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DRAFT REGULATORY GUIDE

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DRAFT REGULATORY GUIDE DG-4012

MINIMIZATION OF CONTAMINATION AND RADIOACTIVE WASTE GENERATION - LIFE CYCLE PLANNING

A. INTRODUCTION

Title 10 of the *Code of Federal Regulations* (CFR) Section 20.1406, "Minimization of Contamination," requires the submission of information by license applicants with regard to design and operational procedures for minimizing contamination of the facility and the environment and for minimizing radioactive waste generation and facilitating decommissioning. As specifically stated, "Applicants for licenses, other than renewals, after August 20, 1997, shall describe in the application how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste." Therefore, a license applicant should consider the total life cycle of the facility, from initial facility layout and design to procedures for operation and for final decontamination and dismantling at the time of decommissioning. During the operating life of a facility, the design and operating procedures might change, but the objectives of 10 CFR 20.1406 need to be addressed. The purpose of this regulatory guide is to present guidance that will assist license applicants in effectively implementing this licensing requirement.

The guidance presented in this document consists of specific design considerations drawn from nuclear industry experience and lessons learned from decommissioning. These design suggestions provide examples of measures which can be combined to support a contaminant management philosophy. The principles embodied in this philosophy are threefold: (1) prevention of unintended release, (2) early detection, if there is unintended release of radioactive contamination, and (3) prompt and aggressive cleanup, should there be an unintended release of radioactive contamination. If the guiding principles are followed through the use of "good" engineering and science, as well as careful attention to operational

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This regulatory guide is being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. It has not received final staff review or approval and does not represent an official NRC staff position.

Public comments are being solicited on this draft guide (including any implementation schedule) and its associated regulatory analysis or value/impact statement. Comments should be accompanied by appropriate supporting data. Written comments may be submitted to the Rulemaking, Directives, and Editing Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Comments may be submitted electronically through the NRC's interactive rulemaking Web page at http://www.nrc.gov. Copies of comments received may be examined at the NRC's Public Document Room, 11555 Rockville Pike, Rockville, MD. Comments will be most helpful if received by **November 1, 2007.**

Electronic copies of this draft regulatory guide are available through the NRC's interactive rulemaking Web page (see above); the NRC's public Web site under Draft Regulatory Guides in the Regulatory Guides document collection of the NRC's Electronic Reading Room at http://www.nrc.gov/reading-rm/doc-collections/; and the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html, under Accession No. ML071210011.

practices, it should result in meeting the requirements of 10 CFR 20.1406. All 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. Some of the mechanisms which can be employed for the life cycle planning are described further in this guide.

License applications submitted to NRC cover over 100 different kinds of activities ranging from large complex facilities such as power reactors and reprocessing facilities which handle significant volumes of radioactive solids, liquid, and gases to small users of sealed sources. They do not all reflect the same potential for contamination of a facility and the environment, or for the generation of radioactive waste. Guidance is provided under "Implementation" for deciding on the extent to which this guide applies for a given activity or facility.

The U.S. Nuclear Regulatory Commission (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 regulatory guides is not required.

This regulatory guide relates to information collections that are covered by the requirements of 10 CFR Part 20 and that the Office of Management and Budget (OMB) has 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.

B. DISCUSSION

Explore Opportunities for Minimizing Contamination Prior to Application Submittal

One of the significant early lessons learned about minimizing the radiological impacts of decommissioning was the importance of early planning for decommissioning. Such planning should include consideration of decommissioning at the time of initial design and continue through facility operations. Prior to license submittal, the applicant should explore opportunities for minimizing contamination of the facility and the environment that carefully consider facility design as well as operating procedures. Thus, the license applicant, during initial facility design planning, should comprehensively consider design aspects, construction, and operation through termination of the license by the NRC. This last aspect includes consideration of decommissioning activities until satisfactory facility and site release is accomplished (i.e., meeting the Subpart E radiological criteria in 10 CFR Part 20, as site-specifically approved by the NRC).

Minimize Leaks and Spills and Provide Containment

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

Prompt Detection of Leakage

The facility should be designed such that any structure, system, or component (SSC) which has the potential for leakage is provided with adequate leak detection capability. In addition to design considerations to control and, if possible, prevent radioactive system leakage, it is important during operations to be able to promptly detect leakage as close as possible to the leakage source to allow timely intervention and the prevention of widespread contamination. Thus, monitoring and routine surveillance programs become an important part of minimizing potential contamination. This approach should include the placement of instruments to detect leakage at readily accessible locations and operational practices that will enable early detection of contamination. Because leakage detection is only the first step in minimizing contamination, the applicant also should develop mitigation plans for quickly stopping any spread of contamination once it is detected.

