Implementation of 10 CFR 20.1406 Through Life Cycle Planning for Decommissioning - 8267

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ABSTRACT

This paper summarizes a regulatory guide that the U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, is currently developing for use in implementing Title 10, Section 20.1406, of the *Code of Federal Regulations* (10 CFR 20.1406), "Minimization of Contamination." The intent of the regulation is to diminish the occurrence and severity of "legacy sites" by taking measures to reduce and control contamination and facilitate eventual decommissioning. The thrust of the regulatory guide is to encourage applicants to use technically sound engineering judgment and a practical risk-informed approach to achieve the objectives of 10 CFR 20.1406. In particular, such an 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 that are most susceptible to leaks, and (3) the appropriate level of consideration that should be incorporated in facility design and operational procedures to prevent and control contamination.

INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) issues regulatory guides to (1) describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency's regulations, (2) explain techniques that the staff uses in evaluating specific problems or postulated accidents, and (3) provide guidance to applicants. As such, regulatory guides are not substitutes for regulations, and compliance with regulatory guides is not required. In that spirit, the NRC published a Federal Register notice, dated July 31, 2007 [1], to announce the availability for public comment of Draft Regulatory Guide DG-4012, "Minimization of Contamination and Radioactive Waste Generation — Life Cycle Planning" [2]. The comment period ended in November 2007, and the NRC staff is currently revising the guide to reflect the comments received. The staff expects to release the final guide in the first quarter of Calendar Year 2008. Until then, DG-4012 will remain available electronically in the NRC's Agencywide Documents Access and Management System (ADAMS), under Accession No. ML071210011.

The regulatory guide under development is intended to provide guidance for implementation of Title 10, Section 20.1406, of the *Code of Federal Regulations* (10 CFR 20.1406), "Minimization of Contamination" [3]. The regulation requires that applicants for licenses, as well as standard design certifications and approvals and manufacturing licenses issued under 10 CFR Part 52 [4], must submit information regarding the design and operational procedures to (1) minimize contamination of the facility and environment, (2) facilitate decommissioning, and (3) minimize generation of radioactive waste. Specifically, 10 CFR 20.1406 sets forth the following requirements:

> (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.
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> (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.

These regulatory requirements are significant because they apply to all new license applications and design certifications/approvals. Consequently, the new regulatory guide under development is intended to facilitate that licensing by suggesting approaches that applicants can use to minimize contamination of the facility and environment, facilitate decommissioning, and minimize the generation of radioactive waste. Toward that end, the guidance consists of specific design considerations drawn from nuclear industry experience and lessons learned from decommissioning. These design suggestions provide examples of measures that can be combined to support a contaminant management philosophy, which embodies the three principles of (1) prevention, (2) early detection, and (3) prompt and aggressive cleanup (when warranted) of any unintended release of radioactive contamination. If these three guiding principles are followed through the use (to the extent practical) of procedures and engineering controls, based on sound radiation protection principles and careful attention to operational practices, they should meet the requirements of 10 CFR 20.1406. 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. The following section discusses some of the mechanisms that can be employed for life cycle planning.

DISCUSSION

Explore Opportunities to Minimize Contamination Before Application Submittal

One significant lesson learned about minimizing the radiological impacts of decommissioning is the importance of early planning. Such planning should include consideration of decommissioning at the time of initial design and continuing throughout the period of facility operations. Before submitting a license application (or application for a standard design certification or approval), an applicant should explore and carefully consider opportunities to minimize contamination of the facility and environment, as they relate to both facility design and operating procedures. Thus, during initial facility design planning, an applicant should comprehensively consider all aspects of design, construction, and operation through termination of the license by the NRC. Moreover, the latter aspect should include consideration of decommissioning activities until satisfactory facility and site release is accomplished (i.e., meeting the radiological criteria in Subpart E of 10 CFR Part 20 [5], as site-specifically approved by the NRC).

