, Regarding Minimizing Contamination and the Generation of Waste, and Facilitating Decommissioning through the Design of Facilities and Operating Procedures

E. O’Donnell, W.R. Ott
Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission
Washington, DC, 20555-0001
United States

ABSTRACT

In the very near future (perhaps as soon as the fall of 2007), the U.S. Nuclear Regulatory Commission (NRC) anticipates receiving one or more license applications for new nuclear power plants. An important consideration for new facilities is that they be designed and operated to minimize contamination, to minimize the generation of waste, and to facilitate decommissioning. A relatively recent regulation, 10 CFR 20.1406, mandates these requirements. The regulation states, “Applicants for licenses, other than renewals, after August 20, 1997, 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.” This paper summarizes various initiatives taken by the NRC and industry to develop guidance for implementing 10 CFR 20.1406 before submission of license applications.

INTRODUCTION

In 1997,modifications to its regulations, NRC added 10 CFR 20.1406 which reads:

> Applicants for licenses, other than renewals, after August 20, 1997, 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.

The intent of 10 CFR 20.1406 is to diminish the occurrence and severity of “legacy sites” by taking measures that will reduce and control contamination and facilitate eventual decommissioning. The Commission’s Office of Nuclear Material Safety and Safeguards has provided much useful information and guidance on decommissioning based on licensing experience (for example, see http://www.nrc.gov/what-we-do/regulatory/decommissioning/lessons-learned.html). That information is broadly applicable and includes a link to a 28-page bibliography of reports relating to decommissioning “lessons learned.” Although 10 CFR 20.1406 applies to all new facilities licensed by the U.S. Nuclear Regulatory Commission (NRC), for the near term, it is a particularly important consideration in the licensing of new nuclear power plants. To facilitate the licensing of new power plants, the NRC staff is preparing guidance for the implementation of 10 CFR 20.1406 before the fall of 2007, when it expects the first license application. Figure 1 shows the timing and interrelations of activities involved in the efforts to develop this guidance. The activities, described in the following sections, fall into three areas. One relates to modifying 10 CFR 20.1406 to apply to existing facilities. The second activity is the development of guidance for new power reactors, which entails revision of the Standard Review Plan (SRP) [1] for license applications for commercial power reactors and development of a regulatory guide for implementing 10 CFR 20.1406. The third is industry's initiatives in ground water protection and lessons learned.

