

RADIATION SAFETY

4.1 RADIATION SAFETY PROGRAM

4.1.1 PURPOSE OF REVIEW

The purpose of this review is to determine, with reasonable assurance, that the applicant's radiation safety (RS) program is adequate to protect the radiological health and safety of the workers and to comply with the regulatory requirements of 10 CFR Parts 19, 20, and 70.

The applicant's program for protection of members of the public and control of effluent releases is not included in this Chapter but is in SRP Chapter 9.0, "Environmental Protection." While this chapter reviews the applicant's RS *program*, radiation safety design aspects of the facility and the radiation safety aspects of the integrated safety analysis (ISA) are reviewed under SRP Chapter 4.2, "Radiation Safety Design Features."

4.1.2 RESPONSIBILITY FOR REVIEW

Primary: Health Physicist

Secondary: None

Supporting: Licensing Project Manager (as reviewer of SRP Chapters 2.0, 3.0 and Section 11.4)

Environmental Engineer (as reviewer of SRP Chapter 9.0)

Quality Assurance Specialist (as reviewer of SRP Section 11.1)

4.1.3 AREAS OF REVIEW

An RS program is required to be established and implemented by 10 CFR 20.1101. (As used in this SRP the terms *Radiation Safety Program* and *Radiation Protection Program* are synonymous). The elements of the applicant's proposed RS program that should be reviewed by the staff are identified in the following list.

1. As Low as Is Reasonably Achievable (ALARA) Considerations

The applicant's management policy should be reviewed with respect to designing and constructing the plant, operating the plant, and the planned organizational structure and how units of that structure interact to maintain occupational doses ALARA. The applicable activities and audits carried on by the individuals in management having responsibility for RS, and commitments to radiological performance goals (ALARA goals) and trend analyses should also be reviewed.

2. Organizational Relationships and Personnel Qualifications

The applicant's organization of the RS program, the qualification requirements for the RS personnel, and the assignment of specific responsibilities and authorities for key functions should be reviewed.

Radiation Safety

3. Radiation Safety Procedures and Radiation Work Permits (RWPs)

The applicant's commitments regarding the need for, development and control of, and use of approved written RS procedures and RWPs for activities related to radiological safety should be reviewed.

4. Training

The applicant's proposed RS training for all personnel who have authorized access to restricted areas should be reviewed. The review should include training objectives, management oversight, methodology of training, who receives training, a description and frequency of training and refresher training, and the effectiveness of the training. Further aspects of training are covered in SRP Section 11.4.

5. Air Sampling

The applicant's radiological air sampling objectives and commitments to procedures should be reviewed including the following:

- a. The frequency and methods of analysis of airborne concentrations,
- b. Sampling methods and frequencies,
- c. Counting techniques,
- d. Lower limits of detection,
- e. Specific calculations for concentrations,
- f. Action levels and actions to be taken when they are exceeded, and
- g. The locations of continuous air monitors and annunciations and alarms associated with them.

Note that the related area of ventilation systems is reviewed under SRP Section 4.2.

6. Contamination Control

The applicant's control of radiological contamination within the facility including the types and frequency of surveys, administrative contamination threshold levels, the methods and choice of instruments used in the surveys, and the action levels and actions to be taken if exceeded should be reviewed. The design features to control access should also be reviewed, including the following:

- a. The technical criteria and levels for defining contamination and high contamination areas,
- b. The types and availability of contamination monitoring equipment,
- c. Specific limits established for personnel decontamination,
- d. Minimum provisions for personnel decontamination,
- e. The minimum types of clothing needed to enter contaminated areas,
- f. The release criteria for contaminated materials, and
- g. The frequency of periodic review of all aspects of access control.

7. External Exposure

The applicant's program for monitoring personnel external radiation dose including the means to measure, assess and record personnel radiation dose should be reviewed. In addition, the types, range, sensitivity, accuracy, and frequency for analyzing personnel dosimetry and the action levels and actions to be taken if action levels or limits are exceeded should be reviewed.

8. Internal Exposure

The applicant's program for monitoring personnel internal radiation doses should be reviewed including the following:

- a. The criteria for determining when it is necessary to monitor an individual's internal dose,
- b. The methods for determining intake,
- c. Frequency of analyses,
- d. Minimum detection levels,
- e. Action levels and actions to be taken when exceeded.

9. Summing Internal and External Exposure

The applicant's program for summing internal and external exposure, including the procedures used to combine a worker's internal and external dose to demonstrate compliance with NRC regulations, should be reviewed.

10. Respiratory Protection

The applicant's respiratory protection program, including equipment to be used, conditions under which respiratory protection is necessary for routine and non-routine operations, the protection factors to be applied when respirators are being employed, and the locations of respiratory equipment in the plant should be reviewed.

11. Instrumentation

The applicant's provisions for radiological measurement instrumentation, including maintenance and use, ranges, counting modes, sensitivity, alarm set points, planned use, and calibration frequency should be reviewed.

4.1.4 ACCEPTANCE CRITERIA

4.1.4.1 Regulatory Requirements

Regulations applicable to this SRP chapter are listed below [the relevant Acceptance Criteria section is in brackets following the regulatory citation].

Radiation Safety

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

§ 19.12 *Instruction to Workers [Sections 4.1.4.3.1, 4.1.4.3.4]*

§ 19.13 *Notifications and Reports to Individuals [Sections 4.1.4.3.7, 4.1.4.3.8]*

Code of Federal Regulations, *Title 10, Energy, Part 20, "Standards for Protection Against Radiation."*

§ 20.1101 *Radiation Protection Programs [Sections 4.1.4.3.1 (Part 20.1101(b)), 4.4.3.3]*

§ 20.1201 *Occupational Dose Limits For Adults [Sections 4.1.4.3.7 (Part 20.1201(a)(1), (a)(2) and (c)), 4.1.4.3.8 (Part 20.1201(a)(1), (d) and (e)), 4.1.4.3.9 (Part 20.1201(a)(1) and (f))]*

§ 20.1202 *Compliance with Requirements for Summation of External and Internal Doses [Section 4.1.4.3.9]*

§ 20.1203 *Determination of External Dose from Airborne Radioactive Material [Section 4.1.4.3.7]*

