

Section 46

Ionizing and Nonionizing Radiation

46.1 Scope

This section applies to Bureau of Reclamation facilities to protect employees from potential exposure to ionizing and nonionizing radiation while performing their job tasks.

46.2 General Requirements

46.2.1 Ionizing and Nonionizing Radiation Levels

Reclamation's goal is to maintain employee exposures as low as reasonably achievable (ALARA) and at no time shall ionizing/nonionizing radiation levels exceed limits set by Federal Occupational Safety and Health (OSHA) 29 CFR 1910.1096, *Ionizing Radiation*, OSHA 1910.97, *Nonionizing Radiation*. At no time shall anyone under 18 years perform work in or around ionizing radiation.

46.2.2 Nuclear Regulatory Commission Licensed Device Requirements

Reclamation facilities using a Nuclear Regulatory Commission (NRC) licensed device must meet the specific requirements of their device(s) outlined in 10 CFR part 20, *Standards for Protection Against Radiation*, Subparts A-O, and Part 31, *General Domestic Licenses for Byproduct Material*. Reclamation facilities that possess or use source material, byproduct material, or special nuclear material, as defined in the Atomic Energy Act of 1954, under a license issued by the NRC and in accordance with the requirements of 10 CFR part 20, shall be considered in compliance with the requirements of CFR 1910.1096 with respect to possession and use.

46.3 Responsibilities

46.3.1 Area Office Managers

46.3.1.1 Shall provide the necessary resources to implement and maintain the procedures within this section.

46.3.1.2 Shall select a radiation safety officer (RSO) that meets the training and experience requirements for their generally licensed device(s).

46.3.2 First-Line Supervisors

46.3.2.1 Shall ensure employees receive training according to paragraph 46.4, *Radiation Safety Training*, where there is reasonable likelihood of exposures to ionizing/nonionizing radiation (e.g., laser surveying equipment and microwave communication tower work).

- 46.3.2.2** Shall coordinate with the regional/local industrial hygienist (IH), safety manager/safety specialist, and RSO to perform workplace assessments, training, job hazard analysis, and exposure monitoring as necessary and remove hazards whenever possible using the hierarchy of controls listed in section Reclamation Safety and Health Standard 8.2, *Personal Protective Equipment*.
- 46.3.2.3** Shall coordinate with the regional/local IH and the safety manager/safety specialist to ensure employees performing job tasks with the potential for exposure to ionizing/nonionizing radiation with the appropriate controls, equipment, and personal protective equipment (PPE).
- 46.3.2.4** Shall immediately notify all ionizing/nonionizing radiation exposures to the RSO and/or safety manager/safety specialist as appropriate.
- 46.3.2.5** Shall coordinate with the RSO to ensure that the ionizing/nonionizing radiation exposure to an embryo/fetus carried by a pregnant employee exposed to radiation, that has voluntarily declared their pregnancy, does not exceed 0.5 rem during their entire pregnancy.
- 46.3.3 Employees**
 - 46.3.3.1** Shall complete radiation protection training requirements in paragraph 46.4, *Radiation Safety Training*, of this section.
 - 46.3.3.2** Shall review the job hazard analysis (JHA) and the identified precautions and controls before conducting job tasks that use ionizing/nonionizing radiation equipment.
 - 46.3.3.3** Shall report ionizing/nonionizing radiation exposure incidents and releases to the first-line supervisor immediately.
 - 46.3.3.4** Shall wear personal monitoring devices where required.
 - 46.3.3.5** Shall follow the voluntary facility reporting procedure, for pregnant employees exposed to radiation, to ensure the RSO, local safety specialist/manager, and first-line supervisor have been notified.
- 46.3.4 Regional Safety Managers**

Shall provide support in developing a radiation safety program, as requested.
- 46.3.5 Regional/Local Industrial Hygienists and Safety Manager/Safety Specialist**
 - 46.3.5.1** Shall provide technical assistance such as workplace hazard assessments, exposure monitoring, and training.

- 46.3.5.2** Shall develop and implement a local radiation safety program covering ionizing radiation equipment, that does not require an NRC license, and for nonionizing radiation equipment used at their facility.
- 46.3.5.3** Shall have a basic understanding for operating ionizing/nonionizing radiation equipment used at their facility.
- 46.3.5.4** Shall provide technical assistance such as workplace hazard assessments, exposure monitoring, and training.