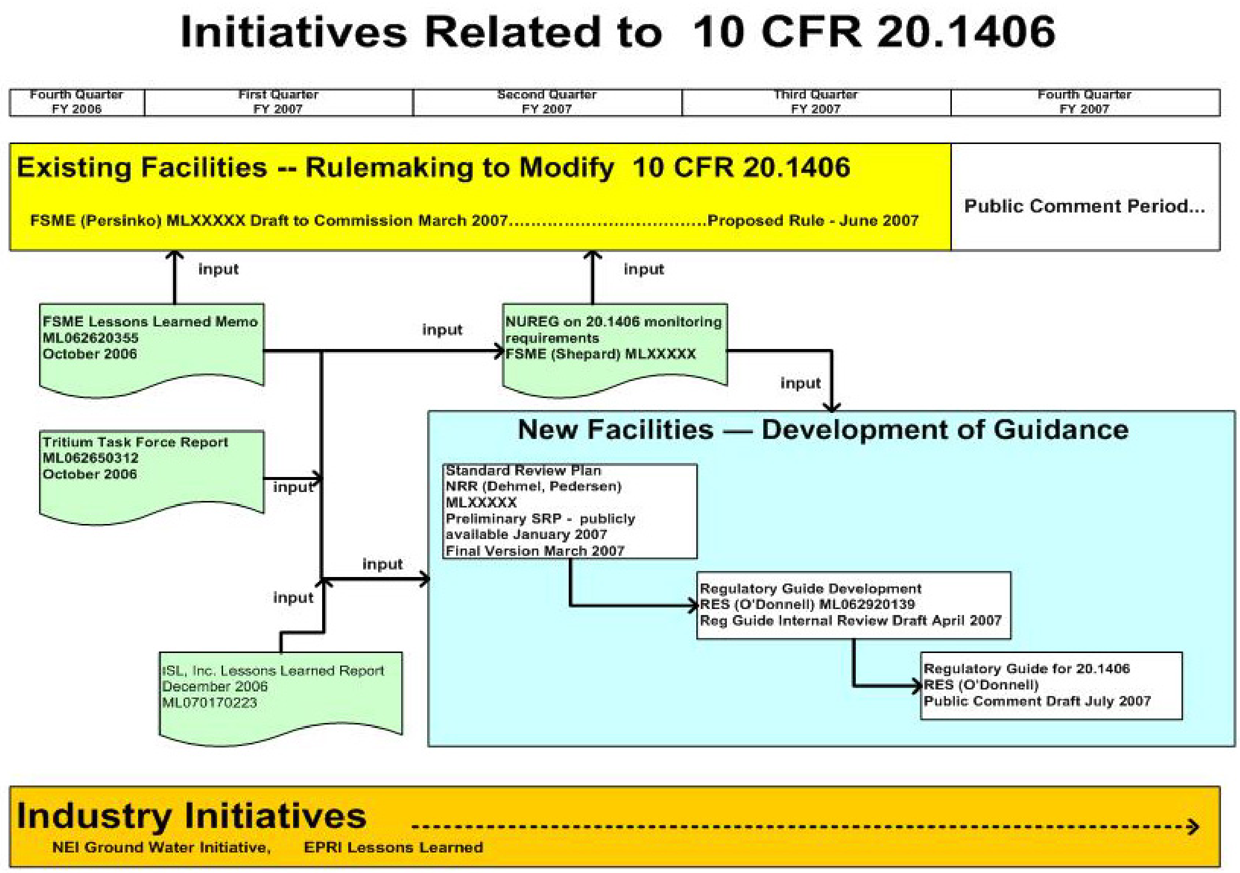

Fig. 1. NRC efforts in development of guidance for implementing 10 CFR 20.1406

GUIDANCE DEVELOPMENT ACTIVITIES

Existing Facilities—Rulemaking to Modify 10 CFR 20.1406

The Office of Federal and State Materials and Environmental Management Programs (FSME) is modifying 10 CFR 20.1406 to apply to existing facilities. As seen in Figure 1, a draft is scheduled to be ready for Commission consideration in March 2007, with a proposed rule available for public comment in Quarter 4 of fiscal year (FY) 2007. At the time this paper was completed, the actual content of this rulemaking was still evolving.

New Facilities—Development of Guidance

The Office of Nuclear Reactor Regulation is actively revising the SRP [1] and is developing a regulatory guide and a draft, DG-1145 [2], was released for public comment September 1, 2006. The draft guide is for combined operating license applications for light water reactors. The combined operating license contains authorization for both construction and operation and is based on preapproved reactor designs. Chapter 11 of the SRP will deal with effluent releases, and Chapter 12 will deal with occupational exposure. Revisions to both chapters will explicitly mention 10 CFR 20.1406. The SRP was available for internal review in January 2007, and the NRC will release it to the public in March 2007.

In addition to the rulemaking mentioned above, FSME is working on background documents that support both the rulemaking and the development of guidance for new facilities. One of these documents is a lessons-learned report [3] completed in October 2006. To support the rulemaking and to assist new facilities, FSME is working on a NUREG to provide guidance for implementing any new provisions of 10 CFR 20.1406. The NUREG is scheduled to accompany the 10 CFR 20.1406 rulemaking when FSME submits it to the Commission in March 2007.

In March 2006, the NRC's Executive Director for Operations established the Liquid Radioactive Release Task Force, commonly referred to as the Tritium Task Force, in response to incidents at the Braidwood, Indian Point, Byron, and Dresden nuclear power plants related to unplanned, unmonitored releases of radioactive liquids into the environment. This task force studied the causes of the releases and the public health impacts. The task force released a public report on its recommendations in October 2006 [4]. One particular theme that runs through the Tritium Task Force report is that industry should have guidance for detecting, evaluating, and monitoring releases from operating facilities via unmonitored pathways and that the NRC should require adequate assurance that facilities will detect leaks and spills before radionuclides migrate off site via an unmonitored pathway. The task force recommendations will serve as input to the 10 CFR 20.1406 rulemaking and the development of guidance for new facilities. Finally, the task force concluded that in no instance did the unplanned releases of radioactive liquids into the environment impact the health of the public.