§ 20.1204 *Determination of Internal Exposure [Sections 4.1.4.3.5, 4.1.4.3.8]*

§ 20.1206 *Planned Special Exposures [Section 4.1.4.3.7]*

§ 20.1207 *Occupational Dose Limits for Minors [Sections 4.1.4.3.7, 4.1.4.3.8, 4.1.4.3.9]*

§ 20.1208 *Dose to Embryo/Fetus [Sections 4.1.4.3.7, 4.1.4.3.8, 4.1.4.3.9]*

§ 20.1301 *Dose Limits for Individual Members of the Public [Sections 4.1.4.3.7 (Parts 20.1301(a)(1), (a)(2), (b), and (c))]*

§ 20.1302 *Compliance with Dose Limits for Individual Members of the Public [Sections 4.1.4.3.7 (Parts 20.1302(a), (b)(1) and (b)(2)(ii))]*

§ 20.1406 *Minimization of Contamination [Section 4.1.4.3.6]*

§ 20.1501 *Surveys and Monitoring - General [Sections 4.1.4.3.6 (Parts 20.1501 (a)(2)(ii) and (a)(2)(iii)), 4.1.4.3.7 (Parts 20.1501(a)(2)(i) and (c)), 4.1.4.3.11 (\$20.1501(b) and (c))]*

§ 20.1502 *Conditions Requiring Individual Monitoring of External and Internal Occupational Doses [Sections 4.1.4.3.7 (Part 20.1502(a)), 4.1.4.3.8 (Part 20.1502(b))]*

§ 20.1601 *Control of Access to High Radiation Areas [Section 4.1.4.3.7]*

- § 20.1602 *Control of Access to Very High Radiation Areas* [**Sections 4.1.4.3.6, 4.1.4.3.7**]
- § 20.1701 *Use of Process or Other Engineering Controls* [**Section 4.1.4.3.10**]
- § 20.1702 *Use of Other Controls* [**Section 4.1.4.3.10**]
- § 20.1703 *Use of Individual Respiratory Protection Equipment* [**Sections 4.1.4.3.5, 4.1.4.3.6** (Part 20.1703(a)(3)(ii)), **4.1.4.3.8** (Parts 20.1703(a)(3)(ii) and (b)), **4.1.4.3.10** (Parts 20.1703(a), (c) and (d))]
- § 20.1901 *Caution Signs* [**Sections 4.1.4.3.6, 4.1.4.3.7**]
- § 20.1902 *Posting Requirements* [**Sections 4.1.4.3.5** (Part 20.1902(d)), **4.1.4.3.6** (Part 20.1902(e)), **4.1.4.3.7** (Parts 20.1902(a), (b) and (c)), **4.1.4.3.8** (Part 20.1902(d))]
- § 20.1904 *Labeling Containers* [**Section 4.1.4.3.6**]
- § 20.1906 *Procedures for Receiving and Opening Packages* [**Sections 4.1.4.3.6, 4.1.4.3.7**]
- § 20.2101 *Records-General Provisions* [**Sections 4.1.4.3.7, 4.1.4.3.8, 4.1.4.3.9**]
- § 20.2102 *Records of Radiation Protection Programs* [**Section 4.1.4.3.1**]
- § 20.2103 *Records of Surveys* [**Sections 4.1.4.3.5, 4.1.4.3.6, 4.1.4.3.7, 4.1.4.3.8, 4.1.4.3.11**]
- § 20.2104 *Determination of Prior Occupational Dose* [**Section 4.1.4.3.9**]
- § 20.2105 *Records of Planned Special Exposures* [**Sections 4.1.4.3.7, 4.1.4.3.8, 4.1.4.3.9**]
- § 20.2106 *Records of Individual Monitoring Results* [**Sections 4.1.4.3.7, 4.1.4.3.8, 4.1.4.3.9**]
- § 20.2110 *Form of Records* [**Sections 4.1.4.3.1, 4.1.4.3.5, 4.1.4.3.6, 4.1.4.3.7, 4.1.4.3.8, 4.1.4.3.9, 4.1.4.3.10**]
- 20.2202 *Notification of Incidents* [**Sections 4.1.4.3.7** (Parts 20.2202(a)-(d)), **4.1.4.3.8** (Parts 20.2202(a)-(d)), **4.1.4.3.9** (Parts 20.2202(a)-(d))]
- § 20.2203 *Reports of Exposures, Radiation Levels, and Concentrations of Radioactive Materials Exceeding the Limits* [**Sections 4.1.4.3.5** (Parts 20.2203(a)(3)(i)-(ii), (b), and (d)), **4.1.4.3.6** (Parts 20.2203(a)(3)(i)-(ii) and (b)), **4.1.4.3.7** (Parts 20.2203(a)(2), (a)(3)(i)-(ii), (b) and (d)), **4.1.4.3.8** (Parts 20.2203(a)(2), (b), and (d), **4.1.4.3.9** (Parts 20.2203(a)(2), (b), and (d))]

Radiation Safety

§ 20.2206 *Reports of Individual Monitoring* [Sections 4.1.4.3.7, 4.1.4.3.8, 4.1.4.3.9]

Code of Federal Regulations, Title 10, Energy, Part 70, "Domestic Licensing of Special Nuclear Material"

§ 70.22 *Contents of Applications* [Sections 4.1.4.3.2 (Part 70.22(a)(6)), 4.1.4.3.3 (Part 70.22(a)(8)), 4.1.4.3.4 (Part 70.22(a)(6)), 4.1.4.3.5 (Part 70.22(a)(7))]

§ 70.23 *Requirements for Approval of Applications* [Sections 4.1.4.3.2, 4.1.4.3.3 (Part 70.23(a)(2))]

4.1.4.2 Regulatory Guidance

Listed in this section are NRC Regulatory Guides (RGs), NUREG reports, Branch Technical Positions (BTPs), and industry standards that, in general, provide a basis that is generally acceptable to the NRC staff for satisfying the regulatory requirements listed in Section 4.1.4.1. The applicable Acceptance Criteria sections, to which a particular guidance document relates, are listed in brackets following each guidance document.

