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DESIGN CERTIFICATION/COMBINED LICENSE

DC/COL-ISG-014

Assessing the Radiological Consequences of Accidental Releases of Radioactive Materials from Liquid Waste Tanks in Ground and Surface Waters for Combined License Applications

Interim Staff Guidance

January 2013

(Final)

INTERIM STAFF GUIDANCE

ASSESSING THE RADIOLOGICAL CONSEQUENCES OF ACCIDENTAL RELEASES OF RADIOACTIVE MATERIALS FROM LIQUID WASTE TANKS IN GROUND AND SURFACE WATERS FOR COMBINED LICENSE APPLICATIONS

DC/COL-ISG-014

Purpose

The purpose of this Interim Staff Guidance (ISG) is to clarify previous U.S. Nuclear Regulatory Commission (NRC) guidance on reviewing the analysis of the radiological consequences of accidental releases of radioactive materials to groundwater and surface water. Such analyses are required as part of the licensing review of new nuclear power reactor applications under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50 and 10 CFR Part 52. Standard Review Plan (SRP) NUREG-0800, Sections 2.4.13 and 11.2, and Branch Technical Position (BTP) 11-6, describe acceptable guidance on how to assess the radiological consequences of such releases. The two SRP sections and BTP are not internally consistent in identifying acceptable criteria for assessing the consequences of accidental releases of radioactive materials, in providing guidance to the staff and applicants for use in establishing conditions for such releases, and in defining acceptable assumptions for describing exposure scenarios and pathways to members of the public.

The primary focus of this ISG is to provide guidance on analyzing the transport of radioactivity in groundwater and surface water through the use of a structured hierarchical approach. ISG-014 emphasizes the consideration of hydrogeologic conditions that control the transport of radioactive materials considered in the analysis. Because of the complexity of the issues related to water contamination and transport, guidance on this topic has been divided between this ISG and ISG-013[1]. These two ISGs are intended to be used in tandem.

The primary focus of ISG-013 is on guidance defining the mechanism of the assumed tank failure, development of the radioactive source term, assumptions and level of conservatism used in the analysis, and approach applied in assessing the radiological impacts at the assumed location of the dose receptor.

This ISG supplements the following SRP guidance:

- SRP Section 2.4.12 "Groundwater;" and
- SRP Section 2.4.13 "Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters"

Background

[1] ISG-013, Assessing the Radiological Consequences of Accidental Releases of Radioactive Materials from Liquid Waste Tanks for Combined License Applications.

The main objective of the radiological transport analysis in the applicant's Safety Analysis Report (SAR) Section 2.4.13 is to determine the ability of the ground and surface water environment to delay, disperse, dilute, or concentrate liquid effluents. The transport analysis in SAR Section 2.4.13 relies on the release scenario provided in BTP 11-6 of SAR Section 11.2. The result of the transport analysis in SAR Section 2.4.13 is used to perform a consequence analysis in SAR Section 11.2.

One of the objectives of the SAR Section 11.2 is to preclude accidental releases from the Liquid Waste Management System (LWMS) (or other systems) to the environment by providing additional protective measures such as mitigation design features or technical specifications to limit the holding capacity of effluent tanks and components. The need for the additional measures is determined based on a radiological consequence analysis in SAR Section 11.2 conducted by the Health Physics staff. The guidance in SRP Section 11.2 and BPT 11-6 specifies that the staff may waive the consequence analysis of accidental releases if the proposed plant design meets the requirement of mitigation design features. In this context, ISG-014 clarifies how mitigation features can be considered within the context of SRP 2.4.13.

Because a release scenario and the associated transport of radionuclides in ground and surface waters are closely coupled, the guidance in ISG-014 has been considered in relation to the guidance in ISG-013. ISG-014 is primarily concerned with clarifying the guidance of SRP Section 2.4.13 of NUREG-0800. The regulatory basis of this SRP section appears in 10 CFR 52.17, 10 CFR 52.79, and 10 CFR 100.10 and 100.20. For new reactor applications submitted under 10 CFR Part 50 and Part 52, the requirements are contained in 10 CFR 100.20(c). The parallel requirements of 10 CFR 100.10(c) apply to reactor applications submitted before January 10, 1997. SRP Section 2.4.13 provides guidance for the evaluation of hydrogeologic characteristics to describe the effects of accidental releases of radioactive liquid effluents in ground and surface waters on existing users and known and likely future users of groundwater or surface water. ISG-014 is intended to clarify specific issues related to hydrologic base conditions, on-site measurement of hydrogeologic parameters, development of a conceptual site model and its alternatives, plausible pathways, numerical groundwater model (if needed), and transport analysis of accidental releases in ground and surface water. This guidance provides an updated guide in Areas of Review, Review Interfaces, Acceptance Criteria, and Review Procedures in SRP Section 2.4.13.