The Office of Nuclear Regulatory Research is developing a regulatory guide for the implementation of 10 CFR 20.1406. A draft for internal review is anticipated in April 2007, with a draft for public comment expected in July 2007. A contractor, Information Systems Laboratories, Inc. (ISL), is assisting with this project. ISL reviewed available information to identify lessons learned that could be applied in a regulatory guide and provided those to the NRC in a letter report in December 2006 [5]. The letter report also contains the results of a related effort, in which ISL reviewed existing regulatory guides to identify those with a potential connection to 10 CFR 20.1406. Screening criteria, which were based on 10 CFR 20.1406, included consideration of (1) contamination, (2) decommissioning, or (3) waste generation through design or operations. Of the guides screened, 14 contain useful information for consideration in the proposed regulatory guide for implementation of 10 CFR 20.1406, 14 potentially need revision to reference 10 CFR 20.1406, 4 need a reference to the proposed regulatory guide, and 1 contains a potential conflict that should be resolved. The December 2006 letter report to the NRC provides detailed results of the regulatory guide review [5].

The regulatory guide for implementation of 10 CFR 20.1406 will draw heavily on input from the lessons-learned reports of FSME, ISL, and the Tritium Task Force, and it will be structured to address the four elements found in 10 CFR 20.1406, namely, (1) contamination of the facility, (2) contamination of the environment, (3) facilitation of decommissioning, and (4) generation of waste. The guide will consider both design and operation for each of these elements. Table I provides a preliminary listing of the factors to be considered for the regulatory guide. Each section begins with a statement of background information or regulatory philosophy and follows with more specific guidance.

Industry Initiatives

The Electric Power Research Institute (EPRI) has produced a number of useful reports relating to the decommissioning of nuclear facilities, and the previously mentioned bibliography developed by the Office of Nuclear Material Safety and Safeguards lists many of them. The detailed information in these reports is proprietary. However, to make the information more accessible to the public, EPRI is extracting the relevant information from key reports for release in summary form [6, 7]. The date of release to the public is unknown.

Recognizing the importance of minimizing releases of contaminants to ground water, the Nuclear Energy Institute (NEI) launched its Industry Initiative on Ground-Water Protection. The industry's chief nuclear officers approved this initiative, which is voluntary. The initiative recommended that each nuclear power plant have a site-specific plan for ground water protection in place by July 31, 2006. The intent is to (1) improve management of inadvertent radiological releases to ground water, (2) prevent migration of licensed radioactive materials off site, (3) quantify the impacts on decommissioning, and (4) enhance the trust and confidence of the local communities, the States, and the NRC. The initiative also provides for increased reporting of events, benchmarking of industry best practices, and possible standardization of some practices.

CONCLUSION

The NRC is working to provide guidance for the implementation of 10 CFR 20.1406 at least 6 months before the expected submittal of the first new reactor license. To ensure that all parties are well informed, the NRC has begun an ongoing public dialogue with industry and stakeholders through public workshops and meetings. For example, the NRC's Advisory Committee on Nuclear Waste held a 1-day session on decommissioning during the Committee's November 2006 meeting, and NEI/EPRI described lessons learned through reactor decommissioning [7]. Two additional information exchanges with industry and stakeholders occurred in public meetings at NRC headquarters on November 21, 2006 [9], and December 18, 2006 [6, 7]. In the November meeting, the NRC described its ongoing activities as shown in Figure 1. In the subsequent meeting, NEI/EPRI described their efforts in developing guidance for industry.

REFERENCES

1. U.S. Nuclear Regulatory Commission, 1996, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," NUREG-0800.
2. U.S. Nuclear Regulatory Commission, 2006, "Combined License Applications for Nuclear Power Plants (LWR Edition)", draft regulatory guide DG-1145.
3. Camper, Larry W., 2006, "List of Decommissioning Lessons Learned in Support of the Development of a Standard Review Plan for New Reactor Licensing," Memorandum, Office of Federal and State Materials and Environmental Management Programs, U.S. Nuclear Regulatory Commission, to David B. Matthews, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, October 10, 2006 (ADAMS Accession No. ML062620355).
4. U.S. Nuclear Regulatory Commission, Liquid Radioactive Release Task Force, 2006, *Liquid Radioactive Release Lessons Learned, Task Force Final Report*, September 1, 2006 (ADAMS Accession No. ML062650312).

