

# PROPOSED DRAFT GUIDANCE<sup>1</sup>

## DECOMMISSIONING PLANNING DURING OPERATIONS

### A. INTRODUCTION

#### Purpose

This guide describes a method acceptable to the U.S. Nuclear Regulatory Commission (NRC) for use in implementing the Decommissioning Planning Rule (DPR), which revises Title 10, Section 20.1406, “Minimization of Contamination,” and Section 20.1501, “General,” of the *Code of Federal Regulations* (10 CFR 20.1406 and 10 CFR 20.1501) (Ref. 1). Licensees of operating facilities are required to minimize contamination and radioactive waste generation, conduct appropriate radiological surveys, maintain records of contamination, and provide adequate funding to complete decommissioning. The DPR revised 10 CFR 20.1406 and 10 CFR 20.1501 to apply during the operational phase of facilities’ life cycles.

#### Background

In 1997, the NRC issued Subpart E, “Radiological Criteria for License Termination,” of 10 CFR Part 20, “Standards for Protection Against Radiation” (Ref. 2), known as the “License Termination Rule” (LTR). At that time, 10 CFR 20.1406 of the LTR required license applicants to describe in their applications how the design and procedures for operation of new facilities would minimize contamination and facilitate decommissioning. This requirement is an inherent, integral part of 10 CFR 20.1101, “Radiation Protection Programs,” (Ref. 3).

At the direction of the Commission, the NRC staff reviewed implementation of the LTR and developed several recommendations for revisions (Ref. 4). In its response (Ref. 5) to the staff recommendations, the Commission authorized the staff to develop rules to minimize the likelihood of new “legacy sites”—those sites with insufficient resources to complete decommissioning and terminate the license at the end of operations. On June 17, 2011, the NRC promulgated the DPR. The DPR requires all licensees to establish operational practices to minimize contamination and perform reasonable subsurface radiological surveys and sets forth new financial assurance requirements.

#### Requirements of the DPR

The current 10 CFR 20.1101 requirements to achieve doses that are as low as is reasonably achievable (ALARA) during facility operations and decommissioning are related to those in the new 10 CFR 20.1406(c). The DPR requires licensees to minimize the introduction of significant residual radioactivity into the site, including the subsurface, and to perform radiological surveys to identify the extent of contamination at their sites, including the subsurface. These surveys are to be reasonable under the circumstances to evaluate concentrations or quantities of residual radioactivity. The term “residual radioactivity” is defined in 10 CFR 20.1003 (Ref. 6), “Definitions,” as radioactivity in structures, materials, soils, ground water, and any other media at a site resulting from activities under the licensee’s control. The DPR characterizes “significant” residual radioactivity as “a quantity of radioactive material

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<sup>1</sup> ***This preliminary document is being issued for public review and comment in preparation for a revision to the draft regulatory guidance on the Decommissioning Planning Rule. It will be the basis for discussion at a public meeting to be held on July 12, 2012.***

that would later require remediation during decommissioning to meet the 25 mrem/yr [millirem/year] unrestricted use criteria of 10 CFR 20.1402.” Significant residual radioactivity may not present a risk to public health and safety during the operational phase of plant life.

The DPR broadens and clarifies the 1997 LTR as follows:

- It extends from applicants to licensees the requirements for operations to be conducted in a manner to minimize contamination, but does not mandate any design changes to operating facilities.
- It explicitly includes the subsurface in the radiological surveys required of all licensees by 10 CFR 20.1501(a).
- It establishes a threshold for when residual radioactivity becomes “significant” residual radioactivity.
- It requires all licensees having significant residual radioactivity to retain 10 CFR 20.1501(a) survey results with records important to decommissioning (it does not require licensees to submit reports of survey results).
- It requires licensees having significant residual radioactivity to arrange for sufficient funding to complete decommissioning and terminate the NRC license.

Although the DPR does require subsurface surveys, it does not require the extensive site characterization and compliance surveys that are required by decommissioning regulations and defined in NUREG-1575, Revision 1, “Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),” issued August 2000 (Ref. 7). Further, it does not set decommissioning criteria, nor does it mandate any remedial activities for onsite or offsite residual radioactivity during operations.

The DPR does not require licensees to conduct complex, detailed site surveys. Rather, the DPR does require licensees to conduct scoping surveys to identify the extent of significant residual radioactivity. Further, the DPR does require that the results of the monitoring and surveys be included in records important to decommissioning. For nuclear power plants, existing radiological environmental monitoring programs and subsurface (ground water) monitoring conducted by implementation of Nuclear Energy Institute (NEI) 07-07, “Industry Ground Water Protection Initiative—Final Guidance Document,” issued August 2007 (Ref. 8), are generally considered adequate to meet the DPR.

#### **Relationship between RG 4.21 and RG 4.22**

Guidance on implementing the minimization of contamination provisions of the 1997 LTR is in Regulatory Guide (RG) 4.21, “Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning” (Ref. 9), which states, in part: “[T]he development of a contaminant management philosophy...requires the use of...conservative radiation protection principles, and attention to operational practices.” RG 4.21 provides guidance to applicants on implementing the requirements of 10 CFR 20.1406(a-b) to design facilities and develop operational procedures to minimize radioactive waste generation and facility contamination. That is, RG-4.21 is directed primarily at the design and construction phase of the facility life cycle. The guidance consists of specific design considerations drawn from nuclear industry experience and lessons learned from decommissioning. These are combined in a threefold contaminant management philosophy: (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.

This document provides draft guidance for operating facilities on methods of meeting regulatory requirements for effective decommissioning planning. This guidance provides methods for determining if changes to operations or monitoring programs are needed to comply with 10 CFR 20.1406(c) and revised 10 CFR 20.1501. The guidance also describes survey methods suitable to identify affected areas and to estimate the approximate volume of radiological contamination that may have to be remediated at the time of license termination. The guidance also will help to determine whether existing financial assurance provided for site-specific decommissioning is adequate.

## Harmonization with International Standards

The following International Atomic Energy Agency (IAEA) Safety Standards and Guides provide useful information on nuclear facility safety, and this guide incorporates their principles: SSG-5, "Safety of Conversion Facilities and Uranium Enrichment Facilities," (Ref. 10); SSG-6, "Safety of Uranium Fuel Fabrication Facilities," (Ref. 11); NS-G-4.6, "Radiation Protection and Radioactive Waste Management in the Design and Operation of Research Reactors," (Ref. 12); NS-R-5, "Safety of Nuclear Fuel Cycle Facilities," (Ref. 13); and WS-G-3.1, "Remediation Process for Areas Affected by Past Activities and Accidents," (Ref. 14). The difference between this guide and the IAEA Safety Standards and Guides is that the latter are generic, whereas this guide provides direct linkage to NRC regulations.

## Scope

Organization of Agreement States and NRC licenses cover many different kinds of activities that reflect the widely varying potential for contamination of a facility and the environment and for the generation of radioactive waste. Therefore, although this guide applies to all types of facilities, it recognizes that there is a wide range of potential contamination sources and facility conditions and so provides a risk-informed approach to implementing the DPR. The risk-informed approach to implementing the DPR recognizes the need for minimizing contamination to the extent practical while at the same time not requiring definitive identification and quantification of all residual radioactivity.

The existing 10 CFR 20.1401(a) specifically excludes uranium recovery facilities from the scope of Subpart E of 10 CFR Part 20. The DPR does not change the exclusion; therefore, uranium recovery licensees are not subject to the new DPR requirements in Subpart E.

This regulatory guide does not address the details of revisions to financial assurance requirements in the DPR. That guidance is presented in NUREG-1757, "Consolidated Decommissioning Guidance," Volume 3, Revision 1, "Financial Assurance, Recordkeeping, and Timeliness," issued November 2011 (Ref. 15).

The NRC issues regulatory guides to describe to the public methods that the staff considers acceptable for use in implementing specific parts of 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.

This regulatory guide contains information collection requirements covered by 10 CFR Part 20 that the Office of Management and Budget (OMB) approved under OMB control number 3150-0014. The NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request or requirement unless the requesting document displays a currently valid OMB control number. This regulatory guide is a rule as designated in the Congressional Review Act (5 U.S.C. 801–808). However, OMB has not found it to be a major rule as designated in the Congressional Review Act.

## B. DISCUSSION

The DPR adds a new paragraph, 10 CFR 20.1406(c), that establishes a new requirement for licensees with operating licenses to operate their facilities in a manner that minimizes the introduction of residual radioactivity into the site, including the subsurface. The purpose of this requirement is to facilitate remediation of the site for unrestricted use at the time of license termination.

The DPR also amends 10 CFR 20.1501(a) to explicitly include a requirement for radiological surveys in the subsurface necessary to evaluate residual radioactivity at licensed sites. This revised regulation retains its existing limit of “reasonable under the circumstances.” The term “residual radioactivity” is defined in 10 CFR 20.1003 as any radioactivity from licensed and unlicensed sources that has been introduced to the site by activities under the licensee’s control. A “significant amount of residual radioactivity” is defined as an amount that would require remediation during decommissioning to meet the unrestricted use criteria specified in 10 CFR 20.1402. Significant residual radioactivity in subsurface media, such as soil, is an important component of waste because, after operations cease, it must be removed and disposed of off site to meet unrestricted use criteria.

The new 10 CFR 20.1501(b) requires licensees to keep records of the required surveys describing the locations and amounts of significant residual radioactivity identified at the site with other records important to decommissioning that are retained until the license is terminated. It does not require licensees to submit reports of survey results.

Neither the DPR nor this regulatory guide defines a specific number of monitoring, surveying, or sampling events to comply with the new requirements. Because of the wide diversity of licensee facilities and processes and the equally wide variation in site conditions, each licensee must develop its own site-specific surveillance and monitoring plan and procedures for the following:

- Demonstrating that the facility is being operated in a manner that minimizes the introduction of radiological contamination into the environment.
- Performing surveys sufficient to determine the extent of significant residual radioactivity contamination in the site environment.
- Periodically evaluating the costs to remediate significant residual radioactivity to unrestricted release levels at the time of license termination. Changes to financial assurance regulations require licensees to include the results of this evaluation in required decommissioning cost and financial assurance updates. The DPR also requires licensees, other than power reactors, to arrange for adequate decommissioning funds by the time of license termination to remediate significant residual radioactivity to the criteria of 10 CFR 20.1402, “Radiological Criteria for Unrestricted Use.”

