

4. RADIATION PROTECTION

4.1 Purpose of Review

The purpose of this review is to determine whether the applicant's radiation protection program is adequate to protect the radiological health and safety of workers and to comply with the regulatory requirements in Title 10, Part 19, "Notices, Instructions and Reports to Workers: Inspection and Investigations," of the *Code of Federal Regulations* (10 CFR Part 19); 10 CFR Part 20, "Standards for Protection Against Radiation;" and 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material."

The content and level of detail in this chapter are generally greater than in other chapters because this chapter provides acceptance criteria for evaluating compliance with 10 CFR Part 20, which has very specific requirements. The applicant should also incorporate, and the U.S. Nuclear Regulatory Commission (NRC) reviewer should consider, insights gained from the conduct of the integrated safety analysis (ISA) and information contained in the ISA summary in developing and reviewing the acceptability of the applicant's radiation protection program. In addition to reviewing the applicant's radiation protection program, the reviewer should evaluate the adequacy of the ISA summary with respect to ensuring that the application meets the radiation exposure performance criteria of 10 CFR 70.61(b) and (c). Review procedures and acceptance criteria for the applicant's program for protecting members of the public and controlling effluent releases are presented in Chapter 9, "Environmental Protection," of this Standard Review Plan (SRP).

4.2 Responsibility for Review

Primary: Health Physicist
Secondary: Licensing Project Manager, Environmental Reviewer
Supporting: Fuel Cycle Facility Inspector

4.3 Areas of Review

The radiation protection program must address the occupational radiation protection measures in 10 CFR Parts 19, 20, and 70. Specifically, licensees must develop, document, and implement a radiation protection program in accordance with 10 CFR 20.1101, "Radiation Protection Programs." Additionally, 10 CFR 20.2102, "Records of Radiation Protection Programs," requires licensees to keep records of the radiation protection program, including a description of the program components, audits, and other aspects of program implementation. The reviewer should also review the ISA summary to identify those facility operations analyzed in the ISA that have radiological consequences, and the items relied on for safety (IROFS) and the management measures implemented to prevent or mitigate such radiological risks. The ISA review should include a judgment as to the comprehensiveness of evaluations performed by the licensee.

The staff will review an applicant's commitments regarding the radiation protection program in the following areas:

- Establish, maintain, and implement a radiation protection program.
- Keep occupational exposures to radiation as low as reasonably achievable (ALARA).
- Appoint radiological protection staff who are suitably qualified and trained in radiation protection procedures.
- Prepare written radiation protection procedures and radiation work permits (RWPs).
- Train employees in radiation protection, including the health protection problems associated with exposure to radiation, precautions and procedures to minimize exposure, and the purposes and functions of protective devices employed.
- Design and implement programs to control airborne concentrations of radioactive material by using ventilation systems, containment systems, and respirators.
- Conduct radiation surveys and monitoring programs to document radiation levels, concentrations of radioactive materials in the facility, and occupational exposures to radiation by workers.
- Evaluate the radiological risks inherent to accidents occurring during operations and identify IROFS that limit high and intermediate consequences consistent with regulatory performance criteria and also to have appropriate management measures in place to ensure that identified IROFS are available and reliable.
- Maintain additional programs including (a) a records maintenance program, (b) a corrective action program, and (c) a program for reporting to the NRC in accordance with requirements in 10 CFR Part 20 and 10 CFR Part 70.

Review Interfaces

In addition to Chapter 4 of the application, the reviewer should examine information in the following other areas to ensure that it is consistent with the information in Chapter 4 of the application:

- emergency plan applicable to radiation protection under SRP Chapter 8.
- safety program, ISA commitments, and ISA documentation applicable to radiation protection under SRP Chapter 3.
- environmental and effluent monitoring as well as any effluent controls applicable to radiation protection under SRP Chapter 9.

4.4 Acceptance Criteria

4.4.1 Commitment to Radiation Protection Program Implementation

4.4.1.1 Regulatory Requirements

Regulations applicable to establishment of a radiation protection program are presented in 10 CFR 20.1101.

4.4.1.2 Regulatory Guidance

The NRC regulatory guide applicable to the commitment to design and implement a radiation protection program is Regulatory Guide 8.2, "Guide for Administrative Practice in Radiation Monitoring."

4.4.1.3 Regulatory Acceptance Criteria

The applicant's radiation protection program is acceptable if the license application provides data and information that meet each of the following commitments:

- Design and implement a radiation protection program that meets the regulatory requirements of 10 CFR 20.1101.
- Outline the radiation protection program structure and define the responsibilities of key program personnel.
- Staff the radiation protection program with suitably trained people, provide sufficient resources, and implement the program.
- Commit to the independence of the radiation protection function from the facility's operations.
- Review, at least annually, the content and implementation of the radiation protection program as required by 10 CFR 20.1101(c). The review should consider facility changes, new technologies, or other process enhancements that could improve the overall program effectiveness.

4.4.2 Commitment to an ALARA Program

4.4.2.1 Regulatory Requirements

Regulations applicable to the ALARA program are presented in 10 CFR 20.1101.

4.4.2.2 Regulatory Guidance

The following are the NRC regulatory guides applicable to the ALARA program:

- Regulatory Guide 8.2, "Guide for Administrative Practice in Radiation Monitoring," February 1973

- Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable," Revision 1-R, May 1977
 - Regulatory Guide 8.13, "Instructions Concerning Prenatal Radiation Exposure," Revision 3, June 1999
 - Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection," Revision 1, May 1977
- Regulatory Guide 8.29, "Instructions Concerning Risks from Occupational Radiation Exposure," February 1996
- Regulatory Guide 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life Cycle Planning," June 2008

4.4.2.3 Regulatory Acceptance Criteria

The applicant's ALARA program is acceptable if the license application provides data and information that meet each of the following commitments:

- Establish a comprehensive, effective, and written ALARA program.
- Prepare policies and procedures to ensure that occupational radiation exposures are maintained ALARA and that such exposures are consistent with the requirements of 10 CFR 20.1101.
- Outline specific ALARA program goals, establish an ALARA program organization and structure, and have written procedures for its implementation in the plant design and operations.
- Establish an ALARA committee, or equivalent organization, with sufficient staff, resources, and clear responsibilities to ensure that the occupational radiation exposure dose limits of 10 CFR Part 20 are not exceeded under normal operations.¹
- Use the ALARA program as a mechanism to facilitate interaction between radiation protection and operations personnel.
- Regularly review and revise, when appropriate, the ALARA program goals and objectives and incorporate, when appropriate, new approaches, technologies, operating

¹ The ALARA committee should meet at least annually, and the membership should include management, radiation protection, environmental safety, industrial safety, production, etc. The ALARA committee's review of the ALARA program should include an evaluation of the results of audits made by the radiation protection organization, reports of radiation levels in the facility, contamination levels, employee exposures, and effluent releases. The review should determine if there are any upward trends in personnel exposure for identified categories of workers and types of operations. The review should identify any upward trends in effluent releases and contamination levels. Finally, the review should determine if exposures, releases, and contamination levels are in accordance with the ALARA concept. The ALARA committee should document its recommendations and track them to completion.

procedures, or changes that could reduce potential radiation exposures at a reasonable cost.

4.4.3 Organization and Personnel Qualifications

4.4.3.1 Regulatory Requirements

Regulations applicable to the organization and qualifications of the radiological protection staff are presented in 10 CFR 70.22, "Contents of Applications."

4.4.3.2 Regulatory Guidance

The following are the NRC regulatory guides applicable to the organization and personnel qualifications of radiation protection program staff:

- Regulatory Guide 8.2, "Guide for Administrative Practice in Radiation Monitoring," February 1973
- Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable," Revision 1-R, May 1977

4.4.3.3 Regulatory Acceptance Criteria

The applicant's commitment to organize and staff a radiation protection program is acceptable if the applicant provides data and information in the license application that meet each of the following commitments:

- Appoint radiation protection personnel and identify their authority and responsibilities for implementation of the radiation protection program functions.
- Establish clear organizational relationships among the individual positions responsible for the radiation protection program and other line managers.
- Appoint a suitably educated, experienced, and trained radiation protection program director (typically referred to as the radiation safety officer) who has direct access to the plant manager, who is skilled in the interpretation of data and regulations pertinent to radiation protection, who is familiar with the operation of the facility and radiation protection concerns of the site, who is used as a resource in radiation safety management decisions, and who will be responsible for establishing and implementing the radiation protection program.
- Describe the minimum education, experience, and training requirements for the radiation protection program director and staff.

4.4.4 Commitment to Written Procedures

4.4.4.1 Regulatory Requirements

The regulations applicable to radiation protection procedures and RWPs are presented in 10 CFR 70.22(a)(8).

4.4.4.2 Regulatory Guidance

The regulatory guidance applicable to procedures and RWPs appears in Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable," Revision 1-R.

4.4.4.3 Regulatory Acceptance Criteria

The applicant's commitment to prepare written radiation protection procedures and RWPs is acceptable if the applicant provides data and information in the license application that meet each of the following commitments:

- Prepare written, approved radiation protection procedures to carry out activities related to the radiation protection program.
- Specify how the radiation protection procedures will be prepared, authorized, approved, and distributed. These procedures should be reviewed and revised as necessary, to incorporate any facility or operational changes or changes in the facility, including changes in the ISA. The radiation safety officer, or an individual who has the qualifications of the radiation safety officer, should have authority to approve the procedures.
- Specify written, approved RWPs for activities involving licensed material that are not covered by written radiation protection procedures. RWPs should define the authorized activities, the level of approval required (a radiation specialist as a minimum), information requirements, period of validity, expiration and termination times, and the recordkeeping requirements for RWPs.

4.4.5 Radiation Safety Training

The SRP addresses an applicant's commitments to employee training in several places. Chapter 4 addresses corporate radiation protection training programs. Chapter 11 addresses training that serves as a management measure for ensuring that an administrative control IROFS is available and reliable when required.

4.4.5.1 Regulatory Requirements

The following regulations apply to the radiation safety training program:

- 10 CFR 19.12, "Instructions to Workers"
- 10 CFR 20.2110, "Form of Records"

4.4.5.2 Regulatory Guidance

NRC regulatory guides, reports of the National Council on Radiation Protection (NCRP), and the American National Standards Institute (ANSI) and American Society for Testing and Materials standards pertaining to radiation protection training are the following:

- Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable," Revision 1-R, May 1977
- Regulatory Guide 8.13, "Instructions Concerning Prenatal Radiation Exposure," Revision 3, June 1999
- Regulatory Guide 8.29, "Instructions Concerning Risks from Occupational Radiation Exposure," Revision 1, February 1996
- NCRP Report No. 134, "Operational Radiation Safety Training," 2000
- ASTM E1168-95, "Radiological Protection Training for Nuclear Facility Workers," reapproved 2008
- ANSI/HPS N13.36, "Ionizing Radiation Safety Training for Workers," October 30, 2001

4.4.5.3 Regulatory Acceptance Criteria

The applicant's commitment to train its employees in radiation protection is acceptable if license application provides data and information that meet each of the following commitments:

- Design and implement an employee radiation protection training program that complies with the requirements of 10 CFR Part 19 and 10 CFR Part 20.
- Provide training to all personnel and visitors entering restricted areas that is commensurate with the health risk to which they may be exposed, or to provide escorts who have received the appropriate training.
- Provide a level of training commensurate with the potential radiological health risks associated with that employee's work responsibilities.
- Conduct refresher training at least every 3 years that will accurately address changes in policies, procedures, requirements, and the facility ISA.
- Incorporate in the radiation protection training program the provisions in 10 CFR 19.12 and topics such as the following:
 - correct handling of radioactive materials
 - minimization of exposures to radiation and/or radioactive materials
 - access and egress controls and escort procedures
 - radiation safety principles, policies, and procedures
 - monitoring for internal and external exposures
 - monitoring instruments
 - contamination control, including protective clothing and equipment
 - ALARA and exposure limits

- radiation hazards and health risks
- emergency response
- Review and evaluate the accuracy, effectiveness, and adequacy of the radiation protection training program curriculum and instructors, as applicable, at least every 3 years.

4.4.6 Ventilation and Respiratory Protection Programs

4.4.6.1 Regulatory Requirements

Regulations applicable to the ventilation and respiratory protection programs are presented in 10 CFR Part 20, Subpart H, "Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas."

4.4.6.2 Regulatory Guidance

The following NRC regulatory guides, ANSI standards, and other publications are applicable to the design of the ventilation and respiratory protection programs:

- Regulatory Guide 8.24, "Health Physics Surveys During Enriched Uranium-235 Processing and Fuel Fabrication," Revision 1, October 1979
- Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection," Revision 1, October 1999
- American Conference of Governmental Industrial Hygienists (ACGIH) 2095, "Industrial Ventilation: A Manual of Recommended Practice for Design," 2007
- Energy Research and Development Administration (ERDA) 76-21, "Nuclear Air Cleaning Handbook," by C.A. Burchsted, A.B. Fuller, and J.E. Kahn, March 31, 1976
- ANSI Z88.2-1992, "Practices for Respiratory Protection"

4.4.6.3 Regulatory Acceptance Criteria

The applicant's commitment to have ventilation and respiratory protection programs is acceptable if the license application provides data and information that meet each of the following commitments:

- Install appropriately sized ventilation and containment systems in areas of the plant identified as having potential airborne concentrations of radionuclides that could exceed the occupational derived air concentration values specified in 10 CFR Part 20, Appendix B, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage," during normal operations.

- Describe management measures, including preventive and corrective maintenance and performance testing, to ensure that the ventilation and containment systems operate when required, and are within their design specifications.
- Describe the criteria for the ventilation and containment systems, including minimum flow velocity at openings in these systems, maximum differential pressure across filters, and types of filters to be used.
- Describe the frequency and types of tests to measure ventilation and containment systems' performance, the acceptance criteria, and the actions to be taken when the acceptance criteria are not satisfied.
- Establish a respiratory protection program that meets the requirements of 10 CFR Part 20, Subpart H.
- Prepare written procedures for the selection, fitting, issuance, maintenance, testing, training of personnel, monitoring, and recordkeeping for individual respiratory protection equipment, and for specifying when such equipment is to be used.
- Revise the written procedures for use of individual respiratory protection equipment as applicable, when processing, facility, or equipment changes are made.
- Maintain records of the respiratory protection program, including training in respirator use and maintenance.

4.4.7 Radiation Surveys and Monitoring Programs

Radiation surveys are conducted for two purposes: (1) to ascertain radiation levels, concentrations of radioactive materials, and potential radiological hazards that could be present in the facility, and (2) to detect releases of radioactive material from plant equipment and operations. Radiation surveys will focus on those areas of the plant necessary to show compliance with the dose limits and monitoring requirements of 10 CFR Part 20, Subparts C ("Occupational Dose Limits"), D ("Radiation Dose Limits for Individual Members of the Public"), and F ("Surveys and Monitoring").

Measurements of airborne radioactive material and/or bioassays are used to determine internal occupational exposures to radiation. When combined with external occupational exposure data, the dose of record can be compared against the dose limits specified in 10 CFR Part 20, Subpart C.

4.4.7.1 Regulatory Requirements

The following NRC regulations in 10 CFR Part 20 are applicable to radiation surveys and monitoring programs:

- Subpart F, "Surveys and Monitoring"
- Subpart C, "Occupational Dose Limits"
- Subpart L, "Records"

- Subpart M, “Reports”

4.4.7.2 Regulatory Guidance

The following NRC regulatory guides, NUREGs, and ANSI standards are applicable to radiation surveys and monitoring programs:

- Regulatory Guide 8.2, “Guide for Administrative Practice in Radiation Monitoring,” February 1973
- Regulatory Guide 8.4, “Direct-Reading and Indirect-Reading Pocket Dosimeters,” February 1973
- Regulatory Guide 8.7, “Instructions for Recording and Reporting Occupational Radiation Exposure Data,” Revision 2, November 2005
- Regulatory Guide 8.9, “Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program,” Revision 1, July 1993
- Regulatory Guide 8.24, “Health Physics Surveys During Enriched Uranium-235 Processing and Fuel Fabrication,” Revision 1, October 1979
- Regulatory Guide 8.25, “Air Sampling in the Workplace,” Revision 1, June 1992
- Regulatory Guide 8.34, “Monitoring Criteria and Methods To Calculate Occupational Radiation Doses,” July 1992
- NUREG-1400, “Air Sampling in the Workplace,” September 1993
- ANSI N13.1-1999, “Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities”
- ANSI N328-1978, “Radiation Protection Instrumentation Test and Calibration”
- ANSI N13.11-2001, “Personnel Dosimetry Performance—Criteria for Testing”
- ANSI N13.15-1985, “Radiation Detectors—Personnel Thermoluminescence Dosimetry Systems—Performance”
- ANSI N13.22-1995, “Bioassay Program for Uranium”
- ANSI N13.27-1981, “Performance Requirements for Pocket-Sized Alarm Dosimeters and Alarm Ratemeters”
- ANSI N13.30-1996, “Performance Criteria for Radiobioassay”
- ANSI N13.6-1999, “Practice for Occupational Radiation Exposure Records Systems”