Avoid Release of Contamination from Undetected Leaks

Past experience has shown that SSCs containing radiation that are not readily accessible for surveillance can be the source of undetected leaks of radioactive material over a prolonged period of time. The contamination from undetected leaks can accumulate as subsurface residual radioactivity that may need to be remediated prior to license termination. SSCs that are buried or are in contact with soil – such as spent fuel pools (SFPs), tanks in contact with the ground, and buried pipes – are particularly susceptible to undetected leakage. The available data from facilities being decommissioned indicate that it was common for some level of undetected releases to occur in the subsurface environment during the facility operating life. These releases were generally minor leaks that occurred over an extended period of time. Many of the leaks occurred in areas where it was difficult or impossible to conduct regular inspections. This likely contributed to the failure to identify the leaks at the time of occurrence. Monitoring of some systems was not sufficiently sensitive to identify small leaks and leakage rates. Such situations and conditions should be avoided during facility design. It is desirable to include leak detection systems within the facility design that are capable of detecting minor leaks that otherwise over time could potentially cause significant environmental contamination.

It is also desirable to design the facility such that any SSC which has the potential for leakage is provided with adequate leak detection capability.

Measures for Reducing the Need to Decontaminate Equipment and Structures

Applicants can reduce the need to decontaminate equipment and structures by taking measures that will decrease the probability of any release, reduce any amounts released, and decrease the spread of the contaminant from the source (e.g., from systems or components that must be opened for service or replacement). Such preventive and corrective measures can include auxiliary ventilation systems, treatment of the exhaust from vents and overflows, and techniques to control releases (i.e., capping or elevating uncontrolled drains, use of barriers or dikes, use of controlled sumps, and protection of SSCs from inclement weather). Leakage from components containing radioactive liquids can be reduced by: (1) inclusion of design specifications such as the proper selection of materials (e.g., corrosion resistant piping, double-walled pipes, and tanks with annulus monitoring), improved protection of buried components (e.g., galvanic corrosion protection, coatings); (2) the use of industry consensus code and standards for repair and/or replacement of SSCs; and (3) application of rigorous quality control and quality assurance programs.

Operational Practices Should be Periodically Reviewed

Operational practices are another important consideration in meeting the requirements of 10 CFR 20.1406. These practices should be subjected to periodic review to ensure: (1) facility personnel follow the operating procedures, (2) operating procedures are revised to reflect the installation of new or modified equipment or facility processes, and (3) personnel qualification and training are kept current with the latest versions of operational programs and procedures. Operational programs and procedures should be subjected to review and evaluation following events that resulted in leaks and spills of radioactive materials. As part of the root-cause analysis, the evaluation should determine: (1) whether procedures, equipment, and/or operator errors contributed to the event and releases, and (2) identify immediate and long-term corrective actions. The results of such lessons-learned should then be assessed as to their broader applicability to similar or related facility operations and incorporated as needed into revised programs and procedures.

Related Regulatory Guides on Minimization of Contamination

Much of the guidance found in the following two regulatory guides would also contribute to the minimization of contamination: (1) Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants," as it relates to potential contamination, and (2) Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable," as it relates to the reduction of occupational radiation exposures, also applies to minimization of contamination. As applicable, this guidance incorporates elements from these regulatory guides that directly bear on minimization of contamination.

Radioactive systems designated as safety related or addressed under other aspects of an applicant's quality programs that are subject to maintenance, inspections, tests, and/or other quality requirements, may also provide some measure of compliance with the specifications of 10 CFR 20.1406. The measures and guidance addressed by this guide apply to the implementation of the 10 CFR 20.1406 requirements, even though they may also be pertinent or applicable to other requirements. No attempt has been made to identify when such dual applicability might be relevant.

Proper Records will Facilitate Decommissioning

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

Final Site Configuration to Prevent or Confine Contamination

License applicants should consider the final site configuration to aid in preventing the migration of radionuclides offsite via an unmonitored pathway. They should develop an onsite monitoring program, as an integral part of the radiological environmental monitoring program (REMP), to provide early detection

and quantification of leaks and spills and maintain a current baseline of radiological and hydrogeological parameters. Plans for responding to detection of leaks and spills should reflect final facility design and site configuration.

C. REGULATORY POSITION

1. Minimizing Facility Contamination

In general, the license applicant can minimize radioactive contamination of the facility by using structure, system, and component designs that limit leakage and/or control the spread of contamination and by employing operational procedures that provide for early detection as well as followup mitigative and corrective measures.