Minimize and Contain Leaks and Spills

Applicants should strive (through design, worker practices, preventive maintenance, and effective operating procedures) to minimize leaks and spills, provide containment in areas where such events might occur, quickly detect and clean 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 cleanup), while minimizing the amount of radiological work performed outside the restricted area.

Detect Leakage Promptly

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 source to minimize the spread of contamination and prevent uncontrolled or unmonitored releases and/or widespread contamination. Thus, monitoring and routine surveillance programs are important in minimizing potential contamination. This approach should include placing leakage detection instruments at readily accessible locations, and implementing operational practices to enable early detection of contamination. Because leakage detection is only the first step in minimizing contamination, the applicant also should also develop mitigation plans to quickly stop any spread of contamination once it is detected.

Avoid Release of Contamination from Undetected Leaks

Past experience has shown that structures, systems, and components (SSCs) that contain radiation and 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. SSCs that are buried or 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 plants' operating lives. These releases were generally from 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. System monitoring was not sufficiently sensitive to identify small leaks and leakage rates. To avoid such situations and conditions, it is desirable for the facility design to include leak detection systems that are capable of detecting minor leaks that otherwise (over time) could potentially cause significant environmental contamination. In addition, it is desirable to design the facility such that adequate leak detection capability is provided for any SSC that has the potential for leakage.

Reduce the Need to Decontaminate Equipment and Plant Areas

Licensees can reduce the need to decontaminate equipment and plant areas by taking measures to decrease the probability of any release, reduce any leakage, 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 may include auxiliary ventilation systems, treatment of exhaust from vents and overflows, and techniques to control releases (i.e., capping or elevating uncontrolled drains; using barriers, dikes, or controlled sumps; and protecting SSCs from inclement weather). Leakage from components containing radioactive liquids can also be reduced by properly selecting corrosion-resistant materials; using industry consensus code repair/replacement requirements; employing adequate quality assurance, design standards, and improved/expanded inspection requirements; improving the protection of buried components (e.g., galvanic corrosion protection, coatings); and implementing design considerations such as double-walled pipes and tanks with annulus monitoring. In addition, minimizing the leakage from SSCs involves corrective action strategies associated with monitoring analyses.

Apply Related Regulatory Guides on Minimizing Contamination

In addition to the regulatory guide that is currently under development, Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants" [6], applies to minimizing potential contamination, and Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable" [7], relates to reducing occupational radiation exposures. As applicable, the new regulatory guide under development incorporates elements from these earlier regulatory guides.

Minimize the Generation of Radioactive Waste

Applicants should evaluate design and operational options to implement measures that minimize both waste generation and radioactivity levels, and suit 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 and lessons learned from the use of similar technology; assess the protection of public health and safety and 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 focus on measures for minimizing the generation of radioactive waste, it is important to recognize that constraints and competing factors may govern the selection of specific measures. In many instances, an applicant has no control over such constraints, and may be compelled to balance competing factors against operational flexibility and costs, while simultaneously satisfying all applicable regulatory requirements. For example, access to or availability of offsite low-level waste disposal capacity may be beyond the control of an applicant.

The methods chosen to manage radioactive waste should be carefully weighed against the regulatory requirements for waste transportation, as well as the acceptance criteria established by specific disposal or treatment outlets. For example, for some waste streams, a processing method that might be used to reduce the overall volume of waste might inadvertently increase the specific activity of the waste. This, in turn, might make it more difficult (or even impossible) to find appropriate disposal outlets for the higher-activity wastes, such as Class B and C wastes subject to the requirements of 10 CFR Part 61 [8]. In other instances, the amount or volume of waste is not the issue; rather, the radiological and chemical properties (mixed waste, for example), may restrict options for disposal or treatment outlets, unless one of the hazardous properties is de-listed. Regulations promulgated by the NRC and the U.S. Environmental Protection Agency (EPA) control the storage of mixed wastes, and some States impose additional regulations regarding their characterization, treatment, transportation, and disposal.

