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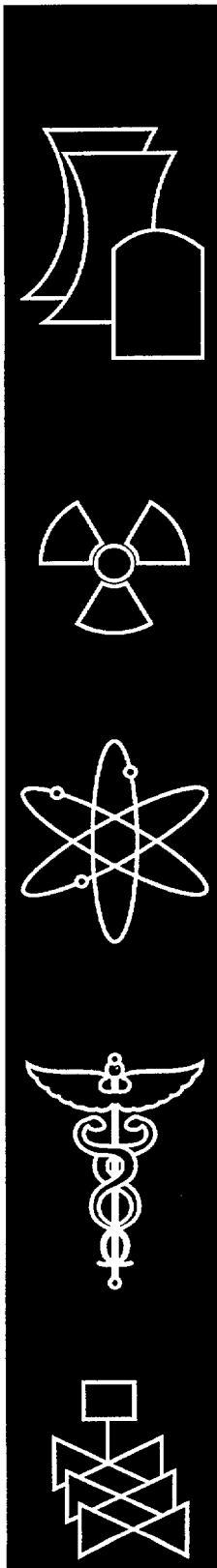

Standard Review Plan for In Situ Leach Uranium Extraction License Applications

Draft Report for Comment

U.S. Nuclear Regulatory Commission
Office of Nuclear Materials Safety and Safeguards
Washington, DC 20555-0001

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NUREG-1569
Rev. 1

Standard Review Plan for In Situ Leach Uranium Extraction License Applications

Draft Report for Comment

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Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
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John Lusher
Mail Stop: T8-A33
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
Phone: 301-415-7694
E-mail: jhl@nrc.gov

ABSTRACT

A U.S. Nuclear Regulatory Commission source and byproduct material license is required to recover uranium by *in situ* leach extraction techniques, under the provisions of Title 10 U.S. Code of Federal Regulations, Part 40 (10 CFR Part 40), "Domestic Licensing of Source Material." An applicant for a research and development or commercial-scale license, or for the renewal or amendment of an existing license, is required to provide detailed information on the facilities, equipment, and procedures used and an environmental report that discusses the effects of proposed operations on the health and safety of the public and on the environment.

The standard review plan is prepared for the guidance of staff reviewers, in the Office of Nuclear Material Safety and Safeguards, in performing safety and environmental reviews of applications to develop and operate uranium *in situ* leach facilities. It provides guidance for new license applications, renewals, and amendments. The principal purpose of the standard review plan is to assure the quality and uniformity of staff reviews and to present a well-defined base from which to evaluate changes in the scope and requirements of a review.

The standard review plan is written to cover a variety of site conditions and facility designs. Each section is written to provide a description of the areas of review, review procedures, acceptance criteria, and evaluation findings. However, for a given application, the staff reviewers may select and emphasize particular aspects of each standard review plan section, as appropriate for the application.

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FIGURES

TABLES

EXECUTIVE SUMMARY

A U.S. Nuclear Regulatory Commission (NRC) source and byproduct material license is required under the provisions of Title 10 of the U.S. Code of Federal Regulations, Part 40 (10 CFR Part 40), Domestic Licensing of Source Material, to recover uranium by *in situ* leach techniques. The licensing process for Part 40 licenses is pictured in Figure 1. NRC authority to regulate *in situ* leach facilities comes from the Atomic Energy Act of 1954, as amended, and the Uranium Mill Tailings Radiation Control Act of 1978, as amended. Specific requirements for *in situ* leach facilities are taken from 10 CFR Part 40, Appendix A criteria. The specific sections in this standard review plan that address these criteria are shown in Appendix B of the review plan. Although the National Environmental Policy Act of 1969 does not provide NRC with any additional authority, it does reinforce NRC authority found in the organic statutes by obligating NRC to evaluate both radiological and nonradiological environmental impacts for NRC-licensed sites. Also the National Environmental Policy Act , as interpreted by the courts, requires NRC to mitigate environmental impacts resulting from Agency actions, to the extent possible, through its licensing. Therefore, NRC can also condition commitments made by applicants to mitigate such environmental impacts.

An applicant for a new operating license, or for the renewal or amendment of an existing license, is required to provide detailed information on the facilities, equipment, and procedures to be used and to submit an environmental report that discusses the effect of proposed operations on public health and safety and the impact on the environment as required by 10 CFR 51.45, 51.60, and 51.66. This information is used by NRC staff to determine whether the proposed activities will be protective of public health and safety and will be environmentally acceptable. General provisions for issuance, amendment, transfer, and renewal of licenses are described in 10 CFR Part 2, Subpart A. General guidance for filing an application and for producing an environmental report is provided in 10 CFR 40.31, Application for Specific Licenses, and in 10 CFR Part 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions, respectively.

The purpose of this standard review plan is to provide the NRC staff in the Office of Nuclear Material Safety and Safeguards with specific guidance on the review of applications for *in situ* leach facilities. The standard review plan complements Regulatory Guide 3.46, Standard Format and Content of License Applications, Including Environmental Reports for *In Situ* Uranium Solution Mining (NRC, 1982) which is guidance to applicants and licensees on an acceptable format and contents for a license application. Sections of this standard review plan are keyed to sections in Regulatory Guide 3.46 (NRC, 1982). Applicants should use Regulatory Guide 3.46 (NRC, 1982) as guidance in preparing their applications. Information in this standard review plan will be used by the Office of Nuclear Material Safety and Safeguards staff in the review of applications for new facilities, renewals, and amendments.

Throughout the remainder of this standard review plan, "application" is synonymous with license application, renewal, or amendment. The principal purpose of the standard review plan is to ensure a consistent quality and uniformity in NRC staff reviews. Each section in this standard review plan provides guidance on what is to be reviewed, the basis for the review, how the staff review is to be accomplished, what the staff will find acceptable in a demonstration of compliance with the regulations, and the conclusions that are sought

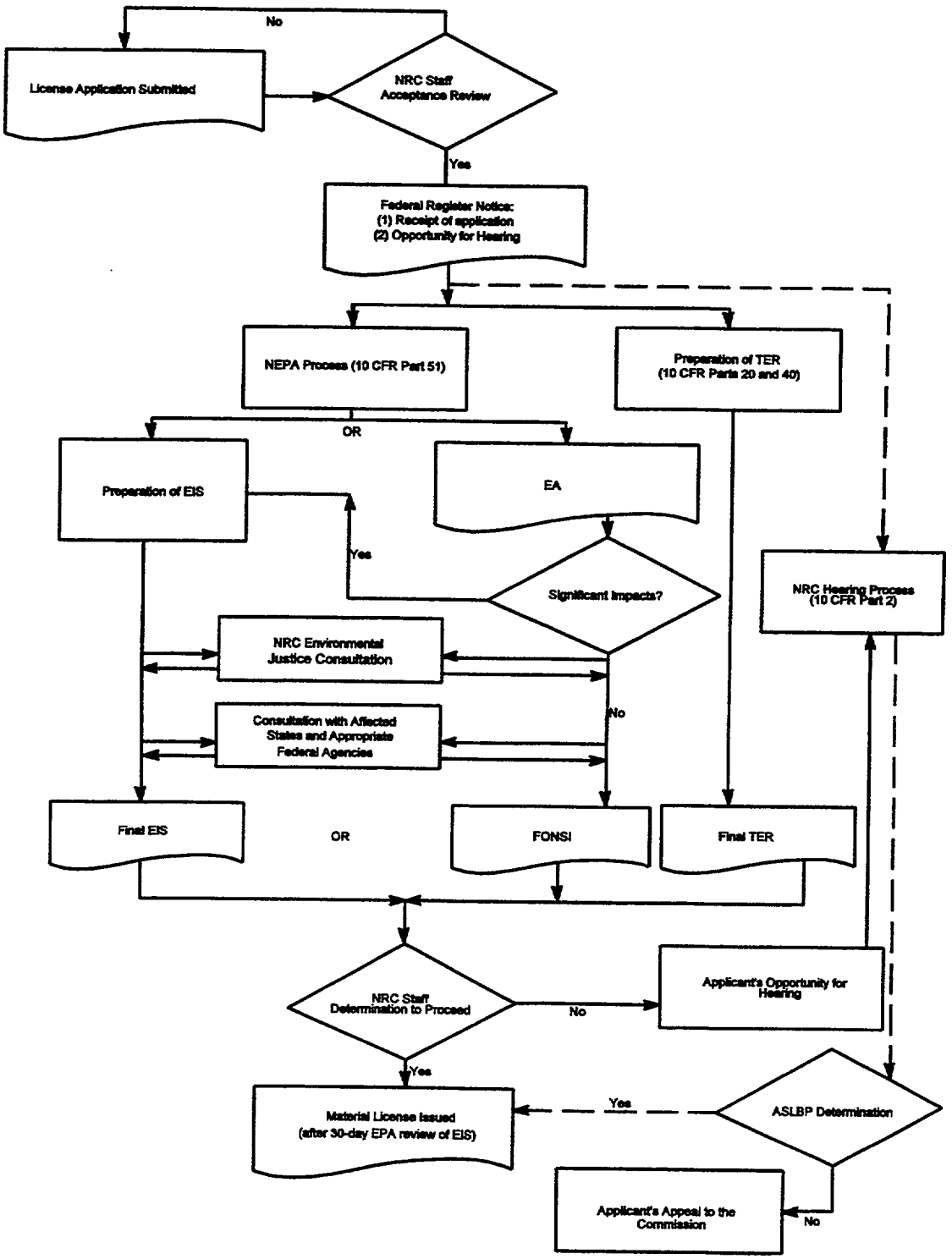

Figure 1. Licensing Process for 10 CFR Part 40 Licenses

operations are much more environmentally benign than conventional mining and milling and pose lower risk of occupational harm. Still, the NRC staff must determine if operations will be conducted in an environmentally acceptable manner and in compliance with applicable regulations. The detailed review procedures and acceptance criteria are intended to assist the Office of Nuclear Material Safety and Safeguards staff in making the necessary findings in an effective and efficient manner. General information regarding procedures for environmental reviews for licensing actions and guidance for the preparation of environmental assessments is available in NUREG–1748, "Environmental Review Licensing Actions Associated with NMSS Programs" (NRC, 2001).

This standard review plan is intended to cover only those aspects of the NRC regulatory mission related to the licensing of an *in situ* leach facility. As such, the standard review plan helps focus the staff review on determining if a facility can be constructed and operated in compliance with the applicable NRC regulations. The standard review plan is also intended to make information about regulatory matters widely available and to improve communications and understanding of the staff review process by interested members of the public and the uranium recovery industry.

For amendments, the focus of the review should be on the changes proposed in the amendment (see Appendix A for guidance for reviewing historical aspects of site performance). Reviewers should not review other previously accepted actions if they are not part of the amendment unless the review of the amendment package identifies problems with other aspects of facility operation.

For renewals, the licensee need only submit information containing changes from the currently accepted license. As for amendments, the staff reviews should focus on those aspects of facility operation that are different from what is in the current license. The licensee need not resubmit a complete application covering all aspects of facility operation. Reviewers should analyze the inspection history and operation of the site to see if any major problems have been identified over the course of the license term and should review changes to operations from those currently found acceptable (see Appendix A). If the changes are found to be acceptable, then the license is acceptable for renewal.

For license amendments and renewals, the operating history of the facility is often a valuable source of information concerning the adequacy of site characterization, the acceptability of radiation protection and monitoring programs, the success of and adherence to operating procedures and training programs, and other data that may influence the staff's determination of compliance. Appendix A to the standard review plan provides guidance for review of these historical aspects of facility performance.

The products that will be prepared by the staff to document the review will be a technical evaluation report , and an environmental assessment with a finding of no significant impact to meet requirements under the National Environmental Policy Act. Preparation of an environmental assessment is required under the provisions of 10 CFR 51.20 unless (i) the staff finds, based on the environmental assessment , that NRC needs to prepare an environmental impact statement; (ii) an environmental impact statement is needed by another federal agency also involved in the action as a cooperating agency; (iii) an environmental impact statement

would be needed because of controversy at the site, or (iv) the action is categorically excluded from the necessity to prepare an environmental assessment by 10 CFR 51.22. Different sections of this standard review plan refer either to a technical evaluation report, an environmental assessment, or both. Table 1 identifies which sections apply to a technical evaluation report and which to an environmental assessment. Details on the NRC National Environmental Policy Act process are contained in NUREG–1748, "Environmental Review guidance for Licensing Actions Associated with NMSS Programs" (NRC, 2001).

It is important to note that the acceptance criteria laid out in this standard review plan are for the guidance of NRC staff responsible for the review of applications to operate *in situ* leach facilities. Review plans are not substitutes for the Commission's regulations, and compliance with a particular standard review plan is not required. This standard review plan provides descriptions of methodologies that have been found acceptable for demonstrating regulatory compliance. Methods and solutions different from those set out in the standard review plan will be acceptable if they provide a basis for the findings requisite to the issuance or continuance of a license by NRC.

General Review Procedure

A licensing review is not intended to be a detailed evaluation of all aspects of facility operations. Specific information about implementation of the program outlined in an application is obtained through NRC review of procedures and operations done as part of the inspection function. A definition of the differences between licensing reviews and inspections is provided in Figure 2.

The general licensing process is outlined in the flow diagram provided in Figure 1. An *in situ* leach source and byproduct material application may be denied or rejected under specific instances during the review process. Beginning construction of process facilities, well fields, or other substantial actions that would adversely affect the environment of the site, before the staff has concluded that the appropriate action is to issue the proposed license, is grounds for denial of the application [10 CFR 40.32(e)]. The applicant's failure to demonstrate compliance with requirements [10 CFR 40.31(h)], or refusal or failure to supply information requested by the staff to complete the review (10 CFR 2.108) is also grounds for denial of the application.

Changes to existing licensed activities and conditions require the issuance of an appropriate license amendment. An application for such an amendment should describe the proposed changes in detail and should discuss the likely consequences of any environmental and health and safety impacts. Amendment requests should be reviewed using the appropriate sections of this document for guidance. Appendix A to this standard review plan provides guidance for examining the historical aspects of facility operations that may be useful for conducting such amendment reviews.

In conducting these evaluations, the reviewer shall consider the technical evaluations conducted by a state or another federal agency with authorities overlapping those of the NRC. Ground-water compliance and protection reviews are the primary technical areas impacted by overlapping authorities. The desired outcome is to identify any areas where duplicative NRC reviews may be reduced or eliminated. The NRC staff must make the necessary evaluations of compliance with applicable regulations for licensing the facility. However, the reviewer may, as

Table 1. Identification of Sections Applicable to a Technical Evaluation Report or an Environmental Assessment			
Section	**Title**	**Applicable to Technical Evaluation Report**	**Applicable to Environmental Assessment**
1.0	PROPOSED ACTIVITIES	X	X
2.0	SITE CHARACTERIZATION	X	X
2.1	Site Location and Layout	X	X
2.2	Uses of Adjacent Lands and Waters	X	X
2.3	Population Distribution	X	X
2.4	Regional Historic, Archeological, Architectural, Scenic, Cultural, and Natural Landmarks		X
2.5	Meteorology	X	X
2.6	Geology and Seismology	X	X
2.7	Hydrology	X	X
2.8	Ecology	X	X
2.9	Background Radiological Characteristics	X	X
2.10	Background Nonradiological Characteristics	X	X
2.11	Other Environmental Features		X
3.0	DESCRIPTION OF PROPOSED FACILITY	X	X
3.1	Solution Mining Process and Equipment	X	X
3.2	Recovery Plant Equipment	X	X
3.3	Instrumentation	X	X
4.0	EFFLUENT CONTROL SYSTEMS	X	X
4.1	Gaseous and Airborne Particulates	X	X
4.2	Liquids and Solids	X	X
4.3	Contaminated Equipment	X	X
5.0	OPERATIONS	X	
5.1	Corporate Organization and Administrative Procedures	X	

Table 1. Identification of Sections Applicable to a Technical Evaluation Report or an Environmental Assessment (continued)			
Section	**Title**	**Applicable to Technical Evaluation Report**	**Applicable to Environmental Assessment**
5.2	Management Control Program	X	
5.3	Management Audit, Inspection, and Record-keeping Program	X	
5.3.1	Management Audit, and Internal Inspection Program	X	
5.3.2	Recordkeeping and Record Retention	X	
5.4	Qualifications	X	
5.5	Training	X	
5.6	Security	X	X
5.7	Radiation Safety Controls and Monitoring	X	
5.7.1	Effluent Control Techniques	X	
5.7.2	External Radiation Exposure Monitoring Program	X	
5.7.3	Airborne Radiation Monitoring Program	X	
5.7.4	Exposure Calculations	X	
5.7.5	Bioassay Program	X	
5.7.6	Contamination Control Program	X	X
5.7.7	Airborne Effluent and Environmental Monitoring Program	X	X
5.7.8	Ground-Water and Surface-Water Monitoring Programs	X	X
5.7.9	Quality Assurance	X	X
6.0	GROUND-WATER QUALITY RESTORATION, SURFACE RECLAMATION, AND PLANT DECOMMISSIONING	X	X
6.1	Plans and Schedules for Ground-water Quality Restoration		X
6.2	Plans and Schedules for Reclaiming Disturbed Lands		X
6.3	Procedures for Removing and Disposing of Structures and Equipment	X	X

Table 1. Identification of Sections Applicable to a Technical Evaluation Report or an Environmental Assessment (continued)			
Section	**Title**	**Applicable to Technical Evaluation Report**	**Applicable to Environmental Assessment**
6.4	Procedures for Conducting Post-reclamation and Decommissioning Radiological Surveys	X	X
6.5	Financial Assessment for Ground-water Restoration, Decommissioning, Reclamation, Waste Disposal, and Monitoring	X	X
7.0	ENVIRONMENTAL EFFECTS		X
7.1	Site Preparation and Construction		X
7.2	Effects of Operations	X	X
7.3	Radiological Effects	X	X
7.3.1	Exposure Pathways	X	X
7.3.1.1	Exposures from Water Pathways	X	X
7.3.1.2	Exposures from Air Pathways	X	X
7.3.1.3	Exposures from External Radiation	X	X
7.3.1.4	Total Human Exposures	X	X
7.3.1.5	Exposures to Flora and Fauna	X	X
7.4	Nonradiological Effects		X
7.5	Effects of Accidents	X	X
7.5.1	Accidents Involving Radioactivity	X	X
7.5.2	Transportation Accidents	X	X
7.5.3	Other Accidents	X	X
7.6	Economic and Social Effects of Construction and Operation		X
7.6.1	Benefits		X
7.6.2	Costs		X
7.6.3	Resources Committed		X
8.0	ALTERNATIVES TO PROPOSED ACTION		X
9.0	BENEFIT-COST ANALYSIS		X
10.0	ENVIRONMENTAL APPROVALS AND CONSULTATIONS		X

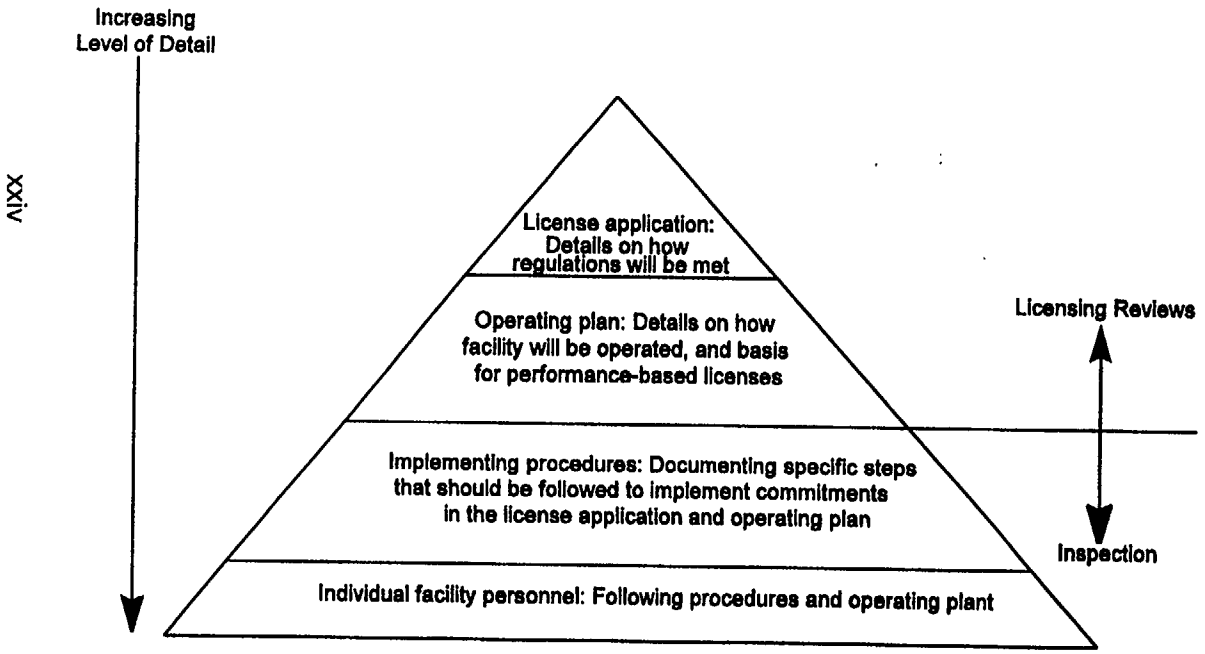

Figure 2. Schematic of NRC Licensing and Inspection Process and Applicability to Different License Documents

appropriate, rely on the applicant's responses to inquiries made by a state or another federal agency to support the NRC evaluation of compliance. The reviewer should make every effort to coordinate the NRC technical review with the state or other federal agency with overlapping authority to avoid unnecessary duplication of effort.

The steps of the application review are described in the following paragraphs.

Acceptance (Administrative) Review Objectives

The staff should conduct an acceptance review of the application, which is an administrative review, to determine the completeness of the information submitted. This review requires a comparison of the submitted information to the information identified in the Standard Format and Content of License Applications, Including Environmental Reports (NRC, 1982). The application will be considered complete for docketing if the information provided is complete, reflects an adequate reconnaissance and physical examination of the regional and site conditions, and provides appropriate analyses and design information to demonstrate that the applicable acceptance criteria will be met. Details for review of the environmental report are also contained in NUREG–1748 (NRC, 2001, Section 6). The staff should complete the acceptance review and transmit the results to the applicant within 30 days of the receipt of the application, along with a projected schedule for the remainder of the review as described in Section 1.1 of the standard review plan. In this transmittal, the staff should identify any additional information needed to make the application complete. Detailed technical questions, although not required, can be included if they are identified during the acceptance review. If the content of the application is acceptable for docketing, the staff should be able to make a finding that the applicable requirements in 10 CFR 40.31 have been met.

Detailed Review Objectives

Following completion of the acceptance review, the staff should conduct a detailed technical review of the application. The results of this review and the basis for acceptance or denial of the requested licensing action are documented by NRC in a technical evaluation report and either an environmental assessment (10 CFR 51.30) if there is a finding of no significant impact, or an environmental impact statement (10 CFR 50.31) if the review indicates that the licensed activity would have a significant impact on the health and safety of the public or on the environment. The detailed review should evaluate the environmental, economic, and technical evidence provided by the applicant to support the ability of the proposed facility to meet applicable regulatory requirements. Details on the NRC National Environmental Policy Act process are contained in NUREG–1748 (NRC, 2001).

Standard Review Plan Organization

The standard review plan is written to address a variety of site conditions and facility designs. Each section provides the complete review procedure and acceptance criteria for all the areas of review pertinent to that section. For any given application, the staff reviewer may select and emphasize particular aspects of each standard review plan section as appropriate for the

application. Because of this, the staff may not carry out in detail all of the review steps listed in each standard review plan section in the review of every application.

Areas of Review Subsection

This subsection describes the scope of the review (i.e., what is being reviewed). It contains a brief description of the specific technical information and analyses in the application that should be reviewed by each technical reviewer.

Review Procedures Subsection

This subsection discusses the appropriate review technique. It is generally a step-by-step procedure that the reviewer uses to determine whether the acceptance criteria have been met.

Acceptance Criteria Subsection

This subsection delineates criteria that can be applied by the reviewer to determine the acceptability of the applicant compliance demonstration. Because the criteria are based on detailed technical approaches for determining compliance with applicable regulations, they do not routinely reference specific regulations. To include such reference would simply restate the requirements, and would not provide guidance on what is an acceptable method of compliance. The technical bases for these criteria have been derived from 10 CFR Parts 40 and 20, NRC regulatory guides, general design criteria, codes and standards, branch technical positions, standard testing methods (e.g., American Society for Testing and Materials standards), technical papers, and other similar sources. These sources typically include solutions and approaches previously determined to be acceptable by the staff for making compliance determinations for the specific area of review. These acceptance criteria have been defined so that staff reviewers can use consistent and well-documented approaches for review of all applications. Flexibility is provided to enable licensees to achieve the type of operation desired at their facilities. Applicants may take approaches to demonstrating compliance that are different from the acceptance criteria in this standard review plan as long as the staff can make the requisite decisions concerning environmental acceptability and compliance with applicable regulations. However, applicants should recognize that, as is the case for regulatory guides, substantial staff time and effort have gone into the development of these procedures and criteria, and a corresponding amount of time and effort may be required to review and accept new or different solutions and approaches. Thus, applicants proposing solutions and approaches to safety problems or safety-related design issues other than those described in this standard review plan may experience longer review times and NRC requests for more extensive supporting information. The staff is willing to consider proposals for other solutions and approaches on a generic basis, apart from a specific application, to avoid the impact of the additional review time for individual cases.

Evaluation Findings Subsection

This subsection presents general conclusions and findings of the staff that result from review of each area of the application as well as an identification of the applicable regulatory

requirements. Conclusions and findings for a specific application and review area are dependent on the site and type of licensing action being considered. For each standard review plan section, a conclusion is included in the technical evaluation report or the environmental assessment/environmental impact statement in which results of the review are published. These documents contain a description of the review; the basis for the staff findings, including aspects of the review selected or emphasized; where the facility design or the applicant programs deviate from the criteria stated in the standard review plan; and the evaluation findings.

References Subsection

This subsection lists any applicable references.

Standard Review Plan Updates

This standard review plan will be revised and updated periodically as the need arises to clarify the content or correct errors and to incorporate modifications approved by NRC management. Corresponding changes to the Standard Format and Content of License Applications, Including Environmental Reports (NRC, 1982) will be made as required.

References

NRC. NUREG–1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs." Washington, DC: NRC. 2001.

———. Regulatory Guide 3.46, "Standard Format and Content of License Applications, Including Environmental Reports, for *In Situ* Uranium Solution Mining." Washington, DC: NRC, Office of Standards Development. 1982.

1.0 PROPOSED ACTIVITIES

1.1 Areas of Review

The reviewer should examine the summary of the proposed activities for which a license is requested to gain a basic understanding of those proposed activities and the likely consequences of any safety or environmental impact. The staff should review the corporate entities involved; the location of the proposed activities; land ownership; ore-body locations and estimated uranium (U_3O_8) content; proposed solution extraction method and recovery processes; operating plans, design throughput and anticipated annual U_3O_8 production; radiation safety protection estimated schedules for construction, startup, and duration of operations; plans for project waste management and disposal; source and byproduct material transportation plans; plans for ground-water quality restoration, decommissioning, and land reclamation; and surety arrangements covering eventual facility decommissioning, ground-water quality restoration, and site reclamation.

1.2 Review Procedures

The reviewer should determine whether the application provides a sufficiently comprehensive summary of the nature of the facilities, equipment, and procedures to be used in the proposed *in situ* leach activity including the name and location. Reviewers should keep in mind that the development and initial licensing of an *in situ* leach facility is not based on comprehensive information. This is because *in situ* leach facilities obtain enough information to generally locate the ore body and to understand the natural systems involved. More detailed information is developed as each area is brought into production. Therefore, reviewers should verify that sufficient information is presented to reach only the conclusion necessary for initial licensing. However, reviewers should not expect that information needed to fully describe each aspect of a full operation will be available in the initial application. For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

Applications for licenses authorizing commercial-scale operations should rely on results from research and development operations or other operational experience that can be used as a basis to support the proposed processes, operating plans (including plans for ground-water quality restoration), and assessment of the likely consequences of any environmental impact. This does not mean that the applicant needs to develop a research and development facility in order to license a full-scale production plant. Rather it is intended to allow the applicant to rely on available data from research and development facilities, other sites currently operated by the applicant, or sites with similar designs or natural features operated by other licensees. In performing the evaluation, the reviewer should use the data available from these other sources to assess how the proposed site compares with already licensed sites.

1.3 Acceptance Criteria

The proposed activities are acceptable if they meet the following criteria:

(1) The application summary of proposed activities includes descriptions of the following items that are sufficient to provide a basic understanding of the proposed activities and the likely consequences of any health, safety, and environmental impact. The content of the introduction is outlined in the "Standard Format and Content of License Applications, Including Environmental Reports, for *In Situ* Uranium Solution Mining" [U.S. Nuclear Regulatory Commission (NRC), 1982].

(a) Corporate entities involved

(b) Location of the proposed facilities by county and state, including the facility name

(c) Land ownership

(d) Ore-body locations and estimated U_3O_8 content

(e) Proposed solution extraction method and recovery process

(f) Operating plans, design throughput, and annual U_3O_8 production

(g) Estimated schedules for construction, startup, and duration of operations

(h) Plans for project waste management and disposal

(i) Plans for ground-water quality restoration, decommissioning, and land reclamation

(j) Surety arrangements covering eventual facility decommissioning, ground-water quality restoration, and site reclamation

(k) For license renewals, a summary of proposed changes, a record of amendments since the last license issuance, and documentation of inspection results

(2) Applications for commercial-scale operations include results from research and development operations or previous operating experience as a basis for the proposed processes, operating plans, ground-water quality restoration, and assessment of the likely consequences of any environmental impact.

1.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the summary of the proposed activities, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

The NRC has completed its review of the summary of the proposed activities at the _____ *in situ* leach facility. This review included an evaluation of the methods that will be used to evaluate the proposed activities using the review procedures in standard review plan Section 1.2 and the acceptance criteria outlined in standard review plan Section 1.3.

The applicant has acceptably described the proposed activities at the _____ *in situ* leach facility including (i) corporate entities involved; (ii) location of the proposed facility; (iii) land ownership; (iv) ore-body locations and estimated U_3O_8 content; (v) proposed solution extraction method and recovery process; (vi) operating plans, design throughput, and annual U_3O_8 production; (vii) schedules for construction, startup, and duration of operations; (viii) waste management and disposal plans; and (ix) ground-water quality restoration, decommissioning, and land reclamation plans; (x) surety arrangements covering facility decommissioning, ground-water quality restoration, and site reclamation. For license renewals, the applicant has provided a summary of proposed changes, a record of amendments since the last license issuance, and documentation of inspection results. Applicants for commercial-scale operations have included results from research and development operations or previous operating experience.

Based on the information provided in the application and the detailed review conducted of the summary of the proposed activities at the _____ *in situ* leach facility, the staff concludes that the summary of the proposed activities is acceptable and is in compliance with 10 CFR 40.32, which describes the general requirements for the issuance of a specific license. The summary of proposed activities is acceptable and is in compliance with 10 CFR 51.45, which requires a description of the proposed action sufficient to allow the staff to evaluate the impacts on the affected environment.

1.5 Reference

NRC. Regulatory Guide 3.46, "Standard Format and Content of License Applications, Including Environmental Reports, for *In Situ* Uranium Solution Mining." Washington, DC: NRC, Office of Standards Development. 1982.