Applicants should consider the following specific measures (or the combination of them) for minimizing facility contamination:

a. The interfaces between the radioactive SSC important to radiological safety and the nonradioactive SSC should be minimized. Necessary interfaces should have a minimum of two barriers, including one that can be a pressure differential, and should have instrumentation for prompt detection and control of cross-contamination.

b. Processing areas for radioactive material should be isolated from other areas within the facility through the use of compartmentalization and access controls to reduce the potential for cross-contamination.

c. A maintenance and inspection program should be applied to radioactive SSCs that have a potential for leakage of radioactive material to the site environs, that is, onsite and offsite locations outside of the facility SSCs.

d. A leak identification program should be developed for components containing radioactive materials to prevent unnecessary contamination of equipment and surrounding areas, and to minimize radioactive waste.

e. Leak or spill collection systems should be provided to protect against leakage and/or isolate the release of liquid contamination through redundancy concepts such as multiple piping enclosures with pans/trays or drainage to channel contamination for collection and processing.

f. Provisions should be made to allow timely identification of leak locations. Structures and components, such as the spent fuel pool and associated piping, should be designed to permit the isolation of clearly-defined zones within that system and should be provided with the capability of detecting and quantifying small leakage rates (e.g., several gallons per week) from each zone.

g. Pipes should be adequately sized to minimize the potential for blockage by encrustation of precipitates and to facilitate the removal of such blockage from the pipes.

h. The initial facility design should include system decontamination facilities/provisions, that provide the means for timely reduction of the buildup of radioactive source terms which could potentially lead to facility contamination.

i. Radioactive SSCs should be designed for the lifetime of the facility, thus avoiding the necessity for replacement of these SSCs and lessening the potential for system leakage and contamination of nonradioactive systems/components. Materials used in radioactive SSCs should be compatible with processing/disposal options.

j. Considering the expected life cycle of the facility, the design should include provisions to facilitate the maintenance, inspection, and removal of radioactive components.

k. The design of highly contaminated areas (e.g., refueling canals, valve alleys) should include provisions for decontamination methods specifically designed for those areas.

l. In areas where the potential for a spill exists, floors should be appropriately sloped to floor drains that lead to the radioactive waste system, thus limiting the extent of contamination.

m. The necessity for decontamination can be reduced by limiting, to the extent practicable, the deposition of radioactive material within processing equipment, particularly in the "dead spaces" or "traps" (i.e., zones of low fluid flow where contaminants settle out) in components where substantial accumulation can occur. Tank and piping systems used for liquid radioactive systems should take advantage of gravity flow (e.g., pipes and tank bottoms should be sloped) to reduce the potential for contamination buildup. The deposition of radioactive material in piping can be reduced, and decontamination efforts enhanced, by avoiding stagnant legs, locating connections above the pipe centerline, using sloping rather than horizontal runs, and providing drains and flushing capabilities (which are routinely inspected and maintained) at low points in the system.

n. Piping should be designed for readily available access for high pressure hydrolyzing and chemical decontamination methods.

o. Potentially radioactive lines in temporary and/or mobile systems should have self-sealing quick disconnects as well as a means to promptly isolate leaks. These systems should incorporate operational interlocks to minimize the possibility of leakage and contamination. Designs should ensure that spills and leaks from skid-mounted systems will be contained and routed to radioactive waste drains.

p. Material selection for SSCs should consider the operating environment and intended means of disposal. The design and materials for reinforced concrete structures as well as piping, liners, bolts, and other items used for the storage and transport of radioactive liquids should be appropriate to mitigate cracking, adverse chemical reactions, and other degradation mechanisms that can result in leakage. The selection of radiation-damage-resistant materials for use in high-radiation areas can reduce the need for frequent replacement and can decrease the probability of contamination from leakage. Where appropriate, the surfaces of concrete structures and components should be sealed to facilitate cleaning and decontamination.

q. Monitoring instrumentation (e.g., level sensors, flow meters, pressure sensors, temperatures indicators) should be designed to allow replacement.

r. Surfaces and expansion joints can be decontaminated more expeditiously if they are pretreated to provide a smooth, nonporous surface that is free of cracks, crevices, and sharp corners. These desirable features can be achieved by specifying appropriate design instructions, giving attention to finishing work during construction or manufacture, and using appropriate sealers on surfaces where contamination can be anticipated. Seals should be maintained over the life of the facility,

and their integrity should be routinely inspected, to ensure that spills and leaks on the floors do not enter unmonitored areas beneath the floors and foundations.

s. Applicants should also ensure that concrete block walls designed to enable the future removal of large components for maintenance or replacement and are completely sealed to prevent the intrusion of radioactive materials into the block interiors. Tops of block walls that are not connected to the ceiling should be sealed, preventing contamination from entering the block interiors. Porous, unsealed blocks should not be used in areas subject to contamination.

t. Floor liners and catch basins should be used for SSCs that have a high potential for periodic leakage during routine operations and/or maintenance. Floor liners and catch basins should be impermeable, durable, and have readily cleanable surfaces.

