

## **PART IX NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS; INSPECTIONS**

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## PART IX

### NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS; INSPECTIONS

#### 64E-5.901 Posting of Notices to Workers.

- (1) Each licensee or registrant shall post current copies of the following documents:
  - (a) The regulations in this part and in Part III;
  - (b) The license, conditions or documents incorporated into the license by reference and amendments thereto;
  - (c) The operating procedures applicable to activities under the license or registration;
  - (d) Any notice of violation involving radiological working conditions, proposed imposition of administrative penalties, or order issued pursuant to Part I, and any response from the licensee or registrant;
  - (e) The certificate of registration; and
  - (f) The emergency procedures applicable to activities conducted under the license or registration.
- 5 (2) If posting of a document specified in paragraphs (a), (b), and (c) above is not  
R5 physically practical, the licensee or registrant may post a notice which describes  
the document and states where it may be examined. The documents specified  
in paragraphs (d), (e) and (f) above must be posted in their entirety.
- R5 (3) "Notice to Employees 3/01", which is herein incorporated by reference and which  
is available from the department, shall be posted by each licensee or registrant  
as required by these regulations.
- (4) Department documents posted pursuant to 64E-5.901(1)(d) shall be posted  
within 5 working days after receipt of the documents from the department; the  
licensee's or registrant's response, if any, shall be posted within 5 working days  
after dispatch from the licensee or registrant. Such documents shall remain  
posted for a minimum of 5 working days or until action correcting the violation  
has been completed, whichever is later.
- (5) Documents, notices, or forms shall be posted to permit workers to observe them  
on the way to or from work, shall be conspicuous, and shall be replaced if  
defaced or altered.

Specific Authority: 404.051, 404.061, 404.081, F.S.

Law Implemented: 404.022, 404.051(1)(4), 404.061(2), 404.081(1)(2), F.S.

History: New July 17, 1985, Amended April 4, 1989, Amended May 12, 1993,

Amended May 15, 1996, Formerly 10D-91.1002, Amended December 19, 2001.

**64E-5.902 Instructions to Workers.**R1  
R1

- (1) All individuals who in the course of employment are likely to receive an occupational dose in excess of 100 millirem (1 mSv) in a year:
- (a) Shall be kept informed of the storage, transfer, or use of sources of radiation in the licensee's or registrant's facility;
  - (b) Shall be instructed in the health protection problems associated with exposure to radiation or radioactive material, in precautions or procedures to minimize exposures, and in the purposes and functions of protective devices employed;
  - (c) Shall be instructed in, and instructed to observe, to the extent within the worker's control, the applicable provisions of these regulations and licenses for the protection of personnel from exposures to radiation or radioactive material;
  - (d) Shall be instructed of their responsibility to report promptly to the licensee or registrant any condition which may constitute, lead to, or cause a violation of the Act, these regulations, and licenses or unnecessary exposure to radiation or radioactive material;
  - (e) Shall be instructed in the appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation or radioactive material; and
  - (f) Shall be advised as to the radiation exposure reports which workers shall be furnished pursuant to 64E-5.903.
- (2) In determining those individuals subject to the requirements of (1), above, licensees or registrants shall consider assigned activities during normal and abnormal situations involving exposure to sources of radiation or radioactive material that reasonably can be expected to occur during the life of the licensee's or registrant's facility. The extent of these instructions shall be commensurate with potential radiological health protection problems present in the workplace.

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Specific Authority: 404.051, 404.061, 404.081, F.S.

Law Implemented: 404.051(1)(4), 404.061(2), 404.081(1), F.S.

History: New July 17, 1985, Amended January 1, 1994, Formerly 10D-91.1003, Amended May 18, 1998.R1  
R1



**64E-5.903 Notification and Reports to Individuals.**

- (1) Licensees or registrants for which personnel monitoring is required shall prepare a report as specified in this section of the radiation exposure data for each affected individual and the results of any measurements, analyses and calculations of radioactive material deposited or retained in the body of the individual. The information reported shall include data and results obtained pursuant to these regulations, orders, or license conditions, as shown in records maintained by the licensee or registrant pursuant to Part III. Each notification and report shall:
  - (a) Be in writing;
  - (b) Include appropriate identifying data such as the name of the licensee or registrant and the name of the individual;
  - (c) Include the individual's exposure information; and
  - (d) Contain the following statement: "This report is furnished to you under the provisions of the Florida Department of Health regulation entitled Chapter 64E-5, Control of Radiation Hazards. You should preserve this report for future reference."
- (2) Each licensee or registrant for which personnel monitoring is required shall furnish each worker annually a written copy of the report specified in (1), above, of the worker's exposure to radiation or radioactive material as shown in records maintained by the licensee or registrant pursuant to Part III. The licensee or registrant shall maintain records that the report was furnished for 3 years.
- (3) Each licensee or registrant shall furnish to the worker upon termination of employment a written report as specified in (1), above, of the worker's exposure to radiation received by that worker from operations of the licensee or registrant. Such report shall be furnished within 30 days from the time of termination of employment or within 30 days after the exposure of the individual has been determined by the licensee or registrant, whichever is later. The report shall cover each calendar quarter in which the worker's activities involved exposure to sources of radiation and shall include the dates and locations of work under the license or registration in which the worker participated. The licensee or registrant shall maintain records that the report was furnished for 3 years.
- (4) When a licensee or registrant is required pursuant to Part III to report to the department any exposure of an individual to radiation or radioactive material, the licensee or the registrant shall also provide the individual a report on the exposure data included therein. Such reports shall be transmitted at a time not later than the transmittal to the department.

- (5) At the request of a worker who is terminating employment in a given calendar quarter with the licensee or registrant in work involving radiation dose, or of a worker who, while employed by another person, is terminating assignment to work involving radiation dose in the licensee's or registrant's facility in that calendar quarter, each licensee or registrant shall provide to each such worker, or to the worker's designee, at termination, a written report regarding the radiation dose received by that worker from operations of the licensee or registrant during that specifically identified calendar quarter or fraction thereof, or provide a written estimate of that dose if the finally determined personnel monitoring results are not available at that time. Estimated doses shall be clearly indicated as such.

Specific Authority: 404.051, 404.061, 404.081, F.S.

Law Implemented: 404.022, 404.051(1)(4), 404.061(2), 404.081, F.S.

History: New July 17, 1985, Amended May 12, 1993, Formerly 10D-91.1004.

**64E-5.904 Presence of Representatives of Licensees or Registrants and Workers During Inspection.**

- (1) Each licensee or registrant shall afford to the department at all reasonable times opportunity to inspect materials, machines, activities, facilities, premises and records pursuant to these regulations.
- (2) During an inspection, department inspectors may consult privately with workers as specified in this part. The licensee or registrant may accompany department inspectors during other phases of an inspection.
- (3) If, at the time of inspection, an individual has been authorized by the workers to represent them during department inspections, the licensee or registrant shall notify the inspectors of such authorization and shall give the workers' representative an opportunity to accompany the inspectors during the inspection of physical working conditions.
- (4) Each workers' representative shall be routinely engaged in work under control of the licensee or registrant and shall have received instructions as specified in this part.
- (5) Different representatives of licensees or registrants and workers may accompany the inspectors during different phases of an inspection if there is no resulting interference with the conduct of the inspection; however, only one workers' representative at a time may accompany the inspectors.
- (6) With approval of the licensee or registrant or the workers' representative, an individual who is not routinely engaged in work under control of the licensee or registrant, such as a consultant to the licensee or registrant or to the workers' representative, shall be afforded the opportunity to accompany department inspectors during the inspection of physical working conditions.

- (7) Notwithstanding the other provisions of this section, department inspectors are authorized to refuse to permit accompaniment by an individual who deliberately interferes with a fair and orderly inspection. With regard to areas containing information classified by an agency of the U.S. Government in the interest of national security, an individual who accompanies an inspector may have access to such information only if authorized to do so. With regard to any area containing proprietary information, the workers' representative for that area shall be an individual previously authorized by the licensee or registrant to enter that area.

Specific Authority: 404.051, 404.061, 404.071, F.S.

Law Implemented: 404.022, 404.051(1)(4), 404.061(2), 404.071(1), F.S.

History: New July 17, 1985, Formerly 10D-91.1005.

#### **64E-5.905 Consultation with Workers During Inspections.**

- (1) Department inspectors may consult privately with workers concerning matters of occupational radiation protection and other matters related to applicable provisions of these regulations and licenses to the extent the inspectors deem necessary for the conduct of an effective and thorough inspection.
- (2) During the course of an inspection, any worker may bring privately to the attention of the inspectors, either orally or in writing, any past or present condition which the worker has reason to believe may have contributed to or caused a violation of the Act, these regulations, or license condition, or any unnecessary exposure of an individual to sources of radiation under the licensee's or registrant's control. Any such notice in writing shall comply with the requirements of 64E-5.906(1).
- (3) The provisions of (2), above, shall not be interpreted as authorization to disregard instructions pursuant to 64E-5.902.

Specific Authority: 404.051, 404.061, 404.071, F.S.

Law Implemented: 404.022, 404.051(1)(4), 404.061(2), 404.071(1), F.S.

History: New July 17, 1985, Formerly 10D-91.1006.

#### **64E-5.906 Request by Workers for Inspections.**

- (1) Any worker or representative of workers believing that a violation of the Act, these regulations or license conditions exists or has occurred in work under a license or registration with regard to radiological working conditions in which the worker is engaged may request an inspection by giving notice of the alleged violation to the department. Any such notice shall be in writing, shall set forth the specific grounds for the notice, and shall be signed by the worker or representative of the workers. A copy shall be provided to the licensee or registrant by the department no later than at the time of inspection.

- (2) If, upon receipt of such notice, the department determines that the complaint meets the requirements set forth in this section and that there are reasonable grounds to believe that the alleged violation exists or has occurred, an inspection shall be made as soon as practicable to determine if such alleged violation exists or has occurred. Inspections pursuant to this section need not be limited to matters referred to in the complaint.

Specific Authority: 404.051, 404.061, 404.071, F.S.

Law Implemented: 404.022, 404.051(1)(4), 404.061(2), 404.071(1), F.S.

History: New July 17, 1985, Formerly 10D-91.1007.

#### **64E-5.907 Inspections Not Warranted; Informal Review.**

- (1) If the department determines, with respect to a complaint under this part, that an inspection is not warranted because there are no reasonable grounds to believe that a violation exists or has occurred, the department shall notify the complainant in writing of such determination. The complainant may obtain review of such determination by submitting a written statement of position with the department. The department will provide the licensee or registrant with a copy of such statement by certified mail. The licensee or registrant may submit an opposing written statement of position with the department. The department will provide the complainant with a copy of such statement by certified mail.
- (2) Upon the request of the complainant, the department may hold an informal conference in which the complainant and the licensee or registrant may orally present their views. An informal conference may also be held at the request of the licensee or registrant, but disclosure of the identity of the complainant will be made only following receipt of written authorization from the complainant. After considering all written and oral views presented, the department shall affirm, modify, or reverse the previous determination of the department and furnish the complainant and the licensee or registrant a written notification of the decision and the reason therefor.
- (3) If the department determines that an inspection is not warranted because the requirements of 64E-5.906(1) have not been met, the complainant shall be notified in writing of such determination. Such determination shall be without prejudice to the filing of a new complaint meeting the requirements of 64E-5.906(1).

Specific Authority: 404.051, 404.061, 404.071, F.S.

Law Implemented: 404.022, 404.051(1)(4), 404.061(2), 404.071(1), F.S.

History: New July 17, 1985, Formerly 10D-91.1008.

**PART X ENVIRONMENTAL RADIATION STANDARDS****SUBPART A RADIATION STANDARDS FOR BUILDINGS**

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## PART X

### ENVIRONMENTAL RADIATION STANDARDS

#### Subpart A

##### ENVIRONMENTAL RADIATION STANDARDS

###### 64E-5.1001 Standards.

- (1) Radiation exposure to the public from naturally occurring radioactive materials shall be maintained as low as reasonably achievable. For the purposes of this part, the normal background level of gamma radiation in buildings is 6 micro-roentgens (1.55 nC/kg) per hour and the normal background radon decay product concentration in buildings is 0.004 Working Level (WL).
- (2) The mean gamma exposure rate in a building shall not exceed 20 micro-roentgens (5.16 nC/kg) per hour, including background, and the annual average radon decay product concentration shall not exceed 0.02 WL, including background.

Specific Authority: 404.051, 404.056, F.S.

Law Implemented: 404.022(2), 404.051(4), 404.056, F.S.

History: New February 16, 1986, Amended January 3, 1989, Formerly 10D-91.1104.

#### Subpart B

##### ENVIRONMENTAL MONITORING

**64E-5.1002 Monitoring Requirements.** The department will perform the following tests both prior to phosphate mining and subsequent to reclamation:

- (1) Gamma radiation exposure measurements.
- (2) Soil characterization measurements consisting of
  - (a) Radon emanation determinations.
  - (b) Soil radium determinations.
- (3) Air monitoring determinations.
- (4) Surface and ground water monitoring of such water that is potentially affected by mining activities unless existing test data is available.

Specific Authority: 404.051, 404.056, F.S.

Law Implemented: 404.022(2), 404.051(4), 404.056, F.S.

History: New November 13, 1985, Amended September 26, 1991, Amended May 15, 1996, Formerly 10D-91.1003

**64E-5.1003****Monitoring Fees.**

- (1) The costs incurred by the department and the subsequent fees associated with the monitoring program shall be annually prorated on the basis of the total number of measurements to be made on land proposed to be mined and land proposed to be reclaimed, excluding bodies of water.
- (2) The annual fees paid by the mining companies shall be calculated by the following method:
  - (a) Gamma radiation exposure measurements will be made at the rate of one per acre. An annual fee of \$7.50 per measurement shall be assessed the mining company by the department.
  - (b) Soil characterization measurements will be made at the rate of one per 20 acres. An annual fee of \$320.00 per each 20 acres measured shall be assessed the mining company by the department.
  - (c) Air monitoring measurements will be assessed at the rate of \$165.00 per measurement. The department shall prorate the cost of air monitoring measurements among the mining companies based on their share of the total acreage to be mined and reclaimed each year. The department will conduct no more than 272 air monitoring measurements per year for all mining companies for which a fee will be assessed.
  - (d) Surface and ground water monitoring measurements will be assessed at the rate of \$300.00 per measurement. The department shall prorate the cost of water monitoring among the mining companies based on their share of the total acreage to be mined and reclaimed each year. The department will analyze no more than 160 water samples per year for all mining companies for which a fee will be assessed.
- (3) The department shall bill each affected company by March for activities which are planned for the following July through December time period. The department shall bill each affected company by September for activities which are planned for the following January through June time period. Each mining company shall remit the fee to the department within 60 days of the billing date.
- (4) Overpayments or underpayments from an affected company will be reconciled by the department on an annual basis.

Specific Authority: 404.022, 404.051, 404.056, 404.131, F.S.

Law Implemented: 404.022(2), 404.051(4), 404.131(5), F.S.

History: New November 13, 1985, Amended September 26, 1991, Formerly 10D-91.1112.



**PART XI RADIATION SAFETY REQUIREMENTS FOR WIRELINE SERVICE OPERATIONS**

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## PART XI

### RADIATION SAFETY REQUIREMENTS FOR WIRELINE SERVICE OPERATIONS AND SUBSURFACE TRACER STUDIES

**64E-5.1101****Prohibitions.**

- (1) No licensee shall perform wireline service operations with a sealed source unless, prior to commencement of the operation, the licensee has a written agreement with the well operator, well owner, drilling contractor or land owner that:
  - (a) In the event a sealed source is lodged downhole, a reasonable effort at recovery will be made; and
  - (b) In the event a decision is made to abandon the sealed source downhole, the requirements of 64E-5.1119 shall be met.
- (2) No registrant shall permit above-ground testing of particle accelerators, designed for use in well-logging, which results in the production of radiation, except in areas or facilities controlled or shielded so that the requirements of Part III, as applicable, are met.

Specific Authority: 404.051, 404.061, 404.22, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6), 404.061(2), 404.22(1), F.S.

History: New July 17, 1985, Formerly 10D-91.1203.

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## SUBPART A EQUIPMENT CONTROL

### 64E-5.1102 Storage and Transportation Precautions.

- (1) Each sealed source of radioactive material shall be provided with a storage or transport container. The container shall be provided with a lock or tamper seal to prevent unauthorized removal of, or exposure to, the source of radiation.
- (2) Sealed sources of radioactive material shall be stored in a manner which will minimize danger from explosion and fire.
- (3) Transport containers shall be physically secured to the transporting vehicle to prevent accidental loss, tampering, or unauthorized removal.

Specific Authority: 404.051, 404.061, F.S.

Law Implemented: 404.022, 404.051(1)(4), 404.061(2), F.S.

History: New July 17, 1985, Amended April 4, 1989, Formerly 10D-91.1204.

### 64E-5.1103 Radiation Survey Instruments.

- R2
- R2
- R2
- (1) The licensee or registrant shall maintain sufficient calibrated and operable radiation survey instruments at each field station and temporary jobsite to make physical radiation surveys as required by this part and by Part III.  
Instrumentation shall be capable of measuring 0.1 milliroentgen (0.001 mSv) per hour through at least 50 milliroentgens (0.5 mSv) per hour.
  - (2) Radiation survey instruments used to establish dose rates shall be calibrated:
    - (a) At energies and geometries appropriate for use;
    - (b) At intervals not to exceed 6 months, and after each instrument servicing;
    - (c) Such that accuracy within plus or minus 20 percent can be demonstrated; and
    - (d) For linear scale instruments, at two points located approximately 1/3 and 2/3 of full-scale on each scale; for logarithmic scale instruments, at midrange of each decade, and at two points of at least one decade; and for digital instruments, at appropriate points.
  - (3) Records of survey instrument calibrations shall be maintained for 3 years after the calibration date for inspection by the department.

Specific Authority: 404.051, 404.061, 404.081, 404.22, F.S.

Law Implemented: 404.022, 404.051(1)(4), 404.061(2), 404.081(1), 404.22, F.S.

History: New July 17, 1985, Amended April 4, 1989, Formerly 10D-91.1205, Amended October 8, 2000.

**64E-5.1104****Leak Testing of Sealed Sources.**

- (1) Requirements. Each licensee using sealed sources containing radioactive material shall have the sources tested for leakage. Records of leak test results shall be kept in units of microcuries and maintained for inspection by the department for 3 years after the leak test is performed or until transfer or disposal of the sealed source.
- (2) Method of Testing. Tests for leakage shall be performed only by persons specifically authorized to perform such tests by the department, the U.S. Nuclear Regulatory Commission, an agreement state, or a licensing state. The test sample shall be taken from the surface of the source, source holder, or from the surface of the device in which the source is stored or mounted and on which contamination might be expected to accumulate. The test sample shall be analyzed for radioactive contamination, and the analysis shall be capable of detecting the presence of 0.005 microcurie (185 Bq) of radioactive material on the test sample.
- (3) Interval of Testing. Each sealed source containing radioactive material shall be tested at intervals not to exceed 6 months. In the absence of a certificate from a transferor indicating that a test has been made prior to the transfer, the sealed source shall not be put into use until tested. If, for any reason, it is suspected that a sealed source may be leaking, it shall be removed from service immediately and tested for leakage as soon as practical.
- (4) Leaking or Contaminated Sources. If the test reveals the presence of 0.005 microcurie (185 Bq) or more of leakage or contamination, the licensee shall immediately withdraw the source from use and shall cause it to be decontaminated, repaired, or disposed of in accordance with these regulations. The licensee shall check the equipment associated with the leaking source for radioactive contamination, and if contaminated, have it decontaminated or disposed of in accordance with these regulations. A report describing the equipment involved, the test results, any contamination which resulted from the leaking source, and corrective action taken shall be filed with the department within 5 days of receiving the test results.
- (5) Exemptions. The following sources are exempted from the periodic leak test requirements of 64E-5.1104(1) through (4):
  - (a) Hydrogen 3 sources;
  - (b) Sources containing radioactive material with a half-life of 30 days or less;
  - (c) Sealed sources containing radioactive material in gaseous form;
  - (d) Sources of beta-emitting or gamma-emitting radioactive material with an activity of 100 microcuries (3.7 MBq) or less; and
  - (e) Sources of alpha-emitting radioactive material with an activity of 10 microcuries (0.370 MBq) or less.

History: New April 4, 1989, Formerly 10D-91.12051.

**64E-5.1105 Quarterly Inventory.** Each licensee or registrant shall conduct a quarterly physical inventory to account for all sources of radiation. Records of inventories shall be maintained for 2 years from the date of the inventory for inspection by the department and shall include the quantities and kinds of sources of radiation, the location where sources of radiation are assigned, the date of the inventory and the name of the individual conducting the inventory.

Specific Authority: 404.051, 404.061, 404.071, 404.081, 404.22, F.S.

Law Implemented: 404.022, 404.051(1)(4), 404.061(2), 404.071(1), 404.081(1), 404.22(1), F.S.

History: New July 17, 1985, Formerly 10D-91.1206.

**64E-5.1106 Utilization Records.** Each licensee using radioactive materials shall maintain utilization records, which shall be kept available for inspection by the department for 2 years from the date of the recorded event, showing the following information for each source of radiation:

- (1) Make, model number and a serial number or a description of each source of radiation used;
- (2) The identity of the well logging supervisor or field unit to whom assigned;
- (3) Locations where used and dates of use; and
- (4) In the case of tracer materials and radioactive markers, the utilization record shall indicate the radionuclide and activity used in a particular well.

Specific Authority: 404.051, 404.061, 404.081, F.S.

Law Implemented: 404.022, 404.051(1)(4), 404.061(2), 404.081(1), F.S.

History: New July 17, 1985, Formerly 10D-91.1207.

**64E-5.1107 Design, Performance and Certification Criteria for Sealed Sources Used in Downhole Operations.**

- (1) Each sealed source, except those containing radioactive material in gaseous form, used in downhole operations and manufactured after June 30, 1982, shall be certified at the time of manufacture, to meet the following minimum criteria:
  - (a) Is of doubly encapsulated construction;
  - (b) Contains radioactive material whose chemical and physical forms are as insoluble and nondispersible as practical; and
  - (c) Has individually passed external pressure testing to at least 24,656 pounds per square inch absolute (170 MN per m<sup>2</sup>).

- (2) Sealed sources, except those containing radioactive material in gaseous form, manufactured prior to June 30, 1982, and acquired after that date, in the absence of a certificate from a transferor certifying that an individual sealed source meets the requirements of (1)(a) and (b), above, shall not be put into use until such determinations and testing according to (1)(c) above, have been performed.
- (3) Certification documents shall be maintained for inspection by the department for a period of 2 years after source disposal. If the source is abandoned downhole, the certification documents shall be maintained for 100 years.

Specific Authority: 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6), 404.061(2), 404.071(1), 404.081(1), F.S.

History: New July 17, 1985, Formerly 10D-91.1208.

**64E-5.1108****Labeling.**

- (1) Each source, source holder or logging tool containing radioactive material shall bear a durable, legible and clearly visible marking or label, which has, as a minimum, the standard radiation caution symbol as described and illustrated in 64E-5.322, without the conventional color requirement, and the following wording:

DANGER (OR "CAUTION")  
RADIOACTIVE

This label shall be on the smallest component transported as a separate piece of equipment.

- (2) Each transport container shall have permanently attached to it a durable, legible and clearly visible label which has, as a minimum, the standard radiation caution symbol as described and illustrated in 64E-5.322 and the following wording:

DANGER (OR "CAUTION")  
RADIOACTIVE  
NOTIFY CIVIL AUTHORITIES IF FOUND

Specific Authority: 404.051, 404.061, 404.081, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4), 404.061(2), 404.081(1), 404.20(1), F.S.

History: New July 17, 1985, Amended January 1, 1994, Formerly 10D-91.1209.

**64E-5.1109            Inspection and Maintenance.**

- (1) Each licensee possessing radioactive material shall conduct, at intervals not to exceed 6 months, a program of inspection and maintenance of source holders, logging tools, source handling tools, storage containers, transport containers and injection tools to assure proper labeling and physical condition. Records of inspection and maintenance shall be maintained for a period of 2 years for inspection by the department.
- (2) If any inspection conducted pursuant to this section reveals damage to labeling or components critical to radiation safety, the device shall be removed from service until repairs have been made.
- (3) The repair, opening or modification of any sealed source device shall be performed only by persons specifically authorized to do so by the department, the U.S. Nuclear Regulatory Commission, an agreement state or a licensing state.

Specific Authority: 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6), 404.061(2), 404.071(1), 404.081(1), F.S.

History: New July 17, 1985, Formerly 10D-91.1210.

## **SUBPART B REQUIREMENTS FOR PERSONNEL SAFETY**

**64E-5.1110            Training Requirements.**

- (1) No licensee or registrant shall permit any individual to act as a logging supervisor as defined in this part until such individual has:
  - (a) Received, in a course taught by an individual who has been licensed by the department, the U.S. Nuclear Regulatory Commission, an agreement state or a licensing state, instruction in the subjects outlined in this part and demonstrated an understanding thereof;
  - (b) Read and received instruction in the regulations contained in this part and the applicable sections of Parts I, III and IX, or their equivalent, conditions of the appropriate license or certificate of registration, and the licensee's or registrant's operating and emergency procedures, and demonstrated an understanding thereof; and
  - (c) Demonstrated competence to use sources of radiation, related handling tools and radiation survey instruments which will be used on the job.
- (2) No licensee or registrant shall permit any individual to assist in the handling of sources of radiation until such individual has:
  - (a) Read or received instruction in the licensee's or registrant's operating and emergency procedures and demonstrated an understanding thereof; and



- (b) Demonstrated competence to use, under the personal supervision of the logging supervisor, the sources of radiation, related handling tools and radiation survey instruments which will be used on the job.
- (3) The licensee or registrant shall maintain employee training records for inspection by the department for 2 years following termination of employment.

Specific Authority: 404.051, 404.061, 404.071, 404.081, 404.22, F.S.

Law Implemented: 404.022, 404.051(1)(4), 404.061(2), 404.071(1), 404.081(1), 404.22(1), F.S.

History: New July 17, 1985, Formerly 10D-91.1211.

**64E-5.1111 Operating and Emergency Procedures.** The licensee's or registrant's operating and emergency procedures shall include appropriate instructions in at least the following:

- (1) Handling and use of sources of radiation to be employed so that no individual is likely to be exposed to radiation doses in excess of the standards established in Part III;
- (2) Methods and occasions for conducting radiation surveys;
- (3) Methods and occasions for locking and securing sources of radiation;
- (4) Personnel monitoring and the use of personnel monitoring equipment;
- (5) As applicable, the transportation of radioactive sources to temporary job sites and field stations, including the packaging and placing of such sources in vehicles, placarding of vehicles and securing the sources during transportation;
- (6) Minimizing exposure of individuals in the event of an accident;
- (7) Procedure for notifying proper personnel in the event of an accident;
- (8) Maintenance of records;
- (9) As applicable, inspection and maintenance of source holders, logging tools, source handling tools, storage containers, transport containers and injection tools;
- (10) As applicable, procedures to be followed in the event a sealed source is lodged downhole; and
- (11) As applicable, procedures to be used for picking up, receiving and opening packages containing radioactive material.

Specific Authority: 404.051, 404.061, 404.081, 404.20, 404.22, F.S.

Law Implemented: 404.022, 404.051(1)(4), 404.061(2), 404.081(1), 404.20(1), 404.22, F.S.

History: New July 17, 1985, Formerly 10D-91.1212.

**64E-5.1112 Personnel Monitoring.** No licensee or registrant shall permit any individual to act as a logging supervisor or to assist in the use of sources of radiation unless such individual wears a film badge, optically stimulated luminescent device (OSLD), or a thermoluminescent dosimeter (TLD). Each film badge, OSLD or TLD shall be assigned to and worn by only one individual.

Specific Authority: 404.051, 404.061, 404.081, F.S.

Law Implemented: 404.022, 404.051(1)(4), 404.061(2), 404.081(1)(2), F.S.

History: New July 17, 1985, Amended May 15, 1996, Formerly 10D-91.1213, Amended October 8, 2000.

### **SUBPART C**

### **PRECAUTIONARY PROCEDURES IN LOGGING AND**

### **SUBSURFACE TRACER OPERATIONS**

**64E-5.1113 Security.** During each logging or tracer application, the logging supervisor or other designated employee shall maintain direct surveillance of the operation to protect against unauthorized or unnecessary entry into a restricted area, as defined in 64E-5.101.

Specific Authority: 404.051, 404.061, F.S.

Law Implemented: 404.022, 404.031, 404.051(1)(4), 404.061(2), F.S.

History: New July 17, 1985, Amended August 29, 1994, Formerly 10D-91.1214.

**64E-5.1114 Handling Tools.** The licensee shall provide and require the use of tools that will assure remote handling of sealed sources except for low-activity calibration sources that result in a gamma exposure rate at contact of less than 100 milliroentgens ( $2.58 \times 10^{-5}$   $\mu\text{C}$  per kg) per hour.

Specific Authority: 404.051, 404.061, F.S.

Law Implemented: 404.022, 404.051(1)(4), 404.061(2), F.S.

History: New July 17, 1985, Formerly 10D-91.1215.

### **64E-5.1115 Subsurface Tracer Studies.**

- (1) Protective gloves and other appropriate protective clothing and equipment shall be used by all personnel handling radioactive material. Precautions shall be taken to avoid ingestion or inhalation of radioactive material.
- (2) No licensee shall intentionally inject radioactive material into any fresh water aquifers unless the Department of Health and the Department of Environmental Regulation determine that such injection will not endanger the public health, safety and welfare.
- (3) No licensee shall inject radioactive material into any well unless it can be demonstrated to the department that the procedure will not result in any liquids or gases distributed to the public exceeding the following criteria:

- (a) For gases, the air concentration in State of Florida Bureau of Radiation Control ALIs, DACs, and Effluent Concentrations, July 1993, Table II, Column 2, shall apply.
- (b) For liquids, the water concentration values in State of Florida Bureau of Radiation Control ALIs, DACs, and Effluent Concentrations, July 1993, Table II, Column 2, shall apply.

Specific Authority: 404.051, 404.061, F.S.

Law Implemented: 404.022, 404.031, 404.051(1)(4), 404.061(2), F.S.

History: New July 17, 1985, Amended January 1, 1994, Formerly 10D-91.1216.

## **SUBPART D RADIATION SURVEYS AND RECORDS**

### **64E-5.1116      Radiation Surveys.**

- (1) Radiation surveys and personnel exposure calculations shall be made and recorded for each area where radioactive materials are stored.
- (2) Radiation surveys and personnel exposure calculations shall be made and recorded for the radiation levels in occupied positions and on the exterior of each vehicle used to transport radioactive material. Such surveys and calculations shall include each source of radiation or combination of sources to be transported in the vehicle.
- (3) After removal of the sealed source from the logging tool and before departing the job site, a survey meter shall be used to assure that the logging tool is free of contamination.
- (4) Radiation surveys shall be made and recorded at the job site or well-head for each tracer operation, except those using tritium, carbon 14 and sulfur 35. These surveys shall include measurements of radiation levels before and after the operation. If radiation levels, post operation, exceed twice background, the area shall be decontaminated or restricted until radiation levels reach twice background.
- (5) Records required pursuant to this section shall include the dates, the identification of individuals making the survey, the identification of survey instruments used and an exact description of the location of the survey. Records of these surveys shall be maintained for inspection by the department for 2 years after completion of the survey.

Specific Authority: 404.051, 404.061, 404.071, 404.081, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6), 404.071(1), 404.081(1), 404.20(1), F.S.

History: New July 17, 1985, Formerly 10D-91.1217.

**64E-5.1117****Documents and Records Required at Field Stations.**

Each licensee or registrant shall maintain, for inspection by the department, the following documents and records for the specific devices and sources used at the field station:

- (1) Appropriate license or certificate of registration;
- (2) Operating and emergency procedures;
- (3) A copy of these regulations;
- (4) Records of the latest survey instrument calibrations pursuant to 64E-5.1103 and Part III;
- (5) Records of the latest leak test results pursuant to license conditions;
- (6) Quarterly inventories required pursuant to 64E-5.1105;
- (7) Utilization records required pursuant to 64E-5.1106;
- (8) Records of inspection and maintenance required pursuant to 64E-5.1109; and
- (9) Survey records required pursuant to 64E-5.1116.

Specific Authority: 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.051(1)(4), 404.061(2), 404.071(1), 404.081(1), F.S.

History: New July 17, 1985, Formerly 10D-91.1218.

**64E-5.1118****Temporary Job sites.**

Each licensee or registrant conducting operations at a temporary job site, which is a location to which radioactive materials have been dispatched to perform wireline service operations or subsurface tracer studies, shall have the following documents and records available at that site for inspection by the department:

- (1) Operating and emergency procedures;
- (2) Survey records required pursuant to 64E-5.1116 for the period of operation at the site;
- (3) Evidence of current calibration for the radiation survey instruments in use at the site; and
- (4) When operating in the state under reciprocity, a copy of the appropriate license, certificate of registration or equivalent documents.

Specific Authority: 404.051, 404.061, 404.081, 404.22, F.S.

Law Implemented: 404.022, 404.051(1)(4)(11), 404.061(2), 404.081(1), 404.22, F.S.

History: New July 17, 1985, Amended May 15, 1996, Formerly 10D-91.1219.

## **SUBPART E NOTIFICATION**

### **64E-5.1119 Notification of Incidents, Abandonment and Lost Sources.**

- (1) Notification shall be made of radiation incidents and radioactive sources lost in other than downhole logging operations in accordance with appropriate provisions of Part III.
- (2) Whenever a sealed source or device containing radioactive material is lodged downhole, the licensee shall:
  - (a) Monitor at the surface for the presence of radioactive contamination with a radiation survey instrument or logging tool during logging tool recovery operations; and
  - (b) Notify the department immediately by telephone or telegraph if radioactive contamination is detected at the surface or if the source appears to be damaged.
- (3) When it becomes apparent that efforts to recover the radioactive source will not be successful, the licensee shall:
  - (a) Advise the well-operator and the department of an appropriate method of abandonment, which shall include:
    1. The immobilization and sealing in place of the radioactive source with a cement plug;
    2. The setting of a whipstock or other deflection device; and
    3. The mounting of a permanent identification plaque, at the surface of the well, containing the appropriate information required by this section;
  - (b) Notify the department by telephone or telegraph, giving the circumstances of the loss, and request approval of the proposed abandonment procedures; and
  - (c) File a written report with the department within 30 days of the abandonment, setting forth the following information:
    1. Date of occurrence and a brief description of attempts to recover the source;
    2. A description of the radioactive source involved, including radionuclide, quantity and chemical and physical form;
    3. Surface location and identification of well;

4. Results of efforts to immobilize and set the source in place;
  5. Depth of the lodged radioactive source;
  6. Depth of the top of the cement plug;
  7. Depth of the well; and
  8. Information contained on the permanent identification plaque.
- (4) Whenever a sealed source containing radioactive material is abandoned downhole, the licensee shall provide a permanent plaque, as described below, for posting the well or well-bore. This plaque shall:
- (a) Be constructed of long-lasting material, such as stainless steel or monel, and
  - (b) Contain the following information engraved on its face:
    1. The word "CAUTION";
    2. The radiation symbol without the conventional color requirement;
    3. The date of abandonment;
    4. The name of the well operator or well owner;
    5. The well name and well identification numbers or other designation;
    6. The sealed sources by radionuclide and quantity of activity;
    7. The source depth and the depth to the top of the plug; and
    8. An appropriate warning, depending on the specific circumstances of each abandonment which may include:
      - a. "Do not drill below plug-back depth";
      - b. "Do not enlarge casing"; or
      - c. "Do not reenter the hole," followed by the words, "before contacting the Department of Health."

- (5) The licensee shall immediately notify the department by telephone or telegraph, and subsequently by confirming letter, if the licensee knows or has reason to believe that radioactive material has been lost in or to an underground potable water source. Such notice shall designate the well location and shall describe the magnitude and extent of loss of radioactive material, assess the consequences of such loss and explain efforts planned or being taken to mitigate these consequences.

Specific Authority: 404.051, 404.061, 404.081, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6), 404.061(2), 404.081(1), F.S.

History: New July 17, 1985, Formerly 10D-91.1220.

**64E-5.1120 Subjects To Be Included In Training Courses For Logging Supervisors.** The following subjects must be included in training courses for logging supervisors.

- (1) Fundamentals of radiation safety, including:
- (a) Characteristics of radiation;
  - (b) Units of radiation dose and, if appropriate, quantity of radioactivity;
  - (c) Significance of radiation dose, including:
    - 1. Radiation protection standards; and
    - 2. Biological effects of radiation dose;
  - (d) Levels of radiation from sources of radiation; and
  - (e) Methods of minimizing radiation dose, including:
    - 1. Working time;
    - 2. Working distances; and
    - 3. Shielding.
- (2) Radiation detection instrumentation to be used, including:
- (a) Use of radiation survey instruments, including operation, calibration and limitations;
  - (b) Survey techniques; and
  - (c) Use of personnel monitoring equipment;

- (3) Equipment to be used, including:
  - (a) Handling equipment, if appropriate;
  - (b) Sources of radiation;
  - (c) Storage precautions, if appropriate, and control of equipment; and
  - (d) Operation and control of equipment.
- (4) The requirements of these regulations.
- (5) The licensee's or registrant's written operating and emergency procedures.
- (6) The licensee's or registrant's record keeping procedures.

Specific Authority: 404.051, 404.061, 404.081, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6), 404.061(2), 404.081(1), 404.22, F.S.

History: New July 17, 1985, Formerly 10D-91.1221.



**PART XIII RADIATION SAFETY REQUIREMENTS FOR POSSESSION AND USE  
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## PART XIII

### RADIATION SAFETY REQUIREMENTS FOR POSSESSION AND USE OF SEALED OR UNSEALED SOURCES OF RADIOACTIVE MATERIALS

**64E-5.1301      Sealed or Unsealed Sources of Radioactive Material.** The rules in this part establish radiation safety requirements for licensees possessing or using sealed or unsealed sources of radioactive materials not otherwise specified in a license or addressed in these rules. The requirements of this part are in addition to and not in substitution for other applicable requirements of these rules. Licenses of broad scope are exempt from the requirements of 64E-5.1313, 64E-5.1318(2), and 64E-5.1319(1)(2)(3) and (4). The requirements of this part do not apply to persons licensed as specified in Parts IV, VI, and XI. General licensees as specified in 64E-5.206(7) and (8) are exempt from the requirements of this part.

Specific Authority: 404.051, 404.061, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(10), 404.061(2)(3), 404.081(1), F.S.

History: New May 12, 1993, Amended May 15, 1996, Formerly 10D-91.1401.

#### SUBPART A GENERAL REQUIREMENTS

**64E-5.1302      Operating and Emergency Procedures.** The licensee's operating and emergency procedures shall be posted in accordance with 64E-5.901 and shall accompany portable devices at all times. The procedures shall include instructions in the following as applicable to the type of use:

- (1) The uses of sources of radiation so that exposures are maintained as low as reasonably achievable and no individual is likely to be exposed to radiation doses in excess of the standards in Part III;
- (2) Methods and occasions for conducting radiation surveys;
- (3) Methods and occasions for locking and securing sources of radiation;
- (4) Personnel monitoring and the use of personnel monitoring equipment;
- (5) Minimizing exposure of individuals in the event of an accident;
- (6) Notifying proper personnel in the event of damage, loss, theft, or accident involving sources of radiation;
- (7) General guidelines for the safe handling and use of unsealed sources of radioactive materials;
- (8) Maintenance of records;
- (9) Procedures for picking up, receiving and opening packages containing radioactive materials; and

- (10) The transportation of radioactive sources to temporary job sites, including the packaging, marking, labeling and placing of such sources in vehicles, placarding of vehicles, securing the sources during transportation and possessing proper shipping papers and emergency response information.

Specific Authority: 404.051, 404.061, 404.081, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Amended January 1, 1994, Amended May 15, 1996, Formerly 10D-91.1403.

**64E-5.1303****Leak Test Requirements for Possession of Sealed Sources.**

- (1) A licensee in possession of a sealed source shall assure that:
- (a) The sealed source is tested for leakage before its first use unless the licensee has a certificate from the supplier indicating that the sealed source was tested semiannually before transfer to the licensee;
  - (b) The sealed source is tested for leakage at least semiannually or at intervals approved by the department;
  - (c) Leak tests are capable of detecting 0.005 microcurie (185 Bq) of radioactive material on the test sample, or, in the case of radium, the escape of radon of 0.001 microcurie (37 Bq) each 24 hours;
  - (d) Test samples are taken from the sealed source or from the surfaces of the device in which the sealed source is mounted or stored on which radioactive contamination might be expected to accumulate; and
  - (e) Device test samples are taken when the sealed source is in the off or shielded position.
  - (f) Leak tests are analyzed by individuals who are licensed by the department, U.S. Nuclear Regulatory Commission, an agreement state or a licensing state to perform leak test services.
- (2) A licensee shall retain leak test records for 3 years. The records shall contain the manufacturer's name, the model and serial numbers of each sealed source tested, the identity of each sealed source radionuclide and its estimated activity, the measured activity of each test sample expressed in microcuries (becquerels), the date of the test, and the signature of the radiation safety officer or designee.

- (3) If the leak test reveals the presence of 0.005 microcurie (185 Bq) or more of removable contamination, the licensee shall:
  - (a) Immediately withdraw the sealed source from use and cause it to be decontaminated and repaired or to be disposed of in accordance with these regulations; and
  - (b) File a report with the department within 5 days of receiving the leak test results describing the equipment involved, the test results, and the action taken.
- (4) A leak test is not required on the following sealed sources:
  - (a) Sealed sources containing only radioactive material with a half-life of less than 30 days;
  - (b) Sealed sources containing only radioactive material as a gas;
  - (c) Sealed sources containing 100 microcuries (3.7 MBq) or less of beta or photon-emitting material or 10 microcuries (370 kBq) or less of alpha-emitting material; and
  - (d) Sealed sources that are listed on a department license for storage only. The licensee shall test each such sealed source for leakage before any use or transfer unless it has been tested for leakage within 6 months before the date of use or transfer.
- (5) The department is authorized to approve leak test frequencies other than semiannually. Criteria used to determine these frequencies include:
  - (a) The isotope and activity;
  - (b) The requested usage;
  - (c) The environmental hazards to which the sealed sources may potentially be exposed;
  - (d) The manufacturer's recommended frequency; and
  - (e) Specific information on the sealed source or device provided by the U.S. Nuclear Regulatory Commission, an agreement state or a licensing state, including:
    - 1. Sealed Source and Device Registry sheets;
    - 2. Naturally Occurring or Accelerator Produced Radioactive Materials Sealed Source and Device Registry sheets.

Specific Authority: 404.022, 404.042, 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.042, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Formerly 10D-91.1404.

sources shall conduct a physical inventory of all such sealed sources semiannually unless another interval is specified in the license. Inventory records shall be retained for 3 years. Inventory records shall contain the following:

- (1) The model and serial number of each sealed source;
- (2) The identity of each sealed source radionuclide and its estimated activity;
- (3) The location of each sealed source;
- (4) The date of the inventory; and
- (5) The signature of the radiation safety officer or designee.

Specific Authority: 404.022, 404.042, 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.042, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Formerly 10D-91.1405.

**64E-5.1305 Training Requirements, Authority, Duties and Responsibilities of the Radiation Safety Officer.**

- (1) The licensee shall appoint a radiation safety officer with the authority to fulfill the duties and responsibilities listed in this part.
- (2) The radiation safety officer shall have sufficient training and experience with radioactive materials to be a user of the requested licensed materials, unless otherwise specified in the license. This training shall include practical experience in the safe use of radioactive materials and knowledge of procedures, facilities and equipment.
- (3) The duties and responsibilities of the radiation safety officer shall include the following:
  - (a) Ensure that all terms and conditions of the license and these regulations are complied with;
  - (b) Ensure that the sealed sources are leak tested timely and as prescribed by the manufacturer or by the license;
  - (c) Ensure that radioactive materials are used only by individuals who are authorized by the license and that all individuals wear required personnel monitoring equipment;
  - (d) Maintain all records required by the license and these regulations. These records shall include personnel monitoring records, leak test records, inventory records, training records for users and receipt, transfer and disposal records;
  - (e) Ensure that radioactive materials are properly secured against unauthorized access or removal;

- (f) Serve as a contact with the department for events such as the loss, theft or damage of radioactive material; and
- (g) Ensure that all users read and understand the licensee's emergency, operating and radiation safety procedures.

Specific Authority: 404.022, 404.042, 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.042, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Formerly 10D-91.1406.

**64E-5.1306 Opening Sealed Sources.** Unless otherwise specifically licensed by the department, the U.S. Nuclear Regulatory Commission, an agreement state or a licensing state to perform such services, the licensee shall not open sealed sources.

Specific Authority: 404.022, 404.042, 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.042, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Formerly 10D-91.1407.

**64E-5.1307 Training Requirements for Authorized Users.**

- (1) Radioactive materials shall be used by individuals who are qualified by training and experience to protect public health, safety and the environment. A description of this training must be submitted and approved by the department and include the following:
  - (a) Principles and fundamentals of radiation protection and safety practices related to the use of radioactive materials, including ALARA principles;
  - (b) Radioactivity measurements;
  - (c) Use of radiation detection instruments and monitoring techniques;
  - (d) Biological effects of radiation;
  - (e) Transportation of radioactive materials;
  - (f) Practical experience with the use of radioactive materials; and
  - (g) Licensee's operating and emergency procedures.
- (2) For licensees who propose to train their own personnel to be authorized users, the following must be provided to and approved by the department:
  - (a) Instructor qualifications, including training and experience with radioactive materials specifically relating to the topics of instruction;
  - (b) A detailed training program, including duration of training for each of the topics listed in (1) of this section;
  - (c) The method of testing the knowledge of students, such as a written and practical examination, and whether the examination is open or closed book; and

- (d) If an examination is used, the passing score, method of retesting students who do not pass and an example of the examination with the correct answers indicated.
- (3) Records of training shall be maintained during the employment of the individual or 5 years, whichever is greater.
- (4) Unless otherwise specified in the license, a licensee's authorized user training program is not transferable to another licensee.

Specific Authority: 404.022, 404.042, 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.042, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Formerly 10D-91.1409.

**64E-5.1308 Additional Requirements for General Licenses.** Specific licensees authorized for a general license described in 64E-5.205(4), 64E-5.206(1), 64E-5.206(4) or 64E-5.206(6), shall comply with the regulations that are applicable to that general license and 64E-5.1304 and 64E-5.1305. Specific licensees authorized for the general license in 64E-5.205(4), or possess generally licensed devices described in 64E-5.206(1) or (4) are not required to remit the annual fees specified in 64E-5.204(1)(c)1., 2., or 5.

Specific Authority: 404.022, 404.042, 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.042, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Formerly 10D-91.1410.

**64E-5.1309 Training for Current Authorized Users.** Individuals who are authorized users on a department, U.S. Nuclear Regulatory Commission, agreement state or licensing state license on May 12, 1993 who perform only those procedures for which they are authorized on that date need not comply with the training requirements in 64E-5.1307, 64E-5.1312 and 64E-5.1313.

Specific Authority: 404.022, 404.042, 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.042, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Formerly 10D-91.1411.

**64E-5.1310 Personnel Monitoring.**

- (1) Unless otherwise specified in the license, no licensee shall permit any individual to use or to assist in the use of sealed sources of radiation in portable devices unless such individual wears a film badge, **OSLD**, or a TLD.
- (2) Unless otherwise specified in the license, no licensee shall permit any individual to perform installations, maintenance or service, initial radiation surveys, relocations or removal from service of sealed sources in fixed devices unless such individual wears a film badge, **OSLD**, or a TLD.
- (3) Licensees who use iodine 125, iodine 131, hydrogen 3, uranium 234, uranium 235 or uranium 238 and are required to have a bioassay program must submit a description of their bioassay program for approval by the department.



- R2 (4) A whole body film badge, OSLD, or TLD is required to be worn by any individual using or assisting in the use of unsealed sources of radioactive materials of any gamma-emitting isotope with a gamma ray energy greater than 50 kiloelectron volts or the use of any beta-emitting isotope with a maximum beta energy of 300 kiloelectron volts or more.
- R2 (5) An extremity film badge or, OSLD, TLD is required to be worn by any individual using or assisting in the use of unsealed sources of radioactive materials of 1,000 microcuries (37 MBq) or more of beta-emitting isotopes with a maximum beta energy of 1,000 kiloelectron volts or more in any month or by any individual who receives a dose of 40 millirem (400  $\mu$ Sv) or more on a whole body film badge, OSLD, or TLD for 2 consecutive months.
- R2 (6) Each film, OSLD, and TLD badge shall be assigned to and worn by only one individual. Film badges and extremity OSLDs and TLDs must be replaced monthly. Whole body OSLDs and TLDs must be replaced quarterly. After replacement, each film badge, OSLD, and TLD must be promptly processed.

Specific Authority 404.051, 404.061, 404.081, F.S.

Law Implemented 404.022, 404.051(1), (4), (6), (10), 404.061(2), 404.081(1)(2), F.S.

R2 History--New May 15, 1996, Formerly 10D-91.1411, Amended October 8, 2000.

## **SUBPART B**

### **REQUIREMENTS FOR THE POSSESSION AND USE OF SEALED SOURCES IN PORTABLE DEVICES**

#### **64E-5.1311**

#### **Storage, Security and Transportation Precautions**

- (1) Each sealed source of radioactive material shall be provided with a storage or transport container. The container shall be equipped with a lock or tamper seal to prevent unauthorized removal of or exposure to the source of radiation.
- (2) Sealed sources must have a minimum of two locks between the device and the public when being transported or stored.
- (3) Transport containers shall be physically secured in the transporting vehicle to prevent accidental loss, tampering, or unauthorized removal. The sealed source shall be transported as far away from occupied areas of the vehicle as possible.
- (4) Sealed sources not in storage or being transported must be under the constant surveillance and immediate control of the licensee.

Specific Authority: 404.022, 404.042, 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.042, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Formerly 10D-91.1412.

**64E-5.1312 Training and User Requirements.**

- (1) Users of sealed sources in portable devices must have completed a minimum of 8 hours of training from individuals approved by the department. This training must include the areas described in 64E-5.1307.
- (2) Documentation of training for each user must be maintained for the duration of employment or 5 years, whichever is greater.
- (3) Sealed sources in portable devices may be used by individuals who are under the direct supervision and in the physical presence of an authorized user.

Specific Authority: 404.022, 404.042, 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.042, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Formerly 10D-91.1415.

**SUBPART C**  
**REQUIREMENTS FOR THE POSSESSION AND USE OF**  
**SEALED SOURCES IN FIXED DEVICES**

**64E-5.1313 Training and User Requirements.** Unless otherwise specifically licensed by the department, the U.S. Nuclear Regulatory Commission, an agreement state or a licensing state to perform such services, the licensee shall not remove sealed sources from source holders; remove source holders containing sealed sources from devices; perform maintenance or repair of devices or source holders containing sealed sources, including repair or maintenance of the shutter; perform installations, replacement, removal from service, relocations, or disposal of sealed sources, source holders or devices containing sealed sources; or perform initial radiation surveys of devices or source holders.

- (1) Users of sealed sources in fixed devices must have completed a minimum of 8 hours of training from individuals approved by the department. This training must include the areas described in 64E-5.1307.
- (2) Individuals who perform installations, maintenance or service, initial radiation surveys, relocations, or removal from service must have completed a minimum of 40 hours of training from individuals approved by the department. This training must include the following:
  - (a) The principles and fundamentals of radiation protection and safety practices related to the use of radioactive material;
  - (b) Radiation measurements, use of radiation detection instruments and monitoring techniques;
  - (c) Biological effects of radiation;
  - (d) Procedures for performing services; and
  - (e) Actual practice in performing the services.

- (3) Documentation of training for each user must be maintained for the duration of employment or 5 years, whichever is greater.
- (4) Sealed sources in fixed devices may be used by individuals under the supervision of an authorized user. An authorized user must be available at all times when sealed sources in fixed devices are being used.
- (5) Installations, maintenance or service, initial radiation surveys, relocations or removal from service may be performed by individuals who are under the direct supervision and in the physical presence of an individual who is an authorized user for these operations.

Specific Authority: 404.022, 404.042, 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.042, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Formerly 10D-91.1418.

**64E-5.1314 Possession of Survey Instruments.** A licensee authorized to perform installations, maintenance or service, initial radiation surveys, relocations or removal from service of sealed sources in fixed devices shall possess portable radiation survey instruments with a range from 1 millirem (10  $\mu$ Sv) per hour to 200 millirem (2 mSv) per hour. The instruments shall be operable and calibrated as provided in 64E-5.314.

Specific Authority: 404.022, 404.042, 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.042, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Amended January 1, 1994, Formerly 10D-91.1419.

**64E-5.1315 Additional Requirements.** A licensee must post and provide to personnel lock-out procedures that prevent employees from entering the radiation beam during maintenance, repairs, or other work in, on, or around a bin, tank, hopper or pipe on which a device is mounted. The department is authorized to require a physical barrier around certain types of devices where the possibility exists that an individual could be exposed to the beam of radiation.

Specific Authority: 404.022, 404.042, 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.042, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Formerly 10D-91.1420.

## SUBPART D

### REQUIREMENTS FOR POSSESSION AND USE OF UNSEALED SOURCES OF RADIOACTIVE MATERIALS

**64E-5.1316 General Rules for the Safe Use of Unsealed Sources of Radioactive Materials.** The licensee shall assure that all individuals who handle unsealed sources of radioactive materials comply with the following, unless otherwise specified in the license:

- (1) Laboratory coats or other protective clothing are worn at all times in areas where radioactive materials are used;
- (2) Disposable gloves are worn at all times while handling radioactive materials;
- (3) Eating, drinking, smoking, or applying cosmetics in any area where radioactive material is stored or used is prohibited;

- (4) Storing food, drinks, or personal effects in areas where radioactive material is stored or used is prohibited;
- (5) If applicable, personnel monitoring devices are worn at all times while in areas where radioactive materials are used or stored;
- (6) Radioactive waste is disposed of only in designated, labeled, and properly shielded receptacles; and
- (7) Radioactive materials are confined in clearly labeled appropriate containers.

Specific Authority: 404.022, 404.042, 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.042, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Formerly 10D-91.1422.

**64E-5.1317****Storage and Control of Volatiles and Gases.**

- (1) A licensee shall store volatile radioactive materials and radioactive gases in the shippers' radiation shield and container or an equivalent shield and container.
- (2) Unless otherwise specified in the license, a licensee shall store and use radioactive volatiles and gases in a properly functioning glove box or fume hood that will maintain airborne concentrations within the limits prescribed by State of Florida Bureau of Radiation Control, ALIs, DACs, and Effluent Concentrations, July 1993, Table I, Column 2 and Table II, Column 1.
- (3) Unless otherwise specified in the license, the glove box or fume hood shall either be directly vented to the atmosphere through an air exhaust or provide for collection and decay or disposal of the volatile or gas.

