Implementation of 10 CFR 20.1406 through Life Cycle Planning for Decommissioning - 9324

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ABSTRACT

This paper summarizes a newly released regulatory guide (RG 4.21 "Minimization of Contamination and Radioactive Waste Generation – Life Cycle Planning") issued by the U.S. Nuclear Regulatory Commission (NRC) in June 2008. The purpose of RG 4.21 is to support implementation of 10 CFR 20.1406 "Minimization of Contamination." That regulation is a portion of NRC's License Termination Rule and it is intended to avoid "legacy sites," that is, those without financial means to satisfactorily terminate a license. As currently written, 10 CFR 20.1406 applies to all NRC license applications and applications for standard design certifications submitted after August 20, 1997. The regulation requires applicants to address in their application how they will (1) minimize contamination of the facility and environment, (2) minimize waste generation, and (3) facilitate decommissioning. The regulation represents a dramatically different approach to licensing because it mandates consideration of decommissioning before submittal of a license application or design for certification.

The guidance in RG 4.21 consists of design considerations drawn from nuclear industry experience and lessons learned from decommissioning. These have been combined to support the development of a contaminant management philosophy. The principles embodied in this philosophy are threefold: (1) prevention of unintended releases; (2) early detection, if there is unintended release of radioactive contamination; and (3) prompt assessment to support a timely and appropriate response. Applying these principles requires the use of sound design, proven engineering practices, conservative radiation protection principles, and attention to operational practices. All of this should be considered in the context of the life cycle of the facility from the early planning stages through the final plans for decommissioning and waste disposal. This guide describes some of the mechanisms that can be employed for facility life-cycle planning for decommissioning and it is relevant to nuclear facilities not subject to licensing by NRC. It is available electronically in NRC's agency data management system (ADAMS accession number ML080500187) or through NRC's public web page at http://www.nrc.gov/reading-rm/doc-collections/reg-guides/environmental-siting/active/.

INTRODUCTION

The purpose of RG 4.21 is to present guidance that will assist applicants covered by 10 CFR 20.1406 in implementing this licensing requirement. 10 CFR 20.1406 requires applicants for licenses, design certification, approval of standard designs, and manufacturing licenses under 10 CFR Part 52 to submit information with regard to design and operational procedures for (1) minimizing radioactive waste generation, contamination of the facility and the environment, and (2) facilitating decommissioning.

As specifically stated in 10 CFR 20.1406:

> "(a) Applicants for licenses, other than early site permits and manufacturing licenses under part 52 of this chapter and renewals, whose applications are submitted 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."

> "(b) Applicants for standard design certifications, standard design approvals, and manufacturing licenses under part 52 of this chapter, whose applications are submitted after August 20, 1997, shall describe in the application how facility design 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."

Finally, the purpose of NRC's regulatory guides is to describe to the public methods that the staff considers acceptable for use in implementing the agency's regulations, to explain techniques that the staff uses in evaluating specific problems or postulated accidents, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations, and compliance with them is not required.

DISCUSSION

Planning for Minimizing Contamination Prior to Application Submittal

One of the significant early lessons learned about minimizing the radiological impacts of decommissioning was the importance of early planning for decommissioning. Such planning should include consideration of decommissioning at the time of initial design and continue throughout facility operations. The strategy should also be applied to minimizing contamination of the facility and the environment. Thus, during initial facility design planning, an applicant should comprehensively consider design aspects, construction, and operation until termination of the license by NRC. License termination includes consideration of decommissioning activities until satisfactory facility and site release is accomplished (i.e., meeting the radiological criteria in Subpart E, "Radiological Criteria for License Termination," of 10 CFR Part 20, "Standards for Protection Against Radiation").

Minimize Leaks and Spills and Provide Containment

Applicants should strive through design, worker practices, preventative maintenance, and effective operating procedures to minimize leaks and spills, provide containment in areas where such events might occur, quickly detect and clean up any leaks and spills that do occur, and take corrective action to stop the leaks. Areas where licensed materials are used and stored should be designed to facilitate operations (including clean-up), and minimize the amount of radiological work performed outside the restricted area.

Prompt Detection of Leakage

In addition to design considerations to control and, if possible, prevent radioactive system leakage, it is important during operations to be able to promptly detect leakage as close as possible to the leakage source to minimize the spread of contamination and to prevent uncontrolled or unmonitored releases and/or widespread contamination. Thus, monitoring and routine surveillance programs become an important part of minimizing potential contamination. This approach should include the placement of instruments to detect leakage at readily accessible locations and to implement operational practices that will enable early detection of contamination. Because leakage detection is only the first step in minimizing contamination, the applicant also should develop mitigation plans for quickly stopping any spread of contamination once it is detected.