u. A program should be developed for maintaining control over the storage and use of radioactive materials in the restricted area outside the physical facility structures. For example, areas in which waste is to be stored should be evaluated and approved for storage and have appropriate design and control features. Administrative controls, e.g., establishment of controls on packaging and transport of radioactive material in and around the facility, should be established to prevent the spread of contamination when radioactive material or contaminated equipment must be transported from one station location to another within the facility and when the route of transport through lower radiation zones cannot be avoided.

v. Drains from locker rooms and clean-up showers should be routed to radwaste processing facilities to prevent the reconcentration of radioactive materials in onsite sewage plants.

w. Ventilation system designs should confine airborne radioactive materials within the process areas and as close to the point of origin as practicable. Construction materials for the ventilation systems should be carefully selected and have smooth internal and external surface finishes to aid in decontamination. Ventilation stacks and duct work should have minimal lengths and minimal abrupt changes in direction. Designs should permit convenient inspection, maintenance, and decontamination; and/or replacement of critical components such as filters, fans, and dampers. Maintaining air pressure gradients and airflows from areas of low potential airborne contamination to areas of higher potential contamination can limit the spread of airborne contamination within the facility. Maintenance programs include periodic checks of ventilation systems to ensure that the design pressure differentials, direction of flow, and flow rates are being maintained and that the design continues to be adequate for controlling contamination.

x. To prevent uncontrolled release through ventilation systems, condensation from all coolers handling potentially contaminated air should be collected and routed to a monitored liquid effluent discharge.

y. Provisions should be made for containing and controlling potential tank overflow through the tank vent discharge piping. Such provisions may include (1) a receiving tank or indoor sump to catch any overflow and (2) high-level alarms on the source tank to indicate overflow occurrences.

z. Tank sampling stations should be designed to minimize the possibility of sample fluid leaking to the ground or to the underlying pad surface.

2. Minimizing Contamination of the Environment

In general, system design features and operational procedures that prevent and/or control releases within the facility also contribute to minimizing contamination of the environment. For systems that directly interface with the environment, the first indication of a leak may be detection in an environmental system. To control and mitigate such events, it is prudent to have a comprehensive understanding of the interface with environmental systems and the features that will control the movement of contamination in the environment. A conceptual site model (CSM) based on site characterization and facility design and construction can be a significant tool in (1) understanding the site and (2) planning and implementing mitigative actions. Therefore, the site should be characterized before construction to assess the impact that the facility will have on the site hydrogeology following construction. In addition to the conceptual site model, attention should be given to identifying the potential release mechanisms and possible location of contaminant releases. Systems or structures that are buried or in contact with soil are particularly susceptible to undetected leakage. Undetected leakage commonly occurs in areas where is was not possible to conduct regular inspections and oftentimes these leaks are not identified in a timely manner. To minimize contamination of the environment, systems should be designed to facilitate early detection of leakage and contamination migration.

Applicants should consider the following specific measures (or the combination of these measures) for minimizing contamination of the environment:

a. License applicants should evaluate the system design with respect to the hydrogeology of a site before construction to: (1) gather information for inclusion in a conceptual site model, (2) identify potential migration and ground-water transport pathways for potential environmental contaminating events, and (3) assess the effect of construction on the hydrogeological characteristics of the site. A plan for implementing and updating the conceptual site model should be one component of the proposed facility operating procedures. Specifically, following facility construction, any impacts of site construction activities on final site hydrogeological characteristics should be identified. If there are significant changes at the site during the operating life of the facility, the conceptual site model should be re-evaluated and adjusted, and appropriate adjustments/changes should be made to the onsite and offsite monitoring program.

b. As a general design consideration, any systems containing radioactive material should have at least two impermeable boundaries to the environment with the capability for periodic testing and inspection. If the design cannot incorporate such features, the applicant should propose specific environmental monitoring (e.g., sampling of ground water in close proximity to potential sources) to periodically verify integrity of the system.

c. Tanks, sumps, and ponds containing radioactive materials should have at least two impermeable boundaries to the environment with an integrated leak detection system capability that triggers an alarm at an operator station. Tank catch basins should be of solid construction, sealed, and leakproof, and should have a capacity sufficiently larger than the maximum tank volume to accommodate the contents of the tank, including related piping, and in the event of a system failure.

d. Exterior tanks should be located on or above bermed concrete pads. The berms should have a capacity sufficiently larger than the maximum tank volume to accommodate the contents of the tank, including related piping, and in the event of a system failure. Each concrete pad should be lined or sealed with an impermeable membrane. Each bermed area should have provisions for sampling and release of rainwater.