Specific Authority: 404.022, 404.042, 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.042, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Amended January 1, 1994, Formerly 10D-91.1423.

**64E-5.1318****Instrumentation**

- (1) The licensee shall have instruments available to detect radioactive materials listed on the license, unless otherwise authorized by the department. Instrumentation shall be sensitive enough to detect activities required for adequate contamination control described in this part.
- (2) The licensee must submit a description of the equipment and procedures to be followed in measuring contamination for departmental approval. These procedures shall include the following:
  - (a) Type of instrument detection system used, such as a Geiger-Mueller or scintillation detector with a scaler, single or multichannel analyzer, and type of radiation detected;
  - (b) Background counting times and average background counts;
  - (c) Sample counting times;

- (d) Instrument efficiency and calculation of efficiency determination;
  - (e) Instrument's lower limit of detection using the sample counting time and the isotope and activity of calibration standards;
  - (f) Sample calculation converting counting results into activity or activity per unit time, if applicable; and
  - (g) Frequency of instrument calibration.
- (3) If portable radiation survey instruments are used to determine compliance with the contamination control action levels described in this part, the instruments shall be operable and calibrated as provided in 64E-5.314.

Specific Authority: 404.022, 404.042, 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.042, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Amended January 1, 1994, Formerly 10D-91.1425.

**64E-5.1319 Contamination Control Program.** The licensee shall establish and submit for department approval a contamination control program to limit the spread of unsealed sources of radioactive materials. This program shall include contamination action levels, corresponding actions taken if these levels are exceeded, frequency of measurement and maintenance of records.

- (1) Unless otherwise specified in the license, the licensee shall perform the following:
- (a) A survey with a radiation survey instrument shall be completed at the end of each day of use or receipt of all areas where radioactive materials are used or received.
  - (b) A weekly survey with a radiation survey instrument shall be completed of all areas where radioactive materials or radioactive waste are stored.
  - (c) A wipe survey shall be completed for removable contamination weekly during weeks of use of all areas where radioactive materials or waste are routinely used or stored.
  - (d) Surveys required by (1)(a)(b) and (f) of this section shall be completed with an instrument capable of measuring dose rates as low as 0.1 millirem (1  $\mu$ Sv) per hour, if applicable.
  - (e) A wipe survey shall be completed for removable contamination at the end of each day of use of all areas where radioactive materials are routinely used if the radioactive materials authorized by the license are not detectable with instruments described in (1)(d) above.
  - (f) Monitoring shall be performed of individuals for contamination prior to leaving the restricted area.
  - (g) The radiation safety officer shall be notified if the contamination detected during the surveys required by this section exceeds the action levels specified in (2), below.

- (2) Unless otherwise specified in the license, the licensee shall take the following actions if the corresponding action levels are exceeded:
- (a) Follow decontamination procedures and resurvey to determine effectiveness of decontamination efforts if the action levels are exceeded when conducting surveys described in (1)(a)(b) or (f) above;
  - (b) Follow emergency procedures if the radiation detected during the survey required in (1)(f) of this section is above action levels; and
  - (c) Follow decontamination procedures and resurvey to determine effectiveness of decontamination efforts if the action levels listed below are exceeded for the survey required in (1)(c) or (e) above;
    - 1. 100 dpm per 100 square centimeters of any alpha-emitting radioactive materials not listed in this section;
    - 2. 1,000 dpm per 100 square centimeters of any beta- or gamma-emitting radioactive materials not listed in this section;
    - 3. 50 dpm per 100 square centimeters of any transuranic;
    - 4. 2,000 dpm per 100 square centimeters of uranium; or
    - 5. 2,000 dpm per 100 square centimeters of any radioactive material with a half-life of less than 80 hours.
- (3) The licensee shall retain a record of each survey required by this section for 3 years. These records shall include:
- (a) The date of the survey;
  - (b) An annotated diagram of each area surveyed;
  - (c) Background levels;
  - (d) Measured dose rates, keyed to the diagram, expressed in millirem (microsieverts) per hour or the removable contamination, keyed to the diagram, expressed in dpm per 100 square centimeters, or counts per minute if performed with a radiation survey instrument, with the action level described in (2)(a) of this section;
  - (e) The serial number and model number of the instrument used to make the survey or analyze the samples; and
  - (f) The initials of the person who performed the survey.
- (4) Records of surveys described in (1)(f) need not be recorded unless the action level described in (2)(a) of this section is exceeded.

Specific Authority: 404.022, 404.042, 404.051, 404.061, 404.071, 404.081, F.S.

Law Implemented: 404.022, 404.042, 404.051(1)(4)(6)(9)(10), 404.061(2)(3), 404.071(1), 404.081(1), F.S.

History: New May 12, 1993, Formerly 10D-91.1426.

**PART XIV LICENSING AND RADIATION SAFETY REQUIREMENTS FOR  
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## PART XIV

### LICENSING AND RADIATION SAFETY REQUIREMENTS FOR IRRADIATORS

#### SUBPART A GENERAL PROVISIONS

##### 64E-5.1401      Irradiators.

- (1) This part contains requirements for licenses authorizing the use of sealed sources containing radioactive materials in irradiators to irradiate objects or material. This part also contains radiation safety requirements for operating irradiators.
- (2) The rules in this part apply to panoramic irradiators which have either dry or wet storage of radioactive sealed sources and to underwater irradiators in which both the source and the product being irradiated are under water. Irradiators covered by the rules in this part are those whose radiation dose rates exceed 500 rads (5 grays) per hour at 1 meter from the radioactive sealed sources in air or in water.
- (3) The rules in this part do not apply to self-contained dry-source-storage irradiators in which both the source and the area subject to irradiation are contained within a device and are not accessible by personnel. This part also does not apply to radioactive material used for medical radiology, teletherapy, industrial radiography, gauging, calibration of radiation instruments, or open-field agricultural irradiations.
- (4) The requirements of this part are in addition to other applicable requirements of these rules.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1501.

##### 64E-5.1402      Definitions.

- (1) "Doubly encapsulated sealed source" means a sealed source in which the radioactive material is sealed within a capsule which is sealed within another capsule.
- (2) "Irradiator" means a facility which uses radioactive sealed sources to irradiate objects or materials and in which radiation dose rates exceeding 500 rads (5 grays) per hour exist at 1 meter from the sealed radioactive sources in air or water, as applicable for the irradiator type, but does not include irradiators in which both the sealed source and the area subject to irradiation are contained within a device and are not accessible to personnel.

- (3) "Irradiator operator" means an individual who successfully completed the training and testing specified in 64E-5.1416 and who is authorized by the licensee and approved by the department to operate the irradiator without a supervisor present.
- (4) "Panoramic dry-source-storage irradiator" means an irradiator in which the irradiation occurs in air in areas potentially accessible to personnel and in which the sources are stored in shields made of solid materials. The term includes beam-type dry-source-storage irradiators in which only a narrow beam of radiation is produced to perform irradiations.
- (5) "Panoramic irradiator" means an irradiator in which the irradiation occurs in air in areas potentially accessible to personnel. The term includes beam-type irradiators.
- (6) "Panoramic wet-source-storage irradiator" means an irradiator in which the irradiation occurs in air in areas potentially accessible to personnel and in which the sources are stored under water in a storage pool.
- (7) "Pool irradiator" means an irradiator in which the sources are stored or used in a pool of water, including panoramic wet-source-storage irradiators and underwater irradiators.
- (8) "Product conveyor system" means a system to move the product to be irradiated to, from, and within the area where irradiation occurs.
- (9) "Radiation room" means a shielded room in which irradiation occurs. Underwater irradiators do not have radiation rooms.
- (10) "Seismic area" means any area where the probability of a horizontal acceleration in rock of more than 0.3 times the acceleration of gravity in 250 years is greater than 10 percent as designated by the U.S. Geological Survey.
- (11) "Underwater irradiator" means an irradiator in which the sources always remain shielded under water and personnel cannot access the sealed source or the space subject to irradiation without entering the pool.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1502.

**SUBPART B**  
**SPECIFIC LICENSING REQUIREMENTS**

**64E-5.1403      Specific License for Large Irradiators.** An application for a specific license to use sealed sources in a large irradiator shall be made as specified in 64E-5.207. A separate license is required for each large irradiator, radiation room or underwater irradiator. The department will approve an application for a specific license for the use of licensed material in an irradiator if the applicant meets the requirements contained in this section.

- (1) The applicant must satisfy the general requirements specified in 64E-5.208 and the requirements contained in this part.
- (2) The applicant must describe training for irradiator operators which includes the following:
  - (a) At least 40 hours of classroom training;
  - (b) At least 160 hours of on-the-job or simulator training;
  - (c) Safety reviews;
  - (d) The means the applicant will use to evaluate the operator's knowledge and understanding of and ability to comply with the department's rules and licensing requirements and the applicant's operating and emergency procedures; and
  - (e) The minimum qualifications of personnel who provide training.
- (3) The applicant shall submit an outline or summary of the written operating and emergency procedures specified in 64E-5.1417. The outline or summary must include important radiation safety aspects of the procedures.
- (4) The applicant shall describe the radiation safety responsibilities and authority of the radiation safety officer and other management personnel and specify who has the authority to stop unsafe operations. The applicant also shall describe the qualifications required of the radiation safety officer.
- (5) The applicant shall submit a description of the access control systems required by 64E-5.1406, the radiation monitors required by 64E-5.1409, the method to detect leaking sources required by 64E-5.1420, including the sensitivity of the method, and a diagram of the facility which shows the position of all required interlocks and radiation monitors.
- (6) The applicant shall assure that any radioactive source not used in the irradiation process shall be removed from the irradiator pool and disposed of or returned to the manufacturer unless otherwise approved by the department.

- (7) If the applicant intends to perform leak testing of dry-source-storage sealed sources, the applicant shall establish procedures for leak testing and submit a description of these procedures to the department for approval. The procedures must include the following:
  - (a) Instruments to be used;
  - (b) Methods of performing the analysis; and
  - (c) Pertinent experience of individuals who analyze the samples.
- (8) If licensee personnel load or unload sources, the applicant shall describe the qualifications of the personnel and the procedures to be used. If the applicant contracts for source loading or unloading, the loading or unloading must be done by an organization licensed by the U.S. Nuclear Regulatory Commission, an agreement state or a licensing state to load or unload irradiator sources.
- (9) The applicant shall perform operational tests on the following to ensure proper functioning of all equipment and safety devices before the irradiator is loaded with sources:
  - (a) Interlock and radiation safety systems;
  - (b) Pool integrity and plumbing;
  - (c) Source rack mechanical positioning system;
  - (d) Source rack movement and position sensing systems;
  - (e) Source rack electrical control system;
  - (f) Uninterruptable electrical power supply for radiation monitoring warning systems;
  - (g) Fire protection system;
  - (h) Emergency systems for returning a stuck source rack into the pool;
  - (i) Systems used for transferring sources to and from transport vehicles; and
  - (j) Product conveyor system.
- (10) The applicant shall describe the operational inspection and maintenance program, including the frequency of operational checks required by 64E-5.1421.
- (11) The roof plug opening or removable shielding providing access for the loading and removal of sources shall be large enough to accommodate the largest applicable transportation cask.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1503.

**64E-5.1404      Start of Construction.**

- (1) The applicant shall not begin construction of a new irradiator before sending a license application to the department for the irradiator. As used in this paragraph, the term "construction" includes the construction of any portion of the permanent facility on the site but does not include:
  - (a) Engineering and design work;
  - (b) Purchase of the site;
  - (c) Site surveys or soil testing;
  - (d) Site preparation;
  - (e) Site excavation;
  - (f) Construction of warehouse structures; and
  - (g) Other similar tasks.
- (2) Site requirements for an irradiator include geological, radiological and hydrological testing to ensure a stable environment before construction begins. Records of the results of the siting requirements shall be maintained for the life of the facility.
- (3) Any activities undertaken before the issuance of a license will be entirely at the risk of the applicant and will have no bearing on the issuance of a license.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1504.

**SUBPART C**  
**DESIGN AND PERFORMANCE REQUIREMENTS FOR LARGE IRRADIATORS**

**64E-5.1405      Performance Criteria for Sealed Sources.**

- (1) The licensee shall assure that sealed sources installed after August 14, 1996 meet the requirements of this section. A prototype of the sealed source must be leak tested and found leak-free after each of the following tests:
  - (a) Temperature. The test source must be held at minus 40 degrees Celsius for 20 minutes, 600 degrees Celsius for 1 hour, and then be subjected to a thermal shock test with a temperature drop from 600 degrees Celsius to 20 degrees Celsius within 15 seconds.
  - (b) Pressure. The test source must be subjected twice to an external pressure of 290 pounds per square inch absolute for at least 5 minutes.
  - (c) Impact. A 2 kilogram steel weight, 2.5 centimeters in diameter, must be dropped from a height of 1 meter onto the test source.

- (d) Vibration. The test source must be subjected three times for 10 minutes each time to a range of vibration from 25 Hertz to 500 Hertz at 5 times the acceleration of gravity for 30 minutes. Each test source must be vibrated for 30 minutes at each resonant frequency found.
  - (e) Puncture. A 50 gram weight and pin, 0.3 centimeter pin diameter, must be dropped from a height of 1 meter onto the test source.
  - (f) Bend. If the length of the source is more than 15 times larger than the minimum cross-sectional dimension, the test source must be subjected to a force of 2,000 newtons at its center equidistant from two support cylinders. The distance between the support cylinders is 10 times the minimum cross-sectional dimension of the source.
- (2) Sealed sources installed after August 14, 1996 must be doubly encapsulated, the isotope or isotope and matrix contained within the sealed sources must be as nondispersible and insoluble as practical or rendered insoluble in water if the source is used in a wet-source-storage or wet-source-change irradiator and must satisfy the requirements specified in 64E-5.210(14).

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1505.

#### **64E-5.1406**

#### **Access Control.**

- (1) Panoramic irradiators shall not be operated unless the following are met:
- (a) Each entrance to a radiation room must have a door or other physical barrier to prevent inadvertent entry of personnel while the sources are exposed. Product conveyor systems can serve as barriers as long as they reliably and consistently function as a barrier. It must not be possible to move the sources out of their shielded position if any door or barrier to the radiation room is open. Opening the door or barrier while the sources are exposed must cause the sources to return promptly to their shielded position. The primary entry door must have a lock which is operated by the same key used to control source movement. The doors and barriers must not prevent any individual in the radiation room from leaving.
  - (b) Each entrance to a radiation room must have an independent backup access control to detect personnel entry while the sources are exposed if the primary access control fails. Entry while the sources are exposed must cause the sources to return to their fully shielded position and also must activate a visible and audible alarm to make the individual entering the room aware of the hazard. The alarm also must alert at least one other individual of the entry who is on site and who is trained to render or summon assistance promptly.

- (c) A radiation monitor must be provided to detect the presence of high radiation levels in the radiation room before personnel entry. The monitor must be integrated with personnel access door locks to prevent room access when the monitor detects high radiation levels. The monitor must generate audible and visible alarms if high radiation levels are detected when personnel entry is attempted. The monitor can be located in the entrance or maze but not in the direct radiation beam.
- (d) Before sources move from their shielded position, the source control automatically must activate conspicuous visible and audible alarms to alert people in the radiation room that the sources will be moved from their shielded position. The alarms must give individuals enough time to leave the room before the sources leave the shielded position.
- (e) Each radiation room must have a clearly visible and readily accessible control which will allow an individual in the room to return the sources to their fully shielded position.
- (f) Each radiation room must contain a control which allows the sources to move from the shielded position only if the control has been activated and the door or barrier to the radiation room subsequently has been closed within a preset time.
- (g) Each entrance to the radiation room and each entrance to the area within the personnel access barrier of an underwater irradiator must be posted as required by Rule 64E-5.323, F.A.C. Panoramic irradiators also must be posted as required by Rule 64E-5.323, F.A.C. The sign can be removed, covered, or otherwise made inoperative when the sources are shielded fully.
- (h) If the radiation room has roof plugs or other movable shielding, it must not be possible to operate the irradiator unless the shielding is in its proper location. This requirement can be met by interlocks which prevent operation if shielding is not placed properly or by an operating procedure requiring inspection of shielding before operating.

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- (2) Underwater irradiators must have a personnel access barrier around the pool which must be locked to prevent access when the irradiator is not attended. Only operators and facility management shall have access to keys to the personnel access barrier. There must be an intrusion alarm to detect unauthorized entry when the personnel access barrier is locked. Activation of the intrusion alarm must alert an individual, not necessarily on site, who is prepared to respond or summon assistance.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

R2 History: New August 14, 1996, Formerly 10D-91.1506, Amended October 8, 2000.

#### **64E-5.1407**

#### **Shielding.**

- (1) The radiation dose rate in areas which normally are occupied during operation of a panoramic irradiator must not exceed 2 millirem (0.02 millisievert) per hour at 30 centimeters or more from the wall of the room when the sources are exposed. The dose rate must be averaged over an area not to exceed 100 square centimeters having no linear dimension greater than 20 centimeters. Areas where the radiation dose rates exceed 2 millirem (0.02 millisievert) per hour must be locked, roped off, or posted to prevent access and not entered without written approval or in the physical presence of the radiation safety officer or his designee.
- (2) The radiation dose at 30 centimeters over the pool of a pool irradiator when the source is in the fully shielded position must not exceed 2 millirem (0.02 millisievert) per hour.
- (3) The radiation dose rate at 1 meter from the shield of a dry-source-storage panoramic irradiator must not exceed 2 millirem (0.02 millisievert) per hour and at 5 centimeters from the shield must not exceed 20 millirem (0.02 millisievert) per hour.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1507.

#### **64E-5.1408**

#### **Fire Protection.**

- (1) The radiation room at a panoramic irradiator must have heat and smoke detectors. The detectors must activate an audible alarm. The alarm must be capable of alerting a person who is prepared to summon assistance promptly. The sources must become fully shielded automatically and the air handling systems within the radiation room must be disabled automatically if a fire is detected.
- (2) The radiation room at a panoramic irradiator must be equipped with a fire suppression or extinguishing system capable of extinguishing a fire without the entry of personnel into the room. The system for the radiation room must have a shut-off valve to control flooding into unrestricted areas.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1508.



**64E-5.1409****Radiation Monitors.**

- (1) Irradiators with automatic product conveyor systems must have a radiation monitor with an audible alarm located to detect loose radiation sources which are carried toward the product exit. If the monitor detects a source, an alarm must sound and product conveyors must stop automatically. The alarm must be capable of alerting an individual in the facility who is prepared to summon assistance. Underwater irradiators in which the product moves within an enclosed stationary tube are exempt from the requirements of this paragraph.
- (2) For pool irradiators, the licensee shall provide a means to detect radioactive contamination in pool water each day the irradiator operates. The means can be either an on-line radiation monitor on the pool water purification system or an analysis of pool water. If the licensee uses an on-line radiation monitor, the detection of above normal background radiation levels must activate the alarm. The alarm set-point must be set as low as practical but high enough to avoid false alarms. If a false alarm due to background radiation occurs, the alarm set-point must be increased. Activation of the alarm must cause the water purification system to shut off automatically. However, the licensee can reset the alarm set-point to a higher level if necessary to operate the pool purification system to clean up contamination in the pool as provided specifically in written emergency procedures.
- (3) Underwater irradiators which are not in a shielded radiation room must have a radiation monitor over the pool to detect abnormal radiation levels. The monitor must have an audible alarm and a visible indicator at entrances to the personnel access barrier around the pool. The audible alarm can have a manual shut-off. The alarm must be capable of alerting an individual who is prepared to respond promptly.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1509.

**64E-5.1410****Control of Source Movement.**

- (1) The mechanism which moves the sources of a panoramic irradiator must require a key to operate. Operation of the mechanism must cause an audible signal to indicate that the sources are leaving the shielded position. Only one key shall be available for use at any time and only operators or facility management can possess it. The key must be attached to a portable radiation survey meter by a chain or cable. The lock must be designed so that the key cannot be removed if the source is in an unshielded position. The door to the radiation room must require the same key. The key must be in the possession of a person entering the radiation room.
- (2) The console of a panoramic irradiator must have a source position indicator which indicates when the sources are in the fully shielded position, when they are in transit, and when they are exposed.

- (3) The control console of a panoramic irradiator must have a control which promptly returns the sources to the shielded position.
- (4) Each control for a panoramic irradiator must be labeled clearly as to its function.
- (5) Controls for a panoramic irradiator must be color-coded or illuminated as follows:
  - (a) Red represents emergency or critical information;
  - (b) Yellow or orange represents caution, no emergency but some function taking place to be aware of; and
  - (c) Green or blue represents normal or safe functioning or information.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1510.

#### **64E-5.1411**

#### **Irradiator Pools.**

- (1) For licenses initially issued after August 14, 1996, irradiator pools must possess a watertight stainless steel liner or a liner metallurgically compatible with other components in the pool or be constructed so that there is a low likelihood of substantial leakage and have a surface designed to facilitate decontamination and must include a means of safely storing sources during repairs of the pool.
- (2) For licenses initially issued after August 14, 1996, irradiator pools must have no penetration more than 0.5 meter below the normal low water level which could allow water to drain out of the pool. Pipes which have intakes more than 0.5 meter below the normal low water level must have siphon breakers to prevent the siphoning of the pool.
- (3) A means must be provided to replenish water losses from the pool.
- (4) An audible and visible indicator must be provided to indicate if the pool water level is below the normal low water level or above the normal high water level.
- (5) Irradiator pools must be equipped with a purification system designed to maintain the water during normal operation at a level of conductance not exceeding 20 microsiemens per centimeter and with a clarity so the sources can be seen clearly.
- (6) A physical barrier such as a railing or cover must be used around irradiator pools during normal operation to prevent personnel from accidentally falling into the pool. The barrier can be removed during maintenance, inspection, and service operations.
- (7) If long-handled tools or poles are used in irradiator pools, the radiation dose rate on the handling areas of the tools must not exceed 2 millirem (0.02 millisievert) per hour.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1511.

**64E-5.1412 Source Rack Protection.** If the product to be irradiated moves on a product conveyor system, the source rack and the mechanism which moves the rack must be protected by a barrier or guides to prevent products and product carriers from hitting or touching the rack or mechanism. A collision alarm system on the protective barrier must cause an alarm at the control console notifying the operator that a collision between the barrier and product conveyor has occurred.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1512.

**64E-5.1413 Power Failures.**

- (1) If electrical power at a panoramic irradiator is lost for longer than 10 seconds, the sources must return automatically to the shielded position.
- (2) The lock on the door of the radiation room of a panoramic irradiator must not be deactivated by a power failure.
- (3) During a power failure, the area around the pool of an irradiator shall not be entered without using an operable and calibrated radiation survey meter.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1513.

**64E-5.1414 Design Requirements.** Irradiators whose construction begins after August 14, 1996 must meet the design requirements of this section. The requirements must be met before the start of the construction of the specific component, but do not have to be met before submitting a license application. After construction of the irradiator is completed, the licensee must submit to the department copies of as-built construction drawings signed by the architect and the licensee.

- (1) Panoramic irradiators shall meet the following design requirements:
  - (a) **Shielding.** The licensee shall design shielding walls to meet generally accepted building code requirements for reinforced concrete and shall design the walls, wall penetrations, and entrance ways to meet the radiation shielding requirements of 64E-5.1407. If the irradiator will use more than  $2 \times 10^{17}$  becquerels (5 million curies) of activity, the licensee shall evaluate the effects of heating of the shielding walls by the irradiator sources.
  - (b) **Foundations.** The licensee shall design the foundation with consideration given to soil characteristics to ensure it is adequate to support the weight of the facility.

- (c) Source Rack. The licensee shall determine that source rack drops due to loss of power will not damage the source rack and that source rack drops due to failure of cables or alternate means of support will not cause loss of integrity of sealed sources. The licensee shall review the design of the mechanism which moves the sources to assure that the likelihood of a stuck source is low and that if the rack sticks it can be freed without causing radiation overexposure of personnel.
  - (d) Access Control. The licensee shall verify from the design and logic diagram that the access control system will meet the requirements of 64E-5.1406.
  - (e) Fire Protection. The licensee shall verify that the number, design, locations and spacing of the smoke and heat detectors and extinguishing system are appropriate to detect fires and that the detectors are protected from mechanical and radiation damage. The licensee shall verify that the design of the fire extinguishing system provides the necessary discharge patterns, densities, and flow characteristics for complete coverage of the radiation room and that the system is protected from mechanical and radiation damage.
  - (f) Source Return. The licensee shall verify that the source rack will be returned automatically to the fully shielded position if off-site power is lost for more than 10 seconds. If a component of the return mechanism fails, the design must allow for accomplishing the return without causing radiation overexposures of personnel.
  - (g) Seismicity. For panoramic irradiators to be built in seismic areas, the licensee shall design the reinforced concrete radiation shields to retain their integrity in the event of an earthquake by designing to seismic requirements of an appropriate source such as American Concrete Institute Standard 318-89, "Building Code Requirements for Reinforced Concrete," Chapter 21, "Special Provisions for Seismic Design," or local building codes.
  - (h) Wiring. The licensee shall verify that electrical wiring and electrical equipment in the radiation room are selected to minimize failures due to prolonged exposure to radiation.
- (2) Pool irradiators shall meet the following design requirements:
- (a) Pool Integrity. The licensee shall design the pool to assure that it is leak-resistant, that it is strong enough to bear the weight of the pool water and shipping casks, that a dropped cask would not fall on sealed sources, that all penetrations meet the requirements of 64E-5.1411(2), and that metal components are metallurgically compatible with other components in the pool.

- (b) Water Handling System. The licensee shall design the water purification system to meet the requirements of 64E-5.1411(5). The system must be designed so that water leaking from the system does not drain to unrestricted areas without being monitored. The licensee shall design the water chiller system so that it shall compensate adequately for the amount of heat generated by the sealed sources. The water handling system must have remote controls capable of safely operating a contaminated system.
  - (c) Source rack. The licensee shall verify that there are no crevices on the source or between the source and source holder that would promote corrosion on a critical area of the source. The lift mechanisms for the source rack and source transport cask must be of designed working and breaking strength to lift safely a source transport cask and sources into and out of the irradiator pool.
- (3) All irradiators shall meet the following design requirements:
  - (a) Radiation Monitors. The licensee shall evaluate the location and sensitivity of the monitor to detect sources carried by the product conveyor system as required by 64E-5.1409(1). The licensee shall verify that the product conveyor will stop before a source on the product conveyor causes a radiation overexposure. For pool irradiators, the licensee shall verify that the radiation monitor on the water purification system is located near the area in which elevated radiation levels will be expected.
  - (b) Product carriers. For irradiators using product carriers, the design of the carrier shall prevent the carrier from opening or coming into contact with the source rack or protective barrier. The design shall be submitted to the department for approval.
  - (c) Floor penetrations. No floor penetrations, including expansion joints, floor joints and drains, shall allow the uncontrolled release of water from the radiation room that has not been analyzed for its radioactive content.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1514.

**64E-5.1415 Construction Control.** The requirements of this section must be met before loading sources.

- (1) Panoramic irradiators shall meet the following construction requirements:
  - (a) **Shielding.** The licensee shall monitor the construction of the shielding to verify that it meets design specifications and generally accepted building code requirements for reinforced concrete.
  - (b) **Foundations.** The licensee shall monitor the construction of the foundations to verify that they meet design specifications.
  - (c) **Source Rack.** The licensee shall test the movement of the source racks for proper operation before source loading. Testing must include source rack lowering due to simulated loss of power. For all irradiators with product conveyor systems, the licensee shall observe and test the operation of the conveyor system to assure that the requirements in 64E-5.1412 and 64E-5.1414(3)(b) are met for protection of the source racks and the mechanism which moves the rack. Testing must include any limit switches and interlocks used to protect the source rack and the mechanism which moves the rack from moving product carriers.
  - (d) **Access Control.** The licensee shall test the access control system to assure that it functions as designed and that all alarms, controls, and interlocks work properly.
  - (e) **Fire Protection.** The licensee shall verify the ability of the heat and smoke detectors to detect a fire, to activate alarms, and to cause the source rack to become fully shielded automatically. The licensee also shall verify the operability of the fire suppression or extinguishing system.
  - (f) **Source Return.** The licensee shall demonstrate that the source racks can be returned to their fully shielded position without off-site power.
  - (g) **Computer Systems.** If a computer is used to control the access control system, the licensee shall demonstrate that the computer and the access control system will operate as planned if off-site power is lost by attempting to defeat the access control system in as many ways as possible. The computer must have suitable security features which prevent an irradiator operator from commanding the computer to override the access control system when it is required to be operable.
  - (h) **Wiring.** The licensee shall verify that the electrical wiring and electrical equipment that were installed meet the design specifications.

- (2) Pool irradiators shall meet the following construction requirements:
  - (a) Pool Integrity. The licensee shall test the integrity of the pool and verify that the pool meets the design specifications. The licensee shall verify that penetrations and water intakes meet the requirements of 64E-5.1411(2).
  - (b) Water Handling System. The licensee shall verify that the water purification system, the conductivity meter and the water level alarms operate properly.
- (3) Radiation Monitors. For all irradiators, the licensee shall verify the proper operation of the monitor to detect sources carried on the product conveyor system and related alarms and interlocks required by 64E-5.1409(1). For pool irradiators, the licensee shall verify the proper operation of the radiation monitor on the water purification system and the related alarms and interlocks required by 64E-5.1409(2). For underwater irradiators, the licensee shall verify the proper operation of the pool monitor, alarms, and interlocks required by 64E-5.1409(3).

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1515.

## **SUBPART D**

### **OPERATION OF IRRADIATORS**

#### **64E-5.1416      Training.**

- (1) Before an individual is permitted to operate an irradiator without a supervisor present, the individual must be instructed in the following:
  - (a) The fundamentals of radiation protection applied to irradiators, including:
    - 1. The difference between external radiation and radioactive contamination;
    - 2. Units of radiation dose;
    - 3. The department's dose limits;
    - 4. Why large radiation doses must be avoided;
    - 5. How shielding and access controls prevent large doses;
    - 6. How an irradiator is designed to avoid contamination;
    - 7. The use of survey meters and personnel dosimeters;
    - 8. Other radiation safety features of an irradiator; and
    - 9. The basic function of the irradiator.

- (b) The requirements of this part and Part IX of these rules;
  - (c) The operation of the irradiator;
  - (d) Licensee operating and emergency procedures which the individual is responsible for performing; and
  - (e) Case histories of accidents or problems involving irradiators similar to those to be used by the individual.
- (2) Before an individual is permitted to operate an irradiator without a supervisor present, the individual shall pass a written test on the instruction received, consisting primarily of questions based on the licensee's operating and emergency procedures that the individual is responsible for performing and other operations necessary to operate the irradiator safely without supervision.
- (3) Before an individual is permitted to operate an irradiator without a supervisor present, the individual must have received on-the-job or simulator training in the use of the irradiator as described in the license application. The individual also shall demonstrate the ability to perform those portions of the operating and emergency procedures that he or she is to perform.
- (4) The licensee shall conduct safety reviews and emergency drills as described below for irradiator operators at least annually. The licensee shall give each operator a brief written test on the information. Each safety review must include, to the extent appropriate, each of the following:
- (a) Changes in operating and emergency procedures since the last review;
  - (b) Changes in rules and license conditions since the last review;
  - (c) Reports on recent accidents, mistakes, or problems which have occurred at irradiators;
  - (d) Relevant results of inspection of operator safety performance;
  - (e) Relevant results of the facility's inspection and maintenance checks; and
  - (f) A drill to practice an emergency or abnormal event procedure.
- (5) The licensee shall evaluate the safety performance of each irradiator operator at least annually to ensure that rules, license conditions, and operating and emergency procedures are followed. The licensee shall discuss the results of the evaluation with the operator and shall instruct the operator on how to correct any mistakes or deficiencies observed.



- (6) Individuals who will be permitted unescorted access to the irradiators but who have not received the training required for operators and the radiation safety officer shall be trained and tested in precautions they should take to avoid radiation exposure, procedures or parts of procedures in 64E-5.1418 which they are expected to perform or comply with, and the proper response to alarms required in this part. Tests can be oral.
- (7) Individuals who must be prepared to respond to alarms required by 64E-5.1406, 64E-5.1408, 64E-5.1409, 64E-5.1411, and 64E-5.1412 shall be trained and tested on how to respond. Each individual shall be retested at least once a year. Tests can be oral.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1516.

**64E-5.1417****Operating and Emergency Procedures.**

- (1) The licensee shall have and follow written operating procedures for the following:
  - (a) Operation of the irradiator, including entering and leaving the radiation room;
  - (b) Use of personnel dosimeters;
  - (c) Surveying the shielding of panoramic irradiators;
  - (d) Monitoring pool water for contamination while the water is in the pool and before release of pool water to unrestricted areas;
  - (e) Leak testing of sources;
  - (f) Inspection and maintenance checks required by 64E-5.1422;
  - (g) Loading, unloading, and repositioning sources, if to be performed by the licensee;
  - (h) Inspection of movable shielding required by 64E-5.1406(1)(h), if applicable; and
  - (i) Security precautions while sources are stored outside the radiation room. Sealed sources must be moved into the radiation room within 48 hours of receipt unless the department is notified in writing that extenuating circumstances do not allow for source loading within the prescribed 48 hour period.
- (2) The licensee shall have and follow emergency or abnormal event procedures for the following:
  - (a) Sources stuck in the unshielded position;
  - (b) Personnel overexposures;

- (c) A radiation alarm from the product exit portal monitor or pool monitor;
  - (d) Detection of leaking sources, pool contamination, or alarm caused by contamination of pool water;
  - (e) A low water level alarm, a high water level alarm, an abnormal water loss, or leakage from the source storage pool;
  - (f) A prolonged loss of electrical power;
  - (g) A fire alarm or explosion in the radiation room;
  - (h) An alarm indicating unauthorized entry into the radiation room, the area around the pool, or another alarmed area;
  - (i) Natural phenomena, including an earthquake, a hurricane, a tornado, flooding, sinkhole formation, or other phenomena; and
  - (j) The jamming of automatic conveyor systems or an alarm indicating a collision between the barrier and product conveyor.
- (3) The licensee can revise operating and emergency procedures only with departmental approval.
- (4) The licensee shall provide and coordinate current emergency procedures annually with the local police, fire department, and civil authorities, including notification of responsible individuals and places of emergency treatment.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1517.

#### 64E-5.1418

#### Personnel Monitoring.

- R2 (1) Irradiator operators shall wear either a film badge, OSLD or a TLD while operating a panoramic irradiator or while in the area around the pool of an underwater irradiator. The film badge, OSLD, and TLD processor must be accredited by NVLAP for high energy photons in the normal and accident dose ranges. Each film badge, OSLD, and TLD must be assigned to and worn by only one individual. Film badges must be replaced at least monthly and OSLDs and TLDs must be replaced at least quarterly. After replacement, each film badge OSLD, and TLD must be processed promptly.
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- (2) Other individuals who enter the radiation room of a panoramic irradiator shall wear a dosimeter, which can be a pocket dosimeter. For groups of visitors, only two people are required to wear dosimeters. Date of entry, all names and total dose must be recorded. If pocket dosimeters are used to meet the requirements of this paragraph, a check of their response must be done at least annually. Acceptable dosimeters must read within 30 percent of the true radiation dose.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

R2 History: New August 14, 1996, Formerly 10D-91.1518, Amended October 8, 2000.

**64E-5.1419            Radiation Surveys.**

- (1) Before the facility starts operation, the following radiation surveys must be performed:
  - (a) A radiation survey of the area above the pool after the sources are loaded and in the shielded position; and
  - (b) A survey of the area outside the shielding of the radiation room of a panoramic irradiator with the sources in the exposed position.
- (2) If the surveys indicate that radiation levels specified in 64E-5.1407 are exceeded, the shielding must be repaired to comply with the dose rate requirement in 64E-5.1407 before operation of the facility can start.
- (3) Radiation surveys described in (1) above must be performed after new sources are loaded and after any modifications which might increase dose rates are made to the radiation room, shielding or structure and at intervals not to exceed 3 years.
- (4) Portable radiation survey meters used to meet the requirements of paragraphs (1) and (3) of this section and the requirements of 64E-5.1413(3) and 64E-5.1424(1) must be calibrated at least annually to an accuracy of 20 percent for the gamma energy of the sources in use. The calibration must be done at two points on each scale or, for digital instruments, at one point per decade over the range that will be used. Portable radiation survey meters must be of a type that does not saturate and read zero at high radiation dose rates.
- (5) Water from the irradiator pool or other potentially contaminated liquids and sediments from pool vacuuming must be monitored for radioactive contamination before release to unrestricted areas. Radioactive concentrations must not exceed those specified in State of Florida Bureau of Radiation Control ALIs, DACs, and Effluent Concentrations, July 1993, Table II, Column 2, or Table III, as applicable. The lower limit of detection for the measurements must be below those concentrations.
- (6) Resins to be released for unrestricted use must be monitored before release in an area with a background level less than 0.05 millirem (0.0005 millisievert) per hour. The resins can be released only if the survey does not detect radiation levels above background radiation levels. The survey meter must be capable of detecting radiation levels of 0.05 millirem (0.0005 millisievert) per hour.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1519.

**64E-5.1420****Detection of Leaking or Contaminated Sources.**

- (1) Each dry-source-storage sealed source must be tested for leakage at least every 6 months using a leak test kit or a method approved by the department, U.S. Nuclear Regulatory Commission, agreement state or licensing state. The analysis must be capable of detecting the presence of 0.005 microcurie (185 becquerels) of radioactive material and must be performed by a person approved by the department, U.S. Nuclear Regulatory Commission, agreement state or licensing state to perform the analysis.
- (2) For pool irradiators, the pool water must be checked for contamination each day the irradiator operates. The check must be done by using an on-line radiation monitor on a pool water circulating system as described in 64E-5.1410(2) or by analysis of pool water. If a check for contamination is done by analysis of pool water, the results of the analysis must be available within 24 hours. If the licensee uses a radiation monitor on a pool water circulating system, the detection above normal radiation levels must activate an alarm. The alarm set-point must be set as low as practical but high enough to avoid false alarms. The licensee can reset the alarm set-point to a higher level if necessary to operate the pool water purification system to clean up contamination in the pool if specifically provided for in written emergency procedures.
- (3) The licensee shall have written procedures and equipment available for the detection, isolation and removal of leaking sources.
- (4) If a leaking source is detected, the licensee shall remove the leaking source from service and have it decontaminated, repaired, or disposed of by a licensee of the department, U.S. Nuclear Regulatory Commission, agreement state or licensing state authorized to perform these functions. The licensee shall check its personnel, equipment, facilities, and irradiated product promptly for radioactive contamination. No product shall be shipped until the product has been checked and found free of contamination. If a product has been shipped that could have been contaminated inadvertently, the licensee shall arrange to locate and survey that product for contamination. If any personnel are contaminated, decontamination must be performed promptly. If contaminated equipment, facilities, or products are found, the licensee shall have them decontaminated or disposed of by a licensee of the department, U.S. Nuclear Regulatory Commission, agreement state or licensing state authorized to perform these functions. If the pool water is contaminated, the licensee shall clean the pool water until the contamination levels do not exceed the appropriate concentration in State of Florida Bureau of Radiation Control ALLs, DACs, and Effluent Concentrations, July 1993, Table II, Column 2.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1520.

**64E-5.1421****Inspection and Maintenance.**

- (1) The licensee shall perform inspection and maintenance checks that include, as a minimum, each of the following at the frequency specified in the license or license application:
  - (a) Operation of each aspect of the access control system required by 64E-5.1406;
  - (b) Functioning of the source position indicator required by 64E-5.1410(2);
  - (c) Operation of the radiation monitor on the pool water purification system using a radioactive check source to detect radioactive contamination in pool water as required by 64E-5.1409(2);
  - (d) Operation of the over-pool radiation monitor at underwater irradiators as required by 64E-5.1409(3).
  - (e) Operation of the product exit monitor required by 64E-5.1409(1);
  - (f) Operation of the emergency source return control required by 64E-5.1410(3);
  - (g) Leak-tightness of systems through which pool water circulates (visual inspection);
  - (h) Operation of the heat and smoke detectors and extinguisher system required by 64E-5.1408 but without turning on extinguishers;
  - (i) Operation of the means of pool water replenishment required by 64E-5.1411(3);
  - (j) Operation of the visible indicator of low and high pool water level required by 64E-5.1411(4);
  - (k) Operation of the intrusion alarm required by 64E-5.1406(2);
  - (l) Functioning and wear on the system, mechanisms, and cables used to raise and lower sources;
  - (m) Condition of the barrier to prevent products from hitting the sources or source mechanism and the operation of the collision alarm system, as required by 64E-5.1412;
  - (n) Amount of water added to the pool to determine if the pool is leaking;
  - (o) Electrical wiring on required safety systems for radiation damage;
  - (p) Pool water conductivity measurements and analysis as required by 64E-5.1422;
  - (q) Condition of the product carriers; and

- (r) Operation of the siphon breakers in the pool plumbing.
- (2) Malfunction and defects found during inspection and maintenance checks must be repaired without undue delay.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1521.

**64E-5.1422****Pool Water Purity.**

- (1) Pool water purification systems must be run sufficiently to maintain the conductivity of the pool water below 20 microsiemens per centimeter under normal circumstances. If pool water conductivity rises above 20 microsiemens per centimeter, the licensee shall take prompt actions to lower the pool water conductivity and shall take corrective actions to prevent future recurrences.
- (2) The licensee shall measure the pool water conductivity frequently enough, but no less than weekly, to assure that the conductivity remains below 20 microsiemens per centimeter. Conductivity meters must be calibrated at least annually.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1522.

**64E-5.1423****Attendance During Operation.**

- (1) An operator and at least one other individual trained and prepared to render or summon assistance promptly if the access control alarm sounds shall be present on site whenever a panoramic irradiator is operated using an automatic product conveyor system and whenever the product is moved into or out of the radiation room when the irradiator is operated in a batch mode.
- (2) At an underwater irradiator, an operator must be present whenever the product is moved into or out of the pool. Individuals who move the product into or out of the pool of an underwater irradiator need not be qualified as irradiator operators; however, they must have received the training described in 64E-5.1416(6) and (7). Static irradiation can be performed without a person present at the facility only if the personnel access barrier around the pool is locked to prevent unauthorized entry and all required alarms are operable.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1523.

**64E-5.1424****Entering and Leaving the Radiation Room.**

- (1) Upon first entering the radiation room of a panoramic irradiator after an irradiation, the irradiator operator shall use a survey meter to determine that the source has returned to its fully shielded position. The operator shall check the functioning of the survey meter with a radiation check source before entry. The response of the survey meter to the radiation check source must be consistent and reproducible.
- (2) Before exiting from and locking the door to the radiation room of a panoramic irradiator before a planned irradiation, the irradiator operator shall perform the following:
  - (a) Inspect visually the entire radiation room to verify that no one else is in it; and
  - (b) Activate a control in the radiation room which permits the sources to be moved from the shielded position only if the door to the radiation room is locked within a preset time after setting the control.
  - (c) During a power failure, the area around the pool of an underwater irradiator cannot be entered without using an operable and calibrated radiation survey meter unless the over-the-pool monitor required by 64E-5.1409(3) is operating with backup power.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1524.

**64E-5.1425****Irradiation of Explosive or Highly Flammable Materials.**

- (1) Irradiation of explosive materials is prohibited unless the licensee has received prior written authorization from the department. Authorization will not be granted unless the licensee can demonstrate that detonation of the explosive would not rupture the sealed sources, injure personnel, damage safety systems, or cause radiation overexposures of personnel.
- (2) Irradiation of more than small quantities of highly flammable material with a flash point below 140 degrees Fahrenheit is prohibited in panoramic irradiators unless the licensee has received prior written authorization from the department. Authorization will not be granted unless the licensee can demonstrate that a fire in the radiation room could be controlled without damage to sealed sources or safety systems and without radiation overexposures of personnel.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1525.

**SUBPART E  
RECORDS AND REPORTS**

**64E-5.1426            Records and Retention Periods.**

- (1) The licensee shall maintain the following records at the irradiator for the periods specified:
- (a) A copy of the license application and the license authorizing the licensee to operate the facility until a new license is issued;
  - (b) Records of each individual's training, tests, and safety reviews provided to meet the requirements of 64E-5.1416 until 3 years after the individual terminates work;
  - (c) Records of the annual evaluation of the safety performance of irradiator operators required by 64E-5.1416(5) for 3 years after the evaluation;
  - (d) An up-to-date copy of the operating and emergency procedures required by 64E-5.1417 until superseded or the department terminates the license;
  - (e) Personnel monitoring results required by 64E-5.1418 until the department terminates the license;
  - (f) Records of radiation surveys required by 64E-5.1420 for 3 years from the date of the survey;
  - (g) Records of radiation survey meter calibrations required by 64E-5.1419 and pool water conductivity meter calibrations required by 64E-5.1422(2) until 3 years from the date of the calibration;
  - (h) Records of the results of leak tests required by 64E-5.1420 and the results of contamination checks required by 64E-5.1420(2) for 3 years from the date of the leak tests;
  - (i) Records of inspection and maintenance checks required by 64E-5.1421 for 3 years;
  - (j) Records of major malfunctions, significant defects, operating difficulties or irregularities, and major operating problems that involve required radiation safety equipment for 3 years after repairs are completed;
  - (k) Records of the receipt, transfer and disposal of all licensed sealed sources as required by 64E-5.103.
  - (l) An inventory of all licensed sealed sources until the irradiator is decommissioned. The inventory must include for each sealed source the following:
    - 1. The date received;



2. The person from whom it was received;
  3. The model of the source;
  4. The serial number of the source;
  5. The radionuclide in the source;
  6. The activity of the source as supplied from the manufacturer and the date of the assigned activity;
  7. An up-to-date location of the source;
  8. Information on leaking or damaged sources and any actions taken to decontaminate or repair those sources;
  9. The date disposed of; and
  10. The person to whom the source was transferred.
- (m) Records on the design checks required by 64E-5.1414 and the construction control checks required by 64E-5.1415 until the license is terminated. The records must be signed and dated. The title or qualification of the person signing must be included;
- (n) Records of water added to the pool as required by 64E-5.1421(1)(n) for 3 years;
- (o) Records related to decommissioning the irradiator as required by 64E-5.214(4)(c)2.
- (p) Records of annual notification to local police, fire department and civil authorities of the current emergency procedures, responsible individuals and places of emergency treatment for 3 years;
- (q) Records of conductivity meter calibration as required by 64E-5.1422(2) for 3 years; and
- (r) Records of written approval of access to restricted areas as required by 64E-5.1407(1) for 3 years.
- (2) Records required by this section shall be available for inspection by the department.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1526.

**64E-5.1427****Reports and Notifications.**

- (1) In addition to the other reporting requirements in these rules, each licensee shall notify the department as soon as possible but not later than 4 hours after the discovery of the following events:
  - (a) Threats of violence or acts of terrorism against the operation of this facility;
  - (b) Fire or explosion in the radiation room;
  - (c) Detection of radiation by the product portal monitors;
  - (d) Detection of any radioactive contamination.
  - (e) Sources stuck in an unshielded position;
  - (f) Damage to source racks;
  - (g) Failure of the cable or drive mechanism used to move the source racks;
  - (h) Inoperability of the access control system;
  - (i) Structural damage to the pool liner or walls;
  - (j) Abnormal water loss or leakage from the source storage pool; or
  - (k) Pool water conductivity exceeding 100 microsiemens per centimeter.
- (2) The licensee must submit a written report within 30 days for any reports required by paragraph (1) above. The report must describe the event, what caused the event to the extent known, and corrective actions to prevent recurrence taken up to the time the report is made.
- (3) The licensee shall notify individuals of their exposure to radiation or radioactive materials as required by 64E-5.903.
- (4) The licensee shall notify the department at least 14 days before a source loading or unloading.

Specific Authority: 404.051(4), F.S.

Law Implemented: 404.051(1)(5)(6), 404.061, 404.081, 404.141, F.S.

History: New August 14, 1996, Formerly 10D-91.1527.

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## PART XV

### TRANSPORTATION OF RADIOACTIVE MATERIALS

#### 64E-5.1501      **Transportation of Radioactive Material.**

- (1) The packaging and transportation of radioactive material are also subject to the requirements of other agencies such as the U.S. Department of Transportation, the U.S. Nuclear Regulatory Commission and the U.S. Postal Service. The requirements of this part are in addition to, and not in substitution for, other requirements.
- (2) Determinations and listings of  $A_1$  and  $A_2$  values are found in 10 CFR Part 71, Appendix A, which is herein incorporated by reference and which is available from the department.

Specific Authority: 404.051, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.20(1), F.S.

History: New July 17, 1985, Amended May 15, 1996, Formerly 10D-91.2001.

#### 64E-5.1502      **Transportation of Radioactive Material.**

- (1) No person shall deliver radioactive material to a carrier for transport or transport radioactive material except as authorized in a general license or specific license issued by the department or as exempted in 64E-5.1503.
- (2) Each licensee who transports radioactive material outside of the confines of his facility or other place of use, or who offers radioactive material to a carrier for transport shall:
  - (a) Comply with the applicable requirements, appropriate to the mode of transport, of 49 CFR Parts 171-173, 177, 383, and 390-397, dated 10-1-97, which are herein incorporated by reference and which are available from the department;
  - (b) Establish procedures for safely opening and closing packages in which radioactive material is transported and to assure that, prior to the delivery to a carrier for transport, each package is properly closed for transport; and
  - (c) Assure that any special instructions needed to safely open the package are sent to or have been made available to the consignee.

Specific Authority: 404.051, 404.061, 404.141, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.061(2), 404.141, 404.20(1), F.S.

R2 History: New July 17, 1985, Formerly 10D-91.2003, Amended October 8, 2000.

**64E-5.1503 Exemptions.**

- (1) Common and contract carriers, freight forwarders, and warehousemen who are subject to the requirements of the U.S. Department of Transportation in 49 CFR Parts 170 through 189 or the U.S. Postal Service in the Postal Service Manual (Domestic Mail Manual), Section 124.3 incorporated by reference, 39 CFR Part 111.1 (1974), are exempt from these regulations to the extent that they transport or store radioactive material in the regular course of their carriage for another or storage incident thereto. Common and contract carriers who are not subject to the requirements of the U.S. Department of Transportation or U.S. Postal Service are subject to 64E-5.1501 and other applicable sections of these regulations.
- (2) Any licensee is exempt from the requirements of this part to the extent that he delivers to a carrier for transport a package containing radioactive material having a specific activity not greater than 0.002 microcurie (74 Bq) per gram.

Specific Authority: 404.051, 404.061, 404.141, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.061(2), 404.141, 404.20(1), F.S.

History: New July 17, 1985, Formerly 10D-91.2004.

**64E-5.1504 General Licenses for Carriers.**

- (1) A general license is hereby issued to any common or contract carrier not exempt under 64E-5.1503 to receive, possess, transport and store radioactive material in the regular course of their carriage for another or storage incident thereto, provided the transportation and storage is in accordance with the applicable requirements, appropriate to the mode of transport, of the U.S. Department of Transportation insofar as such requirements relate to the loading and storage of packages, placarding of the transporting vehicle, and incident reporting. Any notification of incidents referred to in these U.S. Department of Transportation requirements shall also be filed with, or made to, the department.
- (2) A general license is hereby issued to any private carrier to transport radioactive material, provided the transportation is in accordance with the applicable requirements, appropriate to the mode of transport, of the U.S. Department of Transportation insofar as such requirements relate to the loading and storage of packages, placarding of the transporting vehicle, and incident reporting. Any notification of incidents referred to in these U.S. Department of Transportation requirements shall be filed with, or made to, the department.
- (3) Persons who transport radioactive material pursuant to the general license in 64E-5.1504(1) or (2) are exempt from the requirements of Parts III and IX to the extent that they transport radioactive material.

Specific Authority: 404.051, 404.061, 404.141, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.061(2), 404.141, 404.20(1), F.S.

History: New July 17, 1985, Formerly 10D-91.2005.

**64E-5.1505 Routine Determinations.** Prior to each shipment of radioactive material, the licensee shall ensure that the package with its contents satisfies the applicable requirements of this part and of the license. The licensee shall determine that:

- (1) The package is proper for the contents to be shipped;
- (2) The package is in an unimpaired physical condition except for superficial defects such as marks or dents;
- (3) Each closure device of the packaging, including any required gasket, is properly installed and secured and free of defects;
- (4) Any system for containing liquid is adequately sealed and has adequate space or other specified provision for expansion of the liquid;
- (5) Any pressure relief device is operable and set in accordance with written procedures;
- (6) The package has been loaded and closed in accordance with written procedures;
- (7) Any structural part of the package which could be used to lift or tie down the package during transport is rendered inoperable for that purpose unless it satisfies design requirements specified by the U.S. Nuclear Regulatory Commission;
- (8) The level of nonfixed or removable radioactive contamination on the external surfaces of each package presented for shipment is as low as reasonably achievable and shall not exceed the applicable levels specified in the regulations of the U.S. Department of Transportation, 49 CFR 173.443; and
- (9) The external radiation levels around the package and around the vehicle, if applicable, will not exceed the limits specified in the regulations of the U.S. Department of Transportation, 49 CFR 173.441.

Specific Authority: 404.051, 404.061, 404.141, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.061(2), 404.141, 404.20(1), F.S.

History: New July 17, 1985, Formerly 10D-91.2006.

**64E-5.1506 Advance Notification of Shipment of Certain Quantities of Radioactive Waste.**

- (1) In addition to the notification requirements of 64E-5.1508, prior to the transport of certain quantities of radioactive waste outside of the confines of the licensee's facility or other place of use or storage, or prior to the delivery of certain quantities of radioactive waste to a carrier for transport, each licensee shall provide advance notification of such transport in writing to the governor, or governor's designee, of each state through which the waste will be transported. A list of the mailing addresses of the governors and governors' designees is available upon request from the Director, Office of State Programs, U.S. Nuclear Regulatory Commission, Washington, D.C., 20555.

- (2) Such advance notification is required only when:
- (a) The radioactive waste is required to be in Type B packaging for transportation;
  - (b) The radioactive waste is being transported to, through, or across state boundaries to a disposal site or to a collection point for transport to a disposal site;
  - (c) The quantity of licensed material in a single package exceeds:
    - 1. Five thousand curies (185 TBq) of special form radionuclides; or
    - 2. Five thousand curies (185 TBq) of uncompressed gases of argon 41, krypton 85m, krypton 87, xenon 131m, or xenon 135; or
    - 3. Fifty thousand curies (1.85 PBq) of argon 37, or of uncompressed gases of krypton 85 or xenon 133, or of hydrogen 3 as a gas, as luminous paint, or adsorbed on solid material; or
    - 4. Twenty curies (740 GBq) of other nonspecial form radionuclides for which  $A_2$  is less than or equal to 4 curies (148 GBq); or
    - 5. Two hundred curies (7.4 TBq) of other nonspecial form radionuclides for which  $A_2$  is greater than 4 curies (148 GBq); and
  - (d) The quantity of spent nuclear fuel is less than that subject to advance notification requirements of 10 CFR Part 73.
- (3) Each advance notification required by (1) shall contain the following information:
- (a) The name, address, and telephone number of the generator, carrier and receiver of the radioactive waste shipment;
  - (b) A description of the radioactive waste contained in the shipment as required by the regulations of the U.S. Department of Transportation;
  - (c) The point of origin of the shipment and the 7-day period during which departure of the shipment is estimated to occur;
  - (d) The 7-day period during which arrival of the shipment at state boundaries is estimated to occur;
  - (e) The destination of the shipment, and the 7-day period during which arrival of the shipment is estimated to occur; and
  - (f) A point of contact with a telephone number for current shipment information.