4.4.7.3 Regulatory Acceptance Criteria

The applicant's commitment to implement radiation surveys and monitoring programs is acceptable if the license application provides data and information that meet each of the following commitments:

- Have radiation surveys and monitoring programs consistent with the requirements of 10 CFR Part 20, Subpart F.
- Prepare written procedures for the radiation survey and monitoring program that include an outline of the program objectives, sampling procedures, data analysis methods, types of equipment and instrumentation to be used, frequency of measurements, recordkeeping and reporting requirements, and actions to be taken when measurements exceed 10 CFR Part 20 occupational dose limits or administrative levels established by the applicant.
- Design and implement a personnel monitoring program for external occupational radiation exposures that outlines methods or procedures to do the following:
 - identify the criteria for worker participation in the program
 - identify the types of radiation to be monitored
 - specify how exposures will be measured, assessed, and recorded
 - identify the type and sensitivity of personal dosimeters to be used, when they will be used, and how they will be processed and evaluated
 - identify the plant's administrative exposure levels or action levels at which
 - actions are taken to investigate the cause of exposures exceeding these levels
- Design and implement a personnel monitoring program for internal occupational radiation exposures based on the requirements of 10 CFR 20.1201 ("Occupational Dose Limits for Adults"), 10 CFR 20.1204 ("Determination of Internal Exposure"), and 20.1502(b), that outlines methods or procedures to do the following:
 - identify the criteria for worker participation in the program
 - identify the type of sampling to be used, the frequency of collection and measurement, and the minimum detection levels
 - specify how worker intakes will be measured, assessed, and recorded
 - specify how the data will be processed, evaluated, and interpreted
 - identify the plant's administrative exposure levels or the levels at which actions are taken to investigate the causes of exposures exceeding these levels

- Comply with the requirements of 10 CFR 20.1202, "Compliance with Requirements for Summation of External and Internal Doses," for summation of external and internal occupational radiation exposures through the use of procedures such as those outlined in Regulatory Guide 8.7 or 8.34.
- Design and implement an air sampling program in areas of the plant identified as potential airborne radioactivity areas, to conduct airflow studies and to calibrate and maintain the airborne sampling equipment in accordance with the manufacturers' recommendations.
- Implement additional procedures, as may be required by 10 CFR Part 20 and the ISA summary, to control the concentration of airborne radioactive material (e.g., control of access, limitation of exposure times to licensed materials, and use of respiratory protection equipment).
- Conduct a contamination survey program in areas of the plant most likely to be radiologically contaminated (the program must include the types and frequencies of surveys for various areas of the plant and the action levels and actions to be taken when contamination levels are exceeded).
- Implement the facility's corrective action program when the results of personnel monitoring or contamination surveys exceed the applicant's administrative personnel contamination levels.
- Implement the facility's corrective action program when any incident results in airborne occupational exposures to radiation exceeding the facility's administrative limits, or the dose limits in Appendix B to 10 CFR Part 20 or 10 CFR 70.61, "Performance Requirements."
- Use equipment and instrumentation with sufficient sensitivity for the type or types of radiation being measured and calibrate and maintain equipment and instrumentation in accordance with the manufacturers' recommendations.
- Establish policies to ensure that equipment and materials removed from restricted areas to unrestricted areas are not contaminated above the specified release levels in the NRC branch technical position "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," issued April 1993 (this guidance is attached as Appendix B to this chapter for ease of reference).
- Leak-test all sealed sources in accordance with the following NRC branch technical positions issued in April 1993: (1) "License Condition for Leak-Testing Sealed Byproduct Material Sources," (2) "License Condition for Leak-Testing Sealed Plutonium Sources," (3) "License Condition for Plutonium Alpha Sources," (4) "License Condition for Leak-Testing Sealed Source Which Contains Alpha and/or Beta-Gamma Emitters," and (5) "License Condition for Leak-Testing Sealed Uranium Sources"

- Establish and implement an access control program that ensures that (1) signs, labels, and other access controls are properly posted and operative, (2) restricted areas are established to prevent the spread of contamination and are identified with appropriate signs, and (3) step-off pads, change facilities, protective clothing facilities, and personnel monitoring instruments are provided in sufficient quantities and locations.
- Establish a reporting program consistent with the requirements of 10 CFR Part 19 and 10 CFR Part 20.

4.4.8 Control of Radiological Risk Resulting from Accidents

In addition to participating in the integrated review of the ISA summary performed in accordance with Chapter 3 of the SRP, the reviewer should also examine in detail the radiological exposure and/or release accident sequences provided in the ISA summary to demonstrate compliance with 10 CFR 70.61. This review should include an evaluation of sequences involving radiological releases or exposures with respect to the initiators and their frequency, radiological consequences, and IROFS chosen to prevent or mitigate those consequences.

The reviewer should also identify and note any items or issues that should be inspected during an operational readiness review, if such will be performed. These items may include confirming that engineered controls meet performance specifications described in the ISA summary and that administrative controls are implemented through procedures and operator training.

The reviewer should ensure that the emergency plan, if one is required, adequately addresses the licensee response to a release of radioactive materials or else that proper justification is present to preclude development of an emergency plan.

Finally, the reviewer should be aware that accident sequences considered “not unlikely” in the ISA summary are constricted under the 10 CFR Part 20 ALARA requirement to minimize exposure to personnel and the public.

4.4.8.1 Regulatory Requirements

The following NRC regulations apply to the control of radiological risk from accidents:

- 10 CFR 70.22(i)(1) requires either an evaluation that the maximum dose to a member of the public resulting from a release of materials would not exceed 1 rem or 2 milligrams soluble uranium intake or submission of an emergency plan for responding to the radiological hazards of a postulated accident.
- 10 CFR Part 70, Subpart H, “Additional Requirements for Certain Licensees Authorized To Possess a Critical Mass of Special Nuclear Material,” contains requirements for performing ISAs, designating IROFS, and having management measures in place to ensure that IROFS are readily available and reliable, as well as to provide facility change management and configuration control.
- 10 CFR 20.1101 states that licensees shall apply procedures and engineering controls to achieve exposures to workers and the public that are ALARA.

- 10 CFR 20.1406, "Minimization of Contamination," implies that licensees shall design and develop procedures for operation that will minimize contamination of the facility and the environment, facilitate eventual decommissioning, and minimize the generation of radioactive waste.
- 10 CFR Part 20, Subpart H, discusses controls to restrict internal exposures.

4.4.8.2 Regulatory Guidance

The following guidance is applicable to the control of radiological risk resulting from accidents:

- NUREG-1513, "Integrated Safety Analysis Guidance Document," May 2001
- NUREG/CR-6410, "Nuclear Fuel Cycle Accident Analysis Handbook," March 1998
- Regulatory Guide 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life Cycle Planning"

4.4.8.3 Acceptance Criteria

The factors listed below should be considered in determining the acceptability of the applicant's descriptions of radiological exposure or release accident sequences. The checklist in Appendix 4 has been developed to provide guidance on those items that reviewers should consider when evaluating the completeness of the ISA for radiological risks.

- Accident sequences should be sufficiently described and detailed to allow an understanding of the radiological hazards (e.g., radioactive materials at risk) and the release mechanism.
- The applicant should provide adequate descriptions of the radiological consequences (i.e., exposure estimates) identified in the ISA summary. The reviewer should verify that exposures are reasonable based on the sequence description and the radioactive materials involved and use a methodology consistent with regulatory guidance (10 CFR 70.61).
- The applicant should justify the likelihood of the initiating event, its prevention, or consequence mitigation of an accident sequence with high or intermediate consequences if credited in a questionable or nonconservative manner. If controls are relied on to reduce the likelihood or severity of a high- or intermediate-consequence accident sequence, they should be identified as IROFS (10 CFR 70.61).
- Analyses that the applicant has performed as part of the ISA process should be referenced or identified for potential further review (vertical slice) by the NRC staff (10 CFR 70.61).
- The application should demonstrate the management measures proposed to ensure that IROFS are available and reliable when required by briefly describing both of the following:

- procedures to ensure the reliable operation of engineered controls (e.g., inspection and testing procedures and frequencies, calibration programs, functional tests, corrective and preventive maintenance programs, and criteria for acceptable test results) [10 CFR 70.62(d)]
 - procedures to ensure that administrative controls will be correctly implemented when required (e.g., employee training and qualification in operating procedures, refresher training, safe work practices, development of standard operating procedures, and training program evaluations) [10 CFR 70.62(d)]
- The application shall include either of the following:
 - an evaluation that demonstrates public exposures resulting from offsite releases of material are less than 1 rem or 2 milligrams soluble uranium intake
 - an emergency plan that includes sufficient detail for responding appropriately to an offsite release of radioactive materials (10 CFR 70.22(i)(1))

4.4.9 Additional Program Commitments

4.4.9.1 Regulatory Requirements

The following 10 CFR Part 20 regulations are applicable to the additional program commitments:

- Subpart L, “Records”
- Subpart M, “Reports”
- 10 CFR 70.74, “Additional Reporting Requirements”

4.4.9.2 Regulatory Guidance

There are no NRC regulatory guidelines applicable to these additional program commitments.

4.4.9.3 Acceptance Criteria

The applicant’s commitment to implement additional program features is acceptable if the license application provides data and information that meet each of the following commitments:

- Maintain records of the radiation protection program (including program provisions, audits, and reviews of the program content and implementation), radiation survey results (air sampling, bioassays, external exposure data from monitoring of individuals, internal intakes of radioactive material), results of corrective action program referrals, RWPs, and planned special exposures.
- Establish a program to report to the NRC, within the time specified in 10 CFR 20.2202, “Notification of Incidents,” and 10 CFR 70.74, any event that results in an occupational exposure to radiation exceeding the dose limits in 10 CFR Part 20.

- Prepare and submit to the NRC an annual report of the results of individual monitoring, as required by 10 CFR 20.2206(b).
- Refer to the facility's corrective action program any incident that results in an occupational exposure to radiation that exceeds the dose limits in Appendix B to 10 CFR Part 20 or 10 CFR 70.74 and report to the NRC both the corrective action taken (or planned) to protect against a recurrence and the proposed schedule to achieve compliance with the applicable license condition or conditions.

4.5 Review Procedures

4.5.1 Acceptance Review

The primary reviewer should evaluate the license application to determine whether it addresses the areas of review discussed in Section 4.3. If significant deficiencies are identified, the applicant should be asked to submit additional material before the reviewer(s) start the safety evaluation.

4.5.2 Safety Evaluation

The primary reviewer will perform a safety evaluation with respect to the acceptance criteria in Section 4.4. For existing facilities, the reviewer will consult with the cognizant NRC inspector for radiation protection to identify and resolve any issues of concern related to the licensing review. The primary reviewer will prepare a safety evaluation report (SER) on the licensing action for the licensing project manager.

4.6 Evaluation Findings

The reviewer will write an SER addressing each topic reviewed and explaining why the NRC staff has reasonable assurance that the radiation protection part of the application is acceptable and that the health and safety of the workers are adequately protected. License conditions may be proposed to impose requirements where the application is deficient. The following kinds of statements and conclusions will be included in the staff's SER:

The applicant has committed to an acceptable radiation protection program that includes:

- (1) an effective documented program to ensure that occupational radiological exposures are ALARA;
- (2) an organization with adequate qualification requirements for the radiation protection personnel;
- (3) approved written radiation protection procedures and RWPs for radiation protection activities;

- (4) radiation protection training for all personnel who have access to restricted areas;
- (5) a program to control airborne concentrations of radioactive material with engineering controls and respiratory protection;
- (6) a radiation survey and monitoring program that includes requirements for controlling radiological contamination within the facility and monitoring of external and internal radiation exposures; and
- (7) other programs to maintain records, report to the NRC in accordance with 10 CFR Parts 20 and 70, and correct for upsets at the facility.

The NRC staff concludes that the applicant's radiation protection program is adequate and meets the requirements of 10 CFR Parts 19, 20, and 70. Conformance to the license application and license conditions will ensure safe operation.

The applicant has accurately evaluated in the ISA summary those accident sequences with intermediate and high radiological consequences. The applicant has also identified controls and management measures that reduce the likelihood or consequences of accident sequences and meet the performance criteria of 10 CFR 70.61.

4.7 References

U.S. Code of Federal Regulations, Chapter I, Title 10, "Energy," Part 19, "Notices, Instructions and Reports to Workers: Inspection and Investigations"

U.S. Code of Federal Regulations, Chapter I, Title 10, "Energy," Part 20, "Standards for Protection Against Radiation."

U.S. Code of Federal Regulations, Chapter I, Title 10, "Energy," Part 70, "Domestic Licensing of Special Nuclear Material."

Regulatory Guide 8.2, "Guide for Administrative Practice in Radiation Monitoring," February 1973

Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable, Revision 1-R, May 1977

Regulatory Guide 8.13, "Instructions Concerning Prenatal Radiation Exposure," Revision 3, June 1999

Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection," Revision 1, May 1977

Regulatory Guide 8.29, "Instructions Concerning Risks from Occupational Radiation Exposure," Revision 1, February 1996

Regulatory Guide 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life Cycle Planning," June 2008

NCRP Report No. 134, "Operational Radiation Safety Training," 2000

ASTM E1168-95, "Radiological Protection Training for Nuclear Facility Workers," reapproved 2008

ANSI/HPS N13.36, "Ionizing Radiation Safety Training for Workers," October 30, 2001

Regulatory Guide 8.24, "Health Physics Surveys During Enriched Uranium-235 Processing and Fuel Fabrication," Revision 1, October 1979

Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection," Revision 1, October 1999

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APPENDIX A

CONSIDERATIONS FOR RADIOLOGICAL RISK IN ACCIDENT SEQUENCES		
(1) Source Term is Defined		
	Radionuclides should be identified	Consider multiple isotopes Consider chemical form Consider progeny ingrowth Consider contaminants
	Radiation Hazard is identified Alpha Beta Gamma neutron	Consider contributions from progeny ingrowth and interactions with materials (e.g., Bremsstrahlung x-ray emissions, alpha-neutron interactions, etc.)
	Material at risk is identified	Accident may extend to nearby systems or facilities thereby increasing source term Justification should be provided for other aspects of the 5 factor formula (DR, ARF, LPF, RF, etc.)
(2) Release Mechanism or Initiating Event is Defined		
	Loss of Containment Shielding Breach Spill Fire Explosion	Justification should be provided for estimates of event frequencies considered "unlikely" or "highly unlikely"
(3) External Exposures are Correctly Assessed		
	Residence time should be justified Distance from source should be justified Shielding should be realistic	Consider scattering (build-up or skyshine) and interaction (n, γ) contributions Calculations should be verifiable and assumptions justified
(4) Internal Exposures are Correctly Assessed		
	Pathways considered should include: Inhalation Ingestion Absorption Injection	Residence time, release rates, and respiratory protection should be justified when considering inhalation exposures Include uranium toxicity consideration for soluble materials Sequences involving acids or submersions may result in absorption Sequences involving handling of sharps or systems under pressure may result in injection Calculations should be verifiable and assumptions justified
(4) Receptors		
	Exposure assessment should include: Occupational Public	Should justify varying residence times, inhalation rates, and consider sensitive populations, etc.
(5) Computer Codes Used (if applicable)		
	Microshield MCNP Rascal Hotspot CINDY IMBA	Others acceptable if commonly in use and/or have been verified and benchmarked Codes should either use dose conversion methodology for which licensee is authorized (e.g., ICRP 2 vs. ICRP 30 vs. ICRP 60, etc.) or else shown to be equivalent or conservative relative to 10 CFR Part 20