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. When disposal or treatment outlets are not available, an applicant or licensee may be required to develop additional onsite storage capacity. For onsite 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 the waste that is already being stored, given that future changes in disposal requirements might make stored wastes unacceptable for disposition.

Review Operational Practices Periodically

Operational practices are another important consideration for meeting the objectives of 10 CFR 20.1406, so such practices should be subjected to periodic review. In so doing, the purpose is to ensure that facility personnel follow operating procedures, operating procedures are revised to reflect installation of new or modified equipment or plant processes, and personnel qualification and training are kept current with the latest versions of operational programs and procedures. Operational programs and procedures should also be subjected to evaluation following events that result in leaks or spills of radioactive materials. As part of the root-cause analysis of such events and releases, the evaluation should (1) determine whether procedures, equipment, and/or operator errors contributed to the event and/or its 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.

Maintain Proper Records To Facilitate Decommissioning

The provisions of 10 CFR 50.75(g) [9] 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], Subpart L of 10 CFR 35 [11], 10 CFR 40.60 [12] and 40.61 [13], Subpart G of 10 CFR 70 [14], and Subpart D

of 10 CFR 72 [15] have reporting requirements that are important to decommissioning. Thus, 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 that can aid in eventual decommissioning of the facility.

Configure the Site To Prevent or Confine Contamination

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

Employ a Risk-Informed Approach

Use of the regulatory guide should involve a risk-informed approach that considers the magnitude of the associated hazard. License applications submitted to the NRC address more than 100 different kinds of activities. These activities do not all reflect the same potential for either contamination of a facility or the environment, or the generation of radioactive waste. Therefore, in deciding the extent to which this guidance applies to any given facility or activity, an applicant should use sound judgment to evaluate the potential for contamination and its probable consequences. Factors that may enter into this decision include form (e.g., dry solids, liquids, gases), inventory, and environmental mobility of unintended releases. Figure 1 illustrates the decision paths that an applicant might take in determining the applicability of this guide.