e. Monitoring systems and programs to detect the source and extent of leakage of radioactivity from SSCs, particularly those located below grade, should be deployed as close as possible to the SSC and designed to expedite early detection so that remedial action can be taken if necessary.

f. To the extent practicable, systems containing, transporting, or processing radioactive liquids should not use buried piping and drains. Underground piping containing radioactive liquids should be enclosed within structured pipe chases with provisions for periodic inspection (visual) or surveillance (leak detection system) to verify piping integrity. For those situations in which pipe chases are not feasible, the use of double-walled lines with built-in leak detection capability should be considered.

g. If foundation drains are used as part of a building design, the capability for sampling and processing the effluent of those drains should also be included.

h. To minimize the potential for spreading solid or liquid contamination into the environment, radioactive material handling, staging, storage, and decontamination areas should be located inside buildings or in contained areas.

i. To minimize the leakage of radioactive fluids to ground water, and the leakage of ground water into buildings, system and structural designs should avoid the use of below-grade conduit and piping penetrations through walls that form exterior boundaries. This is particularly applicable to penetrations at or through the floor level.

j. The radioactive liquid waste treatment system should not include any bypasses or drains that would allow waste to inadvertently circumvent treatment system components or to be released directly to the environment.

k. Drain systems for storm water and sanitary sewage should be separate from contaminated waste drain systems.

l. The design for any sump or retention pond which has the potential to become contaminated (even if it is not considered a radioactive system) should include a liner and the capability for isolation or collection/routing of overflow to a monitored release path.

m. All ingress/egress points for facilities containing radioactive systems should include provisions for preventing leakage/seepage to the outside environment. For example, the use of sills at outside ingress/egress locations or floor grades sloped toward drain channels can help to prevent flow to outside grounds/soil.

n. Penetrations through outer walls of a building containing radioactive systems should be sealed to prevent leaks to the environment. The integrity of such seals should be periodically verified.

o. Design and construction specifications for major radioactive system barriers such as SFPs and transfer canals should consider measures to minimize the need for seals (e.g., continuous concrete pours). Alternatively, clear separation between major structures should be considered, with both visual and integrated leak detection.

p. The design of excavations and the selection of backfill for SSCs containing radioactive materials should: (1) prevent leakage contaminants from the facility reaching natural permeable layers or fractured rock, and (2) in the event of leakage to the environment, facilitate the migration of

leakage contaminants to designated locations and systems of the facility (e.g., radioactive external waste drains or sumps) for eventual extraction and treatment.

q. Backfill should not contain soil that contains concentrations of radioactive material above the natural occurring levels.

r. Proposed operating procedures should include the monitoring of backfill or structural fill designed to transport leakage from radioactive systems for evidence of clogging (e.g., blockage by migrating fines from surrounding soil).

s. Potential leakage from any existing adjoining nuclear facility should be prevented from migrating into the excavation and backfill of a new nuclear facility.

t. The design ground-water level should be located below the foundation of SSCs containing radioactive liquids so that any leakage is not directly introduced into saturated soils below the foundation.

u. The extraction of ground water or leaked liquid radioactive effluent should be planned with consideration of potential impacts on the SSC foundation support.

v. Proposed monitoring programs should allow for re-evaluation of the location of monitoring sensors and sampling frequency if contaminants are detected. This analysis should provide the technical basis for determining the need for further action.

w. Procedures for mitigation, if contamination is detected, should include use of the conceptual site model and monitoring information to develop event specific models of contaminant migration before the selection of a remediation strategy.

x. Design and operation of ground-water capture zones surrounding SSCs should provide effective means to isolate and collect liquid radioactive contaminants escaping to the subsurface and to prevent abnormal release to ground water.

3. Facilitation of Decommissioning

In general, the means for facilitating decommissioning begin with a facility that considered decommissioning during the design stage of the facility and maintained procedures and operations consistent with this philosophy. The procedures should identify that compliance with the 10 CFR 20.1406 Subpart E decommissioning criteria is required. The objective is to ensure that throughout the life of the facility, design and operating procedures minimize the amount of residual radioactivity that will require remediation at the time of decommissioning. Properly designed and operated facilities will support efficient decommissioning activities (e.g., decontamination, removal, and disposal with a minimum of worker radiation exposure) as well as reduced generation of radioactive waste.

The following specific measures for facilitating decommissioning or the combination of these measures should be considered by applicants:

a. To facilitate decommissioning, all information relating to the facility design, facility construction, site conditions before and after construction, onsite waste disposal, onsite contamination, and results of monitoring should be centrally located and readily recoverable.

b. Applicants should establish procedures to ensure adequate and complete documentation of corporate knowledge of instances of facility and environmental contamination and operational events, over the lifetime of the facility in accordance with the applicable record keeping requirements such as 10 CFR 20 Subpart I, 10 CFR 50.75(g), 10 CFR 70.50, and 10 CFR 72 Subpart D. This program can provide information that will be important in preparing a good historical assessment of a nuclear facility, which can save time and effort during decommissioning planning.