The NRC’s technical basis for identifying the effect that significant residual radioactivity has on decommissioning costs is a 2005 NRC staff study (Ref. 16). The purpose of the study was to compile and evaluate experience at sites undergoing decommissioning to identify the types of events that have caused subsurface contamination. Evaluating these events provided a means for the NRC staff to identify the potential for future subsurface contamination at currently operating facilities. The study identified a number of events that could increase decommissioning costs by increasing the possibility of significant soil or ground water contamination and concluded that these events should cause the licensee to reevaluate its decommissioning cost estimate. In particular, slow and long-lasting leaks of radioactive material into the subsurface may eventually produce radiological hazards and significantly increase the



cost of decommissioning. The study concluded that the sites with a higher likelihood of becoming legacy sites shared the following characteristics:

- relatively large volumes of low specific activity radioactively contaminated liquids,
- large volumes of long-lived radionuclides,
- large throughput,
- liquid processes, or
- processes that involve large quantities of solid radioactive material stored outdoors.

The DPR modified NRC regulations to require all licensees to have sufficient funding to remediate significant residual radioactivity. Decommissioning regulations require licensees to remediate sites to approved release criteria. From initial issue of the license through the operational phase of plant life, licensees should plan to remediate the site for unrestricted use. Cost should not be a limiting factor in defining planned remediation activities. In 1988 (“General Requirements for Decommissioning Nuclear Facilities,” 53 FR 24018, (Ref. 17) the NRC revised 10 CFR 50.2, “Definitions,” to define decommissioning as release for unrestricted use, and added 10 CFR 50.75, “Reporting and Recordkeeping for Decommissioning Planning,” which specifies decommissioning funding requirements for release for unrestricted use.<sup>2</sup> If a licensee determines that it may not be able to meet the planned unrestricted release criteria, it may then submit a decommissioning plan or license termination plan proposing restricted release in accordance with 10 CFR 20.1403(d). In that plan, the licensee must demonstrate how it will meet all of the requirements of 10 CFR 20.1403(a–d), including enforceable institutional controls, financial assurance, and advice from affected parties. To use the alternate criteria of 10 CFR 20.1404, “Alternate Criteria for License Termination,” the licensee must meet additional requirements including specific approval by the Commission. Early detection of significant subsurface contamination through surveys and monitoring and appropriate response by the licensee are the preferred approach because the regulatory objective is to ensure that the licensee and the NRC are aware of contamination that may create conditions that would complicate decommissioning and possibly create a legacy site. Therefore, essential parts of decommissioning planning are early identification of significant residual radioactivity, estimating the total cost of remediation, and financial planning to ensure that funds are available when needed.

This regulatory guide provides a risk-informed, graded approach to implementing the regulation. Figures 1–3 illustrate the risk-informed approach to implementing this rule. A more detailed discussion of each block of the figures is in Appendix A to this guide. Licensees may propose methods and solutions other than those in this guide. Those will be acceptable if they provide the information required by the DPR.

Table 1, on the following page, provides further information that may be useful in determining the applicability of the actions identified in this guide to various facility types. For major, complex facilities with significant inventories of radioactive materials, such as commercial nuclear power plants or radioactive waste facilities, the guide should assist a licensee in meeting the requirements of 10 CFR 1406(c) and the revised 10 CFR 20.1501. For facilities that 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, licensees need to consider only those measures and operational procedures that directly apply to the type of radioactive material and the potential for contamination of the facility or environment. Licensees should

<sup>2</sup> “Decommissioning” as defined in the rule means to “... remove nuclear facilities safely from service and to reduce residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license. Decommissioning activities are initiated when a licensee decides to terminate licensed activities....” The regulations make clear that the licensee is responsible for the funding and completion of decommissioning in a manner that protects public health and safety.

focus on historical information and process knowledge that reflect the likelihood of contamination of the facility and environment. Applicability of the guidance is a facility-by-facility decision.

**Table 1 Applicability of Regulatory Guide 4.22 Actions by  
Type of Facility, Physical Form of Radioactive Material, Half-Life, and Inventory**

Typical Type of Facility or Use of Radioactive Material	Physical Form of Radioactive Material Involved		
	Liquid	Gas	Dry Solid
<b>Group 1 High Inventory, Long Half-Life—Power Plants, Fuel Cycle Facilities</b>			
Commercial nuclear power plants	high	high	high
Fuel fabrication, enrichment, reprocessing	high	high	high
<b>Group 2 High Inventory, Long Half-Life—Waste Facilities</b>			
High-level waste disposal facility	high	moderate	moderate
Low-level waste disposal facility	moderate	low	high
Radioactive waste processors	moderate	low	moderate
<b>Group 3 Intermediate to Low Inventory, Long Half-Life</b>			
Research and test reactors	moderate	moderate	high
Laboratory, research facility, and academic and broad-scope facility	moderate	moderate	moderate
<b>Group 4 Low Inventory, Half-Life Generally Not Long</b>			
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
<b>Legend:</b> high            likelihood of using most of the measures in this guide moderate      likelihood of using some of the measures in this guide low              likelihood of using few of the measures in this guide *                  emphasis on inventory control			

Figure 1, on the following page, illustrates the questions to determine if a licensee needs to do anything because of the DPR. Uranium recovery licensees are exempt from all requirements of this rule. As indicated in Section C of this guide, the NEI's voluntary Industry Groundwater Protection Initiative (GPI) in NEI 07-07, provides an acceptable approach to meeting the requirements of the DPR. For combined license applications, NEI 08-08, Revision 3, "Generic FSAR Template Guidance for Life Cycle Minimization of Contamination," (Ref. 18), specifies that applicants for combined construction and operating licenses should implement the GPI before fuel loading. The DPR does not require anything further from these licensees. Nuclear power plant licensees may propose alternate methods of identifying and recording the information about radiological contamination. Those will be acceptable if they provide the information required by the DPR. If a licensee is not either of these types, the licensee should proceed to Figure 2.

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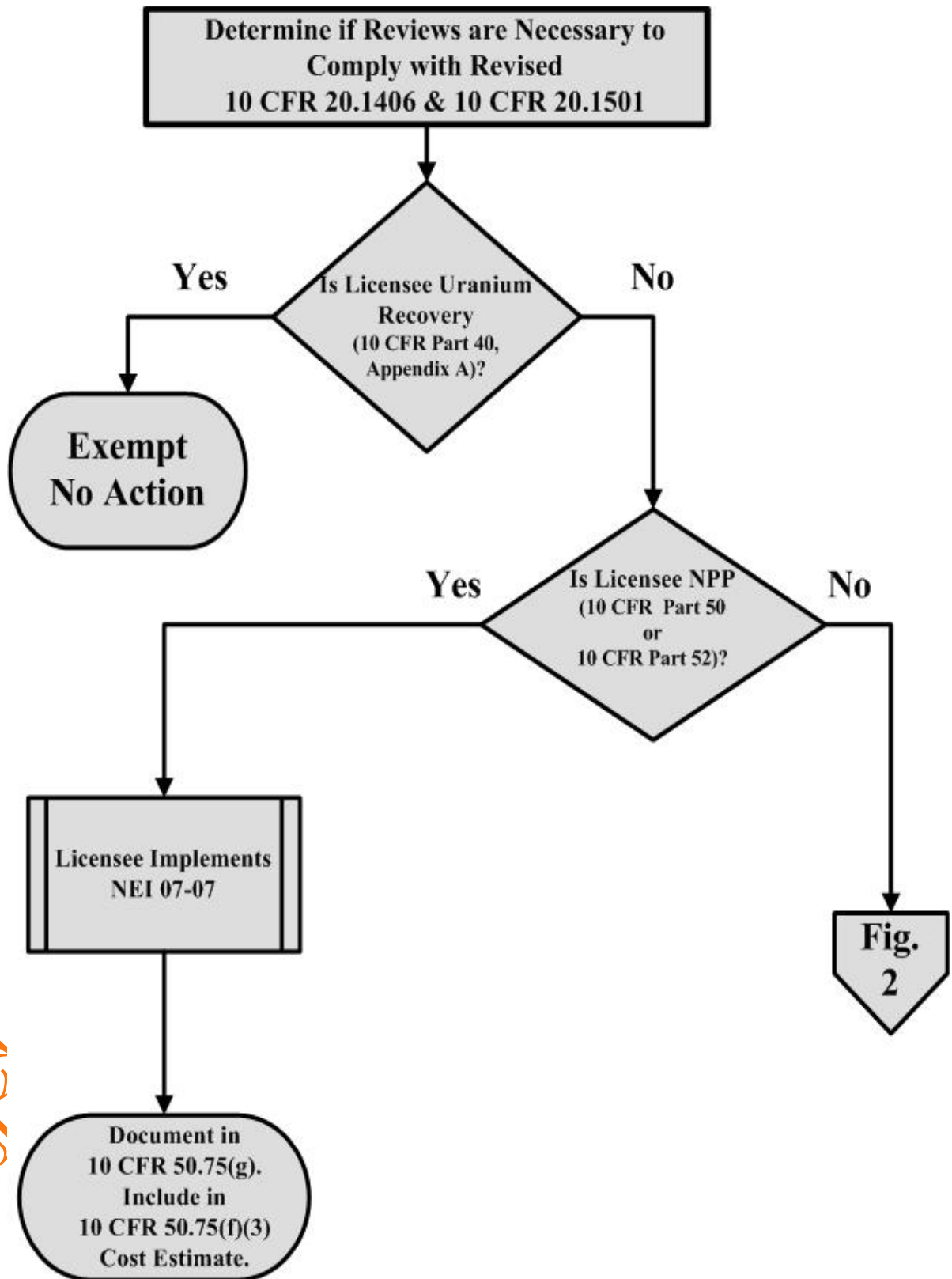


Figure 1 Does the DPR Affect Me?