- (4) The notification required by 64E-5.1506(1) shall be made in writing to the office of each appropriate governor or governor's designee and to the department. A notification delivered by mail must be postmarked at least 7 days before the beginning of the 7-day period during which departure of the shipment is estimated to occur. A notification delivered by messenger must reach the office of the governor, or governor's designee, at least 4 days before the beginning of the 7-day period during which departure of the shipment is estimated to occur. A copy of the notification shall be retained by the licensee for 1 year for inspection by the department.
- (5) The licensee shall notify each appropriate governor, or governor's designee, and the department of any changes to schedule information provided pursuant to 64E-5.1506(1). Such notification shall be by telephone to a responsible individual in the office of the governor, or governor's designee, of the appropriate states. The licensee shall maintain for 1 year for inspection by the department a record of the name of the individual contacted.
- (6) Each licensee who cancels a radioactive waste shipment, for which advance notification has been sent, shall send a cancellation notice to the governor, or governor's designee, of each appropriate state and to the department. A copy of the notice shall be retained by the licensee for 1 year for inspection by the department.

Specific Authority: 404.051, 404.061, 404.081, 404.141, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.061(2), 404.081(1), 404.141, 404.20(1), F.S.

History: New July 17, 1985, Formerly 10D-91.2007.

#### **64E-5.1507      Designation of Routes for Shipment of Radioactive Waste Requiring Advanced Notification.**

- (1) The department may designate routes within the state of Florida for all shipments requiring advanced notification under 64E-5.1506. Factors that the department will consider in the designation of routes for shipments requiring advanced notifications are:
  - (a) Population density in the vicinity of available highways;
  - (b) Accident rates of available highways;
  - (c) Transit time;
  - (d) Time and day of the week during which the shipment is to occur; and
  - (e) Routes that may have been previously designated by other states.
- (2) In lieu of the department's designation of routes, the interstate highway system and limited access roadways are preferred for transportation of radioactive waste requiring advanced notification pursuant to 64E-5.1506.

Specific Authority: 404.051, 404.061, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6), 404.061(2), 404.20(1), F.S.

History: New July 17, 1985, Formerly 10D-91.2008.

**64E-5.1508****Inspection of Low-Level Radioactive Waste Shipments.**

- (1) All persons licensed by the department to use, manufacture, produce, transfer, transport, receive, acquire, own, process or possess radioactive materials, as well as nuclear power plants licensed by the U.S. Nuclear Regulatory Commission, and who desire to ship radioactive waste, including radioactive waste requiring advance notification as specified in 64E-5.1506, to a low-level radioactive waste treatment, storage or disposal facility, shall notify the department no less than 48 hours prior to departure of the shipment. The notification shall be made in writing or by telephone.
  - (a) Each notification must contain the following information:
    1. The name, address and telephone number of the generator;
    2. The name and telephone number of the contact person, designated by the generator, with whom the department may make arrangements for the inspection;
    3. The name and telephone number of the carrier;
    4. The location of departure, if different from the address of the generator;
    5. The scheduled date and time of departure; and
    6. The proposed route to the low-level radioactive waste facility.
- (2) Upon notification from a licensee or nuclear power plant licensed by the U.S. Nuclear Regulatory Commission, the department shall dispatch an authorized representative to the licensee's facility to inspect the shipment of radioactive waste destined for a low-level radioactive waste treatment, storage or disposal facility. The inspection shall include:
  - (a) Surveys of the external radiation levels of the vehicle;
  - (b) Inspection of package integrity, bracing and blocking, if accessible;
  - (c) Verification of required package marking and labeling, if accessible;
  - (d) Verification of required vehicle placarding; and
  - (e) Examination of the shipping papers for compliance with the regulations of the U.S. Department of Transportation.
- (3) Licensees or nuclear power plants licensed by the U.S. Nuclear Regulatory Commission shall also provide the department's representative the following information or material during the course of inspection of the low-level radioactive waste shipment:
  - (a) Time of departure of shipment;

- (b) Proposed route of the shipment to the low-level radioactive waste facility;
  - (c) Estimated time of arrival of the shipment at the low-level radioactive waste facility;
  - (d) The carrier's name;
  - (e) A complete and legible copy of the bill of lading; and
  - (f) A complete and legible copy of the radioactive shipment manifest.
- (4) If the shipment of low-level radioactive waste is found to be in compliance with the regulations of the U.S. Department of Transportation, the department's representative shall affix his initials on the bill of lading and the shipment may then proceed to the low-level radioactive waste facility. If the shipment of low-level radioactive waste is found to be in violation of the regulations of the U.S. Department of Transportation by the department's representative, the licensee shall not allow the shipment to leave the boundaries of his facility until the violation is corrected and the department's representative affixes his initials on the bill of lading signifying the shipment is in compliance.
- (5) Licensees or nuclear power plant licensees of the U.S. Nuclear Regulatory Commission shall, within 72 hours of receiving notice of arrival of their shipment at its destination for unloading, notify the department of such arrival. The licensee shall also forward to the department within 2 weeks of receiving notice of the arrival of the shipment at a destination for unloading, records of receipt and any other records indicating that a shipment was found in violation of the low-level radioactive waste treatment, storage or disposal facility's or host state's rules or regulations.
- (6) Each generator of radioactive waste whose shipment is inspected by the department's representative will be billed quarterly by the department a fee of \$1.95 per cubic foot (0.02832 cubic meter) of waste shipped or \$50 per shipment inspected, whichever is greater. This quarterly billing will be paid to the department within 30 days of receipt of the bill.

Specific Authority: 404.051, 404.061, 404.071, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11)(15), 404.061(2), 404.071(1), 404.20(1)(2)(3)(4)(5), F.S.

History: New July 17, 1985, Amended July 5, 1988, Formerly 10D-91.2009.

#### **64E-5.1509**

#### **Permit Requirements.**

- (1) Any carrier who transports low-level radioactive waste destined for a low-level radioactive waste treatment, storage or disposal facility, prior to entrance into the state of Florida, shall obtain a permit from the department for transporting such waste into the state.
- (a) An application for a permit must contain the following information or material:

1. Name, address and telephone number of the carrier; and
  2. Certification statement that the carrier will comply with this part and the regulations of the U.S. Department of Transportation.
- (b) Each application for a permit must be accompanied by an annual fee of \$100. Permits shall be valid for 365 days following the date of issue. Permit fees are not refundable. Permits may not be transferred or assigned to another carrier.
- (2) (a) Before any shipment of low-level radioactive waste may be transported into or through the state, the permitted carrier shall give written or telephonic notice to the department not less than 48 hours prior to the date of the arrival of the shipment at the borders of the state. The carrier must provide the department with the following information in the notice:
1. The expected date and time the shipment will arrive at the borders of the state;
  2. The estimated time the shipment will remain in the state;
  3. An estimate of the radioisotopes contained within the shipment;
  4. An estimate of the total activity, in curies, contained within the shipment;
  5. An estimate of the total volume, in cubic feet, contained within the shipment; and
  6. The proposed route over which the shipment will be transported.
- (b) The carrier must immediately notify the department of any cancellations or changes of information provided in the prior notification, such as changes in the date of shipment arrival, the length of time the shipment will remain in the state, or the description or quantity of the radioactive waste contained within the shipment.
- (3) Any permit issued pursuant to 64E-5.1509(1), may be suspended if the department has reasonable cause to suspect that the continued shipment of low-level radioactive waste presents a hazard to the public health. Grounds for suspension of a permit may include failure to include the information requested pursuant to 64E-5.1509(2), falsification of information submitted on the application for a permit, or violation of Florida law or department regulations. Prior to the suspension of a permit, the holder of the permit shall be notified in writing that the permit will be suspended and that an opportunity for an administrative hearing will be provided, if requested in writing within 30 days of the receipt of the notice of the intent to suspend the permit. The department may remove the suspension at any time if the department determines that the suspected hazard no longer exists.

- (4) All applications for permits and prior notifications of impending shipments shall be addressed to the department as outlined in 64E-5.1513(2).

Specific Authority: 404.051, 404.061, 404.131, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.131(2)(3), 404.20(6)(7)(8), F.S.

History: New July 17, 1985, Formerly 10D-91.2010.

**64E-5.1510 Air Transport of Plutonium.** Notwithstanding the provisions of any general license and notwithstanding any exemptions stated directly in this part or included indirectly by citation of the U.S. Department of Transportation regulations, as may be applicable, the licensee shall assure that plutonium in any form is not transported by air or offered to a carrier for air transport unless:

- (1) The plutonium is contained in a medical device designed for individual human application; or
- (2) The plutonium is contained in a material in which the specific activity is not greater than 0.002 microcuries (74 Bq) per gram of material and in which the radioactivity is essentially uniformly distributed; or
- (3) The plutonium is shipped in a single package containing no more than an A<sub>2</sub> quantity of plutonium in any isotope or form and is shipped in accordance with 64E-5.1502; or
- (4) The plutonium is shipped in a package specifically authorized for the shipment of plutonium by air in the Certificate of Compliance for that package issued by the U.S. Nuclear Regulatory Commission.

Specific Authority: 404.051, 404.061, 404.141, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.061(2), 404.141, 404.20(1), F.S.

History: New July 17, 1985, Formerly 10D-91.2011.

**64E-5.1511 Notification in the Event of Suspected or Real Breach of Containment.** In addition to the reporting requirements of the U.S. Department of Transportation, any carrier transporting radioactive material in the state shall notify the department immediately in the event the carrier suspects or knows of a breach in the containment of the radioactive material being transported. Notification shall be made as described in 64E-5.1513(2).

Specific Authority: 404.051, 404.20, F.S.

Law Implemented: 404.022, 404.051(1)(4)(6)(11), 404.20(1), F.S.

History: New July 17, 1985, Formerly 10D-91.2012.

**64E-5.1512            Inspections.**

- (1) A department representative is authorized to inspect any record of persons engaged in the transportation of a radioactive material where such records reasonably relate to packaging, preparing for shipment and transporting radioactive material.
- (2) A department representative is authorized to enter upon and inspect the premises and transport vehicles of any person engaged in the transportation of radioactive material for the purpose of determining compliance with or violation of the provisions of section 404.20, Florida Statutes, and these regulations.
- (3) The department may investigate the cause and circumstances of every event in which notification was made pursuant to 64E-5.1511.

Specific Authority: 404.051, 404.061, 404.071, F.S.

Law Implemented: 404.022, 404.051(1)(4)(12), 404.061(2), 404.071(1), 404.20(1)(2)(7)(8), F.S.

History: New July 17, 1985, Formerly 10D-91.2013.

**64E-5.1513            Communications.**

R1  
R2

- (1) All communications concerning this part should be addressed to:  
Department of Health, Bureau of Radiation Control, Bin #C21,  
4052 Bald Cypress Way, Tallahassee, FL 32399-1741.
- (2) All notifications required to be made pursuant to 64E-5.1506, 64E-5.1508, 64E-5.1509 and 64E-5.1511 shall be addressed to:  
Department of Health, Bureau of Radiation Control, Post Office Box 680069,  
Orlando, Florida 32868-0069; telephone (407) 297-2095.
- (3) Immediate notification as required by 64E-5.1511 shall be made by telephone or telegraph.

Specific Authority: 404.042, 404.051, 404.20, F.S.

Law Implemented: 404.042, 404.051(1)(4)(6)(11), 404.061(2), 404.081(1), 404.141, 404.20(1), F.S.

History: New July 17, 1985, Amended April 4, 1989, Formerly 10D-91.2014.

### Appendix A to Part 71 - Determination of A<sub>1</sub> and A<sub>2</sub>

- I. Values of A<sub>1</sub> and A<sub>2</sub> for individual radionuclides, which are the bases for many activity limits elsewhere in these regulations are given in Table A-1. The curie (Ci) values specified are obtained by converting from the Terabecquerel (TBq) figure. The curie values are expressed to three significant figures to assure that the difference in the TBq and Ci quantities is one tenth of one percent or less. Where values of A<sub>1</sub> or A<sub>2</sub> are unlimited, it is for radiation control purposes only. For nuclear criticality safety, some materials are subject to controls placed on fissile material.
- II. For individual radionuclides whose identities are known, but which are not listed in Table A-1, the determination of the values of A<sub>1</sub> and A<sub>2</sub> requires Commission approval, except that the values of A<sub>1</sub> and A<sub>2</sub> in Table A-2 may be used without obtaining Commission approval.
- III. In the calculations of A<sub>1</sub> and A<sub>2</sub> for a radionuclide not in Table A-1, a single radioactive decay chain, in which radionuclides are present in their naturally occurring proportions, and in which no daughter nuclide has a half-life either longer than 10 days, or longer than that of the parent nuclide, shall be considered as a single radionuclide, and the activity to be taken into account, and the A<sub>1</sub> or A<sub>2</sub> value to be applied shall be those corresponding to the parent nuclide of that chain. In the case of radioactive decay chains in which any daughter nuclide has a half-life either longer than 10 days, or greater than that of the parent nuclide, the parent and those daughter nuclides shall be considered as mixtures of different nuclides.
- IV. For mixtures of radionuclides whose identities and respective activities are known, the following conditions apply:

- (a) For special form radioactive material, the maximum quantity transported in a Type A package:

$$\sum_i \frac{B(i)}{A_1(i)} \text{ less than or equal to } 1$$

- (b) For normal form radioactive material, the maximum quantity transported in a Type A package:

$$\sum_i \frac{B(i)}{A_2(i)} \text{ less than or equal to } 1$$

where B(i) is the activity of radionuclide i and A<sub>1</sub>(i) and A<sub>2</sub>(i) are the A<sub>1</sub> and A<sub>2</sub> values for radionuclide i, respectively.

Alternatively, an  $A_1$  value for mixtures of special form material may be determined as follows:

$$A_1 \text{ for mixture} = \frac{1}{\sum_i \frac{f(i)}{A_1(i)}}$$

where  $f(i)$  is the fraction of activity of nuclide  $i$  in the mixture and  $A_1(i)$  is the appropriate  $A_1$  value for nuclide  $i$ .

An  $A_2$  value for mixtures of normal form material may be determined as follows:

$$A_2 \text{ for mixture} = \frac{1}{\sum_i \frac{f(i)}{A_2(i)}}$$

where  $f(i)$  is the fraction of activity of nuclide  $i$  in the mixture and  $A_2(i)$  is the appropriate  $A_2$  value for nuclide  $i$ .

- V. When the identity of each radionuclide is known, but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped and the lowest  $A_1$  or  $A_2$  value, as appropriate, for the radionuclides in each group may be used in applying the formulas in paragraph IV. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest  $A_1$  or  $A_2$  values for the alpha emitters and beta/gamma emitters.



Table A-1 A<sub>1</sub> and A<sub>2</sub> Values for Radionuclide

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Ac-225	Actinium(89)	0.6	16.2	1x10 <sup>-2</sup>	0.270	2.1x10 <sup>3</sup>	5.8x10 <sup>4</sup>
Ac-227		40	1080	2x10 <sup>-5</sup>	5.41x10 <sup>-4</sup>	2.7	7.2x10 <sup>1</sup>
Ac-228		0.6	16.2	0.4	10.8	8.4x10 <sup>4</sup>	2.2x10 <sup>6</sup>
Ag-105	Silver(47)	2	54.1	2	54.1	1.1x10 <sup>3</sup>	3.0x10 <sup>4</sup>
Ag-108m		0.6	16.2	0.6	16.2	9.7x10 <sup>-1</sup>	2.6x10 <sup>1</sup>
Ag-110m		0.4	10.8	0.4	10.8	1.8x10 <sup>2</sup>	4.7x10 <sup>3</sup>
Ag-111		0.6	16.2	0.5	13.5	5.8x10 <sup>3</sup>	1.6x10 <sup>5</sup>
Al-26	Aluminum(13)	0.4	10.8	0.4	10.8	7.0x10 <sup>-4</sup>	1.9x10 <sup>-2</sup>
Am-241	Americium(95)	2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	1.3x10 <sup>-1</sup>	3.4
Am-242m		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	3.6x10 <sup>-1</sup>	1.0x10 <sup>1</sup>
Am-243		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	7.4x10 <sup>-3</sup>	2.0x10 <sup>-1</sup>
Ar-37	Argon(18)	40	1080	40	1080	3.7x10 <sup>3</sup>	9.9x10 <sup>4</sup>
Ar-39		20	541	20	541	1.3x10 <sup>0</sup>	3.4x10 <sup>1</sup>
Ar-41		0.6	16.2	0.6	16.2	1.5x10 <sup>6</sup>	4.2x10 <sup>7</sup>
Ar-42		0.2	5.41	0.2	5.41	9.6	2.6x10 <sup>2</sup>
As-72	Arsenic(33)	0.2	5.41	0.2	5.41	6.2x10 <sup>4</sup>	1.7x10 <sup>6</sup>
As-73		40	1080	40	1080	8.2x10 <sup>2</sup>	2.2x10 <sup>4</sup>
As-74		1	27.0	0.5	13.5	3.7x10 <sup>3</sup>	9.9x10 <sup>4</sup>
As-76		0.2	5.41	0.2	5.41	5.8x10 <sup>4</sup>	1.6x10 <sup>6</sup>
As-77		20	541	0.5	13.5	3.9x10 <sup>4</sup>	1.0x10 <sup>6</sup>
At-211	Astatine(85)	30	811	2	54.1	7.6x10 <sup>4</sup>	2.1x10 <sup>6</sup>
Au-193	Gold(79)	6	162	6	162	3.4x10 <sup>4</sup>	9.2x10 <sup>5</sup>

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Au-194		1	27.0	1	27.0	1.5x10 <sup>4</sup>	4.1x10 <sup>5</sup>
Au-195		10	270	10	270	1.4x10 <sup>2</sup>	3.7x10 <sup>3</sup>
Au-196		2	54.1	2	54.1	4.0x10 <sup>3</sup>	1.1x10 <sup>5</sup>
Au-198		3	81.1	0.5	13.5	9.0x10 <sup>3</sup>	2.4x10 <sup>5</sup>
Au-199		10	270	0.9	24.3	7.7x10 <sup>3</sup>	2.1x10 <sup>5</sup>
Ba-131	Barium(56)	2	54.1	2	54.1	3.1x10 <sup>3</sup>	8.4x10 <sup>4</sup>
Ba-133m		10	270	0.9	24.3	2.2x10 <sup>4</sup>	6.1x10 <sup>5</sup>
Ba-133		3	81.1	3	81.1	9.4	2.6x10 <sup>2</sup>
Ba-140		0.4	10.8	0.4	10.8	2.7x10 <sup>3</sup>	7.3x10 <sup>4</sup>
Be-7	Beryllium(4)	20	541	20	541	1.3x10 <sup>4</sup>	3.5x10 <sup>5</sup>
Be-10		20	541	0.5	13.5	8.3x10 <sup>-4</sup>	2.2x10 <sup>-2</sup>
Bi-205	Bismuth(83)	0.6	16.2	0.6	16.2	1.5x10 <sup>3</sup>	4.2x10 <sup>4</sup>
Bi-206		0.3	8.11	0.3	8.11	3.8x10 <sup>3</sup>	1.0x10 <sup>5</sup>
Bi-207		0.7	18.9	0.7	18.9	1.9	5.2x10 <sup>1</sup>
Bi-210m		0.3	8.11	3x10 <sup>-2</sup>	0.811	2.1x10 <sup>-5</sup>	5.7x10 <sup>-4</sup>
Bi-210		0.6	16.2	0.5	13.5	4.6x10 <sup>3</sup>	1.2x10 <sup>5</sup>
Bi-212		0.3	8.11	0.3	8.11	5.4x10 <sup>5</sup>	1.5x10 <sup>7</sup>
Bk-247	Berkelium(97)	2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	3.8x10 <sup>-2</sup>	1.0
Bk-249		40	1080	8x10 <sup>-2</sup>	2.16	6.1x10 <sup>1</sup>	1.6x10 <sup>3</sup>
Br-76	Bromine(35)	0.3	8.11	0.3	8.11	9.4x10 <sup>4</sup>	2.5x10 <sup>6</sup>
Br-77		3	81.1	3	81.1	2.6x10 <sup>4</sup>	7.1x10 <sup>5</sup>
Br-82		0.4	10.8	0.4	10.8	4.0x10 <sup>4</sup>	1.1x10 <sup>6</sup>
C-11	Carbon(6)	1	27.0	0.5	13.5	3.1x10 <sup>7</sup>	8.4x10 <sup>8</sup>
C-14		40	1080	2	54.1	1.6x10 <sup>-1</sup>	4.5

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Ca-41	Calcium(20)	40	1080	40	1080	3.1x10 <sup>-3</sup>	8.5x10 <sup>-2</sup>
Ca-45		40	1080	0.9	24.3	6.6x10 <sup>2</sup>	1.8x10 <sup>4</sup>
Ca-47		0.9	24.3	0.5	13.5	2.3x10 <sup>4</sup>	6.1x10 <sup>5</sup>
Cd-109	Cadmium(48)	40	1080	1	27.0	9.6x10 <sup>1</sup>	2.6x10 <sup>3</sup>
Cd-113m		20	541	9x10 <sup>-2</sup>	2.43	8.3x10 <sup>0</sup>	2.2x10 <sup>2</sup>
Cd-115m		0.3	8.11	0.3	8.11	9.4x10 <sup>2</sup>	2.5x10 <sup>4</sup>
Cd-115		4	108	0.5	13.5	1.9x10 <sup>4</sup>	5.1x10 <sup>5</sup>
Ce-139	Cerium(58)	6	162	6	162	2.5x10 <sup>2</sup>	6.8x10 <sup>3</sup>
Ce-141		10	270	0.5	13.5	1.1x10 <sup>3</sup>	2.8x10 <sup>4</sup>
Ce-143		0.6	16.2	0.5	13.5	2.5x10 <sup>4</sup>	6.6x10 <sup>5</sup>
Ce-144		0.2	5.41	0.2	5.41	1.2x10 <sup>2</sup>	3.2x10 <sup>3</sup>
Cf-248	Californium(98)	30	811	3x10 <sup>-3</sup>	8.11x10 <sup>-2</sup>	5.8x10 <sup>1</sup>	1.6x10 <sup>3</sup>
Cf-249		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	1.5x10 <sup>-1</sup>	4.1
Cf-250		5	135	5x10 <sup>-4</sup>	1.35x10 <sup>-2</sup>	4.0	1.1x10 <sup>2</sup>
Cf-251		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	5.9x10 <sup>-2</sup>	1.6
Cf-252		0.1	2.70	1x10 <sup>-3</sup>	2.70x10 <sup>-2</sup>	2.0x10 <sup>1</sup>	5.4x10 <sup>2</sup>
Cf-253		40	1080	6x10 <sup>-2</sup>	1.62	1.1x10 <sup>3</sup>	2.9x10 <sup>4</sup>
Cf-254		3x10 <sup>-3</sup>	8.11x10 <sup>-2</sup>	6x10 <sup>-4</sup>	1.62x10 <sup>-2</sup>	3.1x10 <sup>2</sup>	8.5x10 <sup>3</sup>
Cl-36	Chlorine(17)	20	541	0.5	13.5	1.2x10 <sup>-3</sup>	3.3x10 <sup>-2</sup>
Cl-38		0.2	5.41	0.2	5.41	4.9x10 <sup>6</sup>	1.3x10 <sup>8</sup>
Cm-240	Curium(96)	40	1080	2x10 <sup>-2</sup>	0.541	7.5x10 <sup>2</sup>	2.0x10 <sup>4</sup>
Cm-241		2	54.1	0.9	24.3	6.1x10 <sup>2</sup>	1.7x10 <sup>4</sup>
Cm-242		40	1080	1x10 <sup>-2</sup>	0.270	1.2x10 <sup>2</sup>	3.3x10 <sup>3</sup>
Cm-243		3	81.1	3x10 <sup>-4</sup>	8.11x10 <sup>-3</sup>	1.9	5.2x10 <sup>1</sup>

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g) (Ci/g)	
Cm-244		4	108.0	4x10 <sup>-4</sup>	1.08x10 <sup>-2</sup>	3.0	5.7x10 <sup>1</sup>
Cm-245		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	6.4x10 <sup>-3</sup>	1.7x10 <sup>-1</sup>
Cm-246		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	1.1x10 <sup>-2</sup>	3.1x10 <sup>-1</sup>
Cm-247		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	3.4x10 <sup>-6</sup>	9.3x10 <sup>-5</sup>
Cm-248		4x10 <sup>-2</sup>	1.08	5x10 <sup>-5</sup>	1.35x10 <sup>-3</sup>	1.6x10 <sup>-4</sup>	4.2x10 <sup>-3</sup>
Co-55	Cobalt(27)	0.5	13.5	0.5	13.5	1.1x10 <sup>5</sup>	3.1x10 <sup>6</sup>
Co-56		0.3	8.11	0.3	8.11	1.1x10 <sup>3</sup>	3.0x10 <sup>4</sup>
Co-57		8	216	8	216	3.1x10 <sup>2</sup>	8.4x10 <sup>3</sup>
Co-58m		40	1080	40	1080	2.2x10 <sup>5</sup>	5.9x10 <sup>6</sup>
Co-58		1	27.0	1	27.0	1.2x10 <sup>3</sup>	3.2x10 <sup>4</sup>
Co-60		0.4	10.8	0.4	10.8	4.2x10 <sup>1</sup>	1.1x10 <sup>3</sup>
Cr-51	Chromium(24)	30	811	30	811	3.4x10 <sup>3</sup>	9.2x10 <sup>4</sup>
Cs-129	Cesium(55)	4	108	4	108	2.8x10 <sup>4</sup>	7.6x10 <sup>5</sup>
Cs-131		40	1080	40	1080	3.8x10 <sup>3</sup>	1.0x10 <sup>5</sup>
Cs-132		1	27.0	1	27.0	5.7x10 <sup>3</sup>	1.5x10 <sup>5</sup>
Cs-134m		40	1080	9	243	3.0x10 <sup>5</sup>	8.0x10 <sup>6</sup>
Cs-134		0.6	16.2	0.5	13.5	4.8x10 <sup>1</sup>	1.3x10 <sup>3</sup>
Cs-135		40	1080	0.9	24.3	4.3x10 <sup>-5</sup>	1.2x10 <sup>-3</sup>
Cs-136		0.5	13.5	0.5	13.5	2.7x10 <sup>3</sup>	7.3x10 <sup>4</sup>
Cs-137		2	54.1	0.5	13.5	3.2	8.7x10 <sup>1</sup>
Cu-64	Copper(29)	5	135	0.9	24.3	1.4x10 <sup>5</sup>	3.9x10 <sup>6</sup>
Cu-67		9	243	0.9	24.3	2.8x10 <sup>4</sup>	7.6x10 <sup>5</sup>
Dy-159	Dysprosium(66)	20	541	20	541	2.1x10 <sup>2</sup>	5.7x10 <sup>3</sup>
Dy-165		0.6	16.2	0.5	13.5	3.0x10 <sup>5</sup>	8.2x10 <sup>6</sup>

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Dy-166		0.3	8.11	0.3	8.11	8.6x10 <sup>3</sup>	2.3x10 <sup>5</sup>
Er-169	Erbium(68)	40	1080	0.9	24.3	3.1x10 <sup>3</sup>	8.3x10 <sup>4</sup>
Er-171		0.6	16.2	0.5	13.5	9.0x10 <sup>4</sup>	2.4x10 <sup>6</sup>
Es-253	Einsteinium(99) <sup>a</sup>	200	5400	2x10 <sup>-2</sup>	5.4x10 <sup>-1</sup>	--	--
Es-254		30	811	3x10 <sup>-3</sup>	8.11x10 <sup>-2</sup>	--	--
Es-254m		0.6	16.2	0.4	10.8	--	--
Es-255		--	--	--	--	--	--
Eu-147	Europium(63)	2	54.1	2	54.1	1.4x10 <sup>3</sup>	3.7x10 <sup>4</sup>
Eu-148		0.5	13.5	0.5	13.5	6.0x10 <sup>2</sup>	1.6x10 <sup>4</sup>
Eu-149		20	541	20	541	3.5x10 <sup>2</sup>	9.4x10 <sup>3</sup>
Eu-150		0.7	18.9	0.7	18.9	6.1x10 <sup>4</sup>	1.6x10 <sup>6</sup>
Eu-152m		0.6	16.2	0.5	13.5	8.2x10 <sup>4</sup>	2.2x10 <sup>6</sup>
Eu-152		0.9	24.3	0.9	24.3	6.5	1.8x10 <sup>2</sup>
Eu-154		0.8	21.6	0.5	13.5	9.8	2.6x10 <sup>2</sup>
Eu-155		20	541	2	54.1	1.8x10 <sup>1</sup>	4.9x10 <sup>2</sup>
Eu-156		0.6	16.2	0.5	13.5	2.0x10 <sup>3</sup>	5.5x10 <sup>4</sup>
F-18	Fluorine(9)	1	27.0	0.5	13.5	3.5x10 <sup>6</sup>	9.5x10 <sup>7</sup>
Fe-52	Iron(26)	0.2	5.41	0.2	5.41	2.7x10 <sup>5</sup>	7.3x10 <sup>6</sup>
Fe-55		40	1080	40	1080	8.8x10 <sup>1</sup>	2.4x10 <sup>3</sup>
Fe-59		0.8	21.6	0.8	21.6	1.8x10 <sup>3</sup>	5.0x10 <sup>4</sup>
Fe-60		40	1080	0.2	5.41	7.4x10 <sup>-4</sup>	2.0x10 <sup>-2</sup>
Fm-255	Fermium(100) <sup>b</sup>	40	1080	0.8	21.6	--	--
Fm-257		10	270	8x10 <sup>-3</sup>	2.16x10 <sup>-1</sup>	--	--
Ga-67	Gallium(31)	6	162	6	162	2.2x10 <sup>4</sup>	6.0x10 <sup>5</sup>

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Ga-68		0.3	8.11	0.3	8.11	1.5x10 <sup>6</sup>	4.1x10 <sup>7</sup>
Ga-72		0.4	10.8	0.4	10.8	1.1x10 <sup>5</sup>	3.1x10 <sup>6</sup>
Gd-146	Gadolinium(64)	0.4	10.8	0.4	10.8	6.9x10 <sup>2</sup>	1.9x10 <sup>4</sup>
Gd-148		3	81.1	3x10 <sup>-4</sup>	8.11x10 <sup>-3</sup>	1.2	3.2x10 <sup>1</sup>
Gd-153		10	270	5	135	1.3x10 <sup>2</sup>	3.5x10 <sup>3</sup>
Gd-159		4	108	0.5	13.5	3.9x10 <sup>4</sup>	1.1x10 <sup>6</sup>
Ge-68	Germanium(32)	0.3	8.11	0.3	8.11	2.6x10 <sup>2</sup>	7.1x10 <sup>3</sup>
Ge-71		40	1080	40	1080	5.8x10 <sup>3</sup>	1.6x10 <sup>5</sup>
Ge-77		0.3	8.11	0.3	8.11	1.3x10 <sup>5</sup>	3.6x10 <sup>6</sup>
H-3	Hydrogen(1) See T-Tritium						
Hf-172	Hafnium(72)	0.5	13.5	0.3	8.11	4.1x10 <sup>1</sup>	1.1x10 <sup>3</sup>
Hf-175		3	81.1	3	81.1	3.9x10 <sup>2</sup>	1.1x10 <sup>4</sup>
Hf-181		2	54.1	0.9	24.3	6.3x10 <sup>2</sup>	1.7x10 <sup>4</sup>
Hf-182		4	108	3x10 <sup>-2</sup>	0.811	8.1x10 <sup>-6</sup>	2.2x10 <sup>-4</sup>
Hg-194	Mercury(80)	1	27.0	1	27.0	1.3x10 <sup>-1</sup>	3.5
Hg-195m		5	135	5	135	1.5x10 <sup>4</sup>	4.0x10 <sup>5</sup>
Hg-197m		10	270	0.9	24.3	2.5x10 <sup>4</sup>	6.7x10 <sup>5</sup>
Hg-197		10	270	10	270	9.2x10 <sup>3</sup>	2.5x10 <sup>5</sup>
Hg-203		4	108	0.9	24.3	5.1x10 <sup>2</sup>	1.4x10 <sup>4</sup>
Ho-163	Holmium(67)	40	1080	40	1080	2.7	7.6x10 <sup>1</sup>
Ho-166m		0.6	16.2	0.3	8.11	6.6x10 <sup>-2</sup>	1.8
Ho-166		0.3	8.11	0.3	8.11	2.6x10 <sup>4</sup>	7.0x10 <sup>5</sup>
I-123	Iodine(53)	6	162	6	162	7.1x10 <sup>4</sup>	1.9x10 <sup>6</sup>

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
I-124		0.9	24.3	0.9	24.3	$9.3 \times 10^3$	$2.5 \times 10^5$
I-125		20	541	2	54.1	$6.4 \times 10^2$	$1.7 \times 10^4$
I-126		2	54.1	0.9	24.3	$2.9 \times 10^3$	$8.0 \times 10^4$
I-129		Unlimited	Unlimited	Unlimited	Unlimited	$6.5 \times 10^{-6}$	$1.8 \times 10^{-4}$
I-131		3	81.1	0.5	13.5	$4.6 \times 10^3$	$1.2 \times 10^5$
I-132		0.4	10.8	0.4	10.8	$3.8 \times 10^5$	$1.0 \times 10^7$
I-133		0.6	16.2	0.5	13.5	$4.2 \times 10^4$	$1.1 \times 10^6$
I-134		0.3	8.11	0.3	8.11	$9.9 \times 10^5$	$2.7 \times 10^7$
I-135		0.6	16.2	0.5	13.5	$1.3 \times 10^5$	$3.5 \times 10^6$
In-111	Indium(49)	2	54.1	2	54.1	$1.5 \times 10^4$	$4.2 \times 10^5$
In-113m		4	108	4	108	$6.2 \times 10^5$	$1.7 \times 10^7$
In-114m		0.3	8.11	0.3	8.11	$8.6 \times 10^2$	$2.3 \times 10^4$
In-115m		6	162	0.9	24.3	$2.2 \times 10^5$	$6.1 \times 10^6$
Ir-189	Iridium(77)	10	270	10	270	$1.9 \times 10^3$	$5.2 \times 10^4$
Ir-190		0.7	18.9	0.7	18.9	$2.3 \times 10^3$	$6.2 \times 10^4$
Ir-192		1	27.0	0.5	13.5	$3.4 \times 10^2$	$9.2 \times 10^3$
Ir-193m		10	270	10	270	$2.4 \times 10^3$	$6.4 \times 10^4$
Ir-194		0.2	5.41	0.2	5.41	$3.1 \times 10^4$	$8.4 \times 10^5$
K-40	Potassium(19)	0.6	16.2	0.6	16.2	$2.4 \times 10^{-7}$	$6.4 \times 10^{-6}$
K-42		0.2	5.41	0.2	5.41	$2.2 \times 10^5$	$6.0 \times 10^6$
K-43		1.0	27.0	0.5	13.5	$1.2 \times 10^5$	$3.3 \times 10^6$
Kr-81	Krypton(36)	40	1080	40	1080	$7.8 \times 10^{-4}$	$2.1 \times 10^{-2}$
Kr-85m		6	162	6	162	$3.0 \times 10^5$	$8.2 \times 10^6$
Kr-85		20	541	10	270	$1.5 \times 10^1$	$3.9 \times 10^2$

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Kr-87		0.2	5.41	0.2	5.41	1.0x10 <sup>6</sup>	2.8x10 <sup>7</sup>
La-137	Lanthanum(57)	40	1080	2	54.1	1.6x10 <sup>-3</sup>	4.4x10 <sup>-2</sup>
La-140		0.4	10.8	0.4	10.8	2.1x10 <sup>4</sup>	5.6x10 <sup>5</sup>
Lu-172	Lutetium(71)	0.5	13.5	0.5	13.5	4.2x10 <sup>3</sup>	1.1x10 <sup>5</sup>
Lu-173		8	216	8	216	5.6x10 <sup>1</sup>	1.5x10 <sup>3</sup>
Lu-174m		20	541	8	216	2.0x10 <sup>2</sup>	5.3x10 <sup>3</sup>
Lu-174		8	216	4	108	2.3x10 <sup>1</sup>	6.2x10 <sup>2</sup>
Lu-177		30	811	0.9	24.3	4.1x10 <sup>3</sup>	1.1x10 <sup>5</sup>
MFP	For mixed fission products, use formula for mixtures or Table A-2.						
Mg-28	Magnesium(12)	0.2	5.41	0.2	5.41	2.0x10 <sup>5</sup>	5.4x10 <sup>6</sup>
Mn-52	Manganese(25)	0.3	8.11	0.3	8.11	1.6x10 <sup>4</sup>	4.4x10 <sup>5</sup>
Mn-53		Unlimited	Unlimited	Unlimited	Unlimited	6.8x10 <sup>-5</sup>	1.8x10 <sup>-3</sup>
Mn-54		1	27.0	1	27.0	2.9x10 <sup>2</sup>	7.7x10 <sup>3</sup>
Mn-56		0.2	5.41	0.2	5.41	8.0x10 <sup>5</sup>	2.2x10 <sup>7</sup>
Mo-93	Molybdenum(42)	40	1080	7	189	4.1x10 <sup>-2</sup>	1.1
Mo-99		0.6	16.2	0.5	13.5 <sup>c</sup>	1.8x10 <sup>4</sup>	4.8x10 <sup>5</sup>
N-13	Nitrogen(7)	0.6	16.2	0.5	13.5	5.4x10 <sup>7</sup>	1.5x10 <sup>9</sup>
Na-22	Sodium(11)	0.5	13.5	0.5	13.5	2.3x10 <sup>2</sup>	6.3x10 <sup>3</sup>
Na-24		0.2	5.41	0.2	5.41	3.2x10 <sup>5</sup>	8.7x10 <sup>6</sup>
Nb-92m	Niobium(41)	0.7	18.9	0.7	18.9	5.2x10 <sup>3</sup>	1.4x10 <sup>5</sup>
Nb-93m		40	1080	6	162	8.8	2.4x10 <sup>2</sup>
Nb-94		0.6	16.2	0.6	16.2	6.9x10 <sup>-3</sup>	1.9x10 <sup>-1</sup>



Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Nb-95		1	27.0	1	27.0	1.5x10 <sup>3</sup>	3.9x10 <sup>4</sup>
Nb-97		0.6	16.2	0.5	13.5	9.9x10 <sup>5</sup>	2.7x10 <sup>7</sup>
Nd-147	Neodymium(60)	4	108	0.5	13.5	3.0x10 <sup>3</sup>	8.1x10 <sup>4</sup>
Nd-149		0.6	16.2	0.5	13.5	4.5x10 <sup>5</sup>	1.2x10 <sup>7</sup>
Ni-59	Nickel(28)	40	1080	40	1080	3.0x10 <sup>-3</sup>	8.0x10 <sup>-2</sup>
Ni-63		40	1080	30	811	2.1	5.7x10 <sup>1</sup>
Ni-65		0.3	8.11	0.3	8.11	7.1x10 <sup>5</sup>	1.9x10 <sup>7</sup>
Np-235	Neptunium(93)	40	1080	40	1080	5.2x10 <sup>1</sup>	1.4x10 <sup>3</sup>
Np-236		7	189	1x10 <sup>-3</sup>	2.70x10 <sup>-2</sup>	4.7x10 <sup>-4</sup>	1.3x10 <sup>-2</sup>
Np-237		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	2.6x10 <sup>-5</sup>	7.1x10 <sup>-4</sup>
Np-239		6	162	0.5	13.5	8.6x10 <sup>3</sup>	2.3x10 <sup>5</sup>
Os-185	Osmium(76)	1	27.0	1	27.0	2.8x10 <sup>2</sup>	7.5x10 <sup>3</sup>
Os-191m		40	1080	40	1080	4.6x10 <sup>4</sup>	1.3x10 <sup>6</sup>
Os-191		10	270	0.9	24.3	1.6x10 <sup>3</sup>	4.4x10 <sup>4</sup>
Os-193		0.6	16.2	0.5	13.5	2.0x10 <sup>4</sup>	5.3x10 <sup>5</sup>
Os-194		0.2	5.41	0.2	5.41	1.1x10 <sup>1</sup>	3.1x10 <sup>2</sup>
P-32	Phosphorus(15)	0.3	8.11	0.3	8.11	1.1x10 <sup>4</sup>	2.9x10 <sup>5</sup>
P-33		40	1080	0.9	24.3	5.8x10 <sup>3</sup>	1.6x10 <sup>5</sup>
Pa-230	Protactinium(91)	2	54.1	0.1	2.70	1.2x10 <sup>3</sup>	3.3x10 <sup>4</sup>
Pa-231		0.6	16.2	6x10 <sup>-5</sup>	1.62x10 <sup>-3</sup>	1.7x10 <sup>-3</sup>	4.7x10 <sup>-2</sup>
Pa-233		5	135	0.9	24.3	7.7x10 <sup>2</sup>	2.1x10 <sup>4</sup>
Pb-201	Lead(82)	1	27.0	1	27.0	6.2x10 <sup>4</sup>	1.7x10 <sup>6</sup>
Pb-202		40	1080	2	54.1	1.2x10 <sup>-4</sup>	3.4x10 <sup>-3</sup>
Pb-203		3	81.1	3	81.1	1.1x10 <sup>4</sup>	3.0x10 <sup>5</sup>

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Pb-205		Unlimited	Unlimited	Unlimited	Unlimited	4.5x10 <sup>-6</sup>	1.2x10 <sup>-4</sup>
Pb-210		0.6	16.2	9x10 <sup>-3</sup>	0.243	2.8	7.6x10 <sup>1</sup>
Pb-212		0.3	8.11	0.3	8.11	5.1x10 <sup>4</sup>	1.4x10 <sup>6</sup>
Pd-103	Palladium(46)	40	1080	40	1080	2.8x10 <sup>3</sup>	7.5x10 <sup>4</sup>
Pd-107		Unlimited	Unlimited	Unlimited	Unlimited	1.9x10 <sup>-5</sup>	5.1x10 <sup>-4</sup>
Pd-109		0.6	16.2	0.5	13.5	7.9x10 <sup>4</sup>	2.1x10 <sup>6</sup>
Pm-143	Promethium(61)	3	81.1	3	81.1	1.3x10 <sup>2</sup>	3.4x10 <sup>3</sup>
Pm-144		0.6	16.2	0.6	16.2	9.2x10 <sup>1</sup>	2.5x10 <sup>3</sup>
Pm-145		30	811	7	189	5.2	1.4x10 <sup>2</sup>
Pm-147		40	1080	0.9	24.3	3.4x10 <sup>1</sup>	9.3x10 <sup>2</sup>
Pm-148m		0.5	13.5	0.5	13.5	7.9x10 <sup>2</sup>	2.1x10 <sup>4</sup>
Pm-149		0.6	16.2	0.5	13.5	1.5x10 <sup>4</sup>	4.0x10 <sup>5</sup>
Pm-151		3	81.1	0.5	13.5	2.7x10 <sup>4</sup>	7.3x10 <sup>5</sup>
Po-208	Polonium(84)	40	1080	2x10 <sup>-2</sup>	0.541	2.2x10 <sup>1</sup>	5.9x10 <sup>2</sup>
Po-209		40	1080	2x10 <sup>-2</sup>	0.541	6.2x10 <sup>-1</sup>	1.7x10 <sup>1</sup>
Po-210		40	1080	2x10 <sup>-2</sup>	0.541	1.7x10 <sup>2</sup>	4.5x10 <sup>3</sup>
Pr-142	Praseodymium(59)	0.2	5.41	0.2	5.41	4.3x10 <sup>4</sup>	1.2x10 <sup>6</sup>
Pr-143		4	108	0.5	13.5	2.5x10 <sup>3</sup>	6.7x10 <sup>4</sup>
Pt-188	Platinum(78)	0.6	16.2	0.6	16.2	2.5x10 <sup>3</sup>	6.8x10 <sup>4</sup>
Pt-191		3	81.1	3	81.1	8.7x10 <sup>3</sup>	2.4x10 <sup>5</sup>
Pt-193m		40	1080	9	243	5.8x10 <sup>3</sup>	1.6x10 <sup>5</sup>
Pt-193		40	1080	40	1080	1.4	3.7x10 <sup>1</sup>
Pt-195m		10	270	2	54.1	6.2x10 <sup>3</sup>	1.7x10 <sup>5</sup>
Pt-197m		10	270	0.9	24.3	3.7x10 <sup>5</sup>	1.0x10 <sup>7</sup>

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Pt-197		20	541	0.5	13.5	3.2x10 <sup>4</sup>	8.7x10 <sup>5</sup>
Pu-236	Plutonium(94)	7	189	7x10 <sup>-4</sup>	1.89x10 <sup>-2</sup>	2.0x10 <sup>1</sup>	5.3x10 <sup>2</sup>
Pu-237		20	541	20	541	4.5x10 <sup>2</sup>	1.2x10 <sup>4</sup>
Pu-238		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	6.3x10 <sup>-1</sup>	1.7x10 <sup>1</sup>
Pu-239		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	2.3x10 <sup>-3</sup>	6.2x10 <sup>-2</sup>
Pu-240		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	8.4x10 <sup>-3</sup>	2.3x10 <sup>-1</sup>
Pu-241		40	1080	1x10 <sup>-2</sup>	0.270	3.8	1.0x10 <sup>2</sup>
Pu-242		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	1.5x10 <sup>-4</sup>	3.9x10 <sup>-3</sup>
Pu-244		0.3	8.11	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	6.7x10 <sup>-7</sup>	1.8x10 <sup>-5</sup>
Ra-223	Radium(88)	0.6	16.2	3x10 <sup>-2</sup>	0.811	1.9x10 <sup>3</sup>	5.1x10 <sup>4</sup>
Ra-224		0.3	8.11	6x10 <sup>-2</sup>	1.62	5.9x10 <sup>3</sup>	1.6x10 <sup>5</sup>
Ra-225		0.6	16.2	2x10 <sup>-2</sup>	0.541	1.5x10 <sup>3</sup>	3.9x10 <sup>4</sup>
Ra-226		0.3	8.11	2x10 <sup>-2</sup>	0.541	3.7x10 <sup>-2</sup>	1.0
Ra-228		0.6	16.2	4x10 <sup>-2</sup>	1.08	1.0x10 <sup>1</sup>	2.7x10 <sup>2</sup>
Rb-81	Rubidium(37)	2	54.1	0.9	24.3	3.1x10 <sup>5</sup>	8.4x10 <sup>6</sup>
Rb-83		2	54.1	2	54.1	6.8x10 <sup>2</sup>	1.8x10 <sup>4</sup>
Rb-84		1	27.0	0.9	24.3	1.8x10 <sup>3</sup>	4.7x10 <sup>4</sup>
Rb-86		0.3	8.11	0.3	8.11	3.0x10 <sup>3</sup>	8.1x10 <sup>4</sup>
Rb-87		Unlimited	Unlimited	Unlimited	Unlimited	3.2x10 <sup>-9</sup>	8.6x10 <sup>-8</sup>
Rb (natural)		Unlimited	Unlimited	Unlimited	Unlimited	6.7x10 <sup>6</sup>	1.8x10 <sup>8</sup>
Re-183	Rhenium(75)	5	135	5	135	3.8x10 <sup>2</sup>	1.0x10 <sup>4</sup>
Re-184m		3	81.1	3	81.1	1.6x10 <sup>2</sup>	4.3x10 <sup>3</sup>
Re-184		1	27.0	1	27.0	6.9x10 <sup>2</sup>	1.9x10 <sup>4</sup>
Re-186		4	108	0.5	13.5	6.9x10 <sup>3</sup>	1.9x10 <sup>5</sup>

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Re-187		Unlimited	Unlimited	Unlimited	Unlimited	$1.4 \times 10^{-9}$	$3.8 \times 10^{-8}$
Re-188		0.2	5.41	0.2	5.41	$3.6 \times 10^4$	$9.8 \times 10^5$
Re-189		4	108	0.5	13.5	$2.5 \times 10^4$	$6.8 \times 10^5$
Re (natural)		Unlimited	Unlimited	Unlimited	Unlimited	" $8.9 \times 10^{-10}$ "	$2.4 \times 10^{-8}$
Rh-99	Rhodium(45)	2	54.1	2	54.1	$3.0 \times 10^3$	$8.2 \times 10^4$
Rh-101		4	108	4	108	$4.1 \times 10^1$	$1.1 \times 10^3$
Rh-102m		2	54.1	0.9	24.3	$2.3 \times 10^2$	$6.2 \times 10^3$
Rh-102		0.5	13.5	0.5	13.5	$4.5 \times 10^1$	$1.2 \times 10^3$
Rh-103m		40	1080	40	1080	$1.2 \times 10^6$	$3.3 \times 10^7$
Rh-105		10	270	0.9	24.3	$3.1 \times 10^4$	$8.4 \times 10^5$
Rn-222	Radon(86)	0.2	5.41	$4 \times 10^{-3}$	0.108	$5.7 \times 10^3$	$1.5 \times 10^5$
Ru-97	Ruthenium(44)	4	108	4	108	$1.7 \times 10^4$	$4.6 \times 10^5$
Ru-103		2	54.1	0.9	24.3	$1.2 \times 10^3$	$3.2 \times 10^4$
Ru-105		0.6	16.2	0.5	13.5	$2.5 \times 10^5$	$6.7 \times 10^6$
Ru-106		0.2	5.41	0.2	5.41	$1.2 \times 10^2$	$3.3 \times 10^3$
S-35	Sulfur(16)	40	1080	2	54.1	$1.6 \times 10^3$	$4.3 \times 10^4$
Sb-122	Antimony(51)	0.3	8.11	0.3	8.11	$1.5 \times 10^4$	$4.0 \times 10^5$
Sb-124		0.6	16.2	0.5	13.5	$6.5 \times 10^2$	$1.7 \times 10^4$
Sb-125		2	54.1	0.9	24.3	$3.9 \times 10^1$	$1.0 \times 10^3$
Sb-126		0.4	10.8	0.4	10.8	$3.1 \times 10^3$	$8.4 \times 10^4$
Sc-44	Scandium(21)	0.5	13.5	0.5	13.5	$6.7 \times 10^5$	$1.8 \times 10^7$
Sc-46		0.5	13.5	0.5	13.5	$1.3 \times 10^3$	$3.4 \times 10^4$
Sc-47		9	243	0.9	24.3	$3.1 \times 10^4$	$8.3 \times 10^5$
Sc-48		0.3	8.11	0.3	8.11	$5.5 \times 10^4$	$1.5 \times 10^6$

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Se-75	Selenium(34)	3	81.1	3	81.1	5.4x10 <sup>2</sup>	1.5x10 <sup>4</sup>
Se-79		40	1080	2	54.1	2.6x10 <sup>-3</sup>	7.0x10 <sup>-2</sup>
Si-31	Silicon(14)	0.6	16.2	0.5	13.5	1.4x10 <sup>6</sup>	3.9x10 <sup>7</sup>
Si-32		40	1080	0.2	5.41	3.9	1.1x10 <sup>2</sup>
Sm-145	Samarium(62)	20	541	20	541	9.8x10 <sup>1</sup>	2.6x10 <sup>3</sup>
Sm-147		Unlimited	Unlimited	Unlimited	Unlimited	8.5x10 <sup>-10</sup>	2.3x10 <sup>-8</sup>
Sm-151		40	1080	4	108	9.7x10 <sup>-1</sup>	2.6x10 <sup>1</sup>
Sm-153		4	108	0.5	13.5	1.6x10 <sup>4</sup>	4.4x10 <sup>5</sup>
Sn-113	Tin(50)	4	108	4	108	3.7x10 <sup>2</sup>	1.0x10 <sup>4</sup>
Sn-117m		6	162	2	54.1	3.0x10 <sup>3</sup>	8.2x10 <sup>4</sup>
Sn-119m		40	1080	40	1080	1.4x10 <sup>2</sup>	3.7x10 <sup>3</sup>
Sn-121m		40	1080	0.9	24.3	2.0	5.4x10 <sup>1</sup>
Sn-123		0.6	16.2	0.5	13.5	3.0x10 <sup>2</sup>	8.2x10 <sup>3</sup>
Sn-125		0.2	5.41	0.2	5.41	4.0x10 <sup>3</sup>	1.1x10 <sup>5</sup>
Sn-126		0.3	8.11	0.3	8.11	1.0x10 <sup>-3</sup>	2.8x10 <sup>-2</sup>
Sr-82	Strontium(38)	0.2	5.41	0.2	5.41	2.3x10 <sup>3</sup>	6.2x10 <sup>4</sup>
Sr-85m		5	135	5	135	1.2x10 <sup>6</sup>	3.3x10 <sup>7</sup>
Sr-85		2	54.1	2	54.1	8.8x10 <sup>2</sup>	2.4x10 <sup>4</sup>
Sr-87m		3	81.1	3	81.1	4.8x10 <sup>5</sup>	1.3x10 <sup>7</sup>
Sr-89		0.6	16.2	0.5	13.5	1.1x10 <sup>3</sup>	2.9x10 <sup>4</sup>
Sr-90		0.2	5.41	0.1	2.70	5.1	1.4x10 <sup>2</sup>
Sr-91		0.3	8.11	0.3	8.11	1.3x10 <sup>5</sup>	3.6x10 <sup>6</sup>
Sr-92		0.8	21.6	0.5	13.5	4.7x10 <sup>5</sup>	1.3x10 <sup>7</sup>
T	Tritium(1)	40	1080	40 <sup>d</sup>	1080 <sup>d</sup>	3.6x10 <sup>2</sup>	9.7x10 <sup>3</sup>