1. NRC Regulatory Guides (RGs)

RG 8.4 Feb. 1973 *Direct and Indirect-Reading Pocket Dosimeters* [Section 4.1.4.3.7]

RG 8.7 Rev. 1 June 1992 *Instructions for Recording and Reporting Occupational Radiation Exposure Data* [Sections 4.1.4.3.7, 4.1.4.3.8, 4.1.4.3.9]

RG 8.9 Rev. 1 July 1993 *Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program* [Section 4.1.4.3.8]

RG 8.10 Rev. 1-R May 1977 *Operating Philosophy for Maintaining Occupational Radiation Exposures As Low as is Reasonably Achievable* [Section 4.1.4.3.1, 4.1.4.3.2, 4.1.4.3.3, 4.1.4.3.4]

RG 8.13 *Instructions Concerning Prenatal Radiation Exposures* [Section 4.1.4.3.8] (Draft DG-801 proposed Rev. 3, Oct. 1994).

RG 8.15 Oct. 1976 *Acceptable Programs for Respiratory Protection* [Section 4.1.4.3.10]

RG 8.21 Rev. 1 Oct. 1979 *Health Physics Surveys for Byproduct Material at NRC Licensed Processing and Manufacturing Plants* [Section 4.1.4.3.6]

RG 8.25 Rev. 1 June 1992 *Air Sampling in the Workplace* [Sections 4.1.4.3.5, 4.1.4.3.8]

RG 8.28	Aug. 1981	<i>Audible Alarm Dosimeters</i> [Sections 4.1.4.3.7, 4.1.4.3.11]
RG 8.29 Rev. 1	Feb. 1996	<i>Instructions Concerning the Risks from Occupational Radiation Exposure</i> [Section 4.1.4.3.4]
RG 8.34	July 1992	<i>Monitoring Criteria and Methods to Calculate Occupational Radiation Doses</i> [Sections 4.1.4.3.7, 4.1.4.3.8, 4.1.4.3.9]
RG 8.35	June 1992	<i>Planned Special Exposures</i> [Sections 4.1.4.3.7, 4.1.4.3.8, 4.1.4.3.9]
RG 8.36	July 1992	<i>Radiation Dose to the Embryo/Fetus</i> [Section 4.1.4.3.9]

2. NRC NUREG REPORTS

NUREG-0041	Oct. 1976	<i>Manual of Respiratory Protection against Airborne Radioactive Materials</i> [Sections 4.1.4.3.4, 4.1.4.3.5, 4.1.4.3.10]
NUREG-1400	Sept. 1993	<i>Air Sampling in the Workplace</i> [Section 4.1.4.3.5]

3. NRC Branch Technical Positions (BTPs)

April 1993	<i>License Condition for Leak Testing Sealed Byproduct Material Sources</i> [Section 4.1.4.3.6]
April 1993	<i>License Condition for Leak Testing Sealed Plutonium Sources</i> [Section 4.1.4.3.6]
April 1993	<i>License Condition for Plutonium Alpha Sources</i> [Section 4.1.4.3.6]
April 1993	<i>License Condition for Leak Testing a Sealed Source which Contains Alpha and/or Beta-Gamma Emitters</i> [Section 4.1.4.3.6]
April 1993	<i>License Condition for Leak Testing Sealed Uranium Sources</i> [Section 4.1.4.3.6]
April 1993	<i>Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material</i> [Section 4.1.4.3.6]

4. Industry Standards: (Although these industry standards represent acceptable practices of the nuclear industry, and have been successfully utilized in past licensing actions, in some cases their use has not been endorsed by NRC through a regulation or RG. Further, inclusion in this SRP is not necessarily an endorsement of a particular standard by NRC. Therefore, their use is encouraged, but alternative, equivalent methods may be proposed in the application with adequate justification.)

Radiation Safety	
ANSI N13.30, 1996	<i>Performance Criteria for Radiobioassay</i> [Section 4.1.4.3.8]
ANSI N13.4-1971	<i>Specification for Portable X- or Gamma-Radiation Survey Instruments</i> [Section 4.1.4.3.11]
ANSI N13.6-1966 r.1989	<i>Practice for Occupational Radiation Exposure Records Systems</i> [Section 4.1.4.3.9]
ANSI N13.11-1983	<i>Dosimetry-Personnel Dosimetry Performance-Criteria for Testing</i> [Section 4.1.4.3.7]
ANSI N13.15-1985	<i>Radiation Detectors - Personnel Thermoluminescence Dosimetry Systems - Performance</i> [Section 4.1.4.3.7]
ANSI N13.27-1981	<i>Performance Requirements for pocket-Sized Alarm Dosimeters and Alarm Ratemeters</i> [Section 4.1.4.3.7]
ANSI N42.12-1980	<i>Calibration and Usage of Sodium Iodide Detector Systems</i> [Section 4.1.4.3.11]
ANSI N42.15-1980	<i>Performance Verification of Liquid Scintillation Counting Systems</i> [Section 4.1.4.3.11]
ANSI N42.17A-1989	<i>Performance Specifications for Health Physics Instrumentation - Portable Instrumentation for Use in Normal Environmental Conditions</i> [Section 4.1.4.3.11]
ANSI N42.17B-1989	<i>Performance Specifications for Health Physics Instrumentation - Occupational Airborne Radioactivity Monitoring Instrumentation</i> [Sections 4.1.4.3.5, 4.1.4.3.8, 4.1.4.3.11]
ANSI N322-1977	<i>Inspection and Test Specifications for Direct and Indirect Reading Quartz Fiber Pocket Dosimeters</i> [Section 4.1.4.3.7]
ANSI N323-1978 r.1983	<i>Radiation Protection Instrumentation Tests and Calibrations</i> [Sections 4.1.4.3.6, 4.1.4.3.7, 4.1.4.3.11]
ANSI N542-1977	<i>Sealed Radioactive Sources Classification</i> [Section 4.1.4.3.6]
ANSI Z88.2-1992	<i>Practices for Respiratory Protection</i> [Section 4.1.4.3.10]
ANSI Z88.6-1984	<i>Physical Qualifications for Respirator Use</i> [Section 4.1.4.3.10]
ASTM C986-1989 r.1995	<i>Developing Training Programs for the Nuclear Fuel Cycle</i> [Section 4.1.4.3.4]