Figure 2 identifies additional questions for other licensees to use to determine whether the DPR requires them to perform any actions. The first question is whether the licensee is authorized to possess enough radioactive material to potentially create a decommissioning obligation. If the possession limit in the license is below the levels requiring financial assurance specified in 10 CFR 30.35(d), 40.36(b), or 70.25(d), then the DPR requires no further action. Any licensee that is required to provide financial assurance must determine if there have been previous spills or leaks during the operating history of the site. Also, the licensee must identify the potential for such events to occur in the future. Therefore, if fluids—liquids, gases, aerosols—that can spread radiological contamination are part of the operations at the site, licensees should conduct a more detailed review of monitoring and survey plans to ensure identification of the sources and extent of future leaks or spills. The DPR does not mandate any design changes to the physical facility. Figure 3 shows considerations for revisions to procedures.

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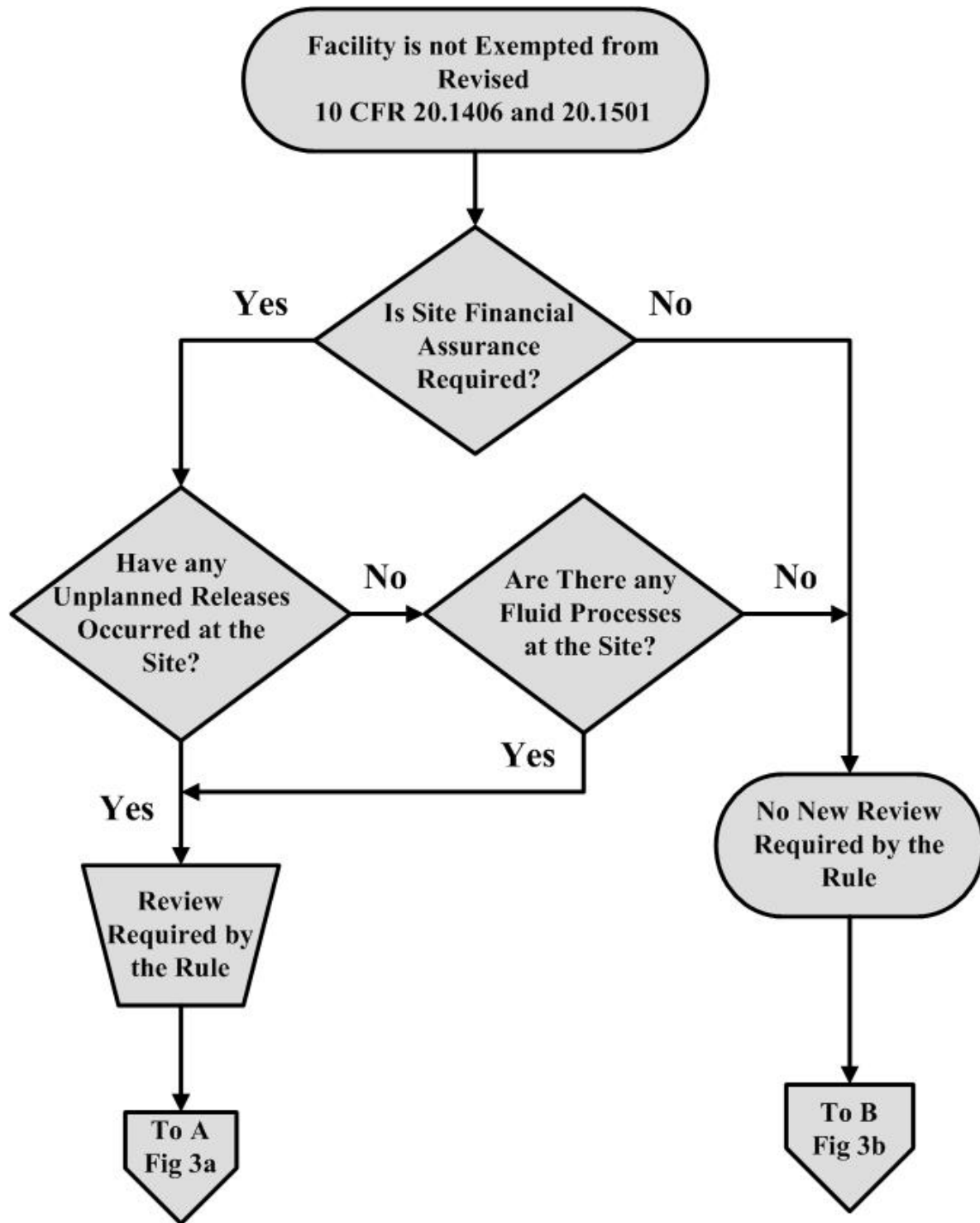


Figure 2 Does the DPR Really Require Me To Do Something?

Figure 3a illustrates specific areas to consider as part of a licensee's review of monitoring and surveillance plans. They include (1) unmonitored areas inside buildings or outside where spills or leaks could occur and (2) unmonitored areas on site where effluents might concentrate. For materials licensees, this may include such things as dispersible powders or aerosols.

Note that some of these areas where significant residual radioactivity may be present may not be readily accessible for direct surveys because of the physical layout of systems and structures. If the licensee identifies areas that cannot be reasonably surveyed directly, it should establish surrogate monitoring (e.g., monitoring locations that are accessible downstream of potential leaks and spills) on a schedule commensurate with the likelihood of significant residual radioactivity occurring there. Appendix B provides some examples of how to identify sampling locations.

For many licensees, either license conditions or documents specifically referenced in the license may establish survey and monitoring requirements. Therefore, changes to these plans may require approval by the NRC. If so, licensees should obtain NRC approval, to the extent necessary, of revisions to these plans.

Figure 3b shows the actions that licensees should normally follow in implementing survey and monitoring plans. Once the cause of the contamination in excess of site action levels or regulatory exposure limits is identified, licensees should take corrective action to minimize further contamination (e.g., repair or replace leaking components and "mop up" liquid leaks and spills). If significant residual radioactivity is not expected to remain at the time of license termination, the DPR requires no additional actions. If significant residual radioactivity may remain at the time of license termination, licensees should estimate the financial impact and consider timely remediation. Licensees should judiciously monitor the area until concentrations are decreasing to ensure that the corrective action has been effective.

The revised 10 CFR 20.1501(b) also requires licensees to record, in records important to decommissioning, the amounts and locations of subsurface residual radioactivity that may need remediation at the time of license termination. These records provide important input to the historical site assessment.

At 10 CFR 30.35(e), 40.36(d), 70.25(e), and 72.30(b), the DPR also requires licensees to adjust decommissioning funding as appropriate to the license type. Nuclear power plant licensees should include the effect of survey results in the decommissioning cost estimates required by 10 CFR 50.75(f)(3) and 10 CFR 50.82(a)(8)(iii). Other licensees should adjust decommissioning funds to reflect the necessary remediation to meet unrestricted use criteria at the time of license termination. See NUREG-1757, Volume 3, Revision 1, for additional information.