Decommissioning activities have been complicated by residual radioactivity which did not meet the record keeping requirements. Applicants are encouraged to consider maintaining records of instances of facility and environmental contamination events that result in residual contamination which may complicate the decommissioning process.

c. Plans and procedures to facilitate decommissioning should include: (1) comprehensive video records of the equipment layout in areas where radiation fields are expected to be high following operations and (2) as-built drawings of the facility. Furthermore, the records should include global positioning system readings that pinpoint all buried component locations, particularly components in the site environs.

d. Facility designs should minimize the use of embedded pipes in facility walls, floors, and the like to the extent practicable, consistent with maintaining radiation doses as low as is reasonably achievable (ALARA) during operations and decommissioning. Embedded pipes, especially those that are small in diameter (less than 6 inches), could complicate decommissioning activities because they can be very difficult to remove or survey. Their location should be carefully documented to facilitate eventual decommissioning.

e. Temporary piping installed during construction should be removed to avoid undocumented random piping in the field that, when uncovered, will raise questions about the extent of site contamination during decommissioning. Construction debris should not be disposed of within the controlled area.

f. During the design stage, consideration should be given to facilitating the removal of any equipment and/or components that may require removal and/or replacement during facility operation or decommissioning. When designing buildings or enclosures for large pieces of equipment (e.g., steam generators, large piping, tanks), a license applicant should determine how these pieces will be removed for replacement or how they will be permanently removed at the time of facility decommissioning. License applicants should evaluate the following:

- size/space clearances
- installation of removable roofs/walls
- placement of cranes and lifts for replacement or removal of heavy equipment or components
- installation of lifting lugs
- design of anchor points for lifts
- use of shearable nuts and bolts
- use of quick-disconnect components
- ease of insulation removal
- set down

4. Minimizing the Generation of Waste

Minimizing the generation of radioactive waste is both a design and operational consideration. A life-cycle approach should be taken in identifying all components used in the facility and all waste that will result from system operations and processing. Life-cycle waste management planning should be carried out for any new waste stream to define the strategy for its conditioning, storage, or disposal. System designs should enable operators to perform decontamination efficiently while minimizing collective dose and the production of radioactive waste.

The following specific measures or a combination of these measures for minimizing waste generation may be employed by applicants:

a. Volume reduction systems should be considered for minimizing the volume of generated waste, consistent with American National Standards Institute (ANSI)/American Nuclear Society (ANS)-40.35-1991, "Volume Reduction of Low Level Radioactive Waste or Mixed Waste."

b. Waste streams with significantly different levels of contamination should not be mixed in order to minimize the volume of the higher-activity wastes. Waste should be shipped offsite when generated, and legacy wastes should be avoided.

c. In general, onsite disposal of radioactive material – that is, disposal of waste under 10 CFR 20.2002, "Method for Obtaining Approval of Proposed Disposal Procedures" – should be avoided or minimized as described in the license application. Such disposals should be located in areas not susceptible to surface-water flooding or occasional water-table rise creating local saturation of the waste, and must have proper monitoring to detect potential radionuclide migration. If the applicant chooses to pursue waste disposal under 10 CFR 20.2002, all the required documentation relating to onsite disposal should be maintained in the facility records until the license is terminated.

d. Onsite decontamination facilities and/or waste segregation facilities should be provided for the orderly management and segregation of large quantities of radioactive material/waste. These decontamination facilities, even if temporary, should follow the guidance contained in this document.

e. Continuous concrete pours eliminate potential leakage paths through seams used for non-continuous concrete pours. However, continuous concrete pours are difficult to dismantle and could create significant quantities of contaminated waste at decommissioning. Consideration should be given to modular construction for those structures for which liquid leakage is not a concern. Modular design permits the removal of separate layers of contaminated material, thereby minimizing the volume of contaminated waste.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants regarding the NRC staff's plans for using this draft regulatory guide. No backfit is intended or approved in connection with issuance of this regulatory guide.

This guide reflects current NRC staff guidance in license application reviews. Therefore, except in those cases in which the applicant proposes an acceptable alternative method for complying with the specified portions of the Commission's regulations, the methods described herein will continue to be used in the evaluation of license applications until this guide is revised as a result of suggestions from the public or additional staff review.