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Ta-178	Tantalum(73)	1	27.0	1	27.0	4.2x10 <sup>6</sup>	1.1x10 <sup>8</sup>
Ta-179		30	811	30	811	4.1x10 <sup>1</sup>	1.1x10 <sup>3</sup>
Ta-182		0.8	21.6	0.5	13.5	2.3x10 <sup>2</sup>	6.2x10 <sup>3</sup>
Tb-157	Terbium(65)	40	1080	10	270	5.6x10 <sup>-1</sup>	1.5x10 <sup>1</sup>
Tb-158		1	27.0	0.7	18.9	5.6x10 <sup>-1</sup>	1.5x10 <sup>1</sup>
Tb-160		0.9	24.3	0.5	13.5	4.2x10 <sup>2</sup>	1.1x10 <sup>4</sup>
Tc-95m	Technetium(43)	2	54.1	2	54.1	8.3x10 <sup>2</sup>	2.2x10 <sup>4</sup>
Tc-96m		0.4	10.8	0.4	10.8	1.4x10 <sup>6</sup>	3.8x10 <sup>7</sup>
Tc-96		0.4	10.8	0.4	10.8	1.2x10 <sup>4</sup>	3.2x10 <sup>5</sup>
Tc-97m		40	1080	40	1080	5.6x10 <sup>2</sup>	1.5x10 <sup>4</sup>
Tc-97		Unlimited	Unlimited	Unlimited	Unlimited	5.2x10 <sup>-5</sup>	1.4x10 <sup>-3</sup>
Tc-98		0.7	18.9	0.7	18.9	3.2x10 <sup>-5</sup>	8.7x10 <sup>-4</sup>
Tc-99m		8	216	8	216	1.9x10 <sup>5</sup>	5.3x10 <sup>6</sup>
Tc-99		40	1080	0.9	24.3	6.3x10 <sup>-4</sup>	1.7x10 <sup>-2</sup>
Te-118	Tellurium(52)	0.2	5.41	0.2	5.41	6.8x10 <sup>3</sup>	1.8x10 <sup>5</sup>
Te-121m		5	135	5	135	2.6x10 <sup>2</sup>	7.0x10 <sup>3</sup>
Te-121		2	54.1	2	54.1	2.4x10 <sup>3</sup>	6.4x10 <sup>4</sup>
Te-123m		7	189	7	189	3.3x10 <sup>2</sup>	8.9x10 <sup>3</sup>
Te-125m		30	811	9	243	6.7x10 <sup>2</sup>	1.8x10 <sup>4</sup>
Te-127m		20	541	0.5	13.5	3.5x10 <sup>2</sup>	9.4x10 <sup>3</sup>
Te-127		20	541	0.5	13.5	9.8x10 <sup>4</sup>	2.6x10 <sup>6</sup>
Te-129m		0.6	16.2	0.5	13.5	1.1x10 <sup>3</sup>	3.0x10 <sup>4</sup>
Te-129		0.6	16.2	0.5	13.5	7.7x10 <sup>5</sup>	2.1x10 <sup>7</sup>
Te-131m		0.7	18.9	0.5	13.5	3.0x10 <sup>4</sup>	8.0x10 <sup>5</sup>

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Te-132		0.4	10.8	0.4	10.8	1.1x10 <sup>4</sup>	3.0x10 <sup>5</sup>
Th-227	Thorium(90)	9	243	1x10 <sup>-2</sup>	0.270	1.1x10 <sup>3</sup>	3.1x10 <sup>4</sup>
Th-228		0.3	8.11	4x10 <sup>-4</sup>	1.08x10 <sup>-2</sup>	3.0x10 <sup>1</sup>	8.2x10 <sup>2</sup>
Th-229		0.3	8.11	3x10 <sup>-5</sup>	8.11x10 <sup>-4</sup>	7.9x10 <sup>-3</sup>	2.1x10 <sup>-1</sup>
Th-230		2	54.1	2x10 <sup>-4</sup>	5.41x10 <sup>-3</sup>	7.6x10 <sup>-4</sup>	2.1x10 <sup>-2</sup>
Th-231		40	1080	0.9	24.3	2.0x10 <sup>4</sup>	5.3x10 <sup>5</sup>
Th-232		Unlimited	Unlimited	Unlimited	Unlimited	4.0x10 <sup>-9</sup>	1.1x10 <sup>-7</sup>
Th-234		0.2	5.41	0.2	5.41	8.6x10 <sup>2</sup>	2.3x10 <sup>4</sup>
Th (natural)		Unlimited	Unlimited	Unlimited	Unlimited	8.1x10 <sup>-9</sup>	2.2x10 <sup>-7</sup>
Ti-44	Titanium(22)	0.5	13.5	0.2	5.41	6.4	1.7x10 <sup>2</sup>
Tl-200	Thallium(81.1)	0.8	21.6	0.8	21.6	2.2x10 <sup>4</sup>	6.0x10 <sup>5</sup>
Tl-201		10	270	10	270	7.9x10 <sup>3</sup>	2.1x10 <sup>5</sup>
Tl-202		2	54.1	2	54.1	2.0x10 <sup>3</sup>	5.3x10 <sup>4</sup>
Tl-204		4	108	0.5	13.5	1.7x10 <sup>1</sup>	4.6x10 <sup>2</sup>
Tm-167	Thulium(69)	7	189	7	189	3.1x10 <sup>3</sup>	8.5x10 <sup>4</sup>
Tm-168		0.8	21.6	0.8	21.6	3.1x10 <sup>2</sup>	8.3x10 <sup>3</sup>
Tm-170		4	108	0.5	13.5	2.2x10 <sup>2</sup>	6.0x10 <sup>3</sup>
Tm-171		40	1080	10	270	4.0x10 <sup>1</sup>	1.1x10 <sup>3</sup>
U-230	Uranium(92)	40	1080	1x10 <sup>-2</sup>	0.270	1.0x10 <sup>3</sup>	2.7x10 <sup>4</sup>
U-232		3	81.1	3x10 <sup>-4</sup>	8.11x10 <sup>-3</sup>	8.3x10 <sup>-1</sup>	2.2x10 <sup>1</sup>
U-233		10	270	1x10 <sup>-3</sup>	2.70x10 <sup>-2</sup>	3.6x10 <sup>-4</sup>	9.7x10 <sup>-3</sup>
U-234		10	270	1x10 <sup>-3</sup>	2.70x10 <sup>-2</sup>	2.3x10 <sup>-4</sup>	6.3x10 <sup>-3</sup>
U-235		Unlimited	Unlimited	Unlimited	Unlimited	8.0x10 <sup>-8</sup>	2.2x10 <sup>-6</sup>
U-236		10	270	1x10 <sup>-3</sup>	2.70x10 <sup>-2</sup>	2.4x10 <sup>-6</sup>	6.5x10 <sup>-5</sup>

Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
U-238		Unlimited	Unlimited	Unlimited	Unlimited	$1.2 \times 10^{-8}$	$3.4 \times 10^{-7}$
U (natural)		Unlimited	Unlimited	Unlimited	Unlimited	$2.6 \times 10^{-8}$	$7.1 \times 10^{-7}$
U (enriched 5% or less)		Unlimited	Unlimited	Unlimited	Unlimited	--	(see Table A-3)
U (enriched more than 5%)		10	270	$1 \times 10^{-3}$	$2.70 \times 10^{-2}$	--	(see Table A-3)
U (depleted)		Unlimited	Unlimited	Unlimited	Unlimited	--	(see Table A-3)
V-48	Vanadium(23)	0.3	8.11	0.3	8.11	$6.3 \times 10^3$	$1.7 \times 10^5$
V-49		40	1080	40	1080	$3.0 \times 10^2$	$8.1 \times 10^3$
W-178	Tungsten(74)	1	27.0	1	27.0	$1.3 \times 10^3$	$3.4 \times 10^4$
W-181		30	811	30	811	$2.2 \times 10^2$	$6.0 \times 10^3$
W-185		40	1080	0.9	24.3	$3.5 \times 10^2$	$9.4 \times 10^3$
W-187		2	54.1	0.5	13.5	$2.6 \times 10^4$	$7.0 \times 10^5$
W-188		0.2	5.41	0.2	5.41	$3.7 \times 10^2$	$1.0 \times 10^4$
Xe-122	Xenon(54)	0.2	5.41	0.2	5.41	$4.8 \times 10^4$	$1.3 \times 10^6$
Xe-123		0.2	5.41	0.2	5.41	$4.4 \times 10^5$	$1.2 \times 10^7$
Xe-127		4	108	4	108	$1.0 \times 10^3$	$2.8 \times 10^4$
Xe-131m		40	1080	40	1080	$3.1 \times 10^3$	$8.4 \times 10^4$
Xe-133		20	541	20	541	$6.9 \times 10^3$	$1.9 \times 10^5$
Xe-135		4	108	4	108	$9.5 \times 10^4$	$2.6 \times 10^6$
Y-87	Yttrium(39)	2	54.1	2	54.1	$1.7 \times 10^4$	$4.5 \times 10^5$
Y-88		0.4	10.8	0.4	10.8	$5.2 \times 10^2$	$1.4 \times 10^4$
Y-90		0.2	5.41	0.2	5.41	$2.0 \times 10^4$	$5.4 \times 10^5$
Y-91m		2	54.1	2	54.1	$1.5 \times 10^6$	$4.2 \times 10^7$



Symbol of Radionuclide	Element and Atomic Number	A <sub>1</sub> (TBq)	A <sub>1</sub> (Ci)	A <sub>2</sub> (TBq)	A <sub>2</sub> (Ci)	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Y-91		0.3	8.11	0.3	8.11	9.1x10 <sup>2</sup>	2.5x10 <sup>4</sup>
Y-92		0.2	5.41	0.2	5.41	3.6x10 <sup>5</sup>	9.6x10 <sup>6</sup>
Y-93		0.2	5.41	0.2	5.41	1.2x10 <sup>5</sup>	3.3x10 <sup>6</sup>
Yb-169	Ytterbium(70)	3	81.1	3	81.1	8.9x10 <sup>2</sup>	2.4x10 <sup>4</sup>
Yb-175		30	811	0.9	24.3	6.6x10 <sup>3</sup>	1.8x10 <sup>5</sup>
Zn-65	Zinc(30)	2	54.1	2	54.1	3.0x10 <sup>2</sup>	8.2x10 <sup>3</sup>
Zn-69m		2	54.1	0.5	13.5	1.2x10 <sup>5</sup>	3.3x10 <sup>6</sup>
Zn-69		4	108	0.5	13.5	1.8x10 <sup>6</sup>	4.9x10 <sup>7</sup>
Zr-88	Zirconium(40)	3	81.1	3	81.1	6.6x10 <sup>2</sup>	1.8x10 <sup>4</sup>
Zr-93		40	1080	0.2	5.41	9.3x10 <sup>-5</sup>	2.5x10 <sup>-3</sup>
Zr-95		1	27.0	0.9	24.3	7.9x10 <sup>2</sup>	2.1x10 <sup>4</sup>
Zr-97		0.3	8.11	0.3	8.11	7.1x10 <sup>4</sup>	1.9x10 <sup>6</sup>

<sup>a</sup> International shipments of Einsteinium require multilateral approvals of A<sub>1</sub> and A<sub>2</sub> values.

<sup>b</sup> International shipments of Fermium require multilateral approvals of A<sub>1</sub> and A<sub>2</sub> values.

<sup>c</sup> 20 curies for Mo<sup>99</sup> for domestic use.

<sup>d</sup> Also, for liquids only, a concentration limit of not greater than 1 TBq/liter (27 Curies/liter).

EDITOR'S NOTE: The specific activity in quotes for Rhenium (natural) in TBq/g and U-234 in TBq/g and Ci/g is calculated by the editor. These values were left blank in 10 CFR Part 71 Appendix A.

Table A-2 General Values for A<sub>1</sub> and A<sub>2</sub>

Contents	A <sub>1</sub>		A <sub>2</sub>	
	(TBq)	(Ci)	(TBq)	(Ci)
Only beta- or gamma-emitting nuclides are known to be present	0.2	5	0.02	0.5
Alpha-emitting nuclides are known to be present, or no relevant data are available.	0.10	2.7	2x10 <sup>-5</sup>	5.41x10 <sup>-4</sup>

Table A-3 Activity-mass Relationships for Uranium

Uranium Enrichment* wt % U-235 present	Specific Activity	
	TBq/g	Ci/g
0.45	1.8x10 <sup>-8</sup>	5.0x10 <sup>-7</sup>
0.72	2.6x10 <sup>-8</sup>	7.1x10 <sup>-7</sup>
1.0	2.8x10 <sup>-8</sup>	7.6x10 <sup>-7</sup>
1.5	3.7x10 <sup>-8</sup>	1.0x10 <sup>-6</sup>
5.0	1.0x10 <sup>-7</sup>	2.7x10 <sup>-6</sup>
10.0	1.8x10 <sup>-7</sup>	4.8x10 <sup>-6</sup>
20.0	3.7x10 <sup>-7</sup>	1.0x10 <sup>-5</sup>
35.0	7.4x10 <sup>-7</sup>	2.0x10 <sup>-5</sup>
50.0	9.3x10 <sup>-7</sup>	2.5x10 <sup>-5</sup>
90.0	2.2x10 <sup>-6</sup>	5.8x10 <sup>-5</sup>
93.0	2.6x10 <sup>-6</sup>	7.0x10 <sup>-5</sup>
95.0	3.4x10 <sup>-6</sup>	9.1x10 <sup>-5</sup>

\* The figures for uranium include representative values for the activity of the uranium-235 which is concentrated during the enrichment process.

**TABLE A-4**  
**ACTIVITY - MASS RELATIONSHIP FOR URANIUM/THORIUM**

Thorium and Uranium Enrichment <sup>1</sup> wt % <sup>235</sup> U present	Specific Activity	
	Ci per G	g per Ci
0.45	$5.0 \times 10^{-7}$	$2.0 \times 10^6$
0.72 (natural)	$7.06 \times 10^{-7}$	$1.42 \times 10^6$
1.0	$7.6 \times 10^{-7}$	$1.3 \times 10^6$
1.5	$1.0 \times 10^{-6}$	$1.0 \times 10^6$
5.0	$2.7 \times 10^{-6}$	$3.7 \times 10^5$
10.0	$4.8 \times 10^{-6}$	$2.1 \times 10^5$
20.0	$1.0 \times 10^{-5}$	$1.0 \times 10^5$
35.0	$2.0 \times 10^{-5}$	$5.0 \times 10^4$
50.0	$2.5 \times 10^{-5}$	$4.0 \times 10^4$
90.0	$5.8 \times 10^{-5}$	$1.7 \times 10^4$
93.0	$7.0 \times 10^{-5}$	$1.4 \times 10^4$
95.0	$9.1 \times 10^{-5}$	$1.1 \times 10^4$
Natural Thorium	$2.2 \times 10^{-7}$	$4.6 \times 10^6$

1. The figures for uranium include representative values for the activity of the uranium <sup>234</sup> which is concentrated during the enrichment process. The activity for thorium includes the equilibrium concentration of thorium <sup>228</sup>.

STATE OF FLORIDA  
BUREAU OF RADIATION CONTROL  
**ALIs, DACs AND EFFLUENT CONCENTRATIONS**  
July 1993

## ATTACHMENT 1

**ANNUAL LIMITS ON INTAKE (ALI) AND DERIVED AIR CONCENTRATIONS (DAC) OF RADIONUCLIDES FOR OCCUPATIONAL EXPOSURE; EFFLUENT CONCENTRATIONS; CONCENTRATIONS FOR RELEASE TO SANITARY SEWERAGE****Introduction**

For each radionuclide, Table I indicates the chemical form which is to be used for selecting the appropriate ALI or DAC value. The ALIs and DACs for inhalation are given for an aerosol with an activity medial aerodynamic diameter (AMAD) of 1  $\mu\text{m}$ , micron, and for three classes (D,W,Y) of radioactive material, which refer to their retention (approximately days, weeks or years) in the pulmonary region of the lung. This classification applies to a range of clearance half-times for D if less than 10 days, for W from 10 to 100 days, and for Y greater than 100 days. Table II provides concentration limits for airborne and liquid effluents released to the general environment. Table III provides concentration limits for discharges to sanitary sewerage.

**Note:**

The values in Tables I, II, and III are presented in the computer "E" notation. In this notation a value of 6E-02 represents a value of  $6 \times 10^{-2}$  or 0.06, 6E+2 represents  $6 \times 10^2$  or 600, and 6E+0 represents  $6 \times 10^0$  or 6.

**Table I "Occupational Values"**

Note that the columns in Table I captioned "Oral Ingestion ALI," "Inhalation ALI," and "DAC," are applicable to occupational exposure to radioactive material.

The ALIs are the annual intakes of given radionuclide by "Reference Man" which would result in either (1) a committed effective dose equivalent of 5 rem (0.05 sievert), stochastic ALI, or (2) a committed dose equivalent of 50 rem (0.5 sievert) to an organ or tissue, non-stochastic ALI. The stochastic ALIs were derived to result in a risk, due to irradiation of organs and tissues, comparable to the risk associated with deep dose equivalent to the whole body to 5 rem (0.05 sievert). The derivation includes multiplying the committed dose equivalent to an organ or tissue by a weighting factor  $W_T$ . This weighting factor is the proportion of the risk of stochastic effects resulting from irradiation of the organ or tissue, T, to the total risk of stochastic effects when the whole body is irradiated uniformly. The values of  $W_T$  are listed under the definition of "weighting factor" in 64E-5.101. The non-stochastic ALIs were derived to avoid non-stochastic effects, such as prompt damage to tissue or reduction in organ function.

A value of  $W_T = 0.06$  is applicable to each of the five organs or tissues in the "remainder" category receiving the highest dose equivalents, and the dose equivalents of all other remaining tissues may be disregarded. The following portions of the GI track --stomach, small intestine, upper large intestine, and lower large intestine -- are to be treated as four separate organs.

Note that the dose equivalents for an extremity, skin and lens of the eye are not considered in computing the committed effective dose equivalent, but are subject to the limits that must be met separately.

When an ALI is defined by the stochastic dose limit, this value alone is given. When an ALI is determined by the non-stochastic dose limit to an organ, the organ or tissue to which the limit applies is shown, and the ALI for the stochastic limit is shown in parenthesis. Abbreviated organ or tissue designations are used:

LLI wall = lower large intestine wall;  
 St. wall = stomach wall;  
 Blad wall = bladder wall; and  
 Bone surf = bone surface.

The use of the ALIs listed first, the more limiting of the stochastic and non-stochastic ALIs, will ensure that non-stochastic effects are avoided and that the risk of stochastic effects is limited to an acceptably low value. If, in a particular situation involving a radionuclide for which the non-stochastic ALI is limiting, use of the non-stochastic ALI is considered unduly conservative, the licensee may use the stochastic ALI to determine the committed effective dose equivalent. However, the licensee shall also ensure that the 50 rem (0.5 sievert) dose equivalent limit for any organ or tissue is not exceeded by the sum of the external deep dose equivalent plus the internal committed dose equivalent to that organ, not the effective dose. For the case where there is no external dose contribution, this would be demonstrated if the sum of the fractions of the non-stochastic ALIs ( $ALI_{ns}$ ) that contributed to the committed dose equivalent to the organ receiving the highest dose does not exceed unity, that is the sum of (intake (in  $\mu\text{Ci}$ ) of each radionuclide/ $ALI_{ns}$ )  $\leq 1.0$ . If there is an external deep dose contribution of  $H_d$ , then this sum must be less than  $1 - (H_d/50)$ , instead of  $\leq 1.0$ .

Note that the dose equivalents for an extremity, skin, and lens of the eye are not considered in computing the committed effective dose equivalent, but are subject to limits that must be met separately.

The derived air concentrations (DAC) values are derived limits intended to control chronic occupational exposures. The relationship between the DAC and the ALI is given by:

$$\begin{aligned} \text{DAC} &= \text{ALI (in } \mu\text{Ci) / (2000 hours per working year} \times 60 \text{ minutes/hour} \\ &\quad \times 2 \times 10^4 \text{ ml per minute)} \\ &= [\text{ALI} / 2.4 \times 10^9] \mu\text{Ci/ml,} \end{aligned}$$

where  $2 \times 10^4$  milliliters is the volume of air breathed per minute at work by Reference Man under working conditions or light work.

The DAC values relate to one of two modes of exposure: either external submersion or the internal committed dose equivalents resulting from inhalation of radioactive materials. DACs based upon submersion are for immersion in a semi-infinite cloud of uniform concentration and apply to each radionuclide separately.

The ALI and DAC values include contributions to exposure by the single radionuclide named and any in-growth of daughter radionuclides produced in the body by decay of the parent. However, intakes that include both the parent and daughter radionuclides should be treated by the general method appropriate for mixtures.

The values of ALI and DAC do not apply when the individual both ingest and inhales a radionuclide, when the individual is exposed to a mixture of radionuclides by either inhalation or ingestion or both, or when the individual is exposed to both internal and external irradiation. See 64E-5.219. When an individual is exposed to radioactive materials which fall under several of the translocation classifications of the same radionuclide, such as, Class D, Class W or Class Y, the exposure may be evaluated as if it were a mixture or different radionuclides.

It should be noted that the classification of a compound as Class D, W, or Y is based on the chemical form of the compound and does not take into account the radiological half-life of different radionuclides. For this reason, values are given for Class D, W, and Y compounds, even for very short-lived radionuclides.

#### **Table II "Effluent Concentrations"**

The columns in Table II captioned "Effluents," "Air" and "Water" are applicable to the assessment and control of dose to the public, particularly in the implementation of the provisions of 64E-5.312. The concentration values given in Columns 1 and 2 of Table II are equivalent to the radionuclide concentrations which, if inhaled or ingested continuously over the course of a year, would produce a total effective dose equivalent of 0.05 rem (0.5 millisievert).

Consideration of non-stochastic limits has not been included in deriving the air and water effluent concentrations limits because non-stochastic effects are presumed not to occur at or below the dose levels established for individual members of the public.

For radionuclides, where the non-stochastic limit was governing in deriving the occupational DAC, the stochastic ALI was used in deriving the corresponding airborne effluent limit in Table II. For this reason, the DAC and airborne effluent limits are not always proportional as they were in 10D-91.429.

The air concentrations values listed in Table II, Column 1 were derived by one of two methods. For those radionuclides for which the stochastic limit is governing, the occupational stochastic inhalation ALI was divided by  $2.4 \times 10^9$ , relating the inhalation ALI to the DAC, as explained above, and then divided by a factor of 300. The factor 300 includes the following components: a factor of 50 to relate to the 5 rem (0.05 sievert) annual occupational dose limit of 0.1 rem limit for members of the public; and a factor of 3 to adjust for the difference in exposure time and the inhalation rate for a worker and that for members of the public; and a factor of 2 to adjust the occupational values, derived for adults, so that they are applicable to other age groups.

For those radionuclides for which submersion, that is external dose, is limiting, the occupational DAC in Table I, Column 3 was divided by 219. The factor 219 is composed of a factor of 50, as described above, and a factor of 4.38 relating occupational exposure for 2,000 hours per year to full-time exposure (8,760 hours per year). Note that an additional factor of 2 for age consideration is not warranted in the submersion case.

The water concentrations were derived by taking the most restrictive occupational stochastic oral ingestion ALI and dividing by  $7.3 \times 10^7$ . The factor of  $7.3 \times 10^7$  (ml) includes the following components: the factor of 50 and 2 described above and a factor of  $7.3 \times 10^5$  (ml) which is the annual water intake of "Reference Man".

Note 2 provides groupings of radionuclides which are applicable to unknown mixtures of radionuclides. These groupings, including occupational inhalation ALIs and DACs, air and water effluent concentrations and releases to sewer, require demonstrating that the most limiting radionuclides in successive classes are absent. The limit for the unknown mixture is defined when the presence of one of the listed radionuclides cannot be definitely excluded as being present either from knowledge of the radionuclide composition of the source or from actual measurements.

#### **Table III "Release to Sewers"**

The monthly average concentrations for release to sanitary sewerage are applicable to the provisions in 64E-5.330. The concentration values were derived by taking the most restrictive occupational stochastic oral ingestion ALI and dividing by  $7.3 \times 10^6$  (ml). The factor of  $7.3 \times 10^6$  (ml) is composed of a factor of  $7.3 \times 10^5$  (ml), the annual water intake by "Reference Man," and a factor of 10, such that the concentrations, if the sewage released by the licensee were the only source of water ingested by a "Reference Man" during a year, would result in a committed effective dose equivalent of 0.5 rem (5 millisievert).



## LIST OF ELEMENTS

Name	Symbol	Atomic Number	Name	Symbol	Atomic Number
Actinium	Ac	89	Mendelevium	Md	101
Aluminum	Al	13	Mercury	Hg	80
Americium	Am	95	Molybdenum	Mo	42
Antimony	Sb	51	Neodymium	Nd	60
Argon	Ar	18	Neptunium	Np	93
Arsenic	As	33	Nickel	Ni	28
Astatine	At	85	Niobium	Nb	41
Barium	Ba	56	Osmium	Os	76
Berkelium	Bk	97	Palladium	Pd	46
Beryllium	Be	4	Phosphorus	P	15
Bismuth	Bi	83	Platinum	Pt	78
Bromine	Br	35	Plutonium	Pu	94
Cadmium	Cd	48	Polonium	Po	84
Calcium	Ca	20	Potassium	K	19
Californium	Cf	98	Praseodymium	Pr	59
Carbon	C	6	Promethium	Pm	61
Cerium	Ce	58	Protactinium	Pa	91
Cesium	Cs	55	Radium	Ra	88
Chlorine	Cl	17	Radon	Rn	86
Chromium	Cr	24	Rhenium	Re	75
Cobalt	Co	27	Rhodium	Rh	45
Copper	Cu	29	Rubidium	Rb	37
Curium	Cm	96	Ruthenium	Ru	44
Dysprosium	Dy	66	Samarium	Sm	62
Einsteinium	Es	99	Scandium	Sc	21
Erbium	Er	68	Selenium	Se	34
Europium	Eu	63	Silicon	Si	14
Fermium	Fm	100	Silver	Ag	47
Fluorine	F	9	Sodium	Na	11
Francium	Fr	87	Strontium	Sr	38
Gadolinium	Gd	64	Sulfur	S	16
Gallium	Ga	31	Tantalum	Ta	73
Germanium	Ge	32	Technetium	Tc	43
Gold	Au	79	Tellurium	Te	52
Hafnium	Hf	72	Terbium	Tb	65
Holmium	Ho	67	Thallium	Tl	81
Hydrogen	H	1	Thorium	Th	90
Indium	In	49	Thulium	Tm	69
Iodine	I	53	Tin	Sn	50
Iridium	Ir	77	Titanium	Ti	22
Iron	Fe	26	Tungsten	W	74
Krypton	Kr	36	Uranium	U	92
Lanthanum	La	57	Vanadium	V	23
Lead	Pb	82	Xenon	Xe	54
Lutetium	Lu	71	Ytterbium	Yb	70
Magnesium	Mg	12	Yttrium	Y	39
Manganese	Mn	25	Zinc	Zn	30
Mendelevium	Md	101	Zirconium	Zr	40

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At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
1	H-3	Water, DAC includes skin absorption	8E+4	8E+4	2E-5	1E-7	1E-3	1E-2
	H-3	Gas (HT or T2) Submersion <sup>1</sup> : Use above values as HT and T2 oxidize in air and in the body to HTO						
1	Be-7	W: all compounds except those given for Y	4E+4	2E+4	9E-6	3E-8	6E-4	6E-3
4	Be-7	Y: oxides, halides, and nitrates	0	2E+4	8E-6	3E-8	0	0
4	Be-10	W: see Be-7	1E+3 LLI wall (1E+3)	2E+2	6E-8	2E-10	0	0
			0	0	0	2E-5	2E-4	
4	Be-10	Y: see Be-7	0	1E+1	6E-9	2E-11	0	0
6	C-11 <sup>2</sup>	Monoxide	0	1E+6	5E-4	2E-6	0	0
6	C-11 <sup>2</sup>	Dioxide	0	6E+5	3E-4	9E-7	0	0
6	C-11 <sup>2</sup>	Compounds	4E+5	4E+5	2E-4	6E-7	6E-3	6E-2
6	C-14	Monoxide	0	2E+6	7E-4	2E-6	0	0
6	C-14	Dioxide	0	2E+5	9E-5	3E-7	0	0
6	C-14	Compounds	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4
9	F-18 <sup>2</sup>	D: fluorides of H, Li, Na, K, Rb, Cs, and Fr	5E+4 St. wall (5E+4)	7E+4	3E-5	1E-7	0	0
			0	0	0	7E-4	7E-3	
9	F-18 <sup>2</sup>	W: fluorides of Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, As, Sb, Bi, Fe, Ru, Os, Co, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, V, Nb, Ta, Mn, Tc, and Re	0	9E+4	4E-5	1E-7	0	0
9	F-18 <sup>2</sup>	Y: lanthanum fluoride	0	8E+4	3E-5	1E-7	0	0
11	Na-22	D: all compounds	4E+2	6E+2	3E-7	9E-10	6E-6	6E-5
11	Na-24	D: all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
12	Mg-28	D: all compounds except those given for W	7E+2	2E+3	7E-7	2E-9	9E-6	9E-5
12	Mg-28	W: oxides, hydroxides, carbides, halides, and nitrates	0	1E+3	5E-7	2E-9	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
13	Al-26	D: all compounds except those given for W	4E+2	6E+1	3E-8	9E-11	6E-6	6E-5
13	Al-26	W: oxides, hydroxides, carbides, halides, and nitrates	0	9E+1	4E-8	1E-10	0	0
14	Si-31	D: all compounds except those given for W, Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
14	Si-31	W: oxides, carbides, hydroxides, and nitrates	0	3E+4	1E-5	5E-8	0	0
14	Si-31	Y: aluminosilicate glass	0	3E+4	1E-5	4E-8	0	0
14	Si-32	D: see Si-31	2E+3 LLI wall (3E+3)	2E+2 0	1E-7 0	3E-10 0	0 4E-5	0 4E-4
14	Si-32	W: see Si-31	0	1E+2	5E-8	2E-10	0	0
14	Si-32	Y: see Si-31	0	5E+0	2E-9	7E-12	0	0
15	P-32	D: all compounds except those given for W	6E+2	9E+2	4E-7	1E-9	9E-6	9E-5
15	P-32	W: phosphates of Zn <sup>2+</sup> , S <sup>3+</sup> , Mg <sup>2+</sup> , Fe <sup>3+</sup> , Bi <sup>3+</sup> , and lanthanides	0	4E+2	2E-7	5E-10	0	0
15	P-33	D: see P-32	6E+3	8E+3	4E-6	1E-8	8E-5	8E-4
15	P-33	W: see P-32	0	3E+3	1E-6	4E-9	0	0
16	S-35	Vapor		1E+4	6E-6	2E-8	0	0
16	S-35	D: sulfides and sulfates except those given for W	1E+4 LLI wall (8E+3)	2E+4 0	7E-6 0	2E-8 0	0 1E-4	0 1E-3
16	S-35	W: elemental sulfur, sulfides of Sr, Ba, Ge, Sn, Pb, As, Sb, Bi, Cu, Ag, Au, Zn, Cd, Hg, W, and Mo. Sulfates of Ca, Sr, Ba, Ra, As, Sb, and Bi	0	2E+3	9E-7	3E-9	0	0
17	Cl-36	D: chlorides of H, Li, Na, K, Rb, Cs, and Fr	2E+3	2E+3	1E-6	3E-9	2E-5	2E-4

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
17	Cl-36	W: chlorides of lanthanides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Mn, Tc, and Re	0	2E+2	1E-7	3E-10	0	0
17	Cl-38 <sup>2</sup>	D: see Cl-36	2E+4 St. wall (3E+4)	4E+4 0	2E-5 0	6E-8 0	0 3E-4	0 3E-3
17	Cl-38 <sup>2</sup>	W: see Cl-36	0	5E+4	2E-5	6E-8	0	0
17	Cl-39 <sup>2</sup>	D: see Cl-36	2E+4 St. wall (4E+4)	5E+4 0	2E-5 0	7E-8 0	0 5E-4	0 5E-3
17	Cl-39 <sup>2</sup>	W: see Cl-36	0	6E+4	2E-5	8E-8	0	0
18	Ar-37	Submersion <sup>1</sup>	0	0	1E+0	6E-3	0	0
18	Ar-39	Submersion <sup>1</sup>	0	0	2E-4	8E-7	0	0
18	Ar-41	Submersion <sup>1</sup>	0	0	3E-6	1E-8	0	0
19	K-40	D: all compounds	3E+2	4E+2	2E-7	6E-10	4E-6	4E-5
19	K-42	D: all compounds	5E+3	5E+3	2E-6	7E-9	6E-5	6E-4
19	K-43	D: all compounds	6E+3	9E+3	4E-6	1E-8	9E-5	9E-4
19	K-44 <sup>2</sup>	D: all compounds	2E+4 St. wall (4E+4)	7E+4 0	3E-5 0	9E-8 0	0 5E-4	0 5E-3
19	K-45 <sup>2</sup>	D: all compounds	3E+4 St. wall (5E+4)	1E+5 0	5E-5 0	2E-7 0	0 7E-4	0 7E-3
20	Ca-41	W: all compounds	3E+3 Bone Surf (4E+3)	4E+3 Bone Surf (4E+3)	2E-6 0	0 5E-9	0 6E-5	0 6E-4
20	Ca-45	W: all compounds	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
20	Ca-47	W: all compounds	8E+2	9E+2	4E-7	1E-9	1E-5	1E-4
20	Sc-43	Y: all compounds	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
21	Sc-44m	Y: all compounds	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
21	Sc-44	Y: all compounds	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
21	Sc-46	Y: all compounds	9E+2	2E+2	1E-7	3E-10	1E-5	1E-4
21	Sc-47	Y: all compounds	2E+3 LLI Wall (3E+3)	3E+3 0	1E-6 0	4E-9 0	0 4E-5	0 4E-4
21	Sc-48	Y: all compounds	8E+2	1E+3	6E-7	2E-9	1E-5	1E-4
21	Sc-49 <sup>2</sup>	Y: all compounds	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
22	Ti-44	D: all compounds except those given for W, Y	3E+2	1E+1	5E-9	2E-11	4E-6	4E-5
22	Ti-44	W: oxides, carbides, halides, nitrates, and hydroxides	0	3E+1	1E-8	4E-11	0	0
22	Ti-44	Y: SrTiO	0	6E+0	2E-9	8E-12	0	0
22	Ti-45	D: see Ti-44	9E+3	3E+4	1E-5	3E-8	1E-4	1E-3
22	Ti-45	W: see Ti-44	0	4E+4	1E-5	5E-8	0	0
22	Ti-45	Y: see Ti-44	0	3E+4	1E-5	4E-8	0	0
23	V-47 <sup>2</sup>	D: all compounds except those given for W	3E+4 St. wall (3E+4)	8E+4 0	3E-5 0	1E-7 0	0 4E-4	0 4E-3
23	V-47	W: oxides, carbides, hydroxides, and halides	0	1E+5	4E-5	1E-7	0	0
23	V-48	D: see V-47	6E+2	1E+3	5E-7	2E-9	9E-6	9E-5
23	V-48	W: see V-47	0	6E+2	3E-7	9E-10	0	0
23	V-49	D: see V-47	7E+4 LLI wall (9E+4)	3E+4 Bone Surf (3E+4)	1E-5 0	0 5E-8	0 1E-3	0 1E-2
23	V-49	W: see V-47	0	2E+4	8E-6	2E-8	0	0
24	Cr-48	D: all compounds except those given for W, Y	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
24	Cr-48	W: halides and nitrates	0	7E+3	3E-6	1E-8	0	0
24	Cr-48	Y: oxides and hydroxides	0	7E+3	3E-6	1E-8	0	0
24	Cr-49 <sup>2</sup>	D: see Cr-48	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
24	Cr-49 <sup>2</sup>	W: see Cr-48	0	1E+5	4E-5	1E-7	0	0
24	Cr-49 <sup>2</sup>	Y: see Cr-48	0	9E+4	4E-5	1E-7	0	0
24	Cr-51	D: see Cr-48	4E+4	5E+4	2E-5	6E-8	5E-4	5E-3
24	Cr-51	W: see Cr-48	0	2E+4	1E-5	3E-8	0	0
24	Cr-51	Y: see Cr-48	0	2E+4	8E-6	3E-8	0	0
25	Mn-51 <sup>2</sup>	D: all compounds except those given for W	2E+4	5E+4	2E-5	7E-8	3E-4	3E-3
25	Mn-51 <sup>2</sup>	W: oxides, halides, hydroxides, and nitrates	0	6E+4	3E-5	8E-8	0	0
25	Mn-52m <sup>2</sup>	D: see Mn-51	3E+4 St. wall (4E+4)	9E+4 0	4E-5 0	1E-7 0	0 5E-4	0 5E-3
25	Mn-52m <sup>2</sup>	W: see Mn-51	0	1E+5	4E-5	1E-7	0	0
25	Mn-52	D: see Mn-51	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
25	Mn-52	W: see Mn-51	0	9E+2	4E-7	1E-9	0	0
25	Mn-53	D: see Mn-51	5E+4	1E+4	5E-6	0	7E-4	7E-3
			0	Bone Surf (2E+4)	0	3E-8	0	0
25	Mn-53	W: see Mn-51	0	1E+4	5E-6	2E-8	0	0
25	Mn-54	D: see Mn-51	2E+3	9E+2	4E-7	1E-9	3E-5	3E-4
25	Mn-54	W: see Mn-51	0	8E+2	3E-7	1E-9	0	0
25	Mn-56	D: see Mn-51	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
25	Mn-56	W: see Mn-51	0	2E+4	9E-6	3E-8	0	0
26	Fe-52	D: all compounds except those given for W	9E+2	3E+3	1E-6	4E-9	1E-5	1E-4
26	Fe-52	W: oxides, halides, and hydroxides	0	2E+3	1E-6	3E-9	0	0
26	Fe-55	D: see Fe-52	9E+3	2E+3	8E-7	3E-9	1E-4	1E-3
26	Fe-55	W: see Fe-52	0	4E+3	2E-6	6E-9	0	0
26	Fe-59	D: see Fe-52	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
26	Fe-59	W: see Fe-52	0	5E+2	2E-7	7E-10	0	0
26	Fe-60	D: see Fe-52	3E+1	6E+0	3E-9	9E-12	4E-7	4E-6
26	Fe-60	W: see Fe-52	0	2E+1	8E-9	3E-11	0	0
27	Co-55	W: all compounds except those given for Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
27	Co-55	Y: oxides, halides, hydroxides, and nitrates	0	3E+3	1E-6	4E-9	0	0
27	Co-56	W: see Co-55	5E+2	3E+2	1E-7	4E-10	6E-6	6E-5
27	Co-56	Y: see Co-55	4E+2	2E+2	8E-8	3E-10	0	0
27	Co-57	W: see Co-55	8E+3	3E+3	1E-6	4E-9	6E-5	6E-4
27	Co-57	Y: see Co-55	4E+3	7E+2	3E-7	9E-10	0	0
27	Co-58m	W: see Co-55	6E+4	9E+4	4E-5	1E-7	8E-4	8E-3
27	Co-58m	Y: see Co-55	0	6E+4	3E-5	9E-8	0	0
27	Co-58	W: see Co-55	2E+3	1E+3	5E-7	2E-9	2E-5	2E-4
27	Co-58	Y: see Co-55	1E+3	7E+2	3E-7	1E-9	0	0
27	Co-60m <sup>2</sup>	W: see Co-55	1E+6	4E+6	2E-3	6E-6	0	0
			St. wall (1E+6)	0	0	0	2E-2	2E-1
27	Co-60m <sup>2</sup>	Y: see Co-55	0	3E+6	1E-3	4E-6	0	0
27	Co-60	W: see Co-55	5E+2	2E+2	7E-8	2E-10	3E-6	3E-5
27	Co-60	Y: see Co-55	2E+2	3E+1	1E-8	5E-11	0	0
27	Co-61 <sup>2</sup>	W: see Co-55	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
27	Co-61 <sup>2</sup>	Y: see Co-55	2E+4	6E+4	2E-5	8E-8	0	0
27	Co-62m <sup>2</sup>	W: see Co-55	4E+4	2E+5	7E-5	2E-7	0	0
			St. wall (5E+4)	0	0	0	7E-4	7E-3
27	Co-62m <sup>2</sup>	Y: see Co-55	0	2E+5	6E-5	2E-7	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
28	Ni-56	D: all compounds except those given for W	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
28	Ni-56	W: oxides, carbides, and hydroxides	0	1E+3	5E-7	2E-9	0	0
28	Ni-56	Vapor	0	1E+3	5E-7	2E-9	0	0
28	Ni-57	D: see Ni-56	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4
28	Ni-57	W: see Ni-56	0	3E+3	1E-6	4E-9	0	0
28	Ni-57	Vapor	0	6E+3	3E-6	9E-9	0	0
28	Ni-59	D: see Ni-56	2E+4	4E+3	2E-6	5E-9	3E-4	3E-3
28	Ni-59	W: see Ni-56	0	7E+3	3E-6	1E-8	0	0
28	Ni-59	Vapor	0	2E+3	8E-7	3E-9	0	0
28	Ni-63	D: see Ni-56	9E+3	2E+3	7E-7	2E-9	1E-4	1E-3
28	Ni-63	W: see Ni-56	0	3E+3	1E-6	4E-9	0	0
28	Ni-63	Vapor	0	8E+2	3E-7	1E-9	0	0
28	Ni-65	D: see Ni-56	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
28	Ni-65	W: see Ni-56	0	3E+4	1E-5	4E-8	0	0
28	Ni-65	Vapor	0	2E+4	7E-6	2E-8	0	0
28	Ni-66	D: see Ni-56	4E+2 LLI wall (5E+2)	2E+3	7E-7	2E-9	0	0
28	Ni-66	W: see Ni-56	0	6E+2	3E-7	9E-10	0	0
28	Ni-66	Vapor	0	3E+3	1E-6	4E-9	0	0
29	Cu-60 <sup>2</sup>	D: all compounds except those given for W, Y	3E+4 St. wall (3E+4)	9E+4	4E-5	1E-7	0	0
29	Cu-60 <sup>2</sup>	W: sulfides, halides, and nitrates	0	1E+5	5E-5	2E-7	0	0
29	Cu-60 <sup>2</sup>	Y: oxides and hydroxides	0	1E+5	4E-5	1E-7	0	0
29	Cu-61	D: see Cu-60	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
29	Cu-61	W: see Cu-60	0	4E+4	2E-5	6E-8	0	0
29	Cu-61	Y: see Cu-60	0	4E+4	1E-5	5E-8	0	0
29	Cu-64	D: see Cu-60	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
29	Cu-64	W: see Cu-60	0	2E+4	1E-5	3E-8	0	0
29	Cu-64	Y: see Cu-60	0	2E+4	9E-6	3E-8	0	0
29	Cu-67	D: see Cu-60	5E+3	8E+3	3E-6	1E-8	6E-5	6E-4
29	Cu-67	W: see Cu-60	0	5E+3	2E-6	7E-9	0	0
29	Cu-67	Y: see Cu-60	0	5E+3	2E-6	6E-9	0	0
30	Zn-62	Y: all compounds	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
30	Zn-63 <sup>2</sup>	Y: all compounds	2E+4 St. wall (3E+4)	7E+4	3E-5	9E-8	0	0
30	Zn-65	Y: all compounds	4E+2	3E+2	1E-7	4E-10	5E-6	5E-5
30	Zn-69m	Y: all compounds	4E+3	7E+3	3E-6	1E-8	6E-5	6E-4



At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
30	Zn-69 <sup>2</sup>	Y: all compounds	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
30	Zn-71m	Y: all compounds	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
30	Zn-72	Y: all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
31	Ga-65 <sup>2</sup>	D: all compounds except those given for W	5E+4 St. wall (6E+4)	2E+5 0	7E-5 0	2E-7 0	0 9E-4	0 9E-3
31	Ga-65 <sup>2</sup>	W: oxides, carbides, halides, nitrates, and hydroxides	0	2E+5	8E-5	3E-7	0	0
31	Ga-66	D: see Ga-65	1E+3	4E+3	1E-6	5E-9	1E-4	1E-3
31	Ga-66	W: see Ga-65	0	3E+3	1E-6	4E-9	0	0
31	Ga-67	D: see Ga-65	7E+3	1E+4	6E-6	2E-8	2E-4	2E-3
31	Ga-67	W: see Ga-65	0	1E+4	4E-6	1E-8	0	0
31	Ga-68 <sup>2</sup>	D: see Ga-65	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
31	Ga-68 <sup>2</sup>	W: see Ga-65	0	5E+4	2E-5	7E-8	0	0
31	Ga-70 <sup>2</sup>	D: see Ga-65	5E+4 St. wall (7E+4)	2E+5 0	7E-5 0	2E-7 0	0 1E-3	0 1E-2
31	Ga-70 <sup>2</sup>	W: see Ga-65	0	2E+5	8E-5	3E-7	0	0
31	Ga-72	D: see Ga-65	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
31	Ga-72	W: see Ga-65	0	3E+3	1E-6	4E-9	0	0
31	Ga-73	D: see Ga-65	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
31	Ga-73	W: see Ga-65	0	2E+4	6E-6	2E-8	0	0
32	Ge-66	D: all compounds except those given for W	2E+4	3E+4	1E-5	4E-8	3E-4	3E-3
32	Ge-66	W: oxides, sulfides, and halides	0	2E+4	8E-6	3E-8	0	0
32	Ge-67 <sup>2</sup>	D: see Ge-66	4E+4 St. wall (3E+4)	9E+4 0	4E-5 0	1E-7 0	0 6E-4	0 6E-3
32	Ge-67 <sup>2</sup>	W: see Ge-66	0	1E+5	4E-5	1E-7	0	0
32	Ge-68	D: see Ge-66	5E+3	4E+3	2E-6	5E-9	6E-5	6E-4
32	Ge-68	W: see Ge-66	0	1E+2	4E-8	1E-10	0	0
32	Ge-69	D: see Ge-66	1E+4	2E+4	6E-6	2E-8	2E-4	2E-3
32	Ge-69	W: see Ge-66	0	8E+3	3E-6	1E-8	0	0
32	Ge-71	D: see Ge-66	5E+5	4E+5	2E-4	6E-7	7E-3	7E-2
32	Ge-71	W: see Ge-66	0	4E+4	2E-5	6E-8	0	0
32	Ge-75 <sup>2</sup>	D: see Ge-66	4E+4 St. wall (7E+4)	8E+4 0	3E-5 0	1E-7 0	0 9E-4	0 9E-3
32	Ge-75 <sup>2</sup>	W: see Ge-66	0	8E+4	4E-5	1E-7	0	0
32	Ge-77	D: see Ge-66	9E+3	1E+4	4E-6	1E-8	1E-4	1E-3
32	Ge-77	W: see Ge-66	0	6E+3	2E-6	8E-9	0	0
32	Ge-78 <sup>2</sup>	D: see Ge-66	2E+4	2E+4	9E-6	3E-8	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
			St. Wall (2E+4)	0	0	0	3E-4	3E-3
32	Ge-78 <sup>2</sup>	W: see Ge-66	0	2E+4	9E-6	3E-8	0	0
33	As-69 <sup>2</sup>	W: all compounds	3E+4 St. Wall (4E.04)	1E+5	5E-5	2E-7	0	0
33	As-70 <sup>2</sup>	W: all compounds	1E+4	5E+4	2E-5	7E-8	2E-4	2E-3
33	As-71	W: all compounds	4E+3	5E+3	2E-6	6E-9	5E-5	5E-4
33	As-72	W: all compounds	9E+2	1E+3	6E-7	2E-9	1E-5	1E-4
33	As-73	W: all compounds	8E+3	2E+3	7E-7	2E-9	1E-4	1E-3
33	As-74	W: all compounds	1E+3	8E+2	3E-7	1E-9	2E-5	2E-4
33	As-76	W: all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
33	As-77	W: all compounds	4E+3 LLI wall (5E+3)	5E+3	2E-6	7E-9	0	0
33	As-78 <sup>2</sup>	W: all compounds	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
34	Se-70 <sup>2</sup>	D: all compounds except those given for W	2E+4	4E+4	2E-5	5E-8	1E-4	1E-3
34	Se-70 <sup>2</sup>	W: oxides, carbides, hydroxides, and elemental Se	1E+4	4E+4	2E-5	6E-8	0	0
34	Se-73m <sup>2</sup>	D: see Se-70	6E+4	2E+5	6E-5	2E-7	4E-4	4E-3
34	Se-73m <sup>2</sup>	W: see Se-70	3E+4	1E+5	6E-5	2E-7	0	0
34	Se-73	D: see Se-70	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
34	Se-73	W: see Se-70	0	2E+4	7E-6	2E-8	0	0
34	Se-75	D: see Se-70	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
34	Se-75	W: see Se-70	0	6E+2	3E-7	8E-10	0	0
34	Se-79	D: see Se-70	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
34	Se-79	W: see Se-70	0	6E+2	2E-7	8E-10	0	0
34	Se-81m <sup>2</sup>	D: see Se-70	4E+4	7E+4	3E-5	9E-8	3E-4	3E-3
34	Se-81m <sup>2</sup>	W: see Se-70	2E+4	7E+4	3E-5	1E-7	0	0
34	Se-81 <sup>2</sup>	D: see Se-70	6E+4 St. wall (8E+4)	2E+5	9E-5	3E-7	0	0
34	Se-81 <sup>2</sup>	W: see Se-70	0	2E+5	1E-4	3E-7	1E-3	1E-2
34	Se-83 <sup>2</sup>	D: see Se-70	4E+4	1E+5	5E-5	2E-7	4E-4	4E-3
34	Se-83 <sup>2</sup>	W: see Se-70	3E+4	1E+5	5E-5	2E-7	0	0
35	Br-74m <sup>2</sup>	D: bromides of H, Li, Na, K, Rb, Cs, and Fr	1E+4 St. Wall (2E+4)	4E+4	2E-5	5E-8	0	0
			0	0	0	0	3E-4	3E-3

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
35	Br-74m <sup>2</sup>	W: bromides of lanthanides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Mn, Tc, and Re	0	4E+4	2E-5	6E-8	0	0
35	Br-74 <sup>2</sup>	D: see Br-74m	2E+4 St. wall (4E+4)	7E+4 0	3E-5 0	1E-7 0	0 5E-4	0 5E-3
35	Br-74 <sup>2</sup>	W: see Br-74m	0	8E+4	4E-5	1E-7	0	0
35	Br-75 <sup>2</sup>	D: see Br-74m	3E+4 St. wall (4E+4)	5E+4 0	2E-5 0	7E-8 0	0 5E-4	0 5E-3
35	Br-75 <sup>2</sup>	W: see Br-74m	0	5E+4	2E-5	7E-8	0	0
35	Br-76	D: see Br-74m	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
35	Br-76	W: see Br-74m	0	4E+3	2E-6	6E-9	0	0
35	Br-77	D: see Br-74m	2E+4	2E+4	1E-5	3E-8	2E-4	2E-3
35	Br-77	W: see Br-74m	0	2E+4	8E-6	3E-8	0	0
35	Br-80m	D: see Br-74m	2E+4	2E+4	7E-6	2E-8	3E-4	3E-3
35	Br-80m	W: see Br-74m	0	1E+4	6E-6	2E-8	0	0
35	Br-80 <sup>2</sup>	D: see Br-74m	5E+4 St. wall (9E+4)	2E+5 0	8E-5 0	3E-7 0	0 1E-3	0 1E-2
35	Br-80 <sup>2</sup>	W: see Br-74m	0	2E+5	9E-5	3E-7	0	0
35	Br-82	D: see Br-74m	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
35	Br-82	W: see Br-74m	0	4E+3	2E-6	5E-9	0	0
35	Br-83	D: see Br-74m	5E+4 St. wall (7E+4)	6E+4 0	3E-5 0	9E-8 0	0 9E-4	0 9E-3
35	Br-83	W: see Br-74m	0	6E+4	3E-5	9E-8	0	0
35	Br-84 <sup>2</sup>	D: see Br-74m	2E+4 St. wall (3E+4)	6E+4 0	2E-5 0	8E-8 0	0 4E-4	0 4E-3
35	Br-84 <sup>2</sup>	W: see Br-74m	0	6E+4	3E-5	9E-8	0	0
36	Kr-74 <sup>2</sup>	Submersion <sup>1</sup>	0	0	3E-6	1E-8	0	0
36	Kr-76	Submersion <sup>1</sup>	0	0	9E-6	4E-8	0	0
36	Kr-77 <sup>2</sup>	Submersion <sup>1</sup>	0	0	4E-6	2E-8	0	0
36	Kr-79	Submersion <sup>1</sup>	0	0	2E-5	7E-8	0	0
36	Kr-81	Submersion <sup>1</sup>	0	0	7E-4	3E-6	0	0
36	Kr-83m <sup>2</sup>	Submersion <sup>1</sup>	0	0	1E-2	5E-5	0	0
36	Kr-85m	Submersion <sup>1</sup>	0	0	2E-5	1E-7	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI ( $\mu$ Ci)	COL. 2 Inhalation ALI ( $\mu$ Ci)	COL. 3 Inhalation DAC ( $\mu$ Ci/ml)	COL. 1 Air ( $\mu$ Ci/ml)	COL. 2 Water ( $\mu$ Ci/ml)	Monthly Average Concentration ( $\mu$ Ci/ml)
36	Kr-85	Submersion <sup>1</sup>	0	0	1E-4	7E-7	0	0
36	Kr-87	Submersion <sup>1</sup>	0	0	5E-6	2E-8	0	0
36	Kr-88	Submersion <sup>1</sup>	0	0	2E-6	9E-9	0	0
37	Rb-79 <sup>2</sup>	D: all compounds	4E+4	1E+5	5E-5	2E-7	0	0
			St. wall (6E+4)	0	0	0	8E-4	8E-3
37	Rb-81m <sup>2</sup>	D: all compounds	2E+5	3E+5	1E-4	5E-7	0	0
			St. wall (3E+5)	0	0	0	4E-3	4E-2
37	Rb-81	D: all compounds	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
37	Rb-82m	D: all compounds	1E+4	2E+4	7E-6	2E-8	2E-4	2E-3
37	Rb-83	D: all compounds	6E+2	1E+3	4E-7	1E-9	9E-6	9E-5
37	Rb-84	D: all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rb-86	D: all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rb-87	D: all compounds	1E+3	2E+3	6E-7	2E-9	1E-5	1E-4
37	Rb-88 <sup>2</sup>	D: all compounds	2E+4	6E+4	3E-5	9E-8	0	0
			St. wall (3E+4)	0	0	0	4E-4	4E-3
37	Rb-89 <sup>2</sup>	D: all compounds	4E+4	1E+5	6E-5	2E-7	0	0
			St. wall (6E+4)	0	0	0	9E-4	9E-3
38	Sr-80 <sup>2</sup>	D: all soluble compounds except SrTiO	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
38	Sr-80 <sup>2</sup>	Y: all insoluble compounds and SrTiO	0	1E+4	5E-6	2E-8	0	0
38	Sr-81 <sup>2</sup>	D: see Sr-80	3E+4	8E+4	3E-5		3E-4	3E-3
38	Sr-81 <sup>2</sup>	Y: see Sr-80	2E+4	8E+4	3E-5		0	0
38	Sr-82	D: see Sr-80	3E+2	4E+2	2E-7	6E-10	0	0
			LLI wall (2E+2)	0	0	0	3E-6	3E-5
38	Sr-82	Y: see Sr-80	2E+2	9E+1	4E-8	1E-8	0	0
38	Sr-83	D: see Sr-80	3E+3	7E+3	3E-6	5E-9	3E-5	3E-4
38	Sr-83	Y: see Sr-80	2E+3	4E+3	1E-6	5E-9	0	0
38	Sr-85m <sup>2</sup>	D: see Sr-80	2E+5	6E+5	3E-4	9E-7	3E-3	3E-2
38	Sr-85m <sup>2</sup>	Y: see Sr-80	0	8E+5	4E-4	1E-6	0	0
38	Sr-85	D: see Sr-80	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
38	Sr-85	Y: see Sr-80	0	2E+3	6E-7	2E-9	0	0
38	Sr-87m	D: see Sr-80	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
38	Sr-87m	Y: see Sr-80	4E+4	2E+5	6E-5	2E-7	0	0
38	Sr-89	D: see Sr-80	6E+2	8E+2	4E-7	1E-9	0	0
			LLI wall (6E+2)	0	0	0	8E-6	5E-5
38	Sr-89	Y: see Sr-80	5E+2	1E+2	6E-8	2E-10	0	0
38	Sr-90	D: see Sr-80	3E+1	2E+1	8E-9	0	0	0
			Bone surf	Bone Surf				