5. Kennedy, M., 2004, *Lessons-Learned Report—Final Deliverable for the First Three Project Milestones of Task Order 4 under Contract No. NRC-04-04-062, ‘Identification and Prioritization of Changes to Regulatory Guidance to Support Implementation of 10 CFR 20.1406,’* Letter Report, Information Systems Laboratories, to E. O’Donnell, U.S. Nuclear Regulatory Commission, December 22, 2004 (ADAMS Accession Nos. ML070170223 and ML070170251).

6. O’Donnell, E., 2006, *Summary, Public Meeting between the Nuclear Regulatory Commission Staff and Nuclear Energy Institute (NEI), and the Electric Power Research Institute (EPRI) to Exchange Information on Industry Plans to Develop Guidance for Implementing 10 CFR Part 20.1406, ‘Minimization of Contamination,’* Memorandum, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, to W.R. Ott, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, December 22, 2006 (ADAMS Accession No. ML063550433).

7. Bushart, S., and K. Kim, 2006, *Guidance for Implementation of 10 CFR 20.1406: Groundwater Protection Requirements for Advanced Power Plants*, Slides Used in Public Meeting with the U.S. Nuclear Regulatory Commission, Electric Power Research Institute, December 18, 2006 (ADAMS Accession No. ML063560018).

8. Andersen, R. and S. Bushart, 2006, *Reactor Decommissioning Program Lessons Learned*, Transcript of 174th meeting of the Advisory Committee on Nuclear Waste, U.S. Nuclear Regulatory Commission, November 14, 2006 (ADAMS Accession No. ML063340136).

9. O’Donnell, E., 2006, *Summary, Public Meeting between the Nuclear Regulatory Commission Staff and Stakeholders to Exchange Information on Plans to Develop Guidance for Implementing 10 CFR Part 20.1406 Minimization of Contamination*, Memorandum, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, to W.R. Ott, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, December 4, 2006 (ADAMS Accession No. ML063380178).

Table I. Framework of Draft Guide for Implementation of 10 CFR 20.1406

Contamination of Facility	Regulatory Philosophy
	Licensees should consider the total life cycle of the facility, including removal and disposal, when designing or modifying facility structures, components, and operating processes.
	Licensees should endeavor to operate a clean plant (prevent leaks and spills and clean them up quickly when they do occur); aggressively control contamination and eliminate hot spots; minimize areas, to the extent practical, where licensed materials are used and stored; and minimize the amount of radiation work performed outside the restricted area.

	A maintenance and inspection program should apply to all components with a potential for leakage. An aggressive leak identification and repair program for components containing radioactive materials will prevent unnecessary contamination and will minimize radioactive waste.
	Despite any design considerations to either avoid or collect liquid waste, it is important during operations to be able to detect when such possible waste contamination starts so that personnel can quickly stop or mitigate its spread. Thus, the design should provide for continuous monitoring to detect any potential contamination. This should include placement of instruments at readily inspectable locations and writing associated procedures that will enable early detection of contamination. Because leakage detection is only the necessary first step, the licensee should have mitigation plans for quickly stopping the spread of any detected contamination.
	Licensees should isolate areas in which liquid radioactive waste is treated from production, loading, storage, and support systems and facilities by compartmentalization and access controls to reduce the potential for cross contamination.
	The initial design should provide system decontamination facilities/provisions to preclude major problems that may arise in operation (e.g., the rupture of temporary hose connections, exposure to partially shielded ion exchange columns, and lack of operating and maintenance space). These shortcomings can result in high doses to station staff, possible high liquid effluent releases, and significant levels of surface contamination.
	Specific Guidance on Structures, Systems, and Components
	The potential for contamination of nonradioactive “clean services” systems (such as station service air, nitrogen, or water supply) and components from leakage from adjacent radioactive systems containing contaminants can be reduced by separating piping for these services from piping that contains radioactive sources.
	Piping that carries radioactive sources can be designed for the lifetime of the station, thus avoiding the necessity for replacement and lessening the potential for contamination of nonradioactive systems if it is impractical to provide isolation through separate chases.
	The design of tank and piping systems used for liquid waste handling and treatment should take advantage of gravity flow to reduce the potential for contamination associated with pumping and pressurization. The design should call for appropriate plumbing materials with minimal pipe lengths and traps. Design considerations should strive to protect and/or isolate any liquid contamination through such redundancy concepts as multiple piping enclosures with pans to channel contamination runoffs for collection and processing.
	The design should specify reusable, life-of-plant components. The licensee should establish a program for selecting materials compatible with processing/disposal options.