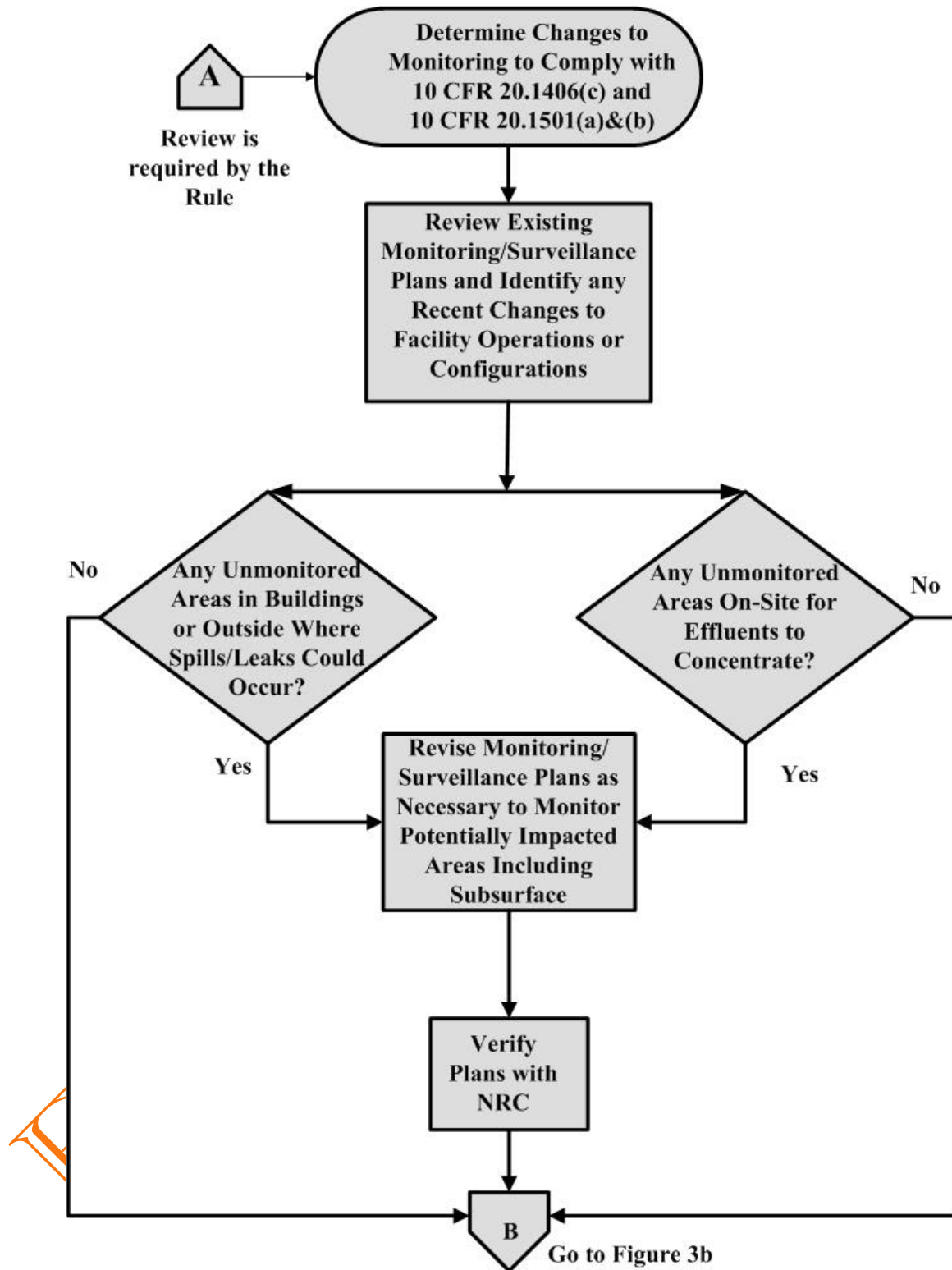
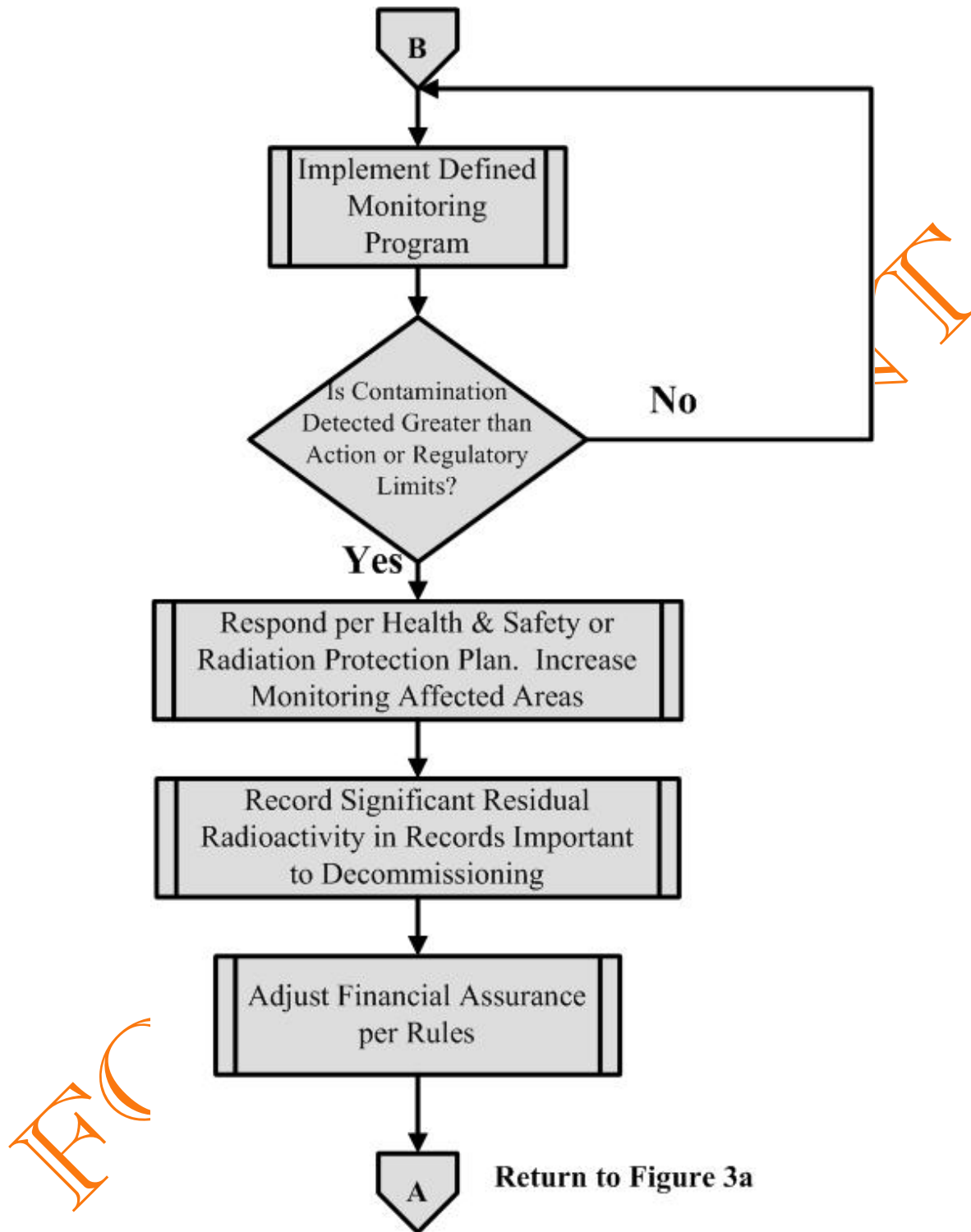


Figure 3a What Does the DPR Require Me To Do?



**Figure 3b What Else Does the DPR Require?**

If a facility will handle dispersible radioactive material that, if released, could necessitate extensive cleanup to meet decommissioning criteria, the licensee should consider control of the form of the material that could be released. The three basic forms are liquids, gases (including aerosols), and



solids. Appendix A-2 provides further information that may be useful in determining the applicability of the guide.

### **C. STAFF REGULATORY GUIDANCE**

The ultimate goal of the DPR is for licensees to have sufficient funds to effectively and efficiently conduct site remediation and terminate their licenses. This means having an adequate decommissioning trust fund. For the trust fund to be adequate, it must include sufficient funds to remove and dispose of all residual radioactivity that is above the criteria for release for unrestricted use at the time of license termination. That is, it must cover the costs of packaging, shipping, and disposal for the total amount of material to be removed from the site, in addition to surveys to demonstrate compliance with approved release criteria. Licensees, except those whose financial assurance for decommissioning is determined by a fixed formula, should adjust the decommissioning fund so that it will be sufficient to complete decommissioning at the time of license termination. If a licensee identifies residual radioactivity that would require remediation to terminate the license, it should increase the value of the fund to account for the added cost. Likewise, if a licensee elects to remediate during the operational phase of facility life, it may reduce the fund to account for remediation it has completed; the remaining fund must be sufficient to complete any remediation necessary to meet release criteria. Appendix A to NUREG-1757, Volume 3, Revision 1 provides additional information and references on estimating decommissioning costs for various types of facilities.

1. Power plant licensees that have implemented the “Industry Ground Water Protection Initiative—Final Guidance Document” (NEI 07-07) are considered to have implemented an adequate subsurface monitoring program for residual radioactivity in and around the facility. Thus, nuclear power plant licensees under 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” and those operating under 10 CFR 52.103, “Operation under a Combined License,” that have implemented NEI 07-07 are presumed to be in compliance with the subsurface survey requirements of the DPR.
  - 1.1. Those licensees should ensure that the results of all surveys conducted according to existing monitoring and surveillance programs, including NEI 07-07, that identify significant residual radioactivity are recorded, or incorporated by reference, in records important to decommissioning as specified in 10 CFR 50.75(g).
  - 1.2. Existing regulations at 10 CFR 50.75(f)(3) require that each power reactor licensee, at or about 5 years before the licensee’s projected end of operations, submit a preliminary decommissioning cost estimate. Licensees should include the results of the surveys in this estimate. The site-specific cost estimate required by 10 CFR 50.82(a)(8)(iii) should also include the costs of removing and disposing of significant residual radioactivity.
  - 1.3. Nuclear power plant licensees should include the results of surveys in computing the site-specific cost estimates required by 10 CFR 50.75(f) (3) and 10 CFR 50.82(a) (8) (iii).
2. Licensees should periodically conduct surveys in accordance with 10 CFR 20.1501(a) to identify the horizontal and vertical extent of significant residual radioactivity throughout the site. The DPR does not alter the existing requirement to conduct surveys reasonable under the circumstances to evaluate the magnitude and extent of residual radioactivity. As part of this identification effort, licensees may use results from a model that has been demonstrated to be representative of the physical conditions of the site. Licensees do not need to conduct formal, comprehensive site characterization. The required surveys should include, but are not limited to, the following:

- a. building interiors, including in and around joints, drains, hoods, exhaust stacks, and other features that could provide pathways for residual radioactivity to concentrate or migrate to inaccessible areas;
  - b. the soil and other media in outside areas at the facility;
  - c. subsurface media, especially around building footers, subsurface pipes and conduits, and below-grade tanks; and
  - d. ground water.
- 2.1. Affected licensees should review, and adjust if necessary, procedures and practices to ensure early identification of potential or actual radiological releases to the environment and act promptly to minimize the spread of radioactivity in accordance with the DPR. If the existing significant residual radioactivity will naturally reduce to levels that meet unrestricted release criteria by the time of license termination, the DPR does not require any further action.
- 2.2. Licensees should also evaluate the potential for significant residual radioactivity to migrate and to concentrate such that it would not meet the release for unrestricted use criteria of 10 CFR 20.1402.
- 2.3. For NRC licensees that have subsurface residual radioactivity with no current or projected ground water contamination, a minimal, routine monitoring plan may remain in effect through license termination activities. NUREG/CR-6948, "Integrated Ground-Water Monitoring Strategy for NRC-Licensed Facilities and Sites: Logic, Strategic Approach and Discussion," (Ref. 19), presents a logical framework for assessing what, how, where, and when to monitor underground water.
3. All licensees must document the results of the surveys required by 10 CFR 20.1501(a) in records important to decommissioning in accordance with 10 CFR 20.1501(b). The NRC is not requiring licensees to submit reports of survey results.
- 3.1. The DPR also places a lower bound on the amount of residual radioactivity licensees should record: that which would require remediation at the time of license termination to meet the unrestricted release criteria of 10 CFR 20.1402. This level of contamination may not present a risk to public health and safety during the operational phase of plant life. However, records of surveys performed that demonstrate that the residual radioactivity has not exceeded the level of significant residual radioactivity may be useful in demonstrating compliance.
4. In 10 CFR 20.1406(c), the NRC requires all licensees to minimize the introduction of radiological contamination into the site environment. To do so, licensees should implement procedures and practices that minimize the occurrence of leaks and spills from piping, tanks, and storage containers. Licensees should also have procedures (1) that identify the plant systems and radioactive materials storage containers with the potential for leaks and spills, (2) inspection procedures that will identify to the extent practical degraded equipment and containers before release and spills occur, and (3) to detect leaks and spills throughout the facility soon after they occur. As part of the ALARA program, licensees should have procedures to minimize to the extent practical the spread of leaks and spills that do occur, especially when the residual radioactivity could migrate to inaccessible areas and eventually to the subsurface. Licensees should review, and update if necessary, the actions to ensure a timely and effective response to unplanned releases of radiological material.