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
			(4E+1)	(2E+1)	0	3E-11	5E-7	5E-6
38	Sr-90	Y: see Sr-80	0	4E+0	2E-9	6E-12	0	0
38	Sr-91	D: see Sr-80	2E+3	6E+3	2E-6	8E-9	2E-5	2E-4
38	Sr-91	Y: see Sr-80	0	4E+3	1E-6	5E-9	0	0
38	Sr-92	D: see Sr-80	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
38	Sr-92	Y: see Sr-80	0	7E+3	3E-6	9E-9	0	0
39	Y-86m <sup>2</sup>	W: all compounds except those given for Y	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
39	Y-86m <sup>2</sup>	Y: oxides and hydroxides	0	5E+4	2E-5	8E-8	0	0
39	Y-86	W: see Y-86m	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
39	Y-86	Y: see Y-86m	0	3E+3	1E-6	5E-9	0	0
39	Y-87	W: see Y-86m	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
39	Y-87	Y: see Y-86m	0	3E+3	1E-6	5E-9	0	0
39	Y-88	W: see Y-86m	1E+3	3E+2	1E-7	3E-10	1E-5	1E-4
39	Y-88	Y: see Y-86m	0	2E+2	1E-7	3E-10	0	0
39	Y-90m	W: see Y-86m	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
39	Y-90m	Y: see Y-86m	0	1E+4	5E-6	2E-8	0	0
39	Y-90	W: see Y-86m	4E+2 LLI wall (5E+2)	7E+2	3E-7	9E-10	0	0
			0	0	0	0	7E-6	7E-5
39	Y-90	Y: see Y-86m	0	6E+2	3E-7	9E-10	0	0
39	Y-91m <sup>2</sup>	W: see Y-86m	1E+5	2E+5	1E-4	3E-7	2E-3	2E-2
39	Y-91m <sup>2</sup>	Y: see Y-86m	0	2E+5	7E-5	2E-7	0	0
39	Y-91	W: see Y-86m	5E+2 LLI wall (6E+2)	2E+2	7E-8	2E-10	0	0
			0	0	0	0	8E-6	8E-5
39	Y-91	Y: see Y-86m	0	1E+2	5E-8	2E-10	0	0
39	Y-92	W: see Y-86m	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
39	Y-92	Y: see Y-86m	0	8E+3	3E-6	1E-8	0	0
39	Y-93	W: see Y-86m	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
39	Y-93	Y: see Y-86m	0	2E+3	1E-6	3E-9	0	0
39	Y-94 <sup>2</sup>	W: see Y-86m	2E+4 St. wall (3E+4)	8E+4	3E-5	1E-7	0	0
			0	0	0	0	4E-4	4E-3
39	Y-94 <sup>2</sup>	Y: see Y-86m	0	8E+4	3E-5	1E-7	0	0
39	Y-95 <sup>2</sup>	W: see Y-86m	4E+4 St. wall (5E+4)	2E+5	6E-6	2E-7	0	0
			0	0	0	0	7E-4	7E-3
39	Y-95 <sup>2</sup>	Y: see Y-86m	0	1E+5	6E-5	2E-7	0	0
40	Zr-86	D: all compounds except those given for W, Y	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
40	Zr-86	W: oxides, halides, nitrates, and	0	3E+3	1E-6	4E-9	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
		hydroxides						
40	Zr-86	Y: carbide	0	2E+3	1E-6	3E-9	0	0
40	Zr-88	D: see Zr-86	4E+3	2E+2	9E-8	3E-10	5E-5	5E-4
40	Zr-88	W: see Zr-86	0	5E+2	2E-7	7E-10	0	0
40	Zr-88	Y: see Zr-86	0	3E+2	1E-7	4E-10	0	0
40	Zr-89	D: see Zr-86	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
40	Zr-89	W: see Zr-86	0	2E+3	1E-6	5E-9	0	0
40	Zr-89	Y: see Zr-86	0	2E+3	1E-6	3E-9	0	0
40	Zr-93	D: see Zr-86	1E+3 Bone surf (3E+3)	6E+0 Bone Surf (2E+1)	3E-9 0	0 2E-11	0 4E-5	0 4E-4
40	Zr-93	W: see Zr-86	0	2E+1 Bone Surf (6E+1)	1E-8 0	0 9E-11	0 0	0 0
40	Zr-93	Y: see Zr-86	0	6E+1 Bone Surf (7E+1)	2E-8 0	0 9E-11	0 0	0 0
40	Zr-95	D: see Zr-86	1E+3 0	1E+2 Bone Surf (3E+2)	5E-8 0	0 4E-10	2E-5 0	2E-4 0
40	Zr-95	W: see Zr-86	0	4E+2	2E-7	5E-10	0	0
40	Zr-95	Y: see Zr-86	0	3E+2	1E-7	4E-10	0	0
40	Zr-97	D: see Zr-86	6E+2	2E+3	8E-7	3E-9	9E-6	9E-5
40	Zr-97	W: see Zr-86	0	1E+3	6E-7	2E-9	0	0
40	Zr-97	Y: see Zr-86	0	1E+3	5E-7	2E-9	0	0
41	Nb-88 <sup>2</sup>	W: all compounds except those given for Y	5E+4 St. wall (7E+4)	2E+5 0	9E-5 0	3E-7 0	0 1E-3	0 1E-2
41	Nb-88 <sup>2</sup>	Y: oxides and hydroxides	0	2E+5	9E-5	3E-7	0	0
41	Nb-89 <sup>2</sup> (66 m)	W: see Nb-88	1E+4	4E+4	2E-5	6E-8	1E-3	1E-2
41	Nb-89 <sup>2</sup> (66 m)	Y: see Nb-88	0	4E+4	2E-5	5E-8	0	0
41	Nb-89 (122 m)	W: see Nb-88	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
41	Nb-89 (122 m)	Y: see Nb-88	0	2E+4	6E-6	2E-8	0	0
41	Nb-90	W: see Nb-88	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
41	Nb-90	Y: see Nb-88	0	2E+3	1E-6	3E-9	0	0
41	Nb-93m	W: see Nb-88	9E+3 LLI wall (1E+1)	2E+3 0	8E-7 0	3E-9 0	0 2E-4	0 2E-3
41	Nb-93m	Y: see Nb-88	0	2E+2	7E-8	2E-10	0	0
41	Nb-94	W: see Nb-88	9E+2	2E+2	8E-8	3E-10	1E-5	1E-4
41	Nb-94	Y: see Nb-88	0	2E+1	6E-9	2E-11	0	0
41	Nb-95m	W: see Nb-88	2E+3 LLI wall (2E+3)	3E+3 0	1E-6 0	4E-9 0	0 3E-5	0 3E-4

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
41	Nb-95m	Y: see Nb-88	0	2E+3	9E-7	3E-9	0	0
41	Nb-95	W: see Nb-88	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
41	Nb-95	Y: see Nb-88	0	1E+3	5E-7	2E-9	0	0
41	Nb-96	W: see Nb-88	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
41	Nb-96	Y: see Nb-88	0	2E+3	1E-6	3E-9	0	0
41	Nb-97 <sup>2</sup>	W: see Nb-88	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
41	Nb-97 <sup>2</sup>	Y: see Nb-88	0	7E+4	3E-5	1E-7	0	0
41	Nb-98 <sup>2</sup>	W: see Nb-88	1E+4	5E+4	2E-5	8E-8	2E-4	2E-3
41	Nb-98 <sup>2</sup>	Y: see Nb-88	0	5E+4	2E-5	7E-8	0	0
42	Mo-90	D: all compounds except those given for Y	4E+3	7E+3	3E-6	1E-8	3E-5	3E-4
42	Mo-90	Y: oxides, MoS, and hydroxides	2E+3	5E+3	2E-6	6E-9	0	0
42	Mo-93m	D: see Mo-90	9E+3	2E+4	7E-6	2E-8	6E-5	6E-4
42	Mo-93m	Y: see Mo-90	4E+3	1E+4	6E-6	2E-8	0	0
42	Mo-93	D: see Mo-90	4E+3	5E+3	2E-6	2E-9	5E-5	5E-4
424 2	Mo-93	Y: see Mo-90	2E+4	2E+2	8E-8	2E-10	0	0
42	Mo-99	D: see Mo-90	2E+3 LLI wall (1E+3)	3E+3 0	1E-6 0	4E-9 0	0 2E-5	0 2E-4
42	Mo-99	Y: see Mo-90	1E+3	1E+3	6E-7	2E-9	0	0
42	Mo-101 <sup>2</sup>	D: see Mo-90	4E+4 St. wall (5E+4)	1E+5 0	6E-5 0	2E-7 0	0 7E-4	0 7E-3
42	Mo-101 <sup>2</sup>	Y: see Mo-90	0	1E+5	6E-5	2E-7	0	0
43	Tc-93m <sup>2</sup>	D: all compounds except those given for W	7E+4	2E+5	6E-5	2E-7	1E-3	1E-2
43	Tc-93m <sup>2</sup>	W: oxides, halides, hydroxides, and nitrates	0	3E+5	1E-4	4E-7	0	0
43	Tc-93	D: see Tc-93m	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
43	Tc-93	W: see Tc-93m	0	1E+5	4E-5	1E-7	0	0
43	Tc-94m <sup>2</sup>	D: see Tc-93m	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
43	Tc-94m <sup>2</sup>	W: see Tc-93m	0	6E+4	2E-5	8E-8	0	0
43	Tc-94	D: see Tc-93m	9E+3	2E+4	8E-6	3E-8	1E-4	1E-3
43	Tc-94	W: see Tc-93m	0	2E+4	1E-5	3E-8	0	0
43	Tc-95m	D: see Tc-93m	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4
43	Tc-95m	W: see Tc-93m	0	2E+3	8E-7	3E-9	0	0
43	Tc-95	D: see Tc-93m	1E+4	2E+4	9E-6	3E-8	1E-4	1E-3
43	Tc-95	W: see Tc-93m	0	2E+4	8E-6	3E-8	0	0
43	Tc-96m <sup>2</sup>	D: see Tc-93m	2E+5	3E+5	1E-4	4E-7	2E-3	2E-2
43	Tc-96m <sup>2</sup>	W: see Tc-93m	0	2E+5	1E-4	3E-7	0	0
43	Tc-96	D: see Tc-93m	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
43	Tc-96	W: see Tc-93m	0	2E+3	9E-7	5E-9	0	0
43	Tc-97m	D: see Tc-93m	5E+3	7E+3	3E-6	0	6E-5	6E-4
			0	St wall (7E+3)	0	1E-8	0	0
43	Tc-97m	W: see Tc-93m	0	1E+3	5E-7	2E-9	0	0
43	Tc-97	D: see Tc-93m	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
43	Tc-97	W: see Tc-93m	0	6E+3	2E-6	8E-9	0	0
43	Tc-98	D: see Tc-93m	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
43	Tc-98	W: see Tc-93m	0	3E+2	1E-7	4E-10	0	0
43	Tc-99m	D: see Tc-93m	8E+4	2E+5	6E-5	2E-7	1E-3	1E-2
43	Tc-99m	W: see Tc-93m	0	2E+5	1E-4	3E-7	0	0
43	Tc-99	D: see Tc-93m	4E+3	5E+3	2E-6	0	6E-5	6E-4
			0	St wall (6E+3)	0	8E-9	0	0
43	Tc-99	W: see Tc-93m	0	7E+2	3E-7	9E-10	0	0
43	Tc-101 <sup>2</sup>	D: see Tc-93m	9E+4	3E+5	1E-4	5E-7	0	0
			St. wall (1E+5)	0	0	0	2E-3	2E-2
43	Tc-101 <sup>2</sup>	W: see Tc-93m	0	4E+5	2E-4	5E-7	0	0
43	Tc-104 <sup>2</sup>	D: see Tc-93m	2E+4	7E+4	3E-5	1E-7	0	0
			St. wall (3E+4)	0	0	0	4E-4	4E-3
43	Tc-104 <sup>2</sup>	W: see Tc-93m	0	9E+4	4E-5	1E-7	0	0
44	Ru-94 <sup>2</sup>	D: all compounds except those given for W, Y	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
44	Ru-94 <sup>2</sup>	W: halides	0	6E+4	3E-5	9E-8	0	0
44	Ru-94 <sup>2</sup>	Y: oxides and hydroxides	0	6E+4	2E-5	8E-8	0	0
44	Ru-97	D: see Ru-94	8E+3	2E+4	8E-6	3E-8	1E-4	1E-3
44	Ru-97	W: see Ru-94	0	1E+4	5E-6	2E-8	0	0
44	Ru-97	Y: see Ru-94	0	1E+4	5E-6	2E-8	0	0
44	Ru-103	D: see Ru-94	2E+3	2E+3	7E-7	2E-9	3E-5	3E-4
44	Ru-103	W: see Ru-94	0	1E+3	4E-7	1E-9	0	0
44	Ru-103	Y: see Ru-94	0	6E+2	3E-7	9E-10	0	0
44	Ru-105	D: see Ru-94	5E+3	1E+4	6E-6	2E-8	7E-5	7E-4
44	Ru-105	W: see Ru-94	0	1E+4	6E-6	2E-8	0	0
44	Ru-105	Y: see Ru-94	0	1E+4	5E-6	2E-8	0	0
44	Ru-106	D: see Ru-94	2E+2	9E+1	4E-8	1E-10	0	0
			LLI wall (2E+2)	0	0	0	3E-6	3E-5
44	Ru-106	W: see Ru-94	0	5E+1	2E-8	8E-11	0	0
44	Ru-106	Y: see Ru-94	0	1E+1	5E-9	2E-11	0	0
44	Rh-99m	D: all compounds except those given for W, Y	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3



At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
45	Rh-99m	W: halides	0	8E+4	3E-5	1E-7	0	0
	Rh-99m	Y: oxides and hydroxides	0	7E+4	3E-5	9E-8	0	0
45	Rh-99	D: see Rh-99m	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
45	Rh-99	W: see Rh-99m	0	2E+3	9E-7	3E-9	0	0
45	Rh-99	Y: see Rh-99m	0	2E+3	8E-7	3E-9	0	0
45	Rh-100	D: see Rh-99m	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4
45	Rh-100	W: see Rh-99m	0	4E+3	2E-6	6E-9	0	0
45	Rh-100	Y: see Rh-99m	0	4E+3	2E-6	5E-9	0	0
45	Rh-101m	D: see Rh-99m	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
45	Rh-101m	W: see Rh-99m	0	8E+3	4E-6	1E-8	0	0
45	Rh-101m	Y: see Rh-99m	0	8E+3	3E-6	1E-8	0	0
45	Rh-101	D: see Rh-99m	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
45	Rh-101	W: see Rh-99m	0	8E+2	3E-7	1E-9	0	0
45	Rh-101	Y: see Rh-99m	0	2E+2	6E-8	2E-10	0	0
45	Rh-102m	D: see Rh-99m	1E+3 LLI wall (1E+3)	5E+2	2E-7	7E-10	0	0
			0	0	0	0	2E-5	2E-4
45	Rh-102m	W: see Rh-99m	0	4E+2	2E-7	5E-10	0	0
45	Rh-102m	Y: see Rh-99m	0	1E+2	5E-8	5E-10	0	0
45	Rh-102	D: see Rh-99m	6E+2	9E+1	4E-8	1E-10	8E-6	8E-5
45	Rh-102	W: see Rh-99m	0	2E+2	7E-8	2E-10	0	0
45	Rh-102	Y: see Rh-99m	0	6E+1	2E-8	8E-11	0	0
45	Rh-103m <sup>2</sup>	D: see Rh-99m	4E+5	1E+6	5E-4	2E-6	6E-6	6E-5
45	Rh-103m <sup>2</sup>	W: see Rh-99m	0	1E+6	5E-4	2E-6	0	0
45	Rh-103m <sup>2</sup>	Y: see Rh-99m	0	1E+6	5E-4	2E-6	0	0
45	Rh-105	D: see Rh-99m	4E+3 LLI wall (4E+3)	1E+4	5E-6	2E-8	0	0
			0	0	0	0	5E-5	5E-4
45	Rh-105	W: see Rh-99m	0	6E+3	3E-6	9E-9	0	0
45	Rh-105	Y: see Rh-99m	0	6E+3	2E-6	8E-9	0	0
45	Rh-106m	D: see Rh-99m	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
45	Rh-106m	W: see Rh-99m	0	4E+4	2E-5	5E-8	0	0
45	Rh-106m	Y: see Rh-99m	0	4E+4	1E-5	5E-8	0	0
45	Rh-107 <sup>2</sup>	D: see Rh-99m	7E+4 St. wall (9E+4)	2E+5	1E-4	3E-7	0	0
			0	0	0	0	1E-3	1E-2
45	Rh-107 <sup>2</sup>	W: see Rh-99m	0	3E+5	1E-4	4E-7	0	0
45	Rh-107 <sup>2</sup>	Y: see Rh-99m	0	3E+5	1E-4	3E-7	0	0
46	Pd-100	D: all compounds except those given for W, Y	1E+3	1E+3	6E-7	2E-9	2E-5	2E-4
	Pd-100	W: nitrates	0	1E+3	5E-7	2E-9	0	0
46	Pd-100	Y: oxides and hydroxides	0	1E+3	6E-7	2E-9	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
46	Pd-101	D: see Pd-100	1E+4	3E+4	1E-5	5E-8	2E-4	2E-3
46	Pd-101	W: see Pd-100	0	3E+4	1E-5	5E-8	0	0
46	Pd-101	Y: see Pd-100	0	3E+4	1E-5	4E-8	0	0
46	Pd-103	D: see Pd-100	6E+3	6E+3	3E-6	9E-9	0	0
			LLI wall (7E+3)	0	0	0	1E-4	1E-3
46	Pd-103	W: see Pd-100	0	4E+3	2E-6	6E-9	0	0
46	Pd-103	Y: see Pd-100	0	4E+3	1E-6	5E-9	0	0
46	Pd-107	D: see Pd-100	3E+4	2E+4	9E-6	0	0	0
			LLI wall (4E+4)	Kidneys (2E+4)	0	3E-8	5E-4	5E-3
46	Pd-107	W: see Pd-100	0	7E+3	3E-6	1E-8	0	0
46	Pd-107	Y: see Pd-100	0	4E+2	2E-7	6E-10	0	0
46	Pd-109	D: see Pd-100	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
46	Pd-109	W: see Pd-100	0	5E+3	2E-6	8E-9	0	0
46	Pd-109	Y: see Pd-100	0	5E+3	2E-6	6E-9	0	0
47	Ag-102 <sup>2</sup>	D: all compounds except those given for W, Y	5E+4	2E+5	8E-5	2E-7	0	0
			St. wall (6E+4)	0	0	0	9E-4	9E-3
	Ag-102 <sup>22</sup>	W: nitrates and sulfides	0	2E+5	9E-5	3E-7	0	0
47	Ag-102 <sup>2</sup>	Y: oxides and hydroxides	0	2E+5	8E-5	3E-7	0	0
47	Ag-103 <sup>2</sup>	D: see Ag-102	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
47	Ag-103 <sup>2</sup>	W: see Ag-102	0	1E+5	5E-5	2E-7	0	0
47	Ag-103 <sup>2</sup>	Y: see Ag-102	0	1E+5	5E-5	2E-7	0	0
47	Ag-104m <sup>2</sup>	D: see Ag-102	3E+4	9E+4	4E-5	1E-7	4E-4	4E-3
47	Ag-104m <sup>2</sup>	W: see Ag-102	0	1E+5	5E-5	2E-7	0	0
47	Ag-104m <sup>2</sup>	Y: see Ag-102	0	1E+5	5E-5	2E-7	0	0
47	Ag-104 <sup>2</sup>	D: see Ag-102	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
47	Ag-104 <sup>2</sup>	W: see Ag-102	0	1E+5	6E-5	2E-7	0	0
47	Ag-104 <sup>2</sup>	Y: see Ag-102	0	1E+5	6E-5	2E-7	0	0
47	Ag-105	D: see Ag-102	3E+3	1E+3	4E-7	1E-9	4E-5	4E-4
47	Ag-105	W: see Ag-102	0	2E+3	7E-7	2E-9	0	0
47	Ag-105	Y: see Ag-102	0	2E+3	7E-7	2E-9	0	0
47	Ag-106m	D: see Ag-102	8E+2	7E+2	3E-7	1E-9	1E-5	1E-4
47	Ag-106m	W: see Ag-102	0	9E+2	4E-7	1E-9	0	0
47	Ag-106m	Y: see Ag-102	0	9E+2	4E-7	1E-9	0	0
47	Ag-106 <sup>2</sup>	D: see Ag-102	6E+4	2E+5	8E-5	3E-7	0	0
			St. wall (6E+4)	0	0	0	9E-4	9E-3
47	Ag-106 <sup>2</sup>	W: see Ag-102	0	2E+5	9E-5	3E-7	0	0
47	Ag-106 <sup>2</sup>	Y: see Ag-102	0	2E+5	8E-5	3E-7	0	0
47	Ag-108m	D: see Ag-102	6E+2	2E+2	8E-8	3E-10	9E-6	9E-5
47	Ag-108m	W: see Ag-102	0	3E+2	1E-7	4E-10	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
47	Ag-108m	Y: see Ag-102	0	2E+1	1E-8	3E-11	0	0
47	Ag-110m	D: see Ag-102	5E+2	1E+2	5E-8	2E-10	6E-6	6E-5
47	Ag-110m	W: see Ag-102	0	2E+2	8E-8	3E-10	0	0
47	Ag-110m	Y: see Ag-102	0	9E+1	4E-8	1E-10	0	0
47	Ag-111	D: see Ag-102	9E+2 LLI wall (1E+3)	2E+3 Liver (2E+3)	6E-7 0	0 2E-9	0 2E-5	0 2E-4
47	Ag-111	W: see Ag-102	0	9E+2	4E-7	1E-9	0	0
47	Ag-111	Y: see Ag-102	0	9E+2	4E-7	1E-9	0	0
47	Ag-112	D: see Ag-102	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
47	Ag-112	W: see Ag-102	0	1E+4	4E-6	1E-8	0	0
47	Ag-112	Y: see Ag-102	0	9E+3	4E-6	1E-8	0	0
47	Ag-115 <sup>2</sup>	D: see Ag-102	3E+4 St. wall (3E+4)	9E+4 0	4E-5 0	1E-7 0	0 4E-4	0 4E-3
47	Ag-115 <sup>2</sup>	W: see Ag-102	0	9E+4	43E-5	1E-7	0	0
47	Ag-115 <sup>2</sup>	Y: see Ag-102	0	8E+4	3E-5	1E-7	0	0
48	Cd-104 <sup>2</sup>	D: all compounds except those given for W, Y	2E+4	7E+4	5E-5	9E-8	3E-4	3E-3
48	Cd-104 <sup>2</sup>	W: sulfides, halides, and nitrates	0	1E+5	5E-5	2E-7	0	0
48	Cd-104 <sup>2</sup>	Y: oxides and hydroxides	0	1E+5	5E-5	2E-7	0	0
48	Cd-107	D: see Cd-104	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
48	Cd-107	W: see Cd-104	0	6E+4	2E-5	8E-8	0	0
48	Cd-107	Y: see Cd-104	0	5E+4	2E-5	7E-8	0	0
48	Cd-109	D: see Cd-104	2E+2 Kidneys (4E+2)	5E+1 Kidney (5E+1)	1E-8 0	0 7E-11	0 6E-6	0 6E-5
48	Cd-109	W: see Cd-104	0	1E+2 Kidney (1E+2)	5E-8 0	0 2E-10	0 0	0 0
48	Cd-109	Y: see Cd-104	0	1E+2	5E-8	2E-10	0	0
48	Cd-113m	D: see Cd-104	2E+1 Kidneys (4E+1)	2E+0 Kidney (4E+0)	1E-9 0	0 5E-12	0 5E-7	0 5E-6
48	Cd-113m	W: see Cd-104	0	8E+0 Kidney (1E+0)	4E-9 0	0 2E-11	0 0	0 0
48	Cd-113m	Y: see Cd-104	0	1E+1	5E-9	2E-11	0	0
48	Cd-113	D: see Cd-104	2E+1 Kidneys (3E+1)	2E+0 Kidney (3E+0)	9E-10	0	0	0
48	Cd-113	W: see Cd-104	0	8E+0 Kidney (8E+0)	3E-9 0	0 2E-11	0 0	0 0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
48	Cd-113	Y: see Cd-104	0	1E+1	6E-9	2E-11	0	0
48	Cd-115m	D: see Cd-104	3E+2	5E+1 Kidney (8E+1)	2E-8	0	4E-6	4E-5
			0		0	1E-10	0	0
48	Cd-115m	W: see Cd-104	0	1E+2	5E-8	2E-10	0	0
48	Cd-115m	Y: see Cd-104	0	1E+2	6E-8	2E-10	0	0
48	Cd-115	D: see Cd-104	9E+2 LLI Wall (1E+3)	1E+3	6E-7	2E-9	0	0
			0	0	0	1E-5	1E-4	
48	Cd-115	W: see Cd-104	0	1E+3	5E-7	2E-9	0	0
48	Cd-115	Y: see Cd-104	0	1E+3	6E-7	2E-9	0	0
48	Cd-117m	D: see Cd-104	5E+3	1E+4	5E-6	2E-8	6E-5	6E-4
48	Cd-117m	W: see Cd-104	0	2E+4	7E-6	2E-8	0	0
48	Cd-117m	Y: see Cd-104	0	1E+4	6E-6	2E-8	0	0
48	Cd-117	D: see Cd-104	5E+3	1E+4	5E-6	2E-8	3E-4	3E-3
48	Cd-117	W: see Cd-104	0	2E+4	7E-6	2E-8	0	0
48	Cd-117	Y: see Cd-104	0	1E+4	6E-6	2E-8	0	0
49	In-109	D: all compounds except those given for W	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
49	In-109	W: oxides, halides, hydroxides, and nitrates	0	6E+4	3E-5	9E-8	0	0
49	In-110 <sup>2</sup> (69.1 m)	D: see In-109	2E+4	4E+4	2E-5	6E-8	0	0
49	In-110 <sup>2</sup> (69.1 m)	W: see In-109	0	6E+4	2E-5	8E-8	7E-3	7E-4
49	In-110 (4.9 h)	D: see In-109	5E+3	2E+4	7E-6	2E-8	0	0
49	In-110 (4.9 h)	W: see In-109	0	2E+4	8E-6	3E-8	0	0
49	In-111	D: see In-109	4E+3	6E+3	3E-6	9E-9	6E-3	6E-4
49	In-111	W: see In-109	0	6E+3	3E-6	9E-7	0	0
49	In-112 <sup>2</sup>	D: see In-109	2E+5	6E+5	3E-4	9E-7	2E-3	2E-2
49	In-112 <sup>2</sup>	W: see In-109	0	7E+5	3E-4	1E-6	0	0
49	In-113m <sup>2</sup>	D: see In-109	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
49	In-113m <sup>2</sup>	W: see In-109	0	2E+5	8E-5	3E-7	0	0
49	In-114m	D: see In-109	3E+2 LLI Wall (4E+2)	6E+1	3E-8	9E-11	0	0
			0	0	0	5E-6	5E-5	
49	In-114m	W: see In-109	0	1E+2	4E-8	1E-10	0	0
49	In-115m	D: see In-109	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
49	In-115m	W: see In-109	0	5E+4	2E-5	7E-8	0	0
49	In-115	D: see In-109	4E+1	1E+0	6E-10	2E-12	5E-7	5E-6
49	In-115	W: see In-109	0	5E+0	2E-9	8E-12	0	0
49	In-116m <sup>2</sup>	D: see In-109	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
49	In-116m <sup>2</sup>	W: see In-109	0	1E+5	3E-5	2E-7	0	0
49	In-117m <sup>2</sup>	D: see In-109	1E+4	3E+4	1E-5	5E-8	2E-4	3E-3
49	In-117m <sup>2</sup>	W: see In-109	0	4E+4	2E-5	6E-8	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
49	In-117 <sup>2</sup>	D: see In-109	6E+4	2E+5	7E-5	2E-7	8E-4	8E-3
49	In-117m <sup>2</sup>	W: see In-109	0	2E+5	9E-5	3E-7	0	0
494 9	In-119m <sup>2</sup>	D: see In-109	4E+4 St Wall (5E+4)	1E+5 0	5E-5 0	2E-7 0	0 7E-4	0 7E-3
49	In-119m <sup>2</sup>	W: see In-109	0	1E+5	6E-5	2E-7	0	0
50	Sn-110	D: all compounds except those given for W	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
	Sn-110	W: sulfides, oxides, hydroxides, halides, nitrates, and stannic phosphate	0	1E+4	5E-6	2E-8	0	0
50	Sn-111 <sup>2</sup>	D: see Sn-110	7E+4	2E+5	9E-5	3E-7	1E-3	1E-2
50	Sn-111 <sup>2</sup>	W: see Sn-110	0	3E+5	1E-4	4E-7	0	0
50	Sn-113	D: see Sn-110	2E+3 LLI Wall (2E+3)	1E+3 0	5E-7 0	2E-9 0	0 3E-5	0 3E-4
50	Sn-113	W: see Sn-110	0	5E+2	2E-7	8E-10	0	0
50	Sn-117m	D: see Sn-110	2E+3 LLI Wall (2E+ )	1E+3 Bone surf (2E+3)	5E-7 0	0 3E-9	0 3E-5	0 3E-4
50	Sn-117m	W: see Sn-110	0	1E+3	6E-7	2E-9	0	0
50	Sn-119m	D: see Sn-110	3E+3 LLI Wall (4E+3)	2E+3 0	1E-6 0	3E-9 0	0 6E-5	0 6E-4
50	Sn-119m	W: see Sn-110	0	1E+3	4E-7	1E-9	0	0
50	Sn-121m	D: see Sn-110	3E+3 LLI Wall (4E+3)	9E+2 0	4E-7 0	1E-9 0	0 5E-5	0 5E-4
50	Sn-121m	W: see Sn-110	0	5E+2	2E-7	8E-10	0	0
50	Sn-121	D: see Sn-110	6E+3 LLI Wall (6E+3)	2E+4 0	6E-6 0	2E-8 0	0 8E-5	0 8E-4
50	Sn-121	W: see Sn-110	0	1E+4	5E-6	2E-8	0	0
50	Sn-123m <sup>2</sup>	D: see Sn-110	5E+4	1E+5	5E-5	2E-7	7E-4	7E-3
50	Sn-123m <sup>2</sup>	W: see Sn-110	0	1E+5	6E-5	2E-7	0	0
50	Sn-123	D: see Sn-110	5E+2 LLI Wall (6E+2)	6E+2 0	3E-7 0	9E-10 0	0 9E-6	0 9E-5
50	Sn-123	W: see Sn-110	0	2E+2	7E-8	2E-10	0	0
50	Sn-125	D: see Sn-110	4E+2 LLI Wall (5E+2)	9E+2 0	4E-7 0	1E-9 0	0 6E-6	0 6E-5
50	Sn-125	W: see Sn-110	0	4E+2	1E-7	5E-10	0	0
50	Sn-126	D: see Sn-110	3E+2	6E+1	2E-8	8E-11	4E-6	4E-5

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
50	Sn-126	W: see Sn-110	0	7E+1	3E-8	9E-11	0	0
50	Sn-127	D: see Sn-110	7E+3	2E+4	8E-6	3E-8	9E-4	9E-4
50	Sn-127	W: see Sn-110	0	2E+4	8E-6	3E-8	0	0
50	Sn-128 <sup>2</sup>	D: see Sn-110	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
50	Sn-128 <sup>2</sup>	W: see Sn-110	0	4E+4	1E-5	5E-8	0	0
51	Sb-115 <sup>2</sup>	D: all compounds except those given for W	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
51	Sb-115 <sup>2</sup>	W: oxides, halides, sulfides, sulfates, nitrates, and hydroxides,	0	3E+5	1E-4	4E-7	0	0
51	Sb-116m <sup>2</sup>	D: see Sb-115	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
51	Sb-116m <sup>2</sup>	W: see Sb-115	0	1E+5	6E-5	2E-7	0	0
51	Sb-116 <sup>2</sup>	D: see Sb-115	7E+4 St Wall (9E+4)	3E+5	1E-4	4E-7	0	0
			0	0	0	0	3E-4	3E-3
51	Sb-116 <sup>2</sup>	W: see Sb-115	0	3E+5	1E-4	5E-7	0	0
51	Sb-117	D: see Sb-115	7E+4	2E+5	9E-5	3E-7	9E-4	9E-3
51	Sb-117	W: see Sb-115	0	3E+5	1E-4	4E-7	0	0
51	Sb-118m <sup>2</sup>	D: see Sb-115	6E+3	2E+4	8E-6	3E-8	7E-5	7E-4
51	Sb-118m <sup>2</sup>	W: see Sb-115	5E+3	2E+4	9E-6	3E-8	0	0
51	Sb-119	D: see Sb-115	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
51	Sb-119	W: see Sb-115	2E+4	3E+4	1E-5	4E-8	0	0
51	Sb-120 <sup>2</sup> (16 m)	D: see Sb-115	1E+5 St Wall (2E+5)	4E+5	2E-4	6E-7	0	0
			0	0	0	0	2E-3	2E-2
51	Sb-120 <sup>2</sup> (16 m)	W: see Sb-115	0	5E+5	2E-4	7E-7	0	0
51	Sb-120 (5.76 d)	D: see Sb-115	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
51	Sb-120 (5.76 d)	W: see Sb-115	9E+2	1E+3	5E-7	2E-9	0	0
51	Sb-122	D: see Sb-115	8E+2 LLI Wall (8E+2)	2E+3	1E-6	3E-9	0	0
			0	0	0	0	1E-5	1E-4
51	Sb-122	W: see Sb-115	7E+2	1E+3	4E-7	2E-9	0	0
51	Sb-124m <sup>2</sup>	D: see Sb-115	3E+5	8E+5	2E-4	1E-6	3E-3	2E-2
51	Sb-124m <sup>2</sup>	W: see Sb-115	2E+5	6E+5	4E-4	8E-7	0	0
51	Sb-124	D: see Sb-115	6E+2	9E+2	4E-7	1E-9	7E-6	7E-5
51	Sb-124	W: see Sb-115	5E+2	2E+2	1E-7	3E-10	0	0
51	Sb-125	D: see Sb-115	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4
51	Sb-125	W: see Sb-115	0	5E+2	2E-7	7E-10	0	0
51	Sb-126m <sup>2</sup>	D: see Sb-115	5E+4 St Wall (7E+4)	2E+5	8E-5	3E-7	0	0
			0	0	0	0	9E-4	9E-3
51	Sb-126m <sup>2</sup>	W: see Sb-115	0	2E+5	8E-5	3E-7	0	0
51	Sb-126	D: see Sb-115	6E+2	1E+3	5E-7	2E-9	7E-6	7E-5

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
51	Sb-126	W: see Sb-115	5E+2	5E+2	2E-7	7E-10	0	0
51	Sb-127	D: see Sb-115	8E+2	2E+3	9E-7	3E-9	0	0
			LLI Wall (8E+2)	0	0	0	1E-5	1E-4
51	Sb-127	W: see Sb-115	7E+2	9E+2	4E-7	1E-9	0	0
51	Sb-128 <sup>2</sup> (10.4 m)	D: see Sb-115	8E+4	4E+5	2E-4	5E-7	0	0
			St Wall (1E+5)	0	0	0	1E-3	1E-2
51	Sb-128 <sup>2</sup> (10.4 m)	W: see Sb-115	0	4E+5	2E-4	6E-7	0	0
51	Sb-128 (9.01 h)	D: see Sb-115	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
51	Sb-128 (9.01 h)	W: see Sb-115	0	3E+3	1E-6	5E-9	0	0
51	Sb-129	D: see Sb-115	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
51	Sb-129	W: see Sb-115	0	9E+3	4E-6	1E-8	0	0
51	Sb-130 <sup>2</sup>	D: see Sb-115	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
51	Sb-130 <sup>2</sup>	W: see Sb-115	0	8E+4	3E-5	1E-7	0	0
51	Sb-131 <sup>2</sup>	D: see Sb-115	1E+4	2E+4	1E-5	0	0	0
			Thyroid (2E+4)	Thyroid (4E+4)		6E-8	2E-4	2E-3
51	Sb-131 <sup>2</sup>	W: see Sb-115	0	2E+4	1E-5	0	0	0
			0	Thyroid (4E+4)	0	6E-8	0	0
52	Te-116	D: all compounds except those given for W	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
52	Te-116	W: oxides, nitrates, and hydroxides	0	3E+4	1E-5	4E-8	0	0
52	Te-121m	D: see Te-116	5E+2	2E+2	8E-8	0	0	0
			Bone Surf (7E+2)	Bone surf (4E+2)	0	5E-10	1E-5	1E-4
52	Te-121m	W: see Te-116	0	4E+2	2E-7	6E-10	0	0
52	Te-121	D: see Te-116	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
52	Te-121	W: see Te-116	0	3E+3	1E-6	4E-9	0	0
52	Te-123m	D: see Te-116	6E+2	2E+2	9E-8	0	0	0
			Bone Surf (1E+3)	Bone surf (5E+2)	0	8E-10	1E-5	1E-4
52	Te-123m	W: see Te-116	0	2E+2	2E-7	8E-10	0	0
52	Te-123	D: see Te-116	5E+2	2E+2	8E-8	0	0	0
			Bone Surf (1E+3)	Bone surf (5E+2)		7E-10	2E-5	2E-4
52	Te-123	W: see Te-116	0	4E+2	2E-7	0	0	0
			0	Bone surf (1E+3)	0	2E-9	0	0
52	Te-125m	D: see Te-116	1E+3	4E+2	2E-7	0	2E-5	2E-4
			Bone Surf (1E+3)	Bone surf (1E+3)	0	1E-9	0	0
52	Te-125m	W: see Te-116	0	7E+2	3E-7	1E-9	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
52	Te-127m	D: see Te-116	6E+2	3E+2 Bone surf (4E+2)	1E-7	0	9E-6	9E-5
			0		0	6E-10	0	0
52	Te-127m	W: see Te-116	0	3E+2	1E-7	4E-10	0	0
52	Te-127	D: see Te-116	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
52	Te-127	W: see Te-116	0	2E+4	7E-6	2E-8	0	0
52	Te-129m	D: see Te-116	5E+2	6E+2	3E-7	9E-10	7E-6	7E-6
52	Te-129m	W: see Te-116	0	2E+2	1E-7	3E-10	0	0
52	Te-129 <sup>2</sup>	D: see Te-116	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
52	Te-129 <sup>2</sup>	W: see Te-116	0	7E+4	3E-5	1E-7	0	0
52	Te-131m	D: see Te-116	3E+2 Thyroid (6E+2)	4E+2 Thyroid (1E+3)	2E-7	0	0	0
					0	2E-9	8E-6	8E-5
52	Te-131m	W: see Te-116	0	4E+2 Thyroid (9E+2)	2E-7	0	0	0
			0		0	1E-9	0	0
52	Te-131 <sup>2</sup>	D: see Te-116	3E+3 Thyroid (6E+3)	5E+3 Thyroid (1E+4)	2E-6	0	0	0
					0	2E-8	8E-5	8E-4
52	Te-131 <sup>2</sup>	W: see Te-116	0	5E+3 Thyroid (1E+4)	2E-6	0	0	0
			0		0	2E-8	0	0
52	Te-132	D: see Te-116	2E+2 Thyroid (7E+2)	2E+2 Thyroid (2E+2)	9E-8	0	0	0
					0	1E-9	9E-6	9E-5
52	Te-132	W: see Te-116	0	2E+2 Thyroid (6E+2)	9E-8	0	0	0
			0		0	9E-10	0	0
52	Te-133m <sup>2</sup>	D: see Te-116	3E+3 Thyroid (6E+3)	5E+3 Thyroid (1E+4)	2E-6	0	0	0
					0	2E-8	9E-3	9E-4
52	Te-133m <sup>2</sup>	W: see Te-116	0	5E+3 Thyroid (1E+4)	2E-6	0	0	0
			0		0	2E-8	0	0
52	Te-133 <sup>2</sup>	D: see Te-116	1E+4 Thyroid (3E+4)	2E+4 Thyroid (6E+4)	9E-6	0	0	0
						8E-8	4E-4	4E-3
52	Te-133 <sup>2</sup>	W: see Te-116	0	2E+4 Thyroid (6E+4)	9E-6	0	0	0
			0		0	8E-8	0	0
52	Te-134 <sup>2</sup>	D: see Te-116	2E+4 Thyroid (2E+4)	2E+4 Thyroid (5E+4)	1E-5	0	0	0
						7E-8	3E-4	3E-3
52	Te-134 <sup>2</sup>	W: see Te-116	0	2E+4 Thyroid (5E+4)	1E-5	0	0	0
			0		0	7E-8	0	0
53	I-120m <sup>2</sup>	D: all compounds	1E+4 Thyroid (1E+4)	2E+4	9E-6	3E-8	0	0
				0	0	0	2E-4	2E-3



At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
53	I-120 <sup>2</sup>	D: all compounds	4E+3 Thyroid (8E+3)	9E+3 Thyroid (1E+4)	4E-6 0	0 2E-8	0 1E-4	0 1E-3
53	I-121	D: all compounds	1E+4 Thyroid (3E+4)	2E+4 Thyroid (5E+4)	8E-6 0	0 7E-8	0 4E-4	0 4E-3
53	I-123	D: all compounds	3E+3 Thyroid (1E+4)	6E+3 Thyroid (2E+4)	3E-6 0	0 2E-8	0 1E-4	0 1E-3
53	I-124	D: all compounds	5E+1 Thyroid (2E+2)	8E+1 Thyroid (3E+2)	3E-8 0	0 4E-10	0 2E-6	0 2E-5
53	I-125	D: all compounds	4E+1 Thyroid (1E+2)	6E+1 Thyroid (2E+2)	3E-8 0	0 3E-10	0 2E-6	0 2E-5
53	I-126	D: all compounds	2E+1 Thyroid (7E+1)	4E+1 Thyroid (1E+2)	1E-8 0	0 2E-10	0 1E-6	0 1E-5
53	I-128 <sup>2</sup>	D: all compounds	4E+4 St Wall (6E+4)	1E+5 0	5E-5 0	2E-7 0	0 8E-4	0 8E-3
53	I-129	D: all compounds	5E+0 Thyroid (2E+1)	9E+0 Thyroid (3E+1)	4E-9 0	0 4E-11	0 2E-7	0 2E-6
53	I-130	D: all compounds	4E+2 Thyroid (1E+3)	7E+2 Thyroid (7E+2)	3E-7 0	0 3E-9	0 2E-5	0 2E-4
53	I-131	D: all compounds	3E+1 Thyroid (9E+1)	5E+1 Thyroid (2E+2)	2E-8 0	0 2E-9	0 1E-6	0 1E-5
53	I-132m <sup>2</sup>	D: all compounds	4E+3 Thyroid (1E+4)	8E+3 Thyroid (2E+4)	4E-6 0	0 3E-8	0 1E-4	0 1E-3
53	I-132	D: all compounds	4E+3 Thyroid (9E+3)	8E+3 Thyroid (1E+4)	3E-6 0	0 2E-8	0 1E-4	0 1E-3
53	I-133	D: all compounds	1E+2 Thyroid (5E+2)	3E+2 Thyroid (9E+2)	1E-7 0	0 1E-9	0 7E-6	0 7E-5
53	I-134 <sup>2</sup>	D: all compounds	2E+4 Thyroid (3E+4)	5E+4 0	2E-5	6E-8 0	0 4E-4	0 4E-3
53	I-135	D: all compounds	8E+2 Thyroid (3E+3)	2E+3 Thyroid (4E+3)	7E-7 0	0 6E-9	0 3E-5	0 3E-4
54	Xe-120 <sup>2</sup>	Submersion1	0	0	1E-5	4E-8	0	0
54	Xe-121 <sup>2</sup>	Submersion1	0	0	2E-6	1E-8	0	0
54	Xe-122	Submersion1	0	0	7E-5	3E-7	0	0
54	Xe-123	Submersion1	0	0	6E-6	3E-8	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
54	Xe-125	Submersion1	0	0	2E-5	7E-8	0	0
54	Xe-127	Submersion1	0	0	1E-5	6E-8	0	0
54	Xe-129m	Submersion1	0	0	2E-4	9E-7	0	0
54	Xe-131m	Submersion1	0	0	4E-4	2E-6	0	0
54	Xe-133m	Submersion1	0	0	1E-4	6E-7	0	0
54	Xe-133	Submersion1	0	0	1E-4	5E-7	0	0
54	Xe-135m <sup>2</sup>	Submersion1	0	0	9E-6	4E-8	0	0
54	Xe-135	Submersion1	0	0	1E-5	7E-8	0	0
54	Xe-138 <sup>2</sup>	Submersion1	0	0	4E-6	2E-8	0	0
55	Cs-125 <sup>2</sup>	D: all compounds	5E+4 St Wall (9E+4)	1E+5	6E-5	2E-7	0	0
55	Cs-127	D: all compounds	6E+4	9E+4	4E-5	1E-7	1E-3	1E-2
55	Cs-129	D: all compounds	2E+4	3E+4	1E-5	5E-8	9E-4	9E-3
55	Cs-130 <sup>2</sup>	D: all compounds	6E+4 St Wall (1E+5)	2E+5	8E-5	3E-7	3E-4	3E-3
55	Cs-131	D: all compounds	2E+4	3E+4	1E-5	4E-8	0	0
55	Cs-132	D: all compounds	3E+3	4E+3	2E-6	6E-9	1E-3	1E-2
55	Cs-134m	D: all compounds	1E+5 St Wall (1E+5)	1E+5	6E-5	2E-7	3E-4	3E-3
55	Cs-134	D: all compounds	7E+1	1E+2	4E-8	2E-10	4E-5	4E-4
55	Cs-135m <sup>2</sup>	D: all compounds	1E+5	2E+5	8E-5	3E-7	0	0
55	Cs-135	D: all compounds	7E+2	1E+3	5E-7	2E-9	2E-3	2E-2
55	Cs-136	D: all compounds	4E+2	7E+2	3E-7	9E-10	9E-7	9E-6
55	Cs-137	D: all compounds	1E+2	2E+2	6E-8	2E-10	1E-3	1E-2
55	Cs-138 <sup>2</sup>	D: all compounds	2E+4 St Wall (3E+4)	6E+4	2E-5	8E-8	6E-6	6E-5
56	Ba-126 <sup>2</sup>	D: all compounds	6E+3	2E+4	6E-6	2E-10	1E-6	1E-5
56	Ba-128	D: all compounds	5E+2	2E+3	7E-7	2E-9	0	0
56	Ba-131m <sup>2</sup>	D: all compounds	4E+5 St Wall (5E+5)	1E+6	6E-4	2E-6	4E-4	4E-3
56	Ba-131	D: all compounds	3E+3	8E+3	3E-6	1E-8	8E-5	8E-4
56	Ba-133m	D: all compounds	2E+3 LLI Wall (3E+3)	9E+3	4E-6	2E-9	7E-6	7E-5
56	Ba-133	D: all compounds	2E+3	7E+2	3E-7	1E-8	0	0
56	Ba-135m	D: all compounds	3E+3	1E+4	5E-6	9E-10	4E-5	4E-4
56	Ba-139 <sup>2</sup>	D: all compounds	1E+4	3E+4	1E-5	2E-8	4E-5	4E-4
56	Ba-140	D: all compounds	5E+2 LLI Wall (6E+2)	1E+3	6E-7	4E-8	2E-4	2E-3
56	Ba-141 <sup>2</sup>	D: all compounds	2E+4	7E+4	3E-5	2E-9	0	0
56							8E-6	8E-5
56							4E-4	4E-3

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
56	Ba-142 <sup>2</sup>	D: all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
57	La-131 <sup>2</sup>	D: all compounds except those given for W	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
	La-131 <sup>2</sup>	W: oxides and hydroxides	0	2E+5	7E-5	2E-7	0	0
57	La-132	D: see La-131	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
57	La-132	W: see La-131	0	1E+4	5E-6	2E-8	0	0
57	La-135	D: see La-131	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
57	La-135	W: see La-131	0	9E+4	4E-5	1E-7	0	0
57	La-137	D: see La-131	1E+4	6E+1 Liver (7E+1)	3E-8	0	2E-4	2E-3
			0		0	1E-10	0	0
57	La-137	W: see La-131	0	3E+2 Liver (3E+2)	1E-7	0	0	0
					0	4E-10	0	0
57	La-138	D: see La-131	9E+2	4E+0	1E-9	5E-12	1E-5	1E-4
57	La-138	W: see La-131	0	1E+1	6E-9	2E-11	0	0
57	La-140	D: see La-131	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
57	La-140	W: see La-131	0	1E+3	5E-7	2E-9	0	0
57	La-141	D: see La-131	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
57	La-141	W: see La-131	0	1E+4	5E-6	2E-8	0	0
57	La-142 <sup>2</sup>	D: see La-131	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
57	La-142 <sup>2</sup>	W: see La-131	0	3E+4	1E-5	5E-8	0	0
57	La-143 <sup>2</sup>	D: see La-131	4E+4 St Wall (4E+4)	1E+5	4E-5	1E-7	0	0
			0		0	0	5E-4	5E-3
57	La-143 <sup>2</sup>	W: see La-131	0	9E+4	4E-5	1E-7	0	0
58	Ce-134	W: all compounds except those given for Y	5E+2 LLI Wall (6E+2)	7E+2	3E-7	1E-9	0	0
			0		0	0	5E-4	5E-3
58	Ce-134	Y: fluorides, oxides, and hydroxides	0	7E+2	3E-7	9E-10	0	0
58	Ce-135	W: see Ce-134	2E+3	4E+3	2E-6	5E-9	2E-5	2E-4
58	Ce-135	Y: see Ce-134	0	4E+3	1E-6	5E-9	0	0
58	Ce-137m	W: see Ce-134	2E+3 LLI Wall (2E+3)	4E+3	2E-6	6E-9	0	0
			0		0	0	3E-5	3E-4
58	Ce-137m	Y: see Ce-134	0	4E+3	2E-6	5E-9	0	0
58	Ce-137	W: see Ce-134	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
58	Ce-137	Y: see Ce-134	0	1E+5	5E-5	2E-7	0	0
58	Ce-139	W: see Ce-134	5E+3	8E+2	3E-7	1E-9	7E-5	7E-4
58	Ce-139	Y: see Ce-134	0	7E+2	3E-7	9E-10	0	0
58	Ce-141	W: see Ce-134	2E+3 LLI Wall (2E+3)	7E+2	3E-7	1E-9	0	0
			0		0	0	3E-5	3E-4