	Limiting, to the extent practicable, the deposition of radioactive material within the processing equipment—particularly in the "dead spaces" or "traps" in components where substantial accumulations can occur—can reduce the necessity for decontamination.
	Ways to reduce the deposition of radioactive material in piping and enhance decontamination efforts include avoiding stagnant legs, locating connections above the pipe centerline, using sloping rather than horizontal runs, and providing drains at low points in the system.
	The design of radwaste processing systems should consider interfaces to mobile processing systems. For potentially radioactive lines, the design should consider connections using self-sealing quick disconnects. The design should incorporate operational interlocks to minimize the possibility of leakage and contamination and should ensure that spills and leaks from skid-mounted systems will be contained and routed to radioactive waste drains.
	Any buried piping that is part of the radwaste processing system should either have its integrity verified periodically or should be part of a monitoring program as a potential source of contamination.
	Measures to reduce the probability of release, reduce the amount released, and reduce the spread of the contaminant from the source (e.g., from systems or components that must be opened for service or replacement) can lessen the need to decontaminate equipment and station areas. Such measures include auxiliary ventilation systems, treatment of the exhaust from vents and overflows, drainage control such as curbing and floors sloping to local drains, or sumps to limit the spread of contamination from leakage of liquid systems.
	The selection of radiation-damage-resistant materials for use in high-radiation areas can reduce the need for frequent replacement and can reduce the probability of contamination from leakage.
	Surfaces can be decontaminated more expeditiously if they are smooth, nonporous, and free of cracks, crevices, and sharp corners. These desirable features can be realized by specifying appropriate design instructions, by giving attention to finishing work during construction or manufacture, and by using sealers (such as special paints) on surfaces where contamination can be anticipated. (American National Standards Institute (ANSI) Standard N101.2 provides helpful guidance on this matter.)
	Surfaces can be decontaminated more expeditiously if they are smooth. Epoxy-type wall and floor coverings that provide smooth surfaces will facilitate decontamination. Equipment and floor drain sumps lined with stainless steel reduce crud buildup and provide surfaces that are easily decontaminated.
	Concrete floors in areas subject to potential contamination should, as a minimum, be sealed, or alternatively, use stainless steel floor liners with catch basins. Appropriately sloped floor drains in areas where the potential for a spill exists can limit the extent of contamination. Drain systems for storm water and sanitary sewage should be separate from contaminated waste drain systems.

	Licensees should ensure that concrete block walls, constructed to allow removal for future maintenance or replacement of large components, are completely sealed to prevent intrusion of radioactive materials into the block interiors. Block walls that are not connected to the ceiling are not always sealed on top, which can allow contamination to enter the walls. In addition, contamination has occurred inside hollow and solid block walls that are sealed by concrete, paint, or other coatings. Contamination has been found within walls that are connected to ceilings and free-standing walls but are not physically connected to the ceilings or roofs. On properly sealed walls, the ceilings are sealed or closed so that no contamination can enter.
	Licensees should develop a floor/wall expansion joint inspection procedure so that floor and wall joints are installed and maintained properly to ensure that spills and leaks on the floors do not enter unmonitored areas beneath the floors and foundations.
	Administrative controls such as standard operating procedures can be effective in preventing the spread of contamination when radioactive material or contaminated equipment must be transported from one station location to another and when the route of transport through lower radiation zones or “clean” areas cannot be avoided.
	Ventilation systems should confine the radioactive materials within the process areas as close to the point of origin as practicable. Licensees should carefully select materials of construction for the ventilation systems and use smooth surface finishes to aid in decontamination. The design should employ ventilation stacks and ductwork with minimal lengths and minimal abrupt changes in direction. The design should permit convenient inspection, maintenance, decontamination, and/or replacement of critical components such as filters, fans, and dampers.
	Maintaining air pressure gradients and airflows from areas of low potential airborne contamination to areas of higher potential contamination can limit the spread of airborne contamination within the station. Licensees should conduct periodic checks to ensure that the design pressure differentials are being maintained.
	Portable or temporary ventilation systems or contamination enclosures and expendable floor coverings can control the spread of contamination.
	Performing work on some components inside disposable tents or, for less complicated jobs, inside commercially available disposable clear plastic glove bags can limit the spread of contamination.
	The construction of enclosures and glove boxes should use the highest quality materials and workmanship to ensure total containment and minimize leakage. Their design should permit filter replacement with minimum exposure to personnel performing this task and with minimum release of contaminants to the environment outside of the glove box or enclosure.