46.3.6 Radiation Safety Officer

- 46.3.6.1** Shall oversee the NRC broad scope or specific licenses issued to their facility's equipment and implement the license requirements in accordance with NRC regulations.
- 46.3.6.2** Shall provide technical oversight, support, and training for NRC licensed devices.
- 46.3.6.3** Shall attend RSO training at intervals according to their licensed device requirements.
- 46.3.6.4** Shall develop and implement a radiation safety program that includes operations using regulated licensed devices at their facility.
- 46.3.6.5** Shall review the radiation safety program at least annually.
- 46.3.6.6** Shall complete annual leak testing for radioactive sources, if required by their license, and ensure an approved laboratory analyzes the results.
- 46.3.6.7** Shall conduct self-audits to ensure licensed device(s) are in compliance with Federal regulations.
- 46.3.6.8** Shall make appropriate notification and reporting of radiation incidences and overexposures to the appropriate governing authority.
- 46.3.6.9** Shall confirm that all authorized users, as defined in the license or permit of licensed equipment, are actively monitored for radiation exposure and accurately maintain exposure records.
- 46.3.6.10** Shall ensure transported licensed material complies with all applicable Department of Transportation requirements.
- 46.3.6.11** Shall ship all licensed material using a commercial carrier according to 49 CFR, *Transportation*, parts 171-177.

46.3.7 Human Resources Officers (HRO)

Shall maintain all medical examination results, clearance documentation, and employee exposure monitoring records in the employee's medical folder according to 29 CFR

1910.1020(d)(1), *Access to Employee Exposure and Medical Records*, the Privacy Act of 1974 (P.L. 93-579), and provide the RSO, regional/local IH, first-line supervisor, and safety manager/safety specialist supervisor with clearance results as requested.

46.4 Radiation Safety Training

46.4.1 Ionizing Radiation Training for Licensed Devices Elements

The RSO shall conduct and/or coordinate training for employees prior to using licensed devices, entering areas where radiation generating devices are used, or where there is a potential for an individual to receive a total effective dose equivalent of 100 mrem or more in 1 year covering the following minimum elements:

- type of radioactive material and/or the device used,
- NRC license conditions and requirements for use of equipment,
- health and safety concerns associated with radiation and the potential effects of radiation on a pregnant female, the embryo/fetus, voluntary reporting procedure for declared pregnant employees,
- contents of the facility's radiation safety program,
- precautions and ALARA controls used to control radiation exposure,
- allowable radiation dose limits,
- types of equipment used for radiation monitoring and surveying,
- types of personal monitoring devices required,
- appropriate PPE used for shielding (e.g., lead apron, gloves, safety goggles, respirators for airborne radionuclides, etc.),
- review of caution signs, labels, and warning signals,
- notification requirements for radiation incidents,
- spill and contamination control of radioactive material, if appropriate for the facility,
- radioactive waste disposal procedure if applicable for the facility, and
- employee rights and responsibilities.

The safety manager/safety specialist, first-line supervisor, and/or the regional/local IH, shall coordinate training for non-licensed devices or equipment used at their facility, covering the appropriate elements in paragraph 46.4.1, *Ionized Safety Training for Licensed Devices Elements*.

46.4.2 Nonionizing Radiation Training Elements

The safety manager/safety specialist, the first-line supervisor, and/or the regional/local IH, shall coordinate employee training covering the following minimum elements for the nonionizing devices/equipment used at their facility:

- electromagnetic radiation (e.g., microwave radiation for communications, radar, etc.) hazards,
- infrared radiation (e.g., furnaces, heat lamps, infrared lasers) hazards,
- ultraviolet radiation (e.g., welding arcs, ultraviolet lasers, black lights) hazards,

- radiofrequency radiation (e.g., radio waves, low energy microwaves, visible light),
- manufacturer's procedures for use and maintenance of nonionizing radiation devices/equipment, and
- OSHA's radiation protection guidance for normal environmental conditions and for incident electromagnetic energy addressed in paragraph 46.8.3, *Radiation Protection Guidance for Nonionizing Radiation*.

46.4.3 Lack of Proficiency

Retraining is necessary when an employee demonstrates a lack of knowledge of ionizing/nonionizing work practices or elements of this section.