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
58	Ce-141	Y: see Ce-134	0	6E+2	2E-7	8E-10	0	0
58	Ce-143	W: see Ce-134	1E+3 LLI Wall (1E+3)	2E+3 0	8E-7 0	3E-9 0	0 2E-5	0 2E-4
58	Ce-143	Y: see Ce-134	0	2E+3	7E-7	2E-9	0	0
58	Ce-144	W: see Ce-134	2E+2 LLI Wall (3E+2)	3E+1 0	1E-8 0	4E-11 0	0 3E-6	0 3E-5
58	Ce-144	Y: see Ce-134	0	1E+1	6E-9	2E-11	0	0
59	Pr-136 <sup>2</sup>	W: all compounds except those given for Y	5E+4 St Wall (7E+4)	2E+5 0	1E-4 0	3E-7 0	0 1E-3	0 1E-2
59	Pr-136 <sup>2</sup>	Y: carbides, oxides, hydroxides, and fluorides	0	2E+5	9E-5	3E-7	0	0
59	Pr-137 <sup>2</sup>	W: see Pr-136	4E+4	2E+5	6E-5	2E-7	5E-4	5E-3
59	Pr-137 <sup>2</sup>	Y: see Pr-136	0	1E+5	6E-5	2E-7	0	0
59	Pr-138m	W: see Pr-136	1E+4	5E+4	2E-5	8E-8	1E-4	1E-3
59	Pr-138m	Y: see Pr-136	0	4E+4	2E-5	6E-8	0	0
59	Pr-139	W: see Pr-136	4E+4	1E+5	5E-5	2E-7	6E-4	6E-3
59	Pr-139	Y: see Pr-136	0	1E+5	5E-5	2E-7	0	0
59	Pr-142m <sup>2</sup>	W: see Pr-136	8E+4	2E+5	7E-5	2E-7	1E-3	1E-2
59	Pr-142m <sup>2</sup>	Y: see Pr-136	0	1E+5	5E-5	2E-7	0	0
59	Pr-142	W: see Pr-136	1E+3	2E+3	9E-7	3E-9	1E-5	1E-5
59	Pr-142	Y: see Pr-136	0	2E+3	8E-7	3E-9	0	0
59	Pr-143	W: see Pr-136	9E+2 LLI Wall (1E+3)	8E+2 0	3E-7 0	1E-9 0	0 2E-5	0 2E-4
59	Pr-143	Y: see Pr-136	0	7E+2	3E-7	9E-10	0	0
59	Pr-144	W: see Pr-136	3E+4 St Wall (4E+4)	1E+5 0	5E-5 0	2E-7 0	0 6E-4	0 6E-3
59	Pr-144	Y: see Pr-136	0	1E+5	5E-5	2E-7	0	0
59	Pr-145	W: see Pr-136	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
59	Pr-145	Y: see Pr-136	0	8E+3	3E-6	1E-8	0	0
59	Pr-147 <sup>2</sup>	W: see Pr-136	5E+4 St Wall (8E+4)	2E+5 0	8E-5 0	3E-7 0	0 1E-3	0 1E-2
59	Pr-147 <sup>2</sup>	Y: see Pr-136	0	2E+5	8E-5	3E-7	0	0
60	Nd-136 <sup>2</sup>	W: all compounds except those given for Y	1E+4	6E+4	2E-5	8E-8	2E-4	2E-3
60	Nd-136 <sup>2</sup>	Y: oxides, carbides, hydroxides, and fluorides	0	5E+4	2E-5	8E-8	0	0
60	Nd-138	W: see Nd-136	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
60	Nd-138	Y: see Nd-136	0	5E+3	2E-6	7E-9	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
60	Nd-139m <sup>2</sup>	W: see Nd-136	5E+3	2E+4	7E-6	2E-8	7E-5	7E-4
60	Nd-139m <sup>2</sup>	Y: see Nd-136	0	1E+4	6E-6	2E-8	0	0
60	Nd-139	W: see Nd-136	9E+4	3E+5	1E-4	5E-7	1E-3	1E-2
60	Nd-139	Y: see Nd-136	0	3E+5	1E-4	4E-7	0	0
60	Nd-141	W: see Nd-136	2E+5	7E+5	3E-4	1E-6	2E-3	2E-2
60	Nd-141	Y: see Nd-136	0	6E+5	3E-4	9E-7	0	0
60	Nd-147	W: see Nd-136	1E+3	9E+2	4E-7	1E-9	0	0
			LLI Wall (1E+3)	0	0	0	2E-5	2E-4
60	Nd-147	Y: see Nd-136	0	8E+2	4E-7	1E-9	0	0
60	Nd-149 <sup>2</sup>	W: see Nd-136	1E+4	3E+4	1E-5	4E-8	1E-4	1E-3
60	Nd-149 <sup>2</sup>	Y: see Nd-136	0	2E+4	1E-5	3E-8	0	0
60	Nd-151 <sup>2</sup>	W: see Nd-136	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
60	Nd-151 <sup>2</sup>	Y: see Nd-136	0	2E+5	8E-5	3E-7	0	0
61	Pm-141 <sup>2</sup>	W: all compounds except those given for Y	5E+4	2E+5	8E-5	3E-7	0	0
			St Wall (6E+4)	0	0	0	8E-4	8E-3
61	Pm-141 <sup>2</sup>	Y: carbides, oxides, fluorides, and hydroxides,	0	2E+5	7E-5	2E-7	0	0
61	Pm-143	W: see Pm-141	5E+3	6E+2	2E-7	8E-10	7E-5	7E-4
61	Pm-143	Y: see Pm-141	0	7E+2	3E-7	1E-9	0	0
61	Pm-144	W: see Pm-141	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
61	Pm-144	Y: see Pm-141	0	1E+2	5E-8	2E-10	0	0
61	Pm-145	W: see Pm-141	1E+4	2E+2	7E-8	0	1E-4	1E-3
			0	Bone surf (2E+2)	0	3E-10	0	0
61	Pm-145	Y: see Pm-141	0	2E+2	8E-8	3E-10	0	0
61	Pm-146	W: see Pm-141	2E+3	5E+1	2E-8	7E-11	2E-5	2E-4
61	Pm-146	Y: see Pm-141	0	4E+1	2E-8	6E-11	0	0
61	Pm-147	W: see Pm-141	4E+3	1E+2	5E-8	0	0	0
			LLI Wall (5E+3)	Bone surf (2E+2)	0	3E-10	7E-5	7E-4
61	Pm-147	Y: see Pm-141	0	1E+2	6E-8	2E-10	0	0
61	Pm-148m	W: see Pm-141	7E+2	3E+2	1E-7	4E-10	1E-5	1E-4
61	Pm-148m	Y: see Pm-141	0	3E+2	1E-7	5E-10	0	0
61	Pm-148	W: see Pm-141	4E+2	5E+2	2E-7	8E-10	0	0
			LLI Wall (5E+2)	0	0	0	7E-6	7E-5
61	Pm-148	Y: see Pm-141	0	5E+2	2E-7	7E-10	0	0
61	Pm-149	W: see Pm-141	1E+3	2E+3	8E-7	3E-9	0	0
			LLI Wall (1E+3)	0	0	0	2E-5	2E-4
61	Pm-149	Y: see Pm-141	0	2E+3	8E-7	2E-9	0	0
61	Pm-150	W: see Pm-141	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
61	Pm-150	Y: see Pm-141	0	2E+4	7E-6	2E-8	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
61	Pm-151	W: see Pm-141	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
61	Pm-151	Y: see Pm-141	0	3E+3	1E-6	4E-9	0	0
62	Sm-141m <sup>2</sup>	W: all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
62	Sm-141 <sup>2</sup>	W: all compounds	5E+4	2E+5	8E-5	2E-7	0	0
			St Wall (6E+4)	0	0	0	8E-4	8E-3
62	Sm-142 <sup>2</sup>	W: all compounds	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
62	Sm-145	W: all compounds	6E+3	5E+2	2E-7	7E-10	8E-5	8E-4
62	Sm-146	W: all compounds	1E+1	4E+2	1E-11	0	0	0
			Bone Surf (3E+1)	Bone surf (6E-2)	0	9E-14	3E-7	3E-6
62	Sm-147	W: all compounds	2E+1	4E+2	2E-11	0	0	0
			Bone Surf (3E+1)	Bone surf (7E-2)	0	1E-13	4E-7	4E-6
62	Sm-151	W: all compounds	1E+4	1E+2	4E-8	0	0	0
			LLI Wall (1E+4)	Bone surf (7E+2)	0	2E-10	2E-4	2E-3
62	Sm-153	W: all compounds	2E+3	3E+3	1E-6	4E-9	0	0
			LLI Wall (2E+3)	0	0	0	3E-5	3E-4
62	Sm-155 <sup>2</sup>	W: all compounds	6E+4	2E+5	9E-5	3E-7	0	0
			St Wall (8E+4)			0	1E-3	1E-2
62	Sm-156	W: all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
63	Eu-145	W: all compounds	2E+3	2E+3	8E-7	3E-9	2E-5	2E-4
63	Eu-146	W: all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
63	Eu-147	W: all compounds	3E+3	2E+3	7E-7	2E-9	4E-5	4E-4
63	Eu-148	W: all compounds	1E+3	4E+2	1E-7	5E-10	1E-5	1E-4
63	Eu-149	W: all compounds	1E+4	3E+3	1E-6	4E-9	2E-4	2E-3
63	Eu-150 (12.62 h)	W: all compounds	3E+3	8E+3	4E-6	1E-8	4E-5	4E-4
63	Eu-150 (34.2 y)	W: all compounds	8E+2	2E+1	8E-9	3E-11	1E-5	1E-4
63	Eu-152m	W: all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
63	Eu-152	W: all compounds	8E+2	2E+1	1E-8	3E-11	1E-5	1E-4
63	Eu-154	W: all compounds	5E+2	2E+1	8E-9	3E-11	7E-6	7E-5
63	Eu-155	W: all compounds	4E+3	9E+1	4E-8	0	5E-5	5E-4
			0	Bone surf (1E+2)	0	2E-10	0	0
63	Eu-156	W: all compounds	6E+2	5E+2	2E-7	6E-10	0	0
63	Eu-157	W: all compounds	2E+3	5E+3	2E-6	7E-9	8E-6	8E-5
63	Eu-158 <sup>2</sup>	W: all compounds	2E+4	6E+4	2E-5	8E-8	3E-5	3E-4
64	Gd-145	D: all compounds except those given for W	5E+4	2E+5	6E-5	2E-7	3E-4	3E-3
			St Wall (5E+4)	0	0	0	0	0
64	Gd-145	W: fluorides, oxides, and hydroxides	0	2E+5	7E-5	2E-7	0	0
64	Gd-146	D: see Gd-145	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
64	Gd-146	W: see Gd-145	0	3E+2	1E-7	4E-10	0	0
64	Gd-147	D: see Gd-145	2E+3	4E+3	2E-6	6E-9	3E-5	3E-4
64	Gd-147	W: see Gd-145	0	4E+3	1E-6	5E-9	0	0
64	Gd-148	D: see Gd-145	1E+1 Bone Surf (2E+1)	8E+3 Bone surf (2E-2)	3E-12 0	0 2E-14	0 3E-7	0 3E-6
64	Gd-148	W: see Gd-145	0 0	3E-2 Bone surf (6E-2)	1E-11 0	0 8E-14	0 0	0 0
64	Gd-149	D: see Gd-145	3E+3	2E+3	9E-7	3E-9	4E-5	4E-4
64	Gd-149	W: see Gd-145	0	2E+3	1E-6	3E-9	0	0
64	Gd-151	D: see Gd-145	6E+3 0	4E+2 Bone surf (6E+2)	2E-7 0	0 9E-10	9E-5 0	9E-4 0
64	Gd-151	W: see Gd-145	0	1E+3	5E-7	2E-9	0	0
64	Gd-152	D: see Gd-145	2E+1 Bone Surf (3E+1)	1E-2 Bone surf (2E-2)	4E-12	0 3E-14	0 4E-7	0 4E-6
64	Gd-152	W: see Gd-145	0 0	4E-2 Bone surf (1E+2)	2E-11 0	0 1E-13	0 0	0 0
64	Gd-153	D: see Gd-145	5E+3 Bone Surf (2E+2)	1E+2 0	6E-8 0	0 3E-10	6E-5 0	6E-4 0
64	Gd-153	W: see Gd-145	0	6E+2	2E-7	8E-10	0	0
64	Gd-159	D: see Gd-145	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
64	Gd-159	W: see Gd-145	0	6E+3	2E-6	8E-9	0	0
65	Tb-147 <sup>2</sup>	W: all compounds	9E+3	3E+4	1E-5	5E-8	1E-4	1E-3
64	Tb-149	W: all compounds	5E+3	7E+2	3E-7	1E-9	7E-5	7E-4
65	Tb-150	W: all compounds	5E+3	2E+4	9E-6	3E-8	7E-5	7E-4
65	Tb-151	W: all compounds	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
65	Tb-153	W: all compounds	5E+3	7E+3	3E-6	1E-8	7E-5	7E-4
65	Tb-154	W: all compounds	2E+3	4E+3	2E-6	6E-9	2E-5	2E-4
65	Tb-155	W: all compounds	6E+3	8E+3	3E-6	1E-8	8E-5	8E-4
65	Tb-156m (5.0 h)	W: all compounds	2E+4	3E+4	1E-5	4E-8	2E-4	2E-3
65	Tb-156m (24.4 h)	W: all compounds	7E+3	8E+3	3E-6	1E-8	1E-4	1E-3
65	Tb-156	W: all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
65	Tb-157	W: all compounds	5E+4 LLI Wall (5E+4)	3E+2 Bone surf (6E+2)	1E-7 0	0 8E-10	0 7E-4	0 7E-3
65	Tb-158	W: all compounds	1E+3	2E+1	8E-9	3E-11	2E-5	2E-4
65	Tb-160	W: all compounds	8E+2	2E+2	9E-8	3E-10	1E-5	1E-4
65	Tb-161	W: all compounds	2E+3 LLI Wall (2E+3)	2E+3 0	7E-7 0	2E-9 0	0 3E-5	0 3E-4
66	Dy-155	W: all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
66	Dy-157	W: all compounds	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
66	Dy-159	W: all compounds	1E+4	2E+3	1E-6	3E-9	2E-4	2E-3
66	Dy-165	W: all compounds	1E+4	5E+4	2E-5	6E-8	2E-4	2E-3
66	Dy-166	W: all compounds	6E+2 LLI Wall (8E+2)	7E+2 0	3E-7 0	1E-9 0	0 1E-5	0 1E-4
67	Ho-155 <sup>2</sup>	W: all compounds	4E+4	2E+5	6E-5	2E-7	6E-4	6E-3
67	Ho-157 <sup>2</sup>	W: all compounds	3E+5	1E+6	6E-4	2E-6	4E-3	4E-2
67	Ho-159 <sup>2</sup>	W: all compounds	2E+5	1E+6	4E-4	1E-6	3E-3	3E-2
67	Ho-161	W: all compounds	1E+5	4E+5	2E-4	6E-7	1E-3	1E-2
67	Ho-162m <sup>2</sup>	W: all compounds	5E+4	3E+5	1E-4	4E-7	7E-4	7E-3
67	Ho-162 <sup>2</sup>	W: all compounds	5E+5 St Wall (1E+5)	2E+6 0	1E-3 0	3E-6 0	0 1E-2	0 1E-1
67	Ho-164m <sup>2</sup>	W: all compounds	1E+5	3E+5	1E-4	4E-7	1E-3	1E-2
67	Ho-164 <sup>2</sup>	W: all compounds	2E+5 St Wall (2E+5)	6E+5 0	3E-4 0	9E-7 0	0 3E-3	0 3E-2
67	Ho-166m	W: all compounds	6E+2	7E+0	3E-9	9E-12	9E-6	9E-5
67	Ho-166	W: all compounds	9E+2 LLI Wall (9E+2)	2E+3 0	7E-7 0	2E-9 0	0 1E-5	0 1E-4
67	Ho-167	W: all compounds	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3
68	Er-161	W: all compounds	2E+4	6E+4	3E-5	9E-8	2E-4	2E-3
68	Er-165	W: all compounds	6E+4	2E+5	8E-5	3E-7	9E-4	9E-3
68	Er-169	W: all compounds	3E+3 LLI Wall (4E+3)	3E+3 0	1E-6 0	4E-9 0	0 5E-5	0 5E-4
68	Er-171	W: all compounds	4E+3	1E+4	4E-6	1E-8	5E-5	5E-4
68	Er-172	W: all compounds	1E+3 LLI Wall (1E+3)	1E+3 0	6E-7 0	2E-9 0	0 2E-5	0 2E-4
69	Tm-162 <sup>2</sup>	W: all compounds	7E+4 St Wall (7E+4)	3E+5 0	1E-4 0	4E-7 0	0 1E-3	0 1E-2
69	Tm-166	W: all compounds	4E+3	1E+4	6E-6	2E-8	6E-5	6E-4
69	Tm-167	W: all compounds	2E+3 LLI Wall (2E+3)	2E+3 0	8E-7 0	3E-9 0	0 3E-5	0 3E-4
69	Tm-170	W: all compounds	8E+2 LLI Wall (1E+3)	2E+2 0	9E-8 0	3E-10 0	0 1E-5	0 1E-4
69	Tm-171	W: all compounds	1E+4 LLI Wall (1E+4)	3E+2 Bone surf (6E+2)	1E-7 0	0 8E-10	0 2E-4	0 2E-3
69	Tm-172	W: all compounds	7E+2 LLI Wall (8E+2)	1E+3 0	5E-7 0	2E-9 0	0 1E-5	0 1E-4
69	Tm-173	W: all compounds	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4



At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
69	Tm-175 <sup>2</sup>	W: all compounds	7E+4 St Wall (9E+4)	3E+5 0	1E-4 0	4E-7 0	0 1E-3	0 1E-2
70	Yb-162 <sup>2</sup>	W: all compounds except those given for Y	7E+4	3E+5	1E-4	4E-7	1E-3	1E-2
70	Yb-162 <sup>2</sup>	Y: fluorides, oxides, and hydroxides	0	3E+5	1E-4	4E-7	0	0
70	Yb-166	W: see Yb-162	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
70	Yb-166	Y: see Yb-162	0	2E+3	8E-7	3E-9	0	0
70	Yb-167 <sup>2</sup>	W: see Yb-162	3E+5	8E+5	3E-4	1E-6	4E-3	4E-2
70	Yb-167 <sup>2</sup>	Y: see Yb-162	0	7E+5	3E-4	1E-6	0	0
70	Yb-169	W: see Yb-162	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
70	Yb-169	Y: see Yb-162	0	7E+2	3E-7	1E-9	0	0
70	Yb-175	W: see Yb-162	3E+3 LLI Wall (3E+3)	4E+3 0	1E-6 0	5E-9 0	0 4E-5	0 4E-4
70	Yb-175	Y: see Yb-162	0	3E+3	1E-6	5E-9	0	0
70	Yb-177 <sup>2</sup>	W: see Yb-162	2E+4	5E+4	2E-5	7E-8	2E-4	2E-3
70	Yb-177 <sup>2</sup>	Y: see Yb-162	0	5E+4	2E-5	6E-8	0	0
70	Yb-178 <sup>2</sup>	W: see Yb-162	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
70	Yb-178 <sup>2</sup>	Y: see Yb-162	0	4E+4	2E-5	5E-8	0	0
71	Lu-169	W: all compounds except those given for Y	3E+3	4E+3	2E-6	6E-9	3E-5	3E-4
71	Lu-169	Y: fluorides, oxides, and hydroxides	0	4E+3	2E-6	6E-9	0	0
71	Lu-170	W: see Lu-169	1E+3	2E+3	9E-7	3E-9	2E-5	2E-4
71	Lu-170	Y: see Lu-169	0	2E+3	8E-7	3E-9	0	0
71	Lu-171	W: see Lu-169	2E+3	2E+3	8E-7	3E-9	3E-5	3E-4
71	Lu-171	Y: see Lu-169	0	2E+3	8E-7	3E-9	0	0
71	Lu-172	W: see Lu-169	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
71	Lu-172	Y: see Lu-169	0	1E+3	5E-7	2E-9	0	0
71	Lu-173	W: see Lu-169	5E+3	3E+2 Bone surf (5E+2)	1E-7 0	0 6E-10	7E-5 0	7E-4 0
71	Lu-173	Y: see Lu-169	0	3E+2	1E-7	4E-10	0	0
71	Lu-174m	W: see Lu-169	2E+3 LLI Wall (3E+3)	2E+2 Bone surf (3E+2)	1E-7 0	0 5E-10	0 4E-5	0 4E-4
71	Lu-174m	Y: see Lu-169	0	2E+2	9E-8	3E-10	0	0
71	Lu-174	W: see Lu-169	5E+3	1E+2 Bone surf (2E+2)	5E-8 0	0 3E-10	7E-5 0	7E-4 0
71	Lu-174	Y: see Lu-169	0	2E+2	6E-8	2E-10	0	0
71	Lu-176m	W: see Lu-169	8E+3	3E+4	1E-5	3E-8	1E-4	1E-3

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
71	Lu-176m	Y: see Lu-169	0	2E+4	9E-6	3E-8	0	0
71	Lu-176	W: see Lu-169	7E+2	5E+0	2E-9	0	1E-5	1E-4
			0	Bone surf (1E+1)	0	2E-11	0	0
71	Lu-176	Y: see Lu-169	0	8E+0	3E-9	1E-11	0	0
71	Lu-177m	W: see Lu-169	7E+2	1E+2	5E-8	0	1E-5	1E-4
			0	Bone surf (1E+2)	0	2E-10	0	0
71	Lu-177m	Y: see Lu-169	0	8E+1	3E-8	1E-10	0	0
							0	
71	Lu-177	W: see Lu-169	2E+3 LLI Wall (3E+3)	2E+3	9E-7	3E-9	4E-5	4E-4
			0	0	0	0	0	0
71	Lu-177	Y: see Lu-169	0	2E+3	9E-7	3E-9	0	0
71	Lu-178m <sup>2</sup>	W: see Lu-169	5E+4 St Wall (6E+4)	2E+5	8E-5	3E-7	0	0
			0	0	0	8E-4	8E-3	
71	Lu-178m <sup>2</sup>	Y: see Lu-169	0	2E+5	7E-5	2E-7	0	0
71	Lu-178 <sup>2</sup>	W: see Lu-169	4E+4 St Wall (4E+4)	1E+5	5E-5	2E-7	0	0
			0	0	0	6E-4	6E-3	
71	Lu-178 <sup>2</sup>	Y: see Lu-169	0	1E+5	5E-5	2E-7	0	0
71	Lu-179	W: see Lu-169	6E+3	2E+4	8E-6	3E-8	9E-5	9E-4
71	Lu-179	Y: see Lu-169	0	2E+4	6E-6	3E-8	0	0
72	Hf-170	D: all compounds except those given for W	3E+3	6E+3	2E-6	8E-9	4E-5	4E-4
72	Hf-170	W: nitrates, oxides, hydroxides, and carbides	0	5E+3	2E-6	6E-9	0	0
72	Hf-172	D: see Hf-170	1E+3	9E+0	4E-9	0	2E-5	2E-4
				Bone surf (2E+1)	0	3E-11	0	0
72	Hf-172	W: see Hf-170	0	4E+1	2E-8	0	0	0
			0	Bone surf (6E+1)	0	8E-11	0	0
72	Hf-173	D: see Hf-170	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
72	Hf-173	W: see Hf-170	0	1E+4	5E-6	2E-8	0	0
72	Hf-175	D: see Hf-170	3E+3	9E+2	4E-7	0	4E-5	4E-4
			0	Bone surf (1E+3)	0	1E-9	0	0
72	Hf-175	W: see Hf-170	0	1E+3	5E-7	2E-9	0	0
72	Hf-177m <sup>2</sup>	D: see Hf-170	2E+4	6E+4	2E-5	8E-8	3E-4	3E-4
72	Hf-177m <sup>2</sup>	W: see Hf-170	0	9E+4	4E-5	1E-7	0	0
72	Hf-178m	D: see Hf-170	3E+2	1E+0	5E-10	0	3E-6	3E-5
			0	Bone surf (2E+0)	0	3E-12	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
72	Hf-178m	W: see Hf-170	0	5E+0 Bone surf (9E+0)	2E-9	0	0	0
			0		0	1E-11	0	0
72	Hf-179m	D: see Hf-170	1E+3	3E+2 Bone surf (6E+2)	1E-7	0	1E-5	1E-4
				0	0	8E-10	0	0
72	Hf-179m	W: see Hf-170	0	6E+2	3E-7	8E-10	0	0
72	Hf-180m	D: see Hf-170	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
72	Hf-180m	W: see Hf-170	0	3E+4	1E-5	4E-8	0	0
72	Hf-181	D: see Hf-170	1E+3	2E+2 Bone surf (4E+2)	7E-8	0	2E-5	2E-4
			0		0	6E-10	0	0
72	Hf-181	W: see Hf-170	0	4E+2	2E-7	6E-10	0	0
72	Hf-182m <sup>2</sup>	D: see Hf-170	4E+4	9E+4	4E-5	1E-7	5E-4	5E-3
72	Hf-182m <sup>2</sup>	W: see Hf-170	0	1E+5	6E-5	2E-7	0	0
72	Hf-182	D: see Hf-170	2E+2 Bone Surf (4E+2)	8E-1 Bone surf (2E+0)	3E-10	0	0	0
				0	0	2E-12	5E-6	5E-5
72	Hf-182	W: see Hf-170	0	3E+0 Bone surf (7E+0)	1E-9	0	0	0
			0		0	1E-11	0	0
72	Hf-183 <sup>2</sup>	D: see Hf-170	2E+4	5E+4	2E-5	6E-8	3E-4	3E-3
72	Hf-183 <sup>2</sup>	W: see Hf-170	0	6E+4	2E-5	8E-8	0	0
72	Hf-184	D: see Hf-170	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
72	Hf-184	W: see Hf-170	0	6E+3	3E-6	9E-9	0	0
73	Ta-172 <sup>2</sup>	W: all compounds except those given for Y	4E+4	1E+5	5E-5	2E-7	5E-4	5E-3
73	Ta-172 <sup>2</sup>	Y: elemental Ta, halides, oxides, hydroxides, carbides, nitrates, and nitrides	0	1E+5	4E-5	1E-7	0	0
73	Ta-173	W: see Ta-172	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
73	Ta-173	Y: see Ta-172	0	2E+4	7E-6	2E-8	0	0
73	Ta-174 <sup>2</sup>	W: see Ta-172	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
73	Ta-174 <sup>2</sup>	Y: see Ta-172	0	9E+4	4E-5	1E-7	0	0
73	Ta-175	W: see Ta-172	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
73	Ta-175	Y: see Ta-172	0	1E+4	6E-6	2E-8	0	0
73	Ta-176	W: see Ta-172	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
73	Ta-176	Y: see Ta-172	0	1E+4	5E-6	2E-8	0	0
73	Ta-177	W: see Ta-172	1E+4	2E+4	8E-6	3E-8	2E-4	2E-3
73	Ta-177	Y: see Ta-172	0	2E+4	7E-6	2E-8	0	0
73	Ta-178	W: see Ta-172	2E+4	9E+4	4E-5	1E-7	2E-4	2E-3
73	Ta-178	Y: see Ta-172	0	7E+4	3E-5	1E-7	0	0
73	Ta-179	W: see Ta-172	2E+4	5E+3	2E-6	8E-9	3E-4	3E-3

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
73	Ta-179	Y: see Ta-172	0	9E+2	4E-7	1E-9	0	0
73	Ta-180m	W: see Ta-172	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
73	Ta-180m	Y: see Ta-172	0	6E+4	2E-5	8E-8	0	0
73	Ta-180	W: see Ta-172	1E+3	4E+2	2E-7	6E-10	2E-5	2E-4
73	Ta-180	Y: see Ta-172	0	2E+1	1E-8	3E-11	0	0
73	Ta-182m <sup>2</sup>	W: see Ta-172	2E+5 St Wall (2E+5)	5E+5 0	2E-4 0	8E-7 0	0 3E-3	0 3E-2
73	Ta-182m <sup>2</sup>	Y: see Ta-172	0	4E+5	2E-4	6E-7	0	0
73	Ta-182	W: see Ta-172	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
73	Ta-182	Y: see Ta-172	0	1E+2	6E-8	2E-10	0	0
73	Ta-183	W: see Ta-172	9E+2 LLI Wall (1E+3)	1E+3 0	5E-7 0	2E-9 0	0 2E-5	0 2E-4
73	Ta-183	Y: see Ta-172	0	1E+3	4E-7	1E-9	0	0
73	Ta-184	W: see Ta-172	2E+3	5E+3	2E-6	8E-9	3E-5	3E-4
73	Ta-184	Y: see Ta-172	0	5E+3	2E-6	7E-9	0	0
73	Ta-185 <sup>2</sup>	W: see Ta-172	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
73	Ta-185 <sup>2</sup>	Y: see Ta-172	0	6E+4	3E-5	9E-8	0	0
73	Ta-186 <sup>2</sup>	W: see Ta-172	5E+4 (St Wall (7E+4)	2E+5 0	1E-4 0	3E-7 0	0 1E-3	0 1E-2
73	Ta-186 <sup>2</sup>	Y: see Ta-172	0	2E+5	9E-5	3E-7	0	0
74	W-176	D: all compounds	1E+4	5E+4	2E-5	7E-8	1E-4	1E-3
74	W-177	D: all compounds	2E+4	9E+4	4E-5	1E-7	3E-4	3E-3
74	W-178	D: all compounds	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
74	W-179 <sup>2</sup>	D: all compounds	5E+5	2E+6	7E-4	2E-6	7E-3	7E-2
74	W-181	D: all compounds	2E+4	3E+4	1E-5	5E-8	2E-4	2E-3
74	W-185	D: all compounds	2E+3 LLI Wall (3E+3)	7E+3 0	3E-6 0	9E-9 0	0 4E-5	0 4E-4
74	W-187	D: all compounds	2E+3	9E+3	4E-6	1E-8	3E-5	3E-4
74	W-188	D: all compounds	4E+2 LLI Wall (5E+2)	1E+3 0	5E-7 0	2E-9 0	0 6E-6	0 6E-5
75	Re-177 <sup>2</sup>	D: all compounds except those given for W	9E+4 St Wall (1E+5)	3E+5 0	1E-4 0	4E-7 0	0 2E-3	0 2E-2
75	Re-177 <sup>2</sup>	W: nitrates, oxides, and hydroxides	0	4E+5	1E-4	5E-7	0	0
75	Re-178 <sup>2</sup>	D: see Re-177	7E+4 St Wall (1E+5)	3E+5 0	1E-4 0	4E-7 0	0 1E-3	0 1E-2
75	Re-178 <sup>2</sup>	W: see Re-177	0	3E+5	1E-4	4E-7	0	0
75	Re-181	D: see Re-177	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
75	Re-181	W: see Re-177	0	9E+3	4E-6	1E-8	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
75	Re-182 (12.7 h)	D: see Re-177	7E+3	1E+4	5E-6	2E-8	9E-5	9E-4
75	Re-182 (12.7 h)	W: see Re-177	0	2E+4	6E-6	2E-8	0	0
75	Re-182 (64.0 h)	D: see Re-177	1E+3	2E+3	1E-6	3E-9	2E-5	2E-4
75	Re-182 (64.0 h)	W: see Re-177	0	2E+3	9E-7	3E-9	0	0
75	Re-184m	D: see Re-177	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
75	Re-184m	W: see Re-177	0	4E+2	2E-7	6E-10	0	0
75	Re-184	D: see Re-177	2E+3	4E+3	1E-6	5E-9	3E-5	3E-4
75	Re-184	W: see Re-177	0	1E+3	6E-7	2E-9	0	0
75	Re-186m	D: see Re-177	1E+3	2E+3	7E-7	0	0	0
			St Wall (2E+3)	St wall (2E+3)	0	3E-9	2E-5	2E-4
75	Re-186m	W: see Re-177	0	2E+2	6E-8	2E-10	0	0
75	Re-186	D: see Re-177	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
75	Re-186	W: see Re-177	0	2E+3	7E-7	2E-9	0	0
75	Re-187	D: see Re-177	6E+5	8E+5	4E-4	0	8E-3	8E-2
			0	St wall (9E+5)	0	1E-6	0	0
75	Re-187	W: see Re-177	0	1E+5	4E-5	1E-7	0	0
75	Re-188m <sup>2</sup>	D: see Re-177	8E+4	1E+5	6E-5	2E-7	1E-3	1E-2
75	Re-188m <sup>2</sup>	W: see Re-177	0	1E+5	6E-5	2E-7	0	0
75	Re-188	D: see Re-177	2E+3	3E+3	1E-6	4E-9	2E-5	2E-4
75	Re-188	W: see Re-177	0	3E+3	1E-6	4E-9	0	0
75	Re-189	D: see Re-177	3E+3	5E+3	2E-6	7E-9	4E-5	4E-4
75	Re-189	W: see Re-177	0	4E+3	2E-6	6E-9	0	0
76	Os-180 <sup>2</sup>	D: all compounds except those given for W, Y	1E+5	4E+5	2E-4	5E-7	1E-3	1E-2
76	Os-180 <sup>2</sup>	W: halides and nitrates	0	5E+5	2E-4	7E-7	0	0
76	Os-180 <sup>2</sup>	Y: oxides and hydroxides	0	5E+5	2E-4	6E-7	0	0
76	Os-181 <sup>2</sup>	D: see Os-180	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
76	Os-181 <sup>2</sup>	W: see Os-180	0	5E+4	2E-5	6E-8	0	0
76	Os-181 <sup>2</sup>	Y: see Os-180	0	4E+4	2E-5	6E-8	0	0
76	Os-182	D: see Os-180	2E+3	6E+3	2E-6	8E-9	3E-5	3E-4
76	Os-182	W: see Os-180	0	4E+3	2E-6	6E-9	0	0
76	Os-182	Y: see Os-180	0	4E+3	2E-6	6E-9	0	0
76	Os-185	D: see Os-180	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
76	Os-185	W: see Os-180	0	8E+2	3E-7	1E-9	0	0
76	Os-185	Y: see Os-180	0	8E+2	3E-7	1E-9	0	0
76	Os-189m	D: see Os-180	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
76	Os-189m	W: see Os-180	0	2E+5	9E-5	3E-7	0	0
76	Os-189m	Y: see Os-180	0	2E+5	7E-5	2E-7	0	0
76	Os-191m	D: see Os-180	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
76	Os-191m	W: see Os-180	0	2E+4	8E-6	3E-8	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
76	Os-191m	Y: see Os-180	0	2E+4	7E-6	2E-8	0	0
76	Os-191	D: see Os-180	2E+3 LLI Wall (3E+3)	2E+3 0	9E-7 0	3E-9 0	0 3E-5	0 3E-4
76	Os-191	W: see Os-180	0	2E+3	7E-7	2E-9	0	0
76	Os-191	Y: see Os-180	0	1E+3	6E-7	2E-9	0	0
76	Os-193	D: see Os-180	2E+3 LLI Wall (2E+3)	5E+3 0	2E-6 0	6E-9 0	0 2E-5	0 2E-4
76	Os-193	W: see Os-180	0	3E+3	1E-6	4E-9	0	0
76	Os-193	Y: see Os-180	0	3E+3	1E-6	4E-9	0	0
76	Os-194	D: see Os-180	4E+2 LLI Wall (6E+2)	4E+1 0	2E-8 0	6E-11 0	0 8E-6	0 8E-5
76	Os-194	W: see Os-180	0	6E+1	2E-8	6E-11	0	0
76	Os-194	Y: see Os-180	0	8E+0	3E-9	1E-11	0	0
77	Ir-182 <sup>2</sup>	D: all compounds except those given for W, Y	4E+4 St Wall (4E+4)	1E+5 0	6E-5 0	2E-7 0	0 6E-4	0 6E-3
77	Ir-182 <sup>2</sup>	W: halides, nitrates, and metallic Ir	0	2E+5	6E-5	2E-7	0	0
77	Ir-182 <sup>2</sup>	Y: oxides and hydroxides	0	1E+5	5E-5	2E-7	0	0
77	Ir-184	D: see Ir-182	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
77	Ir-184	W: see Ir-182	0	3E+4	1E-5	5E-8	0	0
77	Ir-184	Y: see Ir-182	0	3E+4	1E-5	4E-8	0	0
77	Ir-185	D: see Ir-182	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
77	Ir-185	W: see Ir-182	0	1E+4	5E-6	2E-8	0	0
77	Ir-185	Y: see Ir-182	0	1E+4	4E-6	1E-8	0	0
77	Ir-186	D: see Ir-182	2E+3	8E+3	3E-6	1E-8	3E-5	3E-5
77	Ir-186	W: see Ir-182	0	6E+3	3E-6	9E-9	0	0
77	Ir-186	Y: see Ir-182	0	6E+3	2E-6	8E-9	0	0
77	Ir-187	D: see Ir-182	1E+4	3E+4	1E-5	5E-8	1E-4	1E-3
77	Ir-187	W: see Ir-182	0	3E+4	1E-5	4E-8	0	0
77	Ir-187	Y: see Ir-182	0	3E+4	1E-5	4E-8	0	0
77	Ir-188	D: see Ir-182	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
77	Ir-188	W: see Ir-182	0	4E+3	1E-6	5E-9	0	0
77	Ir-188	Y: see Ir-182	0	3E+3	1E-6	5E-9	0	0
77	Ir-189	D: see Ir-182	5E+3 LLI Wall (5E+3)	5E+3 0	2E-6 0	7E-9 0	0 7E-5	0 7E-4
77	Ir-189	W: see Ir-182	0	4E+3	2E-6	5E-9	0	0
77	Ir-189	Y: see Ir-182	0	4E+3	1E-6	5E-9	0	0
77	Ir-190m <sup>2</sup>	D: see Ir-182	2E+5	2E+5	8E-5	3E-7	2E-3	2E-2
77	Ir-190m <sup>2</sup>	W: see Ir-182	0	2E+5	9E-5	3E-7	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
77	Ir-190m <sup>2</sup>	Y: see Ir-182	0	2E+5	8E-5	3E-7	0	0
77	Ir-190	D: see Ir-182	1E+3	9E+2	4E-7	1E-9	1E-5	1E-4
77	Ir-190	W: see Ir-182	0	1E+3	4E-7	1E-9	0	0
77	Ir-190	Y: see Ir-182	0	9E+2	4E-7	1E-9	0	0
77	Ir-192m	D: see Ir-182	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
77	Ir-192m	W: see Ir-182	0	2E+2	9E-8	3E-10	0	0
77	Ir-192m	Y: see Ir-182	0	2E+1	6E-9	2E-11	0	0
77	Ir-192	D: see Ir-182	9E+2	3E+2	1E-7	4E-10	1E-5	1E-4
77	Ir-192	W: see Ir-182	0	4E+2	2E-7	6E-10	0	0
77	Ir-192	Y: see Ir-182	0	2E+2	9E-8	3E-10	0	0
77	Ir-194m	D: see Ir-182	6E+2	9E+1	4E-8	1E-10	9E-6	9E-5
77	Ir-194m	W: see Ir-182	0	2E+2	7E-8	2E-10	0	0
77	Ir-194m	Y: see Ir-182	0	1E+2	4E-8	1E-10	0	0
77	Ir-194	D: see Ir-182	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
77	Ir-194	W: see Ir-182	0	2E+3	9E-7	3E-9	0	0
77	Ir-194	Y: see Ir-182	0	2E+3	8E-7	3E-9	0	0
77	Ir-195m	D: see Ir-182	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
77	Ir-195m	W: see Ir-182	0	3E+4	1E-5	4E-8	0	0
77	Ir-195m	Y: see Ir-182	0	2E+4	9E-6	3E-8	0	0
77	Ir-195	D: see Ir-182	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
77	Ir-195	W: see Ir-182	0	5E+4	2E-5	7E-8	0	0
77	Ir-195	Y: see Ir-182	0	4E+4	2E-5	6E-8	0	0
78	Pt-186	D: all compounds	1E+4	4E+4	2E-5	5E-8	2E-4	2E-3
78	Pt-188	D: all compounds	2E+3	2E+3	7E-7	2E-9	2E-5	0
78	Pt-189	D: all compounds	1E+4	3E+4	1E-5	4E-8	1E-4	0
78	Pt-191	D: all compounds	4E+3	8E+3	4E-6	1E-8	5E-5	5E-4
78	Pt-193m	D: all compounds	3E+3	6E+3	3E-6	8E-9	0	0
			LLI Wall (3E+4)	0	0	0	4E-5	4E-4
78	Pt-193	D: all compounds	4E+4	2E+4	1E-5	3E-8	0	0
			LLI Wall (5E+4)	0	0	0	6E-4	6E-3
78	Pt-195m	D: all compounds	2E+3	4E+3	2E-6	6E-9	0	0
			LLI Wall (2E+3)	0	0	0	3E-5	3E-4
78	Pt-197m <sup>2</sup>	D: all compounds	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
78	Pt-197	D: all compounds	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
78	Pt-199 <sup>2</sup>	D: all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
78	Pt-200	D: all compounds	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
79	Au-193	D: all compounds except those given for W, Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
79	Au-193	W: halides and nitrates	0	2E+4	9E-6	3E-8	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
79	Au-193	Y: oxides and hydroxides	0	2E+4	8E-6	3E-8	0	0
79	Au-194	D: see Au-193	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
79	Au-194	W: see Au-193	0	5E+3	2E-6	8E-9	0	0
79	Au-194	Y: see Au-193	0	5E+3	2E-6	7E-9	0	0
79	Au-195	D: see Au-193	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
79	Au-195	W: see Au-193	0	1E+3	6E-7	2E-9	0	0
79	Au-195	Y: see Au-193	0	4E+2	2E-7	6E-10	0	0
79	Au-198m	D: see Au-193	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
79	Au-198m	W: see Au-193	0	1E+3	5E-7	2E-9	0	0
79	Au-198m	Y: see Au-193	0	1E+3	5E-7	2E-9	0	0
79	Au-198	D: see Au-193	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
79	Au-198	W: see Au-193	0	2E+3	8E-7	3E-9	0	0
79	Au-198	Y: see Au-193	0	2E+3	7E-7	2E-9	0	0
79	Au-199	D: see Au-193	3E+3 LLI Wall (3E+3)	9E+3 0	4E-6 0	1E-8 0	0 4E-5	0 4E-4
79	Au-199	W: see Au-193	0	4E+3	2E-6	6E-9	0	0
79	Au-199	Y: see Au-193	0	4E+3	2E-6	5E-9	0	0
79	Au-200m	D: see Au-193	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
79	Au-200m	W: see Au-193	0	3E+3	1E-6	4E-9	0	0
79	Au-200m	Y: see Au-193	0	2E+4	1E-6	3E-9	0	0
79	Au-200 <sup>2</sup>	D: see Au-193	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
79	Au-200 <sup>2</sup>	W: see Au-193	0	8E+4	3E-5	1E-7	0	0
79	Au-200 <sup>2</sup>	Y: see Au-193	0	7E+4	3E-5	1E-7	0	0
79	Au-201 <sup>2</sup>	D: see Au-193	7E+4 St Wall (9E+4)	2E+5 0	9E-5 0	3E-7 0	0 1E-3	0 1E-2
79	Au-201 <sup>2</sup>	W: see Au-193	0	2E+5	1E-4	3E-7	0	0
79	Au-201 <sup>2</sup>	Y: see Au-193	0	2E+5	9E-5	3E-7	0	0
80	Hg-193m	Vapor	0	8E+3	4E-6	1E-8	0	0
80	Hg-193m	Organic D	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
80	Hg-193m	D: sulfates	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
80	Hg-193m	W: halides, nitrates, sulfides, oxides, and hydroxides	0	8E+3	3E-6	1E-8	0	0
80	Hg-193	Vapor	0	3E+4	1E-5	4E-8	0	0
80	Hg-193	Organic D	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
80	Hg-193	D: see Hg-193m	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
80	Hg-193	W: see Hg-193m	0	4E+4	2E-5	6E-8	0	0
80	Hg-194	Vapor	0	3E+1	1E-8	4E-11	0	0
80	Hg-194	Organic D	2E+1	3E+1	1E-8	4E-11	2E-7	2E-6
80	Hg-194	D: see Hg-193m	8E+2	4E+1	2E-8	6E-11	1E-5	1E-4
80	Hg-194	W: see Hg-193m	0	1E+2	5E-8	2E-10	0	0
80	Hg-195m	Vapor	0	4E+3	2E-6	6E-9	0	0



At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
80	Hg-195m	Organic D	3E+3	6E+3	3E-6	8E-9	4E-5	4E-4
80	Hg-195m	D: see Hg-193m	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
80	Hg-195m	W: see Hg-193m	0	4E+3	2E-6	5E-9	0	0
80	Hg-195	Vapor	0	3E+4	1E-5	4E-8	0	0
80	Hg-195	Organic D	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
80	Hg-195	D: see Hg-193m	1E+4	4E+4	1E-5	5E-8	2E-4	2E-3
80	Hg-195	W: see Hg-193m	0	3E+4	1E-5	5E-8	0	0
80	Hg-197m	Vapor	0	5E+3	2E-6	7E-9	0	0
80	Hg-197m	Organic D	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
80	Hg-197m	D: see Hg-193m	3E+3	7E+3	3E-6	1E-8	4E-5	4E-4
80	Hg-197m	W: see Hg-193m	0	5E+3	2E-6	7E-9	0	0
80	Hg-197	Vapor	0	8E+3	4E-6	1E-8	0	0
80	Hg-197	Organic D	7E+3	1E+4	6E-6	2E-8	9E-5	9E-4
80	Hg-197	D: see Hg-193m	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
80	Hg-197	W: see Hg-193m	0	9E+3	4E-6	1E-8	0	0
80	Hg-199m <sup>2</sup>	Vapor	0	8E+4	3E-5	1E-7	0	0
80	Hg-199m <sup>2</sup>	Organic D	6E+4 St Wall (1E+5)	2E+5 0	7E-5 0	1E-7 0	0 1E-3	0 1E-2
80	Hg-199m <sup>2</sup>	D: see Hg-193m	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
80	Hg-199m <sup>2</sup>	W: see Hg-193m	0	2E+5	7E-5	2E-7	0	0
80	Hg-203	Vapor	0	8E+2	4E-7	1E-9	0	0
80	Hg-203	Organic D	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
80	Hg-203	D: see Hg-193m	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
80	Hg-203	W: see Hg-193m	0	1E+3	5E-7	2E-9	0	0
81	Tl-194m <sup>2</sup>	D: all compounds	5E+4 St Wall (7E+4)	2E+5 0	6E-5 0	2E-7 0	0 1E-3	0 1E-2
81	Tl-194 <sup>2</sup>	D: all compounds	3E+5 St Wall (3E+5)	6E+5 0	2E-4 0	8E-7 0	0 4E-2	0 4E-1
81	Tl-195 <sup>2</sup>	D: all compounds	6E+4	1E+5	5E-5	2E-7	9E-4	9E-3
81	Tl-197	D: all compounds	7E+4	1E+5	5E-5	2E-7	1E-3	1E-2
81	Tl-198m <sup>2</sup>	D: all compounds	3E+4	5E+4	2E-5	8E-8	4E-4	4E-3
81	Tl-198	D: all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
81	Tl-199	D: all compounds	6E+4	8E+4	4E-5	1E-7	9E-4	9E-3
81	Tl-200	D: all compounds	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
81	Tl-201	D: all compounds	2E+4	2E+4	9E-6	3E-8	2E-4	2E-3
81	Tl-202	D: all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
81	Tl-204	D: all compounds	2E+3	2E+3	9E-7	3E-9	2E-5	2E-4
82	Pb-195m <sup>2</sup>	D: all compounds	6E+4	2E+5	8E-5	3E-7	8E-4	8E-3
82	Pb-198	D: all compounds	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
82	Pb-199 <sup>2</sup>	D: all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
82	Pb-200	D: all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
82	Pb-201	D: all compounds	7E+3	2E+4	8E-6	3E-8	1E-4	1E-3

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
82	Pb-202m	D: all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
82	Pb-202	D: all compounds	1E+2	5E+1	2E-8	7E-11	2E-6	2E-5
82	Pb-203	D: all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
82	Pb-205	D: all compounds	4E+3	1E+3	6E-7	2E-9	5E-5	5E-4
82	Pb-209	D: all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
82	Pb-210	D: all compounds	6E-1 Bone Surf (1E+0)	2E+1 Bone surf (4E-1)	1E-10 0	0 6E-13	0 1E-8	0 1E-7
82	Pb-211 <sup>2</sup>	D: all compounds	1E+4	6E+2	3E-7	9E-10	2E-4	2E-3
82	Pb-212	D: all compounds	8E+1 Bone Surf (1E+2)	3E+1 0	1E-8 0	5E-11 0	0 2E-6	0 2E-5
82	Pb-214 <sup>2</sup>	D: all compounds	9E+3	8E+2	3E-7	1E-9	1E-4	1E-3
83	Bi-200 <sup>2</sup>	D: nitrates	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
83	Bi-200 <sup>2</sup>	W: all other compounds	0	1E+5	4E-5	1E-7	0	0
83	Bi-201 <sup>2</sup>	D: see Bi-200	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
83	Bi-201 <sup>2</sup>	W: see Bi-200	0	4E+4	2E-5	5E-8	0	0
83	Bi-202 <sup>2</sup>	D: see Bi-200	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
83	Bi-202 <sup>2</sup>	W: see Bi-200	0	8E+4	3E-5	1E-7	0	0
83	Bi-203	D: see Bi-200	2E+3	7E+3	3E-6	9E-9	3E-5	3E-4
83	Bi-203	W: see Bi-200	0	6E+3	3E-6	9E-9	0	0
83	Bi-205	D: see Bi-200	1E+3	3E+3	1E-6	3E-9	2E-5	2E-4
83	Bi-205	W: see Bi-200	0	1E+3	5E-7	2E-9	0	0
83	Bi-206	D: see Bi-200	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
83	Bi-206	W: see Bi-200	0	9E+2	4E-7	1E-9	0	0
83	Bi-207	D: see Bi-200	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
83	Bi-207	W: see Bi-200	0	4E+2	1E-7	5E-10	0	0
83	Bi-210m	D: see Bi-200	4E+1 Kidneys (6E+1)	5E+0 Kidney (6E+0)	2E-9 0	0 9E-12	0 8E-7	0 8E-6
83	Bi-210m	W: see Bi-200	0	7E-1	3E-10	9E-13	0	0
83	Bi-210	D: see Bi-200	8E+2	2E+2 Kidney (4E+2)	1E-7 0	0 5E-10	1E-5 0	1E-4 0
83	Bi-210	W: see Bi-200	0	3E+1	1E-8	4E-11	0	0
83	Bi-212 <sup>2</sup>	D: see Bi-200	5E+3	2E+2	1E-7	3E-10	7E-5	7E-4
83	Bi-212 <sup>2</sup>	W: see Bi-200	0	3E+2	1E-7	4E-10	0	0
83	Bi-213 <sup>2</sup>	D: see Bi-200	7E+3	3E+2	1E-7	4E-10	1E-4	1E-3
83	Bi-213 <sup>2</sup>	W: see Bi-200	0	4E+2	1E-7	5E-10	0	0
83	Bi-214 <sup>2</sup>	D: see Bi-200	2E+4 St Wall (2E+4)	8E+2 0	3E-7 0	1E-9 0	0 3E-4	0 3E-3
83	Bi-214 <sup>2</sup>	W: see Bi-200	0	9E-2	4E-7	1E-9	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
84	Po-203 <sup>2</sup>	D: all compounds except those given for W	3E+4	6E+4	3E-5	9E-8	3E-4	3E-3
84	Po-203 <sup>2</sup>	W: nitrates, oxides, and hydroxides	0	9E+4	4E-5	1E-7	0	0
84	Po-205 <sup>2</sup>	D: see Po-203	2E+4	4E+4	2E-5	5E-8	3E-4	3E-3
84	Po-205 <sup>2</sup>	W: see Po-203	0	7E+4	3E-5	1E-7	0	0
84	Po-207	D: see Po-203	8E+3	3E+4	1E-5	3E-8	1E-4	1E-4
84	Po-207	W: see Po-203	0	3E+4	1E-5	4E-8	0	0
84	Po-210	D: see Po-203	3E+0	6E-1	3E-10	9E-13	4E-8	4E-7
84	Po-210	W: see Po-203	0	6E-1	3E-10	9E-13	0	0
85	At-207 <sup>2</sup>	D: halides	6E+3	3E+3	1E-6	4E-9	8E-5	8E-4
85	At-207 <sup>2</sup>	W: all compounds except those given in D	0	2E+3	9E-7	3E-9	0	0
85	At-211	D: halides	1E+2	8E+1	3E-8	1E-10	2E-6	2E-5
85	At-211	W: all compounds except those given in D	0	5E+1	2E-8	8E-11	0	0
86	Rn-220	With daughters removed	0	2E+4	7E-6	2E-8	0	0
86	Rn-220	With daughters present	0	2E+1 (or 12 working level months)	9E-9	3E-11 (or 1.0 working level)	0	0
86	Rn-222	With daughters removed	0	1E+4	4E-6	1E-8	0	0
86	Rn-222	With daughters present	0	1E+2 (or 12 working level months)	3E-8	1E-10 (or 0.33 working level)	0	0
87	Fr-222 <sup>2</sup>	D: all compounds	2E+3	5E+2	2E-7	6E-10	3E-5	3E-4
87	Fr-232 <sup>2</sup>	D: all compounds	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
88	Ra-223	W: all compounds	5E+0 Bone Surf (9E+0)	7E-1 0	3E-10 0	9E-13 0	0 1E-7	0 1E-6
88	Ra-224	W: all compounds	8E+0 Bone Surf (2E+1)	2E+0 0	7E-10 0	2E-12 0	0 2E-7	0 2E-6
88	Ra-225	W: all compounds	8E+0 Bone Surf (2E+1)	7E-1 0	3E-10 0	9E-13 0	0 2E-7	0 2E-6
88	Ra-226	W: all compounds	2E+0 Bone Surf (5E+0)	6E-1 0	3E-10 0	9E-13 0	0 6E-8	0 6E-7