Issues

Specific issues targeted for ISG-014 clarification include:

- The need for additional guidance on the acceptability and scope of on-site hydrogeologic measurements for new reactor license applications. The regulations in 10 CFR 100.20(c) specifically require the establishment of on-site hydrogeology characteristics needed to characterize radiological transport in the groundwater.

- To address the inconsistencies between SRP Section 2.4.13 and SRP Section 11.2 and BTP 11-6, and define base hydrologic conditions used in a radiological transport analysis. SRP Section 2.4.13 specifies the use of "demonstrably conservative assumptions and coefficients" in several places, whereas SRP Section 11.2 specifies the use of annual average concentrations of radioactive materials released in gaseous and liquid effluents.

- The lack of guidance in SRP Section 2.4.13 on reviewing release pathways, conceptual site models, and radiological transport analyses submitted by applicants. In particular, SRP Section 2.4.13 does not specify whether an applicant is required to perform a radiological transport analysis when the proposed plant has mitigating design features as described in SRP Section 11.2 and Section B.3 (“Mitigating Design Features”) of BTP 11-6. Further clarification is provided in this ISG.

- The lack of guidance in SRP Section 2.4.13 on reviewing alternate site conceptual models and numerical models for a flow and transport analysis. This ISG provides additional, but limited input into this technical area. Should an applicant propose an alternate site conceptual and numerical model, the staff’s evaluation would involve a review process that is beyond the scope of this ISG. In such an instance, the staff will evaluate the proposed conceptual site model and its supporting information and request additional information as necessary to support the evaluation.

Rationale

The staff finds current guidance incomplete and inconsistent based on experience with reviews of recent early site permit (ESP) and combined license (COL) applications. To address these issues the staff will:

- Redefine Areas of Review, Review Interfaces, Acceptance Criteria, and Review Procedures addressed in SRP Section 2.4.13.

- Resolve the differences in guidance between SRP Sections 2.4.13 and 11.2, and clarify how BTP 11-6 and the newly developed ISG-013 will be used in reviewing the radiological transport analysis in SAR Section 2.4.13.

- Provide guidance for choosing the potential receptor locations of accidental releases for the radiological consequence analysis.

- Provide guidance to meet the requirement of on-site hydrogeology characterization specified in 10 CFR 100.20(c) in characterizing hydrogeologic conditions that control the transport of radioactive materials in surface and ground waters.

- Clarify the degree of conservatism necessary to define the hydrologic base conditions applicable to the transport analysis.

- Provide generic guidance or references for the development of valid alternate conceptual site models and numerical ground models when needed that may help evaluate future groundwater flow directions and pathways in the aquifer system.

Overview of Interim Staff Guidance

In the near-term, the implementation of the interim guidance will involve the staff from two different technical disciplines, Health Physics and Hydrologic Engineering, to take part in the review process for COLs, certified design applications and ESP applications. The interim guidance contains eight primary steps, including:

1. Failure Mechanism and Radioactivity Releases,
2. Mitigating Design Features,
3. Radioactive Source Term,
4. Calculations of Transport Capabilities in Groundwater and Surface Water (Hydrologic Engineering staff),
5. Exposure Scenarios and Acceptance Criteria,
6. SRP Dose Acceptance Criteria,
7. Specifications on Tank Waste Radioactivity Concentration Levels, and
8. Evaluation Findings for Reviews of Part 52 COL and Other Applications.

The regulatory guidance presented here provides acceptable methods in demonstrating compliance with NRC regulations. If, however, an applicant were to make use of assumptions and calculation methods that differ from this NRC guidance, the applicant must describe in detail the bases for the alternative methods and parameters applied in the analysis. In such instances, the applicant must provide sufficient information to enable the staff to conduct an independent evaluation of the results and conclusions presented in the application.