4.1.4.3 Regulatory Acceptance Criteria

4.1.4.3.1 ALARA (As Low as is Reasonably Achievable)

Acceptability of the application should be based on a finding of reasonable assurance that the applicant would meet those requirements of 10 CFR 19.12 and 10 CFR 20.1101(b) related to ALARA, and the following Acceptance Criteria, or information describing acceptable alternatives:

1. Policy Considerations:

Acceptability should be based on a clear statement in the application of the applicant's policies and provisions for maintaining individual and collective doses at levels that are ALARA, and the approach toward addressing the regulatory guidance of RG 8.10 with regard to the following:

- a. Ensuring that all plant personnel are aware of management's commitment to ALARA.
- b. Ensuring the performance of periodic reviews to determine if doses can be lowered.
- c. Ensuring the qualifications and appropriate staffing of the RS organization.
- d. Ensuring the appropriate authority and independence of the RS manager.
- e. Ensuring that all workers receive sufficient and appropriate initial and periodic training.
- f. Ensuring that modifications to procedures, facilities, and equipment will be justified.
- g. Ensuring that workers and management will be held accountable for their radiological performance.
- h. Ensuring that plant contamination will be minimized, to the extent practicable.

2. Design Considerations:

Facility design aspects related to ALARA should be reviewed using SRP Section 4.2.

Radiation Safety

3. Operational Considerations:

Acceptability of the application's ALARA operational considerations should be based on a comparison with the guidance in RG 8.10 related to vigilance of the radiation safety manager (RSM) and RS staff, including the following:

- a. RSM and RS staff will periodically review doses associated with procedures, radiation work permits, and ALARA goals to identify trends (with special audits for unusual exposures).
- b. Adequate equipment and supplies will be available to the RS staff to perform all personnel dosimetry, environmental monitoring, and bioassay functions.
- c. A system of pre-planning work exists such that progressively higher levels of approval will be required for high-dose activities.
- d. A system of operational radiological performance goals (also called ALARA goals) is established.
- e. The application should contain a commitment to perform trending analyses during operation of the facility. Examples of trend analysis variables are:
 - i. Radiation exposures of plant workers and members of the public,
 - ii. Concentrations of airborne radioactivity in plant areas,
 - iii. Radioactive contamination in plant areas and on equipment,
 - iv. Operation/malfunctions of radiation measurement instrumentation and respiratory protection equipment,
 - v. Concentrations of radioactive material in gaseous and liquid effluents, and
 - vi. Operation of effluent treatment systems (the last two trending parameters are reviewed in SRP Chapter 9.0, but are included here for completeness)

The system for operational ALARA goals should be acceptable if they are specified in the application, along with their bases and a qualitative description of how they will be achieved (i.e., numerical goals are not expected in the application, but a commitment towards achieving ALARA goals and a methodology for achieving them should be described). Acceptable bases for goals could be collective dose, contamination events of skin or clothing, intakes of radioactive material, contamination areas, radioactive waste generation, and liquid and gaseous releases. Goals are acceptable if: (1) they are measurable, realistic, auditable, and challenging; (2) senior management periodically reviews the goals and progress towards meeting them, and (3) they are evaluated and adjusted accordingly on at least an annual basis.

4. ALARA Committee:

The ALARA committee should be acceptable if it is designated and assigned responsibility and authority for implementing ALARA policy, including the following elements:

- a. The ALARA committee is shown to have an organizational structure in which RS personnel will interact, in a timely manner, with production personnel to ensure the methods and techniques for reducing occupational dose are incorporated in facility operation
- b. The ALARA committee will perform or receive the results of audits of the RS program at least annually, and reviews the results of the RS organization's internal audits
- c. The ALARA committee membership should include a chairman, and management or worker representatives from the RS organization, environmental organization, engineering, safety, and production
- d. The ALARA committee will evaluate all major design activities, experiments, or plant modifications, and considers the results of the ISA in determining whether further reduction in occupational radiation doses are reasonable
- e. The ALARA committee will evaluate trend analyses and the adequacy and implementation of radiological performance (ALARA) goals
- f. The reviews and recommendations of the ALARA committee will be documented and tracked to completion.

4.1.4.3.2 Organizational Relationships and Personnel Qualifications

Acceptability of the application should be based on a finding of reasonable assurance that the applicant would meet those requirements of 10 CFR 70.22(a)(6) and 70.23(a)(2) related to Organizational Relationships and Personnel Qualifications, and the following Acceptance Criteria, or information describing acceptable alternatives:

1. The organizational relationships with respect to RS should be acceptable if the RS functions and responsibilities of the RS staff, operations, support, and engineering organizations are clearly identified; and if each position with RS functions including authorities and responsibilities such as those identified in RG 8.10, §C.1(c) is defined and identified. RS functions include those of the RSM, the RS staff (specialists and technicians), the RS engineering function, the RS training function, RS monitoring and surveillance, dosimetry and counting services, and RS auditing.
2. The application should be acceptable if it provides a description of the organizational relationships that are to exist between the positions identified as responsible for RS functions and other (line) managers, and if the plant manager, or equivalent, has overall responsibility and authority for safety.

Radiation Safety

3. The responsibilities of the RSM (or equivalent) should be acceptable if it is demonstrated that he/she will have direct responsibility for establishing and implementing the RS program, have input to facility design and operational planning, have assigned organizational emergency duties through the site emergency plan, have stop-work authority, will be independent of operations, and have direct access to the plant manager [See RG 8.10 C.1(e)].
4. The functional organization of the RS staff should be acceptable if RS specialists are shown to have responsibility for specific activities assigned to the RS program (e.g., dosimetry, surveys, audits, bioassay, and calibration) with RS technicians implementing these functions.
5. The minimum staffing of the RS organization should be acceptable if it is based on ensuring that, by shift, all routine RS functions can be performed in a timely manner, and that all RS requirements can be met during routine operations, non-routine operations such as anticipated events, and accidents. For periods of extended absence of the RSM (because of vacations, illness, etc.), a qualified substitute should be available to act on his behalf; this includes qualifications for emergency duties.
6. It is acceptable for certain RS technical support or audit activities (e.g., instrument calibration and dosimetry) to be contracted to qualified off-site corporate or consultant organizations. In these cases, acceptability should be based on a determination that these organizations and their responsibilities are specified in the application, along with a demonstration of how the acceptance criteria of this Section are to be satisfied by the contractor.
7. The RS personnel qualifications should be acceptable if they are based on the following education and experience criteria:
 - a. the RSM has a bachelor's degree in science or engineering and at least 5 years experience in applied radiological controls at an operating nuclear facility;
 - b. RS specialists have a bachelor's degree in science and engineering and at least 1 year of experience in applied radiological controls at an operating nuclear facility; and
 - c. RS technicians have a high school diploma or equivalent, technical training commensurate with their assigned duties (dosimetry, bioassay, etc.), and certification in a technician trainee program.

4.1.4.3.3 Radiation Safety Procedures and Radiation Work Permits (RWPs)

Acceptability of the application should be based on a finding of reasonable assurance that the applicant would meet those requirements of 10 CFR 20.1101 related to Radiation Safety Procedures and Radiation Work Permits (RWPs), and the following Acceptance Criteria, or information describing acceptable alternatives:

1. Activities involving exposure to licensed material should be acceptable if performed in accordance with written, approved RS procedures and/or RWPs.
2. Review, revision, and updating of RS procedures and RWPs should be acceptable if performed periodically, to identify situations for reducing doses] at intervals not exceeding 2 years. Procedures should be reviewed and approved by the RSM, or an individual who has the qualifications of the RSM [RG 8.10 §C.2(b)].
3. Development, maintenance, and use of RS procedures and RWPs should be acceptable if performed under appropriate quality assurance (QA) program requirements, in accordance with the applicant's graded QA program (SRP Section 11.1).
4. A mechanism for providing current copies of RS procedures and RWPs to personnel, and a system for ensuring that RWPs are not used past their expiration date, should be established.
5. A system for receiving and reviewing RS related suggestions from employees should be established, and workers are made knowledgeable of this process [RG 8.10 §C.2(b)].
6. The system for implementing RWPs should be acceptable if the applicant specifies:
 - a. How a determination is made to use an RWP,
 - b. The levels of approval and positions in the organization authorized to approve and issue RWPs,
 - c. The types of information included on an RWP (see acceptance criteria that follows),
 - d. Provisions for updating/terminating RWPs, including a system to update RWPs when tasks or environmental changes affect worker safety,
 - e. Records to be kept for RWPs and retention times, and
 - f. Final disposition of RWPs.
7. The applicant should commit to the use of special reviews and approvals before conducting an activity involving licensed materials with an RWP that is not covered by a written radiation safety procedure.
8. Preparation and approval of RWPs should be acceptable if approval is required from other organizational groups, to ensure that provisions of the RWP address all potential hazards (not just radiological hazards) and operations comply with all applicable regulations.
9. The information on RWPs should be acceptable if it is sufficient to allow independent inspection and reconstruction of the circumstances necessitating the RWP, the factors included, and the results.
10. The applicant should commit to a system that ensures that RWPs are not used past their termination dates. The system should include what types of records are to be kept, the retention times for these records, and the final disposition of the RWP. The record system should be sufficient to allow independent auditors to reconstruct the circumstances necessitating the RWP, the factors included, and the results.

Radiation Safety

11. The applicant should commit to using RWPs for specific purposes only and RWPs are reissued when significant changes in the task or changes that affect the safety of the worker are made. The application should state that the RWP will include a list of the safety requirements for work conducted under the authorization and include at least the following, as applicable:
 - a. The number of and identification of personnel working on the task;
 - b. Expected radiological conditions (radiation, contamination, and airborne levels);
 - c. Type and frequency of monitoring and dosimetry (e.g., continuous air monitor [CAM], self alarming dosimetry);
 - d. Estimated exposure time and doses for the authorization;
 - e. Limiting exposure times and doses for the authorization;
 - f. Special instructions or equipment (e.g., mock-up required, special shielding required);
 - g. Personnel protective equipment (PPE) requirements;
 - h. Authorization signature and date;
 - i. Actual doses, time, or other information resulting from the completed work authorization are recorded on the RWP (RG 8.10 §C.2(a)); and
 - j. Expiration/termination date of the RWP.

4.1.4.3.4 Radiation Training

Acceptability of the application should be based on a finding of reasonable assurance that the applicant would meet those requirements of 10 CFR 19.12, 70.22(a)(6), and 70.23(a)(2) related to RS training, and the following Acceptance Criteria, or information describing acceptable alternatives:

1. Site access should be acceptable if all personnel and visitors entering restricted areas receive either:
 - a. A general indoctrination in site-specific safe practices and emergency situations and escort by an individual who has received RS training, or
 - b. RS training.
2. Frequency of RS training should be acceptable if given prior to occupational exposure and periodically thereafter (RG 8.29); for TWRS, refresher RS training should be completed not later than 2 years following the most recent RS training (can be a condensed version of initial training with emphasis on changes in policy, procedures, requirements, and facilities). However, retraining for employees authorized to perform “higher-risk” work (e.g., work on glove boxes, in high contamination areas, high radiation area entry, etc.) should be acceptable if they receive annual requalification (ASTM E1168-1995).
3. The process for developing an RS training program should be acceptable to NRC staff if it follows the process outlined in ASTM C986-89 (reapproved 1995). The acceptability of the RS training program objectives, content, testing, requalifications, recordkeeping, and audits

should be based on a comparison with the ASTM E1168-1995 standard and Appendix A of RG 8.29. Equivalence should be demonstrated where these standards are not used.

4. The technical content and extent of RS training should be acceptable if it is commensurate with the radiological risk present in the workplace (RG 8.29 and ASTM C986-1995); and is accomplished by grading the training requirements for general employees, radiation workers (possibly more than one type), RS technicians, and supervisors. In addition, training for all groups, except general employee training, should be acceptable if it includes practical demonstrations, by trainees, of proper equipment use, dosimetry use, PPE use, and incident (e.g., spill) response.
5. The verification of received training should be acceptable if each trainee acknowledges in writing that the RS training has been received and understood (RG 8.29), and records of most recent training and testing are maintained as specified in ASTM E1168-1995.

4.1.4.3.5 Air Sampling

Acceptability of the application should be based on a finding of reasonable assurance that the applicant would meet those requirements of 10 CFR 20.1204; 20.1703; 20.1902(d); 20.2103; 20.2110; 20.2203(a)(3)(i)-(ii), (b), and (d); and 10 CFR 70.22(a)(7) related to air sampling, and the following Acceptance Criteria, or information describing acceptable alternatives:

1. The commitment to provide an air sampling program should be acceptable if a program is evidenced that is consistent with the positions in RG 8.25, including evaluating the need for air sampling, locating samplers, sample representativeness, conditions for adjusting derived air concentrations (DACs), measuring sampled air volume, and evaluating results. NUREG-1400 is a sister document to RG 8.25, and presents examples, methods, and techniques for implementing the recommendations of RG 8.25.
2. The basis for the air sampling program should be acceptable if:
 - a. For each work area, a determination that the frequency for analyzing airborne levels of radioactivity, counting techniques, action levels and actions to be taken when action levels are exceeded, and alarm set points are adequate to meet Part 20, and
 - b. Calculations and verification of airborne concentrations in various areas are controlled under the applicant's QA program (SRP Section 11.1).
3. The use of and specifications for air sampling instrumentation should be acceptable if consistent with RG 8.25 and ANSI N42.17B-1989. Calibration methods and frequencies for air sampling instruments are acceptable if they ensure proper operation of the instrumentation, including the operation of flow rate meters. The use of CAMs is acceptable if the locations of detectors, readouts, annunciators, and alarms are specified. (This information can be provided in SRP Section 4.2.4.3.1, under plant and process drawings).
4. The use of action levels for airborne activity should be acceptable if a demonstration that the action levels used are appropriate technical criteria to determine the necessary

Radiation Safety

controls, and if the demonstration includes the minimum detectable concentrations for the radionuclides of interest.

4.1.4.3.6 Contamination Control

Acceptability of the application should be based on a finding of reasonable assurance that the applicant would meet those requirements of 10 CFR 20.1406; 20.1501(a)(1) and (a)(2)(ii)-(iii); 20.1703(a)(3)(ii); 20.1901; 20.1902(e); 20.1904; 20.1906; 20.2103; 20.2110; 20.2203(a)(3)(i)-(ii), and (b); and 10 CFR 70.22(a)(7) related to contamination control, and the following Acceptance Criteria, or information describing acceptable alternatives:

1. Facility operating procedures should include procedures that minimize, to the extent practicable, contamination in the facility pursuant to 10 CFR 20.1406; and a commitment to a contamination survey program.
2. The contamination survey program should be acceptable if it is based on the information provided in RG 8.21 on contamination level limits and types, methods, instruments, and frequencies of surveys. Acceptability should be based on specification, for each area, the types of radiation, the criteria for contamination action levels, for both removable and fixed contamination, and the action levels and actions to be taken if exceeded. Contamination surveys should be acceptable if conducted routinely for the accessible areas of the plant site where contamination is likely, if the types of instruments and methods used in the surveys are adequate to allow assessment of working conditions, and if the instruments are sufficiently sensitive to measure contamination at or below the assigned action levels, and tested and calibrated in accordance with ANSI N323 (or equivalent).
3. Features of the facility that help control contamination should be acceptable if consistent with RG 8.21 and included in the facility descriptions (e.g., fume hoods, step-off pads, personnel monitoring equipment at egress points). (This information can be provided in SRP Section 4.2.4.3.1).
4. The policy for controlling contamination should be acceptable if clearly stated, and if it mandates the use of personnel monitoring equipment, and that personnel perform a whole body survey each time they leave a known contamination area, or a minimum hand and shoe survey each time they leave a potentially contaminated restricted area.
5. Access control and security of stored radioactive material should be acceptable if in accordance with Part 20 and if periodic reviews are performed to verify:
 - a. Proper posting, labeling, and operability of access controls;
 - b. Proper identification of restricted areas to prevent the spread of contamination;
 - c. Sufficient numbers and appropriate locations step-off pads, change facilities, PPE facilities, and personnel monitoring equipment.

6. Removal of equipment and materials from contaminated areas should be acceptable if a system is established to ensure that equipment and materials removed from contaminated areas are not contaminated above specific release levels. The contamination levels of items (tools, equipment, etc.) given release clearance should be acceptable if in accordance with NRC's BTP, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material."
7. The use of maximum personnel contamination levels for skin and clothing should be acceptable if established and specified, consistent with RG 8.21; and if means are used to detect contamination in excess of these levels, then decontaminate, investigate, correct and document the source, probable cause, and other pertinent information. The minimum detectable levels should be stated.
8. Contamination surveys, investigations, corrective actions, and reviews should be documented, along with deficiencies. This documentation should be reviewed by the RSM for possible trends and needed corrective actions. Contamination levels and contaminated areas should be tracked as part of the ALARA goals (see Section 4.1.4.3.1).
9. The sealed source leak testing program is acceptable if performed in accordance with written procedures in accordance with the 5 NRC BTPs listed in Section 4.1.4.2, and if procedures include acceptable contamination levels, test frequencies, and actions if limits are exceeded.

4.1.4.3.7 External Exposure

Acceptability of the application should be based on a finding of reasonable assurance that the applicant would meet those requirements of 10 CFR 19.13; 10 CFR 20.1201(a)(1)-(2) and (c); 20.1203; 20.1206; 20.1207; 20.1208; 20.1301(a)(1)-(2), (b) and (c); 20.1302(a), (b)(1), and (b)(2)(ii); 20.1501(a)(1), (a)(2)(i) and (c); 20.1502(a); 20.1601; 20.1602; 20.1901; 20.1902(a), (b) and (c); 20.1906; 20.2101; 20.2103; 20.2106; 20.2110; 20.2202(a)-(d); 20.2203(a)(2), (a)(3)(i)-(ii), (b) and (d); 20.2206; and 10 CFR 70.22(a)(7) related to external exposure, and the following Acceptance Criteria, or information describing acceptable alternatives:

1. Acceptable determinations of who are and are not occupationally exposed individuals, and who is to be monitored for exposure are given in RG 8.34. For non-occupationally exposed workers, the limits for members of the public apply, and acceptability is based on compliance with the surveys required by 10 CFR 20.1302.
2. The type, range, sensitivity, accuracy, and frequency for personnel dosimetry and area dosimetry (including extremity dosimetry), and methods for recording measured dose, are acceptable if stated and justified based on the types, energy and amount of radiation, and consistent with ANSI N13.11-1983, ANSI N13.15-1985, and ANSI N13.27-1981, ANSI N322-1977, and ANSI N323-r1983.
3. Operational planning systems should be acceptable if dosimetry results are used as a tool, and this process is described and justified in the application. An acceptable program should

Radiation Safety

include use of supplemental dosimetry (e.g., dose and dose rate alarming dosimeters) for work in higher radiation areas, as appropriate, as a means to maintain doses at levels that are ALARA.

4. The use of administrative dose levels, below Part 20 limits, is an acceptable approach for demonstrating that doses are maintained ALARA. The application should be acceptable if the administrative limits are specified, are a fraction (e.g., 20 percent) of Part 20 limits, and actions and approvals necessary to exceed administrative dose limits are identified.
5. Processing and evaluation of personnel dosimetry (except those specified in 10 CFR 20.1501(c)) should be acceptable if processed and evaluated by a dosimetry processor holding accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP), and if the technical bases for ensuring the quality of extremity dosimetry is provided in the application (since these dosimeters do not require NVLAP accreditation).
6. The use of planned special exposures (PSEs) should be acceptable if the requirements of 10 CFR 20.1206, 20.2105, and 20.2206 are satisfied, consistent with RG 8.25.
7. The source identification and control program should be acceptable if:
 - a. Sources of external exposure throughout the facility are identified along with controls and responsibilities for restricted, controlled, and unrestricted areas;
 - b. Methods are identified for materials inventory, movement, and storage, to prevent releases and limit external exposures; and
 - c. Receipt and off-site transfer of radioactive materials will comply with 10 CFR 20.1906, 10 CFR Part 71, and U.S. Department of Transportation requirements (49 CFR 171-178).

4.1.4.3.8 Internal Exposure

Acceptability of the application should be based on a finding of reasonable assurance that the applicant would meet those requirements of 10 CFR 19.13; 10 CFR 20.1201(a)(a), (d) and (e); 20.1204; 20.1207; 20.1208; 20.1501(a)(1); 20.1502(b); 20.1703(a)(3)(ii) and (b); 20.1902(d); 20.2101; 20.2103; 20.2105; 20.2106; 20.2202 (a) and (d); 20.2203(a)(2), (b) and (d); and 20.2206 related to Internal Exposure, and the following Acceptance Criteria, or information describing acceptable alternatives:

1. RG 8.9, RG 8.25, and RG 8.34 provide information, recommendations, and guidance that is acceptable to the NRC staff for establishing and implementing a program to monitor internal doses.
2. The internal dose monitoring program should be acceptable if it specifies:
 - a. Criteria for participation;

- b. Frequencies of routine measurements;
 - c. Use of confirmatory measurements;
 - d. Methods to be used;
 - e. Minimum detectable concentrations (MDCs);
 - f. The action levels and actions to be taken when exceeded;
 - g. The methods for determining worker doses from quantities of radionuclides in the body, in the work area air; and/or combinations of these.
3. When air sampling is used for determining worker intake, the application should be acceptable if it specifies the frequency of sampling and data analyses, the MDC, and the action levels and actions taken when exceeded.
 4. When bioassay is used to determine worker intake, the application should be acceptable if it specifies the types of bioassay used, the frequency of data collection for each type, the MDCs, and the action levels and actions taken when exceeded; and if the applicant commits to a continuing QA program on all phases of the bioassay program, including sample collection, qualifications of laboratory personnel, laboratory intercomparisons, computational checks, and use of appropriate blanks and standards.
 5. Acceptability should be based on statement of a commitment to use engineering controls to limit the intake of radioactive material, including auxiliary ventilation systems (e.g., portable filtration systems) used to control airborne contaminants (e.g., when servicing primary ventilation or machining contaminated surfaces); and containment structures used to protect personnel working in adjacent areas, when feasible.

4.1.4.3.9 Summing Internal and External Exposure

Acceptability of the application should be based on a finding of reasonable assurance that the applicant would meet those requirements of 10 CFR 20.1201(a)(1) and (f); 20.1202; 20.1207; 20.1208; 20.2101; 20.2103; 20.2104; 20.2105; 20.2106; 20.2110; 20.2202(a)-(d); 20.2203(a)(2), (b), and (d); 20.2206; and 10 CFR 70.22(a)(7) related to summing internal and external dose, and the applicant commits to a policy for combining internal and external dose in accordance with RG 8.7, RG 8.34, and RG 8.36.

4.1.4.3.10 Respiratory Protection

Acceptability of the application should be based on a finding of reasonable assurance that the applicant would meet those requirements of 10 CFR 20.1701; 20.1702; 20.1703(a), (c), and (d); and 20.2110 related to respiratory protection, and the following Acceptance Criteria, or information describing acceptable alternatives:

Radiation Safety

1. The respiratory protection program should be acceptable if it provides for meeting ANSI Z88.2, with defined responsibilities and requirements in the areas of training, control and use of respiratory protection equipment, mask-fit testing, and breathing air purity. (ANSI Z88.6 provides additional guidance generally acceptable to NRC staff for respiratory protection medical qualification and examinations.)
2. The use of respiratory protection equipment should be acceptable if the application describes the equipment used, the conditions under which respiratory protection is required for routine and non-routine operations (including anticipated events and accidents), the protection factors that are applied when respirators are used, the locations of respiratory protection equipment in the plant; and if adequate numbers and locations of respiratory protection equipment and current training are to be maintained as needed to satisfy emergency response functions.
3. Acceptability should be based on the application adequately specifying the methods to determine internal dose when respiratory protection equipment is used, or when engineering and administrative controls for respiratory protection are used. The methods should be acceptable if engineered controls are preferred over respiratory protection equipment, and if factors in the dose calculation include the time of exposure to airborne radioactive materials, the measurement and variability of airborne concentrations of radioactive material during the exposure, and for respirators, the respirator's protection factor and proper fitting.

4.1.4.3.11 Instrumentation

Acceptability of the application should be based on a finding of reasonable assurance that the applicant would meet those requirements of 10 CFR 20.1501(b) and (c) and 20.2103 related to RS instrumentation and the following Acceptance Criteria, or information describing acceptable alternatives:

1. The policy for the maintenance and use of operating radiation instrumentation should be acceptable if the applicant commits to continuing availability of sufficient numbers and types of instruments for all routine (Part 20) and emergency operations. The number and types of instruments should be shown to be acceptable through a list in the application of the types of instruments that are to be available, including ranges, counting modes, sensitivities, alarm set points, planned uses, and calibration frequencies. Acceptability should be based on comparison with the information on radiation measuring instruments and instrument calibration in ANSI N42.17A, ANSI N42.17B, and ANSI N323.
2. The applicant's criteria for selecting radiation measuring instruments and equipment should be acceptable if it facilitates:
 - a. Performing radiation and contamination surveys,
 - b. Sampling airborne radioactivity,
 - c. Monitoring area radiation,

- d. Monitoring personnel,
 - e. Performing radioactive analyses, and
 - f. High-range, portable instrumentation, with ranges and a justification for them, as necessary to monitor conditions during and after accidents.
3. The applicant's approach toward instrument calibration should be acceptable if all instruments are to be calibrated at least semi-annually, and recalibrated if the equipment is repaired such that accuracy could be affected.
 4. RS procedures should be acceptable (with respect to RS instrument checks) if they establish daily operational checks of continuously operating RS instruments.
 5. The facilities related to RS instrumentation should be acceptable if the applicant identifies the locations of, and describes the following:
 - a. a radiochemistry laboratory equipped to perform the analyses required by 10 CFR 20.1501;
 - b. a low-background counting room equipped to perform routine counting of all plant samples (water, swipes, air); and
 - c. instrument storage, calibration, decontamination, and maintenance facilities.

4.1.5 REVIEW PROCEDURES

4.1.5.1 Acceptance Review

The primary reviewer should evaluate the application to determine whether it addresses the "Areas of Review" discussed in Section 4.1.3, above. If significant deficiencies are identified, the applicant should be requested to submit additional material before the start of the safety evaluation.

Radiation Safety

4.1.5.2 Safety Evaluation

After determining that the application is acceptable for review in accordance with Section 4.1.5.1, above, the primary reviewer should perform a safety evaluation against the acceptance criteria described in Section 4.1.4. If during the course of the safety evaluation, the primary reviewer determines the need for additional information, the primary reviewer should coordinate a request for additional information with the licensing project manager. The primary reviewer of this SRP section should coordinate the efforts of the secondary reviewers identified in Section 4.1.2, as specified below. The final step would be the preparation of the safety evaluation report (SER) input by the primary reviewer, for the licensing project manager, in accordance with Section 4.1.6, "Evaluation Findings."

The following items should be noted regarding the relationships between the primary reviewer and the secondary reviewers for this SRP section, in performing the safety review:

1. The review performed in this section pertains to programmatic aspects of occupational doses during routine operations and anticipated events. Doses from accidents are reviewed under the SRP chapter dealing with the ISA (SRP Chapter 3.0) and the Radiation Safety Design Features Section (SRP Section 4.2). Doses to the public and the environment, including ALARA, are the subject of SRP Chapter 9.0, "Environmental Protection."
2. The plant organization, functional responsibilities, and qualifications of personnel are also reviewed as part of the SRP chapters on Organization and Administration (SRP Chapter 2.0) and Training and Qualifications (SRP Section 11.4). Applicants may choose to provide the information in this section explicitly, or by providing a reference to those chapters. The primary reviewer of this section coordinates with the primary reviewers of the other chapters to verify the completeness and consistency of the information, and that the acceptance criteria are satisfied.
3. The RS training program and the respiratory protection training program could be described by the applicant in the SRP Section on Training and Qualifications (SRP Section 11.4). Applicants may choose to provide the information in this section explicitly, or by providing a reference to that section. The primary reviewer of this section uses the acceptance criteria in this section to evaluate these commitments, regardless of where they appear in the application.

4.1.6 EVALUATION FINDINGS

The primary reviewer should write an SER section that addresses each topic reviewed under this SRP section and explains why the NRC staff has reasonable assurance that the radiation safety program part of the application is acceptable. License conditions may be proposed to impose requirements where the application is deficient. The SER should include a summary statement of what was evaluated and the basis for the reviewers' conclusions.

The staff can document the evaluation as follows:

The staff has evaluated [Insert a summary statement of what was evaluated and why the reviewer finds the submittal acceptable.] The applicant has committed to an acceptable radiation safety 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 safety personnel; (3) approved written radiation safety procedures or RWPs for radiation safety activities; (4) radiation safety training for all personnel who have access to restricted areas; (5) requirements for radiological air sampling; (7) requirements for control of radiological contamination within the facility; (8) programs for monitoring personnel external and internal radiation exposure; (9) a respiratory protection program; and (10) requirements for radiological measurement instrumentation.

The NRC staff concludes, with reasonable assurance, that the applicant's radiation safety program is adequate and that the applicant has the necessary technical staff to administer an effective radiation safety program that meets the requirements of 10 CFR Parts 19, 20, and 70. Conformance to the application and license conditions should ensure safe operation and provide early detection of unfavorable trends to allow prompt corrective action.

4.1.7 REFERENCES

All referenced documents in the Acceptance Criteria for this review area have been listed in Section 4.1.4.2, and are not repeated here. However, in addition to those documents, the following documents contain information that is specific to nuclear reactors, but which is also relevant to this review area. Applicants may choose to reference portions of these documents in the SAR, with adequate justification.

1. Nuclear Regulatory Commission (U.S.) (NRC). Regulatory Guide 1.33, Rev. 2, "Quality Assurance Program Requirements (Operational)." NRC: Washington, D.C. February 1978.
2. Nuclear Regulatory Commission (U.S.) (NRC). Regulatory Guide 8.8, Rev. 3, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations will be as Low as is Reasonably Achievable." NRC: Washington, D.C. June 1978.
3. Nuclear Regulatory Commission (U.S.) (NRC). Regulatory Guide 1.97, Rev. 3, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environ Conditions During and Following an Accident." NRC: Washington, D.C. May 1983.