Avoid Release of Contamination from Undetected Leaks

Past experience has shown that structures, systems or components (SSC) containing radiation that are not readily accessible for surveillance can be the source of undetected leaks of radioactive material over a prolonged period of time. The contamination from undetected leaks can accumulate as subsurface residual radioactivity that may need to be remediated prior to license termination. SSC that are buried or are in contact with soil, such as spent fuel pools (SFPs), tanks in contact with the ground, and buried pipes, are particularly susceptible to undetected

leakage. The available data from plants being decommissioned indicate that it was not uncommon for some level of undetected releases to occur in the subsurface environment during the plant operating life. These releases were generally minor leaks that occurred over an extended period of time. Many of the leaks occurred in areas where it was difficult or impossible to conduct regular inspections. This likely contributed to the failure to identify the leaks at the time of occurrence. Monitoring of systems was not sufficiently sensitive to identify small leaks and leakage rates. Such situations and conditions should be avoided during facility design. It is desirable to include leak detection systems within the facility design that are capable of detecting minor leaks that otherwise over time could potentially cause significant environmental contamination. It is also desirable to design the facility such that any SSC which has the potential for leakage is provided with adequate leak detection capability.

Measures for Reducing the Need to Decontaminate Equipment and Plant Areas

Licensees can reduce the need to decontaminate equipment and plant areas by taking measures that will decrease the probability of any release, reduce any leakage released, and decrease the spread of the contaminant from the source (e.g., from systems or components that must be opened for service or replacement). Such preventive and corrective measures can include auxiliary ventilation systems, treatment of the exhaust from vents and overflows, and techniques to control releases (i.e., capping or elevating uncontrolled drains, use of barriers or dikes, use of controlled sumps, and protection of SSC from inclement weather). Leakage from components containing radioactive liquids can be reduced by the proper selection of corrosion resistant materials; the use of industry consensus code repair/replacement requirements; adequate quality assurance, design standards, improved and expanded inspection requirements; improved protection of buried components (e.g., galvanic corrosion protection, coatings); and design considerations such as double-walled pipes and tanks with annulus monitoring. Minimization of leakage from SSC also involves corrective action strategies linked to monitoring analyses.

Minimizing the Generation of Radioactive Waste

Applicants should evaluate design and operational options to implement measures that minimize waste generation and radioactivity levels and fit each phase of the expected life-cycle of the facility. For each phase, the implementation of such measures should consider the merits of various technological options, lessons-learned from the use of prior or similar technology, assess public health and safety and protection of the environment, and confirm compliance with applicable Federal, State, and local regulations governing the management of radioactive waste and wastes characterized by the presence of hazardous chemicals and radioactivity.

While the measures identified in the Regulatory Guide 4.21 focus on minimizing the generation of radioactive waste, it is recognized that there are constraints and competing factors that may govern the selection of specific measures for waste minimization. In many instances, an applicant or licensee has no control over such constraints and may be forced to balance competing factors against operational flexibility and costs, while satisfying all applicable regulatory requirements at the same time. For example, access to or availability of offsite low-level waste disposal capacity may be beyond the control of an applicant or licensee.

The methods chosen to manage radioactive waste should be carefully considered for the purpose of meeting regulatory requirements for transportation and waste acceptance criteria of specific disposal or treatment outlets. For some waste streams, a processing method that may be used to reduce the overall volume of waste might result in an increase of the specific activity of the waste; thereby, making it more difficult or impossible to find appropriate disposal outlets for higher activity wastes, such as Class B and C wastes under the requirements of 10 CFR Part 61. In other instances, the amount or volume of waste is not the issue, but rather their radiological and chemical properties, such as for mixed waste, which may restrict options in finding treatment and disposal outlets unless one of the hazardous properties is de-listed. NRC and EPA regulations control the storage of mixed wastes. Some States impose additional regulations addressing the characterization, treatment, transportation, and disposal of mixed wastes.

When disposal or treatment outlets are not available, an applicant or licensee may be required to develop additional onsite storage capacity. The availability of waste disposal facilities depends on whether States or regional low-level waste compacts have provided facilities for long-term storage and disposal. For on-site storage, applicants and licensees should integrate the associated operations into existing waste management programs, address decontamination and decommissioning of the storage facility, and conduct periodic reassessments of waste already being stored, given that changes in future disposal requirements might possibly make stored wastes unacceptable for disposition under new requirements.