Over 100 different kinds of activities are covered by license applications submitted to the NRC. They do not all reflect the same potential for contamination of a facility and the environment, or for the generation of radioactive waste. Therefore, an applicant should use sound judgment to evaluate the potential for contamination and the consequences of such contamination in deciding on the extent to which this guide applies to any given facility or activity. Factors which may enter into this decision include form (e.g., dry solids, liquids, gases), inventory, and environmental mobility of unintended releases.

Figure 1 is a flow diagram indicating the decision paths an applicant might take in determining the applicable of this guide. If the facility will store or handle large volumes of dispersable radioactive material then the applicant should consider the full range of the measures found in the guide. If the facility will still handle significant amounts of dispersable radioactive material (e.g., amounts which if released might result in extensive clean-up activities either during operation or decommissioning) then the form of the material needs to be considered. For example, for a liquid, consideration should be given to the

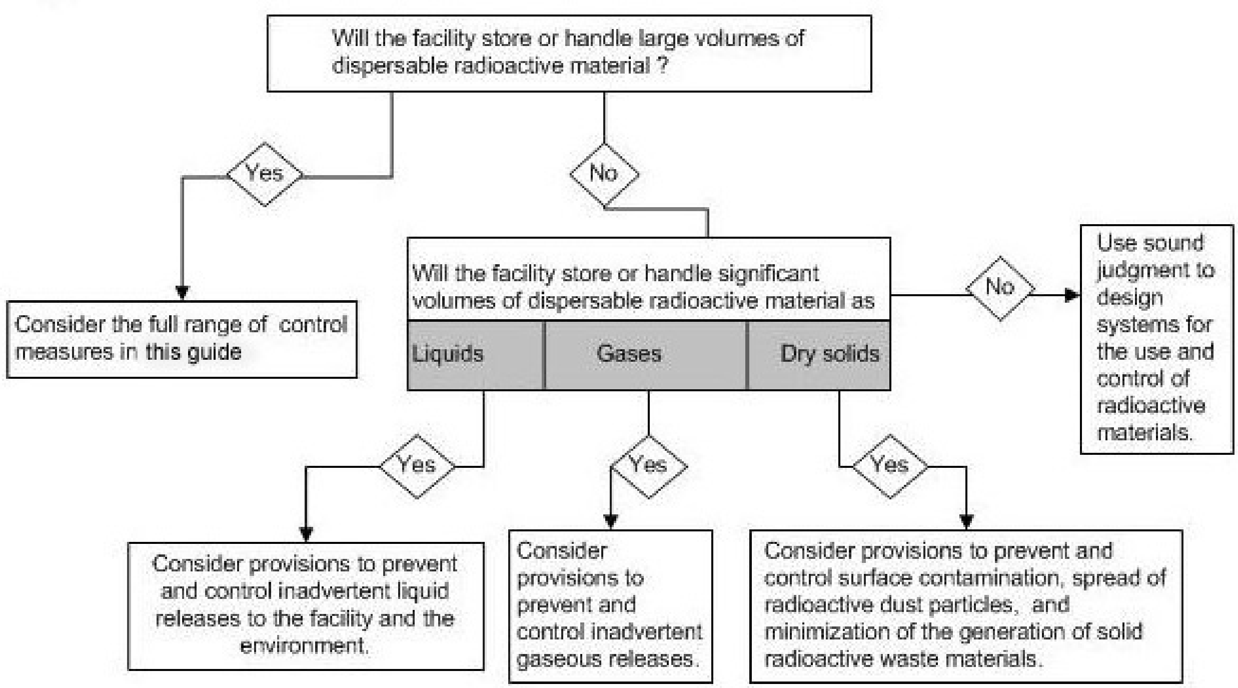

Figure 1: Decision Tree for 10 CFR 20.1406

provisions to prevent and control inadvertent liquid releases. Similarly for a gas, consideration should be given to the provisions to control inadvertent gaseous releases. This also applies to dry solids. It should be noted that there are no exceptions in the regulations with regard to the applicability of 10 CFR 20.1406 fo license applications after August 20, 1997. Even applications that do not deal with large or significant amounts of radioactive material need to address the minimization and facilitation provisions of the regulations but should do so using common sense and good judgement.