46.4.4 Recordkeeping

The RSO, safety manager/safety specialist, and first-line supervisors shall ensure training records are kept in the Department of the Interior's approved repository and managed in accordance with the Information Management Handbook as referenced in Reclamation Manual Directive and Standard, RCD 05-01, *Information Management*.

46.5 Hazard Identification, Assessment, and Safety Measures

46.5.1 Hazard Identification and Assessment

Authorized users shall survey and document locations where employees use licensed devices and/or equipment on and off the facility. Authorized users will also ensure the appropriate controls, personal monitoring devices, PPE, and any other requirements of the license is available to reduce potential employee exposure to ionizing radiation. The survey may include, as appropriate, a physical survey of the location of materials and equipment and measurements of radiation levels or concentrations of radioactive material.

The safety manager/safety specialist shall survey and document areas where nonionizing radiation hazards are present, used, released, or disposed from non-licensed devices.

46.6 Safety Measures

46.6.1.1 Radiation Safety Program for Ionizing/Nonionizing Devices/Equipment

The RSO, in coordination with the safety manager/safety specialist and radiation safety council, where present, shall develop and implement a radiation safety program covering the following minimum elements appropriate to the type of licensed/non-licensed equipment used at their facility:

- use of appropriate ALARA procedures to reduce potential exposures,
- a dosimetry program for personal exposure monitoring,
- surveys to document potential radiation exposure,
- radiological controls (e.g., entry/exit and inventory/storage/disposal controls),
- employee training,
- emergency procedures for responding to radiological situations,
- recordkeeping and reporting requirements, and
- annual internal audit procedures.

46.7 Pre-job Briefing and Planning Requirements

46.7.1 Job Hazard Analysis

The RSO, in coordination with the first-line supervisor and the safety manager/specialist, shall ensure JHAs include ALARA procedures and the appropriate PPE for reducing potential exposures to radiation devices/sources and nonionizing equipment when performing job tasks.

46.8 Safe Practices

46.8.1 As Low as Reasonably Achievable

RSOs and the safety managers/specialist shall develop ALARA procedures and/or work practices to minimize an employee's radiation exposure when working with or around radioactive materials using the following principles:

- reducing the amount of time spent near a radioactive source to reduce the dose,
- increasing distance from a radioactive source to decrease the dose, and
- using proper shielding for the radiation source to protect employees from potential exposure.

46.8.2 Radiation Exposure to Employees in Restricted Areas

Reclamation shall not possess, use, or transfer sources of ionizing radiation that may cause any individuals in a restricted area to receive, in any period of 1 calendar quarter, from a dose more than the limits specified below:

- 1.25 rems per calendar quarter whole body: head and trunk, active blood-forming organs, lens of eyes, or gonads,
- 18.75 rems per calendar quarter: hands and forearms, feet and ankles,
- 7.50 rems per calendar quarter: skin of whole body, and
- The dose to an embryo/fetus shall follow the guidelines in 10 CFR 20.1208, *Dose Equivalent to an Embryo/Fetus*.

46.8.2.1 Dose Monitoring

The RSO shall coordinate dose monitoring when an employee is likely to receive a dose in any calendar quarter more than 25 percent of the applicable occupational limit and for each employee who enters a high radiation area.

46.8.3 Radiation Protection Guidance for Nonionizing Radiation

For normal environmental conditions and for incident electromagnetic energy of frequencies from 10 MHz to 100 GHz, the radiation protection guide is 10 mW/cm² (milliwatt per square centimeter) as averaged over any possible 0.1-hour period (i.e., the guide applies whether the radiation is continuous or intermittent) as follows:

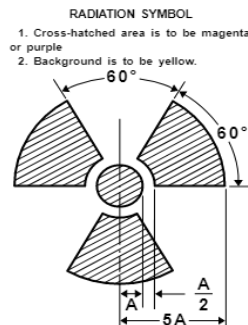
- power density: 10 mW/cm² for periods of 0.1-hour or more, and
- energy density: 1 mW-hr/cm² (milliwatt hour per square centimeter) during any 0.1-hour period.

This guide applies whether the radiation is continuous or intermittent.

46.8.4 Ionizing and Nonionizing Radiation Signs

46.8.4.1 Caution Radiation Area

The RSO shall ensure that each radiation area has conspicuous signs posted with the radiation caution colors (black, magenta, or purple on a yellow background) and symbol (3-bladed fan) with the words: **CAUTION RADIATION AREA** where radiation exists at such levels that a major portion of the body could receive a dose more than 5 mrem per hour, or in any 5 consecutive days a dose more than 100 mrem.



46.8.4.2 Caution High Radiation Area

The RSO shall post conspicuous signs with the radiation caution colors and symbol with the words: **CAUTION HIGH RADIATION AREA**, where airborne radiation exists at such levels that a major portion of the body could receive a dose more than 100 mrem per hour.

46.8.4.3 Caution Airborne Radioactivity Area

The RSO shall post conspicuous signs with the radiation caution colors and symbol with the words: **CAUTION AIRBORNE RADIOACTIVITY AREA**, for any room,

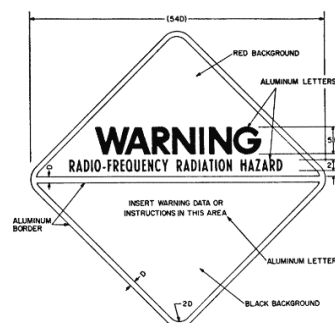
enclosure, or operating area in which airborne radioactive materials, composed wholly or partly of radioactive material, exist in concentrations in excess of the amounts specified in column 1 of Table 1 of appendix B to 10 CFR part 20. The RSO shall also post conspicuous signs in any room, enclosure, or operating area in which airborne radioactive materials exist in concentrations which, averaged over the number of hours in any week during which individuals are in the area, exceed 25 percent of the amounts specified in column 1 of Table 1 of appendix B to 10 CFR part 20.

46.8.4.4 Additional Radioactive Signage Requirements

The RSO shall post conspicuous signs with the radiation caution colors and symbol with the words: **CAUTION RADIOACTIVE MATERIALS** where airborne radioactive material is used or stored and which contains any radioactive material (other than natural uranium or thorium) in any amount exceeding 10 times the quantity of such material specified in 10 CFR 20, appendix C, *Quantities of Licensed Material Requiring Labeling*, (1971 version). For natural uranium or thorium, this sign is required when the amount present exceeds 100 times the quantity of such material specified in 10 CFR 20 (as referenced in 29 CFR 1910.1096(e)(5)(ii)).

46.8.4.4 Nonionizing Radiation Microwave

The RSO shall ensure that each nonionizing radiation area has conspicuous signs posted. The warning symbol for radio frequency radiation hazards shall consist of a red isosceles triangle above an inverted black isosceles triangle, separated and outlined by an aluminum color border. The words **WARNING—RADIO-FREQUENCY RADIATION HAZARD** shall appear in the upper triangle.



46.8.4.5 Nonionizing Radiation Telecommunications

The RSO shall ensure that accessible areas associated with microwave communication systems where the electromagnetic radiation level exceeds the

radiation protection guide given in §1910.97 are posted as described in that section.

The warning symbol for telecommunications radio frequency radiation hazard shall consist of a red isosceles triangle above an inverted black isosceles triangle, separated and outlined by an aluminum color border. The words **WARNING—RADIO-FREQUENCY RADIATION HAZARD** shall appear in the upper triangle.

The lower half of the warning symbol shall include the following:

“Radiation in this area may exceed hazard limitations and special precautions are required. Obtain specific instruction before entering.”

46.8.5 Ionizing Warning Signal

The RSO should ensure the design of radiation-producing equipment or devices has an audible alarm, in locations employees are present, that is at least 75 decibels to warn that a radiation hazard exists indicating immediate and complete evacuation is essential. The signal shall be unique to other alarms at the facility and initiated without requiring employee activation. The RSO shall coordinate periodic alarm tests, checks, and inspections to guard against malfunctions of the system.

46.8.6 Notification of Incidents

The RSO shall immediately notify the NRC operations center by phone for reportable incidents and local management (e.g., lost or stolen devices/equipment, damaged devices/equipment that cannot be brought back into the shielding, personal dosimetry results exceeding allowable dose limits) with licensed devices/equipment that meet the radiation doses in 10 CFR 20.2202, *Notification of Incidents*.

46.9 Definitions

Air dose	A dose measured on an appropriately calibrated instrument in air at or near the body surface in the region of the highest dosage rate.
Authorized user	An employee authorized by the RSO to possess and use radiation devices/equipment and has completed training required for the licensed device/equipment.
Dose	The quantity of ionizing radiation absorbed, per unit of mass, by the body or by any portion of the body.
Electromagnetic radiation	Restricted to the radio frequency spectrum, which for the purpose of this specification shall include the microwave frequency region.
Energy density	Amount of energy stored in a given mass of a substance or system or region of space per unit volume.

Generally licensed device	Consists of radioactive material contained in a sealed source within a shielded device, such as gas chromatograph units, fixed gauging devices, static eliminators, luminous exit signs, calibration or reference standards, some ice detection devices and in vitro laboratory kits. The device is designed with inherent radiation safety features so that it can be used by persons with no radiation training or experience. The general license simplifies the licensing process so that a case-by-case determination of the adequacy of the radiation training or experience of each user is not necessary. NRC evaluates the adequacy of these generally licensed products, ensuring that distributors meet the specific requirements in 10 CFR Part 32 Subpart B and that users meet the requirements in 10 CFR Part 31 .
High radiation area	An area accessible to employees, where radiation is at levels, that a major portion of the body could receive in any one hour a dose more than 100 millirems.
Infrared radiation	Electromagnetic radiation (EMR) with wavelengths longer than those of visible light and is invisible to the human eye.
Ionizing radiation	The most energetic form of radiation, capable of removing electrons from atoms (ionization) and damaging the DNA within living cells. X-rays, gamma rays, and alpha and beta particles are examples of ionizing radiation.
Nonionizing radiation	A series of energy waves composed of oscillating electric and magnetic fields traveling at the speed of light including the spectrum of ultraviolet (UV), visible light, infrared (IR), microwave (MW), radio frequency (RF), and extremely low frequency (ELF).
Partial body radiation	Pertains to which part of the body is exposed to the incident electromagnetic energy.
Personnel monitoring equipment	Devices designed worn or carried by an individual for the purpose of measuring the dose received (e.g., film badges, pocket chambers, pocket dosimeters, film rings, etc.).
Power density	Power per unit area in a radiated microwave field or other type of electromagnetic field.
Radiation area	An area accessible to employees where radiation is at levels. that a major portion of the body could receive in any 1 hour a dose more than 5 millirem, or in any 5 consecutive days a dose more than 100 millirems.
Radiation sources	Radioactive materials or devices that produce ionizing radiation (e.g., byproduct materials and X-ray producing devices).
Radioactive material	Any material which emits, by spontaneous nuclear disintegration, ionizing radiation in the form of particulate or electromagnetic emanations.

Radiofrequency	Radiation which includes radio waves and microwaves, is at the low-energy end of the electromagnetic spectrum. It is a type of non-ionizing radiation. Visible light is another type of non-ionizing radiation.
Rem	Measure of the dose of any ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of 1 roentgen (r) of X-rays (1 millirem (mrem)=0.001 rem). The relation of the rem to other dose units depends upon the biological effect under consideration and upon the conditions for irradiation.
Restrictive area	Any area access controlled by the employer for purposes of protection of individuals from exposure to radiation or radioactive materials.
Ultraviolet radiation	Portion of the electromagnetic spectrum between x-rays and visible light.
Whole body irradiation	Where the entire body is exposed to the incident electromagnetic energy or in which the cross section of the body is smaller than the cross section of the incident radiation beam.
X-rays	Penetrating electromagnetic radiation (photons) having a wavelength that is much shorter than that of visible light. These rays are usually produced by excitation of the electron field around certain nuclei.

46.10 References

- Nuclear Regulatory Commission. 10 CFR 20.1208, *Dose Equivalent to an Embryo/Fetus*. § [20.1208 Dose Equivalent to An Embryo/fetus. | NRC.gov](#)
- Nuclear Regulatory Commission. 10 CFR 20.2202, *Notification of Incidents*. § [20.2202 Notification of Incidents. | NRC.gov](#)
- Nuclear Regulatory Commission. 10 CFR, Part 20, *Standards for Protection Against Radiation*. <https://www.nrc.gov/reading-rm/doc-collections/cfr/part020/full-text.html>
- Occupational Safety and Health Administration. 29 CFR 1910.1096, *Ionizing Radiation*. [1910.1096 - Ionizing radiation. | Occupational Safety and Health Administration \(osha.gov\)](#).
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- Occupational Safety and Health Administration. Safety and Health Topic, *Ionizing Radiation*. [Ionizing Radiation - Background | Occupational Safety and Health Administration \(osha.gov\)](#)