Operational Practices Should be Periodically Reviewed

Operational practices are another important consideration in meeting the objectives of 10 CFR 20.1406. These practices should be subjected to periodic review to ensure that facility personnel follow operating procedures; that operating procedures are revised to reflect the installation of new or modified equipment or plant processes; and that personnel qualification and training are kept current with the latest versions of operational programs and procedures. Operational programs and procedures should be subjected to review and evaluation following events that resulted in leaks and spills of radioactive materials. As part of the root-cause analysis, the evaluation should determine (1) whether procedures, equipment, and operator errors contributed to the event and releases, and (2) identify immediate and long-term corrective actions. The results of such lessons-learned should then be assessed as to their broader applicability to similar or related facility operations and incorporated as needed into revised programs and procedures.

Proper Records will Facilitate Decommissioning

The provisions of 10 CFR 50.75(g) contain requirements for maintaining records "...of information important to the safe and effective decommissioning of the facility." These records furnish information important to the decommissioning process, providing details on contaminating events and residual levels of contamination in the environment. In addition, regulations including, but not limited to, 10 CFR 30.50, 10 CFR 35 Subpart L, 10 CFR 40.60 and 40.61, 10 CFR 70 Subpart G, and 10 CFR 72 Subpart D have reporting requirements important to decommissioning. It is important to capture these events (e.g., leaks or spills), properly record them when they occur, and maintain records in a readily accessible manner which can aid in the eventual decommissioning of the facility.

Site Configuration to Prevent or Confine Contamination

License and certification applicants should consider the site configuration following construction to aid in preventing the migration of radionuclides offsite via an unmonitored pathway. They should develop an onsite monitoring program, as an integral part of the radiological environmental monitoring program (REMP), to provide early detection and quantification of leaks and spills and maintain a current baseline of radiological and hydrogeological parameters. Plans for responding to detection of leaks and spills should reflect final facility design and site configuration.

A Risk Informed Approach

The guide should be implemented in a risk-informed approach that considers the magnitude of the hazard involved. License applications submitted to the NRC cover more than 100 different kinds of activities. These activities do not all reflect the same potential for contamination of a facility and the environment, or for the generation of radioactive waste. Therefore, the applicant should use judgment to determine the extent to which the guide applies to any given facility or activity. Factors that may enter into this decision include the material's form (e.g., dry solids, liquids, gases), the inventory, and the material's environmental mobility. Figure 1 shows the decision paths an applicant might take in determining the applicability of this guide. In considering the flow paths in Figure 1, note that the regulations contain no exceptions with regard to the applicability of 10 CFR 20.1406 for

license applications and design certifications submitted after August 20, 1997 other than an exception for early site permits and license renewals. Even applications that do not deal with large or significant amounts of radioactive material need to address the minimization and facilitation provisions of the regulations, but they should do so using common sense and good judgment.

As seen in Figure 1, if a facility will store or handle large volumes of dispersible radioactive material, then the applicant should consider the full range of the measures found in the guide. If the facility will handle significant amounts of dispersible radioactive material (e.g., amounts that, if released, might result in extensive cleanup activities either during operation or decommissioning), the form of the material that will be released needs to be considered. A facility which primarily stores or handles liquid radioactive material, for example, should give consideration to the provisions in this guide to prevent and control inadvertent liquid releases. Similarly, for a gas, consideration should be given to the provisions to control inadvertent gaseous releases. Conceptually, this also applies to dry solid radioactive wastes, with consideration taken for obvious differences in chemical and physical forms.