- 4.1. Storage containers are commonly used to store radioactive material and to minimize the spread of contamination. Licensees are required to conduct surveys of containers to meet 10 CFR 20.1501(a) (2) requirements and to perform container inspections to verify container integrity to meet 10 CFR 20.1406(c) requirements. An acceptable inspection program is based on the likelihood of container failure and the resulting radiological risk significance (i.e., there is no required time-specific inspection frequency). Containers having a higher radiological risk significance may need to be inspected on a more frequent basis (e.g., quarterly, semi-annually, or annually), and containers with less radiological risk significance may be inspected on a less frequent basis (e.g., yearly or longer time interval inspection may be appropriate). The basis for selecting the inspection frequency should be documented. Factors to consider when developing a container inspection program include the:
- a. type of containers (e.g., high integrity container, carbon steel drum, canister, storage safe),
  - b. age and condition of containers,
  - c. waste form / type of material being stored (e.g., wet filters or resins vs. dry active waste, medical waste, sealed sources),
  - d. isotopes, concentrations, and radiation levels,
  - e. storage environment (e.g., storage in an unprotected outdoor area subject to weathering vs. storage in an indoor protected environment),
  - f. length of anticipated storage (e.g., short term, interim storage, decay in storage)
  - g. secondary containment (e.g., sumps, or concrete floors and walls, storage safe, earthen berm),
  - h. installed radiation monitoring equipment to provide detection of loss of container integrity,
  - i. ALARA considerations and operating experience.
5. For licensees under 10 CFR Parts 30, 40, and 70, if the quantity of material authorized in the license is below the amount requiring financial assurance as specified in 10 CFR 30.35(d), 40.36(b), and 70.25(d), the DPR does not require any further action. The NRC presumes that such licensees will have minimal residual radioactivity resulting from operations, have current ALARA and health and safety programs that are adequate to identify radioactivity requiring remediation, and will have funds from operating revenues to remediate the facility to unrestricted use criteria.
6. Staff experience (Ref. 16) shows that fluids are the primary source of contamination beyond facility equipment. If there are no fluid processes, the NRC presumes that licensees' current ALARA and health and safety programs are adequate to identify radioactivity requiring remediation to meet unrestricted use criteria. The DPR requires action only if there are fluids (gases or liquids), dispersible powders, aerosols, or nanoparticles in site processes, including hoods.
7. The DPR does not require licensees to perform any dose analyses; however, licensees can use dose assessments on a site-specific basis to determine whether the amount of residual radioactivity is

significant with respect to meeting the radiological criteria for unrestricted use in 10 CFR 20.1402. Alternatively, a licensee should make a reasonable effort to estimate the amount of the identified residual radioactivity that would require remediation to meet the release for unrestricted use criteria of 10 CFR 20.1402 at the time it intends to terminate the license. The licensee should consider the following:

- a. the radionuclides in the source term;
- b. actual and potential migration, both vertical and horizontal;
- c. dilution and natural attenuation; and
- d. radioactive decay.

7.1. Licensees can estimate the amount of significant residual radioactivity by comparing the concentrations and exposure rates they measure with readily available data to determine if they may need to conduct remediation to meet the license termination criteria for release for unrestricted use. Available sources for this comparison include the following:

- a. Table 2, "Effluent Concentrations," of Appendix B to 10 CFR Part 20, lists concentrations that equate to 50 millirems/year. One-half of the table values equates to 25 millirem/year, the limit for release for unrestricted use, for the default exposure scenario.
- b. Screening values are in Appendix H to NUREG-1757, Volume 2, Revision 1, "Characterization, Survey, and Determination of Radiological Criteria," issued September 2006 (Ref. 20).
- c. Remediation levels (derived concentration guidelines) appear in final status survey plans approved by the NRC for other facilities.

## GLOSSARY

**monitoring**—The measurement of radiation levels, concentrations, surface area concentrations, or quantities of radioactive material.

**residual radioactivity**—Radioactivity in structures, materials, soils, ground water, and other media at a site resulting from activities under the licensee's control. This includes radioactivity from all licensed and unlicensed sources used by the licensee, but excludes background radiation. It also includes radioactive materials remaining at the site as a result of routine or accidental releases of radioactive material at the site and previous burials at the site, even if those burials were made in accordance with the provisions of 10 CFR Part 20.

**significant residual radioactivity**—An amount of radioactive material that would require remediation to meet the unrestricted use criteria specified in 10 CFR 20.1402 at the time of decommissioning.

**subsurface**—Any media below about 15 centimeters (6 inches) from a surface.

**survey**—An evaluation of the radiological conditions and potential hazards of radioactive material. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.



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11. --- “Safety of Uranium Fuel Fabrication Facilities,” Specific Safety Guide SSG-6, Vienna, Austria, 2010.

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<sup>3</sup> Publicly available NRC published documents are available electronically through the NRC Library on the NRC’s public Web site at <http://www.nrc.gov/reading-rm/doc-collections/>. The documents can also be viewed on-line or printed for a fee in the NRC’s Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD; the mailing address is USNRC PDR, Washington, DC 20555; telephone 301-415-4737 or (800) 397-4209; fax (301) 415-3548; and e-mail to [pdr\\_resource@nrc.gov](mailto:pdr_resource@nrc.gov).

<sup>4</sup> Publications from the Nuclear Energy Institute (NEI) are available at their Web site: <http://www.nei.org/> or by contacting the headquarters at Nuclear Energy Institute, 1776 I Street NW, Washington DC 20006-3708, Phone: 202-739-8000, Fax 202-785-4019.

<sup>5</sup> Copies of International Atomic Energy Agency (IAEA) documents may be obtained through their Web site: [WWW.IAEA.Org/](http://WWW.IAEA.Org/) or by writing the International Atomic Energy Agency P.O. Box 100 Wagramer Strasse 5, A-1400 Vienna, Austria. Telephone (+431) 2600-0, Fax (+431) 2600-7, or E-Mail at [Official.Mail@IAEA.Org](mailto:Official.Mail@IAEA.Org)

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APPENDIX A

EXPLANATION OF RISK-INFORMED APPROACH TO DETERMINING  
ACTIONS TO COMPLY WITH  
THE DECOMMISSIONING PLANNING RULE

## APPENDIX A-1

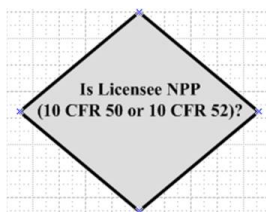
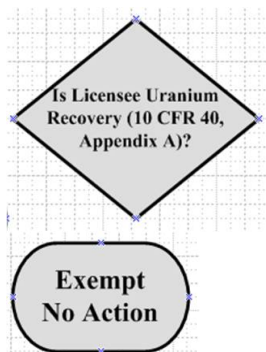
### DISCUSSION OF FIGURES 1–3

This appendix discusses the individual pieces of Figures 1 through 3 in the guidance on implementing the Decommissioning Planning Rule (DPR). It does not present any regulatory information. This appendix only provides additional information on the U.S. Nuclear Regulatory Commission (NRC) staff's intentions for licensees to consider in developing the risk-informed approach to implementing the DPR.

FOR COMMENT

## Discussion of Figure 1. Does the DPR Affect Me?

Determine if Reviews are Necessary to Comply with Revised 10 CFR 20.1406 & 10 CFR 20.1501



Document in 10 CFR 50.75(g). Include in 10 CFR 50.75(f)(3) Cost Estimate.

The first step in the process is for each licensee to determine if it needs to take any action because of the changes to Title 10, Sections 20.1406, “Minimization of Contamination,” and 20.1501, “General,” of the *Code of Federal Regulations* (10 CFR 20.1406 and 10 CFR 20.1501). The first action that any licensee would have to perform would be a comprehensive review of its existing monitoring and surveillance plans.

The first question to ask in making this determination is whether the current license is a uranium recovery license under 10 CFR Part 40, “Domestic Licensing of Source Material,” Appendix A, “Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily for Their Source Material Content.” If the answer is no, further actions are necessary because these licensees are specifically exempt from the requirements of the DPR under 10 CFR 20.1401(a).

The second question is whether the licensee is a power plant licensed under 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities.” If so, the NRC has determined that the monitoring and surveillance activities that 10 CFR Part 50 licensees are conducting as part of existing as low as is reasonably achievable (ALARA) and radiological and environmental monitoring program activities, and the Nuclear Energy Institute (NEI) Ground Water Protection Initiative (NEI 07-07), meet or exceed the requirements of 10 CFR 20.1501(a). Therefore, the DPR does not impose any additional survey or monitoring requirements on these licensees.

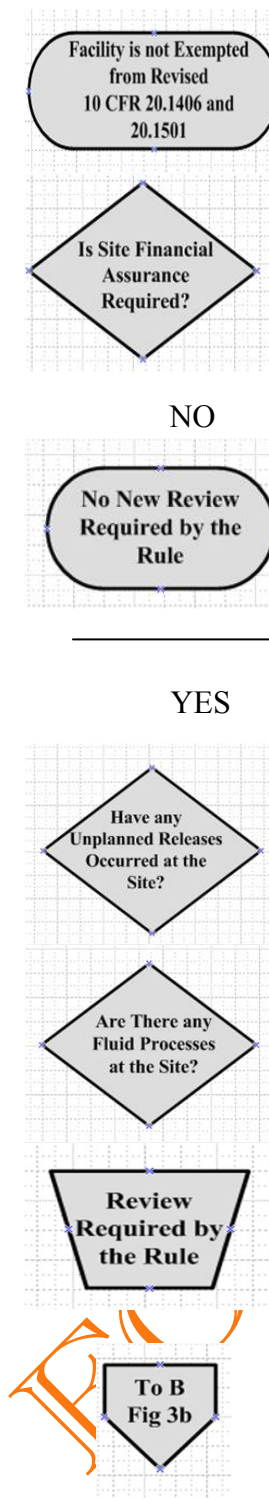
The DPR does require that 10 CFR Part 50 nuclear power plant licensees record the results of the existing monitoring and sampling programs in their 10 CFR 50.75(g) files, either directly or by reference.