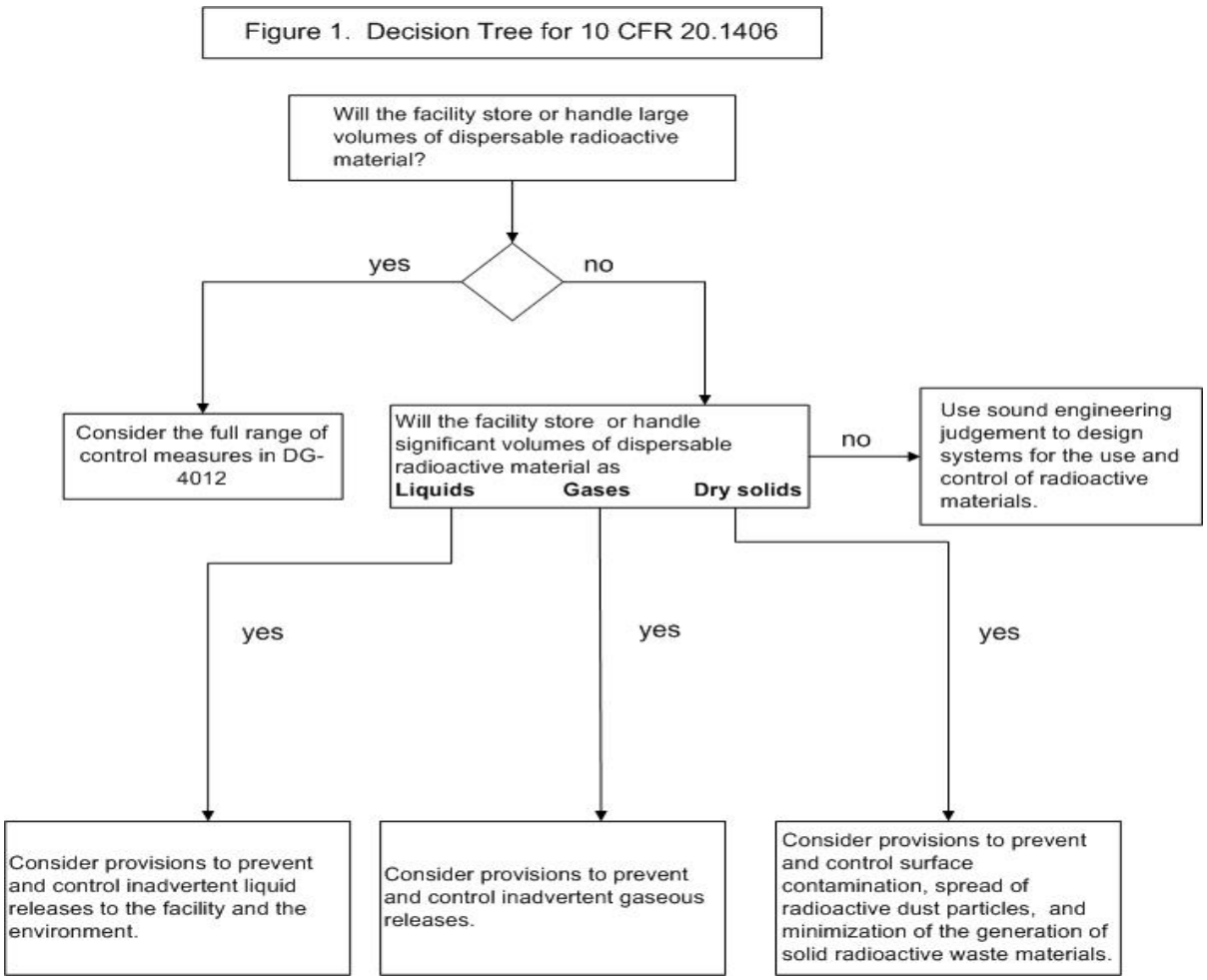

Fig. 1. The decision paths an applicant might take in determining the applicability of the regulatory guide.

In considering the flow paths in Figure 1, it is important to note that there are no exceptions regarding the applicability of 10 CFR 20.1406 for license and design certification applications submitted after August 20, 1997. Even applications that do not involve large or significant amounts of radioactive material must address the minimization and facilitation provisions of the regulation, but should do so using common sense and good judgment.

As seen in Figure 1, if a facility will store or handle large volumes of dispersable radioactive material, the applicant should consider the full range of measures found in this regulatory guide. If (despite those measures) the facility will still handle significant amounts of dispersable radioactive material (e.g., amounts that, if released, might result in extensive cleanup activities during either operation or decommissioning), the applicant should also consider the form of the material. In other words, depending on whether the dispersable radioactive material is a liquid, gas, or dry solid, the applicant should consider the provisions to prevent and control inadvertent liquid, gaseous, or solid releases.

Table I presents additional information that may be useful in assessing the applicability of the final regulatory guide, relative to the type of facility, physical form of the radioactive material, half-life, and inventory.

Table I: Applicability of the Regulatory Guide Relative to Type of Facility, Physical Form of Material, Half-Life, and Inventory

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, Generally Brief Half-Life			
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 the regulatory guide
moderate = moderate likelihood of using the measures in the regulatory guide
low = low likelihood of using the measures in the regulatory guide
***** = emphasis on inventory control

As shown in Table I, for major, complex facilities (Groups 1 and 2) with significant inventories of radioactive material (such as commercial nuclear power plants, enrichment facilities, fuel fabrication facilities, or radioactive waste disposal facilities), the regulatory guide should assist applicants in meeting the requirements of 10 CFR 20.1406. For smaller facilities (Group 4) that do not have large inventories, especially those in which the material has a short half-life or is in the form of a sealed source, applicants would need to consider only those design measures that directly apply to the type of material and processes to be authorized, and the potential for contamination of the facility or environment. In such cases, 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 in a manner that is consistent with 10 CFR 20.1406.