Contamination of Environment	Regulatory Philosophy	
	Any systems containing radioactivity should have double boundaries to the environment, have inspection capabilities, be part of a routine maintenance program (e.g., seals), and undergo periodic verification of integrity. Licensees should implement specific environmental monitoring (e.g., sampling of ground water close to the source), and environmental monitoring for the overall site.	
	Licensees should establish a comprehensive ground water monitoring program beyond the normal radioactive effluent monitoring program (REMP). REMP is not intended to define and monitor onsite conditions and contamination. In addition, REMP is not adequate for future site characterization and support of dose assessments. A comprehensive ground water monitoring program, beyond the normal REMP, will ensure the detection of leaks and spills before radionuclides migrate off site via an unmonitored pathway and will allow licensees to gather sufficient data so that the NRC staff can fully understand the types and movement of radioactive material contamination in ground water at the facility, as well as the extent of this contamination.	
	Guidance on Siting	
	Licensees should consider site suitability for mitigating any unplanned liquid releases into the soil and surrounding environment. They should perform detailed site surveys before reactor construction takes place to establish radioactive background levels. They should also perform detailed site characterization to determine contamination pathways for the release of radionuclides.	
	Licensees should adequately characterize the subsurface hydrologic characteristics of a site before construction to understand how potential contamination resulting from daily operation of the facility will migrate through the soil and possibly into the ground water. After the facility is built, licensees should verify that the subsurface hydrologic characteristics (e.g., directions and flow rates of ground water aquifers and geochemistry) remain consistent with the preconstruction hydrologic profile. If there are changes, licensees may need to evaluate those changes and address them during operations and before starting decommissioning.	

	Guidance on Leakage Detection
	Minor leaks over long periods of time can contribute to significant contamination in soil and ground water that results in significant costs for remediation. Tanks (e.g., radioactive waste storage tanks, chemical storage tanks), spent fuel pools, and process/transfer lines should be designed to resist corrosion and minimize leaks and should have leak detection and monitoring capabilities. For example, the detection system of a spent fuel pool should be capable of detecting minor leaks from the pool. This system should have the ability to be flushed with clean water to remove small quantities of borated water, and dissolve boric acid solids resulting from minor leaks from the spent fuel pool wall and floor welds, bellows to transfer channels, and access gates areas. In addition, the licensee should implement an operational program throughout the life of the facility to monitor and remediate any leaks.
	Leak detection systems for a spent fuel pool should be capable of detecting minor leakage from the pool.
	Storage tanks for radioactive material should have leak detection systems to ensure that any leakage of material is detected to prevent contamination of the soil and ground water under the tank. In addition, these tanks should have a catch basin around the base of the tank to collect minor through-wall leaks and ensure adequate collection and monitoring of precipitation on the outside of the tank.
	The instrument sensitivity of the leak detection systems should be at least consistent with that established for the routine REMP.
	Guidance on Structures, Systems, and Components
	Plant designs should minimize the use of embedded pipes, to the extent practicable, consistent with maintaining radiation doses as low as reasonably achievable during operations and decommissioning. Embedded pipes, especially those that are small in diameter (less than 6 inches), could complicate decommissioning activities because they can be very difficult to remove or to survey.
	There should be no bypasses or drains in the radioactive liquid waste treatment system by which waste may inadvertently circumvent treatment equipment components or be released directly to the environment.
	Sumps and retention ponds should have liners. Overflow of sumps should go to a monitored release path.
	Licensees should know what is underground and avoid the use of underground piping (or place it into structured pipe chases). Piping located within pipe chases should be inspectable (through a visual or leak detection system) to permit verification of the integrity of the piping. The design should eliminate floor drains and buried piping where possible, consider the use of double-walled lines in this instance, and minimize storm drains.