2.0 SITE CHARACTERIZATION

2.1 Site Location and Layout

2.1.1 Areas of Review

The staff should review geographic maps, topographic maps, and drawings that identify the site and its location relative to federal, state, county, and other political subdivisions. These should include maps provided to show the location and layout of the proposed facilities, well fields, and all principal structures such as surface impoundments, deep injection wells, recovery plant buildings, exclusion area boundaries and fences, applicant property and leases, and adjacent properties.

The regional location and site layout for the proposed *in situ* leach operations should be reviewed using maps that show the relationship of the site to local water bodies (lakes and streams); geographic features (highlands, forests); geologic features (faults, folds, outcrops); transportation links (roads, rails, airports, waterways); political subdivisions (counties, townships); population centers (cities, towns); historical and archeological features; key species habitat; and nonapplicant property (farms, settlements). A contour map of the site showing a plan layout of constructions, significant topographic variations of the site environs, and drainage gradients, should be evaluated.

2.1.2 Review Procedures

The reviewer should establish the validity and completeness of the basic data, to determine that the site location and layout proposed in the application are complete and accurate, and that the site information is sufficient to evaluate the location of the proposed facilities relative to key features and activities. For new applications, the staff should conduct a site visit of the facility, after becoming familiar with the submitted materials, to develop an acceptable familiarization for the review and to verify the general aspects of the submitted materials.

The staff should examine maps and drawings provided in the application and associated environmental reports to determine whether they provide sufficient detail to locate the site regionally relative to local political subdivisions and natural and man-made features and that the maps allow the staff to determine the proposed layout within the existing topography at the site. On a regional scale, the reviewer should examine the location of the facility and all federal, state, County, and local political subdivisions that have a bearing on estimating the environmental impact of the proposed operations. The staff should verify that the total acreage that is owned or leased by the applicant and the portion of that real estate or any adjacent properties that could be affected by site activities have been identified. The reviewer should examine a contour map to determine that the contour intervals and information included on the map are sufficient to show any significant variations in site environs and important drainage gradients. The staff should also determine that the relationship between the site and surface drainage is readily apparent from the provided maps. Likewise, it should be possible to ascertain the likely areas of and effects of site activities on local flora and fauna from the location maps. The staff should determine that the scale and clarity of the maps are adequate to conduct the necessary environmental and safety reviews.

Site Characterization

Reviewers should keep in mind that the development and initial licensing of an *in situ* leach facility is not based on comprehensive information. This is because *in situ* leach facilities obtain enough information to generally locate the ore body and understand the natural systems involved. More detailed information is developed as each area is brought into production. Therefore, reviewers should ensure that sufficient information is presented to reach only the conclusion necessary for initial licensing. However, reviewers should not expect that information needed to fully describe each aspect of all the operations will be available in the initial application.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.1.3 Acceptance Criteria

The characterization of the site location and layout is acceptable if it meets the following criteria:

(1) Maps are provided that show geologic features, well fields, and all planned principal structures such as surface impoundments, diversion channels, monitoring wells, deep injection wells, and recovery plant buildings. If detailed information on actual well field design is not available at the time of the initial facility application, the maps show the expected well field locations with an indication that this information is preliminary.

(2) Any maps previously submitted (e.g., maps from the original application in the call of renewals) are legible, and actual or proposed changes are highlighted.

(3) Maps are provided that show exclusion area boundaries and fences.

(4) Maps are provided that show the applicant property and leases and current adjacent properties, including water bodies, forests, and farms, and all federal, state, county, and local political subdivisions.

(5) Maps are provided that show nearby population centers and transportation links such as railroads, highways, and waterways.

(6) A topographic map is provided with elevation contours that show the locations of drainage basins and variations in the drainage gradient in the vicinity of the proposed *in situ* leach facility. The specific locations of natural streams and proposed diversion channels, relative to principal structures, should also be provided.

(7) The proposed *in situ* leach facility is clearly labeled at a scale appropriate to the area being covered (regional and local) and with sufficient clarity and detail to allow identification and evaluation of the proposed *in situ* leach facility. Maps are at an appropriate scale and are clear and readable.

(8) Data sources are documented in reports such as U.S. Geological Survey open files or existing published maps. If data have been generated by the applicant, the data documentation should include a description of the investigation and data reduction techniques.

(9) Maps include designation of scale, orientation (e.g., north arrow), and geographic coordinates. In addition to maps, the applicant may provide tabular locations of facilities using universal transverse Mercator coordinates with appropriate Northing and Easting in meters.

2.1.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the description of the site location and layout, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the site characterization information concerned with site location and layout at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.1.2 and the acceptance criteria outlined in standard review plan Section 2.1.3.

The licensee has acceptably described the site location and layout with appropriately scaled and labeled maps showing site layout, principal facilities and structures, regional location, geology, boundaries, exclusion areas and fences, applicant property including leases and adjacent properties, nearby population centers and transportation links, and topography. References are cited acceptably. Any maps previously submitted (e.g .,maps from the original application in the case of renewals) are legible, and actual or proposed changes are highlighted.

Based on the information provided in the application, and the detailed review conducted of the characterization of site location and layout for the _____ *in situ* leach facility, the staff concludes that the information is acceptable and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis.

2.1.5 References

None.

2.2 Uses of Adjacent Lands and Waters

2.2.1 Areas of Review

The staff should review descriptions of the nature and extent of present and projected land use (e.g., agriculture, sanctuaries, hunting, mining, grazing, industry, recreation, roads), any recent

trends or changes in population or industrial patterns, and any other nuclear fuel cycle facilities located or proposed within an 80-km [0-mi] radius of the site.

The staff should also review tables showing, for each of the 22½-degree sectors centered on each of the 16 compass points (i.e., north, north-northeast, etc.), the distances {to a distance of 3.3 km [2 mi]} from the center of the site to the nearest resident and to the nearest site boundary.

The staff review should include the location, nature, and amounts of present and projected surface-and ground-water use (e.g., water supplies, irrigation, reservoirs, recreation, and transportation) within 3.3 km [2 mi] of the site boundary {0.8 km [0.5 mi] for research and development operations} and the present and projected population associated with each use point.

2.2.2 Review Procedures

The reviewer should determine whether the application provides sufficient information on the use of the lands and waters within a 3.3 km [2 mi] distance from the site boundary surrounding the proposed facilities {0.8 km [0.5 mi] for research and development operations} to assess the likely consequences of any impacts of *in situ* leach operations on adjacent properties.

The staff should determine that the application contains the location of residences, ground-water supply wells, surface-water reservoirs, and the estimated use of water in the lands surrounding the site of the proposed facility. Data sources should be referenced. This information should be evaluated to determine whether it is sufficient to delineate the likely impact(s) of the facility, under both normal operating conditions and accidents, on the ground-water, surface water, and population (both human and animal) near the site. The reviewer should determine that within 3.3 km [2 mi] from the site boundary, the nature and extent of present and projected water and land use and any other trends or changes in population or industrial patterns have been reported. Any other nuclear fuel cycle facilities located or proposed within an 80-km [50-mi] radius of the site should be identified.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining historical aspects of facility performance and the approach that should be used in evaluating amendments and renewal applications.

2.2.3 Acceptance Criteria

The characterization of the uses of adjacent lands and waters is acceptable if it meets the following criteria:

(1) Information is presented in detail sufficient to understand the surrounding land and water uses, such that the likely risks imposed by *in situ* leach operations can be adequately assessed.

Although the specific requirements may vary from site to site, the general purpose for determining land and water use patterns is to provide supporting data for exposure calculations, cost-benefit analyses, and determinations of air emissions (e.g., dust). A 3.3-km [2-mi] distance from the site boundary is an acceptable area for which land and water use data should be collected. One acceptable method for presenting these data is for the applicant to provide the information requested in the Standard Format and Content of License Applications, Including Environmental Reports (NRC, 1982), Section 2.2. The information presented should include:

(a) Maps showing the locations of nearest residences, ground-water supply wells, and abandoned wells

(b) Types of present and projected (life of facility) water use (e.g., municipal, domestic, agriculture, livestock) and descriptions of the methodology and sources used to develop projections

(c) Present and projected (life of facility) water use estimates, by type, for both ground water and surface water, including present and projected withdrawal, and descriptions of the methodology and sources used to develop projections

(d) For ground-water wells, well depth, ground-water elevations, flow rates, drawdown, and a description of the producing aquifer(s)

(e) The locations of abandoned wells and drill holes, including the depth, type of use, condition of closing, plugging procedure used, and date of completion for each well or drill hole within the site area and within 0.4 km [.25 mi] of the well field boundary

(f) Descriptions of the nature and extent of projected land use (e.g., agriculture, recreation, industry, grazing, and infrastructure) and descriptions of the methodology and sources used to develop projections

(g) The location of any other nuclear fuel cycle facilities located or proposed within an 80-km [50-mi] radius of the site

(2) For each of the 22½-degree sectors centered on the 16 cardinal compass points, the information identified in Section 2.2.3 of the Standard Format and Content of License Application, Including Environment Report (NRC, 1982) concerning human residences, nearest site boundary(ies) to residences, surface- and ground-water use, and projected water use, is provided. As described in Section 2.2 of the Standard Format and Content of License Application, Including Environment Report (NRC, 1982), appropriate presentation of the data should include mapped data as appropriate, a tabular summary for each of the 22½-degree sectors centered on the 16 cardinal compass points, and for each, the distance from the center of the site to the site boundary and the nearest residence.

(3) Data sources are documented in reports such as U.S. Geological Survey open files or existing published reports or maps. If data have been generated by the applicant, the data documentation should include a description of the investigations and data reduction techniques.

(4) Maps include designation of scale, orientation (e.g., north arrow), and geographic coordinates.

2.2.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the described uses of adjacent lands and waters, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the site characterization information concerned with uses of adjacent lands and waters near the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.2.2 and acceptance criteria outlined in standard review plan Section 2.2.3.

The applicant has acceptably described the present and projected land use, including residential, commercial, agricultural, industrial, flora and fauna sanctuaries, arboreal, grazing, recreation (e.g., hunting, swimming, skiing), and infrastructure. Appropriate information on the location and extent of each use has been provided. In particular, the description and associated tabulated data of the location, nature, amounts, and population associated with each use point of present and projected (life of the facility) surface-and ground-water adjacent to the site including water supplies, irrigation, reservoirs, recreation, and transportation within at least 3.3 km [2 mi] of the site boundary {0.8 km [0.5 mi] for research and development operations} are acceptable for determination of likely impacts of the proposed *in situ* leach facility. Tabulated data on present and projected water withdrawal rates, return rates, types of water use (e.g., municipal, domestic, agriculture, and livestock); source, water-use estimates, and abandoned well locations are acceptable. The applicant has identified and located (or has noted the absence of) other nuclear fuel cycle facilities located or proposed within an 80-km [50-mi] radius of the site.

Based on the information provided in the application, and the detailed review conducted of the characterization of uses of adjacent lands and waters for the _____ *in situ* leach facility, the staff concludes that the information is acceptable and is in compliance with 10 CFR 51.45 which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis, and 10 CFR Part 40, Appendix A, Criteria 5B(4) and 5G(3) which provide criteria for identification if underground sources of drinking water and exempted aquifers and the current uses of ground water.

2.2.5 Reference

NRC. Regulatory Guide 3.46, "Standard Format and Content of License Applications, Including Environmental Reports, for *In Situ* Uranium Solution Mining." Washington, DC: NRC, Office of Standards Development. 1982.

2.3 Population Distribution

2.3.1 Areas of Review

The staff should review population data based on the most recent census, including maps that identify places of significant population grouping, such as cities and towns within an 80-km [50-mi] radius {3.2 km [2 mi] for research and development operations} from the approximate center of projected (life of facility) activities in the format specified in the Standard Format and Content of License Application, Including Environmental Reports (NRC, 1982). For the purposes of environmental justice (see Sections 7.6.1.3) and NUREG–1748 (NRC, 2001) the staff should also examine the distribution of low-income and minority populations based on the most recent census data available. The staff should review the basis for population projections.

In addition, for commercial-scale operations, the staff should review descriptive material giving significant population and visitor statistics of neighboring schools, plants, hospitals, sports facilities, residential areas, parks, *et cetera*, within 3.3 km [2 mi] of the *in situ* leach operations. The review should include appropriate available food production data in kg/yr for vegetables (by type and totals), meat (all types), and milk, and any available future predictions for this production by local governmental, industrial, or institutional organizations within 3.3 km [2 mi] of the site boundary.

2.3.2 Review Procedures

The reviewer should determine that data have been tabulated and presented in pie segments as described in Section 2.3 of the Standard Format and Content of License Application, Including Environmental Reports (NRC, 1982). The basis for population projections should be examined. Recent agricultural production data should be evaluated for vegetables, meat, milk, and other foodstuffs, in addition to predictions for future production by government, industry, or institutions for land within 3.3 km [2 mi] of the site. It is important to ascertain that the most recent census data have been used and that the data presented will support subsequent exposure and dose calculations and risk assessments.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.3.3 Acceptance Criteria

The characterization of the population distribution is acceptable if it meets the following criteria:

(1) Population data including demographic information on minority and low-income populations are provided based on generally accepted sources such as the U.S. Census Bureau, and other federal, state, and local agencies.

(2) A map of suitable scale is provided that identifies significant population centers within an 80-km radius [50 mi] {3.2 km [2 mi] for research and development operations} from the approximate center of the projected activities.

(3) A map of suitable scale is provided, centered on the proposed ISL facility, marked with concentric circles at 1, 2, 3, 4, 5, 10, 20, 30, 40, 50, 60, 70, and 80 km divided into 22½-degree sectors centered on one of the 16 compass points. A table keyed to this map showing separate and cumulative population totals for each sector and annular ring is provided. The distance to the nearest residence is noted for each sector.

(4) Descriptions of significant population and visitor statistics of neighboring schools, plants, hospitals, sports facilities, residential areas, parks, and forests within 3.2 km [2 mi] of the proposed *in situ* leach facility, based on generally accepted sources such as the U.S. Census Bureau, and State and local agencies, are provided, with identification of data sources.

(5) Projections are included of population, visitor, and food production data over the expected life of the *in situ* leach facility (typically tens of years).

(6) Descriptions of the methodology and sources used to develop projections are provided.

The food production data are acceptable if data (kg/yr) for vegetables, meat, and milk, based on generally accepted sources such as the U.S. Department of Agriculture, Farm Bureau, and state and local agriculture services, are provided, with identification of data sources.

2.3.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the population distribution and food production data, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the site characterization information concerned with population distribution and food production near the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.3.2 and acceptance criteria outlined in standard review plan Section 2.3.3.

The applicant has acceptably described the population distribution using population data from generally accepted sources. A map showing the location of significant population centers,

within an 80-km radius [50 mi] of the approximate center of proposed operations, is provided. A table and accompanying map providing population in pie-shaped wedges, centered on each of the 16 compass points, is included. Nearest residence distances are noted for each sector. The applicant has provided acceptable information on minority and low-income populations, schools, industrial facilities, sports facilities, residential areas, parks, and forests within 3.2 km [2 mi] of the proposed *in situ* leach facility. Food production data (e.g., vegetables, meat, milk) have been described and keyed on a map. Based on a description of the methodology and sources, all the data have been appropriately projected for the proposed life of the *in situ* leach facility.

Based on the information provided in the application, and the detailed review conducted of the characterization of population distribution and food production for the _____ *in situ* leach facility, the staff concludes that the information is acceptable and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis.

2.3.5 References

NRC. Regulatory Guide 3.46, "Standard Format and Content of License Applications, Including Environmental Reports, for *In Situ* Uranium Solution Mining." Washington, DC: NRC, Office of Standards Development. 1982.

———. NUREG–1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs." Washington, DC: NRC. 2001.

2.4 Historic, Scenic, and Cultural Resources

2.4.1 Areas of Review

The staff shall review discussions of the historic, cultural, and scenic resources, if any, within the area of potential effect. Historic properties include districts, sites, buildings, structures, or objects of historical, archaeological, architectural, or traditional cultural significance. Specific attention should be directed to properties included in or eligible for inclusion in the National Register of Historic Places (the National Register) and properties registered as National Natural Landmarks.

The staff should review identifications of those properties included in, or eligible for, inclusion in the National Register of Historic Places, located within the area of the proposed project, and should review evidence of contact with the appropriate state historic preservation officer , including a copy of any state historic preservation officer comments concerning the effect of the facility on historic, scenic, and cultural resources.

The review should include information on whether new roads, pipelines, or utilities for the proposed activity will pass through or near any area or location of known historic, scenic, or cultural significance.

2.4.2 Review Procedures

The staff should determine that the applicant has used the appropriate databases and records to identify historic, scenic, and cultural resources that are found within the study region. The staff should determine that the locations and descriptions of the features are sufficient to allow an evaluation of the likely consequences of any impacts of the proposed facilities on these resources. Of particular interest are features included in or eligible for the National Register and National Natural Landmarks. Means to consider and treat such data are discussed in several National Park Service guidelines (e.g., National Park Service, 1973, 1990, 1995). The reviewer should verify that data presented support the of estimates of long-term costs in terms of the likely consequences of any effects on the aesthetic or recreational values of such landmarks. It is important that the application document evidence of contact with knowledgeable sources when no historic, scenic, or cultural resources are identified by the applicant within the study area. The reviewer should examine the likely impact of the presence of new roads, pipelines, or other utilities on areas and locations of known historic, scenic, or cultural significance.

The reviewer should also confer with the state historic preservation officer in accordance with the as required by 36 CFR Part 800. As specified in Part 800, the state historic preservation officer can enter into a memorandum of understanding to assume the function of the Advisory Council on Historic Preservation. In these situations, consistent with 36 CFR 800.7(b)(1), NRC can comply with the state review process in lieu of the Advisory Council on Historic Preservation regulations. If such a memorandum of understanding is not in place, the staff must consult with the state historic preservation officer and other interested parties. If adverse effects are found, and the Advisory Council on Historic Preservation does not participate, the NRC may enter into a memorandum of agreement with the State Historic Preservation Officer as specified in 36 CFR 800.6(b)(1). The NRC must submit a copy of the executed memorandum of agreement, along with the documentation specified in 36 CFR 800.11(f) to the Advisory Council on Historic Preservation prior to approving the undertaking in order to meet the requirements of Section 106 of the National Historic Preservation Act. If adverse effects are found, and the Advisory Council on Historic Preservation does not participate, the NRC should follow the requirements of 36 CFR 800.6(b)(2).

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.4.3 Acceptance Criteria

The characterization of regional historic, scenic, and cultural resources is acceptable if it meets the following criteria:

(1) A listing for all properties included in or eligible for inclusion in the National Register including National Natural Landmarks is provided.

(2) A map is included showing all identified National Register Properties and National Natural Landmarks with respect to the location of facilities such as buildings, new roads, well fields, pipelines, surface impoundments, and utilities that might affect these areas.

A license condition will be placed in the license prohibiting work if any previously unknown cultural artifacts are found.

(3) Discussions are incorporated of the treatment of areas of historic, scenic, and cultural significance that follow guidance equivalent to that provided by the National Park Service Preparation of Environmental Statements: Guidelines for Discussion of Cultural (Historic, Archeological, Architectural) Resources (National Park Service, 1973). Where appropriate, tribal authorities have been consulted for the likely consequences of any impact on Native American cultural resources. For a consideration of environmental justice, see Section 7.6.1.3, Acceptance Criterion (3) and NUREG–1748 (NRC, 2001).

(4) If delegated by NRC, the applicant provides evidence of contact with the appropriate state historic preservation officer and tribal authorities. This evidence includes a copy of the state historic preservation officer and tribal authority comments concerning the effects of the proposed facility on historic, archeological, architectural, and cultural resources.

(5) If delegated by NRC, the applicant presents a memorandum of agreement between the state historic preservation officer, tribal authorities, and other interested parties regarding their satisfaction with regard to the protection of historic, archeological, architectural, and cultural resources during site construction and operations.

(6) A letter from the state historic preservation officer has been obtained that discusses any issues associated with sites in or eligible for the National Register, National Natural Landmarks, or other cultural properties that may be affected by the *in situ* leach operations.

(7) The aesthetic and scenic quality of the site is rated in accordance with U.S. Bureau of Land Management 8400—Visual Resource Management (U.S. Bureau of Land Management, 2001).

If the rating is below 19 (scale of 0 to 33), no special management is required. If the rating is 19 or above, the application provides a management plan for minimizing the impact of the proposed facility.

2.4.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the characterization of the historic, scenic, and cultural resources the following conclusions may be presented in the environmental assessment.

Site Characterization

NRC has completed its review of the site characterization information concerned with regional historic, scenic, and cultural resources near the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.4.2 and acceptance criteria outlined in standard review plan Section 2.4.3.

The licensee has acceptably described the historic, scenic, and cultural resources. A listing of all nearby areas and properties included or eligible for inclusion in the National Register or National Natural Landmarks is provided. A map showing all historic landmarks and places with respect to *in situ* leach facilities is included. A record of the investigation of places and properties with historic, scenic, and cultural significance, which follows guidance equivalent to that of the National Park Service, is provided. Contact with local tribal authorities, where appropriate, is acceptably documented. A letter from the state historic preservation officer addressing any issues related to the properties that might be affected by the *in situ* leach facilities is included. The applicant has acceptably demonstrated that the state historic preservation officer and tribal authorities agree with the planned protection from or determination of lack of conflict with *in situ* leach facilities and activities and with any places of importance to the state, federal, or tribal authorities. The applicant has acceptably rated the aesthetic and scenic quality of the site in accordance with the U.S. Bureau of Land Management Visual Resource Inventory and Evaluation System.

Based on the information provided in the application, and the detailed review conducted of the characterization of regional historic, archeological, architectural, scenic, cultural, and natural landmarks near the _____ *in situ* leach facility, the staff concludes that the information is acceptable and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis.

2.4.5 References

National Park Service. "How to Apply the National Register Criteria for Evaluation." National Park Service Bulletin No. 15. Washington, DC: National Park Service, U.S. Department of the Interior. 1995.

———. "Guidelines for Evaluating and Documenting Traditional Cultural Properties. National Register Bulletin No. 38. Washington, DC: National Park Service, U.S. Department of the Interior. 1990.

———. "Preparation of Environmental Statements: Guidelines for Discussion of Cultural (Historic, Archeological, Architectural) Resources." Washington, DC: National Park Service. 1973.

NRC. NUREG–1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs." Washington, DC: NRC. 2001.

U.S. Bureau of Land Management. "Visual Resource Management." U.S. Bureau of Land Management Manual—8400. Washington, DC: U.S. Department of the Interior. http://lm0005.blm.gov/nstc/rrm/8400.html. 2000.

2.5 Meteorology

2.5.1 Areas of Review

The staff should review descriptions of the atmospheric diffusion characteristics of the site and its surrounding area based on data collected onsite or at nearby meteorological stations. The data to be reviewed include

(1) National Weather Service station data, including locations of all National Weather Service stations within an 80-km [50-mi] radius; and available joint frequency distribution data by wind direction, wind speed, stability class, period of record, and height of data measurement

(2) On-site meteorological data, including locations and heights of instrumentation, descriptions of instrumentation, and joint frequency distribution data, if National Weather Service data representative of the site are not available

(3) Miscellaneous data, including annual average mixing layer heights, a description of the regional climatology, and total precipitation and evaporation, by month

The staff should also review a discussion of the general climatology including existing levels of air pollution, the relationship of the regional meteorological data to the local data, the meteorological impact of the local terrain and large lakes and other bodies of water, and the occurrence of severe weather in the area and its effects. This review should also include data on averages of temperature and humidity.

2.5.2 Review Procedures

The staff should determine whether the application includes sufficient local and regional-scale meteorological information to support estimates of airborne radionuclide transport from the proposed *in situ* leach facility to the surrounding area and for determination of airborne pathway inputs to risk assessment models. This information may include National Weather Service data, on-site monitoring data, or data from local meteorological stations, and any maps or tables that describe meteorological conditions at the site and surrounding area. Section 2.5 of the Standard Format and Content of License Applications, Including Environmental Reports (NRC, 1982) contains a list of acceptable meteorological data requirements.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.5.3 Acceptance Criteria

The characterization of the site meteorology is acceptable if it meets the following criteria:

(1) A description of the general climate of the region and local meteorological conditions is provided, based on appropriate data from National Weather Service, military, or other stations recognized as standard installations.

These data include precipitation, evaporation, and joint-frequency distribution data by wind direction, wind speed, stability class, period of record, and height of data measurement. The average inversion height should also be identified. Data should also be provided on diurnal and monthly averages of temperature and humidity. The locations of all stations used in the data analysis and the height of the data measurement should be included. Data periods should be defined by month and year and cover a sufficient time period to constrain long-term trends and support atmospheric dispersion modeling.

Data from local meteorological weather stations supplemented, if necessary, by data from an on-site monitoring program, are provided.

A minimum of one full year of joint frequency data presented with a joint data recovery of 90 percent or more is provided.

The on-site program should be designed in accordance with Regulatory Guide 3.63, "Onsite Meteorological Measurement Program for Uranium Recovery Facilities—Data Acquisition and Reporting" (NRC, 1988).

(2) Consideration of relationships between regional weather patterns and local meteorological conditions based on weather station data and the on-site monitoring program, if necessary, is included. The impacts of terrain and nearby bodies of water on local meteorology are assessed, and the occurrence of locally severe weather is described and its impact considered.

Information on anticipated air quality impacts from nonradiological sources, such as vehicle emissions and dust from well field activities, is provided for assessing cumulative impacts.

(3) The meteorological data used for assessing impacts are substantiated as being representative of expected long-term conditions at and near the site.

(4) The application contains a description of existing levels of air pollution.

The applicant must demonstrate that the radiological and non-radiological air quality impacts caused by *in situ* leach facilities are virtually indistinguishable from background, or information on the likelihood of air pollution is based on U.S. Environmental Protection Agency (EPA) studies. Affected counties within 80 km

[50 mi] of the facility are classified according to the National Ambient Air Quality Standards as being in attainment (below National Ambient Air Quality Standards) or nonattainment (above National Ambient Air Quality Standards status.

(5) The sources of all meteorological and air quality data are documented in open file reports or other published documents. If data have been generated by the applicant the data documentation should include a description of the investigations and data reduction techniques.

2.5.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the meteorology, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the site characterization information concerned with meteorology at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.5.2 and acceptance criteria outlined in standard review plan Section 2.5.3.

The licensee has acceptably described the site meteorology by providing data from National Weather Service military, or other stations recognized as standard installations located within 80 km [50 mi] of the site, including available joint frequency distribution data on (i) wind direction and speed, (ii) stability class, (iii) period of record, (iv) height of data measurement, and (v) average inversion height. The data cover a sufficient time period to constrain long-term trends and support atmospheric dispersion modeling. The applicant has provided acceptable on-site meteorological data, if necessary, including (i) descriptions of instruments, (ii) locations and heights of instruments, and (iii) joint frequency distributions. The joint-frequency data presented are for a minimum of 1 year, with a joint data recovery of 90 percent or more. Additional data on (i) annual average mixing layer heights, (ii) a description of the regional climate, and (iii) total precipitation and evaporation by month have been provided. The applicant has noted any effect of nearby water bodies or terrain on meteorologic measurements. The applicant has acceptably demonstrated that meteorologic data used for assessing environmental impacts are representative of long-term meteorologic conditions at the site. The applicant report on the existing levels of air pollution at the site and nearby is acceptable.

Based on the information provided in the application, and the detailed review conducted of the characterization of meteorology at the _____ *in situ* leach facility, the staff concludes that the information is acceptable to allow evaluation of the spread of airborne contamination at the site and development of conceptual and numerical models, and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis. The characterization also meets the requirements of 10 CFR Part 40, Appendix A, Criterion 7, which requires pre-operational and operational monitoring programs.

2.5.5 References

NRC. Regulatory Guide 3.63, "Onsite Meteorological Measurement Program for Uranium Recovery Facilities—Data Acquisition and Reporting." Washington, DC: NRC, Office of Standards Development. 1988.

———. Regulatory Guide 3.46, "Standard Format and Content of License Applications, Including Environmental Reports, for *In Situ* Uranium Solution Mining." Washington, DC: NRC, Office of Standards Development. 1982.

2.6 Geology and Seismology

2.6.1 Areas of Review

The reviewer should examine information on the geologic aspects of the site acquired through standard geologic analyses, including a survey of pertinent literature and field investigations. This information should include regional seismicity and seismic history, local stratigraphy, petrology or lithology of rock units, tectonic features (faulting, folding, fracturing), and the continuity of the geologic strata at the site and in nearby regions.

Geologic, structural, and stratigraphic maps and cross sections, including representative core and geophysical well-log data of the site and its environs, should be reviewed. An isopach map of the intended zone of injection or production and associated confining beds should be evaluated. All conclusions regarding the lateral continuity and vertical thickness of the ore zone(s), surrounding lithologic units, and confining zones, as based on lithologic logs from core and drill cuttings, geophysical data, remote-sensing measurements, and the results of other appropriate investigations should be reviewed. Some of the applicant's supporting information for this review area might be included in the documents submitted to satisfy the hydrology review area (Section 2.7).

The staff should review the information presented on any economically important minerals and energy-related deposits in addition to the uranium ore, including the likely consequences of any production of such related deposits on the *in situ* leach facility.

Data on the geochemistry of the ore zone and the geologic zones immediately surrounding the ore zone that will or could be affected by injected lixiviant should be evaluated. Information on unique minerals (including those that might be affected by fluid movement associated with the proposed project, such as bentonite) or paleontologic deposits of particular scientific interest, should also be reviewed. The staff should examine descriptions of any effects that planned operations at the site might have on the future availability of other mineral resources.

2.6.2 Review Procedures

The staff should review the application to determine whether a thorough evaluation of the geologic setting for the proposed *in situ* leach activity has been presented along with the basic data supporting all conclusions. In addition to a description of the basic geology, both at the

surface and at the depths of interest, the establishment of the continuity of the geologic strata at the site should be reviewed for applicability, correctness, inclusivity, and likely ability of the strata to isolate *in situ* leach fluids. The reviewer should particularly focus attention on fractures or faults, permeable stratigraphic units, and lateral facies changes that might preclude the applicant-identified geologic barriers to fluid migration from performing adequately.

The reviewer should determine that the application contains viable geologic maps, isopach maps of the ore-bearing strata and of the confining layers, geologic cross sections at places critical to a thorough understanding of the selected site, representative supporting core samples and geophysical and lithologic logs, and other data required for a thorough understanding of the pertinent geology. The reviewer should determine that regional stratigraphic and geologic information is discussed in sufficient detail to give clear perspective and orientation to the site-specific material presented. The discussion of regional geology and stratigraphy should be assessed to determine if it is adequately referenced and is illustrated by regional surface and subsurface geologic maps, stratigraphic columns, and cross sections.

The staff may also perform an independent analysis of the data provided to assess whether reasonable and conservative alternative interpretations are indicated.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.6.3 Acceptance Criteria

The characterizations of the site geology and seismology are acceptable if they meet the following criteria:

(1) The application includes a description of the local and regional stratigraphy based on techniques such as:

(a) Surface sampling and descriptions

(b) Cuttings and core logging reports

(c) Wireline geophysical logs, such as electrical resistivity, neutron density, and gamma logs

(d) Geologic interpretations of surface geology and balanced cross sections

These interpretations may be based either on original work submitted by the applicant, or on an appropriate evaluation of previous work in the region performed by state or federal agencies (e.g., U.S. Geological Survey,

U.S. Bureau of Land Reclamation, U.S. Bureau of Mines), universities, mining companies, or oil and gas exploration companies. The interpretations should be accompanied by:

(i) Maps such as geologic, topographic, and isopach maps that show surface and subsurface geology and locations for all wells used in defining the stratigraphy

(ii) Cross sections through the ore deposit roughly perpendicular and parallel to the principal ore trend

(iii) Fence diagrams showing stratigraphic correlations among wells

(2) All maps and cross sections are at sufficient scale and resolution to show clearly the intended geologic information. Maps show the locations of all site explorations such as borings, trenches, seismic lines, piezometer readings, and geologic cross sections.