SUMMARY AND CONCLUSIONS

The three guiding principles of the regulatory guide under development encompass prevention, early detection, and prompt response when warranted. If these guiding principles are followed through the use (to the extent practical) of procedures and engineering controls based on sound radiation protection principles, as well as careful attention to operational practices, they should meet the requirements of 10 CFR 20.1406, as graphically depicted in Figure 2. Toward that end, applicants should aim to be in the region where the three circles overlap. In summary, the thrust of the guide is for applicants 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 that should be incorporated in facility design and operational procedures to prevention and control contamination. Given that the applicability of the guidance is a facility-by-facility decision, early consultation with the NRC is strongly suggested.

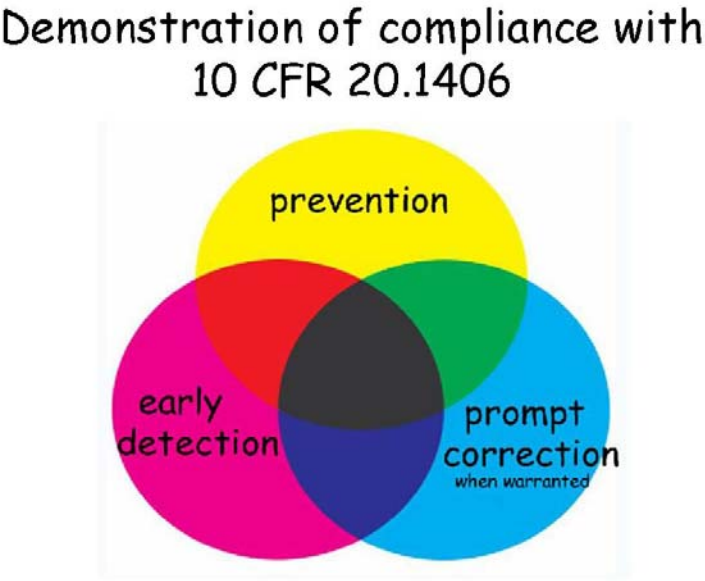

Fig. 2. Demonstration of compliance with 10 CFR 20.1406 (applicants should aim to be in the region where the three circles overlap).

References

1. **U.S. Nuclear Regulatory Commission**, "Draft Regulatory Guide: Issuance, Availability," *Federal Register*, Volume 72, No. 146, p. 41794, Office of the Federal Register (2007).

2. "Minimization of Contamination and Radioactive Waste Generation — Life Cycle Planning," Draft Regulatory Guide DG-4012, U.S. Nuclear Regulatory Commission (2007).

3. "Minimization of Contamination," Title 10, Section 20.1406, of the *Code of Federal Regulations* (10 CFR 20.1406), U.S. Nuclear Regulatory Commission.

4. "Licenses, Certifications, and Approvals for Nuclear Power Plants," 10 CFR Part 52, U.S. Nuclear Regulatory Commission.

5. "Radiological Criteria for License Termination," Subpart E of 10 CFR Part 20, "Standards for Protection Against Radiation," U.S. Nuclear Regulatory Commission.

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7. "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable," Regulatory Guide 8.8, Rev. 3, U.S. Nuclear Regulatory Commission (1978).

8. "Licensing Requirements for Land Disposal of Radioactive Waste," 10 CFR Part 61, U.S. Nuclear Regulatory Commission.

9. "Reporting and Recordkeeping for Decommissioning Planning," 10 CFR 50.75, U.S. Nuclear Regulatory Commission.

10. "Reporting Requirements," 10 CFR 30.50, U.S. Nuclear Regulatory Commission.

11. "Records," Subpart L of 10 CFR 35, "Medical Use ff Byproduct Material," U.S. Nuclear Regulatory Commission.

12. "Reporting Requirements," 10 CFR 40.60, U.S. Nuclear Regulatory Commission.

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14. "Special Nuclear Material Control Records, Reports, and Inspections," Subpart G of 10 CFR 70, "Domestic Licensing of Special Nuclear Material," U.S. Nuclear Regulatory Commission.

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