Site-Specific Analyses for Demonstrating Compliance with 10 CFR 61 Performance Objectives - 12179

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ABSTRACT

The U.S. Nuclear Regulatory Commission (NRC) is proposing to amend its regulations at 10 CFR Part 61 to require low-level radioactive waste disposal facilities to conduct site-specific analyses to demonstrate compliance with the performance objectives in Subpart C. The amendments would require licensees to conduct site-specific analyses for protection of the public and inadvertent intruders as well as analyses for long-lived waste. The amendments would ensure protection of public health and safety, while providing flexibility to demonstrate compliance with the performance objectives, for current and potential future waste streams. NRC staff intends to submit proposed rule language and associated regulatory basis to the Commission for its approval in early 2012. The NRC staff also intends to develop associated guidance to accompany any proposed amendments. The guidance is intended to supplement existing low-level radioactive waste guidance on issues pertinent to conducting site-specific analyses to demonstrate compliance with the performance objectives. The guidance will facilitate implementation of the proposed amendments by licensees and assist competent regulatory authorities in reviewing the site-specific analyses. Specifically, the guidance provides staff recommendations on general considerations for the site-specific analyses, modeling issues for assessments to demonstrate compliance with the performance objectives including the performance assessment, intruder assessment, stability assessment, and analyses for long-lived waste. This paper describes the technical basis for changes to the rule language and the proposed guidance associated with implementation of the rule language.

INTRODUCTION

The NRC is proposing to amend its regulations at 10 CFR 61 to require radioactive waste disposal facilities to conduct site-specific analyses to demonstrate compliance with the performance objectives. The amendments would require licensees to conduct site-specific analyses for protection of the public and inadvertent intruders as well as analyses for long-lived waste. The amendments would ensure protection of public health and safety, while providing flexibility to demonstrate compliance with the performance objectives, for current and potential future waste streams. The NRC staff also intends to develop associated guidance to accompany any proposed amendments. The guidance is intended to supplement existing low-level radioactive waste guidance on issues pertinent to conducting site-specific analyses to demonstrate compliance with the performance objectives. The guidance will facilitate implementation of the proposed amendments by licensees and assist regulatory authorities in reviewing the site-specific analyses.

10 CFR Part 61

The NRC's requirements for the land disposal of commercial radioactive waste were adopted in 1982 [1] and can be found in Part 61 of Title 10 of the *Code of Federal Regulations* [2]. The regulations emphasize a performance-based approach that assures safe disposal through compliance with key objectives and technical requirements while allowing applicants flexibility to determine how to meet the established performance objectives. The performance objectives are:

1. Protection of the general population from releases of radioactivity (Section 61.41);
2. Protection of individuals from inadvertent intrusion (Section 61.42);
3. Protection of individuals during operations (Section 61.43); and
4. Stability of the site after closure (Section 61.44).

To demonstrate that the performance objectives and technical requirements can be met, Part 61 license applicants must provide specific technical information specified in Section 61.12 including the technical analyses specified in Section 61.13. The technical analyses require a(n):

1. Assessment of radiological exposures to humans from the release of radioactivity;
2. Demonstration that waste classification and segregation requirements will be met and adequate barriers to inadvertent intrusion will be provided;
3. Assessment of expected exposures due to routine operations; and
4. Assessment of the need for ongoing active maintenance of the disposal site following closure considering active natural processes.

The NRC specifies the requirements for determination of waste classification for near-surface disposal at Section 61.55. The determination involves two considerations. First, consideration is given to the concentration of long-lived radionuclides whose potential hazard will persist long after such precautions as institutional controls, improved waste form, and deeper disposal have ceased to be effective. Second, consideration is given to the concentration of shorter-lived radionuclides for which requirements for institutional controls, waste form, and disposal methods are effective. The classification system for near-surface disposal is comprised of three waste classes – Class A, B, and C. Waste designated as Class A is considered relatively innocuous waste that would present an acceptable hazard within 100 years, and, therefore, wouldn't need more stringent disposal requirements associated with the other waste classes. Waste designated as Class B contains higher concentrations of short-lived radionuclides and must meet more rigorous requirements on waste form to ensure stability after disposal. Waste designated as Class C is waste that is not expected to decay to levels which present an acceptable hazard within 100 years, and, therefore, requires use of an intruder barrier to limit potential disturbance of the waste. Waste with concentrations above the Class C limits are generally considered unacceptable for near-surface disposal.