	The usage and design of seals should consider access for periodic maintenance and visual inspection to verify their integrity.
	Berms should be provided outside all doors associated with radioactive materials to prevent flow to outside grounds/soil.
	Penetrations through outer walls of a building containing radiation sources are sealed to prevent miscellaneous leaks to the environment. Licensees should thoroughly apply sealant to original construction joints.
	Licensees should develop a quality assurance inspection program that ensures that grouted areas have no cracks or fissures to allow fluids to bypass the floor drain and enter into unmonitored areas beneath the floors and foundations. The construction of concrete grouted connections for floor drains should be such that floor drains will collect leaks and spills on the floor.
	Licensees should construct clear separation between containment and the spent fuel pool in the fuel transfer canal. The design should consider use of continuous concrete pours for major containment barriers such as the spent fuel pool and transfer canal.
Facilitate Decommissioning	Regulatory Philosophy
	Licensees should keep good plant records and establish a program to ensure adequate and complete documentation of corporate knowledge and operational events beyond those required by the NRC in 10 CFR 50.75(g). This program can assist licensees in preparing a good historical assessment of a nuclear facility. An adequate historical assessment can save time and effort during decommissioning planning.

	Guidance on Planning for Decommissioning
	At some time during design and construction, either the architect-engineer or the operator should make comprehensive videotapes of equipment layout in areas where radiation fields are expected to be high following operations. For reactor system areas, the design should consider ease of robot access for carrying out activities such as inspections, maintenance operations, surveys, and sample taking. Licensees should ensure that as-built drawings are available after the plant is constructed. Global positioning system readings that pinpoint all buried component locations should also be available.
	During decommissioning planning, licensees should establish adequate measurement capabilities at the facility (e.g., onsite radiological laboratories and mobile units). This approach could increase efficiency by ensuring early in the decommissioning process that site characterization measurements to establish radiological conditions in the field or on site are accurate and reliable. Licensees should develop and implement a comprehensive site characterization plan before starting decommissioning activities. Comprehensive site characterization allows licensees to properly identify and quantify the amount and extent of contamination that needs to be remediated.
	Licensees that conduct radiological work in onsite areas not designated for radiological work should upgrade these areas. For example, this applies to the storage of radioactive waste. Upgrades could include increased effluent monitoring for sumps in turbine buildings and temporary or permanent enclosures of areas. Surveillance programs for these areas should monitor liquid and airborne effluents. Improvements to control contamination will facilitate decommissioning planning. Licensees should collect radiological information from these areas, which could be used later during decommissioning planning.
	In their planning, licensees should consider minimizing replacement of contaminated components, as well as methods to reduce their degree of contamination before disposal. Planning should include mockups and procedure development to help ensure the use of appropriate equipment or systems.
	Licensees should ensure the removal of all field-run piping during construction so as not to have random piping in the field that, when uncovered, will raise questions at decommissioning time. Licensees should not dispose of construction debris on site.

	The design should consider methods for easier removal of any equipment and/or components that may require removal and/or replacement. Mechanisms, such as cranes and lifts, should receive placement and type consideration for use and convenience to facilitate removal of any equipment and/or components. When designing enclosures for large pieces of equipment (e.g., steam generators, large piping, tanks), the licensee should determine how these pieces will be removed for replacement or permanently removed at the time of decommissioning. Licensees should evaluate the following: • size/space clearances • installation of removal roofs/walls • installation of lifting lugs • anchor points for lifts • shearable nuts and bolts • quick-disconnect components • ease of removal of insulation
Generation of Waste	Regulatory Philosophy
	Generators of any new waste stream should perform life-cycle waste management planning to define the strategy for waste conditioning, storage, or disposal. The design of the systems should enable operators to carry out decontamination efficiently, with a minimum of collective dose and production of radioactive waste.
	Workers should know how to inspect for leakage. Workers should also know how to use any equipment for removing liquid contamination and/or techniques in a responsive way at any time during reactor operations.
	Licensees should ship waste off site when it is generated, thereby avoiding legacy wastes.
	Licensees should establish onsite decontamination facilities and/or waste segregation facilities to manage large quantities of radioactive material/waste. Licensees should also consider component placement and packaging to provide for waste compaction and to minimize contaminant disposal.
	Guidance on Structures, Systems, and Components
	Licensees should consider volume reduction systems for minimizing the volume of generated waste, consistent with ANSI/American Nuclear Society (ANS) Standard 40.35-1984, “Volume Reduction of Low-Level Radioactive Waste.”
	Continuous pours eliminate potential leakage in seams but are difficult to dismantle and could create significant quantities of contaminated waste at decommissioning. Modular construction permits separate layers of contaminated material to be removed to minimize the volume of contaminated waste.