The revised guidance presented in the following sections identifies the responsible technical discipline for each step of the process. The Hydrologic Engineering staff is primarily responsible in leading the evaluation of the fourth step which addresses the transport of radioactivity in surface water and groundwater and derives radionuclide concentrations in unrestricted areas considering the predicted post-construction conditions. The corresponding guidance for the Hydrologic Engineering staff is described in this ISG and the guidance for the Health Physics staff is provided in ISG-013.

Conceptually, the review process is shared between staff as follows:

a. The Hydrologic Engineering staff will review and evaluate the applicant's approach in modeling the transport of radioactivity in surface water and groundwater, confirm the validity of the defined point of entry in unrestricted areas in light of available site-specific information and stated assumptions, and verify the resulting radionuclide concentrations at the point of entry in unrestricted areas. The Hydrologic Engineering staff will confirm whether the information and results comply with the acceptance criteria of SRP Section 2.4.13 and requirements of 10 CFR 100.20(c). The Health Physics staff will use the resulting radionuclide concentrations in its evaluation once the approach used in modeling the transport of radioactivity in surface water or groundwater and resulting radionuclide concentrations in unrestricted areas are deemed acceptable by the Hydrologic Engineering staff. The corresponding guidance for the Hydrologic Engineering staff is described in this ISG and, later, in SRP Section 2.4.13, once updated.

b. In a parallel effort, Health Physics staff will confirm the applicant's approach used in developing the postulated tank failure scenario, confirm the radiological source term for the assumed failed tank or component, confirm the assumptions applied in modeling exposures and doses to members of the public, conduct an independent assessment of dose results, confirm compliance with the SRP acceptance criteria, and determine whether the results of the analysis warrant, as specifications, the imposition of maximum radioactivity limits in the tank(s) identified by the applicant. The Health Physics staff will coordinate its review with other technical disciplines, including civil engineering in evaluating building plant structures and foundations and mechanical engineering for the review of plant systems and components and design of mitigating features. The corresponding guidance for the Health Physics staff is described in ISG-013 and, later in SRP Section 11.2 and BTP 11-6, once updated.

As part of the review process, the staff will evaluate whether the applicant has applied a screening approach to the consequence analysis, starting with a simple worst-case scenario and then progressing to more realistic site-specific analyses. If the results of the worst-case analysis do not demonstrate compliance with the SRP acceptance criteria, the applicant would need to conduct a more refined analysis using a site-specific conceptual model and parameters until compliance with SRP acceptance criteria is demonstrated. The staff recognizes that should an applicant propose an alternate site conceptual and numerical model, the staff's evaluation would involve a process that is beyond the scope of this ISG.

If the results of site-specific analyses still do not demonstrate compliance with the SRP acceptance criteria, the applicant is expected to propose technical specifications limiting the total amount of radioactivity in such tanks or components. In all instances, the applicant is requested to provide sufficient information for the staff to conduct independent analyses to confirm compliance with the regulations and SRP acceptance criteria.

The transport analysis under SRP Section 2.4.13 requires several sequential steps for the determination of hydrogeologic parameters and for the fate and transport analysis of released radionuclides in ground and surface waters. To clarify the steps in analyzing transport conditions, Figure 1 shows generalized hierarchical approach as recommended in SRP Section 2.4.13.

The analysis begins by determining the basic conditions for the transport analysis:

a. Site conceptualization and hydrogeologic characteristics;
b. Location of release from identified tank or component;
c. Receptor points (e.g., points of entry of contaminated water from the release point to public water bodies);
d. Post-construction groundwater and surface pathways and their characteristics; and
e. Travel times to the point of entry in unrestricted areas.

The information regarding the postulated accidental release scenario which includes the release location, and volume and concentrations of radionuclide effluents is obtained from SAR Section 11.2 and the Health Physics staff. Post-construction groundwater pathways and travel times may be predicted using a conceptual model for a simple, stationary groundwater system, or if warranted, a more detailed numerical model for a more complex groundwater system.

The groundwater contaminant transport analysis may initially be performed using a simplistic model which considers only advection, decay and dilution. The estimated radionuclide concentrations to surface and or groundwater environments for existing and future water resource users located in unrestricted areas will be provided to the Health Physics staff who will analyze various exposure scenarios.