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
88	Ra-227 <sup>2</sup>	W: all compounds	2E+4 Bone Surf (2E+4)	1E+4 Bone surf (2E+4)	6E-6 0	0 3E-8	0 3E-4	0 3E-3
88	Ra-228	W: all compounds	2E+0 Bone Surf (4E+0)	1E+0 0	5E-10 0	2E-12 0	0 6E-8	0 6E-7
89	Ac-224	D: all compounds except those given for W, Y	2E+3 LLI Wall 2E+3	3E+1 Bone surf (4E+1)	1E-8 0	0 5E-11	0 3E-5	0 3E-4
89	Ac-224	W: halides and nitrates	0	5E+1	2E-8	7E-11	0	0
89	Ac-224	Y: oxides and hydroxides	0	5E+1	2E-8	6E-11	0	0
89	Ac-225	D: see Ac-224	5E+1 LLI Wall (5E+)	3E-1 Bone surf (5E-1)	1E-10 0	0 7E-13	0 7E-7	0 7E-6
89	Ac-225	W: see Ac-224	0	6E-1	3E-10	9E-13	0	0
89	Ac-225	Y: see Ac-224	0	6E-1	3E-10	9E-13	0	0
89	Ac-225	D: see Ac-224	1E+2 LLI Wall (1E+2)	3E+0 Bone surf (4E+0)	1E-9 0	0 5E-12	0 2E-6	0 2E-5
89	Ac-225	W: see Ac-224	0	5E+0	2E-9	7E-12	0	0
89	Ac-225	Y: see Ac-224	0	5E+0	2E-9	6E-12	0	0
89	Ac-227	D: see Ac-224	2E-1 Bone Surf (4E-1)	4E-4 Bone surf (8E-4)	2E-13 0	0 1E-15	0 5E-9	0 5E-8
89	Ac-227	W: see Ac-224	0	2E-3 Bone surf (3E-3)	7E-13 0	0 4E-15	0 0	0 0
89	Ac-227	Y: see Ac-224	0	4E-3	2E-12	6E-15	0	0
89	Ac-228	D: see Ac-224	2E+3 0	9E+0 Bone surf (4E+1)	4E-9 0	0 2E-11	3E-5 0	3E-4 0
89	Ac-228	W: see Ac-224	0	4E+1 Bone surf (6E+1)	2E-8 0	0 8E-11	0 0	0 0
89	Ac-228	Y: see Ac-224	0	4E+1	2E-8	6E-11	0	0
90	Th-226	W: all compounds except those given for Y	5E+3 St Wall (5E+3)	2E+2 0	6E-8 0	2E-10 0	0 7E-5	0 7E-4
90	Th-226 <sup>2</sup>	Y: oxides and hydroxides	0	1E+2	6E-8	2E-10	0	0
90	Th-227	W: see Th-226	1E+2	3E-1	1E-10	5E-13	2E-6	2E-5
90	Th-227	Y: see Th-226	0	3E-1	1E-10	5E-13	0	0
90	Th-228	W: see Th-226	6E+0 Bone Surf (1E+1)	1E-2 Bone surf (2E-2)	4E-12 0	0 3E-14	0 2E-7	0 2E-6
90	Th-228	Y: see Th-226	0	2E-2	7E-12	2E-14	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
90	Th-229	W: see Th-226	6E-1 Bone Surf (1E+0)	9E-4 Bone surf (2E-3)	4E-13 0	0 3E-15	0 2E-8	0 2E-7
90	Th-229	Y: see Th-226	0 0	2E-3 Bone surf (3E-3)	1E-12 0	0 4E-15	0 0	0 0
90	Th-230	W: see Th-226	4E+0 Bone Surf (9E+0)	6E-3 Bone surf (2E-2)	3E-12 0	0 2E-14	0 1E-7	0 1E-6
90	Th-230	Y: see Th-226	0 0	2E-2 Bone surf (2E-2)	6E-12	0 3E-14	0 0	0 0
90	Th-231	W: see Th-226	4E+3	6E+3	3E-6	9E-9	5E-5	5E-4
90	Th-231	Y: see Th-226	0	6E+3	3E-6	9E-9	0	0
90	Th-232	W: see Th-226	7E-1 Bone Surf (2E+0)	1E-3 Bone surf (3E-3)	5E-13 0	0 4E-15	0 3E-8	0 3E-7
90	Th-232	Y: see Th-226	0	3E-3 Bone surf (4E-3)	1E-12	0 6E-15	0 0	0 0
90	Th-234	W: see Th-226	3E+2 LLI Wall (4E+2)	2E+2 0	8E-8 0	3E-10 0	0 5E-6	0 5E-5
90	Th-234	Y: see Th-226	0	2E+2	6E-8	2E-10	0	0
91	Pa-227 <sup>2</sup>	W: all compounds except those given for Y	4E+3	1E+2	5E-8	2E-10	5E-5	5E-4
91	Pa-227 <sup>2</sup>	Y: oxides and hydroxides	0	1E+2	4E-8	1E-10	0	0
91	Pa-228	W: see Pa-227	1E+3 0	1E+1 Bone surf (2E+1)	5E-9 0	0 3E-11	2E-5 0	2E-4 0
91	Pa-228	Y: see Pa-227	0	1E+1	5E-9	2E-11	0	0
91	Pa-230	W: see Pa-227	6E+2 Bone Surf (9E+2)	5E+0 0	2E-9 0	7E-12 0	0 1E-5	0 1E-4
91	Pa-230	Y: see Pa-227	0	4E+0	1E-9	5E-12	0	0
91	Pa-231	W: see Pa-227	2E-1 Bone Surf (5E-1)	3E-3 Bone surf (4E-3)	6E-13 0	0 6E-15	0 6E-9	0 6E-8
91	Pa-231	Y: see Pa-227	0 0	4E-3 Bone surf (6E-3)	2E-12 0	0 8E-15	0 0	0 0
91	Pa-232	W: see Pa-227	1E+3 0	2E+1 Bone surf (6E+1)	9E-9 0	0 8E-11	2E-5 0	2E-4 0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
91	Pa-232	Y: see Pa-227	0	6E+1 Bone surf (7E+0)	2E-8	0	0	0
91	Pa-233	W: see Pa-227	1E+3 LLI Wall (2E+3)	7E+2	2E-7	1E-9	0	0
91	Pa-233	Y: see Pa-227	0	6E+2	3E-7	8E-10	0	0
91	Pa-234	W: see Pa-227	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
91	Pa-234	Y: see Pa-227	0	7E+3	3E-6	9E-9	0	0
92	U-230	D: UF <sub>6</sub> , UO <sub>2</sub> F <sub>2</sub> , UO <sub>2</sub> (NO <sub>3</sub> ) <sub>2</sub>	4E+0 Bone Surf (6E+0)	4E-1 Bone surf (6E-1)	2E-10	0	0	0
92	U-230	W: UO <sub>3</sub> , UF <sub>4</sub> , UCl <sub>4</sub>	0	4E-1	1E-10	5E-13	0	0
92	U-230	Y: UO <sub>2</sub> , U <sub>3</sub> O <sub>8</sub>	0	3E-1	1E-10	4E-13	0	0
92	U-231	D: see U-230	5E+3 LLI Wall (4E+3)	8E+3	3E-6	1E-8	0	0
92	U-231	W: see U-230	0	6E+3	2E-6	8E-9	0	0
92	U-231	Y: see U-230	0	5E+3	2E-6	6E-9	0	0
92	U-232	D: see U-230	2E+0 Bone Surf (4E+0)	2E-1 Bone surf (4E-1)	9E-11	0	0	0
92	U-232	W: see U-230	0	4E-1	2E-10	5E-13	0	0
92	U-232	Y: see U-230	0	8E-3	3E-12	1E-14	0	0
92	U-233	D: see U-230	1E+1 Bone Surf (2E+1)	1E+0 Bone surf (2E+0)	5E-10	0	0	0
92	U-233	W: see U-230	0	7E-1	3E-10	1E-12	0	0
92	U-233	Y: see U-230	0	4E-2	2E-11	5E-14	0	0
92	U-234 <sup>3</sup>	D: see U-230	1E+1 Bone Surf (2E+1)	1E+0 Bone surf (2E+0)	5E-10	0	0	0
92	U-234 <sup>3</sup>	W: see U-230	0	7E-1	3E-10	1E-12	0	0
92	U-234 <sup>3</sup>	Y: see U-230	0	4E-2	2E-11	5E-14	0	0
92	U-235 <sup>3</sup>	D: see U-230	1E+1 Bone Surf (2E+1)	1E+0 Bone surf (2E+0)	6E-10	0	0	0
92	U-235 <sup>3</sup>	W: see U-230	0	8E-1	3E-10	1E-12	0	0
92	U-235 <sup>3</sup>	Y: see U-230	0	4E-2	2E-11	6E-14	0	0
92	U-236	D: see U-230	1E+1 Bone Surf (2E+1)	1E+0 Bone surf (2E+0)	5E-10	0	0	0
92	U-236	W: see U-230	0	8E-1	3E-10	1E-12	0	0
92	U-236	Y: see U-230	0	4E-2	2E-11	6E-14	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
92	U-237	D: see U-230	2E+3 LLI Wall (2E+3)	3E+3 0	1E-6 0	4E-9 0	0 3E-5	0 3E-4
92	U-237	W: see U-230	0	2E+3	7E-7	2E-9	0	0
92	U-237	Y: see U-230	0	2E+3	6E-7	2E-9	0	0
92	U-238 <sup>3</sup>	D: see U-230	1E+1 Bone Surf (2E+1)	1E+0 Bone surf (2E+0)	6E-10 0	0 3E-12	0 3E-7	0 3E-6
92	U-237	W: see U-230	0	8E-1	3E-10	1E-12	0	0
92	U-237	Y: see U-230	0	4E-2	2E-11	6E-14	0	0
92	U-239 <sup>2</sup>	D: see U-230	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
92	U-239 <sup>2</sup>	W: see U-230	0	2E+5	7E-5	2E-7	0	0
92	U-239 <sup>2</sup>	Y: see U-230	0	2E+5	6E-5	2E-7	0	0
92	U-240	D: see U-230	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
92	U-240	W: see U-230	0	3E+3	1E-6	4E-9	0	0
92	U-240	Y: see U-230	0	2E+3	1E-6	3E-9	0	0
92	U-Nat <sup>3</sup>	D: see U-230	1E+1 Bone Surf (2E+1)	1E+0 Bone surf (2E+0)	5E-10 0	0 3E-12	0 3E-7	0 3E-6
92	U-Nat <sup>3</sup>	W: see U-230	0	8E-1	3E-10	9E-13	0	0
92	U-Nat <sup>3</sup>	Y: see U-230	0	5E-2	2E-11	9E-14	0	0
93	Np-232 <sup>2</sup>	W: all compounds	1E+5 0	2E+3 Bone surf (5E+2)	7E-7 0	0 6E-9	2E-3 0	2E-2 0
93	Np-233 <sup>2</sup>	W: all compounds	8E+5	3E+6	1E-3	4E-6	1E-2	1E-1
93	Np-234	W: all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
93	Np-235	W: all compounds	2E+4 LLI Wall 2E+4	8E+2 Bone surf (1E+3)	3E-7 0	0 2E-9	0 3E-4	0 3E-3
93	Np-236 (1E+5 y)	W: all compounds	3E+0 Bone Surf (6E+0)	2E-2 Bone surf (5E-2)	9E-12 0	0 8E-14	0 9E-8	0 9E-7
93	Np-236: (22.5 h)	W: all compounds	3E+3 Bone Surf (4E+3)	3E+1 Bone surf (7E+1)	1E-8 0	0 1E-10	0 5E-5	0 5E-4
93	Np-237	W: all compounds	5E-1 Bone Surf (1E+0)	4E-3 Bone surf (1E-2)	2E-12 0	0 1E-14	0 2E-8	0 2E-7
93	Np-238	W: all compounds	1E+3	6E+1 Bone surf (2E+2)	3E-8 0	0 2E-10	2E-5 0	2E-4 0
93	Np-239	W: all compounds	2E+3 LLI Wall (2E+3)	2E+3 0	9E-7 0	3E-9 0	0 2E-5	0 2E-4
93	Np-240 <sup>2</sup>	W: all compounds	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
94	Pu-234	W: all compounds except PuO <sub>2</sub>	8E+3	2E+2	9E-8	3E-10	1E-4	1E-3

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
94	Pu-234	Y: PuO <sub>2</sub>	0	2E+2	8E-8	3E-10	0	0
94	Pu-235 <sup>2</sup>	W: see Pu-234	9E+5	3E+6	1E-3	4E-6	1E-2	1E-1
94	Pu-235	Y: see Pu-234	0	3E+6	1E-3	3E-6	0	0
94	Pu-236	W: see Pu-234	2E+0 Bone Surf (4E+0)	2E-2 Bone surf (4E-2)	8E-12	0  5E-14	0  6E-8	0  6E-7
94	Pu-236	Y: see Pu-234	0	4E-2	2E-11	6E-14	0	0
94	Pu-237	W: see Pu-234	1E+4	3E+3	1E-6	5E-9	2E-4	2E-3
94	Pu-237	Y: see Pu-234	0	3E+3	1E-6	4E-9	0	0
94	Pu-238	W: see Pu-234	9E-1 Bone Surf (2E+0)	7E-3 Bone surf (1E-2)	3E-12  0	0  2E-14	0  2E-8	0  2E-7
94	Pu-238	Y: see Pu-234	0	2E-2	8E-12	2E-14	0	0
94	Pu-239	W: see Pu-234	8E-1 Bone Surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12  0	0  2E-14	0  2E-8	0  2E-7
94	Pu-239	Y: see Pu-234	0  0	2E-2 Bone surf (2E-2)	7E-12  0	0  2E-14	0  0	0  0
94	Pu-240	W: see Pu-234	8E-1 Bone Surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12	0  2E-14	0  2E-8	0  2E-7
94	Pu-240	Y: see Pu-234	0  0	2E-2 Bone surf (2E-2)	7E-12  0	0  2E-14	0  0	0  0
94	Pu-241	W: see Pu-234	4E+1 Bone Surf (7E+1)	3E-1 Bone surf (6E-1)	1E-10  0	0  8E-13	0  2E-6	0  2E-5
94	Pu-241	Y: see Pu-234	0  0	8E-1 Bone surf (1E+0)	3E-10  0	0  1E-12	0  0	0  0
94	Pu-242	W: see Pu-234	8E-1 Bone Surf (1E+0)	7E-3 Bone surf (1E-2)	3E-12  0	0  2E-14	0  2E-8	0  2E-7
94	Pu-242	Y: see Pu-234	0  0	2E-2 Bone surf (2E-2)	7E-12  0	0  2E-14	0  0	0  0
94	Pu-243	W: see Pu-234	2E+4	4E+4	2E-5	5E-8	2E-4	2E-3
94	Pu-243	Y: see Pu-234	0	4E+4	2E-5	5E-8	0	0
94	Pu-244	W: see Pu-234	8E-1 Bone Surf (2E+0)	7E-3 Bone surf (1E-2)	3E-12  0	0  2E-14	0  2E-8	0  2E-7
94	Pu-244	Y: see Pu-234	0	2E-2 Bone surf (2E-2)	7E-12  0	0  2E-14	0  0	0  0
94	Pu-245	W: see Pu-234	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
94	Pu-245	Y: see Pu-234	0	4E+3	2E-6	6E-9	0	0



At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
94	Pu-246	W: see Pu-234	4E+2 LLI Wall (4E+2)	3E+2 0	1E-7 0	4E-10 0	0 6E-6	0 6E-5
94	Pu-246	Y: see Pu-234	0	3E+2	1E-7	4E-10	0	0
95	Am-237 <sup>2</sup>	W: all compounds	8E+4	3E+5	1E-4	4E-7	1E-3	1E-2
95	Am-238 <sup>2</sup>	W: all compounds	4E+4	3E+3 Bone surf (6E+3)	1E-6 0	0 9E-9	5E-4 0	5E-3 0
95	Am-239	W: all compounds	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
95	Am-240	W: all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
95	Am-241	W: all compounds	8E-1 Bone Surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12 0	0 2E-14	0 2E-8	0 2E-7
95	Am-242m	W: all compounds	8E-1 Bone Surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12 0	0 2E-14	0 2E-8	0 2E-7
95	Am-242	W: all compounds	4E+3	8E+1 Bone surf (9E+1)	4E-8 0	0 1E-10	5E-5 0	5E-4 0
95	Am-243	W: all compounds	8E-1 Bone Surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12 0	0 2E-14	0 2E-8	0 2E-7
95	Am-244m <sup>2</sup>	W: all compounds	6E+4 St Wall (8E+4)	4E+3 Bone surf (7E+3)	2E-6 0	0 1E-8	0 1E-3	0 1E-2
95	Am-244	W: all compounds	3E+3 0	2E+2 Bone surf (3E+2)	8E-8 0	0 4E-10	4E-5 0	4E-4 0
95	Am-245	W: all compounds	3E+4	8E+4	3E-5	1E-7	4E-4	4E-3
95	Am-246m <sup>2</sup>	W: all compounds	5E+4 St Wall (6E+4)	2E+5 0	8E-5 0	3E-7 0	0 8E-4	0 8E-3
95	Am-246 <sup>2</sup>	W: all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
96	Cm-238	W: all compounds	2E+4	1E+3	5E-7	2E-9	2E-4	2E-3
96	Cm-240	W: all compounds	6E+1 Bone Surf (8E+1)	6E- Bone surf (6E-1)	2E-10 0	0 9E-13	0 1E-6	0 1E-5
96	Cm-241	W: all compounds	1E+3 0	3E+1 Bone surf (4E+1)	1E-8 0	0 5E-11	2E-5 0	2E-4 0
96	Cm-242	W: all compounds	3E+1 Bone Surf (5E+1)	3E-1 Bone surf (3E-1)	1E-10 0	0 4E-13	0 7E-7	0 7E-6
96	Cm-243	W: all compounds	1E+0 Bone Surf (2E+0)	9E-3 Bone surf (2E-2)	4E-12 0	0 2E-14	0 3E-8	0 3E-7

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
96	Cm-244	W: all compounds	1E+0 Bone Surf (2E+0)	1E-2 Bone surf (2E-2)	5E-12 0	0 3E-14	0 3E-8	0 3E-7
96	Cm-245	W: all compounds	7E-1 Bone Surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12 0	0 2E-14	0 2E-8	0 2E-7
96	Cm-246	W: all compounds	7E-1 Bone Surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12 0	0 2E-14	0 2E-8	0 2E-7
96	Cm-247	W: all compounds	8E-1 Bone Surf (1E+0)	6E-3 Bone surf (1E-2)	3E-102 0	0 2E-14	0 2E-8	0 2E-7
96	Cm-248	W: all compounds	2E-1 Bone Surf (4E-1)	2E-3 Bone surf (3E-3)	7E-13 0	0 4E-15	0 5E-9	0 5E-8
96	Cm-249 <sup>2</sup>	W: all compounds	5E+4 0	2E+4 Bone surf (3E+4)	7E-6 0	0 4E-8	7E-4 0	7E-3 0
96	Cm-250	W: all compounds	4E-2 Bone Surf (6E-2)	3E-4 Bone surf (5E-4)	1E-13 0	0 8E-16	0 9E-10	0 9E-9
97	Bk-245	W: all compounds	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
97	Bk-246	W: all compounds	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
97	Bk-247	W: all compounds	5E-1 Bone Surf (1E+0)	4E-3 Bone surf (9E-3)	2E-12 0	0 1E-14	0 2E-8	0 2E-7
97	Bk-249	W: all compounds	2E+2 Bone Surf (5E+2)	2E+0 Bone surf (4E+0)	7E-10 0	0 5E-12	0 6E-6	0 6E-5
97	Bk-250	W: all compounds	9E+3 0	3E+2 Bone surf (7E+2)	1E-7 0	0 1E-9	1E-4 0	1E-3 0
98	Cf-244 <sup>2</sup>	W: all compounds except those given for Y	3E+4 St Wall (3E+4)	6E+2 0	2E-7 0	8E-10	0 4E-4	0 4E-3
98	Cf-244 <sup>2</sup>	Y: oxides and hydroxides	0	6E+2	2E-7	8E-10	0	0
98	Cf-246	W: see Cf-244	4E+2	9E+0	4E-9	1E-11	5E-6	5E-5
98	Cf-246	Y: see Cf-244	0	9E+0	4E-9	1E-11	0	0
98	Cf-248	W: see Cf-244	8E+0 Bone Surf (2E+1)	6E-2 Bone surf (1E-1)	3E-11 0	0 2E-13	0 2E-7	0 2E-6
98	Cf-248	Y: see Cf-244	0	1E-1	4E-11	1E-13	0	0
98	Cf-249	W: see Cf-244	5E-1 Bone Surf (1E+0)	4E-3 Bone surf (9E-3)	2E-12 0	0 1E-14	0 2E-8	0 2E-7

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
98	Cf-249	Y: see Cf-244	0	1E-2 Bone surf (1E-2)	4E-12	0	0	0
			0		0	2E-14	0	0
98	Cf-250	W: see Cf-244	1E+0 Bone Surf (2E+0)	9E-3 Bone surf (2E-2)	4E-12	0	0	0
					0	3E-14	3E-8	3E-8
98	Cf-250	Y: see Cf-244	0	3E-2	1E-11	4E-14	0	0
98	Cf-251	W: see Cf-244	5E-1 Bone Surf (1E+0)	4E-3 Bone surf (9E-3)	2E-12	0	0	0
						1E-14	2E-8	2E-7
98	Cf-251	Y: see Cf-244	0	1E-2 Bone surf (1E-2)	4E-12	0	0	0
			0		0	2E-14	0	0
98	Cf-252	W: see Cf-244	2E+0 Bone Surf (5E+0)	2E-2 Bone surf (4E-2)	8E-12	0	0	0
					0	5E-14	7E-8	7E-7
98	Cf-252	Y: see Cf-244	0	3E-2	1E-11	5E-14	0	0
98	Cf-253	W: see Cf-244	2E+2 Bone Surf (4E+2)	2E+0	8E-10	2E-12	0	0
				0	0	0	5E-6	5E-4
98	Cf-253	Y: see Cf-244	0	2E+0	7E-10	2E-12	0	0
98	Cf-254	W: see Cf-244	2E+0	2E-2	9E-12	3E-14	3E-8	3E-7
98	Cf-254	Y: see Cf-244	0	2E-2	7E-12	2E-14	0	0
99	Es-250	W: all compounds	4E+4	5E+2 Bone surf (12E+3)	2E-7	0	0	0
			0		0	2E-9	0	0
99	Es-251	W: all compounds	7E+3	9E+2 Bone surf (1E+3)	4E-7	0	1E-4	1E-3
			0		0	2E-9	0	0
99	Es-253	W: all compounds	2E+2	1E+0	6E-10	2E-12	2E-6	2E-5
99	Es-254m	W: all compounds	3E+2 LLI Wall (3E+2)	1E+1	4E-9	1E-11	0	0
				0	0	0	4E-6	4E-5
99	Es-254	W: all compounds	8E+0 Bone Surf (2E+1)	7E-2 Bone surf (1E-1)	3E-11	0	0	0
					0	2E-13	2E-7	2E-6
100	Fm-252	W: all compounds	5E+2	1E+1	5E-9	2E-11	6E-6	6E-5
100	Fm-253	W: all compounds	1E+3	1E+1	4E-9	1E-11	1E-5	1E-4
100	Fm-254	W: all compounds	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
100	Fm-255	W: all compounds	5E+2	2E+1	9E-9	3E-11	7E-6	7E-5
100	Fm-257	W: all compounds	2E+1 Bone Surf (4E+1)	2E-1 Bone surf (2E-1)	7E-11	0	0	0
					0	3E-13	5E-7	5E-6
101	Md-257	W: all compounds	7E+3	8E+1 Bone surf (9E+1)	4E-8	0	1E-4	1E-3
			0		0	1E-10	0	0
101	Md-258	W: all compounds	3E+1 Bone Surf	2E-1 Bone surf	1E-10	0	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
			(5E+1)	(3E-1)	0	5E-13	6E-7	6E-6
---	Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours	SUBMERSION <sup>1</sup>	0	2E+2	1E-7	1E-9	0	0
---	Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours		0	2E-1	1E-10	1E-12	1E-8	1E-7
---	Any single radionuclide not listed above that decays by alpha emission or spontaneous fission, or any mixture for which either the identity or the concentration of any radionuclide in the mixture is not known		0	4E-4	2E-13	1E-15	2E-9	2E-8
	If it is known that Ac-227-D and Cm-250-W are not present		0	7E-4	3E-13	0	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI ( $\mu$ Ci)	COL. 2 Inhalation ALI ( $\mu$ Ci)	COL. 3 Inhalation DAC ( $\mu$ Ci/ml)	COL. 1 Air ( $\mu$ Ci/ml)	COL. 2 Water ( $\mu$ Ci/ml)	Monthly Average Concen- tration ( $\mu$ Ci/ml)
	If, in addition, it is known that Ac-227-W,Y, Th-229-W,Y, Th-230-W,Y, Pa-231-W,Y, Np-237-W, Pu-239-W, Pu-242-W, Am-241-W, Am-242m-W, Am-243-W, Cm-245-W, Cm-246-W, Cm-247-W, Cm-248-W, Bk-247-W, Cf-249-W, and Cf-251-W are not present		0	7E-3	3E-12	0	0	0
	If, in addition, it is known that Sm-146-W, Sm-147-W, Gd-148-D,W, Gd-152-D,W, Th-228,-W,Y, Th-230-Y, U-233-Y, U-235-Y, U-236-Y, U-238-Y, Np-236-W, Pu-236-W,Y, Pu-238-W,Y, Pu-239-Y, Pu-240-Y, Pu-242-Y, Pu-244-W,Y, Cm-243-W, Cm-244-W, Cf-248-W, Cf-249-Y, Cf-250-W,Y, Cf-251-Y, Cf-252-W,Y, and Cf-252-W,Y, are not present		0	7E-2	3E-11	0	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
	If, in addition, it is known that Pb-210-D, Bi-210m-W, Po-210-D,W, Ra-223-W, Ra-226-W, Ac-225-D,W,Y, Th-227-W,Y, U-230-D,W,Y, C-232-D,W, Pu-241-W, Cm-240-W, Cm-242-W, Cf-248-Y, Es-254-W, Fm-257-W, and Md-258-W are not present		0	7E-1	3E-10	0	0	0
	If, in addition, it is known that Si-32-Y, Ti-44-Y, Fe-60-D, Sr-90-Y, Zr-93-D, Cd-113m-D, Cd-113-D, In-115-D,W, La-138-D, Lu-176-W, Hf-178m-D,W, Bi-210m-D, Ra-224-W, Ra-228-W, Ac-226-D,W,Y, Pa-230-W,Y, u-233-D,W, U-234-D,W, U-235-D,W, U-236-D,W, U-238-D,W, Pu-241-Y, Bk-249-W, Cf-253-W,Y, and Es-253-W are not present		0	7E+0	3E-9	0	0	0
	If it is known that Ac-227-D,W,Y, Th-229-W,Y, Th-232-W,Y, Pa-231-W,Y, Cm-248-W, and Cm-250-W are not present		0	0	0	1E-14	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
	If, in addition, it is known that Sm-146-W, Gd-148-D, Gd-152-D, Th-228-W,Y, Th-230-W,Y, U-232-Y, U-2333-Y, U-234-Y, U-235-Y, U-236-Y, U-238-Y, U-Nat-Y, Np-236-W, Np-237-W, Pu-236-Y, Pu-238-W,Y, Pu-239-W,Y, Pu-240-W,Y, Pu-242-W,Y, Pu-244-W,Y, Am-241-W, Am-242m-W, Am-243-W, Cm-243-W, Cm-244-W, Cm-245-W, Cm-246-W, Cm-247-W, Bk-247-2, Cf-249-W,Y, Cf-250-W,Y, Cf-251-W,Y, Cf-252-W,Y, and Cf-254-W,Y are not present		0	0	0	1E-13	0	0
	If, in addition, it is known that Sm-147-W, Gd-152-W, Pb-210-D, Bi-210m-W, Po-210-D-W, Ra-223-W, Ra-225-W, Ra-226-W, Ac-225-D,W,Y, Th-227-W,Y, U-230-D,W,Y, U-232-D,W, U-Nat-W, Pu-241-W, Cm-240-W, Cm-242-W, Cf-248-W,Y, Es-254-W, Fm-257-W, and Md-258-W are not present		0	0	0	1E-12	0	0

At. No.	Radionuclide	Class	TABLE I Occupational Values			TABLE II Effluent Concentrations		TABLE III Release to Sewers
			COL. 1 Oral Ingestion ALI (μCi)	COL. 2 Inhalation ALI (μCi)	COL. 3 Inhalation DAC (μCi/ml)	COL. 1 Air (μCi/ml)	COL. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
	If, in addition it is known that Fe-60, Sr-90, Cd-113m, Cd-113, In-115, I-129, Cs-134, Sm-145, Gd-148, Gd-152, Hg-194 (organic), Bi-210m, Ra-223, Ra-224, Ra-225, Ac-225, Th-228, Th-230, U-233, U-234, U-235, U-236, U-238, U-Nat, Cm-242, Cf-248, Ex-254, Fm-257, and Md-258 are not present		0	0	0	0	1E-6	1E-5

## FOOTNOTES:

- <sup>1</sup> "Submersion" means that values given are for submersion in a hemispherical semi-infinite cloud of airborne material.
- <sup>2</sup> These radionuclides have radiological half-lives of less than 2 hours. The total effective dose equivalent received during operations with these radionuclides might include a significant contribution from external exposure. The DAC values for all radionuclides, other than those designated Class "Submersion," are based upon the committed effective dose equivalent due to the intake of the radionuclide into the body and do NOT include potentially significant contributions to dose equivalent from external exposures. The licensee may substitute 1E-7 μCi/ml for the listed DAC to account for the submersion dose prospectively, but should use individual monitoring devices or other measuring instruments that measure external exposure to demonstrate compliance with the limits.
- <sup>3</sup> For soluble mixtures, of U-238, U-234, and U-235 in air, chemical toxicity may be the limiting factor. If the percent by weight (enrichment) or U-235 is not greater than 5, the concentration value for a 40-hour workweek is 0.2 milligrams uranium per cubic meter of air average. for any enrichment, the product of the average concentration and time of exposure during a 40-hour workweek shall not exceed 8E-3 (SA) μCi-hr/ml, where SA is the specific activity of the uranium inhaled. The specific activity for natural uranium is 6.77E-7 curies per gram U. The specific activity for other mixtures of U-238, U-235, and U-234, if not known, shall be:

SA = 3.6E-7 curies/gram U U-depleted

SA =  $[0.4 + 0.38(\text{enrichment})^2] \text{ E-6,}$  enrichment  $\geq 0.72$

Where enrichment is the percentage by weight of U-235, expressed as percent



## NOTE:

1. If the identity of each radionuclide in a mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the DAC for the mixture shall be the most restrictive DAC of any radionuclide in the mixture.
2. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in this appendix are not present in the mixture, the inhalation ALI, DAC, and effluent and sewage concentrations for the mixture are the lowest values specified in this appendix for any radionuclide that is not known to be present from the mixture; or
3. If the mixture of radionuclides consists of uranium and its daughters in ore dust (10 µm AMAD particle distribution assumed) prior to chemical separation of the uranium from the ore, the following values may be used for the DAC of the mixture: 6E-11 µCi of gross alpha activity from uranium 238, uranium 234, thorium 230, and radium 226 per milliliter of air; 3E-11 µCi of natural uranium of air; or 45 micrograms of natural uranium per cubic meter of air.
4. If the identity and concentration of each radionuclide in a mixture are known, the limiting values should be derived as follows: determine, for each radionuclide in the mixture, the ratio between the concentration present in the mixture and the concentration otherwise established State of Florida Bureau of Radiation Control ALIs, DACs, and Effluent Concentrations, July 1993 for the specific radionuclide when not in a mixture. The sum of such ratios for all of the radionuclides in the mixture may not exceed "1" (i.e., unity)

Example: If radionuclides "A", "B", and "C" are present in concentrations  $C_A$ ,  $C_B$ , and  $C_C$ , and if the applicable DACs are  $DAC_A$ ,  $DAC_B$ , and  $DAC_C$ , respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_A}{DAC_A} + \frac{C_B}{DAC_B} + \frac{C_C}{DAC_C} \leq 1$$

STATE OF FLORIDA  
BUREAU OF RADIATION CONTROL  
**PROTECTION FACTORS FOR RESPIRATORS**

July 1993

## ATTACHMENT 2

## PROTECTION FACTORS FOR RESPIRATORS\*

Protection Factors <sup>d</sup>		Tested & Certified Equipment		
Description <sup>b</sup>	Modes <sup>c</sup>	Particu- lates only	Particu- lates, gases, vapors <sup>c</sup>	National Institute for Occupational Safety and Health & Mike Safety And Health Administration tests for permissibility
I. AIR -PURIFYING RESPIRATORS <sup>f</sup>				
Facepiece, half-mask <sup>g</sup> Facepiece, full Facepiece, half-mask full, or hood	NP NP PP	10 50 1000		30 CFR 11, Subpart K.
II. ATMOSPHERE-SUPPLYING RESPIRATORS				
1. Air-line respirator  Facepiece, half-mask Facepiece, half-mask Facepiece, full Facepiece, full Facepiece, full Hood Suit	CF D CF D PD CF CF		1000 5 2000 5 2000 h i	30 CFR 11, Subpart J. j
2. Self-contained breathing apparatus (SCBA)  Facepiece, full Facepiece, full Facepiece, full Facepiece, full	D PD RD RP		50 10000 <sup>k</sup> 50 5000 <sup>l</sup>	30 CFR, Subpart H
III. COMBINATION RESPIRATORS				
Any combination of air-purifying and atmosphere- supplying respirators	Protection factor for type and mode or operation as listed above			30 CFR 11 11.63(b)

**FOOTNOTES**

- (a) For use in the selection of respiratory protection equipment to be used only where the contaminants have been identified and the concentrations, or possible concentrations, are known
- (b) Only for shaven faces and where nothing interferes with the seal of tight-fitting facepieces against the skin. Hoods and suits are excepted
- (c) The mode symbols are defined as follows:

CF = continuous flow

D = demand

NP = negative pressure, that is, always negative phase during inhalation

PD = pressure demand, that is, always positive pressure

PR = positive pressure

RD = demand, recirculating or closed circuit

RP = pressure demand, recirculating or closed circuit

- (d) (1) The protection factor is a measure of the degree of protection afforded by a respirator, defined as the ratio of the concentration of airborne radioactive material outside the respiratory protective equipment to that inside the equipment, usually inside the facepiece, under conditions of use. It is applied to the ambient airborne concentration to estimate the concentrations inhaled by the wearer according to the following formula

$$\text{Concentration inhaled} = \frac{\text{Ambient airborne Concentration}}{\text{Protection factor}}$$

- (2) The protection factors apply:

- (i) Only for individuals trained in using respirators and wearing properly fitted respirators that are used and maintained under supervision on a well planned respiratory protective program.
- (ii) For air-purifying respirators only when high efficiency particulate filters, above 99.97 percent removal efficiency by thermally generated 0.3 micrometer dioctyl phthalate (DOP) test of equivalent, are used in atmospheres not deficient in oxygen and not containing radioactive gas or vapor respiratory hazards.
- (iii) No adjustment is to be made for the use of sorbents against radioactive material in the form of gases or vapors.

- (iv) For atmosphere-supplying respirators only when supplied with adequate respirable air. Respirable air shall be provided of the quality and quantity required in accordance with the National Institute for Occupational Safety and Health and the Mine Safety Administration certification described in 30 CFR 11. Oxygen and air shall not be used in the same apparatus.
- (e) Excluding radioactive contaminants that present an absorption or submersion hazard. For tritium oxide, approximately one-third of the intake occurs by absorption through the skin so that an overall protection factor of less than 2 is appropriate when atmosphere-supplying respirators are used to protect against tritium oxide. If the protection factor of respiratory protective equipment is 5,, the effective protection factor for tritium is about 1.4; with protection factors of 10, the effective factor of tritium oxide is 1.7; and with protection factors of 100 or more, the effective factor for tritium oxide is about 1.9. Air-purifying respirators are not suitable for protection against tritium oxide. See also footnote I concerning supplied-air suits.
- (f) Canisters and cartridges shall not be used beyond service-life limitation.
- (g) Under-chin type only. This type of respirator is not satisfactory for use where it might be possible, such as, if an accident or emergency were to occur, for the ambient airborne concentration to reach instantaneous values greater than 10 time the pertinent values in the State of Florida Bureau of Radiation Control ALLs, DACs, and Effluent Concentrations, July 1993, Table I, Column 3. This type of respirator is not suitable for protection against plutonium or other high-toxicity materials. The mask is to be tested for fit prior to use, each time it is donned.
- (h)
  - (1) Equipment shall be operated in a manner that ensures that proper air flow-rates are maintained. A protection factor of no more than 1000 may be utilized for tested-and-certified supplied-air hoods when a minimum air flow of 6 ft<sup>3</sup>/min. (0.17 m<sup>3</sup>/min.) is maintained and calibrated air line pressure gauges or flow measuring device are used. A protection factor of up to 2000 may be used for tested-and-certified hoods only when the air flow is maintained at the manufacturer's recommended maximum rate for the equipment, this rate is greater than 6 ft<sup>3</sup>/min. (0.17 m<sup>3</sup>/min.) and calibrated air line pressure gauges or flow measuring devices are used.
  - (2) The design of the supplied-air hood or helmet, with a minimum flow of 6 ft<sup>3</sup>/min. (0.17 m<sup>3</sup>/min.) of air, may determine its overall efficiency and the protection it provides. For example, some hoods aspirate contaminated air into the breathing zone when the wearer works with hands-over-head. This aspiration may be overcome if a short cape-like extension to the hood is worn under a coat or overalls. Other limitations specified by the approval agency shall be considered before using a hood in certain types of atmospheres. See footnote i.

- (i) Appropriate protection factors shall be determined, taking into account the design of the suit and its permeability to the contaminant under conditions of use. There shall be a standby rescue person equipped with a respirator or other apparatus appropriate for the potential hazards and communications equipment whenever supplied-air suits are used
- (j) No approval schedules are currently available for this equipment. Equipment is to be evaluated by testing or on the basis of reliable test information
- (k) This type of respirator may provide greater protection and be used as an emergency device in unknown concentrations for protection against inhalation hazards. External radiation hazards and other limitations to permitted exposure, such as skin absorption must be taken into account in such circumstances.
- (l) Quantitative fit testing shall be performed on each individual, and no more than 0.02 percent leakage is allowed with this type of apparatus. Perceptible outward leakage of gas from this or any positive pressure self-contained breathing apparatus is unacceptable because service life will be reduced substantially. Special training in the use of this type of apparatus shall be provided to the wearer.

Note 1: Protection factors for respirators approved by the U.S. Bureau of Mines and the National Institute for Occupational Safety and Health, according the applicable approvals for respirator for type and mode of use to protect against airborne radionuclides, may be used to the extent that they do not exceed the protection factors listed in this table. The protection factors listed in this table may not be appropriate to circumstances where chemical or other respiratory hazards exist in addition to radioactive hazards. The selection and use of respirators for such circumstances should take into account applicable approvals of the U.S. Bureau of Mines and the National Institute for Occupational Safety and Health.

Note 2: Radioactive contaminants, for which the concentration values in State of Florida Bureau of Radiation Control. ALIs, DACs, and Effluent Concentrations, July 1003. Table I, Column 3 are based on internal dose due to inhalation, may present external exposure hazards at higher concentrations. Under these circumstances, limitations of occupancy may have to be governed by external dose limits.

STATE OF FLORIDA  
BUREAU OF RADIATION CONTROL  
**RADIOACTIVE MATERIAL  
REQUIRING LABELING**

May 2000

**64E-5 Florida Administrative Code ATT 3 -- Radioactive Materials Requiring Labeling**

Radionuclide	Quantity ( $\mu$ Ci)	Radionuclide	Quantity ( $\mu$ Ci)
Actinium-224	1	Antimony-125	100
Actinium-225	0.01	Antimony-126	100
Actinium-226	0.1	Antimony-126m	1000
Actinium-227	0.001	Antimony-127	100
Actinium-228	1	Antimony-128 (10.4m)	1000
Aluminum-26	10	Antimony-128 (9.01h)	100
Americium-237	1000	Antimony-129	100
Americium-238	100	Antimony-130	1000
Americium-239	1000	Antimony-131	1000
Americium-240	100	Argon-41	1000
Americium-241	0.001	Arsenic-72	100
Americium-242	10	Arsenic-73	100
Americium-242m	0.001	Arsenic-74	100
Americium-243	0.001	Arsenic-76	100
Americium-244	10	Astatine-207	100
Americium-244m	100	Astatine-211	10
Americium-245	1000	Barium-126	1000
Americium-246	1000	Barium-128	100
Americium-246m	1000	Barium-131	100
Antimony-115	1000	Barium-131m	1000
Antimony-116	1000	Barium-133	100
Antimony-116m	1000	Barium-133m	100
Antimony-117	1000	Barium-135m	100
Antimony-118m	1000	Barium-139	1000
Antimony-119	1000	Barium-140	100
Antimony-120 (16m)	1000	Barium-141	1000
Antimony-120 (5.76d)	100	Barium-142	1000
Antimony-122	100	Berkelium-245	100
Antimony-124	10	Berkelium-246	100
Antimony-124m	1000	Berkelium-247	0.001



**64E-5 Florida Administrative Code ATT 3 -- Radioactive Materials Requiring Labeling**

Radionuclide	Quantity (μCi)	Radionuclide	Quantity (μCi)
Berkelium-249	0.1	Cadmium-117	1000
Berkelium-250	10	Cadmium-117m	1000
Beryllium-10	1	Calcium-41	100
Beryllium-7	1000	Calcium-45	100
Bismuth-200	1000	Calcium-47	100
Bismuth-201	1000	Californium-244	100
Bismuth-202	1000	Californium-246	1
Bismuth-203	100	Californium-248	0.01
Bismuth-205	100	Californium-249	0.001
Bismuth-206	100	Californium-250	0.001
Bismuth-207	10	Californium-251	0.001
Bismuth-210	1	Californium-252	0.001
Bismuth-210m	0.1	Californium-253	0.1
Bismuth-212	10	Californium-254	0.001
Bismuth-213	10	Carbon-11	1000
Bismuth-214	100	Carbon-14	100
Bromine-74	1000	Cerium-134	100
Bromine-74m	1000	Cerium-135	100
Bromine-75	1000	Cerium-137	1000
Bromine-76	100	Cerium-137m	100
Bromine-77	1000	Cerium-139	100
Bromine-80	1000	Cerium-141	100
Bromine-80m	1000	Cerium-143	100
Bromine-82	100	Cerium-144	1
Bromine-83	1000	Cesium-125	1000
Bromine-84	1000	Cesium-127	1000
Cadmium-104	1000	Cesium-129	1000
Cadmium-107	1000	Cesium-130	1000
Cadmium-109	1	Cesium-131	1000
Cadmium-113	100	Cesium-132	100
Cadmium-113m	0.1	Cesium-134	10
Cadmium-115	100	Cesium-134m	1000
Cadmium-115m	10	Cesium-135	100

**64E-5 Florida Administrative Code ATT 3 -- Radioactive Materials Requiring Labeling**

<b>Radionuclide</b>	<b>Quantity (<math>\mu</math>Ci)</b>	<b>Radionuclide</b>	<b>Quantity (<math>\mu</math>Ci)</b>
Cesium-135m	1000	Dysprosium-166	100
Cesium-136	10	Einsteinium-250	100
Cesium-137	10	Einsteinium-251	100
Cesium-138	1000	Einsteinium-253	0.1
Chlorine-36	10	Einsteinium-254	0.01
Chromium-48	1000	Einsteinium-254m	1
Chromium-49	1000	Erbium-161	1000
Chromium-51	1000	Erbium-165	1000
Cobalt-55	100	Erbium-169	100
Cobalt-56	10	Erbium-171	100
Cobalt-57	1000	Erbium-172	100
Cobalt-60	1	Europium-145	100
Cobalt-61	1000	Europium-146	100
Cobalt-62m	1000	Europium-147	100
Copper-60	1000	Europium-148	10
Copper-61	1000	Europium-149	100
Copper-64	1000	Europium-150 (12.62h)	100
Copper-67	1000	Europium-150 (34.2y)	1
Curium-238	100	Europium-152	1
Curium-240	0.1	Europium-152m	100
Curium-241	1	Europium-154	1
Curium-242	0.01	Europium-155	10
Curium-243	0.001	Europium-156	100
Curium-244	0.001	Europium-157	100
Curium-245	0.001	Europium-158	1000
Curium-246	0.001	Fermium-252	1
Curium-247	0.001	Fermium-253	1
Curium-248	0.001	Fermium-254	10
Curium-249	1000	Fermium-255	1
Dysprosium-155	1000	Fermium-257	0.01
Dysprosium-157	1000	Fluorine-18	1000
Dysprosium-159	100	Francium-222	100
Dysprosium-165	1000		

**64E-5 Florida Administrative Code ATT 3 -- Radioactive Materials Requiring Labeling**

Radionuclide	Quantity ( $\mu$ Ci)	Radionuclide	Quantity ( $\mu$ Ci)
Francium-223	100	Hafnium-170	100
Gadolinium-145	1000	Hafnium-172	1
Gadolinium-146	10	Hafnium-173	1000
Gadolinium-147	100	Hafnium-175	100
Gadolinium-148	0.001	Hafnium-177m	1000
Gadolinium-149	100	Hafnium-178m	0.1
Gadolinium-151	10	Hafnium-179m	10
Gadolinium-152	100	Hafnium-180m	1000
Gadolinium-153	10	Hafnium-181	10
Gadolinium-159	100	Hafnium-182	0.1
Gallium-65	1000	Hafnium-182m	1000
Gallium-66	100	Hafnium-183	1000
Gallium-67	1000	Hafnium-184	100
Gallium-68	1000	Holmium-155	1000
Gallium-70	1000	Holmium-157	1000
Gallium-72	100	Holmium-159	1000
Gallium-73	1000	Holmium-161	1000
Germanium-66	1000	Holmium-162	1000
Germanium-67	1000	Holmium-162m	1000
Germanium-68	10	Holmium-164	1000
Germanium-69	1000	Holmium-164m	1000
Germanium-71	1000	Holmium-166	100
Germanium-75	1000	Holmium-166m	1
Germanium-77	1000	Holmium-167	1000
Gold-193	1000	Hydrogen-3	1000
Gold-194	100	Indium-109	1000
Gold-195	10	Indium-110m (69.1m)	1000
Gold-198	100	Indium-111	100
Gold-198m	100	Indium-112	1000
Gold-199	100	Indium-113m	1000
Gold-200	1000	Indium-114m	10
Gold-200m	100	Indium-115	100
Gold-201	1000	Indium-115m	1000

**64E-5 Florida Administrative Code ATT 3 -- Radioactive Materials Requiring Labeling**

Radionuclide	Quantity ( $\mu$ Ci)	Radionuclide	Quantity ( $\mu$ Ci)
Indium-116m	1000	Iridium-194	100
Indium-117	1000	Iridium-194m	10
Indium-117m	1000	Iridium-195	1000
Indium-119m	1000	Iridium-195m	1000
Indium-110 (4.9h)	1000	Iron-52	100
Iodine-120	100	Iron-55	100
Iodine-120m	1000	Iron-59	10
Iodine-121	1000	Iron-60	1
Iodine-123	100	Krypton-74	1000
Iodine-124	10	Krypton-76	1000
Iodine-125	1	Krypton-77	1000
Iodine-126	1	Krypton-79	1000
Iodine-128	1000	Krypton-81	1000
Iodine-129	1	Krypton-83m	1000
Iodine-130	10	Krypton-85	1000
Iodine-131	1	Krypton-85m	1000
Iodine-132	100	Krypton-87	1000
Iodine-132m	100	Krypton-88	1000
Iodine-133	10	Lanthanum-131	1000
Iodine-134	1000	Lanthanum-132	100
Iodine-135	100	Lanthanum-135	1000
Iridium-182	1000	Lanthanum-137	10
Iridium-184	1000	Lanthanum-138	100
Iridium-185	1000	Lanthanum-140	100
Iridium-186	100	Lanthanum-141	100
Iridium-187	1000	Lanthanum-142	1000
Iridium-188	100	Lanthanum-143	1000
Iridium-189	100	Lead-195m	1000
Iridium-190	100	Lead-198	1000
Iridium-190m	1000	Lead-199	1000
Iridium-192 (73.8d)	1	Lead-200	100
Iridium-192m (1.4m)	10	Lead-201	1000
		Lead-202	10

**64E-5 Florida Administrative Code ATT 3 -- Radioactive Materials Requiring Labeling**

Radionuclide	Quantity ( $\mu$ Ci)	Radionuclide	Quantity ( $\mu$ Ci)
Lead-202m	1000	Mercury-194	1
Lead-203	1000	Mercury-195	1000
Lead-205	100	Mercury-195m	100
Lead-209	1000	Mercury-197	1000
Lead-210	0.01	Mercury-197m	100
Lead-211	100	Mercury-199m	1000
Lead-212	1	Mercury-203	100
Lead-214	100	Molybdenum-101	1000
Lutetium-169	100	Molybdenum-90	100
Lutetium-170	100	Molybdenum-93	10
Lutetium-171	100	Molybdenum-93m	100
Lutetium-172	100	Molybdenum-99	100
Lutetium-173	10	Neodymium-136	1000
Lutetium-174	10	Neodymium-138	100
Lutetium-174m	10	Neodymium-139	1000
Lutetium-176	100	Neodymium-139m	1000
Lutetium-176m	1000	Neodymium-141	1000
Lutetium-177	100	Neodymium-147	100
Lutetium-177m	10	Neodymium-149	1000
Lutetium-178	1000	Neodymium-151	1000
Lutetium-178m	1000	Neptunium-232	100
Lutetium-179	1000	Neptunium-233	1000
Magnesium-28	100	Neptunium-234	100
Manganese-51	1000	Neptunium-235	100
Manganese-52	100	Neptunium-236 (1.15E+5y)	0.001
Manganese-52m	1000	Neptunium-236 (22.5h)	1
Manganese-53	1000	Neptunium-237	0.001
Manganese-54	100	Neptunium-238	10
Manganese-56	1000	Neptunium-239	100
Mendelevium-257	10	Neptunium-240	1000
Mendelevium-258	0.01	Nickel-56	100
Mercury-193	1000	Nickel-57	100
Mercury-193m	100		

**64E-5 Florida Administrative Code ATT 3 -- Radioactive Materials Requiring Labeling**

<b>Radionuclide</b>	<b>Quantity (<math>\mu</math>Ci)</b>	<b>Radionuclide</b>	<b>Quantity (<math>\mu</math>Ci)</b>
Nickel-59	100	Platinum-188	100
Nickel-63	100	Platinum-189	1000
Nickel-65	1000	Platinum-191	100
Nickel-66	10	Platinum-193	1000
Niobium-88	1000	Platinum-193m	100
Niobium-89 (122m)	1000	Platinum-195m	100
Niobium-89m (66m)	1000	Platinum-197	100
Niobium-90	100	Platinum-197m	1000
Niobium-93m	10	Platinum-199	1000
Niobium-94	1	Platinum-200	100
Niobium-95	100	Plutonium-234	10
Niobium-95m	100	Plutonium-235	1000
Niobium-96	100	Plutonium-236	0.001
Niobium-97	1000	Plutonium-237	100
Niobium-98	1000	Plutonium-238	0.001
Osmium-180	1000	Plutonium-239	0.001
Osmium-181	1000	Plutonium-240	0.001
Osmium-182	100	Plutonium-241	0.01
Osmium-185	100	Plutonium-242	0.001
Osmium-189m	1000	Plutonium-243	1000
Osmium-191	100	Plutonium-244	0.001
Osmium-191m	1000	Plutonium-245	100
Osmium-193	100	Polonium-203	1000
Osmium-194	1	Polonium-205	1000
Palladium-100	100	Polonium-207	1000
Palladium-101	1000	Polonium-210	0.1
Palladium-103	100	Potassium-40	100
Palladium-107	10	Potassium-42	1000
Palladium-109	100	Potassium-43	1000
Phosphorus-32	10	Potassium-44	1000
Phosphorus-33		Potassium-45	1000
Platinum-186	1000	Praseodymium-136	1000
		Praseodymium-137	1000

**64E-5 Florida Administrative Code ATT 3 -- Radioactive Materials Requiring Labeling**

Radionuclide	Quantity ( $\mu$ Ci)	Radionuclide	Quantity ( $\mu$ Ci)
Praseodymium-138m	1000	Radon-222	1
Praseodymium-139	1000	Rhenium-177	1000
Praseodymium-142	100	Rhenium-178	1000
Praseodymium-142m	1000	Rhenium-181	1000
Praseodymium-143	100	Rhenium-182 (12.7)	1000
Praseodymium-144	1000	Rhenium-182 (64.0h)	100
Praseodymium-145	100	Rhenium-184	100
Praseodymium-147	1000	Rhenium-184m	10
Promethium-141	1000	Rhenium-186	100
Promethium-143	100	Rhenium-186m	10
Promethium-144	10	Rhenium-187	1000
Promethium-145	10	Rhenium-188	100
Promethium-146	1	Rhenium-188m	1000
Promethium-147	10	Rhenium-189	100
Promethium-148	10	Rhodium-100	100
Promethium-148m	10	Rhodium-101	10
Promethium-149	100	Rhodium-101m	1000
Promethium-150	1000	Rhodium-102	10
Promethium-151	100	Rhodium-102m	10
Protactinium-227	10	Rhodium-103m	1000
Protactinium-228	1	Rhodium-105	100
Protactinium-230	0.1	Rhodium-106m	1000
Protactinium-231	0.001	Rhodium-107	1000
Protactinium-232	1	Rhodium-99	100
Protactinium-233	100	Rhodium-99m	1000
Protactinium-234	100	Rubidium-79	1000
Radium-223	0.1	Rubidium-81	1000
Radium-224	0.1	Rubidium-81m	1000
Radium-225	0.1	Rubidium-82m	1000
Radium-226	0.1	Rubidium-83	100
Radium-227	1000	Rubidium-84	100
Radium-228	0.1	Rubidium-86	100
Radon-220	1		

**64E-5 Florida Administrative Code ATT 3 -- Radioactive Materials Requiring Labeling**

<b>Radionuclide</b>	<b>Quantity (<math>\mu</math>Ci)</b>	<b>Radionuclide</b>	<b>Quantity (<math>\mu</math>Ci)</b>
Ruthenium-103	100	Silver-103	1000
Ruthenium-105	1000	Silver-104	1000
Ruthenium-106	1	Silver-104m	1000
Ruthenium-94	1000	Silver-105	100
Ruthenium-97	1000	Silver-106	1000
Samarium-141	1000	Silver-106m	100
Samarium-141m	1000	Silver-108m	1
Samarium-142	1000	Silver-111	100
Samarium-145	100	Silver-112	100
Samarium-146	1	Silver-115	1000
Samarium-147	100	Silver-110m	10
Samarium-151	10	Sodium-22	10
Samarium-153	100	Sodium-24	100
Samarium-155	1000	Strontium-81	1000
Samarium-156	1000	Strontium-83	100
Scandium-43	1000	Strontium-85	10
Scandium-44	100	Strontium-85m	1000
Scandium-44m	100	Strontium-90	0.1
Scandium-46	10	Strontium-91	100
Scandium-47	100	Strontium-92	100
Scandium-48	100	Sulfur-35	100
Scandium-49	1000	Tantalum-172	1000
Selenium-70	1000	Tantalum-173	1000
Selenium-73	100	Tantalum-174	1000
Selenium-73m	1000	Tantalum-175	1000
Selenium-75	100	Tantalum-176	100
Selenium-79	100	Tantalum-177	1000
Selenium-81	1000	Tantalum-178	1000
Selenium-81m	1000	Tantalum-179	100
Selenium-83	1000	Tantalum-180	100
Silicon-31	1000	Tantalum-180m	1000
Silicon-32	1	Tantalum-182	10
Silver-102	1000	Tantalum-182m	1000



**64E-5 Florida Administrative Code ATT 3 -- Radioactive Materials Requiring Labeling**

Radionuclide	Quantity ( $\mu$ Ci)	Radionuclide	Quantity ( $\mu$ Ci)
Tantalum-183	100	Terbium-147	1000
Tantalum-184	100	Terbium-149	100
Tantalum-185	1000	Terbium-150	1000
Tantalum-186	1000	Terbium-151	100
Technetium-101	1000	Terbium-153	1000
Technetium-104	1000	Terbium-154	100
Technetium-93	1000	Terbium-155	1000
Technetium-93m	1000	Terbium-156	100
Technetium-94	1000	Terbium-156m (24.4h)	1000
Technetium-94m	1000	Terbium-156m (5.0h)	1000
Technetium-96	100	Terbium-157	10
Technetium-96m	1000	Terbium-158	1
Technetium-97	1000	Terbium-160	10
Technetium-97m	100	Terbium-161	100
Technetium-98	10	Thallium-194	1000
Technetium-99	100	Thallium-194m	1000
Technetium-99m	1000	Thallium-195	1000
Tellurium-116	1000	Thallium-197	1000
Tellurium-121	100	Thallium-198	1000
Tellurium-121m	10	Thallium-198m	1000
Tellurium-123	100	Thallium-199	1000
Tellurium-123m	10	Thallium-200	1000
Tellurium-125m	10	Thallium-201	1000
Tellurium-127	1000	Thallium-202	100
Tellurium-127m	10	Thallium-204	100
Tellurium-129	1000	Thorium-226	10
Tellurium-129m	10	Thorium-227	0.01
Tellurium-131	100	Thorium-228	0.001
Tellurium-131m	10	Thorium-229	0.001
Tellurium-132	10	Thorium-230	0.001
Tellurium-133	1000	Thorium-231	100
Tellurium-133m	100	Thorium-232	100
Tellurium-134	1000		

**64E-5 Florida Administrative Code ATT 3 -- Radioactive Materials Requiring Labeling**

Radionuclide	Quantity ( $\mu$ Ci)	Radionuclide	Quantity ( $\mu$ Ci)
Thorium-234	10	Uranium-230	0.01
Thorium-natural	100	Uranium-231	100
Thulium-162	1000	Uranium-232	0.001
Thulium-166	100	Uranium-233	0.001
Thulium-167	100	Uranium-234	0.001
Thulium-170	10	Uranium-235	0.001
Thulium-171	10	Uranium-236	0.001
Thulium-172	100	Uranium-237	100
Thulium-173	100	Uranium-238	100
Thulium-175	1000	Uranium-239	1000
Tin-110	100	Uranium-240	100
Tin-111	1000	Uranium-natural	100
Tin-113	100	Vanadium-47	1000
Tin-117m	100	Vanadium-48	100
Tin-119m	100	Vanadium-49	1000
Tin-121	1000	Xenon-120	1000
Tin-121m	100	Xenon-121	1000
Tin-123	10	Xenon-122	1000
Tin-123m	1000	Xenon-123	1000
Tin-125	10	Xenon-125	1000
Tin-126	10	Xenon-127	1000
Tin-127	1000	Xenon-129m	1000
Tin-128	1000	Xenon-131m	1000
Titanium-44	1	Xenon-133	1000
Titanium-45	1000	Xenon-133m	1000
Tungsten-176	1000	Xenon-135	1000
Tungsten-177	1000	Xenon-135m	1000
Tungsten-178	1000	Xenon-138	1000
Tungsten-179	1000	Ytterbium-162	1000
Tungsten-181	1000	Ytterbium-166	100
Tungsten-185	100	Ytterbium-167	1000
Tungsten-187	100	Ytterbium-169	100
Tungsten-188	10	Ytterbium-175	100

**64E-5 Florida Administrative Code ATT 3 -- Radioactive Materials Requiring Labeling**

Radionuclide	Quantity ( $\mu$ Ci)	Radionuclide	Quantity ( $\mu$ Ci)
Ytterbium-177	1000	Zinc-69m	100
Ytterbium-178	1000	Zinc-71m	1000
Yttrium-86	100	Zinc-72	100
Yttrium-86m	1000	Zirconium-86	100
Yttrium-87	100	Zirconium-88	10
Yttrium-88	10	Zirconium-89	100
Yttrium-90	10	Zirconium-93	1
Yttrium-90m	1000	Zirconium-95	10
Yttrium-91	10	Zirconium-97	100
Yttrium-91m	1000	Any alpha-emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	0.001
Yttrium-92	100	Any radionuclide other that emitting radionuclides not listed above, or mixtures of beta emitters of unknown composition	0.01
Yttrium-93	100		
Yttrium-94	1000		
Yttrium-95	1000		
Zinc-62	100		
Zinc-63	1000		
Zinc-65	10		
Zinc-69	1000		

To convert  $\mu$ Ci to kBq, multiple  $\mu$ Ci value by 37.