(3) In the local stratigraphic section, all ore horizons, confining units, and other important units such as drinking water aquifers and deep well injection zones are clearly shown, with their depths from the surface clearly indicated. Isopach maps are prepared showing the variations in thickness of the mineralized zone and the confining units over the proposed mining area.

(4) A geologic and geochemical description of the ore zone and the geologic units immediately surrounding the ore zone is provided.

(5) An inventory of economically significant mineral and energy-related deposits, in addition to the uranium ore, is provided. Locations of all known wells, surface and underground mine workings, and surface impoundments that may have an effect on the proposed operations are provided.

These items should be located on a map of sufficient scale and clarity to identify their relationship to the proposed facility. For existing wells, the depth should be shown, if possible. To allow evaluation of connections between the ore zone and underground sources of drinking water, plugging and abandonment records provided from state, federal, and local sources, as appropriate, should be provided. The applicant should provide evidence that action has been undertaken to properly plug and abandon all wells that cannot be documented in this manner.

(6) A description of the local and regional geologic structure, including folds and faults, is provided.

Folds and faults can be shown on the geologic maps used to describe the stratigraphy. Major and minor faults traversing the proposed site should be evaluated for the likely consequences of any future effects of faulting on the uranium production activities and on the ability of the strata to contain lixiviant should fault motion occur. Geologic

structures that are preferential pathways or barriers to fluid flow must be described and the basis for likely effects on flow given.

(7) A discussion of the seismicity and the seismic history of the region is included.

Historical seismicity based on data from universities and state and local agencies should be summarized on a regional earthquake epicenter map, including magnitude, location, and date of all known seismic events. Where possible, seismic events should be associated with the tectonic features described in the geologic structures.

(8) A generalized stratigraphic column, including the thicknesses of rock units, representation of lithologies, and definition of ore horizon, is presented.

(9) The sources of all geological and seismological data are documented in U.S. Geological Survey open files or other published documents. If data have been generated by the applicant, the documentation should include a description of the investigations and data reduction techniques.

(10) Maps have designation of scale, orientation (e.g., North arrow), and geographic coordinates.

(11) Short-term seismic stability has been demonstrated for the *in situ* leach facility in accordance with Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills," Section 2.6 (NRC, 1977).

(12) A general description of the site soils and their properties has been provided to support an evaluation of the environmental effects of construction and operation on erosion.

(13) A detailed description of soils and their properties has been provided for any areas where land application of water is anticipated to support an assessment of the impacts.

2.6.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the characterization of the geology and seismology, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the site characterization information concerned with geology and seismology at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.6.2 and acceptance criteria outlined in standard review plan Section 2.6.3.

The licensee has acceptably described the geology and seismology by providing (i) a description of the local and regional stratigraphy; (ii) geologic, topographic, and isopach maps at acceptable scales showing surface and subsurface features and locations of all wells and site explorations used in defining stratigraphy; (iii) a geologic and geochemical description of

the ore zone and the geologic units adjacent to the ore zone; (iv) an inventory of nearby economically significant minerals and energy-related deposits; (v) a description of the local and regional geologic structure; (vi) a discussion of the seismicity and seismic history of the region; (vii) a generalized stratigraphic column that includes thickness of rock units, representation of lithologies, and definition of ore horizon; and (viii) a description and map of the soils.

Based on the information provided in the application, and the detailed review conducted of the characterization of the geology and seismology at the _____ *in situ* leach facility, the staff concludes that the information is acceptable to allow evaluation of the geologic and seismologic characteristics of the site and associated conceptual and numerical models and is in compliance with 10 CFR 40.31(f), which requires inclusion of an environmental report in the application, and 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis. The characterization is sufficient to meet the requirements of 10 CFR Part 40, Appendix A, Criteria 4(e), which requires locations away form faults capable of causing impoundment failure and 5G(2), which requires adequate descriptions of the characteristics of the underlying soils and geologic formations.

2.6.5 Reference

NRC. Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills." Washington, DC: NRC, Office of Standards Development. 1977.

2.7 Hydrology

2.7.1 Areas of Review

Characterization of the hydrology at *in situ* leach uranium extraction facilities must be sufficient to establish potential effects of *in situ* leach operations on the adjacent surface- water and ground-water resources and the potential effects of surface-water flooding on the *in situ* leach facility. The areas of review include:

(1) Descriptions of surface-water features in the site area including type, size, pertinent hydrological or morphological characteristics, and proximity to *in situ* leach processing plants, well fields, evaporation ponds, or other facilities that might be negatively affected by surface erosion or flooding.

(2) Assessment of the potential for erosion or flooding that may require special design features or mitigation measures to be implemented.

(3) A description of site hydrogeology, including: (a) identification of aquifer and aquitard formations that may affect or be affected by the *in situ* leach operations; (b) a description of aquifer properties, including material type, formation thickness, effective porosity, hydraulic conductivity, and hydraulic gradient; (c) estimated conductivities, thickness, and lateral extent of aquitards, and other information relative to the control and prevention of excursions; and (d) data to support conclusions concerning the local

ground-water flow system, based on well borings, core samples, water-level measurements, pumping tests, laboratory tests, soil surveys, and other methods

(4) Assessment of available ground-water resources and ground-water quality within the proposed permit boundaries and adjacent properties, including quantitative description of the chemical and radiological characteristics of the ground water and potential changes in water quality caused by operations

(5) An assessment of typical seasonal ranges and averages and the historical extremes for levels of surface-water bodies and aquifers

(6) Information on past, current, and anticipated future water use, including descriptions of local ground-water well locations, type of use, amounts used, and screened intervals

In conducting these evaluations, the reviewer shall consider the technical evaluations conducted by a state or another federal agency with authorities overlapping those of the NRC. Ground-water compliance and protection reviews are the primary technical areas impacted by overlapping authorities. The desired outcome is to identify any areas where duplicative NRC reviews may be reduced or eliminated. The NRC staff must make the necessary evaluations of compliance with applicable regulations for licensing the facility. However, the reviewer may, as appropriate, rely on the applicant's responses to inquiries made by a state or another federal agency to support the NRC evaluation of compliance. The reviewer should make every effort to coordinate the NRC technical review with the state or other federal agency with overlapping authority to avoid unnecessary duplication of effort.

2.7.2 Review Procedures

At a minimum, the reviewer should evaluate whether the applicant has developed an acceptable conceptual model of the site hydrology and whether the conceptual model is adequately supported by the data presented in the site characterization. To this end, the reviewer should:

(1) Review surface-water data, including maps that identify nearby lakes, rivers, surface drainage areas, or other surface-water bodies; stream flow data; and the applicant assessment of the likely consequences of surface-water contamination from *in situ* leach operations. Verify that the applicant has generally characterized perennial surface-water bodies, such that an assessment of impacts from operations can be made.

(2) Evaluate the applicant's assessment of the potential for erosion or flooding. If surface water or erosion modeling is used by the applicant, verify that acceptable models and input parameters have been used in the flood analyses and that the resulting flood forces have been acceptably accommodated in the design of surface impoundments. Regardless of whether modeling is used, ensure that the evaluation of flooding and erosion potential is consistent with available geomorphological, and topographic data or analysis of paleodischarge information.

(3) Evaluate the site hydrogeologic conceptual model for ground-water flow in potentially affected aquifers. Review available data from well logs and hydrologic tests and measurements to obtain confidence that sufficient data have been collected and that the data support the applicant's hydrologic conceptual model for ground-water flow within and around the permit boundary. The applicant's interpretation of ground-water hydraulic gradients (used to infer flow direction), horizontal conductivity, and the thickness, areal extent, and vertical conductivity of confining formations should be evaluated. Examine pump tests, analyses, and/or other measurement techniques used to determine the hydrologic properties of the local aquifers and aquitards that affect or may be affected by the proposed *in situ* leach activities. Also examine pump tests that are used to investigate vertical confinement or hydraulic isolation between the ore production zone and upper and lower aquifers.

(4) Evaluate the applicant's assessment of water quality of potentially affected ground-water resources. This information will provide the basis for evaluating potential effects of *in situ* leach extraction on the quality of local ground-water resources. Verify that a sufficient number of baseline ground-water samples are collected to provide meaningful statistics, that samples are spaced in time sufficiently to capture temporal variations, and that the chemical constituents and water quality parameters evaluated are sufficient to establish pre-operational water quality, including class of use.

(5) Review the applicant's assessment of seasonal and the historical variability for levels of surface-water bodies and water levels or potentiometric heads in aquifers and ensure that sufficient time intervals have elapsed between measurements to allow assessment of seasonal variability.

(6) Verify that the applicant has provided information on past, current, and anticipated future water use, including descriptions of local ground-water well locations, type of use, amounts used, and screened intervals.

In conducting an evaluation of ground-water activities, the reviewer should follow the reviews conducted by the state. Where appropriate, the evaluation should not duplicate state regulatory efforts. Although NRC must make its own independent findings, reviewers need not duplicate questions if a state or other federal regulatory agency has already addressed the issue. If the applicant response to questions from a state or other federal agency is submitted to NRC so that it becomes part of the license application to NRC, then the reviewer can use the information to prepare the technical evaluation report on ground-water issues.

2.7.3 Acceptance Criteria

The hydrologic characterization should establish a hydrologic conceptual model for the *in situ* leach site and surrounding region. The conceptual model provides a framework for the applicant to make decisions on the optimal methods for extracting uranium from the ore zone, and to minimize environmental and safety concerns caused by *in situ* leach operations. Hydrologic characterizations that accomplish this objective are considered acceptable.

The characterization of the site hydrology is acceptable if it meets the following criteria:

(1) The applicant has characterized surface-water bodies and drainages within the permit boundaries and surrounding areas. Maps provided in the application identify the location, size, shape, hydrologic characteristics, and uses of surface-water bodies near the proposed site, including likely surface drainage areas near the proposed facilities. An acceptable application should also identify the zones of interchange between surface water and ground water.

(2) The applicant has provided an assessment of the potential for flooding and erosion that could affect the *in situ* leach processing facilities or surface impoundments. The staff recognizes that the flooding and erosion protection design of impoundments for *in situ* facilities may be relatively simple. This is true when impoundments are located near or on a drainage divide and little or no diversion of runoff is necessary to protect the impoundment side slopes from erosion. In such cases, it will be easy to demonstrate that no erosion to the slopes will occur. In flood-prone areas, however, it may be necessary to conduct surface water and erosion modeling. Information regarding acceptable models may be found in NUREG–1623 (NRC, 1999). The reviewer should recognize, however, that the staff guidance (NRC, 1999) was prepared for use in evaluating a 1,000-year design life for large tailings impoundments, whereas the design life of the surface impoundments at *in situ* leach facilities is on the order of tens of years.

(3) The applicant has described the local and regional hydraulic gradient and hydrostratigraphy. The applicant has shown that subsurface water level measurements were collected by acceptable methods, such as American Society for Testing and Materials D4750 (American Society for Testing and Materials, 2001). Potentiometric maps are the recommended means for presenting hydraulic gradient data. These maps should include two levels of detail: regional and local. The regional map should represent the ore zone aquifer and should encompass the likely consequences on any affected highly populated areas. The local (site-scale) map should encompass the entire license boundary. If overlying and underlying aquifers exist, local-scale potentiometric or water surface elevation maps of these aquifers should also be included. These maps should clearly show the locations, depths, and screened intervals of the wells used to determine the potentiometric surface elevations. Alternatively, this information can be provided in separate maps and/or tables. The appropriate contour interval will vary from site to site; however, contour intervals should be sufficient to clearly show the ground-water flow direction in the ore zone and in the overlying and underlying aquifers. The number of piezometer elevation measurements used to construct each map should be sufficient to determine the direction of ground-water flow in the ore zone and the overlying aquifer. To construct a regional potentiometric map, a reasonable effort should be made to consider as many existing wells as possible.

Hydrogeologic cross sections are recommended for illustrating the interpreted hydrostratigraphy. These cross sections should be constructed for the area within the license boundary. For very large or irregularly shaped well field areas, more than one cross section may be necessary. Cross sections must be based on borehole data

collected during well installation or exploratory drilling. All significant borehole data should be included in an appendix. Staff should verify that, an adequate number of boreholes is used to support the assertion of hydrogeologic unit continuity, if shown as such in the cross sections.

The applicant should describe all hydraulic parameters used to determine expected operational and restoration performance. Aquifer and aquitard hydraulic properties may be determined using aquifer pump tests for parameters such as hydraulic conductivity, transmissivity, and specific storage. Any of a number of commonly used aquifer pump tests may be used including single-well drawdown and recovery tests, drawdown versus time in a single observation well, and drawdown versus distance pump tests using multiple observation wells. The methods or standards used to analyze pump test data should be described and referenced: acceptable methods of analysis include use of curve fitting techniques for drawdown or recovery curves that are referenced to peer-reviewed journal publications, texts, or American Society for Testing and Materials Standards. It is important for the reviewer to ensure that where fitted curves deviate from measured drawdown, the applicant explains the probable cause of the deviation (e.g., leaky aquitards, delayed yield effects, boundary effects, etc.). For estimates of porosity, it is acceptable to use laboratory analysis of core samples, borehole geophysical methods, and analysis of the barometric efficiency of the aquifer (e.g., Lohman, 1979). The applicant should distinguish between total porosity estimated from borehole geophysical methods and effective porosity that determines transport of chemical constituents.

(4) Reasonably comprehensive chemical and radiochemical analyses of water samples, obtained within the ore body and at locations away from the ore body, have been made to determine pre-operational baseline conditions. Baseline water quality should be determined for the ore zone and surrounding aquifers. These data should include water quality parameters that are expected to increase in concentration as a result of *in situ* leach activities and that are of concern to the water use of the aquifer (i.e., drinking water, etc.). The applicant should show that water samples were collected by acceptable sampling procedures, such as American Society for Testing and Materials D4448 (American Society for Testing and Materials, 1992).

For example, *in situ* leach operations are not expected to mobilize aluminum, and unless an ammonia-based lixiviant is used, ammonia concentrations in the ground water should not be increased as a result of *in situ* leach operations. Therefore, little is gained by sampling these parameters. Studies have shown that thorium-230 is mobilized by bicarbonate-laden leaching solutions. However, studies have also shown that after restoration, thorium in the ground water will not remain in solution, because the chemistry of thorium causes it to precipitate and chemically react with the rock matrix (Hem, 1970). As a result of its low solubility in natural waters, thorium is found in only trace concentrations. Additionally, chemical tests for thorium are expensive, and are not commonly included in water analyses at *in situ* leach facilities.

The applicant should identify the list of constituents to be sampled for baseline concentrations. The list of constituents in Table 2.7.3-1 is accepted by the NRC for

Table 2.7.3-1. Typical Baseline Water Quality Indicators to be Determined During Pre-operational Data Collection		
A. Trace and Minor Elements		
Arsenic	Iron	Selenium
Barium	Lead	Silver
Boron	Manganese	Uranium
Cadmium	Mercury	Vanadium
Chromium	Molybdenum	Zinc
Copper	Nickel	
Fluoride	Radium-226 and 228	
B. Common Constituents		
Alkalinity	Chloride	Sodium
Bicarbonate	Magnesium	Sulfate
Calcium	Nitrate	
Carbonate	Potassium	
C. Physical Indicators		
Specific Conductivity*		Total Dissolved Solids#
pH*		
D. Radiological Parameters		
Gross Alpha†	Gross Beta	

*Field and Laboratory determination.
#Laboratory only.
†Excluding radon, radium, and uranium.

in situ leach facilities. Alternatively, applicants may propose a list of constituents that is tailored to a particular location. In such cases, sufficient technical bases must be provided for the selected constituent list.

At least four sets of samples should be collected and analyzed for each listed constituent for determining baseline water quality conditions. Some samples should be split and sent to different laboratories as part of a quality assurance program. Sets of samples should be taken within a minimum of a week or two of each other unless

natural conditions are such that the water quality of the aquifers changes significantly with time. The applicant should document any variability in the ground-water flow rates or recharge that are observed in the collected data. Additional sampling to establish the natural cyclical fluctuations of the water quality is necessary if natural ground-water flow rates and recharge conditions vary considerably. Where perennial surface-water sources are present, surface-water quality measurements should be taken on a seasonal basis for a minimum of 1 year before implementation of *in situ* leach operations. Surface-water samples can be obtained by grab sampling and should be taken at the same location each time. The average water quality for each aquifer zone and the range of each indicator in the zone have been tabulated and evaluated. If zones of distinct water quality characteristics are identified, they are delineated and referenced on a topographic map. For example, since uranium rollfront deposits are formed at the interface between chemically oxidizing and reducing environments, water quality characteristics may differ significantly across the rollfront.

(5) The applicant has provided an assessment of seasonal and the historical variability for potentiometric heads and hydraulic gradients in aquifers and water levels of surface-water bodies. This assessment should include water levels or water potentials measurements over at least 1 year and collected periodically to represent any seasonal variability.

(6) The applicant has provided information on past, current, and anticipated future water use, including descriptions of local ground-water well locations, type of use, amounts used, and screened intervals. This information must be sufficient to evaluate potential risks to ground-water or surface-water users in the vicinity of the *in situ* leach facility.

For license renewals and amendment applications, most or all of the preceding acceptance criteria may previously have been met. Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.7.4 Evaluation Findings

If the staff's review as described in this section results in the acceptance of the site hydrology, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the hydrologic site characterization information for the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.7.2 and acceptance criteria outlined in standard review plan Section 2.7.3.

The licensee has acceptably described the hydrology by providing (i) estimates of the local and regional hydraulic gradients, using potentiometric surface maps with acceptable contour intervals, including the ore zone aquifer and other overlying or underlying aquifers, and the likely consequences to affected populated areas; (ii) hydrologic cross-sections, based on an appropriate number of boreholes; (iii) acceptable comprehensive chemical and radiochemical

analyses of water samples, from in and near the ore body that define the pre-operational baseline water quality conditions; (iv) all hydraulic parameters used to determine expected operational and restoration performance; and (v) characterization of surface water in the *in situ* leach facility and nearby areas, including presentation of such information on maps. Zones of interchange between surface and ground water have been identified. The applicant has provided acceptable erosion protection against the effects of flooding from nearby streams and for drainage and diversion channels, such that the suggested criteria in NUREG–1623 (NRC, 1999) have been followed and that the design meets the requirements of 10 CFR Part 40, Appendix A.

Based on the information provided in the application, and the detailed review conducted of the characterization of the hydrology at the _____ *in situ* leach facility, the staff concludes that the information is acceptable to allow evaluation of the site and associated conceptual and numerical models and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis.

2.7.5 References

American Society for Testing and Materials. "Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)." Test Method D4750-87. West Conshohcken, Pennsylvania: American Society for Testing and Materials. 2001.

———. "Standard Guide for Sampling Groundwater Monitoring Wells." Guide D4448-85a. West Conshohcken, Pennsylvania: American Society for Testing and Materials. 1992.

Crippen, J.R. and C.D. Bue. "Maximum Floodflows in the Conterminous United States." USGS Water Supply Paper No. 1887. Denver, Colorado: U.S. Geological Survey. 1977.

Hem, J.D. "Study and Interpretation of the Chemical Characteristics of Natural Water." USGS Water Supply Paper 1473. Denver, Colorado: U.S. Geological Survey. 1970.

Lohman, S.W. "Groundwater Hydraulics." USGS Professional Paper 708. Reston, Virginia: U.S. Geological Survey. 1979.

U.S. Army Corps of Engineers. "Flood Hydrograph Package." HEC–1. Washington, DC: U.S. Army Corps of Engineers, Hydrologic Engineering Center. 1997a.

———. "Water Surface Profiles." HEC–2. Davis, California: Hydrologic Engineering Center. 1997b.

———. "Wave Runup and Wind Setup on Reservoir Embankments." ETL 1110-2-221. 1966.

U.S. Bureau of Reclamation. "Comparison of Estimated Maximum Flood Peaks with Historic Floods." Washington, DC: U.S. Department of the Interior. 1986.

NRC. NUREG–1623, "Draft Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiaiton Control Act." Washington, DC: NRC. 1999.

2.8 Ecology

2.8.1 Areas of Review

The staff should review descriptions of the flora and fauna in the vicinity of the site, their habitats, and their distribution. The review should include identification of important species that are (i) threatened or endangered, (ii) commercially or recreationally valuable, (iii) affecting the well-being of some important species within Criterion (i) or (ii), or (iv) critical to the structure and function of the ecological system or a biological indicator of radionuclides or chemical pollutants in the environment.

The review should include the inventory of the majority of the terrestrial and aquatic organisms on or near the site and their relative (qualitative) abundance, the quantitative abundance of the important species, and species that migrate through the area or use it for breeding grounds. The staff should review discussions of the relative importance of the proposed site environs to the total regional area for the living resources (potential or exploited).

For commercial-scale operations and for research and development operations involving drying of yellowcake, the staff should examine data on the count and distribution of important domestic fauna, in particular cattle, sheep, and other meat animals that may be involved in the exposure of man to radionuclides. Important game animals should receive similar treatment. A map showing the distribution of the principal plant communities should be reviewed.

The staff should also review the discussion of species-environment relationships, including descriptions of area usage (e.g., habitat, breeding) for important species, life histories of important regional animals and aquatic organisms, normal seasonal population fluctuations and habitat requirements, and identification of food chains and other interspecies relationships, particularly when these contribute to prediction or evaluation of the impact of the facility on the regional biota. The staff should examine any information presented on definable pre-existing environmental stresses from sources such as pollutants, as well as pertinent ecological conditions suggestive of such stresses and the status of ecological succession. As appropriate, the staff should review a list of pertinent published material dealing with the ecology of the region and ecological or biological studies of the site or its environs currently in progress or planned.

2.8.2 Review Procedures

The reviewer should consult with the U.S. Fish and Wildlife Service using procedures in 50 CFR Part 402, "Interagency Cooperation—Endangered Species Act of 1973," as amended. The staff should review the descriptions and inventories of the flora and fauna in the vicinity of the site, including habitats and distribution. The review should include terrestrial and aquatic organisms on or near the site, and their relative (qualitative) abundance should be established.

Particular attention should be given to species based on their relative importance to the community. The reviewer should determine that all important species have been identified. Important species include those (i) threatened or endangered, (ii) commercially or recreationally valuable, (iii) any species that affects the well-being of another important species within Criterion (i) or (ii), and (iv) organism(s) that are critical to the structure and function of the ecological system or are biological indicators of radionuclides or chemical pollutants in the environment. Important species should be a part of the larger inventory of species. If important species are determined to be present, the staff should evaluate any likely detrimental effects on the organism by the proposed facility.

The reviewer should determine that information on the various species is presented in two separate subsections: terrestrial ecology and aquatic ecology. The reviewer should also determine that the discussion of the species-environment relationships includes descriptions of area usage (e.g., habitat, breeding) for important species and discussions of life histories of important regional animals and aquatic organisms, including normal seasonal population fluctuations and their habitat requirements. Food chains and other interspecies relationships should be examined, particularly when these may bear on predictions or evaluations of the impact of the proposed facility on the stability of regional biota. The reviewer should also examine documentation provided for any pre-existing environmental stresses from sources such as pollutants, as well as pertinent ecological indicators suggestive of such stresses. A discussion of the status of ecological succession should be evaluated.

For any operation involving the drying of yellowcake, disposal of waste, or generation of hazardous effluents, the staff should review data on the number and distribution of locally significant domestic flora and fauna, in particular cattle, sheep, commercial fish, and other meat animals, and commercial crops that may be part of the food chain delivering radiation exposure to man. Important game animals should be treated similarly. A map showing the distribution and estimates of numbers of commercially significant species should be examined. Specific review guidance is provided in NUREG–1748 (NRC, 2001).

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.8.3 Acceptance Criteria

The characterization of the site ecology is acceptable if it meets the following criteria:

(1) Inventories of terrestrial and aquatic species are compiled by the applicant based on reports or databases of state or federal agencies (e.g, U.S. Fish and Wildlife Service, EPA).

Historical sitings of important species, as defined in the Standard Format and Content of License Applications, Including Environmental Reports (NRC, 1982) should be included in the inventory. If such reports do not exist, inventories should be prepared by the applicant based on a radius within which impacts are reasonably expected to occur. Documentation should be provided that inventories were prepared in consultation with

appropriate local, state, and federal agencies to confirm the presence or absence of important species (especially threatened or endangered species). Inventories may be based on historical data, but should be updated to within 2 years of the time of application to establish current baselines.

(2) Inventories of locally significant domestic flora and fauna, in particular cattle, sheep, commercial fish, and other meat-producing animals and commercial crops are based on recent production figures from local, state, and federal agencies (e.g., U.S. Department of Agriculture).

The statistics should cover at least 3 years and have been conducted within 2 years of the date of the application to establish reasonable baselines. Important game animals should be treated similarly. A map showing the distribution and estimates of numbers of commercially significant species should be provided and may be combined with land use maps discussed in Section 2.2 of the standard review plan.

(3) The applicant has identified any endangered species as listed in 50 CFR Part 17, "Endangered and Threatened Wildlife and Plants."

Any discussion should include nonpermanent inhabitants migrating through the area or using it for breeding grounds. The preservation of habitat, particularly for important species, should be a prime consideration. A map of the principal floral and faunal communities has been provided. Additional information can be found in 50 CFR Parts 401–453.

(4) The application provides a thorough description of the species-environment relationships for each important species identified within a radius where impacts are reasonably expected to occur. If no important species are identified within this radius, the application should plainly state so, and no additional review is necessary.

The application should take these relationships into account in providing a discussion of any likely detrimental effects that operation of the site may have on the species through changes in habitat, pollution, and aspects of the operations that may place stress on the species-environment relationship. Finally, the application should provide information regarding steps that will be taken to minimize the effect of operating the facility on the species-environment relationship.

(5) All sources of ecological information are documented in open file reports or other published documents. If data have been generated by the applicant, the documentation should provide a description of the investigations and data reduction techniques.

A list of pertinent published material dealing with the ecology of the region should be included. Any ecological or biological study of the site or its environs either in progress or planned should be described and referenced.

2.8.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the description of the site ecology, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the site characterization information concerned with ecology at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.8.2 and acceptance criteria outlined in standard review plan Section 2.8.3.

The licensee has described the ecology by providing acceptable (i) inventories of terrestrial and aquatic species, including threatened or endangered species listed in 50 CFR Part 17 (ii) inventories of locally significant domestic flora and fauna (e.g., cattle, sheep, goats), (iii) discussions of important species found within a radius where impacts are reasonably expected to occur and estimations of their current and historical abundance, and (iv) thorough descriptions of the species-environment relationships for any important species.

Based on the information provided in the application and the detailed review conducted of the characterization of the ecology at the _____*in situ* leach facility, the staff concludes that the information is acceptable to allow evaluation of the site ecology and associated conceptual and numerical models and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis.

2.8.5 References

NRC. NUREG–1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs." Washington, DC: NRC. 2001.

———. Regulatory Guide 3.46, "Standard Format and Content of License Applications, Including Environmental Reports, for *In Situ* Uranium Solution Mining." Washington, DC: NRC, Office of Standards Development. 1982.

2.9 Background Radiological Characteristics

2.9.1 Areas of Review

The reviewer should examine site-specific radiological data provided in the application including the results of measurements of radioactive materials occurring in important species, soil, air, and in surface and ground waters that could be affected by the proposed operations. The reviewer should examine the design of the pre-operational monitoring program, including which radionuclides are analyzed, sampling locations, sample type, sampling frequency, location and density of monitoring stations, and the detection limits.

2.9.2 Review Procedures

The reviewer should examine data from the pre-operational monitoring program with particular attention paid to the design of the monitoring program, the radionuclides monitored, the results, and the detection limits reported for each radionuclide in each sample medium. The reviewer should compare and contrast the pre-operational monitoring program as implemented against the guidance provided in Regulatory Guide 4.14, Revision 1, "Radiological Effluent and Environmental Monitoring at Uranium Mills" (NRC, 1980) and NUREG–5849 (draft), "Manual for Conducting Radiological Surveys in Support of License Termination" (Berger, 1992) or NUREG–1575, Revision 1, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.9.3 Acceptance Criteria

The characterization of the site background radiological characteristics is acceptable if it meets the following criteria:

(1) Monitoring programs to establish background radiological characteristics, including sampling frequency, sampling methods, and sampling location and density are established in accordance with pre-operational monitoring guidance provided in Regulatory Guide 4.14, Revision 1, Section 1.1 (NRC, 1980). Air monitoring stations are located in a manner consistent with the principal wind directions reviewed in Section 2.5 of the standard review plan.

(2) Soil sampling is conducted at both a 5-cm [2-inch] depth as described in Regulatory Guide 4.14, Section 1.1.4 (NRC, 1980) and 15 cm [6 in] for background decommissioning data.

(3) Baseline water quality is determined for the common constituents as well as minor constituents for which concentrations are likely to change as a result of chemical reactions initiated during *in situ* solution removal of uranium (see acceptance Criterion 3 in Section 2.7.3 of this standard review plan for baseline water quality data collection).

Because of the difficulty of predicting effects of mobilization, reprecipitation, and adsorption, comprehensive chemical and radiochemical analyses of water samples obtained within and away from the ore body should be made. Table 2.9.3-1 shows an acceptable format for the water quality data submitted to NRC for uranium recovery facilities.

Table 2.9.3-1. Standard Format for Water Quality Data Submittal to the NRC for Uranium Recovery Facilities

1. Water quality sampling techniques and analysis should be in accordance with U.S. Environmental Protection Agency (EPA) (1974)
2. All water quality data submitted to NRC should
   a. Be submitted in tabular form with the appropriate standards (i.e., EPA national interim primary drinking water regulations, livestock standards, baseline or excursion levels, or 10 CFR Part 20, Maximum Permissible Concentrations)[1] listed in the same table, for ease of data comparison. Methods of sampling and preserving and the laboratory utilized should be indicated in the table. The sampled depths, formation(s) sampled, water-level elevations and data measured, and distances from the tailings pond [2] or well field for each monitor should be noted in the table.
   b. Be submitted graphically to illustrate water quality and water-level elevation changes with time with applicable governing standards, EPA national interim primary drinking water standards and livestock standards, baseline or excursion levels, or maximum permissible concentrations[1] (whatever is appropriate), for the particular constituent on the graph.
   c. Include a short summary of the data interpretation, noting any anomalies, with an explanation.
   d. Water quality data reports should include a map that shows all water quality sampling points.

EPA. "Manual for Chemical Analysis of Water and Wastes". EPA–625–/6–74–003a. Cincinnati, Ohio: EPA, Office of Research and Development Publications. 1974.
[1]10 CFR Part 20 liquid effluent control limits are specified in Table 2 of Appendix B and are not termed Maximum Permissible Concentrations. This table is a direct extraction from the EPA reference.
[2]Tailings ponds do not exist at *in situ* leach facilities. This table is a direct extraction from the EPA reference.

2.9.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the description of the site background radiological characteristics, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the characterization information concerned with the background radiological characteristics at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.9.2 and acceptance criteria outlined in standard review plan Section 2.9.3.

The licensee has acceptably established the background radiological characteristics by providing (i) monitoring programs to determine background radiologic characteristics that include radionuclides monitored, sampling frequency, and methods, location, and density; (ii) air quality stations located consistent with the prevailing wind directions; (iii) time periods for reoperational monitoring that allow for 12 consecutive months of sampling; and (iv) radiologic analyses of soil samples at 5-cm [2-in.] and 15-cm [6-in.] depths.

Site Characterization

Based on the information provided in the application, and the detailed review conducted of the characterization of the background radiological characteristics at the _____ *in situ* leach facility, the staff concludes that the information is acceptable to allow evaluation of the radiological background of the site and associated conceptual and numerical models and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis.

2.9.5 References

Berger, J.D. NUREG/CR–5849, "Manual for Conducting Radiological Surveys in Support of License Termination." Washington, DC: NRC. 1992

NRC. Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills." Revision 1. Washington, DC: NRC, Office of Standards Development. 1980.

———. "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)." Revision 1. Washington, DC: NRC. 2000

EPA. "Manual for Chemical Analysis of Water and Wastes." EPA–625–/6–74–003a. Cincinnati, Ohio: EPA, Office of Research and Development Publications. 1974.

2.10 Background Non-Radiological Characteristics

2.10.1 Areas of Review

The staff should review information in the application on site-specific nonradiological characteristics, particularly those that are related to expected site-related effluents. Data to be examined should include such indicators as heavy metals and other toxic substances in surface and ground waters, atmospheric pollutants, and dusts, that could affect water or air quality. Other regional sources of these same materials should be examined, along with any discussion of the consequences of any likely incremental contribution to the existing levels found.

2.10.2 Review Procedures

The reviewer should examine data from the pre-operational monitoring program with particular attention paid to the design of the monitoring program, constituents analyzed, and the results and the detection limits reported for each constituent in each sample medium. Maps should be examined to determine sampling locations and identify relationships to the proposed facility and the surrounding areas. Other local and regional sources of the same materials should be identified.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.10.3 Acceptance Criteria

The characterization of the site background nonradiological characteristics is acceptable if it meets the following criteria:

(1) A listing of expected site-related effluents is provided. This listing should be used to identify those constituents for which pre-operational baseline values should be established.

(2) Air quality effects are evaluated in accordance with acceptance Criterion 4 of Section 2.5.3 of this standard review plan.

Special attention should be paid to those constituents that may be produced during operation of the proposed facility. These data can be gathered as part of the meteorological information reviewed in Section 2.5 of the standard review plan.

(3) When activities such as land applications are involved, background concentrations for soil constituents are established.

Sampling locations should be clearly shown, and samples should be collected near areas that may be disturbed during construction and operation of the facility. Soil and sediment sampling should also be conducted near and in drainage areas and surface-water bodies that might be affected in the event of spills. Soil and sediment sampling locations may be the same for both radiological and non-radiological sampling.

(4) Ground-water and surface-water background conditions are established in accordance with specific acceptance criteria identified in Section 2.7.3 of this standard review plan.

(5) Data are gathered from either a pre-operational surveillance program or from previous reports from other sources such as local, state, and federal agencies or universities. In all cases, data sources are documented and substantiated.

2.10.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the description of the site background nonradiological characteristics, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the information concerned with the background nonradiological characteristics at the _____*in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.10.2 and acceptance criteria outlined in standard review plan Section 2.10.3.

The licensee has acceptably established the background nonradiological characteristics by documenting (i) site-related effluents (e.g., heavy metals, and other toxic substances), (ii) baseline atmospheric constituent levels, (iii) background soil constituent concentrations,

(iv) ground- and surface-water background constituents, and (v) pre-operational data or information from other sources.

Based on the information provided in the application, and the detailed review conducted of the characterization of the background nonradiological characteristics at the _____ *in situ* leach facility, the staff concludes that the information is acceptable to allow evaluation of the nonradiologic background of the site and associated conceptual and numerical models and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis.

2.10.5 References

None.

2.11 Other Environmental Features

2.11.1 Areas of Review

This review should include environmental site characterization information that does not clearly fall into any of the other subsections in Section 2 of the standard review plan. These will typically be site-specific, and may be used by the applicant to mitigate unfavorable conditions, or to provide additional information in support of the description of the proposed facility. Information that the applicant believes is important to establish the value of the site and site environs to important segments of the population is appropriately included in this subsection.

2.11.2 Review Procedures

The staff should consider environmental information provided in this section as auxiliary information to support an application for a given facility. The information should be considered in a site-specific context and should be consistent with the information provided in other sections of the application. Depending on the site-specific situation, there may be no information in this section of the application.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

2.11.3 Acceptance Criteria

The characterization of other site environmental features is acceptable if it meets the following criteria:

(1) It is consistent with information provided in previous subsections.

(2) Information is provided in a manner consistent with good scientific practice, is supported by objective data to the extent possible, and is relevant to the site under consideration.

(3) Information supports a determination that the *in situ* leach facility can be operated in a manner that will protect public health and safety and the environment.

2.11.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the description of other environmental features at the site, the following conclusions may be presented in the technical evaluation report and in the environmental assessment.

NRC has completed its review of the characterization information concerned with other environmental features at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 2.11.2 and acceptance criteria outlined in standard review plan Section 2.11.3.

The licensee has acceptably described any other important environmental features by providing information that is (i) consistent with other aspects of the site description, (ii) supported by objective data, (iii) relevant to the site under consideration, and (iv) supportive of a determination that the *in situ* leach facility can be operated while protecting public health and safety.

Based on the information provided in the application, and the detailed review conducted of the characterization of the other environmental features at the _____ *in situ* leach facility, the staff concludes that the information is acceptable to allow evaluation of the other environmental features and associated conceptual and numerical models and is in compliance with 10 CFR 51.45, which requires a description of the affected environment containing sufficient data to aid the Commission in its conduct of an independent analysis; and 10 CFR Part 40, Appendix A, Criterion 6(7), which provides requirements for control of non-radiological hazards.

2.11.5 References

None.

3.0 DESCRIPTION OF PROPOSED FACILITY

3.1 *In Situ* Leaching Process and Equipment

3.1.1 Areas of Review

The staff should review the *in situ* leaching process as described in the application. This review should include, but not be limited to:

(1) A description of the ore bodies and the feasibility of processing the defined well field areas

(2) Well construction techniques and integrity testing procedures to ensure well installations will not result in hydraulic communication between production zones and adjacent aquifers

(3) A process description including injection/production rates and pressures; plant material balances and flow rates; lixiviant makeup; recovery efficiency; and gaseous, liquid, and solid wastes and effluents that will be generated

(4) Proposed operating plans and schedules that include timetables and sequences for well field operation, surface reclamation, and ground-water restoration

(5) Review of process to ensure that a proliferation of small waste disposal sites is avoided.

The review should also include maps showing the facilities layout, descriptions of the process and/or circuit, water and material balances, and the chemical recycling system.

3.1.2 Review Procedures

The staff should determine whether the description of the *in situ* leaching process provided in the application is sufficient to permit evaluation of the operations and processes involved in conformance with the acceptance criteria contained in Section 3.1.3. Staff should ensure the following are included in this section: a map or maps showing the proposed sequence and schedules for uranium extraction and ground-water quality restoration operations, a flow diagram of the process or circuit, a material balance diagram, a description of any chemical recycle systems, a water balance diagram for the entire system, and a map or maps showing the proposed sequence and schedules for land reclamation of the well field areas.

If wells are not properly completed, lixiviant can flow through casing breaks and into overlying aquifers. Casing breaks can occur if the well is damaged during well construction activities. Casing breaks can also occur if water injection pressures exceed the strength of the well materials. Well completion techniques should be reviewed in sufficient detail to give the reviewer a clear understanding of how recovery, injection, and monitor wells are drilled; how their location and spacing are selected; and what materials and methods are used in construction, casing installation, and abandonment. The reviewer should pay particular attention to the techniques employed to prevent hydraulic communication between overlying or underlying aquifers through well boreholes and ensure that secondary ground-water protection

standards are not violated (10 CFR Part 40, Appendix A, Criteria 5B, 5C, and 13). Additionally, the applicant should describe methods for well abandonment. The reviewer should ensure that the well casing material used is appropriate for the depths to which the wells are drilled. The reviewer should examine a description of the procedures used to test well integrity. The wells should be retested with sufficient frequency to ensure the integrity of the well construction. The reviewer should examine in detail the justification provided by the licensee for the recommended time interval between successive weld integrity tests. The reviewer may refer to a well handbook (e.g., Driscoll, 1989) to verify the appropriateness and expected performance of well installation, testing, and abandonment methods.

To ensure that hydraulic communication between overlying or underlying aquifers through well boreholes is promptly detectable, the reviewer should pay particular attention to the design and installation of vertical and horizontal excursion monitoring wells. Additional review procedures for excursion monitoring systems are provided in Section 5.7.8.2 of this standard review plan.

The reviewer should also pay particular attention to the methods used for effective detection of leaks in surface and near-surface pipes carrying the lixiviant solutions to individual wells within a well field or between the well fields and the processing facilities. Spills of pregnant lixiviant in particular can constitute a significant hazard to health and the environment if allowed to pond and dry on the ground surface, to run off into surface-water bodies, or to infiltrate and transport to ground water.

The reviewer should determine that any lined impoundment to contain wastes is acceptably designed, constructed, and installed. Materials used to construct the liner should be reviewed to determine that they have acceptable chemical properties and sufficient strength for the design application. The reviewer should determine that the liner will not be overtopped. The reviewer should determine that a proper quality control program is in place. The review should be based on the concept that the site will be in compliance with 10 CFR Part 40, Appendix A, Criterion 2, which precludes long-term disposal of byproduct material onsite and ensures that the proliferation of small waste disposal sites is avoided. The reviewer shall examine the terms of the approved waste disposal agreement.

For surface impoundments containing 11e.(2) byproduct material, the reviewer should ensure that the applicable requirements of 10 CFR Part 40, Appendix A, Criterion 5(A) have been met. If the waste water retention impoundments are located below grade, the reviewer should determine that the surface impoundments have an acceptable liner and leak detection system in place to ensure protection of ground water. The location of a surface impoundment below grade will eliminate the likelihood of embankment failure that could result in any release of waste water. Should the applicant propose to construct a surface impoundment to handle waste water, the reviewer should determine that the design of associated dikes is such that they will not experience massive failure. The design of such dikes to resist erosion and protect against possible flooding events is evaluated in Section 2.7 of this standard review plan. In this section, the reviewer should evaluate the stability of any dikes with respect to seismic events.

In addition, the reviewer should evaluate any proposed surface impoundment to determine if it meets the definition of a dam as given in Regulatory Guide 3.11 (NRC, 1977). If this is the case, the surface impoundment should be included in the NRC Dam Safety Program, and be

subject to Section 215, National Dam Safety Program of the Water Resources Development Act of 1996. If the reviewer finds that the impoundment meets the definition of a dam, an evaluation of the dam ranking (low or high hazard) should be made. If the dam is considered a high hazard, an Emergency Action Plan is needed consistent with Federal Emergency Management Agency requirements. For low-hazard dams, no Emergency Action Plan is required. For either ranking of dam, the reviewer should also determine that the licensee has an acceptable inspection program in place to ensure routine checks, and that performance is properly maintained (see Section 5.3 of this standard review plan).

In conducting these evaluations, the reviewer shall consider the technical evaluations conducted by a state or another federal agency with authorities overlapping those of the NRC. Ground-water compliance and protection reviews are the primary technical areas impacted by overlapping authorities. The desired outcome is to identify any areas where duplicative NRC reviews may be reduced or eliminated. The NRC staff must make the necessary evaluations of compliance with applicable regulations for licensing the facility. However, the reviewer may, as appropriate, rely on the applicant's responses to inquiries made by a state or another federal agency to support the NRC evaluation of compliance. The reviewer should make every effort to coordinate the NRC technical review with the state or other federal agency with overlapping authority to avoid unnecessary duplication of effort.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining historical aspects of facility operations and the approach that should be used in evaluating amendments and renewal applications.

3.1.3 Acceptance Criteria

The *in situ* leaching process and equipment are acceptable if they meet the following criteria:

(1) The description of the ore body is sufficiently detailed to identify the mineralized zone, its areal distribution, and its approximate thickness.

If more than one ore zone is to be leached, each ore zone should be defined separately. The estimated ore grade should be specified.

(2) Well design, testing, and inspection reflect accepted NRC practice for *in situ* leach operations.

(a) Well Design and Construction—Injection and recovery wells should be constructed from materials that are inert to lixiviants and are strong enough to withstand injection pressures. Polyvinyl Chloride, fiberglass, or acrylonitrile butadiene styrene plastic casings are generally used in wells less than 152-m [500-ft] deep. Wells deeper than 152-m [500-ft], or those subjected to high-pressure cementing techniques, are subject to collapse. However, Polyvinyl Chloride can be used for wells greater than 152 m [500 ft], if the applicant demonstrates that the Polyvinyl Chloride well can be completed and perform in an acceptable manner at those depths. In these instances, steel or

fiberglass casing is generally necessary. In all wells (including monitor wells), the annular space between the side of the borehole and the casing should be backfilled with a sealant from the bottom of the casing to the surface in one continuous operation. Proper backfilling isolates the screened formation against vertical migration of water from the surface or from other formations, and also provides support for the casing. Cement or cement-bentonite grout is generally acceptable as a sealant.

Procedures in American Society for Testing and Materials D 5092 provide acceptable methods for design and construction of monitoring wells (American Society for Testing and Materials, 1995). Material normally used for monitor well casing is either metal or plastic. The possibility that chemical reactions may take place between the casing and the mineral constituents in the water affects the choice of casing material used for monitor wells. For example, iron oxide in steel-cased wells will adsorb trace and heavy metals dissolved in the ground water. Therefore, a baseline water sampling program should be used to determine concentrations of trace metals. The applicant should use casing that is inert to these metals, such as Polyvinyl Chloride or fiberglass. When any well is completed, it should be developed until production of essentially sediment-free water is assured for the life of the well. One acceptable development method is to use a swab in the well to create a vacuum on the upstroke and positive pressure on the downstroke. Air lifting is also an acceptable method for well development.

(b) Well Integrity Testing—Injection and recovery wells should be tested for mechanical integrity. The following well integrity testing procedures are acceptable. To inspect for casing leaks after a well has been completed and opened to the aquifer, a packer is set above the well screen, and each well casing is filled with water. At the surface, the well is pressurized with either air or water to 25 percent above the expected operating pressure. A well is satisfactory if a pressure drop of less than 10 percent occurs over 1 hour. A procedure that uses a 5 percent pressure drop in 30 minutes is also acceptable. Operating pressure varies with the depth of the well and should be less than formation fracture pressure. Well integrity tests should be performed on each injection and production well before the wells are utilized and on wells that have been serviced with equipment or procedures that could damage the well casing. Additionally, each well should be retested with sufficient frequency (once each 5 years or less) to ensure the integrity of the well construction if it is in use. Sole reliance on single-point resistance geophysical tools are not acceptable for determining the mechanical integrity at a well.

(3) The number, location, and screened intervals of excursion monitoring wells are described in sufficient detail, follow industry standard practice, and are adequate to ensure prompt detection of horizontal and vertical excursions, taking into account site specific parameters such as local geology and hydrology. Acceptance criteria for methods and calculations used to determine the placement of horizontal and vertical excursion monitoring wells are presented in Section 5.7.8.3 of this standard review plan.

(4) Methods for timely detection and cleanup of leaks from surface and near-surface pipes within the well fields and between the well field and processing facilities are clearly described and included in the design.

(5) The description of the *in situ* leaching process includes the following information and demonstrations:

(a) Projected down-hole injection pressures with the hydrostatic pressure of the fluid column should be demonstrated to be maintained below casing (casing and cement) failure pressures and formation fracture pressures, to avoid hydrofracturing the aquifer and promoting leakage into the overlying units. Piping burst strength should be considered in deep well fields {greater than about 305 m [1,000 ft]}.

(b) Overall production rates should be higher than injection rates.

(c) Proposed plant material balances and flow rates should be acceptably described.

(d) Lixiviant makeup should be such that impact on the ground-water quality and the prospects for long-term ground-water restoration will be maintained at levels that ensure acceptable restoration goals can be achieved in a timely manner. Oxidants such as gaseous oxygen and hydrogen peroxide, and carbonates such as sodium bicarbonate or carbon dioxide gas have been demonstrated in a number of *in situ* leach facilities to be suitable lixiviants.

(e) The description should include an estimate of gaseous, liquid, and solid wastes and effluents that will be generated. Effluent monitoring and control measures are discussed in Section 4.0 of this standard review plan.

(f) An analysis of the impact that *in situ* leach operations are likely to have on surrounding water users has been provided. An acceptable impact analysis should be based on results of numerical or analytical modeling calculations that are used to estimate ground-water travel times from the proposed extraction areas to the nearby points of ground-water or surface-water usage, estimate the amount of process bleed necessary to prevent migration of lixiviant from the well field, and demonstrate the ability to recover lixiviant excursions. If the applicant chooses to use nominal parameter estimates, parameter uncertainties should be considered to ensure that the selected values represent expected conditions. An acceptable impact analysis should demonstrate the following:

(i) The ability to control the migration of lixiviant from the ore zones to the surrounding environs

(ii) Ground-water and surface-water pathways that might transport extraction solutions offsite in the event of an uncontrolled excursion or incomplete restoration

(iii) The impact of *in situ* leach operations on ground-water flow patterns and aquifer levels

(iv) The expected post-extraction impact on geochemical properties and water quality

(6) Proposed operating plans and schedules include timetables for well field operation, surface reclamation, and ground-water restoration. Water balance calculations should be provided that demonstrate that the liquid waste disposal facilities (surface impoundments, land application, deep well injection) are adequate to process the proposed production and restoration efforts at any time.

(7) The staff should verify the applicant analyses or perform independent review analyses of floods and flood velocities. If the design assumptions and calculations are reasonable, accurate, and compare favorably with independent staff estimates, the designs are acceptable.

(8) The staff should evaluate the design of diversion channels in several critical areas using the criteria and guidance presented in NUREG–1623 (NRC, 1998). For the main channel area, the staff should verify that appropriate models and input parameters have been used to design the erosion protection. The staff should assure that flow rates, flow depths, and shear stresses have been correctly computed. The diversion channels should be sized and protected to pass a probable maximum flood with minimal, if any, damage to the diversion channel. No release of contained materials should occur during a probable maximum flood. The staff should determine that the depth of burial of any disposed of material is sufficient to preclude bottom scouring, if an existing or constructed channel is located in or near a pit or impoundment. Where practical, the use of diversion channels at new facilities should be avoided to lessen costs of reclamation and future maintenance.

(9) The staff should review the plans, specifications, inspection programs, and quality assurance/quality control programs to assure that acceptable measures are being taken to construct the facility according to accepted engineering practices. The staff will compare the information provided with typical programs used in the construction industry.

(10) Results from research and development or other production operations are used to support the description of the *in situ* leaching process, where appropriate.

(11) The applicant has an approved waste disposal agreement for 11e.(2) byproduct material disposal at an NRC or NRC Agreement State licensed disposal facility. This agreement is maintained onsite. The applicant has committed to notify NRC in writing within 7 days if this agreement expires or is terminated and to submit a new agreement for NRC approval within 90 days of the expiration or termination (failure to comply with this license condition will result in a prohibition from further lixivient injection).

3.1.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the *in situ* leaching process and equipment, the following conclusions may be presented in the technical evaluation report.

NRC has completed its review of the *in situ* leaching process and equipment proposed for use at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 3.1.2 and the acceptance criteria in standard review plan Section 3.1.3.

The applicant has acceptably described the ore body(ies), demonstrated protection against vertical migration of water, proposed tests for well integrity that assure facility stability, and demonstrated that the *in situ* leaching process will meet the following criteria: (i) down hole injection pressures are less than formation fracture pressures; (ii) overall production rates are higher than injection rates; (iii) plant material balances and flow rates are appropriate; (iv) lixiviant makeup is such that restoration goals can be achieved in a timely manner; (v) recovery efficiency is assessed through mass balance calculations; and (vi) reasonable estimates of gaseous, liquid, and solid wastes and effluents are provided (used in evaluation of effluent monitoring and control measures in standard review plan Section 4.0). The applicant has used the results from research and development or other production operations to support the evaluation of the *in situ* leaching process. The applicant has provided acceptable operating plans, schedules, and timetables for well field operation, surface reclamation, and ground-water restoration.

Based on the information provided in the application and the detailed review conducted of the *in situ* leaching process and equipment for the _____ *in situ* leach facility, the staff concludes that the proposed *in situ* leaching process and equipment are acceptable and are in compliance with 10 CFR 40.32(c), which requires the applicant's proposed equipment, facilities, and procedures to be adequate to protect health and minimize danger to life or property; 10 CFR 40.32(d), which requires that the issuance of the license will not be inimical to the common defense and security or to the health and safety of the public; 10 CFR 40.41(c), which requires the applicant to confine source or byproduct material to the location and purposes authorized in the license; and 10 CFR Part 40, Appendix A, Criteria 2 for non-proliferation of small disposal sites; 5(A) for ground-water protection; 5B for secondary ground-water protection; 5C for maximum values for ground-water protection; and 13 for hazardous constituents. The related reviews of the 10 CFR Part 20 radiological aspects of the *in situ* leaching process and equipment in accordance with standard review plan Sections 4.0, "Effluent Control Systems;" 5.0, "Operations;" and 7.0, "Environmental Effects;" are addressed elsewhere in this technical evaluation report.

3.1.5 References

American Society for Testing and Materials. "Standard Practice for Design and Installaiton of Ground Water Monitoring Wells in Aquifers." Designation D5092-90. Philadelphia, Pennsylvania: American Society for Testing and Materials. 1995.

Driscoll, F.G. "Groundwater and Wells." St. Paul, Minnesota: Johnson Filtration Systems, Inc. 1989.

NRC. "Recommendation on Ways to Improve the Efficiency of NRC Regulation at *In Situ* Leach Uranium Recovery Facilities." SECY–99–0013. Washington, DC: NRC. 2000.

———. NUREG–1623, "Design of Erosion Protection for Long-Term Stabilization." Washington, DC: NRC. 1998.

———. Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills." Washington, DC: NRC, Office of Standards Development. 1977.

3.2 Recovery Plant, Satellite Processing Facilities, Well Fields, and Chemical Storage Facilities—Equipment Used and Materials Processed

3.2.1 Areas of Review

The staff should review the physical descriptions and reported operating characteristics for the major equipment items of the processing cycle. The staff should also review descriptions of the proposed process information and control systems relevant to safety, as well as radiation sampling and monitoring equipment. The staff should review a diagram that indicates the plant layout and locations where dusts, fumes, or gases would be generated; locations of all ventilation, filtration, confinement, and dust collection systems; and radiation safety and radiation monitoring devices.

In addition, staff should review the list and specifications related to all radioactive and hazardous materials used in the recovery plant, satellite processing facilities, well fields, and chemical storage facilities. These should be reviewed for the hazards associated with the quantities, locations, operating flow rates, temperatures, and pressures associated with these materials.

While safety concerns with the use of all hazardous materials are important and need to be addressed, direct NRC regulatory authority is limited to situations where hazardous materials have a potential affect on radiological safety. Chemicals of concern typically used in the uranium *in situ* leach facilities are identified in NUREG/CR–6733 (NRC, 2001). Therefore, staff should review the list of applicable federal, state, and local regulations that the licensee intends to use, to ensure that all hazardous chemicals that have the potential to impact radiological safety, are safely handled. Staff should also review the safety features used in the facility process design for eliminating or mitigating the hazards presented by these materials.

3.2.2 Review Procedures

The staff should determine whether the physical descriptions and reported operating characteristics for the major equipment items of the processing cycle, the proposed control

systems, and safety/radiation instrumentation are sufficient to evaluate the performance of the proposed uranium *in situ* leach facility. Staff should ensure that the application identifies all areas where releases of radioactive and hazardous materials (such as radon gas and uranium dust) can occur and that locations of control equipment (e.g., ventilation and exhaust systems) and instrumentation are provided.

Staff should determine whether the hazards associated with the storage and processing of the radioactive materials and those hazardous materials with the potential to impact radiological safety, have been sufficiently addressed in the process design for the recovery plant, satellite processing facilities, well fields, and chemical storage facilities.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

3.2.3 Acceptance Criteria

The description of the equipment used and materials processed in the recovery plant, satellite processing facilities, well fields, and chemical storage facilities is acceptable if it meets the following criteria:

(1) The application provides diagrams showing the proposed (or existing) plant/facilities layout in adequate detail.

(2) Areas where dusts, fumes, or gases would be generated are clearly identified, along with a description of the source of the emissions.

(3) All ventilation, filtration, confinement, dust collection, and radiation monitoring equipment are described as to size, type, and location.

(4) Availability requirements for safety equipment are adequately stated, and design features for ensuring availability are clearly identified.

(5) Specifications, quantities, locations, and operating conditions such as flow rates, temperatures, and pressures of radioactive materials and those hazardous materials with the potential to impact radiological safety, are clearly identified together with the hazards associated with these materials.

(6) A list of applicable federal, state and local regulations that the licensee intends to use to ensure that process chemicals having the potential to impact radiological safety are safely handled, is provided.

(7) Safety features used for eliminating or mitigating the hazards presented by the radioactive materials and those hazardous materials with the potential to impact radiological safety, are adequately described.

Further discussion on Criteria 4–7 may be found in NUREG/CR–6733 (NRC, 2001).

3.2.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the equipment used and materials processed in the *in situ* leach facility, the following conclusions may be presented in the technical evaluation report.

NRC has completed its review of the equipment proposed for use and materials to be processed in the recovery plant, satellite processing facilities, well fields, and chemical storage facilities at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 3.2.2 and the acceptance criteria outlined in standard review plan Section 3.2.3.

Based on the information provided in the application and the detailed review conducted of the equipment to be used and materials to be processed in the recovery plant, satellite processing facilities, well fields and chemical storage facilities for the _____ *in situ* leach facility, the staff concludes that the proposed equipment to be used and materials to be processed in the recovery plant, satellite processing facilities, well fields, and chemical storage facilities are acceptable and are in compliance with 10 CFR 40.32(c), which requires that applicant proposed equipment, facilities, and procedures be adequate to protect health and minimize danger to life or property; 10 CFR 40.32(d), which requires that the issuance of the license will not be inimical to the common defense and security or to the health and safety of the public; and 10 CFR 40.41(c), which requires the applicant to confine source or byproduct material to the locations and purposes authorized in the license. The related reviews of the 10 CFR Part 20 radiological aspects of the recovery plant equipment in accordance with standard review plan Sections 4.0, "Effluent Control Systems;" 5.0, "Operations;" and 7.0, "Environmental Effects" are addressed elsewhere in this technical evaluation report.

3.2.5 Reference

NRC. NUREG/CR–6733, "A Baseline Risk-Informed, Performance-Based Approach for *In Situ* Leach Uranium Extraction Licensees." Washington, DC: NRC. 2001.

3.3 Instrumentation and Control

3.3.1 Areas of Review

The staff should review descriptions of the proposed process instrumentation and control systems relevant to safety and radiation safety sampling and monitoring instrumentation, including their minimum specifications and operating characteristics. This review should include well field process control equipment for monitoring injection pressures, injection rates, and production rates. It should also include safety related process monitoring and control equipment used in the recovery plant, satellite processing facilities, well fields, chemical storage facilities, and surface impoundments.

3.3.2 Review Procedures

The staff should review the descriptions of the proposed instrumentation and control systems provided in the application to determine whether they are sufficient to evaluate the interrelationship between the proposed instrumentation systems and the operations or processes to be controlled or monitored. The staff should also determine whether the proposed instrumentation systems are sufficient to control and monitor operations and processes identified in the description of the proposed facility. Particular attention should be focused on whether proposed monitoring and control instrumentation is adequate to quickly identify and remedy *in situ* leaching and processing problems that can increase exposures to radiological and chemical hazards. Areas of concern include monitoring and ventilation systems designed to detect and control elevated releases of yellowcake dust from drying and storage operations and radon gas buildup in buildings. Areas of concern also include instrumentation used to record, monitor and control key operating parameters of the yellowcake dryers and their associated stack emission scrubbing systems. Instrumentation to detect and control liquid releases from well field and processing pipe failures, surface impoundment leaks, and chemical tank valve failures should also be evaluated in the staff review.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

3.3.3 Acceptance Criteria

The facility instrumentation is acceptable if it meets the following criteria:

(1) Instrumentation has been described for the various components of the processing facility, including well fields, well field houses, trunk lines, the production circuit, surface impoundments, and deep injection disposal wells.

(2) Instrumentation is designed to allow the plant operator to continuously monitor and control a variety of systems and parameters, including total flow into the plant, total waste flow leaving the plant, tank levels, and the yellowcake dryer. Instrumentation includes alarms and interlocks in the event of a failure.

(3) Critical components of the systems are equipped with backup systems that activate in the event of a failure of the operating system or a common cause failure such as power failure.

(4) Well field operating pressures are kept below casing and formation rupture pressures, to prevent vertical excursions. Well field operation pressures are routinely monitored either at the well head or on the entire system, and are measured and recorded daily.

(5) Manufacturer's recommendations for maintenance and operation of yellowcake dryers, and checking and logging requirements contained in 10 CFR Part 40, Appendix A. Criterion 8 are followed.

3.3.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the facility instrumentation and control systems, the following conclusions may be presented in the technical evaluation report.

NRC has completed its review of the instrumentation and control proposed for use at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 3.3.2 and the acceptance criteria outlined in standard review plan Section 3.3.3.

The instrumentation and control has been acceptably described for components including the well fields, well field houses, trunk lines, production circuit, surface impoundments, and deep injection disposal wells. The instrumentation allows for continuous monitoring and control of systems, including total inflow to the plant, total waste flow exiting the plant, tank levels, and the yellowcake dryer. Appropriate alarms and interlocks are part of the instrumentation systems. Each critical system is equipped with an acceptable backup system that automatically activates in the event of a failure of the operating system or a common cause failure such as a power failure.

Based on the information provided in the application and the detailed review conducted of the instrumentation and control for the _____ *in situ* leach facility, the staff concludes that the proposed instrumentation is acceptable and is in compliance with 10 CFR 40.32(c), which requires applicant proposed equipment, facilities, and procedures to be adequate to protect health and minimize danger to life or property; 10 CFR 40.32(d), which requires that the issuance of the license will not be inimical to the common defense and security or to the health and safety of the public; and 10 CFR 40.41(c), which requires the applicant to confine source or byproduct material to the locations and purposes authorized in the license. The related reviews of the 10 CFR Part 20 radiological aspects of the solution mining process and equipment, in accordance with standard review plan Sections 4.0, "Effluent Control Systems;" 5.0, "Operations;" and 7.0, "Environmental Effects" are addressed elsewhere in this technical evaluation report.

3.3.5 References

None.

4.0 EFFLUENT CONTROL SYSTEMS

4.1 Gaseous And Airborne Particulates

4.1.1 Areas of Review

The staff should review the proposed ventilation, filtration, and confinement systems that are to be used to control the release of radioactive materials to the atmosphere. The staff should also review analyses of equipment as designed and operated to prevent radiation exposures and to limit exposures and releases to as low as is reasonably achievable. A review should also be conducted of a physical description of discharge stacks, types and estimated composition and flow rates of atmospheric effluents, and proposed methods for controlling such releases.

4.1.2 Review Procedures

The staff should review facilities, designs, and operational modes to determine whether the proposed ventilation, filtration, and confinement systems and equipment described in the application are sufficient to control the release of radioactive materials to the atmosphere to meet acceptance criteria identified in Section 4.1.3.

4.1.3 Acceptance Criteria

The gaseous and airborne particulate effluent control systems are acceptable if they meet the following criteria:

(1) Monitoring and control systems for the facility are located to optimize their intended function. Monitors used to assess worker exposures are placed in locations of maximum concentration based upon determination of airflow patterns.

(2) Monitoring and control systems for the facility are appropriate for the types of effluents generated. The intended purposes of measurement devices are clearly stated and criteria for monitoring are provided. The acceptance criteria from Section 5.7.7.3 of this standard review plan should be met.

(3) The application provides a demonstration that adequate ventilation systems are planned for process buildings to avoid radon gas buildup. Ventilation systems should be consistent with the requirements of Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills Will Be as Low as Is Reasonably Achievable," Section 3.3 (NRC, 1983).

The review emphasis should be on (i) radon gas mobilization from recovery solutions entering the plant, (ii) the extraction process (where tanks are vented), and (iii) uranium particulate emissions resulting from drying and packaging operations and spills. For facilities using an open air design for processing (i.e., processing equipment is not enclosed by a building), ventilation will be less of a safety concern. Aspects of design that can significantly limit airborne releases include closed production systems (i.e., no venting) and the use of vacuum dryers that eliminate airborne uranium particulate releases from drying operations.

(4) The application demonstrates that the effluent control systems will limit exposures under both normal and accident conditions. The application also provides information on the health and safety impacts of system failures and identifies contingencies for such occurrences.

(5) The application demonstrates that the operations will be conducted so that all airborne effluent releases are as low as is reasonably achievable.

4.1.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the effluent control systems for gaseous and airborne particulates, the following conclusions may be presented in the technical evaluation report and environmental assessment.

NRC has completed its review of the effluent control systems for gaseous and airborne particulates proposed for use at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 4.1.2 and the acceptance criteria outlined in standard review plan Section 4.1.3.

The applicant has acceptably described the discharge stacks and the types, estimated composition, and flow rates of effluents released to the atmosphere. The applicant has designated monitoring and control systems (e.g., ventilation, filtration, and confinement) for the types of effluents generated. Also, the applicant has specified acceptable monitoring criteria and has located the facility monitoring and control systems for the required functions to optimally assess worker exposure in locations of likely maximum concentrations determined by the applicant's analysis of airflow patterns. The applicant has demonstrated that ventilation systems are acceptable to prevent radon gas buildup where (i) recovery solutions enter the plant, (ii) tanks are vented during the extraction process, and (iii) drying and packaging operations occur. By providing information on the health and safety impacts of system failures and identifying contingencies for such occurrences, the applicant has acceptably shown that effluent control systems will limit radiation exposures under both normal and accident conditions. The applicant has committed to occupational radiation doses and doses to the general public that meet dose limits and as low as is reasonably achievable goals.

Based on the information provided in the application and the detailed review conducted of the effluent control systems for gaseous and airborne particulates for the _____ *in situ* leach facility, the staff concludes that the proposed effluent control systems for gaseous and airborne particulates are acceptable and are in compliance with 10 CFR 20.1101, which requires that an acceptable radiation protection program that achieves as low as is reasonably achievable goals is in place and that a constraint on air emissions, excluding Radon-222 and its decay products, will be established to limit doses from these emissions; 10 CFR 20.1201, which defines the allowable occupational dose limits for adults; 10 CFR 20.1301, which defines dose limits allowable for individual members of the public; 10 CFR 20.1302, which requires compliance with dose limits for individual members of the public; 10 CFR Part 40, appendix A, Criterion 5(G)(1), which requires that the chemical and radioactive characteristics of wastes be defined; and 10 CFR Part 40, Appendix A, Criterion 8, which provides requirements for control

of airborne effluent releases. The related reviews of the 10 CFR Part 20 radiological aspects of the effluent control systems for gaseous and airborne radionuclides in accordance with standard review plan Sections 5.0, "Operations;" and 7.0, "Environmental Effects" are addressed elsewhere in this technical evaluation report.

4.1.5 Reference

NRC. Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills will be as low as is Reasonably Achievable." Washington, DC: NRC, Office of Standards Development. 1983.

4.2 Liquids and Solids

4.2.1 Areas of Review

The staff should review estimates of quantities and compositions of waste residues expected during construction and operation and the procedures proposed for their management. The staff should also review design specifications for effluent control systems for liquids and solids. Staff should review the design specifications of any retention systems such as surface impoundments. If effluents are to be released into surface waters or injected into disposal wells, the staff should also review the plans to obtain any water quality certifications and discharge permits that may be necessary. Appendix C provides staff guidance on effluent disposal at licensed uranium recovery facilities.

Areas to be reviewed include:

(1) Information related to surface impoundment design, monitoring programs, freeboard requirements, and leak reporting procedures

(2) Liquid effluent disposal plans

(3) Contingency plans for dealing with leaks and spills

(4) Contaminated solid waste generation and disposal plans

(5) Non-contaminated solid waste generation and disposal plans

4.2.2 Review Procedures

The staff should ensure that facility descriptions include a discussion of design features to contain contamination from spills resulting from normal operations and the likely consequences of any accidents (e.g., valve and tank failures, leaks in impoundment liners). The staff should perform the following assessments:

(1) Verify that surface impoundments rely on standard engineering design to ensure proper containment performance, including appropriate leak detection systems. The staff

should also ensure that appropriate freeboard requirements are established, and that appropriate monitoring programs and reporting procedures are in place.

(2) If liquid effluents are to be released into surface waters, applied to land surfaces, or injected into disposal wells, determine whether the applicant has applied for or been issued appropriate water quality certifications and discharge permits (see standard review plan Section 10.0 for review of these documents). If the applicant has are not yet applied for or been issued such permits, the reviewer should determine that the applicant has identified the necessary permits, and should ensure that a license condition is required prohibiting lixiviant injection until all permits are received.

(3) Ensure that contingency plans are in place for dealing with spills of process fluids from valve, pipe, or tank failures.

(4) Ensure that an agreement is in place for disposal of 11.e(2) byproduct material in an NRC licensed disposal facility or a licensed mill tailings facility.

(5) Ensure that all noncontaminated solid waste will be collected and disposed of in accordance with state and local requirements regarding landfill disposal.

In evaluating surface impoundments, an evaluation of environmental impacts must be made, and a conclusion of the acceptability of those impacts should be documented. The reviewer should also determine if the design of the impoundment meets the applicable requirements of 10 CFR Part 40, Appendix A.

4.2.3 Acceptance Criteria

The liquids and solids effluent control systems are acceptable if they meet the following criteria:

(1) Common liquid effluents generated from the process bleed, process solutions (e.g., backwash, resin transfer waters), wash-down water, well development water, and restoration waters are properly controlled.

Acceptable control methods include diversion of liquid wastes to surface impoundments, deep well injection, and land application/irrigation. Solid effluents can be considered either as contaminated or as noncontaminated. Contaminated solid effluent that can be decontaminated and released for unrestricted use is discussed in detail in Section 5.7.6 of this standard review plan.

To dispose of liquid waste by on-site land application, the applicant must provide (i) a description of the waste including its physical and chemical properties that are important to risk, (ii) a description of the proposed manner and conditions of waste disposal, (iii) an analysis and evaluation of pertinent information on the nature of the environment, (iv) information on the nature and location of other facilities likely to be affected, and (v) analyses and procedures to ensure that doses are maintained as low as is reasonably achievable and within the dose limits in 10 CFR 20.1301.

For land application, the applicant must analyze and assess projected (i) concentrations of radioactive contaminants in the soils to show that the concentration of radium and other nuclides in the soil will not exceed the standard in 10 CFR Part 40, Appendix A, Criterion 6(6); (ii) impacts on ground-water and surface-water quality; (iii) impacts on land use, particularly crops and vegetation; and (iv) exposures and health risks that may be associated with radioactive constituents reaching the food chain. All projected doses and risks must conform to the risk levels permitted under 10 CFR Part 20. The applicant should propose periodic soils surveys that include contaminant monitoring to verify that contaminant levels in the soil do not exceed the projected levels. A remediation plan must be in place to be implemented in the event that the projected levels are exceeded.

The applicant must conduct analyses to assess the chemical toxicity of radioactive and nonradioactive constituents to evaluate health risks associated with land application involving irrigation at particular sites. The staff should determine that the specific toxicity evaluations and any necessary permits are sufficient to conform to the applicable regulations such as 10 CFR 20.2007. In the absence of compliance monitoring wells in the uppermost aquifer in the area used for land application, the applicant must demonstrate that contaminants will not be returned to the ground water and cause any exceedance of site-specific ground-water protection standards.

Applicants are required to comply with NRC requirements for decommissioning before facility closure and license termination. (Decommissioning requirements are discussed in Section 6 of this standard review plan.)

(2) On-site evaporation systems are designed and operated in a manner that prevents migration of waste from the evaporation system to the subsurface.

The following discussion provides guidelines for an acceptable application section dealing with surface impoundments.

The monitoring and inspection program consists of documented daily checks of impoundment freeboard and the leak detection system. Because small amounts of condensation can accumulate in leak detection sumps, chemical samples are not commonly collected until water levels greater than a specified amount are detected. NRC has found 15 cm [6 in.] to be an acceptable level. When significant water levels are detected, the water in the standpipes must be sampled for indicator parameters to confirm that the water in the detection system is from the impoundment. The applicant should specify and provide the basis for selecting the indicator parameter(s) used to verify leaks.

Corrective actions should commence on leak confirmation and should consist of transferring the solution to another impoundment so that liner repairs can be made. Thus, sufficient freeboard capacity should be maintained in the surface impoundments such that any one impoundment could be transferred to the remaining impoundments in the event of a leak. An additional freeboard requirement is that water levels should be

kept far enough below the top of the impoundment to prevent waves from overtopping during high wind conditions.

Actions to be taken in the event that surface impoundment water analyses indicate leakage include (i) notifying NRC by telephone within 48 hours of verification, (ii) analyzing standpipe water quality samples for leak parameters once every 7 days during the leak period and once every 7 days for at least 14 days following repairs, and (iii) filing a written report with NRC within 30 days of first notifying NRC that a leak exists. (This report includes analytical data and describes the mitigative action and the results of that action.)

(3) The design, installation, and operation of surface impoundments at the site used to manage 11e.(2) byproduct material meet relevant guidance provided in Regulatory Guide 3.11, Section 1 (NRC, 1977). The impoundments should have sufficient capacity that the entire contents of one impoundment can be transferred to the other surface impoundments in the event of a leak. (See Section 2.7.3 of this standard review plan for additional discussion of design and evaluation of retention systems and diversion facilities.) Inspections of impoundments will be done consistent with Regulatory Guide 3.11.1, "Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings" (NRC, 1980).

The surface impoundment must have sufficient capacity and must be designed, constructed, maintained, and operated to prevent overtopping resulting from (i) normal or abnormal operations, overfilling, wind and wave actions, rainfall, or run-on; (ii) malfunctions of level controllers, alarms, and other equipment; and (iii) human error. If dikes are used to form the surface impoundment, the dikes must be designed, constructed, and maintained with sufficient structural integrity to prevent massive failure of the dikes. In ensuring structural integrity, the applicant must not assume that the liner system will function without leakage during the active life of the impoundment.

Controls should be established over access to the impoundment, including access during routine maintenance. A procedure should be provided that assures that unnecessary traffic is not directed to the impoundment area.

(4) The design of surface impoundments used in the management of 11e.(2) byproduct material meets or exceeds the requirements in 10 CFR Part 40, Appendix A, Criterion 5(A) .

The design of a clay or synthetic liner and its appurtenant component parts should be presented in the application or related amendment applications for a uranium recovery operation. At a minimum, design details, drawings, and pertinent analyses should be provided. Expected construction methods, testing criteria, and quality assurance programs should be presented. Planned modes of operation, inspection, and maintenance should be discussed in the application. Deviation from these plans should be submitted to and approved by the staff before implementation.

The liner for a surface impoundment used to manage 11e.(2) byproduct material must be designed, constructed, and installed to prevent any migration of wastes out of the impoundment to the subsurface soil, ground water, or surface water at any time during the active life of the surface impoundment. The liner may be constructed of materials that allow wastes to migrate into the liner provided that the impoundment decommissioning includes removal or decontamination of all waste residues, contaminated containment system components, contaminated subsoils, and structures and equipment contaminated with waste and leachate.

The liner must be constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure because of pressure gradients, physical contact with the waste or leachate, climatic conditions, and the stresses of installation and daily operation. The subgrade must be sufficient to prevent failure of the liner because of settlement, compression, or uplift. Liners must be installed to cover all surrounding earth which is likely to be in contact with the wastes or leachate.

Tests should show conclusively that the liner will not deteriorate when subjected to the waste products and expected atmospheric and temperature conditions at the site. Applicant test data and all available manufacturers test data should be submitted with the application. For clay liners, tests, at a minimum, should consist of falling head permeameter tests performed on columns of liner material obtained during and after liner installation. The expected reaction of the impoundment liner to any combination of solutions or atmospheric conditions should be known before the liner is exposed to them. Field seams of synthetic liners should be tested along the entire length of the seam. Representative sampling may be used for factory seams. The testing should use state-of-the-art test methods recommended by the liner manufacturer. Compatibility tests that document the compatibility of the field seam material with the waste products and expected weather conditions should be submitted for staff review and approval. If it is necessary to repair the liner, representatives of the liner manufacturer should be called on to supervise the repairs.

Proper preparation of the subgrade and slopes of an impoundment is very important to the success of the surface impoundment. The strength of the liner is heavily dependent on the stability of the slopes of the subgrade. The subgrade should be treated with a soil sterilant. The subgrade surface for a synthetic liner should be graded to a surface tolerance of less than 2.54 cm [1 in.] across a 30.3 cm [1 ft] straightedge. NRC Regulatory Guide 3.11, Section 2 (NRC, 1977) outlines acceptable methods for slope stability and settlement analyses, and should be used for design. If a surface impoundment with a synthetic liner is located in an area where the water table could rise above the bottom of the liner, under drains may be required. The impoundment will be inspected in accordance with Regulatory Guide 3.11.1 (NRC, 1980).

A quality control program should be established for the following factors: (i) clearing, grubbing, and stripping; (ii) excavation and backfill; (iii) rolling; (iv) compaction and moisture control; (v) finishing; (vi) subgrade sterilization; and (vii) liner subdrainage and gas venting.

To prevent damage to liners, some form of protection should be provided, including (i) soil covers, (ii) venting systems, (iii) diversion ditches, (iv) side slope protection, or (v) game-proof fences. A program for maintenance of the liner features should be developed, and repair techniques should be planned in advance.

A leak detection system should be installed at all sites using natural or synthetic liners. The system should be designed to perform the following functions: (i) detect accidental leaks from the impoundment, (ii) identify the location of the leak so that liner repair can be implemented immediately, and (iii) isolate the leakage and control it.

Daily inspections should be made of the liner, liner slopes, and other earthwork features. Any damage or defects that could result in leakage should be immediately reported to the staff. Appropriate repairs should be implemented as soon as possible.

(5) Plans and procedures are provided for addressing contingencies for all reasonably expected system failures and include:

(a) A listing of the likely consequences of any failures in process or well field equipment that could result in a release of material

(b) Identification of appropriate plant and corporate personnel who must be notified in the event of specific types of failures

(c) Measures for quickly containing and mitigating the impacts of released materials

(d) Provisions for issuing radiation work permits for workers to mitigate impacts

(e) Specific procedures for complying with notification requirements in the regulations, license, and other permits, as appropriate

Processing plants should have sump capacity sufficient to contain the volume of the largest tank in the plant that contains hazardous material. Well field flow circuits should be equipped with alarms to notify the operator in the event of loss of pressure or excess pressure anywhere within the production circuit. NRC should be notified of spills in accordance with criteria in Section 5.3.1.3(2) of this standard review plan.

(6) The application contains a description of the methods to be used for disposing of contaminated solid wastes that are generated during operation of the facility.

Equipment that can be decontaminated and released for unrestricted use is discussed in Section 5.7.6 of this standard review plan. The storage of byproduct material that either cannot or will not be decontaminated and released for unrestricted use will be managed to ensure compliance with occupational dose limits in 10 CFR Part 20, Subpart C. The detailed review of occupational doses will be completed as described in Section 5.7 of this standard review plan. The application should provide an estimate of the amount of contaminated material that will be generated and objective evidence of an agreement for

disposal of these materials either in a licensed waste disposal site or at a licensed mill tailings facility.

The applicant has an approved waste disposal agreement for 11e.(2) byproduct material disposal at an NRC or NRC Agreement State licensed disposal facility. This agreement is maintained onsite. The applicant has committed to notify NRC in writing within 7 days if this agreement expires or is terminated and to submit a new agreement for NRC approval within 90 days of the expiration or termination (failure to comply with this license condition will result in a prohibition from further lixivient injection).

(7) Noncontaminated solid waste will be gathered periodically and disposed of in a sanitary landfill in accordance with state and local regulations. Regulation of this disposal is not part of NRC licensing responsibility.

(8) Water quality certification and discharge permits have been obtained, or plans are in place to obtain them (review requirements for the status of these permits are addressed in Section 10.0 of the standard review plan). If such permits are not yet applied for or issued, the reviewer should determine that the applicant has identified the necessary permits and should ensure that a license condition is required prohibiting lixiviant injection until all permits are received. Table 4.2.3-1 provides a list of non-NRC permits that may be required to support liquid effluent disposal at *in situ* leach facilities.

(9) Acceptable methods for effluent disposal by release to surface water, evaporation from surface impoundments, land application, and deep well injection are consistent with the guidance in Appendix C of this standard review plan.

(10) Alternatives to liquid management activities have been considered and none is found to be obviously superior to the selected option. In addition, environmental impacts from all liquid waste management activities have been found to be acceptable.

4.2.4 Evaluation Findings

If the staff review as described in this section results in the acceptance of the effluent control systems for liquids and solids, the following conclusions may be presented in the technical evaluation report and environmental assessment.

NRC has completed its review of the effluent control systems for liquids and solids proposed for use at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 4.2.2 and the acceptance criteria outlined in standard review plan Section 4.2.3.

The applicant has acceptably described the common liquid effluents generated at the facility. Appropriate control methods, including diversion to surface impoundments, deep well injection, and land application/irrigation (select appropriate methods) are identified. On-site evaporation system designs are prescribed in acceptable detail, including engineering plans and drawings. The applicant has shown that liquid waste disposal facilities are adequate to handle production

Table 4.2.3-1. Non-NRC Permits That May Be Required to Support Liquid Effluent Disposal at Uranium *in Situ* Leach Facilities

Permit	Comments
Underground Injection Control	Mandatory. Issued either by EPA or a state under EPA authority. EPA reserves exclusive aquifer exemption action.
Surface-Water Discharge	Optional. Usually issued by the state, under U.S. Environmental Protection Agency (EPA) authority.
Air	Mandatory with dryer. Usually issued by state under EPA authority; may also be local.
Mining	Mandatory. Usually issued by state under legislative authority.
Wetlands	Issued by U.S. Army Corps of Engineers
Consumptive Water Use	Mandatory. Issued by a state under legislative authority. (Secure water rights)
Leases/Permits on Federal Lands	Issued by U.S Bureau of Land Management , U.S. Bureau of Indian Affairs (Department of the Interior), U.S. Forest Services. U.S. Department of Agriculture, or U.S. Bureau of Reclamation.
Construction/Sewage	Issued by local authorities: building codes, utility authorities, and planning authorities.
Leases/Permits on State Lands	Issued by state land offices.

and restoration efforts and has designed installation and operation of surface impoundments such that the impoundments can contain the entire contents of any other leaking or inoperative impoundment. The applicant has demonstrated that any dikes used to form a surface impoundment are designed, constructed, and maintained with sufficient structural integrity to prevent massive failure. Additionally, surface impoundments and associated liners are properly designed. The applicant has proposed daily checks of impoundment freeboard and leak detection systems. Chemical sampling is initiated when levels are greater than 15 cm [6 in.]. The planned sampling and analysis of contaminants in the leak detection systems are acceptable.

An appropriate corrective action plan is described that allows for the contents of a given impoundment to be transferred to another impoundment with no release of contamination. The applicant has an acceptable action plan to notify NRC, analyze samples, and file a written report in the event of leaks. The applicant has ensured that disposal plans are in compliance with applicable directives. Acceptable plans and procedures that address contingencies for all reasonably expected system failures are provided. The applicant has demonstrated that sump

capacity is sufficient to contain the volume of the largest hazardous material source. The facility has acceptable alarms to notify the operator of loss of or excess pressure within the production circuits. The applicant log of significant solution spills is acceptable. Applicant plan for spill notification is acceptable. The applicant has an acceptable plan for the disposal of contaminated solid wastes that are generated by the facility. The applicant has proposed storage of contaminated material that either cannot or will not be decontaminated and released for unrestricted use. The applicant has demonstrated that the contamination will be managed to insure compliance with occupational dose limits, as discussed in Section 5.7 of this standard review plan. The applicant will dispose of noncontaminated solid waste periodically at a licensed disposal site landfill, in accordance with state and local regulations. The applicant has demonstrated possession of the appropriate water quality certification and discharge permits or has plans in place to obtain them. By providing information on the health and safety impacts of system failures and identifying contingencies for such occurrences, the applicant has shown that effluent control systems will limit radiation exposures under both normal and accident conditions. The applicant has committed to maintaining occupational radiation doses and doses to the general public that meet exposure limits and as low as is reasonably achievable goals.

Based on the information provided in the application and the detailed review conducted of the effluent control systems for liquids and solids for the _____ *in situ* leach facility, the staff has concluded that the proposed effluent control systems for liquids and solids are acceptable and are in compliance with 10 CFR 20.1101, which requires that an acceptable radiation protection program that achieves as low as is reasonably achievable goals is in place; 10 CFR 20.1201, which defines the allowable occupational dose limits for adults; 10 CFR 20.1301, which defines dose limits allowable for individual members of the public; 10 CFR 20.1302, which requires compliance with dose limits for individual members of the public; 10 CFR 20.2007, which requires that disposal by injection in deep wells must also meet any other applicable federal, state, and local government regulations pertaining to deep well injection; 10 CFR Part 40, Appendix A, Criterion 2, which requires that the applicant provide an estimate of the amount of contaminated material that will be generated and objective evidence of an agreement for disposal of these materials either in a licensed waste disposal site or at a licensed mill tailings facility to demonstrate nonproliferation of waste disposal sites; 10 CFR Part 40, Appendix A, Criteria 5A(1) through 5A(5), which define design provisions for surface impoundments; Criterion 5E which requires measures to protect ground water; Criterion 5F which provides requirements for seepage control; Criterion 5G(1), which requires that the chemical and radioactive characteristics of wastes be defined; Criterion 6(6), which defines cleanup standards for radium. The related reviews of the 10 CFR Part 20 radiological aspects of the effluent control systems for liquids and solid radionuclides, in accordance with standard review plan Sections 5.0, "Operations" and 7.0, "Environmental Effects" are addressed elsewhere in this technical evaluation report.

The design of dikes used to construct surface-water impoundments has been demonstrated to comply with Regulatory Guide 3.11, Sections 2 and 3 (NRC, 1977), and therefore meet the requirements of 10 CFR Part 40, Appendix A, Criterion 5(A)5. In addition, because the impoundment dikes may meet the definition of a dam as given in the Federal Guidelines for Dam Safety, they are subject to the NRC Dam Safety Program, and to Section 215, "National

Dam Safety Program, of the Water Resources Development Act of 1966" (optional, staff should add only if appropriate).

The staff has also considered the environmental impacts from the proposed liquid waste management approach. Considered in the evaluation were the potential environmental impacts as well as alternatives and mitigative measures. In evaluating the environmental impacts, the staff examined effects from radiological as well as non-radiological aspects. Alternatives considered include [staff should list as appropriate]. In addition, the applicant will take the following mitigative measures to reduce the environmental impacts (staff should list measures and discuss how they reduce impact based on this evaluation). The staff has determined that the environmental impacts from the proposed facility are acceptable.

4.2.5 References

NRC. "Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings." Revision 1. Washington, DC: NRC. 1980.

———. Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills." Washington, DC: NRC, Office of Standards Development. 1977.

4.3 Contaminated Equipment

The review in this area will be conducted using Section 5.7.6 of this standard review plan.

5.0 OPERATIONS

5.1 Corporate Organization And Administrative Procedures

5.1.1 Areas of Review

The staff should review the detailed description of the applicant's proposed organization and administrative procedures, including a description and/or chart depicting the key positions in the management structure, and the responsibilities and functions of each with respect to development, review, approval, implementation, and adherence to operating procedures, radiation safety programs, environmental and ground-water monitoring programs, quality assurance programs, routine and nonroutine maintenance activities, and changes to any of these. In addition, the reviewer should examine the plans proposed by the applicant for establishing a Safety and Environmental Review Panel including the proposed composition and responsibilities of the Panel.

5.1.2 Review Procedures

The staff should review areas outlined in the Standard Format and Content of License Applications (NRC, 1982). Specifically, the reviewer should determine whether the proposed organization and administrative procedures are defined in sufficient detail to evaluate the responsibilities and authority of persons in positions responsible for developing, reviewing, approving, implementing, and enforcing the proposed programs related to radiological safety, environmental safety, and ground-water protection. In addition, the reviewer should examine the plans proposed by the applicant for establishing a Safety and Environmental Review Panel including the proposed composition and responsibilities of the Panel.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

5.1.3 Acceptance Criteria

The corporate organization and administrative procedures are acceptable if they meet the following criteria:

(1) The applicant has provided adequate descriptions of the corporate organization, clearly defining management responsibilities and authority at each level.

Specifically, the radiation safety officer should have the responsibilities and authority outlined in Draft Regulatory Guide DG–8027, Section 1.2 (NRC, 2000).

(2) The organizational structure shows integration among groups that support the operation and maintenance of the facility. If the facility is new, integration between plant construction and plant management should be detailed.

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(3) The applicant has established a Safety and Environmental Review Panel that will consist of at least three individuals. One member of the Safety and Environmental Review Panel will have expertise in management and will be responsible for implementing managerial and financial changes. One member will have expertise in operations and/or construction and will have responsibility for implementing any operational changes. One member will be the radiation safety officer, or equivalent, with the responsibility for assuring that changes conform to radiation safety and environmental requirements. Additional members may be included in the Safety and Environmental Review Panel, as appropriate, to address specific technical issues such as health physics, ground-water hydrology, surface-water hydrology, and specific earth sciences or other technical disciplines. Temporary members may include consultants. A description of when additional members will be used is provided.

(4) To the extent possible, proposed administrative procedures conform with Regulatory Guide 8.2, "Guide for Administrative Practices in Radiation Monitoring" (NRC, 1973) and with Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations)—Effluent Streams and the Environment, Revision 1, (NRC, 1979).

(5) Sufficient independence is available to the plant supervisor, radiation safety officer, and Safety and Environmental Review Panel such that significant safety issues can be raised to senior management.

5.1.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the corporate organization and administrative procedures, the following conclusions may be presented in the technical evaluation report.

NRC has completed its review of the corporate organization and administrative procedures proposed for use at the _____*in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 5.1.2 and the acceptance criteria outlined in standard review plan Section 5.1.3.

The applicant has an acceptable corporate organization that defines management responsibilities and authority at each level. The applicant definition of the responsibilities and procedures with respect to development, review, approval, implementation, and adherence to operating procedures, radiation safety programs (including record keeping and reporting), environmental and ground-water monitoring programs, quality assurance programs, routine/nonroutine maintenance activities, and changes to any of these is acceptable. Integration among groups that support operation and maintenance of the facility is demonstrated. In the case of a new facility, integration between facility construction and plant management is acceptably detailed. The applicant has established a Safety and Environmental Review Panel with at least three individuals representing expertise in management/financial, operations/construction, and radiation safety matters. The applicant has demonstrated that specific technical issues will be dealt with by the Safety and Environmental Review Panel, with support from other qualified staff members, or consultants, as appropriate.

Based on the information provided in the application and the detailed review conducted of the corporate organization and administrative procedures for the _____ *in situ* leach facility, the staff concludes that the proposed corporate organization and administrative procedures are acceptable and are in compliance with 10 CFR 20.1101, which defines radiation protection program requirements; 10 CFR Part 20, Subpart L, Sections 2101–2110, which define requirements for record keeping; and 10 CFR Part 20, Subpart M, Sections 2201–2206, which present the requirements for reporting. In addition, the requirements of 10 CFR 40.32(b), (c), and (d) are also met as they relate to the proposed corporate organization and Safety and Environmental Review Panel functions.

5.1.5 References

NRC. Draft Regulatory Guide DG–8027, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills Will Be As Low As Is Reasonably Achievable." Washington, DC: NRC, Office of Nuclear Regulatory Research. 2000.

———. Regulatory Guide 3.46, "Standard Format and Content of License Applications, Including Environmental Reports, for *In Situ* Uranium Solution Mining." Washington, DC: NRC, Office of Standards Development. 1982.

———. Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations)–Effluent Streams and the Environment." Revision 1. Washington, DC: NRC, Office of Standards Development. 1979.

———. Regulatory Guide 8.2, "Guide for Administrative Practices in Radiation Monitoring." Washington, DC: NRC, Office of Standards Development. 1973.

5.2 Management Control Program

5.2.1 Areas of Review

The staff should review the management control program and administrative procedures proposed to ensure that activities affecting health, safety, and the environment are conducted in accordance with written standard operating procedures. The reviewer should evaluate the management control and decision bases to be used by the Safety and Environmental Review Panel in deciding when it is necessary to apply for a license amendment. Procedures governing non-routine work or maintenance that is not covered by an standard operating procedure should be reviewed.

While occupational and safety concerns are important and need to be included in the development of standard operating procedures, NRC regulatory authority is limited to those instances where occupational safe concerns affect radiological operations or accidents.

5.2.2 Review Procedures

The reviewer should determine that the proposed management control program and administrative procedures are sufficient to assure that any likely proposed activities affecting health, safety, and the environment, including compliance with any license commitments or conditions, will be conducted in accordance with written operating procedures. The review should include the process for identifying and developing standard operating procedures for routine work, and the review and approval process to be used by the radiation and occupational safety staff to modify standard operating procedures when appropriate. Methods for review and approval of nonroutine work or maintenance activity by the radiation and occupational safety staff should be examined.

For license renewals and amendment application, Appendix A to this standard review plan provide guidance for examining facility operations and the approach that should be used in evolutionary amendments and renewal applications.

The licensee has agreed to administer a cultural resources inventory before engaging in any development activity not previously assessed by NRC. Any disturbances to be associated with such development will be completed in compliance with the National Historic Preservation Act, the Archeological Resources Protection Act, and their implementing regulations. Additionally, the licensee will cease any work resulting in the discovery of previously unknown cultural artifacts to ensure that no unapproved disturbance occurs. Any such artifacts will be inventoried and evaluated, and no further disturbance will occur until the licensee has received authorization from the NRC to proceed.

5.2.3 Acceptance Criteria

The management control system is acceptable if

(1) The proposed management control program and administrative procedures are sufficient to assure that all proposed activities that may affect health, safety, and the environment, including compliance with any license commitments or conditions, will be conducted in accordance with written operating procedures. These shall include procedures that evaluate the consequences of a spill or incident/event against 10 CFR Part 20, Subpart M and 10 CFR 40.60 reporting criteria.

If the licensee is required to report any spills; pond leaks; excursions of source, 11e.(2) byproduct material, or process chemicals that may have an impact on the environment; or any other incidents/events to state or federal agencies, a report shall be made to the NRC Region IV Uranium Recovery Branch Chief and NRC Headquarters Project Manager by telephone or electronic mail (e-mail) within 48 hours of the event. This notification shall be followed, within thirty (30) days of the notification, by submittal of a written report to NRC Region IV and NRC Headquarters, detailing the conditions leading to the spill or incident/event, corrective actions taken, and results achieved. A license condition will be established to this effect.

(2) The applicant provides a process that will be used to identify and prepare operating procedures for routine work.

There should be a mechanism for the development, approval, and review of all standard operating procedures by the radiation and occupational safety staff, on an annual basis. Subsequent inspections will ensure that standard operating procedures are adequate and applied correctly.

The process should include procedures covering all aspects of radiation and occupational safety, maintenance activities (especially in radiation areas), development of well fields, and Safety and Environmental Review Panel reviews and activities.

For standard operating procedures for radiation safety, refer to Draft Regulatory Guide DG–8027, Section 2 (NRC, 2000).

(3) The applicant presents methods for review and approval of nonroutine work or maintenance activity by the radiation and occupational safety staff. The methods should include the preparation and issuance of radiation work permits for activities where standard operating procedures do not apply.

(4) The applicant provides for the establishment of a Safety and Environmental Review Panel. A detailed review of Safety and Environmental Review Panel composition is addressed in Section 5.1 of this standard review plan.

(a) The Safety and Environmental Review Panel may, without obtaining a license amendment pursuant to 10 CFR 40.44:

(i) Make changes in the facility as described in the license application (as updated)

(ii) Make changes in the procedures as described in the license application (as updated)

(iii) Conduct a test or experiments not described in the license application (as updated)

(iv) The change, test, or experiment is consistent with the NRC conclusions, or the basis of or analysis leading to the conclusions of, actions, designs, or design configurations analyzed and selected in the site or facility safety evaluation report, technical evaluation report, and environmental impact statement of environmental assessment, including all supplements and amendments, and technical evaluation reports, environmental assessments, and environmental impact statements issued with amendments to this license.

(b) Subject to the following constraints, the licensee shall obtain a license amendment pursuant to 10 CFR 40.44 prior to implementing a proposed change, test or experiment if the change, test, or experiment would

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(i) Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the license application (as updated)

(ii) Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a structure, system, or component important to safety previously evaluated in the license application (as updated)

(iii) Result in more than a minimal increase in the consequences of an accident previously evaluated in the license application (as updated)

(iv) Result in more than a minimal increase in the consequences of a malfunction of a structure, system, or component important to safety previously evaluated in the license application

(v) Create a possibility for an accident of a different type than any previously evaluated in the license application (as updated)

(vi) Create a possibility for a malfunction of a structure, system, or component important to safety with a different result than previously evaluated in the license application (as updated)

(vii) Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report or the environmental assessment or technical evaluation reports or other analyses and evaluations for license amendments

(5) The licensee is exempted from the requirements of 20 CFR 1902(e) for areas within the facility, provided that all entrances to the facility are conspicuously posted with the words "ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL."

(6) The licensee has agreed to administer a cultural resources inventory before engaging in any development activity not previously assessed by NRC. Any disturbances to be associated with such development will be completed in compliance with the National Historic Preservation Act, the Archeological Resources Protection Act, and their implementing regulations. Additionally, the licensee will cease any work resulting in the discovery of previously unknown cultural artifacts to ensure that no unapproved disturbance occurs. Any such artifacts will be inventoried and evaluated, and no further disturbance will occur until the licensee has received authorization from the NRC to proceed.

5.2.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the management control program, the following conclusions may be presented in the technical evaluation report.

NRC has completed its review of the management control program proposed for use at the _____ *in situ* leach facility. This review included an evaluation using the review

procedures in standard review plan Section 5.2.2 and the acceptance criteria outlined in standard review plan Section 5.2.3.

The applicant has an acceptable management control program that assures that all safety-related operating activities can be conducted according to written operating procedures. The applicant has provided acceptable operating procedures or a process that will be used to develop standard operating procedures. The applicant has acceptably identified radiation protection, maintenance activities (especially in radiation areas), development of well fields, and Safety and Environmental Review Panel reviews as areas where standard operating procedures are acceptable and correctly applied. The applicant has demonstrated that nonroutine work or maintenance activity will comply with radiation safety requirements and has provided for the issuance of radiation work permits for activities where standard operating procedures do not apply.

Based on the information provided in the application and the detailed review conducted of the management control program for the _____ *in situ* leach facility, the staff concludes that the proposed management control program is acceptable and is in compliance with 10 CFR 20.1101, which defines radiation protection program requirements; 10 CFR Part 20, Subpart L, Sections 2101–2110, which define requirements for record keeping; and 10 CFR Part 20, Subpart M, Sections 2201–2206, which present the requirements for reporting.

5.2.5 Reference

NRC. Draft Regulatory Guide DG–8027, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills will be as low as is Reasonably Achievable." Washington, DC: NRC, Office of Nuclear Regulatory Research. 2000.

5.3 Management Audit, Inspection, and Record Keeping Program

5.3.1 Management Audit and Internal Inspection Program

5.3.1.1 Areas of Review

The staff should review the proposed management audit, inspection, and as low as is reasonably achievable program, including the frequencies, types, and scopes of reviews and inspections; action levels; corrective action measures; and spill notification procedures; as well as the responsibilities of each participant. The staff should also review the program for ensuring that employee exposures (to both airborne and external radiation) and effluent releases are as low as is reasonably achievable.

5.3.1.2 Review Procedures

The reviewer should determine whether the proposed management audit, inspection, and spill notification programs are acceptable to ensure the implementation of the proposed management control program and to ensure that employee exposures and effluent releases are as low as is reasonably achievable. This review will include records and reports prepared by the Safety and Environmental Review Panel. The reviewer shall ensure that yellowcake drying

and packaging operations are in accordance with 10 CFR Part 40, Appendix A, Criterion 8, and inspection of waste retention systems is in accordance with Criterion 8A.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

5.3.1.3 Acceptance Criteria

The management audit, and inspection programs are acceptable if they meet the following criteria:

(1) The proposed frequencies, types, and scopes of reviews and inspections; action levels; spill notification procedures; and corrective action measures are determined to be acceptable to implement the proposed controls.

Correct addresses and telephone numbers are identified for all written notices and reports to NRC.

Acceptable programs for inspection of embankment systems on a regular basis are described in Regulatory Guide 3.11 (NRC, 1977).

Acceptable programs for annual as low as is reasonably achievable audits are described in Draft Regulatory Guide DG–8027 (NRC, 2000).

(2) For spill reporting, the requirements of 10 CFR Part 20, Subpart M are met.

(3) A detailed review of record keeping and retention procedures is conducted using Section 5.3.2 of the standard review plan.

(4) The Safety and Environmental Review Panel records will include written safety and environmental evaluations made by the Safety and Environmental Review Panel that provide the basis for determining whether changes were made in accordance with the bases described in Section 5.2.3. Changes pages should have both a change indicator for the area changed (e.g., a bold line vertically drawn in the right margin adjacent to the portion actually changed) and a page change indication (date of change or change number, or both).

The applicant has made provisions to furnish an annual report to NRC that includes a description of these changes, tests, or experiments, and a summary of the safety and environmental evaluation for each. In addition, the licensee has made provisions to annually submit change pages to NRC, for the approved application and/or the approved operations plans and reclamation plan.

(5) An annual report will be submitted to the NRC that includes the as low as is reasonably achievable audit report, land use survey, monitoring data, corrective action program report, one of the semiannual effluent and environmental monitoring reports, and the

Safety and Environmental Review Panel information. A license condition will be established to this effect.

The annual Safety and Environmental Review Panel report and page changes may be furnished along with reports normally submitted to satisfy 10 CFR 40.65 reporting requirements.

5.3.1.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the management audit, inspection, and record keeping programs, the following conclusions may be presented in the technical evaluation report.

NRC has completed its review of the management audit, inspection, and record keeping programs proposed for use at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 5.3.1.2 and the acceptance criteria outlined in standard review plan Section 5.3.1.3.

The applicant has acceptable management audit, inspection, and record keeping programs that provide frequencies, types, and scopes of reviews and inspections; action levels; and corrective action measures sufficient to implement the proposed actions. The applicant has established acceptable record control procedures that insure maintenance of all necessary records for the required period. The applicant has acceptably demonstrated that it will record and report spills of hazardous materials at the site in an accurate and timely manner. The applicant will furnish an annual, written report, to NRC, that provides the bases for any changes in the approved management audit, inspection, and spill notification programs, or operations and reclamation plans, along with any appropriate change pages.

Based on the information provided in the application and the detailed review conducted of the management audit, inspection, and spill notification programs for the _____ *in situ* leach facility, the staff concludes that the proposed programs are acceptable and are in compliance with 10 CFR 20.1101, which defines radiation protection program requirements; 10 CFR 20.1501, which contains the general requirements for surveying and monitoring; 10 CFR 20.1204, which provides procedures for determining individual exposure; 10 CFR 20.1702, which requires the use of process or other engineering measures to control the concentrations of radioactive material in the air; 10 CFR Part 20, Subpart L, Sections 2101–2110, which define requirements for record keeping; and 10 CFR Part 20, Subpart M, Sections 2201–2206, which present the requirements for reporting. In addition, the requirements of 10 CFR 40.32(b), (c), and (d) are met as they relate to the acceptability of management audits to ensure protection of health and minimize danger to life and property. The requirements of 10 CFR Part 40, Appendix A, Criteria 8 and 8A are met as they relate to yellowcake drying and packaging operations, and inspection of waste retention systems.

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5.3.1.5 References

NRC. Draft Regulatory Guide DG–8027, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills will be as low as is Reasonably Achievable." Washington, DC: NRC, Office of Nuclear Regulatory Research. 2000.

———. Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills." Revision 2. Washington, DC: NRC, Office of Standards Development. 1977.

5.3.2 Record Keeping and Record Retention

5.3.2.1 Areas of Review

The staff should review the applicant's record keeping plans for the materials control and tracking program; the radiation protection program; the sampling, survey and calibration programs; for planned special exposures; to track doses to workers and members of the public; for the disposal of source, and byproduct materials made under 10 CFR 20.2002 and 20.2003; and for the records important to decommissioning the facility, including records of spills or unusual occurrences involving the spread of contamination, cleanup actions taken, and the location of remaining contamination. The staff should also review the licensee's plans and arrangements to identify and maintain the records that must be retained for the life of the facility and ultimately be transferred to NRC at the termination of the license.

5.3.2.2 Review Procedures

The reviewer should determine whether the proposed record keeping programs are adequate to ensure that the licensee will be able to track, control, and demonstrate control of, the source and byproduct material at the site, such that on-site and off-site dose limits will not be exceeded. The reviewer should determine whether records important to decommissioning, such as descriptions of spills and other unusual occurrences and established annual surety amounts, will be maintained by the licensee, and are in an identifiable or, preferably, separate file. The reviewer should also determine whether the licensee has a plan to maintain the records that will be turned over to NRC at license termination.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

5.3.2.3 Acceptance Criteria

The licensee record keeping and record retention plans should be acceptable if they meet the following criteria:

(1) The record keeping requirements specified in the regulatory guides cited in the other sections of the standard review plan are met.

(2) The record keeping plan demonstrates that the licensee will maintain and retain records of the receipt, transfer, and disposal of any source or byproduct material processed or produced at the licensed facility, for the period set out in the licensee's license conditions, or until the Commission terminates the license.

(3) The following will be routinely maintained and retained for a permanent site record for the licensed life of the *in situ* leach facility:

(a) Records of on-site disposal such as by deep well injection, land application, or burial made under 10 CFR 20.2002 and 20.2007.

(b) Records required by 10 CFR 20.2103(b)(4).

(c) Records required by 10 CFR 40, Appendix A, Criteria 8 and 8A.

(d) Records containing information important to decommissioning and reclamation of an *in situ* leach facility will be maintained until license termination, including

(i) Descriptions of any spills, excursions, contamination events or unusual occurrences, including the dates, locations, areas, or facilities affected; assessments of hazard; cleanup actions taken; assessment of the effectiveness of cleanup, and the location of any remaining contamination; nuclides involved; quantities, forms and concentrations, and descriptions of hazardous constituents; descriptions of inaccessible areas that cannot be cleaned up; and sketches, diagrams, or drawings marked to show areas of contamination and places where measurements were made. Significant spills that should be included are any radiological spills that have the potential to exceed site cleanup standards and any radiological spill that leaves the site. A license condition will be established to this effect.

(ii) Information related to site characterization; residual soil contamination levels; on-site locations used for burials of radioactive materials; hydrology and geology with particular emphasis on problem areas that could contribute to ground-water or surface-water contamination; and locations of surface impoundments, waste water ponds, lagoons, and well field aquifer anomalies.

(iii) As-built drawings or photographs of structures, equipment, restricted areas, well fields, areas where radioactive materials are stored, and any modifications showing the locations of these structures and systems through time.

(iv) Drawings of areas of possible inaccessible contamination, including features such as buried pipes or pipelines.

(v) Pre-operational background radiation levels at and near the site.

These records will be kept in an identifiable, and, preferably, separate file.

(4) The licensee demonstrates that records can be provided to a new owner or new licensee in the event that the property or license is transferred, or to NRC, after license termination.

(5) New licensees or owners indicate that any such records received from the previous owner or licensee will be retained along with their own records to be turned over to NRC after license termination.

(6) Records will be maintained as hard copy originals, as copies on microfiche, or will be electronically protected, and will be readily retrievable for NRC inspection.

5.3.2.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the record keeping and record retention program, the following conclusions may be presented in the technical evaluation report.

NRC has completed its review of the record keeping and record retention program proposed for use at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 5.3.2.2 and the acceptance criteria outlined in standard review plan Section 5.3.2.3.

The applicant has proposed an acceptable record keeping and record retention program that will be adequate to ensure that the licensee is able to track, control, and demonstrate control over the source and byproduct materials that are processed, produced, or stored at the facility during its operating life, through decommissioning, and to license termination. The record keeping plans are demonstrated to assist the applicant in ensuring that both on-site and off-site exposures are kept within regulatory limits and in documenting compliance with NRC regulations. The applicant has demonstrated an acceptable program to maintain records on spills, likely contamination events, and unusual occurrences for use in calculating annual surety amounts and to ensure complete decommissioning. The applicant has demonstrated an awareness of, and a commitment to, the long-term need to maintain records on decommissioning, on-site and off-site disposal, personnel exposure, and off-site releases of radioactivity, as a permanent record for the facility that will be transferred to any new owner or licensee, and then ultimately to NRC, before license termination.

Based on the information provided in the application and the detailed review conducted of the proposed record keeping and record retention program for the _____ *in situ* leach facility, the staff concludes that the proposed record keeping and record retention plans are acceptable and are in compliance with 10 CFR Part 20, Subpart L, which defines requirements for record keeping; 10 CFR 40.61(d) and (e), which also define requirements for record keeping; and 10 CFR Part 40, Appendix A, Criteria 8 and 8A, which specify documentation requirements for airborne effluents and waste retention systems.

5.3.2.5 References

None.

5.4 Qualifications for the Health Physics Organization Staff

5.4.1 Areas of Review

The staff should review descriptions of the minimum qualifications and experience levels required for personnel who will be assigned the responsibility for developing, conducting, and administering the radiation safety program. The staff should also review the qualifications of people specifically proposed for these positions.

5.4.2 Review Procedures

The reviewer should determine whether the minimum qualifications and experience levels required for personnel who will be assigned the responsibility for developing, conducting, and administering the radiation safety program are sufficient to meet the guidance provided by Draft Regulatory Guide DG–8027 (NRC, 2000). The staff should also determine whether the qualifications of people specifically proposed for these positions are consistent with the minimum qualifications and experience levels.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

5.4.3 Acceptance Criteria

The qualifications of radiation safety personnel are acceptable if they meet the following criteria:

(1) The personnel meet minimum qualifications and experience for radiation safety staff that are consistent with Draft Regulatory Guide DG–8027, Section 2.4 (NRC, 2000). The emphasis of this guidance is for uranium mills; however, the training requirements apply equally to *in situ* leach facilities.

5.4.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the qualifications of facility personnel conducting the radiation safety program, the following conclusions may be presented in the technical evaluation report.

NRC has completed its review of the qualifications of facility personnel conducting the radiation safety program at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 5.4.2 and the acceptance criteria outlined in standard review plan Section 5.4.3.

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The qualifications of personnel conducting the radiation safety program at the _____ *in situ* leach site are acceptable as they meet the requirements of NRC Draft Regulatory Guide DG–8027 (NRC, 2000).

Based on the information provided in the application and the detailed review conducted of the qualifications of the personnel conducting the radiation safety program for the_____ *in situ* leach facility, the staff concludes that the qualifications of the personnel are acceptable and are in compliance with 10 CFR 20.1101, which defines radiation protection program requirements, and 10 CFR 40.32(b), which provides requirements for applicant qualifications.

5.4.5 Reference

NRC. Draft Regulatory Guide DG–8027, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills Will Be As Low As Is Reasonably Achievable." Washington, DC: NRC, Office of Nuclear Regulatory Research. 2000.

5.5 Radiation Safety Training

5.5.1 Areas of Review

The staff should review the proposed employee radiological protection training program, including the content of the initial training or indoctrination, testing, on-the-job training, and the extent and frequency of retraining. This material will most likely be presented as an appendix to the application. The staff should also review the proposed written radiological safety instructions that will be provided to employees to include personal hygiene, contamination surveying before eating or leaving the operating area, requirements for personal monitoring devices and respirators, house keeping requirements, spill cleanup procedures, and emergency actions.

5.5.2 Review Procedures

The staff should determine whether the applicant has procedures for an employee radiological protection training program that are adequate to provide radiological safety instructions to the employees. The staff should also determine whether the proposed written radiological safety instructions that will be provided to employees are sufficiently detailed to meet acceptance criteria identified in Section 5.5.3.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

5.5.3 Acceptance Criteria

The training program is acceptable if it meets the following criteria:

(1) It is consistent with the approach described in Draft Regulatory Guide DG–8027, Section 2.5 (NRC, 2000).

This guide recommends that before beginning their jobs, all new employees should be instructed, by means of an established course, in the inherent risks of exposure to radiation and the fundamentals of protection against exposure to uranium and its daughters.

(2) It is consistent with Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure, Revision 3" (NRC, 1999).

This guide provides guidance for protection of the fetus.

(3) It is consistent with Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure, Revision 1" (NRC, 1996).

This guide provides a basis for training employees on the risks from radiation exposure in the work place.

5.5.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the radiological protection training program for personnel, the following conclusions may be presented in the technical evaluation report.

NRC has completed its review of the radiation safety training program for personnel conducting the radiation safety program and personnel entering restricted area at the _____*in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 5.5.2 and the acceptance criteria outlined in standard review plan Section 5.5.3.

The radiation safety training program for personnel at the _____*in situ* leach site adheres to the guidance and acceptable approaches contained in NRC Regulatory Guides DG–8027 (NRC, 2000), 8.13 (NRC, 1999), and 8.29 (NRC, 1996). The content of the training material, testing, on-the-job training, and the extent and frequency of retraining are acceptable. Acceptable written safety instructions for employees have been produced.

Based on the information provided in the application and the detailed review conducted of the radiological protection training program for personnel for the _____ *in situ* leach facility, the staff concludes that the radiation safety training program is acceptable and is in compliance with 10 CFR 20.1101, which defines radiation protection program requirements, and 10 CFR 40.32(b), as it relates to applicant qualifications through training.

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5.5.5 References

NRC. Draft Regulatory Guide DG–8027, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Mills Will Be As Low As Is Reasonably Achievable." Washington, DC: NRC, Office of Nuclear Regulatory Research. 2000.

———. Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure." Revision 3. Washington, DC: NRC, Office of Standards Development. 1999.

———. Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure, Revision 1." Washington, DC: NRC, Office of Standards Development. 1996.

5.6 Security

5.6.1 Areas of Review

The staff should review the security measures proposed to prevent unauthorized entry into the controlled area.

5.6.2 Review Procedures

The staff should determine whether the proposed security measures are sufficient to prevent unauthorized entry into the controlled area in accordance with regulatory requirements in 10 CFR Part 20, Subpart I.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

5.6.3 Acceptance Criteria

The security program is acceptable if the applicant has acceptable passive controls, such as fencing for well fields, and active controls, such as daily inspections and locks for plant buildings.

5.6.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the security measures, the following conclusions may be presented in the technical evaluation report and environmental assessment.

NRC has completed its review of the security measures at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 5.6.2 and the acceptance criteria outlined in standard review plan Section 5.6.3.

The security measures at the _____ *in situ* leach site demonstrate that the applicant has acceptable active and passive constraints on entry to the licensed and restricted areas. The applicant has identified acceptable passive controls including barbed wire fencing, locked gates, and warning signage for site control and active security systems for buildings.

Based on the information provided in the application and the detailed review conducted of the security measures for the _____ *in situ* leach facility, the staff concludes that the security measures are acceptable and are in compliance with 10 CFR Part 20, Subpart I, which provides requirements for the security of stored material and control of material not in storage.

5.6.5 References

None.

5.7 Radiation Safety Controls And Monitoring

5.7.1 Effluent Control

5.7.1.1 Areas of Review

The staff should review descriptions of the systems and procedures (e.g., ventilation, confinement, filtration) designed to minimize in-plant and environmental emissions at each step of the process where releases might occur. Major airborne radioactive effluents include radioactive particulates (from drying and packaging areas) and radon gas emanating from production solutions. Radon gas mobilization can occur from recovery solutions at process locations where systems allow venting. The staff should evaluate effluent control systems for uranium particulate emissions located in drying and packaging areas and in any other areas where release of significant quantities of uranium particulate is a concern. Closed systems can eliminate releases of uranium particulates and radon gas. For example, the use of vacuum packaging equipment has been shown to eliminate uranium releases from packaging operations.

Common liquid effluent sources are process bleed, process solutions (e.g., backwash, resin transfer waters), and wash-down water. The staff should review the facility design for containment of contamination from spills resulting from normal operations and probable accidents (e.g., tank, valve, or pipe joint failure). For surface impoundments used in the management of 11e.(2) byproduct material, the staff should also review engineering design to ensure proper containment performance, and evaluate leak detection and monitoring systems for surface impoundments containing contaminated effluents.

The staff reviews should include minimum performance specifications such as filtration or scrubber efficiency and ventilation airflow at their reasonably expected best performance and the frequency of tests and inspections to ensure that these specifications are being met.

The staff should review contingency plans and notification requirements to be implemented in the event of equipment failures, spills, or excursions.

5.7.1.2 Review Procedures

The staff should determine whether the proposed safety controls and monitoring procedures are sufficient to limit radiation exposures and radioactive releases to as low as is reasonably achievable and to ensure conformance with regulatory requirements identified in 10 CFR Part 20.

In general, the staff should be familiar with 10 CFR Part 40, Appendix A, Criterion 8 and Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable" (NRC, 1977). Additional guidance is found in Regulatory Guide 8.37, "ALARA Levels for Effluent from Materials Facilities" (NRC, 1993); Draft Regulatory Guide DG–8027, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mill Will Be As Low As Is Reasonably Achievable" (NRC, 2000); and Regulatory Guide 3.56, "General Guidance for Designing, Testing, Operating, and Maintaining Emission Control Devices at Uranium Mills" (NRC, 1986). The staff should determine whether the proposed systems and procedures (e.g., ventilation, confinement, filtration) are acceptably described and sufficient to control in-plant and environmental emissions at each step of the process where releases might occur. The staff should ensure that minimum performance specifications for ventilation, filtration, and confinement systems throughout the recovery plant and laboratories are provided and are consistent with assumptions made in exposure estimates for areas of the facility where the systems are operating. The staff should also check that the frequencies of equipment tests and inspections are consistent with manufacturers recommendations to ensure that these specifications are being met. Contingencies for equipment failures, maintenance shutdowns, and spills should be reviewed to ensure procedures are in place to maintain exposures as low as is reasonably achievable.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

5.7.1.3 Acceptance Criteria

The radiation safety controls and monitoring program for effluents is acceptable if it meets the following criteria:

(1) Radon gas from processing tanks within enclosed buildings is properly controlled.

Effective control of radon gas can be achieved by using a pressurized processing tank system that eliminates venting in process buildings, or by using appropriate ventilation systems in buildings where radon gas venting is expected.

(2) Emissions from yellowcake drying operations are properly controlled.

Acceptable control of yellowcake emissions from the dryer is achieved by meeting the criteria of 10 CFR Part 40, Appendix A, Criterion 8 and Regulatory Guide 3.56, Section 1 (NRC, 1986).

(3) Release of liquids into surface waters must comply with the public dose limits in 10 CFR 20.1301, which may be demonstrated by one of the following methods:

(a) The licensee demonstrates compliance with 10 CFR Part 20, Appendix B, by one of the following methods and shows that if an individual were continuously present in an unrestricted area, the dose from external sources would not exceed 0.02 mSv/hr [2 mrem/hr] or 0.5 mSv/yr [50 mrem/yr]:

(i) Showing that the discharge of effluent from any surface impoundment is within 10 CFR Part 20, Appendix B, limits at the point of discharge.

(ii) Monitoring the incoming process water to demonstrate compliance with the effluent discharge requirements of 10 CFR Part 20, Appendix B, for process water.

(b) The licensee demonstrates that the total effective dose equivalent to the individual likely to receive the highest dose from the facility does not exceed the annual dose limit for the public.

(4) The applicant describes minimum performance specifications for the operation of the effluent control systems and the frequencies of tests and inspections to ensure proper performance to specifications. Details of acceptable excursion control techniques are found in Section 5.7.8.3 of this standard review plan.

Acceptable methods for testing, maintenance, and inspection of effluent control systems are given in Regulatory Guide 3.56, Section 1 (NRC, 1986).

(5) Record keeping for the effluent control system is sufficient to meet requirements in 10 CFR 20.2103(b)(4).

(6) The applicant describes emergency procedures in the event of equipment failures or spills, references existing emergency procedures, or commits to the development of emergency procedures.

For license renewal applications, the historical effluent control program summary is included through the most recent reporting period preceding the submittal of the application.

The effectiveness of the historical program should be discussed with regard to all applicable 10 CFR Part 20 regulatory requirements identified in the preceding paragraphs. Long-term trends should be discussed, and any short-term deviations from the long-term trend should be explained.

(7) The effluent control techniques are designed to keep exposures to members of the public as low as is reasonably achievable as described in Regulatory Guide 8.37, Section 2 (NRC, 1993).

(8) The effluent control techniques are designed to limit exposures to members of the public from emissions to air (excluding Radon-222 and progeny) to no greater than 0.1 mSv [10 mrem/yr].

5.7.1.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the radiation safety controls and monitoring for effluents, the following conclusions may be presented in the technical evaluation report and environmental assessment.

NRC has completed its review of the radiation safety controls and monitoring program for effluents at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 5.7.1.2 and the acceptance criteria outlined in standard review plan Section 5.7.1.3.

The applicant has an acceptable radiation safety controls and monitoring program for effluents at the _____ *in situ* leach site and has demonstrated that important effluent streams are controlled and monitored. The applicant has used an acceptable pressurized processing tank system or appropriate ventilation systems in buildings where radon gas is vented. Acceptable control of the yellowcake dryer system is evidenced by a vacuum dryer or other appropriate particulate scrubber equipment on the dryer stack. The applicant has shown that the discharge of process water is within the dose limits of 10 CFR 20.1301. The applicant has demonstrated acceptable effluent control systems and associated test and inspection frequencies to ensure specified performance. Record keeping and monitoring procedures are acceptable. Acceptable emergency procedures for managing equipment failures or spills are identified by the applicant.

Based on the information provided in the application and the detailed review conducted of the radiation safety controls and monitoring program for effluents at the _____ *in situ* leach facility, the staff concludes that this program is acceptable and is in compliance with 10 CFR 20.1301, which provides dose limits for members of the public; 10 CFR 20.1101, which defines radiation protection program and as low as is reasonably achievable requirements; 10 CFR 20.1201(a), which provides occupational dose limits; and 10 CFR Part 20, Subpart M, which defines requirements for reports. An evaluation of proposed effluent control techniques is contained in Section 5.7.1.3 of this standard review plan. In addition, the staff concludes that the equipment and procedures meet the requirements of 10 CFR 40.32(b) to protect health and minimize danger to life and property, and 10 CFR Part 40, Appendix A, Criterion 8, which specifies standards for yellowcake dryer operations.

5.7.1.5 References

NRC. Draft Regulatory Guide DG–8027, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills Will Be As Low As Is Reasonably Achievable." Washington, DC: NRC, Office of Nuclear Regulatory Research. 2000.

———. Regulatory Guide 8.37, "ALARA Levels for Effluent from Materials Facilities." Washington, DC: NRC, Office of Standards Development. 1993.

———. Regulatory Guide 3.56, "General Guidance for Designing, Testing, Operating, and Maintaining Emission Control Devices at Uranium Mills." Washington, DC: NRC, Office of Standards Development. 1986.

———. Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as low as is Reasonably Achievable." Revision 1–R. Washington, DC: NRC, Office of Standards Development. 1977.

5.7.2 External Radiation Exposure Program

5.7.2.1 Areas of Review

The staff should review survey methods, instrumentation, and equipment for determining exposures of employees to external radiation during routine and nonroutine operations, maintenance, and cleanup activities. This review should include the types of surveys conducted, criteria for determining survey locations, frequency of surveys, action levels, management audits, and corrective action requirements. Staff should also review the program for personal monitoring with the criteria for including workers in the program, the sensitivity and range of devices used, and calibration frequency and methods.

5.7.2.2 Review Procedures

The staff should determine whether proposed monitoring methods, instrumentation, and equipment are sufficient to meet the regulatory requirements for determining the exposures of employees to external radiation (10 CFR 20.1203). In conducting its review, the staff should ensure that the applicant has provided one or more charts that identify the facility layout and the location of monitors for external radiation as well as providing acceptable criteria for determining the sampling locations. The staff should ensure all monitoring equipment will be identified by type with additional specification of the range, sensitivity, calibration methods and frequency, availability, and planned use. Staff should ensure that the proposed monitoring program is sufficient to adequately protect workers from hazards of beta radiation (skin, extremity, lens of eye) resulting from the decay products of U-238 when effective shielding is not present (e.g., maintenance operations). The staff should also ensure that the monitoring program is acceptable to detect and control gamma radiation from uranium decay products in areas where large volumes of uranium may be present (e.g., processing tanks, yellowcake storage areas).

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

5.7.2.3 Acceptance Criteria

The external radiation exposure monitoring program is acceptable if it meets the following criteria:

(1) The application contains one or more drawings that depict the facility layout and the location of monitors for external radiation. Criteria for determining the sampling locations, are consistent with Regulatory Guide 4.14, Sections 1.1.1 and 2.1.2 (NRC, 1980).

(2) The application provides criteria to be used in establishing which employees are to receive external exposure monitoring. These criteria are consistent with Regulatory Guide 8.34, "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses," Section C (NRC, 1992).

(3) Monitoring equipment is identified by type, sensitivity, calibration methods and frequency, availability, and planned use to protect health and safety and the environment. The application also demonstrates that the ranges of sensitivity are those expected from the facility operation.

(4) All monitoring equipment has a lower limit of detection that allows measurement of 10 percent of the applicable limits. Planned surveys of external radiation are consistent with the guidance in Regulatory Guide 8.30, "Health Physics Surveys in Uranium Mills," Section 1 (NRC, 1983).

(5) Plans for documentation of radiation exposures are consistent with the approach in Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Exposure Data, Revision 1" (NRC, 1982).

(6) The application presents levels for corrective action that are consistent with the 10 CFR Part 20 regulatory requirements.

(7) Radiation doses will be kept as low as is reasonably achievable by following Regulatory Guide 8.10 (NRC, 1980) and Draft Regulatory Guide DG–8027 (NRC, 2000a).

(8) The applicant monitoring program is adequate to protect workers from hazards of beta radiation (skin, extremity, lens of eye) resulting from the decay products of uranium-238 when effective shielding is not present (e.g., maintenance operations) and is consistent with Draft Regulatory Guide DG–8026 (NRC, 2000b).

(9) The monitoring program is sufficient to detect and control gamma radiation from uranium decay products in areas where large volumes of uranium may be present (e.g., processing tanks, yellowcake storage areas) and is consistent with Draft Regulatory Guide DG–8026 (NRC, 2000b).

(10) The program for external exposure monitoring and determining doses from external exposure is consistent with Regulatory Guide 8.34, Section C (NRC, 1992).

5.7.2.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the external radiation exposure monitoring program, the following conclusions may be presented in the technical evaluation report.

NRC has completed its review of the external radiation exposure monitoring program at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 5.7.2.2 and the acceptance criteria outlined in standard review plan Section 5.7.2.3.

The applicant has an acceptable external radiation exposure monitoring program at the _____ *in situ* leach site. The applicant has provided an acceptable drawing(s) that depicts the facility layout and the location of external radiation monitors. The external radiation monitors are acceptably placed. The applicant has established appropriate criteria to determine which employees should receive external radiation monitoring. The applicant has demonstrated that the range, sensitivity, and calibration of external radiation monitors will protect health and safety of employees during the full scope of facility operations. Planned radiation surveys are adequate. Planned documentation of radiation exposures is acceptable. The applicant monitoring is acceptable to protect workers from beta and gamma radiation.

Based on the information provided in the application and the detailed review conducted of the external radiation exposure monitoring program at the _____ *in situ* leach facility, the staff concludes that the external radiation exposure monitoring program is acceptable and is in compliance with 10 CFR 20.1101, which defines a radiation protection program and as low as is reasonably achievable requirements; 10 CFR 20.1201(a), which defines occupational dose limits; 10 CFR 20.1501, which provides requirements of surveying and radiation monitoring; 10 CFR 20.1502, which defines conditions requiring individual monitoring of external dose; 10 CFR Part 20, Subpart L, which specifies record keeping requirements; and 10 CFR Part 20, Subpart M, which defines reporting requirements.

5.7.2.5 References

NRC. Draft Regulatory Guide DG–8027, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Is Reasonably Achievable." Washington, DC: NRC, Office of Nuclear Regulatory Research. 2000a.

———. Draft Regulatory Guide DG–8026, "Health Physics Surveys in Uranium Mills." Washington, DC: NRC, Office of Nuclear Regulatory Research. 2000b.

———. Regulatory Guide 8.34, "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses." Washington, DC: NRC, Office of Standards Development. 1992.

———. Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Exposure Data." Revision 1. Washington, DC: NRC, Office of Standards Development. 1982.

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———. Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills." Washington, DC: NRC, Office of Standards Development. 1980.

———. Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable." Washington, DC: NRC, Office of Standards Development. 1977.

5.7.3 Airborne Radiation Monitoring Program

5.7.3.1 Areas of Review

The staff should review the proposed airborne radiation monitoring program to determine concentrations of airborne radioactive materials (including radon) during routine and nonroutine operations, maintenance, and cleanup. This review should include criteria for determining sampling locations and sampling frequency with respect to process operations and personnel occupancy, as well as analytical procedures and sensitivity and instrument calibration requirements. Action levels, audits, and corrective action requirements should also be evaluated. This information may be presented in an appendix to the application.

5.7.3.2 Review Procedures

The staff should determine whether the safety controls and monitoring procedures proposed by the applicant are sufficient to limit radiation exposures and radioactive releases to as low as is reasonably achievable and are in conformance with regulatory requirements identified in 10 CFR Part 20. The staff should evaluate whether the proposed sampling program to determine concentrations of airborne radioactive materials (including radon) during routine and nonroutine operations, maintenance, and cleanup is in conformance with the regulatory requirements identified in 10 CFR 20.1301; 20.1501; 20.1502; 20.1204; and the other applicable requirements listed in Section 5.7.3.3 of this standard review plan.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

5.7.3.3 Acceptance Criteria

The airborne radiation monitoring program is acceptable if it meets the following criteria:

(1) The applicant provides one or more drawings that depict the facility layout and the location of samplers for airborne radiation. Locations are based, in part, on a determination of airflow patterns in areas where monitoring is needed, and determination of monitoring locations is consistent with Draft Regulatory Guide DG–8026, "Health Physics Surveys in Uranium Recovery Facilities," (NRC, 2000a).

(2) Monitoring equipment is identified by type, sensitivity, calibration methods and frequency, availability, and planned use to protect health and safety and the

environment. The application also demonstrates that the ranges of sensitivity are those expected from the facility operation.

(3) Planned surveys of airborne radiation are consistent with the guidance in Regulatory Guide 8.24, Section 1 (NRC, 1979) and Draft Regulatory Guide DG–8026 (NRC, 2000a).

(4) The proposed monitoring program is sufficient to adequately protect workers from radon gas releases from venting of processing tanks and from yellowcake dust from drying operations, spills, and maintenance activities and is consistent with Regulatory Guide 4.14, Sections 1.1 and 2.1 (NRC, 1980). The air sampling program is consistent with Draft Regulatory Guide DG–8026 (NRC, 2000a).

(5) Plans for documentation of radiation exposures are consistent with the requirements in 10 CFR 20.2102, 20.2103, 20.2106, and 20.2110.

(6) The applicant demonstrates that respirators will routinely be used for operations within drying and packaging areas and identifies the criteria for determining when respirators will be required for special jobs or emergency situations. The respiratory protection program should be consistent with guidance in Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection" (NRC, 1976) and Draft Regulatory Guide DG–8027, Section 2.7 (NRC, 2000b).

(7) For license renewal applications, the historical results summary of the airborne radiation monitoring program is included through the most recent reporting period preceding the submittal of the application. The effectiveness of the historical program is discussed with regard to all applicable 10 CFR Part 20 regulatory requirements identified in the preceding paragraphs. Long-term trends are discussed, and any short-term deviations from the long-term trends are explained.

5.7.3.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the airborne radiation monitoring program, the following conclusions may be presented in the technical evaluation report.

NRC has completed its review of the airborne radiation monitoring program at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 5.7.3.2 and the acceptance criteria outlined in standard review plan Section 5.7.3.3.

The applicant has an acceptable airborne radiation monitoring program at the _____ *in situ* leach site. The applicant has provided an acceptable chart(s) that depicts the facility layout and the location of airborne radiation monitors. The airborne radiation monitors are acceptably placed. The applicant demonstrated that the range, sensitivity, and calibration of monitors of airborne radiation will support protection of the health and safety of employees during facility operations. The workers are acceptably protected from radon gas

releases from venting of processing tanks and from yellowcake dust from drying operations, spills, and maintenance activities. Planned radiation surveys are acceptable. Planned documentation of radiation exposures is consistent with the requirements. The applicant respiratory protection program is acceptable. The applicant program for monitoring uranium and sampling of radon or its daughters is acceptable, and the results of this monitoring will be used for employee exposure calculations.

Based on the information provided in the application and the detailed review conducted of the airborne radiation monitoring program at the _____ *in situ* leach facility, the staff has concluded that the airborne radiation monitoring program is acceptable and is in compliance with 10 CFR 20.1101, which defines radiation protection program and as low as is reasonably achievable requirements; 10 CFR 20.1201(a), which provides individual occupational dose limits; 10 CFR 20.1201(e), which specifies allowed intake of soluble uranium; 10 CFR 20.1202, which describes the means of compliance when summing internal and external doses; 10 CFR 20.1203, for determination of dose from airborne external radiation; 10 CFR 20.1208, which specifies the exposure limits to a fetus during pregnancy; 10 CFR 20.1301 which identifies public dose limits; 10 CFR 20.1702, which allows employees to limit dose to individuals by controlling access, limiting exposure times, prescribing use of respiratory equipment, or use of other controls; 10 CFR Part 20, Subpart L, which specifies record keeping requirements; 10 CFR Part 20, Subpart M, which provides requirements for reports and notification; and 10 CFR Part 40, Appendix A, Criterion 8, which provides requirements for control of airborne effluents.

5.7.3.5 References

NRC. Draft Regulatory Guide DG–8026, "Health Physics Surveys in Uranium Mills." Washington, DC: NRC, Office of Nuclear Regulatory Research. 2000a.

———. Draft Regulatory Guide DG–8027, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills Will Be As Low As Reasonably Achievable." Washington, DC: NRC, Office of Nuclear Regulatory Research. 2000b.

———. Regulatory Guide 4.1.4, "Radiological Effluent and Environmental Monitoring at Uranium Mills." Washington, DC: NRC, Office of Standards Development. 1980.

———. Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection." Washington, DC: NRC, Office of Standards Development. 1976.

5.7.4 Exposure Calculations

5.7.4.1 Areas of Review

The staff should review the procedures proposed to determine the exposure to radioactive materials by personnel in work areas where airborne radioactive materials could exist. This review should include procedures for determining exposures during routine and nonroutine operations, maintenance, and cleanup activities.

5.7.4.2 Review Procedures

The staff should evaluate whether the procedures proposed to determine the intake of radioactive materials by personnel in work areas where airborne radioactive materials could exist are in accordance with 10 CFR 20.1204 and 20.1201. The review should also place emphasis on the parameters used in exposure calculations to ensure they are representative of conditions at the site. Estimation of airborne uranium concentrations should take into account the maximum production capacity requested in the application and the anticipated efficiencies of airborne particulate control systems described in Section 5.7.1 of this standard review plan.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

5.7.4.3 Acceptance Criteria

The exposure calculations are acceptable if they meet the following criteria:

(1) The procedures proposed to determine the intake of radioactive materials by personnel in work areas where airborne radioactive materials could exist are in accordance with 10 CFR 20.1204 and 20.1201.

(2) Exposure calculations for natural uranium are consistent with Draft Regulatory Guide DG–8026, Section 3 (NRC, 2000).

For natural uranium, the 10 mg/wk intake limit for protection against kidney toxicity specified in 10 CFR 20.1201(e) is more limiting than the derived air concentrations provided in 10 CFR Part 20, Appendix B, for solubility Classes D and W. The most conservative being solubility class (Y) which should be used in the absence of site-specific solubility characterization results.

(3) For airborne radon daughter exposure (working levels), calculations are consistent with Draft Regulatory Guide DG–8026 (NRC, 2000) and Regulatory Guide 8.34, Section C (NRC, 1992a).

(4) Calculations for prenatal and fetal radiation exposure are consistent with Regulatory Guide 8.36, "Radiation Dose to the Embryo/Fetus" (NRC, 1992b) and Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure" (NRC, 1999).

(5) Exposure calculations are presented for routine operations, nonroutine operations, maintenance, and cleanup activities and are consistent with Draft Regulatory Guide DG–8026 (NRC, 2000) and Regulatory Guide 8.34, Section C (NRC, 1992a).

(6) Parameters used in exposure calculations are representative of conditions at the site and include the time-weighted exposure that incorporates occupancy time and average airborne concentrations.

For example, the time of exposure may be arbitrarily set at 40 hours per week; however, workers at some facilities may regularly work longer shifts. Both full-time and part-time employees should be considered in these calculations.

(7) Estimation of airborne uranium concentrations takes into account the maximum production capacity requested in the application and the anticipated efficiencies of airborne particulate control systems described in Sections 4.1 and 5.7.1 of this standard review plan.

(8) All reporting and record keeping of worker doses is done in conformance with Regulatory Guide 8.7 (NRC, 1982) and 10 CFR 20.2103.

(9) For license renewal applications, the historical results of radiation exposure calculations are included through the most recent reporting period preceding the submittal of the application. The effectiveness of historical radiation exposure calculations is discussed with regard to applicable 10 CFR Part 20 regulatory requirements.

5.7.4.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the exposure calculations, the following conclusions may be presented in the technical evaluation report.

NRC has completed its review of the exposure calculations at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 5.7.4.2 and the acceptance criteria outlined in standard review plan Section 5.7.4.3.

The applicant has provided acceptable techniques for exposure calculations at the _____ *in situ* leach site. The applicant has provided procedures allowing determination of intake of radioactive materials by personnel in work areas. The applicant exposure calculations for natural uranium and airborne radon daughter exposure are acceptable and are in conformance with the guidance in Draft Regulatory Guide DG–8026 (NRC, 2000) and Regulatory Guide 8.34 (NRC, 1992a). The applicant has acceptable procedures for calculating prenatal and fetal radiation exposures consistent with Regulatory Guides 8.13 (NRC, 1999) and 8.36 (NRC, 1992b). All exposure calculation methods for routine operations, nonroutine operations, maintenance, and cleanup activities are acceptable and are consistent with Draft Regulatory Guide DG–8026 (NRC, 2000) and Regulatory Guide 8.34 (NRC, 1992a). The applicant has used parameters that are representative of the site, such as using both full- and part-time workers in exposure calculations. The applicant has considered maximum production capacity and anticipated efficiencies of airborne particulate control systems in providing procedures for exposure calculations. All reporting and record keeping is in conformance with Regulatory Guide 8.7 (NRC, 1982).

Based on the information provided in the application and the detailed review conducted of the exposure calculations at the _____ *in situ* leach facility, the staff has concluded that the exposure calculations are acceptable and are in compliance with 10 CFR 20.1101, which defines radiation protection program requirements; 10 CFR 20.1201(a), which specifies

individual occupational dose limits; 10 CFR 20.1201(e), which defines allowed intake of soluble uranium; 10 CFR 20.1202, which describes the means of compliance when summing internal and external doses; 10 CFR 20.1203 for determination of dose from airborne external radiation; 10 CFR 20.1204, which provides requirements for determination of internal exposure; and 10 CFR 20.1208, which specifies the exposure limits for a fetus.

5.7.4.5 References

NRC. Draft Regulatory Guide DG–8026, "Health Physics Surveys in Uranium Mills." Washington, DC: NRC, Office of Nuclear Regulatory Research. 2000.

———. Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure." Revision 3. Washington, DC: NRC, Office of Standards Development. 1999.

———. Regulatory Guide 8.3, "Monitoring Criteria and Methods To Calculate Occupational Radiation Doses." Washington, DC: NRC, Office of Standards Development. 1992a.

———. Regulatory Guide 8.36, "Radiation Dose to the Embryo/Fetus." Washington, DC: NRC, Office of Standards Development. 1992b.

———. Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Exposure Data." Revision 1. Washington, DC: NRC, Office of Standards Development. 1982.

5.7.5 Bioassay Program

5.7.5.1 Areas of Review

The staff should review descriptions of the bioassay program proposed to confirm results derived from the airborne radiation monitoring program (standard review plan Section 5.7.3) and the exposure calculations (standard review plan Section 5.7.4). The staff should review the criteria for including workers in the bioassay program, the types and frequencies of bioassays performed, and action levels applied to the results.

5.7.5.2 Review Procedures

The staff should determine whether the bioassay program proposed to confirm results determined in the airborne radiation monitoring program (standard review plan Section 5.7.3) and the exposure calculations (standard review plan Section 5.7.4) is adequate. The staff should review the bioassay program to ensure that it is consistent with applicable sections of Regulatory Guide 8.22, "Bioassay at Uranium Mills" (NRC, 1988). The staff review should check to ensure that all workers who are routinely exposed to yellowcake dust are included in the bioassay program and that sampling and analysis frequencies are sufficient to detect and take action against high intakes of uranium in the workplace. Primarily, the program should involve workers stationed in yellowcake drying areas and those who conduct regular maintenance on drying and ventilation/filtration equipment.

Operations

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

5.7.5.3 Acceptance Criteria

The bioassay program is acceptable if it meets the following criteria:

(1) It is consistent with applicable sections of Regulatory Guide 8.22 (NRC, 1988) and Draft Regulatory Guide DG–8027 (NRC, 2000) including as low as is reasonably achievable requirements. The bioassay program proposed to confirm results determined from the airborne radiation monitoring program (standard review plan Section 5.7.3) and the exposure calculations (standard review plan Section 5.7.4) is adequate.

(2) The determination of which workers will be monitored in the bioassay program is consistent with Regulatory Guide 8.22, Section 2 (NRC, 1988).

(3) Sampling and analysis frequencies include baseline urinalyses for all new employees and exit bioassays on termination of employment and are consistent with Regulatory Guide 8.22, Section 4 (NRC, 1988) and Regulatory Guide 8.9, "Acceptable Concepts, Equations, and Assumptions for a Bioassay Program" (NRC, 1973).

(4) Action levels for bioassay monitoring are set in accordance with Regulatory Guide 8.22, Section 5 (NRC, 1988).

Any time a uranium action level of 35 micrograms per liter (ug/l) for two consecutive urine specimens or 130 ug/l for any one specimen is reached or exceeded, the licensee will provide documentation within 30 days to the NRC indicating what corrective actions have been performed. A license condition will be established to this effect.

(5) All reporting and record keeping are done in conformance with the requirements of 10 CFR Part 20, Subpart L.

Any time uranium in a worker's urine specimen exceeds 15 micrograms per liter (ug/l), the annual as low as is reasonably achievable audit (addressed in Section 5.3.1 of this standard review plan) will indicate what corrective actions were considered or performed. A license condition will be established to this effect.

(6) For license renewal applications, the historical bioassay program results are included through the most recent reporting period preceding the submittal of the application. The effectiveness of the historical program is discussed with regard to all applicable 10 CFR Part 20 regulatory requirements. Long-term trends are discussed, and any short-term deviations from the long-term trend are explained.

5.7.5.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the bioassay program, the following conclusions may be presented in the technical evaluation report.

NRC has completed its review of the bioassay program at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 5.7.5.2 and the acceptance criteria outlined in standard review plan Section 5.7.5.3.

The applicant has established an acceptable bioassay program at the _____ *in situ* leach site that is consistent with Regulatory Guide 8.22 (NRC, 1988). An acceptable program for baseline urinalysis and exit bioassay is in place. Individuals routinely exposed to yellowcake dust are a part of the bioassay program. An acceptable action program to curtail uranium intake is established, and appropriate actions levels are set. The applicant has established reporting and record keeping protocols in conformance with the requirements of 10 CFR Part 20, Subpart L.

Based on the information provided in the application and the detailed review conducted of the bioassay program at the _____ *in situ* leach facility, the staff concludes that the bioassay program is acceptable and is in compliance with 10 CFR 20.1204, which provides requirements for the determination of internal exposure; and 10 CFR Part 20, Subpart L, which establishes record keeping requirements.

5.7.5.5 References

NRC. Draft Regulatory Guide DG–8027, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills Will Be As Low As Reasonably Achievable." Washington, DC: NRC, Office of Nuclear Regulatory Research. 2000.

———. Regulatory Guide 8.22, "Bioassay at Uranium Mills." Revision 1. Washington, DC: NRC, Office of Standards Development. 1988.

———. Regulatory Guide 8.9, "Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program." Washington, DC: NRC, Office of Standards Development. 1973.

5.7.6 Contamination Control Program

5.7.6.1 Areas of Review

The staff should review the occupational radiation survey program proposed to prevent employees from entering clean areas or leaving the site while contaminated with radioactive materials. Review areas include proposed housekeeping and cleanup requirements and specifications in process areas to control contamination; frequency of surveys of clean areas; survey methods; and minimum sensitivity, range, and calibration frequency of survey equipment. Proposed contamination criteria or action levels for clean areas and for the release

of materials, equipment, and work clothes from clean areas or from the site should be evaluated. Related procedures should be provided as an appendix to the application. The staff should also review the methods proposed to ensure that the licensee reduces residual contamination below limits before recommended release of equipment for unrestricted use.

5.7.6.2 Review Procedures

The staff should determine whether the proposed safety controls and monitoring procedures proposed by the applicant are sufficient to limit radiation exposures and radioactive releases to as low as is reasonably achievable and are in conformance with regulatory requirements identified in 10 CFR Part 20.

The staff should determine whether the occupational radiation survey program proposed to prevent contaminated employees from entering clean areas or leaving the site is in conformance with regulatory requirements in 10 CFR 20.1702 and relevant guidance. Requirements for a contamination control program (e.g., maintaining change areas and personal alpha radiation monitoring before leaving radiation areas) should be included in standard operating procedures or discussed in the application. The staff should confirm that the license applicant has a contamination control program consistent with the guidance on conducting surveys for contamination of skin and personal clothing provided in Draft Regulatory Guide DG–8026 (NRC, 2000a). The staff should ensure that the licensee eliminates residual contamination on equipment and materials to within acceptable release limits before release for unrestricted use.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

5.7.6.3 Acceptance Criteria

The contamination control program is acceptable if it meets the following criteria:

(1) The occupational radiation survey program proposed to prevent contaminated employees from entering clean areas or leaving the site is in conformance with regulatory requirements in 10 CFR 20.1702.

The proposed contamination control program is consistent with the guidance on conducting surveys for contamination of skin and personal clothing provided in Draft Regulatory Guide DG–8026 (NRC, 2000a).

(2) Requirements for a contamination control program (e.g., maintaining change areas and personal alpha radiation monitoring before leaving radiation areas) are included in standard operating procedures or are discussed in the application.

These plans should be consistent with the guidance on conducting surveys for contamination of skin and personal clothing provided in Draft Regulatory Guide DG–8026 (NRC, 2000a).

(3) Action levels for surface contamination are set in accordance with Draft Regulatory Guide DG–8026, Section 4 (NRC, 2000a).

(4) Monitoring equipment by type, specification of the range, sensitivity, calibration methods and frequency, availability, and planned use protect health and safety and the environment. The application also demonstrates that the ranges of sensitivity are those expected from the facility operation.

(5) All reporting and record keeping is done in conformance with the requirements of 10 CFR Part 20, Subpart L and Regulatory Guide 8.7 (NRC, 1982).

(6) The licensee will ensure that radioactivity on equipment or surfaces is not covered by paint, plating, or other covering material unless contamination levels, as determined by a survey and documented, are below the limits specified in Table 5.7.6.3-1 of this standard review plan before application of the covering. A reasonable effort will be made to minimize the contamination before the use of any covering.

(7) The radioactivity of the interior surfaces of pipes, drain lines, or duct work will be determined by making measurements at all traps, and other appropriate access points, provided that contamination at these locations is likely to be representative of contamination on the interior of the pipes, drain lines, or duct work.

(8) The licensee will make a comprehensive radiation survey, in conformance with Draft Regulatory Guide DG–8026, Section 1 (NRC, 2000a) and NUREG–1575, Revision 1 (NRC, 2000b) "Multi-Agency Survey and Site Investigation Manual (MARSSIM)" that establishes that contamination is within the limits specified in Table 5.7.6.3-1 and as low as is reasonably achievable procedures before release of equipment, or scrap for unrestricted use.

(9) Appropriate criteria are established to relinquish possession or control of equipment, or scrap having surfaces contaminated with material in excess of the limits specified:

(a) The applicant has provided detailed information describing the equipment, or scrap; the radioactive contaminants; and the nature, extent, and degree of residual surface contamination.

(b) The applicant has provided a detailed health and safety analysis that reflects that the residual amounts of contaminated materials on surface areas, together with other considerations such as prospective use of the equipment, or scrap, is unlikely to result in an unreasonable risk to the health and safety of the public.

Table 5.7.6.3-1. Acceptable Surface Contamination Levels*

Nuclides[a]	Average[b,c,d]	Maximum[b,d,e]	Removable[b,d,f]
Natural Uranium, Uranium-235, -238, and associated decay products	5,000 α dpm/100 cm^2	15,000 α dpm/100 cm^2	1,000 α dpm/100 cm^2
Transuranics, Radium-226, Radium-228, Thorium-230, Thorium-118, Protactinium-231, Actinium-227, Iodine-125, Iodine-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Natural Thorium, Thorium-232, Strontium-90, Radium-223, -224, Uranium-232, Iodine-126, Iodine-131, Iodine-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Strontium-90, and others noted above	5,000 dpm/100 cm^2	15,000 dpm/100 cm^2	1,000 dpm/100 cm^2

[a] Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate factor for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contamination should not be averaged over more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[d] The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 mg/cm^2 of total absorber.

[e] The maximum contamination level applies to an area of not more than 100 cm^2.

[f] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

*U.S. Atomic Energy Commission. Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors." Washington, DC: U.S. Atomic Energy Commission. June 1974.

(c) The applicant includes materials created by special circumstances including, but not limited to, the razing of buildings, transfer of structures or equipment, or conversion of facilities to a long-term storage facility or to standby status.

5.7.6.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the contamination control program, the following conclusions may be presented in the technical evaluation report and environmental assessment.

NRC has completed its review of the contamination control program at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 5.7.6.2 and the acceptance criteria outlined in standard review plan Section 5.7.6.3.

The applicant has established an acceptable contamination control program at the _____ *in situ* leach site. The program is consistent with Regulatory Guide 8.30 (NRC, 1983). Acceptable controls are in place to prevent contaminated employees from entering clean areas or leaving the site. The standard operating procedures will include provisions for contamination control, such as maintaining changing areas and personal alpha radiation monitoring before leaving radiation areas. Acceptable action levels have been set in accordance with Regulatory Guide 8.30 (NRC, 1983), and plans for surveys are in place for skin and personal clothing contamination. The applicant has established that all items removed from the restricted area are surveyed by the radiation safety staff and meet release limits. All reporting and record keeping is done in conformance with protocols established in Regulatory Guide 8.7 (NRC, 1982). The applicant has demonstrated that the range, sensitivity, and calibration of monitoring equipment will protect the health and safety of employees during the full scope of facility operations. The licensee has demonstrated that contaminated surfaces will not be covered unless, before covering, a survey documents that the contamination level is below the limits specified in Table 5.7.6.3-1. The applicant will determine the radioactivity on the interior surfaces of pipes, drain lines, or duct work by making measurements at appropriate access points that will have been shown to be representative of the interior contamination. The applicant has committed to establishing that contamination on equipment, or scrap will be within the limits in Table 5.7.6.3-1 before unrestricted release. To relinquish possession or control of equipment, or scrap with material in excess of the limits specified in Table 5.7.6.3-1, the applicant will provide detailed information on the contaminated material, provide a detailed health and safety analysis that shows that the release of the contaminated material will not result in an unreasonable risk to the health and safety of the public, and obtain NRC staff approval.

Based on the information provided in the application and the detailed review conducted of the contamination control program at the _____ *in situ* leach facility, the staff concludes that the contamination control program is acceptable and is in compliance with 10 CFR 20.1101, which defines radiation protection program and as low as is reasonably achievable requirements; 10 CFR 20.1501, which provides survey and monitoring

requirements; and 10 CFR 20.1702, which allows employees to limit dose to individuals by controlling access, limiting exposure times, prescribing use of respiratory equipment, or other controls.

5.7.6.5 References

NRC. Draft Regulatory Guide DG–8026, "Health Physics Surveys in Uranium Recovery Facilities." Washington, DC: NRC, Office of Nuclear Regulatory Research. 2000a.

———. "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)." Revision 1. Washington, DC: NRC. 2000b.

———. Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Exposure Data." Revision 1. Washington, DC: NRC, Office of Standards Development. 1982.

U.S. Atomic Energy Commission. Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors." Washington, DC: U.S. Atomic Energy Commission. June 1974.

5.7.7 Environmental Monitoring Programs

5.7.7.1 Areas of Review

The staff should review the present and future operational airborne effluent and environmental monitoring programs proposed for measuring concentrations and quantities of both radioactive and nonradioactive materials released to and in the environment surrounding the facility. The staff should review the technical bases proposed for determining environmental concentrations for demonstrating compliance with standards. The staff review should focus on the frequency of sampling and analysis, the types and sensitivity of analysis, action levels and corrective action requirements, the minimum number and criteria for locating effluent and environmental monitoring stations and the commitments for semiannual effluent and environmental monitoring reporting. The staff should review the topographic map of the site and the surrounding area showing monitoring locations.

5.7.7.2 Review Procedures

The reviewer should be familiar with the requirements of 10 CFR Part 20, which provides the regulatory standards for protection against radiation. Applicants are required to demonstrate not only that public exposure to radiation is below allowable dose limits, as specified in 10 CFR Part 20, Subparts D and F, but also, in accordance with Subpart B, that radiation exposure during *in situ* leach operations is as low as is reasonably achievable.

The staff should determine whether the proposed environmental monitoring programs are sufficient to limit exposures and releases of radioactive and hazardous materials to as low as is reasonably achievable and are in conformance with regulatory requirements identified in 10 CFR Part 20.

The staff should determine whether the effluent and environmental monitoring programs proposed for measuring concentrations and quantities of both radioactive and hazardous materials released to and in the environment around the proposed facility as described in the site characterization (see Section 2.0 of this standard review plan) are in accordance with the regulatory requirements described in 10 CFR Part 20, Subparts D and F (10 CFR 20.1302 and 10 CFR 20.1501, in particular).

The staff should ensure that the license applicant has adequately considered site-specific aspects of climate and topography in determining locations for off-site airborne monitoring stations and environmental sampling areas such that they are capable of detecting maximum off-site concentrations of effluents in the environment. In conducting its review, the staff should refer to guidance in Regulatory Guide 4.14, Revision 1 (NRC, 1980) which contains information on determining sampling locations, types, methods, frequencies, and analyses that are sufficient to comply with the applicable requirements for protection of the public from off-site exposures in 10 CFR Part 20, Subparts D and F.

The reviewer shall confirm that the applicant has committed to adequate semiannual effluent and environmental monitoring reporting.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

5.7.7.3 Acceptance Criteria

The environmental monitoring programs are acceptable if they meet the following criteria:

(1) The proposed environmental monitoring program is consistent with Regulatory Guide 4.14, Sections 1.1 and 2.1 (NRC, 1980) and as low as is reasonably achievable requirements as described in Regulatory Guide 8.37, Section 3 (NRC, 1993).

(2) The proposed locations of the air monitoring stations are consistent with guidance in Regulatory Guide 4.14, Sections 1.1.1 and 2.1.2 (NRC, 1980).

The license applicant adequately considers site-specific aspects of climate and topography, as described in the site characterization (reviewed using Section 2.0 of this standard review plan), in determining the number and locations of off-site airborne monitoring stations and environmental sampling areas. The criteria used in selecting sampling locations should be given. All sampling locations should be clearly shown relative to the proposed facility, nearest residences, and population centers on topographic maps of the appropriate scale.

(3) The proposed environmental monitoring program should sample radon, air particulates, surface soils, subsurface soils, vegetation, direct radiation, and sediment in accordance with Regulatory Guide 4.14, Section 3 (NRC, 1980).

Pre-operational baselines should be established for each of these categories using statistically valid methods before startup of the facility.

(4) The proposed sampling methods are consistent with guidance in Regulatory Guide 4.14, Section 3 (NRC, 1980).

(5) All reporting and record keeping are done in conformance with the requirements of 10 CFR Part 20, Subpart L.

(6) For license renewal applications, the historical airborne effluent and environmental monitoring program results are included through the most recent reporting period preceding the submittal of the application. The effectiveness of the historical program is discussed with regard to all applicable 10 CFR Part 20 regulatory requirements identified in the preceding paragraphs. Long-term trends are discussed, and any short-term deviations from the long-term trend are explained.

(7) The applicant commits to semiannual effluent and environmental monitoring reporting. These reports will be submitted to the appropriate NRC Regional Office with copies to the Director of Nuclear Material Safety and Safeguards. The reports will specify the quantity of each of the principal radionuclides released to unrestricted areas in liquid and gaseous effluents during the previous 6 months, injection rates, recovery rates, injection manifold pressures, and injection trunk line pressures for each satellite facility. The process rate and pressure data are to be reported as monthly averages. A license condition will be imposed specify these reporting requirements.

5.7.7.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the environmental monitoring program, the following conclusions may be presented in the technical evaluation report and environmental assessment.

NRC has completed its review of the environmental monitoring program at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 5.7.7.2 and the acceptance criteria outlined in standard review plan Section 5.7.7.3.

The applicant has established an acceptable environmental monitoring program at the _____ _____ *in situ* leach site. The overall program is consistent with guidance in Regulatory Guide 4.14 (NRC, 1980). The applicant will sample radon, air particulates, surface soils, subsurface soils, vegetation, direct radiation, and sediment. Locations of air monitoring stations are consistent with Regulatory Guide 4.14 (NRC, 1980). Instrumentation is appropriate for the measurement task and is acceptable. All reporting and record keeping is done in accordance with the requirements of the 10 CFR Part 20, Subpart L.

Based on the information provided in the application and the detailed review conducted of the environmental monitoring program at the _____ *in situ* leach facility, the staff concludes that the airborne effluent and environmental monitoring program is acceptable and is

in compliance with 10 CFR 20.1302, which requires effluent monitoring to determine dose to individual members of the public; 10 CFR 20.1501, which specifies survey and monitoring requirements; 10 CFR Part 20, Subpart L, which establishes record keeping requirements; and10 CFR 40.65, which specifies effluent and environmental monitoring requirements.

5.7.7.5 References

NRC. Regulatory Guide 8.37, "ALARA Levels for Effluent from Materials Facilities." Washington, DC: NRC, Office of Standards Development. 1993.

———. Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills." Revision 1. Washington, DC: NRC, Office of Standards Development. 1980.

5.7.8 Ground-Water and Surface-Water Monitoring Programs

5.7.8.1 Areas of Review

There are three distinct phases of ground-water and surface-water monitoring: pre-operational, operational, and restoration. Pre-operational monitoring is conducted as a part of site characterization, and review procedures are covered in Section 2 of this standard review plan. Restoration monitoring is conducted during the ground-water restoration phase of operations, and review procedures are discussed in Section 6. This standard review plan section deals specifically with monitoring ground-water and surface-water quality during the production or operational phase of *in situ* leach activities.

The staff should review the technical bases and procedures for the following components of an effective ground-water and surface-water operational monitoring program:

(1) Well field baseline water quality monitoring programs (ground water and surface water)

(2) Selection of excursion indicators and their respective upper control limits

(3) The placement of excursion monitoring wells

(4) Well field testing to verify horizontal continuity between the ore zone and perimeter wells and vertical isolation between the ore zone and vertical excursion monitor wells

(5) The excursion monitoring program, including well sampling schedules, criteria for placing well fields on excursion status, and corrective actions to be taken in the event of an excursion

(6) The surface-water monitoring program

For all of the preceding aspects of ground-water and surface-water monitoring programs that involve analysis of water samples, procedures for sample collection and analysis should be reviewed.

5.7.8.2 Review Procedures

Well field hydrologic and water chemistry data are collected before *in situ* leach operations to establish a basis for comparing opertional monitoring data. Hydrologic data, or information that describes the flow of ground water, are used to (i) evaluate whether the well field can be operated safely, (ii) confirm monitor wells have been located correctly, and (iii) design aquifer restoration activities. Water chemistry data are used to establish a set of water quality indicators, and the concentrations of these indicators in monitoring wells are used to determine whether the well field is being operated safely. Water chemistry data are also used to set the water quality standard for restoring the ore-body and adjacent aquifers after *in situ* leach extraction ceases. The reviewer should determine whether these objectives of the operational monitoring program have been met. To this end, the reviewer should

(1) Verify that procedures for establishing baseline water quality include acceptable sample collection methods, a set of sampled parameters that is appropriate for the site and *in situ* leach extraction method, and collection of sample sets that are sufficient to represent any natural spatial and temporal variations in water quality.

(2) Review the applicant's selection (or procedure for selecting) the set of water quality parameters and their respective upper control limits that will be used as indicators to ensure timely detection and reporting of unplanned lixiviant migration (excursions) from the ore zone. The reviewer is not expected to review the collected operational monitoring data for individual well fields. This will be done during routine inspections of operations.

(3) Review the applicant's technical basis or procedures for establishing the appropriate monitor well spacing for vertical and horizontal excursion monitoring.

(4) Evaluate whether well field testing is sufficient to show a horizontal hydraulic connection between the ore zone and the perimeter monitor well network, and vertical hydraulic separation between the ore zone and the shallow and deep monitor wells.

(5) Evaluate whether procedures describing the operational excursion monitoring program include sampling schedules, sampling and analytical procedures, criteria for placing well fields on excursion status, and corrective action and notification procedures to be followed if an excursion is detected.

(6) Evaluate whether a surface-water monitoring program is necessary at the site and, if so, whether the monitoring program will be effective to detect migration of contaminants into surface-water bodies.

In conducting these evaluations, the reviewer should consider the review of ground-water activities conducted by state and other federal agencies to identify any areas where dual reviews can be eliminated. Although the staff must make the necessary findings of compliance with applicable regulations, if a state or other federal agency asks questions in a particular area, the reviewer need not duplicate those questions. Instead, the reviewer can rely on the answers to the state or federal agency questions if they are acceptable, and if the applicant

submits them as part of the NRC application. The reviewer should make every effort to coordinate the NRC technical review with the state or other federal agency with overlapping authority to avoid unnecessary duplication of effort.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

5.7.8.3 Acceptance Criteria

The ground-water monitoring program should ensure that an excursion is detected long before *in situ* leach solutions could seriously degrade the quality of ground water outside the well field area. Early detection of excursions by a monitor well is influenced by the thickness of the aquifer monitored, the distance that monitor wells are placed from the well field and from each other, the frequency that the monitor wells are sampled, the water quality parameters that are sampled, and the concentrations of parameters that will be used to declare that an excursion has been detected.

The ground-water and surface-water monitoring programs are acceptable if they are sufficient to ensure that, during operations, ground water and surface water will be monitored such that early detection and timely restoration of excursions will be achieved. The following criteria must be met by *in situ* leach operational monitoring programs:

(1) For each new well field, the applicant's approach for establishing baseline water quality data is sufficient to (i) define the primary restoration goal of returning each well field to its pre-operational water quality conditions and (ii) provide a standard for determining when an excursion has occurred. The reviewer should verify that acceptable procedures were used to collect water samples, such as American Society for Testing and Materials D4448 (American Society for Testing and Materials, 1992). The reviewer should also ensure that acceptable statistical methods are used to meet these three objectives, such as American Society for Testing and Materials D6312 (American Society for Testing and Materials, 1998).

Baseline sampling programs should provide enough data to adequately evaluate natural spatial and temporal variations in pre-operational water quality. At least four independent sets of samples should be collected, with adequate time between sets to represent any pre-operational temporal variations. A set of samples is defined as a group of at least one sample at each of the designated baseline monitor wells and analyzed for the water quality conditions of the sampled aquifer at a specific time.

An acceptable set of samples should include all well field perimeter monitor wells, all upper and lower aquifer monitor wells, and at least one production/injection well per acre in each well field. For large well fields, it may not be practical to sample one production/injection well per acre. Consequently, enough production/injection wells must be sampled to provide an adequate statistical population if fewer than one well per acre is used. As a general guideline, for normally and log-normally distributed populations, at least six samples are required to achieve 90 percent confidence that any

random sample will lie within two standard deviations from the sample mean. In no case should the baseline sampling density for production/injection wells be less than one per 4 acres.

The applicant should identify the list of constituents sampled for baseline concentrations. Table 2.7.3-1provides a list of acceptable constituents for monitoring at *in situ* leach facilities. Alternatively, applicants may propose a list of constituents that is tailored to a particular location. In such cases, sufficient technical bases must be provided to demonstrate the acceptability of the selected constituent list. For example, many licensees have decided not to sample for Th-230; Th-230 is a daughter product from the decay of uranium-238, and studies have shown that it is mobilized by bicarbonate-laden leaching solutions. However, studies have also shown that after restoration, thorium in the ground water will not remain in solution, because the chemistry of thorium causes it to precipitate and chemically react with the rock matrix (Hem, 1985). As a result of its low solubility in natural waters, thorium is found in only trace concentrations. Additionally, chemical tests for thorium are expensive, and are not commonly included in water analyses at *in situ* leach facilities. This example concerning Th-230 demonstrates an acceptable technical basis for excluding Th-230 from the list of sampled constituents. For all constituents that are sampled, laboratory reports documenting the measurements should be maintained by the applicant.

An outlier is a single nonrepeating value that lies far above or below the rest of the sample values for a single well. Dealing with outliers in the sample sets should be done using proper statistical methods. The outlier may represent a sampling, analytical, or other unknown source of error or an unidentified randomness in the data. Its inclusion within the sample could significantly change the baseline data, since the outlier is not typical of the bulk of the samples. All calculations, assumptions, and conclusions made by the applicant in evaluating outliers should be fully explained. When an outlier is suspected, perhaps the easiest solution is to take another sample from the source well; if the repeat sample yields the same results, then the outlier should not be discarded. If the repeat sample is more consistent with the statistical population, the outlier can be replaced with the new sample. Another acceptable method for dealing with potential outliers is to accept any value within three standard deviations of the mean (the standard deviation should be calculated without using the suspected outliers). It is often necessary to perform log transformations on data to better approximate a normal distribution before calculating sample statistics. Care should be taken not to exclude suspected outliers that ultimately may represent bimodal distributions. Methods in American Society for Testing and Materials E178 (American Society for Testing and Materials, 1994), NUREG/CR–4604 (NRC, 1988) and NUREG–1475 (NRC, 1994) are acceptable methods for outlier calculation. Other documented and technically justified methods used by applicants will be considered in the evaluation of outliers (e.g., EPA, 1989).

(2) The applicant selects excursion indicator constituents and upper control limits. Upper control limits are intended to provide early warning that leaching solutions are moving away from the well fields so that ground water outside the monitor well ring is not significantly threatened. This is accomplished by choosing parameters that are strong

indicators of the *in situ* leach process and that are not significantly attenuated by geochemical reactions in the aquifers. If possible, the parameters chosen should be easily analyzed to allow timely data reporting. The concentration of the chosen indicator parameters should be set high enough that false positives (false alarms from natural fluctuations in water chemistry) are not a frequent problem, but not so high that significant ground-water quality degradation occurs by the time an excursion is identified. A minimum of three excursion indicators must be proposed. The choice of excursion indicators must be based on lixiviant content and ground-water geochemistry. Ideal excursion indicators are measurable parameters that are found in significantly higher concentrations during *in situ* leach operations than in the natural waters. At most uranium *in situ* leach operations, chloride is an excellent excursion indicator because it acts as a conservative tracer, it is easily measured, and chloride concentrations are significantly increased during *in situ* leaching. Conductivity, which is correlated to total dissolved solids, is also considered to be a good excursion indicator (Staub, 1986; Deutsch, 1985). Total alkalinity (carbonate plus bicarbonate plus hydroxide) is an excellent indicator in well fields where sodium bicarbonate or carbon dioxide is used in the lixiviant. If conductivity is used to estimate total dissolved solids, it must be clearly stated that measurements will be normalized to a reference temperature, usually 25 °C, because of the temperature dependence of conductivity.

Calcium, sodium, and sulfate are usually found at significantly higher levels in *in situ* solutions than in natural ground-water concentrations. The use of cations (e.g., calcium^{2+}, sodium^{+}) as excursion indicators is generally not appropriate, because they are subject to ion exchange with the host rock. The use of sulfate may give false alarms because of induced oxidation around a monitor well (Staub, 1986; Deutsch, 1985). However, this should only be a problem if upper control limit values are set too conservatively. Uranium is not considered a good indicator, because, although it is mobilized by *in situ* leaching, it may be retarded by reducing conditions in the aquifer. Although water level changes in artesian aquifers are quickly transmitted, water levels are generally not considered good indicators, because water levels tend to have significant natural variability. The applicant may choose to add a nonreactive, conservative tracer to *in situ* leach solutions to act as an excursion indicator. The applicant is required to provide the technical bases for the selection of excursion indicators.

Upper control limits must be set at a level that indicates an excursion has occurred when two or more excursion indicators in a monitoring well exceed the upper control limit. The upper control limit for each excursion indicator must be less than the lowest concentration that typically occurs in the lixiviant while the well field is in operation. Each upper control limit must also be greater than the baseline concentration for its respective excursion indicator. Applicant site-specific experience is often valuable in determining appropriate upper control limits that provide timely detection and avoid false alarms. Guidance for appropriate statistical methods that can be used to establish upper control limits can be found in American Society for Testing and Materials D6312 (American Society for Testing and Materials, 1998).

Upper control limits for a specific excursion parameter should be determined on a statistical basis, to account for likely spatial and temporal variations for the parameter concentrations within the ore zone. Statistical techniques such as the student's t-test, are acceptable for setting upper control limits. In some cases, the use of a simple percentage increase above baseline values is acceptable. The staff has decided that in areas with good water quality (a total dissolved solids less than 500 mg/L), setting the upper control limit at a value of 5 standard deviations above the mean of the measured concentrations is an acceptable approach. However, in some aquifers of good water quality, low chloride concentrations have been found to have such a narrow statistical distribution that a specified concentration (e.g., 15 mg/L) above the mean or the mean plus 5 standard deviations approach, which ever is greater, has been used to establish the chloride upper control limit.

The same upper control limits may be assigned to all monitor wells within a particular hydrogeologic unit in a given well field if baseline data indicate little chemical heterogeneity. Alternatively, if individual monitor wells in a given unit exhibit unique baseline water quality, upper control limits may be assigned on a well-by-well basis. If upper control limits vary from well to well, a table should be included, listing all monitor wells and their respective upper control limits.

(3) The applicant establishes criteria for determining monitor well locations. Ore zone perimeter monitor wells are used to detect horizontal excursions outside the well field boundary. They generally surround the entire well field and are screened over the entire ore zone hydrogeologic unit. Perimeter monitor wells should be placed close enough to the well field to provide timely detection, yet they should be far enough away from the well field to avoid numerous false alarms. Previously approved *in situ* leach excursion monitoring systems used monitor wells as far as 180 m [600 ft] and as near as 75 m [250 ft] from the well field edge (NRC, 2001, Table 4-6). The licensee should be afforded some discretion in determining the appropriate distance of horizontal excursion monitor wells from the well field, but should provide justification for distances greater than about 150 m [500 ft]. For example, a rigorous modeling demonstration that a theoretical excursion can be controlled at the monitor well locations within 60 days of detection is an acceptable technical basis. The horizontal excursion monitor wells must be spaced close enough to one another so that the likelihood of missing an excursion plume is low. In determining the appropriate spacing between perimeter monitoring wells, the applicant must consider such factors as the distance of the monitoring wells from the edge of the well field, the minimum likely size of an excursion source zone, ground-water flow directions and velocities outside of the well field, and the potential for mixing and dispersion. Staff should consult NUREG/CR–6733 (NRC, 2001, Section 4.3.3) for an analysis and discussion of acceptable approaches for establishing the appropriate monitor well spacing.

In an analysis and discussion of the risks of undetected vertical excursions in NUREG/CR–6733 (NRC, 2001, Section 4.3.3), it was concluded that significant risks for vertical excursions may exist if monitor wells are randomly located, given the typical criteria for spacing of vertical excursion monitor wells at licensed *in situ* leach facilities {e.g., one well per 1.6 ha [4 acres] for overlying aquifers; one well per 3.2 ha [8 acres]

for underlying aquifers}. Thus, location of vertical excursion monitor wells within the well field should be such that the likelihood of detecting a vertical excursion is maximized. The appropriate number of these monitor wells may vary from site to site. It may be appropriate to exclude the requirement to monitor water quality in the underlying aquifer if (i) the underlying aquifer is a poor producer of water, (ii) the underlying aquifer is of poor water quality, (iii) there is a large aquitard between the ore zone and the underlying aquifer and few boreholes have penetrated the aquitard, or (iv) deep monitor wells would significantly increase the risk of a vertical excursion into the underlying aquifer. Monitor wells completed in aquifers above the first overlying aquifer may not be required when (i) the aquifers are separated from the production zone by thick aquitards, (ii) a high quality mechanical integrity well testing program will be implemented, or (iii) the aquifers are unsubstantial producers of water or of poor water quality. In well fields where the ore zone confining layers are particularly thin, or of questionable continuity, a greater number of monitor wells is appropriate. In general, when the direction of ground-water flow in an upper or lower aquifer is well known, the applicant should consider locating these wells on the hydraulically down gradient side of a well field, in areas where ore zone confining layers may be thin or incompetent, and in areas where injection pressure may be highest (i.e., closer to injection wells than to production wells).

The process for determining the screened interval of the monitor wells should be described. Fully screened monitor wells sample the entire thickness of the aquifer. Therefore, excursions could not pass above or below the well screens. However, the concentration of the indicator parameters might be diluted and therefore may not provide the earliest possible warning that an excursion is occurring. Partially screened monitor wells only sample the zone of ore extraction within an aquifer. These wells might miss some excursions, but would suffer less from dilution effects than fully screened wells. For most situations the staff favors fully screened monitor wells. Fully screened monitor wells would assure that excursions will eventually be detected, have the advantage of more accurately representing the water quality that a ground-water user is likely to experience, and do not suffer from the uncertainty of predicting the completion intervals of injection and production wells that have not yet been drilled.

(4) The applicant establishes well field test procedures. Once a well field is installed, it should be tested to establish that the ore zone production and injection wells are hydraulically connected to the perimeter horizontal excursion monitor wells and are hydraulically isolated from the vertical excursion monitor wells. Such testing will serve to confirm the performance of the monitoring system and will verify the validity of the site conceptual model reviewed in Section 2 of this standard review plan. The reviewer should verify that well field test approaches have sound technical bases. Test approaches typically consist of a pump test that subjects the well field to a sustained maximum withdrawal rate while monitoring the perimeter and vertical excursion wells for drawdown. The test should continue until the effects of pumping can be clearly seen via drawdown in the perimeter monitor wells. Typically, about 0.3 m [1 ft] of drawdown in the perimeter monitor wells will verify hydraulic connection, but the amount may vary because of the distance from the pumping wells, pumping rates, and hydraulic conductivity. To investigate vertical confinement or hydraulic isolation between the ore

zone and upper and lower aquifers, it is acceptable to perform pump tests that in addition to the ore zone, also monitor water levels in upper or lower aquifers.

(5) The applicant defines operational approaches for the monitoring program. The monitoring program must indicate which wells will be monitored for excursion indicators, the monitoring frequency, and the criteria for determining when an excursion has occurred. An acceptable excursion monitoring program should indicate that all monitor wells will be sampled for excursion indicators at least every 2 weeks during *in situ* leach operations.

An excursion is deemed to have occurred if any two excursion indicators in any monitor well exceed their respective upper control limits, or if a single excursion indicator exceeds its upper control limit by 20 percent. A verification sample must be taken within 48 hours after results of the first analyses were received. If the second sample does not indicate that upper control limits were exceeded, a third sample must be taken within 48 hours after the second set of sampling data was acquired. If neither the second nor the third sample indicates that upper control limits are exceeded, the first sample is considered in error, and the well is removed from excursion status. If either the second or third sample contains indicators above upper control limits, an excursion is confirmed, the well is placed in excursion status, and corrective action must be initiated.

Generally, the risk of contamination to surface-water bodies from *in situ* leach operations is low when proper operational procedures are followed. Any surface-water body that lies within the proposed license boundary should be sampled at upstream and downstream locations, both before and during operations. The reviewer should ensure that pre-operational water quality sampling locations for applicable surface waters are indicated in the application. The pre-operational data should be collected on a seasonal basis for a minimum of 1 year before *in situ* leach operations. Procedures for monitoring surface-water quality during operations should be discussed in the application: this discussion must include a monitoring schedule, monitor locations, and a list of sampled constituents. The applicant may be exempted from monitoring during operations if the site characterization demonstrates that no significant flow of ground water to surface water occurs near the site (e.g., if surface-water bodies are perched and ephemeral).

The excursion monitoring operational procedures must also include corrective action and notification plans in the event of an excursion. NRC must be notified within 24 hours by telephone and within 7 days in writing from the time an excursion is verified. A written report describing the excursion event, corrective actions, and the corrective action results must be submitted to NRC within 60 days of the excursion confirmation. If wells are still on excursion when the report is submitted, the report must also contain a schedule for submittal of future reports describing the excursion event, corrective actions taken, and results obtained. In the case of a vertical excursion, the report must contain a projected date when characterization of the extent of the vertical excursion would be completed.

Corrective action to retrieve horizontal excursions within the ore-zone aquifer is generally accomplished by adjusting the flow rates of the pumping/injection wells to increase process bleed in the area of the excursion. Vertical excursions have proven more difficult to retrieve: at some *in situ* leach facilities, vertical excursions have persisted for years. If an excursion is not corrected within 60 days of confirmation, applicants must either terminate injection of lixiviant into the well field until the excursion is retrieved, or provide an increase to the reclamation surety in an amount that is agreeable to NRC and that would cover the expected full cost of correcting and cleaning up the excursion. The surety increase must remain in force until the excursion is corrected. The written 60-day excursion report should state and justify which course of action will be followed.

If wells are still on excursion status at the time the 60-day report is submitted to NRC, and the surety option is chosen, the well field restoration surety will be adjusted upward. To calculate the increase in surety for horizontal excursions, it is assumed that the entire thickness of the aquifer between the well field and the monitor wells on excursion has been contaminated with lixiviant. It is also assumed that the width of the excursion is the distance between the monitor wells on excursion status plus one monitor well spacing distance on either side of the excursion. When the excursion is corrected, the additional surety requirements resulting from the excursion will be removed.

To calculate the increase in surety for vertical excursions, an initial estimate of the area contaminated above background is made. All estimates assume that the entire thickness of the aquifer is contaminated. As characterization of the extent of contamination proceeds, the surety may be increased or decreased, as appropriate. Once the extent of contamination is determined, the area contaminated above background is used to calculate the level of surety. When the vertical excursion is cleaned up, the additional surety requirements resulting from the excursion are removed.

In calculating the increase in surety bonding for horizontal and vertical excursions, the same formula used to calculate the number of pore volumes required to restore a well field is applied to the assumed areas of contamination. This approach is consistent with 10 CFR Part 40, Appendix A, Criterion 9. Increased surety provides assurance that cleanup will be accomplished in the event of licensee default, and surety can be adjusted downward once cleanup is complete. In calculating the area affected by an excursion and the volume of water required to effect restoration, a conservative estimate is taken to ensure that adequate funds are available to clean up the ground water should the licensee fail to do so.

Corrective action for vertical and horizontal excursions can be determined complete when all excursion indicators are below their respective upper control limits, or no more than one excursion indicator does not exceed its respective upper control limit by 20 percent. Stability in the excursion indicator concentrations must be demonstrated by measurements over a suitable time period before the corrective action measures can be discontinued. to their upper control limits or lower.

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(6) If an *in situ* leach facility is located adjacent to bodies of surface water, the applicant must establish a surface-water monitoring program that will be effective to detect migration of contaminants into surface-water bodies . Alternatively, the applicant may demonstrate that the risk of contamination from *in situ* leach activities is negligible or that potential releases are within limits set by the Safe Drinking Water Act.

5.7.8.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the ground-water and surface-water monitoring programs, the following conclusions may be presented in the technical evaluation report and environmental assessment.

NRC has completed its review of the ground-water and surface-water monitoring programs at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 5.7.8.2 and the acceptance criteria outlined in standard review plan Section 5.7.8.3.

The applicant has established acceptable ground-water and surface-water monitoring programs at the _____ *in situ* leach site. The applicant has established acceptable baseline sampling programs including the number and timing of samples, constituents sampled, and appropriate statistical methods to remove outliers. The applicant has selected acceptable excursion indicator parameters and an approach for establishing upper control limits. Appropriate criteria are used to establish monitor well locations for all aquifers likely to be affected. Appropriate well field test procedures are established. The applicant has defined acceptable operational approaches for the ground-water and surface-water monitoring programs, including identifying appropriate wells for monitoring for excursion indicators, monitoring frequency, and criteria for determining the presence of an excursion. The applicant has defined an acceptable sampling program for any surface-water body that lies within the facility boundary, including downstream sampling locations; appropriate pre-operational seasonal data collection, and standard approaches for monitoring including a schedule and a list of analyzed constituents. The applicant has prepared an acceptable corrective action plan, including notification of NRC and subsequent reporting in the event of an excursion.

Based on the information provided in the application and the detailed review conducted of the ground-water and surface-water monitoring programs at the _____ *in situ* leach facility, the staff concludes that the ground-water and surface-water monitoring programs are acceptable and are in compliance with 10 CFR 40.32(c), which requires the applicant proposed equipment, facilities, and procedures to be adequate to protect health and minimize danger to life or property; 10 CFR 40.32(d), which requires that the issuance of the license will not be inimical to the common defense and security or to the health and safety of the public; 10 CFR 40.41(c), which requires the applicant to confine source or byproduct material to the locations and purposes authorized in the license; and 10 CFR 40.31, which defines requirements for applications for specific licenses. The ground water and surface water monitoring programs are also in compliance with 10 CFR Part 40, Appendix A, Criteria 5B(1), 5B(5), and 5C, which provide concentration limits for contaminants; 10 CFR Part 40, Appendix A, Criterion 5D, which requires a ground-water corrective action program; and

10 CFR Part 40, Appendix A, Criteria 7 and 7A, which require ground-water monitoring programs.

Pre-operational monitoring is conducted as part of site characterization and is addressed in Section 2 of this technical evaluation report whereas restoration monitoring is conducted during ground-water restoration and is addressed in Section 6 of this technical evaluation report.

5.7.8.5 References

American Society for Testing and Materials. "Standard Guide for Developing Appropriate Statistical Approaches for Ground-Water Detection Monitoring." Designation D6312-98. West Conshohocken, Pennsylvania: American Society for Testing and Materials. 1998.

———. "Standard Practice for Dealing with Outlying Observations." Designation E178. West Conshohocken, Pennsylvania: American Society for Testing and Materials. 1994.

———. "Standard Guide for Sampling Groundwater Monitoring Wells." Designation D4448-85a. West Conshohocken, Pennsylvania: American Society for Testing and Materials. 1992.

Deutsch, W.J., et al. NUREG/CR–3709, "Method of Minimizing Ground-Water Contamination From *In Situ* Leach Uranium Mining." Washington, DC: NRC. 1985.

EPA. "Statistical Analysis of Ground-Water Monitoring Data at RCRA (Resource Conservation and Recovery Act) Facilities, Interim Final Guidance." EPA/530–SW–89–026. Washington, DC: EPA. 1989.

Hem, J.D. "Study and Interpretation of the Chemical Characteristics of Natural Water." USGS Water Supply Paper 2254. Third edition. Reston, Virginia: U.S. Geological Survey. 1985.

NRC. NUREG/CR–6733, "A Baseline Risk-Informed, Performance-Based Approach for *In Situ* Leach Uranium Extraction Licensees." Washington, DC: NRC. 2001.

———. NUREG–1475, "Applying Statistics." Washington, DC: NRC. 1994.

———. NUREG/CR–4604, "Statistical Methods for Nuclear Material Management." Washington, DC: NRC. 1988.

Staub, W.P., et al. NUREG/CR–3967, "An Analysis of Excursions at Selected *In Situ* Uranium Mines in Wyoming and Texas." Washington, DC: NRC. 1986.

5.7.9 Quality Assurance for Monitoring Programs

5.7.9.1 Areas of Review

The staff should review the quality assurance programs proposed for all radiological, effluent, and environmental (including ground water) monitoring programs.

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5.7.9.2 Review Procedures

The staff should determine whether the safety controls and monitoring procedures proposed by the applicant are sufficient to limit radiation exposures and radioactive releases to as low as is reasonably achievable and are in conformance with regulatory requirements identified in 10 CFR Part 20. The staff should determine if the quality assurance programs proposed for all radiological, effluent, and environmental (including ground water) monitoring are in accordance with Regulatory Guides 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations)—Effluent Streams and the Environment, Revision 1" (NRC, 1979) and 10 CFR Part 40, Appendix A, Criteria 7 and 7A.

For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications.

5.7.9.3 Acceptance Criteria

The quality assurance program is acceptable if it meets the following criteria:

(1) The quality assurance plan has been established and applied to all radiological, effluent, and environmental programs. The proposed quality assurance plan should be consistent with guidance provided in Regulatory Guide 4.14, Section 3 and 6 (NRC, 1980) and Regulatory Guide 4.15 (NRC, 1979).

(2) All reporting and record keeping will be done in conformance with the criteria presented in Section 5.3.2 of this standard review plan.

Note that under the existing 10 CFR Part 20 requirements, a licensee must retain survey and calibration records for 3 years instead of the 2 years mentioned in Regulatory Guide 4.15 (NRC, 1979). Furthermore, existing 10 CFR Part 20 requirements have been updated to include a requirement that all licensees maintain records used to demonstrate compliance and evaluate dose, intake, and releases to the environment until NRC terminates the license.

(3) For license renewal applications, the historical quality assurance program results are included through the most recent reporting period preceding the submittal of the application. The effectiveness of the historical program is discussed with regard to all applicable 10 CFR Part 20 regulatory requirements. Long-term trends are discussed, and any short-term deviations from the long-term trends are explained.

5.7.9.4 Evaluation Findings

If the staff review, as described in this section, results in the acceptance of the quality assurance program, the following conclusions may be presented in the technical evaluation report and environmental assessment.

NRC has completed its review of the quality assurance program at the _____ *in situ* leach facility. This review included an evaluation using the review procedures in standard review plan Section 5.7.9.2 and the acceptance criteria outlined in standard review plan Section 5.7.9.3.

The applicant has established an acceptable quality assurance program at the _____ *in situ* leach site. The quality assurance program has been applied to all radiological, effluent, and environmental programs consistent with Regulatory Guides 4.14 (NRC, 1980) and 4.15 (NRC, 1979). The applicant has agreed to retain survey and instrument calibration records for 3 years and to retain records to demonstrate compliance and evaluate dose, intake, and releases to the environment until NRC terminates the license.

Based on the information provided in the application and the detailed review conducted of the quality assurance program at the _____ *in situ* leach facility, NRC staff concludes that the quality assurance program is acceptable and is in compliance with 10 CFR 20.1101, which provides requirements for radiation protection programs; 10 CFR Part 20, Subpart L, which specifies record keeping requirements; and 10 CFR Part 20, Subpart M, which defines reporting and notification requirements; and 10 CFR Part 40, Criteria 7 and 7A, which establish requirements for monitoring programs.

5.7.9.5 References

NRC. Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills, Revision 1." Washington, DC: NRC, Office of Standards Development. 1980.

———. Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations)—Effluent Streams and the Environment." Revision 1. Washington, DC: NRC, Office of Standards Development. 1979.