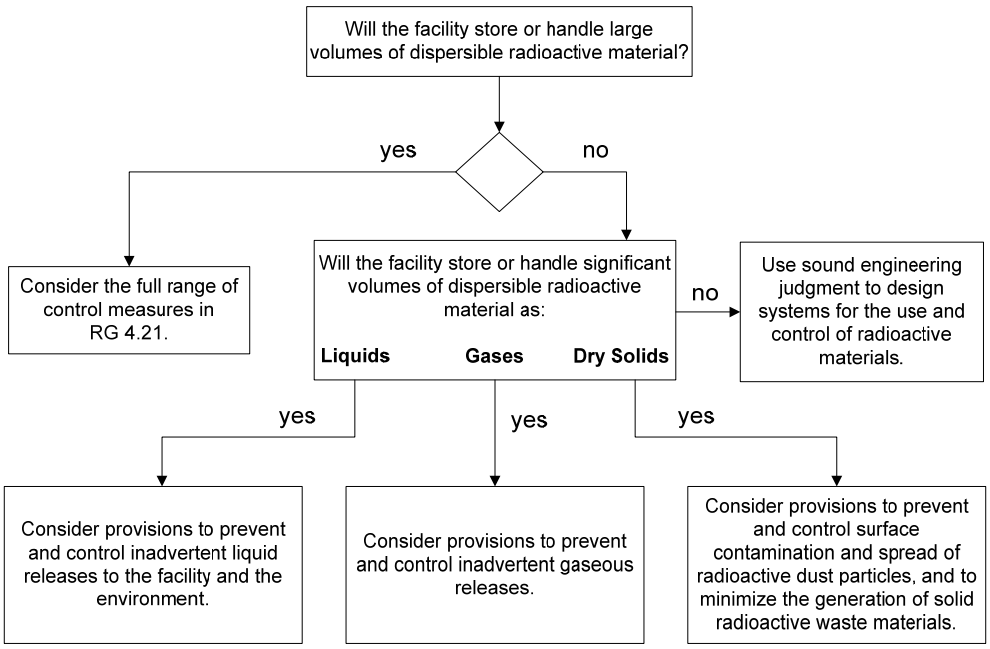

Fig. 1. The decision paths an applicant might take in determining the applicability of the draft guide

Further information which may be useful in determining the applicability of the guide is found in Table I. The Table is based on the type of facility, the physical form of the radioactive material, half-life, and inventory. For major, complex facilities with significant inventories of radioactive material such as a commercial nuclear power plant, enrichment facility, fuel fabrication facility, or a radioactive waste disposal facility (Table 1, Groups 1 and 2), the guide should assist an applicant in meeting the requirements of 10 CFR 20.1406. For smaller facilities which do not have large inventories, especially ones in which the material has a short half-life or is in the form of a sealed source (Table 1, Group 4), an applicant would need to consider only those design measures which directly apply to the type of radioactive material and processes to be authorized and the potential for contamination of the facility or environment. In this case, applicants should focus on historical information that reflects the likelihood of contamination of the facility and environment to identify the systems that should be designed and operated consistent with 10 CFR 20.1406.

Table I: Applicability of Draft Guide Relative to Type of Facility, Physical Form of Radioactive Material (i.e., liquid, gas, solid), Half-life, and Inventory (i.e., High, Intermediate, Low)

Type of facility or use of radioactive material	Physical form of radioactive material involved		
	liquid	gas	dry solid
Group 1 High inventory, long half-life – Power Plants and Fuel Cycle Facilities			
commercial nuclear power plant	high	high	high
fuel fabrication plant	high	high	high
enrichment plant	high	high	high
reprocessing facility	high	high	high
Group 2 High inventory, long half-life – Waste Disposal Facilities			
high level waste disposal facility	high	moderate	moderate
low level waste disposal facility	moderate	low	high
radioactive waste processors	moderate	low	moderate
Group 3 Intermediate to low inventory, long half-life			
uranium mills and mines	moderate	moderate	moderate
research and test reactors	moderate	moderate	high
laboratories, research facilities, and academic and broad scope facilities	moderate	moderate	moderate
Group 4 Low inventory, half-life generally not long			
medical use of radioactive material	low*	low	low*
industrial use of radioactive material	low	low	low dependent on material.*
medical or industrial use of sealed sources	low	low	low

Legend: high = highest likelihood of using the measures in this guide
moderate = moderate likelihood of using the measures in this guide
low = low likelihood of using the measures in this guide
* emphasis on inventory control

SUMMARY AND CONCLUSIONS

The principles of Regulatory Guide 4.21 are threefold: (1) prevention, (2) early detection, and (3) prompt assessment to support a timely and appropriate response. If the guiding principles are followed through the use of sound scientific principles, proven engineering practices, and application of sound radiation protection principles, as well as careful attention to operational practices, it should result in meeting the requirements of 10 CFR 20.1406. This is shown graphically in Fig. 2. An applicant should aim to be in the region where the three circles overlap. In summary, the thrust of the draft guide is for an applicant to use technically sound engineering judgment and a practical risk-informed approach to achieve the objectives of 10 CFR 20.1406. This approach should consider the materials and processes involved (e.g., solids, liquids, gases) and focus on: (1) the relative significance of potential contamination; (2) areas most susceptible to leaks; and (3) the appropriate level of consideration to prevention and control of contamination that should be incorporated in facility design. Since the applicability of the guidance is a facility-by-facility decision, early consultation with the NRC is strongly suggested.

Fig. 2. Applicants should aim to be in the region where the three circles overlap.