STATE OF FLORIDA  
BUREAU OF RADIATION CONTROL  
**DH FORM 1622**  
**OCCUPATIONAL EXPOSURE**  
**RECORD FOR A MONITORING**  
**PERIOD**

July 1993



# OCCUPATIONAL EXPOSURE RECORD FOR A MONITORING PERIOD

1. NAME (LAST, FIRST MIDDLE INITIAL)				2. IDENTIFICATION NUMBER		3. ID TYPE		4. SEX  <input type="checkbox"/> MALE <input type="checkbox"/> FEMALE		5. DATE OF BIRTH	
6. MONITORING PERIOD				7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER(S)		9A.  <input type="checkbox"/> RECORD <input type="checkbox"/> ESTIMATE		9B.  <input type="checkbox"/> ROUTINE <input type="checkbox"/> PSE	

INTAKES				DOSES (in rem)	
10A. RADIONUCLIDE	10B. CLASS	10C. MODE	10D. INTAKE IN $\mu$ Ci		
				DEEP DOSE EQUIVALENT (DDE)	11.
				EYE DOSE EQUIVALENT TO THE LENS OF THE EYE (LDE)	12.
				SHALLOW DOSE EQUIVALENT, WHOLE BODY (SDE,WB)	13.
				COMMITTED DOSE EQUIVALENT, MAX EXTREMITY (SDE,ME)	14.
				COMMITTED DOSE EQUIVALENT (CEDE)	15.
				COMMITTED DOSE EQUIVALENT MAXIMALLY EXPOSED ORGAN (CDE)	16.
				TOTAL EFFECTIVE DOSE EQUIVALENT (BLOCKS 11+15) (TEDE)	17.
				TOTAL ORGAN DOSE EQUIVALENT, MAX ORGAN (BLOCKS 11+16) (TODE)	18.
				19. COMMENTS	

20. SIGNATURE -- LICENSEE OR REGISTRANT										21. DATE PREPARED	
---	--	--	--	--	--	--	--	--	--	-------------------	--

1. Type or print the full name of the monitored individual in the order of last name (include "jr.", "Sr.", III", etc.), first name, middle name, middle initial (If applicable).
2. Enter the individual's identification number, including punctuation. this number should be the 9-digit social security number if at all possible. If the individual has no social security number, enter the number from another official identification such as a passport or work permit.
3. Enter the code for the type of identification used as shown below:

CODE	ID TYPE
SSN	U.S. Social Security Number
PPN	Passport Number
CSI	Canadian Social Insurance Number
WPN	Work Permit Number
IND	INDEX Identification Number
OTH	Other

4. Check the box that denotes the sex of the individual being monitored.
5. Enter the date of birth of the individual being monitored in the format MM/DD/YY.
6. Enter the monitoring period for which this report is filed. The format should be MM/DD/YY - MM/DD/YY.
7. Enter the name of the licensee or registrant.
8. Enter the Agency license or registration number or numbers.

9A. Place an "X" in Record or Estimate. Choose "record" if the dose data listed represents a final determination of the dose received to the best of the licensee's or registrants knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in subsequent report. An example of such an instance would be dose data based on self-reading dosimeter results and the licensee intends to assign the record dose on the basis of the TLD results that are yet available.

9B. Place an "X" in either Routine or PSE. Choose "Routine" if the data represents the results of monitoring for routine exposures. Choose "PSE" if the dose data represents the results of monitoring of planned special exposures received during the monitoring period. If more than one PSE was received in a single year, the licensee or registrant should sum them and report the total of all PSEs.

10A. Enter the symbol for each radionuclide that resulted in an inter exposure recorded for the individual in the format "Xx-###x," for instance Cs-139 or Tc-99m.

10B. Enter the lung clearance class as listed in Appendix B to Part D (D, W, Y, V, or O for other) for all intakes by inhalation.

10C. Enter the mode of intake. For inhalation, enter "H." For absorption through the skin, enter "B." For oral ingestion, enter "G." for injection, enter "J."

10D. Enter the intake of each radionuclide in  $\mu\text{Ci}$ .

11. Enter the deep dose equivalent (DDE) to the whole body.

12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye.

13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE, WB).

14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE, ME).

15. Enter the committed effective dose equivalent (CEDE) or "NR" for "Not Required" or "NC" for "Not Calculated".

16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ or "NR" for Required" or "NC" for "Not Calculated".

17. Enter the total effective dose equivalent (TEDE). The TEDE is the sum of items 11 and 15.

18. Enter the total organ dose equivalent (TODE) for maximally exposed organ. The TODE is the sum of items 11 and 16.

19. Signature of the person designated to represent the licensee or registrant.

20. Enter the date this form was prepared.

21. COMMENTS.

In the space provided, enter additional information that might be needed to determine compliance with limits. An example might be to enter the note that the SDE,ME was the result of exposure from a discrete hot particle. Another possibility would be to indicate that an overexposed report has been sent to the Agency in reference to the exposure report.

STATE OF FLORIDA  
BUREAU OF RADIATION CONTROL  
**DH FORM 1623**  
**CUMULATIVE OCCUPATIONAL**  
**EXPOSURE HISTORY**

July 1993



# CUMULATIVE OCCUPATIONAL EXPOSURE HISTORY

1. NAME (LAST, FIRST, MIDDLE INITIAL)		2. IDENTIFICATION NUMBER		3. ID TYPE	4. SEX MALE <input type="checkbox"/> FEMALE <input type="checkbox"/>	5. DATE OF BIRTH
6. MONITORING PERIOD	7. LICENSEE OR REGISTRANT NAME	8. LICENSE OR REGISTRATION NUMBER		9. RECORD <input type="checkbox"/> ESTIMATE <input type="checkbox"/> NO RECORD <input type="checkbox"/>	10. ROUTINE <input type="checkbox"/> PSE <input type="checkbox"/>	
11. DDE	12. LDE	13. SDE, WB		17. TEDE	18. TODO	
6. MONITORING PERIOD	7. LICENSEE OR REGISTRANT NAME	8. LICENSE OR REGISTRATION NUMBER		9. RECORD <input type="checkbox"/> ESTIMATE <input type="checkbox"/> NO RECORD <input type="checkbox"/>	10. ROUTINE <input type="checkbox"/> PSE <input type="checkbox"/>	
11. DDE	12. LDE	13. SDE, WB		17. TEDE	18. TODO	
6. MONITORING PERIOD	7. LICENSEE OR REGISTRANT NAME	8. LICENSE OR REGISTRATION NUMBER		9. RECORD <input type="checkbox"/> ESTIMATE <input type="checkbox"/> NO RECORD <input type="checkbox"/>	10. ROUTINE <input type="checkbox"/> PSE <input type="checkbox"/>	
11. DDE	12. LDE	13. SDE, WB		17. TEDE	18. TODO	
6. MONITORING PERIOD	7. LICENSEE OR REGISTRANT NAME	8. LICENSE OR REGISTRATION NUMBER		9. RECORD <input type="checkbox"/> ESTIMATE <input type="checkbox"/> NO RECORD <input type="checkbox"/>	10. ROUTINE <input type="checkbox"/> PSE <input type="checkbox"/>	
11. DDE	12. LDE	13. SDE, WB		17. TEDE	18. TODO	
6. MONITORING PERIOD	7. LICENSEE OR REGISTRANT NAME	8. LICENSE OR REGISTRATION NUMBER		9. RECORD <input type="checkbox"/> ESTIMATE <input type="checkbox"/> NO RECORD <input type="checkbox"/>	10. ROUTINE <input type="checkbox"/> PSE <input type="checkbox"/>	
11. DDE	12. LDE	13. SDE, WB		17. TEDE	18. TODO	
6. MONITORING PERIOD	7. LICENSEE OR REGISTRANT NAME	8. LICENSE OR REGISTRATION NUMBER		9. RECORD <input type="checkbox"/> ESTIMATE <input type="checkbox"/> NO RECORD <input type="checkbox"/>	10. ROUTINE <input type="checkbox"/> PSE <input type="checkbox"/>	
11. DDE	12. LDE	13. SDE, WB		17. TEDE	18. TODO	



**INSTRUCTIONS AND ADDITIONAL INFORMATION PERTINENT TO THE COMPLETION OF DH FORM 1623 JULY 93**  
*(All doses should be stated in rems)*

PAGE      OF

1. Type or print the full name of the monitored individual in the order of last name (include "jr.", "Sr.", III", etc.), first name, middle name, middle initial (If applicable).
2. Enter the individual's identification number, including punctuation. this number should be the 9-digit social security number if at all possible. If the individual has no social security number, enter the number from another official identification such as a passport or work permit.
3. Enter the code for the type of identification used as shown below:

CODE	ID TYPE
SSN	U.S. Social Security Number
PPN	Passport Number
CSI	Canadian Social Insurance Number
WPN	Work Permit Number
IND	INDEX Identification Number
OTH	Other

4. Check the box that denotes the sex of the individual being monitored.
5. Enter the date of birth of the individual being monitored in the format MM/DD/YY.
6. Enter the monitoring period for which this report is filed. The format should be MM/DD/YY - MM/DD/YY.
7. Enter the name of the licensee or registrant.
8. Enter the Agency license or registration number or numbers.

9. Place an "X" in Record or Estimate. Choose "record" if the dose data listed represents a final determination of the dose received to the best of the licensee's or registrants knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in subsequent report. An example of such an instance would be dose data based on self-reading dosimeter results and the licensee intends to assign the record dose on the basis of the TLD results that are yet available.
10. Place an "X" in either Routine or PSE. Choose "Routine" if the data represents the results of monitoring for routine exposures. Choose "PSE" if the dose data represents the results of monitoring of planned special exposures received during the monitoring period. If more than one PSE was received in a single year, the licensee or registrant should sum them and report the total of all PSEs.
11. Enter the deep dose equivalent (DDE) to the whole body.
12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye.
13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE, WB).
14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE, ME).
15. Enter the committed effective dose equivalent (CEDE) or "NR" for "Not Required" or "NC" for "Not Calculated".
16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ or "NR" for Required" or "NC" for "Not Calculated".

17. Enter the total effective dose equivalent (TEDE). The TEDE is the sum of items 11 and 15.
18. Enter the total organ dose equivalent (TODE) for maximally exposed organ. The TODE is the sum of items 11 and 16.
19. Signature of the monitored individual. The signature of the monitored individual on this form indicates that the information contained on the form is complete and correct to the best of his or her knowledge.
20. Enter the date this form was signed by the monitored individual.
21. [OPTIONAL]S. Enter the name of the licensee, registrant or facility not licensed by the Agency, providing monitoring for exposure to radiation (such as a DOE facility) or the employer if the individual is not employed by the licensee or registrant and the employer chooses to maintain exposure records for its employees.
22. [OPTIONAL] Signature of the person designated to represent the licensee, registrant or employer entered in item 21. The licensee registrant or employer who chooses to countersign the form should have on file documentation of all the information on the Agency Form Y being signed.
23. [OPTIONAL] Enter the date this form was signed by the designated representative.

STATE OF FLORIDA  
BUREAU OF RADIATION CONTROL  
**DH FORM 1059**  
**CERTIFICATE - DISPOSITION OF RADIOACTIVE  
MATERIALS**



STATE OF FLORIDA  
DEPARTMENT OF HEALTH  
BUREAU OF RADIATION CONTROL



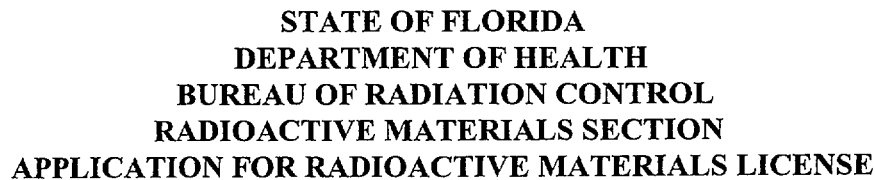
Bin #C21 • 4052 Bald Cypress Way • TALLAHASSEE, FLORIDA 32399-1741

**CERTIFICATE - DISPOSITION OF RADIOACTIVE MATERIALS**

(All items MUST be completed, please print)

LICENSEE NAME AND ADDRESS		LICENSE NUMBER	
		LICENSE EXPIRATION DATE	
THE LICENSEE OR ANY INDIVIDUAL EXECUTING THIS CERTIFICATE ON BEHALF OF THE LICENSEE CERTIFIES THAT: (Check and complete the appropriate item(s) below.)			
<b>A. MATERIALS DATA (Check one and complete, as necessary)</b>			
<input type="checkbox"/> 1. NO MATERIALS HAVE EVER BEEN PROCESSED OR PROCURED BY THE LICENSEE UNDER THIS LICENSE			
OR			
<input type="checkbox"/> 2. ALL MATERIALS PROCURED OR PROCESSED BY THE LICENSEE UNDER THE LICENSE NUMBER CITED ABOVE HAVE BEEN TRANSFERRED ON			
DATE:		TO:	
		LICENSE NUMBER:	
OR			
<input type="checkbox"/> 3. ALL MATERIALS PROCURED OR PROCESSED BY THE LICENSEE UNDER THE LICENSE NUMBER CITED ABOVE HAVE BEEN TRANSFERRED ON			
DATE:		TO:	
		WHICH HAS LICENSE NUMBER	
		ISSUED BY THE STATE OF	
OR			
<input type="checkbox"/> 4. MATERIALS HAVE BEEN DISPOSED OF IN THE FOLLOWING MANNER. (Describe specific disposal procedures - if additional space is needed, use the reverse of this form, of provide attachments)			
<b>B. OTHER DATA</b>			
<input type="checkbox"/> 1. OUR LICENSE HAS NOT YET EXPIRED, PLEASE TERMINATE IT.			
<input type="checkbox"/> 2. WAS A RADIATION SURVEY CONDUCTED TO CONFIRM THE ABSENCE OF LICENSED RADIOACTIVE MATERIALS AND TO DETERMINE WHETHER ANY CONTAMINATION REMAINS ON THE PREMISES COVERED BY THE LICENSE? (Check one)			
<input type="checkbox"/> NO			
<input type="checkbox"/> YES, THE RESULTS (Check one)			
<input type="checkbox"/> ARE ATTACHED, OR			
<input type="checkbox"/> WERE FORWARDED TO DEPARTMENT OF HEALTH ON (Date)			
3. THE PERSON TO BE CONTACTED REGARDING THIS INFORMATION PROVIDED ON THIS FORM			
NAME		TELEPHONE NUMBER	
4. MAIL ALL FUTURE CORRESPONDENCE REGARDING LICENSE TO			
RETURN TO:		<b>CERTIFYING OFFICIAL</b>	
BUREAU OF RADIATION CONTROL BIN #C21 4052 Bald Cypress Way TALLAHASSEE, FL 32399-1741		SIGNATURE	DATE
		PRINTED NAME AND TITLE	

STATE OF FLORIDA  
BUREAU OF RADIATION CONTROL  
**DH FORM 1054**  
**RADIOACTIVE MATERIALS LICENSE**  
**APPLICATION -- Non-Human Use**



## NON-HUMAN USE

INSTRUCTIONS - Complete Items 1 through 15 as applicable. Use supplemental sheets where necessary. Item 15 must be completed on all applications. Mail three copies to: Department of Health, Bureau of Radiation Control, Radioactive Materials Section, Bin #C21, 4052 Bald Cypress Way, Tallahassee, FL 32399-1741.

<p>1.a. NAME AND MAILING ADDRESS OF APPLICANT (institution, firm, company, person, etc.). INCLUDE ZIP CODE.</p>	<p>1.b. STREET ADDRESS(ES) AT WHICH RADIOACTIVE MATERIAL WILL BE USED, IF DIFFERENT FROM 1.a. INCLUDE ZIP CODE.</p>
<p>TELEPHONE NO.: Area Code (    )</p>	
<p>2.a. LICENSE FEE CATEGORY:</p>	<p>3. THIS IS AN APPLICATION FOR (check and complete appropriate items):              ___ a. NEW LICENSE              ___ b. AMENDMENT TO LICENSE NO. _____              ___ c. RENEWAL OF LICENSE NO. _____</p>
<p>b. LICENSE FEE ENCLOSED: \$ _____</p>	
<p>4. INDIVIDUAL USERS: Name individuals who will use or directly supervise use of radioactive material.</p>	<p>5. RADIATION SAFETY OFFICER (RSO): Name of person designated.</p>

## 6. TRAINING AND EXPERIENCE IN RADIATION SAFETY.

- a. **FORMAL TRAINING IN RADIATION SAFETY:** Attach a resumé for each individual named in Items 4 and 5. Describe each individual's formal training in principles and practices of radiation protection; radioactivity measurement standardization and monitoring techniques and the use of instruments; mathematics and calculations basic to the use and measurement of radioactivity; and biological effects of radiation. Include the name of the person or institution providing the training, duration of training and when training was received, or attach a copy of a training certificate from an approved training course where applicable.
- b. **EXPERIENCE:** Attach a resumé for each individual named in Items 4 and 5. Describe each individual's work experience with radiation, including where the experience was obtained. Include a list of radioisotopes and the maximum activity of each use. Work experience or on-the-job training should be commensurate with the proposed use.

7. RADIOACTIVE MATERIAL.

- |                            |   |  |
|----------------------------|---|--|
| a. ELEMENT AND MASS NUMBER | b. CHEMICAL AND/OR PHYSICAL FORM<br>(if sealed sources, include manufacturer and model number). | c. MAXIMUM AMOUNT TO BE POSSESSED AT ANY ONE TIME<br>(if sealed source(s), state number of sources and maximum activity per source). |
|----------------------------|---|--|

8. DESCRIBE PURPOSE FOR WHICH RADIOACTIVE MATERIALS LISTED IN ITEM 7, ABOVE, WILL BE USED.  
(if radioactive material is in the form of a sealed source, include the manufacturer and model number of the storage container and/or device in which the source will be stored and/or used).

9. RADIATION DETECTION INSTRUMENTS.

TYPE OF INSTRUMENTS (include manufacturer and model number of each)	NUMBER AVAILABLE	RADIATION DETECTED	SENSITIVITY RANGE (mR/hr)	USE (e.g., monitoring, surveying, measuring)

10. CALIBRATION OF INSTRUMENTS LISTED ABOVE.

- |  |   |
|--|---|
| <input type="checkbox"/> a. CALIBRATED BY SERVICE COMPANY<br>State the name, address and license number of the service company and the frequency of calibration of the device. | <input type="checkbox"/> b. CALIBRATED BY APPLICANT<br>Attach a separate sheet describing procedures, frequency and standards used for calibrating instruments. |
|--|---|

11. PERSONNEL MONITORING DEVICES. Complete Items a, b, c and d.

- |  |   |
|--|---|
| a. <input type="checkbox"/> Film <input type="checkbox"/> TLD  | b. <input type="checkbox"/> Whole Body <input type="checkbox"/> Extremity |
| c. Radiation Detected: <input type="checkbox"/> Beta <input type="checkbox"/> Gamma <input type="checkbox"/> Neutron |   |
| d. SUPPLIER _____ FREQUENCY OF EXCHANGE _____  |   |

- 
12. **FACILITIES AND EQUIPMENT.** Describe facilities where radioactive material, including waste, will be used and/or stored. **Attach an annotated diagram of the areas of use and/or storage, including adjacent areas.** Describe equipment such as remote handling devices, storage containers, shielding, fume hoods, etc.

- 
13. **RADIATION PROTECTION PROGRAM.** Describe the radiation protection program as appropriate for the material to be used, including general radiation safety procedures, emergency procedures and bioassay procedures. If the application includes a request for sealed sources, submit leak testing procedures, or if leak testing will be performed using a leak test kit, specify the manufacturer and model number of the kit and the name and radioactive materials license number of the individuals who will perform the analysis.

- 
14. **WASTE DISPOSAL.** Describe the procedures for handling, storing and disposing of radioactive wastes (solid, liquid and/or gas). Name the commercial waste disposal service employed, if applicable. If sealed sources and/or devices will be returned to the manufacturer, so state.

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15. **CERTIFICATE.**

The applicant and any official executing this certificate on behalf of the applicant named in Item 1, certify that this application has been prepared in accordance with Chapter 64E-5, Florida Administrative Code, and that all information contained herein, including any supplements attached hereto, is true and correct to the best of our knowledge and belief.

\_\_\_\_\_  
Certifying Official (signature)

\_\_\_\_\_  
Name (typed or printed)

\_\_\_\_\_  
Title

\_\_\_\_\_  
Date

---

**WARNING:** KNOWINGLY MAKING FALSE STATEMENTS TO A PUBLIC SERVANT IS A VIOLATION OF SECTION 837.06, FLORIDA STATUTES, AND IS PUNISHABLE BY FINE OR IMPRISONMENT.

STATE OF FLORIDA  
BUREAU OF RADIATION CONTROL  
**DH FORM 1081**  
**NOTICE TO EMPLOYEES**





## DEPARTMENT OF HEALTH



### NOTICE TO EMPLOYEES

#### STANDARDS FOR PROTECTION AGAINST RADIATION; NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS; INSPECTIONS

**THE DEPARTMENT OF HEALTH HAS ESTABLISHED STANDARDS FOR PROTECTION  
AGAINST RADIATION HAZARDS IN CHAPTER 64E-5, FLORIDA ADMINISTRATIVE CODE.**

#### **YOUR EMPLOYER'S RESPONSIBILITY**

Your employer is required to:

1. Apply these regulation to work involving sources of radiation.
2. Post or otherwise make available to you a copy of the Department of Health regulations, and the operating procedures which apply to work you are engaged in, and explain their provisions to you.
3. Post or otherwise make available to you Notice of Violation involving radiological working conditions, proposed imposition of civil penalties and orders.

#### **YOUR RESPONSIBILITY AS A WORKER**

You should familiarize yourself with those provisions of the Department of Health regulations, and the operating procedures which apply to the work you are engaged in. You should observe their provisions for your own protection and protection of co-workers.

#### **WHAT IS COVERED BY THESE REGULATIONS**

1. Limits on exposure to radiation and radioactive material in restricted and unrestricted areas
2. Measures to be taken after accidental exposure
3. Personnel monitoring, surveys, and equipment
4. Caution signs, labels, and safety interlock equipment
5. Exposure records and reports
6. Options for workers regarding Department of Health inspections
7. Related matters

#### **REPORTS ON YOUR RADIATION EXPOSURE HISTORY**

The Department of Health regulations require that your employer give you a written report if you receive an exposure in excess of any applicable limit set forth in

the regulations or in the license. The limits for exposure to employees are set forth in Part III of the regulations. These sections specify limits on radiation exposure and exposure to concentrations of radioactive material in air.

If you work where personnel monitoring is required:

1. Your employer must give you a written report of your radiation exposures when you terminate your employment.
2. Your employer must give you a written report of your radiation exposures annually.

#### **INSPECTIONS**

All licensed and registered activities are subject to inspection by representatives of the Department of Health. In addition, any worker or worker representative who believes that there is a violation of Chapter 404, Florida Statutes; Chapter 64E-5, Florida Administrative Code; or the terms of the employer's license or registration regarding radiological working conditions in which the worker is engaged, may request an inspection by contacting the Bureau of Radiation Control, Bin #C21, 4052 Bald Cypress Way, Tallahassee, FL 32399-1741 (850) 245-4266. The request must set forth specific grounds for the inspection. During inspections, Department of Health inspectors may confer privately with workers, and any worker may bring to the attention of the inspectors any past or present condition which he believes contributed to or caused any violation as described above.

Copies of Chapter 64E-5, F.A.C., radioactive materials license, the operating procedures, notice of violation involving working conditions or penalty orders issued and responses thereto may be examined at:

#### **POSTING REQUIREMENT**

**COPIES OF THIS NOTICE MUST BE POSTED IN SUFFICIENT NUMBER OF PLACES IN EVERY ESTABLISHMENT WHERE EMPLOYEES ARE EMPLOYED IN ACTIVITIES LICENSED OR REGISTERED AS SPECIFIED BY CHAPTER 64E-5, FLORIDA ADMINISTRATIVE CODE, BY THE DEPARTMENT OF HEALTH, TO PERMIT EMPLOYEES WORKING IN OR FREQUENTING ANY PORTION OF A RESTRICTED AREA TO OBSERVE A COPY ON THE WAY TO OR FROM THEIR PLACE OF EMPLOYMENT.**

STATE OF FLORIDA  
BUREAU OF RADIATION CONTROL

**REQUIREMENTS FOR TRANSFERS OF  
LOW-LEVEL RADIOACTIVE WASTE INTENDED  
FOR DISPOSAL AT LICENSED LAND DISPOSAL  
FACILITIES AND MANIFEST**

July, 1997



## **REQUIREMENTS FOR TRANSFERS OF LOW-LEVEL RADIOACTIVE WASTE INTENDED FOR DISPOSAL AT LICENSED LAND DISPOSAL FACILITIES AND MANIFEST**

### **I. Manifest**

A waste generator, collector, or processor who transports or offers for transportation low-level radioactive waste intended for ultimate disposal at a licensed low-level radioactive waste land disposal facility shall prepare a manifest reflecting information requested on applicable NRC Form 540 (3-95), Uniform Low-Level Radioactive Waste Manifest - Shipping Paper and NRC Form 541 (11-96), Uniform Low-Level Radioactive Waste Manifest - Container and Waste Description and, if necessary, NRC Form 542 (3-95), Uniform Low-Level Radioactive Waste Manifest - Manifest Index and Regional Compact Tabulation, which are herein incorporated by reference and which are available from the department. NRC Form 540 (3-95) and NRC Form 540A (3-95) shall be completed and physically shall accompany the pertinent low-level waste shipment. Upon agreement between shipper and consignee, NRC Form 541 (11-96) and NRC Form 541A (3-95) and NRC Form 542 (3-95) and NRC Form 542A (3-95) can be completed, transmitted, and stored in electronic media able to produce legible, accurate, and complete records on the respective forms. Licensees are not required to comply with the manifesting requirements of this part when they ship:

- LLW for processing and expect its return for storage under their license before disposal at a licensed land disposal facility;
- LLW that is being returned to the licensee who is the waste generator or generator as defined in this part; or
- Radioactively contaminated material to a waste processor that becomes the processor's residual waste.

For guidance in completing these forms, refer to the instructions that accompany the forms. Copies of manifests required by this appendix can be legible carbon copies, photocopies, or computer printouts that reproduce the data in the format of the uniform manifest.

NRC Form 540 (3-95), NRC Form 540A (3-95), NRC Form 541 (11-96), NRC Form 541A (3-95), NRC Form 542 (3-95), and NRC Form 542A (3-95), and the accompanying instructions in hard copy can be obtained from the department.

This appendix includes information requirements of the Department of Transportation, as codified in 49 CFR Part 172. Information on hazardous, medical, or other waste required to meet Environmental Protection Agency regulations as codified in 40 CFR Parts 259, 261 or elsewhere is not addressed in this section and shall be provided on the required EPA forms. However, the required EPA forms shall accompany the Uniform Low-Level Radioactive Waste Manifest required by this rule.

As used in this appendix, the following definitions apply:

*Chelating agent* means amine polycarboxylic acids such as EDTA and DTPA, hydroxy-carboxylic acids, and polycarboxylic acids such as citric acid, carbolic acid, and glucinic acid.

*Chemical description* means a description of the principal chemical characteristics of a low-level radioactive waste.

*Computer-readable medium* means that the department's computer can transfer the information from the medium into its memory.

*Consignee* means the designated receiver of the shipment of low-level radioactive waste.

*Decontamination facility* means a facility operating under an NRC or Agreement State license whose principal purpose is decontamination of equipment or materials to accomplish recycle, reuse, or other waste management objectives, and, for purposes of this part, is not considered to be a consignee for LLW shipments.

*Disposal container* means a container principally used to confine low-level radioactive waste during disposal operations at a land disposal facility. (Also see "high integrity container".) Note that for some shipments the disposal container could be the transport package.

*EPA identification number* means the number received by a transporter following application to the Administrator of EPA as required by 40 CFR part 263.

*Generator* means a licensee operating under an NRC or Agreement State license who is a waste generator or is the licensee to whom waste can be attributed within the context of the Low-Level Radioactive Waste Policy Amendments Act of 1985, for example, waste generated as a result of decontamination or recycle activities.

*High integrity container (HIC)* means a container commonly designed to meet the structural stability requirements of 64E-5.333(9), F.A.C., and to meet Department of Transportation requirements for a Type A package.

*Land disposal facility* means the land, buildings and structures, and equipment which are intended to be used for the disposal of radioactive wastes. For the purposes of these regulations, a geologic repository as defined in 10 CFR Part 60 is not considered a land disposal facility.

*NRC Form 540 (3-95), NRC Form 540A (3-95), NRC Form 541 (11-96), NRC Form 541A (3-95), NRC Form 542 (3-95), and NRC Form 542A (3-95)* are official department forms referenced in this appendix. Licensees need not use originals of these department forms as long as any substitute forms are equivalent to the original documentation in respect to content, clarity, size, and location of information. Upon agreement between the shipper and consignee, NRC Form 540 (3-95), NRC Form 540A (3-95), NRC Form 541 (11-96), and NRC Form 541A (3-95), can be completed, transmitted, and stored in electronic media. The electronic media shall be able to produce legible, accurate, and complete records in the format of the uniform manifest.

*Package* means the assembly of components necessary to ensure compliance with the packaging requirements of DOT regulations with its radioactive contents as presented for transport.

*Physical description* means the items called for on NRC Form 541 (11-96) to describe a low-level radioactive waste.

*Residual waste* means low-level radioactive waste resulting from processing or decontamination activities that cannot be separated easily into distinct batches attributable to specific waste generators. This waste is attributable to the processor or decontamination facility, as applicable.

*Shipper* means the waste generator, waste collector, or waste processor who offers low-level radioactive waste for transportation, typically consigning this type of waste to a licensed waste collector, waste processor, or land disposal facility operator.

*Shipping paper* means NRC Form 540 (3-95) and, if required, NRC Form 540A (3-95), which includes the information required by DOT in 49 CFR part 172.

*Source material* has the same meaning as that given in 64E-5.101, F.A.C.

*Special nuclear material* has the same meaning as that given in 64E-5.101, F.A.C.

*Uniform Low-Level Radioactive Waste Manifest* or *uniform manifest* means the combination of NRC Form 540 (3-95), NRC Form 541 (11-96), and, if necessary, NRC Form 542 (3-95), and their respective continuation sheets as needed, or equivalent.

*Waste collector* means an entity operating under an NRC or Agreement State license whose principal purpose is to collect and consolidate waste generated by others and to transfer this waste without processing or repackaging the collected waste to another licensed waste collector, licensed waste processor, or licensed land disposal facility.

*Waste description* means the physical, chemical and radiological description of a low-level radioactive waste as called for on NRC Form 541 (11-96).

*Waste generator* means an entity operating under an NRC or Agreement State license who possesses any material or component that contains radioactivity or is radioactively contaminated for which the licensee foresees no further use and transfers this material or component to a licensed land disposal facility or to a licensed waste collector or processor for handling or treatment prior to disposal. A licensee performing processing or decontamination services can be a waste generator if the transfer of low-level radioactive waste from its facility is defined as residual waste.

*Waste processor* means an entity operating under an NRC or agreement state license whose principal purpose is to process, repackage, or otherwise treat low-level radioactive material or waste generated by others prior to eventual transfer of waste to a licensed low-level radioactive waste land disposal facility.

*Waste type* means a waste within a disposal container having a unique physical description such as a specific waste descriptor code or description; or a waste sorbed on or solidified in a specifically defined media.

## ***Information Requirements***

### **A. General Information**

The shipper of the radioactive waste shall provide the following information on the uniform manifest:

1. The name, facility address, and telephone number of the licensee shipping the waste;
2. An explicit declaration indicating whether the shipper is acting as a waste generator, collector, processor, or a combination of these identifiers for the manifested shipment; and
3. The name, address, and telephone number or the name and EPA identification number for the carrier transporting the waste.

## **B. Shipment Information**

The shipper of the radioactive waste shall provide the following information regarding the waste shipment on the uniform manifest:

1. The date of the waste shipment;
2. The total number of packages and disposal containers;
3. The total disposal volume and disposal weight in the shipment;
4. The total radionuclide activity in the shipment;
5. The activity of each of the radionuclides H-3, C-14, Tc-99, and I-129 contained in the shipment; and
6. The total masses of U-233, U-235, and plutonium in special nuclear material and the total mass of uranium and thorium in source material.

## **C. Disposal Container and Waste Information**

The shipper of the radioactive waste shall provide the following information on the uniform manifest regarding the waste and each disposal container of waste in the shipment:

1. An alphabetic or numeric identification that uniquely identifies each disposal container in the shipment;
2. A physical description of the disposal container, including the manufacturer and model of high integrity container;
3. The volume displaced by the disposal container;
4. The gross weight of the disposal container, including the waste;
5. For waste consigned to a disposal facility, the maximum radiation level at the surface of each disposal container;
6. A physical and chemical description of the waste;
7. The total weight percentage of chelating agent for any waste containing more than 0.1% chelating agent by weight plus the identity of the principal chelating agent;
8. The approximate volume of waste within a container;
9. The sorbing or solidification media if any and the identity of the solidification media vendor and brand name;
10. The identities and activities of individual radionuclides contained in each container, the masses of U-233, U-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material. For discrete waste types such as activated materials, contaminated equipment, mechanical filters, sealed sources or devices, and wastes in solidification or stabilization media, the identities and activities of individual radionuclides associated with or contained on these waste types within a disposal container shall be reported;

11. The total radioactivity within each container; and
12. For wastes consigned to a disposal facility, the classification of the waste pursuant to 64E-5.333(1)-(8), F.A.C. Waste not meeting the structural stability requirements of 64E-5.333(9)(b), F.A.C. shall be identified.

#### **D. Uncontainerized Waste Information**

The shipper of radioactive waste shall provide the following information on the uniform manifest regarding a waste shipment delivered without a disposal container:

1. The approximate volume and weight of the waste;
2. A physical and chemical description of the waste;
3. The total weight percentage of chelating agent if the chelating agent exceeds 0.1% by weight plus the identity of the principal chelating agent;
4. For waste consigned to a disposal facility, the classification of the waste pursuant to 64E-5.333(1)-(8), F.A.C. Waste not meeting the structural stability requirements of 64E-5.333(9)(b), F.A.C. shall be identified;
5. The identities and activities of individual radionuclides contained in the waste, the masses of U-233, U-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material; and
6. For wastes consigned to a disposal facility, the maximum radiation levels at the surface of the waste.

#### **E. Multi-Generator Disposal Container Information**

This section applies to disposal containers enclosing mixtures of waste originating from different generators. The origin of the LLW resulting from a processor's activities can be attributable to one or more generators including "waste generators as defined in this part. It also applies to mixtures of wastes shipped in an uncontainerized form for which portions of the mixture within the shipment originate from different generators.

1. For homogeneous mixtures of waste, such as incinerator ash, provide the waste description applicable to the mixture and the volume of the waste attributed to each generator.
2. For heterogeneous mixtures of waste such as the combined products from a large compactor, identify each generator contributing waste to the disposal container, and, for discrete waste types such as activated materials, contaminated equipment, mechanical filters, sealed source or devices and wastes in solidification or stabilization media, the identities and activities of individual radionuclides contained on these waste types within the disposal container. For each generator, provide the following:
  - (a) The volume of waste within the disposal container;
  - (b) A physical and chemical description of the waste including the solidification agent, if any;
  - (c) The total weight percentage of chelating agents for any disposal container containing more than 0.1% chelating agent by weight plus the identity of the principal chelating agent;



(d) The sorbing or solidification media if any and the identity of the solidification media vendor and brand name if the media is claimed to meet stability requirements in 64E-5.333(9)(b); and

(e) Radionuclide identities and activities contained in the waste, the masses of U-233, U-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material if contained in the waste.

## **II. Certification**

An authorized representative of the waste generator, processor, or collector shall certify by signing and dating the shipment manifest that the transported materials are classified, described, packaged, marked, and labeled properly and are in proper condition for transportation according to the applicable regulations of the Department of Transportation and the department. By signing the certification, a collector is certifying that nothing has been done to the collected waste that would invalidate the waste generator's certification.

## **III. Control and Tracking**

A. Any licensee who transfers radioactive waste to a land disposal facility or a licensed waste collector shall comply with the requirements in paragraphs A.1 through 9 of this section. Any licensee who transfers waste to a licensed waste processor for waste treatment or repackaging shall comply with the requirements of paragraphs A.4 through 9 of this section. A licensee shall:

1. Prepare all wastes so that the waste is classified according to 64E-5.333(1)-(8), F.A.C. and meets the waste characteristics requirements in 64E-5.333(9), F.A.C.;
2. Label each disposal container or transport package if potential radiation hazards preclude labeling of the individual disposal container of waste to identify whether it is Class A waste, Class B waste, Class C waste, or greater than Class C waste, in accordance with 64E-5.333(1)-(8), F.A.C.;
3. Conduct a quality assurance program to assure compliance with 64E-5.333(1)-(8), F.A.C. and 64E-5.333(9), F.A.C. The program shall include management evaluation of audits;
4. Prepare the manifest as required by this appendix;
5. Forward a copy or electronically transfer the manifest to the intended consignee so that receipt of the manifest precedes the LLW shipment or the manifests delivered to the consignee with the waste at the time the waste is transferred to the consignee;
6. Include NRC Form 540 (3-95) and NRC Form 540A (3-95) if required with the shipment regardless of the option chosen in paragraph A.5 of this section;
7. Receive acknowledgment of the receipt of the shipment in the form of a signed copy of NRC Form 540 (3-95);
8. Retain a copy of or electronically store the manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 64E-5, F.A.C.; and
9. Conduct an investigation in accordance with paragraph E of this appendix for any shipments or any part of a shipment for which acknowledgment of receipt has not been received within the times set forth in this appendix.

B. Any waste collector licensee who handles only prepackaged waste shall:

1. Acknowledge receipt of the waste from the shipper within 1 week of receipt by returning a signed copy of NRC Form 540 (3-95);
2. Prepare a new manifest to reflect consolidated shipments that meet the requirements of this appendix. The waste collector shall ensure that the manifest identifies the generator of that container of waste for each container of waste in the shipment;
3. Forward a copy or electronically transfer the manifest to the intended consignee so that either receipt of the manifest precedes the LLW shipment or the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee;
4. Include NRC Form 540 (3-95) and NRC Form 540A (3-95) if required with the shipment regardless of the option chosen in paragraph B.3 of this section;
5. Receive acknowledgment of the receipt of the shipment in the form of a signed copy of NRC Form 540 (3-95);
6. Retain a copy of or electronically store the manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 64E-5, F.A.C.;
7. Conduct an investigation for any shipments or any part of a shipment for which acknowledgment of receipt has not been received within the times set forth in this appendix as specified in paragraph E of this appendix; and
8. Notify the shipper and the department when any shipment or part of a shipment has not arrived within 60 days after receipt of an advance manifest unless notified by the shipper that the shipment has been canceled.

C. Any licensed waste processor who treats or repackages waste shall:

1. Acknowledge receipt of the waste from the shipper within 1 week of receipt by returning a signed copy of NRC Form 540 (3-95);
2. Prepare a new manifest that meets the requirements of this appendix. Preparation of the new manifest reflects that the processor is responsible for meeting these requirements. The manifest shall identify the waste generators, the preprocessed waste volume, and the other information required in paragraph I.E. of this appendix for each container of waste in the shipment;
3. Prepare all wastes so that the waste is classified according to 64E-5.333(1)-(8), F.A.C., and meets the waste characteristics requirements in 64E-5.333(9), F.A.C.;
4. Label each package of waste to identify whether it is Class A waste, Class B waste or Class C waste as specified in 64E-5.333(1)-(8), F.A.C., and 64E-5.333(10), F.A.C.;
5. Conduct a quality assurance program to assure compliance with 64E-5.333(1)-(9), F.A.C. The program shall include management evaluation of audits;
6. Forward a copy or electronically transfer the manifest to the intended consignee so that either receipt of the manifest precedes the LLW shipment or the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee;
7. Include NRC Form 540 (3-95) and NRC Form 540A (3-95) if required with the shipment regardless of the option chosen in paragraph C.6 of this section;

8. Receive acknowledgment of the receipt of the shipment in the form of a signed copy of NRC Form 540 (3-95);

9. Retain a copy of or electronically store the manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 64E-5, F.A.C.;

10. Conduct an investigation in accordance with paragraph E of this appendix for any shipment or any part of a shipment for which acknowledgment of receipt has not been received within the times set forth in this appendix; and

11. Notify the shipper and the department when any shipment or part of a shipment has not arrived within 60 days after receipt of an advance manifest unless notified by the shipper that the shipment has been canceled.

D. The land disposal facility operator shall:

1. Acknowledge receipt of the waste within 1 week of receipt by returning as a minimum a signed copy of NRC Form 540 (3-95) to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the operator. If any discrepancy exists between materials listed on the manifest and materials received, copies or electronic transfer of affected forms shall be returned indicating the discrepancy.

2. Maintain copies of all completed manifests and electronically store the information required by (a) and (b) below until the department terminates the license:

(a) All information required in this appendix except shipper and carrier telephone numbers and shipper and consignee certifications; and

(b) Following receipt and acceptance of a shipment of radioactive waste, the date that the shipment is received at the disposal facility, the date of disposal of the waste, a traceable shipment manifest number, a description of any engineered barrier or structural overpack provided for disposal of the waste, the location of disposal at the disposal site, the containment integrity of the waste disposal containers as received, any discrepancies between materials listed on the manifest and those received, the volume of any pallets, bracing, or other shipping or onsite generated materials that are contaminated and are disposed of as contaminated or suspect materials, any evidence of leaking or damaged disposal containers or radiation or contamination levels in excess of limits specified in DOT and department regulations, brief description of any repackaging operations of any of the disposal containers included in the shipment, and any other information required by the department as a license condition.

3. Notify the shipper and the department when any shipment or part of a shipment has not arrived within 60 days after receipt of an advance manifest unless notified by the shipper that the shipment has been canceled.

E. Any shipment or part of a shipment for which acknowledgment is not received within the times set forth in this section shall:

1. Be investigated by the shipper if the shipper has not received notification or receipt within 20 days after transfer; and

2. Be traced and reported. The investigation shall include tracing the shipment and filing a report with the department. Each licensee who conducts a trace investigation shall file a written report with the department within 2 weeks of completion of the investigation.



STATE OF FLORIDA  
DEPARTMENT OF HEALTH  
BUREAU OF RADIATION CONTROL

Bin #C21 • 4052 Bald Cypress Way • TALLAHASSEE, FLORIDA 32399-1741

**CERTIFICATE - DISPOSITION OF RADIOACTIVE MATERIALS**

(All items MUST be completed, please print)

LICENSEE NAME AND ADDRESS	LICENSE NUMBER
	LICENSE EXPIRATION DATE

THE LICENSEE OR ANY INDIVIDUAL EXECUTING THIS CERTIFICATE ON BEHALF OF THE LICENSEE CERTIFIES THAT:  
(Check and complete the appropriate item(s) below.)

**A. MATERIALS DATA (Check one and complete, as necessary)**

- ☐ 1. NO MATERIALS HAVE EVER BEEN PROCESSED OR PROCURED BY THE LICENSEE UNDER THIS LICENSE
- OR
- ☐ 2. ALL MATERIALS PROCURED OR PROCESSED BY THE LICENSEE UNDER THE LICENSE NUMBER CITED ABOVE HAVE BEEN TRANSFERRED ON
- DATE: \_\_\_\_\_ TO: \_\_\_\_\_
- LICENSE NUMBER: \_\_\_\_\_
- OR
- ☐ 3. ALL MATERIALS PROCURED OR PROCESSED BY THE LICENSEE UNDER THE LICENSE NUMBER CITED ABOVE HAVE BEEN TRANSFERRED ON
- DATE: \_\_\_\_\_ TO: \_\_\_\_\_
- WHICH HAS LICENSE NUMBER \_\_\_\_\_ ISSUED BY THE STATE OF \_\_\_\_\_
- OR
- ☐ 4. MATERIALS HAVE BEEN DISPOSED OF IN THE FOLLOWING MANNER. (Describe specific disposal procedures - if additional space is needed, use the reverse of this form, of provide attachments)

**B. OTHER DATA**

- ☐ 1. OUR LICENSE HAS NOT YET EXPIRED, PLEASE TERMINATE IT.
- ☐ 2. WAS A RADIATION SURVEY CONDUCTED TO CONFIRM THE ABSENCE OF LICENSED RADIOACTIVE MATERIALS AND TO DETERMINE WHETHER ANY CONTAMINATION REMAINS ON THE PREMISES COVERED BY THE LICENSE? (Check one)
- ☐ NO
- ☐ YES, THE RESULTS (Check one)
- ☐ ARE ATTACHED, OR
- ☐ WERE FORWARDED TO DEPARTMENT OF HEALTH ON (Date) \_\_\_\_\_

3. THE PERSON TO BE CONTACTED REGARDING THIS INFORMATION PROVIDED ON THIS FORM	
NAME	TELEPHONE NUMBER

4. MAIL ALL FUTURE CORRESPONDENCE REGARDING LICENSE TO
--

RETURN TO:  BUREAU OF RADIATION CONTROL BIN #C21 4052 BALD CYPRESS WAY TALLAHASSEE, FL 32399-1741	CERTIFYING OFFICIAL	
	SIGNATURE	DATE
	PRINTED NAME AND TITLE	

## **Authorized Nuclear Pharmacist Training Requirements**

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### **64B16-28.903 Training Qualifications.**

- (1) A pharmacist licensed to practice pharmacy in this state who performs a radiopharmaceutical service shall, prior to engaging in such specialized practice, be actively licensed as a nuclear pharmacist from the Board of Pharmacy.
- (2) A licensed pharmacist seeking licensure as a nuclear pharmacist in this state shall submit to the Board of Pharmacy a course outline from an accredited college of pharmacy or other program recognized by the Florida Department of Health and the Florida Board of Pharmacy (a program comparable to those offered by accredited colleges of pharmacy for the training of nuclear pharmacists), and a certificate of training which provides a minimum of 200 clock hours of formal didactic training, which includes:
  - (a) Radiation physics and instrumentation (85 hours);
  - (b) Radiation protection (45 hours);
  - (c) Mathematics pertaining to the use and measurement of radioactivity (20 hours);
  - (d) Radiation biology (20 hours);
  - (e) Radiopharmaceutical chemistry (30 hours).
- (3) Such academic training programs will be submitted to the Board for approval by an accredited educational institution which operates under the auspices of or in conjunction with an accredited college of pharmacy.
- (4) The minimum on-the-job training which shall be included in a radiopharmacy internship is five hundred (500) hours of training and experience in the handling of unsealed radioactive material under the supervision of a licensed nuclear pharmacist. The training and experience shall include, but shall not be limited to the following:
  - (a) Ordering, receiving and unpackaging in a safe manner, radioactive material, including the performance of related radiation surveys;
  - (b) Calibrating dose calibrators, scintillation detectors, and radiation monitoring equipment;
  - (c) Calculating, preparing and verifying patient doses, including the proper use of radiation shields;
  - (d) Following appropriate internal control procedures to prevent mislabeling;
  - (e) Learning emergency procedures to safely handle and contain spilled materials, including related decontamination procedures and surveys;
  - (f) Eluting technetium-99m from generator systems, assaying the eluate for technetium-99m and for molybdenum-99 contamination, and processing the eluate with reagent kits to prepare technetium-99m labeled radiopharmaceuticals;
  - (g) Clinical practice concepts.
- (5) Guidelines for such programs are in a publication entitled "Guidelines for Florida Board of Pharmacy Internship Training in Radiopharmacy" (1988). Governmental and private radiopharmacy internship programs shall not apply to the pharmacy internship required under Rule 64B16-26.401, F.A.C.
- (6) If the didactic and experiential training required in this section have not been completed within the last seven years, the applicant must have been engaged in the lawful practice of nuclear pharmacy in another jurisdiction at least 1080 hours during the last seven years.
- (7) The Board of Pharmacy shall, subsequent to its review of the certificates of training, inform each applicant in writing as to whether or not licensure has been granted.

# State Boundaries

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**Approximate Boundaries Shown**  
**See Florida Constitution for Exact Boundaries**



0 40 80 120 Miles

1:4158925



**Florida Department of Health**  
**Bureau of Radiation Control**

Disclaimer:  
This product is for reference purposes only  
and is not to be construed as a legal  
document. Any reliance on the information  
contained herein is at the user's own risk.  
The Florida Department of Health and its  
agents assume no responsibility for any  
use of the information contained herein  
or any loss resulting therefrom.

**CONSTITUTION OF THE STATE OF FLORIDA – Article II, Section 1**  
**State Boundaries**  
AS REVISED IN 1968 AND SUBSEQUENTLY AMENDED

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**ARTICLE II GENERAL PROVISIONS**

**SECTION 1. State boundaries.**

- (a) The state boundaries are: Begin at the mouth of the Perdido River, which for the purposes of this description is defined as the point where latitude 30°16'53" north and longitude 87°31'06" west intersect; thence to the point where latitude 30°17'02" north and longitude 87°31'06" west intersect; thence to the point where latitude 30°18'00" north and longitude 87°27'08" west intersect; thence to the point where the center line of the Intracoastal Canal (as the same existed on June 12, 1953) and longitude 87°27'00" west intersect; the same being in the middle of the Perdido River; thence up the middle of the Perdido River to the point where it intersects the south boundary of the State of Alabama, being also the point of intersection of the middle of the Perdido River with latitude 31°00'00" north; thence east, along the south boundary line of the State of Alabama, the same being latitude 31°00'00" north to the middle of the Chattahoochee River; thence down the middle of said river to its confluence with the Flint River; thence in a straight line to the head of the St. Marys River; thence down the middle of said river to the Atlantic Ocean; thence due east to the edge of the Gulf Stream or a distance of three geographic miles whichever is the greater distance; thence in a southerly direction along the edge of the Gulf Stream or along a line three geographic miles from the Atlantic coastline and three leagues distant from the Gulf of Mexico coastline, whichever is greater, to and through the Straits of Florida and westerly, including the Florida reefs, to a point due south of and three leagues from the southernmost point of the Marquesas Keys; thence westerly along a straight line to a point due south of and three leagues from Loggerhead Key, the westernmost of the Dry Tortugas Islands; thence westerly, northerly and easterly along the arc of a curve three leagues distant from Loggerhead Key to a point due north of Loggerhead Key; thence northeast along a straight line to a point three leagues from the coastline of Florida; thence northerly and westerly three leagues distant from the coastline to a point west of the mouth of the Perdido River three leagues from the coastline as measured on a line bearing south 0°01'00" west from the point of beginning; thence northerly along said line to the point of beginning. The State of Florida shall also include any additional territory within the United States adjacent to the Peninsula of Florida lying south of the St. Marys River, east of the Perdido River, and south of the States of Alabama and Georgia.
- (b) The coastal boundaries may be extended by statute to the limits permitted by the laws of the United States or international law.

*(one league = three statute miles)*



## FLORIDA DEPARTMENT OF HEALTH



# NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION;  
NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS; INSPECTIONS

### POSTING REQUIREMENT

THIS NOTICE MUST BE POSTED IN PLACES THAT PERMIT EMPLOYEES IN A RESTRICTED AREA  
TO SEE A COPY ON THE WAY TO OR FROM THEIR PLACE OF EMPLOYMENT.

The Department of Health has established standards for protection against radiation hazards  
in Chapter 64E-5, Florida Administrative Code.

#### YOUR EMPLOYER IS REQUIRED TO:

- Post or provide you a copy of the Department of Health rules and operating procedures that apply to your work and explain them to you.
- Apply the rules to work involving radiation sources.
- Post or provide you any Notice of Violation involving radiological working conditions, proposed civil penalties, and orders.

#### YOU ARE REQUIRED TO:

- Become familiar with the rules and the operating procedures that apply to your work.
- Observe the requirements to protect yourself and your co-workers.

#### WHAT IS IN THESE RULES:

- Limits on exposure to radiation and radioactive material in restricted and unrestricted areas
- Actions to take after accidental exposure
- Personnel monitoring, surveys, and equipment
- Caution signs, labels, and safety interlocks
- Exposure records and reports
- Options for workers about Department of Health inspections
- Related matters

#### REPORTS ON RADIATION EXPOSURE

Your employer must give you a written report if you receive an exposure above the limits in the rules or in the license. The maximum limits for exposure to employees are in Part III of the rules. However, your employer should keep your radiation exposure as low as reasonably achievable.

If you work where personnel monitoring is required:

- Your employer must give you a written annual report of your radiation exposures.
- Your employer must give you a written report of your radiation exposures when you terminate employment.

#### INSPECTIONS

Representatives of the Department of Health inspect all licensed and registered activities. Any worker or worker representative who believes that there is a violation of Chapter 404, Florida Statutes; Chapter 64E-5, Florida Administrative Code; or the terms of the employer's license or registration can request an inspection by contacting the Bureau of Radiation Control, Bin C21, 4052 Bald Cypress Way, Tallahassee, FL 32399-1741 (850) 245-4266. The request must state specific reasons for the inspection. During inspections, Department of Health inspectors can confer privately with workers and any worker can bring to the attention of the inspectors any past or present condition that they believe contributed to or caused any violation.

Copies of Chapter 64E-5, F.A.C., the license or registration, operating procedures, any notice of violation about working conditions, penalty orders issued, and responses can be examined at: