U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NUREG-2126

Standard Review Plan for Conventional Uranium Mill and Heap Leach Facilities

Draft Report for Comment

Office of Nuclear Material Safety and Safeguards

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Office of Nuclear Material Safety and Safeguards

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Any interested party may submit comments on this report for consideration by the NRC staff. Comments may be accompanied by additional relevant information or supporting data. Please specify the report number **NUREG-2126** in your comments, and send them by the end of the comment period specified in the *Federal Register* notice announcing the availability of this report.

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Federal Rulemaking Website: Go to http://www.regulations.gov and search for documents filed under Docket ID **NRC-2014-0178**. Address questions about NRC dockets to Carol Gallagher at 301-287-3422 or by e-mail at Carol.Gallagher@nrc.gov.

Mail comments to: Cindy Bladey, Chief, Rules, Announcements, and Directives Branch (RADB), Division of Administrative Services, Office of Administration, Mail Stop: 3WFN-06-A44MP, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

For any questions about the material in this report, please contact: Douglas T. Mandeville, Project Manager, at 301-415-0724 or by e-mail at douglas.mandeville@nrc.gov.

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ABSTRACT

A U.S. Nuclear Regulatory Commission source and byproduct materials 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," for the operation of a uranium mill and the disposal of 'tailings," wastes produced by the extraction of concentration of source material from ores processed primarily for their source material content. Appendix A to Part 40 establishes technical and other criteria related to siting, operation, decontamination, decommissioning, and reclamation of mills and tailings at mill sites. An applicant for a new 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 reviews of applications to develop and operate conventional uranium mills or heap 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.

Paperwork Reduction Act Statement

The information collections contained in the Standard Review Plan are covered by the requirements of 10 CFR Part 20 and 10 CFR Part 40, and were approved by the Office of Management and Budget, approval numbers 3150-0014 and 3150-0020.

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EXECUTIVE SUMMARY

This standard review plan (SRP) has been developed to assist U.S. Nuclear Regulatory Commission (NRC) staff in performing safety reviews of license applications associated with uranium recovery operations using conventional uranium milling or heap leach techniques. Both techniques extract and concentrate uranium from mined ore to create a product that is commonly referred to as "yellowcake," which is used for making fuel for nuclear reactors.

The NRC has the authority to regulate uranium milling under the Atomic Energy Act of 1954, as amended, and the Uranium Mill Tailings Radiation Control Act of 1978, as amended. Uranium recovery is any activity that produces byproduct material, which is defined as "the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content." Most byproduct material from conventional uranium mills and heap leach facilities is mill tailings. Other wastes, such as contaminated equipment, are also byproduct material. NRC does not regulate the mining of uranium. The U.S. Department of Interior Office of Surface Mining, the U.S. Department of Labor Mine Safety and Health Administration, and the individual states regulate mining operations.

An NRC source and byproduct material license is required under the provisions of 10 CFR Part 40 to recover uranium from ore (physical and/or chemical processes). General provisions for issuance, amendment, transfer, and renewal of NRC licenses are contained in 10 CFR Part 2 and 10 CFR 40.31. An applicant for a new operating license for a facility is required to provide detailed information on the facility, equipment, and procedures it plans to use in a technical report that also discusses the effects of proposed operations on public health and safety. For license renewals and amendments, the licensee's (hereafter referred to as an applicant) focus should be on changes in proposed operations that NRC has not previously reviewed. Also for license renewals, the applicant needs to present operational history since the last license issuance. The technical report will serve as a basis for a detailed review by NRC staff to determine whether the proposed activities will protect public health and safety and whether the applicant has addressed the applicable NRC regulations in 10 CFR Part 20; 10 CFR Part 40 and 10 CFR Part 40, Appendix A.

This SRP provides guidance for the detailed safety (technical) review of new and renewal license applications and amendment requests associated with conventional uranium mills and heap leach facilities. The staff will use information in this SRP in the review of applications for new facilities, renewals, and amendments. Reference to guidance and licensing documents in this SRP will refer to the most current version of that document. In any application, it is the responsibility of the reviewer, as well as the applicant, to use the most current update that may occur following publication of this SRP. Throughout this SRP and accompanying appendices, "application" is synonymous with new, renewal, or amendment license applications, and "applicant" is synonymous with new applicant or licensee.

An applicant must clearly demonstrate the manner in which the requirements and objectives in applicable sections of 10 CFR Part 20 and 10 CFR Part 40 have been addressed, as well as NRC regulations in 10 CFR Part 51 implementing the National Environmental Policy Act of 1969, as amended (NEPA). Guidance for addressing NEPA requirements for the licensing of uranium recovery operations is contained in NUREG–1748, Environmental Review Guidance for Licensing Actions Associated with NMSS Programs (NRC, 2003).

Use of the SRP enables consistent quality and uniformity in NRC staff reviews. Each section in this SRP provides guidance on areas of review, review procedures, acceptance criteria, and evaluation findings. The subsection on areas of review describes what should be reviewed. The subsection on review procedures lists how the staff review is to be accomplished. The subsection on acceptance criteria lists what is acceptable in a demonstration of compliance with the regulations. The subsection on evaluation findings outlines a procedure for reporting the NRC staff evaluation whether compliance with the applicable sections in Title 10 of the U.S. Code of Federal Regulations has been met. In the license application review, the NRC staff must determine whether operations will be conducted in an acceptable manner and in compliance with applicable regulations.

The detailed review procedures and acceptance criteria contained in this standard review plan are intended to provide guidance on the review of applications for conventional uranium mills or heap leach facilities and assist NRC staff in making the necessary findings in an effective and efficient manner. If information is not contained in an application in accordance with a section of this SRP, then the applicant should describe why the information is not necessary or appropriate. The NRC staff has the responsibility to conduct an evaluation of the public health and safety aspects of an applicant's proposed program. Some sections of this SRP may not be appropriate or necessary for a detailed review because of site-specific characteristics or other circumstances. However, if the NRC staff determines that an application is incomplete, then delays in processing the application may occur or the application may be rejected.

This SRP is intended to cover only those aspects of the NRC regulatory mission related to the licensing of conventional uranium mills or heap leach facilities. Uranium ore removed from a mine and transported directly to a conventional mill or heap leach facility would be subject to NRC jurisdiction when it crosses the license boundary. This is consistent with of 10 CFR Part 40, Appendix A, Criterion 5H, which requires that steps be taken to minimize penetration of radionuclides into underlying soils at uranium ore stockpile locations. The initiation of NRC jurisdiction for other scenarios where uranium ore is altered after removal from its place in nature prior to transport to a conventional mill or heap leach facility would be handled on a case by case basis. This evaluation depends on proposed operating characteristics of individual facilities.

This SRP focuses on review guidance for the applicant's technical report accompanying license applications and amendments to determine whether the proposed activities will protect public health and safety. The product documenting the staff review of the applicant's technical report is a safety evaluation report (SER) or technical evaluation report (TER), depending on the licensing action. As such, the SRP helps focus the staff review on determining whether a facility can be constructed and operated in compliance with the applicable NRC regulations. This SRP is also intended to make information about the regulatory review process widely available and to improve communication and understanding of the staff review process by interested members of the public and the uranium recovery industry.

The acceptance criteria presented in this SRP are for the guidance of the NRC staff responsible for the review of applications to operate conventional uranium mills and heap leach facilities. Review plans are not substitutes for the NRC's regulations, and compliance with a particular SRP is not required. This SRP describes acceptable methodologies for demonstrating regulatory compliance. Methods and solutions different from those set out in the SRP will be acceptable if the applicant provides an adequate basis for the findings necessary for the issuance or continuance of a license by NRC.

For license application amendments and renewals, the review should focus on the changes proposed in the application and, if applicable, operational and inspection history since the prior license was issued or renewed. In addition, the applicant should discuss the likely consequences of any health and safety impacts of the proposed activities. Staff should use the appropriate sections of this document when reviewing amendment requests. The NRC staff does not ordinarily review other previously accepted actions, if they are not part of the application under review, unless staff identifies issues with other aspects of facility operation; however, NRC review of previously accepted actions may provide useful information concerning the operations and the site.

Accompanying this SRP are appendices to assist staff in their detailed review. SRP Appendix A is guidance for staff to use solely for reviewing historical aspects of site performance for license renewals and amendments. SRP Appendix B provides a correlation between 10 CFR Part 40, Appendix A requirements and the subsection(s) in this SRP where the review standards and acceptance criteria for the requirements are met. SRP Appendix C is guidance on the use of the radium benchmark dose approach, which is used to support decommissioning activities described in Chapter 7. SRP Appendix D is guidance for decontamination of facilities and equipment prior to release for unrestricted use in support of license terminations. SRP Appendix E contains an outline recommended by the NRC staff for preparing site-specific facility reclamation and stabilization cost estimates for review. SRP Appendix F contains the NRC's safety culture policy statement.

The following is a brief overview of the NRC license review process.

General Review Procedure

Figure 1.1 outlines the general safety review process for obtaining a new license, renewal of an existing license, or an amendment to an existing license. This SRP is intended to cover only those aspects of the safety review associated with the licensing of conventional uranium mills or heap leach facilities. The first step is submittal of an application by an applicant. After all documents have been properly submitted, typically a technical report and an environmental report, the NRC staff will then conduct acceptance reviews to evaluate whether sufficient information is contained in the application documents to conduct detailed reviews. For safety reviews, the focus is on the applicant's technical report. If the application and supporting documents are not sufficient for a detailed safety review, then the staff will not docket the application and supporting documents. If the application and supporting documents are sufficient for a detailed safety review, then staff will docket the application and supporting documents. The next step is conducting a detailed examination of the docketed documents for acceptability or inadequacy of information. If appropriate, staff will develop requests for additional information (RAIs) for incomplete, inadequate, or unclear information in the docketed documents.

The staff typically issues RAIs when the information given in a license application is not sufficient for staff to make a licensing decision. The applicant will supplement the docketed application package by responding to the RAIs from the NRC. If staff still finds the information to be incomplete, inadequate, or unclear, then the staff discusses these open issues with the applicant to give the applicant another opportunity to provide the necessary information. The staff documents its determination of whether the proposed activities protect public health and

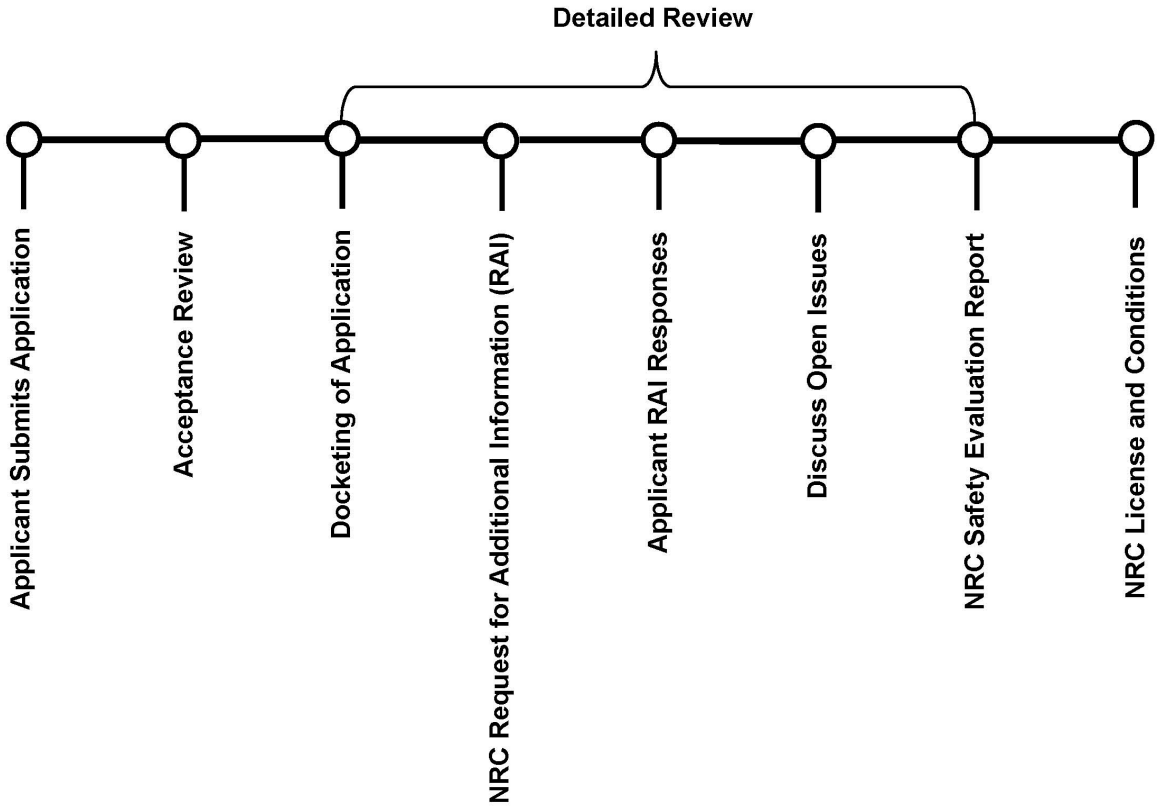

Figure 1.1 General Safety Review Process

safety and comply with applicable regulations in a SER or TER, depending on the licensing action. If necessary, license conditions may be established after discussions with the applicant to protect public health and safety and ensure compliance with regulations. In the SER or TER, if staff finds that operations can be conducted in accordance with regulations and in a safe manner, then a license is issued, which may contain license conditions. If the staff finds that operations will be unsafe, then a license will not be issued. A source material application also may be denied or rejected under specific instances during the review process. For example, the applicant's failure to demonstrate compliance with 10 CFR 40.31(h) or refusal or failure to supply information staff requested to complete the review in accordance with 10 CFR 2.108 is also grounds for denial of the application.

The following are review objectives for conducting the safety application review.

Acceptance (Administrative) Review Objectives

The staff conducts an acceptance review of the technical report in the license application. The acceptance review serves two purposes: an administrative review to determine the completeness of the information submitted and a limited review to identify any potential regulatory compliance issues. This review involves a comparison of the submitted information to the information needs identified in this SRP. 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 local site conditions, and provides appropriate analyses and design information. The acceptance review is very important because

deficiencies in the license application materials may be identified early. This will ensure completeness of the application and result in fewer RAIs and a more efficient safety review process.

Detailed Technical Review Objectives

Following completion of the acceptance review and the docketing of the application, the staff conducts a detailed technical review of the application. As previously stated, results of this review and the basis for acceptance or denial of the requested licensing action are documented in an SER or TER, depending on the licensing action. A detailed review should evaluate the technical information submitted by the applicant to confirm the ability of the proposed facility to meet applicable regulatory requirements.

Standard Review Plan Organization

This SRP is written to address a variety of potential site conditions and facility designs for the detailed safety review. Each section provides areas of review, review procedures, acceptance criteria, evaluation findings, and references subsections. The sections typically reflect significant health and safety concerns that would need to be addressed for the activity for which the SRP was developed. For any given application, the staff may select and emphasize particular aspects of each SRP section, as appropriate for the application. Therefore, the staff may not carry out all of the review steps listed in each SRP 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 staff should review.

Review Procedures Subsection

This subsection lists items and topics that the staff may review to assess compliance with regulations or accepted procedures. In this SRP, the review procedures are linked to specific regulations.

Acceptance Criteria Subsection

This subsection forms the basis for staff reviews and analyses in the SER or TER and provides specific guidance for review steps. It states the appropriate acceptance criteria to be reviewed and generally a step-by-step procedure that staff may use to determine whether the acceptance criteria have been met.

Evaluation Findings Subsection

The evaluation findings need to address the unique nature of the application or specific site conditions and proposed practices. If the information is adequate and complete and the staff finds that the application meets the applicable acceptance criteria, then typically a single paragraph is sufficient for the staff to conclude that the applicant has shown compliance with applicable regulations. In its analysis, the staff should include the justification as to why the applicant has shown compliance with applicable regulations. If the information is inadequate or

incomplete, then the staff should explain why the applicant has not shown compliance with applicable regulations and impose a license condition, if necessary.

The Evaluation Findings Subsection is written so that guidance is given to staff for including four elements. The first element states what technical criteria were used to review the application and that the review was performed in accordance with a specified section in the SRP. The second element states what the applicant provided in the application and states why the provided information is complete and adequate or incomplete or inadequate. If the information is complete and adequate, then statements are given that explain why the information is complete and adequate. If the information is incomplete or inadequate, then statements are given that describe why the information is incomplete or inadequate. If needed, a third element may state that a license condition is being imposed to address the incomplete or inadequate information with respect to a specific technical criterion. In a following sentence, the license condition is stated. Note that more than one license condition may be associated with each technical criterion being reviewed. Finally, the fourth element states that the information provided, including any imposed license conditions, meets the applicable acceptance criteria of the applicable section of the SRP. The fourth element also states clearly the regulations to which the technical criteria apply.

References Subsection

This subsection lists any applicable references that are cited in the preceding subsections. To avoid duplication of references, it is possible to list all references in one section of the SER or TER.

Standard Review Plan Updates

The staff will revise and update this SRP periodically as the need arises to clarify the content, correct errors, or to incorporate review modifications approved by NRC management.

NRC Safety Culture

Individuals and organizations performing regulated activities are expected to establish and maintain a positive safety culture commensurate with the safety and security significance of their activities and the nature and complexity of their organizations and functions. This applies to all licensees, certificate holders, permit holders, authorization holders, holders of quality assurance program approvals, vendors and suppliers of safety-related components, and applicants for a license, certificate, permit, authorization, or quality assurance program approval, subject to NRC authority.

"Nuclear safety culture" is defined in the safety culture policy statement as *the core values and behaviors resulting from a collective commitment by leaders and individuals to emphasize safety over competing goals to ensure protection of people and the environment*. (Appendix F of this SRP). Individuals and organizations performing regulated activities bear the primary responsibility for safely handling and securing these materials. Experience has shown that certain personal and organizational traits are present in a positive safety culture. A trait, in this case, is a pattern of thinking, feeling, and behaving that emphasizes safety, particularly in goal-conflict situations (e.g., production versus safety, schedule versus safety, and cost of the effort versus safety). Refer to Table 1.1 for the traits of a positive safety culture from NRC's safety culture policy statement.

Table 1.1. Traits of a Positive Safety Culture		
Leadership Safety Values and Actions	**Problem Identification and Resolution**	**Personal Accountability**
Leaders demonstrate a commitment to safety in their decisions and behaviors	Issues potentially impacting safety are promptly identified, fully evaluated, and promptly addressed and corrected commensurate with their significance	All individuals take personal responsibility for safety
Work Processes	**Continuous Learning**	**Environment for Raising Concerns**
The process of planning and controlling work activities is implemented so that safety is maintained	Opportunities to learn about ways to ensure safety are sought out and implemented	A safety conscious work environment is maintained where personnel feel free to raise safety concerns without fear of retaliation, intimidation, harassment or discrimination
Effective Safety Communications	**Respectful Work Environment**	**Questioning Attitude**
Communications maintain a focus on safety	Trust and respect permeate the organization	Individuals avoid complacency and continually challenge existing conditions and activities in order to identify discrepancies that might result in error or inappropriate action

The NRC, as the regulatory agency with an independent oversight role, reviews the performance of individuals and organizations to determine compliance with requirements and commitments through its existing inspection and assessment processes. However, NRC's safety culture policy statement and traits are not incorporated into the regulations. Many of the safety culture traits may be inherent to an organization's existing radiation safety practices and programs. For instance, the requirement for daily inspections of tailings or waste retention systems may correspond with the "work processes" (the process of planning and controlling work activities is implemented so that safety is maintained) safety culture trait. Additionally, the requirement for establishment of a detection monitoring system to detect leakage of hazardous constituents from the tailings disposal area may correspond with the "problem identification and resolution" (issues potentially impacting safety are promptly identified, fully evaluated, and promptly addressed and corrected commensurate with their significance) safety culture trait.

More information on NRC activities relating to safety culture can be found at http://www.nrc.gov/about-nrc/regulatory/enforcement/safety-culture.html.

References

NRC. NUREG–1748, "Environmental Review Guidance for Licensing Actions Associated With NMSS Programs." Washington, DC: NRC, Office of Nuclear Material Safety and Safeguards. August 2003.

1.0 PROPOSED ACTIVITIES

1.1 Areas of Review

The purpose of this section of the standard review plan (SRP) is to provide a general overview of the proposed activities so that staff can gain a basic understanding of those proposed activities and the likely consequences of any public health and safety impacts. It is important for staff to obtain an overview of the proposed operations before initiating a detailed review of individual aspects of the source and 11e.(2) byproduct materials license application. For example, site location and layout, milling facilities, surface impoundments (including tailings impoundments, retention ponds, barren solution ponds, and heap leach pads), operations (including the maximum production rate for which a license is to be granted or amended), management, safety training, waste management, monitoring, and decommissioning plans, as well as other activities should be discussed in general terms. The overview needs to be consistent with other sections of the license application and needs to reflect how the license or amendment is to be written. Inconsistencies in the license application may result in a greater number of requests for additional information, significantly lengthening the license application review process. Specific details of the proposed activities can be discussed in other sections of the SRP where it is appropriate. Although some details may not be available for all activities at the time of the license application review, the reviewer should be provided enough information to obtain a basic understanding of the proposed activities and potential public health and safety impacts.

1.2 Review Procedure

Ensure that the summary of proposed activities in the application provides a basic and sufficient understanding of the proposed activities and the likely magnitude of any public health and safety impacts. This information should meet, in part, the requirements of 10 CFR 40.31.

1.3 Acceptance Criterion

The summary descriptions of the proposed activities are acceptable if they are sufficiently detailed to provide a basic understanding of the activities for which a license or amendment is requested, and include the following:

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

(b) Corporate entities involved, including ownership.

(c) Land ownership.

(d) Maximum instantaneous (gallons per minute) and permitted annual (lbs U_3O_8) production rates of the mill (operations: tonnage of ore brought to the site and yellowcake production). The maximum permitted rate for which a license is to be written or amended needs to be clearly listed and consistent throughout the license application.

(e) Ore-body locations and estimated uranium content [Note: The U.S. Nuclear Regulatory Commission (NRC) regulates milling operations, not mining operations. The U.S. Department of Interior Office of Surface Mining, the U.S. Department of Labor Mine Safety and Health Administration, and the individual states regulate mining operations.

The information on ore body location and estimated uranium content is for understanding milling operations.]

(f) Milling process.

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

(h) Plans for surface impoundments management.

(i) Plans for decommissioning and land reclamation.

(j) Plans for operational and postoperational monitoring.

(k) Financial assurance arrangements covering eventual facility decommissioning, site reclamation, and long-term monitoring.

(l) For license renewals, a summary of proposed changes, a record of amendments since the last license issuance, documentation of inspection results, and other relevant historical information.

1.4 Evaluation Findings

If the staff determines that no license conditions are required for the summary of proposed activities because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the summary of proposed activities at the conventional uranium mill or heap leach facility in accordance with Section 1.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to describe the information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's summary of proposed activities is acceptable and is in compliance 10 CFR 40.31, which describes the general requirements for the issuance of a specific license." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the summary of proposed activities at the conventional uranium mill or heap leach facility in accordance with Section 1.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's summary of proposed activities is acceptable and is in compliance with 10 CFR 40.31, which describes the general requirements for the issuance of a specific license." If not discussed in the preceding paragraph, include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

1.5 References

None.

2.0 SITE CHARACTERIZATION

2.1 Site Location and Layout

2.1.1 Areas of Review

The staff should review regional and local geographic maps, topographic maps, and drawings that identify the conventional uranium mill or heap leach facility and its location relative to federal, state, county, and other political subdivisions. This should include maps provided to show the location and layout of the proposed facilities, principal structures (e.g., milling buildings, heap, ore stockpiles, surface impoundments, recovery plant buildings, diversion channels, drains, berms, and other major structures), supply wells, restricted area and site boundaries, fences, adjacent properties, site topography, property ownership, and land use.

The regional location and site layout for the proposed operations should be reviewed using maps that show the relationship of the site to local water bodies (lakes, ponds, streams, wetlands, and springs); geomorphologic features (highlands, depression zones, areas of subsidence); transportation links (roads, rails, airports, waterways); political subdivisions (counties and townships); population centers (cities, towns); and nonapplicant property (farms, ranches, settlements). A contour map of the site showing a plan layout of construction and significant topographic variations of the site environs should be evaluated.

Staff should ensure that sufficient information about natural surface and subsurface systems is presented to reach the conclusion necessary for initial licensing.

2.1.2 Review Procedures

Use the following procedures when reviewing the characterization of the site layout and location:

(1) 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. Verify that the applicant provided sufficient site-specific information to evaluate the suitability of the location of surface impoundments. This information should meet, in part, the requirements of 10 CFR 40.31(h) and 10 CFR Part 40, Appendix A, Criteria 1 and 4(b).

(2) Verify that maps showing the proposed conventional uranium mill or heap leach facility provided in the application are clear and readable and at an appropriate scale. This information should meet, in part, the requirements of 10 CFR 40.31(h) and 10 CFR Part 40, Appendix A, Criterion 1.

(3) Verify that the data sources supporting the description of site location and site layout of the proposed facility are clearly described. This information should meet, in part, the requirements of 10 CFR 40.31(h).

(4) Verify that the regional and site-specific geomorphic features, in particular those that may adversely affect site stability and integrity of surface impoundments, are adequately

identified. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 1, 3, 4(a), and 4(b).

2.1.3 Acceptance Criteria

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

(1) Data presented in the form of maps, drawings, tables, figures, and charts in support of site characterization of the proposed facility are complete and accurate. Such data include sufficient information on the following:

(a) Locations of planned principal structures, such as milling buildings, surface impoundments (as described in Introduction), diversion channels, and recovery plant buildings. Data clearly show that sufficient land space is available for these principal structures at the proposed site.

(b) Restricted and site boundaries, ore stockpiles, berms, curbs, buffer zones, and fences.

(c) Current adjacent properties, including surface water bodies, forests, farms, ranches, settlements, property and mineral ownership, and federal, state, county, and local political subdivisions.

(d) Nearby population centers (e.g., towns, cities, and ranches) and transportation links such as railroads, highways, and waterways at present and for the anticipated life of the conventional uranium mill or heap leach facility.

(e) Elevation contours that show on a topographic map the boundaries of drainage basins and variations in the drainage gradient in the vicinity of the proposed conventional uranium mill or heap leach facility. The topographic map also includes surface drainage features upstream and downstream of the proposed surface impoundments. Topographic maps are in sufficient detail to assess whether topographic features would provide good wind protection for surface impoundments and minimize potential for extreme surface erosion, mass wasting, and stream encroachments. A proper siting for surface impoundments is crucial for meeting 1,000-year longevity without the use of active maintenance in conformance with NUREG–1620, “Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978,” Revision 1 (NRC, 2003). The specific locations of natural streams and proposed diversion channels, relative to principal structures, are also provided.

(f) Descriptions of the nature and extent of projected land use (e.g., agriculture, recreation, industry, livestock grazing, and infrastructure) and descriptions of the methodology and sources used to develop projections. Land use data are collected within a 3.2-km [2-mi] distance from the site boundary. Information on residences within the 3.2-km [2-mi] distance is provided.

(g) Locations of uranium ore mines or mineral or resource recovery sites; abandoned, in remediation, in operation, or proposed uranium and other mineral

or resource recovery operations; nuclear fuel cycle facilities within an 80-km [50-mi]-geographic radius of the site.

(h) Locations of abandoned, properly or improperly plugged wells, borings, exploratory holes, and mine shafts. The applicant has properly assessed whether or not these previous features are properly plugged and provide information on methods of assessment. The staff should review information on the depth of these abandoned or plugged features at and near the proposed site. If detailed information on locations of water supply and monitoring wells is not available at the time of the initial facility application, expected well locations are provided with an indication that the information is preliminary.

(2) Maps described in Section 2.1.1 of this standard review plan (SRP) are at an appropriate scale and are clear and readable. Maps include designation of scale, orientation (e.g., north arrow), and geographic coordinates. The proposed conventional uranium mill or heap 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 facility. 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. In addition to maps, the applicant may provide tabular locations of facilities using standard, established geographic coordinate systems.

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

(4) Regional and site-specific geomorphology and geomorphic processes are described in general. The description addresses the current geomorphological features and potential geomorphological changes in the course of construction and operation phases at the site. This information is used, in part, to support the geomorphic and geotechnical stability of the site, which will be reviewed in detail in Section 2.6 of this SRP.

2.1.4 Evaluation Findings

If the staff determines that no license conditions are required for site characterization because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: “NRC staff has completed its review of the site characterization information concerned with site location and layout at the conventional uranium mill or heap leach facility in accordance with Section 2.1.3 of the standard review plan.” Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: “Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 2.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant’s site characterization information is acceptable and is in compliance with 10 CFR 40.31(h), which requires completeness and accuracy in all materials provided by an applicant; 10 CFR Part 40, Appendix A, Criterion 1, the goal of which is isolation of the proposed facility; 10 CFR Part 40,

Appendix A, Criterion 3, which requires reasonable isolation of the tailings from natural erosional forces; and 10 CFR Part 40, Appendix A, Criteria 4, which requires that site design criteria need to be adhered to whether the tailings are located above or below grade." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the site characterization information at the conventional uranium mill or heap leach facility in accordance with Section 2.1.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 2.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's site characterization information is acceptable and is in compliance with 10 CFR 40.31(h), which requires completeness and accuracy in all materials provided by an applicant,10 CFR Part 40, Appendix A, Criterion 1, the goal of which is isolation of the proposed facility; 10 CFR Part 40, Appendix A, Criterion 3, which requires reasonable isolation of the tailings from natural erosional forces; and 10 CFR Part 40, Appendix A, Criterion 4, which requires that site design criteria needs to be adhered to whether the tailings are located above or below grade." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

2.1.5 Reference

NRC. NUREG–1620, "Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978." Rev. 1. Washington, DC: U.S. Nuclear Regulatory Commission. June 2003.

2.2 Historical Investigations

2.2.1 Areas of Review

Abandoned or active man-made features penetrating through unsaturated zones may act as preferential contaminant pathways, through which contaminants may be conveyed from ground surface and unsaturated zones to the underlying water-bearing units. For example, abandoned wells, exploratory drillings, and boreholes resulting from historical site investigations may form pathways for surface impoundment leakage, if not plugged properly. Therefore, for new license applications, staff should review previous activities that may affect subsequent monitoring programs or provide potential for chemical migration. Staff should review the description and scope of historical site investigations undertaken by former site owners and third parties. This will aid in site characterization and help identify locations of abandoned boreholes, open pit mines, and mine shafts, including their current status. The third parties may include, but are not

limited to, State and Federal agencies (e.g., U.S. Geological Survey, U.S. Bureau of Land Reclamation, U.S. Bureau of Mines), universities, mining companies, prospectors, or oil and gas exploration companies.

2.2.2 Review Procedures

Use the following procedure when reviewing historical investigations:

(1) Examine whether the information on historical site characterizations is complete. This information should meet, in part, the requirements of 10 CFR 40.31(h).

(2) Verify that the applicant provided either official records or evidence that action was undertaken to properly plug and abandon wells and exploratory drill holes. This information should meet, in part, the requirements of 10 CFR 40.31(h).

(3) Verify that all maps containing data on historical investigations are at an appropriate scale and are readable. This information should meet, in part, the requirements of 10 CFR 40.31(h).

2.2.3 Acceptance Criteria

The historical investigations are typically acceptable if they meet the following criteria:

(1) A summary of historical investigations is provided. The summary clearly identifies the previous investigators, the scope of investigation, equipment used, investigation dates and durations, and investigation locations.

(2) Well plugging and abandonment records (including well depth, well materials, and their plugging status) obtained from state, federal, and local sources, as appropriate, are provided. Well plugging and abandonment records are sufficiently clear to allow evaluation of potential connections or preferential pathways through the ground surface where conventional uranium mill or heap leach activities take place, uppermost aquifers,[1] and underground sources of drinking water. For wells without plugging and abandonment records, the applicant provides evidence that action is underway to properly plug and abandon wells.

(3) Maps containing data on historical investigations provided are at sufficient scale and resolution to clearly show the locations of historical site explorations, such as borings, exploratory drillings, trenches, and seismic lines.

2.2.4 Evaluation Findings

If the staff determines that no license conditions are required for historical investigations because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: “NRC staff has completed its review of historical investigations at the conventional uranium mill or heap leach facility in

[1]Uppermost aquifer means the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility’s property boundary (10 CFR Part 40, Appendix A, Definition).

accordance with Section 2.2.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 2.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's historical investigations are acceptable and are in compliance with 10 CFR 40.31(h), which requires completeness and accuracy in all materials provided by an applicant." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of historical investigations at the conventional uranium mill or heap leach facility in accordance with Section 2.2.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 2.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's historical investigations are acceptable and are in compliance with 10 CFR 40.31(h), which requires completeness and accuracy in all materials provided by an applicant." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

2.2.5 References

None.

2.3 Meteorology

2.3.1 Areas of Review

Staff should review descriptions of the atmospheric diffusion characteristics of the site and its surrounding area based on onsite meteorological data. Staff also should review a discussion of the general climatology including precipitation, evaporation, existing air quality, the relationship of the regional meteorological data to the onsite data, the meteorological impact of the onsite terrain and large lakes and other bodies of water, and the occurrence of severe and extreme weather in the area and its effects. This review also should include information on wind speed and direction, average temperature, and relative humidity. The meteorology program—which is part of the site monitoring programs required by 10 CFR Part 40, Appendix A, Criterion 7—needs to be sufficiently complete to allow for estimating maximum potential annual radiation

doses to workers and members of the public resulting from the routine releases of airborne radioactive materials in gaseous and particulate effluents to demonstrate compliance with 10 CFR 20.1101, 10 CFR 20.1302, 40 CFR 190.10, and 40 CFR Part 192.

2.3.2 Review Procedures

Use the following procedures when reviewing the site meteorology:

(1) Verify whether information on onsite meteorological conditions is sufficient to support environmental monitoring locations, estimates of airborne radionuclide transport from the proposed conventional uranium mill or heap leach facility to the unrestricted areas, and the performance of dose assessments to determine airborne pathway inputs to risk assessment models in conformance with Regulatory Guide 3.63, "Onsite Meteorological Measurement Program for Uranium Recovery Facilities—Data Acquisition and Reporting" (NRC, 1988). This information should meet, in part, the requirements of 10 CFR 20.1302 and 10 CFR Part 40, Appendix A, Criterion 7.

(2) Determine whether the applicant provided onsite meteorological data that are representative of long-term meteorological data from a National Weather Service station. This information should meet, in part, the requirements of 10 CFR 20.1501 and 10 CFR 40.31(h).

(3) Review the description of existing radiological and nonradiological air quality. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 8; 40 CFR 50.6(a); and 40 CFR 50.7(a).

(4) Verify that the sources of meteorological and air quality data are documented in open file reports or other published documents and the references to those documents are provided. This information should meet, in part, the requirements of 10 CFR 40.31(h).

2.3.3 Acceptance Criteria

The minimum amount of meteorological data needed for a siting evaluation is considered to be that amount of data gathered on a continuous basis for a consecutive 12-month period that is representative of long-term weather patterns in accordance with Regulatory Guide 3.63 (NRC, 1988). Consistent with the recommendation in Regulatory 3.63 (NRC, 1988), continuous sampling should continue until the applicant demonstrates that the data collected is representative of long-term conditions. The characterization of the site meteorology is acceptable if it meets the following criteria:

(1) Onsite meteorological conditions are described, based on appropriate data from National Weather Service, U.S. military, or other stations recognized as standard installations. The onsite meteorological data includes the following:

   (a) Locations and heights of instrumentation, description of instrumentation, and joint-frequency distribution data by wind direction, wind speed, atmospheric stability, annual wind rose diagrams, and period of record in accordance with Regulatory Guide 3.63 (NRC, 1988), and ANSI/ANS-3.11-2005 (American Nuclear Society, 2005). Quarterly and annual wind direction, wind speed, and atmospheric stability data are compiled in terms of joint frequency and joint

relative frequency, with an annual joint data recovery of 75 percent from heights representative of airborne gaseous releases (e.g., radon). The applicant may chose to use insulation-cloud cover and wind speed method, temperature lapse rate method, wind fluctuation method, Richardson method, or some other method to obtain information on atmospheric stability. The atmospheric stability classification scheme needs adjustment based on local influences such as surface roughness of terrain [ANSI/ANS-3.11-2005 (American Nuclear Society, 2005)]. For individual meteorological parameters, an annual data recovery of at least 90 percent in accordance with Regulatory Guide 3.63 (NRC, 1988) is provided.

(b) Miscellaneous data, including average mixing layer heights (which defines the upper boundary of the volume through which contaminants are capable of being mixed), a description of regional climatology, daily-averaged and maximum ambient temperatures, monthly and annual time series of daily-totaled precipitation and evaporation, and description of extreme weather conditions. Supplemental meteorological measurements could be necessary to address site-specific concerns, such as atmospheric motions in complex terrain, building wake-effects, which can potentially affect dispersion of effluents and airflow trajectories. Such supplementary meteorological measurements may include, but are not limited to, atmospheric moisture, solar and net radiation, barometric pressure, soil temperature in accordance with ANSI/ANS-3.11-2005 (American Nuclear Society, 2005).

(c) Maps or tables that describe meteorological conditions at the site and in the vicinity of the facility. In-situ measurements may also be augmented by remote-sensing technologies and supplemental monitoring locations especially for sites located in complex terrain environment (ANSI/ANS-3.11-2005).

(2) Meteorological data gathered on-site over a minimum 12-month consecutive period for a siting evaluation is representative of long-term (e.g., 30 years) meteorological conditions. To assess whether the period during which onsite meteorological data gathered are representative of expected long-term conditions, the concurrent period of meteorological data from a National Weather Service station are compared with the long-term meteorological data from the same station. The National Weather Service station selected for this comparison is in a similar geographical and topographical location and is reasonably close to the site (preferably within 50 mi [80 km]), if possible. The assessment is consistent with the guidance provided in Regulatory Guide 3.63 (NRC, 1988).

(3) Nonradiological air quality data (in reference to daily averaged PM_{10}, daily averaged $PM_{2.5}$, and annually averaged $PM_{2.5}$, in which PM_x stands for particulate matter of size less than and equal to x μm) collected over at least 1 full year prior to site construction are presented. If there has been significant changes or nearby construction, the air quality data should be collected in close temporal proximity to site construction. This type of data is preferred. However, if the area around a site remained unchanged between data collection and construction, it is possible to rely on the older data, if available. The U.S. Environmental Protection Agency (EPA) is concerned about $PM_{7.5}$ and PM_{10}, because once they are inhaled, they can affect heart and lungs and cause serious health effects. Radiological air quality parameters include, but are not limited to, radon levels.

(4) The sources of all meteorological and air quality data are documented in open file reports or other published documents. If the applicant generated data, the data documentation includes a description of the investigations and data reduction techniques.

2.3.4 Evaluation Findings

If the staff determines that no license conditions are required for meteorology because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of meteorology at the conventional uranium mill or heap leach facility in accordance with Section 2.3.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 2.3.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's meteorological characterization is acceptable and is in compliance with 10 CFR 20.1101, which requires licensees to have a radiation protection program; 10 CFR 20.1302, which requires compliance with dose limits for individual members of the public; 10 CFR 20.1501, which requires surveys to establish the magnitude and extent of radiation levels, concentrations or quantities of radioactive material, and the potential radiological hazards; 10 CFR 40.31(h), which requires completeness and accuracy of information; 10 CFR Part 40, Appendix A, Criterion 7, which requires preoperational and operational monitoring programs; 10 CFR Part 40, Appendix A, Criterion 8, which requires that milling operations must be conducted such that airborne effluent releases are reduced to as low as is reasonably achievable (ALARA) levels; 40 CFR 50.6(a) and 40 CFR 50.7(a), which set the limits for national primary and secondary ambient air quality standards for PM_{10} and $PM_{2.5}$, respectively; 40 CFR 190.10, which establishes environmental standards for normal operations; and 40 CFR Part 192, which establishes health and environmental protection standards for uranium and thorium mills." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of meteorology at the conventional uranium mill or heap leach facility in accordance with Section 2.3.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 2.3.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's meteorological characterization is acceptable and is in

compliance with 10 CFR 20.1101, which requires licensees to have a radiation protection program; 10 CFR 20.1302, which requires compliance with dose limits for individual members of the public; 10 CFR 20.1501, which requires surveys to establish the magnitude and extent of radiation levels, concentrations or quantities of radioactive material, and the potential radiological hazards; 10 CFR 40.31(h), which requires completeness and accuracy of information; 10 CFR Part 40, Appendix A, Criterion 7, which requires preoperational and operational monitoring programs; 10 CFR Part 40, Appendix A, Criterion 8, which requires that milling operations must be conducted such that airborne effluent releases are reduced to ALARA levels; 40 CFR 50.6(a) and 40 CFR 50.7(a), which set the limits for national primary and secondary ambient air quality standards for PM_{10} and $PM_{2.5}$, respectively; 40 CFR 190.10, which establishes environmental standards for normal operations; and 40 CFR Part 192, which establishes health and environmental protection standards for uranium and thorium mills." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

2.3.5 References

American Nuclear Society. ANSI/ANS-3-11, "American National Standard for Determining Meteorological Information at Nuclear Facilities." La Grange Park, Il: American Nuclear Society. 2005.

NRC. Regulatory Guide 3.63, "Onsite Meteorological Measurement Program for Uranium Recovery Facilities—Data Acquisition and Reporting." Washington, DC: U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research. 1988.

2.4 Geology and Seismology

2.4.1 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 local (site-scale) and regional stratigraphy, horizontal and vertical extents of major geologic units at the site and regional scale, petrologic characteristics of major geologic units (e.g., thickness, composition), tectonic features (faults, folds, fractures, and joints), volcanic features (e.g., cones, plugs, and dikes), and regional seismicity and seismic history. Some of the applicant's supporting information for this review area might be included in the documents submitted to satisfy the subsurface hydrology review area (see Section 2.7.1 of this SRP).

The staff should review the information presented on mining of economically important minerals (e.g., uranium or coal) and on energy-related deposits (e.g., coal-bed methane or oil production), including:

(1) Soil and geotechnical stability at, and near, the proposed facility;

(2) Changes in topographical features and drainage patterns that may affect surface water flooding and erosion and wind protection for surface impoundments; and

(3) Excessive dewatering of groundwater in the uppermost aquifer and/or affecting groundwater flow directions and rates in the uppermost aquifer, if the uppermost aquifer is a source for consumptive water use at other facilities.

Where applicable, the staff should perform independent analyses to verify the geologic data provided. The staff should also examine descriptions of any effects that planned operations at the site might have on the future availability of other mineral resources.

2.4.2 Review Procedures

The staff should use the following procedure in performing the review of the site geology and seismology:

(1) Determine whether a thorough evaluation of the geologic setting, including near surface geology, for the proposed conventional uranium mill or heap leach site is presented along with the basic geological data supporting the applicant's conceptual model of the geology. Determine whether stratigraphic units are described in sufficient detail to provide input to a geotechnical stability analysis review area as described in Section 2.6 of this SRP. This information should meet, in part, the requirements of 10 CFR 40.31(h).

(2) Determine whether the application contains accurate geologic, structural, and stratigraphic maps, isopach maps of the uppermost aquifer (as described in Section 2.2.3 of this SRP) and confining layer below the uppermost aquifer; geologic cross sections at places critical to a thorough understanding of the selected site; descriptions of representative supporting core samples; geophysical and lithologic logs and surveys, trenches, and remote-sensing measurements; and other data required for a thorough understanding of the pertinent geology. This information should meet, in part, the requirements of 10 CFR 40.31(h), 10 CFR Part 40, Appendix A, Criteria 5B(3) and 7.

(3) Determine whether the regional stratigraphic, structural, and geologic information is discussed in sufficient detail to give clear perspective and orientation to the site-specific material presented. This information should meet, in part, the requirements of 10 CFR 40.31(h).

(4) Determine whether an inventory of regional and local economically significant mineral and energy-related deposits is provided. This information should meet, in part, the requirements of 10 CFR 40.31(h).

(5) Evaluate the discussion of the seismicity and the seismic history of the region. This information should meet, in part, the requirements of 10 CFR 40.31(h) and 10 CFR Part 40, Appendix A, Criterion 4(e).

(6) Verify that the sources of all geological and seismological data are documented in U.S. Geological Survey open files or other published documents. This information should meet, in part, the requirements of 10 CFR 40.31(h).

(7) Determine whether any volcanic features, such as solidified lava channels, cones, and dikes, if located in the proposed site, are discussed in sufficient detail. This information should meet, in part, the requirements of 10 CFR 40.31(h).

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

2.4.3 Acceptance Criteria

The characterization of the site geology and seismology is acceptable if it meets the following criteria:

(1) A detailed description is presented of the geologic setting at the local and regional scales by including the description of the major rock types (stratigraphic units) and their thickness, composition, orientation, distribution both at the surface and at the depths of interest, and continuity. Geological data and the sources to support the description of the geological setting at the proposed site are presented. Geological data may be included in the original work the applicant submitted or obtained from previous work in the region that third parties performed as discussed in Section 2.2 of this SRP. Geological data may be acquired through cuttings and core logging and through wireline geophysical logs, such as electrical resistivity, neutron density, and gamma logs. Surface geophysical methods may provide useful data. Geological descriptions of the proposed site may be presented as stratigraphic columns, geologic maps, cross sections, fence diagrams showing stratigraphic correlations among sampling locations, aerial photography, and remote sensing images.

(2) The following information is presented:

(i) Geologic, structural, stratigraphic, and isopach maps of the uppermost aquifer, the confining layer below the uppermost aquifer. Isopach maps for the confining layer below the uppermost aquifer may not be required, if sufficient local or regional data from literature or nearby mining or oil fields exist to confirm the continuity and spatial uniformity (in thickness and porosity) of the confining layer. If the confining layer is discontinuous and it is underlain by a major aquifer, which is being used or could be used as a potential water source, then geologic, structural, stratigraphic, and isopach maps of the underlying major aquifer below the confining layer are presented.

(ii) Geologic cross sections, with groundwater levels indicated (see Section 2.7 of this SRP), below the proposed surface impoundments and mill buildings and at other critical places at the proposed facility essential for a thorough understanding of the proposed site and description of representative core samples

(iii) Geophysical and lithological logs, remote-sensing measurements, and other data required for a thorough understanding of the pertinent geology.

All maps and cross sections are at sufficient scale and resolution to clearly show the intended geologic information and also include the location of major facility structures. Maps show sampling locations (e.g., geophysical logs, borehole locations) and geologic cross sections. Maps have designation of scale, orientation (e.g., north arrow), and geographic coordinates. Cross sections show groundwater elevations in the uppermost aquifer and also in the underlying major aquifer, if there is evidence that the underlying aquifer may not be hydraulically isolated.

(3) The discussion of regional geology and stratigraphy is adequately referenced and illustrated by regional surface and subsurface geologic maps, stratigraphic columns, and cross sections. A generalized stratigraphic column including the thicknesses and type of rock units and representation of lithologies is presented. In the local stratigraphic section, the uppermost aquifer, its underlying confinement, and other important underlying units, such as drinking water aquifers, are clearly shown with their depths from the surface.

The local and regional geologic structure, including folds, fractures, and faults, is described with the aid of, for example, aerial photography, remote sensing images and field studies. Folds and faults are shown on the geologic maps used to describe the stratigraphy. Structural maps of faults are provided and fault offsets are shown on cross-section maps. Lateral facies changes of stratigraphic units and major structural features are shown in cross sections. Major and minor faults traversing the proposed site are evaluated for the likely consequences (e.g., their potential barrier effects or preferential pathways) of any future effects of active faulting on the stability of surface impoundments.

(4) An inventory of economically significant mineral and energy-related deposits is provided. Locations (via, for example, aerial photography, remote sensing images, or site visits) are provided for known wells, surface and underground mine workings, disturbed lands (e.g., construction zones, open pits, sites chosen for land application of treated produced water), and surface impoundments that may have an effect on the proposed operations. These items are located on a map of sufficient scale and clarity.

(5) The seismicity and the seismic history of the region are discussed. Historical seismicity data are summarized on a regional earthquake epicenter map within 200 km [124 mi] of the site, including the date of occurrence, magnitude, and location of known seismic events [NUREG–1620 (NRC, 2003)]. Seismic events associated with the tectonic features are described in the geologic structures.

The applicant provides deterministic and/or probabilistic seismic hazard analyses. For a deterministic analysis, the potential ground motion at the site from capable faults that might affect the integrity of surface impoundments, and hence, the licensed area, is assessed.[2] A probabilistic seismic hazard analysis yields a curve of exceedance probability versus peak horizontal acceleration. The 10^{-4} value represents a 1 in 10 chance of the site exceeding the peak horizontal acceleration in a 1,000-year period, which is appropriate for a 1,000-year design life. The applicant demonstrated that surface impoundments have been designed to withstand the credible earthquake (the largest earthquake that can reasonably be expected) the fault may generate. Additionally, the proposed designs for surface impoundments are shown to be capable of withstanding the liquefaction potential associated with the expected maximum ground acceleration from earthquakes (see Section 3.3 of this SRP).

(6) The sources of geological and seismological data are documented in U.S. Geological Survey open files or other published documents. If the applicant generated data, the documentation includes a description of the investigations and data reduction techniques.

[2]The term capable fault, as used in 10 CFR Part 40, Appendix A, Criterion 4(e), has the same meaning as defined in 10 CFR Part 100, Appendix A, Section III(g).

(7) Volcanic features may act as flow conduits or barriers to groundwater flow, if they exist. Therefore, a discussion of volcanic features (such as dike, cone, and solidified lava channels), if they exist at the proposed site or nearby, is adequately referenced and interrelations among these features and with other geological (stratigraphic units) and structural features (joints, fractures, faults, folds), including geologic age relationships, are supported by maps, logs, and cross sections.

2.4.4 Evaluation Findings

If the staff determines that no license conditions are required for geology and seismology because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of geology and seismology at the conventional uranium mill or heap leach facility in accordance with Section 2.4.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 2.4.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's geology and seismology is acceptable and is in compliance with 10 CFR 40.31(h), which requires completeness and accuracy in all materials provided by an applicant; 10 CFR Part 40, Appendix A, Criterion 4(e), which requires locations away from faults capable of causing surface impoundment failure; 10 CFR Part 40, Appendix A, Criterion 5B(3), which establishes criteria for excluding a detected constituent; and 10 CFR Part 40, Appendix A, Criterion 7, which requires preoperational and operational monitoring programs." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of geology and seismology at the conventional uranium mill or heap leach facility in accordance with Section 2.4.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 2.4.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's geology and seismology is acceptable and is in compliance with 10 CFR 40.31(h), which requires completeness and accuracy in all materials provided by an applicant; 10 CFR Part 40, Appendix A, Criterion 4(e), which requires locations away from faults capable of causing surface impoundment failure; 10 CFR Part 40, Appendix A, Criterion 5B(3), which establishes criteria for excluding a

detected constituent; and 10 CFR Part 40, Appendix A, Criterion 7, which requires preoperational and operational monitoring programs." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

2.4.5 Reference

NRC. NUREG–1620, "Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978." Rev. 1. Washington, DC: U.S. Nuclear Regulatory Commission. June 2003.

2.5 Soil

2.5.1 Areas of Review

Characterization of the soil must be sufficient so that the staff can assess whether public health and safety may be affected by conventional uranium mill or heap leach facility operations (e.g., surface impoundments design). Because soil properties affect several practices at conventional uranium mill and heap leach facilities, soil-related properties may be discussed in more detail in other sections; however, basic information needs to be presented in this section, including reporting the range in soil properties found at the facility site. Important soil characteristics are soil texture (percent sand, silt, and clay), coarse fragments (percentage of gravels, cobbles, and boulders), organic matter content, clay mineralogy, soil depth, porosity, bulk density (oven-dry mass density of soil), permeability or saturated hydraulic conductivity, soil strength, and characteristics important for soil chemistry. Soil maps of the site should also be reported. The baseline (preoperational) radioactive content of the soil is reported in Section 2.8 of this SRP.

2.5.2 Review Procedures

The staff should use the following procedure in performing the review of the site soil characterization:

(1) Determine whether a soil map is provided for the facility and whether there is a discussion relating soil types to landforms (e.g., valley bottoms, side slopes, terraces, ridge/hill tops) of the site. This information should meet, in part, the requirements of 10 CFR 40.31(h); 10 CFR Part 40, Appendix A, Criteria 1 and 5G(2).

(2) Verify that soil properties are discussed and representative values and ranges are given for the various soil types (and layers) shown in the soil map. This information should meet, in part, the requirements of 10 CFR 40.31(h); 10 CFR Part 40, Appendix A, Criteria 1 and 5G(2).

The staff also should evaluate the methods used to characterize the soil properties to ensure that they are consistent with generally accepted standards, such as those of the ASTM International, the U.S. Department of Agriculture, or other industry standards (see Dane and Topp, 2002).

2.5.3 Acceptance Criteria

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

(1) The application includes a map outlining boundaries among soil types or soil complexes (a mapping unit containing two or more soil types). The map is at a sufficient scale and resolution to show clearly the soil mapping units. A discussion accompanies the map describing how the soil types are associated with particular landforms or other pertinent information at the site. The use of a soil survey the Natural Resources Conservation Service of the U.S. Department of Agriculture conducted, if available, is adequate.

(2) Representative values (with ranges) of the following soil properties are given and are appropriate for conventional uranium mill or heap leach operations. At a minimum, values are reported for the surface (upper 5 cm [2 in]) and subsurface layers (at a depth of 1 m [3.3 ft] or shallower if soil depth is less than 1 m [3.3 ft]). Changes in soil properties, including depth, are noted. The methods used to determine the values are also given. Values the Natural Resources Conservation Service reported are acceptable. Soil descriptions should be based on U.S. Department of Agriculture soil taxonomy or soil science classification descriptions. The following soil properties are provided:

(a) Soil texture (percentage of sand, silt, and clay of the less than 2-mm [0.079-in] diameter size class)—if the particle size distribution is determined by sieve analyses, then the percentage passing through the 200-mesh sieve;

(b) Coarse fragments (percentage of gravels, cobbles, and boulders in the soil);

(c) Dominant mineralogy of the clay-sized particles (e.g., smectite or other swelling clays; kaolinite, allophane, or other nonswelling clays)—some indication of whether the clay-sized minerals will swell or shrink depending on the soil water content;

(d) Soil depth;

(e) Soil porosity;

(f) Bulk density (oven-dry mass density or wet mass density and associated water content);

(g) Soil chemistry;

(h) Permeability or saturated hydraulic conductivity; and

(i) Soil strength—typically the shear strength.

The soil strength may be discussed in more detail in sections addressing geotechnical properties (see Section 2.6 of this SRP).

2.5.4 Evaluation Findings

If the staff determines that no license conditions are required for the applicant's description of soil because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the applicant's description of soil at the conventional uranium mill or heap leach facility in accordance with Section 2.5.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 2.5.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of soil is acceptable and is in compliance with 10 CFR 40.31(h), which requires completeness and accuracy of information; 10 CFR Part 40, Appendix A, Criterion 1, which requires isolation of tailings and associated contaminants; and 10 CFR Part 40, Appendix A, Criterion 5G(2), which requires providing characteristics of underlying soils in support of a tailings disposal system proposal." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the applicant's description of soil at the conventional uranium mill or heap leach facility in accordance with Section 2.5.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 2.5.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of soil is acceptable and is in compliance with 10 CFR 40.31(h), which requires completeness and accuracy of information; 10 CFR Part 40, Appendix A, Criterion 1, which requires isolation of tailings and associated contaminants; and 10 CFR Part 40, Appendix A, Criterion 5G(2), which requires providing characteristics of underlying soils in support of a tailings disposal system proposal." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

2.5.5 Reference

Dane, J.H. and G.C. Topp, eds. "Methods of Soil Analysis: Part 4 Physical Methods." Madison, Wisconsin: Soil Science Society of America, Inc. 2002.

2.6 Geotechnical

2.6.1 Areas of Review

Staff should examine information in the license application on the geotechnical aspects of the site geography and stratigraphy and geotechnical characteristics of the proposed surface impoundments and associated substructure materials. In addition, staff should examine geotechnical characteristics of materials used to provide stabilization, including borrow-area material characteristics. The staff should also examine exploration data; the description of physical and chemical properties; sampling and laboratory and/or field measurement techniques; and test results with interpretation, including static and dynamic properties of the materials. This review should be coordinated with the review of geological, stratigraphical, and seismological information, as described in Section 2.4 of this SRP.

2.6.2 Review Procedures

The geotechnical site characterization information constitutes part of the input data needed for analysis and design of the conventional uranium mill or heap leach facilities. The review should focus on the appropriateness of the geotechnical site characterization for the proposed conventional uranium mill or heap leach facility, including the determination of whether appropriate characterization methods are properly used. The reviewer should use the following procedures when reviewing the geotechnical characterization of the conventional uranium mill or heap leach facility:

(1) Ensure that the applicant has described the stratigraphy of sites for mill buildings, surface impoundment(s), and/or the heap leach facilities. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5G(2).

(2) Ensure that the applicant has described the stratigraphy of the site for borrow areas designated to be used for construction of the surface impoundment(s). This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 5G(2).

(3) Ensure that the applicant has adequately described the sampling program(s) to obtain samples and used appropriate laboratory and field tests to adequately characterize the geotechnical properties of the tailings, leachable ores, borrow materials, materials underlying the site, and other materials to be used. For a new conventional uranium mill, properties of the tailings may be estimated. Verify that the applicant has provided adequate technical justification for selecting these estimated property values. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5G(2).

(4) Ensure that the physical and engineering properties of the tailings, leachable ore, underlying materials at the site(s), borrow materials, and other materials have been properly presented. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5G(2).

The reviewer should evaluate methods used to characterize the site to ensure that they comply with generally accepted standards, such as those of the American Society for Testing and Materials (ASTM International) and those commonly used in the geotechnical engineering profession. Areas to be examined in this respect include the *in situ* and laboratory testing

programs, sampling techniques, and analyses for determining the physical and engineering properties of materials at the site. Field investigations and laboratory testing procedures generally not used in the geotechnical engineering profession should be reviewed in greater detail.

2.6.3 Acceptance Criteria

The geotechnical site characterization is acceptable if it provides the needed input for the design and analysis of these facilities and meets the following criteria:

(1) The description of the stratigraphy provides detailed information about the extent, thickness, uniformity, shape, and orientation of the underlying strata at the surface impoundment(s). The description includes, but is not limited to:

(a) Information obtained from borings, test pits, and other surface- and subsurface-based surveying methods;

(b) Information included in both geological and geophysical logs;

(c) Information obtained using techniques that can detect significant discontinuities, fractures (e.g., faults), and channels of deposits with high hydraulic conductivity; and

(d) Information that has been collected from a sufficient number of locations to provide adequate spatial coverage.

(2) The stratigraphy of the borrow areas for materials to be used in constructing the radon barrier, cover, and any embankments for the surface impoundment(s) has been described in detail. The description includes both geological and geophysical techniques to delineate the extent of available materials and establish their characteristics.

(3) Sampling scopes and sample collection techniques conducted to obtain laboratory samples and laboratory and field tests selected to characterize or estimate geotechnical properties of the tailings, leachable ores, borrow materials, materials underlying the site, and other materials to be used are appropriate and follow acceptable standards (e.g., regulatory guides, appropriate standards published by ASTM International, and the suggested methods published by the International Society for Rock Mechanics). The sample collection program(s) provide adequate spatial coverage and are sufficient to ensure that samples collected are representative of the range of *in-situ* soil and rock conditions taking into consideration the associated variabilities within the site. If standard procedures are not used, a detailed discussion of the sample preparation, testing conditions, testing technique, and data interpretation, in addition to the justification of the testing method, is presented. The applicant has provided adequate technical justification for the appropriateness of estimated properties of the mill tailings.

Locations of soils and rocks that may be unsuitable due to their physical or chemical properties are appropriately identified and documented.

Laboratory and field tests used to characterize the soil and rock are appropriate and are consistent with guidance. Regulatory Guide 1.132, “Site Investigations for Foundations

of Nuclear Power Plants," Revision 2 (NRC, 2003a) and Regulatory Guide 1.138, "Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants," Revision 2 (NRC, 2003b, Appendix A) contain acceptable testing techniques for investigating a particular property both *in situ* and in a laboratory, respectively.

(4) Physical and engineering properties of the tailings, leachable ore, underlying materials at the site(s), borrow materials, and other materials determined from laboratory and field tests are properly presented using appropriate plots and graphs. The parameters for evaluation of heap leach operations, mill tailings, borrow materials, other materials, and underlying soil and rock include, but are not limited to, the following:

(a) Estimated or measured size distribution of mill tailings, leachable ore, and borrow materials;

(b) Strength of soil and rock underneath the surface impoundments in addition to tailings and heap leach materials including potential loss of shear strength resulting from strain softening;

(c) Soil and geomembrane liner interface strength, if geomembrane liner is to be used as a liner component;

(d) Compressibility and rate of consolidation of tailings or heap leach ore;

(e) Permeability of mill tailings and ore particles for heap leach;

(f) Swelling and shrinkage of cover materials;

(g) Liquefaction potential of mill tailings and ore particles on heap leach pads; and

(h) Long-term moisture content for radon barrier material.

The information is sufficient to provide the required input for the design of the facility and to enable the reviewer to assess compliance with the regulatory requirements, such as site features contributing to waste isolation; facility location with respect to an active fault; and reasonable assurance of control of radiological hazards to be effective for 1,000 years to the extent reasonably achievable, and in any case, for at least 200 years.

2.6.4 Evaluation Findings

If the staff determines that no license conditions are required for geotechnical aspects because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the applicant's description of geotechnical aspects at the conventional uranium mill or heap leach facility in accordance with Section 2.6.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 2.6.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of geotechnical aspects is acceptable and is in compliance with 10 CFR Part 40, Appendix A, Criterion 5G(2), relating to the permeability characteristics of the site." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license condition(s) are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the applicant's description of geotechnical aspects at the conventional uranium mill or heap leach facility in accordance with Section 2.6.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 2.6.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of geotechnical aspects is acceptable and is in compliance with 10 CFR Part 40, Appendix A, Criterion 5G(2), relating to the permeability characteristics of the site." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

2.6.5 References

NRC. Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants." Rev. 2. Washington, DC: U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research. 2003a.

——. Regulatory Guide 1.138, "Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants." Rev. 2. Washington, DC: U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research. 2003b.

2.7 Hydrology

2.7.1 Groundwater Hydrology—Regional and Site Specific

2.7.1.1 Areas of Review

Characterization of the regional and site-specific groundwater hydrology at conventional uranium mill or heap leach facilities must be sufficient to assess potential effects of conventional uranium mill or heap leach operations on the uppermost aquifer (as defined in Section 2.2.3 of this SRP), where regulatory compliance is to be evaluated. The areas of review include:

(1) The description of regional and local (site-specific) groundwater hydrology;

(2) The assessment of available groundwater resources and groundwater quality within the proposed facility boundaries and adjacent properties; and

(3) The assessment of the potential effect of pumping to groundwater drawdown in the uppermost aquifer, if the groundwater in the uppermost aquifer is pumped for consumptive water use during construction, operation, and site reclamation.

2.7.1.2 Review Procedures

Staff should use the following procedures when conducting the review of regional and site-specific groundwater hydrology:

(1) Review available data from well logs, hydrologic tests, and measurements to obtain confidence that sufficient hydrological data have been collected at the conventional uranium mill or heap leach facility, and at proposed locations for surface impoundments, and that the data support the applicant's hydrologic conceptual model for groundwater flow in the uppermost aquifer beneath the proposed facility and surface impoundments. This information should meet, in part, the requirements of 10 CFR 40.31(h) and 10 CFR Part 40, Appendix A, Criterion 5G(2).

(a) Verify that the applicant used acceptable techniques for groundwater-level measurements in the uppermost aquifer. Verify that the applicant adequately presented groundwater levels, hydraulic gradients, groundwater flow directions, and groundwater recharge zones and rates for the uppermost aquifer beneath the proposed facility.

(b) Review the applicant's assessment of seasonal and historical variations of groundwater levels in the uppermost aquifer.

(c) Verify that the unsaturated zone between the ground surface and the uppermost aquifer is properly characterized. Verify that the applicant identifies perched zones beneath the proposed site above the uppermost aquifer, if they exist. Note that the saturated zone created by conventional uranium mill or heap leach operations (through accidental water seepage or leakage from the operation site or surface impoundments) would not be considered to be an aquifer unless the zone is, or potentially is (i) hydraulically interconnected to a natural aquifer, (ii) capable of discharge to surface water, or (iii) reasonably accessible because of migration beyond the vertical projection of the boundary of the land transferred for long-term government ownership and care in accordance with 10 CFR Part 40, Appendix A, Criterion 11.

(d) Verify that the zones of water exchanges between surface water bodies and the uppermost aquifer are identified.

(e) Review the adequacy of local groundwater sources (from shallow or deep aquifers) for use, and determine whether a limiting extraction rate would avoid dewatering of the uppermost aquifer if the consumptive water use during operations or site reclamation is supplied locally from the uppermost aquifer beneath the proposed facility.

(2) Verify that the number and location of boreholes are sufficient to support the hydrologic characterization, if shown as such in the cross sections. This part of the review should be coordinated with the review of Section 2.4 of this SRP. This information should meet, in part, the requirements of 10 CFR 40.31(h) and 10 CFR Part 40, Appendix A, Criterion 5G(2).

(3) Determine whether hydraulic properties for the uppermost aquifer and its underlying confinement are determined using appropriate methods (e.g., aquifer pumping tests, slug tests) and whether the methods or standards used to analyze the field test data are properly described and referenced. If the confining layer below the uppermost aquifer is absent or ineffective, and if the uppermost aquifer is not hydraulically isolated from underlying deep major aquifers, determine whether the hydraulic properties of underlying major aquifers are also determined using appropriate methods. This information should meet, in part, the requirements of 10 CFR 40.31(h) and 10 CFR Part 40, Appendix A, Criterion 5G(2).

(4) Evaluate whether the applicant has developed an acceptable conceptual model of the groundwater hydrology at the proposed site and whether the conceptual model is adequately supported by the site characterization data. This information should meet, in part, the requirements of 10 CFR 40.31(h); 10 CFR 40.41(c); and 10 CFR Part 40, Appendix A, Criterion 5G(2).

(5) Verify that the applicant identified sources, uses (e.g., domestic, irrigation, livestock), and quality of groundwater, along with locations of existing groundwater supply wells at and near the site. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 5B(4) and 5G(3).

(6) Evaluate the applicant's assessment of the potential interference of other nearby mining, and mineral or resource recovery activities to the groundwater hydrology at the proposed site (e.g., changes in water quality, flow rates and directions in the uppermost aquifer). This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5G(2).

(7) Evaluate the applicant's groundwater simulation model, if available. It should be noted that groundwater simulation model is not required as part of license application, but the applicant may choose to use simulation models to support their site-specific hydrogeologic conceptual model and to demonstrate how they chose the locations and spacing of compliance and other groundwater monitoring wells. If the numerical simulation model is submitted as part of the license application, verify that the applicant validated its groundwater simulation model using field data (e.g., groundwater levels, flow directions, and hydraulic gradients) acquired in different seasons including high and low recharge periods. This information should meet, in part, the requirements of 10 CFR 40.31(h).

2.7.1.3 Acceptance Criteria

The characterization of the regional and site-specific groundwater hydrology is acceptable if it meets the following criteria:

(1) The applicant has described the local and regional hydraulic gradient and hydrostratigraphy in sufficient detail using data from well logs, hydrologic tests, and

measurements, and data from other sources, as described in Section 2.1.3(3) of this SRP. The applicant's description of groundwater hydraulic gradients, horizontal hydraulic conductivity, the thickness of the uppermost aquifer, the thickness and vertical hydraulic conductivity of the lower confinement of the uppermost aquifer, outcrop areas, and areal extent of the uppermost aquifer is consistent with the applicant's conceptual hydrogeologic model.

(a) The applicant has shown that groundwater-level measurements are collected by acceptable methods, such as ASTM D4750–87 (ASTM International, 2001). Potentiometric maps or separate maps and/or tables present groundwater elevations and hydraulic gradient data. These maps provide two levels of details: (i) the regional map represents the groundwater elevations and areal extent of the uppermost aquifer and encompasses the likely consequences on any affected highly populated areas; and (ii) the local (site-scale) map encompasses groundwater elevations and the extent of the uppermost aquifer within the proposed area. Potentiometric maps clearly show the locations of the wells and boreholes used to determine the groundwater surface elevations. The depths and screened intervals of the wells and boreholes are provided on cross sections and/or in tables. The contour interval of potentiometric maps is sufficient to clearly show the groundwater flow direction in the uppermost aquifer. The number of boreholes and wells, where groundwater surface elevation measurements were taken, is sufficient to determine hydraulic gradients and groundwater flow directions in the uppermost aquifer. A reasonable effort has been made to consider as many existing wells and boreholes as possible in constructing regional and groundwater potentiometric maps.

(b) The applicant has provided an assessment of the seasonal and historical variability of groundwater elevations and hydraulic gradients in the uppermost aquifer based on either data the applicant collected onsite or acquired from different sources, as described in Section 2.1.3 of this SRP. The applicant also provided an assessment of the seasonal and historical variability of the depth to groundwater levels in the uppermost aquifer from ground surface and an assessment of infiltration rates and distributions to the uppermost aquifer.

(c) The applicant has provided an adequate hydrogeologic description of the unsaturated zone extending from ground surface to the uppermost aquifer, including an assessment of potential preferential pathways (e.g., buried stream channels, sinkholes, or abandoned wells). If local perched zones (i.e., isolated and disconnected fully saturated zones) above the uppermost aquifer exist, the applicant noted their presence. Such perched zones may cause contaminated water to be diverted around monitoring systems or may be improperly interpreted as the uppermost aquifer. The applicant has distinguished naturally occurring perched aquifers from potentially temporarily formed perched zones during uranium milling and heap leach operations below the proposed facility.

(d) The applicant has adequately identified hydraulic connections and water exchange zones between the uppermost aquifers and surface waters. If such groundwater–surface water exchange zones exist, the applicant provided an estimate for the direction and flux rate of water exchanges by presenting seasonal variations in the groundwater elevations in the uppermost aquifer and the stream stage along the zone of hydraulic connections between the

uppermost aquifers and surface waters. The direction and flux rate water exchanges between a hydraulically connected uppermost aquifer and surface waters are important for the assessment of potential contaminant and mass transfer between surface waters and groundwater due to proposed actions.

(e) The applicant has identified sources for consumptive water use during construction, operations, and reclamation at the proposed conventional uranium mill or heap leach site. If the consumptive water use is to be supplied partly or entirely from the uppermost aquifer beneath the facility, the applicant has provided an estimate for the consumptive water use from the uppermost aquifer during construction, operation, and reclamation. The applicant has also provided an assessment of the potential impacts of consumptive water use from the uppermost aquifer on the quality and quantity (in terms of drawdown) of groundwater in the uppermost aquifer within the proposed facility boundaries and adjacent properties.

(2) The applicant has provided adequate hydrological cross sections for illustrating the interpreted hydrostratigraphy. For large or hydrologically complex areas, more than one cross section may be necessary. These cross sections have been constructed for the area within the proposed facility boundary such that they cut through the operational area, milling buildings, surface impoundments, and other critical locations. The cross sections identified continuity and thickness of the uppermost aquifer, its underlying confinement, major structural features (e.g., faults, folds, dikes), and groundwater levels. Cross sections are based on borehole data acquired during well installation or exploratory drilling. Significant borehole data are included in an appendix to the application. The information gathered on boreholes allows the identification of potential discontinuities and fractured zones in the uppermost aquifer and the underlying confinement, and potential channel deposits of high vertical conductivity above the uppermost aquifer beneath the surface impoundments.

(3) The applicant has described hydraulic properties of the uppermost aquifer to estimate potential migration paths and distribution of hazardous contaminants if they leak from surface impoundments during or after milling operations. The hydrological properties of aquifers include aquifer type, shape, extent, thickness, porosity, hydraulic conductivity, transmissivity, and storativity or storage coefficient. The hydrologic properties of the underlying confinement of the uppermost aquifer include vertical conductivity, continuity, uniformity (e.g., jointed or fractured rock type), porosity, and thickness.

Hydraulic properties of the uppermost aquifer, next underlying aquifer and confining layers are determined using proper field tests (e.g., aquifer pumping tests, slug tests) for parameters such as hydraulic conductivity, transmissivity, and specific storage. Field tests are also designed to take into account the effects of faults and other geological and structural features. The field tests are designed to take into account the aquifer type (e.g., unconfined, confined, leaky) of the uppermost aquifer. Appropriate methods are used to interpret aquifer properties from field test data. If aquifer pumping tests are used, appropriate methods include single-well drawdown and recovery tests, drawdown versus time in a single observation well, and drawdown versus distance pumping tests using multiple observation wells. The methods or standards used to analyze pumping test data are 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 ASTM standards (ASTM International,

2001). 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). For estimates of porosity, the applicant uses laboratory analysis of core samples, borehole geophysical methods, and/or analysis of the barometric efficiency[3] of the aquifer (e.g., Lohman, 1972). The applicant distinguishes between total porosity estimated from borehole geophysical methods and effective porosity (excluding immobile zone porosity) that affects transport of chemical constituents.

(4) The applicant has established an acceptable conceptual hydrological model for the conventional uranium mill or heap leach site and surrounding areas. The conceptual model provides a framework for the applicant to make decisions on the optimal methods for uranium milling or heap leaching that minimize potential environmental and safety impacts. The applicant adequately incorporated data acquired onsite during site characterization, from the U.S. Geological Survey, or from other sources to support the conceptual hydrological model.

(5) The applicant has provided information on underground sources of drinking water and aquifers (e.g., the state groundwater classification at the proposed conventional uranium mill or heap leach facility). The applicant has adequately described:

(a) The types of present and projected (life of proposed facility) water uses (e.g., domestic, irrigation, livestock) and descriptions of the methodology and sources used to develop projected water demands;

(b) The present and projected (life of facility) water use estimates for groundwater by types and rates, including present and projected withdrawal and descriptions of the methodology and sources used to develop water use projects; and

(c) The well depth, groundwater elevations, flow rates, drawdown, and descriptions of the uppermost aquifer for existing groundwater wells.

(6) The applicant has adequately assessed the potential interference of other nearby uranium recovery and/or other mineral or resource recovery to site groundwater hydrology. The applicant considered interferences including, but not limited to, (i) groundwater drawdown in the uppermost aquifer beneath the proposed mill facility due to consumptive groundwater uses from the uppermost aquifer at nearby facilities or (ii) groundwater contamination in the uppermost aquifer beneath the proposed mill facility due to artificial connection (through, for example, exploratory drills or abandoned mine shafts or pit mines) between the uppermost aquifer beneath the proposed mill facility and underlying major aquifers operated offsite for mineral and resources recoveries. This information provides the basis for evaluating potential effects of other nearby uranium or mineral resources recovery on local groundwater resources beneath the proposed site. The applicant has demonstrated that the effect of these additional activities can be differentiated from that caused by the conventional uranium mill or heap leach activities alone. The applicant used sufficient information to evaluate the potential effects, such as aquifer drawdown, artificial connections, and water quality.

(7) If a groundwater model is used for simulating site hydrogeology, model assumptions, inputs (e.g., flow domain geometry, hydraulic parameters, initial and boundary

[3]The total porosity of the aquifer is the product of the specific storativity of the aquifer and the barometric efficiency.

conditions), calibration, and outputs are detailed. The model structure and model parameterization are consistent with the site hydrostratigraphy and the conceptual model. The model validation data are clearly identified, and the validation procedure is clearly presented. The model validation with field data is conducted for different seasons including high and low recharge (and hence, high and low infiltration) periods to build confidence in the model results. The model outputs are shown in graphic formats. If discontinuous structural features, such as faults and dikes, are present (as discussed in Section 2.4 of this SRP), such features are properly characterized into either barriers or conduits to fluid flows, the characterization is consistent with pumping tests, and faults are appropriately included as special features in the applicant's groundwater simulation model.

2.7.1.4 Evaluation Findings

If the staff determines that no license conditions are required for the regional and site-specific groundwater hydrology information because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the regional and site-specific groundwater hydrology information at the conventional uranium mill or heap leach facility in accordance with Section 2.7.1.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 2.7.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's regional and site-specific groundwater hydrology information is acceptable and is in compliance with 10 CFR 40.31(h), which requires completeness and accuracy in all materials provided by an applicant;10 CFR 40.41(c), which requires confinement of possession and control over process fluids containing source and byproduct materials to the locations and purposes authorized in the license; 10 CFR Part 40, Appendix A, Criterion 5B(4), which requires identification of underground source of drinking water exempted aquifers; 10 CFR Part 40, Appendix A, Criterion 5G(2), which requires detailed information on the characteristics of the underlying soil and geological formation; 10 CFR Part 40, Appendix A, Criterion 5G(3), which requires information on the location, extent, quality, capacity, and current uses of groundwater; and 10 CFR Part 40, Appendix A, Criterion 11, which relates to ownership of tailings and their disposal sites." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the regional and site-specific groundwater hydrology information at the conventional uranium mill or heap leach facility in accordance with Section 2.7.1.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 2.7.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's regional and site-specific groundwater hydrology information is acceptable and is in compliance with 10 CFR 40.31(h) 10 CFR 40.41(c), which requires confinement of possession and control over process fluids containing source and byproduct materials to the locations and purposes authorized in the license; 10 CFR Part 40, Appendix A, Criterion 5B(4), which requires identification of underground source of drinking water exempted aquifers; 10 CFR Part 40, Appendix A, Criterion 5G(2), which requires detailed information on the characteristics of the underlying soil and geological formation; 10 CFR Part 40, Appendix A, Criterion 5G(3), which requires information on the location, extent, quality, capacity, and current uses of groundwater; and 10 CFR Part 40, Appendix A, Criterion 11, which relates to ownership of tailings and their disposal sites." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete. If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

2.7.1.5 References

ASTM International. "Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)." Test Method D4750–87 (Reapproved 2001). West Conshohocken, Pennsylvania: ASTM International. 2001.

Lohman, S.W. "Ground-Water Hydraulics." U.S. Geological Survey Professional Paper 708. Denver, Colorado: U.S. Geological Survey. 1972.

2.7.2 Surface Water Hydrology—Regional and Site Specific

2.7.2.1 Areas of Review

Characterization of the regional and site-specific surface water hydrology at the conventional uranium mill or heap leach facility must be sufficient to properly assess isolation of surface impoundments, to establish potential effects of conventional uranium mill or heap leach operations on surface waters, and to assess the potential effects of surface water flooding and erosion on the conventional uranium mill or heap leach facility. The areas of review include:

(1) Descriptions of surface water features in the site area including type (ephemeral or perennial), size, drainage area, jurisdictional status (e.g., U.S. Army Corps of Engineers), current and predicted future uses, permanency, pertinent hydrological or morphological characteristics, and their proximity to conventional uranium mill or heap leach processing plants, and surface impoundments or to 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; and

(3) Assessment of typical seasonal ranges and averages and the historical extremes for levels and/or flow rates of surface water bodies.

2.7.2.2 Review Procedures

Staff should use the following procedures when conducting the review of regional and site-specific surface water hydrology:

(1) Review surface water data, including maps that identify lakes, wetlands, springs, permanent and intermittent streams, rivers and creeks, surface drainage areas, and other surface water bodies within the proposed facility boundaries and adjacent properties. Review hydrographs of important surface water features within and adjacent to the site boundary. This information should meet, in part, the requirements of 10 CFR 40.31(h) and 10 CFR Part 40, Appendix A, Criterion 1.

(2) Examine the topographic contour map to determine whether the contour intervals and information included on the map are sufficient to show significant variations in site environs, important drainage gradients, and upstream rainfall catchment areas. This information should meet, in part, the requirements of 10 CFR 40.31(h) and 10 CFR Part 40, Appendix A, Criteria 1, 4(a) and 4(b).

(3) Evaluate the applicant's assessment of the potential for erosion or flooding. Information regarding acceptable models for use in calculating the design storm for a 1,000-year design life for large surface impoundments may be found in NUREG–1623, "Design of Erosion Protection for Long-Term Stabilization" (NRC, 2002). Review guidance for flood mitigation structures is provided in NUREG–1620 (NRC, 2003). Review any special engineering features used to mitigate or prevent negative impacts of surface erosion and flooding. This information should meet, in part, the requirements of10 CFR 40.31(h); 10 CFR 40.32(c); and 10 CFR Part 40, Appendix A, Criteria 1 and 4(f).

(4) Review the applicant's assessment of seasonal and, if data are available, the historical variability for discharge rates and/or levels of surface water features, and ensure that sufficient time intervals have elapsed between measurements to allow assessment of seasonal variability. This information should meet, in part, the requirements of 10 CFR 40.31(h) and 10 CFR Part 40, Appendix A, Criterion 5B(6).

2.7.2.3 Acceptance Criteria

The characterization of the regional and onsite surface water hydrology is acceptable if it meets the following criteria:

(1) The applicant has characterized surface water bodies and drainages within the site boundary and affected surroundings. Maps and information provided in the application identify the location, size, shape, hydrologic characteristics, jurisdictional status, and water use types of surface water bodies (including lakes, wetlands, permanent and intermittent streams, rivers, creeks, springs) within the proposed facility boundaries and adjacent properties, upstream and downstream river control structures, proposed diversion channels, upstream catchment areas, and surface drainage areas near the proposed facilities. The scale and clarity of the site topographic maps are adequate to conduct the necessary safety reviews.

The applicant has provided unit hydrographs (with tabulated values) for running surface water features within and upgradient of the proposed facility. The unit hydrographs indicate the response of a basin or watershed, in terms of discharge or stage, to 1 cm

[0.4 in] of excess rainfall occurring over the basin at a uniform rate for a specified duration (in terms of hours). The unit hydrograph can be used to estimate the direct runoff and stream flow (and hence to assess potential flooding and erosion impacts) from arbitrary rainfall or storm events.

(2) The choice of contour intervals and the locations of drainage basins on a topographic map are adequate to identify the relationship between the site and surface drainage, and variations in the drainage gradient in the vicinity of the proposed conventional uranium mill or heap leach facility. The choice of contour intervals is adequate to show that the applicant has selected a site that minimizes upstream rainfall catchment areas.

(3) The applicant has provided a comprehensive assessment of the potential for flooding, erosion, and depositional zones that could affect the conventional uranium mill or heap leach facility and surface impoundments. The evaluation of flooding and erosion potential is consistent with available geomorphological and topographic data or analysis of paleodischarge information. The applicant has provided inundation maps (e.g., for 10 years, 100 years) for the major stream and creeks within and near the proposed facilities. In flood-prone areas, the applicant has conducted surface water and erosion modeling to assess the potential for erosion or flooding. The applicant has described acceptable flood mitigation and erosion protection measures (included proposed engineering structures) against the effects of flooding from nearby streams and for drainage and diversion channels. Erosion protection for drainage and diversion channels, including channel outlets, has been provided. If the applicant uses surface water or erosion modeling, acceptable models and input parameters have been used in the flood analyses and the resulting flood forces were acceptably accommodated in the design of surface impoundments and diversion channels or other onsite flood mitigation measures.

The applicant has adequately demonstrated the probable maximum precipitation potential and resulting runoff for site drainage and for drainage areas adjacent to the site. The probable maximum precipitation/probable maximum flood event is consistent with NUREG–1623 (NRC, 2002, Appendix D). In determining a local probable maximum precipitation event:

(a) The applicant has provided adequate support for values of the 1-hour, 6-hour, and 12-hour probable maximum precipitation events, as applicable.

(b) The applicant has demonstrated that appropriate values of infiltration have been selected.

(c) The applicant has demonstrated that appropriate methods (i.e., depending on the slope, configuration) have been selected. The U.S. Nuclear Regulatory Commission (NRC) staff independently verified that the methods selected compare reasonably well with various velocity-based methods.

(d) The applicant has demonstrated the rainfall distributions (particularly the 2½-, 5-, and 15-minute distributions), and NRC staff has verified that the distributions are consistent with the distributions suggested in NUREG–1623 (NRC, 2002, Appendix D).

The applicant has demonstrated that the design of diversion channels in critical areas is consistent with guidance presented in NUREG–1623 (NRC, 2002, Appendix D). For the main channel area, appropriate models and input parameters have been used to design the erosion protection. The applicant has demonstrated that flow rates, flow depths, and flow shear stresses have been correctly computed. For the channel side slopes, the applicant has demonstrated that the side slopes are capable of resisting flow velocities and shear stresses from flows that occur directly down the side slope. This occurs often when diversion channels are constructed perpendicular to natural gullies (which discharge into the diversion channel). The shear forces in these locations often greatly exceed the forces produced by flows in the channel, particularly when the slope of the natural ground in the area is greater than the slope of the diversion channel.

For the outlet of the diversion channel, the applicant adequately addressed erosion in the discharge area. The applicant evaluated designs, similar to apron/toe designs, to determine their resistance to erosion. NUREG–1623 (NRC, 2002, Appendix D) discusses acceptable methods for designing channel outlets.

For the entire length of the diversion channel, the applicant discussed the effects of sediment accumulations on flow velocities, channel capacity, and need for increased rock size. The applicant has demonstrated that designs in which steep natural streams discharge into relatively flat diversion channels will not greatly increase the potential for blockage of the channel due to sedimentation, consistent with NUREG–1623 (NRC, 2002, Appendix E).

(4) The applicant has provided an assessment of seasonal and historical variability for discharge rates and/or water levels in surface water bodies. This assessment included discharge rates and/or water levels over at least 1 year and collected periodically to represent seasonal variability. The applicant has provided minimum, maximum, and average flow rates and/or water levels for the surface bodies. The applicant has adequately explained interrupted measurements during discontinuity in water level and discharge data.

2.7.2.4 Evaluation Findings

If the staff determines that no license conditions are required for the regional and onsite surface water hydrology characterization because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the regional and onsite surface water hydrology characterization at the conventional uranium mill or heap leach facility in accordance with Section 2.7.2.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 2.7.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's regional and onsite surface water hydrology characterization is acceptable and is in compliance with 10 CFR 40.31(h), which requires completeness and accuracy in all materials provided by a applicant; 10 CFR 40.32(c), which requires that the applicant's proposed equipment and

procedures are adequate to protect public health; 10 CFR Part 40, Appendix A, Criterion 1, which requires permanent isolation of tailings and associated contaminants during siting decisions; 10 CFR Part 40, Appendix A, Criterion 4(a), which requires that upstream catchment areas be minimized; 10 CFR Part 40, Appendix A, Criterion 4(b), which requires that topographic features should provide good wind protection; 10 CFR Part 40, Appendix A, Criterion 4(f), which requires consideration of features that will promote deposition in the design of surface impoundments; and 10 CFR Part 40, Appendix A, Criterion 5B(6), which requires consideration of the adverse effects of a conventional uranium mill or heap leach facility on the quality of surface waters." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the regional and onsite surface water hydrology characterization at the conventional uranium mill or heap leach facility in accordance with Section 2.7.2.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions. In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 2.7.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's regional and onsite surface water hydrology characterization is acceptable and is in compliance with 10 CFR 40.31(h), which requires completeness and accuracy in all materials provided by a applicant; 10 CFR 40.32(c), which requires that the applicant's proposed equipment and procedures are adequate to protect public health; 10 CFR Part 40, Appendix A, Criterion 1, which requires permanent isolation of tailings and associated contaminants during siting decisions; 10 CFR Part 40, Appendix A, Criterion 4(a), which requires that upstream catchment areas be minimized; 10 CFR Part 40, Appendix A, Criterion 4(b), which requires that topographic features should provide good wind protection; 10 CFR Part 40, Appendix A, Criterion 4(f), which requires consideration of features that will promote deposition in the design of surface impoundments; and 10 CFR Part 40, Appendix A, Criterion 5B(6), which requires consideration of the adverse effects of a conventional uranium mill or heap leach facility on the quality of surface waters." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

2.7.2.5 References

NRC. NUREG–1620, "Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978." Rev. 1. Washington, DC: U.S. Nuclear Regulatory Commission. June 2003.

———. NUREG–1623, "Design of Erosion Protection for Long-Term Stabilization." Rev. 1. Washington, DC: U.S. Nuclear Regulatory Commission. August 2002.

2.8 Preoperational Monitoring

2.8.1 Radiological Preoperational Monitoring

2.8.1.1 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 soil, air, and in surface water and groundwaters that could be affected by the proposed operations. The reviewer should examine the design of the preoperational monitoring program, including which radionuclides are analyzed, sampling locations, sample type, sampling frequency, location and density of monitoring stations, the detection limits, and analytical methods used (see SRP Section 4.7.3).

An acceptable preoperational monitoring program includes air sampling (both particulate and radon); water sampling (groundwater and surface water); sampling of vegetation, food, and fish; soil and sediment sampling; direct radiation measurements; and radon flux. The preoperational monitoring program should include at least 12 consecutive months of data as identified in Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills," (NRC, 1980, Revision 1). Complete soil sampling, direct radiation, and radon flux data should be completed prior to major site construction. It should be recognized that some samples may not be collected due to weather conditions, seasonal availability, or access to an area. For minimizing the number of potential requests for additional information, it is recommended that the data be collected before submittal of an application.

2.8.1.2 Review Procedures

The reviewer should use the following procedure when conducting the review of the preoperational monitoring program:

(1) Review the preoperational monitoring program to verify that it establishes preoperational conditions. Verify that the preoperational monitoring program is in accordance with the guidance provided in Regulatory Guide 4.14 (NRC, 1980, Revision 1, Table 1), including sampling frequency, sampling methods, and sampling location and density. Verify that soil sampling is conducted to a depth of 5 cm [2 in] in accordance with Regulatory Guide 4.14 (NRC, 1980, Revision 1), and to a depth of 15 cm [6 in] for preoperational decommissioning data. The information reviewed in this procedure should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

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

2.8.1.3 Acceptance Criteria

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

(1) The description of the preoperational monitoring program includes sampling frequency, sampling methods, and sampling locations and is in accordance with preoperational monitoring guidance provided in Regulatory Guide 4.14 (NRC, 1980, Revision 1, Section 1.1).

The monitoring results from the following types of samples have been obtained as described in Regulatory Guide 4.14 (NRC, 1980, Revision 1, Section 1.1):

(a) Air Particulate and Radon Sampling. Preoperational air particulate and radon sampling results have been provided for a minimum of three locations at or near the site boundaries. If there are residences or occupiable structures within 16 km [10 mi] of the site, sampling results from at least one location at or close to the nearest residence or occupiable structure is provided. Finally, sampling results from at least one control location remote from the site is provided. Preoperational air particulate samples have been collected as quarterly composites of weekly samples for 12 consecutive months and have been analyzed for natural uranium, Th-230, Ra-226, and Pb-210. Preoperational radon samples were collected for 1 week during each month for 12 consecutive months and have been analyzed for Rn-222. Justification for alternative air particulate and radon sampling measurements has been provided, when necessary.

(b) Groundwater Sampling. The applicant has provided data from groundwater samples collected quarterly from at least three sampling wells located hydrologically downgradient from the proposed surface impoundments (e.g., tailings areas), at least three locations near other sides of the surface impoundments, and one well located hydrologically upgradient from the surface impoundments area that serves as background. In addition, the applicant has provided data from groundwater samples collected quarterly from each well within 2 km [1.2 mi] of the proposed tailings area. The samples have been analyzed for dissolved and suspended natural uranium, Th-230, Ra-226, Po-210, and Pb-210. Quarterly groundwater sampling data from at least three wells located within the uppermost aquifer, at least three wells located hydrologically downgradient from the conventional or heap leach facility, and at least one well located hydrologically upgradient from the conventional and heap leach facility to serve as a background sample are provided. Groundwater sampling data from the aquifers below the uppermost aquifer are also provided, if there is a hydraulic connection between the uppermost aquifer and underlying aquifers and if the underlying aquifers are source of drinking water. The technical basis for choosing the sampling locations is described. Quarterly groundwater sampling data are also provided for each well within 2 km [1.2 mi] of the surface impoundments that is or could be used for drinking water, watering of livestock, or crop irrigation. Preoperational samples have been collected for 12 consecutive months (see SRP, Section 2.7.1). Justification for alternative groundwater sampling measurements has been provided, when necessary.

(c) Surface Water Sampling. If required, preoperational surface water sampling results are provided. Surface water samples from running and standing waters are analyzed quarterly for natural uranium, Th-230, and Ra-226 and semiannually for Pb-210 and Po-210. The locations include, but are not limited to, permanent and ephemeral creeks; river, ponds, lakes, and offsite impoundments that may be subject to direct surface drainage from potentially contaminated areas; surface waters or drainage systems crossing the site boundary; and surface waters that may be subject to drainage from potentially contaminated areas. These surface water samples are collected as a grab sample on a monthly and quarterly basis for surface impoundments and drainage

systems, respectively. Preoperational samples are collected for 12 consecutive months in accordance with Section 2.7.2 of this SRP. Justification for alternative surface water sampling measurements has been provided, when necessary.

(d) Vegetation, Food, and Fish Sampling. Preoperational vegetation, food, and fish sampling results are provided from (i) at least three times during the grazing season, three vegetation locations near the site in different sectors having the highest predicted airborne radionuclide concentration due to milling or heap leach operations; (ii) three food locations that include crops, livestock, at time of harvest or slaughter or removal of animals from grazing for each type of crop (including vegetable gardens) within 3 km [1.9 mi] of the site; and (iii) fish (if any) in each body of water that may be subject to seepage or surface drainage from potentially contaminated areas. Preoperational samples are collected for 12 consecutive months. Vegetation, food, and fish (edible portion) samples are analyzed for natural uranium, Th-230, Ra-226, Pb-210, and Po-210. Justification is provided for any sampling data that are not provided. Justification for alternative vegetation, food, and fish sampling measurements has been provided, when necessary.

(e) Soil Sampling. Preoperational soil sampling results have been provided for up to 40 surface soil samples taken at a depth of 5 cm [2 in] collected at 300 m [110 ft] intervals to a distance of 1,500 m [5,000 ft] from the proposed locations for surface impoundments in 8 meteorological sectors and at 5 or more air particulate sampling stations. All soil samples have been analyzed for Ra-226. Soil samples collected at air particulate sampling locations and 10 percent of other soil samples (including at least 1 subsurface set) have been analyzed for natural uranium, Th-230, and Pb-210. Analysis of extra soil samples may be necessary for repeat samples collected at locations disturbed by site excavation, leveling, or contouring. Soil sampling results from areas disturbed by site excavation, leveling, or contouring also have been provided. Results from subsurface samples at a depth of 1 m [3.3 ft] are provided from the center of the proposed locations for surface impoundments and from distances of 750 m [2,500 ft] in each of the 4 compass directions. At least 12 consecutive months of soil sampling data have been provided prior to major site construction. Soil sampling is conducted at both a 5-cm [2-in] depth as described in Regulatory Guide 4.14 (NRC, 1980, Revision 1, Section 1.1.4) and at a depth of 15 cm [6 in] for background decommissioning data. Justification for alternative soil sampling measurements has been provided, when necessary.

(f) Sediment Sampling. Results from one set of sediment samples have been provided for each of the surface water locations described previously. Sediment samples have been analyzed for natural uranium, Th-230, Ra-226, and Pb-210. For surface water passing through the site, sediment sampling results, both upstream and downstream of the site, have been provided. Samples have been collected following spring runoff and in late summer following an extended period of low flow, if possible. For each location, results from several sediment samples collected in a transverse across the body of water and composited for analysis have been provided. The applicant has committed to submit results of sediment sampling prior to beginning milling or heap leach operations. Justification for alternative sediment sampling measurements has been provided, when necessary.

(g) Direct Radiation Measurements. Prior to initiation of major construction, the applicant has committed to provide the results of gamma exposure rate (direct radiation) measurements. The number and location of the measurements are consistent with Regulatory Guide 4.14 (NRC, 1980, Revision 1, Section 1.1.6). The applicant has determined the number and location of measurements based on the particular design of the mill or heap leach facility and support buildings, and waste management facilities. Measurement results also have been provided for the sites chosen for air particulate samples and for each location disturbed by site excavation, leveling, or contouring. Gamma exposure measurements have been made with passive integrating devices (such as thermoluminescent or optically stimulated-luminescence dosimeters), pressurized ionization chambers, or properly calibrated portable survey instruments. Direct radiation measurements using instruments have been only completed in dry weather and not during periods following rainfall or when the soil is abnormally wet. Justification for alternative direct radiation measurements has been provided, when necessary.

(h) Radon Flux Measurements. Results from Rn-222 flux measurements have been provided for three separate months during normal weather conditions in the spring through the fall when the ground is thawed. Results include measurements made at the center of the mill area and at locations 750 and 1,500 m [2,500 and 5,000 ft] from the center in each of the 4 compass directions. Measurements taken when the ground is frozen, covered with ice or snow, or following periods of rain have not been included. When radon flux data are required, at least 12 consecutive months of radon flux data are provided prior to major site construction. Justification for alternative radon flux measurements has been provided, when necessary.

2.8.1.4 Evaluation Findings

If the staff determines that no license conditions are required for the description of the site preoperational radiological characteristics because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: “NRC staff has completed its review of the description of the site preoperational radiological characteristics at the conventional uranium mill or heap leach facility in accordance with Section 2.8.1.3 of the standard review plan.” Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: “Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 2.8.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant’s description of the site preoperational radiological characteristics is acceptable and is in compliance with 10 CFR Part 40, Appendix A, Criterion 7, which requires preoperational and operational monitoring programs.” As a concluding statement, indicate the reason why the applicant’s information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the description of the site preoperational radiological characteristics at the conventional uranium mill or heap leach facility in accordance with Section 2.8.1.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 2.8.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of the site preoperational radiological characteristics is acceptable and is in compliance with 10 CFR Part 40, Appendix A, Criterion 7, which requires preoperational and operational monitoring programs." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

2.8.1.5 Reference

NRC. Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Recovery Facilities." Rev. 1. Washington, DC: U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research. 1980.

2.8.2 Nonradiological Preoperational Monitoring

2.8.2.1 Areas of Review

The staff should evaluate the applicant's assessment of preoperational water quality of potentially affected surface water and groundwater resources within the proposed permit boundaries and adjacent properties. This information will provide the basis for evaluating potential effects of conventional mill or heap leach operations on the quality of local water resources. The staff should review a list of constituents to be sampled for preoperational concentrations.

2.8.2.2 Review Procedures

The staff should review the nonradiological preoperational monitoring program in accordance with 10 CFR Part 40, Appendix A, Criterion 7:

(1) Evaluate the applicant's assessment of preoperational water quality. This information will provide the basis for evaluating potential effects of conventional mill or heap leach operations on the quality of local water resources.

(2) Review the list of constituents to be sampled, the groundwater and surface water sampling procedure, and method for excluding outliers (see Appendix E) in the samples. Review the applicant's quality control procedure for groundwater and surface water sampling. Verify that a sufficient number of surface water and groundwater 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 preoperational water quality, including classes of use.

2.8.2.3 Acceptance Criteria

The applicant's assessment of preoperational nonradiological characteristics is acceptable if it meets the following criteria:

(1) Preoperational groundwater quality has been determined for the uppermost aquifer. If there is any evidence that the uppermost aquifer may not be hydraulically isolated from underlying major aquifers, due to the absence of or through an ineffective underlying confinement, groundwater baseline parameters have been also provided for the underlying aquifers. Reasonably comprehensive chemical analyses of water samples from the uppermost aquifer have been made to determine preoperational baseline conditions.

(2) A sufficient number of preoperational surface and groundwater samples are collected to provide meaningful statistics so 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 preoperational water quality, including classes of use. In particular:

(a) The applicant has provided a list of constituents sampled for preoperational concentrations. Table 2.8.2-1 lists acceptable constituents for monitoring at

Table 2.8.2-1. Typical Water Quality Indicators To Be Determined During Preoperational 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	Ra-226*	
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	

*If site initial sampling indicates the presence of Th-232, then Ra-228 should be considered in the baseline sampling or an alternative may be proposed.
†Field and laboratory determination.
‡Laboratory only.
§Excluding radon, radium, and uranium.

conventional mill or heap leach facilities. Alternatively, the applicant may propose a list of constituents tailored to a particular location. If a detected constituent is excluded from the set of baseline parameters, the applicant provided the technical justification for their exclusion. For all constituents that are sampled, the applicant should maintain laboratory reports documenting the measurements. The applicant should show that water samples were collected by acceptable sampling procedures, such as ASTM D4448 (ASTM International, 2007).

(b) The applicant collected and analyzed at least four sets of samples, spaced sufficiently in time to indicate seasonal variability 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. Additional sampling to establish the natural cyclical fluctuations of the water quality is necessary if natural groundwater flow rates and recharge conditions vary considerably. The average water quality for each aquifer zone and the range of each indicator in the aquifer zone have been tabulated and evaluated. If regions of distinct water quality characteristics are identified, then they are delineated and referenced on a topographic map.

(c) An outlier is a single nonrepeating value that lies far above or below the rest of the sample values for a single well. 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, because the outlier is not typical of the bulk of the samples. Appendix E to this SRP provides guidance on proper statistical methods for dealing with outliers in the sample sets. All calculations, assumptions, and conclusions the applicant makes in evaluating outliers should be fully explained. If an extreme sample is determined to represent part of the natural variations, it should not be removed from the sample set.

(d) Preoperational water quality has been adequately determined for potentially affected surface water bodies within the proposed permit boundaries and adjacent properties. A number of preoperational surface water samples are collected to provide meaningful statistics. 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 conventional mill or heap leach operations. Surface water samples can be obtained by grab sampling and should be taken at the same location each time.

2.8.2.4 Evaluation Findings

If the staff determines that no license conditions are required for the description of the site preoperational nonradiological characteristics because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: “NRC staff has completed its review of the description of the site nonradiological characteristics at the conventional uranium mill or heap leach facility in accordance with Section 2.8.2.3 of the standard review plan.” Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of

this SRP, a bullet list or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 2.8.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of the site preoperational nonradiological characteristics is acceptable and is in compliance with 10 CFR Part 40, Appendix A, Criterion 7, which requires preoperational and operational monitoring programs." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the description of the site preoperational nonradiological characteristics at the conventional uranium mill or heap leach facility in accordance with Section 2.8.2.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 2.8.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's the description of the site preoperational nonradiological characteristics is acceptable and is in compliance with 10 CFR Part 40, Appendix A, Criterion 7, which requires preoperational and operational monitoring programs." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

2.8.2.5 Reference

ASTM International. "Standard Guide for Sampling Groundwater Monitoring Wells." Guide D4448–01. West Conshohocken, Pennsylvania: ASTM International. 2007.

3.0 DESCRIPTION AND DESIGN OF PROPOSED FACILITY

3.1 Conventional Uranium Mill Facilities

3.1.1 Areas of Review

The staff should review the description of the conventional uranium mill facilities provided in the application including:

(1) A review of descriptions of the ore to be milled including, but not limited to, the estimated volume of ore-bearing rocks to be processed, the average grade of ore, and the mineral content of the ore.

(2) A review of descriptions of the proposed conventional uranium mill design and milling process. The applicant's recovery plant is reviewed in Section 3.4 of this standard review plan (SRP).

(3) A review of the proposed operating plans and schedules that include timetables and sequences for conventional uranium mill operation.

3.1.2 Review Procedures

The staff should use the following procedures when reviewing the description of the conventional uranium mill facilities:

(1) Ensure that the applicant has identified the chemical composition of the ore, its estimated volume to be processed and average grade. This information should meet, in part, the requirements of 10 CFR 40.32(a).

(2) Determine that the applicant has adequately described the conventional uranium mill facilities. This description of the process and equipment is sufficiently detailed to characterize ore transport; ore crushing and grinding; leaching; and uranium extraction operations in the mill. This information should meet, in part, the requirements of, 10 CFR 40.31(h) and 10 CFR Part 40, Appendix A, Criterion 5H.

(3) Determine that proposed operating plans and schedules include timetables for conventional uranium mill operation. This information should meet, in part, the requirements of 10 CFR 40.31(h) and 10 CFR 40.41(c).

3.1.3 Acceptance Criteria

The description of the conventional uranium mill facilities is acceptable if it meets the following criteria:

(1) The volume and source of ore-bearing rocks to be processed at the proposed facility has been described. The applicant has provided a detailed description of the ore to be processed, average grade, mineral content, and chemical form of its uranium content. If more than one type of ore is to be processed, each type of ore has been described separately.

(2) The applicant also has provided a detailed description of the proposed facilities and equipment for safe receiving, storing, and processing of ore-bearing source rocks at the proposed facility, including, but not limited to:

(a) A map or maps showing the facility's location, including facilities for receiving, storing, and processing of ore;

(b) Diagrams showing the proposed (or existing) plant/facilities layout in adequate detail, including the license boundary and restricted area boundary;

(c) A flow diagram of the process or circuit, a material balance diagram, a description of any chemical recycle systems, and a water balance diagram for the entire system;

(d) A detailed description of each processing unit in the plant (e.g., crusher, grinder, uranium leaching circuit, solvent extraction/ion exchange circuit); and

(e) If materials are stockpiled, a description of the plan to minimize penetration of radionuclides into the soil below the stockpile.

(3) Proposed operating plans and schedules include timetables for conventional uranium mill operation. Water-balance calculations are provided to demonstrate that disposal facilities for mill tailings (surface impoundments) and process effluents (retention ponds, land application, and/or deep well injection) are adequate to dispose the proposed milling effluents during the license period.

3.1.4 Evaluation Findings

If the staff determines that no license conditions are required for the description of the conventional uranium mill facilities because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is needed for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the description of the conventional uranium mill facilities in accordance with Section 3.1.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 3.1.3 of the SRP. Therefore, NRC staff concludes that the applicant's description of the conventional uranium mill facilities is acceptable and is in compliance with 10 CFR 40.31(h), which establishes requirements for license applications; 10 CFR 40.32(a), which requires that the application is for a purpose authorized by the Atomic Energy Act of 1954, as amended; 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, Criterion 5H, which requires the applicant to minimize the penetration of radionuclides into underlying soil in a stockpile." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the description of the conventional uranium mill facilities in accordance with Section 3.1.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 3.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of the conventional uranium mill facilities is acceptable and is in compliance with 10 CFR 40.31(h), which establishes requirements for license applications; 10 CFR 40.32(a), which requires that the application is for a purpose authorized by the Atomic Energy Act of 1954, as amended; 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, Criterion 5H, which requires the applicant to minimize the penetration of radionuclides into underlying soil in a stockpile." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

3.1.5 References

None.

3.2 Heap Leach Facilities

3.2.1 Areas of Review

The staff should review the description of the heap leach facilities provided in the application. This review should include:

(1) A review of descriptions of the ore to be leached including, but not limited to, the estimated volume of ore-bearing rocks to be processed, the average grade of ore, the mineral content of the ore, and its suitability for leaching.

(2) A review of descriptions of the proposed heap leach facility design and leaching process. The review of applicant's recovery plant is reviewed in Section 3.4 of this SRP.

(3) A review of the proposed operating plans and schedules that include timetables and sequences for heap leach facility operation.

3.2.2 Review Procedures

The staff should use the following procedures when reviewing the description of the heap leach facilities:

(1) Ensure that the applicant has identified the ore including its chemical composition, estimated volume to be processed, and average grade. This information should meet, in part, the requirements of 10 CFR 40.31(h).

(2) Verify the adequacy of the heap leach materials including the size distribution of the ore particles to be leached, strength and permeability of these particles, expected degree of packing in the heap, and any need for pretreatment of the ore. This information should meet, in part, the requirements of 10 CFR 40.31(h).

(3) Determine that the applicant has adequately described the leaching process and the heap leach facilities are sufficiently detailed to characterize the ore stockpile, if any; ore transport; ore crushing (size reduction) operations, and the heap leach process. This information should meet, in part, the requirements of 10 CFR 40.31(h), 10 CFR 40.41(c), and 10 CFR Part 40, Appendix A, Criteria 5E(2) and 5H.

(4) Determine that proposed operating plans and schedules include timetables for heap leaching operation, including disposal of liquid wastes. This information should meet, in part, the requirements of 10 CFR 40.31(h) and 10 CFR 40.41(c).

3.2.3 Acceptance Criteria

The description of the heap leaching facilities is acceptable if it meets the following criteria:

(1) The applicant has identified the ore to be processed at the proposed heap leach facility and provided a detailed description of the ore including its chemical composition, source, average grade, mineral content, and chemical form of its uranium content. If more than one type of ore is to be processed, each type of ore has been described separately.

(2) The described materials are appropriate for heap leaching, that is:

   (a) The size distribution of ore particles will be commensurate with the specifications of the geomembrane to avoid puncture and associated leachate leak.

   (b) The types of pretreatment needed for the materials have been described; pretreatment of the ore can range from none (for “run of mine” ore particles) to crushing, grinding, and agglomeration in addition to any chemical pretreatments of the ore.

   (c) The strength of the ore particles is adequate to resist the load imposed by the construction equipment to avoid significant compaction of the ore particles resulting in a decrease of heap permeability, especially at the top of the heap.

   (d) The expected degree of compaction is appropriate for sustaining an adequate leaching rate.

(e) The ore is available in porous and permeable host rock; and the permeability of the ore particles is adequate for the proposed leaching operations.

(f) The ore is relatively free of fines and/or clays that may restrict uniform percolation of the leaching solution.

(g) If materials are stockpiled, a plan exists to minimize penetration of radionuclides into the soil below the stockpile.

(3) The application:

(a) Provides diagrams showing the proposed (or existing) facilities layout in adequate detail, including the license boundary and restricted area boundary;

(b) Includes a flow diagram of the process or circuit, a material balance diagram, a description of any chemical recycle systems, and a water balance diagram for the entire system;

(c) Includes a map or maps showing the facilities location, including facilities for receiving, storing, and processing ore-bearing source rocks; and

(d) Describes a process that maximizes solution recycling and water conservation.

The applicant also has provided a detailed description of proposed facilities and equipment for safe receiving, stockpiling, storing, and processing of ore-bearing source rocks at the proposed facility. The leach pad(s) have sufficient capacity to accommodate the entire quantity of ore to be leached.

(4) Proposed operating plans and schedules include timetables for heap leaching operation. Water-balance calculations are provided to demonstrate that disposal of leaching process effluents (retention ponds, land application, and or deep well injection) is adequate for disposal of the proposed milling effluents during the compliance period.

3.2.4 Evaluation Findings

If the staff determines that no license conditions are required for the description of the heap leach facilities because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is needed for the evaluation findings section. Begin the section with the sentence: “NRC staff has completed its review of the description of the heap leach facilities in accordance with Section 3.2.3 of the standard review plan.” Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: “Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 3.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant’s description of the heap leach facilities is acceptable and is in compliance with 10 CFR 40.31(h), which establishes requirements for license applications; 10 CFR 40.41(c), which requires the applicant to confine source or byproduct material to the location and purposes authorized in the license;

10 CFR Part 40, Appendix A, Criterion 5E(2), which requires use of a process design that maximizes solution recycling and water conservation; and 10 CFR Part 40, Appendix A, Criterion 5H, which requires the applicant to minimize the penetration of radionuclides into underlying soil in a stockpile." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the description of the heap leach facilities in accordance with Section 3.2.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 3.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of the heap leach facilities is acceptable and is in compliance with 10 CFR 40.31(h), which establishes requirements for license applications; 10 CFR 40.41(c), which requires the applicant to confine source or byproduct material to the location and purposes authorized in the license; 10 CFR Part 40, Appendix A, Criterion 5E(2), which requires use of a process design that maximizes solution recycling and water conservation; and 10 CFR Part 40, Appendix A, Criterion 5H, which requires the applicant to minimize the penetration of radionuclides into underlying soil in a stockpile." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

3.2.5 References

None.

3.3 Design of Surface Impoundments

The following information is presented in a more detailed manner because of the nature of the regulations in 10 CFR Part 40, Appendix A.

3.3.1 Areas of Review

The staff should review the license application for the description, design, and proposed construction method of surface impoundments. The review of surface impoundments of a conventional uranium mill facility should include characteristics of the mill tailings, and locations and design of surface impoundments under static and earthquake loads in reference to slope stability, potential liquefaction, seepage, and consolidation/settlement. In addition, effects of soil and/or synthetic liners, leak detection systems, and design and construction of the erosion protection cover should be reviewed. The review should include effects of uncertainties of shape of the slope, applied load, and material properties including any spatial variations of the parameters to ensure that they have been adequately characterized.

The review should include location of the leach pad(s) including surrounding topography, characteristics of leach materials, and type of leach pads and associated design. The staff should assess the leach pad characteristics, foundation design, liner system(s), and solution (leachate) collection and leak detection system(s). In addition, the staff should review the design of leach solution and barren solution ponds, and monitoring and inspection of the heaps. The review should also include the method of pad loading; static and dynamic loads that may be imposed on the liner system and also on the geomembrane, if used; and design of collection pipes. In addition, the stability of the heap leach pad under seismic conditions including any potential liquefaction under seismic loads should be reviewed. This review should be coordinated with the review of geological/geotechnical, stratigraphical, seismological, and hydrological information as described in this SRP.

Surface impoundments of a conventional uranium mill and a heap leach facility have many similar characteristics, although each has a few unique features. Consequently, the staff has developed this SRP section for reviewing the design, construction, and inspection/maintenance of an existing or a new conventional uranium mill facility or heap leaching facility in the license application. Review procedure(s) unique to a particular type of facility have been clearly identified in this section.

3.3.2 Review Procedures

The staff should use the following procedures to review the design of surface impoundments.

Site Selection

(1) Verify that the technical basis for selecting the location of the surface impoundments is adequate, as discussed in Section 2 of this SRP. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 1, 4(a), and 4(b).

Site-Specific Information

(2) Verify that the geological and geotechnical data obtained from site investigations are appropriate and conservative for the assumptions and analyses presented in the license application. Ensure that the spatial variability of the geotechnical parameters of the underlying soil and geologic formations (e.g., soil type, soil density, soil layer thickness, soil strength properties, continuity of layers, depth to groundwater) have been characterized adequately and incorporated into the design analysis. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 1 and 5G(2).

(3) For an existing facility, verify that the applicant has provided adequate information on sand and slime tailings. Ensure that this information includes the sand and slime tailings characteristics, spatial extent, and spatial variation of depth and thickness of each layer. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 1 and 5G(2).

Design of Surface Impoundments

(4) Verify that the design description of the surface impoundment is sufficiently detailed. This information should meet, in part, the requirements of 10 CFR 40.31(h) and 10 CFR Part 40, Appendix A, Criteria 1 and 4(b)–(d).

(5) Verify that the capacity of the surface impoundment would be sufficient to dispose all tailings and other byproduct material generated through the lifecycle of the facility. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 1 and 6A(3).

(6) Verify that the tailings will be disposed below grade. If full below-grade disposal is not practical or environmentally sound, ensure that the tailings retention system would be appropriately located and sized so that the slope angles of the embankment and final cover would be relatively flat after final stabilization for long-term stability and minimum erosion potential. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 3 and 4(c).

(7) Ensure that the applicant has provided the technical justification for final slopes of the surface impoundments steeper than five horizontal (5h) to one vertical (1v) unit. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 1 and 4(c).

(8) Verify that freeboard in surface impoundments is sufficient to prevent any overtopping at all times. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5A(4).

(9) Verify that adequate protection has been provided for embankment and cover slope stability against wind and water erosion, weathering, and ice damage. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 1, 3, and 4(d).

Foundation Design

(10) Ensure that the foundation of the surface impoundment is able to withstand the anticipated static and dynamic/seismic loads, including the differential stress/deformation, so that the integrity and function of the liner system and any under-pad leak detection system are maintained. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 5A(2) and 5G(2).

(11) Verify that the top of the foundation exhibits a low permeability. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 5A(2) and 5G(2).

Liner Design

(12) Verify that the design of the liner system for the surface impoundment has been described. Also, verify that materials of appropriate quality are available in sufficient quantity. Ensure that the technical basis for selection of the liner system has been provided, the selected liner system has been demonstrated to be physically and chemically inert to the waste materials in the surface impoundment, and the selected liner system has sufficient thickness and strength to prevent failure from hydrologic pressure gradient, climatic conditions, stress of installation (i.e., construction equipment and materials), and stress of daily operations (i.e., initial loading). This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 1 and 5A(2).

(13) Verify that a liner has been designed, constructed, and will be installed to prevent leakage from surface impoundments to the surrounding environment. Also, verify that the applicant has established an allowable leakage rate for the liner and provided adequate technical justification. Ensure that the liner system has sufficient strength and thickness to prevent failure due to pressure gradient, settlement, compression, or uplift when placed upon a foundation. Verify that adequate protective measures to prevent any damage or puncture of the liner system have been described. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 1, and 5A(2).

(14) Ensure that a leak detection system will be installed immediately below the liner. Also, ensure that the design of the leak detection system will be effective in detecting a leak and identifying its location for repair. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 1 and 5E(1).

Cover Design

(15) Ensure that the applicant has described the proposed cover to be placed over the surface impoundment including any long-term erosion-protection features. Verify that information also includes materials to be used for construction and associated borrow areas. If a geomembrane is proposed as a part of the cover, ensure that description of the geomembrane and method of construction are provided. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 1, 4(d), 6(1), and 6(5).

Leachate Storage Pond in Heap Leach Facility

(16) Ensure that the applicant has provided an adequate description of the leachate storage pond, including the capacity, liner materials, stability, and description of the pond, especially the side slopes. Verify that the liner characteristics meet the requirements specified in review procedures 12 through 14 of this section of the SRP. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 5A(1), 5A(2), 5A(3), and 5E(1).

Barren Solution Pond in a Heap Leach Facility

(17) Verify that the applicant has provided an adequate description of the barren solution pond, including the capacity, liner materials, stability, and description of the pond, especially the side slopes. Verify that the liner characteristics meet the requirements specified in review procedures 12 through 14 of this section of the SRP. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 5A(1), 5A(2), 5A(3), and 5E(1).

Other Types of Ponds

(18) Verify that other types of ponds (e.g., evaporation ponds) in a conventional uranium mill or a heap leach facility are designed appropriately for effective containment, including the capacity, liner materials, stability, and description of the pond, especially the side slopes. Verify that the liner characteristics meet the requirements specified in review procedures 12–14 of this section of the SRP. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 5A(1), 5A(2), 5A(3), and 5E(1).

Dewatering of Tailings/Leachate Collection System

(19) Verify that a system to dewater the tailings at the bottom of the impoundment to lower the phreatic surface and reduce the driving seepage head has been described. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5E(3).

(20) Ensure that the applicant has provided an adequate description of the leachate collection system to be used in the surface impoundment. Review the design rate of leachate flow, construction materials, method of construction, design of leachate pond, and effectiveness of the heap leach pad design. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5E(3).

(21) Ensure that the applicant has demonstrated that drains of the dewatering system of the surface impoundment and/or the leachate collection system will remain free running and adequately sized. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5E(3).

Slope Stability

(22) Ensure that the applicant has provided sufficient design details on the surface impoundment or heap leach facility to conduct the stability analyses. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5A(5).

(23) Verify that the applicant has provided a basis for selecting specific locations of soil/rock profiles and cross sections of the surface impoundment at a sufficient number of locations including values of relevant parameters. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5A(5).

(24) Verify that the applicant has assessed the stability of a surface impoundment, deterministically or probabilistically, using an acceptable method. Verify that the analysis presented used the most probable values or appropriate range of values for the parameters involved, if deterministic approach is used. Alternatively, assess the method used by the applicant to quantify the probability of unsatisfactory performance, P_{up}, or reliability of an embankment ($1 - P_{up}$). This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5A(5).

(25) Verify that appropriate material properties of the surface impoundment have been used in stability assessment. Ensure that the boundaries and material properties of the surface impoundment used in stability assessment accounted for the associated uncertainties. Verify that the uncertainties associated with strength and loading parameters are appropriately represented by the probability distributions selected if a probabilistic approach is used. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5A(5).

(26) Verify that the maximum credible earthquake and the associated seismic load have been considered in the stability analysis of the surface impoundment and that they will not be located near a capable (active) fault. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 4(e) and 5A(5).

(27) Ensure that reasonable ranges of material parameters have been considered in the analysis if the estimated factor of safety or the reliability index of the surface impoundments is low and that effects of other factors, such as flooding conditions, pore pressure effects, possible material erosion, and seismic effects, are conservatively considered. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5A(5).

(28) Verify that the applicant has designed stable surface impoundments that have been demonstrated to be able to withstand anticipated static and dynamic loads. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5A(5).

(29) Determine whether a surface impoundment that would continue to hold process effluents after the cessation of operations meets the definition of a dam as provided in Federal Emergency Management (2004). If so, determine whether or not it has been classified as a structure with a low- or high-hazard potential. If the hazard potential is high, evaluate the emergency action plan for the facility. This information should meet, in part, the requirements of the Federal Dam Safety Program of U.S. Federal Emergency Management Agency.

Liquefaction

(30) Review the analysis of liquefaction potential of the surface impoundments by reviewing the results of geotechnical investigations and *in-situ* tests, such as standard penetration, cone penetration, piezocone, density, and strength tests, as well as boring logs, laboratory classification test data, water table measurements, locations of perched water zones, and soil profiles, to determine whether any of the site soils or the tailings could be susceptible to liquefaction. Ensure that site exploration programs, the laboratory test program, and analyses are adequate to assess whether soils are susceptible to liquefaction beneath the site or in the surface impoundments. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5A(5).

(31) Ensure that the liquefaction potential of the surface impoundment have been adequately characterized using appropriate method(s). Determine that liquefaction has been mitigated or eliminated where the potential exists. Verify that minor or local liquefaction potentials are included in settlement analyses. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 5A(5), and 5G(2).

Settlement

(32) Ensure that the applicant has provided a settlement measurement and monitoring plan for the surface impoundment. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 5A(4), 5A(5), and 6(1).

(33) Verify that the method used to assess settlement is appropriate for estimating both instantaneous settlement and secondary settlement due to pore pressure dissipation and long-term creep. Verify that an analysis of immediate settlement of tailings surfaces has been provided. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 5A(4), 5A(5), and 6(1).

(34) Verify that the magnitude of total and differential settlements has been shown to be within limits that will not induce cracking of the dikes (embankments), if used to form the surface impoundment, leading to instability. In addition, verify that the expected settlement will not reduce freeboard of the surface impoundment. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 5A(4) and 5A(5).

Construction

(35) Verify that the configuration of the proposed surface impoundment has enough capacity to contain all tailings and other contaminated materials that could be generated during operations. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5A(4).

(36) Ensure that the applicant has provided a detailed plan and schedule for constructing the surface impoundment. Also, ensure that the applicant has described the construction sequence in sufficient detail. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 1, 4(c), 5A(2), 5A(4), and 5A(5).

(37) Verify that the applicant demonstrates that the moisture content of borrow materials will be sufficient to allow the required degree of compaction. In addition, ensure that the applicant has indicated the duration and season for completing the construction activities. Additionally, verify that the applicant describes how borrow materials will be compacted with appropriate compaction equipment. Ensure that material placement and compaction procedures, moisture content, placement density and permeability, and schedule will meet the design specifications. Additionally, ensure that the proposed quality control program for construction of the surface impoundments is adequate to ensure adherence to the design specifications. This should include measures to protect the liner system during construction and initial loading. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5A(2).

(38) Verify that the applicant demonstrates that proper subgrade preparation will be conducted for installing the liner system. If necessary, ensure that the applicant demonstrates that moisture of the subgrade soil will be conditioned to prevent drying before the liner is placed. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5A(2).

(39) Verify that the applicant has demonstrated that the seams of the synthetic liner system, if used, will be placed and tested for integrity as per manufacturer's recommendations. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5A(2).

Inspection and Monitoring

(40) Ensure that an inspection program for the surface impoundment using a qualified engineer or scientist has been described and that the applicant commits to documenting these inspections. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 8A.

(41) Verify that, after operational activities begin, the applicant commits to performing inspections at regular intervals to check the conditions of the surface impoundment and

associated facilities and to evaluate the operational adequacy. Ensure that the applicant has adequately described the instrumentation to be used for inspection. Ensure that the proposed frequency of inspections of each element of the surface impoundment accounts for the size, nature of the foundation, and consequences of failure. Ensure that the inspection plan dictates that the surface impoundment will be inspected after a major natural event (e.g., a major earthquake with a nearby epicenter or a major rainfall event). This information should meet, in part, the requirements of 10 CFR 40.27(b)(2) and 10 CFR Part 40, Appendix A, Criteria 1 and 8A.

3.3.3 Acceptance Criteria

The design of surface impoundments is acceptable if they meet the following criteria.

Site Selection

(1) The technical basis for selecting suitable locations for surface impoundments, as discussed in Section 2 of this SRP, has been provided.

Site-Specific Information

(2) Data from site investigations were used to describe the surface impoundments.

(a) Data used are site-specific, appropriate, and conservative.

(b) The geotechnical parameters of the subgrade materials (e.g., soil cohesion and friction, thickness and continuity of the layers) have been adequately characterized.

(3) The applicant has provided information on sand and slime tailings for an existing surface impoundment in the reclamation plan, which includes, at a minimum:

(a) Characteristics of sand and slime tailings at the facility; and

(b) Variation of depth and thickness of sand and slime layers spatially and also vertically in the surface impoundment, including the basis of this information.

Design of Surface Impoundments

(4) The applicant has provided sufficient design description of the surface impoundment. The description includes, at a minimum, the following, as applicable:

(a) Dimensions of the surface impoundment and/or any retaining dike (embankment) including outside and inside slope angles;

(b) For an existing surface impoundment, history of operation and quantity, characteristics, and method of placement of the tailings;

(c) For a proposed surface impoundment, quantity and expected characteristics of the tailings and any other contaminated materials, proposed rate and method of placement of tailings, any dike or embankment to act as a retaining structure, and anticipated operating life of the impoundment; and

(d) For a heap leach facility:

(i) The proposed heap leaching method and its appropriateness for the site considering topography and type and quantity of ore.

(ii) The heap leaching method selected is appropriate for the local topography, space availability, and expected production capacity. Heap and pad dimensions have been provided. The area of the pad base, number of cells to be constructed and method(s) of their construction, height of each lift of ore placed for leaching, final pad height, equipment to be used and sequence of stacking ore, and slope of the heap have been adequately described. In addition, the number of lifts planned to reach the final pad height has been specified.

(iii) The applicant has provided the selected outside slope angle of the heap. If the slope is steep (e.g., the slope angle is close to the angle of repose of the materials), the design of the heap calls for benching or multiple lifts to reduce the overall slope angle for resisting instability or excessive erosion (Strachan and Dorey, 1988). Stability of the heap will be evaluated under acceptance criterion 28 of this section of the SRP.

(iv) The anticipated operating life of each new lift and the pad has been provided. Characteristics of the leaching solution and method and rate of application of the leaching solution have been provided.

(v) The method of application of the leaching solution to the heap has been provided (Muhtadi, 1988).

(vi) The description of other components of the facility, such as surface impoundments, has been provided.

(5) The surface impoundment has sufficient capacity to accommodate all leached materials and any other byproduct material throughout the complete lifecycle of the facility, considering uncertainties in volume estimates.

(6) Disposal of tailings in a below-grade facility is the preferred option. If the applicant demonstrates that above-grade disposal is necessary for environmental or practical reasons, the applicant has demonstrated that the retention system would be appropriately located and sized so that the steepness of the final stabilization slopes are minimized.

(7) If above-grade disposal is proposed, the steepness of the final surfaces of the surface impoundments is a minimum of five horizontal units (5h) to one vertical unit (1v). If the proposed slopes are steeper than 5h:1v, a technical justification is provided describing why a 5h:1v or flatter slope would be impractical. If necessary, the applicant has demonstrated that given the site-specific conditions, a steeper slope is needed and that the use of a steeper slope provides an equivalent level of stabilization and containment for protection of public health, safety, and the environment. Stability of the slopes will be evaluated under acceptance criterion 28 of this section of the SRP. In addition,

compensating features have been incorporated in the slope design to assure long-term stability when slopes are steeper than 5h:1v.

(8) The surface impoundments are 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, or other equipment; and (iii) human error. If dikes are used to form the surface impoundment, the dikes are designed, constructed, and maintained with sufficient structural integrity to prevent massive failure of the dikes.

(9) At the surface impoundment, adequate protection has been provided to prevent wind and water erosion, weathering, ice damage, and piping in the retention embankment or the foundation.

Foundation Design

(10) The applicant has demonstrated that the foundation of the surface impoundment is able to withstand the anticipated static and dynamic/seismic loads using laboratory and/or field experimental results. The foundation is able to withstand the differential stress/deformation so that the integrity and function of the liner system and any under-pad leak detection system can be maintained.

(11) The top part of the foundation acts as a barrier to vertical fluid flow and, consequently, has a very low hydraulic conductivity. JBR Environmental Consultants, Inc. (1998) suggests that the top 0.3 m [12 in] of the foundation of a heap leach pad have a hydraulic conductivity of 1×10^{-6} cm/s [3×10^{-6} in/s] or less. Adequate technical justification has been provided for other hydraulic conductivity values for the top part of the foundation.

Liner Design

(12) The applicant describes the design of the liner system for the surface impoundment including leachate storage ponds. At a minimum, design details, drawings, and pertinent analyses have been provided. Expected construction methods, testing criteria, and quality assurance programs have been presented. In addition, the applicant has provided the source(s) of the materials to be used in constructing the liner. These materials are available in acceptable quality and in sufficient quantities to construct the liner. The soil to be used in constructing the liner and liner bed is characterized to define the mechanical and hydraulic properties.

The applicant provides justification for the selection of the liner system including the type and thickness of the geomembrane to be used, if applicable. The liner will be constructed of materials that have appropriate chemical properties for use in the facility. Compatibility with waste, leachate, and any other liquids used in operation were tested using appropriate test parameters (e.g., temperature range) and design requirements (e.g., ASTM International, 2009a,b, 2008a, 2007a).

The applicant has submitted test results on the longevity of the proposed liner system, and the test results show conclusively that the liner will not deteriorate when subjected to the waste products and expected atmospheric and temperature conditions at the site. If a clay liner system has been selected, the potential increase in hydraulic conductivity

due to development of cracks from excessive differential settlement, drying (desiccation), and alteration of liner permeability due to geochemical reactions have been considered (Van Zyl, et al., 1988). This increase in hydraulic conductivity reduces the effectiveness of earthen liner systems, and the increase has been appropriately considered.

The applicant has provided the thickness of the geomembrane liner, if applicable, and demonstrated that it is adequate for the expected loads to be encountered. The applicant has specified the engineering properties of the geomembrane liner to be used in the project, if applicable. These properties include resistance to rock puncture, adequate elongation capacity to withstand settlement under heap loads (seam tests for strength and water tightness), adequate frictional strength with ore particles and under-liner materials for slope stability assessment, and resistance to degradation due to long-term exposure to the climactic conditions expected (including resistance to ultraviolet light) (Lupo and Morrison, 2007; Gilbert, et al., 1996; Deatherage, et al., 1988). The geomembrane liner proposed to be used in the heap leach pad is able to withstand the loads imposed by the dynamic construction traffic and final static loads, including any irregularities of the foundation. Additionally, the applicant has demonstrated that the liner has adequate puncture-resistance capabilities based on liner puncture performance tests (Thiel and Smith, 2004). The applicant has considered protective measures such as the use of low ground pressure equipment, visual inspection of first layer of material placed, construction techniques to minimize stresses on the liner system, or inclusion of sacrificial geosynthetics.

(13) The proposed design of the liner system has considered subgrade materials, the type of liner system, liner system protection, and detection of leaks. Additionally, it addresses the anticipated installation techniques and operating practices. Proposed construction procedures include provisions for modification of the moisture condition of subgrade soil. The subgrade has been demonstrated to be competent to take the construction traffic so that anticipated settlement of the subgrade will not damage the liner system. The subgrade has been found to be sufficient to prevent failure of the liner because of settlement, compression, or uplift. The applicant has also agreed to install liners to cover all surrounding earth that is likely to be in contact with the wastes or leachate. Proper preparation of the subgrade and slopes of an impoundment is important to the success of the surface impoundments. The strength of the liner is heavily dependent on the stability of the slopes. The applicant has agreed to treat the subgrade with a soil sterilant. The applicant has established an allowable leakage rate of the liner taking into consideration the expected defect rates in the synthetic liner, if used; hydraulic shear strength of the liner system; and the flow rates within the detection layer. If the observed leakage rate is more than the allowable leakage rate, remedial actions would be taken (NRC, 2008).

The applicant has provided adequate technical justification for the materials including their size distribution, hydraulic conductivity, and moisture content to be used in constructing the bed for placing the geomembrane. The bed under the geomembrane liner should be composed of fine particles to minimize the risk of rock particles puncturing the geomembrane. An adequate technical justification has been provided for maximum particle size, moisture content, and hydraulic conductivity of the bedding soil.

The applicant has provided adequate information on the characteristics of the over-liner or geomembrane cover fill layer. Information includes the size distribution of the

materials to be used, layer thickness, and permeability in addition to the characteristics of the geomembrane. The geomembrane is chemically inert to the chemicals to be used for leaching.

The thickness and hydraulic conductivity of the over-liner or geomembrane cover are adequate to protect the liner or geomembrane. JBR Environmental Consultants, Inc. (1998) suggests that the over-liner or cover of the geomembrane should be thicker than 0.6 m [2 ft] with the maximum hydraulic conductivity of 1×10^{-7} cm/s [3×10^{-7} in/s]. Sufficient technical justification has been provided if other design parameters for the over-liner or the geomembrane cover are proposed.

The size distribution of particles in the over-liner or geomembrane cover fill layer is commensurate with the specifications of the geomembrane, if applicable. Hydraulic conductivity of the over-liner or geomembrane cover fill layer is higher than the overlying ore lifts to maintain low hydraulic heads on the liner system for quick recovery of the leachate solution.

A quality control program has been established for the following factors when developing surface impoundments: (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. The licensee has committed to perform inspections of the liner, liner slopes, and other earthwork features. Any damage or defects that could result in leakage will be immediately reported to the NRC staff. Appropriate repairs will be implemented as soon as possible.

The applicant has agreed to perform tests on seams of synthetic liners along the entire length of the seam. Representative sampling may be used for factory seams using testing 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 will be submitted for staff review and approval. If it is necessary to repair the liner, representatives of the liner manufacturer will be called on to supervise the repairs.

For clay liners, at a minimum, the licensee has committed to conduct tests such as falling head permeameter tests performed on columns of liner material obtained during and after liner installation. These tests will determine the expected reaction of the impoundment liner to any combination of solutions or atmospheric conditions before the liner is exposed to them.

(14) In ensuring structural integrity, the applicant does not assume that the liner system will function without leakage during the active life of the surface impoundment. A leak detection system is included at all surface impoundments using natural or synthetic liners. The applicant has provided sufficient information on the under-pad leak detection and collection system. The leak detection system is designed to (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. The applicant has demonstrated the following:

(a) Soil or fine particles will not migrate to the leak detection system.

(b) Aggregate material to be used as a seepage detection medium has a high hydraulic conductivity. JBR Environmental Consultants, Inc. (1998) suggests a hydraulic conductivity of the seepage detection medium should not be less than 1×10^{-2} cm/s [3×10^{-2} in/s] for the aggregate material to be effective as a seepage detection medium. Sufficient technical justification has been provided if other values of hydraulic conductivity are proposed.

The surface impoundment is divided into subcells to identify the location of leakage. The applicant may specify the threshold rate to identify leakage. A seepage collection and conveyance system consisting of perforated pipes has been placed at the bottom of leak detection layer.

Cover Design

(15) Sufficient details of the proposed cover of the surface impoundments have been provided.

(a) Different material layers for the cover are described.

(b) Materials and their characteristics for each layer, including borrow areas from which the materials will be collected, are described.

(c) The geomembrane is described, if used, and its properties are provided.

(d) The method of construction of the cover is described.

(e) A description of any vegetation and/or rock cover (riprap) is provided.