The isotopic concentration limits for waste classification were based on the NRC's understanding (circa 1980) of the characteristics and volumes of commercial low-level radioactive waste reasonably expected for commercial disposal through the year 2000, the potential disposal methods likely to be used at a reference disposal facility, and potential exposure pathways [3]. The intent was to determine which waste streams as well as which hypothetical exposure scenarios resulted in the highest exposures. Two classes of exposure scenarios were considered: concentration-limited and activity-limited. Concentration-limited exposure scenarios involved inadvertent intruders in direct contact with the disposed waste, whereas, the activity-limited exposure scenarios involved environmental transport (*e.g.*, surface water and groundwater) of radionuclides from the disposed waste to receptor locations. In general, the concentration-limited exposure scenarios produced the highest estimated exposures. Therefore, the isotopic concentration limits specified in the waste classification requirements are largely based on the results of the concentration-limited scenarios (*i.e.*, inadvertent intruders).

Recent Developments in Low-Level Radioactive Waste

If waste differs significantly in quantity and concentration from what was considered in the development of Part 61, it may be possible to dispose of a waste that may meet the waste classification requirements, but could result in exposures that exceed those used to develop the waste classification requirements. Recently, two waste streams have been identified by industry and the NRC that were not envisioned during the development of Part 61. These waste streams include large quantities of concentrated depleted uranium from enrichment facilities and the large-scale blending of certain waste streams to generate lower class wastes (e.g., mixing of a Class B waste with a similar waste classified as A to generate a Class A waste for disposal).

The recent interest in licensing commercial uranium enrichment facilities in the United States has brought depleted uranium to the forefront of commercial low-level radioactive waste disposal issues. With the existing stockpile of depleted uranium at existing U.S. Department of Energy enrichment facilities and the recent licensing of the Louisiana Energy Services' National Enrichment Facility and the United States Enrichment Corporation's American Centrifuge Plant, more than 1 billion kg (200 thousand tons) of depleted uranium hexafluoride may need a disposition path. During the development of Part 61, some radionuclides, such as isotopes of uranium, were not expected to be generated in sufficient quantities or concentrations in commercial waste streams to warrant limitation in the waste classification requirements. The technical basis for Part 61 considered that only 629 GBq (17 Ci) of U-238 and 111 GBq (3 Ci) of U-235 would be disposed in 1 million m^3 (33 million ft^3) of waste over a 20-year operating life for a reference disposal facility. The NRC derived concentration limits for uranium, but these limits were not included in the final rule because NRC determined that, based on the relatively small quantities of uranium expected to be generated by commercial facilities at the time, uranium did not pose a significant hazard to warrant limitation by the waste classification requirements at Section 61.55.

Large-scale blending of different classes of waste could also result in waste streams with concentrations that are inconsistent with the development of the waste classification requirements. Large-scale blending of wastes would enable some materials that would otherwise have been disposed of as Class B and C waste to be mixed with Class A waste to create large volumes of waste that has concentrations near the Class A limits. As with depleted uranium, the NRC did not evaluate the disposal of large volumes of low-level radioactive waste with concentrations near the limit for Class A in the technical basis for Part 61.

Commission Direction

During the licensing proceedings for Louisiana Energy Services' National Enrichment Facility, the Commission directed staff, outside of the proceedings, to consider whether the quantities of depleted uranium at issue in the waste stream from uranium enrichment facilities warrant amending the waste classification requirements [4]. In order to develop an informed response to the Commission direction, NRC staff performed a technical analysis to evaluate the impacts of near-surface disposal of large quantities of depleted uranium and to determine if amendments to the waste classification requirements are necessary to assure its safe disposal [5]. The technical analysis determined that depleted uranium has characteristics that are dissimilar from typical commercial low-level radioactive waste. The radiological hazard from depleted uranium *increases* over long periods of time due to in-growth of decay products in contrast to typical commercial low-level radioactive waste, which decreases significantly over a few hundred years. Also, the technical analysis concluded that near-surface disposal may comply with the Part 61 performance objectives for large quantities of depleted uranium *under certain conditions* that are site-specific.