Table 1 provides further information which may be useful in determining the applicability of the guide. For major, complex facilities with significant inventories of radioactive material such as a commercial nuclear power plant, enrichment facility, fuel fabrication facility, or a radioactive waste disposal facility (Table 1, Groups 1 and 2), this guide should assist an applicant in meeting the

Table 1. Applicability of This Guide Relative to Type of Facility, Physical Form of Radioactive Material (liquid, gas, solid), Half-life, and Inventory (High, Intermediate, Low)

Type of facility or use of radioactive material	Physical form of radioactive material involved		
	liquid	gas	dry solid
Group 1 **High inventory, long half-life – Power Plants and Fuel Cycle Facilities**			
commercial nuclear power plant	3	3	3
fuel fabrication plant	3	3	3
enrichment plant	3	3	3
reprocessing facility	3	3	3
Group 2 **High inventory, long half-life – Waste Disposal Facilities**			
high level waste disposal facility	1	2	2
low level waste disposal facility	2	1	3
Group 3 **Intermediate to low inventory, long half-life**			
uranium mills and mines	2	2	2
research and test reactors	2	2	3
Group 4 **Low inventory, half-life generally not long**			
medical use of radioactive material	2*	1	2*
industrial use of radioactive material	1	2	1 dependent on material.*
medical or industrial use of sealed sources	1	1	1
Legend: 3 (highest likelihood of using the measures in this guide) 2 (moderate likelihood of using the measures in this guide) 1 (low likelihood of using the measures in this guide) * emphasis on inventory control			

requirements of 10 CFR 20.1406. For smaller facilities which do not have large inventories, especially ones in which the material has a short half-life or is in the form of a sealed source (Table 1, Group 4), an applicant would need to consider only those design measures which directly apply to the type of radioactive material and processes to be authorized and the potential for contamination of the facility or environment. In this case, applicants should focus on historical information that reflects the likelihood of contamination of the facility and environment to identify the systems that should be designed and operated consistent with 10 CFR 20.1406.

In summary, the thrust of this guide is for an applicant to use technically sound engineering judgment and a practical risk-informed approach to achieve the objectives of 10 CFR 20.1406. This approach should consider the materials and processes involved (e.g., solids, liquids, gases) and focus on: (1) the relative significance of potential contamination; (2) areas most susceptible to leaks; and (3) the appropriate level of consideration to prevention and control of contamination that should be incorporated in facility design. Following this approach should result in meeting the objectives of 10 CFR 20.1406. Since the applicability of the guidance is a facility-by-facility decision, early consultation with the NRC is strongly suggested.

REGULATORY ANALYSIS

The NRC staff did not prepare a separate regulatory analysis for this regulatory guide. The regulatory basis for this guide is the regulatory analysis prepared for the amendments to 10 CFR Part 20 promulgated July 21, 1997 (62 FR 39086). That regulatory analysis examined the costs and benefits of the rule as implemented by this guide. A copy of that regulatory analysis is available for inspection and may be copied (for a fee) at the NRC Public Document Room, located at One White Flint North, 11555 Rockville Pike, Rockville, MD 20852. No separate regulatory analysis was prepared for this regulatory guide.

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1 All regulatory guides listed herein were published by the U.S. Nuclear Regulatory Commission. Where an ADAMS accession number is identified, the specified regulatory guide is available electronically through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html. All other regulatory guides are available electronically through the Public Electronic Reading Room on the NRC's public Web site, at http://www.nrc.gov/reading-rm/doc-collections/reg-guides/. Single copies of regulatory guides may also be obtained free of charge by writing the Reproduction and Distribution Services Section, ADM, USNRC, Washington, DC 20555-0001, or by fax to (301) 415-2289, or by email to DISTRIBUTION@nrc.gov. Active guides may also be purchased from the National Technical Information Service (NTIS) on a standing order basis. Details on this service may be obtained by contacting NTIS at 5285 Port Royal Road, Springfield, VA 22161,online at http://www.ntis.gov, by telephone at (800) 553-NTIS (6847) or (703) 605-6000, or by fax to (703) 605-6900. Copies are also available for inspection or copying for a fee from the NRC's Public Document Room (PDR), which is located at 11555 Rockville Pike, Rockville, Maryland; the PDR's mailing address is USNRC PDR, Washington, DC 20555-0001. The PDR can also be reached by telephone at (301) 415-4737 or (800) 397-4205, by fax at (301) 415-3548, and by email to PDR@nrc.gov.

2 Copies of American National Standards (ANS) may be purchased from the American National Standards Institute (ANSI), 1819 L Street, NW., 6th floor, Washington, DC 20036 [phone: (202) 293-8020)]. Purchase information is available through the ASCE Web site at http://webstore.ansi.org/ansidocstore/.

3 All NUREG-series reports listed herein were published by the U.S. Nuclear Regulatory Commission, and are available electronically through the Public Electronic Reading Room on the NRC's public Web site, at http://www.nrc.gov/reading-rm/doc-collections/nuregs/. Copies are also available for inspection or copying for a fee from the NRC's Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301) 415-4737 or (800) 397-4209; fax (301) 415-3548; email PDR@nrc.gov. In addition, copies are available at current rates from the U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20402-9328, telephone (202) 512-1800; or from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161, online at http://www.ntis.gov, by telephone at (800) 553-NTIS (6847) or (703) 605-6000, or by fax to (703) 605-6900.