Procedures, specifications, and requirements for riprap, rock mulch, and filter production and placement are provided and are shown to be consistent with NUREG–1623, "Design of Erosion Protection for Long-Term Stabilization" (NRC, 2002), accepted engineering practice, and accepted design specifications (Walters, 1982). Soil or rock to be used for constructing cover materials does not contain elevated levels of radium.

Applicants should be aware of the research into actual field scale performance of engineered barrier cover systems (NRC, 2011). When considering cover design during the initial licensing of a conventional mill or heap leach facility, it may be beneficial to develop an understanding of long term behavior of the soil, rock, and vegetation conditions in the vicinity of the proposed site. Applicants may consider installation of instrumented test sections of various cover systems to collect on-site performance data supporting the selection of the final cover system at reclamation.

Leachate Storage Pond in a Heap Leach Facility

(16) The design of the solution storage pond:

(a) Has adequate capacity for collecting leachate solution and runoff from anticipated storm events.

(b) Has identified and adequately described materials for the liner of the solution storage pond.

(c) Contains side slopes that are relatively flat (i.e., generally not steeper than 3h:1v) (Strachan and Dorey, 1988). If a steeper slope is proposed, the applicant has provided technical justifications for such selection.

(d) Contains liner materials that are resistant to sunlight, anticipated temperature fluctuations, wave actions, chemical attack, and wind pressures; the applicant has provided sufficient information on the proposed liner system of the leachate storage pond for review using acceptance Criteria 12–14 of this section of the SRP.

(e) Demonstrates that permeability of the liner is acceptably low.

Barren Solution Pond in Heap Leach Facility

(17) The barren solution pond has a low-permeability liner and is adequate for effective containment, which will be reviewed using the acceptance Criteria 12–14 of this section of the SRP. The capacity of the pond is adequate to accommodate the anticipated maximum volume of barren solution during operation.

Other Types of Ponds

(18) Other types of ponds (e.g., evaporation ponds) have a low-permeability liner and are adequately designed for effective containment, which will be reviewed using the acceptance Criteria 12–14 of this section of the SRP. The capacities of the ponds are adequate to accommodate the anticipated maximum volume of solution during operation.

Dewatering of Tailings/Leachate Collection System

(19) The applicant has described an acceptable system to dewater the mill tailings to lower the phreatic surface and reduce the driving seepage head acting on the liner system. New surface impoundments should be dewatered by a drainage system to lower the pheretic surface (i.e., height of the saturated zone) above the liner system (NRC, 2008). The applicant has demonstrated the following:

(a) The dewatering system of the surface impoundment is adequately sized to keep the height of the saturated zone to a minimum.

(b) Materials to be used for constructing the dewatering system are chemically compatible with the tailings.

(c) An analysis has demonstrated that the pipes, if used to dewater the tailings, will not be crushed or deflected significantly due to the weight of the tailings placed above so that the dewatering system will not lose effectiveness.

(20) The applicant has adequately described the design of the solution collection system to be used to collect and convey the leachate solution to the pregnant solution pond. The applicant has demonstrated the following:

(a) Design of the solution collection system can accommodate the rate of flow of leachate in addition to runoff and seepage through the heap from anticipated

storms. The applicant has provided adequate justification for selecting the extreme precipitation event to design the storage capacity.

(b) The applicant has demonstrated that design of the solution collection system would keep the height of the saturated zone (expected pheretic surface) above the liner to a minimum so that stability of the heap is not affected.

(c) Materials to be used to construct the collection pipes are chemically compatible with the leachate solution.

(d) An analysis has demonstrated that the collection pipes, if used to collect leachate, will not crush or deflect significantly due to the weight of the heap materials above them so that the solution collection system will remain effective.

(e) The solution collection system would be able to collect the liquid if rinsing or any special treatment of the leached ore is necessary before reclamation operation begins.

(f) Tests have been conducted to show that the load from heap leach materials would not significantly affect permeability of ore particles as the leaching operation progresses, thus requiring different filter characteristics (Ulrich, et al., 2003).

(21) The drains of the dewatering system in a surface impoundment or the leachate collection system in a heap leach pad will be protected by filter materials to prevent clogging so that the dewatering system remains free running. U.S. Department of Agriculture (1994) provides acceptable examples of designing soil filters. The capacity of the dewatering system has also been shown to be adequate.

Slope Stability

(22) The applicant has provided detailed information about the surface impoundment for assessing the slope stability. The information, at a minimum, includes:

(a) Detailed dimensions of the surface impoundment;

(b) All materials are identified and located in the drawings including any earthen or synthetic liner system and the cover system;

(c) Properties of each type of material based on laboratory and/or field measurements; these measurements were conducted using appropriate acceptable standards, such as American Society for Testing and Materials; and

(d) Height of the phreatic zone (i.e., height of the saturated zone) in the surface impoundment in addition to the height of the water table in the surrounding soil or rock mass.

(23) Cross sections and profiles of the surface impoundment are presented in sufficient number and detail to enable the staff to select the cross sections for detailed stability analysis or verification. Locations selected for slope stability analysis consider the location of maximum slope angle, slope height, foundation characteristics, groundwater

levels, the extent of rock mass fracturing (for an excavated slope in rock), and the potential for local erosion including the effects of toe erosion, incision at the base of the slope, and other deleterious effects of surface runoff.

(24) An appropriate analytical method has been used to assess stability of a surface impoundment or a heap leaching pad. Sufficient justification is provided for the selection of a two-dimensional or a three-dimensional method to estimate the safety of the slope. A plane strain analysis conducted in two dimensions along the maximum section of the slope may not adequately simulate the behavior under seismic load, especially for steep slopes (e.g., in steep canyons) and may result in an unsatisfactory design (Mejia and Seed, 1983). If a two-dimensional analysis is presented to demonstrate stability of the slopes, justification for not needing a three-dimensional analysis for the particular case is provided. Although in the vast majority of cases a two-dimensional analysis is satisfactory, the staff has examined the potential failure surface to assure that it is not constrained so that the plain strain assumption used in two-dimensional analyses is valid. Additionally, the applicant has justified the values(s) of the parameters used in the analysis.

For cases where seismic load is negligible, the method selected may be one of the limit equilibrium methods. A number of different methods of analysis are available (e.g., slip circle method, method of slices, and wedge analysis) with several variants of each (Lambe and Whitman, 1979; U.S. Army Corps of Engineers, 2003; NRC, 2008; Bromhead, 1992). The effect of the assumptions and limitations of the methods used is discussed and accounted for in the stability assessment. The limit equilibrium methods are acceptable only for slopes with relatively simple geometry and material variations. Appropriate conservatism has been incorporated in the analysis using the limit equilibrium methods. A full stability analysis requiring use of either finite element or finite difference methods has been used for complex slopes. Appropriate failure modes during and after construction have been identified. The appropriate limit equilibrium method has been used to determine the factor of safety against the identified failure mode, if a deterministic approach is used. The critical slip surface of the failure surface corresponding to the lowest factor of safety has been determined. The analysis takes into account the failure surfaces within the slopes, including those through the foundation, if any.

If a probabilistic approach is used, an appropriate method has been used to estimate the reliability index[1] β or, alternatively, the probability of unsatisfactory performance, P_{up}. In geotechnical disciplines, it is more appropriate to calculate P_{up} by using the reliability index β (U.S. Army Corps of Engineers, 2006). The reliability index β for a slope has been estimated using one of several techniques (e.g., First Order Reliability Method (FORM), Second Order Reliability Method (SORM), Monte Carlo method) (Baecher and Christian, 2003; Chowdhury, 2010; Wu, 2008). Technical justification has been provided if a different method has been used to estimate the reliability index or probability of

[1]Reliability Index β is the "number of standard deviations by which the expected value of the factor of safety is away from the unsatisfactory performance condition or the factor of safety equaling one" (U.S. Army Corps of Engineers, 2006). As the value of β increases, the impoundment becomes less likely to fail.

unsatisfactory performance. The analysis submitted by the applicant has considered the following:

(a) Appropriate failure surfaces have been considered to estimate the minimum reliability index value, β, for the slope. A search algorithm to identify the critical surface with β is provided in Hassan and Wolff (1999) and U.S. Army Corps of Engineers (2006). As discussed in U.S. Army Corps of Engineers (2006), the failure surface associated with the minimum factor of safety may be significantly different from the failure surface associated with the minimum reliability index.

(b) An acceptable number of simulations were conducted to estimate the reliability index if a Monte Carlo method was used.

(25) The variability of the boundaries and the material properties of soil and rock types within and beneath the slope, and the uncertainties associated with the forces acting on the slope and the pore pressures acting within and beneath the slope were considered. Adverse conditions, such as high water levels from severe rain and the probable maximum flood, were evaluated.

(26) The applicant has selected the maximum credible earthquake for analyzing stability of the surface impoundment. The applicant has demonstrated that the surface impoundment is located a sufficient distance away from a capable fault, on which a maximum credible earthquake larger than that which the surface impoundment could reasonably be expected to withstand, might occur.

Appropriate analyses considering the effect of seismic ground motions on slope stability are presented. A seismic load on a slope can develop significant inertial forces, causing instability or permanent deformation of the slope. Current practice is to use either a limit equilibrium method using a pseudostatic representation of the seismic forces or a displacement-based analysis using either the Newmark sliding block concept (Newmark, 1965) or rigorous numerical modeling methods (e.g., finite element or finite difference methods) (Transportation Research Board, 2008). The applicant has considered the following in the analysis to assess the effect of seismic ground motions on slope stability, as appropriate:

(a) The overall seismic stability was evaluated using pseudostatic analysis or dynamic analysis, as appropriate (U.S. Army Corps of Engineers, 1995a; NRC, 2008). Alternatively, a dynamic analysis following Newmark (1965) was carried out to establish that the permanent deformation of the disposal cell from the design seismic event would not be detrimental to the disposal cell. The yield acceleration or pseudostatic horizontal yield coefficient necessary to reduce the factor of safety against slippage of a potential sliding mass to 1.0 in a "Newmark-type" analysis has been adequately estimated (Seed and Bonaparte, 1992).

(b) For dynamic loads, the dynamic analysis includes calculations with appropriate assumptions and methods (NRC, 2008; Seed, 1967; Department of the Navy, 1986a,b, 1997; U.S. Army Corps of Engineers, 1986, 1995a, 2001, 2003; Bureau of Reclamation, 1998). The effect of the assumptions and limitations of the method(s) used are discussed in the analysis.

(c) Degradation of dynamic shear strength of cohesive soils due to repeated cycles of earthquake loading has been appropriately considered following the American Society of Testing and Materials Society or other acceptable standards (e.g., ASTM International, 2007b, 2003).

For dynamic loads, a pseudostatic analysis was performed in lieu of dynamic analysis if the strength parameters used in the analysis are conservative, the materials are not subject to significant loss of strength and development of high pore pressures under dynamic loads, the design seismic coefficient is 0.20 or less, and the resulting minimum factor of safety suggests an adequate margin consistent with Regulatory Guide 3.11, Revision 3 (NRC, 2008).

(d) For pseudostatic analysis of slopes subjected to earthquake loads, an assumption is made that the earthquake imparts additional horizontal force acting in the direction of the potential failure (U.S. Army Corps of Engineers, 2003, 1995a; Goodman, 1989). The critical failure surface obtained in the static analysis is used in this analysis with the added driving force. The estimated safety factors for slopes analyzed using a deterministic approach are consistent with the minimum acceptable values of safety factors for slope stability analysis consistent with Regulatory Guide 3.11, Revision 3 (NRC, 2008).

(e) The influence of local site conditions on the ground motions associated with the design level event was evaluated.

(f) The applicant has justified the design seismic coefficient used in the pseudostatic analysis. The seismic coefficient is generally expressed as a fraction of the peak ground acceleration and typically ranges from less than 50 percent to peak ground acceleration (Anderson, et al., 2008). If the design seismic coefficient is greater than 0.20 g, then the dynamic stability investigation (Newmark, 1965) has been augmented by other appropriate methods (i.e., finite element method, finite difference method) depending on specific site conditions.

(g) If a pseudostatic stability analysis using limit equilibrium methods is used to assess the effects of seismic loads on slope stability, the effect of dynamic or cyclic stresses of the design earthquake on soil strength parameters and damping is determined. Use of static undrained strength in the analysis may be acceptable if the potential increase in undrained strength during the first cycle of loading could be negated by degradation of strength after 10 to 15 cycles (Anderson, et al., 2008; Seed, et al., 1986). Alternatively, measured strength under cyclic loading has been provided if the use of static undrained strength is questionable. As in a static analysis, the parameters such as geometry, soil strength, and hydrodynamic and pore pressure forces are varied in the analysis to show that there is an adequate margin of safety.

(h) If a displacement-based approach [e.g., Newmark (1965) method or its modification, finite element/finite difference methods] is used to assess stability, the appropriate site peak ground acceleration coefficient and yield acceleration (i.e., seismic coefficient for a factor of safety equal to 1.0) was used in the assessment. Seismically induced displacement is calculated and documented. The acceptable performance of the disposal cell is consistent with Seed and Bonaparte (1992) and Goodman and Seed (1966). Seed and Bonaparte (1992)

indicate that the acceptable displacement should be 15 cm [6 in] or less. In rare cases, a permanent displacement of 30 cm [12 in] or less may be acceptable if a conservative analysis is used and the tailings impoundment can be demonstrated to undergo such permanent displacement without adverse consequences. The applicant has justified the acceptable permanent displacement value, which would not produce adverse consequences, and the license application is also augmented by provisions for periodic maintenance of the slope(s).

(i) Where there is potential for liquefaction, changes in pore pressure from cyclic loading are considered in the analysis to assess the effect of pore pressure increase on the stress-strain characteristics of the soil and the post-earthquake stability of the slopes. Evaluations of the dynamic properties and shear strengths for the tailings, underlying foundation material, and base liner system are based on representative material properties obtained through appropriate field and laboratory tests.

(27) The applicant has considered reasonable ranges of the parameters if the estimated safety margin (i.e., estimated factor of safety or reliability index) is low. Additionally, the applicant has considered other factors, such as flooding conditions, pore pressure effects, possible material erosion, and seismic amplification, in the stability assessment. The degree of conservatism necessary depends on the type of analysis used, and variabilities and uncertainties associated with the parameters.

(28) The stability of the surface impoundments is appropriately demonstrated following guidance in Regulatory Guide 3.11, Revision 3 (NRC, 2008) if a deterministic approach is used. However, accepted values of the reliability index β or the probability of unsatisfactory performance P_{up} has not been established yet. Only a few publications provide a minimum acceptable value of β (e.g., Chowdhury, 2010, pp. 541–542). Therefore, the applicant justifies why the estimated β or P_{up} would be acceptable given the potential consequence in case of a failure.

(29) Any dike (or dam) meets the requirements of the federal dam safety program if the application demonstrates the following:

(a) The dike is correctly categorized as a low hazard potential or a high hazard potential structure using the definition of the U.S. Federal Emergency Management Agency (1998).

(b) If the dike is ranked as a high hazard potential, an acceptable emergency action plan consistent with the Federal Emergency Management Agency guide (U.S. Federal Emergency Management Agency, 1998) has been developed.

Liquefaction

(30) The results of site exploration, geotechnical investigations, and *in-situ* tests, such as standard penetration, cone penetration, piezocone, density, and strength tests as well as boring logs, laboratory classification test data, water table measurements, perched water zones, and soil profiles, are adequate to ensure that the site soils beneath the site and the surface impoundments are not susceptible to liquefaction. Applicable laboratory and/or field tests were properly conducted (NRC, 2003a,b; U.S. Army Corps of Engineers, 1986, 2001) using acceptable standards, such as those of the American

Society for Testing and Materials. Data for all relevant parameters for assessing liquefaction potential are adequately presented, and their variabilities have been quantified. The time history of earthquake ground motions used in the analysis is consistent with the design seismic event.

Preliminary evaluation of liquefaction potential considers the following site characteristics identified in Regulatory Guide 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites" (NRC, 2003c), Youd, et al. (2001) Ferritto (1997), and Seed, et al. (2003): (i) whether potentially liquefiable soils are present beneath the surface impoundment, (ii) whether the liquefiable soils are saturated or could become saturated in the future, and (iii) whether the thicknesses or lateral extent of these soils sufficient to pose a risk to the project. The applicant demonstrates an understanding of whether the soils present are liquefiable or the surface impoundments are stable. The soil screening criteria include the following characteristics (NRC, 2008; Koester, et al., 2000):

(a) Geologic age and origin;
(b) Fines contents and plasticity index;
(c) Saturation;
(d) Depth below the ground surface; and
(e) Penetration resistance.

If the screening evaluation did not definitively address whether the soil is liquefiable, detailed evaluations were conducted in accordance with Acceptance Criterion 31.

(31) The liquefaction potential has been characterized using appropriate methods, including analysis of minor or local liquefaction. Appropriate measures have been proposed to mitigate or eliminate the effects of liquefaction, when necessary.

(a) If the potential for complete or partial liquefaction exists, the effects such liquefaction has on the stability of slopes and settlement of tailings are adequately quantified. Assessment of the liquefaction potential is consistent with current practice in the geotechnical engineering profession (e.g., Seed and Idriss, 1971, 1982; National Center for Earthquake Engineering Research, 1997; Youd, et al., 2001; Idriss and Boulanger, 2004). Two broad classes of methods are used: (i) empirical procedures; and (ii) analytical methods. Currently, four *in-situ* test methods have been widely used: (i) Standard Penetration Test (SPT) (Seed, et al., 2003; Seed and Harder, 1990; Cetin, et al., 2000, 2004); (ii) Cone Penetration Test (Seed ,et al., 2003; Moss, et al., 2006); (iii) measurement of *in-situ* shear wave velocity (Seed, et al., 2003); and (iv) Becker Penetration Test (BPT) (Seed, et al., 2003; U.S. Army Corps of Engineers, 2001). Applicability of these test methods in assessing liquefaction potential is discussed in Youd, et al. (2001) and Regulatory Guide 1.198 (NRC, 2003c). The estimated factor of safety is consistent with Regulatory Guide 1.198 (NRC, 2003c). Analytical methods typically use laboratory test results to assess development of liquefaction. An assessment of the potential adverse effects that complete or partial liquefaction could have on the stability of the embankment may be based on cyclic strength test data obtained from undisturbed soil samples taken from the critical zones in the site area (Seed and Harder, 1990). Uncertainties associated with the parameter values are addressed consistent with Regulatory Guide 1.198 (NRC, 2003c). If procedures based on laboratory tests combined

with ground response analyses were used, laboratory test results were corrected to account for the difference between laboratory and field conditions (NRC, 2003b; Department of Navy, 1997). Guidelines for laboratory testing are described in Regulatory Guide 1.138, "Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants," Revision 2 (NRC, 2003b). The applicant may use procedures that are alternative to those suggested in these documents, provided appropriate justification has been provided for their use.

(b) If probabilistic methods are used to assess liquefaction potential, the methodology is consistent with the current practice (e.g., Hynes, 1999; Cetin, et al., 2002; Juang, et al., 2006). The probability of liquefaction on reliability index β is consistent with the current engineering practice and is technically justified.

(c) If a potential for major liquefaction is identified, mitigation measures consistent with current engineering practice or redesign of surface impoundment embankments are proposed and the proposed measures provide reasonable assurance that the liquefaction potential has been eliminated or mitigated.

(d) If minor liquefaction potential is identified and is evaluated to have only a localized effect that may not directly alter the stability of embankments, the effect of liquefaction is adequately assessed in analyses of both differential and total settlement and is shown not to compromise the intended performance of the radon barrier. Additionally, the disposal cell is shown to be capable of withstanding the liquefaction potential associated with the expected maximum ground acceleration from earthquakes. The licensee may use post-earthquake stability methods (e.g., Ishihara and Yoshimine, 1990) based on residual strengths and deformation analysis to examine the effects of liquefaction potential. Furthermore, the effect of potential localized lateral displacement from liquefaction, if any, is adequately analyzed with respect to slope stability and disposal cell integrity (e.g., Bardet, et al., 1999; Koester, et al., 2000; Seed, et al., 2003).

Settlement

(32) The method used for settlement analysis is appropriate for the surface impoundment and soil conditions at the site. Contributions to settlement by drainage of mill tailings and by consolidation/compression of slimes and sands are considered for the surface impoundment. Similarly, contributions to settlement by drainage of leachate and any rinsing solution, if used, and consolidation/compression of the leached ore by cover placement operations in a heap leach pad are appropriately considered. Both instantaneous and time-dependent components of total and differential settlements are appropriately considered in the analyses (Nelson, et al., 1983a, b). Calculation of immediate settlement and secondary compression is consistent with the standard procedures [e.g., those recommended in NAVFAC DM 7.1 (Department of the Navy, 1986a) and U.S. Army Corps of Engineers (1990)]. If different procedures are used, the basis for the procedures is justified. Properties used in calculating settlement are measured using appropriate testing standards [e.g., ASTM International (2004, 2007c)]. The magnitude and the rate of the expected settlement of the embankment and the radon barrier cover are estimated using the results of consolidation tests conducted in

the laboratory on samples from embankment materials, foundation, and tailings. However, significant uncertainties exist in the estimated time for settlement because settlement in the field is affected by soil drainage (NRC, 2008), which is controlled by small-scale geological details. Generally, site investigations may not be able to capture these small-scale details adequately. Therefore, the applicant may need to modify the settlement predictions, which is based on laboratory-measured data, using actual measurements.

(a) Each of the following is appropriately considered in calculating stress increments for assessment of consolidation settlement:

(i) Decrease in overburden pressure from excavation, if any;
(ii) Increase in overburden pressure from tailings emplacement;
(iii) Excess pore pressure generated within the surface impoundment; or
(iv) Changes in water levels from dewatering of the tailings.

(b) Material properties and thicknesses of compressible soil/rock layers used in stress change and volume change calculations for assessment of consolidation settlement are representative of *in-situ* conditions at the site.

(c) Values of pore pressure within and beneath the disposal cell used in settlement analyses are consistent with initial and postconstruction hydrologic conditions at the site.

(33) The applicant has provided the expected instantaneous and long-term settlement magnitudes for the embankment. The magnitude of anticipated total settlement is small enough so that sufficient freeboard will be available to prevent overtopping from operations, overfilling, wind and wave actions, rainfall or run-on, malfunction of level controllers and other equipment, and human error. Additionally, differential settlement is within tolerable limits so that cracks will not develop, affecting the integrity of the embankment.

(34) The surface impoundment will be divided into appropriate zones, depending on field conditions, for assessment of differential settlement and the overall settlement pattern of the disposal cell of the surface impoundment.

The applicant has estimated the time at which the settlement, due to primary consolidation of the mill tailings or leached ore, will be essentially complete. The applicant proposes to place the radon barrier and disposal cell cover after this time.

Results of settlement analyses are properly documented. The magnitudes of total and differential settlement are within the tolerable limits of the engineered components of the surface impoundment [e.g., clay liners, geomembranes (if used), drainage layers, and pipes] so that cracks will not develop affecting their intended safety function. An adequate analysis is provided of the potential for development of cracks in the radon/infiltration barrier because of differential settlement.

Construction

(35) The planned configuration will have adequate capacity to accommodate all leached materials and other contaminated materials throughout the planned lifecycle of the

facility including any alternate feed of materials from other facilities. Uncertainties in the estimated volume of contaminated materials can be accommodated.

(36) The applicant has provided a detailed plan for constructing the surface impoundment that includes construction specifications for areas such as excavation, embankment construction, subgrade preparation, and liner placement. The following were considered as minimum guidelines, with the understanding that additional or more stringent specifications may be required depending on site conditions at individual sites:

(a) Engineering drawings at appropriate scales clearly show the design features with appropriate dimensions.

(b) A geotechnical or construction inspector will be onsite during embankment construction.

(c) Materials to be used for each feature of the facility are identified.

(d) Source, quality, and quantities of borrow materials, if needed in the construction, are identified. The borrow materials, if needed, have been characterized using field and laboratory tests for use in constructing the surface impoundment. The background level of contamination of the borrow materials, if needed, has been adequately established. Borrow materials will be taken from an approved, designated borrow area that is free of roots, stumps, wood, rubbish, stones greater than 15 cm [6 in], and frozen or other objectionable materials.

(e) Areas on which fill is to be placed will be scarified before its placement.

(f) Methods, procedures, and requirements for excavating, hauling, and stockpiling of contaminated and noncontaminated materials have been provided and have been shown to be consistent with commonly accepted engineering practice for earthen works (Department of Navy, 1997, 1986b; U.S. Army Corps of Engineers, 2008, 2004, 1995b; U.S. Department of Agriculture, 2008).

(g) Procedures, specifications, and requirements for riprap, rock mulch, and filter production and placement have been provided and have been shown to be consistent with NUREG–1623 (NRC, 2002) and accepted engineering practice (Walters, 1982).

(h) The construction sequence has been described and demonstrated to be adequate to achieve the intended configuration and characteristics for the surface impoundment and associated other components of facility.

(i) The method of placement of tailings in the surface impoundments has been adequately described. The description also includes the equipment to be used and the method of placing the tailings. For a heap leach facility, the applicant has provided the method (e.g., dumping with dozer leveling, conveyor stacking) and equipment to be used in constructing the heap leach pad. Additionally, the method (e.g., flooding or ponding, pressure emitters, “wobblers,” “wigglers”) and application rate of the leaching solution to the heap have been provided (Muhtadi, 1988).

(j) Appropriate quality control provisions have been provided to ensure that the construction will be in accordance with the plan. The descriptions of the methods, procedures, and frequencies by which the construction materials and activities are to be tested and inspected are reasonable, and appropriate records will be maintained (Johnson, et al., 1983).

(k) The schedule to complete the construction activities has been provided.

(37) Material placement and compaction procedures are adequate to achieve the desired moisture content, placement density, and permeability and will follow an accepted standard, such as U.S. Army Corps of Engineers (1995b) and recommendations made in NUREG/CR–5041 (Denson, et al., 1987). Compaction specifications include restriction on work during adverse weather conditions (e.g., rainfall, freezing conditions) and include season and duration of the construction activities as they affect the moisture content.

The compaction requirements for the borrow materials will include the maximum dry density, allowable range of moisture content, and maximum loose lift thickness. Borrow materials will be compacted with appropriate compaction equipment (e.g., sheepsfoot, rubber tired, or vibratory roller). The number of passes required by the compaction equipment may vary with soil conditions. Borrow materials will contain sufficient moisture to develop the required degree of compaction by the equipment to be used. Field density tests will be performed regularly throughout the embankment construction. Typically, a routine control test will be performed for every 765 to 2,294 m^3 (1,000 to 3,000 yd^3) of compacted material and as directed by the geotechnical engineer consistent with Regulatory Guide 3.11, Revision 3 (NRC, 2008). The applicant has proposed adequate quality control techniques to verify material placement, including geosynthetics.

(38) The subgrade will be adequately prepared for installing the liner system. The site will be cleared of all debris, vegetation, and potential root systems. The surface will be graded so that it is smooth and free of protruding rock particles. The applicant has provided sufficient information on the proposed construction procedures, which includes provisions for modification of moisture condition of subgrade soil, if necessary.

(39) Seams of a synthetic liner will run up and down and not across a slope unless the applicant has provided a technical justification. Additionally, seams will not be located near the crest of a slope consistent with Regulatory Guide 3.11, Revision 3 (NRC, 2008). Seaming will be carried out under supervision of experienced personnel. The applicant will test the seams of the synthetic liner system, if used, for integrity along the entire length using appropriate test procedures (e.g., ASTM, 2010; 2009c,d; 2008b,c,d; 2007c; 2006a,b,c). The testing procedures follow the manufacturer's recommendations for the liner system.

Inspection and Monitoring

(40) A plan to inspect the conditions and adequacy of the surface impoundment, including access during routine maintenance, has been described. The procedure assures that unnecessary traffic is not directed to the impoundment/leach area. The inspection program uses a qualified engineer or scientist, and the applicant commits to documenting the inspections. The NRC staff considers that a person with a 4-year

engineering or science degree could be designated as a qualified engineer or scientist. The inspection and monitoring program will start at the beginning of construction and will be consistent with the guidance provided in Regulatory Guide 3.11, Revision 3 (NRC, 2008).

(41) The applicant has proposed acceptable inspection frequencies of important elements of surface impoundments. Additionally, the applicant has described the instrumentation and procedures to inspect the facilities following a recognized standard, such as U.S. Army Corps of Engineers (1995c). Available records and readings of these instruments will be reviewed to detect any unusual performance or distress of the structure.

The proposed frequency of inspection of each element of the retention system is commensurate with the size, characteristics of the foundation, and consequence of failure of the element to minimize jeopardizing human health and safety and causing environmental and property damage.

The scope of a special inspection after a major event is commensurate with the severity of the event. For example, an inspection would be made after a major nearby earthquake to assess the integrity of the dike and the impoundment. Similarly, after a major rainfall event, the impoundments would be inspected for breach, overtopping, and containment release.

3.3.4 Evaluation Findings

If the staff determines that no license conditions are required for the design of surface impoundments because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is needed for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the design of surface impoundments at the conventional uranium millheap leach facility in accordance with Section 3.3.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 3.3.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's design of surface impoundments is acceptable and is in compliance with 10 CFR 40.27(b)(2), which requires a detailed description of the final disposal site conditions; 10 CFR 40.31(h), which establishes requirements for license applications; 10 CFR Part 40, Appendix A, Criterion 1, which requires permanent isolation of tailings and associated contaminants by minimizing disturbances and dispersion by natural forces; 10 CFR Part 40, Appendix A, Criterion 3, which prescribes the preferred option for disposal of tailings below the grade and reasonable isolation of the tailings from natural erosional forces; 10 CFR Part 40, Appendix A, Criterion 4(a), which requires that upstream catchment areas be minimized; 10 CFR Part 40, Appendix A, Criterion 4(b), which requires that topographic features should provide good wind protection; 10 CFR Part 40, Appendix A, Criterion 4(c), which specifies final embankment cover slopes be relatively flat; 10 CFR Part 40, Appendix A, Criterion 4(d), which prescribes a self-sustaining vegetative or rock cover to reduce wind and water erosion to negligible levels; and 10 CFR Part 40,

Appendix A, Criterion 4(e), which prescribes that the surface impoundments should be constructed away from capable faults."

In addition, add: "NRC staff concludes that the applicant's design of surface impoundments is also in compliance with 10 CFR Part 40, Appendix A, Criterion 5A(1), which requires a liner system to prevent migration of waste; 10 CFR Part 40, Appendix A, Criterion 5A(2), which requires that the liner to be installed has sufficient strength, an adequate foundation for the liner, and that the liner covers all surrounding earth likely to be in contact with the waste or leachate; 10 CFR Part 40, Appendix A, Criterion 5A(3), which allows for alternate designs and operating practices if the Commission approves; 10 CFR Part 40, Appendix A, Criterion 5A(4), which requires prevention of overtopping; 10 CFR Part 40, Appendix A, Criterion 5A(5), which prescribes that the dikes for the impoundments should be designed, constructed, and maintained to have sufficient structural integrity; 10 CFR Part 40, Appendix A, Criterion 5E(1), which requires a bottom liner; 10 CFR Part 40, Appendix A, Criterion 5E(3), which requires dewatering of tailings; 10 CFR Part 40, Appendix A, Criterion 5G(2), which prescribes the required characteristics of the subgrade; 10 CFR Part 40, Appendix A, Criterion 6(1), which requires an earthen cover over the tailings; 10 CFR Part 40, Appendix A, Criterion 6(5), which prescribes that the near-surface cover materials should not have elevated levels of radium; and 10 CFR Part 40, and Appendix A, Criterion 6A(3), which authorizes a licensee to dispose of byproduct or similar materials from other sources if appropriate criteria are met."

In addition, add: "NRC staff concludes that the applicant's design of surface impoundments is also in compliance with 10 CFR Part 40, Appendix A, Criterion 8A, which requires daily inspections of tailings retention systems; and the requirements of the Federal Dam Safety Program of the U.S. Federal Emergency Management Agency if the hazard potential of the surface impoundment is high." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the design of surface impoundments at the conventional uranium millheap leach facility in accordance with Section 3.3.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 3.3.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's design of surface impoundments is acceptable and is in compliance with 10 CFR 40.27(b)(2), which requires a detailed description of the final disposal site conditions; 10 CFR 40.31(h), which establishes requirements for license applications; 10 CFR Part 40, Appendix A, Criterion 1, which requires permanent isolation of tailings and associated contaminants by minimizing disturbances and dispersion by natural forces; 10 CFR Part 40, Appendix A, Criterion 3, which prescribes the preferred option for disposal of tailings below the grade and reasonable isolation of the tailings from natural erosional forces; 10 CFR Part 40, Appendix A, Criterion 4(a), which requires that upstream catchment areas be minimized; 10 CFR Part 40, Appendix A, Criterion 4(b), which requires that topographic features

should provide good wind protection; 10 CFR Part 40, Appendix A, Criterion 4(c), which specifies embankment cover slopes be relatively flat; 10 CFR Part 40, Appendix A, Criterion 4(d), which prescribes a self-sustaining vegetative or rock cover to reduce wind and water erosion to negligible levels; and 10 CFR Part 40, Appendix A, Criterion 4(e), which prescribes that the surface impoundments should be constructed away from capable faults."

In addition, add: "NRC staff concludes that the applicant's design of surface impoundments is also in compliance with 10 CFR Part 40, Appendix A, Criterion 5A(1), which requires a liner system to prevent migration of waste; 10 CFR Part 40, Appendix A, Criterion 5A(2)(a), which requires that the liner to be installed has sufficient strength; 10 CFR Part 40, Appendix A, Criterion 5A(2)(b), which requires an adequate foundation for the liner; 10 CFR Part 40, Appendix A, Criterion 5A(2)(c), which requires the liner to cover all surrounding earth likely to be in contact with the waste or leachate; 10 CFR Part 40, Appendix A, Criterion 5A(3), which allows for alternate designs and operating practices if the Commission approves; 10 CFR Part 40, Appendix A, Criterion 5A(4), which requires prevention of overtopping; 10 CFR Part 40, Appendix A, Criterion 5A(5), which prescribes that the dikes for the impoundments should be designed, constructed, and maintained to have sufficient structural integrity; 10 CFR Part 40, Appendix A, Criterion 5E(1), which requires a bottom liner; 10 CFR Part 40, Appendix A, Criterion 5E(3), which requires dewatering of tailings; 10 CFR Part 40, Appendix A, Criterion 5G(2), which prescribes the required characteristics of the subgrade; 10 CFR Part 40, Appendix A, Criterion 6(1), which requires an earthen cover over the tailings; 10 CFR Part 40; 10 CFR Part 40, Appendix A, Criterion 6(5), which prescribes that the near-surface cover materials should not have elevated levels of radium; 10 CFR Part 40, 10 CFR Part 40, Appendix A, Criterion 6A(3), which authorizes a licensee to dispose of byproduct or similar materials from other sources if appropriate criteria are met; 10 CFR Part 40, Appendix A, Criterion 8A which requires daily inspections of tailings retention systems; and the requirements of the Federal Dam Safety Program of the U.S. Federal Emergency Management Agency if the hazard potential of the surface impoundment is high." If not already discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

3.3.5 References

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3.4 Uranium Recovery Process

3.4.1 Areas of Review

The staff should review the physical descriptions and operating characteristics for the major equipment of the recovery cycle. The staff should also review descriptions of the proposed process information and controls, as well as radiation sampling and monitoring equipment. Controls mean the apparatus or mechanisms that could affect the chemical, physical, metallurgical, or nuclear processes of the facility in such a manner as to influence radiation health and safety. 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 and chemical storage facilities. These should be reviewed for the hazards associated with the quantities, locations, operating flow rates, temperatures, and pressures of 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 effect on radiological health and safety. Chemicals of concern typically used in uranium recovery facilities are identified in NUREG/CR–6733 (NRC, 2001) and DOE/EIA–0592 (DOE, 1995). Therefore, staff should review the list of applicable federal, state, and local regulations that the applicant intends to use to determine that all hazardous chemicals that have the potential to impact radiological health and safety are safely handled. Staff should also review the safety features used in the facility process design for eliminating or mitigating the hazards these materials present.

3.4.2 Review Procedures

The staff should use the following procedures when conducting the review of the description of the uranium recovery process:

(1) Ensure that the ore operations are adequately described, including crushing, pulping, and dissolution. This information should meet, in part, the requirements of 10 CFR 40.32(c) and (d).

(2) Verify that the proposed plant material balances and flow rates are adequately described. Ensure that the plans, specifications, inspection programs, and construction quality assurance/quality control programs are adequate to meet, in part, the requirements of 10 CFR 40.32(c) and (d).

(3) Verify that the applicant has identified the volume of the largest tank within the building and that the volume of the tank can be contained within the building. Additionally, verify that the applicant has identified measures taken to minimize potential for leakage through the floor. Verify that the applicant has adequately described protection pipes running to and from buildings or chemical storage areas. This information should meet, in part, the requirements of 10 CFR 40.32(c) and (d).

(4) Verify that all radiation protection aspects of the plant design, including ventilation, filtration, confinement, dust collection, and radiation monitoring equipment are adequate to meet, in part, the requirements of 10 CFR 40.32(c) and 10 CFR Part 40, Appendix A, Criterion 8.

(5) Determine that operating parameters are provided and are adequate to meet, in part, the requirements of 10 CFR 40.32(c).

For facility instrumentation

(5) Verify that instrumentation has been described for the various components of the processing facility and the production circuit. This information should meet, in part, the requirements of 10 CFR 40.32(c).

3.4.3 Acceptance Criteria

The description of the uranium recovery process is acceptable if it meets the following criteria:

(1) The description of the recovery process includes proposed plant material balances and flow rates that are adequately described. The amount of flow into the plant has been shown to equal the sum of the various flows out of the plant.

(2) Plans, specifications, and inspection programs are adequate to construct the facility according to accepted engineering practices. The applicant provides detailed information on processing equipment (e.g., tanks, ion exchange columns, piping materials). A commitment to adhere to local building codes during facility construction is provided. Construction quality assurance/quality control programs exist for radiologically significant structures, including:

(a) Processing plant sumps, berms, containment, and pump pits;
(b) Piping;
(c) Processing plant structures; and
(d) Tornado, hurricane, earthquake, and fire protection, as necessary.

(3) The processing building has been designed to contain the volume of the largest tank without a release to the environment. This could be through the use of a sump, or a concrete berm around the tank. The applicant has also identified measures to prevent liquid flow through cracks or joints in the floor of the process building. The applicant has proposed leak detection or secondary containment for pipes running to and from buildings or chemical storage areas.

(3) All ventilation, filtration, confinement, dust collection, and radiation monitoring equipment are described as to size, type, and location. Availability requirements for safety equipment are adequately stated, and measures for ensuring availability and reliability are clearly identified, including the type of safety equipment, its locations, the maintenance requirements, and the responsibility for performing maintenance.

(4) 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. Furthermore, controls 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.

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

(5) Instrumentation has been described for the various components of the processing facility and the production circuit. Specific brands of instrumentation are not necessary; however, the basic type of instrument or component that is used to maintain control of radioactive and 11e.(2) byproduct material is provided. 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. Furthermore, the instrumentation includes alarms and interlocks in the event of a failure.

Control 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 a fire.

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.

3.4.4 Evaluation Findings

If the staff determines that no license conditions are required for the description of the uranium recovery process because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is needed for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the description of the uranium recovery process at the conventional uranium mill or heap leach facility in accordance with Section 3.4.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 3.4.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of the uranium recovery process at the conventional uranium mill or heap leach facility is acceptable and is 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 a license will not be inimical to the health and safety of the public; and 10 CFR Part 40, Appendix A, Criterion 8, which provides requirements for control of airborne effluent releases." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the description of the uranium recovery process at the conventional uranium mill or heap leach facility in accordance with Section 3.4.3 of the standard review plan." Following this sentence, state what information

the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 3.4.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of the uranium recovery process at the conventional uranium mill or heap leach facility is acceptable and is 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 a license will not be inimical to the health and safety of the public; and 10 CFR Part 40, Appendix A, Criterion 8, which provides requirements for control of airborne effluent releases." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

3.4.5 References

DOE. "Decommissioning of U.S. Uranium Production Facilities." DOE/EIA–0592. Washington, DC: DOE, Office of Coal, Nuclear, Electric and Alternate Fuels. 1995.

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

3.5 Waste Management

3.5.1 Areas of Review

This section focuses on the requirements to manage wastes; wastes include liquid (process effluents), gaseous effluents, and solid wastes, including both byproduct material and non-byproduct material. Areas of review should include:

(1) Quantities and compositions of wastes expected during construction, operation, and decommissioning;

(2) Effluent control systems for liquids and gases;

(3) Control of solid and liquid wastes; and

(4) Design specifications of any waste retention and disposal systems such as surface impoundments and deep injection wells.

3.5.2 Review Procedures

The staff should use the following procedures when conducting the review of waste management:

(1) Determine that the description of the proposed conventional uranium mill or heap leach process is adequate for the type and quantity of wastes generated, including a description of the chemical and radioactive characteristics of waste solutions. The description should include: (a) an analysis and evaluation on the nature of the environment; (b) the location of other potentially affected licensed and unlicensed facilities; and (c) analyses and procedures to ensure that doses are maintained as low as is reasonably achievable (ALARA) and within the dose limits in 10 CFR Part 20. This information should meet, in part, the requirements of 10 CFR 20.2002; 10 CFR 20.2007; 10 CFR Part 40, Appendix A, Criteria 5G(1) and 8.

(2) Verify that monitoring and control systems for the facility are located to optimize their intended function and are appropriate for the types of effluents generated. This information should meet, in part, the requirements of 10 CFR 20.1101; 10 CFR 20.1301; 10 CFR Part 20, Appendix B, Table 2; 10 CFR 40.32(c); 10 CFR 40.41(c); 10 CFR Part 40, Appendix A, Criteria 7 and 8; and 40 CFR Part 190.

(3) Review the application to determine that the effluent control systems will limit exposures under both normal and accident conditions. Ensure that the application also provides information on the health and safety impacts of system failures and identifies contingencies for such occurrences. In addition, verify that the application describes minimum performance specifications for the operation of the effluent controls and the frequencies of tests and inspections to ensure proper performance to specifications. This information should meet, in part, the requirements of 10 CFR 40.32(c) and 10 CFR Part 40, Appendix A, Criteria 7 and 10.

(4) Review the application to determine that it addresses contaminated solid waste management and disposal. This information should meet, in part, the requirements of 10 CFR Part 20, Subpart C; 10 CFR 40.31(h); and 10 CFR Part 40, Appendix A, Criterion 2.

The staff should use the following procedures when reviewing the liquid effluent control systems:

(5) Review the description of instrumentation for the liquid effluent disposal method considered to determine that it has been adequately described. The review should focus on instrumentation used to measure flow rates and pressures. Review the methods for controlling liquid effluents, including the use of neutralizing agents to immobilize hazardous constituents. This information should meet, in part, the requirements of 10 CFR 20.1301; 10 CFR 20.1302; 10 CFR 20.2002; 10 CFR 20.2007; 10 CFR 40.32(c); 10 CFR 40.41(c); 10 CFR Part 40, Appendix A, Criteria 5E(1), 5E(4), 7, and 7A; and 40 CFR Part 190.

(6) If surface impoundments are considered as a method to dispose of liquid effluents, review the proposed design of surface impoundments, the monitoring and inspection program, and the corrective action plans to confirm that they are adequately designed to

prevent migration of waste from the surface impoundments to the subsurface soil, groundwater, or surface water (Section 3.3 of this SRP).

(7) Confirm that water quality certification and discharge permits have been obtained or plans are in place to obtain them in accordance with 10 CFR 20.2007 and 40 CFR Part 146. Determine that releases of process waste water to surface waters comply with 40 CFR 440.34 and 10 CFR 20.1302(b). Verify that release of liquids into surface waters complies with the public dose limits in 10 CFR 20.1301; the water concentration limits defined in 10 CFR Part 20, Appendix B; and 40 CFR Part 190.

The staff should use the following procedures when reviewing the gaseous and airborne particulate effluent control systems:

(8) Verify that areas where dusts, fumes, or gases would be generated are clearly identified, along with a description of the source of the emissions. This information should meet, in part, the requirements of 10 CFR 40.41(c).

(9) Review the application to confirm it demonstrates that adequate ventilation systems are planned for process buildings to avoid gaseous and radioactive particulate emission buildup, including radon gas, and that ventilation systems are 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 Reasonably Achievable," Revision 1 (NRC, 2002, Section 3.3). The ventilation system and controls should be sufficient to maintain airborne concentrations of radon and its progeny in the workplace to less than 25% of the Derived Air Concentration (DAC) given in Table 1 of 10 CFR Part 20, Appendix B, as recommended in Regulatory Guide 8.31. According to the regulatory guide, the 25 percent figure is used to encourage the use of ventilation systems and controls in an effort to prevent the existence of airborne radioactivity areas. This information should meet, in part, the requirements of 10 CFR 20.1701; 10 CFR Part 20, Appendix B; 10 CFR 40.32(c); 10 CFR 40.41(c); and 10 CFR Part 40, Appendix A, Criteria 7 and 8.

(10) Verify that the application demonstrates that the operations will be conducted so that airborne effluent releases are ALARA. This information should meet, in part, the requirements of 10 CFR 20.1101 and 10 CFR Part 40, Appendix A, Criterion 8.

(11) Confirm that gaseous and particulate emissions within enclosed buildings are properly controlled. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 8.

(12) Determine that emissions from yellowcake drying operations are properly controlled. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 8.

3.5.3 Acceptance Criteria

The description of waste management is acceptable if it meets the following criteria:

(1) The description of the conventional uranium mill or heap leach process identifies gaseous and liquid effluents, and solid wastes that will be generated. Physical, chemical, and radiological characteristics of each waste type are identified, and a

determination that a waste is or is not byproduct material is provided. In addition, the quantity of each waste type and its retention and transport potential (e.g., sorptive and reactive characteristics with the host media) are identified, as well as the manner of disposal.

(2) Monitoring and control systems for the facility are located to optimize their intended function and are appropriate for the types of effluents generated. The intended purposes of measurement devices are clearly stated, and criteria for monitoring are provided. Preoperational monitoring and detection monitoring programs are developed for chemical and radiological constituents to be monitored on a site-specific basis. Monitors used to assess worker exposures are placed in locations of maximum anticipated radionuclide concentration based on determination of airflow patterns. Milling operations are conducted under the condition that airborne effluents releases are maintained ALARA. Control and monitoring systems at the proposed facility protect health and minimize danger to life and property.

(3) The application demonstrates that the effluent control systems will limit exposures under both normal and accident conditions. The type of effluent controls are described, including the specific equipment to be used, parameters used to measure performance, and frequency of performance assessments. The application also provides information on the health and safety impacts of system failures and identifies contingencies for such occurrences.

The application describes minimum performance specifications for the operation of the effluent controls and the frequencies of tests and inspections to ensure proper performance with specifications. Details of acceptable leakage and spill control techniques are found in Section 4.1 of this SRP. Acceptable methods for testing, maintenance, and inspection of effluent controls are consistent with Regulatory Guide 3.56, “General Guidance for Designing, Testing, Operating, and Maintaining Emission Control Devices at Uranium Mills” (NRC, 1986, Section 1). The application provides sufficient information on how the effluent control and detection monitoring program at the proposed facility will provide sufficient data and information for NRC to establish standards, if leakage of hazardous constituents from surface impoundments is detected.

(4) The application identifies and differentiates solid byproduct material (e.g., contaminated soil and debris by process solutions, pipes, building materials, filters, protective clothes), contaminated solid waste that is not byproduct material (e.g., used equipments, sanitary waste), and hazardous solid waste (e.g., waste oil, used batteries). The application contains a description of the methods to be used for disposing of each solid waste type that is generated during operation of the facility. 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 application provides an estimate of the amount of contaminated material that will be generated and disposal method identified. In particular, the application describes whether contaminated equipments are to be disposed into surface impoundments, or stored on site, or shipped to an offsite disposal facility at a later date.

For process effluent control systems:

(5) Liquid effluents generated during the uranium mill or heap leach process are designated as byproduct material. Acceptable control methods include diversion of liquid effluents to surface impoundments, land application sites, deep injection wells, or their combinations. To dispose of liquid waste in surface impoundments, the applicant provides (i) a description of physical properties and chemical toxicity of radioactive and nonradioactive constituents of liquid effluents that are important to risk, (ii) a description of design features of surface impoundments, (iii) the use of neutralizers to promote immobilization of hazardous constituents, and (iv) a description of onsite instrumentation and procedures for leakage detection and seepage control to ensure adequate containment of liquid effluent in surface impoundments.

To dispose of liquid waste after treatment by onsite land application, the application provides (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, and (iii) onsite instrumentations, analyses, and procedures to ensure that doses are maintained ALARA and within the dose limits of 10 CFR 20.1301. For land application, the application describes activities and onsite instrumentation in sufficient detail for assessing: (i) projected concentrations of radioactive contaminants in the soils and demonstrates that instrumentation and detection systems will be adequate to ensure that the concentration of radium and other radionuclides in the soil will not exceed the groundwater protection standards; (ii) projected impacts on groundwater and surface-water quality; (iii) projected impacts on land use, particularly crops, vegetation, and livestock grazing; and (iv) projected exposures and health risks that may be associated with radioactive constituents reaching the food chain. The specific toxicity evaluations and necessary permits are sufficient to conform to the applicable environmental and health protection regulations. In the absence of compliance monitoring wells in the uppermost aquifer beneath the proposed land application site, onsite instrumentation demonstrates that contaminants will not be returned to the groundwater and cause site-specific groundwater protection standards to be exceeded and will not adversely affect groundwater levels and site-hydrology beneath the proposed conventional uranium mill or heap leach facility. The application proposes periodic soil surveys that include contaminant monitoring to verify that contaminant levels in the soil do not exceed the projected levels. A remediation plan is in place to be implemented in the event that the projected levels are exceeded and also includes a remediation plan that can be implemented if projected levels are exceeded.

If the liquid effluent is to be treated and reinjected into a deep disposal well, the appropriate local, state, or federal authorities will approve the injection program. The licensee has committed to provide (i) a description of the chemical toxicity of radioactive and nonradioactive constituents of liquid effluents 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 affected environment, (iv) information on the nature and location of other facilities likely to be affected, and (v) onsite instrumentation in sufficient detail to demonstrate that liquid effluents disposed into a designated aquifer will not exceed the approved injection well capacity and have adequate monitoring well and instrumentation to ensure that groundwater protection standards in adjacent aquifers will not be exceeded, and that doses are ALARA and within dose limits for individual members of the public.

For release of liquid waste to surface waters, the applicant has committed to comply with dose limits and will have adequate sampling instruments and procedures to demonstrate that doses are maintained ALARA. NRC has no specific requirements for nonradiological constituents, and the applicant has committed to adopt the appropriate state limits. Anticipated discharges are described in enough detail to evaluate environmental impacts. The applicant has committed to comply with NRC requirements for decommissioning before facility closure and license termination. Decommissioning requirements are discussed in Section 7 of this SRP.

(6) If surface impoundments are considered as a method to dispose of liquid effluents, the proposed design of surface impoundments, the monitoring and inspection program and the corrective action plans are adequately designed to prevent migration of waste from the surface impoundments to the subsurface soil, groundwater, or surface water. The design, installation, and operation of surface impoundments at the proposed conventional uranium mill or heap leach site used to manage byproduct material are consistent with guidance provided in Regulatory Guide 3.11, Revision 3, (NRC, 2008, Section 1). Onsite retention ponds are designed and operated in a manner that prevents migration of liquid waste from the all surface impoundments to the uppermost aquifer. The monitoring and inspection program consists of documented daily checks of freeboard of surface impoundments and the leak detection system. Section 3.3 of this SRP contains additional discussion of the design and evaluation of surface impoundments, diversion facilities, and the monitoring and inspection program.

Corrective actions will commence on leak confirmation and will consist of transferring the solution to another surface impoundment so that liner repairs can be made. Thus, sufficient freeboard capacity will be maintained in the surface impoundments such that any one surface impoundment could be transferred to the remaining surface impoundments in the event of a leak. An additional freeboard requirement is that water levels will be kept far enough below the top of the retention pond 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 corrective actions and the results of those actions.

(7) The applicant has obtained applicable local, state, and federal permits for the disposal of any toxic or hazardous effluents and properties of materials. If deep disposal of liquid effluents is to be implemented, the applicant's proposal satisfies U.S. Environmental Protection Agency (EPA) regulations for the underground injection control program, and applicants will obtain necessary permits from the EPA and states EPA authorizes to enforce these provisions. Applicants disposing of liquid waste from process water by injection in deep wells will comply with NRC regulatory provisions for decommissioning.

If the treated liquid effluents are to be released to surface waters, release of liquids into surface waters will comply with the public dose limits in 10 CFR 20.1301, which may be demonstrated by one of the following methods:

(a) The application demonstrates compliance with effluent concentration limits in 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 effluent concentration limits at the point of discharge.

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

(b) The application 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.

(c) The application demonstrates compliance with 40 CFR 440.34, which prohibits discharges of process waste water to navigable waters by conventional uranium mill and heap leach extraction operations.

For gaseous and airborne particulate effluent control systems:

(8) Areas where dusts, fumes, or gases would be generated are clearly identified, along with a description of the source of the emissions. The applicant identifies locations of specific release points including discharge points. An acceptable release point would be that defined in Regulatory Guide 1.21, “Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste,” Revision 2 (NRC, 2009). This definition states that a release point is:

> A location from which radioactive materials are released from a system, structure, or component (including evaporative releases and leaching from ponds lakes in the controlled or restricted area before release under 10 CFR 20.2001)

A discharge point is consistent with the definition in Regulatory Guide 1.21, Revision 2 (NRC, 2009). This definition states that a discharge point is”

> A location from which radioactive material enters the unrestricted area—This would be the point beyond the vertical plane of the unrestricted area (surface or subsurface).

(9) The application demonstrates that adequate ventilation systems are planned for process buildings to avoid gaseous and airborne particulate emissions buildup, including radon gas. Proposed ventilation systems are consistent with the requirements of Regulatory Guide 8.31, Revision 1 (NRC, 2002, Section 3.3).

Ventilation systems emphasize (i) recovery solutions entering the plant, (ii) radon gas mobilization from the extraction process (where tanks are vented), and (iii) uranium particulate emissions resulting from drying and packaging operations and spills. Aspects of design that can significantly limit airborne releases may include closed production systems (i.e., no venting) and the use of vacuum dryers that eliminate airborne uranium particulate releases from drying operations.

(10) The application demonstrates that the operations will be conducted so that airborne effluent releases are ALARA.

(11) Airborne effluent emissions within enclosed buildings are properly controlled. Effective control of airborne effluent emissions is achieved by using a pressurized processing tank system that eliminates venting in process buildings or by using appropriate ventilation systems in buildings where airborne effluent emissions are expected.

(12) Emissions from yellowcake drying operations are properly controlled. Acceptable control of yellowcake emissions from the dryer is achieved by meeting the criteria of Regulatory Guide 3.56 (NRC, 1986, Section 1).

3.5.4 Evaluation Findings

If the staff determines that no license conditions are required for waste management because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is needed for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the description of waste management at the conventional uranium mill or heap leach facility in accordance with Section 3.5.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 3.5.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of waste management at the conventional uranium mill or heap leach facility is acceptable and is in compliance with 10 CFR Part 20, Subpart C, which requires that occupational dose limits need to be controlled; 10 CFR 20.1101, which requires that an acceptable radiation protection program that achieves ALARA goals is in place and that a constraint on air emissions, excluding Rn-222 and its decay products, will be established to limit doses from these emissions; 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 20.1701, which requires the use of process or other engineering controls; 10 CFR 20.2002, which requires approval of proposed disposal procedures from relevant state and federal authorities; 10 CFR 20.2007, which requires compliance with environmental and health protection regulations; 10 CFR 20, Appendix B, which establishes annual limits on intakes and DACs; 10 CFR 40.31(h), which defines requirements for applications for uranium or thorium milling licenses; 10 CFR 40.32(c), which requires that the applicant's equipment, facilities, and procedures are adequate to protect health and minimize danger to life and property; and 10 CFR 40.41(c), which requires that source and byproduct materials shall be confined to the locations and purposes authorized in the licensed area."

In addition, add: "NRC staff concludes that the applicant's description of waste management at the conventional uranium mill or heap leach facility is also in compliance with 10 CFR Part 40, Appendix A, Criterion 2, which prohibits the proliferation of small waste disposal sites; 10 CFR Part 40, Appendix A, Criterion 5E(1), which requires the installation of a leak detection system for synthetic liners and appropriate testing for clay/soil liners; 10 CFR Part 40, Appendix A, Criterion 5E(4), which requires hazardous constituents to be neutralized to promote immobilization; 10 CFR Part 40, Appendix A, Criterion 5G(1), which requires definition of the chemical and radioactive characteristics of waste solutions; 10 CFR Part 40, Appendix A, Criterion 7, which requires preoperational monitoring to set baseline parameters; 10 CFR Part 40, Appendix A, Criterion 7A, which requires detection monitoring programs to set the site-specific groundwater protection standards, respectively; 10 CFR Part 40, Appendix A, Criterion 8, which provides requirements for control of airborne effluent releases; 10 CFR Part 40, Appendix A, Criterion 10, which requires that long-term surveillance costs need to be covered by mill operators; 40 CFR Part 146, which provides requirements for deep injection wells; 40 CFR Part 190, which establishes environmental radiation protection standards for nuclear power operations; and 40 CFR 440.34, which prohibits discharges of process wastewater to navigable waters by conventional uranium mill and heap leach extraction operations." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the description of waste management at the conventional uranium mill or heap leach facility in accordance with Section 3.5.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 3.5.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of waste management at the conventional uranium mill or heap leach facility is acceptable and is in compliance with 10 CFR Part 20, Subpart C, which requires that occupational dose limits need to be controlled; 10 CFR 20.1101, which requires that an acceptable radiation protection program that achieves ALARA goals is in place and that a constraint on air emissions, excluding Rn-222 and its decay products, will be established to limit doses from these emissions; 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 20.1701, which requires the use of process or other engineering controls; 10 CFR 20.2002, which requires approval of proposed disposal procedures from relevant state and federal authorities; 10 CFR 20.2007, which requires compliance with environmental and health protection regulations; 10 CFR Part 20, Appendix B, which establishes annual limits on intakes and DACs; 10 CFR 40.31(h), which defines requirements for applications for uranium or thorium milling licenses; 10 CFR 40.32(c), which requires that the applicant's equipments, facilities, and procedures are adequate to protect health and minimize danger to life and property; 10 CFR 40.41(c), which requires that source and byproduct materials shall be confined to the locations and purposes authorized in the licensed area."

In addition, add: "NRC staff concludes that the applicant's description of waste management at the conventional uranium mill or heap leach facility is also in compliance with 10 CFR Part 40, Appendix A, Criterion 2, which prohibits the proliferation of small waste disposal sites; 10 CFR Part 40, Appendix A, Criterion 5E(1), which requires the installation of a leak detection system for synthetic liners and appropriate testing for clay/soil liners; 10 CFR Part 40, Appendix A, Criterion 5E(4), which requires hazardous constituents to be neutralized to promote immobilization; 10 CFR Part 40, Appendix A, Criterion 5G(1), which requires definition of the chemical and radioactive characteristics of waste solutions; 10 CFR Part 40, Appendix A, Criterion 7, which requires preoperational monitoring to set baseline parameters; 10 CFR Part 40, Appendix A, Criterion 7A, which requires detection monitoring programs to set the site-specific groundwater protection standards, respectively; 10 CFR Part 40, Appendix A, Criterion 8, which provides requirements for control of airborne effluent releases; 10 CFR Part 40, Appendix A, Criterion 10, which requires that long-term surveillance costs need to be covered by mill operators; 40 CFR Part 146, which provides requirements for deep injection wells; 40 CFR 190, which establishes environmental radiation protection standards for nuclear power operations; and 40 CFR 440.34, which prohibits discharges of process wastewater to navigable waters by conventional uranium mill and heap leach extraction operations." If not already discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

3.5.5 References

NRC. Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste." Rev. 2. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2009.

———. Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills." Rev. 3. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2008.

——. Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills Will Be as Low as Is Reasonably Achievable." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2002.

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

4.0 MANAGEMENT

4.1 Corporate Organization and Administrative Procedures

4.1.1 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 procedure with respect to several key areas. These areas include development, review, approval, and implementation of, and adherence to, operating procedures, radiation safety programs, groundwater monitoring programs, quality assurance programs, and routine and nonroutine maintenance activities. The management structure should also describe how changes to these key areas are implemented. These key areas include procedures that evaluate the consequences of a spill or incident/event in relation to the reporting requirements in 10 CFR 20.2201, 10 CFR 20.2202, and 10 CFR 40.60. Finally, staff should examine the plans the applicant proposes for establishing a Safety and Environmental Review Panel (SERP), or similarly named panel, including the proposed composition and responsibilities of the panel.

4.1.2 Review Procedures

Staff should use the following procedures when reviewing corporate organization and administrative procedures:

(1) Verify that the applicant adequately described the corporate organization, clearly defined management responsibilities and authority at each level. This information should meet, in part, the requirements of 10 CFR 20.1101 and 10 CFR 40.32(b).

(2) If the applicant requests a performance-based license, verify that the applicant has established a SERP that consists of at least three individuals with specific qualifications in management, operations, and radiation safety. This information should meet, in part, the requirements of 10 CFR 20.1101 and 10 CFR 40.32(b).

(3) Verify that proposed administrative procedures are consistent with Regulatory Guide 8.2, "Guide for Administrative Practices in Radiation Monitoring," (U.S. Atomic Energy Commission, 1973), and with Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Inception Through Normal Operations to License Termination)—Effluent Streams and the Environment," Revision 2 (NRC, 2007). This information should meet, in part, the requirements of 10 CFR 20.1101 and 10 CFR 40.32(c).

(4) Ensure that sufficient independence exists among operations, maintenance, and radiological safety staff such that significant safety issues can be raised to corporate management. This information should meet, in part, the requirements of 10 CFR 20.1101 and 10 CFR 40.32(b).

4.1.3 Acceptance Criteria

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

(1) The applicant has adequately described the corporate organization, clearly defining management responsibilities and authority at each level. Specifically, the radiation safety officer (RSO), or equivalent, has responsibilities and authority that are consistent with Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Revision 1 (NRC, 2002, Section 1.2). The organizational structure shows integration among groups that support the operation, maintenance, and safety of the facility. If the facility is new, ensure that integration between plant construction and plant management is detailed.

(2) If the applicant requested a performance-based license, the applicant has established a SERP that will consist of at least three individuals with specific qualifications in management, operations, and radiation safety. One member of the SERP 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 RSO, or equivalent, with the responsibility for assuring that changes conform to radiation safety requirements. Additional members may be included in the SERP, as appropriate, to address specific technical issues such as health physics, groundwater 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. The applicant states that the SERP will review all proposed changes and will refer to the NRC those changes that the SERP determines will require a license amendment.

(3) The proposed administrative procedures are consistent with Regulatory Guide 8.2 (U.S. Atomic Energy Commission, 1973) and Regulatory Guide 4.15, Revision 2 (NRC, 2007). The applicant has provided or has committed to provide written procedures for dose calculations and measurements, sample collection, sample management and chain of custody, sample preparation and analysis, data reduction and recording, data assessment and reporting, and final sample disposal. Procedures are also provided for addressing support functions, such as operation of process monitors, training, preparation of quality control samples, corrective actions, audits, and records. In addition, the applicant has committed to provide training instructions, procedures, or schedules for the staff performing functions associated with the Quality Assurance program, such as the following:

   (a) Ancillary laboratory functions (including cleaning of glassware, contamination control, and storage of standards and chemicals);

   (b) Calibration and quality control of instrumentation (including range of activity, range of energy, and frequency of calibration);

   (c) Internal quality control programs (including frequency, types, acceptance criteria for the laboratory performance testing samples, and individual analyst qualifications); and

(d) Timetables for verification and validation of data.

(4) Sufficient independence exists between operations and maintenance staff and radiological safety staff such that significant safety issues can be raised to corporate management. This is demonstrated in an organizational chart and in the application text. The applicant states what the radiological staff can and cannot do to maintain radiological safety.

4.1.4 Evaluation Findings

If the staff determines that no license conditions are required for the corporate organization and administrative procedures because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the corporate organization and administrative procedures at the conventional uranium mill or heap leach facility in accordance with Section 4.1.3 of the standard review plan." Following this statement, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 4.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's corporate organization and administrative procedures are acceptable and are in compliance with 10 CFR 20.1101, which requires the use of procedures in the radiation protection program, and 10 CFR 40.32(b) and (c), which define requirements for the corporate organization and SERP functions." As a concluding statement, state the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the corporate organization and administrative procedures at the conventional uranium mill or heap leach facility in accordance with Section 4.1.3 of the standard review plan." Following this statement, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 4.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's corporate organization and administrative procedures are acceptable and are in compliance with 10 CFR 20.1101, which requires the use of procedures in the radiation protection program, and 10 CFR 40.32(b) and (c), which define requirements for the corporate organization and SERP functions." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

4.1.5 References

NRC. Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Inception Through Normal Operations to License Termination)—Effluent Streams and the Environment." Rev. 2. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2007.

———. Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2002.

U.S. Atomic Energy Commission. Regulatory Guide 8.2, "Guide for Administrative Practices in Radiation Monitoring." Washington, DC: NRC, Directorate of Regulatory Standards. 1973.

4.2 Management Control Program

4.2.1 Areas of Review

The staff should review the management control program proposed to ensure that activities affecting health and safety will be conducted in accordance with written standard operating procedures, including record keeping and reporting. Staff should evaluate the management controls and decision bases the SERP will use in deciding when it is necessary to apply for a license amendment. Procedures governing nonroutine work or maintenance that is not covered by a standard operating procedure, such as use of radiation work permits, should be reviewed.

The staff should review the applicant's record keeping and retention plans for:

- The materials control and tracking program;
- The radiation protection program;
- The sampling, survey, and calibration programs;
- Planned special exposures;
- The tracking of doses to workers and members of the public;
- The disposal of source and byproduct materials;
- 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; and
- Inspection records.

The staff should also review the applicant'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.

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 safety concerns may affect radiological operations or accidents. Detailed procedures for the interface between NRC and the Operational Safety and Health Administration (OSHA) are included in the "Memorandum of Understanding Between NRC and the Occupational Safety and Health Administration" (OSHA, 1988).

4.2.2 Review Procedures

The following procedures should be used to review the management control program:

(1) Verify that all proposed activities that may affect health and safety, including compliance with any license commitments or conditions, will be conducted in accordance with written operating procedures.

Verify that a process will be used to identify and prepare operating procedures for routine work and that it includes procedures covering all aspects of radiation safety, routine maintenance activities (especially in radiation areas), and SERP reviews and activities. This information should meet, in part, the requirements of 10 CFR 20.1101, 10 CFR 40.44, 10 CFR 40.60, 10 CFR 20.2201, and 10 CFR 20.2202.

(2) Verify that the applicant presents methods for review and approval of nonroutine work or maintenance activities as required by 10 CFR 20.1101.

(3) Ensure that procedures governing SERP functions for approvals of all proposed changes in the facility, the operating procedures, or the conduct of tests or experiments are appropriately documented and reported. This information should meet, in part, the requirements of 10 CFR 20.1101.

(4) Verify that the applicant agrees to 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 license conditions, or until the Commission terminates the license. This information should meet, in part, the requirements of 10 CFR 20.2103(b)(4) and 10 CFR 40.60.

(5) Ensure that the following will be permanently maintained and retained until license termination:

(a) Records of onsite radioactive waste disposal;

(b) Records of certain types of radiation surveys;

(c) Records included in Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities," Revision 3 (NRC, 2008); and

(d) Records containing information important to decommissioning and reclamation.

This information should meet, in part, the requirements of 10 CFR 20.2002; 10 CFR 20.2007; 10 CFR 20.2103(b)(4); 10 CFR 40.36(f)(4); and 10 CFR Part 40, Appendix A, Criteria 8 and 8A.

(6) Verify that the applicant demonstrates that records, including records received from a previous owner or applicant, will be provided to a new owner or new applicant if the property or license is transferred, or to NRC after license termination. Ensure that all records will be maintained as hard copy originals or as copies on microfiche, or will be electronically protected, and will be readily retrievable for NRC inspection. This information should meet, in part, the requirements of 10 CFR 20.2103(b)(4) and 10 CFR 40.61(d) and (e).

(7) Verify that reports of spills, surface impoundment leaks, or process chemical leaks will be made to the NRC project manager (or Operations Center, if required) by telephone or electronic mail (e-mail) within 48 hours of the event. This information should meet, in part, the requirements of 10 CFR 20.2202.

(8) Verify that theft or loss of material in an aggregate quantity greater than 1,000 times the quantity specified in Appendix C to Part 20 is reported to the NRC project manager (or Operations Center, if required) by telephone or by electronic mail within 48 hours of the event. Verify that within 30 days after the occurrence of any lost, stolen, or missing licensed material becomes known to the licensee in quantities greater than 10 times the quantity specified in 10 CFR Part 20, Appendix C is reported in writing and includes the quantity that is still missing at this time. Verify that the discovery of any incident in which an attempt has been made, or is believed to have been made, to create a theft or unlawful diversion of more than 6.8 kg [15 lb] at any one time or more than 68 kg [150 lb] of such material in any one calendar year is reported to the NRC project manager (or Operations Center, if required). This information should meet, in part, the requirements of 10 CFR 20.2201 and 10 CFR 40.64(c).

(9) Ensure that the applicant has committed to submit an annual report to NRC that includes the as low as is reasonably achievable (ALARA) audit report, monitoring data, corrective action program report, semiannual effluent and monitoring reports, and the SERP determinations. This information should meet, in part, the requirements of 10 CFR 20.2103(b)(4); 10 CFR 40.61(d) and (e); and 10 CFR 40.65.

4.2.3 Acceptance Criteria

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

(1) The proposed management control program is sufficient to ensure that any activities affecting health and safety, including compliance with any license commitments or conditions, will be conducted in accordance with written standard operating procedures. The applicant describes the process for identifying and developing standard operating procedures for routine work, and the review and approval process the radiation safety staff will use to modify standard operating procedures when appropriate.

Subsequent NRC inspections will ensure that standard operating procedures are adequate and applied correctly. Standard operating procedures for radiation safety are consistent with Regulatory Guide 8.31, “Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable,” Revision 1 (NRC, 2002, Section 2).

(2) The applicant presents methods for review and approval of nonroutine work or maintenance activities by the radiation safety staff. The methods include the preparation

and issuance of radiation work permits for activities where standard operating procedures do not apply. For example, repair of a malfunctioning vacuum dryer is considered to be nonroutine work and will be performed after the radiation work permit has been approved by radiation safety, industrial safety, quality assurance, and line management.

(3) A detailed review of SERP composition is addressed in Section 4.1 of this SRP. Procedures governing the functioning of the SERP ensure that approvals of any changes in the facility, the operating procedures, or the conduct of tests or experiments are appropriately documented and reported. The applicant will verify that these changes, tests, or experiments may be implemented without obtaining a license amendment pursuant to 10 CFR 40.44, so long as the change, test, or experiment does not:

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

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

(c) 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 technical evaluation reports or other analyses and evaluations for license amendments.

(d) Amend a license condition.

SERP records will include evaluations of all proposed changes to operations and the SERP decision of whether the change requires a license amendment. SERP records will also include written health and safety evaluations the SERP makes that provide the basis for determining whether changes, tests, or experiments were implemented in accordance with the basis described in Section 4.1.3 in this SRP. The applicant states that all SERP reports shall be sufficiently comprehensive to allow staff to thoroughly evaluate the change, test, or experiment.

(4) The record keeping and retention plans demonstrate that the applicant 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 license, or until the Commission terminates the license. The proposed record keeping and retention programs are adequate to ensure that the applicant will be able to track, control, and demonstrate control of the source and byproduct material at the site, such that onsite and offsite dose limits will not be exceeded.

(5) The following will be permanently maintained and retained until license termination:

(a) Records of onsite radioactive waste disposal, such as by deep well injection, land application, or burial.

(b) Records of radiation measurements and surveys required by 10 CFR 20.2103(b)(4), including:

(i) Surveys to measure radiation dose;

(ii) Measurements and calculations used to determine individual intakes of radioactive materials;

(iii) Measurements resulting from air sampling, surveys, and bioassays; and

(iv) Measurements and calculations used to evaluate the release of radioactive effluents.

(c) Records required by 10 CFR Part 40, Appendix A, Criteria 8 and 8A as discussed in Regulatory Guide 3.11, Revision 3 (NRC, 2008).

(d) Records containing information important to decommissioning and reclamation, including:

(i) Descriptions of any spills, leaks, contamination events, or unusual occurrences, including the dates, locations, areas, or facilities affected; assessments of hazards; corrective and cleanup actions taken; assessment of cleanup effectiveness 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 will 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; onsite locations used for burials of radioactive materials; hydrology and geology, with particular emphasis on conditions that could contribute to groundwater or surface-water contamination; preoperational background radiation levels at and near the site; and locations of waste water ponds and lagoons.

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

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

The applicant will maintain these records, such as descriptions of spills and other unusual occurrences and retain them in an identifiable or, preferably, separate file with adequate safeguards against tampering and loss.

(6) The applicant demonstrates a plan to maintain the records and provides the records (i) to a new owner or new applicant if the property or license is transferred or (ii) to NRC after license termination. These records include any such records received from a previous owner or applicant. The records will be maintained as hard copy originals or as copies on microfiche, or will be electronically protected, and will be readily retrievable for NRC inspection.

(7) The applicant commits to making reports of spills; surface impoundment leaks; and leaks of source, byproduct material, or process chemicals to the NRC project manager (or Operations Center if required) by telephone or electronic mail (e-mail) within 48 hours of the event. This notification will be followed within 30 days by submittal of a written report to NRC detailing the conditions leading to the spill or incident/event, corrective actions taken, and results achieved.

(8) The applicant commits to reporting the theft or loss of source material in an aggregate quantity greater than 1,000 times the quantity specified in Appendix C to Part 20 to the NRC project manager (or Operations Center, if required) by telephone or by electronic mail within 48 hours of the event. The applicant further commits to reporting in writing, within 30 days after the occurrence, any lost, stolen, or missing licensed material that becomes known to the licensee in quantities greater than 10 times the quantity specified in 10 CFR 20, Appendix C and includes the quantity that is still missing at this time. The applicant also commits to reporting the discovery of any incident in which an attempt has been made or is believed to have been made to create a theft or unlawful diversion of more than 6.8 kg [15 lb] at any one time or more than 68 kg [150 lb] of such material in any one calendar year to the NRC project manager (or Operations Center, if required).

(9) An annual report will be submitted to NRC that includes the ALARA audit report, monitoring data, the corrective action program report, the semiannual effluent and monitoring reports, and the SERP determinations.

4.2.4 Evaluation Findings

If the staff determines that no license conditions are required for the management control program because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: “NRC staff has completed its review of the management control program at the conventional uranium mill or heap leach facility in accordance with Section 4.2.3 of the standard review plan.” Following this statement, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: “Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 4.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant’s management control program is acceptable and is in compliance with 10 CFR 20.1101, which defines radiation protection program requirements; 10 CFR 20.2002, which describes requirements of obtaining approval of proposed disposal procedures; 10 CFR 20.2007, which requires compliance with environmental and health protection regulations; 10 CFR 20.2103(b)(4), which describes record retention requirements; 10 CFR 20.2201, which defines requirements for record keeping;

10 CFR 20.2202, which defines requirements for reporting incidents; 10 CFR 40.36(f)(4), which describes requirements for records of the cost estimate performed for the decommissioning funding plan and records of the funding method; 10 CFR 40.61(d) and (e), which also define requirements for record keeping; 10 CFR 40.44, which describes requirements for amending the license; 10 CFR 40.60, which describes reporting requirements; 10 CFR 40.64(c), which describes reporting requirements for stolen or unlawful diversion of source material; 10 CFR 40.65, which defines requirements for effluent record keeping; and 10 CFR Part 40, Appendix A, Criteria 8 and 8A, which specify documentation requirements for airborne effluents and waste retention systems." As a concluding statement, state the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the management control program at the conventional uranium mill or heap leach facility in accordance with Section 4.2.3 of the standard review plan." Following this statement, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s) include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 4.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's management control program is acceptable and is in compliance with 10 CFR 20.1101, which defines radiation protection program requirements; 10 CFR 20.2002, which describes requirements of obtaining approval of proposed disposal procedures; 10 CFR 20.2007, which requires compliance with environmental and health protection regulations; 10 CFR 20.2103(b)(4), which describes record retention requirements; 10 CFR 20.2201, which defines requirements for record keeping; 10 CFR 20.2202, which defines requirements for reporting incidents; 10 CFR 40.36(f)(4), which describes requirements for records of the cost estimate performed for the decommissioning funding plan and records of the funding method; 10 CFR 40.61(d) and (e), which also define requirements for record keeping; 10 CFR 40.44, which describes requirements for amending the license; 10 CFR 40.60, which describes reporting requirements; 10 CFR 40.64(c), which describes reporting requirements for stolen or unlawful diversion of source material; 10 CFR 40.65, which defines requirements for effluent record keeping; and 10 CFR Part 40, Appendix A, Criteria 8 and 8A, which specify documentation requirements for airborne effluents and waste retention systems." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

4.2.5 References

NRC. Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities." Rev. 3. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2008.

———. Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2002.

OSHA. "Memorandum of Understanding Between the U.S. Nuclear Regulatory Commission and the Occupational Safety and Health Administration." 1988. <http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=MOU&p_id=233> (12 April 2011).

4.3 Management Audit and Inspection Program

4.3.1 Areas of Review

The staff should review the proposed management audit, inspection, and ALARA programs, including the frequencies, types, and scopes of reviews and inspections; action levels; corrective action measures; and 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 ALARA.

4.3.2 Review Procedure

Staff should verify that the proposed frequencies, types, and scopes of reviews and inspections; action levels; and corrective action measures of the management audit and inspection program are acceptable to implement the proposed controls and that management responsibilities for audit and inspection are adequately defined. This information should meet, in part, the requirements of 10 CFR 20.1701; 10 CFR 20.1702; 10 CFR 20.1101; 10 CFR 40.32(b), (c), and (d); and 10 CFR Part 40, Appendix A, Criteria 8 and 8A.

4.3.3 Acceptance Criterion

The management audit and inspection program, including the proposed frequencies, types, and scopes of reviews and inspections; action levels; and corrective action measures, is acceptable if:

(a) The management responsibilities for audit and inspection are adequately defined.

(b) The 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 10 CFR Part 40, Appendix A, Criterion 8A.

(c) The embankment systems inspection program is consistent with Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities," Revision 3 (NRC, 2008).

(d) The annual ALARA audit program is consistent with Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Revision 1, (NRC, 2002).

4.3.4 Evaluation Findings

If the staff determines that no license conditions are required for the management audit and inspection program because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the management audit and inspection program at the conventional uranium mill or heap leach facility in accordance with Section 4.3.3 of the standard review plan." Following this statement, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 4.3.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's management audit and inspection program is acceptable and is in compliance with 10 CFR 20.1101, which requires maintaining radiation exposure limits ALARA; 10 CFR 20.1701 and 10 CFR 20.1702, which require the use of process or other engineering measures to control the concentrations of radioactive material in the air; 10 CFR 40.32(b), (c), and (d), which require management audits to ensure protection of health and minimize danger to life and property; and 10 CFR Part 40, Appendix A, Criteria 8 and 8A, which require inspection of yellowcake drying and packaging operations and waste retention systems." As a concluding statement, state the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the management audit and inspection program at the conventional uranium mill or heap leach facility in accordance with Section 4.3.3 of the standard review plan." Following this statement, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 4.3.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's management audit and inspection program is acceptable and is in compliance with 10 CFR 20.1101, which requires maintaining radiation exposure limits ALARA; 10 CFR 20.1701 and 10 CFR 20.1702, which require the use of process or other engineering measures to control the concentrations of radioactive material in the air; 10 CFR 40.32(b), (c), and (d), which require management audits to ensure protection of health and minimize danger to life and property; and 10 CFR Part 40, Appendix A, Criteria 8 and 8A, which require inspection of yellowcake drying and packaging operations and waste retention systems." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

4.3.5 References

NRC. Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities." Rev. 3. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2008.

———. Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2002.

4.4 Qualifications for Personnel Conducting the Radiation Safety Program

4.4.1 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.

4.4.2 Review Procedure

When reviewing the qualifications for personnel conducting the radiation safety program, staff should ensure that the personnel meet minimum qualifications and experience for radiation safety staff that are consistent with Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Revision 1 (NRC, 2002, Section 2.4). This information should meet, in part, the requirements of 10 CFR 20.1101 and 10 CFR 40.32(b).

4.4.3 Acceptance Criterion

The qualifications of radiation safety personnel are acceptable if the personnel meet minimum qualifications and experience for radiation safety staff consistent with Regulatory Guide 8.31, Revision 1 (NRC, 2002, Section 2.4), and the qualifications of the people specifically proposed for these positions are consistent with the minimum qualifications and experience levels. If the licensee proposes to use a designee in the absence of the RSO who does not meet the education and experience of the RSO or health physics technician as recommended in Regulatory Guide 8.31, the minimum qualifications of the designee should be described in the license application.

4.4.4 Evaluation Findings

If the staff determines that no license conditions are required for the qualifications of the facility personnel conducting the radiation safety program because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the qualifications of facility personnel conducting the radiation safety program at the conventional uranium mill or heap leach facility in accordance with Section 4.4.3 of the standard review plan." Following this statement, state what information the applicant provided in the application. As discussed in the introduction

of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 4.4.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's qualifications of facility personnel conducting the radiation safety program is acceptable and is 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." As a concluding statement, state the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the qualifications of facility personnel conducting the radiation safety program at the conventional uranium mill or heap leach facility in accordance with Section 4.4.3 of the standard review plan." Following this statement, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 4.4.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's qualifications of facility personnel conducting the radiation safety program is acceptable and is 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." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

4.4.5 Reference

NRC. Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2002.

4.5 Radiation Safety Training

4.5.1 Areas of Review

The staff should review the proposed radiation safety training program, including the content of the initial training or indoctrination, testing, on-the-job training, and the extent and frequency of retraining. 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, housekeeping requirements, spill cleanup procedures, and emergency actions.

4.5.2 Review Procedure

When reviewing radiation safety training, staff should verify that the applicant presents the training program. Such presentation should discuss the personnel to be trained, classroom and on-the-job training, and personnel evaluations to determine proficiency. Staff should also review procedures to prevent erosion of the radiation safety program.

This information should meet, in part, the requirements of 10 CFR 20.1101 and 10 CFR 40.32(b).

4.5.3 Acceptance Criterion

The applicant's radiation safety training program is adequate and is acceptable to provide radiological safety instructions to the employees if the radiation safety training program is consistent with the following guidance documents:

(a) Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Revision 1 (NRC, 2002, Section 2.5). This guide recommends that before beginning their jobs, all new employees will be instructed, through an established course, in the inherent risks of exposure to radiation and the fundamentals of protection against exposure to uranium and its daughters.

(b) Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure," Revision 3 (NRC, 1999). This guide provides a basis for protection of the fetus.

(c) 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.

The applicant may propose alternative training guidelines provided that the applicant demonstrates that these alternative guidelines will not increase the risk of an accident or exposures to workers or members of the general public. If the licensee proposes to use a designee in the absence of the RSO who does not meet the education and experience of the RSO or health physics technician as recommended in Regulatory Guide 8.31, the minimum qualifications of the designee should be described in the license application.

4.5.4 Evaluation Findings

If the staff determines that no license conditions are required for the radiation safety training program because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the radiation safety training program at the conventional uranium mill or heap leach facility in accordance with Section 4.5.3 of the standard review plan." Following this statement, state what information the applicant provided in the application. As discussed in the introduction

of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 4.5.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's 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." As a concluding statement, state the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the radiation safety training program at the conventional uranium mill or heap leach facility in accordance with Section 4.5.3 of the standard review plan." Following this statement, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 4.5.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's 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." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

4.5.5 References

NRC. Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2002.

———. Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure." Rev. 3. Washington, DC: NRC, Office of Nuclear Regulatory Research. 1999.

———. Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 1996.

4.6 Security

4.6.1 Areas of Review

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

4.6.2 Review Procedure

When reviewing the applicant's security program, staff should verify that the security program has acceptable passive controls, such as fencing and warning signage, and active controls, such as daily inspections and locks for plant buildings. This information should meet, in part, the requirements of 10 CFR Part 20, Subparts H and J, 10 CFR 20.1801, and 10 CFR 20.1802.

4.6.3 Acceptance Criterion

The security program is acceptable if the applicant has acceptable passive controls, such as fencing and warning signage, and active controls, such as daily inspections and locks for plant buildings. The proposed security measures should be sufficient to prevent unauthorized entry into the controlled and restricted areas.

4.6.4 Evaluation Findings

If the staff determines that no license conditions are required for the security measures because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the security measures at the conventional uranium mill or heap leach facility in accordance with Section 4.6.3 of the standard review plan." Following this statement, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 4.6.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's security measures are acceptable and are in compliance with 10 CFR Part 20, Subpart H, which provides requirements for control of access to buildings containing airborne radioactive material; 10 CFR 20.1801, which provides requirements for the security of stored material, 10 CFR 20.1802, which provides requirements for the control of material not in storage; and 10 CFR Part 20, Subpart J, which provides requirements for posting warning signage for potential exposure to radiation." As a concluding statement, state the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the security measures at the conventional uranium mill or heap leach facility in accordance with Section 4.6.3 of the standard review plan." Following this statement, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the

applicable acceptance criteria of Section 4.6.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's security measures are acceptable and are in compliance with 10 CFR Part 20, Subpart H, which provides requirements for control of access to buildings containing airborne radioactive material; 10 CFR 20.1801, which provides requirements for the security of stored material, 10 CFR 20.1802, which provides requirements for the control of material not in storage; and 10 CFR Part 20, Subpart J, which provides requirements for posting warning signage for potential exposure to radiation." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

4.6.5 References

None.

4.7 Quality Assurance

4.7.1 Areas of Review

The staff should review the quality assurance programs proposed for all radiological, nonradiological, and effluent monitoring programs. Nonradiological quality assurance programs should be consistent with guidance in U.S. Environmental Protection Agency (EPA) QA/R–5 (2001).

4.7.2 Review Procedures

Staff should use the following procedures when reviewing quality assurance:

(1) Ensure that the radiological and nonradiological quality assurance program has been established and applied to all radiological, nonradiological, and effluent monitoring programs.

(2) Verify that all reporting and record keeping will be done in conformance with the criteria presented in Section 4.2.2 of this SRP.

(3) For license renewal applications, ensure that historical quality assurance program results are included through the most recent reporting period preceding application submittal.

This information should meet, in part, the requirements of 10 CFR 20.1101.

4.7.3 Acceptance Criteria

The quality assurance program is acceptable if it meets the following criteria:

(1) The radiological quality assurance program has been established and applied to all radiological and effluent monitoring programs during the preoperational, operational, and decommissioning periods. The proposed radiological quality assurance plan is consistent with guidance provided in Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills," Revision 1 (NRC, 1980, Sections 3 and 6) and Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs

(Inception Through Normal Operations to License Termination)—Effluent Streams and the Environment," Revision 2 (NRC, 2007). The proposed radiological quality assurance program is sufficient to limit radiation exposures and radioactive releases to ALARA and is in conformance with regulatory requirements identified in 10 CFR Part 20.

The quality assurance program contains or encompasses the following elements:

(a) Formal delineation of organizational structure, management responsibilities, and the organizational relationship between these individuals and the person who has ultimate authority for the quality assurance program as discussed in Section 4.1 of this SRP.

(b) Both review and approval of written procedures and radiological data and reports.

(c) A description of the minimum qualifications and training programs for individuals performing radiological monitoring and those individuals in the quality assurance program.

(d) Written procedures for quality assurance activities, including activities involving sample analysis, calibration of instrumentation, calculation techniques, data evaluation, and data reporting.

(e) Quality control in the laboratory, including procedures covering statistical data evaluation, instrument calibration, duplicate sample programs, and spike sample programs. Outside laboratory quality assurance/quality control programs are included.

(f) Provisions for periodic management audits to verify that the quality assurance program is effectively implemented to verify compliance with applicable rules, regulations, and license requirements and to protect employees by maintaining effluent releases and exposures ALARA.

(2) All reporting and record keeping will be done in conformance with the criteria presented in Section 4.2.2 of this SRP. Furthermore, the applicant will maintain records used to demonstrate compliance and evaluate dose, intake, and releases until NRC terminates the license as required by 10 CFR Part 20. The radiological quality assurance programs proposed for all radiological, effluent, and environmental (including groundwater) monitoring are in accordance with Regulatory Guide 4.14, Revision 1 (NRC, 1980) and Regulatory Guide 4.15, Revision 2 (NRC, 2007).

(3) For license renewal applications, the historical radiological 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 adequately discussed with regard to all applicable 10 CFR Part 20 regulatory requirements. Long-term trends are discussed, any short-term deviations from the long-term trends are appropriately explained, and mitigation measures are described.

4.7.4 Evaluation Findings

If the staff determines that no license conditions are required for the quality assurance program because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the quality assurance program at the conventional uranium mill or heap leach facility in accordance with Section 4.7.3 of the standard review plan." Following this statement, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 4.7.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's quality assurance program is acceptable and is in compliance with 10 CFR 20.1101, which provides requirements for radiation protection programs." As a concluding statement, state the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the quality assurance program at the conventional uranium mill or heap leach facility in accordance with Section 4.7.3 of the standard review plan." Following this statement, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 4.7.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's quality assurance program is acceptable and is in compliance with 10 CFR 20.1101, which provides requirements for radiation protection programs." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

4.7.5 References

EPA. "EPA Requirements for Quality Assurance Project Plans." EPA QA/R–5. Washington, DC: EPA, Office of Environmental Information. 2001.

NRC. Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Inception Through Normal Operations to License Termination)—Effluent Streams and the Environment." Rev. 2. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2007.

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

5.0 OPERATIONAL ENVIRONMENTAL MONITORING

This section provides guidance for reviewing the operational environmental monitoring program for the proposed or existing site. Operational environmental monitoring addresses monitoring of effluents that leave the protected area and, as such, are no longer under the control of the operator. In plant occupational monitoring, which is monitoring in the protected area for the purposes of determining occupational exposure, is discussed in Section 6 of this standard review plan (SRP). Preoperational environmental monitoring, which is monitoring prior to operations, is discussed in Section 2 of this SRP.

5.1 Operational Environmental Monitoring—Surface Water

5.1.1 Areas of Review

This section provides staff review guidance on surface water monitoring during the operational phase of conventional uranium mill or heap leach facilities. Preoperational monitoring is conducted as part of site characterization, and staff review procedures and acceptance criteria are given in Section 2.8 of this SRP. The applicant's surface water operational monitoring program should allow timely detection of contaminant runoff into surface waters. The staff should review the technical bases and procedures of the applicant's surface water operational monitoring program and the sampling locations and frequencies. For all of the aspects of surface water monitoring program that involve analysis of water samples, procedures for sample collection, sample preservation, and analysis should be reviewed.

5.1.2 Review Procedures

The staff should use the following procedures when reviewing the operational surface water monitoring program:

(1) Review the surface water monitoring program and determine if the applicant identified the proper sampling locations, sampling frequency, and types of analysis consistent with Regulatory Guide 4.14 (NRC, 1980, Table 2). This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

(2) Ensure the license application includes a detailed discussion on procedures for monitoring surface water quality during operations. This information should meet, in part, the requirements of 10 CFR 40.31(h); 10 CFR 40.32(c); 10 CFR 40.32(d); 10 CFR 40.41(c); and 10 CFR Part 40, Appendix A, Criterion 7.

5.1.3 Acceptance Criteria

The surface water operational monitoring program is acceptable if it meets the following criteria:

(1) If a conventional uranium mill or heap leach facility is located adjacent to surface water bodies, the applicant establishes a surface water monitoring program, consistent with Regulatory Guide 4.14 (NRC, 1980), that will effectively detect releases of contaminants from disposal areas, including surface impoundments, into surface water bodies crossing the side boundary and nearby offsite surface waters, including running or standing ephemeral and perennial surface waters. Alternatively, the applicant adequately demonstrates that the risk of contamination from conventional uranium mill

or heap leach activities is negligible or that potential releases will be within limits set by the Clean Water Act (33 U.S.C. 1251 et seq.) and 10 CFR Part 20, Appendix B, effluent limits. Surface water bodies that occur within, upstream, and downstream of the facility boundary will be sampled during milling or leaching operations.

(2) The surface water sampling locations (e.g., soil samples from bottom sediments and floodplains, water samples near the edge (or shore) and midpoint of flowing waters, and at multiple depths in stagnant water bodies), sampling duration and frequencies (e.g., monthly routine sampling as well as increased sampling frequencies in case of seepage from disposal areas to nearby surface water bodies), a list of sampling radiological and nonradiological constituents, and reporting procedures are described in detail consistent with Regulatory Guide 4.14 (NRC, 1980). The application includes a sampling schedule and a map (or maps) showing preoperational monitoring, standby monitoring (if the facility is on standby, but the applicant continues the monitoring program), and operational monitoring locations in reference to disposal areas, natural surface water bodies within and in the vicinity of the facility boundary, and within 100-year flood zone boundaries. Maps are clearly labeled and designate scale, orientation, and geographic coordinates. In addition to maps, the applicant provides tabular summaries of sampling locations. The sampling locations are arranged so that major upstream and downstream locations of the conventional uranium mill or heap leach facility are properly monitored. If streams are ephemeral, the applicant proposes appropriate deviations from the regular sampling program.

5.1.4 Evaluation Findings

If the staff determines that no license conditions are required for the surface water monitoring program because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the surface water monitoring program at the conventional uranium milling or heap leach facility in accordance with Section 5.1.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 5.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's operational surface water monitoring program is acceptable and is in compliance with 10 CFR 40.31(h), which defines requirements for applications for specific licenses; 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 locations and purposes authorized in the license; and 10 CFR Part 40, Appendix A, Criterion 7, which requires preoperational and operational monitoring and detection programs." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the surface water monitoring program at the conventional uranium milling or heap leach facility in accordance with Section 5.1.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 5.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's operational surface water monitoring program is acceptable and is in compliance with 10 CFR 40.31(h), which defines requirements for applications for specific licenses, 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 locations and purposes authorized in the license; and 10 CFR Part 40, Appendix A, Criterion 7, which requires preoperational and operational monitoring and detection programs." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

5.1.5 References

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

5.2 Operational Environmental Monitoring—Groundwater

5.2.1 Areas of Review

This section discusses monitoring groundwater quality in the uppermost aquifer[1] during the operational phase of conventional uranium mill or heap leach activities. The groundwater operational monitoring program should ensure that leakage of hazardous contaminants from disposal areas, including surface impoundments, is detected long before process effluents and hazardous contaminants could degrade the quality of groundwater beyond the regulatory point of compliance or downstream of the facility boundary.

The regulatory point of compliance is the location at which the groundwater is monitored to determine the compliance with the groundwater protection standards. The operational groundwater monitoring program should also allow timely implementation of corrective actions against these hazardous constituents. The point of compliance is to provide the earliest practicable warning for groundwater contamination on the hydraulically downgradient edge of the disposal area, if hazardous constituents leak from disposal areas into the groundwater. The point of compliance is a site-specific location in the uppermost aquifer and defined as the intersection of a vertical plane with the uppermost aquifer at the hydraulically downgradient limit

[1]The definition of the uppermost aquifer is provided in Section 2.2.3 of this SRP.

of the disposal area, where the groundwater protection standard must be met (10 CFR Part 40, Appendix A; NUREG–1620, NRC, 2003).

Early detection of leakage of hazardous contaminants by monitoring wells is influenced by:

- The thickness of the uppermost aquifer, local- and regional-scale groundwater flow and local-scale milling-induced disturbances (e.g., groundwater pumpage from the uppermost aquifer to meet consumptive water uses during construction and operation);
- Development of short- or long-term groundwater mounds due to leaks or accidental spills from operation sites, surface impoundments on the groundwater flow in the uppermost aquifer;
- The distance that monitoring wells are placed from disposal areas;
- The boundaries of the proposed facility;
- The well spacing;
- The frequency with which the monitoring wells are sampled; and
- The water quality parameters and chemical constituents that are sampled.

The staff should review the technical bases and procedures for the following components of the applicant's groundwater operational monitoring program:

- Selection of hazardous contaminants and their respective background levels, consistent with Regulatory Guide 4.14 (NRC, 1980).
- A description and technical basis for determining location of the regulatory point of compliance.
- The placement of detection monitoring wells upgradient and downgradient of disposal areas, and downgradient of the facility boundary.
- If the unsaturated zone hydrology has complex infiltration patterns, applicant-proposed field tests (subject to NRC approval) to verify horizontal continuity between the upgradient (baseline) and downgradient wells with respect to disposal areas, and monitoring wells at or downstream of the facility boundary, and vertical isolation between the uppermost aquifer and vertical leakage monitoring wells below the uppermost aquifer.
- The leakage monitoring program, including well sampling schedules, criteria for placing wells on detection status, and corrective actions to be taken in the event of detection (leakage detection system in liners underlying surface impoundments are discussed in Section 3 of this SRP).

For all of the preceding aspects of the groundwater monitoring program that involve analysis of water samples, procedures for sample collection and analysis should be reviewed.

5.2.2 Review Procedures

Hydrogeologic and groundwater chemistry data are collected before conventional uranium mill or heap leach operations commence to establish a basis for comparing with operational monitoring data. Hydrogeologic data are used to evaluate whether disposal areas, including surface impoundments, are confined and operated safely, and to confirm that monitoring wells have been located correctly. Water chemistry data are used to establish a set of water quality standards for detection monitoring and corrective action programs. The staff should determine whether these objectives of the operational monitoring program have been met. To this end, the staff should perform the following activities:

(1) Review the applicant's proposed (or procedure for proposing) preoperational (baseline) groundwater quality parameters (in conjunction with Section 2.8.2.3, Acceptance Criterion 2 of this SRP), chemical and radioactive constituents, and the respective specified background limits for a groundwater protection standard, which will be used as indicators to enable timely detection and reporting of leakage of hazardous constituents [as described in Regulatory Guide 4.14 (NRC, 1980)] from disposal areas. Staff may refer to the procedures given in Section 2 of this SRP for establishing baseline parameters. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 5B(1), 5B(2), 5B(5), 5C, and 7.

(2) Verify that a point of compliance is established and properly delineated. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 5B(1).

(3) Review the applicant's water sampling procedure at operational monitoring wells and the method for excluding outliers in the samples. This information should meet, in part, the requirements of 10 CFR 40.32(c).

(4) Review the applicant's technical basis or procedures for establishing the appropriate monitoring well spacing for vertical and horizontal leakage monitoring. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

(5) If uncertainties and complexities exist in the hydrogeology beneath the proposed conventional uranium mill or heap leach facility, evaluate the applicant's aquifer test procedures for groundwater monitoring in the uppermost aquifer within and downstream of the point of compliance. If the hydrogeology beneath the propose site is uniform and well-described in previous studies and publically-available reports, aquifer testing may not be necessary. Determine whether aquifer testing for groundwater monitoring is sufficient to show (i) a horizontal hydraulic connection between the uppermost aquifer beneath the site and the monitoring well network completed in the same aquifer at the downstream point of compliance and, if it exists, beyond the facility boundary, and (ii) a vertical hydraulic separation between the uppermost aquifer and underlying major aquifers, if it exists, within the facility boundary. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

(6) Evaluate whether procedures describing the operational leakage monitoring program include sampling schedules, sampling and analytical procedures, criteria for placing the disposal areas on leakage status, and corrective action and notification procedures to be followed if leakage from the disposal areas is detected. This information should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criteria 5B(2), 5D, 5F, 7, and 13.

5.2.3 Acceptance Criteria

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

(1) As discussed in Section 2.8.2.3 of this SRP, a preoperational monitoring program has been in place for 1 year and samples were taken at least monthly. However, if mills were in existence prior to groundwater compliance provisions of 10 CFR Part 40, Appendix A, background water quality may already be defined by a license condition. In either case, in accordance with developed data on the groundwater flow, potential contaminants, and site information, a license condition identifies hazardous constituents and establishes the site-specific point of compliance for the licensing period.

Hazardous constituents that may leak from disposal areas will not exceed the NRC-approved groundwater protection standards in the uppermost aquifer beyond the point of compliance during the licensing period. The same groundwater protection standards are assigned to monitoring wells within the uppermost aquifer if baseline data indicate insignificant chemical heterogeneity. Alternatively, if individual monitoring wells in the uppermost aquifer exhibit unique baseline water quality, the groundwater protection standards are assigned on a well-by-well basis. If the groundwater protection standards vary at monitoring wells, a table is included listing monitoring wells and their respective standards.

The applicant commits to establishing limits for hazardous constituents at the point of compliance, such that the concentration of a hazardous constituent will not exceed either:

(a) The NRC-approved background concentration of that constituent in groundwater.

(b) The respective maximum contaminant level contained in 10 CFR Part 40, Appendix A, Criterion 5C.

(c) An NRC-approved alternative concentration limit (ACL). The Commission may establish a site-specific ACL for a hazardous constituent as provided in 10 CFR Part 40, Appendix A, Criterion 5B(5) if it finds that the proposed limit is as low as is reasonably achievable (ALARA), after considering practicable corrective actions, and that the constituent will not pose a substantial present or potential hazard to human health or the environment as long as the ACL is not exceeded. See 10 CFR Part 40, Appendix A, Criterion 5B(6). ACLs are to be requested as part of a license amendment application.

(2) A site-specific point of compliance is established to provide the earliest practicable warning for groundwater contamination on the hydraulically downgradient edge of the disposal area, if hazardous constituents leak from disposal areas into the groundwater. The established point of compliance is consistent with the definition in 10 CFR Part 40, Appendix A.

(3) The applicant uses an appropriate water sampling procedure and method for excluding outliers in the samples. The applicant provides a reference for outlier elimination. Outliers are not eliminated if the applicant demonstrates that the concentration is in natural variation.

(4) The applicant establishes criteria for determining monitoring well locations and spacing.

(a) Horizontal Monitoring Well Spacing. Monitoring wells between the point of compliance and the downgradient facility boundary are used to detect horizontal migration of hazardous constituents beyond the point of compliance. These monitoring wells generally surround the entire disposal area and are screened through the entire saturated thickness of the uppermost aquifer to maximize the likelihood of leakage detection. The applicant has some discretion in determining the appropriate distance of horizontal monitoring wells from disposal areas, but provides justification for well spacing in the application. For example, the applicant can use rigorous geochemical, flow, and contaminant transport models to demonstrate that theoretical leakage can be detected and controlled at the monitoring well locations within 60 days of leakage. In determining the appropriate spacing between perimeter monitoring wells, the applicant considers such factors as the distance of the monitoring wells from the edge of disposal areas; the size of disposal areas; groundwater flow directions and velocities beneath the facility; and the potential for mixing, dispersion, sorption, and chemical reactions.

(b) Vertical Monitoring Well Spacing. Vertical monitoring wells at the point of compliance are used to detect vertical leakage from the uppermost aquifer into the underlying major aquifers (used as drinking, livestock, or agricultural supplies by local people within and nearby the facility boundary), if they exist. The applicant considers the thickness, continuity, and vertical conductivity of the confining layer below the uppermost aquifer, the vertical hydraulic gradient across the confining layer, and hydraulic properties of the underlying major aquifers in determining the number, location, depth, and spacing of vertical monitoring wells. Well spacing and placement for vertical leakage monitoring wells should be supported by technical analyses, such as calculations and modeling. Monitoring well placement should also account for geologic (e.g., fractures, joints, faults) or artificial features (e.g., exploratory holes, improperly abandoned water or oil wells, abandoned open pits) that could affect groundwater flow in the uppermost aquifer and underlying major aquifers. The appropriate number of these monitoring wells varies from site to site. It might 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 (i.e., not suitable for any consumption or irrigation), or (iii) there is a large and effective confining layer (aquitard) between the uppermost aquifer and the underlying major aquifer.

(5) The applicant establishes aquifer test procedures for groundwater monitoring. However, if the hydrogeology beneath the proposed site is uniform and well-described in previous studies and publically-available reports, aquifer testing may not be necessary. Monitoring wells will be tested to establish (i) the hydraulic connection between the uppermost aquifer beneath the facility and monitoring wells placed in the same aquifer within and beyond the facility boundary and (ii) vertical hydraulic separation between the uppermost aquifer and the vertical leakage monitoring wells placed below the uppermost aquifer. Once a monitoring well is installed, it should be tested for hydraulic connection between the uppermost aquifer beneath the disposal areas and horizontal monitoring wells within and beyond the facility boundary. Moreover, there should be vertical isolation between the uppermost aquifer and vertical leakage monitoring wells, if

required, below the uppermost aquifer. Such testing will confirm monitoring system performance and will verify the validity of the site conceptual model reviewed in Section 2 of this SRP. The field test approaches (e.g., aquifer pumping tests, slug tests) the applicant proposed should have sound technical bases. For example, if aquifer pump testing is chosen, the test approaches typically consist of a pumping test that subjects the pumping well to a sustained maximum withdrawal rate while monitoring the horizontal and vertical leakage monitoring wells for drawdown. The test should continue until the effects of pumping can be clearly seen via drawdown at the monitoring wells. To investigate vertical confinement or hydraulic isolation between the uppermost aquifer and underlying major aquifers, if they exist, water levels in the uppermost and underlying aquifers may also be monitored during the pumping tests.

(6) The applicant defines operational approaches for the monitoring program.

(a) The monitoring program indicates those wells that will be monitored for hazardous constituent concentration levels included in the NRC-approved groundwater protection standards (as specified by 10 CFR Part 40, Appendix A, Criteria 5D and 13), the monitoring frequency, and the criteria for determining when leakage has occurred. 10 CFR Part 40, Appendix A, Criterion 13 includes a list of hazardous constituents for which standards must be set and complied with, if the specific constituents are reasonably expected to be in or derived from the byproduct material and have been detected in groundwater in the uppermost aquifer. As discussed in Section 2.8.2.3 of this SRP, if a new constituent is detected during operational monitoring and is excluded from the set of baseline constituents, the applicant commits to providing the technical justification for its exclusion. NRC has flexibility to add other constituents not identified in Criterion 13 on a case-by-case basis, but such additions must be based on a sound technical and regulatory basis. If necessary, new constituents will be added in a timely manner if a corrective action plan is required following detection of a leak, either when the corrective action plan is accepted for review or at some time during the lifetime of the corrective action program (NUREG–1620, NRC, 2003).

An acceptable leakage monitoring program indicates that monitoring wells will be sampled for hazardous constituent concentrations at least every 2 weeks during conventional uranium mill or heap leach operations. Criteria for determining leakage are discussed in Acceptance Criterion 1 of this section. The applicant commits to obtaining a verification sample within 48 hours after results of the first analyses are received. If the second sample does not indicate that NRC-approved groundwater protection standards were exceeded, then a third sample will be taken within 48 hours after the second set of sampling data was acquired. If neither the second nor the third sample indicates that groundwater protection standards are exceeded, then the first sample is considered in error and the well is removed from leakage status. If either the second or third sample contains hazardous constituents exceeding groundwater protection standards, then leakage is confirmed, the monitoring well is placed in leakage status, and corrective action is initiated.

(b) The leakage monitoring operational procedures also include corrective action and notification plans in the event of leakage. As recommended, NRC will be notified within 24 hours by telephone or e-mail and within 7 days in writing from

the time leakage is verified. A written report describing the leakage event, proposed corrective action program, and supporting rationale for NRC approval prior to putting the program into operation unless otherwise directed by NRC must be submitted to NRC within 60 days of the detection confirmation.

In the event of leakage, the corrective action program will be implemented to alleviate conditions that lead to excessive seepage impacts and restore groundwater quality as soon as possible and, in no event, later than 18 months after NRC has been notified that the groundwater protection standards have been exceeded. The corrective action program will address removing or treating-in-place hazardous constituents between the point of compliance and the downgradient facility boundary and return the hazardous concentration levels to the concentration limits set as groundwater protection standards. The corrective action plan should consider whether the ALARA analysis and target concentration levels may be reasonably attained by practicable corrective actions (NRC, 2003). NRC will determine when the licensee may terminate the corrective action operations based on field data from the monitoring program and other information that provides reasonable assurance that NRC-approved site-specific groundwater protection standards are met.

5.2.4 Evaluation Findings

If the staff determines that no license conditions are required for the groundwater monitoring program because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the groundwater monitoring program at the conventional uranium milling or heap leach facility in accordance with Section 5.2.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 5.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's operational groundwater monitoring program is acceptable and is in compliance with 10 CFR 40.32(c), which requires that proposed equipment, facilities and procedures be adequate to protect health and minimize danger to life or property; 10 CFR Part 40, Appendix A, Criterion 5B(1), which requires applicants to prevent hazardous constituents from exceeding concentration limits in the uppermost aquifer beyond the point of compliance; 10 CFR Part 40, Appendix A, Criterion 5B(2), which provides criteria for chemical constituents to be considered as a hazardous constituent subject to 5B(5); 10 CFR Part 40, Appendix A, Criterion 5B(5), which requires applicants to ensure that hazardous constituents at the point of compliance do not exceed the background concentration; and 10 CFR Part 40, Appendix A, Criterion 5C, which provide concentration limits for contaminants; 10 CFR Part 40, Appendix A, Criterion 5D, which requires a groundwater corrective action program; 10 CFR Part 40, Appendix A, Criterion 5F, which requires action to be taken to alleviate seepage impacts where they are occurring and restore groundwater quality; 10 CFR Part 40, Appendix A, Criterion 7, which requires groundwater compliance monitoring programs; and 10 CFR Part 40, Appendix A, Criterion 13, which requires that groundwater protection standards need to be established for constituents

reasonably expected to be in or derived from byproduct materials and detected in groundwater in the uppermost aquifer." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the groundwater monitoring program at the conventional uranium mill or heap leach facility in accordance with Section 5.2.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 5.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's operational groundwater monitoring program is acceptable and is in compliance with 10 CFR 40.32(c), which requires that proposed equipment, facilities and procedures be adequate to protect health and minimize danger to life or property; 10 CFR Part 40, Appendix A, Criterion 5B(1), which requires applicants to prevent hazardous constituents from exceeding concentration limits in the uppermost aquifer beyond the point of compliance; 10 CFR Part 40, Appendix A, Criterion 5B(2), which provides criteria for chemical constituents to be considered as a hazardous constituent subject to 5B(5); 10 CFR Part 40, Appendix A, Criterion 5B(5), which requires applicants to ensure that hazardous constituents at the point of compliance do not exceed the background concentration; and 10 CFR Part 40, Appendix A, Criterion 5C, which provide concentration limits for contaminants; 10 CFR Part 40, Appendix A, Criterion 5D, which requires a groundwater corrective action program; 10 CFR Part 40, Appendix A, Criterion 5F, which requires action to be taken to alleviate seepage impacts where they are occurring and restore groundwater quality; 10 CFR Part 40, Appendix A, Criterion 7, which requires groundwater compliance monitoring programs; and 10 CFR Part 40, Appendix A, Criterion 13, which requires that groundwater protection standards need to be established for constituents reasonably expected to be in or derived from byproduct materials and detected in groundwater in the uppermost aquifer." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

5.2.5 References

NRC. NUREG–1620, "Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978." Rev. 1. Washington, DC: NRC. June 2003.

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

5.3 Operational Airborne Monitoring

Operational airborne monitoring pertains to monitoring of airborne effluents that leave the protected area and, as such, are no longer under the control of the operator. The purpose of operational air monitoring is to verify compliance with public dose limits. Procedures for review of workplace air monitoring, which is air monitoring in the protected area to verify compliance with occupational dose limits, are provided in Section 6 of this SRP. Procedures for review of preoperational air monitoring, which is monitoring of air prior to operations, are provided in Section 2 of this SRP.

5.3.1 Areas of Review

The staff should review the effluent verification program proposed for assessing concentrations and quantities of radioactive materials released to the unrestricted area surrounding the facility. The staff should review the following areas:

- Technical bases proposed for determining radionuclide concentrations for demonstrating compliance with standards;
- Frequency of sampling and analysis;
- The types and sensitivity of analysis;
- Action levels and corrective action requirements;
- Minimum number and criteria for locating monitoring stations; and
- Commitments for semiannual effluent and environmental monitoring reporting.

5.3.2 Review Procedures

Staff should use the following procedures when reviewing the airborne radiation monitoring program:

(1) Verify that the applicant provided sufficient information regarding estimated public doses and that those doses are consistent with the ALARA requirements described in Regulatory Guide 8.37, “ALARA Levels for Effluents from Materials Facilities” (NRC, 1993). Furthermore, review the type of verification program the applicant proposes. If calculations are proposed to demonstrate compliance, ensure that the applicant agrees to perform effluent monitoring to confirm the licensing basis and the validity of calculations used for estimating effluent concentrations and calculating dose. This information should meet, in part, the requirements of 10 CFR 20.1101; 10 CFR 20.1301; 10 CFR 20.1302; 10 CFR 20.1501; and 10 CFR Part 40, Appendix A, Criterion 8.

(2) Determine whether the proposed locations of the airborne effluent monitoring stations are consistent with guidance in Regulatory Guide 4.14, “Radiological Effluent and Environmental Monitoring at Uranium Mills,” Revision 1 (NRC, 1980) if an effluent monitoring program is proposed. This information should meet, in part, the requirements of 10 CFR 20.1501.

(3) Verify that the applicant commits to, at a minimum, semiannual airborne effluent reporting. This information should meet, in part, the requirements of 10 CFR 40.65.

(4) Confirm that the applicant provides a drawing that depicts the location of environmental air samplers and provides a basis for the location of the samplers. This information should meet, in part, the requirements of 10 CFR 20.1501 and 10 CFR Part 40, Appendix A, Criterion 8.

(5) Verify that monitoring equipment is identified by type, sensitivity, calibration methods and frequency, availability, range of sensitivity, and planned use to accurately measure concentrations of airborne radioactive species. This information should meet, in part, the requirements of 10 CFR 20.1501.

(6) Verify that the applicant uses appropriate techniques to measure airborne uranium, Ra-226, and Th-230. This information should meet, in part, the requirements of 10 CFR 20.1101 and 10 CFR 20.1701.

(7) Verify that the historical airborne effluent monitoring program and the airborne radiation monitoring program results are included through the most recent reporting period preceding application submittal for license renewal applications. This information should meet, in part, the requirements of 10 CFR 20.1101.

5.3.3 Acceptance Criteria

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

(1) The program:

- Provides data to analyze maximum public exposure in accordance with 10 CFR 20.1301 and 10 CFR 20.1302;
- Provides data to report airborne effluents in accordance with 10 CFR 40.65 (i.e., at the boundary of unrestricted areas);
- Uses airborne effluent monitoring programs to evaluate both point (e.g., a defined stack or pipe) and diffuse (e.g., loose surface contamination escaping the uranium recovery facility) sources; and
- Performs airborne effluent monitoring consistent with guidance so that the applicant can confirm the licensing basis and the validity of calculations used for estimating effluent concentrations and calculating dose, if the applicant proposes calculations to demonstrate compliance with 10 CFR 20.1101, 10 CFR 20.1301, 10 CFR 20.1302, and 10 CFR 20.1501.

(2) If the applicant proposes airborne monitoring, the proposed locations of the monitoring stations are presented and are consistent with guidance in Regulatory Guide 4.14, Revision 1 (NRC, 1980). The proposed airborne monitoring program samples radon and air particulates in accordance with Regulatory Guide 4.14, Revision 1 (NRC, 1980), and air samples to be analyzed for Rn-222 will not be composited and will be analyzed

quickly enough to minimize decay losses. The criteria used in selecting sampling locations are provided.

(3) The applicant commits to, at a minimum, semiannual airborne monitoring reporting. These reports will be submitted to the appropriate NRC Regional Office with copies to the chief, Uranium Recovery Licensing Branch, and the project manager. 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. The process rate and pressure data are to be reported as monthly averages. A license condition will be imposed to specify these reporting requirements.

(4) The applicant provides a drawing that depicts the location of environmental air samplers. Locations are based, in part, on a determination of general environmental airflow patterns and are consistent with Regulatory Guide 4.14, Revision 1 (NRC, 1980).

(5) Monitoring equipment is identified by type, sensitivity, calibration methods and frequency, availability, and planned use to accurately measure concentrations of airborne radioactive species. The application also demonstrates that the ranges of sensitivity are appropriate for the facility operation.

(6) The applicant uses appropriate techniques to measure uranium in air. If Ra-226 and Th-230 may also be present in the air, additional characterization of the radionuclides in the sample is provided because gross alpha counting alone will not be able to differentiate specific radionuclides.

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

5.3.4 Evaluation Findings

If the staff determines that no license conditions are required for the airborne radiation monitoring program because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: “NRC staff has completed its review of the airborne radiation monitoring program at the conventional uranium mill or heap leach facility in accordance with Section 5.2.3 of the standard review plan.” Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: “Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 5.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant’s airborne radiation monitoring program is acceptable and is in compliance with 10 CFR 20.1101, which defines the radiation protection program and ALARA requirements; 10 CFR 20.1301, which provides dose limits to members of the public; 10 CFR 20.1302, which requires monitoring to ensure compliance with dose limits to members of the public; 10 CFR 20.1501, which requires surveys

and monitoring; 10 CFR 20.1701, which requires use of process or engineering controls; 10 CFR 40.65, which requires reports of effluent monitoring; and 10 CFR Part 40, Appendix A, Criterion 8, which provides requirements for control of airborne effluents." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the airborne radiation monitoring program at the conventional uranium mill or heap leach facility in accordance with Section 5.2.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 5.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's airborne radiation monitoring program is acceptable and is in compliance with 10 CFR 20.1101, which defines the radiation protection program and ALARA requirements; 10 CFR 20.1301, which provides dose limits to members of the public; 10 CFR 20.1302, which requires monitoring to ensure compliance with dose limits to members of the public; 10 CFR 20.1501, which requires surveys and monitoring; 10 CFR 20.1701, which requires use of process or engineering controls; 10 CFR 40.65, which requires reports of effluent monitoring; and 10 CFR Part 40, Appendix A, Criterion 8, which provides requirements for control of airborne effluents." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

5.3.5 References

NRC. Regulatory Guide 8.37, "ALARA Levels for Effluents from Materials Facilities." Washington, DC: NRC, Office of Nuclear Regulatory Research. 1993.

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

5.4 Other Operational Monitoring

5.4.1 Areas of Review

An acceptable operational monitoring program exclusive of water and air sampling includes: (i) sampling of animals, vegetation, and fish; (ii) soil and sediment sampling; (iii) direct radiation measurements; and in some instances; and (iv) radon flux. The staff should review plans for performing sampling of animals, crops, vegetation, fish, soils, and sediments that could exhibit elevated levels of radioactivity from exposure to radioactive effluents during operation and the procedures proposed for collecting the samples. The staff should review plans for performing direct radiation measurements. Staff should also review preoperational sampling data and

procedures to determine whether plans for operational sampling are consistent with preoperational sampling and procedures.

The staff should examine site-specific preoperational radiological data provided in the application including the results of measurements of radioactive materials occurring in important animals, crops, vegetation, fish, soils, and sediment that could be affected by the proposed operations. The staff should examine the design of the operational monitoring program, including which radionuclides are analyzed, sampling locations, sample type, sampling frequency, location and density of monitoring stations, and the detection limits for consistency with preoperational sampling.

The operational monitoring program should be consistent with the recommendations in Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills," Revision 1 (NRC, 1980) unless a justification for another sampling approach is provided. The schedule for obtaining some samples should account for seasonal availability and access to a particular area. Vegetation, food, and fish samples should be collected where a significant pathway to humans is identified in individual licensing cases.

5.4.2 Review Procedures

The staff should review the operational monitoring program, including sampling frequency, sampling methods, and sampling location and density, and exclusive of water and air sampling, in accordance with the operational monitoring guidance provided in Regulatory Guide 4.14 (NRC, 1980, Section 1.2). The staff should also confirm that air monitoring stations are located in a manner consistent with the principal wind directions reviewed in Section 2.3 of this SRP. The information reviewed in this procedure should meet, in part, the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

The staff should examine data from the operational monitoring program, paying particular attention to the design of the monitoring program, the radionuclides monitored, and the detection limits reported for each radionuclide in each sample medium. The staff should compare and contrast the operational monitoring program as implemented against the guidance provided in Regulatory Guide 4.14 (NRC, 1980).

5.4.3 Acceptance Criteria

The operational monitoring program exclusive of water and air sampling, including sampling frequency, sampling methods, and sampling location and density is acceptable if it is established in accordance with operational monitoring guidance provided in Regulatory Guide 4.14 (NRC, 1980, Section 2.1), which describes the following types of samples that should be obtained:

(a) Animals, crops, vegetation, and fish;

(b) Soil;

(c) Sediment; and

(d) Direct radiation measurements.

Descriptions of the various types of sampling are as follows.

Animals, Crops, Vegetation, and Fish Sampling. Where a significant pathway to humans is identified in individual licensing cases, animals, vegetation, crops, and fish (edible portion) samples are collected. Crops and forage vegetation are sampled at least three times during the grazing season in grazing areas in three different sectors having the highest predicted airborne radionuclide concentration due to conventional uranium mill or heap leach operations. At least three samples are collected at the time of harvest or slaughter or removal of animals from grazing for each type of crop (including vegetable gardens) or livestock raised within 3 km [1.9 mi] of the conventional uranium mill or heap leach site. Fish samples are collected semiannually from bodies of water that may be subject to seepage or surface drainage from potentially contaminated areas. Animal, crop, vegetation, and fish samples are analyzed for Ra-226 and Pb-210.

Soil Sampling. Surface soil samples are collected annually using a consistent technique at each of the locations chosen for air particulate samples. Soil samples are analyzed for natural uranium, Ra-226, and Pb-210. Section 2.8.1.3 of this SRP provides additional details on appropriate soil sampling techniques.

Sediment Sampling. Sediment samples are collected annually from surface-water locations. Sediment samples are analyzed for natural uranium, Th-230, Ra-226, and Pb-210. Section 2.8.1.3 of this SRP provides additional details on appropriate sediment sampling techniques.

Direct Radiation Measurements. Gamma exposure rates (direct radiation measurements) are measured quarterly at the sites chosen for air particulate samples. Gamma exposure rate measurements are made with passive integrating devices (such as thermoluminescence or optically stimulated luminescence dosimeters), pressurized ionization chambers, or properly calibrated portable survey instruments. Direct radiation measurements using instruments are only made in dry weather and not during periods following rainfall or when the soil is abnormally wet. Alternative direct radiation measurements are justified. Section 2.8.1.3 of this SRP provides additional details on appropriate direct radiation measurement techniques.

5.4.4 Evaluation Findings

If the staff determines that no license conditions are required for the operational monitoring program excluding water and air sampling because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: “NRC staff has completed its review of the operational monitoring program excluding water and air sampling at the conventional uranium mill or heap leach facility in accordance with Section 5.4.3 of the standard review plan.” Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: “Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 5.4.3 of the standard review plan. Therefore, NRC staff concludes that the applicant’s operational monitoring program excluding water and air sampling is acceptable and is in compliance with

10 CFR Part 40, Appendix A, Criterion 7, which requires operational monitoring programs." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the operational monitoring program excluding water and air sampling at the conventional uranium mill or heap leach facility in accordance with Section 5.4.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 5.4.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's operational monitoring program excluding water and air sampling is acceptable and is in compliance with 10 CFR Part 40, Appendix A, Criterion 7, which requires operational monitoring programs." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

5.4.5 Reference

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

6.0 RADIATION SAFETY CONTROLS AND MONITORING

6.1 External Radiation Exposure Monitoring Program

6.1.1 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 personnel exposure monitoring, the criteria for including workers in the program, the sensitivity and range of devices used, and calibration frequency and methods.

6.1.2 Review Procedures

Staff should use the following procedures when reviewing the external radiation exposure monitoring program:

(1) Verify that the application depicts the facility layout and the location of monitors for external radiation and that the criteria for determining the external radiation monitor locations during operation are consistent with Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities," Revision 1 (NRC, 2002a, Sections 2.4 and 2.8). This information should meet, in part, the requirements of 10 CFR 20.1101(d), 10 CFR 20.1201(a), and 10 CFR 20.1501.

(2) Determine that the application provides criteria to be used in identifying those employees who are to receive external exposure monitoring and that these criteria are consistent with Regulatory Guide 8.34, "Monitoring Criteria and Methods To Calculate Occupational Radiation Doses" (NRC, 1992, Section C). This information should meet, in part, the requirements of 10 CFR 20.1502.

(3) Verify that the applicant describes the proposed monitoring equipment. This information should meet, in part, the requirements of 10 CFR 20.1501.

(4) Verify that plans for documenting radiation exposures meet the requirements of 10 CFR 20.2106. Verify that expected doses will be below regulatory limits in 10 CFR Part 20 and will be as low as is reasonably achievable (ALARA).

(5) Ensure that the applicant's monitoring program is adequate to protect workers from the 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) and is consistent with Regulatory Guide 8.30, Revision 1 (NRC, 2002a). This information should meet, in part, the requirements of 10 CFR 20.1201.

(6) Verify that 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 Regulatory Guide 8.30, Revision 1 (NRC, 2002a). This information should meet, in part, the requirements of 10 CFR 20.1501.

(7) Verify that the program for external exposure monitoring and determining doses from external exposure is consistent with Regulatory Guide 8.34 (NRC, 1992, Section C). This information should meet, in part, the requirements of 10 CFR 20.1501.

6.1.3 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 during operation. Criteria for determining the external radiation monitoring locations are consistent with Regulatory Guide 8.30, Revision 1 (NRC, 2002a, Sections 2.4 and 2.8). The applicant has provided criteria for changing monitoring locations.

(2) The application provides criteria used to establish which employees will receive external exposure monitoring. These criteria are consistent with Regulatory Guide 8.34 (NRC, 1992, Section C). The determination of which workers will be monitored is based on an evaluation of the likely annual occupational dose a worker receives. In some cases, a category of workers for monitoring will be established if these workers are exposed to similar radiological conditions. If the radiation exposure conditions for a worker change, the need to provide individual monitoring for that worker will be reevaluated.

(3) Monitoring equipment is identified by type, sensitivity, calibration methods and frequency, availability, and planned use to protect health and safety. The ranges of sensitivity for the proposed external radiation monitors are consistent with those appropriate to the facility operation. 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, Revision 1 (NRC, 2002a, Section 1).

(4) Plans for documentation of radiation exposures are consistent with the approach in Regulatory Guide 8.7, “Instructions for Recording and Reporting Occupational Radiation Dose Data,” Revision 2 (NRC, 2005).

The application presents radiation dose levels for corrective action that are consistent with the regulatory requirements in 10 CFR Part 20.

Radiation doses will be kept ALARA in accordance with 10 CFR 20.1101(b) and (d), 10 CFR 20.1702 and 10 CFR 20.1704(a) and consistent with the approach described in Regulatory Guide 8.10, “Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable,” Revision 1 (NRC, 1977) and Regulatory Guide 8.31, “Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable,” Revision 1 (NRC, 2002b) or NRC-approved equivalent.

(5) The applicant monitoring program is adequate to identify sources 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) and is consistent with Regulatory Guide 8.30, Revision 1 (NRC, 2002a).

(6) The monitoring program is sufficient to detect 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 Regulatory Guide 8.30, Revision 1 (NRC, 2002a).

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

6.1.4 Evaluation Findings

If the staff determines that no license conditions are required for the external radiation exposure monitoring program because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the external radiation exposure monitoring program at the conventional uranium mill or heap leach facility in accordance with Section 6.1.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 6.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's external radiation exposure monitoring program is acceptable and is in compliance with 10 CFR 20.1101, which defines a radiation protection program and ALARA requirements; 10 CFR 20.1201, 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; and 10 CFR 20.2106, which describes records of individual monitoring results." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the external radiation exposure monitoring program at the conventional uranium mill or heap leach facility in accordance with Section 6.1.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 6.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's external radiation exposure monitoring program is acceptable and is in compliance with 10 CFR 20.1101, which defines a radiation protection program and ALARA requirements; 10 CFR 20.1201, 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; and

10 CFR 20.2106, which describes records of individual monitoring results." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

6.1.5 References

NRC. Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Dose Data." Rev. 2. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2005.

———. Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2002a.

———. Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2002b.

———. Regulatory Guide 8.34, "Monitoring Criteria and Methods To Calculate Occupational Radiation Doses." Washington, DC: NRC, Office of Nuclear Regulatory Research. 1992.

———. Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable." Rev. 1. Washington, DC: NRC, Office of Standards Development. 1977.

6.2 Airborne Radioactivity Monitoring Program

6.2.1 Areas of Review

The staff should review the workplace airborne radioactivity monitoring program proposed for assessing concentrations and quantities of radioactive materials released within the restricted area of the facility. The staff should review the following areas:

- Technical bases proposed for determining radionuclide concentrations for demonstrating compliance with standards;
- Frequency of sampling and analysis;
- The types and sensitivity of analysis for the counting device;
- Action levels and corrective action requirements; and
- Minimum number and criteria for locating monitoring stations.

In addition to the aforementioned areas, the staff should review the proposed airborne radioactivity monitoring program to determine concentrations of airborne radioactive materials (including radon) within the restricted area during routine and nonroutine operations, maintenance, and cleanup. This review should include criteria for determining airborne radioactivity monitoring 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 also should be evaluated.

6.2.2 Review Procedures

Staff should use the following procedures when reviewing the airborne radioactivity monitoring program:

(1) Verify that the applicant provided sufficient information regarding estimated occupational doses and that those doses meet ALARA guidelines as described in Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable," Revision 1 (NRC, 1977). Furthermore, review the type of verification program the applicant proposes. If calculations are proposed to demonstrate compliance, ensure that the applicant agrees to perform air monitoring to confirm the licensing basis and the validity of calculations used for calculating dose. This information should meet, in part, the requirements of 10 CFR 20.1101 and 10 CFR 20.1501.

(2) Determine whether the proposed locations of the airborne radioactivity monitoring stations are consistent with guidance in Regulatory Guide 8.25, "Air Sampling in the Workplace," Revision 1 (NRC, 1992) and Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities," Revision 1 (NRC, 2002a, Sections 2.1, 2.2, and 2.3) if an airborne radioactivity monitoring program is proposed. This information should meet, in part, the requirements of 10 CFR 20.1501.

(3) Ensure that the applicant correctly determines the derived air concentration (DAC) for mixtures of radionuclides. This information should meet, in part, the requirements of 10 CFR 20.1204(e), (f), and (g).

(4) Confirm that the applicant provides one or more drawings that depict the facility layout and the location of samplers for airborne radioactivity and provides a basis for the location of the samplers. This information should meet, in part, the requirements of 10 CFR 20.1501.

(5) Verify that monitoring equipment is identified by type, sensitivity, calibration methods and frequency, availability, range of sensitivity, and planned use to accurately measure concentrations of airborne radioactive species. This information should meet, in part, the requirements of 10 CFR 20.1501.

(6) Determine whether planned surveys of airborne radioactivity are consistent with the guidance in Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities," Revision 1 (NRC, 2002a). This information should meet, in part, the requirements of 10 CFR 20.1101, 10 CFR 20.1501, 10 CFR 20.1701, 10 CFR 20.1702, and 10 CFR 20.1902(d).

(7) Confirm that 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 8.25, Revision 1 (NRC, 1992) and Regulatory Guide 8.30, Revision 1 (NRC, 2002a, Sections 2.2 and 2.3). This information should meet, in part, the requirements of 10 CFR 20.1101, 10 CFR 20.1501, 10 CFR 20.1701, 10 CFR 20.1702, and 10 CFR 20.1902(d).

(8) Verify that the applicant uses appropriate techniques to measure airborne uranium, Ra-226, and Th-230. This information should meet, in part, the requirements of 10 CFR 20.1101, 10 CFR 20.1501, 10 CFR 20.1701, 10 CFR 20.1702, and 10 CFR 20.1902(d).

(9) Verify that plans for documentation of doses from airborne radioactivity exposures are consistent with the requirements in 10 CFR 20.2102, 10 CFR 20.2103, 10 CFR 20.2106, 10 CFR 20.2110, and the recommendations in Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Dose Data," Revision 2 (NRC, 2005).

(10) Confirm that 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 consistent with guidance in Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection," Revision 1 (NRC, 1999) and Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Revision 1 (NRC, 2002b, Section 2.7). This information should meet, in part, the requirements of 10 CFR 20.1703.

(11) Verify that the historical airborne radioactivity monitoring program and the airborne radioactivity monitoring program results are included through the most recent reporting period preceding application submittal for license renewal applications. This information should meet, in part, the requirements of 10 CFR 20.1101.

6.2.3 Acceptance Criteria

The airborne radioactivity monitoring program within the restricted area is acceptable if it meets the following criteria:

(1) The program:

- Provides data to analyze maximum worker exposure in accordance with 10 CFR 20.1203 and 10 CFR 20.1204 (e.g., anywhere within the permit area) and

- Performs airborne radioactivity monitoring consistent with guidance so that the applicant can confirm the licensing basis and the validity of calculations used for calculating dose, if the applicant proposes calculations to demonstrate compliance with 10 CFR 20.1203 and 10 CFR 20.1204.

(2) If the applicant proposes airborne monitoring, the proposed locations of the monitoring stations are presented and are consistent with guidance in Regulatory Guide 8.25, Revision 1 (NRC, 1992) and Regulatory Guide 8.30, Revision 1 (NRC, 2002a, Sections 2.1, 2.2, and 2.3). The proposed airborne monitoring program samples radon and air particulates in accordance with Regulatory Guide 8.25, Revision 1 (NRC, 1992) and Regulatory Guide 8.30, Revision 1 (NRC, 2002a) and air samples to be analyzed for Rn-222 will not be composited and will be analyzed quickly enough to minimize decay losses. The criteria used in selecting sampling locations are provided.

(3) The applicant calculates the DAC for mixtures of radionuclides in accordance with the following:

(a) If the identity of each radionuclide in a mixture is known, the DAC for the mixture is the sum of the ratios of the concentration to the appropriate DAC value for each radionuclide in the mixture.

(b) If the identity of each radionuclide in a mixture is known, but the concentration of one or more of the radionuclides in the mixture is not known, the DAC for the mixture is the most restrictive DAC of any radionuclide in the mixture.

(c) If the applicant states that natural uranium is the primary radionuclide for all airborne particulate samples, then the applicant will analyze composite samples from each of the air particulate monitoring locations and use the results of these samples to disregard certain radionuclides in the mixture to determine the DAC if:

(i) The licensee uses the total activity of the mixture to determine compliance with dose limits in § 20.1201 and monitoring requirements in § 20.1502(b);

(ii) The concentration of any disregarded radionuclide is less than 10 percent of its DAC; and

(iii) The sum of the percentages of disregarded radionuclides is less than 30 percent.

(4) The applicant provides one or more drawings that depict the facility layout and the location of samplers for airborne radioactivity. Locations are based, in part, on a determination of airflow patterns in areas where monitoring is needed, and the determination of monitoring locations is consistent with Regulatory Guide 8.30, Revision 1 (NRC, 2002a).

(5) Monitoring equipment is identified by type, sensitivity, calibration methods and frequency, availability, and planned use to accurately measure concentrations of airborne radioactive species. The application also demonstrates that the ranges of sensitivity are appropriate for the facility operation.

(6) Planned surveys of airborne radioactivity are consistent with the guidance in Regulatory Guide 8.30, Revision 1 (NRC, 2002a).

(7) 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 8.25, Revision 1 (NRC, 1992). The air sampling program is consistent with Regulatory Guide 8.30, Revision 1 (NRC, 2002a).

(8) The applicant uses appropriate techniques to measure uranium in air. If Ra-226 and Th-230 may also be present in the air, additional characterization of the radionuclides in the sample is provided because gross alpha counting alone will not be able to differentiate specific radionuclides.

(9) Plans to document doses from airborne radioactivity exposures are consistent with the requirements in 10 CFR 20.2102, 10 CFR 20.2103, 10 CFR 20.2106, 10 CFR 20.2110, and the recommendations in Regulatory Guide 8.7, Revision 2 (NRC, 2005).

(10) 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 is consistent with guidance in Regulatory Guide 8.15, Revision 1 (NRC, 1999) and Regulatory Guide 8.31, Revision 1 (NRC, 2002b, Section 2.7).

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

6.2.4 Evaluation Findings

If the staff determines that no license conditions are required for the airborne radioactivity monitoring program because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the airborne radioactivity monitoring program at the conventional uranium mill or heap leach facility in accordance with Section 6.2.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 6.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's airborne radioactivity monitoring program is acceptable and is in compliance with 10 CFR 20.1101, which defines the radioactivity protection program and ALARA requirements; 10 CFR 20.1203, which provides requirements for determination of external exposure from airborne radioactivity; 10 CFR 20.1204, which provides requirements for determination of internal exposure; 10 CFR 20.1501, which requires surveys and monitoring; 10 CFR 20.1701, which requires use of process or engineering controls; 10 CFR 20.1702, which allows employees to limit dose to individuals by controlling access, limiting exposure times, prescribing use of respiratory equipment, or using other controls; 10 CFR 20.1703, which defines the use of individual respiratory equipment; 10 CFR 20.1902(d), which requires posting of airborne radioactivity areas; 10 CFR 20.2102, which describes the means of compliance when summing internal and external doses; 10 CFR 20.2103, which requires determination of dose from airborne external radiation; 10 CFR 20.2106, which defines the requirements of records of individual monitoring results; and 10 CFR 20.2110, which further defines records of individual monitoring results." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the airborne radioactivity

monitoring program at the conventional uranium mill or heap leach facility in accordance with Section 6.2.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 6.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's airborne radioactivity monitoring program is acceptable and is in compliance with 10 CFR 20.1101, which defines the radiation protection program and ALARA requirements; 10 CFR 20.1203, which provides requirements for determination of external exposure from airborne radioactivity; 10 CFR 20.1204, which provides requirements for determination of internal exposure; 10 CFR 20.1501, which requires surveys and monitoring; 10 CFR 20.1701, which requires use of process or engineering controls; 10 CFR 20.1702, which allows employees to limit dose to individuals by controlling access, limiting exposure times, prescribing use of respiratory equipment, or using other controls; 10 CFR 20.1703, which defines the use of individual respiratory equipment; 10 CFR 20.1902(d), which requires posting of airborne radioactivity areas; 10 CFR 20.2102, which describes the means of compliance when summing internal and external doses; 10 CFR 20.2103, which requires determination of dose from airborne external radiation; 10 CFR 20.2106, which defines the requirements of records of individual monitoring results; 10 CFR 2110, which further defines records of individual monitoring results." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

6.2.5 References

NRC. Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Dose Data." Rev. 2. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2005.

———. Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2002a.

———. Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2002b.

———. Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 1999.

———. Regulatory Guide 8.25, "Air Sampling in the Workplace." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 1992.

———. Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable." Rev. 1. Washington, DC: NRC, Office of Standards Development. 1977.

6.3 Exposure Calculations

6.3.1 Areas of Review

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

6.3.2 Review Procedures

Staff should use the following procedures when reviewing exposure calculations:

(1) Verify that the methodologies 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 10 CFR 20.1201(a).

(2) Ensure that exposure calculations for natural uranium are consistent with Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities," Revision 1 (NRC, 2002, Section 3). This information should meet, in part, the requirements of 10 CFR 20.1201(e).

(3) Ensure that calculations are consistent with Regulatory Guide 8.30, Revision 1 (NRC, 2002) and Regulatory Guide 8.34, "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses," (NRC, 1992a, Section C) for airborne radon daughter exposure (working levels). This information should meet, in part, the requirements of 10 CFR 20.1201(e) and 10 CFR 20.1203.

(4) Ensure that the DAC from 10 CFR Part 20, Appendix B for the mixture is the most restrictive DAC of any radionuclide in the mixture if the identity of each radionuclide in air is known, but the concentration of one or more of the radionuclides in air is not known. If a mixture exists that does not meet the exclusion rule of 10 CFR 20.1204(g), ensure that a sum of fractions method will be used to determine the appropriate DAC. This information should meet, in part, the requirements of 10 CFR 20.1204(f) and 10 CFR 20.1204(g).

(5) Ensure that calculations and guidance 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," Revision 3 (NRC, 1999). This information should meet, in part, the requirements of 10 CFR 20.1201(e), 10 CFR 20.1203, 10 CFR 20.1208, and 10 CFR 20.1502.

(6) Verify that exposure calculations are presented for routine operations, nonroutine operations, maintenance, and cleanup activities and are consistent with Regulatory Guide 8.30, Revision 1 (NRC, 2002) and Regulatory Guide 8.34 (NRC, 1992a, Section C). This information should meet, in part, the requirements of 10 CFR 20.1202 and 10 CFR 20.1206.

(7) Ensure that 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. This information should meet, in part, the requirements of 10 CFR 20.1202.

(8) Ensure that 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 reviewed in Sections 3.4 and 6.2 of this SRP. This information should meet, in part, the requirements of 10 CFR 20.1204 and 10 CFR 20.1201(e).

(9) Verify that all reporting and record keeping of worker doses conforms with Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Dose Data," Revision 2 (NRC, 2005) and 10 CFR 20.2103.

(10) Include the historical results of radiation exposure calculations through the most recent reporting period preceding application submittal in the case of license renewal applications. This information should meet, in part, the requirements of 10 CFR 20.2104 and 10 CFR 20.2106.

6.3.3 Acceptance Criteria

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

(1) The methodologies 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 10 CFR 20.1201(e).

(2) Exposure calculations for natural uranium are consistent with Regulatory Guide 8.30, Revision 1 (NRC, 2002, Section 3).

(3) For airborne radon daughter exposure (working levels), calculations are consistent with Regulatory Guide 8.30, Revision 1 (NRC, 2002) and Regulatory Guide 8.34 (NRC, 1992a, Section C).

(4) If the identity of each radionuclide in air is known, but the concentration of one or more of the radionuclides in air is not known, the DAC from 10 CFR Part 20, Appendix B, Table 1 for the mixture is the most restrictive DAC of any radionuclide in the mixture. If a mixture exists that does not meet the exclusion rule of 10 CFR 20.1204(g), a sum of fractions method will be used to determine the appropriate DAC. The applicant may need to conduct periodic composite samples and compare the results to 10 CFR 20.1204(g) to ensure that the appropriate DAC is used.

(5) Calculations and guidance for prenatal and fetal radiation exposure are consistent with Regulatory Guide 8.36 (NRC, 1992b).

(6) Exposure calculations are presented for routine operations, nonroutine operations, maintenance, and cleanup activities and are consistent with Regulatory Guide 8.30, Revision 1 (NRC, 2002) and Regulatory Guide 8.34 (NRC, 1992a, Section C).

(7) 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.

(8) 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 reviewed in Sections 3.5.2 and 6.2 of this SRP.

(9) All reporting and record keeping of worker doses is done in conformance with Regulatory Guide 8.7, Revision 2 (NRC, 2005) and 10 CFR 20.2103.

(10) For license renewal applications, the historical results of radiation exposure calculations are included through the most recent reporting period preceding application submittal.

6.3.4 Evaluation Findings

If the staff determines that no license conditions are required for the exposure calculations because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the exposure calculations at the conventional uranium mill or heap leach facility in accordance with Section 6.3.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 6.3.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's exposure calculations are acceptable and in compliance with 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; 10 CFR 20.1206, which describes the requirements for planned special exposures; 10 CFR 20.1208, which specifies the exposure limits for a fetus; 10 CFR 20.1502, which defines the conditions requiring individual monitoring; 10 CFR 20.2103, which requires records of surveys; 10 CFR 20.2104, which requires determination of prior occupational dose; and 10 CFR 20.2106, which describes requirements for records of individual monitoring results." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the exposure calculations at the conventional uranium mill or heap leach facility in accordance with Section 6.3.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what

information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 6.3.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's exposure calculations are acceptable and in compliance with 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; 10 CFR 20.1206, which describes the requirements for planned special exposures; 10 CFR 20.1208, which specifies the exposure limits for a fetus; 10 CFR 20.1502, which defines the conditions requiring individual monitoring; 10 CFR 20.2103, which requires records of surveys; 10 CFR 20.2104, which requires determination of prior occupational dose; and 10 CFR 20.2106, which describes requirements for records of individual monitoring results." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

6.3.5 References

NRC. Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Dose Data." Rev. 2. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2005.

———. Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2002.

———. Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure." Rev. 3. Washington, DC: NRC, Office of Nuclear Regulatory Research. 1999.

———. Regulatory Guide 8.34, "Monitoring Criteria and Methods To Calculate Occupational Radiation Doses." Washington, DC: NRC, Office of Nuclear Regulatory Research. 1992a.

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

6.4 Bioassay Program

6.4.1 Areas of Review

The staff should review descriptions of the bioassay program and how the bioassay results will be used to confirm results derived from the airborne radiation monitoring program in Section 6.2 of this SRP and the exposure calculations in Section 6.3 of this SRP. 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.

6.4.2 Review Procedures

Staff should use the following procedures when reviewing the bioassay program:

(1) Verify that the bioassay program is consistent with applicable sections of Regulatory Guide 8.22, "Bioassay at Uranium Mills," Revision 1 (NRC, 1988) and Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Revision 1 (NRC, 2002) including ALARA requirements. This information should meet, in part, the requirements of 10 CFR 20.1101 and 10 CFR 20.1204.

(2) Ensure that the determination of which workers will be monitored in the bioassay program is consistent with Regulatory Guide 8.22, Revision 1 (NRC, 1988, Section 2). This information should meet, in part, the requirements of 10 CFR 20.1502 and 10 CFR 20.1703.

(3) Verify that 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, Revision 1 (NRC, 1988, Section 4) and Regulatory Guide 8.9, "Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program," Revision 1 (NRC, 1993). This information should meet, in part, the requirements of 10 CFR 20.1502.

(4) Ensure that action levels for bioassay monitoring are set in accordance with Regulatory Guide 8.22, Revision 1 (NRC, 1988, Section 5). This information should meet, in part, the requirements of 10 CFR 20.1502 and 10 CFR 20.1201(e).

(5) Ensure that bioassay includes urinalysis for Class D forms of uranium and *in-vivo* techniques if Classes W or Y forms of uranium are present. This information should meet, in part, the requirements of 10 CFR 20.1502.

(6) Ensure that all reporting and record keeping are done in conformance with the recommendations of Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Dose Data," Revision 2 (NRC, 2005) and the requirements of10 CFR Part 20, Subpart L.

(7) Ensure that the historical bioassay program results are included through the most recent reporting period preceding application submittal for license renewal applications. This information should meet, in part, the requirements of 10 CFR 20.2104 and 10 CFR 20.2106.

6.4.3 Acceptance Criteria

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

(1) The bioassay program is consistent with applicable sections of Regulatory Guide 8.22 (NRC, 1988) and Regulatory Guide 8.31, Revision 1 (NRC, 2002) including ALARA requirements. The bioassay program is adequate to confirm results determined from the airborne radiation monitoring program in Section 6.2 of this SRP and the exposure calculations in Section 6.3 of this SRP.

(2) The determination of which workers will be monitored in the bioassay program is consistent with Regulatory Guide 8.22, Revision 1 (NRC, 1988, Section 2). All workers who are routinely exposed to yellowcake dust are included in the bioassay program. Primarily, the program will involve workers stationed in yellowcake drying areas and those who conduct regular maintenance on drying and ventilation/filtration equipment.

(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, Revision 1 (NRC, 1988, Section 4) and Regulatory Guide 8.9, Revision 1 (NRC, 1993). Sampling and analysis frequencies are sufficient to detect and take corrective action against high intakes of uranium in the workplace.

(4) Action levels for bioassay monitoring are set in accordance with Regulatory Guide 8.22, Revision 1 (NRC, 1988, Section 5) for both radiation dose and chemical toxicity.

(5) Bioassay includes urinalysis for Class D forms of the radionuclide and *in-vivo* techniques for Classes W and Y forms of the radionuclide.

(6) All reporting and record keeping are done in conformance with the recommendations of Regulatory Guide 8.7, Revision 2 (NRC, 2005) and the requirements of 10 CFR Part 20, Subpart L.

(7) For license renewal applications, the historical bioassay program results are included through the most recent reporting period preceding the application submittal.

6.4.4 Evaluation Findings

If the staff determines that no license conditions are required for the bioassay program because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the bioassay program at the conventional uranium mill or heap leach facility in accordance with Section 6.4.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 6.4.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's bioassay program is acceptable and is in compliance with 10 CFR 20.1101, which defines the radiation protection program and ALARA requirements; 10 CFR 20.1201(e), which establishes a limit of intake of soluble uranium to prevent chemical toxicity; 10 CFR 20.1204, which provides requirements for the determination of internal exposure; 10 CFR 20.1502, which defines the conditions requiring individual monitoring; 10 CFR 20.1703, which defines the use of individual respiratory equipment; 10 CFR 20.2104, which requires determination of prior occupational dose; 10 CFR 20.2106, which describes requirements for records of individual monitoring results; and 10 CFR Part 20, Subpart L, which establishes record keeping requirements." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the bioassay program at the conventional uranium mill or heap leach facility in accordance with Section 6.4.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 6.4.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's bioassay program is acceptable and is in compliance with 10 CFR 20.1101, which defines the radiation protection program and ALARA requirements; 10 CFR 20.1201(e), which establishes a limit of intake of soluble uranium to prevent chemical toxicity; 10 CFR 20.1204, which provides requirements for the determination of internal exposure; 10 CFR 20.1502, which defines the conditions requiring individual monitoring; 10 CFR 20.1703, which defines the use of individual respiratory equipment; 10 CFR 20.2104, which requires determination of prior occupational dose; 10 CFR 20.2106, which describes requirements for records of individual monitoring results; and 10 CFR Part 20, Subpart L, which establishes record keeping requirements." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

6.4.5 References

NRC. Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Dose Data." Rev. 2. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2005.

———. Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Reasonably Achievable." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2002.

———. Regulatory Guide 8.9, "Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 1993.

———. Regulatory Guide 8.22, "Bioassay at Uranium Mills." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 1988.

6.5 Contamination Control Program

6.5.1 Areas of Review

The staff should review the contamination control program proposed to prevent employees from entering clean areas or from leaving the site while contaminated with radioactive materials. Levels of radioactive contamination will be monitored using a radiation survey program. Review areas include methods for surveying occupational radiation levels, housekeeping, and cleanup requirements; 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. The staff should also review the methods proposed to ensure that the applicant reduces residual contamination below limits before authorizing release of equipment for unrestricted use.

6.5.2 Review Procedures

Staff should use the following procedures when reviewing the contamination control program:

(1) Ensure that radiation surveys of workers will be conducted to prevent contaminated employees from entering clean areas or from leaving the site consistent with guidance in Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities," Revision 1 (NRC, 2002). This information should meet, in part, the requirements of 10 CFR 20.1501.

(2) Ensure that 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. This information should meet, in part, the requirements of 10 CFR 20.1501.

(3) Verify that action levels for surface contamination are set consistent with Regulatory Guide 8.30, Revision 1 (NRC, 2002, Section 4). This information should meet, in part, the requirements of 10 CFR 20.1101.

(4) Verify that monitoring equipment is described by type, specification of the range, sensitivity, calibration methods and frequency, availability, and planned use. This information should meet, in part, the requirements of 10 CFR 20.1501.

(5) Verify that all reporting and record keeping is done in conformance with the requirements of 10 CFR Part 20, Subpart L and the recommendations of Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Dose Data," Revision 2 (NRC, 2005).

(6) Verify that the applicant ensures that radioactivity on equipment or surfaces is not released for uncontrolled use or covered by paint, plating, or other covering material unless contamination levels, as determined by a documented survey, are below the limits specified in Guidance Directive FC 83-23, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material" (NRC, 1993, Appendix G). This information should meet, in part, the requirements of 10 CFR 20.1501.

(7) Ensure that volumetrically contaminated material will be evaluated on a case-by-case basis prior to license termination in accordance with NUREG–1757, Volume 1, "Consolidated Decommissioning Guidance: Decommissioning Process for Materials Applicants," Revision 2 (NRC, 2006, Section 15.11.2) and Guidance Directive FC 83-23 (NRC, 1993, Appendix G).

(8) Verify that the radioactivity on the interior surfaces of pipes, drain lines, or ductwork 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 ductwork. This information should meet, in part, the requirements of 10 CFR 20.1501.

(9) Ensure that the applicant will make a comprehensive radiation survey in conformance with Regulatory Guide 8.30, Revision 1 (NRC, 2002, Section 2), which establishes contamination is within the limits specified in Guidance Directive FC 83-23 (NRC, 1993, Appendix G) and is ALARA before equipment or scrap is released for unrestricted use. This information should meet, in part, the requirements of 10 CFR 20.1501.

(10) Ensure that appropriate criteria are established to relinquish possession or control of equipment or scrap having surfaces contaminated with material exceeding the limits specified in Guidance Directive FC 83-23 (NRC, 1993, Appendix G). This information should meet, in part, the requirements of 10 CFR 20.1101 and 10 CFR 20.1501.

6.5.3 Acceptance Criteria

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

(1) Radiation surveys of workers will be conducted to prevent contaminated employees from entering clean areas or from leaving the site in conformance with guidance in Regulatory Guide 8.30, Revision 1 (NRC, 2002). The proposed contamination control program will be consistent with the guidance on conducting surveys for contamination of skin and personal clothing provided in Regulatory Guide 8.30, Revision 1 (NRC, 2002).

(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 procedures will be consistent with the guidance on conducting surveys for contamination of skin and personal clothing provided in Regulatory Guide 8.30, Revision 1 (NRC, 2002).

(3) Action levels for surface contamination are set in accordance with Regulatory Guide 8.30, Revision 1 (NRC, 2002, Section 4).

(4) Monitoring equipment is adequately described by type, specification of the range, sensitivity, calibration methods and frequency, availability, and planned use. The application demonstrates that the ranges of sensitivity for monitoring equipment will be appropriate to expected facility operation.

(5) All reporting and record keeping is done in conformance with the requirements of 10 CFR Part 20, Subpart L and the recommendations of Regulatory Guide 8.7, Revision 2 (NRC, 2005).

(6) The applicant ensures that radioactivity on equipment or surfaces is not released for uncontrolled use or covered by paint, plating, or other covering material unless contamination levels, as determined by a documented survey, are below the limits specified in Guidance Directive FC 83-23 (NRC, 1993, Appendix G) before the covering is applied. A reasonable effort will be made to minimize the contamination before using any covering.

(7) Existing NRC regulations do not contain generally applicable standards for the disposition of solid materials with relatively small amounts of radioactivity in, or on, materials and equipment. Therefore, the applicant commits that the offsite disposition of volumetrically solid materials prior to license termination is evaluated on a case-by-case basis in accordance with NUREG–1757, Volume 1, Revision 2 (NRC, 2006, Section 15.112) and its equivalent, Guidance Directive FC 83-23 (NRC, 1993, Appendix G). NRC staff reviews of applicant requests for the disposition of these materials using criteria other than those in existing guidance are coordinated with the NRC Office of Nuclear Material Safety and Safeguards.

(8) The radioactivity of the interior surfaces of pipes, drain lines, or ductwork 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 ductwork.

(9) The applicant will make a comprehensive radiation survey in conformance with Regulatory Guide 8.30, Revision 1 (NRC, 2002, Section 2). Any contamination is within the limits specified in Guidance Directive FC 83-23 (NRC, 1993, Appendix G) and is ALARA before release of equipment or scrap for unrestricted use.

(10) Appropriate criteria are established to relinquish possession or control of equipment or scrap having surfaces contaminated with material exceeding the limits specified in Guidance Directive FC 83-23 (NRC, 1993, Appendix G).

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

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

(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.

6.5.4 Evaluation Findings

If the staff determines that no license conditions are required for the contamination program because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: “NRC staff has completed its review of the contamination control program at the conventional uranium mill or heap leach facility in accordance with Section 6.5.3 of the standard review plan.” Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: “Based on the review conducted by NRC staff, the information

provided in the application meets the applicable acceptance criteria of Section 6.5.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's contamination control program is acceptable and is in compliance with 10 CFR 20.1101, which defines radiation protection program and ALARA requirements; 10 CFR 20.1501, which provides survey and monitoring requirements; and 10 CFR Part 20, Subpart L, which specifies record keeping requirements." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the contamination control program at the conventional uranium mill or heap leach facility in accordance with Section 6.5.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 6.5.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's contamination control program is acceptable and is in compliance with 10 CFR 20.1101, which defines radiation protection program and ALARA requirements; 10 CFR 20.1501, which provides survey and monitoring requirements; and 10 CFR Part 20, Subpart L, which specifies record keeping requirements." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

6.5.5 References

NRC. NUREG–1757, Volume 1, "Consolidated Decommissioning Guidance: Decommissioning Process for Materials Applicants." Rev. 2. Washington, DC: NRC. September 2006.

———. Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Dose Data." Rev. 2. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2005.

———. Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities." Rev. 1. Washington, DC: NRC, Office of Nuclear Regulatory Research. 2002.

———. Guidance Directive FC 83-23, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material." Washington, DC: NRC, Division of Fuel Cycle Safety and Safeguards. 1993.

7.0 RECLAMATION AND DECOMMISSIONING PLAN

This section provides guidance for reviewing the reclamation, decommissioning, and financial assurance aspects of the proposed facility. Staff should review the proposed plans for restoration, surface reclamation of surface impoundments, and decommissioning at the proposed conventional uranium mill or heap leach facility in accordance with NUREG–1620, "Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978." Rev. 1. (NRC, 2003). The reviewer should consult with NUREG–1620 for details on the areas of reviews, acceptance criteria, evaluation findings, and underlying regulatory requirements in regard to the reclamation and decommissioning plan; therefore, such detailed information will not be included in this section. However, the review, at minimum, should address the following:

(i) The proposed groundwater constituents of concern, as described in NUREG–1620 (NRC, 2003, Section E 3.2.2), at the point of compliance wells based on a sound technical and regulatory basis.

(ii) The proposed decommissioning (radiological cleanup and restoration) of land and structures (e.g., buildings) in reference to site conditions (e.g., nature and extent of the contamination, soil background radioactivity), including:

- Planned decommissioning activities (how and what measurements will be made, quality assurance/quality control program, gamma guideline levels for soil cleanup, radioactivity of near surface cover materials (10 CFR Part 40, Appendix A, Criterion 6(5));

- A long-term radon flux limit and gamma exposure level for the tailings disposal cell cover [10 CFR Part 40, Appendix A, Criterion 6(1)];

- Dust emission limit from tailings that are not covered by standing liquids (10 CFR Part 40, Appendix A, Criterion 8);

- Control measures and methods to achieve occupational and public doses that are as low as is reasonably achievable to protect workers, the public, and the environment (10 CFR 20.1101); and

- Verification (final status survey) plan with procedures; and the decommissioning cost estimate, financial assurance amount, financial assurance updates in response to facility changes, annual updates, and changes in closure or decommissioning plans (10 CFR Part 40, Appendix A, Criterion 9).

The decommissioning plans should also address soil background radioactivity, cleanup requirements for radioactive contamination (10 CFR Part 40, Appendix A, Criterion 6(1)–6(6)), instruments and procedures, procedures for final radiation surveys and soil analysis, and disposal of nonradiological hazardous constituents of byproduct materials (10 CFR Part 40, Appendix A, Criterion 6(7)). Usually, the detailed conventional uranium mill or heap leach decommissioning plan and the soil cleanup and verification plan are submitted for NRC approval a year before decommissioning is scheduled to begin. However, the reclamation plan must describe the expected

decommissioning activities in enough detail to support the cost estimate needed for financial assurance purposes.

(iii) The preliminary decommissioning plan contained in the reclamation plan should include commitments to provide a detailed plan and cost estimate for NRC approval at least 9 months before decommissioning is expected to begin. The reviewer should determine whether sufficient detail has been provided in the preliminary decommissioning plan to justify that the financial assurance amount for decommissioning activities is adequate. Reclamation of the disposal areas, as appropriate, must be completed in a timely manner after disposal operations cease, in accordance with 10 CFR Part 40, Appendix A, Criterion 6A(1); however, these actions are not required to be complete as part of meeting the deadline for final radon barrier construction. The radon barrier needs to be completed as expeditiously as practical after ceasing operations in accordance with a written, Commission-approved reclamation plan. The reviewer should document in the technical evaluation report whether the reclamation plan stipulates if the radon barrier is to be placed in phases or as a fairly continuous operation. Any milestone completion dates may be extended if justified by radon release levels, cost considerations consistent with available technology, in accordance with 10 CFR Part 40, Appendix A, Criterion 6A(2). As described in NUREG–1620 (NRC, 2003, Section 3.4), the radon barrier should be effective for 1,000 years, to the extent reasonably achievable, and in any case for at least 200 years.

(iv) Plans for (a) reclaiming slopes, temporary diversion ditches, surface impoundments; (b) reestablishing surface drainage patterns disrupted by the proposed activities; and (c) restoring the ground surface and structures for postoperational use (i.e., license termination).

(v) Methodologies proposed for removal and disposal of contaminated structures and equipment used during conventional uranium mill or heap leach operations, as well as techniques for managing hazardous and radioactive waste materials. Staff should evaluate approaches for (a) identifying radiological hazards before initiating dismantlement of structures and equipment and (b) detecting and decontaminating removable contamination from such structures and equipment. The staff should review plans for ensuring that all contaminated facilities and equipment are addressed and are either to be disposed in a licensed facility, will meet the contamination levels for unrestricted release, or are designated for reuse at another uranium recovery facility. The staff should also review provisions made for the removal and disposal of byproduct material to an existing uranium extraction site or licensed disposal site.

(vi) Methodologies for conducting postreclamation and decommissioning radiological surveys on land and structure surfaces. The staff should review the radiological verification survey program that will serve as a basis for determining compliance with NRC concentration limits for license termination (in part, 10 CFR 40.42(g)(4) and (5)). The staff should evaluate the measurement techniques and sampling procedures proposed.

7.1.1 Acceptance Criteria

The cost estimate for decommissioning, reclamation, and waste disposal is acceptable if it meets the following criteria:

(1) The financial assurance amount provides sufficient resources to complete facility reclamation to levels which allow unrestricted use and technical criteria delineated in10 CFR Part 40, Appendix A, Section I, including decontamination and decommissioning of buildings and structures, reclamation of surface impoundments, and soil reclamation by a third party, if necessary. Activities covered by the financial assurance amount include reclamation, disposal of byproduct material, groundwater and surface water restoration (if necessary), structure and equipment removal, and closure. The bases for establishing a financial assurance are satisfied if:

(a) All activities included in the cost estimate are activities that are included r in the reclamation plan. An estimate of the decommissioning/restoration costs is provided in the application. Once accepted, NRC will review the financial assurance amount annually to assure that sufficient funds would be available for completion of the reclamation plan by a third party.

(b) The assumptions used for the proposed financial assurance amount are consistent with what is known about the site [Section 2.0 of the standard review plan (SRP)} and the design and operations of the facility and its effluent control system (Sections 3.0, 4.0, and 5.0 of the SRP). To the extent possible, the applicant should have based these assumptions on experience from generally accepted industry practices, any research and development at the site, or previous operating experience in the case of a license renewal.

(c) Financial assurance values are based on current dollars (or are adjusted for inflation) and reasonable costs for the required reclamation activities. Costs are documented in the application, which includes the basis for the costs. The applicant commits to funding the approved financial assurance amount through one of the mechanisms including (i) a surety method or insurance, (ii) trust funds, an external sinking fund, or prepayment, (iii) irrevocable letters of credit, or (iv) combinations of these mechanisms or other types of arrangements as may be approved by the Commission.

(d) Financial assurance documentation includes a breakdown of costs; the basis for cost estimates with adjustments for inflation; a minimum 15 percent contingency; and changes in engineering plans, activities performed, and any other conditions affecting estimated costs for site closure.

(2) The applicant has committed to proposed schedules for financial assurance updates in response to facility changes, annual updates, and changes in closure or decommissioning plans. The bases for updating the financial assurance are satisfied if:

(a) The applicant commits to updating the financial assurance value annually, in response to changes in closure or decommissioning plans, and as necessitated by changes in the facility and its operations. The annual update will be submitted 90 days prior to the financial assurance anniversary date each year.

(b) The applicant commits to extending the financial assurance mechanism for an additional year if NRC has not approved a proposed revision 30 days prior to the expiration date.

(c) The applicant commits to revising the financial assurance arrangement within 3 months of NRC approval of a revised closure (decommissioning) plan if estimated costs exceed the amount of the existing financial assurance amount. This revised financial assurance instrument will take effect within 30 days of NRC written approval of the financial assurance mechanism documents.

(d) The applicant commits to submitting for NRC approval an updated financial assurance estimate to cover any planned expansion or operational change not included in the annual financial assurance update at least 90 days prior to beginning associated construction.

(e) The applicant commits to providing NRC with copies of financial assurance related correspondence submitted to a state, a copy of the state's review, and the final approved financial assurance arrangement. The applicant also commits that, where the financial assurance is authorized to be held by the state, the financial assurance covers all appropriate costs.

(3) Verify that the correct charge for long term surveillance is used and has been properly adjusted to account for inflation based on the Consumer Price Index published by the U.S. Department of Labor, Bureau of Labor Statistics.

7.1.2 Evaluation Findings

If the staff's review, as described in this section, results in the acceptance of the financial assurance cost estimate, the following conclusions may be presented in the technical evaluation report.

NRC has completed its review of the financial assurance cost estimate for the conventional uranium mill or heap leach facility. This review included an evaluation of the methods that will be used to develop the procedures using the review procedures in Section 7.1.2 of this SRP and the acceptance criteria outlined in Section 7.1.3 of this SRP.

Based on the information provided in the application and the detailed review conducted of the financial assurance cost estimate for the conventional uranium mill or heap leach facility, the staff concludes that the formulas and calculations submitted are accurate. The NRC staff reviewed the quantities of plant equipment to be removed and disposed of and found these quantities to be consistent with its knowledge of the site. The NRC staff determined the licensee had correctly increased the estimate to account for new infrastructure. For these reasons, the NRC staff determined that adequate justification for costs related to equipment removal and disposal has been provided. Therefore, the NRC staff finds that the updated costs are acceptable and are consistent with 10 CFR Part 40, Appendix A, Criterion 9, which requires that each operator establish financial assurance arrangements.

7.1.3 Reference

NRC. NUREG–1620, "Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978." Rev. 1. Washington, DC: NRC. June 2003.

8.0 ACCIDENTS

NRC has evaluated the effects of accidents at uranium recovery facilities (NUREG–0706, "Final Generic Environmental Impact Statement on Uranium Milling, Project M–25" (NRC, 1980)). Specific areas where NUREG-0706 (NRC, 1980) indicated that consequences could be significant are (i) radon releases from process streams, (ii) yellowcake dryer explosions, and (iii) chemical accidents. In addition, the analysis needs to include all chemical forms of uranium that occur at a conventional uranium mill or heap leach facility.

The staff review should focus on accident response procedures and personnel training in the use of these procedures. Radiation safety training is evaluated using Section 4.5 of this standard review plan (SRP). If an applicant's operating assumptions, site features, and designs are not consistent with these analyses in NUREG–0706 (NRC, 1980), the applicant should conduct independent accident analyses. In that case, the staff review should evaluate the adequacy of these independent analyses. The scope of this review includes radiological, transportation, and nonradiological accidents. This review should verify that the accident analyses address a spectrum of accidents ranging in severity from trivial to significant, including a characterization of the occurrence rate or probability and likely consequences.

8.1 Accidents Involving Radioactivity

8.1.1 Areas of Review

For all applicants, the staff should examine standard operating and radiological accident procedures and the training programs for ensuring that personnel can execute them properly. Conventional uranium mill and heap leach facility radiation safety training programs are reviewed using Section 4.5 of this SRP.

8.1.2 Review Procedures

Staff should use the following procedures when reviewing accidents involving radioactivity:

(1) Verify that analyses of radiological accident consequences include mitigation measures, as appropriate. This information should meet, in part, the requirements of 10 CFR 40.32(c).

(2) Verify that analyses of radiological accidents include results from operating experience at similar facilities. For license renewal applications, analyses of radiological accidents that occurred at the existing facility should be presented, if applicable. This information should meet, in part, the requirements of 10 CFR 40.32(c).

(3) Ensure that the applicant's response program for radiological accidents provides for notification to NRC in compliance with the requirements of 10 CFR 20.2202 and 10 CFR 20.2203.

(4) Verify that the applicant identifies or references adequate procedures to respond to and mitigate or remediate the likely consequences of radiological accidents. This information should meet, in part, the requirements of 10 CFR 40.32(c).

8.1.3 Acceptance Criteria

The independent analyses of consequences of accidents involving radioactivity are acceptable if they meet the following criteria:

(1) Analyses of radiological accident consequences include mitigation measures, as appropriate. These scenarios and estimates are supported by properly interpreted data, calculations, and model results using reasonable assumptions. If consequences cannot be quantified, an adequate qualitative description of the impacts should be provided. The applicant has verified that the assumptions in NUREG–0706 (NRC, 1980) are applicable to the site.

(2) Analyses of radiological accidents include results from operating experience at similar facilities including, for renewal applications, accidents that may have occurred at the existing facility. Uranium recovery industry experience is used to support any radiological accident analyses, including consideration of plant design and specific components that are prone to failure or are known to have failed at other facilities.

(3) The applicant's response program for radiological accidents provides for notification to NRC in compliance with the notification and reporting requirements of 10 CFR 20.2202 and 10 CFR 20.2203. Notification requirements include both immediate and 24-hour notification, depending on severity. Reporting requirements include both written (including electronic submission, when practicable) and verbal (telephone or emergency notification system) reports.

(4) The applicant describes adequate procedures to respond to and mitigate or remediate the likely consequences of radiological accidents. The applicant describes procedures related to monitoring, identification, and response to accidents related to (i) radon release, (ii) yellowcake dryer operations, and (iii) chemical releases as they might affect radiological accidents.

8.1.4 Evaluation Findings

If the staff determines that no license conditions are required for the description of the effects of radiological accidents because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the description of the effects of radiological accidents at the conventional uranium mill or heap leach facility in accordance with Section 8.1.3 of the standard review plan." Following this statement, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 8.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of the effects of radiological accidents is acceptable and is in compliance with 10 CFR 20.2202 and 10 CFR 20.2203, which define response program requirements for radiological accidents, and 10 CFR 40.32(c), which requires that the applicant's proposed equipment, facilities, and procedures be adequate to protect health and minimize danger to life or property." As a

concluding statement, state the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the description of the effects of radiological accidents at the conventional uranium mill or heap leach facility in accordance with Section 8.1.3 of the standard review plan." Following this statement, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 8.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of the effects of radiological accidents is acceptable and is in compliance with 10 CFR 20.2202 and 10 CFR 20.2203, which define response program requirements for radiological accidents, and 10 CFR 40.32(c), which requires that the applicant's proposed equipment, facilities, and procedures be adequate to protect health and minimize danger to life or property." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

8.1.5 Reference

NRC. NUREG–0706, "Final Generic Environmental Impact Statement on Uranium Milling, Project M–25." Washington, DC: NRC. September 1980.

8.2 Transportation Accidents

8.2.1 Areas of Review

For all applicants, the staff should examine standard operating and transportation accident procedures and the training programs for ensuring that personnel can execute them properly. Conventional uranium mill or heap leach facility radiation safety training programs are reviewed using Section 4.5 of this SRP.

8.2.2 Review Procedures

Staff should use the following procedures when reviewing transportation accidents:

(1) Ensure that the applicant has provided analyses of transportation accident consequences that include mitigation measures, as appropriate. This information should meet, in part, the requirements of 10 CFR 40.32(c).

(2) Verify that analyses of transportation accidents include results from operating experience at similar facilities. This information should meet, in part, the requirements of 10 CFR 40.32(c).

(3) Verify that the applicant identifies or references adequate procedures to respond to and mitigate or remediate the likely consequences of transportation accidents in the application. This information should meet, in part, the requirements of 10 CFR 40.32(c).

8.2.3 Acceptance Criteria

The independent analyses of consequences of transportation accidents are acceptable if they meet the following criteria:

(1) Analyses of transportation accident consequences include mitigation measures, as appropriate. For applications that contain independent transportation accident analyses, these analyses and estimates are supported by properly interpreted data, calculations, and model results using reasonable assumptions. If consequences cannot be quantified, an adequate qualitative description of the impacts is provided. Some operational aspects of transportation activities are addressed through inspections relevant to the general transportation license requirements.

(2) Analyses of transportation accidents include results from operating experience at similar facilities. Uranium recovery industry experience is used to support any transportation accident analyses, including consideration of plant design and specific components that are prone to failure or are known to have failed at other facilities.

(3) Adequate procedures to respond to and mitigate or remediate the likely consequences of transportation accidents are identified or referenced in the application. The applicant has procedures in place to detect and respond to postulated transportation accident conditions and to mitigate consequences. These procedures include those related to monitoring, identification, and response to transportation accidents related to accidents and spills.

8.2.4 Evaluation Findings

If the staff determines that no license conditions are required for the description of the effects of transportation accidents because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the description of the effects of transportation accidents at the conventional uranium mill or heap leach facility in accordance with Section 8.2.3 of the standard review plan." Following this statement, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 8.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of the effects of transportation accidents is acceptable and is in compliance with 10 CFR 40.32(c), which requires that the applicant's proposed procedures be adequate to protect health and minimize danger to life or property." As a concluding statement, state the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the description of the effects of transportation accidents at the conventional uranium mill or heap leach facility in accordance with Section 8.2.3 of the standard review plan." Following this statement, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 8.2.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of the effects of transportation accidents is acceptable and is in compliance with 10 CFR 40.32(c), which requires that the applicant's proposed procedures be adequate to protect health and minimize danger to life or property." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

8.2.5 References

None.

8.3 Nonradiological Accidents

8.3.1 Areas of Review

For all applicants, the staff should examine standard operating and nonradiological accident procedures and the training programs for ensuring that personnel can execute them properly.

8.3.2 Review Procedures

Staff should use the following procedures when reviewing nonradiological accidents:

(1) Verify that analyses of nonradiological accident consequences include mitigation measures, as appropriate. This information should meet, in part, the requirements of 10 CFR 40.32(c).

(2) Verify that analyses of nonradiological accidents include results from operating experience at similar facilities. This information should meet, in part, the requirements of 10 CFR 40.32(c).

(3) Verify that the applicant identifies or references adequate procedures to respond to and mitigate or remediate the likely consequences of nonradiological accidents. This information should meet, in part, the requirements of 10 CFR 40.32(c).

8.3.3 Acceptance Criteria

The independent analyses of consequences of nonradiological accidents are acceptable if they meet the following criteria:

(1) Analyses of nonradiological accident consequences include mitigation measures, as appropriate. For applications that contain independent accident analyses, these analyses and estimates are supported by properly interpreted data, calculations, and model results using reasonable assumptions. If consequences cannot be quantified, an adequate qualitative description of the impacts is provided.

(2) Analyses of nonradiological accidents include results from operating experience at similar facilities. Uranium recovery industry experience is used to support any other accident analyses, including consideration of plant design and specific components that are prone to failure or are known to have failed at other facilities.

(3) Adequate procedures to respond to and mitigate or remediate the likely consequences of nonradiological accidents are identified or referenced in the application. The applicant has procedures in place to address nonradiological accidents. These procedures include those related to identification of an accident, monitoring, and reporting.

8.3.4 Evaluation Findings

If the staff determines that no license conditions are required for the description of the effects of nonradiological accidents because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the description of the effects of nonradiological accidents at the conventional uranium mill or heap leach facility in accordance with Section 8.3.3 of the standard review plan." Following this statement, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section 8.3.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of the effects of nonradiological accidents is acceptable and is in compliance with 10 CFR 40.32(c), which requires that the applicant's proposed procedures be adequate to protect health and minimize danger to life or property." As a concluding statement, state the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the description of the effects of nonradiological accidents at the conventional uranium mill or heap leach facility in accordance with Section 8.3.3 of the standard review plan." Following this statement, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section 8.3.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's description of the effects of nonradiological accidents is acceptable and is in compliance with 10 CFR 40.32(c), which requires that the applicant's proposed procedures be adequate to protect health and minimize danger to life or property." If not discussed in the preceding paragraph(s), include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

8.3.5 References

None.

APPENDIX A

GUIDANCE FOR REVIEWING HISTORICAL ASPECTS OF SITE PERFORMANCE FOR LICENSE RENEWALS AND AMENDMENTS

GUIDANCE FOR REVIEWING HISTORICAL ASPECTS OF SITE PERFORMANCE FOR LICENSE RENEWALS AND AMENDMENTS

For license renewals and amendments, the historical record of site operations, including air and groundwater quality monitoring, provides valuable information for evaluating the licensing actions. Following are specific areas where a compliance history or record of site operations and changes should be provided for review:

- For license renewals, U.S. Nuclear Regulatory Commission (NRC) inspection reports and license performance reports;
- Amendments and changes to operating practices or procedures;
- License violations identified during NRC or Agreement State site inspections;
- Excursions, incide;nt investigations or root cause analyses, and resultant cleanup histories or status
- Exceedances of any regulatory standard or license condition pertaining to radiation exposure, contamination, or release limits;
- Exceedances of any non-radiation contaminant exposure or release limits;
- Updates and changes to any site characterization information important to the evaluation of exposure pathways and doses including site location and layout; uses of adjacent lands and waters; population distributions; meteorology; the geologic or hydrologic setting; ecology; background radiological or nonradiological characteristics; and other environmental features;
- Environmental effects of site operations including data on radiological and nonradiological effects and accidents;
- Updates and changes to factors that may cause reconsideration of alternatives to the proposed action;
- For license renewals, updates and changes to the economic costs and benefits for the facility since the last application; and
- For license renewals, the results and effectiveness of any mitigation proposed and implemented in the original license.

If, after a review of these historical aspects of site operations, the staff concludes that the site has been operated so as to protect health and safety and that no unreviewed safety-related concerns have been identified, then only those changes the license renewal or amendment application proposes should be reviewed using the appropriate sections of this standard review plan. Aspects of the facility and its operations that have not changed since the last license renewal or amendment should not be reexamined.

APPENDIX B

RELATIONSHIP OF 10 CFR PART 40, APPENDIX A, REQUIREMENTS TO STANDARD REVIEW PLAN SECTIONS

RELATIONSHIP OF 10 CFR PART 40, APPENDIX A, REQUIREMENTS TO STANDARD REVIEW PLAN SECTIONS

This appendix identifies the specific standard review plan sections where the applicable NRC regulations are addressed.

10 CFR Part 2	Locations in NUREG–2126 Where the Regulation Is Addressed
Subpart A. Procedure for issuance, amendment, transfer, or renewal of a license, and standard design approval	Introduction,
§ 108. Denial of application for failure to supply information	Introduction,
10 CFR Part 20	**Locations in NUREG–2126 Where the Regulation Is Addressed**
Subpart B. Radiation protection programs	
§ 1101. Radiation protection programs	2.3, 3.5, 5.3, 6.1, 6.2, 6.4, 6.5
Subpart C. Occupational dose limits	3.5
§ 1201. Occupational dose limits for adults	6.1
(a) License shall control occupational dose to individual adults	6.1, 6.3
(e) Licensee shall limit soluble uranium intake to 10 mg in a week	6.3, 6.4
§ 1202. Compliance with requirements for summation of external and internal doses	6.3
§ 1203. Determination of external dose from airborne radioactive material	6.2, 6.3
§ 1204. Determination of internal exposure	6.2, 6.3, 6.4
§ 1206. Planned special exposures	6.3
§ 1208. Dose equivalent to an embryo/fetus	6.3
Subpart D. Radiation dose limits for individual members of the public	
§ 1301. Dose limits for individual members of the public	3.5, 5.3

§ 1302. Compliance with dose limits for individual members of the public	2.3, 3.5, 5.3
Subpart F..Surveys and monitoring	
§ 1501. General	2.3, 5.3, 6.1, 6.2, 6.5
§ 1502. Conditions requiring individual monitoring of external and internal occupational dose	6.1, 6.3, 6.4
Subpart H. Respiratory protection and controls to restrict internal exposure in restricted areas	
§ 1701. Use of process or other engineering controls	3.5, 5.3, 6.2
§ 1702. Use of other controls	6.2
§ 1703. Use of individual respiratory protection equipment	6.2, 6.4
Subpart I. Storage and Control of licensed material	
§ 1801. Security of stored material	4.6
§ 1802. Control of material not in storage	4.6
Subpart J. Precautionary procedures	
§ 1902(d). Posting of airborne radioactivity areas	6.2
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§ 2203. Reports of exposures and radiation levels	8.1
Appendix B. Annual limits on intake and derived air concentrations of radionuclides	3.5
10 CFR Part 40	**Locations in NUREG–2126 Where the Regulation Is Addressed**
§ 27. General license for custody and long-term care of residual radioactive material disposal sites	
(b)(2) Detailed description of the final disposal site conditions	3.3
§ 31. Application for specific licenses	Introduction, 1.2,
(h) Each application must clearly demonstrate how requirements and objectives of Part 40, Appendix A have been addressed	Introduction, 2.1, 2.2, 2.3, 2.4, 2.5, 2.7.1, 2.7.2, 3.1, 3.2, 3.3, 3.5, 5.1
§ 32. General requirements for issuance of specific licenses	
(a) Application is for an authorized purpose	3.1
(c) Proposed equipment, facilities, and procedures are adequate to protect health and minimize danger to life or property	2.7.2, 3.4, 3.5, 5.1, 5.2, 8.1, 8.2, 8.3
(d) Issuance of license will not be inimical to the common defense and security or to the health and safety of the public	3.4, 5.1
§ 41. Terms and conditions of licenses	
(c) Possession and use of source or byproduct material	2.7.1, 3.1, 3.2, 3.5, 5.1

§ 64. Reports § 65. Effluent monitoring reporting requirements	4.2 5.3
10 CFR Part 40, Appendix A Criterion	**Locations in NUREG–2126 Where the Criterion Is Addressed**
Criterion 1: Optimize site selection to achieve permanent isolation of tailings without maintenance.	2.1, 2.5, 2.7.2, 3.3
Criterion 2: Avoid proliferation of small waste disposal sites.	3.5
Criterion 3: Dispose of tailings below grade or provide equivalent isolation.	2.1, 3.3
Criterion 4: Adhere to siting and design criteria. (a) Upstream catchment areas must be minimized (b) Topographic features should provide good wind protection (c) Embankment and cover slopes must be relatively flat after final stabilization (d) A full, self-sustaining vegetative cover must be established or a rock cover employed (e) The impoundment must not be located near a capable fault (f) The impoundment, where feasible, should be designed to incorporate features which will promote deposition	 2.1, 2.7.2 2.1, 2.7.2 3.3 3.3 2.4, 3.3 2.7.2
Criterion 5A: Meet the primary groundwater protection standard. (1) Design, construct, and install an impoundment liner that prevents migration of wastes to subsurface soil, groundwater, or surface water. (2) Liner characteristics: (3) Apply alternate design or operating practices that will prevent migration of hazardous constituents into groundwater or surface water. (4) Design, construct, maintain, and operate impoundments to prevent overtopping.	 3.3 3.3 3.3 3.3

(5) Design, construct, and maintain dikes to prevent massive failure.	
Criterion 5B: Conform to the secondary groundwater protection standards. (1) Prevent hazardous constituents from exceeding specified concentration limits in the uppermost aquifer beyond the point of compliance. (2) Define hazardous constituents as those expected to be in or derived from the byproduct material, those detected in the uppermost aquifer, and those listed in Criterion 13. (3) Exclude hazardous constituents if they are not capable of posing a substantial present or potential hazard to human health or the environment. (4) Consider identification of underground sources of drinking water and exempted aquifers. (5) Ensure hazardous constituents at the point of compliance do not exceed the background concentration, the value in Paragraph 5C, or an approved alternate concentration limit. (6) Establish alternate concentration limits, if necessary, after considering practical corrective actions, as low as is reasonably achievable requirements, and potential hazard to human health or the environment.	3.3 5.2 5.2 2.4 2.7.1 5.2 2.7.2
Criterion 5C: Comply with maximum values for groundwater protection.	5.2
Criterion 5D: Implement a groundwater corrective action program if groundwater protection standards are exceeded.	5.2
Criterion 5E: Consider appropriate measures when developing and conducting a groundwater protection program. (1) Incorporate leak detection systems for synthetic liners, and conduct appropriate testing for clay/soil liners. (2) Use process designs that maximize solution recycling and water conservation. (3) Dewater tailings by process devices or	 3.3, 3.5 3.2 3.3

properly designed and installed drainage systems. (4) Neutralize hazardous constituents to promote immobilization.	 3.5
Criterion 5F: Alleviate seepage impacts where they are occurring and restore groundwater quality.	5.2
Criterion 5G: Provide appropriate information for a disposal system. (1) Define the chemical and radioactive characteristics of waste solutions. (2) Describe the characteristics of the underlying soil and geologic formations. (3) Define the location, extent, quality, capacity, and current uses of groundwater.	 3.5 2.5, 2.6, 2.7.1, 3.3 2.7.1
Criterion 5H: Minimize penetration of radionuclides into underlying soils when stockpiling.	3.1, 3.2
Criterion 6: Install an appropriate cover, and close the waste disposal area. (1) Ensure the cover meets lifetime and radioactive material release specifications. This establishes a long-term radon flux limit and direct gamma exposure (background) level for the tailings disposal cell cover. (5) Ensure that radon exhalation does not significantly exceed background (surrounding surface soils) because of the near-surface cover material.	 3.3, 3.3,
Criterion 6A: Ensure expeditious completion of the final radon barrier. (3) Authorize disposal of byproduct materials or similar materials from other sources if appropriate criteria are met.	 3.3
Criterion 7: Conduct preoperational and operational monitoring programs.	2.3, 2.4, 2.8.1, 2.8.2, 3.5, 5.1, 5.2, 5.4

Criterion 7A: Establish a detection monitoring program to set site-specific groundwater protection standards, a compliance monitoring system once groundwater protection standards have been established, and a corrective action monitoring program in conjunction with a corrective action program.	3.5
Criterion 8: Conduct milling operations, including ore storage, tailings placement, and yellowcake drying and packaging operations so that airborne releases are as low as is reasonably achievable. Dust emissions from tailings that are not covered by standing liquids will be minimized using methods that include wetting or chemical stabilization.	2.3, 3.4, 3.5, 4.2, 4.3, 5.3
Criterion 8A: Conduct and record daily inspections of tailings or waste retention systems, and report failures or unusual conditions to NRC.	3.3, 4.2, 4.3
Criterion 9: Establish appropriate financial surety arrangements for decontamination, decommissioning, and reclamation.	7.0
Criterion 10: Establish sufficient funds to cover the costs of long-term surveillance and control.	3.5
Criterion 11: Ownership of tailings and their disposal sites requirements.	2.7.1
Criterion 12: Minimize or avoid long-term active maintenance, and conduct and report on annual inspections.	This criterion is not addressed in this Standard Review Plan. Please refer to NUREG–1620, "Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978," Revision 1[1] for information pertaining to this criterion.
Criterion 13: Establish standards for constituents reasonably expected to be in or derived from byproduct materials and detected in groundwater.	5.2

[1]NRC. NUREG–1620, "Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978." Rev. 1. Washington, DC: U.S. Nuclear Regulatory Commission. 2003.

APPENDIX C

GUIDANCE TO THE U.S. NUCLEAR REGULATORY COMMISSION STAFF ON THE RADIUM BENCHMARK DOSE APPROACH

GUIDANCE TO THE U.S. NUCLEAR REGULATORY COMMISSION STAFF ON THE RADIUM BENCHMARK DOSE APPROACH

C1.0 BACKGROUND

In 10 CFR 40.4, byproduct material is defined as the tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. Uranium milling is defined as any activity resulting in byproduct material. Therefore, 10 CFR Part 40, Appendix A applies to both conventional uranium and thorium recovery facilities. This guidance only addresses uranium recovery facilities because there are no currently licensed or planned thorium recovery facilities.

The final rule, "Radiological Criteria for License Termination of Uranium Recovery Facilities," (64 FR 17506; April 12, 1999) became effective on June 11, 1999, and added the following paragraph after the "radium in soil" criteria in 10 CFR Part 40, Appendix A, Criterion 6(6):

> Byproduct material containing concentrations of radionuclides other than radium in soil, and surface activity on remaining structures, must not result in a total effective dose equivalent (TEDE) exceeding the dose from cleanup of radium contaminated soil to the above standard (benchmark dose), and must be at levels which are as low as is reasonably achievable [ALARA]. If more than one residual radionuclide is present in the same 100-square-meter [1,076-ft^2] area, the sum of the ratios for each radionuclide of concentration present to the concentration limit will not exceed "1" (unity). A calculation of the potential peak annual TEDE within 1,000 years to the average member of the critical group that would result from applying the radium standard (not including radon) on the site must be submitted for approval. The use of decommissioning plans with benchmark doses which exceed 100 mrem/yr [1 Sv/yr], before application of ALARA, requires the approval of the Commission after consideration of the recommendation of the NRC staff. This requirement for dose criteria does not apply to sites that have decommissioning plans for soil and structures approved before June 11, 1999.

C2.0 RADIUM BENCHMARK DOSE APPROACH

The general requirements for a decommissioning plan, including verification of soil contamination cleanup, are addressed in Section 7.4 of the standard review plan (SRP). This appendix discusses the U.S. Nuclear Regulatory Commission (NRC) staff evaluation of the radium benchmark dose approach; specifically, dose modeling and its application to site cleanup activities that should be addressed in the decommissioning plan for those uranium recovery facilities licensed by NRC and subject to the new requirements for cleanup of contaminated soil and buildings under 10 CFR Part 40, Appendix A, Criterion 6(6), as amended in 1999. The facilities that did not have an approved decommissioning plan at the time the rule became final are required to reduce residual radioactivity (i.e., byproduct material) as defined by 10 CFR Part 40, to levels based on the potential dose, excluding radon, resulting from the application of the radium (Ra-226) standard at the site. This is referred to as the radium benchmark dose approach.

This guidance also applies to any revised decommissioning plan submitted for NRC review and approval, after the final rule is effective. However, if a subject applicant can demonstrate that

no contaminated buildings will remain, that Th-230 does not exceed 0.19 Bq/g [5 pCi/g] above background in the surface soil and 0.56 Bq/g [15 pCi/g] in subsurface soil in any 100-m^2 [1,076-ft^2] area that meets the radium standard, and that the natural uranium (i.e., U-nat, U-238, U-234, and U-235) level is less than 0.19 Bq/g [5 pCi/g] above background, radium benchmark dose modeling is not required. If future modeling with site-specific parameters for uranium recovery sites indicates that this is not a protective approach, the guidance will be revised. Therefore, it would be prudent for a uranium recovery applicant to consider the potential dose from any residual thorium and uranium.

The unity "rule" mentioned in Criterion 6(6) applies to all licensed residual radionuclides. Therefore, if the ore (processed by the facility), tailings, or process fluid analyses indicate that elevated levels of Th-232 could exist in certain areas after cleanup for Ra-226, some verification samples in those areas should be analyzed for Th-232 or Ra-228. The thorium (Th-232) chain radionuclides (above local background levels) in milling waste would have soil cleanup criteria similar to the uranium chain radionuclides. The staff considers the U.S. Environmental Protection Agency memorandum of February 12, 1998 (Directive No. 9200.4–25), concerning use of 40 CFR Part 192 soil criteria for Comprehensive Environmental Response, Compensation and Liability Act sites, an acceptable approach. This means that the Th-230 and Th-232 should be limited to the same concentration as their radium progeny with the 0.19 Bq/g [5 pCi/g] criterion applying to the sum of the radium (Ra-226 plus Ra-228) as well as the sum of the thorium (Th-230 plus Th-232) above background.

C2.1 Radium Benchmark Dose Modeling

C2.1.1 Areas of Review

The radium benchmark dose approach involves calculation of the peak potential dose for the site resulting from the 0.19 Bq/g [5 pCi/g] concentration of radium in the surface 15 cm [6 in] of soil. The dose from the 0.56 Bq/g [15 pCi/g] subsurface radium would also be calculated for any area where the criterion is applied. The dose modeling review involves examining the computer code or other calculations employed for the dose estimates, the code or calculation input values and assumptions, and the modeling results (data presentation).

Evaluation of the radium benchmark dose modeling as proposed in the decommissioning plan requires an understanding of the site conditions and site operations. The relevant site information presented in the plan or portions of previously submitted documents (e.g., environmental reports, license renewal applications, reclamation plan, and characterization survey report) should be reviewed.

C2.1.2 Review Procedures

The radium benchmark dose modeling review consists of ascertaining, in accordance with 10 CFR Part 40, Appendix A, Criterion 6(6), that:

(1) An acceptable dose modeling computer code or other type of calculation has been used;

(2) Input parameter values appropriate for the site (reasonable considering long-term conditions and representative of the application) have been used in the modeling;

(3) A realistic dose estimate is provided (overly conservative is not acceptable as it would result in higher allowable levels of uranium or thorium that would not be ALARA); and

(4) The data presentation is clear and complete.

C2.1.3 Acceptance Criteria

The radium benchmark dose modeling results will be acceptable if the dose assessment (modeling) meets the following criteria:

(1) Dose Modeling Codes and Calculations

The assumptions are considered reasonable for the site analysis, and the calculations employed are adequate. Reference to documentation concerning the code or calculations is provided [e.g., the RESRAD Handbook and Manual (Argonne National Laboratory, 1993a, b)].

The RESRAD code the U.S. Department of Energy (Yu, et al., 2001) developed may be acceptable for dose calculations because, although the RESRAD groundwater calculations have limitations, this does not affect the uranium recovery sites that have deep aquifers (groundwater exposure pathway is insignificant). The DandD code (Kennedy and Strenge, 2001) NRC developed (the code is available at the website http://www.orau.gov/ddsc/dose/compcode.htm) provides conservative default values, but does not allow for modeling subsurface soil contamination and does not allow calculation of source removal due to soil erosion. Both the RESRAD and DandD codes would not be adequate to model the dose from offsite contamination, but codes such as GENII are acceptable. See NUREG–1727 (NRC, 2000, Appendix C) for additional information.

If the code or calculation assumptions are not compatible with site conditions, adjustments have been made in the input to adequately reflect site conditions. For example, the RESRAD code assumes a circular contaminated zone. The shape factor (external gamma, code screen R017) must be adjusted for an area that is not circular.

The code and/or calculation provide an estimated annual dose as total effective dose equivalent in mrem/yr. The DandD code provides the annual dose, but RESRAD calculates the highest instantaneous dose. However, RESRAD results are acceptable for long-lived radionuclides that do not move rapidly out of surface soils.

(2) Input Parameter Values

The code/calculation input data are appropriate for the site and represent current or long-term conditions, whichever is more applicable to the time of maximum dose. When code default values are used, they are justified as appropriate (representative) for the site. Excessive conservatism (i.e., upper bound value) is not used, as this would result in a higher dose and thus higher levels of uranium and thorium could be allowed to remain onsite.

Previously approved MILDOS code input parameter values may not be appropriate, because derived operational doses in the restricted area may be an order of magnitude higher than acceptable doses for areas to be released for unrestricted use.

Site-specific input values are demonstrated to be average values of an adequate sample size. Confidence limits are provided for important parameters so that the level of uncertainty can be estimated for that input value. Alteration of input values considers that some values are interrelated and relevant parameters are modified accordingly. The preponderance of important parameter values are based on site measurements and not on conservative estimates. One or more models consider the annual average range of parameter values likely to occur within the next 200 years for important parameters that can reasonably be estimated. Some other considerations for the input parameter values follow:

(a) Scenarios for the Critical Group and Exposure Pathways

The scenario(s) chosen to model the potential dose to the average member of the critical group[1] from residual radionuclides at the site reflect reasonable probable future land use. The applicant has considered ranching, mining, home-based business, light industry, and residential farmer scenarios and has justified the scenarios modeled.

On the basis of one or more of these projected (within 200 years is reasonably foreseeable) land uses to define the critical group(s), the applicant has determined and justified what exposure pathways are probable for potential exposure of the critical group to residual radionuclides at the site. Dairies are not likely to be established in the area of former uranium recovery facilities, because the climate and soil restrict feed production. Even if some dairy cows were to graze in contaminated areas, the milk would probably be sent for processing (thus diluted) and not be consumed directly at the site. Therefore, milk consumption is not a likely ingestion exposure pathway. Also, a pond in the contaminated area providing a significant quantity of fish for the resident's diet is not likely, so the aquatic exposure pathway may not have to be modeled. However, the external gamma, plant ingestion, and inhalation pathways are likely to be important.

The radon pathway is excluded from the benchmark dose calculation as defined in 10 CFR Part 40, Appendix A, Criterion 6(6). This also reflects the approach in 10 CFR Part 20, Subpart E, "Standards for Protection Against Radiation—Radiological Criteria for License Termination."

(b) Source Term

If the RESRAD code is used, the input includes Pb-210 at the same input value as for Ra-226. The other radium progeny are automatically included in the code calculations. The chemical form of the contamination in the environment is considered in determining input values related to transport or inhalation class (retention in the lung) for dose conversion factors.

[1]As defined in 10 CFR Part 20, "the group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances."

(c) Time Periods

The time periods for calculation of the dose from soil Ra-226 include the 1,000-year time frame. The calculated maximum annual dose and the year of occurrence are presented in the results.

(d) Cover and Contaminated Zone

A cover depth of zero is used in the surface contamination model, and a depth of at least 15 cm [6 in] is used for the subsurface model. The values for area and depth of contamination are derived from site characterization data. The erosion rate value for the contaminated zone is less than the RESRAD default value because in regions drier than normal, the erosion rate is less, as discussed in the RESRAD Data Collection Handbook (Argonne National Laboratory, 1993a), and the proposed value is justified. The soil properties are based on site data (sandy loam or sandy silty loam are typical for uranium recovery sites), and other input parameters are based on this demonstration of site soil type [see RESRAD handbook (Argonne National Laboratory, 1993a, pp. 23, 29, 77, and 105)].

The evapotranspiration coefficient for the semiarid uranium recovery sites is between 0.6 and 0.99. The precipitation value is based on annual values averaged over at least 20 years, obtained from the site or from a nearby meteorological station.

The irrigation rate value may be zero, or less than a code's default value, if supported by data on county or regional irrigation practices (e.g., zero is acceptable if irrigation water is obtained from a river, not a well). The runoff coefficient value is based on the site's soil type, expected land use, and regional morphology.

(e) Saturated Zone

The dry bulk density, porosity, "b" parameter, and hydraulic conductivity values are based on local soil properties. The hydraulic gradient for an unconfined aquifer is approximately the slope of the water table. For a confined aquifer, it represents the difference in potentiometric surfaces over a unit distance.

If the RESRAD code is used, the nondispersion model parameter is chosen for areas greater than 1,000 m^2 [10,764 ft^2] (code screen R014), and the well pump rate is based on irrigation, stock, or drinking water well pump rates in the area.

(f) Uncontaminated and Unsaturated Strata

The thickness value represents the typical distance from the soil contamination to the saturated zone. Because the upper aquifer at uranium recovery sites is often of poor quality and quantity, the depth of the shallowest well used for irrigation or stock water in the region is chosen for the unsaturated zone thickness. A value of 18 m [60 ft] is typical for most sites {15 m [50 ft] for the Nebraska site}, but regional data are provided for justification. The density, porosity, and "b" parameter values are similar to those for the saturated zone, or any changes

are justified.

(g) Distribution Coefficients and Leach Rates

The distribution coefficient (K_d) is based on the physical and chemical characteristics of the soil at the site. The leach rate value of zero in the RESRAD code is acceptable as it allows calculation of the value. If a value greater than zero is given, the value is justified.

(h) Inhalation

An average inhalation rate value of approximately 8,395 m^3/yr [10,980 ft^3/yr] is used for the activity assumed for the rancher or farmer scenario. The mass loading for inhalation (air dust loading factor) value is justified based on the average level of airborne dust in the local region for similar activities as assumed in the model.

(i) External Gamma

The shielding factor for gamma is in the range of 0.4 to 0.8 (60 to 20 percent shielding) based on DandD Parameter data (the DandD code screening default value is 0.55). The factor is influenced by the type (foundation, materials) of structures likely to be built on the site and the gamma energy of the radionuclides under consideration.

The time fractions for indoor and outdoor occupancy are similar to default values in RESRAD. For example, the staff would consider fraction values approximating 0.7 indoors and 0.15 outdoors for a resident working at home, and 0.5 outdoors and 0.25 indoors for the farmer scenario (the remaining fraction allocated to time spent offsite).

The site-specific windspeed value is based on adequate site data. The average annual windspeed for the uranium recovery sites varies from 3.1 to 5.5 m/s [7 to 13 mph]. The maximum and annual average windspeed are also considered when evaluating proposed erosion rates.

(j) Ingestion

Average consumption values (g/yr) for the various types of foods are based on average values and are justified. Livestock ingestion parameters are default values or are otherwise justified.

For sites with more than 40.5 ha [100 ac] of contamination, the fraction of diet from the contaminated area is assumed to be 0.25 for the farmer scenario or is otherwise justified based on current or anticipated regional consumption practices for home-grown food. When low levels of precipitation exist in the areas in which uranium recovery facilities are located, extensive gardens or areas of dense animal grazing are not likely, so the percentage of the diet obtained from contaminated areas would be lower than the code default value.

Note that often the default plant mass loading factor in the DandD code can reasonably be reduced to 1 percent. The depth of roots is an important input parameter for uranium recovery applicants using the RESRAD code. The value is justified based on the type of crops likely to be grown on the site in the future. For vegetable gardens, a value of 0.3 is more appropriate than the RESRAD default value of 0.9 m [3 ft] that is reasonable for alfalfa or for a similar deep-rooted plant.

(3) Presentation of Modeling Results

The radium benchmark dose modeling section of the decommissioning plan includes the code or calculation results as the maximum annual dose (TEDE) in mrem/yr, the year that this dose would occur, and the major exposure pathways by percentage of total dose. The modeling section also discusses the likelihood of the various land-use scenarios modeled (reflecting the probable critical groups) and provides the variations in dose (dose distribution) created by changing key parameter values to reflect the range of dose values that are likely to occur on the site. The section also contains the results of a sensitivity analysis (RESRAD can provide a sensitivity analysis via the graphics function) to identify the important parameters for each scenario.

C2.1.4 Evaluation Findings

If the staff's review, as described in this section, results in the acceptance of the radium benchmark dose modeling, the following conclusions may be presented in the safety evaluation report.

If the staff determines that no license conditions are required for the site benchmark dose modeling because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the site benchmark dose modeling at the conventional uranium mill or heap leach facility in accordance with Section E2.1.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this standard review plan (SRP), a bullet list or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section E2.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's site benchmark dose modeling is acceptable and is in compliance 10 CFR Part 40, Appendix A, Criterion 6(6), which describes requirements for site benchmark dose modeling." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the site benchmark dose modeling at the conventional uranium mill or heap leach facility in accordance with Section E2.1.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be

used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section E2.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's site benchmark dose modeling is acceptable and is in compliance with 10 CFR Part 40, Appendix A, Criterion 6(6), which describes requirements for site benchmark dose modeling." If not discussed in the preceding paragraph, include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

C2.2 Implementation of the Benchmark Dose

C2.2.1 Areas of Review

The results of the radium benchmark dose calculations are used to establish a surface and subsurface soil dose limit for residual radionuclides other than radium, as well as a limit for surface activity on structures that will remain after decommissioning. The staff should review the applicant's conversion of the benchmark dose limit to soil concentration pCi/g or surface activity levels dpm/100 cm^2 as a first step to determine cleanup levels. Alternatively, the applicant can derive the estimated dose from the uranium or thorium contamination (as discussed in Section E2.1.3) and compare this to the radium benchmark dose.

The staff should also evaluate the proposed cleanup guideline levels (derived concentration limit) in relation to the ALARA requirement and the unity rule.

C2.2.2 Review Procedures

The decommissioning plan section on cleanup criteria should be evaluated for appropriate conversion of the radium standard benchmark dose to cleanup limits for soil uranium and thorium and/or surface activity. The plan should also be examined to ensure reasonable application of ALARA to the cleanup guideline values and application of the unity rule where appropriate.

C2.2.3 Acceptance Criteria

(1) The soil concentration limit is derived from the site radium dose estimate. The modeling performed to estimate mrem/yr per Bq/g [pCi/g] of Th-230 and/or U-nat follows the criteria listed in Section E2.1.3. In addition, the U-nat source term input is represented as percentage of activity by 48.9 percent U-238, 48.9 percent U-234, and 2.2 percent U-235, or is based on analyses of the ore processed. For a soil uranium criterion (derived concentration limit), the chemical toxicity is considered in deriving a soil concentration limit if soluble forms of uranium are present.

(2) Detailed justification for the inhalation pathway parameters is provided, such as the determination of the chemical form in the environment, to support the inhalation class.

(3) The derived Th-230 soil limit will not cause any 100 m^2 [1.076 ft^2] area to exceed the Ra-226 limit at 1,000 years (i.e., current concentrations of Th-230 are less than 0.52 Bq/g [14 pCi/g] surface and 1.6 Bq/g [43 pCi/g] subsurface, if Ra-226 is at approximately background levels).

(4) In conjunction with the activity limit, the ALARA principle is considered in setting cleanup levels (derived concentration guideline levels). The ALARA guidance in NUREG–1727 (NRC, 2000, Appendix D) is considered. The proposed levels allow the applicant to demonstrate that the requirements of 10 CFR 40.42(k) (the premises are suitable for release, and reasonable effort has been made to eliminate residual radioactive contamination) can be met.

(5) In recent practice at mill sites, the ALARA principle is implemented by removing about 5 cm [2 in] more soil than is estimated to achieve the radium standard (reduce any possible excess or borderline contamination). At recovery facilities, it is generally cheaper to remove more soil than to do sampling and testing that may indicate failure and require additional soil removal with additional testing.

(6) The unity rule is applied to the cleanup if more than one residual radionuclide is present in a soil verification grid 100 m^2 [1,076 ft^2]. This means that the sum of the ratios for each radionuclide of the concentration present/concentration limit may not exceed 1 (i.e., unity).

(7) The subsurface soil standard, if it is to be used, is applied to small areas of deep excavation where at least 15 cm [6 in] of compacted clean fill is to be placed on the surface and where that depth of cover is expected to remain in place for the foreseeable future. The long-term cover depth used in the model is justified.

(8) The surface activity limit for remaining structures is appropriately derived using an approved code or calculation. Because recent conservative dose modeling by NRC staff has indicated that more than 2,000 dpm/100 cm^2 alpha (U-nat or uranium chain radionuclides) in habitable buildings [2,000 hr/yr] could exceed an effective dose equivalent of 0.25 m Sv/yr [25 mrem/yr], the applicant proposes a total (fixed plus removable) average surface activity limit for such buildings that is lower than 2,000 dpm/100 cm^2 or a higher value is suitably justified.

(9) If the DandD code is used, data are provided to support that 10 percent or less of the activity is removable; otherwise, the resuspension factor is scaled to reflect the site-specific removable fraction. Note that this code assumes that the contamination is only on the floor, which can be overly conservative. If the RESRAD-Build code is used, the modeled distribution of contamination on walls and floor is justified.

C2.2.4 Evaluation Findings

If the staff's review, as described in this section, results in the acceptance of the application of the radium benchmark dose modeling to the site cleanup criteria, the following conclusions may be presented in the safety evaluation report.

If the staff determines that no license conditions are required for the site benchmark dose implementation because the applicant or licensee provided adequate and complete information that fully addresses all relevant regulatory requirements, typically a single paragraph is sufficient for the evaluation findings section. Begin the section with the sentence: "NRC staff has completed its review of the site benchmark dose implementation at the conventional uranium mill or heap leach facility in accordance with Section E3.1.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application. As discussed in the introduction of this SRP, a bullet list or sentence format may be used to list what information the applicant has provided.

After the description of the information the applicant provided, the following or a similar statement can be added: "Based on the review conducted by NRC staff, the information provided in the application meets the applicable acceptance criteria of Section E3.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's site benchmark dose implementation is acceptable and is in compliance 10 CFR Part 40, Appendix A, Criterion 6(6), which describes requirements for site benchmark dose implementation." As a concluding statement, indicate the reason why the applicant's information is considered adequate and complete, and why or how that information complies with the identified regulatory requirements.

If license conditions are needed, then a more detailed discussion is typically required. Begin this section with the sentence: "NRC staff has completed its review of the site benchmark dose implementation at the conventional uranium mill or heap leach facility in accordance with Section E3.1.3 of the standard review plan." Following this sentence, state what information the applicant provided in the application, including identification of the information that was omitted or inadequate. As discussed in the introduction of this SRP, a bullet or sentence format may be used to list what information the applicant has provided. Next, state why a license condition is needed, followed by the license condition or conditions.

In a separate paragraph following the discussion of the required license condition(s), include the statement: "Based on the review conducted by NRC staff, the information provided in the application, supplemented by provisions of the license condition(s) discussed above, meets the applicable acceptance criteria of Section E3.1.3 of the standard review plan. Therefore, NRC staff concludes that the applicant's site benchmark dose implementation is acceptable and is in compliance with 10 CFR Part 40, Appendix A, Criterion 6(6), which describes requirements for site benchmark dose implementation." If not discussed in the preceding paragraph, include a statement or summation as to why or how the application and license condition(s) jointly comply with the identified regulatory requirements.

C3.0 REFERENCES

Argonne National Laboratory. "Data Collection Handbook To Support Modeling the Impacts of Radioactive Material in Soil." ANL/EAIS–8. Washington, DC: U.S. Department of Energy. April 1993a.

———. "Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0." ANL/EAD/LD–2. Washington, DC: U.S. Department of Energy. September 1993b.

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NRC. NUREG–1727, "NMSS Decommissioning Standard Review Plan." Washington, DC: NRC. July 2000.

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APPENDIX D

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIAL

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIAL[1]

U.S. Nuclear Regulatory Commission
Division of Fuel Cycle Safety and Safeguards
Washington, DC 20555

April 1993

The instructions in this guide, in conjunction with Table D–1, specify the radionuclides and radiation exposure rate limits which should be used in decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use. The limits in Table 1 do not apply to premises, equipment, or scrap containing induced radioactivity for which the radiological considerations pertinent to their use may be different. The release or such facilities or items from regulatory control is considered on a case-by-case basis.

1. The applicant shall make a reasonable effort to eliminate residual radioactive contamination.

2. Radioactivity on equipment or surfaces should not be 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 1 prior to the application of the covering. A reasonable effort should be made to minimize the contamination prior to use of any covering.

3. The radioactivity on the interior surfaces of pipes, drain lines, or ductwork should 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 ductwork. Surfaces of premises, equipment, or scrap which are likely to be contaminated but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement shall be presumed to be contaminated in excess of the limits.

4. Upon request, the NRC may authorize an applicant to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated with radioactive materials in excess of the limits specified. This may include, but would not be limited to, special circumstances such as razing of buildings, transfer of premises to another

[1]NRC. "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use of Termination of Licenses for ByProduct, Source, or Special Nuclear Material." ML103620647. Washington, DC: U.S. Nuclear Regulatory Commission, Division o9f Fuel Cycle Safety and Safeguards. April 1993.

Table D–1. Acceptable Surface Contamination Levels

Nuclides*	Average†‡§	Maximum†//§	Removable†¶§
U-nat, U-235, U-238 and associated decay products	5,000 dpm *α*/ 100 cm^2	15,000 dpm *α* / 100 cm^2	1,000 dpm *α* / 100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-126, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-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 Sr-90 and others noted above.	5,000 dpm *βγ*/ 100 cm^2	15,000 dpm *βγ*/ 100 cm^2	1,000 dpm *βγ*/ 100 cm^2

*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.
†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 detector for background, efficiency, and geometric factors associated with the instrumentation.
‡Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.
§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 milligrams per square centimeter of total absorber.
//The maximum contamination level applies to an area of not more than 100 cm^2.
¶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.

organization continuing work with radioactive materials, or conversion of facilities to a long-term storage or standby status. Such requests should:

a. Provide detailed, specific information describing the premises, equipment or scrap, radioactive contaminants, and the nature, extent, and degree of residual surface contamination.

b. Provide a detailed health and safety analysis which reflects that the residual amounts of materials on surface areas, together with other considerations such as prospective use of the premises, equipment, or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

5. Prior to release of premises for unrestricted use, the applicant should make a comprehensive radiation survey which establishes that contamination is within the limits specified in Table D–1. A copy of the survey report should be filed with the Division of

Fuel Cycle Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555, and also the Administrator of the NRC Regional Office having jurisdiction. The report should be filed at least 30 days prior to the planned date of abandonment. The survey report should:

a. Identify the premises.

b. Show that reasonable effort has been made to eliminate residual contamination.

c. Describe the scope of the survey and general procedures followed.

d. State the findings of the survey in units specified in the instruction.

Following review of the report, the NRC will consider visiting the facilities to confirm the survey.

APPENDIX E

OUTLINE RECOMMENDED BY THE U.S. NUCLEAR REGULATORY COMMISSION STAFF FOR PREPARING SITE-SPECIFIC FACILITY RECLAMATION AND STABILIZATION COST ESTIMATES FOR REVIEW

OUTLINE RECOMMENDED BY THE U.S. NUCLEAR REGULATORY COMMISSION STAFF FOR PREPARING SITE-SPECIFIC FACILITY RECLAMATION AND STABILIZATION COST ESTIMATES FOR REVIEW

As required by Criteria 9 and 10 of 10 CFR Part 40, Appendix A, the licensee shall supply sufficient information for the U.S. Nuclear Regulatory Commission (NRC) to verify that the amount of coverage provided by the financial assurance will permit the completion of all decontamination, decommissioning, and reclamation of sites, structures, and equipment used in conjunction with byproduct material. Cost estimates for the following items (where applicable) must be submitted to NRC with the initial license application or reclamation plan, and must be updated annually, or as otherwise specified in the license. Cost estimates must be calculated on the basis of completion of all activities by a third party. Unit costs, calculations, references, assumptions, equipment and operator efficiencies, *et cetera*, must be provided. The annual surety estimate must be prospective of all work to be performed at the site. The licensee must provide estimated costs for all decommissioning, reclamation, and ground-water cleanup work remaining to be performed at the site, and should not simply deduct the cost of work already performed from the previous surety estimate [see NRC Generic Letter 97-03 (NRC, 1997)]. The licensee can propose a deduction for work done and approved by NRC as meeting specifications with its annual cost estimate.

The detailed cost information necessary to verify the cost estimates for the preceding categories of closure work is summarized in the recommended outline that follows. For each area, estimates should include the costs for equipment; materials; labor and overhead; licenses, permits, and miscellaneous site-specific costs; and any other activity or resource that will require expenditure of funds.

(I) Facility Decommissioning

This includes dismantling and decontamination, or disposal of all structures and equipment. This work may be done in two phases. In the first phase, only the equipment not used for groundwater cleanup (including the stability monitoring period) is removed. Removal of the remaining equipment would be performed in a second phase, after the approved completion of ground-water cleanup. The buildings may be decontaminated and released for unrestricted use.

(A) Salvageable building and equipment decontamination. For each building or piece of equipment listed, the following data should be provided:

(1) Area of contamination;

(2) Survey costs; and

(3) Decontamination costs.

(B) Non-salvageable building and equipment demolition and disposal:

(1) List of major categories of building and equipment to be disposed of and their corresponding quantities:

(a) Structures (list each major structure), metric tons [tons(short)] of material, and building volume cubic meters (cubic yards);

(b) Foundation concrete [cubic meters (cubic yards)];

(c) Process equipment [metric tons (tons (short)];

(d) Piping and insulation (lump sum); and

(e) Electrical and instrumentation (lump sum).

(2) Disposal of chemical solutions within the facility.

(C) Cleanup of contaminated areas (ore storage pad, access roads, process area, evaporation pond residues, etc.)

Reclamation—This entails recontouring the tailings disposal cell and evaporation ponds and placing top soil or other materials acceptable to NRC. Reclamation may also include cleanup of windblown materials and revegetation, including, but not limited to:

(1) Cleanup of windblown materials (e.g., volume and area, unit cost/cubic yard);

(2) Placement of borrow materials removal (e.g., rental rate, cost/cubic yard);

(3) Dust suppression and site maintenance;

(4) Monitoring and testing of construction;

(5) Regrading;

(6) Placement of the frost barrier;

(7) Placement of the radon barrier

(8) Installation of erosion protection and armor

(9) Installation of any vegetative cover;

(10) Design and construction of drainage ditches;

(11) Recontouring of land surfaces; and

(12) Revegetation.

(II) Ground-Water Cleanup and Well Decommissioning

Ground-water cleanup is done in accordance with an approved corrective action plan. The costs include water treatment equipment, operation, maintenance, and component replacement.

(A) Method of cleanup;

(B) Volume of aquifer required to be restored, area and thickness of aquifer, number of required pumping cycles, and cycling time;

(C) Verification sample analysis; and

(D) Well decommissioning:

(1) Number of drill holes to be plugged;

(2) Depth and size of each drill hole; and

(3) Material to be used for plugging including acquisition, transportation, and plugging.

(III) Radiological Survey and Monitoring

Radiological Survey—Surveys and soil samples for radium in areas to be released for restricted use. Soils around the tailings disposal cell, evaporation ponds, and process buildings should be analyzed for radium content. A gamma survey of all areas should be made before release for unrestricted use. All equipment released for unrestricted use should be surveyed and records maintained.

(A) Soil samples for radium (and uranium and thorium, if needed) (e.g., number, cost to collect, and analyze);

(B) Decommissioning equipment and building smear samples and alpha surface surveys;

(C) Gamma survey frequency, location, and techniques (e.g., type, number, unit cost);

(D) Environmental monitoring; and

(E) Personnel monitoring.

(IV) Project Management Costs and Miscellaneous

Itemize estimated costs associated with project management; engineering design, review, and change; mobilization; legal expenses; power during reclamation; quality control; radiological safety; and any costs not included in other estimation categories. Costs should include preparation of completion report and license termination activities.

Potential needs for future well maintenance or replacement are identified. If periodic well replacement is projected, an increase in the long-term care payment is included [ASTM Standard D 5978 (ASTM International, 2005)].

(V) Labor and Equipment Overhead, Contractor Profit

Overhead costs for labor and equipment and contractor profit may be calculated as separate items or loaded into hourly rates. If included in hourly rates, the unit costs must identify the percentages applied for each area.

(VI) Long-term Surveillance Fee

The fee required by 10 CFR Part 40, Appendix A, Criterion 10, to include cost of any required long-term monitoring (e.g., ground water) or maintenance (e.g., fences, vegetation control).

(VII) Contingency

The licensee should add a contingency amount to the total cost estimate for the final site closure. As of the date of this SRP, the staff currently considers a 15 percent contingency to be an acceptable minimum amount. The licensee should evaluate if the 15 percent contingency recommendation has been revised by staff.

(VIII) Adjustments to Surety Amounts

The licensee is required by 10 CFR Part 40, Appendix A, Criterion 9, to adjust cost estimates annually to account for inflation and changes in reclamation plans. The submittal should be in the form of a request for amendment to the license.

(A) Adjustments for inflation: The licensee should submit a revised surety incorporating adjustments to the cost estimates for inflation 90 days before each anniversary of the date on which the first reclamation plan and cost estimate was approved. The adjustment should be made using the inflation rule indicated by the change in the Urban Consumer Price Index published by the U.S. Department of Labor, Bureau of Labor Statistics.

(B) Changes in Plans:

(1) Changes in the process, such as size or method of operation;

(2) Licensee-initiated changes in reclamation plans or reclamation/ decommissioning activities performed;

(3) Adjustments to reclamation plans required by NRC; and

(4) Proposed revisions to reclamation plans must be thoroughly documented and cost estimates and the basis for cost estimates must be detailed for NRC review and approval.

To avoid unnecessary duplication and expense, NRC shall take into account surety arrangements required by other federal agencies, state agencies, or other local governing bodies. However, NRC is not required to accept such sureties if they are not sufficient. Similarly, no reduction to surety amounts established with other agencies shall be effected without NRC approval. Copies of all correspondence relating to the surety between the licensee and the state should be submitted to NRC. If authorized by NRC to maintain a surety with the state as the beneficiary, it is the responsibility of the licensee to give NRC verification of that surety; ensure that the agreement with the State specifically identifies the financial surety's application, uranium mill tailings site, and decommissioning/reclamation requirements; and transfer the long-term surveillance and control fee to the U.S. Department of the Treasury before license termination.

All costs (unit and total) are to be estimated on the basis of third party independent contractor costs (include overhead and profit in unit costs or as a percentage of the total). Equipment owned by the licensee and the availability of licensee staff should not be considered in the estimate to reduce cost calculations. All costs should be based on current-year dollars. Credit for salvage value is generally not acceptable on the estimated costs.

NRC staff review may include a comparison of unit cost estimates with standard construction cost guides (e.g., R.S. Means, Dodge Guide, Data Quest) and discussions with appropriate state or local authorities (e.g., highway cost construction). The licensee should provide supporting information or the basis for selection of the unit cost figures used in estimates. The staff may elect to use a publicly available computer code such as RACER™ (Talisman Partners, Ltd., 2000) or spreadsheet to assess these costs.

References

ASTM International. D 5978, "Standard Guide for Maintenance and Rehabilitation of Ground-Water Monitoring Wells." West Conshohocken, Pennsylvania: ASTM International. 2005.

NRC. "Annual Financial Surety Update Requirements for Uranium Recovery Licensees." Generic Letter 97-03. Washington, DC: NRC. July 1997.

Talisman Partners, Ltd. "Introduction to RACER 2000™ (Version 2.1.0)—A Quick Reference." Englewood, Colorado: Talisman Partners, Ltd. 2000.

APPENDIX F

U.S. NUCLEAR REGULATORY COMMISSION POLICY OF SAFETY CULTURE

U.S. NUCLEAR REGULATORY COMMISSION POLICY OF SAFETY CULTURE

Safety Culture

The safety culture policy statement was published in the Federal Register (76 FR 34773) on June 14, 2011, and can be found at http://www.gpo.gov/fdsys/pkg/FR-2011-06-14/pdf/2011-14656.pdf. It is also posted in the U.S. Nuclear Regulatory Commission's (NRC) Agencywide Documents Access and Management System (ADAMS) Accession Number ML11146A047.

Safety Culture Policy Statement

The purpose of this Statement of Policy is to set forth the Commission's expectation that individuals and organizations establish and maintain a positive safety culture commensurate with the safety and security significance of their activities and the nature and complexity of their organizations and functions. This includes all licensees, certificate holders, permit holders, authorization holders, holders of quality assurance program approvals, vendors and suppliers of safety-related components, and applicants for a license, certificate, permit, authorization, or quality assurance program approval, subject to NRC authority. The Commission encourages the Agreement States, Agreement State licensees and other organizations interested in nuclear safety to support the development and maintenance of a positive safety culture, as articulated in this Statement of Policy.

Nuclear Safety Culture is defined as *the core values and behaviors resulting from a collective commitment by leaders and individuals to emphasize safety over competing goals to ensure protection of people and the environment*. Individuals and organizations performing regulated activities bear the primary responsibility for safety and security. The performance of individuals and organizations can be monitored and trended and, therefore, may be used to determine compliance with requirements and commitments and may serve as an indicator of possible problem areas in an organization's safety culture. The NRC will not monitor or trend values. These will be the organization's responsibility as part of its safety culture program.

Organizations should ensure that personnel in the safety and security sectors have an appreciation for the importance of each, emphasizing the need for integration and balance to achieve both safety and security in their activities. Safety and security activities are closely intertwined. While many safety and security activities complement each other, there may be instances in which safety and security interests create competing goals. It is important that consideration of these activities be integrated so as not to diminish or adversely affect either; thus, mechanisms should be established to identify and resolve these differences. A safety culture that accomplishes this would include all nuclear safety and security issues associated with NRC regulated activities.

Experience has shown that certain personal and organizational traits are present in a positive safety culture. A trait, in this case, is a pattern of thinking, feeling, and behaving that emphasizes safety, particularly in goal conflict situations, e.g., production, schedule, and the cost of the effort versus safety. It should be noted that although the term ‘‘security’’ is not expressly included in the following traits, safety and security are the primary pillars of the NRC's

regulatory mission. Consequently, consideration of both safety and security issues, commensurate with their significance, is an underlying principle of this Statement of Policy.

The following are traits of a positive safety culture:

(1) *Leadership Safety Values and Actions*—Leaders demonstrate a commitment to safety in their decisions and behaviors.

(2) *Problem Identification and Resolution*—Issues potentially impacting safety are promptly identified, fully evaluated, and promptly addressed and corrected commensurate with their significance.

(3) *Personal Accountability*—All individuals take personal responsibility for safety.

(4) *Work Processes*—The process of planning and controlling work activities is implemented so that safety is maintained.

(5) *Continuous Learning*—Opportunities to learn about ways to ensure safety are sought out and implemented.

(6) *Environment for Raising Concerns*—A safety conscious work environment is maintained where personnel feel free to raise safety concerns without fear of retaliation, intimidation, harassment, or discrimination.

(7) *Effective Safety Communication*—Communications maintain a focus on safety.

(8) *Respectful Work Environment*—Trust and respect permeate the organization.

(9) *Questioning Attitude*—Individuals avoid complacency and continuously challenge existing conditions and activities in order to identify discrepancies that might result in error or inappropriate action.

There may be traits not included in this Statement of Policy that are also important in a positive safety culture. It should be noted that these traits were not developed to be used for inspection purposes.

It is the Commission's expectation that all individuals and organizations, performing or overseeing regulated activities involving nuclear materials, should take the necessary steps to promote a positive safety culture by fostering these traits as they apply to their organizational environments. The Commission recognizes the diversity of these organizations and acknowledges that some organizations have already spent significant time and resources in the development of a positive safety culture. The Commission will take this into consideration as the regulated community addresses the Statement of Policy.

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U.S. NUCLEAR REGULATORY COMMISSION

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10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)
A U.S. Nuclear Regulatory Commission source and byproduct materials 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," for the operation of a uranium mill and the disposal of 'tailings," wastes produced by the extraction of concentration of source material from ores processed primarily for their source material content. Appendix A to Part 40 establishes technical and other criteria related to siting, operation, decontamination, decommissioning, and reclamation of mills and tailings at mill sites. An applicant for a new 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 reviews of applications to develop and operate conventional uranium mills or heap leach facilities. It provides guidance for new license applications, renewals, and amendments.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)
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