As discussed in ISG-013, the Health Physics staff will compare the results of the analyses of radiological impacts with the appropriate acceptance criteria when assessing the acceptability of these results. The acceptance criteria presented here are based on doses to members of the public, rather than on effluent concentration limits, as was the case in SRP Section 11.2 and BTP 11-6. The acceptance criteria state that the postulated release should not result in radionuclide concentrations in usable surface water or groundwater exceeding the effluent control limits (ECLs) and unity rule of 10 CFR Part 20, Appendix B, Table 2, Column 2. While the ECLs are a reasonable standard for direct consumption of water, their use is not as obvious or practical for indirect uses of water and for the consumption of impacted food products. As a result, a dose-based limit will be applied instead by the Health Physics staff because it provides the most flexibility in assessing compliance, regardless of the postulated exposure scenarios.

For the purpose of this ISG and ISG-013, a receptor is defined as a member of the public assumed to consume and use water at a point of entry located in an unrestricted area. Member of the public means any individual that is not receiving an occupational dose. Unrestricted area means an area, access to which is neither limited nor controlled by the licensee (10 CFR 20.1003). The point of entry in an unrestricted area is assumed be a domestic well, or part or all of a fresh surface water body (e.g., stream, river, lake), which are also referred to as points of entry. In the context of ISG-014, the point of entry is not the same as the point of discharge in light of the definition given in Regulatory Guide 1.21, Revision 2. Under ISG-014 (and ISG-013), radiological impacts associated with postulated accidental releases of radioactive materials are not used in demonstrating literal compliance with the requirements of 10 CFR 20.1301, 20.1302, and 20.1301(e) and design objectives and ALARA provisions of Appendix I to Part 50. Compliance with these requirements is addressed in SRP Sections 11.2 to 11.5 using the guidance of Regulatory Guides 1.21 and 4.15 implemented under a plant and site-specific offsite dose calculation manual.

The following subsections describe revised guidance in Areas of Review, Review Interfaces, Acceptance Criteria, and Review Procedures addressed in SRP Section 2.4.13.

1. <u>Areas of Review</u>

    The areas of review defined in SRP Sections 2.4.12 and 2.4.13 differ from those in Regulatory Guide (RG) 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)" which applicants have been using in preparing recent COL applications. To resolve the difference, ISG-014 recommends that SRP Section 2.4.13 covers the guidance in reviewing radiological transport in ground and surface waters exclusively, while SRP Section 2.4.12 handles all other hydrogeologic safety issues as follows:

    (a) Item 1 of the specific areas of review (p. 2.4.12-1) in SRP Section 2.4.12 is redefined by deleting the terms "travel time, gradient, and other properties that affect post-construction movement of an accidental release to groundwater."

(b) At the end of Item 2 of the specific areas of review (p. 2.4.13-2) in SRP Section 2.4.13, the following sentence is added: “The staff reviews travel time, gradient, and other properties that affect movement of accidental contaminants in groundwater.”

(c) The text in Section C.I.2.4.12.3 of RG 1.206 is moved to the beginning of the text in Section C.I.2.4.13.

2. Review Interfaces

Items (a) and (b) below are added to supplement Review Interfaces in SRP Section 2.4.13:

(a) In reviewing issues pertinent to establishing on-site hydrogeologic characteristics, the staff should reference SAR Sections 2.5.1 for the regional and site geology information and 2.5.4 for the geotechnical aspect of foundation, excavation, and backfill.

(b) SRP Section 11.2 and BTP 11-6 provide a guide for defining the radioactive source term, mitigation design features, and tank radionuclide concentration levels. ISG-013 provides additional guidance in defining the failure mechanism, radiological release scenario, mitigating features, technical specifications, source term and concentrations at the point of entry, and assumed exposure scenarios in unrestricted areas.