Based on the results of the technical analysis, NRC staff recommended to the Commission to proceed with rulemaking for Part 61 to specify a requirement for a site-specific analysis for the disposal of large quantities of depleted uranium [6]. The site-specific analysis would demonstrate whether the performance objectives of Part 61 could be met. The Commission approved this recommendation to proceed with rulemaking and develop guidance to facilitate implementation of the amended rule [7].

Subsequently, due to the closing of the Barnwell disposal facility in 2008, the issue of blending of low-level radioactive waste received increased attention. NRC Chairman Jaczko directed staff to assess issues associated with blending of low-level radioactive waste for disposal [8]. The NRC staff responded with an assessment of regulatory issues associated with blending and noted that large-scale blending of Class B and Class C concentrations of low-level radioactive waste with Class A to produce a Class A mixture could result in exposures exceeding those considered in the development of the waste classification requirements for Part 61 [9]. NRC staff also provided a recommendation to the Commission to improve blending policy using risk-informed, performance-based approaches through amendments to regulations and guidance [9]. The Commission approved the recommendation and directed the NRC staff to include a requirement for a site-specific analysis to ensure that blended waste is disposed of safely [10].

RULEMAKING

As a result of recent interest in waste streams different than those considered in the development of Part 61 (i.e., large quantities of concentrated depleted uranium and blended waste) and Commission direction, NRC began development of proposed amendments to Part 61 to require license applicants to prepare site-specific analyses to demonstrate compliance with the performance objectives and ensure safe disposal of low-level radioactive waste. The amendments will also define the specific technical parameters of the analyses including period of performance and dose limit for protection of inadvertent intruders.

Specifically, the proposed amendments would update and add new requirements which are used to demonstrate compliance with the performance objectives, to require: 1) a performance assessment to demonstrate protection of the general population from releases of radioactivity; 2) an inadvertent intruder assessment to demonstrate protection of individuals from inadvertent intrusion; and 3) a long-term analysis to evaluate how the disposal system may mitigate the risk from disposal of long-lived wastes.

Performance Assessment

The Part 61 performance objective for protection of the general population (Section 61.41) would continue to be demonstrated with a site-specific analysis. However, the amendment to Section 61.13(a) would require the analysis to specifically be a performance assessment that addresses the “risk triplet” – namely, what can happen; how likely is it to happen; and what are the resulting consequences [11]. The essential elements of a performance assessment include: 1) an identification of features, events, and processes that might affect the disposal system; 2) an examination of the effects of these features, events, and processes on the performance of the disposal system; and 3) an estimation of the annual total effective dose equivalent to a member of the public including associated uncertainties. The amendments in this area are intended to update the methodology to more modern approaches consistent with other radioactive waste disposal activities.

Inadvertent Intruder Assessment

Secondly, the proposed amendments to Part 61 would add a requirement to perform an inadvertent intruder assessment to demonstrate protection of individuals from inadvertent intrusion. Currently, Part 61 does not require a site-specific analysis to demonstrate protection of inadvertent intruders. Instead, the safety of inadvertent intruders is currently ensured by the waste classification and segregation requirements as well as the disposal requirements imposed for each class of waste. The connection between the waste classification system and protection of inadvertent intruders is reflected in the isotopic concentration limits in the waste classification requirements. Thus, significant inconsistencies between actual waste disposal practices and the underlying considerations used to develop the isotopic concentration limits in the waste classification requirements could either significantly under- or overestimate the ability of a disposal facility to adequately protect individuals from inadvertent intrusion. Therefore, the NRC staff is proposing to add a requirement that licensees conduct a site-specific inadvertent intruder assessment to demonstrate compliance with the performance objective to protect individuals from inadvertent intrusion.

An inadvertent intruder assessment quantitatively estimates the radiological exposure of inadvertent intruders at a disposal facility following an assumed loss of institutional controls. An intruder assessment can employ a similar methodology to that used for performance assessment, but the intruder assessment assumes that an individual occupies the disposal site after closure, engages in normal activities, and is *unknowingly* exposed to radiation from the waste. The NRC continues to view the inadvertent intruder scenarios considered in the development of Part 61, which included normal activities such as dwelling construction and agriculture, as protective of public health and safety. However, the proposed amendment would provide licensees flexibility to consider reasonably foreseeable site-specific exposure scenarios. Licensees or applicants could take credit, with an appropriate technical justification, for characteristics of the disposal system that would likely limit speculation about the types of activities that a hypothetical future intruder may engage in. These considerations are described more fully in the discussion on guidance below.

Intruder Dose Limit

Per the Commission's direction to specify the technical parameters of the analyses, the NRC staff is also proposing to specify an intruder dose limit as described in the original development of Part 61 – 5 mSv/yr (500 mrem/yr). The development of Part 61 considered a range of values that were consistent with exposure guidelines of different orders of magnitude: 0.25 mSv/yr (25 mrem/yr), 5 mSv/yr (500 mrem/yr), and 50 mSv/yr (5,000 mrem/yr) [12]. The rationale for selecting 5 mSv/yr (500 mrem/yr) acknowledged several considerations including: (1) the hypothetical nature of inadvertent intrusion; (2) similarity to the public dose limit at that time; (3) cost; (4) impact on disposal efficiency and existing practice; and (5) potential for extending intruder hazard for long periods of time as a result of disposal of larger quantities of long-lived radionuclides. In 1994, NRC, in light of public dose limit (10 CFR 20) change to 1 mSv/yr (100 mrem/yr), stated that it continued to believe that the 5 mSv/yr (500 mrem/yr) dose limit used to develop the waste classification tables provides an acceptable level of protection to inadvertent intruders [13].

The NRC staff acknowledges that the activities in which the hypothetical intruder might engage while on the disposal site and the location of the disposal site in which the intruder might contact waste are difficult to quantify given the uncertainty in future human behavior. It is possible, therefore, that a hypothetical intruder could contact isotopic concentrations in waste that are highly variable depending on the intruder's activities and the location of contact with the waste. Therefore, NRC staff is seeking comments on whether it should consider alternative approaches for specifying a dose limit to account for variability in radionuclide concentrations. For example, one proposal is to specify a limit of 5 mSv/yr (500 mrem/yr) for average concentrations and a limit of 50 mSv/yr (5,000 mrem/yr) for 95^{th} percentile concentrations. The limits in the example are consistent with the range of values considered in the development of Part 61, and provide a safety margin within the reference levels for which reasonable efforts should be made to reduce the probability of human intrusion or to limit its consequences that are advised by the International Commission on Radiological Protection (ICRP) [14]. The ICRP has advised that an annual dose[1] of around 10 mSv/yr (1,000 mrem/yr) may be used as a generic reference level below which intervention is not likely to be justifiable. Conversely, the ICRP also noted that an annual dose of around 100 mSv/yr (10,000 mrem/yr) may be used as a generic reference level above which intervention should be considered almost always justifiable.

Period of Performance

The proposed amendments would specify a two-tiered period of performance. The first tier would extend to 20,000 years and would be used to demonstrate compliance with the performance objectives (i.e., compliance period). The second tier would estimate the peak dose after 20,000 years and would be used to assess how the design of the facility considers the potential long-term radiological impacts (i.e., long-term performance period). Currently, Part 61 does not specify a limit to the period of performance. However, the development of Part 61 and related guidance documents recognized the need to use a time period for the analyses commensurate with the persistence of the hazard of the source and the waste classification requirements are based on analyses considering a 10,000 year time frame [3, 15].

Within the NRC, the debate concerning the specification of an appropriate period of performance for waste disposal extends back as far as 1994. The NRC's Advisory Committee on Nuclear Waste (ACNW), while commenting on a NRC staff draft technical position regarding low-level waste performance assessment, noted that the time frame of 10,000 years was arbitrary and lacked bases in either standards or regulations [16]. In 1996, the NRC staff recommended a 10,000 year period to the Commission as sufficiently long to capture the peak dose from more mobile long-lived radionuclides, which will tend to bound the potential doses at longer times and demonstrate the relationship of site suitability to compliance with the performance objective [17]. In response, the Commission directed the staff publish the draft technical position for public comment and to provide, in the final technical position, the technical basis used to limit assessment to 10,000 years [18]. In 1997, the ACNW recommended a two-tiered approach: a first tier requiring compliance with a numerical standard; and a second tier used to evaluate the robustness of the facility over a range of processes and events that may affect the performance of the facility over long time periods [19]. For the first tier, the ACNW recommended the time period be site-specific and established by consideration of (i) the estimated time for release and transport of more mobile radionuclides to reach the critical group, (ii) the definition of a reference biosphere and lifestyle of the critical group, and (iii) the time

[1] The term annual dose is used by the ICRP to mean the existing and persisting annual dose incurred by individuals in a given location. The exposure that may occur from a disposal facility is a component of the existing annual dose.

period over which scientific extrapolations can be convincingly made. ACNW envisioned the second tier would ensure that no significant changes in the dose from the disposal facility would occur in the near term after the calculated time of compliance and warned against the second tier becoming a *de facto* regulation. In 2000, the NRC staff re-proposed a 10,000 year time period citing its consistency with other allied standards and authoritative technical recommendations [15]. Supporting the recommendation were calculations the NRC staff had performed for a hypothetical low-level radioactive waste disposal facility. The NRC staff considered the 10,000 year performance period sufficient to capture the risk from the short-lived radionuclides and the peaks from the more mobile long-lived radionuclides. The NRC staff's recommendations noted that there could be exceptions to the 10,000 year performance period. Disposal of large quantities of uranium or transuranics was one of the examples provided. Therefore, the NRC staff advocated the use of a second tier, similar to the one proposed by the ACNW, that would be used to understand whether the less mobile, long-lived radionuclides might have potentially higher doses. The NRC staff advised that this second tier not be used for determining regulatory compliance with the performance objective, rather to assess whether potential doses in the distant future, considering uncertainties, would be sufficiently high to either warrant the imposition of inventory limits or restrict disposal of the waste stream in question at that site.

Selection of a period of performance generally considers the characteristics of the waste, the analysis framework, and uncertainty in predicting the behavior of systems over time. Both technical (*e.g.*, the characteristics and persistence of the radiological hazard attributed to the waste) and socioeconomic factors (*e.g.*, trans-generational equity) should be considered [14]. A variety of options were considered as part of this rulemaking for the selection of the proposed period of performance [20]. These options range from no change to the current framework (i.e., no specification of period of performance) to specifying a calculation to peak dose for demonstration of compliance and considered other waste disposal regulatory regimes for both radioactive and hazardous waste. The compliance period of 20,000 years was selected based on consideration of natural cycling of climate, characteristics of the waste, radionuclide transport characteristics, and previous recommendations by the ACNW and NRC staff [20]. Technical considerations form the primary basis for the current proposal.

A period of 20,000 years is proposed because this period of time would result in the consideration of one of the major stressors for the near-surface disposal – natural cycling of climate – whereas, shorter time periods such as 10,000 years may not depending on the location of the disposal facility. The ACNW in its recommendation on a time frame for assessment noted the importance of considering the alteration of rates of deleterious surface processes resulting from climatic change [19].

Additionally, 20,000 years would better capture, compared to shorter time frames, the in-growth of daughter products (e.g., Ra-226, Rn-222) from long-lived parents that can occur in some waste streams. While longer time frames would better capture the in-growth of progeny in the uranium isotope decay series, the rate of increase in progeny diminishes over time. For instance, an increase from 5,000 years to 50,000 years results in an increase of about 15 times in radium concentrations, whereas, an increase from 50,000 years to 100,000 years results in an increase of less than a factor of two.

Further, NRC staff performed an analysis of transport for a suite of radionuclides of varying mobility to understand the ability of compliance period to capture radionuclide arrival at a potential receptor. The analysis considered a range of disposal depths and climate states for five radionuclides evaluated in a probabilistic manner to account for uncertainty and variability.

The results of the analysis suggest that there is benefit to selecting 20,000 years over shorter time periods when transport characteristics are taken into consideration, but limited additional benefit to selecting longer time periods.

Finally, NRC staff considered previous recommendations by the ACNW and NRC staff in formulating a period of performance [16, 20]. Therefore, the NRC staff is proposing a two-tiered approach, similar to these previous recommendations, in which compliance is demonstrated by comparison to the performance objective during the time period for the first tier, and, thereafter, qualitatively to assess the capabilities of the disposal facility to limit potential impacts into the distant future for the second tier. The requirements for the long-term assessment for this second tier are discussed below.

Long-Term Analysis

Lastly, NRC staff is proposing an amendment for an additional site-specific analysis to determine whether additional limitations on the disposal of certain long-lived waste streams at specific sites may be necessary and ensure protection of the general public from long-lived waste. The long-term analysis, which would be required by the proposed Section 61.13(e), would consider the uncertainties associated with the disposal of long-lived low-level radioactive waste streams. The analysis would be required to consider the peak annual dose that occurs beyond the compliance period. Because of the uncertainties with projecting exposures into the distant future, the analysis is intended to focus on a demonstration of how the natural and engineered barriers of the disposal system may limit releases of material rather than an estimation of radiological impact to an individual or group. Therefore, no dose limit would apply to the results of the analysis, but the analysis would need to be included as an indication of the performance of the disposal facility over the long-term.

GUIDANCE

In addition to specifying requirements for licensees and applicants to conduct site-specific analyses to demonstrate compliance with the performance objectives of 10 CFR Part 61, the Commission also directed NRC staff to develop a guidance document for public comment that provides acceptable approaches for conducting the site-specific analyses. NRC staff responded by developing proposed guidance for public comment that supplements existing guidance in areas related to conducting site-specific analyses. The guidance is intended to assist licensees and applicants conducting site-specific analyses as well as NRC and Agreement State regulators who are reviewing the analyses to determine acceptable approaches to demonstrate compliance with the performance objectives.

Specifically, the proposed guidance covers the technical analyses, required at Section 61.13, that are associated with the long-term performance of the disposal facility. The analyses required to demonstrate long-term performance include the performance assessment [Section 61.13(a)], inadvertent intruder assessment [Section 61.13(b)], and the long-term analysis [Section 61.13(e)], which are related to amendments NRC staff has proposed in this rulemaking as well as the requirement for analyses to demonstrate site stability [Section 61.13(d)] which NRC staff is not proposing to amend in this rulemaking. The guidance also consolidates recommended approaches for common elements to all site-specific analyses.

Common Elements

All the site-specific analyses associated with long-term performance of the disposal system include elements that are common to the various analyses described above. In general, an acceptable approach, described in the proposed guidance, includes defining the scope of the analysis, which estimates what can happen and how likely it is to happen, and general elements of the consequence modeling, which estimates the resulting impacts. Defining the scope of the analysis includes identification and screening of features, events, and processes (FEPs), and formation of FEPs into scenarios that describe potential evolutions of the disposal facility over the performance period. In addition, proposed guidance is provided on six general technical elements form the basic components of performance assessment modeling:

- Description of the disposal system;
- Adequacy of the data to support the models;
- Treatment of uncertainty in supporting data;
- Support for the adequacy of models to represent the disposal system;
- Treatment of uncertainty in models; and
- Integration of the models comprising the performance assessment.

Performance Assessment

The proposed amendments to Part 61 update what is required of the technical analysis to demonstrate protection of the general population performance objective. As mentioned above, the proposed amendment updates the terminology to performance assessment. A performance assessment is a type of systematic risk analysis that addresses (1) what can happen, (2) how likely it is to happen, (3) what the resulting impacts are, and (4) how these impacts compare to the performance objective in Section 61.41 (radiological protection of the general public) [11]. The proposed guidance describes acceptable methods for conducting the more modern methodology associated with performance assessment.

In addition to the proposed guidance on common elements, specific guidance on assessing consequences in a performance assessment supplements existing guidance in NUREG-1573 [15]. The proposed guidance emphasizes considerations for long-lived radionuclides such as those associated with the uranium decay chain. Specific guidance supplements methods for modeling the source term and radionuclide transport in the environment. The source term includes the inventory, physical and chemical characteristics, and other properties of the waste used to estimate release rates. Radionuclides released from low-level radioactive waste disposal facilities can then be transported through the environment by groundwater, surface water (including suspended sediments), air, and biota (e.g., rodents, insects, etc.).

Inadvertent Intruder Assessment

The proposed regulation at Section 61.13 would require an assessment to demonstrate that exposures to an individual inadvertently intruding in the disposal site will not exceed the limits specified in Section 61.42. The primary objective of an inadvertent intruder assessment is to quantitatively analyze the potential radiological exposures to any individual who is assumed to occupy the site at some time as a result of a loss of institutional controls and engage in reasonably foreseeable pursuits while on the site. Given the intruder assessment would be a new requirement; a primary purpose of the proposed guidance is to provide acceptable approaches for conducting the intruder assessment.

The process to conduct an inadvertent intruder assessment is similar to the process for conducting a performance assessment except that an intruder assessment constrains the scenario by assuming the intruder accesses the disposal site and may directly or indirectly contact the disposed waste. Therefore, the proposed guidance focuses on acceptable methods to develop reasonably acceptable exposure scenarios.

The definition of scenarios and the intruder assessment can be generic or site-specific. Licensees may use default scenarios similar to those described in the development of the original Part 61 [12] with site-specific waste streams or develop site-specific scenarios to evaluate site-specific waste streams. The NRC continues to view the default scenarios as reasonably conservative to estimate potential radiological exposures to inadvertent intruders while limiting excessive speculation about future human activities. However, some site-specific waste streams, facility designs, or environmental conditions may require additional consideration of the disposal facility’s ability to limit potential exposures to inadvertent intruders in order to demonstrate compliance with the inadvertent intrusion performance objective. The proposed guidance details approaches for appropriate uses of physical (e.g., water resources) and cultural information (e.g., land use) to develop site-specific exposure scenarios.

The proposed guidance also includes acceptable approaches for modeling consequences to a hypothetical inadvertent intruder. Specific guidance is provided related to appropriately representing intruder barriers, radiological source term for direct and indirect contact scenarios, and on-site radionuclide transport.

Site Stability Analysis

The site stability analysis evaluates the long-term stability of the disposal site and determines compliance with 10 CFR 61.44. The performance objective for disposal site stability after closure states that the disposal facility must be sited, designed, used, operated, and closed to achieve long-term stability of the disposal site and to eliminate, to the extent practicable, the need for ongoing active maintenance of the disposal site following closure. This site stability analysis consists of (1) identification of disruptive processes that could affect the stability of the disposal site (e.g., erosion, flooding, and seismicity); (2) technical assessment of the stability of the waste form, disposal facility, and the site; (3) the use of engineered barriers for site stability; and (4) evaluation and monitoring. The proposed guidance, which provides acceptable approaches for conducting site stability analyses, supplements NUREG-1200 [21], in particular, for the site stability analyses for long-lived waste.

Long-Term Analysis

The primary purpose of the long-term analyses is to provide information to decision makers with respect to the potential performance of the disposal facility and disposal site for the disposal of long-lived waste. Long-term analyses are not required if the disposal facility is not accepting long-lived waste. The proposed guidance describes acceptable approaches for conducting long-term analyses of various methods including quantitative, semi-quantitative, and qualitative. The proposed guidance recognizes that there are limits to the value of analyses of projected performance over very long timeframes (e.g., tens of thousands of years) and specifies guidelines that provide confidence that a disposal facility may be more likely to achieve long term isolation of waste from the accessible environment. The proposed guidelines for long-term isolation are:

- Simple, passive designs;
- Designs that mimic natural features;
- Low relief designs;
- Low water contact with waste;
- Robust, low-porosity waste forms;
- Geochemical compatibility of the waste and disposal environment;
- Stable disposal environment conditions;
- Accreting environments;
- Large distance to water table and homogeneous natural materials;
- Deep disposal;
- Low population density;
- Limited natural resources;
- Stable climate; and
- Low frequency of geologic and tectonic events.

The proposed guidance also offers acceptable methods for interpretation and representation of data in analyses and limiting speculation on future human behavior. Finally the guidance discusses barrier analyses used to assess the capability of features of the disposal system to limit reduce long-term impacts.

CONCLUSION

The NRC staff, per Commission direction, intends to propose amendments to 10 CFR Part 61 to require licensees to conduct site-specific analyses to demonstrate compliance with performance objectives for the protection of public health and the environment. The amendments would require a performance assessment to demonstrate protection of the general population from releases of radioactivity, an assessment to demonstrate protection of a potential inadvertent intruder, and a long-term analysis to assess how the design of the facility considers the potential radiological impacts associated with disposal of long-lived waste streams. Concurrently, the NRC staff intends to propose associated guidance to facilitate the implementation of the requirements to conduct site-specific analyses. In proposing these amendments to the regulation and associated guidance, the NRC staff has conducted extensive public outreach since 2009 including three public meetings and four briefings of the NRC's Advisory Committee on Reactor Safeguards. The NRC staff plans to submit the proposed amendments to the regulations to the Commission in early 2012. Subsequently, the proposed amendments and associated guidance would be published in the Federal Register for public comment pending approval of the proposed amendments to the regulations by the Commission. Following the public comment period, NRC staff plans to address public comments and revise, as necessary, the regulations and associated guidance before publishing a final rule, which is anticipated in 2013.

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