The regulation in 10 CFR 50.75(f)(3) requires a preliminary decommissioning cost estimate about 5 years before the projected end of operations, which includes an up-to-date assessment of the major factors that could affect the cost to decommission. This estimate should include the results of monitoring and sampling.

Within 2 years after permanent shutdown, 10 CFR 50.82(a)(8)(iii) requires an updated site-specific estimate of remaining decommissioning costs, which should include the results of DPR monitoring.

If the answer to the second question is no (the licensee is not licensed under 10 CFR Part 50), the licensee should proceed to Figure 2 to determine the next actions.





## Discussion of Figure 2. Does the DPR Really Require Me To Do Something?

For purposes of the DPR, the NRC is using the requirement for financial assurance as a surrogate for the amount of material a licensee is authorized to possess. NRC regulations at 10 CFR 30.35, 40.36, and 70.25, each entitled “Financial Assurance and Recordkeeping for Decommissioning,” require some licensees to set aside funds devoted to decommissioning the site at the time of license termination. The amount of funds is a function of how much radiological material the licensee is authorized to possess. Licensees can meet the financial assurance requirements either by the methods specified in those regulations or by a site-specific estimate.

If a licensee’s possession limit does not require it to have financial assurance, the DPR does not require the licensee to perform any further action because the potential for significant residual radioactivity is low. These licensees should continue executing the existing ALARA and health and safety programs as discussed in Figure 3b.

If, however, regulations do require financial assurance, either by formula or by site-specific estimate, the licensee must determine if there have been previous spills or leaks during the operating history of the site. Also, the licensee must identify the potential for such events to occur in the future. Staff experience (Ref. 16) shows that the presence of liquid or gaseous processes presents the possibility of unplanned or unmonitored releases. Further, after planned discharges within regulatory limits (e.g., Appendix B to Part 20), fluids can concentrate in various locations to greater than NRC-approved limits for release of the area. Therefore, if fluids are part of the operations at the site, licensees should conduct a more detailed review of monitoring and survey plans to ensure that they will identify the sources and extent of future leaks or spills. The outflow of hoods, which can move particulates beyond the facility, should also be considered. The amount of review depends on the complexity of the process and facility and on the potential release.

If there are no fluids in the site processes, the DPR requires no further review, and licensees should continue implementing existing plans as illustrated in Figure 3b.

### Discussion of Figure 3a. What Does the DPR Require Me To Do?

Review Existing Monitoring/Surveillance Plans and Identify any Recent Changes to Facility Operations or Configurations

Licensees should review existing plans and procedures related to identification and management of leaks, spills, aerosols, dispersible solids, and other unplanned releases. Licensees should pay particular attention to identifying any changes in the facility operations, such as revisions to specifications for products, addition of new products or discontinuation of previous products, and changes to the process rate since the last revision of the procedures. The review should also note any physical changes to the facility, especially those that could result in unanalyzed release paths, such as new discharge ducts or piping. These changes are not limited to those in the immediate vicinity of the process. For example, rerouted plumbing could result in irregular fittings in normally inaccessible areas, or construction of a tall building on adjacent land could alter the airborne discharge paths.

Any Unmonitored Areas in Buildings or Outside Where Spills/Leaks Could Occur?

Any Unmonitored Areas On-Site for Effluents to Concentrate?

The ultimate goal of the DPR is for licensees to identify the extent of contamination on the site and reserve enough money during operations to complete site remediation and license termination in a timely manner at the end of operations. In this review, licensees should identify any areas of the site not currently monitored regularly for radiological contamination. In addition to “under-” sources (such as embedded or buried pipes, tanks, valves, and onsite disposals under 10 CFR 20.2002, “Method for Obtaining Approval of Proposed Disposal Procedures”), leaks and spills onto interior or exterior surfaces may migrate through floor joints, cracks, failed seals, or through porous media to other areas. Some of these areas may not be readily accessible for direct observation. In these cases, licensees should consider alternatives to identify potential contamination, such as use of remote sensors and robotics. Contamination could also enter utility conduits and move far from the point of origin. If the contamination moves into the subsurface, it could concentrate there over time, or it could migrate through ground water to other locations where it could concentrate. Monitoring of the subsurface should be established downstream of potential sources, such as building footers, and buried tanks and pipes. NUREG/CR-6948, “Integrated Ground-Water Monitoring Strategy for NRC-Licensed Facilities and Sites: Logic, Strategic Approach and Discussion,” issued November 2007, contains detailed information on establishing a subsurface monitoring program. Likewise, airborne effluents may precipitate and concentrate in some pattern because of the local meteorology, such as prevailing wind direction and speed, and relative humidity. Licensees should identify these potential locations and include them in survey and monitoring plans.

Revise Monitoring/  
Surveillance Plans as  
Necessary to Monitor  
Potentially Impacted  
Areas Including  
Subsurface

At the time of license termination, 10 CFR Part 20, “Standards for Protection against Radiation,” Subpart E, “Radiological Criteria for License Termination,” requires licensees to remediate existing residual radioactivity above release levels without regard to cost. Therefore, licensees must have a monitoring plan sufficient to identify the complete extent of contamination at that time. The goal of the DPR is to encourage licensees to develop plans that will identify contamination as it occurs rather than wait until license termination when significant amounts of previously unknown contamination can result in sizable cost and time overruns during decommissioning.

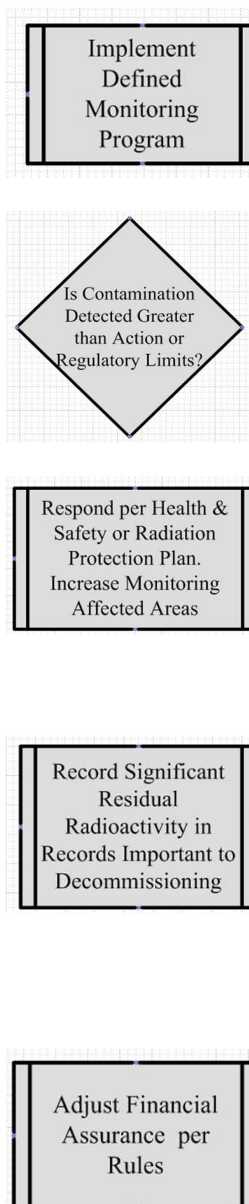
For licensees that do not have significant residual radioactivity because they possess only small amounts of short-lived radioactive material or sealed sources, the staff does not expect significant changes to the existing monitoring and health and safety programs.

For licensees with subsurface residual radioactivity but no ground water implications, a minimal, routine monitoring plan may be sufficient through operations.

Licensees other than those described above should enhance the existing programs to include areas of potential contamination not previously identified. The revised plans should also contain provisions for altering the frequency of surveillance in response to contamination events and the “conclusion” of those events.

Verify  
Plans with  
NRC

Surveillance plans are identified in the license, so licensees should discuss changes with the NRC and, if the plans to be changed are specified in the license, obtain prior NRC approval.



### Discussion of Figure 3b. What Else Does the DPR Require?

Once a licensee has an approved plan(s) for monitoring and surveillance, whether changed or not as a result of review, it should conduct the activities specified in the plan(s).

As long as no readings are above the site action limits specified in the plans or regulatory limits for worker or public exposure, the DPR does not require any additional actions. Licensees should continue to implement the existing plans routinely.

If the results of the sampling are above the specified limits, the licensee should respond according to the site health and safety plan. This response should include defining the extent of contamination, identifying and implementing corrective actions to mitigate the event (locate and stop the leak or spill), and remediating the area to meet occupational requirements. Once it completes those actions, the licensee should conduct additional periodic monitoring for a time to ensure that the “fix” is effective.

Another important part of the DPR is the requirement in 10 CFR 20.1501(b) that licensees record the results of surveys identifying significant subsurface residual radioactivity—requiring remediation to meet unrestricted use criteria—in records important to decommissioning. This will assist in planning and costing remedial actions and surveys to support license termination. It also provides important input to the historical site assessment required by the decommissioning section of the NRC’s licensing regulations.<sup>6</sup>

Once it has collected this information, licensees should use it in revising decommissioning cost estimates, as appropriate to license type requirements. Nuclear power plant licensees should include this information in the decommissioning cost estimates required by 10 CFR 50.75(f)(3) and 10 CFR 50.82(a)(8)(iii). Other licensees should adjust financial assurance for decommissioning to reflect the necessary remediation to meet unrestricted release criteria at the time of license termination. See NUREG-1757, “Consolidated Decommissioning Guidance,” Volume 3, Revision 1, “Financial Assurance, Recordkeeping, and Timeliness,” issued November 2011 (Agencywide Documents Access and Management System [ADAMS] Accession No. ML090850301), for additional information. If a licensee has adjusted its financial assurance in response to previous contamination events, it could elect to conduct partial site remediation during operations. If this results in a decrease in the remaining remediation necessary to meet unrestricted release limits, it could also result in a decrease in the required trust fund amount. The staff encourages licensees to evaluate the total costs of prompt versus delayed remediation. Nothing in the DPR mandates remediation during operations.

<sup>6</sup>

While not required by the DPR, records of less, or no, contamination can be useful in defining and costing site remediation and in setting initial classes of survey areas.



## APPENDIX A-2

## EXCERPTS FROM NUREG-1757

The following information is from Appendix D to NUREG-1757, "Consolidated Decommissioning Guidance," Volume 1, Revision 2, "Decommissioning Process for Materials Licensees," (Ref. 21). The first table shows a division of licensees into groups as a function of the existing or potential contamination at the site and the expected complexity in decommissioning. The second table is excerpted from one indicating the level of detail that the staff expects in a decommissioning plan (DP). While the purpose of this regulatory guide is not to develop a DP, this table can be used as a guide to the amount of information licensees should collect during operations to support decommissioning planning.

Table A-2-1 Descriptions and Examples of Decommissioning Groups

Group	Brief Description	Examples
1	Licensed material was not released into the environment, did not cause the activation of adjacent materials, and did not contaminate work areas.	Licensees who used only sealed sources such as radiographers and irradiators
2	Licensed material was used in a way that resulted in residual radioactivity on building surfaces and/or soils. The licensee is able to demonstrate that the site meets the screening criteria for unrestricted use.	Licensees who used only quantities of loose radioactive material that they routinely cleaned up (e.g., R&D facilities)
3	Licensed material was used in a way that could meet the screening criteria, but the license needs to be amended to modify or add procedures to remediate buildings or sites.	Licensees who may have occasionally released radioactivity within NRC limits (e.g., broad scope)
4	Licensed material was used in a way that resulted in residual radiological contamination of building surfaces or soils, or a combination of both (but not ground water). The licensee demonstrates that the site meets unrestricted use levels derived from site-specific dose modeling.	Licensees whose sites released loose or dissolved radioactive material within NRC limits and may have had some operational occurrences that resulted in releases above NRC limits (e.g., waste processors)
5	Licensed material was used in a way that resulted in residual radiological contamination of building surfaces, soils, or ground water, or a combination of all three. The licensee demonstrates that the site meets unrestricted use levels derived from site-specific dose modeling.	Licensees whose sites released, stored, or disposed of large amounts of loose or dissolved radioactive material on site (e.g., fuel cycle facilities)
6	Licensed material was used in a way that resulted in residual radiological contamination of building surfaces, and/or soils, and possibly ground water. The licensee demonstrates that the site meets restricted use levels derived from site-specific dose modeling.	Licensees whose sites would cause more health and safety or environmental impact than could be justified when cleaning up to the unrestricted release limit (e.g., facilities where large inadvertent release(s) occurred)
7	Licensed material was used in a way that resulted in residual radiological contamination of building surfaces, and/or soils, and possibly ground water. The licensee demonstrates that the site meets alternate restricted use levels derived from site-specific dose modeling.	Licensees whose sites would cause more health and safety or environmental impact than could be justified when cleaning up to the restricted release limit (e.g., facilities where large inadvertent release(s) occurred)



Table A-2.2, excerpted from Table D.1 of NUREG-1757, Volume 1, is a guide to assist licensees in developing the information expected at the beginning of the decommissioning process. The table shows that describing site conditions for simpler sites does not require as much information as for complex sites.

- For the blocks labeled with 1, only minimal information is normally expected; this information is usually in existing documentation.
- For blocks marked with 2, additional information would normally be needed to allow the NRC staff to complete its independent assessment. Some specific data and short analysis may be required.
- For blocks marked with 3, a complete discussion is needed to explain the topic. Significant data and analysis may be required. Such information is obtained through detailed site characterization and planning for remediation.

For Decommissioning Groups 1 and 2, the basic qualitative approach for required information is the same, but a formal DP is not required.

**Table A-2-2 Application of Information Checklist to Decommissioning Groups**

Section \ Group	3	4	5	6	7
<b>FACILITY OPERATING HISTORY</b>					
License Number/Status/Authorized Activities	1	1	2	3	3
License History	1	1	2	3	3
Previous Decommissioning Activities	1	1	2	3	3
Spills	1	1	2	3	3
<b>RADIOLOGICAL STATUS OF FACILITY</b>					
Contaminated Structures	2	2	2	3	3
Contaminated Systems and Equipment	2	2	2	3	3
Surface Soil Contamination	1	1	3	3	3
Subsurface Soil Contamination	N/A	N/A	3	3	3
Surface Water	1	1	3	3	3
Ground Water	1	1	3	3	3
<b>FACILITY RADIATION SURVEYS</b>					
Release Criteria	1	2	2	3	3
Characterization Surveys	1	2	2	3	3
In-Process Surveys	1	2	2	3	3
Final Status Survey Design	1	2	2	3	3

# PREDECISIONAL DRAFT

Section \ Group	3	4	5	6	7
Final Status Survey Report	1	2	2	3	3
FINANCIAL ASSURANCE					
Cost Estimate	1	2	2	3	3
Certification Statement	1	2	2	3	3
Financial Mechanism	1	2	2	3	3

FOR

COMMENT

APPENDIX B

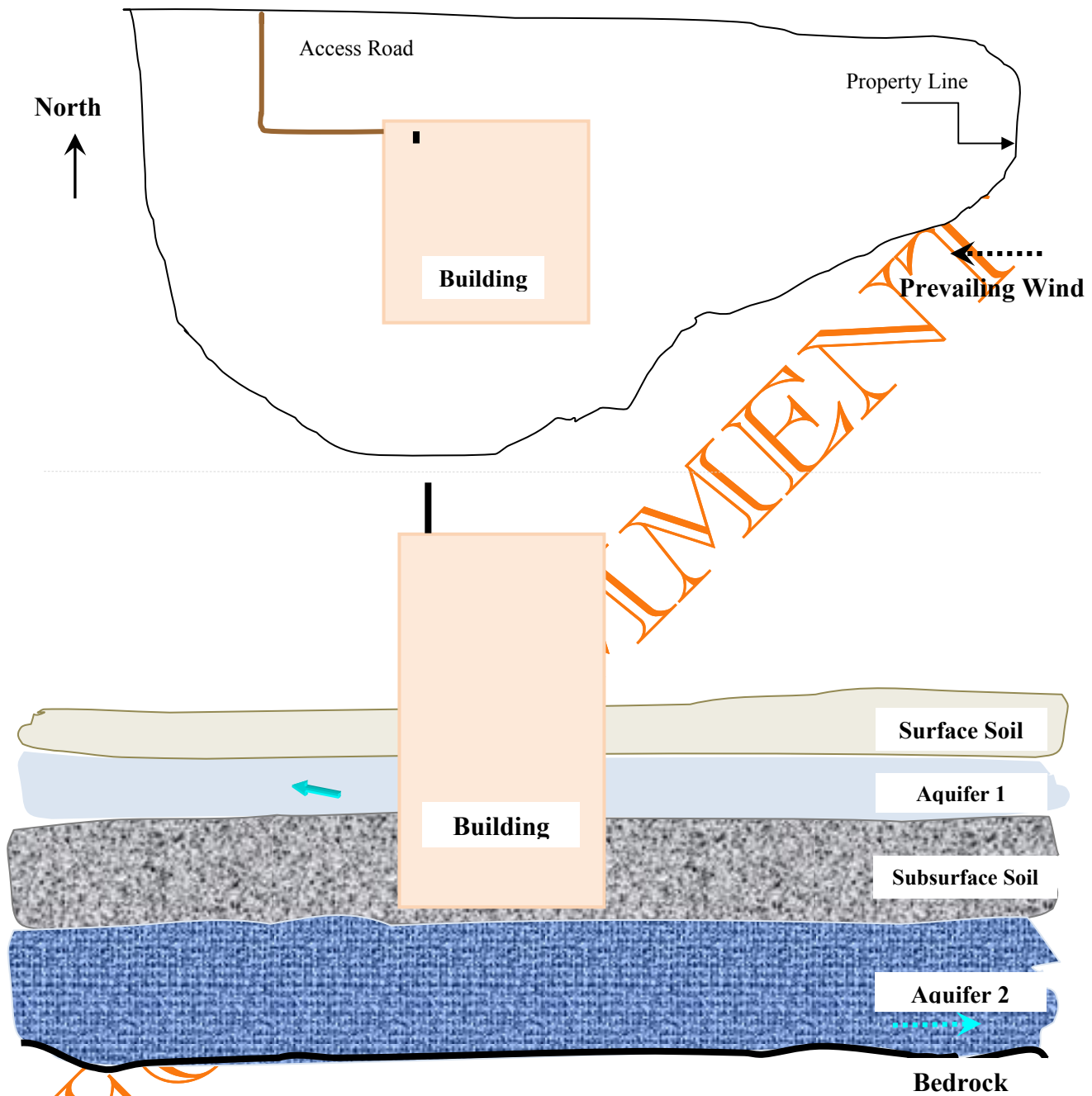
EXAMPLES FOR DETERMINING SAMPLE LOCATIONS

## MONITORING BASES AND EXAMPLES

The U.S. Nuclear Regulatory Commission (NRC) regulations require that, as part of the decommissioning process, licensees provide a comprehensive definition of the radiological condition of the site. The Decommissioning Planning Rule requires licensees to begin the process of site characterization during the operational phase of plant life. Licensees should use the “defense in depth” concept in demonstrating the radiological condition of the site. Licensees should already be monitoring areas where contamination is likely to occur. As shown in Figure 3a in Appendix A, licensees should review existing plans to ensure that all potential areas are adequately monitored. For those areas not currently being monitored that could become contaminated but are not accessible, alternate monitoring should be developed. If the use of remote monitors, robotics, or other techniques is not feasible within the facility, subsurface monitoring downstream of release areas should be evaluated and instituted as appropriate to the potential risk. From the preconstruction site characterization, licensees should have an understanding of the underlying hydrogeology of the site. Following are some examples of updating survey plans for various license types. These examples are for illustration and are not intended to be comprehensive.

For purposes of these examples, the facility comprises a building of several stories with the basement set about 25 feet below grade and some surrounding open land. Site studies show ground water “aquifers” at minus 15 feet and at minus 27 feet, and regional geology information indicates that the upper aquifer flows generally northwesterly and the lower one flows generally easterly. Meteorological data show the predominant wind (greater than 85 percent) is east. Because the leaks are mostly likely to occur in the same general area of the facility, it is not generally reasonable to try to separate molecules among the various occurrences. So, under these circumstances, where is it reasonable to sample?

***SCHEMATIC FOR POTENTIAL SAMPLING LOCATIONS***



**INSIDE:**

- Tops of ducts, cabinets, open structures, etc.
- Floors around drains, edges and joints, under equipment

**OUTSIDE:**

- Surface soil northwest along road and west of the building for airborne deposits
- Shallow aquifer northwest of the building for soluble isotopes if indicated
- Deep aquifer east of building for potential releases around footer if indicated

## **I. Large Fuel Cycle Facility**

Fuel cycle facilities have reported unplanned releases to various parts of the facilities, including inside and outside of buildings, some resulting in radiological contamination in the subsurface. Over time, process leaks have resulted in extensive subsurface contamination that has spread through ground water migration. Once the licensee identifies that process leaks have occurred, it must survey the interior areas where the contamination was released, where it may collect—sumps, drains, building joints—and the potentially affected subsurface to determine the actual extent of contamination. Sampling and monitoring of the subsurface should occur downstream of and close to potential release points from buildings, tanks, piping, etc. Preconstruction studies should provide some information on the hydrogeology of the area, such as material types, depth(s) to ground water, and geochemistry, which is useful in identifying potential sampling locations.