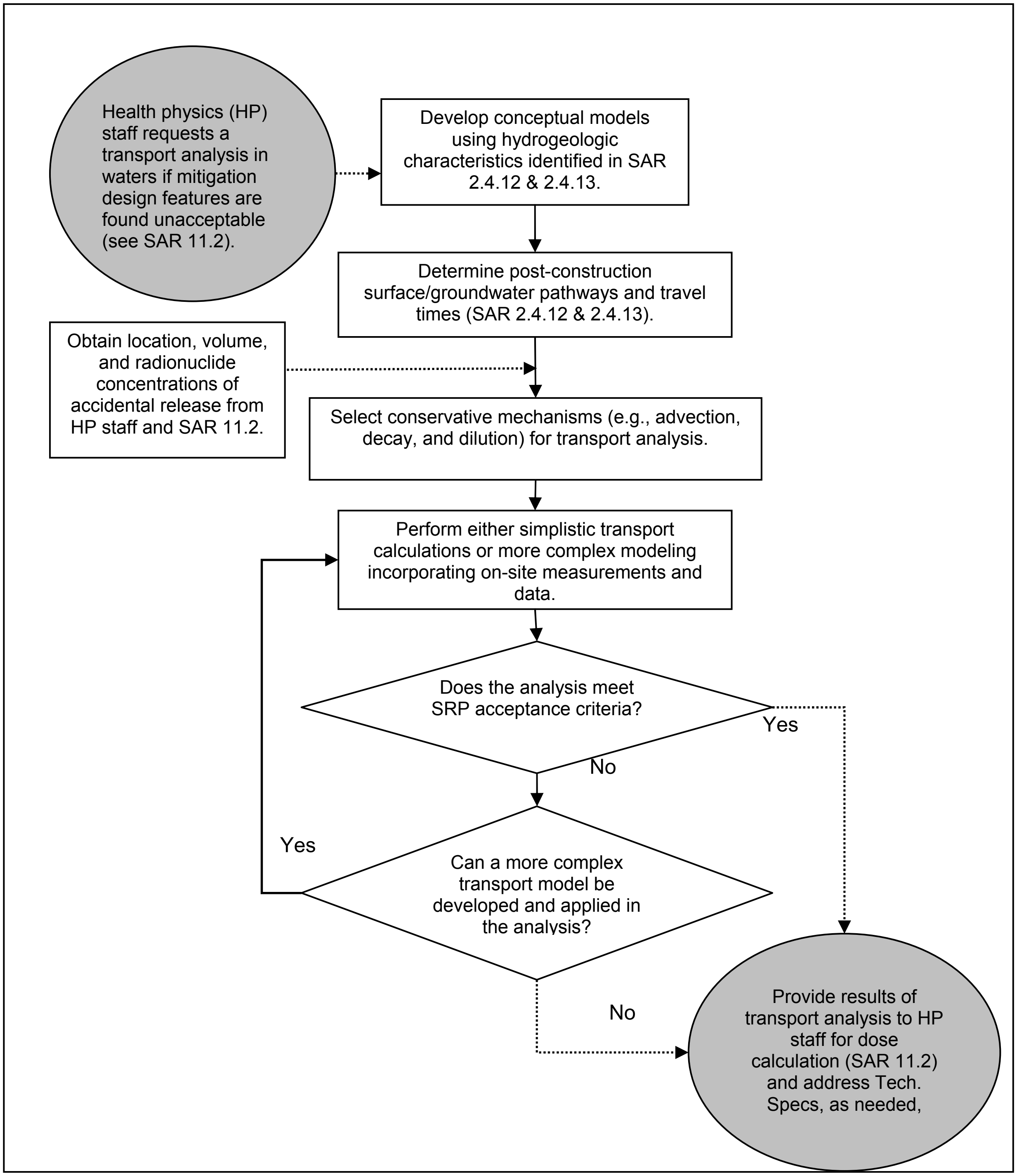
3. Acceptance Criteria

Items 2 through 4 of the Acceptance Criteria requirements (p.2.4.13-3) in SRP Section 2.4.13 are deleted, while Item 1 in the requirements is revised as:

(a) 10 CFR 100.20(c)(3) specifies that factors important to hydrological radionuclide transport (such as soil, sediment, and rock characteristics, adsorption and retention coefficients, ground water velocity, and distances to the nearest surface body of water) must be obtained from on-site measurements.

(b) CFR Part 50, Appendix A, “General Design Criteria for Nuclear Power Plants,” GDC 2, “Design Bases for Protection Against Natural Phenomena,” as it relates to the evaluation of accidents, as described in ISG-013.

Figure 1. Hierarchical approach to review a radiological transport analysis in surface and groundwater



(c) 10 CFR Part 50, Appendix A, GDC 60, "Control of Releases of Radioactive Materials to the Environment, as it relates to the means of controlling releases, as described under ISG-013.

(d) 10 CFR Part 50, Appendix A, GDC 61, "Fuel Storage and Handling and Radioactivity Control," as it relates to system design features and radioactivity inventories in ensuring safety under normal and postulated accident conditions, as described in ISG-013.

4. SRP Acceptance Criteria

Items 1 through 3 of the SRP Acceptance Criteria (p. 2.4.13-4) in SRP Section 2.4.13 are replaced as:

(a) Alternative Conceptual Models: Alternate conceptual models of hydrology in the vicinity of the site are reviewed. The description of these alternate conceptual models should be sufficient in terms of a hierarchical framework to define the transport of radioactive liquid effluent in ground and surface water environments. The staff recognizes that should an applicant propose an alternate site conceptual and numerical model, the staff's evaluation would involve a process that is beyond the scope of this ISG.

(b) Pathways: The bounding set of plausible surface and subsurface post-construction pathways from the points of release [tank/component] are reviewed. The description of these pathways should provide sufficient information including data to reasonably ensure that the bounding set of plausible pathways that may result in the worst-case contamination for a dose receptor located at the point of entry are adequately identified. Estimates of physical parameters necessary to calculate the transport of liquid effluent from the point of release onsite to a dose receptor located at the point of entry or known and likely future water users should be described. The acceptable accuracy for predicting pathways and travel time is depending on a hierarchical transport analysis framework where sufficient margins on the predicted radiological concentrations leading to dose-based limits will alleviate the need for detailed pathway analysis.

(c) Characteristics that Affect Transport: Radionuclide transport characteristics of the groundwater environment with respect to existing and known and likely future water users should be described. Estimates and bases for coefficients of dispersion, adsorption, groundwater velocities, travel times, gradients, permeabilities, porosities and potentiometric map or piezometric levels between the site and existing or known and likely future surface and groundwater users should be described.

The requirement for site specific information described in 10 CFR 100.20(c) should be interpreted from a functional, performance-oriented standpoint. That is, if the site suitability determination can be made without measuring or determining the on-site parameter values, these parameters are not a factor important to hydrological radionuclide transport and need not be determined with actual observations or measurements. In determining transport parameters (e.g., distribution coefficients, etc.), an acceptable approach would be to perform a graded approach where a simple consequence analysis that conservatively considers only decay and dilution processes with a distribution coefficient (K_d) value of zero (resulting in no retardation), or by applying values based on a review of literature that is representative of site conditions.

5. Review Procedures

Alternate Conceptual Models:

Item (a) below replaces the text in SRP Section 2.4.13, while items (b) and (c) are new addition.

(a) The first two sentences in Item 1 Alternative Conceptual Models (p. 2.4.13-5) are revised as:

Simple or highly complex multi-dimensional models are employed under a hierarchical framework. When uncertainty in data and models are of issue, conservative or bounding simulations with conservative conceptual models populated with conservative model parameters should be considered. In determining an appropriate level of conservatism to be applied, the staff should appropriately account for model uncertainties, including uncertainties of assumptions used to develop the conceptual model, variabilities and uncertainties in hydrogeologic data and parameters, and the uncertainty in future water use scenarios based on information provided by the applicant.

(b) In predicting post-construction groundwater pathways and travel times, the staff may use a simple conceptual site model and analytical solution methods if the groundwater system is simple and stationary, or apply an incrementally more complex analysis to the point where numerical models are developed based on site-specific conditions and concerns. Numerical groundwater models may be used if groundwater conditions change significantly over time or the potential effects of the proposed site changes on groundwater flow and transport are significant.

(c) The numerical groundwater model used in predicting pathways and travel times should be calibrated and validated. The staff may use the guidance in NUREG/CR-6805 or others for model calibration and verification. The selected model should account for the specific hydrogeologic processes and conditions occurring at a particular site. Calibrated parameter values used with the model should be within the range of measured values or those derived from field test data. The model should be validated by using differing sets of data in time. The staff should perform a sensitivity analysis by varying key model input and parameters over a reasonable range (typically upper and lower one standard deviations from the respective mean) to define the variability of predicted pathways and travel times in worst case scenarios.

Pathways:

Items (a), and (b) below are a revision to the existing SRP Section 2.4.13, while the remaining items are new additions.

(a) The first paragraphs in Item 2 (p. 2.4.13-6) is revised as:

The staff makes independent calculations of the transport capabilities and potential contamination pathways of the post-construction groundwater environment under accidental conditions with respect to existing users and known and likely future users. Special attention should be directed to proposed plant facilities with permanent dewatering systems to ensure that pathways created by those systems have been identified and considered in the model. The staff should, in consultation with the organizations responsible for the review of radioactive waste management systems design, choose the accidental release scenarios leading to the most adverse contamination of the groundwater or surface water at the point of entry and dose receptor located in an unrestricted area.

(b) The second through fourth paragraphs in Item 2 (p. 2.4.13-6) are moved to "Characteristics the Affect Transport" (p. 2.4.13-7).

(c) The staff should consider accidental releases directly to groundwater and surface water separately, and postulate post-construction groundwater pathways, surface pathways, and their combinations. Properly developed, a numerical groundwater model is a useful tool to predict potential groundwater pathways accurately and efficiently. In many cases, a numerical groundwater model is the only way to reasonably predict the impacts of proposed structures and foundations, temporary and permanent dewatering systems, and engineered backfills on pathways and travel times to the point of entry and dose receptor located in an unrestricted area.

(d) The staff should confirm that the applicant has selected appropriate receptor points from all potential receptor points in the portion of the unrestricted area and work closely with the Health Physics staff in order to provide the data needed for various exposure scenarios such as direct and indirect water use, and combined use of water. For the purpose of this ISG, a dose receptor is defined as a member of the public assumed to consume and use water at a point of entry located in an unrestricted area. Member of the public means any individual that is not receiving an occupational dose. Unrestricted area means an area, access to which is neither limited nor controlled by the licensee (10 CFR 20.1003). The point of entry in an unrestricted area is assumed be a domestic well, or part or all of a fresh surface water body (e.g., stream, river, lake), which are also referred to as points of entry.

Characteristics that Affect Transport:

Items (a) and (b) are revisions to the existing SRP Section 2.4.13, while the remaining items are new additions.

(a) Three paragraphs (2^{nd}, 3^{rd}, 4^{th}) in “Pathways” subtitle in p. 2.4.13-6 of SRP Section 2.4.13 are attached here as they are relevant to the transport analysis.

(b) The post-construction radiological transport analysis in SAR Section 2.4.13 should be based on an annual average hydrogeologic condition that is consistent with the condition of the SRP acceptance criteria. At many new proposed sites, long-term surface and ground water time series data used to develop a reliable annual average condition may not be available. In these cases, the staff could use either a transport analysis based on a severe hydrologic condition (e.g., higher groundwater gradient, severe drought flow, or peak concentrations) or an indirect method of determining annual average conditions. The indirect methods include: (1) estimating on-site conditions based on a transposition of regional studies and data from nearby locations; and (2) correlating groundwater levels from on-site wells with limited data to local or regional wells screened within the same hydrogeologic setting. Because of the uncertainty associated with using indirect methods of characterization, the transport analysis in these cases should be done under conservative hydrologic conditions and parameter assumptions (e.g., using demonstrably conservative groundwater gradients from a source release to a receptor point).

(c) Measured hydrogeologic parameters or those derived from analysis of measured data such as hydraulic conductivities should be representative of areal hydrogeologic conditions (e.g., an aquifer pumping test) rather than of conditions within a localized depth interval or location (e.g., an aquifer slug test). Transport parameters, including porosities and distribution coefficients, if measured, must be representative of field conditions during the expected operating period.

(d) Characterization of distribution coefficient (K_d) values is challenging due to a combination of the number of radionuclide species in liquid effluents and the spatial variability of aquifer materials. Determining K_d values for short half-life species is generally not practical because they decay quickly and, as a result, have limited travel paths. An acceptable approach would be to perform a simple transport analysis that conservatively considers only radioactive decay and dilution processes with a K_d value of zero and no dispersion in order to identify radionuclides with potentially high concentrations in groundwater. The staff would apply this functional and performance-oriented transport analysis, noticing that the objective of the SAR Section 11.2 radiological consequence analysis is to bound the consequences of potential accidental releases, and consider design feature and mitigation measures, or place limits on maximum radiological inventories of such tanks and components. Given this screening approach, species that exceed the applicable concentration limits at the receptor point are then selected for K_d value determination using aquifer material samples collected on-site. When measurements of material K_d values are planned, samples from two or three equally divided segments on each identified pathway should be considered in the analysis. The K_d values determined should be compared and cross-checked with published values for similar material obtained from professional journals or studies conducted by the NRC, the U.S. Environmental Protection Agency (EPA), and the U.S. Department of Energy (DOE) Laboratories.

(e) The consequence analysis in SAR Section 2.4.13 should account for decay chains and radionuclides decay products that would be produced during groundwater transport. This information would be provided by the Health Physics staff. If applicable, the hydrology staff should consider the effects of chemicals (e.g., chelating agents, if present in soils or liquids) that could comingle with radioactive materials and increase the mobility of radionuclides in the environment. Geochemistry of the site should be reviewed by staff for significance in the radionuclide transport processes considered for the consequence analysis.

(f) For surface water, a hierarchical approach similar to that outlined in Figure 1 is recommended for the staff to review the acceptance of the applicant-submitted surface transport analysis from postulated accidental releases direct to surface water bodies. Starting with a transport analysis using one of the simplified computational procedures or models such as those introduced in NUREG/CR-3332, the staff may proceed to a progressively more complex transport model considering dispersion or boundary layer stratification. If the simulation of the detailed model does not meet the SRP acceptance criterion of dose-based limits, technical specifications or mitigative design features may be necessary. It is acceptable to use an extreme hydrologic condition (e.g., severe drought flow rate) as a bounding hierarchical approach. In all cases, the hydraulic communication and relationship, if any, between the surface water discharge and groundwater pathways should be assessed considering a release traveling from the site to the point(s) of discharge. For cases involving surface water/groundwater interaction, staff would review the influence of the surface and groundwater system on transport to the point(s) of discharge.

Final Resolution

The NRC will formally incorporate the ISG-014 in a future update of SRP Sections 2.4.12 and 2.4.13. The update will include revisions of the Areas of Review, Review Interfaces, Acceptance Criteria, and Review Procedures. As part of these revisions, the staff will determine the applicability of associated revisions to the review of ESP and Design Certified applications. Similarly, RG 1.206 will be revised to address the updated guidance of ISG-014.

Applicability

The guidance of this ISG and SRP 2.4.13, once revised, applies to all 10 CFR Part 50 and 10 CFR 52 applicants that submit applications after this ISG's effective date. This ISG complements the corresponding guidance described in ISG-013, as it applies to SRP Section 11.2 and BTP 11-6. The guidance of the March 2007 version of SRP 2.4.13 and SRP Section

11.2 and BTP 11-6 remains in effect for holders of nuclear power reactor operating licenses under 10 CFR 50 and combined licenses under 10 CFR 52 as of the effective date of this ISG and revision of SRP Section 2.4.13, and for applicants for nuclear power reactor operating licenses under 10 CFR 50 or combined licenses under 10 CFR 52 that have committed, in applications docketed with the NRC as of the effective date of this ISG and revision of SRP Section 2.4.13, to specific guidance in assessing the radiological consequences of a postulated failure of a tank containing radioactive materials.

References

1. 10 CFR Part 20, "Standards for Protection against Radiation"

2. 10 CFR 20.1003, "Definitions"

3. 10 CFR Part 20, Appendix B, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage."

4. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities"

5. 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," GDC 2, "Design Bases for Protection Against Natural Phenomena."

6. 10 CFR Part 50, Appendix A, GDC 60, "Control of Releases of Radioactive Materials to the Environment."

7. 10 CFR Part 50, Appendix A, GDC 61, "Fuel Storage and Handling and Radioactivity Control."

8. 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

9. 10 CFR Part 52.17 "Contents of Applications: Technical Information"

10. 10 CFR Part 52.79, "Contents of Applications: Technical Information in Final Safety Analysis Report."

11. 10 CFR Part 100, "Reactor Site Criteria"

12. 10 CFR 100.20, "Factors to be Considered When Evaluating Sites," Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or After January 10, 1997."

13. 10 CFR 100.10, "Factors to be Considered When Evaluating Sites," Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications Before January 10, 1997 and for Testing Reactors."

14. NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," March 2007.

15. NUREG-0800, SRP Section 2.4.12, “Groundwater”

16. NUREG-0800, SRP Section 2.4.13, “Accidental Releases of Radionuclide Liquid Effluents in Ground and Surface Waters.”

17. NUREG-0800, SRP Section 2.5.1, “Basic Geologic and Seismic Information.”

18. NUREG-0800, SRP Section 2.5.4, “Stability of Subsurface Materials and Foundations”

19. NUREG-0800, SRP Section 11.2, “Liquid Waste Management System”

20. NUREG-0800, SRP Section 11.2, BTP 11-6, “Postulated Radioactive Releases Due to Liquid-Containing Tank Failures.”

21. NEI 08-08A, “Generic FSAR Template Guidance for Life Cycle Minimization of Contamination,” Nuclear Energy Institute, Revision 0, October 2009.

22. RG 1.21, “Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste,” Rev. 2, June 2009.

23. RG 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition),” June 2007.

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