## **II. RTR**

RTRs have reported unplanned losses of pool water through drain overflows and erroneous valve alignments. Consider a case in which facility records include comprehensive water quality data that demonstrate no elevated radionuclide concentrations during the entire operational life, and water level/makeup data demonstrating no losses during the entire operational life, including from any auxiliary systems, “rabbits,” etc. The licensee could then argue that it is “reasonable under the circumstances” to not conduct additional sampling.

Lacking any of this information, the licensee should review its sampling program to identify potential unmonitored releases downstream of possible release points, including connected piping systems, drains, building joints, and the subsurface. Potential sample locations include those where liquids can “pool” and could, over the operational life of the facility, result in concentration of radionuclides.

## **III. Radiopharmaceutical Processor**

A facility “tags” chemicals with radionuclides. The facility air system controls internal contamination and discharges some radioactive material up the stack within the limits of Table 2 of Appendix B, “Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage,” to Title 10, of the *Code of Federal Regulations*, Part 20, “Standards for Protection against Radiation.” Because the entrained chemicals are heavier than air, they subsequently fall to the ground and may concentrate above release limits in the predominant wind direction(s). They could also migrate into the ground water and result in wider contamination. Parameters affecting the potential concentration include process discharge rate, weight of particulates, radionuclide half-life, terrain, precipitation, and variability of windspeed and direction. The licensee could calculate the maximum concentration using conservative assumptions such as monodirectional stable wind conditions, maximum half-life, and minimum solubility for the isotope(s) processed. Assuming higher solubility would potentially result in lower surface concentrations but higher ground water concentrations. Alternatively, the licensee could take some samples based on known processes and meteorological conditions. If a licensee does not have sufficient meteorological data, it should do more surface monitoring to determine possible deposition patterns.



#### **IV. Medical Laboratory**

In laboratories, on rare occasions, radioactive materials may be poured, spilled, or dropped into drains or onto floors. Generally, the materials are dilute or are diluted by subsequent drain use. However, some radioactive compounds may concentrate in building joints or at irregular fittings in piping systems, such as p-traps. Materials may also escape from hoods and associated vent ducting into the rooms, or collect within the ductwork, more likely at joints or other fittings.



## **APPENDIX C**

### **EXCERPTS FROM PERTINENT REGULATIONS**

### 10 CFR 20.1003, “Definitions”

*Residual radioactivity* means radioactivity in structures, materials, soils, groundwater, and other media at a site resulting from activities under the licensee’s control. This includes radioactivity from all licensed and unlicensed sources used by the licensee, but excludes background radiation. It also includes radioactive materials remaining at the site as a result of routine or accidental releases of radioactive material at the site and previous burials at the site, even if those burials were made in accordance with the provisions of 10 CFR Part 20.

### 10 CFR 20.1101, “Radiation Protection Programs”

- (a) Each licensee shall develop, document, and implement a radiation protection program commensurate with the scope and extent of licensed activities and sufficient to ensure compliance with the provisions of this part.
- (b) The licensee shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).
- (c) The licensee shall periodically (at least annually) review the radiation protection program content and implementation.

### 10 CFR 20.1402, “Radiological Criteria for Unrestricted Use”

A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE [total effective dose equivalent] to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA)...

### 10 CFR 20.1403, “Criteria for License Termination under Restricted Conditions”

A site will be considered acceptable for license termination under restricted conditions if:

- (a) The licensee can demonstrate that further reductions in residual radioactivity necessary to comply with the provisions of § 20.1402 **would result in net public or environmental harm** or were not being made because the residual levels associated with restricted conditions are ALARA....
- (b) The licensee has made provisions for legally enforceable institutional controls....
- (c) The licensee has provided sufficient financial assurance to enable an independent third party, including a governmental custodian of a site, to assume and carry out responsibilities for any necessary control and maintenance of the site.
- (d) The licensee has submitted a decommissioning plan or License Termination Plan (LTP) to the Commission indicating the licensee’s intent to decommission in accordance with [regulations], and specifying that the licensee intends to decommission by restricting use of the site. The licensee shall document in the LTP or decommissioning plan how the advice of individuals and institutions in the community who may be affected by the decommissioning has been sought and incorporated, as appropriate, following analysis of that advice.

(e) Residual radioactivity at the site has been reduced so that if the institutional controls were no longer in effect, there is reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group is as low as reasonably achievable and would not exceed either—

(1) 100 mrem (1 mSv) per year; or

(2) 500 mrem (5 mSv) per year provided the licensee—

(i) Demonstrates that further reductions in residual radioactivity necessary to comply with the 100 mrem/y (1 mSv/y) value of paragraph (e)(1) of this section are not technically achievable, would be prohibitively expensive, or would result in net public or environmental harm;

(ii) Makes provisions for durable institutional controls;

(iii) Provides sufficient financial assurance to enable a responsible government entity or independent third party, including a governmental custodian of a site, both to carry out periodic rechecks of the site no less frequently than every 5 years to assure that the institutional controls remain in place as necessary to meet the criteria of § 20.1403(b) and to assume and carry out responsibilities for any necessary control and maintenance of those controls.

#### **10 CFR 20.1406, “Minimization of Contamination”**

(c) Licensees shall, to the extent practical, conduct operations to minimize the introduction of residual radioactivity into the site, including the subsurface, in accordance with existing radiation protection requirements in Subpart B and radiological criteria for license termination in Subpart E of this part.

#### **10 CFR 20.1501, “General” (part of Subpart F, “Surveys and Monitoring”)**

(a) Each licensee shall make or cause to be made, surveys of areas, including the subsurface, that—

(1) May be necessary for the licensee to comply with the regulations in this part; and

(2) Are reasonable under the circumstances to evaluate in a timely manner—

(i) The magnitude and extent of radiation levels; and

(ii) Concentrations or quantities of residual radioactivity; and

(iii) The potential radiological hazards of the radiation levels and residual radioactivity detected.

(b) Notwithstanding § 20.2103(a) of this part, records from surveys describing the location and amount of subsurface residual radioactivity identified at the site must be kept with records important for decommissioning, and such records must be retained in accordance with §§ 30.35(g), 40.36(f), 50.75(g), 70.25(g), or 72.30(d), as applicable.

**10 CFR 30.35, “Financial Assurance and Recordkeeping for Decommissioning”**

(d) Table of required amounts of financial assurance for decommissioning by quantity of material. Licensees required to submit the \$1,125,000 amount must do so by December 2, 2004. Licensees required to submit the \$113,000 or \$225,000 amount must do so by June 2, 2005. Licensees having possession limits exceeding the upper bounds of this table must base financial assurance on a decommissioning funding plan.

Greater than $10^4$ but less than or equal to $10^5$ times the applicable quantities of appendix B to part 30 in unsealed form. (For a combination of isotopes, if R, as defined in § 30.35(a)(1), divided by $10^4$ is greater than 1 but R divided by $10^5$ is less than or equal to 1.)	\$1,125,000
Greater than $10^3$ but less than or equal to $10^4$ times the applicable quantities of appendix B to part 30 in unsealed form. (For a combination of isotopes, if R, as defined in § 30.35(a)(1), divided by $10^3$ is greater than 1 but R divided by $10^4$ is less than or equal to 1.)	225,000
Greater than $10^{10}$ but less than or equal to $10^{12}$ times the applicable quantities of appendix B to part 30 in sealed sources or plated foils. (For a combination of isotopes, if R, as defined in § 30.35(a)(1), divided by $10^{10}$ is greater than, 1, but R divided by $10^{12}$ is less than or equal to 1)	113,000

**10 CFR 40.36, “Financial Assurance and Recordkeeping for Decommissioning”**

(b) Each applicant for a specific license authorizing possession and use of quantities of source material greater than 10 mCi but less than or equal to 100 mCi in a readily dispersible form shall either—

- (1) Submit a decommissioning funding plan as described in paragraph (d) of this section; or
- (2) Submit a certification that financial assurance for decommissioning has been provided in the amount of \$225,000 by June 2, 2005 using one of the methods described in paragraph (e) of this section. For an applicant, this certification may state that the appropriate assurance will be obtained after the application has been approved and the license issued but before the receipt of licensed material. If the applicant defers execution of the financial instrument until after the license has been issued, a signed original of the financial instrument obtained to satisfy the requirements of paragraph (e) of this section must be submitted to NRC prior to receipt of licensed material. If the applicant does not defer execution of the financial instrument, the applicant shall submit to NRC, as part of the certification, a signed original of the financial instrument obtained to satisfy the requirements of paragraph (e) of this section.

**10 CFR 50.75, “Reporting and Recordkeeping for Decommissioning Planning”**

(f)(3) Each power reactor licensee shall at or about 5 years prior to the projected end of operations submit a preliminary decommissioning cost estimate which includes an up-to-date assessment of the major factors that could affect the cost to decommission.

**10 CFR 50.82, “Termination of License”**

(a)(8)(iii) Within 2 years following permanent cessation of operations, if not already submitted, the licensee shall submit a site-specific decommissioning cost estimate.

**10 CFR 70.25, “Financial Assurance and Recordkeeping for Decommissioning”**

(d) Table of required amounts of financial assurance for decommissioning by quantity of material. Licensees required to submit the \$1,125,000 amount must do so by December 2, 2004. Licensees required to submit the \$225,000 amount must do so by June 2, 2005. Licensees having possession limits exceeding the upper bounds of this table must base financial assurance on a decommissioning funding plan.

greater than $10^4$ but less than or equal to $10^5$ times the applicable quantities of appendix B to part 30. (For a combination of isotopes, if R, as defined in § 70.25(a), divided by $10^4$ is greater than 1 but R divided by $10^5$ is less than or equal to 1.)	\$1,125,000
greater than $10^3$ but less than or equal to $10^4$ times the applicable quantities of appendix B to part 30. (For a combination of isotopes, if R, as defined in § 70.25(a), divided by $10^3$ is greater than 1 but R divided by $10^4$ is less than or equal to 1.)	\$225,000