

PART I. RADIATION SAFETY REQUIREMENTS FOR INDUSTRIAL RADIOGRAPHIC OPERATIONS.

RH-1800. General Provisions.

- a. Purpose. The Regulations in this Part establish radiation safety requirements for persons utilizing sources of radiation for industrial radiography. The requirements of this Part are in addition to and not in substitution for other applicable requirements of these Regulations.
- b. Scope. The Regulations in this Part apply to all licensees or registrants who use sources of radiation for industrial radiography. Except for the Regulations in this Part clearly applicable only to sealed radioactive sources, both radiation machines and sealed radioactive sources are covered by this Part. The provisions of this Part are not applicable to systems designed exclusively for microscopic examination of material, e.g., x-ray diffraction, spectroscopic and electron microscope equipment or to systems for intentional exposure of humans to x-rays.
- c. Definitions. As used in these Regulations. Additional definitions used only in a certain part will be found in that part.
 1. Access panel - Any barrier or panel which is designed to be removed or opened for maintenance or service purposes, requires tools to open and permits access to the interior of the cabinet.
 2. Aperture - Any opening in the outside surface of the cabinet, other than a port, which remains open during generation of x-radiation.
 3. Cabinet radiography - Industrial radiography conducted in an enclosed cabinet which is so shielded that every location on the exterior meets conditions for an unrestricted area as specified in RH-1208.
 4. Cabinet x-ray system - An x-ray system with the x-ray tube installed in an enclosure (hereinafter termed "cabinet") which, independently of existing architectural structures except the floor on which it may be placed, is intended to contain at least that portion of a material being irradiated,

Revision effective January 1, 1997

provide radiation attenuation and exclude personnel from its interior during generation of x-radiation. Included are all x-ray systems designed primarily for the inspection of carry-on baggage at airline, railroad and bus terminals and in similar facilities. An x-ray tube used within a shielded part of a building or x-ray equipment which may temporarily or occasionally incorporate portable shielding is not considered a cabinet x-ray system.

5. Certified cabinet system - X-ray systems which are subject to regulations promulgated under Public Law 90-602, the Radiation Control for Health and Safety Act of 1968.
6. Collimator - A device used to limit the size and direction of the primary beam.
7. Door - Any barrier which is designed to be movable or opened for routine operations purposes, does not generally require tools to open and permits access to the interior of the cabinet. For the purposes of RH-1803.g.1.A of this Section, inflexible hardware rigidly affixed to the door shall be considered part of the door.
8. Enclosed radiography - Industrial radiography conducted in an enclosed cabinet or room and includes cabinet radiography, cabinet x-ray systems and shielded room radiography.
9. External surface - The outside surface of the cabinet x-ray system, including the high-voltage generator, doors, access panels, latches, control knobs and other permanently mounted hardware and including the plane across any aperture or port.
10. Floor - The underside external surface of the cabinet.
11. Ground fault - An accidental electrical grounding of an electrical conductor.
12. Industrial radiography - The examination of the macroscopic structure of materials by non-destructive methods utilizing sources of radiation.

Revision effective January 1, 1997

13. Permanent radiographic installation - A shielded installation or structure designed or intended for radiography in which radiography is regularly performed.
14. Personal supervision - Supervision such that the supervisor is physically present at the radiography site and in such proximity that contact can be maintained and immediate assistance given as required.
15. Port - Any opening in the outside surface of the cabinet which is designed to remain open, during generation of x-rays, for the purpose of conveying material to be irradiated into and out of the cabinet or for partial insertion for irradiation of an object whose dimensions do not permit complete insertion into the cabinet.
16. Primary beam - The x-radiation emitted directly from the target and passing through the window of the x-ray tube.
17. Radiographer - Any individual who performs or who, in attendance at the site where sources of radiation are being used, personally supervises industrial radiographic operations and who is responsible to the licensee or registrant for assuring compliance with the requirements of these regulations and the conditions of registration or of a license.
18. Radiographer instructor - Any radiographer who has been listed on a specific license from the Department and meeting the requirements of RH-1803.f.5.
19. Radiographer's assistant - Any individual who, under the personal supervision of a radiographer, uses sources of radiation, related handling tools or radiation survey instruments in industrial radiography.

Revision effective January 1, 1997

20. Radiographic exposure device - Any instrument containing a sealed source fastened or contained therein, in which the sealed source or shielding thereof may be moved or otherwise changed, from a shielded to unshielded position for purposes of making a radiographic exposure.
21. Radiography - The examination of the structure of materials by nondestructive methods, utilizing sealed sources of radioactive materials.
22. Safety interlock - A device which is intended to prevent the generation of x-radiation when access by any part of the human body to the interior of the cabinet x-ray system through a door or access panel is possible.
23. Sealed source - Any radioactive material that is encased in a capsule designed to prevent leakage or escape of the radioactive material.
24. Shielded position - The location within the radiographic exposure device or storage container which, by manufacturer's design, is the proper location for storage of the sealed source.
25. Shielded room radiography - Industrial radiography conducted in an enclosed room, the interior of which is not occupied during radiographic operations, which is so shielded that every location on the exterior meets condition for an unrestricted area as specified in RH-1208.
26. Source changer - A device designed and used for replacement of sealed sources in radiographic exposure devices, including those also used for transporting and storage of sealed sources.
27. Storage area - Any location, facility, or vehicle which is used to store, to transport, or to secure a radiographic exposure device, a storage container, or a sealed source when it is not in use and which is locked or has a physical barrier to prevent accidental exposure, tampering with, or unauthorized removal of the device, container, or source.

Revision effective January 1, 1997

- 28. Storage container - A device in which sealed sources are transported or stored.
- 29. Temporary job site - Any location where industrial radiography is performed other than specific location(s) listed in a license or certificate of registration.
- 30. Transport container - A package that is designed to provide radiation safety and security when sealed sources are transported and meets all applicable requirements of the U.S. Department of Transportation.
- 31. X-ray system - An assemblage of components for the controlled generation of x-rays.
- 32. X-ray tube - Any electron tube which is designed for the conversion of electrical energy into x-ray energy.

d. Maintenance of records.

Each record required by this Part must be legible throughout the retention period specified by each Department Regulation. The record may be the original of a reproduced copy of a microform, provided that the copy or microform is authenticated by authorized personnel and that the microform is capable of producing a clear copy throughout the required retention period. The record may also be stored in electronic media with the capability for producing legible, accurate, and complete records during the required retention period. Records such as letters, drawings, and specifications must include all pertinent information such as stamps, initials, and signatures. The licensee or registrant shall retain adequate safeguards against tampering with and loss of records.

Revision effective January 1, 1997

RH-1801. Equipment Control.

- a. Performance requirements for radiography equipment.
Equipment used in industrial radiographic operations must meet the following minimum criteria:

1. Each radiographic exposure device and all associated equipment must meet the requirements specified in American National Standards Institute N432-1980, "Radiological Safety for the Design and Construction of Apparatus for Gamma Radiography", (published as NBS Handbook 136, issued January 1981). This publication has been approved for incorporation by the Director, Division of Radiation Control and Emergency Management. This publication may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Engineering analysis may be submitted by an applicant or licensee to demonstrate the applicability of previously performed testing on similar individual radiography equipment components. Upon review, the Department may find this an acceptable alternative to actual testing of the component pursuant to the reference standard.

2. In addition to the requirements specified in RH-1801.a, the following requirements apply to radiographic exposure devices and associated equipment.
 - A. Each radiographic exposure device must have attached to it by the user a durable, legible, clearly visible label bearing the:
 - i. Chemical symbol and mass number of the radionuclide in the device;
 - ii. Activity and the date on which this activity was last measured;
 - iii. Model number and serial number of the sealed source;
 - iv. Manufacturer of the sealed source; and
 - v. Licensee's name, address, and telephone number.

Revision effective January 1, 1997

- B. Radiographic exposure devices intended for use as Type B transport containers must meet the applicable requirements of Section 4, Transportation of Radioactive Materials.
 - C. Modification of any exposure devices and associated equipment is prohibited, unless the design of any replacement component, including the source holder, source assembly, controls or guide tubes would not compromise the design safety features of the system.
3. In addition to the requirements specified in RH-1801.a.1 and 2, the following requirements apply to radiographic exposure devices and associated equipment that allow the source to be moved out of the device for routine operation.
- A. The coupling between the source assembly and the control cable must be designed in such a manner that the source assembly will not become disconnected if cranked outside the guide tube. The coupling must be such that it cannot be unintentionally disconnected under normal and reasonably foreseeable abnormal conditions.
 - B. The device must automatically secure the source assembly when it is cranked back into the fully shielded position within the device. This securing system may only be released by means of a deliberate operation on the exposure device.
 - C. The outlet fittings, lock box, and drive cable fittings on each radiographic exposure device must be equipped with safety plugs or covers which must be installed during storage and transportation to protect the source assembly from water, mud, sand, or other foreign matter.
 - D. Each sealed source or source assembly must have attached to it or engraved on it, a durable, legible, visible label with the words "**DANGER - RADIOACTIVE**". The label must not interfere with the safe operation of the exposure device or associated equipment.

- E. The guide tube must have passed the crushing tests for the control tube as specified in ANSI N432 and a kinking resistance test that closely approximates the kinking forces likely to be encountered during use.
 - F. Guide tubes must be used when moving the source out of the device.
 - G. An exposure head or similar device designed to prevent the source assembly from passing out of the end of the guide tube must be attached to the outermost end of the guide tube during radiographic operations.
 - H. The guide tube exposure head connection must be able to withstand the tensile test for control units specified in ANSI N432.
 - I. Source changers must provide a system for assuring that the source will not be accidentally withdrawn from the changer when connecting or disconnecting the drive cable to or from a source assembly.
- 4. All newly manufactured radiographic exposure devices and associated equipment acquired by licensees after January 10, 1992 must comply with the requirements of this Section.
 - 5. All radiographic exposure devices and associated equipment in use after January 10, 1996 must comply with the requirements of this Section.
 - 6. Notwithstanding RH-1801.a, RH-1801.d, and RH-1801.e, equipment used in industrial radiographic operations need not comply with Section 8.9.2(c) of the Endurance Test in American National Standards Institute N432-1980, if the prototype equipment has been tested using a torque value representative of the torque that an individual using the radiography equipment can realistically exert on the lever or crankshaft of the drive mechanism.

Revision effective January 1, 1997

RH-1801 (Cont'd)

NOTE: RH-1801.b of this Section applies to all equipment manufactured prior to January 10, 1992. After January 10, 1996, radiographic equipment other than storage containers and source changers must meet the requirements of RH-1801.a, and RH-1801.b applies only to storage containers (source changers).

- b. Limits on levels of radiation for radiographic exposure devices and storage containers. Radiographic exposure devices measuring less than four (4) inches [10 centimeters] from the sealed source storage position to any exterior surface of the device shall have no radiation level in excess of 50 milliroentgens per hour at six (6) inches [15 centimeters] from any exterior surface of the device. Radiographic exposure devices measuring a minimum of four (4) inches [10 centimeters] from the sealed source storage position to any exterior surface of the device and all storage containers for sealed sources or outer containers for radiographic exposure devices, shall have no radiation level in excess of 200 milliroentgens per hour at any exterior surface and ten (10) milliroentgens per hour at one (1) meter [39.4 inches] from any exterior surface. The radiation levels specified are with the sealed source in the shielded (i.e., "off") position.
- c. Locking of radiographic exposure devices, storage containers, and source changers.
 - 1. Each radiographic exposure device shall have a lock or outer locked container designed to prevent unauthorized or accidental removal of the sealed source from its shielded position. The exposure device or its container shall be kept locked when not under the direct surveillance of a radiographer or a radiographer's assistant or as otherwise may be authorized in RH-1803.a. In addition, during radiographic operations the sealed source assembly shall be secured in the shielded position each time the source is returned to that position. A survey shall be performed to determine that the sealed source is in the shielded position pursuant to RH-1803.c.2.

Revision effective January 1, 1997

2. Each sealed source storage container and source changer shall have a lock or outer locked container designed to prevent unauthorized or accidental removal of the sealed source from its shielded position. Storage containers and source changers shall be kept locked when containing sealed sources except when under the direct surveillance of a radiographer or a radiographer's assistant.
3. Radiographic exposure devices, source changers, and storage containers shall be locked and surveyed to assure that the sealed source is in the shielded position prior to being moved from one location to another and also prior to being secured at a given location.

d. Storage precautions.

1. Locked radiographic exposure devices, storage containers and radiation machines shall be physically secured to prevent tampering or removal by unauthorized personnel.
2. Radiographic exposure devices, source changers, or transport containers that contain radioactive material may not be stored in residential locations. This rule does not apply to storage of radioactive material in a vehicle in transit for use at temporary job sites, if the licensee complies with RH-1801.d.3 and if the vehicle does not constitute a permanent storage location as described in RH-1801.d.4.
3. If a vehicle is to be used for storage of radioactive material, a vehicle survey shall be performed after securing radioactive material in the vehicle and before transport to ensure that radiation levels do not exceed the limits specified in RH-1208 at the exterior surface of the vehicle.
4. A storage or use location is permanent if radioactive material is stored or used at the location for more than 90 days and any one or more of the following applies to the location:
 - A. Telephone service is established by the licensee;

- B. Industrial radiographic services are advertised for or from the location;
- C. Industrial radiographic operations are conducted at other sites due to arrangements made from the location.

e. Radiation survey instruments.

1. The licensee or registrant shall maintain sufficient calibrated and operable radiation survey instruments to make physical radiation surveys as required by this Part and RH-1300.
2. Instrumentation required by this Part shall have a range such that 2 milliroentgens per hour through 1 roentgen per hour can be measured and other ranges as necessary to determine conformance with other requirements of this Part.
3. Each radiation survey instrument shall be calibrated:
 - A. Against appropriate energy and exposure levels at intervals not to exceed three (3) months and after each instrument servicing;
 - B. Such that accuracy within ± 20 percent traceable to a national standard can be demonstrated;
 - C. At two points located approximately $1/3$ and $2/3$ of full-scale on each scale for linear scale instruments; at midrange of each decade, and at two points of at least one decade for logarithmic scale instruments; and at appropriate points for digital instruments.
4. Records shall be maintained of these calibrations for two (2) years after the calibration date for inspection by the Department.
5. Each radiation survey instrument shall be checked with a radiation source at the beginning of each day of use and at the beginning of each work shift to ensure it is operating properly.

- f. Leak testing, repair, tagging, opening, modification, and replacement of sealed sources.
1. The replacement of any sealed source fastened to or contained in a radiographic exposure device and leak testing, repair, tagging, opening or any other modification of any sealed source shall be performed only by persons specifically authorized to do so by the Department, the U.S. Nuclear Regulatory Commission, or any Agreement State.
 2. Each sealed source shall be tested for leakage at intervals not to exceed six (6) months. In the absence of a certificate from a transferor that a test has been made within the six (6) month period prior to the transfer, the sealed source shall not be put into use until tested.
 3. The leak test shall be capable of detecting the presence of 0.005 microcurie of removable contamination on the sealed source. An acceptable leak test for sealed sources in the possession of a radiography licensee would be to test at the nearest accessible point to the sealed source storage position or other appropriate measuring point, by a procedure to be approved pursuant to RH-405.f.6. Records of leak test results shall be kept in units of microcuries and maintained for inspection by the Department.
 4. Any test conducted pursuant to the requirements of RH-1801.f.2 and 3 which reveals the presence of 0.005 microcurie or more of removable radioactive material shall be considered evidence that the sealed source is leaking. The licensee shall immediately withdraw the equipment involved from use and shall cause it to be decontaminated and repaired or to be disposed of, in accordance with Regulations of the Department. Within five (5) days after obtaining results of the test, the licensee shall file a report with the Department describing the equipment involved, the test results and the corrective action taken.

5. A sealed source which is not fastened to or contained in a radiographic exposure device shall have permanently attached to it a durable tag at least one (1) inch square bearing the prescribed radiation caution symbol in conventional colors, magenta or purple on a yellow background and at least the instructions: **"Danger - Radioactive Material - Do Not Handle - Notify Civil Authorities if Found."**

- g. Quarterly inventory. Each licensee shall conduct a quarterly physical inventory to account for all sealed sources received or possessed by him/her. The records of the inventories shall be maintained for two (2) years from the date of the inventory for inspection by the Department and shall include the quantities and kinds of radioactive material, the location of sealed sources, the date of the inventory, the name of the individual making the inventory, the manufacturer, the model number and the serial number.

- h. Utilization logs. Each licensee or registrant shall maintain current logs, which shall be kept available for inspection by the Department, showing for each source of radiation the following information:
 1. A unique identification (e.g., serial number) of each radiation machine, each radiographic exposure device in which a sealed source is located, and each sealed source;
 2. The identity of the radiographer to whom assigned;
 3. Locations where used and dates of use; and
 4. The date(s) each source of radiation is removed from storage and returned to storage.

Revision effective January 1, 1997

i. Inspection and maintenance of radiographic exposure devices and storage containers.

1. The licensee or registrant shall check for obvious defects in radiation machines, radiographic exposure devices, storage containers, and source changers prior to use each day the equipment is used.
2. Each licensee or registrant shall conduct a program of at least quarterly inspection and maintenance of radiation machines, radiographic exposure devices, storage containers and source changers, to assure proper functioning of components important to safety. Records of inspection and maintenance shall be maintained for inspection by the Department. All appropriate parts shall be maintained in accordance with the manufacturer's specifications.
3. If any inspection conducted pursuant to RH-1801.i.1 or 2 reveals damage to components critical to radiation safety, the device shall be removed from service and labeled as defective until repairs have been made.

j. Permanent radiographic installations.

1. Permanent radiographic installations having high radiation area entrance controls of the types described in RH-1303.c.2 through 4 shall also meet the following special requirements:
 - A. Each entrance that is used for personnel access to the high radiation area in a permanent radiographic installation to which this Section applies shall have both visible and audible warning signals to warn of the present of radiation. The visible signal shall be activated by radiation whenever the source is exposed. The audible signal shall be actuated when an attempt is made to enter the installation while the source is exposed.

Revision effective January 1, 1997

- B. The control device or alarm system shall be tested for proper operation at the beginning of each day of equipment use. If a control device or alarm system is operating improperly, it shall be immediately labeled as defective and repaired before industrial radiographic operations are resumed. Records of these tests shall be maintained for Department inspection.

k. Reporting requirements.

- 1. In addition to the reporting requirements specified in RH-1502 and under other Sections, each licensee or registrant shall provide a written report to the Director, Division of Radiation Control and Emergency Management, Arkansas Department of Health, 4815 West Markham Street, Mail Slot #30, Little Rock, Arkansas 72205-3867 within 30 (thirty) days of the occurrence of any of the following incidents involving radiographic equipment:
 - A. Unintentional disconnection of the source assembly from the control cable.
 - B. Inability to retract the source assembly to its fully shielded position and secure it in this position.
 - C. Failure of any component (critical to safe operation of the device) to properly perform its intended function.
- 2. The licensee or registrant shall include the following information in each report submitted under RH-1801.a of this Section:
 - A. A description of the equipment problem.
 - B. Cause of each incident, if known.
 - C. Manufacturer and model number of equipment involved in the incident.
 - D. Place, time, and date of the incident.

- E. Actions taken to establish normal operations.
 - F. Corrective actions taken or planned to prevent recurrence.
 - G. Qualifications of personnel involved in the incident.
3. Reports of overexposure submitted under RH-1504 which involve failure of safety components of radiography equipment must also include the information specified in RH-1801.b of this Section.

RH-1802. Personnel Radiation Safety Requirements for Radiographers and Radiographer's Assistants.

a. Limitations.

- 1. No licensee or registrant shall permit any individual to act as a radiographer as defined in this Part until such individual:
 - A. Has met the requirements of RH-1802.a.2.
 - B. Has provided the Department with documentation showing completion of at least 30 days of on-the-job training by a radiographer instructor as a radiographer's assistant following completion of the requirements of RH-1802.a.2. **Note:** This requirement does not apply to individuals designated as radiographers prior to May 1, 1990.

Revision effective January 1, 1997

- C. Has demonstrated competence to use the source of radiation, related handling tools and radiation survey instruments which will be employed in his/her assignment.
 - D. Has demonstrated understanding of the instructions in this Paragraph by successful completion of a written test and a field examination on the subjects covered.
 - E. If deemed necessary by the Department has successfully completed an examination administered by the Department or its agent.
2. No licensee or registrant shall permit any individual to act as a radiographer's assistant unless such individual has received copies of and has demonstrated an understanding of:
- A. The subjects outlined in RH-1804 of this Part;
 - B. The Regulations contained in this Part and the applicable sections of Section 3 of these Regulations;
 - C. Appropriate license and/or certificate of registration; and
 - D. The licensee's or registrant's operating and emergency procedures;
3. Records of the above training, including copies of written tests and dates of oral tests and field examinations, shall be maintained for inspection by the Department for three (3) years following termination of employment.
- b. Operating and emergency procedures. The licensee's or registrant's operating and emergency procedures shall include instructions in at least the following:
- 1. The handling and use of sources of radiation to be employed such that no individual is likely to be exposed to radiation doses in excess of the limits established in Part C of these Regulations;

2. Methods and occasions for conducting radiation surveys;
3. Methods for controlling access to radiographic areas;
4. Methods and occasions for locking and securing sources of radiation;
5. Personnel monitoring and the use of personnel monitoring equipment, including steps that must be taken immediately by radiography personnel in the event a pocket dosimeter is found to be off-scale;
6. Transportation to field locations, including packing of sources of radiation in the vehicles, posting of vehicles and control of sources of radiation during transportation;
7. Minimizing exposure of individuals in the event of an accident;
8. The procedure for notifying proper personnel in the event of an accident;
9. Maintenance of records; and
10. The inspection and maintenance of radiographic exposure devices, storage containers and radiation machines.

c. Personnel monitoring control.

1. No licensee or registrant shall permit any individual to act as a radiographer or a radiographer's assistant unless, at all times during radiographic operations, each such individual wears a direct reading pocket dosimeter, an alarm ratemeter, and either a film badge or a thermoluminescent dosimeter (TLD), except that for permanent radiography facilities where other appropriate alarming or warning devices are in routine use, the wearing of an alarming ratemeter is not required. Pocket dosimeters shall have a range from zero to at least 200 milliroentgens and shall

be recharged daily or at the start of each shift. Each film badge or thermoluminescent dosimeter shall be assigned to and worn by only one individual.

2. Pocket dosimeters shall be read and exposures recorded daily. Records of these exposures shall be kept for inspection by the Department.
3. Pocket dosimeters shall be checked at periods not to exceed one (1) year for correct response to radiation. Acceptable dosimeters shall be read within plus or minus 30 percent of the true radiation exposure. Records of this check shall be maintained for inspection by the Department.
4. If an individual's pocket dosimeter is discharged beyond its range (i.e., goes "off-scale"), industrial radiographic operations by that individual shall cease and the individual's film badge or TLD shall be processed immediately. The individual shall not return to work with sources of radiation until a determination of the individual's radiation exposure has been made.
5. Reports received from the film badge or thermoluminescent dosimeter processor shall be maintained for inspection by the Department until it authorizes their disposal.
6. If a film badge or TLD is lost or damaged, the worker shall cease work immediately until a replacement film badge or TLD is provided and the exposure is calculated for the time period from issuance to loss or damage of the film badge or TLD.
7. Each alarm ratemeter shall:
 - A. Be checked to ensure that the alarm functions properly (sounds) prior to each day's use;
 - B. Be set to give an alarm signal at a preset dose rate of 500 mR/hr;

Revision effective January 1, 1997

- C. Require special means to change the preset alarm function; and
- D. Be calibrated at periods not to exceed one (1) year for correct response to radiation. Acceptable ratemeters must alarm within plus or minus 20 percent ($\pm 20\%$) of the true radiation dose rate.

d. Internal audit program

The licensee or registrant shall establish and submit to the Department a description of its auditing program adequate to ensure that its radiographers and radiographer's assistants follow the Department's regulatory requirements and the licensee or registrants emergency procedures. The audit program must:

1. Include observation of the performance of each radiographer and radiographer's assistant during an actual radiographic operation intervals not to exceed three months;
2. Provide that, if a radiographer or a radiographer's assistant has not participated in a radiographic operation for more than three months since the last inspection, that individual's performance must be observed and recorded the next time the individual participates in a radiographic operation; and
3. Include the retention of inspection records on the performance of radiographers or radiographers' assistants for three years.

RH-1803. Precautionary Procedures in Radiographic Operations.

- a. Security. During each radiographic operation, the radiographer, radiographer instructor or radiographer's assistant shall maintain a direct surveillance of the operation to protect against unauthorized entry into a high radiation area, as defined in Section 3, Part D, RH-1303.c, except:
 1. Where the high radiation area is equipped with a control device or alarm system as described in RH-1303.c.2, or
 2. Where the high radiation area is locked to protect against unauthorized or accident entry.
- b. Posting. Notwithstanding any provisions in RH-1304.c, areas in which radiography is being performed shall be conspicuously posted as required by RH-1303.b and c.1.
- c. Radiation surveys and survey records.
 1. No radiographic operation shall be conducted unless calibrated and operable radiation survey instrumentation as described in RH-1801.e is available and used at each site where radiographic exposures are made.
 2. A survey with a radiation survey instrument shall be made after each radiographic exposure to determine that the sealed source has been returned to its shielded position. A survey shall be made of the storage area as defined in RH-1800.c.27. Whenever a radiographic exposure device is placed in storage the entire circumference of the radiographic exposure device shall be surveyed. If the radiographic exposure device has a source guide tube, the survey shall include the guide tube.
 3. A physical radiation survey as specified in RH-1801.c.3 shall be made to determine that each sealed source is in its shielded position prior to securing the radiographic exposure device, storage container, or source changer in a storage area as defined in RH-1800.c.27. The entire circumference of the radiographic exposure device, storage container, or source changer must be surveyed.
 4. A physical radiation survey shall be made after each radiographic exposure using radiation machines to determine that the machine is "off".

Revision effective January 1, 1997

5. Records shall be kept of the surveys required by RH-1803.c.3 and maintained for inspection by the Department for at least two years after the completion of the survey. If the survey was used to determine an individual's exposure; however, the records of the survey shall be maintained until the Department authorizes their disposition.
- d. Supervision of radiographer's assistants. Whenever a radiographer's assistant uses radiographic exposure devices, sealed sources and/or related source handling tools, or conducts radiation surveys required by RH-1803.c.2 to determine that the sealed source has returned to the shielded position after an exposure, the radiographer's assistant shall be under the personal supervision of a radiographer instructor. The supervision shall include:
 1. The radiographer instructor's personal presence at the site where the sealed sources are being used,
 2. The ability of the radiographer instructor to give immediate assistance if required, and
 3. The radiographer instructor's watching the assistant's performance of the operations referred to in this Section.
- e. Records required at temporary job sites. Each licensee or registrant conducting industrial radiography at temporary site shall have the following records available at that site for inspection by the Department:
 1. Current copy of appropriate license, certificate of registration or an equivalent document.
 2. Operating and emergency procedures.
 3. Applicable regulations.
 4. Survey records required pursuant to RH-1803.c for the period of operation at the site.
 5. Daily pocket dosimeter records for the period of operation at the site.

6. The latest instrument calibration and leak test record for specific devices in use at the site.

f. Specific requirements for radiographic personnel performing industrial radiography.

1. At a job site, the following shall be supplied by the licensee or registrant:
 - A. At least one operable, calibrated survey instrument;
 - B. A current whole body personnel monitor (TLD or film badge) for each individual;
 - C. An operable, calibrated pocket dosimeter with a range of zero to 200 milliroentgens for each worker; and
 - D. An operable, calibrated alarming ratemeter set to give an alarm signal at a preset dose rate of 500 mR/hr; and
 - E. The appropriate barrier ropes and signs.
2. Industrial radiographic operations shall not be performed if any of the items in RH-1803.f.1 are not available at the job site or are inoperable.
3. No individual other than a radiographer or a radiographer's assistant who is under the personal supervision of a radiographer instructor shall manipulate controls or operate equipment used in industrial radiographic operations.
4. During an inspection by the Department, the Department inspector may terminate an operation if any of the items in RH-1803.f.1 are not available and operable or if the required number of radiographic personnel are not present. Operations shall not be resumed until such conditions are met.
5. No individual shall act as a radiographer instructor unless such individual:
 - A. Has met the requirements of RH-1802.a.1;

- B. Has one year of documented experience as an radiographer; and
- C. Has been named as a radiographer instructor on the license or registration certificate issued by the Department.

g. Special Requirements and Exemptions for Enclosed Radiography.

1. Cabinet X-ray Systems.

A. Emission limit.

- i. Radiation emitted from the cabinet x-ray system shall not exceed an exposure of 0.5 milliroentgen in one hour at any point 5 (five) centimeters outside the external surface.
- ii. Compliance with the exposure limit in RH-1800.g.1.A.i of this Section shall be determined by measurements averaged over a cross sectional area of 10 (ten) square centimeters with no linear dimension greater than 5 (five) centimeters, with the cabinet x-ray system operated at those combinations of x-ray tube potential, current, beam orientation and conditions of scatter radiation which produce the maximum x-ray exposure at the external surface and with the door(s) and access panel(s) fully closed as well as fixed at any other position(s) which will allow the generation of x-radiation.

- B. Floors. A cabinet x-ray system shall have a permanent floor. Any support surface to which a cabinet x-ray system is permanently affixed may be deemed the floor of the system.

C. Ports and apertures

- i. The insertion of any part of the human body through any port into the primary beam shall not be possible.
- ii. The insertion of any part of the human body through any aperture shall not be possible.

D. Safety interlocks.

- i. Each door of a cabinet x-ray system shall have a minimum of two safety interlocks. One, but not both of the required interlocks shall be such that door opening results in physical disconnection of the energy supply circuit to the high-voltage generator and such disconnection shall not be dependent upon any moving part other than the door.
- ii. Each access panel shall have at least one safety interlock.
- iii. Following interruption of x-ray generation by the functioning of any safety interlock, use a control provided in accordance with RH-1803.g.1.F shall be necessary for resumption of x-ray generation.
- iv. Failure of any single component of the cabinet x-ray system shall not cause failure of more than one required safety interlock.

E. Ground fault. A ground fault shall not result in the generation of x-rays.

F. Controls and indicators for all cabinet x-ray systems.

For all systems to which this Section is applicable there shall be provided:

- i. A key-actuated control to insure that x-ray generation is not possible with the key removed.
- ii. A control or controls to initiate and terminate the generation of x-rays other than by functioning of a safety interlock or the main power control.

iii. Two independent means which indicate when and only when x-rays are being generated, unless the x-ray generation period is less than one-half second, in which case the indicators shall be activated for one-half second and which are discernible from any point at which initiation of x-ray generation is possible. Failure of a single component of the cabinet x-ray system shall not cause failure of both indicators to perform their intended function. One, but not both of the indicators required by this subdivision may be a milliammeter labeled to indicate x-ray tube current. All other indicators shall legibly labeled "X-RAY ON".

iv. Additional means other than milliammeters which indicate when and only when x-rays are being generated, unless the x-ray generation period is less than one-half second in which case the indicators shall be activated for one-half second, as need to ensure that at least one indicator is visible from each door, access panel and port and is legibly labeled "X-RAY ON".

G. Additional controls and indicators for cabinet x-ray systems designed to admit humans. For cabinet x-ray systems designed to admit humans there shall also be provided:

i. Comply with all applicable requirements of this Part and RH-1208 of these Regulations. If such a system is a certified cabinet x-ray system, it shall comply with all applicable requirements of this Part and 21 CFR 1020.40.

ii. Be evaluated at intervals not to exceed one (1) year to assure compliance with the applicable requirements as specified in RH-1803.g.1.A. Records of these evaluations shall be maintained for inspection by the Department for a period of (5) years after the evaluation.

- iii. A control within the cabinet for preventing and terminating x-ray generation, which cannot be reset, over-ridden or bypassed from the outside of the cabinet.
- iv. No means by which x-ray generation can be initiated from within the cabinet.
- v. Audible and visible warning signals within the cabinet which are actuated for at least 10 seconds immediately prior to the first initiation of x-ray generation after closing any door designed to admit humans. Failure of any single component of the cabinet x-ray system shall not cause failure of both the audible and visible warning signals.
- vi. A visible warning signal within the cabinet which remains actuated when and only when x-rays are being generated, unless the x-ray generation period is less than one-half second in which case the indicators shall be activated for one-half second.
- vii. Signs indicating the meaning of the warning signals provided pursuant to RH-1803.g.l.G.v and iv and containing instructions for the use of the control provided pursuant to RH-1803.g.l.G.iii. These signs shall be legible, accessible to view and illuminated when the main power control is in the "on" position.

H. Warning labels.

- i. There shall be permanently affixed or inscribed on the cabinet x-ray system at the location of any controls which can be used to initiate x-ray generation, a clearly legible and visible label bearing the statement:

CAUTION:
X-RAYS PRODUCED WHEN ENERGIZED

- ii. There shall be permanently affixed or inscribed of the cabinet x-ray system at the location of any controls which can be used to initiate x-ray generation, a clearly legible and visible bearing the statement:

**CAUTION: DO NOT INSERT ANY PART OF
THE BODY WHEN SYSTEM IS
ENERGIZED—X-RAY HAZARD**

I. Instructions.

- i. Manufacturers of cabinet x-ray systems shall provide for purchasers and to others upon request at a cost not to exceed the cost of preparation and distribution, manuals and instructions which shall include at least the following technical and safety information: Potential, current and duty cycle ratings of the x-ray generation equipment; adequate instructions concerning any radiological safety procedures and precautions which may be necessary because of unique features of the system; and a schedule of maintenance necessary to keep the system in compliance with this Section.
- ii. Manufacturers of cabinet x-ray systems which are intended to be assembled or installed by the purchaser, shall provide instructions for assembly, installation, adjustment and testing of the cabinet x-ray system adequate to assure the system is in compliance with applicable provisions of this Section when assembled, installed, adjusted and tested as directed.

- J. Additional requirements for x-ray baggage inspection systems.** X-ray systems designed primarily for the inspection of carry-on baggage at airline, railroad and bus terminals and at similar facilities, shall be provided with means, pursuant to RH-1803.g.1.J.i and ii, to insure operator presence at the control area in a position which permits surveillance of the ports and doors during generation of x-radiation.

- i. During an exposure or preset succession of exposures of one-half second or greater duration, the means provided shall enable the operator to terminate the exposure or preset succession of exposures at any time.
 - ii. During an exposure or preset succession of exposures of less than one-half second or greater duration, the means provided may allow completion of the exposure in progress but shall enable the operator to prevent additional exposures.
- 2. Cabinet Radiography. Cabinet radiography units are exempt from other requirements of this Part; however,
 - A. No licensee or registrant shall permit any individual to operate a cabinet radiography unit until such individual has received a copy of, and instruction in, and demonstrated an understanding of operating procedures for the unit, and has demonstrated competence in its use.
 - B. A cabinet radiography unit shall not be operated until a physical radiation survey of the unit and areas adjacent to the unit has been performed. The licensee or registrant shall perform survey with a properly calibrated instrument as described in RH-1803.c. to determine conformance with RH-1200.
 - C. The registrant shall perform an evaluation, at intervals not to exceed one (1) year, to determine conformance with Part C of these Regulations. If such a system is a certified cabinet x-ray system, it shall be evaluated at intervals not to exceed one (1) year to determine conformance with 21 CFR 1020.40. Records of these evaluations shall be maintained for inspection by the Department for a period of five (5) years after the evaluation.

- D. The operating personnel must be provided with either a film badge or a thermoluminescent dosimeter and reports of the results must be maintained for inspection by the Department.
 - E. Tests for proper operation of high radiation control devices or alarm systems must be conducted and recorded in accordance with RH-1801.i.
- 3. Shielded room radiography. Shielded room radiography shall comply with all applicable requirements of this Part.
 - 4. Certified cabinet x-ray systems shall be maintained in compliance with 21 CFR 1020.40 unless prior approval has been granted by the Department pursuant to RH-55 of these Regulations.
- h. Prohibitions

Industrial radiography performed with a sealed source which is not fastened to or contained in a radiographic exposure device (fish pole technique) is prohibited unless specifically authorized in a license issued by the Department.

RH-1804. Subjects to be Covered During the Instruction of Radiographers.

a. Fundamentals of radiation safety.

1. Characteristics of radiation.
2. Units of radiation dose (mrem) and quantity of radioactivity (curie).
3. Significance of radiation dose.
 - A. Radiation protection standards.
 - B. Biological effects of radiation.
 - C. Case histories of radiography accidents.
4. Levels of radiation from sources of radiation.
5. Methods of controlling radiation dose.
 - A. Working time.
 - B. Working distances.
 - C. Shielding.

b. Radiation detection instrumentation to be used.

1. Use of radiation survey instruments.
 - A. Operation.
 - B. Calibration.
 - C. Limitations.
2. Survey techniques.
3. Use of personnel monitoring equipment.
 - A. Film badges.
 - B. Thermoluminescent dosimeters (TLDs).
 - C. Pocket dosimeters.
 - D. Alarm ratemeters.

Revision effective January 1, 1997

- c. Radiographic equipment to be used.
 - 1. Remote handling equipment.
 - 2. Operation and control of radiographic exposure devices and sealed sources, including pictures or models of source assemblies (pigtaills).
 - 3. Storage and transport containers, source changers.
 - 4. Operation and control of x-ray equipment if applicable.
 - 5. Collimators.
- d. The requirements of pertinent federal and state regulations.
- e. The licensee's or registrant's written operating and emergency procedures.

**PART J. RADIATION SAFETY REQUIREMENTS FOR WIRELINE SERVICE OPERATIONS
AND SUBSURFACE TRACER STUDIES**

RH-1900. General Provisions.

- a. Scope. The Regulations in this Part apply to all licensees who use sources of radiation for wireline service operations including mineral logging, radioactive markers or subsurface tracer studies.
- b. Purpose. The Regulations in this Part establish radiation safety requirements for persons utilizing sources of radiation for wireline service operations including mineral logging, radioactive markers and subsurface tracer studies. The requirements of this Part are in addition to and not in substitution for other applicable requirements of these Regulations.
- c. Definitions. As used in this Part, the following definitions apply. Additional definitions used only in a certain Part will be found in that Part.
 1. Field station - A facility where radioactive sources may be stored or used and from which equipment is dispatched to temporary job sites.
 2. Fresh water aquifer - A geologic formation that is capable of yielding fresh water to a well or spring.
 3. Injection tool - A device used for controlled subsurface injection of radioactive tracer material.
 4. Irretrievable well logging source - Any sealed source containing radioactive material that is pulled off or not connected to the wireline that suspends the source in the well and for which all reasonable effort at recovery has been expended.
 5. Logging assistant - Any individual who, under the personal supervision of a logging supervisor, handles sealed sources, tracers, or radiation producing machines that are not in logging tools or shipping containers or who performs surveys required by RH-1967.

Revision effective January 1, 1997

6. Logging supervisor - Any individual who uses radioactive material or radiation producing machines, or provides personal supervision in the use of radioactive material or radiation producing machines at a temporary jobsite and who is responsible to the licensee for assuring compliance with the requirements of the Department's Regulations and the conditions of the license.
7. Logging tool - A device used subsurface to perform well-logging.
8. Mineral logging - Any logging performed for the purpose of mineral exploration other than oil or gas.
9. Particle accelerator - Any machine capable of accelerating electrons, protons, deuterons or their charged particles in a vacuum and of discharging the resultant particulate or other radiation into a medium at energies usually in excess of one (1) MeV.
10. Personal supervision - Guidance and instruction by the logging supervisor who is physically present at the job site and watching the performance of the operation in such proximity that contact can be maintained and immediate assistance given as required.
11. Radioactive marker - Radioactive material placed subsurface or on a structure intended for subsurface use for the purpose of depth determination or direction orientation.
12. Safety review - A periodic review provided by the licensee for its employees on radiation safety aspects of well logging. The review may include, as appropriate, the results of internal inspections, new procedures or equipment, accidents or errors that have been observed, and opportunities for employees to ask safety questions.

Revision effective January 1, 1997

13. Sealed source - Any radioactive material that is encased in a capsule designed to prevent leakage or escape of the radioactive material.
14. Source holder - A housing or assembly into which a radioactive source is placed for the purpose of facilitating the handling and use of the source in well-logging operations.
15. Subsurface tracer study - The release of a substance tagged with radioactive material for the purpose of tracing the movement or position of the tagged substance in the well-bore or adjacent formation.
16. Surface casing for protecting fresh water aquifers - A pipe or tube used as a lining in a well to isolate fresh water aquifers from the well.
17. Temporary jobsite - A location to which radioactive materials have been dispatched to perform wireline service operations and subsurface tracer studies are performed.
18. Uranium sinker bar - A weight containing depleted Uranium used to pull a logging tool toward the bottom of a well.
19. Well-bore - A drilled hole in which wireline service operations and subsurface tracer studies are performed.
20. Well-logging - The lowering and raising of measuring devices or tools which may contain sources of radiation into well-bores or cavities for the purpose of obtaining information about the well and/or adjacent formations.
21. Wireline - A cable containing one or more electrical conductors which is used to lower and raise logging tools in the well-bore.
22. Wireline service operation - Any evaluation or mechanical service which is performed in the well-bore using devices on a wireline.

Revision effective January 1, 1997

RH-1901-
RH-1910. Reserved.

RH-1911. Application for a Specific License. A person, as defined in RH-1100.bc of these Regulations, shall file an application for a specific license authorizing the use of radioactive material in well logging in accordance with RH-403 and RH-404.

RH-1912. Reserved.

- RH-1913. Specific Licenses for Well Logging. The Department will approve an application for a specific license for the use of radioactive material in well logging if the applicant meets the following requirements.
- a. The application shall satisfy the general requirements specified in RH-404 of these Regulations, and any special requirements contained in this Part.
 - b. The applicant shall develop a program for training logging supervisors and logging assistants and submit to the Department a description of this program which specifies the:
 - 1. Initial training;
 - 2. On-the-job training;
 - 3. Annual safety reviews provided by the licensee;
 - 4. Means the applicant will use to demonstrate the logging supervisor's knowledge and understanding of and ability to comply with the Department's Regulations and licensing requirements and the applicant's operating and emergency procedures; and
 - 5. Means the applicant will use to demonstrate the logging assistant's knowledge and understanding of and ability to comply with the applicant's operating and emergency procedures.
 - c. The applicant shall submit to the Department written operating and emergency procedures as described in RH-1963 or an outline or summary of the procedures that includes the important radiation safety aspects of the procedures.

Revision effective January 1, 1997

RH-1913 (Cont'd)

- d. The applicant shall establish and submit to the Department its program for annual inspections of the job performance of each logging supervisor to ensure that the Department's regulations, license requirements, and the applicant's operating and emergency procedures are followed. Inspection records must be retained for three (3) years after each annual internal inspection.
- e. The applicant shall submit a description of its overall organizational structure as it applies to the radiation safety responsibilities in well logging, including specified delegations of authority and responsibility.
- f. If an applicant wants to perform leak testing of sealed sources, the applicant shall identify the manufacturers and model numbers of the leak test kits to be used. If an applicant want to analyze its own wipe samples, the applicant shall establish procedures to be followed and submit a description of these procedures to the Department. The description must include the:
 - 1. Instruments to be used;
 - 2. Methods of performing the analysis; and
 - 3. Pertinent experience of the person who will analyze the wipe samples.

RH-1914. Reserved.

RH-1915. Agreement with Well Owner or Operator.

- a. A licensee may perform well logging with a sealed source only after the licensee has a written agreement with the employing well owner or operator. This written agreement must identify who will meet the following requirements:
 - 1. If a sealed source becomes lodged in the well, a reasonable effort will be made to recover it.
 - 2. A person may not attempt to recover a sealed source in a manner which, in the licensee's opinion, could result in its rupture.

Revision effective January 1, 1997

3. The radiation monitoring required in RH-1969.a will be performed.
4. If the environment, any equipment, or personnel are contaminated with radioactive material, they must be decontaminated before release from the site or release for unrestricted use. And;
5. If the sealed source is classified as irretrievable after reasonable efforts at recovery have been expended, the following requirements must be implemented within 30 (thirty) days:
 - i. Each irretrievable well logging source must be immobilized and sealed in place with a cement plug;
 - ii. A mechanical device to prevent inadvertent intrusion on the source must be set at some point in the well above the cement plug, unless the cement plug and source are not accessible to any subsequent drilling operations; and;
 - iii. A permanent identification plaque, constructed of long-lasting material such as stainless steel, brass, bronze, or monel, must be mounted at the surface of the well, unless the mounting of the plaque is not practical. The size of the plaque must be at least 7 inches (17 cm) square and 1/8-inch (3 mm) thick. The plaque¹⁴ must contain:
 - A. The word "CAUTION";
 - B. The radiation symbol (the color requirement in RH-1303.a.1 need not be met);
 - C. The date the source was abandoned;
 - D. The name of the well owner or operator, as appropriate;

Revision effective January 1, 1997

RH-1915 (Cont'd)

- E. The well name and well identification number(s) or other designation;
 - F. An identification of the sealed source(s) by radionuclide and quantity;
 - G. The depth of the source and depth to the top of the plug; and
 - H. An appropriate warning, such as "DO NOT RE-ENTER THIS WELL". ^{15/}
- b. The licensee shall retain a copy of the written agreement for three (3) years after the completion of the well logging operation.
 - c. A licensee may apply, pursuant to RH-1991, for Department approval, on a case-by-case basis, of proposed procedures to abandon an irretrievable well logging source in a manner not otherwise authorized in RH-1915.a.5 of this Section.
 - d. A written agreement between the licensee and the well owner or operator is not required if the licensee and the well owner or operator are part of the same corporate structure or otherwise similarly affiliated. However, the licensee shall still otherwise meet the requirements in RH-1915.a.1 through RH-1915.a.5.

RH-1916. Reserved.

RH-1917. Request for Written Statements. Each licensee is issued with the condition that the licensee will, at any time before expiration of the license, upon the Department's request, submit written statements, signed under oath or affirmation, to enable the Department to determine whether or not the license should be modified, suspended, or revoked.

RH-1918-
RH-1930. Reserved.

Revision effective January 1, 1997

RH-1931. Labels, Security, and Transportation Precautions.

a. Labels.

1. The licensee may not use a source, source holder, or logging tool that contains radioactive material unless the smallest component that is transported as a separate piece of equipment with the radioactive material inside bears a durable, legible, and clearly visible marking or label. The marking or label must contain the radiation symbol specified in RH-1303.a.1 and 2, without the conventional color requirements, and the wording **"DANGER (or CAUTION) RADIOACTIVE MATERIAL"**.
2. The licensee may not use a container to store radioactive material unless the container has securely attached to it a durable, legible, and clearly visible label. The label must contain the radiation symbol specified in RH-1303.a and the wording **"CAUTION (or DANGER), RADIOACTIVE MATERIAL, NOTIFY CIVIL AUTHORITIES OR IF FOUND."** (Name of Company)
3. The licensee may not transport radioactive material unless the material is packaged, labeled, marked, and accompanied with appropriate shipping papers in accordance with Section 4 of these Regulations.

b. Security Precautions During Storage and Transportation.

1. The licensee shall store each source containing radioactive material in a storage container or transportation package. The container or package must be locked and physically secured to prevent tampering or removal of radioactive material from storage by unauthorized personnel. The licensee shall store radioactive material in a manner which will minimize the danger from explosion or fire.
2. The licensee shall lock and physically secure the transport package containing radioactive material in the transporting vehicle to prevent accidental loss, tampering, or unauthorized removal of the radioactive material from the vehicle.

RH-1932. Reserved.

Revision effective January 1, 1997

RH-1933. Radiation Detection Instruments.

- a. The licensee shall keep a calibrated and operable radiation survey instrument capable of detecting beta and gamma radiation at each field station and temporary jobsite to make the radiation surveys required by this Part and by other Parts of Section 3. To satisfy this requirement, the radiation survey instrument must be capable of measuring 0.1 milliroentgen (2.58×10^{-8} C/kg) per hour through at least 50 milliroentgens (1.29×10^{-5} C/kg) per hour. Survey instruments acquired before July 14, 1987, and capable of measuring 0.1 milliroentgen (2.58×10^{-8} C/kg) per hour through at least 20 milliroentgens (5.16×10^{-6} C/kg) per hour also satisfy this requirement until July 14, 1992.
- b. The licensee shall have available additional calibrated and operable radiation detection instruments sensitive enough to detect the low radiation and contamination levels that could be encountered if a sealed source ruptured. The licensee may own the instruments or may have a procedure to obtain them quickly from a second party.
- c. The licensee shall have each radiation survey instrument required under RH-1933.a of this Section calibrated:
 1. At intervals not to exceed six (6) months and after instrument servicing;
 2. 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; and
 3. So that an accuracy within plus or minus 20 percent ($\pm 20\%$) of the calibration standard can be demonstrated on each scale.
- d. The licensee shall retain calibration records for a period of three (3) years after the date of calibration for inspection by the Department.

RH-1934. Reserved.

Revision effective January 1, 1997

RH-1935. Leak Testing of Sealed Sources.

- a. Testing and recordkeeping requirements. Each licensee who uses a sealed source shall have the source leak tested for leakage periodically. The licensee shall keep a record of leak test results in units of microcuries and retain the record for inspection by the Department for three (3) years after the leak test is performed.
- b. Method of testing. The wipe of a sealed source must be performed using a leak test kit or method approved by the Department. The wipe sample must be taken from the nearest accessible point to the sealed source where contamination might accumulate. The wipe sample must be analyzed for radioactive contamination. The analysis must be capable of detecting the presence of 0.005 microcurie (185 Bq) of radioactive material on the test sample and must be performed by a person approved by the Department, U.S. Nuclear Regulatory Commission, or an Agreement State to perform the analysis.
- c. Test frequency. Each sealed source must be tested at intervals not to exceed six (6) months. In the absence of a certificate from a transferor that a test has been made within the six (6) months before the transfer, the sealed source may not be used until tested.
- d. Removal of leaking source from service.
 1. If the test conducted pursuant to RH-1935.a and RH-1935.b reveals the presence of 0.005 microcurie (185 Bq) or more of removable radioactive material, the licensee shall remove the sealed source from service immediately and have it decontaminated, repaired, or disposed of by a Department, U.S. Nuclear Regulatory Commission, or Agreement State licensee that is authorized to perform these functions. The licensee shall check the equipment associated with the leaking source for radioactive contamination and, if contaminated, have it decontaminated or disposed of by a Department, U.S. Nuclear Regulatory Commission, or Agreement State licensee that is authorized to perform these functions.

Revision effective January 1, 1997

RH-1935 (Cont'd)

2. The licensee shall submit a report to the Department within five (5) days of receiving the test results. The report must describe the equipment involved in the leak, the test results, any contamination which resulted from the leaking source, and the corrective actions taken up to the time the report is made.
- e. Exemptions from testing requirements. The following sealed sources are exempt from the periodic leak test requirements set out in RH-1935.a through RH-1935.d:
1. Hydrogen-3 sources;
 2. Sources containing licensed material with a half-life of 30 (thirty) days or less;
 3. Sealed sources containing licensed material in gaseous form;
 4. Sources of beta- or gamma-emitting radioactive material with an activity of 100 microcuries (3,700,000 Bq) or less; and
 5. Sources of alpha- or neutron-emitting radioactive material with an activity of 10 microcuries (370,000 Bq) or less.

RH-1936. Reserved.

RH-1937. Physical Inventory. Each licensee shall conduct a quarterly physical inventory to account for all radioactive material received and possessed under the license. The licensee shall retain records of the inventory for three (3) years from the date of the inventory for inspection by the Department. The inventory must indicate the quantity and type of radioactive material, the location of the radioactive material, the date of the inventory, and the name of the individual conducting the inventory.

RH-1938. Reserved.

Revision effective January 1, 1997

RH-1939. Records of Material Use.

- a. Each licensee shall maintain records for each use of radioactive material showing:
 - 1. The make, model number, and a serial number or a description of each sealed source used;
 - 2. In the case of unsealed radioactive material used for subsurface tracer studies, the radionuclide and quantity of activity used in a particular well and the disposition of any unused tracer material;
 - 3. The identity of the logging supervisor who is responsible for the licensed material and the identity of logging assistants present; and
 - 4. The location and date of use of the radioactive material.
- b. The licensee shall make the records required by RH-1939.a of this Section available for inspection by the Department. The licensee shall retain the records for three (3) years from the date of the recorded event.

RH-1940. Reserved.

RH-1941. Design and Performance Criteria for Sealed Sources.

- a. After August 15, 1990, a licensee may not use a sealed source in well logging unless the sealed source:
 - 1. Is doubly encapsulated;
 - 2. Contains radioactive material whose chemical and physical forms are as insoluble and nondispersible as practical; and
 - 3. The sealed source's prototype has been tested and found to maintain its integrity after each of the following tests:
 - A. Temperature. The test source must be held at -40°C for 20 minutes, 600°C for one (1) hour, and then be subject to a thermal shock test with a temperature drop from 600°C to 20°C within 15 seconds.

Revision effective January 1, 1997

RH-1941 (Cont'd)

- B. Impact test. A 5 kg steel hammer, 2.5 cm in diameter, must be dropped from a height of one (1) meter onto the test source.
 - C. Vibration test. The test source must be subject to a vibration from 25 Hz to 500 Hz at 5 g amplitude for 30 minutes.
 - D. Puncture test. A one (1) gram hammer and pin, 0.3 cm pin diameter, must be dropped from a height of 1 meter onto the test source.
 - E. Pressure test. The test source must be subjected to an external pressure of 24,600 pounds per square inch absolute [1.695×10^7 pascals].
- b. The requirements of RH-1941 do not apply to sealed sources that contain radioactive material in gaseous form.

RH-1942. Reserved.

RH-1943. Inspection, Maintenance, and Opening of a Source or Source Holder.

- a. Each licensee shall visually check source holders, logging tools, and source handling tools for defects before each use to ensure that the equipment is in good working condition and that required labeling is present. If defects are found, the equipment must be removed from service until repaired, and a record must be made listing: the date of check, name of inspector, equipment involved, defects found, and repairs made. These records must be retained for three (3) years after the defect is found.
- b. Each licensee shall have a program for semiannual visual inspection and routine maintenance of source holders, logging tools, injection tools, source handling tools, storage containers, transport containers, and Uranium sinker bars to ensure that the required labeling is legible and that no physical damage is visible. If defects are found, the equipment must be removed from

Revision effective January 1, 1997

service until repaired, and a record must be made listing: date, equipment involved, inspection and maintenance operations performed, any defects found, and any actions taken to correct the defects. These records must be retained for three (3) years after the defect is found.

- c. Removal of a sealed source from a source holder or logging tool, and maintenance on sealed sources or holders in which sealed sources are contained may not be performed by the licensee unless a written procedure developed pursuant to RH-1963 has been approved either by the Department, U.S. Nuclear Regulatory Commission, or by an Agreement State pursuant to RH-1913.c.
- d. If a sealed source is stuck in the source holder, the licensee may not perform any operation, such as drilling, cutting, or chiseling, on the source holder unless the licensee is specifically approved by the Department, U.S. Nuclear Regulatory Commission, or by an Agreement State to perform this operation.
- e. The opening, repair, or modification of any sealed source must be performed by persons specifically approved to do so by the Department, U.S. Nuclear Regulatory Commission, or by an Agreement State.

RH-1944. Reserved.

RH-1945. Subsurface Tracer Studies.

- a. The licensee shall require all personnel handling radioactive tracer material to use protective gloves and, if required by the license, other protective clothing and equipment. The licensee shall take precautions to avoid ingestion or inhalation of radioactive tracer material and to avoid contamination of field stations and temporary jobsites.
- b. A licensee may not knowingly inject radioactive material into fresh water aquifers unless specifically authorized to do so by the Department.

RH-1946. Reserved.

Revision effective January 1, 1997

RH-1947. Radioactive Markers. The licensee may use radioactive markers in wells only if the individual markers contain quantities of radioactive material not exceeding the quantities specified in RH-901, Schedule B. The use of markers is subject to the requirements of RH-1937.

RH-1948. Reserved.

RH-1949. Uranium Sinker Bars. The licensee may use a Uranium sinker bar in a well logging after July 14, 1988, only if it is legibly impressed with the words **"CAUTION - RADIOACTIVE - DEPLETED URANIUM"** and **"NOTIFY CIVIL AUTHORITIES OR IF FOUND"**

(fill in Company Name).

RH-1950. Reserved.

RH-1951. Use of a Sealed Source in a Well Without a Surface Casing. The licensee may use a sealed source in a well without a surface casing for protecting fresh water aquifers only if the licensee follows a procedure for reducing the probability of the source becoming lodged in the well. The procedure must be approved by the Department pursuant to RH-1913.

RH-1952-
RH-1960. Reserved.

RH-1961. Training.

- a. The licensee may not permit an individual to act as a logging supervisor until that person:
 1. Has completed training in the subjects outlined in RH-1961.e of this Section;
 2. Has received copies of, and instruction in:
 - A. The applicable Parts of Section 3 of these Regulations;
 - B. The license under which the logging supervisor will perform well logging; and
 - C. The licensee's operating and emergency procedures required by RH-1963;

Revision effective January 1, 1997

3. Has completed on-the-job training and demonstrated competence in the use of radioactive materials, remote handling tools, and radiation survey instruments by a field evaluation; and
 4. Has demonstrated understanding of the requirements in RH-1961.a.1 and RH-1961.a.2 by successfully completing a written test.
- b. The licensee may not permit an individual to act as a logging assistant until that person:
1. Has received instruction in applicable Parts of Section 3 of these Regulations;
 2. Has received copies of, and instruction in, the licensee's operating and emergency procedures required by RH-1963;
 3. Has demonstrated understanding of the material in RH-1961.b.1 and RH-1961.b.2 of this Section by successfully completing a written or oral test; and
 4. Has received instruction in the use of radioactive materials, remote handling tools, and radiation survey instruments, as appropriate for the logging assistant's intended job responsibilities.
- c. The licensee shall provide safety reviews for logging supervisors and logging assistants at least once during each calendar year.
- d. The licensee shall maintain a record on each logging supervisor's and logging assistant's training and annual safety review. The training records must include copies of written tests and dates of oral tests given after July 14, 1987. The training records must be retained until three (3) years following the termination of employment. Records of annual safety reviews must list the topics discussed and be retained for three (3) years.
- e. The licensee shall include the following subjects in the training required in RH-1961.a.1 of this Section.
1. Fundamentals of radiation safety, including:
 - A. Characteristics of radiation;

- B. Units of radiation dose and quantity of radioactivity;
 - C. Hazards of exposure to radiation;
 - D. Levels of radiation from licensed material;
 - E. Methods of controlling radiation dose (time, distance, and shielding); and
 - F. Radiation safety practices, including prevention of contamination, and methods of decontamination.
- 2. Radiation detection instruments, including:
 - A. Use, operation, calibration, and limitations of radiation survey instruments;
 - B. Survey techniques; and
 - C. Use of personnel monitoring equipment.
 - 3. Equipment to be used, including:
 - A. Operation of equipment, including source handling equipment and remote handling tools;
 - B. Storage, control, and disposal of radioactive material;
 - C. Maintenance of equipment.
 - 4. The requirements of pertinent Department regulations; and
 - 5. Case histories of accidents in well logging.

RH-1962. Reserved.

Revision effective January 1, 1997

RH-1963. Operating and Emergency Procedures. Each licensee shall develop and follow written operating and emergency procedures that cover:

- a. The handling and use of radioactive materials including the use of sealed sources in wells without surface casing for protecting fresh water aquifers, if appropriate;
- b. The use of remote handling tools for handling sealed sources and radioactive tracer material except low-activity calibration sources;
- c. Methods and occasions for conducting radiation surveys, including surveys for detecting contamination, as required by RH-1967.c through RH-1967.e;
- d. Minimizing personnel exposure including exposures from inhalation and ingestion of radioactive materials;
- e. Methods and occasions for locking and securing stored radioactive materials;
- f. Personnel monitoring and the use of personnel monitoring equipment;
- g. Transportation of radioactive material to field stations or temporary jobsites, packaging of radioactive materials for transport in vehicles; placarding of vehicles when needed, and physically securing radioactive materials in transport vehicles during transportation to prevent accidental loss, tampering, or unauthorized removal;
- h. Picking up, receiving, and opening packages containing radioactive materials, in accordance with RH-1307;
- i. For the use of tracers, decontamination of the environment, equipment, and personnel;
- j. Maintenance of records generated by logging personnel at temporary jobsites;
- k. The inspection and maintenance of sealed sources, source holders, logging tools, injection tools, source handling tools, storage containers, transport containers, and Uranium sinker bars as required by RH-1943;
- l. Actions to be taken if a sealed source is lodged in a well;

Revision effective January 1, 1997

RH-1963 (Cont'd)

- m. Notifying proper persons in the event of an accident; and
- n. Actions to be taken if a sealed source is ruptured including actions to prevent the spread of contamination and minimize inhalation and ingestion of radioactive materials and actions to obtain suitable radiation survey instruments as required by RH-1933.b.

RH-1964. Reserved.

RH-1965. Personnel Monitoring.

- a. The licensee may not permit an individual to act as a logging supervisor or logging assistant unless that person wears, at all times during the handling of licensed radioactive materials, either a film badge or a thermoluminescent dosimeter (TLD). Each film badge or TLD must be assigned to and worn by only one individual. Film badges must be replaced at least monthly and TLD replaced at least quarterly. After replacement, each film badge or TLD must be promptly processed.
- b. The licensee shall provide bioassay services to individuals using radioactive materials in subsurface tracer studies if required by the license.
- c. The licensee shall retain records of film badge, TLD, and bioassay results for inspection until the Department authorized disposition of the records.

RH-1966. Reserved.

RH-1967. Radiation Surveys.

- a. The licensee shall make radiation surveys, including but not limited to the surveys required under RH-1967.b through RH-1967.e of this Section, of each area where radioactive materials are used and stored.

Revision effective January 1, 1997

RH-1967 (Cont'd)

- b. Before transporting radioactive materials, the licensee shall make a radiation survey of the position occupied by each individual in the vehicle and of the exterior of each vehicle used to transport the radioactive materials.
- c. If the sealed source assembly is removed by the logging tool before departure from the temporary jobsite, the licensee shall confirm that the logging tool is free of contamination by energizing the logging tool detector or by using a survey meter.
- d. If the licensee has reason to believe that, as a result of any operation involving a sealed source, the encapsulation of the sealed source could be damaged by the operation, the licensee shall conduct a radiation survey, including a contamination survey, during and after the operation.
- e. The licensee shall make a radiation survey at the temporary jobsite before and after each subsurface tracer study to confirm the absence of contamination.
- f. The results of surveys required under RH-1967.a through RH-1967.e of this Section must be recorded and must include the date of the survey, the name of the individual making the survey, the identification of the survey, instrument used, and the location of the survey. The licensee shall retain records of surveys for inspection by the Department for three (3) years after they are made.

RH-1968. Reserved.

RH-1969. Radioactive Contamination Control.

- a. If the licensee detects evidence that a sealed source has ruptured or radioactive materials have caused contamination, the licensee shall initiate immediately the emergency procedures required by RH-1963.
- b. If contamination results from the use of radioactive material in well logging, the licensee shall decontaminate all work areas, equipment, and unrestricted areas.

Revision effective January 1, 1997

RH-1969 (Cont'd)

- c. During efforts to recover a sealed source lodged in the well, the licensee shall continuously monitor, with an appropriate radiation detection instrument or a logging tool with a radiation detector, the circulating fluids from the well, if any, to check for contamination resulting from damage to the sealed source.

RH-1970. Reserved.

RH-1971. Security.

- a. A logging supervisor must be physically present at a temporary jobsite whenever radioactive materials are being handled or are not stored and locked in a vehicle or storage place. The logging supervisor may leave the jobsite in order to obtain assistance if a source becomes lodged in a well.
- b. During well logging, except when radiation sources are below ground or in shipping or storage containers, the logging supervisor or other individual designated by the logging supervisor shall maintain direct surveillance of the operation to prevent unauthorized entry into a restricted area, as defined in RH-1100.

RH-1972. Reserved.

RH-1973. Documents and Records Required at Field Stations. Each licensee shall maintain the following documents and records at the field station:

- a. A copy of these Regulations;
- b. The license authorizing the use of radioactive material;
- c. Operating and emergency procedures required by RH-1963;
- d. The record of radiation survey instrument calibrations required by RH-1933;

Revision effective January 1, 1997

RH-1973 (Cont'd)

- e. The record of leak test results required by RH-1935;
- f. Physical inventory records required by RH-1937;
- g. Utilization records required by RH-1939;
- h. Records of inspection and maintenance required by RH-1943;
- i. Training records required by RH-1961.d; and
- j. Survey records required by RH-1967.

RH-1974. Reserved.

RH-1975. Documents and Records Required at Temporary Jobsites. Each licensee conducting operations at a temporary jobsite shall maintain the following documents and records at the temporary jobsite until the well logging operation is completed:

- a. Operating and emergency procedures required by RH-1963;
- b. Evidence of latest calibration of the radiation survey instruments in use at the site required by RH-1933;
- c. Latest survey records required by RH-1967.b, RH-1967.c, and RH-1967.e.
- d. The shipping papers for the transportation of radioactive materials required by Section 4 of these Regulations;
- e. When operating under reciprocity pursuant to Section 2, Part H of these Regulations, a copy of the U.S. Nuclear Regulatory Commission license or Agreement State license authorizing use of radioactive materials.

RH-1976. Reserved.

Revision effective January 1, 1997

RH-1977. Notification of Incidents and Lost Sources; Abandonment Procedures for Irretrievable Sources.

- a. The licensee shall immediately notify the Department by telephone and subsequently, within 30 (thirty) days, by confirmatory letter if the licensee knows or has reason to believe that a sealed source has been ruptured. The letter must designate the well or other location, describe the magnitude and extent of the escape of radioactive materials, assess the consequences of the rupture, and explain efforts planned or being taken to mitigate these consequences.
- b. The licensee shall notify the Department of the theft or loss of radioactive materials, radiation overexposures, excessive levels and concentrations of radiation, and certain other accidents as required by RH-1501, RH-1502, and RH-1504 of these Regulations.
- c. If a sealed source becomes lodged in a well, and when it becomes apparent that efforts to recover the sealed source will not be successful, the licensee shall:
 1. Notify the Department by telephone of the circumstances that resulted in the inability to retrieve the source and obtain approval to implement abandonment procedures;
 2. Advise the well owner or operator, as appropriate, of the abandonment procedures under RH-1915.a or RH-1915.c; and
 3. Either ensure that abandonment procedures are implemented within 30 (thirty) days after the sealed source has been classified as irretrievable or request an extension of time if unable to complete the abandonment procedures.
- d. The licensee shall, within 30 (thirty) days after a sealed source has been classified as irretrievable, make a report in writing to the Department. The licensee shall send a copy of the report to each appropriate State or Federal agency that issued permits or otherwise approved the drilling operation. The report shall contain the following information:
 1. Date of occurrence;
 2. A description of the irretrievable well logging source involved including the radionuclide and its quantity, chemical, and physical form;

Revision effective January 1, 1997

3. Surface location and identification of the well;
4. Results of effort to immobilize and seal the source in place;
5. A brief description of the attempted recovery effort;
6. Depth of the source;
7. Depth of the top of the cement plug;
8. Depth of the well;
9. Any other information, such as a warning statement, contained on the permanent identification plaque; and
10. State and Federal agencies receiving a copy of this report.

RH-1978-
RH-1990. Reserved.

RH-1991. Applications for Exemptions. The Department may, upon application of any interested person or upon its own initiative, grant such exemptions from the requirements of the Regulations in this Part as it determines are authorized by law and will not endanger life or property or the common defense and security and are otherwise in the public interest.

Revision effective January 1, 1997

Example of Plaque for Identifying Wells Containing Sealed Sources
Containing Radioactive Material Abandoned Downhole



The size of the plaque should be convenient for use on active or inactive wells, e.g., a 7-inch square. Letter size of the word "CAUTION" should be approximately twice the letter size of the rest of the information, e.g., 1/2-inch and 1/4-inch letter size, respectively.

RH-1992. Subjects to be Included in Training Courses for Logging Supervisors.

a. Fundamentals of radiation safety.

1. Characteristics of radiation.
2. Units of radiation dose (rem) and quantity of radioactivity (curie).
3. Significance of radiation dose.
 - A. Radiation protection standards.
 - B. Biological effects of radiation dose.
4. Levels of radiation from sources of radiation.
5. Methods of minimizing radiation dose.
 - A. Working time.
 - B. Working distances.
 - C. Shielding.

b. Radiation detection instrumentation to be used.

1. Use of radiation survey instruments.
 - A. Operation.
 - B. Calibration.
 - C. Limitations.
2. Survey techniques.
3. Use of personnel monitoring equipment.

c. Equipment to be used.

1. Handling equipment.
2. Sources of radiation.
3. Storage and control of equipment.
4. Operation and control of equipment.

d. The requirements of pertinent federal and state regulations.

e. The licensee's written operating and emergency procedures.

f. The licensee's record keeping procedures.

PART K. EXEMPTIONS AND ADDITIONAL REQUIREMENTS

- RH-2000. Applications for Exemptions. The Department may, upon application therefor or upon its own initiative, grant such exemptions or exceptions from the requirements of these Regulations as it determines are authorized by law and will not result in undue hazard to public health and safety or to property.
- RH-2001. Orders. The Department may, by order, impose upon any licensee or registrant such requirements, issued in furtherance of these Regulations, as it deems appropriate or necessary to protect health or minimize danger to life or property.

PART L. ENFORCEMENT

RH-2110. Violations.

- a. Any person who violates any of the provisions of the Act or rules, regulations or orders in effect pursuant thereto of the Department shall, upon conviction thereof, be punished by a fine of not less than one hundred dollars (\$100.00) nor more than two thousand dollars (\$2,000.00) or by imprisonment for not more than six (6) months or be both so fined and imprisoned.
- b. Impounding. Sources of radiation shall be subject to impounding pursuant to Section 5 of these Regulations.

PART M. APPENDICES

RH-2200.

APPENDIX A CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND (See notes at end of Appendix)

Element (atomic number)	Isotope ^{16/}	Table I		Table II	
		Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)
Actinium (89)	Ac-227	S	2×10^{-12}	6×10^{-5}	8×10^{-14}
		I	3×10^{-11}	9×10^{-3}	9×10^{-13}
	Ac-228	S	8×10^{-8}	3×10^{-3}	3×10^{-9}
		I	2×10^{-8}	3×10^{-3}	6×10^{-10}
Americium (95)	Am-241	S	6×10^{-12}	1×10^{-4}	2×10^{-13}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}
	Am-242m	S	6×10^{-12}	1×10^{-4}	2×10^{-13}
		I	3×10^{-10}	3×10^{-3}	9×10^{-12}
	Am-242	S	4×10^{-8}	4×10^{-3}	1×10^{-9}
		I	5×10^{-8}	4×10^{-3}	2×10^{-9}
	Am-243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}
	Am-244	S	4×10^{-6}	1×10^{-1}	1×10^{-7}
		I	2×10^{-5}	1×10^{-1}	8×10^{-7}
Antimony (51)	Sb-122	S	2×10^{-7}	8×10^{-4}	6×10^{-9}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}
	Sb-124	S	2×10^{-7}	7×10^{-4}	5×10^{-9}
		I	2×10^{-8}	7×10^{-4}	7×10^{-10}
	Sb-125	S	5×10^{-7}	3×10^{-3}	2×10^{-8}
		I	3×10^{-8}	3×10^{-10}	9×10^{-3}
Argon (18)	A-37	Sub ^{17/}	6×10^{-3}	-----	1×10^{-4}
	A-41	Sub	2×10^{-6}	-----	4×10^{-8}
Arsenic (33)	As-73	S	2×10^{-6}	1×10^{-2}	7×10^{-8}
		I	4×10^{-7}	1×10^{-2}	1×10^{-8}
	As-74	S	3×10^{-7}	2×10^{-3}	1×10^{-8}
		I	1×10^{-7}	2×10^{-3}	4×10^{-9}
	As-76	S	1×10^{-7}	6×10^{-4}	4×10^{-9}
		I	1×10^{-7}	6×10^{-4}	3×10^{-9}
	As-77	S	5×10^{-7}	2×10^{-3}	2×10^{-8}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}
Astatine (85)	At-211	S	7×10^{-9}	5×10^{-5}	2×10^{-10}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}
Barium (56)	Ba-131	S	1×10^{-6}	5×10^{-3}	4×10^{-8}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}
	Ba-140	S	1×10^{-7}	8×10^{-4}	4×10^{-9}
		I	4×10^{-8}	7×10^{-4}	1×10^{-9}

APPENDIX A
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

Element (atomic number)	Isotope ^{16/}	Table I		Table II	
		Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)
Berkelium (97)	Bk-249	S	9×10^{-10}	2×10^{-2}	3×10^{-11}
		I	1×10^{-7}	2×10^{-2}	6×10^{-4}
	Bk-250	S	1×10^{-7}	6×10^{-3}	6×10^{-4}
		I	1×10^{-6}	5×10^{-9}	2×10^{-4}
Beryllium (4)			6×10^{-6}	4×10^{-8}	2×10^{-3}
	Be-7	S	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	5×10^{-2}	4×10^{-8}	2×10^{-3}
Bismuth (83)	Bi-206	S	2×10^{-7}	1×10^{-3}	6×10^{-9}
		I	1×10^{-7}	1×10^{-3}	4×10^{-5}
	Bi-207	S	2×10^{-7}	2×10^{-3}	5×10^{-9}
		I	1×10^{-8}	2×10^{-3}	6×10^{-5}
	Bi-210	S	6×10^{-9}	1×10^{-3}	5×10^{-10}
		I	6×10^{-9}	2×10^{-3}	6×10^{-5}
	Bi-212	S	1×10^{-7}	1×10^{-2}	2×10^{-10}
		I	2×10^{-7}	3×10^{-9}	4×10^{-5}
Bromine (35)			1×10^{-6}	7×10^{-9}	4×10^{-4}
	Br-82	S	8×10^{-3}	4×10^{-8}	3×10^{-4}
		I	1×10^{-3}	6×10^{-9}	4×10^{-5}
Cadmium (48)	Cd-109	S	5×10^{-8}	5×10^{-3}	2×10^{-9}
		I	7×10^{-8}	5×10^{-3}	2×10^{-4}
	Cd-115m	S	4×10^{-8}	7×10^{-4}	3×10^{-9}
		I	4×10^{-8}	7×10^{-4}	1×10^{-9}
	Cd-115	S	2×10^{-7}	1×10^{-3}	8×10^{-9}
		I	2×10^{-7}	6×10^{-9}	3×10^{-5}
Calcium (20)			3×10^{-8}	3×10^{-4}	1×10^{-9}
	Ca-45	S	1×10^{-7}	5×10^{-3}	4×10^{-9}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}
	Ca-47	S	2×10^{-7}	1×10^{-3}	6×10^{-9}
Californium (98)			2×10^{-12}	1×10^{-4}	5×10^{-14}
	Cf-249	S	1×10^{-10}	7×10^{-4}	3×10^{-12}
		I	5×10^{-12}	4×10^{-4}	2×10^{-13}
	Cf-250	S	1×10^{-10}	7×10^{-4}	3×10^{-12}
		I	2×10^{-12}	1×10^{-4}	6×10^{-14}
	Cf-251	S	1×10^{-10}	8×10^{-4}	3×10^{-12}
		I	6×10^{-12}	2×10^{-4}	2×10^{-13}
	Cf-252	S	3×10^{-11}	2×10^{-4}	1×10^{-12}
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cont'd

APPENDIX A
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

Element (atomic number)	Isotope ^{16/}	Table I		Table II	
		Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)
Californium (98) (continued)	Cf-253 S	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
	I	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
	Cf-254 S	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
	I	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
Carbon (6)	C-14 S	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	(CO ₂) Sub ^{17/}	5×10^{-5}	-----	1×10^{-6}	-----
Cerium (58)	Ce-141 S	4×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
	I	2×10^{-7}	3×10^{-3}	5×10^{-9}	9×10^{-5}
	Ce-143 S	3×10^{-7}	1×10^{-3}	9×10^{-9}	4×10^{-5}
	I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	Ce-144 S	1×10^{-8}	3×10^{-4}	3×10^{-10}	1×10^{-5}
	I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Cesium (55)	Cs-131 S	1×10^{-5}	7×10^{-2}	4×10^{-7}	2×10^{-3}
	I	3×10^{-6}	3×10^{-2}	1×10^{-7}	9×10^{-4}
	Cs-134m S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
	I	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	Cs-134 S	4×10^{-8}	3×10^{-4}	1×10^{-10}	9×10^{-6}
	I	1×10^{-8}	1×10^{-3}	4×10^{-10}	4×10^{-5}
	Cs-135 S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	I	9×10^{-8}	7×10^{-3}	3×10^{-9}	2×10^{-4}
	Cs-136 S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
	I	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
	Cs-137 S	6×10^{-8}	4×10^{-4}	2×10^{-9}	2×10^{-5}
	I	1×10^{-8}	1×10^{-3}	5×10^{-10}	4×10^{-5}
Chlorine (17)	Cl-36 S	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
	I	2×10^{-8}	2×10^{-3}	8×10^{-10}	6×10^{-5}
	Cl-38 S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
	I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
Chromium (24)	Cr-51 S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
	I	2×10^{-6}	5×10^{-2}	8×10^{-8}	2×10^{-3}
Cobalt (27)	Co-57 S	3×10^{-6}	2×10^{-2}	1×10^{-7}	5×10^{-4}
	I	2×10^{-7}	1×10^{-2}	6×10^{-9}	4×10^{-4}
	Co-58m S	2×10^{-5}	8×10^{-2}	6×10^{-7}	3×10^{-3}
	I	9×10^{-6}	6×10^{-2}	3×10^{-7}	2×10^{-3}

cont'd

APPENDIX A
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

		Table I		Table II		
Element (atomic number)	Isotope ^{16/}	Column 1 Air (μCi/ml)	Column 2 Water (μCi/ml)	Column 1 Air (μCi/ml)	Column 2 Water (μCi/ml)	
Cobalt (27) (continued)	Co-58	S	8 X 10 ⁻⁷	4 X 10 ⁻³	3 X 10 ⁻⁸	1 X 10 ⁻⁴
		I	5 X 10 ⁻⁸	3 X 10 ⁻³	2 X 10 ⁻⁹	9 X 10 ⁻⁵
	Co-60	S	3 X 10 ⁻⁷	1 X 10 ⁻³	1 X 10 ⁻⁸	5 X 10 ⁻⁵
		I	9 X 10 ⁻⁹	1 X 10 ⁻³	3 X 10 ⁻¹⁰	3 X 10 ⁻⁵
Copper (29)	Cu-64	S	2 X 10 ⁻⁶	1 X 10 ⁻²	7 X 10 ⁻⁸	3 X 10 ⁻⁴
		I	1 X 10 ⁻⁶	6 X 10 ⁻³	4 X 10 ⁻⁸	2 X 10 ⁻⁴
Curium (96)	Cm-242	S	1 X 10 ⁻¹⁰	7 X 10 ⁻⁴	4 X 10 ⁻¹²	2 X 10 ⁻⁵
		I	2 X 10 ⁻¹⁰	7 X 10 ⁻⁴	6 X 10 ⁻¹²	2 X 10 ⁻⁵
	Cm-243	S	6 X 10 ⁻¹²	1 X 10 ⁻⁴	2 X 10 ⁻¹³	5 X 10 ⁻⁶
		I	1 X 10 ⁻¹⁰	7 X 10 ⁻⁴	3 X 10 ⁻¹²	2 X 10 ⁻⁵
	Cm-244	S	9 X 10 ⁻¹²	2 X 10 ⁻⁴	3 X 10 ⁻¹³	7 X 10 ⁻⁶
		I	1 X 10 ⁻¹⁰	8 X 10 ⁻⁴	3 X 10 ⁻¹²	3 X 10 ⁻⁵
	Cm-245	S	5 X 10 ⁻¹²	1 X 10 ⁻⁴	2 X 10 ⁻¹³	4 X 10 ⁻⁶
		I	1 X 10 ⁻¹⁰	8 X 10 ⁻⁴	4 X 10 ⁻¹²	3 X 10 ⁻⁵
	Cm-246	S	5 X 10 ⁻¹²	1 X 10 ⁻⁴	2 X 10 ⁻¹³	4 X 10 ⁻⁶
		I	1 X 10 ⁻¹⁰	8 X 10 ⁻⁴	4 X 10 ⁻¹²	3 X 10 ⁻⁵
	Cm-247	S	5 X 10 ⁻¹²	1 X 10 ⁻⁴	2 X 10 ⁻¹³	4 X 10 ⁻⁶
		I	1 X 10 ⁻¹⁰	6 X 10 ⁻⁴	4 X 10 ⁻¹²	2 X 10 ⁻⁵
	Cm-248	S	6 X 10 ⁻¹³	1 X 10 ⁻⁵	2 X 10 ⁻¹⁴	4 X 10 ⁻⁷
		I	1 X 10 ⁻¹¹	4 X 10 ⁻⁵	4 X 10 ⁻¹³	1 X 10 ⁻⁶
	Cm-249	S	1 X 10 ⁻⁵	6 X 10 ⁻²	4 X 10 ⁻⁷	2 X 10 ⁻³
		I	1 X 10 ⁻⁵	6 X 10 ⁻²	4 X 10 ⁻⁷	2 X 10 ⁻³
Dysprosium (66)	Dy-165	S	3 X 10 ⁻⁶	1 X 10 ⁻²	9 X 10 ⁻⁸	4 X 10 ⁻⁴
		I	2 X 10 ⁻⁶	1 X 10 ⁻²	7 X 10 ⁻⁸	4 X 10 ⁻⁴
	Dy-165	S	2 X 10 ⁻⁷	1 X 10 ⁻³	8 X 10 ⁻⁹	4 X 10 ⁻⁵
		I	2 X 10 ⁻⁷	1 X 10 ⁻³	7 X 10 ⁻⁹	4 X 10 ⁻⁵
Einsteinium (99)	Es-253	S	8 X 10 ⁻¹⁰	7 X 10 ⁻⁴	3 X 10 ⁻¹¹	2 X 10 ⁻⁵
		I	6 X 10 ⁻¹⁰	7 X 10 ⁻⁴	2 X 10 ⁻¹¹	2 X 10 ⁻⁵
	Es-254m	S	5 X 10 ⁻⁹	5 X 10 ⁻⁴	2 X 10 ⁻¹⁰	2 X 10 ⁻⁵
		I	6 X 10 ⁻⁹	5 X 10 ⁻⁴	2 X 10 ⁻¹⁰	2 X 10 ⁻⁵
	Es-254	S	2 X 10 ⁻¹¹	4 X 10 ⁻⁴	6 X 10 ⁻¹³	1 X 10 ⁻⁵
		I	1 X 10 ⁻¹⁰	4 X 10 ⁻⁴	4 X 10 ⁻¹²	1 X 10 ⁻⁵
	Es-255	S	5 X 10 ⁻¹⁰	8 X 10 ⁻⁴	2 X 10 ⁻¹¹	3 X 10 ⁻⁵
		I	4 X 10 ⁻¹⁰	8 X 10 ⁻⁴	1 X 10 ⁻¹¹	3 X 10 ⁻⁵
Erbium (68)	Er-169	S	6 X 10 ⁻⁷	3 X 10 ⁻³	2 X 10 ⁻⁸	9 X 10 ⁻⁵
		I	4 X 10 ⁻⁷	3 X 10 ⁻³	1 X 10 ⁻⁸	9 X 10 ⁻⁵
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APPENDIX A
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

		Table I		Table II		
Element (atomic number)	Isotope ^{16/}	Column 1 Air (μCi/ml)	Column 2 Water (μCi/ml)	Column 1 Air (μCi/ml)	Column 2 Water (μCi/ml)	
Erbium (68) (continued)	Er-171	S	7 X 10 ⁻⁷	3 X 10 ⁻³	2 X 10 ⁻⁸	
		I	6 X 10 ⁻⁷	3 X 10 ⁻³	2 X 10 ⁻⁸	
Europium (63)	Eu-152	S	4 X 10 ⁻⁷	2 X 10 ⁻³	1 X 10 ⁻⁸	6 X 10 ⁻⁵
		T/2= 9.2 hrs)I	3 X 10 ⁻⁷	2 X 10 ⁻³	1 X 10 ⁻⁸	6 X 10 ⁻⁵
	Eu-152	S	1 X 10 ⁻⁸	2 X 10 ⁻³	4 X 10 ⁻¹⁰	8 X 10 ⁻⁵
		(T/2= 13 yrs) I	2 X 10 ⁻⁸	2 X 10 ⁻³	6 X 10 ⁻¹⁰	8 X 10 ⁻⁵
	Eu-154	S	4 X 10 ⁻⁹	6 X 10 ⁻⁴	1 X 10 ⁻¹⁰	2 X 10 ⁻⁵
		I	7 X 10 ⁻⁹	6 X 10 ⁻⁴	2 X 10 ⁻¹⁰	2 X 10 ⁻⁵
	Eu-155	S	9 X 10 ⁻⁸	6 X 10 ⁻³	3 X 10 ⁻⁹	2 X 10 ⁻⁴
		I	7 X 10 ⁻⁸	6 X 10 ⁻³	3 X 10 ⁻⁹	2 X 10 ⁻⁴
Fermium (100)	Fm-254	S	6 X 10 ⁻⁸	4 X 10 ⁻³	2 X 10 ⁻⁹	1 X 10 ⁻⁴
		I	7 X 10 ⁻⁸	4 X 10 ⁻³	2 X 10 ⁻⁹	1 X 10 ⁻⁴
	Fm-255	S	2 X 10 ⁻⁸	1 X 10 ⁻³	6 X 10 ⁻¹⁰	3 X 10 ⁻⁵
		I	1 X 10 ⁻⁸	1 X 10 ⁻³	4 X 10 ⁻¹⁰	3 X 10 ⁻⁵
	Fm-256	S	3 X 10 ⁻⁹	3 X 10 ⁻⁵	1 X 10 ⁻¹⁰	9 X 10 ⁻⁷
		I	2 X 10 ⁻⁹	3 X 10 ⁻⁵	6 X 10 ⁻¹¹	9 X 10 ⁻⁷
Fluorine (9)	F-18	S	5 X 10 ⁻⁶	2 X 10 ⁻²	2 X 10 ⁻⁷	8 X 10 ⁻⁴
		I	3 X 10 ⁻⁶	1 X 10 ⁻²	9 X 10 ⁻⁸	5 X 10 ⁻⁴
Gadolinium (64)	Gd-153	S	2 X 10 ⁻⁷	6 X 10 ⁻³	8 X 10 ⁻⁹	2 X 10 ⁻⁴
		I	9 X 10 ⁻⁸	6 X 10 ⁻³	3 X 10 ⁻⁹	2 X 10 ⁻⁴
	Gd-159	S	5 X 10 ⁻⁷	2 X 10 ⁻³	2 X 10 ⁻⁸	8 X 10 ⁻⁵
		I	4 X 10 ⁻⁷	2 X 10 ⁻³	1 X 10 ⁻⁸	8 X 10 ⁻⁵
Gallium (31)	Ga-72	S	2 X 10 ⁻⁷	1 X 10 ⁻³	8 X 10 ⁻⁹	4 X 10 ⁻⁵
		I	2 X 10 ⁻⁷	1 X 10 ⁻³	6 X 10 ⁻⁹	4 X 10 ⁻⁵
Germanium (32)	Ge-68*	S	4 X 10 ⁻⁶	2 X10 ⁻²	1 X 10 ⁻⁷	8 X 10 ⁻⁴
		I	1 X 10 ⁻⁸	-----	5 X 10 ⁻¹⁰	-----
	Ge-71	S	1 X 10 ⁻⁵	5 X 10 ⁻²	4 X 10 ⁻⁷	2 X 10 ⁻³
		I	6 X 10 ⁻⁶	5 X 10 ⁻²	2 X 10 ⁻⁷	2 X 10 ⁻³
Gold (79)	Au-195*	S	8 X 10 ⁻⁶	4 X 10 ⁻²	3 X 10 ⁻⁷	1 X 10 ⁻³
		I	6 X 10 ⁻⁸	6 X 10 ⁻³	2 X 10 ⁻⁹	2 X 10 ⁻⁴
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APPENDIX A
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

Element (atomic number)	Isotope ^{16/}	Table I		Table II	
		Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)
Gold (79) (continued)	Au-196 S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
	I	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
	Au-198 S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
	I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Au-199 S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
	I	8×10^{-7}	4×10^{-3}	3×10^{-8}	2×10^{-4}
Hafnium (72)	Hf-181 S	4×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
	I	7×10^{-8}	2×10^{-3}	3×10^{-9}	7×10^{-5}
Holmium (67)	Ho-166 S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
	I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Hydrogen (1)	H-3 S	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
	I	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
	Sub ^{17/}	2×10^{-3}	-----	4×10^{-5}	-----
Indium (49)	In-113m S	8×10^{-6}	4×10^{-2}	3×10^{-7}	1×10^{-3}
	I	7×10^{-6}	4×10^{-2}	2×10^{-7}	1×10^{-3}
	In-114m S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
	I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
	In-115m S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
	I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	In-115 S	2×10^{-7}	3×10^{-3}	9×10^{-9}	9×10^{-5}
	I	3×10^{-8}	3×10^{-3}	1×10^{-9}	9×10^{-5}
Iodine (53)	I-125 S	5×10^{-9}	4×10^{-5}	8×10^{-11}	2×10^{-7}
	I	2×10^{-7}	6×10^{-3}	6×10^{-9}	2×10^{-4}
	I-126 S	8×10^{-9}	5×10^{-5}	9×10^{-11}	3×10^{-7}
	I	3×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	I-129 S	2×10^{-9}	1×10^{-5}	2×10^{-11}	6×10^{-8}
	I	7×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
	I-131 S	9×10^{-9}	6×10^{-5}	1×10^{-10}	3×10^{-7}
	I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	I-132 S	2×10^{-7}	2×10^{-3}	3×10^{-9}	8×10^{-6}
	I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	I-133 S	3×10^{-8}	2×10^{-4}	4×10^{-10}	1×10^{-6}
	I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
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APPENDIX A
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

Element (atomic number)			Table I		Table II	
			Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)
Iodine (53) (continued)	I-134	S	5×10^{-7}	4×10^{-3}	6×10^{-9}	2×10^{-5}
		I	3×10^{-6}	2×10^{-2}	1×10^{-7}	6×10^{-4}
	I-135	S	1×10^{-7}	7×10^{-4}	1×10^{-9}	4×10^{-6}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Iridium (77)	Ir-190	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ir-192	S	1×10^{-7}	1×10^{-3}	4×10^{-9}	4×10^{-5}
		I	3×10^{-8}	1×10^{-3}	9×10^{-10}	4×10^{-5}
	Ir-194	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
Iron (26)	Fe-55	S	9×10^{-7}	2×10^{-2}	3×10^{-8}	8×10^{-4}
		I	1×10^{-6}	7×10^{-2}	3×10^{-8}	2×10^{-3}
	Fe-59	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	5×10^{-5}
Krypton (36)	Kr-85m	Sub ^{17/}	6×10^{-6}	-----	1×10^{-7}	-----
	Kr-85	Sub	1×10^{-5}	-----	3×10^{-7}	-----
	Kr-87	Sub	1×10^{-6}	-----	2×10^{-8}	-----
	Kr-88	Sub	1×10^{-6}	-----	2×10^{-8}	-----
Lanthanum (57)	La-140	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
		I	1×10^{-7}	7×10^{-4}	4×10^{-9}	2×10^{-5}
Lead (82)	Pb-203	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	Pb-210	S	1×10^{-10}	4×10^{-6}	4×10^{-12}	1×10^{-7}
		I	2×10^{-10}	5×10^{-3}	8×10^{-12}	2×10^{-4}
	Pb-212	S	2×10^{-8}	6×10^{-4}	6×10^{-10}	2×10^{-5}
		I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
Lutetium (71)	Lu-177	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Manganese (25)	Mn-52	S	2×10^{-7}	1×10^{-3}	7×10^{-9}	3×10^{-5}
		I	1×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Mn-54	S	4×10^{-7}	4×10^{-3}	1×10^{-8}	1×10^{-4}
		I	4×10^{-8}	3×10^{-3}	1×10^{-9}	1×10^{-4}
	Mn-56	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}

APPENDIX A
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

		Table I		Table II		
Element (atomic number)	Isotope ^{16/}	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	
Mercury (80)	Hg-197m	S	7×10^{-7}	6×10^{-3}	3×10^{-8}	2×10^{-4}
		I	8×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Hg-197	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
	Hg-203	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
Molybdenum (42)	Mo-99	S	7×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Neodymium (60)	Nd-144	S	8×10^{-11}	2×10^{-3}	3×10^{-12}	7×10^{-5}
		I	3×10^{-10}	2×10^{-3}	1×10^{-11}	8×10^{-5}
	Nd-147	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	6×10^{-5}
	Nd-149	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	1×10^{-6}	8×10^{-3}	5×10^{-8}	3×10^{-4}
Neptunium (93)	Np-237	S	4×10^{-12}	9×10^{-5}	1×10^{-13}	3×10^{-6}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	Np-239	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	7×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
Nickel (28)	Ni-59	S	5×10^{-7}	6×10^{-3}	2×10^{-8}	2×10^{-4}
		I	8×10^{-7}	6×10^{-2}	3×10^{-8}	2×10^{-4}
	Ni-63	S	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	7×10^{-4}
	Ni-65	S	9×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Niobium (41)	Nb-93m	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	4×10^{-4}
		I	2×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Nb-95	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	1×10^{-7}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Nb-97	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}

APPENDIX A
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

Element (atomic number)	Isotope ^{16/}	Table I		Table II	
		Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)
Osmium (76)	Os-185 S	5×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
	I	5×10^{-8}	2×10^{-3}	2×10^{-9}	7×10^{-5}
	Os-191m S	2×10^{-5}	7×10^{-2}	6×10^{-7}	3×10^{-3}
	I	9×10^{-6}	7×10^{-2}	3×10^{-7}	2×10^{-3}
	Os-191 S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
	I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Os-193 S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	I	3×10^{-7}	2×10^{-3}	9×10^{-9}	5×10^{-5}
Palladium (46)	Pd-103 S	1×10^{-6}	1×10^{-2}	5×10^{-8}	3×10^{-4}
	I	7×10^{-7}	8×10^{-3}	3×10^{-8}	3×10^{-4}
	Pd-109 S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
	I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Phosphorus (15)	P-32 S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
	I	8×10^{-8}	7×10^{-4}	3×10^{-9}	2×10^{-5}
Platinum (78)	Pt-191 S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
	I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Pt-193m S	7×10^{-6}	3×10^{-2}	2×10^{-8}	1×10^{-3}
	I	5×10^{-7}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	Pt-193 S	1×10^{-6}	3×10^{-2}	4×10^{-8}	9×10^{-4}
	I	3×10^{-7}	5×10^{-2}	1×10^{-8}	2×10^{-3}
	Pt-197m S	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
	Pt-197 S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
	I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Plutonium (94)	Pu-238 S	2×10^{-12}	1×10^{-4}	7×10^{-14}	5×10^{-6}
	I	3×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu-239 S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
	I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu-240 S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
	I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu-241 S	9×10^{-11}	7×10^{-3}	3×10^{-12}	2×10^{-4}
	I	4×10^{-8}	4×10^{-2}	1×10^{-9}	1×10^{-3}
	Pu-242 S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
	I	4×10^{-11}	9×10^{-4}	1×10^{-12}	3×10^{-5}

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APPENDIX A
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

Element (atomic number)	Isotope ^{16/}		Table I		Table II	
			Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)
Plutonium (94) (continued)	Pu-243	S	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
		I	2×10^{-6}	1×10^{-2}	8×10^{-8}	3×10^{-4}
	Pu-244	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
		I	3×10^{-11}	3×10^{-4}	1×10^{-12}	1×10^{-5}
Polonium (84)	Po-210	S	5×10^{-10}	2×10^{-5}	2×10^{-11}	7×10^{-7}
		I	2×10^{-10}	8×10^{-4}	7×10^{-12}	3×10^{-5}
Potassium (19)	K-42	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
		I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Praseodymium (59)	Pr-142	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Pr-143	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
Promethium (61)	Pm-147	S	6×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
		I	1×10^{-7}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Pm-149	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Protoactinium (91)	Pa-230	S	2×10^{-9}	7×10^{-3}	6×10^{-11}	2×10^{-4}
		I	8×10^{-10}	7×10^{-3}	3×10^{-11}	2×10^{-4}
	Pa-231	S	1×10^{-12}	3×10^{-5}	4×10^{-14}	9×10^{-7}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	2×10^{-5}
	Pa-233	S	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
		I	2×10^{-7}	3×10^{-3}	6×10^{-9}	1×10^{-4}
Radium (88)	Ra-233	S	2×10^{-9}	2×10^{-5}	6×10^{-11}	7×10^{-7}
		I	2×10^{-10}	1×10^{-4}	8×10^{-12}	4×10^{-6}
	Ra-224	S	5×10^{-9}	7×10^{-5}	2×10^{-10}	2×10^{-6}
		I	7×10^{-10}	2×10^{-4}	2×10^{-11}	5×10^{-6}
	Ra-226	S	3×10^{-11}	4×10^{-7}	3×10^{-12}	3×10^{-8}
		I	5×10^{-11}	9×10^{-4}	2×10^{-12}	3×10^{-5}
	Ra-228	S	7×10^{-11}	8×10^{-7}	2×10^{-12}	3×10^{-8}
		I	4×10^{-11}	7×10^{-4}	1×10^{-12}	3×10^{-5}
Radon (86)	Rn-220	S	3×10^{-7}	-----	1×10^{-8}	-----
	Rn-222 ^{18/}	S	3×10^{-8}	-----	3×10^{-9}	-----

APPENDIX A
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

			Table I		Table II	
Element (atomic number)	Isotope ^{16/}		Column 1 Air (μCi/ml)	Column 2 Water (μCi/ml)	Column 1 Air (μCi/ml)	Column 2 Water (μCi/ml)
Rhenium (75)	Re-183	S	3 X 10 ⁻⁶	2 X 10 ⁻²	9 X 10 ⁻⁸	6 X 10 ⁻⁴
		I	2 X 10 ⁻⁷	8 X 10 ⁻³	5 X 10 ⁻⁹	3 X 10 ⁻⁴
	Re-186	S	6 X 10 ⁻⁷	3 X 10 ⁻³	2 X 10 ⁻⁸	9 X 10 ⁻⁵
		I	2 X 10 ⁻⁷	1 X 10 ⁻³	8 X 10 ⁻⁹	5 X 10 ⁻⁵
	Re-187	S	9 X 10 ⁻⁶	7 X 10 ⁻²	3 X 10 ⁻⁷	3 X 10 ⁻³
		I	5 X 10 ⁻⁷	4 X 10 ⁻²	2 X 10 ⁻⁸	2 X 10 ⁻³
	Re-188	S	4 X 10 ⁻⁷	2 X 10 ⁻³	1 X 10 ⁻⁸	6 X 10 ⁻⁵
		I	2 X 10 ⁻⁷	9 X 10 ⁻⁴	6 X 10 ⁻⁹	3 X 10 ⁻⁵
Rhodium (45)	Rh-103m	S	8 X 10 ⁻⁵	4 X 10 ⁻¹	3 X 10 ⁻⁶	1 X 10 ⁻²
		I	6 X 10 ⁻⁵	3 X 10 ⁻¹	2 X 10 ⁻⁶	1 X 10 ⁻²
	Rh-105	S	8 X 10 ⁻⁷	4 X 10 ⁻³	3 X 10 ⁻⁸	1 X 10 ⁻⁴
		I	5 X 10 ⁻⁷	3 X 10 ⁻³	2 X 10 ⁻⁸	1 X 10 ⁻⁴
Rubidium (37)	Rb-86	S	3 X 10 ⁻⁷	2 X 10 ⁻³	1 X 10 ⁻⁸	7 X 10 ⁻⁵
		I	7 X 10 ⁻³	7 X 10 ⁻⁴	2 X 10 ⁻⁹	2 X 10 ⁻⁵
	Rb-87	S	5 X 10 ⁻⁷	3 X 10 ⁻³	2 X 10 ⁻⁸	1 X 10 ⁻⁴
		I	7 X 10 ⁻⁸	5 X 10 ⁻³	2 X 10 ⁻⁹	2 X 10 ⁻⁴
Ruthenium (44)	Ru-97	S	2 X 10 ⁻⁶	1 X 10 ⁻²	8 X 10 ⁻⁸	4 X 10 ⁻⁴
		I	2 X 10 ⁻⁶	1 X 10 ⁻²	6 X 10 ⁻⁸	3 X 10 ⁻⁴
	Ru-103	S	5 X 10 ⁻⁷	2 X 10 ⁻³	2 X 10 ⁻⁸	8 X 10 ⁻⁵
		I	8 X 10 ⁻⁸	2 X 10 ⁻³	3 X 10 ⁻⁹	8 X 10 ⁻⁵
	Ru-105	S	7 X 10 ⁻⁷	3 X 10 ⁻³	2 X 10 ⁻⁸	1 X 10 ⁻⁴
		I	5 X 10 ⁻⁷	3 X 10 ⁻³	2 X 10 ⁻⁸	1 X 10 ⁻⁴
	Ru-106	S	8 X 10 ⁻⁸	4 X 10 ⁻⁴	3 X 10 ⁻⁹	1 X 10 ⁻⁵
		I	6 X 10 ⁻⁹	3 X 10 ⁻⁴	2 X 10 ⁻¹⁰	1 X 10 ⁻⁵
Samarium (62)	Sm-147	S	7 X 10 ⁻¹¹	2 X 10 ⁻³	2 X 10 ⁻¹²	6 X 10 ⁻⁵
		I	3 X 10 ⁻¹⁰	2 X 10 ⁻³	9 X 10 ⁻¹²	7 X 10 ⁻⁵
	Sm-151	S	6 X 10 ⁻⁸	1 X 10 ⁻²	2 X 10 ⁻⁹	4 X 10 ⁻⁴
		I	1 X 10 ⁻⁷	1 X 10 ⁻²	5 X 10 ⁻⁹	4 X 10 ⁻⁴
	Sm-153	S	5 X 10 ⁻⁷	2 X 10 ⁻³	2 X 10 ⁻⁸	8 X 10 ⁻⁵
		I	4 X 10 ⁻⁷	2 X 10 ⁻³	1 X 10 ⁻⁸	8 X 10 ⁻⁵
Scandium (21)	Sc-46	S	2 X 10 ⁻⁷	1 X 10 ⁻³	8 X 10 ⁻⁹	4 X 10 ⁻⁵
		I	2 X 10 ⁻⁸	1 X 10 ⁻¹⁰	8 X 10 ⁻¹⁰	4 X 10 ⁻⁵
	Sc-47	S	6 X 10 ⁻⁷	3 X 10 ⁻³	2 X 10 ⁻⁸	9 X 10 ⁻⁵
		I	5 X 10 ⁻⁷	3 X 10 ⁻³	2 X 10 ⁻⁸	9 X 10 ⁻⁵
	Sc-48	S	2 X 10 ⁻⁷	8 X 10 ⁻⁴	6 X 10 ⁻⁹	3 X 10 ⁻⁵
		I	1 X 10 ⁻⁷	8 X 10 ⁻⁴	5 X 10 ⁻⁹	3 X 10 ⁻⁵

APPENDIX A
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

Element (atomic number)	Isotope ^{16/}	Table I		Table II	
		Column 1 Air ($\mu\text{Ci}/\text{ml}$)	Column 2 Water ($\mu\text{Ci}/\text{ml}$)	Column 1 Air ($\mu\text{Ci}/\text{ml}$)	Column 2 Water ($\mu\text{Ci}/\text{ml}$)
Selenium (34)	Se-75	S	1×10^{-6}	9×10^{-3}	4×10^{-8}
		I	1×10^{-7}	8×10^{-3}	3×10^{-4}
Silicon (14)	Si-31	S	6×10^{-6}	3×10^{-2}	2×10^{-7}
		I	1×10^{-6}	6×10^{-3}	3×10^{-8}
Silver (47)	Ag-105	S	6×10^{-7}	3×10^{-3}	2×10^{-8}
		I	8×10^{-8}	3×10^{-3}	3×10^{-9}
	Ag-110m	S	2×10^{-7}	9×10^{-4}	7×10^{-9}
		I	1×10^{-8}	9×10^{-4}	3×10^{-10}
	Ag-111	S	3×10^{-7}	1×10^{-3}	1×10^{-8}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}
Sodium (11)	Na-22	S	2×10^{-7}	1×10^{-3}	6×10^{-9}
		I	9×10^{-9}	9×10^{-4}	3×10^{-10}
	Na-24	S	1×10^{-6}	6×10^{-3}	4×10^{-8}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}
Strontium (38)	Sr-85m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}
		I	3×10^{-5}	2×10^{-1}	1×10^{-6}
	Sr-85	S	2×10^{-7}	3×10^{-3}	8×10^{-9}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}
	Sr-89	S	3×10^{-8}	3×10^{-4}	3×10^{-10}
		I	4×10^{-8}	8×10^{-4}	1×10^{-9}
	Sr-90	S	1×10^{-9}	1×10^{-5}	3×10^{-11}
		I	5×10^{-9}	1×10^{-3}	2×10^{-10}
	Sr-91	S	4×10^{-7}	2×10^{-3}	2×10^{-8}
		I	3×10^{-7}	1×10^{-3}	9×10^{-9}
	Sr-92	S	4×10^{-7}	2×10^{-3}	2×10^{-8}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}
Sulfur (16)	S-35	S	3×10^{-7}	2×10^{-3}	9×10^{-9}
		I	3×10^{-7}	8×10^{-3}	9×10^{-9}
Tantalum (73)	Ta-182	S	4×10^{-8}	1×10^{-3}	1×10^{-9}
		I	2×10^{-8}	1×10^{-3}	7×10^{-10}

APPENDIX A
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

Element (atomic number)	Isotope ^{16/}	Table I		Table II	
		Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)
Technetium (43)	Tc-96m S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
	I	3×10^{-5}	3×10^{-1}	1×10^{-6}	1×10^{-2}
	Tc-96 S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Tc-97m S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
	I	2×10^{-7}	5×10^{-3}	5×10^{-9}	2×10^{-4}
	Tc-97 S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
	I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Tc-99m S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
	I	1×10^{-5}	8×10^{-2}	5×10^{-7}	3×10^{-3}
	Tc-99 S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
	I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Tellurium (52)	Te-125m S	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
	Te-127m S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
	I	4×10^{-8}	2×10^{-3}	1×10^{-9}	5×10^{-5}
	Te-127 S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
	I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Te-129m S	8×10^{-8}	1×10^{-3}	3×10^{-9}	3×10^{-5}
	I	3×10^{-8}	6×10^{-4}	1×10^{-9}	2×10^{-5}
	Te-129 S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
	I	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	Te-131m S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Terbium (65)	Te-132 S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
	I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Terbium (65)	Tb-160 S	1×10^{-7}	1×10^{-3}	3×10^{-9}	4×10^{-5}
	I	3×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
Thallium (81)	Tl-200 S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
	I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Tl-201 S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
	I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Tl-202 S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
	I	2×10^{-7}	2×10^{-3}	8×10^{-9}	7×10^{-5}
	Tl-204 S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	I	3×10^{-8}	2×10^{-3}	9×10^{-10}	6×10^{-5}

APPENDIX A
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

Element (atomic number)	Isotope ^{16/}	Table I		Table II	
		Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)
Thorium (90)	Th-227 S	3×10^{-10}	5×10^{-4}	1×10^{-11}	2×10^{-5}
	I	2×10^{-10}	5×10^{-4}	6×10^{-12}	2×10^{-5}
	Th-228 S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
	I	6×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
	Th-230 S	2×10^{-12}	5×10^{-5}	8×10^{-14}	2×10^{-6}
	I	1×10^{-11}	9×10^{-4}	3×10^{-13}	3×10^{-5}
	Th-231 S	1×10^{-6}	7×10^{-3}	5×10^{-8}	2×10^{-4}
	I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Th-232 S	3×10^{-11}	5×10^{-5}	1×10^{-12}	2×10^{-6}
	I	3×10^{-11}	1×10^{-3}	1×10^{-12}	4×10^{-5}
	Th-natural S	6×10^{-11}	6×10^{-5}	2×10^{-12}	2×10^{-6}
	I	6×10^{-11}	6×10^{-4}	2×10^{-12}	2×10^{-5}
Thulium (69)	Th-234 S	6×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
	I	3×10^{-8}	5×10^{-4}	1×10^{-9}	2×10^{-5}
	Tm-170 S	4×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
	I	3×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
Tin (50)	Tm-171 S	1×10^{-7}	1×10^{-2}	4×10^{-9}	5×10^{-4}
	I	2×10^{-7}	1×10^{-2}	8×10^{-9}	5×10^{-4}
	Sn-113 S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
	I	5×10^{-8}	2×10^{-3}	2×10^{-9}	8×10^{-5}
Tungsten (74)	Sn-125 S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
	I	8×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
	W-181 S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
	I	1×10^{-7}	1×10^{-2}	4×10^{-9}	3×10^{-4}
Uranium (92)	W-185 S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
	I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
	W-187 S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
	I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Uranium (92)	U-230 S	3×10^{-10}	1×10^{-4}	1×10^{-11}	5×10^{-6}
	I	1×10^{-10}	1×10^{-4}	4×10^{-12}	5×10^{-6}
	U-232 S	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	I	3×10^{-11}	8×10^{-4}	9×10^{-13}	3×10^{-5}
	U-233 S	5×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
	I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}

cont'd

APPENDIX A
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

			Table I		Table II	
Element (atomic number)	Isotope ^{16/}		Column 1 Air (μCi/ml)	Column 2 Water (μCi/ml)	Column 1 Air (μCi/ml)	Column 2 Water (μCi/ml)
Uranium (92) (continued)	U-234	S ^{19/}	6 X 10 ⁻¹⁰	9 X 10 ⁻⁴	2 X 10 ⁻¹¹	3 X 10 ⁻⁵
		I	1 X 10 ⁻¹⁰	9 X 10 ⁻⁴	4 X 10 ⁻¹²	3 X 10 ⁻⁵
	U-235	S ^{19/}	5 X 10 ⁻¹⁰	8 X 10 ⁻⁴	2 X 10 ⁻¹¹	3 X 10 ⁻⁵
		I	1 X 10 ⁻¹⁰	8 X 10 ⁻⁴	4 X 10 ⁻¹²	3 X 10 ⁻⁵
	U-236	S	6 X 10 ⁻¹⁰	1 X 10 ⁻³	4 X 10 ⁻¹²	3 X 10 ⁻⁵
		I	1 X 10 ⁻¹⁰	1 X 10 ⁻³	4 X 10 ⁻¹²	3 X 10 ⁻⁵
	U-238	S ^{19/}	7 X 10 ⁻¹¹	1 X 10 ⁻³	3 X 10 ⁻¹²	4 X 10 ⁻⁵
		I	1 X 10 ⁻¹⁰	1 X 10 ⁻³	5 X 10 ⁻¹²	4 X 10 ⁻⁵
	U-240	S	2 X 10 ⁻⁷	1 X 10 ⁻³	8 X 10 ⁻⁹	3 X 10 ⁻⁵
		I	2 X 10 ⁻⁷	1 X 10 ⁻³	6 X 10 ⁻⁹	3 X 10 ⁻⁵
U- natural	S ^{19/}	1 X 10 ⁻¹⁰	1 X 10 ⁻³	5 X 10 ⁻¹²	3 X 10 ⁻⁵	
	I	1 X 10 ⁻¹⁰	1 X 10 ⁻³	5 X 10 ⁻¹²	3 X 10 ⁻⁵	
Vanadium (23)	V-48	S	2 X 10 ⁻⁷	9 X 10 ⁻⁴	6 X 10 ⁻⁹	3 X 10 ⁻⁵
		I	6 X 10 ⁻⁸	8 X 10 ⁻⁴	2 X 10 ⁻⁹	3 X 10 ⁻⁵
Xenon (54)	Xe-131m	Sub ^{17/}	2 X 10 ⁻⁵	-----	4 X 10 ⁻⁷	-----
	Xe-131	Sub	1 X 10 ⁻⁵	-----	3 X 10 ⁻⁷	-----
	Xe-133	Sub	1 X 10 ⁻⁵	-----	3 X 10 ⁻⁷	-----
	Xe-135	Sub	4 X 10 ⁻⁶	-----	1 X 10 ⁻⁷	-----
Ytterbium (70)	Yb-175	S	7 X 10 ⁻⁷	3 X 10 ⁻³	2 X 10 ⁻⁸	1 X 10 ⁻⁴
		I	6 X 10 ⁻⁷	3 X 10 ⁻³	2 X 10 ⁻⁸	1 X 10 ⁻⁴
Yttrium (39)	Y-88*	S	3 X 10 ⁻⁷	2 X 10 ⁻³	6 X 10 ⁻⁹	7 X 10 ⁻⁵
		I	5 X 10 ⁻⁸	3 X 10 ⁻³	2 X 10 ⁻⁹	9 X 10 ⁻⁵
	Y-90	S	1 X 10 ⁻⁷	6 X 10 ⁻⁴	4 X 10 ⁻⁹	2 X 10 ⁻⁵
		I	1 X 10 ⁻⁷	6 X 10 ⁻⁴	3 X 10 ⁻⁹	2 X 10 ⁻⁵
	Y-91m	S	2 X 10 ⁻⁵	1 X 10 ⁻¹	8 X 10 ⁻⁷	3 X 10 ⁻³
		I	2 X 10 ⁻⁵	1 X 10 ⁻¹	6 X 10 ⁻⁷	3 X 10 ⁻³
	Y-91	S	4 X 10 ⁻⁸	8 X 10 ⁻⁴	1 X 10 ⁻⁹	3 X 10 ⁻⁵
		I	3 X 10 ⁻⁸	8 X 10 ⁻⁴	1 X 10 ⁻⁹	3 X 10 ⁻⁵
	Y-92	S	4 X 10 ⁻⁷	2 X 10 ⁻³	1 X 10 ⁻⁸	6 X 10 ⁻⁵
		I	3 X 10 ⁻⁷	2 X 10 ⁻³	1 X 10 ⁻⁸	6 X 10 ⁻⁵
	Y-93	S	2 X 10 ⁻⁷	8 X 10 ⁻⁴	6 X 10 ⁻⁹	3 X 10 ⁻⁵
		I	1 X 10 ⁻⁷	8 X 10 ⁻⁴	5 X 10 ⁻⁹	3 X 10 ⁻⁵

APPENDIX A
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

			Table I		Table II	
Element (atomic number)	Isotope ^{16/}		Column 1 Air (μCi/ml)	Column 2 Water (μCi/ml)	Column 1 Air (μCi/ml)	Column 2 Water (μCi/ml)
Zinc (30)	Zn-65	S	1 X 10 ⁻⁷	3 X 10 ⁻³	4 X 10 ⁻⁹	1 X 10 ⁻⁴
		I	6 X 10 ⁻⁸	5 X 10 ⁻³	2 X 10 ⁻⁹	2 X 10 ⁻⁴
	Zn-69m	S	4 X 10 ⁻⁷	2 X 10 ⁻³	1 X 10 ⁻⁸	7 X 10 ⁻⁵
		I	3 X 10 ⁻⁷	2 X 10 ⁻³	1 X 10 ⁻⁸	6 X 10 ⁻⁵
	Zn-69	S	7 X 10 ⁻⁶	5 X 10 ⁻²	2 X 10 ⁻⁷	2 X 10 ⁻³
		I	9 X 10 ⁻⁶	5 X 10 ⁻²	3 X 10 ⁻⁷	2 X 10 ⁻³
Zirconium (40)	Zr-93	S	1 X 10 ⁻⁷	2 X 10 ⁻²	4 X 10 ⁻⁹	8 X 10 ⁻⁴
		I	3 X 10 ⁻⁷	2 X 10 ⁻²	1 X 10 ⁻⁸	8 X 10 ⁻⁴
	Zr-95	S	1 X 10 ⁻⁷	2 X 10 ⁻³	4 X 10 ⁻⁹	6 X 10 ⁻⁵
		I	3 X 10 ⁻⁸	2 X 10 ⁻³	1 X 10 ⁻⁹	6 X 10 ⁻⁵
	Zr-97	S	1 X 10 ⁻⁷	5 X 10 ⁻⁴	4 X 10 ⁻⁹	2 X 10 ⁻⁵
		I	9 X 10 ⁻⁸	5 X 10 ⁻⁴	3 X 10 ⁻⁹	2 X 10 ⁻⁵
Any single radio-nuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours.		Sub ^{17/}	1 X 10 ⁻⁶	-----	3 X 10 ⁻⁸	-----
Any single radio-nuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours.			3 X 10 ⁻⁹	9 X 10 ⁻⁵	1 X 10 ⁻¹⁰	3 X 10 ⁻⁶
Any single radio-nuclide not listed above, which decays by alpha emission or spontaneous fission.			6 X 10 ⁻¹³	4 X 10 ⁻⁷	2 X 10 ⁻¹⁴	3 X 10 ⁻⁸

*The values for Ge-98, Au-195 and Y-88 have been calculated using the committed dose equivalent values of ICRP Publication 30 for the controlling organ.

APPENDIX A (Continued)
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

Footnotes continued:

Maximum Time Between Collection and Measurement (hours) ^{18a/}	Alpha-Emitting Daughter Activity Collected Per Milliliter of Air	
	Microcuries/ml	Total alpha disintegrations per minute per ml
0.5	7.2×10^{-8}	0.16
1.0	4.5×10^{-8}	0.10
2.0	1.3×10^{-8}	0.028
3.0	0.3×10^{-8}	0.0072

NOTE: In any case where there is a mixture in air or water of more than one radionuclide, the limiting values for purposes of this Appendix should be determined as follows.

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values should be derived as follows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit otherwise established in Appendix "A" for the specific radionuclide when not in a mixture. The sum of such ratios for all 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 MPC's are MPC_a , MPC_b and MPC_c respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_a}{MPC_a} + \frac{C_b}{MPC_b} + \frac{C_c}{MPC_c} = 1$$

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the limiting values for purposes of Appendix "A" shall be:
 - a. For purposes of Table I, Column 1: 6×10^{-13}
 - b. For purposes of Table I, Column 2: 4×10^{-7}
 - c. For purposes of Table II, Column 1: 2×10^{-14}
 - d. For purposes of Table II, Column 2: 3×10^{-8}

APPENDIX A (Continued)
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

3. If any of the conditions specified below are met, the corresponding values specified below may be used in lieu of those specified in Paragraph 2 above.
- a. If the identity of each radionuclide in the mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the concentration limit for the mixture is the limit specified in Appendix "A" for the radionuclide in the mixture having the lowest concentration limit; or,
 - b. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in Appendix "A" are not present in the mixture, the concentration limit for the mixture is the lowest concentration limit specified in Appendix "A" for any radionuclide which is not known to be absent from the mixture; or,

Element (atomic number) and isotope	Table I		Table II	
	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)

If it is known
that Sr-90, I-125,
I-126, I-129,
I-131, I-133
(Table II only),
Pb-210, Po-210,
At-211, Ra-223,
Ra-224, Ra-226,
Ac-227, Ra-228,
Th-230, Pa-231,
Th-232, Th-nat,
Cm-248, Cf-254
and Fm-256
are not present

----- 9×10^{-5} ----- 3×10^{-6}

If it is known
that Sr-90, I-125,
I-126, I-129,
I-131, (I-133,
Table II only),
Pb-210, Po-210,
Ra-223, Ra-226,
Ra-228, Pa-231,
Th-nat, Cm-248,
Cf-254 and Fm-256
are not present

----- 6×10^{-5} ----- 2×10^{-6}

APPENDIX A (Continued)
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of Appendix)

Element (atomic number) and isotope	Table I		Table II	
	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)	Column 1 Air ($\mu\text{Ci/ml}$)	Column 2 Water ($\mu\text{Ci/ml}$)
If it is known that Sr-90, I-129, (I-125, I-126, I-131, Table II only), Pb-210, Ra-226, Ra-228, Cm-248 and Cf-254 are not present	-----	2×10^{-5}	-----	6×10^{-7}
If it is known that (I-129, Table II only), Ra-226 and Ra-228 are not present	-----	3×10^{-6}	-----	1×10^{-7}
If it is known that alpha-emitters and Sr-90, I-129, Pb-210, Ac-227, Ra-228, Pa-230, Pu-241 and Bk-249 are not present	3×10^{-9}	-----	1×10^{-10}	-----
If it is known that alpha-emitters and Pb-210, Ac-227, Ra-228 and Pu-241 are not present	3×10^{-10}	-----	1×10^{-11}	-----
If it is known that alpha-emitters and Ac-227 are not present	3×10^{-11}	-----	1×10^{-12}	-----
If it is known that Ac-227, Th-230, Pa-231, Pu-238, Pu-239, Pu-240, Pu-242, Pu-244, Cm-248, Cf-249 and Cf-251 are not present	3×10^{-12}	-----	1×10^{-13}	-----

4. If the mixture of radionuclides consists of Uranium and its daughter products in ore dust prior to chemical processing of the Uranium ore, the values specified below may be used in lieu of those determined in accordance with Paragraph 1 above or those specified in Paragraphs 2 and 3 above.

- a. For purposes of Table I, Column 1, 1×10^{-10} $\mu\text{c/ml}$ gross alpha activity; or 5×10^{-11} $\mu\text{c/ml}$ natural Uranium; or 75 micrograms per cubic meter of air natural Uranium.
- b. For purposes of Table II, Column 1, 3×10^{-12} $\mu\text{c/ml}$ gross alpha activity; or 2×10^{-13} $\mu\text{c/ml}$ natural Uranium; or 3 micrograms per cubic meter of air natural Uranium.

5. For purposes of this note, a radionuclide may be considered as not present in a mixture if:

- a. The ratio of the concentration of that radionuclide in the mixture (C_a) to the concentration limit for that radionuclide in Table II of Appendix A (MPC_a) does not exceed $1/10$, i.e.,

$$\frac{C_a}{\text{MPC}_a} < \frac{1}{10}$$

and

- b. The sum of all radionuclides considered as not present in the mixture does not exceed $1/4$,

i.e.:

$$\frac{C_a}{\text{MPC}_a} + \frac{C_b}{\text{MPC}_b} + \dots \leq \frac{1}{4}$$

RH-2300. Appendix B. (For use in RH-409, RH-1303, RH-1402 and RH-1403)

<u>Material</u>	<u>Microcuries</u>	<u>Material</u>	<u>Microcuries</u>
Americium 241	.01	Germanium 71	100
Antimony 122	100	Gold 195	10
Antimony 124	10	Gold 198	100
Antimony 125	10	Gold 199	100
Arsenic 73	100	Hafnium 181	10
Arsenic 74	10	Holmium 166	100
Arsenic 76	10	Hydrogen 3	1,000
Arsenic 77	100	Indium 111	100
Barium 131	10	Indium 113m	100
Barium 133	10	Indium 114m	10
Barium 140	10	Indium 115m	100
Bismuth 210	1	Indium 115	10
Bromine 82	10	Iodine 123	100
Cadmium 109	10	Iodine 125	1
Cadmium 115m	10	Iodine 126	1
Cadmium 115	100	Iodine 129	0.1
Calcium 45	10	Iodine 131	1
Calcium 47	10	Iodine 132	10
Carbon 14	100	Iodine 133	1
Cerium 141	100	Iodine 134	10
Cerium 143	100	Iodine 135	10
Cerium 144	1	Iridium 192	10
Cesium 129	100	Iridium 194	100
Cesium 131	1,000	Iron 52	10
Cesium 134m	100	Iron 55	100
Cesium 134	1	Iron 59	10
Cesium 135	10	Krypton 85	100
Cesium 136	10	Krypton 87	10
Cesium 137	10	Lanthanum 140	10
Chlorine 36	10	Lutetium 177	100
Chlorine 38	10	Manganese 52	10
Chromium 51	1,000	Manganese 54	10
Cobalt 57	100	Manganese 56	10
Cobalt 58m	10	Mercury 197m	100
Cobalt 58	10	Mercury 197	100
Cobalt 60	1	Mercury 203	10
Copper 64	100	Molybdenum 99	100
Dysprosium 165	10	Neodymium 147	100
Dysprosium 166	100	Neodymium 149	100
Erbium 169	100	Nickel 59	100
Erbium 171	100	Nickel 63	10
Europium 152 9.2 h	100	Nickel 65	100
Europium 152 13 yr	1	Niobium 93m	10
Europium 154	1	Niobium 95	10
Europium 155	10	Niobium 97	10
Fluorine 18	1,000	Osmium 185	10
Gadolinium 153	10	Osmium 191m	100
Gadolinium 159	100	Osmium 191	100
Gallium 67	100	Osmium 193	100
Gallium 72	10	Palladium 103	100
Germanium 68	10	Palladium 109	100

RH-2300. Appendix B. (Continued)

Material	Microcuries	Material	Microcuries
Phosphorus 32	10	Technetium 99	10
Platinum 191	100	Tellurium 125m	10
Platinum 193m	100	Tellurium 127m	10
Platinum 193	100	Tellurium 127	100
Platinum 197m	100	Tellurium 129m	10
Platinum 197	100	Tellurium 129	100
Plutonium 239	.01	Tellurium 131m	10
Polonium 210	0.1	Tellurium 132	10
Potassium 42	10	Terbium 160	10
Potassium 43	10	Thallium 200	100
Praseodymium 142	100	Thallium 201	100
Praseodymium 143	100	Thallium 202	100
Promethium 147	10	Thallium 204	10
Promethium 149	10	Thorium (natural) ^{20/}	100
Radium 226	.01	Thulium 170	10
Rhenium 186	100	Thulium 171	10
Rhenium 188	100	Tin 113	10
Rhodium 103m	100	Tin 125	10
Rhodium 105	100	Tungsten 181	10
Rubidium 81	10	Tungsten 185	10
Rubidium 86	10	Tungsten 187	100
Rubidium 87	10	Uranium (natural) ^{21/}	100
Ruthenium 97	100	Uranium 233	.01
Ruthenium 103	10	Uranium 234 -	
Ruthenium 105	10	Uranium 235	.01
Ruthenium 106	1	Vanadium 48	10
Samarium 151	10	Xenon 131m	1,000
Samarium 153	100	Xenon 133	100
Scandium 46	10	Xenon 135	100
Scandium 47	100	Ytterbium 175	100
Scandium 48	10	Yttrium 87	10
Selenium 75	10	Yttrium 88	10
Silicon 31	100	Yttrium 90	10
Silver 105	10	Yttrium 91	10
Silver 110m	1	Yttrium 92	100
Silver 111	100	Yttrium 93	100
Sodium 22	1	Zinc 65	10
Sodium 24	10	Zinc 69m	100
Strontium 85	10	Zinc 69	1,000
Strontium 89	1	Zirconium 93	10
Strontium 90	0.1	Zirconium 95	10
Strontium 91	10	Zirconium 97	10
Strontium 92	10		
Sulfur 35	100	Any alpha emitting	
Tantalum 182	10	radionuclide not	
Technetium 96	10	listed above or	
Technetium 97m	100	mixtures of alpha	
Technetium 97	100	emitters of unknown	
Technetium 99m	100	composition.....	.01

MaterialMicrocuries

Any radionuclide other
than alpha emitting
radionuclides, not
listed above or mixtures
of beta emitters of
unknown composition.

0.1

Note: For purposes of RH-1303 and RH-1403, where there is involved a combination of isotopes in known amounts, the limit for the combination should be derived as follows: Determine, for each isotope in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific isotope when not in combination. The sum of such ratios for all the isotopes in the combination may not exceed "1" (i.e., "unity"). Example: For purposes of RH-1403, if a particular batch contains 20,000 μCi of Au^{198} and 50,000 μCi of C^{14} , it may also include not more than 300 μCi of I^{131} . This limit was determined as follows:

$$\frac{20,000 \mu\text{Ci } \text{Au}^{198}}{100,000 \mu\text{Ci}} + \frac{50,000 \mu\text{Ci } \text{C}^{14}}{100,000 \mu\text{Ci}} + \frac{300 \mu\text{Ci } \text{I}^{131}}{1,000 \mu\text{Ci}} = 1$$

The denominator in each of the above ratios was obtained by multiplying the figure in the Table by 1,000 as provided in RH-1403.

NOTICE TO EMPLOYEES

Arkansas Department of Health STANDARDS FOR PROTECTION AGAINST RADIATION

The Arkansas Department of Health (ADH) has adopted regulations with standards to protect you from hazards associated with radioactive materials and radiation emitting machines which are licensed or registered by ADH. In particular, the following information is available for your review:

Section 3: Standards for Protection Against Radiation
Part N: Notice, Instructions, and Reports to Workers
Any other documents your employer must provide, as noted below

These may be found at the following location:

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to:

1. Comply with all applicable regulations and the conditions of the license or registration.
2. Post or otherwise make available to you a copy of the regulations, licenses, regulations, and operating procedures which apply to work in which you are engaged, and explain the provisions to you.

YOUR RESPONSIBILITY AS A WORKER

You should:

1. Know the provisions of the ADH regulations, the precautions, the operating procedures, and the emergency procedures which apply to your work.
2. Observe the provisions for your own protection and for the protection of your co-workers.
3. Report unsafe working conditions or violations of the license or registration conditions, or regulations to ADH.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The ADH regulations specify the occupational limits for radiation exposure including concentrations of radioactive material in air and water. These regulations require your employer to give you a written report if you receive an exposure in excess of any applicable limit. The limits on your exposure are contained in RH-1200, RH-1206, and RH-1207. While these are the maximum allowable limits, your employer should keep your radiation exposure below those limits as is reasonably achievable.
2. If you work where personnel monitoring is required and request information on your radiation exposures,
 - a. your employer must advise you annually of your exposure to radiation, and
 - b. upon termination of employment, your employer must give you a written report of your radiation exposures. A report of any exposure in excess of a limit must be reported to you.

INSPECTIONS: All licensed or registered activities are subject to inspection by the ADH.

INQUIRIES

Direct all inquiries on matters outlined above to: Radiation Control, Arkansas Department of Health, 4815 West Markham, Mail Slot #30, Little Rock, AR 72205-3867; (501) 661-2301 Emergencies only (800) 633-1735

POSTING REQUIREMENT: Copies of this notice must be posted in every establishment where employees are engaged in activities licensed or registered by the ADH. Posting must 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.

ARKANSAS DEPARTMENT OF HEALTH FORM Y OCCUPATIONAL EXPOSURE RECORD FOR A MONITORING PERIOD				[AGENCY]	
1. NAME (LAST, FIRST, MIDDLE INITIAL)		2. IDENTIFICATION NUMBER		3. ID TYPE	
4. SEX		5. DATE OF BIRTH			
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER(S)	
9A. RECORD		9B. ROUTINE			
ESTIMATE		PSE			

INTAKES				DOSES (In rem)	
10A. RADIONUCLIDE	10B. CLASS	10C. MODE	10D. INTAKE IN μ 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.
				SHALLOW DOSE EQUIVALENT, MAX EXTREMITY (SDE, ME)	14.
				COMMITTED EFFECTIVE 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
---	-------------------

**INSTRUCTIONS AND ADDITIONAL INFORMATION PERTINENT TO THE
COMPLETION OF ARKANSAS DEPT OF HEALTH FORM Y**
(All doses should be stated in rads)

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 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 represent a final determination of the dose received to the best of the licensee's or registrant's knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in a 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 TLD results that are not yet available.

9B. Place an "X" in either Routine or PSE. Choose "Routine" if the data represent the results of monitoring for routine exposures. Choose "PSE" if the listed 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 internal exposure recorded for the individual, using the format "Xx-###x," for instance, Co-137 or Tc 99m.

10B. Enter the lung clearance class as listed in Appendix G Sec 3D, W, Y, V, or Q for other) for all intakes by inhalation.

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

10D. Enter the intake of each radionuclide in μ Cl.

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

12. Enter the eye dose equivalent (EDE) 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 "Not 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 the 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.

ARKANSAS DEPARTMENT OF HEALTH FORM Z

[AGENCY]

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 ESTIMATE NO RECORD		10. ROUTINE PSE			
11. DDE	12. IDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE		18. TODE			
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ESTIMATE NO RECORD		10. ROUTINE PSE			
11. DDE	12. IDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE		18. TODE			
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ESTIMATE NO RECORD		10. ROUTINE PSE			
11. DDE	12. IDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE		18. TODE			
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ESTIMATE NO RECORD		10. ROUTINE PSE			
11. DDE	12. IDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE		18. TODE			
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ESTIMATE NO RECORD		10. ROUTINE PSE			
11. DDE	12. IDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE		18. TODE			
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ESTIMATE NO RECORD		10. ROUTINE PSE			
11. DDE	12. IDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE		18. TODE			
19. SIGNATURE OF MONITORED INDIVIDUAL		20. DATE SIGNED		21. CERTIFYING ORGANIZATION		22. SIGNATURE OF DESIGNEE		23. DATE SIGNED			

**INSTRUCTIONS AND ADDITIONAL INFORMATION PERTINENT TO THE
COMPLETION OF ARKANSAS DEPT OF HEALTH FORM Z**
(All doses should be stated in rera)

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 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, registrant, or facility not licensed by the Agency that provided monitoring.
8. Enter the Agency license or registration number or numbers.
9. Place an "X" in Record, Estimate, or No Record. Choose "Record" if the dose data listed represent a final determination of the dose received to the best of the licensee's or registrant's knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in a subsequent report. An example of such an instance would be dose data based on self-reading dosimeter results and the licensee or registrant intends to assign the record dose on the basis of TLD results that are not yet available.
10. Place an "X" in either Routine or PSE. Choose "Routine" if the data represent the results of monitoring for routine exposures. Choose "PSE" if the listed 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 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 (EDE) 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).
16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ.
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 the 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] 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.

RH-2700. Appendix C: Determination of A_1 and A_2 Quantities

a. Single radionuclides.

1. For a single radionuclide of known identity, the values of A_1 and A_2 are taken from Table C-1 if listed there. The values A_1 and A_2 in Table C-1 are also applicable for radionuclides contained in (a,n) or (y,n) neutron sources.
2. For any single radionuclide whose identity is known but which is not listed in Table C-1, the values of A_1 and A_2 are determined according to the following procedure:
 - A. If the radionuclide emits only one type of radiation, A_1 is determined according to the rules in RH-2700.a.2. 1 through 1v of this Paragraph. For radionuclides emitting different kinds of radiation, A_1 is the most restrictive value of those determined for each kind of radiation. However, in both cases, A_1 is restricted to a maximum of 1000 Ci. If a parent nuclide decays into a shorter lived daughter with a half-life not greater than 10 days, A_1 is calculated for both the parent and the daughter and the more limiting of the two values is assigned to the parent nuclide.

- i. For gamma emitters, A_2 is determined by the expression:

$$A_2 = \frac{9 \text{ curies}}{I}$$

where I is the gamma-ray constant, corresponding to the dose in R/h at 1 meter per Ci; the number 9 results from the choice of 1 rem/h at a distance of 3 meter as the reference dose-equivalent rate.

- ii. For x-ray emitters, A_1 is determined by the atomic number of the nuclide:

$$\text{for } Z \leq 55 - A_1 = 1000 \text{ Ci}$$

$$\text{for } Z > 55 - A_1 = 200 \text{ Ci}$$

where Z is the atomic number of the nuclide.

- iii. For beta emitters, A_1 is determined by the maximum beta energy (E_{\max}) according to Table A-2;

Appendix C: Determination of A_1 and A_2 Quantities (Cont'd)

- iv. For alpha emitters, A_1 is determined by the expression:

$$A_1 = 1000 A_3$$

where A_3 is the value listed in Table A-3.

- B. A_2 is the more restrictive of the following two values:

- i. The corresponding A_1 ; and
- ii. The value A_3 obtained from Table C-3.

3. For any single radionuclide whose identity is unknown, the value of A_1 is taken to be 2 Ci and the value of A_2 is taken to be 0.002 Ci. However, if the atomic number of the radionuclide is known to be less than 82, the value of A_1 is taken to be 10 Ci and the value of A_2 is taken to be 0.4 Ci.

- b. Mixtures of radionuclides, including radioactive decay chains.

1. For mixed fission products the following activity limits may be assumed if a detailed analysis of the mixture is not carried out:

$$\begin{aligned} A_1 &= 10 \text{ Ci} \\ A_2 &= 0.4 \text{ Ci} \end{aligned}$$

2. A single radioactive decay chain is considered to be a single radionuclide when the radionuclides are present in their naturally occurring proportions and no daughter nuclide has a half-life either longer than ten (10) days or longer than that of the parent nuclide. The activity to be taken into account and the A_1 or A_2 value from Table C-1 to be applied are those corresponding to the parent nuclide of that chain. When calculating A_1 or A_2 values, radiation emitted by daughters must be considered. However, in the case of radioactive decay chains in which any daughter nuclide has a half-life either longer than ten (10) days or greater than that of the parent nuclide, the parent and daughter nuclides are considered to be mixtures of different nuclides.
3. In the case of a mixture of different radionuclides, where the identity and activity of each radionuclide are

Appendix C: Determination of A_1 and A_2 Quantities (Cont'd)

known, the permissible activity of each radionuclide R_1, R_2, \dots, R_n is such that $F_1 + F_2 + \dots + F_n$ is not greater than unity, where

$$F_1 = \frac{\text{Total activity of } R_1}{A_1(R_1)}$$

$$F_2 = \frac{\text{Total activity of } R_2}{A_1(R_2)}$$

$$F_n = \frac{\text{Total activity of } R_n}{A_1(R_n)}$$

$A_1(R_1, R_2, \dots, R_n)$ is the value of A_1 or A_2 as appropriate for the nuclide R_1, R_2, \dots, R_n .

4. When the identity of each radionuclide is known but the individual activities of some of the radionuclides are not known, the formula given in Paragraph 3 is applied to establish the values of A_1 or A_2 as appropriate. All the radionuclides whose individual activities are not known (their total activity will, however, be known) are classed in a single group and the most restrictive value of A_1 and A_2 applicable to any one of them is used as the value of A_1 or A_2 in the denominator of the fraction.
5. Where the identity of each radionuclide is known but the individual activity of none of the radionuclides is known, the most restrictive value of A_1 or A_2 applicable to any one of the radionuclides present is adopted as the applicable value.
6. When the identity of none of the nuclides is known, the value of A_1 is taken to be 2 Ci and the value of A_2 is taken to be 0.002 Ci. However, if alpha emitters are known to be absent, the value of A_2 is taken to be 0.4 Ci.

TABLE C-1
A₁ AND A₂ VALUES FOR RADIONUCLIDES
 (See footnotes at end of Table)

Symbol of radionuclide	Element and Atomic Number	A ₁ (Ci)	A ₂ (Ci)	Specific activity (Ci/g)
Ac-227	Actinium (89)	1000	0.003	7.2 x 10 ⁵
Ac-228		10	4	2.2 x 10 ⁶
Ag-105	Silver (47)	40	40	3.1 x 10 ⁴
Ag-110m		7	7	4.7 x 10 ³
Ag-111	Americium (95)	100	20	1.6 x 10 ⁵
Am-241		8	0.008	3.2
Am-243		8	0.008	1.9 x 10 ⁻¹
Ar-37 (compressed or uncompressed)*	Argon (18)	1000	1000	1.0 x 10 ⁵
Ar-41 (uncompressed)*		20	20	4.3 x 10 ⁷
Ar-41 (compressed)*		1	1	4.3 x 10 ⁷
As-73	Arsenic (33)	1000	400	2.4 x 10 ⁴
As-74		20	20	1.0 x 10 ⁵
As-76		10	10	1.6 x 10 ⁶
As-77		300	20	1.1 x 10 ⁶
At-211	Astatine (85)	200	7	2.1 x 10 ⁶
Au-193	Gold (79)	200	200	9.3 x 10 ⁵
Au-196		30	30	1.2 x 10 ⁵
Au-198		40	20	2.5 x 10 ⁵
Au-199		200	25	2.1 x 10 ⁵
Ba-131	Barium (56)	40	40	8.7 x 10 ⁴
Ba-133		40	10	4.0 x 10 ²
Ba-140		20	20	7.3 x 10 ⁴
Be-7	Beryllium (4)	300	300	3.5 x 10 ⁵
Bi-206	Bismuth (83)	5	5	9.9 x 10 ⁴
Bi-207		10	25	2.2 x 10 ²
Bi-210 (RaE)		100	4	1.2 x 10 ⁵
Bi-212	Berkelium (97)	6	6	1.5 x 10 ⁷
Bk-249		1000	1	1.8 x 10 ³
Br-77		70	25	7.1 x 10 ⁵
Br-82	Bromine (35)	6	6	1.1 x 10 ⁶
C-11		20	20	8.4 x 10 ⁸
C-14		1000	60	4.6
Ca-45	Calcium (20)	1000	25	1.9 x 10 ⁴
Ca-47		20	20	5.9 x 10 ⁵
Cd-109	Cadmium (48)	1000	70	2.6 x 10 ³
Cd-115m		30	30	2.6 x 10 ⁴
Cd-115		80	20	5.1 x 10 ⁵
Ce-139	Cerium (58)	100	100	6.5 x 10 ³
Ce-141		300	25	2.8 x 10 ⁴
Ce-143		60	20	6.6 x 10 ⁵

m = metastable state

TABLE C-1
A₁ AND A₂ VALUES FOR RADIONUCLIDES
 (See footnotes at end of Table)

Symbol of radionuclide	Element and Atomic Number	A ₁ (Ci)	A ₂ (Ci)	Specific activity (Ci/g)
Ce-144	Californium (98)	10	7	3.2 x 10 ³
Cf-249		2	0.002	3.1
Cf-250		7	0.007	1.3 x 10 ²
Cf-252	Chlorine (17)	2	0.009	6.5 x 10 ²
Cl-36		300	10	3.2 x 10 ⁻²
Cl-38		10	10	1.3 x 10 ⁸
Cm-242	Curium (96)	200	0.2	3.3 x 10 ³
Cm-243		9	0.009	4.2 x 10
Cm-244		10	0.01	8.2 x 10
Cm-245	Cobalt (27)	6	0.006	1.0 x 10 ⁻¹
Cm-246		6	0.006	3.6 x 10 ⁻¹
Co-56		5	5	3.0 x 10 ⁴
Co-57		90	90	8.5 x 10 ³
Co-58m		1000	1000	5.9 x 10 ⁶
Co-58		20	20	3.1 x 10 ⁴
Co-60	Chromium (24)	7	7	1.1 x 10 ³
Cr-51		600	600	9.2 x 10 ⁴
Cs-129		40	40	7.6 x 10 ⁵
Ca-131	Cesium (55)	1000	1000	1.0 x 10 ⁵
Ca-134m		1000	10	7.4 x 10 ⁶
Cs-134		10	10	1.2 x 10 ³
Cs-135		1000	25	8.8 x 10 ⁻⁴
Cs-136		7	7	7.4 x 10 ⁴
Ca-137		30	10	9.8 x 10
Cu-64	Copper (29)	80	25	3.8 x 10 ⁶
Cu-67		200	25	7.9 x 10 ⁵
Dy-165		100	20	8.2 x 10 ⁶
Dy-166	Dysprosium (66)	1000	200	2.3 x 10 ⁵
Er-169		1000	25	8.2 x 10 ⁴
Er-171		50	20	2.4 x 10 ⁶
Eu-152m	Europium (63)	30	30	2.2 x 10 ⁶
Eu-152		20	10	1.9 x 10 ²
Eu-154		10	5	1.5 x 10 ²
Eu-155	Fluorine (9)	400	60	1.4 x 10 ³
F-18		20	20	9.3 x 10 ⁷
Fe-52		5	5	7.3 x 10 ⁶
Fe-55	Iron (26)	1000	1000	2.2 x 10 ³
Fe-59		10	10	4.9 x 10 ⁴
Ga-67		100	100	6.0 x 10 ⁵
Ga-68	Gallium (31)	20	20	4.0 x 10 ⁷
Ga-72		7	7	3.1 x 10 ⁶
Gd-153		200	100	3.6 x 10 ³

m = metastable state

TABLE C-1
A₁ AND A₂ VALUES FOR RADIONUCLIDES

(See footnotes at end of Table)

Symbol of radionuclide	Element and Atomic Number	A ₁ (Ci)	A ₂ (Ci)	Specific activity (Ci/g)
Gd-159	Germanium (32)	300	20	1.1 x 10 ⁶
Ge-68		20	10	7.0 x 10 ³
Ge-71		1000	1000	1.6 x 10 ⁵
H-3	Hydrogen (1) see T-Tritium			
Hf-181	Hafnium (72)	30	25	1.6 x 10 ⁴
Hg-197m	Mercury (80)	200	200	6.6 x 10 ⁵
Hg-197		200	200	2.5 x 10 ⁵
Hg-203	Holmium (67)	80	25	1.4 x 10 ⁴
Ho-166		30	30	6.9 x 10 ⁵
I-123		50	50	1.9 x 10 ⁶
I-125	Iodine (53)	1000	70	1.7 x 10 ⁴
I-126		40	10	7.8 x 10 ⁴
I-129	Indium (49)	1000	2	1.6 x 10 ⁻⁴
I-131		40	10	1.2 x 10 ⁵
I-132		7	7	1.1 x 10 ⁷
I-133		30	10	1.1 x 10 ⁶
I-134		8	8	2.7 x 10 ⁷
I-135		10	10	3.5 x 10 ⁶
In-111		30	25	4.2 x 10 ⁵
In-113m		60	60	1.6 x 10 ⁷
In-114m		30	20	2.3 x 10 ⁴
In-115m		100	20	6.1 x 10 ⁶
Ir-190	Iridium (77)	10	10	6.2 x 10 ⁴
Ir-192		20	10	9.1 x 10 ³
Ir-194		10	10	8.5 x 10 ⁵
K-42	Potassium (19)	10	10	6.0 x 10 ⁶
K-43		20	10	3.3 x 10 ⁶
Kr-85m (uncompressed)*	Krypton (36)	100	100	8.4 x 10 ⁶
Kr-85m (compressed)*		3	3	8.4 x 10 ⁶
Kr-85 (uncompressed)*		1000	1000	4.0 x 10 ²
Kr-85 (compressed)*	Lanthanum (57)	5	5	4.0 x 10 ²
Kr-87 (uncompressed)*		20	20	2.8 x 10 ⁷
Kr-87 (compressed)*		0.6	0.6	2.8 x 10 ⁷
La-140		30	30	5.6 x 10 ⁵
LSA: Low specific activity material - see Footnote				
Lu-177	Lutetium (71)	300	25	1.1 x 10 ⁵
MFP: Mixed fission products		10	0.4	

m = metastable state

TABLE C-1
A₁ AND A₂ VALUES FOR RADIONUCLIDES

(See footnotes at end of Table)

Symbol of radionuclide	Element and Atomic Number	A ₁ (Ci)	A ₂ (Ci)	Specific activity (Ci/g)
Mg-28	Magnesium (12)	6	6	5.2 x 10 ⁶
Mn-52	Manganese (25)	5	5	4.4 x 10 ⁵
Mn-54		20	20	8.3 x 10 ³
Mn-56		5	5	2.2 x 10 ⁷
Mo-99	Molybdenum (42)	100	20	4.7 x 10 ⁵
N-13	Nitrogen (7)	20	10	1.5 x 10 ⁹
Na-22	Sodium (11)	8	8	6.3 x 10 ³
Na-24		5	5	8.7 x 10 ⁶
Nb-93m	Niobium (41)	1000	200	1.1 x 10 ³
Nb-95		20	20	3.9 x 10 ⁴
Nb-97		20	20	2.6 x 10 ⁷
Nd-147	Neodymium (60)	100	20	8.0 x 10 ⁴
Nd-149		30	20	1.1 x 10 ⁷
Ni-59	Nickel (28)	1000	900	8.1 x 10 ⁻²
Ni-63		1000	100	4.6 x 10
Ni-65		10	10	1.9 x 10 ⁷
Np-237	Neptunium (93)	5	0.005	6.9 x 10 ⁻⁴
Np-239		200	25	2.3 x 10 ⁵
Os-185	Osmium (76)	20	20	7.3 x 10 ³
Os-191		600	200	4.6 x 10 ⁴
Os-191m		200	200	1.2 x 10 ⁶
Os-193		100	20	5.3 x 10 ⁵
P-32	Phosphorus (15)	30	30	2.9 x 10 ⁵
Pa-230	Protactinium (91)	20	0.8	3.2 x 10 ⁴
Pa-231		2	0.002	4.5 x 10 ⁻²
Pa-233		100	100	2.1 x 10 ⁴
Pb-201	Lead (82)	20	20	1.7 x 10 ⁶
Pb-210		100	0.2	8.8 x 10
Pb-212		6	5	1.4 x 10 ⁴
Pd-103	Palladium (46)	1000	700	7.5 x 10 ⁴
Pd-109		100	20	2.1 x 10 ⁴
Pm-147	Promethium (61)	1000	25	9.4 x 10 ²
Pm-149		100	20	4.2 x 10 ⁵
Po-210	Polonium (84)	200	0.2	4.5 x 10 ³
Pr-142	Praseodymium (59)	10	10	1.2 x 10 ⁴
Pr-143		300	20	6.6 x 10 ⁴
Pt-191	Platinum (78)	100	100	2.3 x 10 ⁵
Pt-193m		200	200	2.0 x 10 ⁵
Pt-197m		300	20	1.2 x 10 ⁷
Pt-197		300	20	8.8 x 10 ⁵
Pu-238	Plutonium (94)	3	0.003	1.7 x 10

m = metastable state

TABLE C-1
A₁ AND A₂ VALUES FOR RADIONUCLIDES
 (See footnotes at end of Table)

Symbol of radionuclide	Element and Atomic Number	A ₁ (Ci)	A ₂ (Ci)	Specific activity (Ci/g)
Pu-239	Radium (88)	2	0.002	6.2 x 10 ⁻²
Pu-240		2	0.002	2.3 x 10 ⁻¹
Pu-241		1000	0.1	1.1 x 10 ²
Pu-242		3	0.003	3.9 x 10 ⁻³
Ra-223		50	0.2	5.0 x 10 ⁴
Ra-224	Rubidium (37)	6	0.5	1.6 x 10 ⁶
Ra-226		10	0.05	1.0
Ra-228		10	0.05	2.3 x 10 ²
Rb-81		30	25	8.2 x 10 ⁴
Rb-86		30	30	8.1 x 10 ⁴
Rb-87	Rhenium (75)	«-»	«-»	6.6 x 10 ⁻⁸
Rb (natural)		«-»	«-»	1.8 x 10 ⁻⁸
Re-186		100	20	1.9 x 10 ⁵
Re-187		«-»	«-»	3.8 x 10 ⁻⁸
Re-188		10	10	1.0 x 10 ⁴
Re (natural)	Rhodium (45)	«-»	«-»	2.4 x 10 ⁻⁸
Rh-103m		1000	1000	3.2 x 10 ⁷
Rh-105		200	25	8.2 x 10 ⁵
Rn-222		10	2	1.5 x 10 ⁵
Ru-97		80	80	5.5 x 10 ⁵
Ru-103	Ruthenium (44)	30	25	3.2 x 10 ⁴
Ru-105		20	20	6.6 x 10 ⁴
Ru-106		10	7	3.4 x 10 ³
S-35		1000	60	4.3 x 10 ⁴
Sb-122		30	30	3.9 x 10 ⁵
Sb-124	Scandium (21)	5	5	1.8 x 10 ⁴
Sb-125		40	25	1.4 x 10 ³
Sc-46		8	8	3.4 x 10 ⁴
Sc-47		200	20	8.2 x 10 ⁵
Sc-48		5	5	1.5 x 10 ⁶
Se-75	Selenium (34)	40	40	1.4 x 10 ⁴
Si-31	Silicon (14)	100	20	3.9 x 10 ⁷
Sm-147	Samarium (62)	«-»	«-»	2.0 x 10 ⁻⁸
Sm-151		1000	90	2.6 x 10
Sm-153		300	20	4.4 x 10 ⁵
Sn-113		60	60	1.0 x 10 ⁴
Sn-119m		100	100	4.4 x 10 ³
Sn-125	Strontium (38)	10	10	1.1 x 10 ⁵
Sr-85m		80	80	3.2 x 10 ⁷
Sr-85		30	30	2.4 x 10 ⁴
Sr-87m		50	50	1.2 x 10 ⁷

m = metastable state

«-» = Unlimited

TABLE C-1
A₁ AND A₂ VALUES FOR RADIONUCLIDES

(See footnotes at end of Table)

Symbol of radionuclide	Element and Atomic Number	A ₁ (Ci)	A ₂ (Ci)	Specific activity (Ci/g)
Sr-89		100	10	2.9 x 10 ⁴
Sr-90		10	0.4	1.5 x 10 ²
Sr-91		10	10	3.6 x 10 ⁶
Sr-92		10	10	1.3 x 10 ⁷
T (uncompressed)*	Tritium (1)	1000	1000	9.7 x 10 ³
T (compressed)*		1000	1000	9.7 x 10 ³
T (activated luminous paint)		1000	1000	9.7 x 10 ³
T (absorbed on solid carrier)		1000	1000	9.7 x 10 ³
T (tritiated water)		1000	1000	9.7 x 10 ³
T (other forms)		20	20	9.7 x 10 ³
Ta-182	Tantalum (73)	20	20	6.2 x 10 ³
Tb-160	Terbium (65)	20	10	1.1 x 10 ⁴
Tc-96m	Technetium (43)	1000	1000	3.8 x 10 ⁷
Tc-96		6	6	3.2 x 10 ⁵
Tc-97m		1000	200	1.5 x 10 ⁴
Tc-97		1000	400	1.4 x 10 ⁻³
Tc-99m		100	100	5.2 x 10 ⁶
Tc-99		1000	25	1.7 x 10 ⁻²
Te-125m	Tellurium (52)	1000	100	1.8 x 10 ⁴
Te-127m		300	20	4.0 x 10 ⁴
Te-127		300	20	2.6 x 10 ⁶
Te-129m		30	10	2.5 x 10 ⁴
Te-129		100	20	2.0 x 10 ⁷
Te-131m		10	10	8.0 x 10 ⁵
Te-132		7	7	3.1 x 10 ⁵
Th-227	Thorium (90)	200	0.2	3.2 x 10 ⁴
Th-228		6	0.008	8.3 x 10 ²
Th-230		3	0.003	1.9 x 10 ⁻²
Th-231		1000	25	5.3 x 10 ⁵
Th-232		«-»	«-»	1.1 x 10 ⁻⁷
Th-234		10	10	2.3 x 10 ⁴
Th (natural)		«-»	«-»	2.2 x 10 ⁻⁷
Th (irradiated)**				
Tl-200	Thallium (81)	20	20	5.8 x 10 ⁵
Tl-201		200	200	2.2 x 10 ⁵
Tl-202		40	40	5.4 x 10 ⁴
Tl-204		300	10	4.3 x 10 ²
Tm-170	Thulium (69)	300	10	6.0 x 10 ³
Tm-171		1000	100	1.1 x 10 ³
U-230	Uranium (92)	100	0.1	2.7 x 10 ⁴
U-232		30	0.03	2.1 x 10

m = metastable state

«-» = Unlimited

TABLE C-1
A₁ AND A₂ VALUES FOR RADIONUCLIDES

(See footnotes at end of Table)

Symbol of radionuclide	Element and Atomic Number	A ₁ (Ci)	A ₂ (Ci)	Specific activity (Ci/g)
U-233		100	0.1	9.5×10^{-3}
U-234		100	0.1	6.2×10^{-3}
U-235		100	0.2	2.1×10^{-6}
U-236		200	0.2	6.2×10^{-5}
U-238		«-»	«-»	3.3×10^{-7}
U (natural)		«-»	«-»	(SEE TABLE C-4)
U (enriched)				
20%		«-»	«-»	(SEE TABLE C-4)
20% or greater		100	0.1	(SEE TABLE C-4)
U (depleted)		«-»	«-»	(SEE TABLE C-4)
U (irradiated)***				
V-48	Vanadium (23)	6	6	1.7×10^5
W-181	Tungsten (74)	200	100	5.0×10^3
W-185		1000	25	9.7×10^{-3}
W-187		40	20	7.0×10^5
Xe-127 (uncompressed)*	Xenon (54)	70	70	2.8×10^4
Xe-127 (compressed)*		5	5	2.8×10^4
Xe-131m (compressed)*		10	10	1.0×10^5
Xe-131m (uncompressed)*		100	100	1.0×10^5
Xe-133 (uncompressed)*		1000	1000	1.9×10^5
Xe-133 (compressed)*		5	5	1.9×10^5
Xe-135 (uncompressed)*		70	70	2.5×10^5
Xe-135 (compressed)*		2	2	2.5×10^5
Y-87	Yttrium (39)	20	20	4.5×10^5
Y-90		10	10	2.5×10^5
Y-91m		30	30	4.1×10^7
Y-91		30	30	2.5×10^4
Y-92		10	10	9.5×10^6
Y-93		10	10	3.2×10^6
Yb-169	Ytterbium (70)	80	80	2.3×10^5
Yb-175		400	25	1.8×10^5
Zn-65	Zinc (30)	30	30	8.0×10^3
Zn-69m		40	20	3.3×10^6
Zn-69		300	20	5.3×10^7
Zr-93	Zirconium (40)	1000	200	3.5×10^{-3}
Zr-95		20	20	2.1×10^4
Zr-97		20	20	2.0×10^6

Notes for this table are on the next page

m = metastable state

«-» = Unlimited

TABLE C-1

A₁ AND A₂ VALUES FOR RADIONUCLIDES

FOOTNOTES

- * For the purpose of Table C-1, compressed gas means a gas at a pressure which exceeds the ambient atmospheric pressure at the location where the containment system was closed.
- ** The values of A₁ and A₂ must be calculated in accordance with the procedure specified in Appendix C, Paragraph b, taking into account the activity of the fission products and of the Uranium-233 in addition to that of the Thorium.
- *** The values of A₁ and A₂ must be calculated with the procedure specified in Appendix C, Paragraph b, taking into account the activity of the fission products and Plutonium isotopes in addition to that of the Uranium.

Low specific activity material means any of the following:

1. Uranium or Thorium ores and physical or chemical concentrates of those ores;
2. Unirradiated natural or depleted Uranium or unirradiated natural Thorium;
3. Tritium oxide in aqueous solutions provided the concentration does not exceed 5.0 millicuries per milliliter;
4. Material in which the radioactivity is essentially uniformly distributed and in which the estimated average concentration per gram of contents does not exceed;
 - i. 0.0001 millicurie of radionuclides for which the A₂ quantity in Appendix C is not more than 0.05 curie;
 - ii. 0.005 millicurie of radionuclides for which the A₂ quantity in Appendix C is more than 0.05 curie, but not more than 1 curie; or
 - iii. 0.3 millicurie of radionuclides for which the A₂ quantity in Appendix C is more than 1 curie.
5. Objects of nonradioactive material externally contaminated with radioactive material, provided that the radioactive material is not readily dispersible and the surface contamination, when averaged over an area of 1 square meter, does not exceed 0.0001 millicuries (220,000 disintegrations per minute) per square centimeter of radionuclides for which the A₂ quantity in Appendix C is not more than 0.05 curie, or 0.001 millicurie (2,200,000 disintegrations per minute) per square centimeter for other radionuclides.

TABLE C-2
RELATIONSHIP BETWEEN A_1 AND E_{\max} FOR BETA EMITTERS

E_{\max} (MeV)	A_1 (Ci)
< 0.5	1000
0.5 - < 1.0	300
1.0 - < 1.5	100
1.5 - < 2.0	30
≥ 2.0	10

TABLE C-3
RELATIONSHIP BETWEEN A_3 AND THE ATOMIC NUMBER
OF THE RADIONUCLIDE

A_3			
Atomic Number	Half-life less than 1000 days	Half-life 1000 days to 10^6 years	Half-life greater than 10^6 years
1 to 81	3 Ci	.05 Ci	3 Ci
82 and above	.002 Ci	.002 Ci	3 Ci

TABLE C-4.

**ACTIVITY-MASS RELATIONSHIPS
FOR URANIUM/THORIUM**

Thorium and Uranium enrichment* wt % U-234 present	Specific activity	
	Ci/g	g/Ci
0.45	5.0×10^{-7}	2.0×10^6
0.72 (natural)	7.06×10^{-7}	1.42×10^6
1.0	7.6×10^{-7}	1.3×10^6
1.5	1.0×10^{-6}	1.0×10^6
5.0	2.7×10^{-6}	3.7×10^5
10.0	4.8×10^{-6}	2.1×10^5
20.0	1.0×10^{-5}	1.0×10^5
35.0	2.0×10^{-5}	5.0×10^4
50.0	2.5×10^{-5}	4.0×10^4
90.0	5.8×10^{-5}	1.7×10^4
93.0	7.0×10^{-5}	1.4×10^4
95.0	9.1×10^{-5}	1.1×10^4
Natural Thorium	2.2×10^{-7}	4.6×10^6

* The figures for Uranium include representative values for the activity of the Uranium-234 which is concentrated during the enrichment process. The activity for Thorium includes the equilibrium concentration of Thorium-228.

APPENDIX E TO RH-1000 THROUGH RH-2110 - PROTECTION FACTORS FOR RESPIRATORS^a

DESCRIPTION ^b	PROTECTION FACTORS ^d			TESTED & CERTIFIED EQUIPMENTS
	Modes ^c	Particu- lates Only	Particulates, gases, and vapors ^e	National Institute for Occupational Safety and Health/Mine Safety and Health Administration tests for permissibility
I. AIR-PURIFYING RESPIRATORS ^f				
Facepiece, half-mask ^g	NP	10	-----	30 CFR Part 11, Subpart K
Facepiece, full	NP	50	-----	
Facepiece, half-mask full, or hood	PP	1000	-----	
II. ATMOSPHERE-SUPPLYING RESPIRATORS				
1. Air-line respirator				
Facepiece, half-mask	CF	-----	1000	30 CFR Part 11, Subpart J.
Facepiece, half-mask	D	-----	5	
Facepiece, full	CF	-----	2000	
Facepiece, full	D	-----	5	
Facepiece, full	PD	-----	2000	
Hood	CF	-----	(h)	
Suit	CF	-----	(i)	
2. Self-contained breathing apparatus (SCBA)				
Facepiece, full	D	-----	50	30 CFR Part 11, Subpart H.
Facepiece, full	PD	-----	10,000 ^k	
Facepiece, full	RD	-----	50	
Facepiece, full	RP	-----	5,000 ^l	
III. COMBINATION RESPIRATORS				
Any combination of air-purifying and atmosphere-supplying respirators			Protection factor for type and mode of operation as listed above.	30 CFR Part 11, 11.63(b).

FOOTNOTES TO APPENDIX E

- a. For use in the selection of respiratory protective devices 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 (i.e., negative phase during inhalation)
 - PD = pressure demand (i.e., always positive pressure)
 - PP = positive pressure
 - RD = demand, recirculating (closed circuit)
 - RP = pressure demand, recirculating (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:
 - a. Only for individuals trained in using respirators and wearing properly fitted respirators that are used and maintained under supervision in a well-planned respiratory protective program.
 - b. For air-purifying respirators only when high efficiency particulate filters (above 99.97% removal efficiency by thermally generated 0.3 mm dioctyl phthalate [DOP] test or equivalent) are used in atmospheres not deficient in oxygen and not containing radioactive gas or vapor respiratory hazards.
 - c. No adjustment is to be made for the use of sorbents against radioactive material in the form of gases or vapors.

FOOTNOTES TO APPENDIX E

(CONTINUED)

- d. 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 NIOSH/MSHA certification. 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 for a device is 5 the effective protection factor for Tritium is about 1.4; for devices with protection factors of 10 the effective factor for Tritium Oxide is about 1.7, and for devices 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 limitations.
- g. Under-chin type only. This type of respirator is not satisfactory for use where it might be possible (e.g., if an accident or emergency were to occur) for the ambient airborne concentrations to reach instantaneous values greater than 10 times the pertinent values in Table 1, Column 3 of Appendix G to RH-1000 through RH-2110 of this part. 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 air hoods when a minimum air flow of 6 cfm (0.17 m³ per minute) is maintained and calibrated air-line pressure gauges or flow measuring devices 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 cfm (0.17 m³ per minute), and calibrated air-line pressure gauges or flow measuring devices are used.

FOOTNOTES TO APPENDIX E

(CONTINUED)

2. The design of the supplied-air hood or helmet (with a minimum flow of 6 cfm (0.17 m³ per minute) 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 over-alls. 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% 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 as may be approved by the U.S. Bureau of Mines/National Institute for Occupational Safety and Health (NIOSH), according to applicable approvals for respirators 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/NIOSH.

FOOTNOTES TO APPENDIX E

(CONTINUED)

Note 2: Radioactive contaminants for which the concentration values in Table 1, Column 3 of Appendix G to RH-1000 through RH-2110 of this part are based on internal dose due to inhalation may, in addition, present external exposure hazards at higher concentrations. Under these circumstances, limitations on occupancy may have to be governed by external dose limits.

APPENDIX F: LIST OF ELEMENTS

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

APPENDIX G TO RH-1000 THROUGH RH-2110
ANNUAL LIMITS ON INTAKE (ALIs) AND DERIVED AIR CONCENTRATIONS
(DACs) OF RADIONUCLIDES FOR OCCUPATIONAL EXPOSURE; EFFLUENT
CONCENTRATIONS; CONCENTRATIONS FOR RELEASE TO SEWERAGE

Introduction

For each radionuclide Table 1 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 median aerodynamic diameter (AMAD) of 1 μm 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 of less than 10 days, for W from 10 to 100 days, and for Y greater than 100 days. Table 2 provides concentration limits for airborne and liquid effluents released to the general environment. Table 3 provides concentration limits for discharges to sanitary sewer systems.

Notation

The values in Tables 1, 2, and 3 are presented in the computer "E" notation. In this notation, a value of 6E-02 represents a value of 6×10^{-2} or 0.06, 6E+2 represents 6×10^2 or 600, and 6E+0 represents 6×10^0 or 6.

Table 1 "Occupational"

Note that the columns in Table 1 of this Appendix captioned "Oral Ingestion ALI," "Inhalation ALI," and "DAC," are applicable to occupational exposure to radioactive material.

The ALIs in this Appendix are the annual intakes of given radionuclide by "Reference Man" which would result in either:

1. A committed effective dose equivalent of 5 Rems (stochastic ALI) or
2. A committed dose equivalent of 50 Rems 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

RH-2792 (Cont'd)

APPENDIX G TO RH-1000 THROUGH RH-2110, Cont'd.

ALIs AND DACs OF RADIONUCLIDES FOR OCCUPATIONAL EXPOSURE; EFFLUENT CONCENTRATIONS; CONCENTRATIONS FOR RELEASE TO SEWERAGE

risk associated with deep dose equivalent to the whole body of 5 Rems. 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 RH-1000.c.j. 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 parts of the GI tract: stomach, small intestine, upper large intestine, and lower large intestine -- are to be treated as four separate organs.

Note that the dose equivalents for extremities (hands and forearms, feet and lower legs), 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.

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 parentheses. Abbreviated organ or tissue designations are used:

LLI wall	=	lower large intestine wall
St wall	=	stomach wall
Blad wall	=	bladder wall
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 that 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 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 to that organ.

APPENDIX G TO RH-1000 THROUGH RH-2110, Cont'd.

ALIs AND DACs OF RADIONUCLIDES FOR OCCUPATIONAL EXPOSURE; EFFLUENT
CONCENTRATIONS; CONCENTRATIONS FOR RELEASE TO SEWERAGE

(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 contribute to the committed dose equivalent to the organ receiving the highest dose does not exceed unity (i.e., $\sum [intake \text{ (in } \mu Ci) \text{ of each radionuclide} / ALI_{ns}] < 1.0$). If there is an external deep dose equivalent contribution of H_d , then this sum must be less than $1 - (H_d/50)$ instead of being < 1.0 .

Note that the dose equivalents for extremities (hand and forearms, feet and lower legs), 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 concentration (DAC) values are derived limits intended to control chronic occupational exposures. The relationship between the DAC and the ALI is given by:

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

where 2×10^4 ml per minute is the volume of air breathed per minute at work by "Reference Man" under working conditions of "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. Derived air concentrations 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 relate to exposure to the single radionuclide named, but also include contributions from the in-growth of any daughter radionuclide produced in the body by the 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 value of ALI and DAC do not apply directly when the individual both ingests 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 RH-1201). When an individual is exposed to radioactive materials which fall

APPENDIX G TO RH-1000 THROUGH RH-2110, Cont'd.

ALIs AND DACs OF RADIONUCLIDES FOR OCCUPATIONAL EXPOSURE; EFFLUENT
CONCENTRATIONS; CONCENTRATIONS FOR RELEASE TO SEWERAGE

under several of the translocation classifications (i.e., Class D, Class W, or Class Y) of the same radionuclide, the exposure may be evaluated as if it were a mixture of 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 radioisotopes. For this reason, values are given for Class D, W, and Y compounds, even for very short-lived radionuclides.

Table 2 "Effluent Concentrations"

The columns in Table 2 of this Appendix 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 RH-1208. The concentration values given in Columns 1 and 2 of Table 2 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 (50 millirem or 0.5 millisieverts).

Consideration of non-stochastic limits has not been included in deriving the air and water effluent concentration limits because non-stochastic effects are presumed not to occur at 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 2. For this reason, the DAC and airborne effluent limits are not always proportional as was the case in Appendix G to RH-102 through RH-1308.

The air concentration values listed in Table 2, 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 2.4×10^9 , relating the inhalation ALI to the DAC, as explained above, and then divided by a factor of 300. The factor of 300 includes the following components: a factor of 50 to relate the 5 Rem annual occupational dose limit to the 0.1 Rem limit for members of the public, 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.

APPENDIX G TO RH-1000 THROUGH RH-2110, Cont'd.

**ALIs AND DACs OF RADIONUCLIDES FOR OCCUPATIONAL EXPOSURE; EFFLUENT
CONCENTRATIONS; CONCENTRATIONS FOR RELEASE TO SEWERAGE**

For those radionuclides for which submersion (external dose) is limiting, the occupational DAC in Table 1, Column 3, was divided by 219. The factor of 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 considerations 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 7.3×10^7 . The factor of 7.3×10^7 (ml) includes the following components: the factors of 50 and 2 described above and a factor of 7.3×10^5 (ml) which is the annual water intake of "Reference Man."

Note 2 of this Appendix 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 sewerage) require demonstrating that the most limiting radionuclides in successive classes are absent. The limit for the unknown mixture is defined when the presence of the 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 3 "Sewer Disposal"

The monthly average concentrations for release to sanitary sewers are applicable to the provisions in RH-1402. The concentration values were derived by taking the most restrictive occupational stochastic oral ingestion ALI and dividing by 7.3×10^6 (ml). The factor of 7.3×10^6 (ml) is composed of a factor of 7.3×10^5 (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.

Atomic Radionuclide No.		Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)			
1	Hydrogen-3	Water, DAC includes skin absorption	8E+4	8E+4	2E-5	1E-7	1E-3	1E-2
		Gas (HT or T ₂) Submersion ¹ : Use above values as HT and T ₂ oxidize in air and in the body to HT0.						
4	Beryllium-7	W, all compounds except those given for Y	4E+4	2E+4	9E-6	3E-8	6E-4	6E-3
		Y, oxides, halides, and nitrates	-	2E+4	8E-6	3E-8	-	-
4	Beryllium-10	W, see ⁷ Be	1E+3	2E+2	6E-8	2E-10	-	-
		LLI wall (1E+3)	-	-	-	-	2E-5	2E-4
		Y, see ⁷ Be	-	1E+1	6E-9	2E-11	-	-
6	Carbon-11 ²	Monoxide	-	1E+6	5E-4	2E-6	-	-
		Dioxide	-	6E+5	3E-4	9E-7	-	-
		Compounds	4E+5	4E+5	2E-4	6E-7	6E-3	6E-2
6	Carbon-14	Monoxide	-	2E+6	7E-4	2E-6	-	-
		Dioxide	-	2E+5	9E-5	3E-7	-	-
		Compounds	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4
9	Fluorine-18 ²	D, fluorides of H, Li, Na, K, Rb, Cs, and Fr	5E+4	7E+4	3E-5	1E-7	-	-
		St wall (5E+4)	-	-	-	-	7E-4	7E-3
		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	-	9E+4	4E-5	1E-7	-	-
		Y, lanthanum fluoride	-	8E+4	3E-5	1E-7	-	-
11	Sodium-22	D, all compounds	4E+2	6E+2	3E-7	9E-10	6E-6	6E-5
11	Sodium-24	D, all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
12	Magnesium-28	D, all compounds except those given for W	7E+2	2E+3	7E-7	2E-9	9E-6	9E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	1E+3	5E-7	2E-9	-	-
13	Aluminum-26	D, all compounds except those given for W	4E+2	6E+1	3E-8	9E-11	6E-6	6E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	9E+1	4E-8	1E-10	-	-
14	Silicon-31	D, all compounds except those given for W and Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, oxides, hydroxides, carbides, and nitrates	-	3E+4	1E-5	5E-8	-	-
		Y, aluminosilicate glass	-	3E+4	1E-5	4E-8	-	-
14	Silicon-32	D, see ³¹ Si	2E+3	2E+2	1E-7	3E-10	-	-
		LLI wall (3E+3)	-	-	-	-	4E-5	4E-4
		W, see ³¹ Si	-	1E+2	5E-8	2E-10	-	-
		Y, see ³¹ Si	-	5E+0	2E-9	7E-12	-	-

Atomic Radionuclide No.	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
		Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC ($\mu\text{Ci/ml}$)	Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)	
15	Phosphorus-32	D, all compounds except phosphates given for W W, phosphates of Zn^{2+} , S^{3+} , Mg^{2+} , Fe^{3+} , Bi^{3+} , and lanthanides	6E+2 -	9E+2 4E+2	4E-7 2E-7	1E-9 5E-10	9E-6 -	9E-5 -
15	Phosphorus-33	D, see ^{32}P W, see ^{32}P	6E+3 -	8E+3 3E+3	4E-6 1E-6	1E-8 4E-9	8E-5 -	8E-4 -
16	Sulfur-35	Vapor D, sulfides and sulfates except those given for W LLI wall (8E+3) 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	1E+4 1E+4 6E+3 -	6E-6 2E+4 - 2E+3	2E-8 7E-6 - 9E-7	- 2E-8 - 3E-9	- - 1E-4 -	- - 1E-3 -
17	Chlorine-36	D, chlorides of H, Li, Na, K, Rb, Cs, and Fr 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	2E+3 -	2E+3 2E+2	1E-6 1E-7	3E-9 3E-10	2E-5 -	2E-4 -
17	Chlorine-38 ²	D, see ^{36}Cl St wall (3E+4) W, see ^{36}Cl	2E+4 - -	4E+4 - 5E+4	2E-5 - 2E-5	6E-8 - 6E-8	- 3E-4 -	- 3E-3 -
17	Chlorine-39 ²	D, see ^{36}Cl St wall (4E+4) W, see ^{36}Cl	2E+4 - -	5E+4 - 6E+4	2E-5 - 2E-5	7E-8 - 8E-8	- 5E-4 -	- 5E-3 -
18	Argon-37	Submersion ¹	-	-	1E+0	6E-3	-	-
18	Argon-39	Submersion ¹	-	-	2E-4	8E-7	-	-
18	Argon-41	Submersion ¹	-	-	3E-6	1E-8	-	-
19	Potassium-40	D, all compounds	3E+2	4E+2	2E-7	6E-10	4E-6	4E-5
19	Potassium-42	D, all compounds	5E+3	5E+3	2E-6	7E-9	6E-5	6E-4
19	Potassium-43	D, all compounds	6E+3	9E+3	4E-6	1E-8	9E-5	9E-4
19	Potassium-44 ²	D, all compounds St wall (4E+4)	2E+4 -	7E+4 -	3E-5 -	9E-8 -	- 5E-4	- 5E-3
19	Potassium-45 ²	D, all compounds St wall (5E+4)	3E+4 -	1E+5 -	5E-5 -	2E-7 -	- 7E-4	- 7E-3
20	Calcium-41	W, all compounds Bone surf (4E+3)	3E+3 -	4E+3 Bone surf (4E+3)	2E-6 -	- 5E-9	- 6E-5	- 6E-4

		3 Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
Atomic No.	Radionuclide	Class	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)
			Oral Ingestion ALI (μCi)	Inhalation		Air (μCi/ml)	Water (μCi/ml)	
				ALI (μCi)	DAC (μCi/ml)			
20	Calcium-45	W, all compounds	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
20	Calcium-47	W, all compounds	8E+2	9E+2	4E-7	1E-9	1E-5	1E-4
21	Scandium-43	Y, all compounds	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
21	Scandium-44m	Y, all compounds	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
21	Scandium-44	Y, all compounds	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
21	Scandium-46	Y, all compounds	9E+2	2E+2	1E-7	3E-10	1E-5	1E-4
21	Scandium-47	Y, all compounds	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
21	Scandium-48	Y, all compounds	8E+2	1E+3	6E-7	2E-9	1E-5	1E-4
21	Scandium-49 ²	Y, all compounds	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
22	Titanium-44	D, all compounds except those given for W and Y	3E+2	1E+1	5E-9	2E-11	4E-6	4E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	3E+1	1E-8	4E-11	-	-
		Y, SrTiO	-	6E+0	2E-9	8E-12	-	-
22	Titanium-45	D, see ⁴⁴ Ti	9E+3	3E+4	1E-5	3E-8	1E-4	1E-3
		W, see ⁴⁴ Ti	-	4E+4	1E-5	5E-8	-	-
		Y, see ⁴⁴ Ti	-	3E+4	1E-5	4E-8	-	-
23	Vanadium-47 ²	D, all compounds except those given for W	3E+4	8E+4	3E-5	1E-7	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
		W, oxides, hydroxides, carbides, and halides	-	1E+5	4E-5	1E-7	-	-
23	Vanadium-48	D, see ⁴⁷ V	6E+2	1E+3	5E-7	2E-9	9E-6	9E-5
		W, see ⁴⁷ V	-	6E+2	3E-7	9E-10	-	-
23	Vanadium-49	D, see ⁴⁷ V	7E+4	3E+4	1E-5	-	-	-
			LLI wall (9E+4)	Bone surf (3E+4)	-	5E-8	1E-3	1E-2
		W, see ⁴⁷ V	-	2E+4	8E-6	2E-8	-	-
24	Chromium-48	D, all compounds except those given for W and Y	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, halides and nitrates	-	7E+3	3E-6	1E-8	-	-
		Y, oxides and hydroxides	-	7E+3	3E-6	1E-8	-	-
24	Chromium-49 ²	D, see ⁴⁸ Cr	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
		W, see ⁴⁸ Cr	-	1E+5	4E-5	1E-7	-	-
		Y, see ⁴⁸ Cr	-	9E+4	4E-5	1E-7	-	-
24	Chromium-51	D, see ⁴⁸ Cr	4E+4	5E+4	2E-5	6E-8	5E-4	5E-3
		W, see ⁴⁸ Cr	-	2E+4	1E-5	3E-8	-	-
		Y, see ⁴⁸ Cr	-	2E+4	8E-6	3E-8	-	-
25	Manganese-51 ²	D, all compounds except those given for W	2E+4	5E+4	2E-5	7E-8	3E-4	3E-3
		W, oxides, hydroxides, halides, and nitrates	-	6E+4	3E-5	8E-8	-	-

Atomic Radionuclide No.	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
		Col. 1 Oral Ingestion ALI (μCi)	Col. 2	Col. 3	Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
			Inhalation				
			ALI (μCi)	DAC ($\mu\text{Ci}/\text{ml}$)			
25	Manganese-52m ²	D, see ⁵¹ Mn	3E+4 St wall (4E+4)	4E-5	1E-7	-	-
		W, see ⁵¹ Mn	-	4E-5	1E-7	5E-4	5E-3
25	Manganese-52	D, see ⁵¹ Mn	7E+2	5E-7	2E-9	1E-5	1E-4
		W, see ⁵¹ Mn	-	4E-7	1E-9	-	-
25	Manganese-53	D, see ⁵¹ Mn	5E+4	5E-6	-	7E-4	7E-3
		W, see ⁵¹ Mn	-	5E-6	3E-8 2E-8	-	-
25	Manganese-54	D, see ⁵¹ Mn	2E+3	4E-7	1E-9	3E-5	3E-4
		W, see ⁵¹ Mn	-	3E-7	1E-9	-	-
25	Manganese-56	D, see ⁵¹ Mn	5E+3	6E-6	2E-8	7E-5	7E-4
		W, see ⁵¹ Mn	-	9E-6	3E-8	-	-
26	Iron-52	D, all compounds except those given for W, oxides, hydroxides, and halides	9E+2	1E-6	4E-9	1E-5	1E-4
		W, see ⁵² Fe	-	1E-6	3E-9	-	-
26	Iron-55	D, see ⁵² Fe	9E+3	8E-7	3E-9	1E-4	1E-3
		W, see ⁵² Fe	-	2E-6	6E-9	-	-
26	Iron-59	D, see ⁵² Fe	8E+2	1E-7	5E-10	1E-5	1E-4
		W, see ⁵² Fe	-	2E-7	7E-10	-	-
26	Iron-60	D, see ⁵² Fe	3E+1	3E-9	9E-12	4E-7	4E-6
		W, see ⁵² Fe	-	8E-9	3E-11	-	-
27	Cobalt-55	W, all compounds except those given for Y	1E+3	1E-6	4E-9	2E-5	2E-4
		Y, oxides, hydroxides, halides, and nitrates	-	1E-6	4E-9	-	-
27	Cobalt-56	W, see ⁵⁵ Co	5E+2	1E-7	4E-10	6E-6	6E-5
		Y, see ⁵⁵ Co	4E+2	8E-8	3E-10	-	-
27	Cobalt-57	W, see ⁵⁵ Co	8E+3	1E-6	4E-9	6E-5	6E-4
		Y, see ⁵⁵ Co	4E+3	3E-7	9E-10	-	-
27	Cobalt-58m	W, see ⁵⁵ Co	6E+4	4E-5	1E-7	8E-4	8E-3
		Y, see ⁵⁵ Co	-	3E-5	9E-8	-	-
27	Cobalt-58	W, see ⁵⁵ Co	2E+3	5E-7	2E-9	2E-5	2E-4
		Y, see ⁵⁵ Co	1E+3	3E-7	1E-9	-	-
27	Cobalt-60m ²	W, see ⁵⁵ Co	1E+6 St wall (1E+6)	2E-3	6E-6	-	-
		Y, see ⁵⁵ Co	-	1E-3	4E-6	2E-2	2E-1
27	Cobalt-60	W, see ⁵⁵ Co	5E+2	7E-8	2E-10	3E-6	3E-5
		Y, see ⁵⁵ Co	2E+2	1E-8	5E-11	-	-
27	Cobalt-61 ²	W, see ⁵⁵ Co	2E+4	3E-5	9E-8	3E-4	3E-3
		Y, see ⁵⁵ Co	2E+4	2E-5	8E-8	-	-
27	Cobalt-62m ²	W, see ⁵⁵ Co	4E+4 St wall (5E+4)	7E-5	2E-7	-	-
		Y, see ⁵⁵ Co	-	6E-5	2E-7	7E-4	7E-3

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration ($\mu\text{Ci/ml}$)
			Oral Ingestion	Inhalation		Air ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)	
			ALI (μCi)	ALI (μCi)	DAC ($\mu\text{Ci/ml}$)			
28	Nickel-56	D, all compounds except those given for W W, oxides, hydroxides, and carbides Vapor	1E+3 - -	2E+3 1E+3 1E+3	8E-7 5E-7 5E-7	3E-9 2E-9 2E-9	2E-5 - -	2E-4 - -
28	Nickel-57	D, see ^{56}Ni W, see ^{56}Ni Vapor	2E+3 - -	5E+3 3E+3 6E+3	2E-6 1E-6 3E-6	7E-9 4E-9 9E-9	2E-5 - -	2E-4 - -
28	Nickel-59	D, see ^{56}Ni W, see ^{56}Ni Vapor	2E+4 - -	4E+3 7E+3 2E+3	2E-6 3E-6 8E-7	5E-9 1E-8 3E-9	3E-4 - -	3E-3 - -
28	Nickel-63	D, see ^{56}Ni W, see ^{56}Ni Vapor	9E+3 - -	2E+3 3E+3 8E+2	7E-7 1E-6 3E-7	2E-9 4E-9 1E-9	1E-4 - -	1E-3 - -
28	Nickel-65	D, see ^{56}Ni W, see ^{56}Ni Vapor	8E+3 - -	2E+4 3E+4 2E+4	1E-5 1E-5 7E-6	3E-8 4E-8 2E-8	1E-4 - -	1E-3 - -
28	Nickel-66	D, see ^{56}Ni W, see ^{56}Ni Vapor	4E+2 LLI wall (5E+2) - -	2E+3 - 6E+2 3E+3	7E-7 - 3E-7 1E-6	2E-9 - 9E-10 4E-9	- 6E-6 - -	- 6E-5 - -
29	Copper-60 ²	D, all compounds except those given for W and Y W, sulfides, halides, and nitrates Y, oxides and hydroxides	3E+4 St wall (3E+4) - -	9E+4 - 1E+5 1E+5	4E-5 - 5E-5 4E-5	1E-7 - 2E-7 1E-7	- 4E-4 - -	- 4E-3 - -
29	Copper-61	D, see ^{60}Cu W, see ^{60}Cu Y, see ^{60}Cu	1E+4 - -	3E+4 4E+4 4E+4	1E-5 2E-5 1E-5	4E-8 6E-8 5E-8	2E-4 - -	2E-3 - -
29	Copper-64	D, see ^{60}Cu W, see ^{60}Cu Y, see ^{60}Cu	1E+4 - -	3E+4 2E+4 2E+4	1E-5 1E-5 9E-6	4E-8 3E-8 3E-8	2E-4 - -	2E-3 - -
29	Copper-67	D, see ^{60}Cu W, see ^{60}Cu Y, see ^{60}Cu	5E+3 - -	8E+3 5E+3 5E+3	3E-6 2E-6 2E-6	1E-8 7E-9 6E-9	6E-5 - -	6E-4 - -
30	Zinc-62	Y, all compounds	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
30	Zinc-63 ²	Y, all compounds	2E+4 St wall (3E+4)	7E+4 - -	3E-5 - -	9E-8 - -	- 3E-4	- 3E-3
30	Zinc-65	Y, all compounds	4E+2	3E+2	1E-7	4E-10	5E-6	5E-5
30	Zinc-69m	Y, all compounds	4E+3	7E+3	3E-6	1E-8	6E-5	6E-4
30	Zinc-69 ²	Y, all compounds	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
30	Zinc-71m	Y, all compounds	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
30	Zinc-72	Y, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
Atomic Radionuclide No.	Class	Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)	
			Col. 2 ALI (μCi)	Col. 3 DAC (μCi/ml)				
31	Gallium-65 ²	D, all compounds except those given for W	5E+4 St wall (6E+4)	2E+5	7E-5	2E-7	-	-
		W, oxides, hydroxides, carbides, halides, and nitrates	-	-	-	9E-4	9E-3	
			-	2E+5	8E-5	3E-7	-	-
31	Gallium-66	D, see ⁶⁵ Ga	1E+3	4E+3	1E-6	5E-9	1E-5	1E-4
		W, see ⁶⁵ Ga	-	3E+3	1E-6	4E-9	-	-
31	Gallium-67	D, see ⁶⁵ Ga	7E+3	1E+4	6E-6	2E-8	1E-4	1E-3
		W, see ⁶⁵ Ga	-	1E+4	4E-6	1E-8	-	-
31	Gallium-68 ²	D, see ⁶⁵ Ga	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ⁶⁵ Ga	-	5E+4	2E-5	7E-8	-	-
31	Gallium-70 ²	D, see ⁶⁵ Ga	5E+4 St wall (7E+4)	2E+5	7E-5	2E-7	-	-
		W, see ⁶⁵ Ga	-	2E+5	8E-5	3E-7	1E-3	1E-2
			-	-	-	-	-	-
31	Gallium-72	D, see ⁶⁵ Ga	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ⁶⁵ Ga	-	3E+3	1E-6	4E-9	-	-
31	Gallium-73	D, see ⁶⁵ Ga	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
		W, see ⁶⁵ Ga	-	2E+4	6E-6	2E-8	-	-
32	Germanium-66	D, all compounds except those given for W	2E+4	3E+4	1E-5	4E-8	3E-4	3E-3
		W, oxides, sulfides, and halides	-	2E+4	8E-6	3E-8	-	-
32	Germanium-67 ²	D, see ⁶⁶ Ge	3E+4 St wall (4E+4)	9E+4	4E-5	1E-7	-	-
		W, see ⁶⁶ Ge	-	1E+5	4E-5	1E-7	6E-4	6E-3
			-	-	-	-	-	-
32	Germanium-68	D, see ⁶⁶ Ge	5E+3	4E+3	2E-6	5E-9	6E-5	6E-4
		W, see ⁶⁶ Ge	-	1E+2	4E-8	1E-10	-	-
32	Germanium-69	D, see ⁶⁶ Ge	1E+4	2E+4	6E-6	2E-8	2E-4	2E-3
		W, see ⁶⁶ Ge	-	8E+3	3E-6	1E-8	-	-
32	Germanium-71	D, see ⁶⁶ Ge	5E+5	4E+5	2E-4	6E-7	7E-3	7E-2
		W, see ⁶⁶ Ge	-	4E+4	2E-5	6E-8	-	-
32	Germanium-75 ²	D, see ⁶⁶ Ge	4E+4 St wall (7E+4)	8E+4	3E-5	1E-7	-	-
		W, see ⁶⁶ Ge	-	8E+4	4E-5	1E-7	9E-4	9E-3
			-	-	-	-	-	-
32	Germanium-77	D, see ⁶⁶ Ge	9E+3	1E+4	4E-6	1E-8	1E-4	1E-3
		W, see ⁶⁶ Ge	-	6E+3	2E-6	8E-9	-	-
32	Germanium-78 ²	D, see ⁶⁶ Ge	2E+4 St wall (2E+4)	2E+4	9E-6	3E-8	-	-
		W, see ⁶⁶ Ge	-	2E+4	9E-6	3E-8	3E-4	3E-3
			-	-	-	-	-	-
33	Arsenic-69 ²	W, all compounds	3E+4 St wall (4E+4)	1E+5	5E-5	2E-7	-	-
			-	-	-	-	6E-4	6E-3
33	Arsenic-70 ²	W, all compounds	1E+4	5E+4	2E-5	7E-8	2E-4	2E-3

Atomic Radionuclide No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)			
33	Arsenic-71	W, all compounds	4E+3	5E+3	2E-6	6E-9	5E-5	5E-4
33	Arsenic-72	W, all compounds	9E+2	1E+3	6E-7	2E-9	1E-5	1E-4
33	Arsenic-73	W, all compounds	8E+3	2E+3	7E-7	2E-9	1E-4	1E-3
33	Arsenic-74	W, all compounds	1E+3	8E+2	3E-7	1E-9	2E-5	2E-4
33	Arsenic-76	W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
33	Arsenic-77	W, all compounds	4E+3 LLI wall (5E+3)	5E+3 - -	2E-6 - -	7E-9 - -	- 6E-5	- 6E-4
33	Arsenic-78 ²	W, all compounds	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
34	Selenium-70 ²	D, all compounds except those given for W W, oxides, hydroxides, carbides, and elemental Se	2E+4 1E+4	4E+4	2E-5	5E-8	1E-4	1E-3
34	Selenium-73m ²	D, see ⁷⁰ Se W, see ⁷⁰ Se	6E+4 3E+4	2E+5 1E+5	6E-5 6E-5	2E-7 2E-7	4E-4 -	4E-3 -
34	Selenium-73	D, see ⁷⁰ Se W, see ⁷⁰ Se	3E+3 -	1E+4 2E+4	5E-6 7E-6	2E-8 2E-8	4E-5 -	4E-4 -
34	Selenium-75	D, see ⁷⁰ Se W, see ⁷⁰ Se	5E+2 -	7E+2 6E+2	3E-7 3E-7	1E-9 8E-10	7E-6 -	7E-5 -
34	Selenium-79	D, see ⁷⁰ Se W, see ⁷⁰ Se	6E+2 -	8E+2 6E+2	3E-7 2E-7	1E-9 8E-10	8E-6 -	8E-5 -
34	Selenium-81m ²	D, see ⁷⁰ Se W, see ⁷⁰ Se	4E+4 2E+4	7E+4 7E+4	3E-5 3E-5	9E-8 1E-7	3E-4 -	3E-3 -
34	Selenium-81 ²	D, see ⁷⁰ Se W, see ⁷⁰ Se	6E+4 St wall (8E+4) -	2E+5 - 2E+5	9E-5 - 1E-4	3E-7 - 3E-7	- 1E-3 -	- 1E-2 -
34	Selenium-83 ²	D, see ⁷⁰ Se W, see ⁷⁰ Se	4E+4 3E+4	1E+5 1E+5	5E-5 5E-5	2E-7 2E-7	4E-4 -	4E-3 -
35	Bromine-74m ²	D, bromides of H, Li, Na, K, Rb, Cs, and Fr 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	1E+4 St wall (2E+4) -	4E+4 - 4E+4	2E-5 - 2E-5	5E-8 - 6E-8	- 3E-4 -	- 3E-3 -
35	Bromine-74 ²	D, see ^{74m} Br W, see ^{74m} Br	2E+4 St wall (4E+4) -	7E+4 - 8E+4	3E-5 - 4E-5	1E-7 - 1E-7	- 5E-4 -	- 5E-3 -

Atomic Radionuclide No.	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
		Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)	Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)	
35	Bromine-75 ²	D, see ^{74m} Br	3E+4 St wall (4E+4)	5E+4	2E-5	7E-8	-	-
		W, see ^{74m} Br	-	5E+4	2E-5	7E-8	5E-4	5E-3
35	Bromine-76	D, see ^{74m} Br	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
		W, see ^{74m} Br	-	4E+3	2E-6	6E-9	-	-
35	Bromine-77	D, see ^{74m} Br	2E+4	2E+4	1E-5	3E-8	2E-4	2E-3
		W, see ^{74m} Br	-	2E+4	8E-6	3E-8	-	-
35	Bromine-80m	D, see ^{74m} Br	2E+4	2E+4	7E-6	2E-8	3E-4	3E-3
		W, see ^{74m} Br	-	1E+4	6E-6	2E-8	-	-
35	Bromine-80 ²	D, see ^{74m} Br	5E+4 St wall (9E+4)	2E+5	8E-5	3E-7	-	-
		W, see ^{74m} Br	-	2E+5	9E-5	3E-7	1E-3	1E-2
35	Bromine-82	D, see ^{74m} Br	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
		W, see ^{74m} Br	-	4E+3	2E-6	5E-9	-	-
35	Bromine-83	D, see ^{74m} Br	5E+4 St wall (7E+4)	6E+4	3E-5	9E-8	-	-
		W, see ^{74m} Br	-	6E+4	3E-5	9E-8	9E-4	9E-3
35	Bromine-84 ²	D, see ^{74m} Br	2E+4 St wall (3E+4)	6E+4	2E-5	8E-8	-	-
		W, see ^{74m} Br	-	6E+4	3E-5	9E-8	4E-4	4E-3
36	Krypton-74 ²	Submersion ¹	-	-	3E-6	1E-8	-	-
36	Krypton-76	Submersion ¹	-	-	9E-6	4E-8	-	-
36	Krypton-77 ²	Submersion ¹	-	-	4E-6	2E-8	-	-
36	Krypton-79	Submersion ¹	-	-	2E-5	7E-8	-	-
36	Krypton-81	Submersion ¹	-	-	7E-4	3E-6	-	-
36	Krypton-83m ²	Submersion ¹	-	-	1E-2	5E-5	-	-
36	Krypton-85m	Submersion ¹	-	-	2E-5	1E-7	-	-
36	Krypton-85	Submersion ¹	-	-	1E-4	7E-7	-	-
36	Krypton-87 ²	Submersion ¹	-	-	5E-6	2E-8	-	-
36	Krypton-88	Submersion ¹	-	-	2E-6	9E-9	-	-
37	Rubidium-79 ²	D, all compounds	4E+4 St wall (6E+4)	1E+5	5E-5	2E-7	-	-
			-	-	-	8E-4	8E-3	
37	Rubidium-81m ²	D, all compounds	2E+5 St wall (3E+5)	3E+5	1E-4	5E-7	-	-
			-	-	-	4E-3	4E-2	
37	Rubidium-81	D, all compounds	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
37	Rubidium-82m	D, all compounds	1E+4	2E+4	7E-6	2E-8	2E-4	2E-3
37	Rubidium-83	D, all compounds	6E+2	1E+3	4E-7	1E-9	9E-6	9E-5

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration ($\mu\text{Ci/ml}$)
			Oral Ingestion ALI (μCi)	Inhalation		Air ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)	
				ALI (μCi)	DAC ($\mu\text{Ci/ml}$)			
37	Rubidium-84	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rubidium-86	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rubidium-87	D, all compounds	1E+3	2E+3	6E-7	2E-9	1E-5	1E-4
37	Rubidium-88 ²	D, all compounds	2E+4	6E+4	3E-5	9E-8	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
37	Rubidium-89 ²	D, all compounds	4E+4	1E+5	6E-5	2E-7	-	-
			St wall (6E+4)	-	-	-	9E-4	9E-3
38	Strontium-80 ²	D, all soluble compounds except SrTiO Y, all insoluble com- pounds and SrTiO	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
			-	1E+4	5E-6	2E-8	-	-
38	Strontium-81 ²	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	3E+4 2E+4	8E+4 8E+4	3E-5 3E-5	1E-7 1E-7	3E-4 -	3E-3 -
38	Strontium-82	D, see ⁸⁰ Sr	3E+2	4E+2	2E-7	6E-10	-	-
			LLI wall (2E+2)	-	-	-	3E-6	3E-5
		Y, see ⁸⁰ Sr	2E+2	9E+1	4E-8	1E-10	-	-
38	Strontium-83	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	3E+3 2E+3	7E+3 4E+3	3E-6 1E-6	1E-8 5E-9	3E-5 -	3E-4 -
38	Strontium-85m ²	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	2E+5 -	6E+5 8E+5	3E-4 4E-4	9E-7 1E-6	3E-3 -	3E-2 -
38	Strontium-85	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	3E+3 -	3E+3 2E+3	1E-6 6E-7	4E-9 2E-9	4E-5 -	4E-4 -
38	Strontium-87m	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	5E+4 4E+4	1E+5 2E+5	5E-5 6E-5	2E-7 2E-7	6E-4 -	6E-3 -
38	Strontium-89	D, see ⁸⁰ Sr	6E+2	8E+2	4E-7	1E-9	-	-
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
		Y, see ⁸⁰ Sr	5E+2	1E+2	6E-8	2E-10	-	-
38	Strontium-90	D, see ⁸⁰ Sr	3E+1	2E+1	8E-9	-	-	-
			Bone surf (4E+1)	Bone surf (2E+1)	-	3E-11 6E-12	5E-7 -	5E-6 -
		Y, see ⁸⁰ Sr	-	4E+0	2E-9	-	-	-
38	Strontium-91	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	2E+3 -	6E+3 4E+3	2E-6 1E-6	8E-9 5E-9	2E-5 -	2E-4 -
38	Strontium-92	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	3E+3 -	9E+3 7E+3	4E-6 3E-6	1E-8 9E-9	4E-5 -	4E-4 -
39	Yttrium-86m ²	W, all compounds except those given for Y Y, oxides and hydroxides	2E+4 -	6E+4 5E+4	2E-5 2E-5	8E-8 8E-8	3E-4 -	3E-3 -
39	Yttrium-86	W, see ^{86m} Y Y, see ^{86m} Y	1E+3 -	3E+3 3E+3	1E-6 1E-6	5E-9 5E-9	2E-5 -	2E-4 -
39	Yttrium-87	W, see ^{86m} Y Y, see ^{86m} Y	2E+3 -	3E+3 3E+3	1E-6 1E-6	5E-9 5E-9	3E-5 -	3E-4 -

Atomic Radionuclide No.	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
		Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)	
			ALI (μCi)	DAC				
				($\mu\text{Ci}/\text{ml}$)				
39	Yttrium-88	W, see ^{86m}Y Y, see ^{86m}Y	1E+3 -	3E+2 2E+2	1E-7 1E-7	3E-10 3E-10	1E-5 -	1E-4 -
39	Yttrium-90m	W, see ^{86m}Y Y, see ^{86m}Y	8E+3 -	1E+4 1E+4	5E-6 5E-6	2E-8 2E-8	1E-4 -	1E-3 -
39	Yttrium-90	W, see ^{86m}Y Y, see ^{86m}Y	4E+2 LLI wall (5E+2) -	7E+2 - 6E+2	3E-7 - 3E-7	9E-10 - 9E-10	- 7E-6 -	- 7E-5 -
39	Yttrium-91m ²	W, see ^{86m}Y Y, see ^{86m}Y	1E+5 -	2E+5 2E+5	1E-4 7E-5	3E-7 2E-7	2E-3 -	2E-2 -
39	Yttrium-91	W, see ^{86m}Y Y, see ^{86m}Y	5E+2 LLI wall (6E+2) -	2E+2 - 1E+2	7E-8 - 5E-8	2E-10 - 2E-10	- 8E-6 -	- 8E-5 -
39	Yttrium-92	W, see ^{86m}Y Y, see ^{86m}Y	3E+3 -	9E+3 8E+3	4E-6 3E-6	1E-8 1E-8	4E-5 -	4E-4 -
39	Yttrium-93	W, see ^{86m}Y Y, see ^{86m}Y	1E+3 -	3E+3 2E+3	1E-6 1E-6	4E-9 3E-9	2E-5 -	2E-4 -
39	Yttrium-94 ²	W, see ^{86m}Y Y, see ^{86m}Y	2E+4 St wall (3E+4) -	8E+4 - 8E+4	3E-5 - 3E-5	1E-7 - 1E-7	- 4E-4 -	- 4E-3 -
39	Yttrium-95 ²	W, see ^{86m}Y Y, see ^{86m}Y	4E+4 St wall (5E+4) -	2E+5 - 1E+5	6E-5 - 6E-5	2E-7 - 2E-7	- 7E-4 -	- 7E-3 -
40	Zirconium-86	D, all compounds except those given for W and Y W, oxides, hydroxides, halides, and nitrates Y, carbide	1E+3 - -	4E+3 3E+3 2E+3	2E-6 1E-6 1E-6	6E-9 4E-9 3E-9	2E-5 - -	2E-4 - -
40	Zirconium-88	D, see ^{86}Zr W, see ^{86}Zr Y, see ^{86}Zr	4E+3 - -	2E+2 5E+2 3E+2	9E-8 2E-7 1E-7	3E-10 7E-10 4E-10	5E-5 - -	5E-4 - -
40	Zirconium-89	D, see ^{86}Zr W, see ^{86}Zr Y, see ^{86}Zr	2E+3 - -	4E+3 2E+3 2E+3	1E-6 1E-6 1E-6	5E-9 3E-9 3E-9	2E-5 - -	2E-4 - -
40	Zirconium-93	D, see ^{86}Zr W, see ^{86}Zr Y, see ^{86}Zr	1E+3 Bone surf (3E+3) - - -	6E+0 Bone surf (2E+1) 2E+1 Bone surf (6E+1) 6E+1 Bone surf (7E+1) -	3E-9 - 1E-8 - 2E-8 -	- 2E-11 - 9E-11 - 9E-11	- 4E-5 - - -	- 4E-4 - - -
40	Zirconium-95	D, see ^{86}Zr W, see ^{86}Zr Y, see ^{86}Zr	1E+3 - - -	1E+2 Bone surf (3E+2) 4E+2 3E+2	5E-8 - 2E-7 1E-7	- 4E-10 5E-10 4E-10	2E-5 - - -	2E-4 - - -

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
Atomic No.	Radionuclide	Class	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)
			Oral Ingestion ALI (μCi)	Inhalation				
				ALI (μCi)	DAC (μCi/ml)			
40	Zirconium-97	D, see ⁸⁶ Zr W, see ⁸⁶ Zr Y, see ⁸⁶ Zr	6E+2 - -	2E+3 1E+3 1E+3	8E-7 6E-7 5E-7	3E-9 2E-9 2E-9	9E-6 - -	9E-5 - -
41	Niobium-88 ²	W, all compounds except those given for Y	5E+4 St wall (7E+4)	2E+5 - 2E+5	9E-5 - 9E-5	3E-7 - 3E-7	- 1E-3 -	- 1E-2 -
41	Niobium-89 ² (66 min)	Y, oxides and hydroxides	-	2E+5	9E-5	3E-7	-	-
41	Niobium-89 ² (66 min)	W, see ⁸⁸ Nb Y, see ⁸⁸ Nb	1E+4 -	4E+4 4E+4	2E-5 2E-5	6E-8 5E-8	1E-4 -	1E-3 -
41	Niobium-89 (122 min)	W, see ⁸⁸ Nb Y, see ⁸⁸ Nb	5E+3 -	2E+4 2E+4	8E-6 6E-6	3E-8 2E-8	7E-5 -	7E-4 -
41	Niobium-90	W, see ⁸⁸ Nb Y, see ⁸⁸ Nb	1E+3 -	3E+3 2E+3	1E-6 1E-6	4E-9 3E-9	1E-5 -	1E-4 -
41	Niobium-93m	W, see ⁸⁸ Nb LLI wall (1E+4) Y, see ⁸⁸ Nb	9E+3 - -	2E+3 - 2E+2	8E-7 - 7E-8	3E-9 - 2E-10	- 2E-4 -	- 2E-3 -
41	Niobium-94	W, see ⁸⁸ Nb Y, see ⁸⁸ Nb	9E+2 -	2E+2 2E+1	8E-8 6E-9	3E-10 2E-11	1E-5 -	1E-4 -
41	Niobium-95m	W, see ⁸⁸ Nb LLI wall (2E+3) Y, see ⁸⁸ Nb	2E+3 - -	3E+3 - 2E+3	1E-6 - 9E-7	4E-9 - 3E-9	- 3E-5 -	- 3E-4 -
41	Niobium-95	W, see ⁸⁸ Nb Y, see ⁸⁸ Nb	2E+3 -	1E+3 1E+3	5E-7 5E-7	2E-9 2E-9	3E-5 -	3E-4 -
41	Niobium-96	W, see ⁸⁸ Nb Y, see ⁸⁸ Nb	1E+3 -	3E+3 2E+3	1E-6 1E-6	4E-9 3E-9	2E-5 -	2E-4 -
41	Niobium-97 ²	W, see ⁸⁸ Nb Y, see ⁸⁸ Nb	2E+4 -	8E+4 7E+4	3E-5 3E-5	1E-7 1E-7	3E-4 -	3E-3 -
41	Niobium-98 ²	W, see ⁸⁸ Nb Y, see ⁸⁸ Nb	1E+4 -	5E+4 5E+4	2E-5 2E-5	8E-8 7E-8	2E-4 -	2E-3 -
42	Molybdenum-90	D, all compounds except those given for Y Y, oxides, hydroxides, and MoS	4E+3 2E+3	7E+3 5E+3	3E-6 2E-6	1E-8 6E-9	3E-5 -	3E-4 -
42	Molybdenum-93m	D, see ⁹⁰ Mo Y, see ⁹⁰ Mo	9E+3 4E+3	2E+4 1E+4	7E-6 6E-6	2E-8 2E-8	6E-5 -	6E-4 -
42	Molybdenum-93	D, see ⁹⁰ Mo Y, see ⁹⁰ Mo	4E+3 2E+4	5E+3 2E+2	2E-6 8E-8	8E-9 2E-10	5E-5 -	5E-4 -
42	Molybdenum-99	D, see ⁹⁰ Mo LLI wall (1E+3) Y, see ⁹⁰ Mo	2E+3 - 1E+3	3E+3 - 1E+3	1E-6 - 6E-7	4E-9 - 2E-9	- 2E-5 -	- 2E-4 -
42	Molybdenum-101 ²	D, see ⁹⁰ Mo St wall (5E+4) Y, see ⁹⁰ Mo	4E+4 - -	1E+5 - 1E+5	6E-5 - 6E-5	2E-7 - 2E-7	- 7E-4 -	- 7E-3 -

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
Atomic Radionuclide No.	Class	Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC ($\mu\text{Ci/ml}$)	Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
43	Technetium-93m ²	D, all compounds except those given for W	7E+4	2E+5	2E-7	1E-3	1E-2
		W, oxides, hydroxides, halides, and nitrates	-	3E+5	4E-7	-	-
43	Technetium-93	D, see ^{93m} Tc	3E+4	7E+4	1E-7	4E-4	4E-3
		W, see ^{93m} Tc	-	1E+5	1E-7	-	-
43	Technetium-94m ²	D, see ^{93m} Tc	2E+4	4E+4	6E-8	3E-4	3E-3
		W, see ^{93m} Tc	-	6E+4	8E-8	-	-
43	Technetium-94	D, see ^{93m} Tc	9E+3	2E+4	3E-8	1E-4	1E-3
		W, see ^{93m} Tc	-	2E+4	3E-8	-	-
43	Technetium-95m	D, see ^{93m} Tc	4E+3	5E+3	8E-9	5E-5	5E-4
		W, see ^{93m} Tc	-	2E+3	3E-9	-	-
43	Technetium-95	D, see ^{93m} Tc	1E+4	2E+4	3E-8	1E-4	1E-3
		W, see ^{93m} Tc	-	2E+4	3E-8	-	-
43	Technetium-96m ²	D, see ^{93m} Tc	2E+5	3E+5	4E-7	2E-3	2E-2
		W, see ^{93m} Tc	-	2E+5	3E-7	-	-
43	Technetium-96	D, see ^{93m} Tc	2E+3	3E+3	5E-9	3E-5	3E-4
		W, see ^{93m} Tc	-	2E+3	3E-9	-	-
43	Technetium-97m	D, see ^{93m} Tc	5E+3	7E+3	-	6E-5	6E-4
		St wall	-	(7E+3)	1E-8	-	-
		W, see ^{93m} Tc	-	1E+3	2E-9	-	-
43	Technetium-97	D, see ^{93m} Tc	4E+4	5E+4	7E-8	5E-4	5E-3
		W, see ^{93m} Tc	-	6E+3	8E-9	-	-
43	Technetium-98	D, see ^{93m} Tc	1E+3	2E+3	2E-9	1E-5	1E-4
		W, see ^{93m} Tc	-	3E+2	4E-10	-	-
43	Technetium-99m	D, see ^{93m} Tc	8E+4	2E+5	2E-7	1E-3	1E-2
		W, see ^{93m} Tc	-	2E+5	3E-7	-	-
43	Technetium-99	D, see ^{93m} Tc	4E+3	5E+3	-	6E-5	6E-4
		St wall	-	(6E+3)	8E-9	-	-
		W, see ^{93m} Tc	-	7E+2	9E-10	-	-
43	Technetium-101 ²	D, see ^{93m} Tc	9E+4	3E+5	5E-7	-	-
		St wall	-	(1E+5)	-	2E-3	2E-2
		W, see ^{93m} Tc	-	4E+5	5E-7	-	-
43	Technetium-104 ²	D, see ^{93m} Tc	2E+4	7E+4	1E-7	-	-
		St wall	-	(3E+4)	-	4E-4	4E-3
		W, see ^{93m} Tc	-	9E+4	1E-7	-	-
44	Ruthenium-94 ²	D, all compounds except those given for W and Y	2E+4	4E+4	6E-8	2E-4	2E-3
		W, halides	-	6E+4	9E-8	-	-
		Y, oxides and hydroxides	-	6E+4	8E-8	-	-
44	Ruthenium-97	D, see ⁹⁴ Ru	8E+3	2E+4	3E-8	1E-4	1E-3
		W, see ⁹⁴ Ru	-	1E+4	2E-8	-	-
		Y, see ⁹⁴ Ru	-	1E+4	2E-8	-	-

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
Atomic Radionuclide No.	Class	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration ($\mu\text{Ci/ml}$)	
		Oral Ingestion ALI (μCi)	Inhalation		Air ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)		
			ALI (μCi)	DAC ($\mu\text{Ci/ml}$)				
44	Ruthenium-103	D, see ^{94}Ru W, see ^{94}Ru Y, see ^{94}Ru	2E+3 - -	2E+3 1E+3 6E+2	7E-7 4E-7 3E-7	2E-9 1E-9 9E-10	3E-4 - -	
44	Ruthenium-105	D, see ^{94}Ru W, see ^{94}Ru Y, see ^{94}Ru	5E+3 - -	1E+4 1E+4 1E+4	6E-6 6E-6 5E-6	2E-8 2E-8 2E-8	7E-4 - -	
44	Ruthenium-106	D, see ^{94}Ru W, see ^{94}Ru Y, see ^{94}Ru	2E+2 LLI wall (2E+2) - -	9E+1 - 5E+1 1E+1	4E-8 - 2E-8 5E-9	1E-10 - 8E-11 2E-11	- - 3E-5 -	
45	Rhodium-99m	D, all compounds except those given for W and Y W, halides Y, oxides and hydroxides	2E+4 - -	6E+4 8E+4 7E+4	2E-5 3E-5 3E-5	8E-8 1E-7 9E-8	2E-4 - -	2E-3 - -
45	Rhodium-99	D, see ^{99m}Rh W, see ^{99m}Rh Y, see ^{99m}Rh	2E+3 - -	3E+3 2E+3 2E+3	1E-6 9E-7 8E-7	4E-9 3E-9 3E-9	3E-5 - -	3E-4 - -
45	Rhodium-100	D, see ^{99m}Rh W, see ^{99m}Rh Y, see ^{99m}Rh	2E+3 - -	5E+3 4E+3 4E+3	2E-6 2E-6 2E-6	7E-9 6E-9 5E-9	2E-5 - -	2E-4 - -
45	Rhodium-101m	D, see ^{99m}Rh W, see ^{99m}Rh Y, see ^{99m}Rh	6E+3 - -	1E+4 8E+3 8E+3	5E-6 4E-6 3E-6	2E-8 1E-8 1E-8	8E-5 - -	8E-4 - -
45	Rhodium-101	D, see ^{99m}Rh W, see ^{99m}Rh Y, see ^{99m}Rh	2E+3 - -	5E+2 8E+2 2E+2	2E-7 3E-7 6E-8	7E-10 1E-9 2E-10	3E-5 - -	3E-4 - -
45	Rhodium-102m	D, see ^{99m}Rh W, see ^{99m}Rh Y, see ^{99m}Rh	1E+3 LLI wall (1E+3) - -	5E+2 - 4E+2 1E+2	2E-7 - 2E-7 5E-8	7E-10 - 5E-10 2E-10	- - 2E-5 -	- - 2E-4 -
45	Rhodium-102	D, see ^{99m}Rh W, see ^{99m}Rh Y, see ^{99m}Rh	6E+2 - -	9E+1 2E+2 6E+1	4E-8 7E-8 2E-8	1E-10 2E-10 8E-11	8E-6 - -	8E-5 - -
45	Rhodium-103m ²	D, see ^{99m}Rh W, see ^{99m}Rh Y, see ^{99m}Rh	4E+5 - -	1E+6 1E+6 1E+6	5E-4 5E-4 5E-4	2E-6 2E-6 2E-6	6E-3 - -	6E-2 - -
45	Rhodium-105	D, see ^{99m}Rh W, see ^{99m}Rh Y, see ^{99m}Rh	4E+3 LLI wall (4E+3) - -	1E+4 - 6E+3 6E+3	5E-6 - 3E-6 2E-6	2E-8 - 9E-9 8E-9	- - 5E-5 -	- - 5E-4 -
45	Rhodium-106m	D, see ^{99m}Rh W, see ^{99m}Rh Y, see ^{99m}Rh	8E+3 - -	3E+4 4E+4 4E+4	1E-5 2E-5 1E-5	4E-8 5E-8 5E-8	1E-4 - -	1E-3 - -
45	Rhodium-107 ²	D, see ^{99m}Rh W, see ^{99m}Rh Y, see ^{99m}Rh	7E+4 St wall (9E+4) - -	2E+5 - 3E+5 3E+5	1E-4 - 1E-4 1E-4	3E-7 - 4E-7 3E-7	- - 1E-3 -	- - 1E-2 -

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
Atomic Radionuclide No.	Class	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)	
		Oral Ingestion ALI (μCi)	Inhalation					
			ALI (μCi)	DAC (μCi/ml)				
					Air (μCi/ml)	Water (μCi/ml)		
46	Palladium-100	D, all compounds except those given for W and Y	1E+3	1E+3	6E-7	2E-9	2E-5	2E-4
		W, nitrates	-	1E+3	5E-7	2E-9	-	-
		Y, oxides and hydroxides	-	1E+3	6E-7	2E-9	-	-
46	Palladium-101	D, see ¹⁰⁰ Pd	1E+4	3E+4	1E-5	5E-8	2E-4	2E-3
		W, see ¹⁰⁰ Pd	-	3E+4	1E-5	5E-8	-	-
		Y, see ¹⁰⁰ Pd	-	3E+4	1E-5	4E-8	-	-
46	Palladium-103	D, see ¹⁰⁰ Pd	6E+3	6E+3	3E-6	9E-9	-	-
		LLI wall (7E+3)	-	-	-	-	1E-4	1E-3
		W, see ¹⁰⁰ Pd	-	4E+3	2E-6	6E-9	-	-
		Y, see ¹⁰⁰ Pd	-	4E+3	1E-6	5E-9	-	-
46	Palladium-107	D, see ¹⁰⁰ Pd	3E+4	2E+4	9E-6	-	-	-
		LLI wall (4E+4)	-	Kidneys (2E+4)	-	3E-8	5E-4	5E-3
		W, see ¹⁰⁰ Pd	-	7E+3	3E-6	1E-8	-	-
		Y, see ¹⁰⁰ Pd	-	4E+2	2E-7	6E-10	-	-
46	Palladium-109	D, see ¹⁰⁰ Pd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
		W, see ¹⁰⁰ Pd	-	5E+3	2E-6	8E-9	-	-
		Y, see ¹⁰⁰ Pd	-	5E+3	2E-6	6E-9	-	-
47	Silver-102 ²	D, all compounds except those given for W and Y	5E+4	2E+5	8E-5	2E-7	-	-
		St wall (6E+4)	-	-	-	-	9E-4	9E-3
		W, nitrates and sulfides	-	2E+5	9E-5	3E-7	-	-
		Y, oxides and hydroxides	-	2E+5	8E-5	3E-7	-	-
47	Silver-103 ²	D, see ¹⁰² Ag	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
		W, see ¹⁰² Ag	-	1E+5	5E-5	2E-7	-	-
		Y, see ¹⁰² Ag	-	1E+5	5E-5	2E-7	-	-
47	Silver-104m ²	D, see ¹⁰² Ag	3E+4	9E+4	4E-5	1E-7	4E-4	4E-3
		W, see ¹⁰² Ag	-	1E+5	5E-5	2E-7	-	-
		Y, see ¹⁰² Ag	-	1E+5	5E-5	2E-7	-	-
47	Silver-104 ²	D, see ¹⁰² Ag	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
		W, see ¹⁰² Ag	-	1E+5	6E-5	2E-7	-	-
		Y, see ¹⁰² Ag	-	1E+5	6E-5	2E-7	-	-
47	Silver-105	D, see ¹⁰² Ag	3E+3	1E+3	4E-7	1E-9	4E-5	4E-4
		W, see ¹⁰² Ag	-	2E+3	7E-7	2E-9	-	-
		Y, see ¹⁰² Ag	-	2E+3	7E-7	2E-9	-	-
47	Silver-106m	D, see ¹⁰² Ag	8E+2	7E+2	3E-7	1E-9	1E-5	1E-4
		W, see ¹⁰² Ag	-	9E+2	4E-7	1E-9	-	-
		Y, see ¹⁰² Ag	-	9E+2	4E-7	1E-9	-	-
47	Silver-106 ²	D, see ¹⁰² Ag	6E+4	2E+5	8E-5	3E-7	-	-
		St. wall (6E+4)	-	-	-	-	9E-4	9E-3
		W, see ¹⁰² Ag	-	2E+5	9E-5	3E-7	-	-
		Y, see ¹⁰² Ag	-	2E+5	8E-5	3E-7	-	-
47	Silver-108m	D, see ¹⁰² Ag	6E+2	2E+2	8E-8	3E-10	9E-6	9E-5
		W, see ¹⁰² Ag	-	3E+2	1E-7	4E-10	-	-
		Y, see ¹⁰² Ag	-	2E+1	1E-8	3E-11	-	-
47	Silver-110m	D, see ¹⁰² Ag	5E+2	1E+2	5E-8	2E-10	6E-6	6E-5
		W, see ¹⁰² Ag	-	2E+2	8E-8	3E-10	-	-
		Y, see ¹⁰² Ag	-	9E+1	4E-8	1E-10	-	-

Atomic Radionuclide No.	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
		Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC ($\mu\text{Ci/ml}$)	Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
47 Silver-111	D, see ^{102}Ag	9E+2 LLI wall (1E+3)	2E+3 Liver (2E+3)	6E-7 -	- 2E-9	- 2E-5	- 2E-4
	W, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
	Y, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
47 Silver-112	D, see ^{102}Ag	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
	W, see ^{102}Ag	-	1E+4	4E-6	1E-8	-	-
	Y, see ^{102}Ag	-	9E+3	4E-6	1E-8	-	-
47 Silver-115 ²	D, see ^{102}Ag	3E+4 St wall (3E+4)	9E+4 -	4E-5 -	1E-7 -	- 4E-4	- 4E-3
	W, see ^{102}Ag	-	9E+4	4E-5	1E-7	-	-
	Y, see ^{102}Ag	-	8E+4	3E-5	1E-7	-	-
48 Cadmium-104 ²	D, all compounds except those given for W and Y	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
	W, sulfides, halides, and nitrates	-	1E+5	5E-5	2E-7	-	-
	Y, oxides and hydroxides	-	1E+5	5E-5	2E-7	-	-
48 Cadmium-107	D, see ^{104}Cd	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
	W, see ^{104}Cd	-	6E+4	2E-5	8E-8	-	-
	Y, see ^{104}Cd	-	5E+4	2E-5	7E-8	-	-
48 Cadmium-109	D, see ^{104}Cd	3E+2 Kidneys (4E+2)	4E+1 Kidneys (5E+1)	1E-8 -	- 7E-11	- 6E-6	- 6E-5
	W, see ^{104}Cd	-	1E+2 Kidneys (1E+2)	5E-8 -	- 2E-10	-	-
	Y, see ^{104}Cd	-	1E+2	5E-8	2E-10	-	-
48 Cadmium-113m	D, see ^{104}Cd	2E+1 Kidneys (4E+1)	2E+0 Kidneys (4E+0)	1E-9 -	- 5E-12	- 5E-7	- 5E-6
	W, see ^{104}Cd	-	8E+0 Kidneys (1E+1)	4E-9 -	- 2E-11	-	-
	Y, see ^{104}Cd	-	1E+1	5E-9	2E-11	-	-
48 Cadmium-113	D, see ^{104}Cd	2E+1 Kidneys (3E+1)	2E+0 Kidneys (3E+0)	9E-10 -	- 5E-12	- 4E-7	- 4E-6
	W, see ^{104}Cd	-	8E+0 Kidneys (1E+1)	3E-9 -	- 2E-11	-	-
	Y, see ^{104}Cd	-	1E+1	6E-9	2E-11	-	-
48 Cadmium-115m	D, see ^{104}Cd	3E+2	5E+1 Kidneys (8E+1)	2E-8 -	- 1E-10	4E-6 -	4E-5 -
	W, see ^{104}Cd	-	1E+2	5E-8	2E-10	-	-
	Y, see ^{104}Cd	-	1E+2	6E-8	2E-10	-	-
48 Cadmium-115	D, see ^{104}Cd	9E+2 LLI wall (1E+3)	1E+3 -	6E-7 -	2E-9 -	- 1E-5	- 1E-4
	W, see ^{104}Cd	-	1E+3	5E-7	2E-9	-	-
	Y, see ^{104}Cd	-	1E+3	6E-7	2E-9	-	-
48 Cadmium-117m	D, see ^{104}Cd	5E+3	1E+4	5E-6	2E-8	6E-5	6E-4
	W, see ^{104}Cd	-	2E+4	7E-6	2E-8	-	-
	Y, see ^{104}Cd	-	1E+4	6E-6	2E-8	-	-

Table 1
Occupational ValuesTable 2
Effluent
ConcentrationsTable 3
Releases to
Sewers

Atomic Radionuclide No.	Class	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)
		Oral Ingestion ALI (μCi)	Inhalation		Air (μCi/ml)	Water (μCi/ml)	
		ALI (μCi)	DAC (μCi/ml)				
48	Cadmium-117	D, see ¹⁰⁴ Cd	5E+3	1E+4	5E-6	2E-8	6E-4
		W, see ¹⁰⁴ Cd	-	2E+4	7E-6	2E-8	-
		Y, see ¹⁰⁴ Cd	-	1E+4	6E-6	2E-8	-
49	Indium-109	D, all compounds except those given for W	2E+4	4E+4	2E-5	6E-8	3E-3
		W, oxides, hydroxides, halides, and nitrates	-	6E+4	3E-5	9E-8	-
49	Indium-110 ² (69.1 min)	D, see ¹⁰⁹ In	2E+4	4E+4	2E-5	6E-8	2E-3
		W, see ¹⁰⁹ In	-	6E+4	2E-5	8E-8	-
49	Indium-110 (4.9 h)	D, see ¹⁰⁹ In	5E+3	2E+4	7E-6	2E-8	7E-4
		W, see ¹⁰⁹ In	-	2E+4	8E-6	3E-8	-
49	Indium-111	D, see ¹⁰⁹ In	4E+3	6E+3	3E-6	9E-9	6E-4
		W, see ¹⁰⁹ In	-	6E+3	3E-6	9E-9	-
49	Indium-112 ²	D, see ¹⁰⁹ In	2E+5	6E+5	3E-4	9E-7	2E-2
		W, see ¹⁰⁹ In	-	7E+5	3E-4	1E-6	-
49	Indium-113m ²	D, see ¹⁰⁹ In	5E+4	1E+5	6E-5	2E-7	7E-3
		W, see ¹⁰⁹ In	-	2E+5	8E-5	3E-7	-
49	Indium-114m	D, see ¹⁰⁹ In	3E+2	6E+1	3E-8	9E-11	-
		LLI wall (4E+2)	-	-	-	5E-6	5E-5
		W, see ¹⁰⁹ In	-	1E+2	4E-8	1E-10	-
49	Indium-115m	D, see ¹⁰⁹ In	1E+4	4E+4	2E-5	6E-8	2E-3
		W, see ¹⁰⁹ In	-	5E+4	2E-5	7E-8	-
49	Indium-115	D, see ¹⁰⁹ In	4E+1	1E+0	6E-10	2E-12	5E-6
		W, see ¹⁰⁹ In	-	5E+0	2E-9	8E-12	-
49	Indium-116m ²	D, see ¹⁰⁹ In	2E+4	8E+4	3E-5	1E-7	3E-3
		W, see ¹⁰⁹ In	-	1E+5	5E-5	2E-7	-
49	Indium-117m ²	D, see ¹⁰⁹ In	1E+4	3E+4	1E-5	5E-8	2E-3
		W, see ¹⁰⁹ In	-	4E+4	2E-5	6E-8	-
49	Indium-117 ²	D, see ¹⁰⁹ In	6E+4	2E+5	7E-5	2E-7	8E-3
		W, see ¹⁰⁹ In	-	2E+5	9E-5	3E-7	-
49	Indium-119m ²	D, see ¹⁰⁹ In	4E+4	1E+5	5E-5	2E-7	-
		St wall (5E+4)	-	-	-	7E-4	7E-3
		W, see ¹⁰⁹ In	-	1E+5	6E-5	2E-7	-
50	Tin-110	D, all compounds except those given for W	4E+3	1E+4	5E-6	2E-8	5E-4
		W, sulfides, oxides, hydroxides, halides, nitrates, and stannic phosphate	-	1E+4	5E-6	2E-8	-
50	Tin-111 ²	D, see ¹¹⁰ Sn	7E+4	2E+5	9E-5	3E-7	1E-2
		W, see ¹¹⁰ Sn	-	3E+5	1E-4	4E-7	-
50	Tin-113	D, see ¹¹⁰ Sn	2E+3	1E+3	5E-7	2E-9	-
		LLI wall (2E+3)	-	-	-	3E-5	3E-4
		W, see ¹¹⁰ Sn	-	5E+2	2E-7	8E-10	-

Atomic Radionuclide No.	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
		Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)	Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
50	Tin-117m	D, see ^{110}Sn	2E+3 LLI wall (2E+3)	1E+3 Bone surf (2E+3)	5E-7	-	-
		W, see ^{110}Sn	-	1E+3	3E-9 2E-9	3E-5	3E-4
50	Tin-119m	D, see ^{110}Sn	3E+3 LLI wall (4E+3)	2E+3	1E-6	-	-
		W, see ^{110}Sn	-	1E+3	3E-9 1E-9	6E-5	6E-4
50	Tin-121m	D, see ^{110}Sn	3E+3 LLI wall (4E+3)	9E+2	4E-7	-	-
		W, see ^{110}Sn	-	5E+2	1E-9 8E-10	5E-5	5E-4
50	Tin-121	D, see ^{110}Sn	6E+3 LLI wall (6E+3)	2E+4	6E-6	-	-
		W, see ^{110}Sn	-	1E+4	2E-8 2E-8	8E-5	8E-4
50	Tin-123m ²	D, see ^{110}Sn	5E+4	1E+5	5E-5	2E-7	7E-3
		W, see ^{110}Sn	-	1E+5	6E-5	2E-7	-
50	Tin-123	D, see ^{110}Sn	5E+2 LLI wall (6E+2)	6E+2	3E-7	9E-10	-
		W, see ^{110}Sn	-	2E+2	-	9E-6	9E-5
50	Tin-125	D, see ^{110}Sn	4E+2 LLI wall (5E+2)	9E+2	4E-7	1E-9	-
		W, see ^{110}Sn	-	4E+2	-	6E-6	6E-5
50	Tin-126	D, see ^{110}Sn	3E+2	6E+1	2E-8	8E-11	4E-5
		W, see ^{110}Sn	-	7E+1	3E-8	9E-11	-
50	Tin-127	D, see ^{110}Sn	7E+3	2E+4	8E-6	3E-8	9E-4
		W, see ^{110}Sn	-	2E+4	8E-6	3E-8	-
50	Tin-128 ²	D, see ^{110}Sn	9E+3	3E+4	1E-5	4E-8	1E-3
		W, see ^{110}Sn	-	4E+4	1E-5	5E-8	-
51	Antimony-115 ²	D, all compounds except those given for W	8E+4	2E+5	1E-4	3E-7	1E-2
		W, oxides, hydroxides, halides, sulfides, sulfates, and nitrates	-	3E+5	1E-4	4E-7	-
51	Antimony-116m ²	D, see ^{115}Sb	2E+4	7E+4	3E-5	1E-7	3E-3
		W, see ^{115}Sb	-	1E+5	6E-5	2E-7	-
51	Antimony-116 ²	D, see ^{115}Sb	7E+4 St wall (9E+4)	3E+5	1E-4	4E-7	-
		W, see ^{115}Sb	-	3E+5	-	1E-3	1E-2
51	Antimony-117	D, see ^{115}Sb	7E+4	2E+5	9E-5	3E-7	9E-3
		W, see ^{115}Sb	-	3E+5	1E-4	4E-7	-
51	Antimony-118m	D, see ^{115}Sb	6E+3	2E+4	8E-6	3E-8	7E-4
		W, see ^{115}Sb	5E+3	2E+4	9E-6	3E-8	-
51	Antimony-119	D, see ^{115}Sb	2E+4	5E+4	2E-5	6E-8	2E-3
		W, see ^{115}Sb	2E+4	3E+4	1E-5	4E-8	-

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
Atomic Radionuclide No.	Class	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)	
		Oral Ingestion ALI (μCi)	Inhalation					
			ALI (μCi)	DAC (μCi/ml)				
					Air (μCi/ml)	Water (μCi/ml)		
51	Antimony-120 ² (16 min)	D, see ¹¹⁵ Sb	1E+5 St wall (2E+5)	4E+5	2E-4	6E-7	-	-
		W, see ¹¹⁵ Sb	-	5E+5	2E-4	7E-7	2E-3	2E-2
51	Antimony-120 (5.76 d)	D, see ¹¹⁵ Sb	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
		W, see ¹¹⁵ Sb	9E+2	1E+3	5E-7	2E-9	-	-
51	Antimony-122	D, see ¹¹⁵ Sb	8E+2 LLI wall (8E+2)	2E+3	1E-6	3E-9	-	-
		W, see ¹¹⁵ Sb	7E+2	1E+3	4E-7	2E-9	1E-5	1E-4
51	Antimony-124m ²	D, see ¹¹⁵ Sb	3E+5	8E+5	4E-4	1E-6	3E-3	3E-2
		W, see ¹¹⁵ Sb	2E+5	6E+5	2E-4	8E-7	-	-
51	Antimony-124	D, see ¹¹⁵ Sb	6E+2	9E+2	4E-7	1E-9	7E-6	7E-5
		W, see ¹¹⁵ Sb	5E+2	2E+2	1E-7	3E-10	-	-
51	Antimony-125	D, see ¹¹⁵ Sb	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4
		W, see ¹¹⁵ Sb	-	5E+2	2E-7	7E-10	-	-
51	Antimony-126m ²	D, see ¹¹⁵ Sb	5E+4 St wall (7E+4)	2E+5	8E-5	3E-7	-	-
		W, see ¹¹⁵ Sb	-	2E+5	8E-5	3E-7	9E-4	9E-3
51	Antimony-126	D, see ¹¹⁵ Sb	6E+2	1E+3	5E-7	2E-9	7E-6	7E-5
		W, see ¹¹⁵ Sb	5E+2	5E+2	2E-7	7E-10	-	-
51	Antimony-127	D, see ¹¹⁵ Sb	8E+2 LLI wall (8E+2)	2E+3	9E-7	3E-9	-	-
		W, see ¹¹⁵ Sb	7E+2	9E+2	4E-7	1E-9	1E-5	1E-4
51	Antimony-128 ² (10.4 min)	D, see ¹¹⁵ Sb	8E+4 St wall (1E+5)	4E+5	2E-4	5E-7	-	-
		W, see ¹¹⁵ Sb	-	4E+5	2E-4	6E-7	1E-3	1E-2
51	Antimony-128 (9.01 h)	D, see ¹¹⁵ Sb	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
		W, see ¹¹⁵ Sb	-	3E+3	1E-6	5E-9	-	-
51	Antimony-129	D, see ¹¹⁵ Sb	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		W, see ¹¹⁵ Sb	-	9E+3	4E-6	1E-8	-	-
51	Antimony-130 ²	D, see ¹¹⁵ Sb	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		W, see ¹¹⁵ Sb	-	8E+4	3E-5	1E-7	-	-
51	Antimony-131 ²	D, see ¹¹⁵ Sb	1E+4 Thyroid (2E+4)	2E+4 Thyroid (4E+4)	1E-5	-	-	-
		W, see ¹¹⁵ Sb	-	2E+4 Thyroid (4E+4)	1E-5	6E-8	2E-4	2E-3
			-	-	-	6E-8	-	-
52	Tellurium-116	D, all compounds except those given for W	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, oxides, hydroxides, and nitrates	-	3E+4	1E-5	4E-8	-	-
52	Tellurium-121m	D, see ¹¹⁶ Te	5E+2 Bone surf (7E+2)	2E+2 Bone surf (4E+2)	8E-8	-	-	-
		W, see ¹¹⁶ Te	-	4E+2	2E-7	5E-10 6E-10	1E-5	1E-4

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
Atomic Radionuclide No.	Class	Col. 1 Oral Ingestion ALI (μCi)	Col. 2 <div>Inhalation</div> <div>ALI (μCi)</div>	Col. 3 DAC ($\mu\text{Ci/ml}$)	Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
52	Tellurium-121	D, see ^{116}Te W, see ^{116}Te	3E+3 -	4E+3 3E+3	2E-6 1E-6	6E-9 4E-9	4E-4 -
52	Tellurium-123m	D, see ^{116}Te W, see ^{116}Te	6E+2 Bone surf (1E+3) -	2E+2 Bone surf (5E+2) 5E+2	9E-8 - 2E-7	- 8E-10 8E-10	- 1E-4 -
52	Tellurium-123	D, see ^{116}Te W, see ^{116}Te	5E+2 Bone surf (1E+3) -	2E+2 Bone surf (5E+2) 4E+2 Bone surf (1E+3)	8E-8 - 2E-7 -	- 7E-10 - 2E-9	- 2E-4 -
52	Tellurium-125m	D, see ^{116}Te W, see ^{116}Te	1E+3 Bone surf (1E+3) -	4E+2 Bone surf (1E+3) 7E+2	2E-7 - 3E-7	- 1E-9 1E-9	- 2E-4 -
52	Tellurium-127m	D, see ^{116}Te W, see ^{116}Te	6E+2 -	3E+2 Bone surf (4E+2) 3E+2	1E-7 - 1E-7	- 6E-10 4E-10	9E-5 -
52	Tellurium-127	D, see ^{116}Te W, see ^{116}Te	7E+3 -	2E+4 2E+4	9E-6 7E-6	3E-8 2E-8	1E-3 -
52	Tellurium-129m	D, see ^{116}Te W, see ^{116}Te	5E+2 -	6E+2 2E+2	3E-7 1E-7	9E-10 3E-10	7E-5 -
52	Tellurium-129 ²	D, see ^{116}Te W, see ^{116}Te	3E+4 -	6E+4 7E+4	3E-5 3E-5	9E-8 1E-7	4E-3 -
52	Tellurium-131m	D, see ^{116}Te W, see ^{116}Te	3E+2 Thyroid (6E+2) -	4E+2 Thyroid (1E+3) 4E+2 Thyroid (9E+2)	2E-7 - 2E-7 -	- 2E-9 - 1E-9	- 8E-6 -
52	Tellurium-131 ²	D, see ^{116}Te W, see ^{116}Te	3E+3 Thyroid (6E+3) -	5E+3 Thyroid (1E+4) 5E+3 Thyroid (1E+4)	2E-6 - 2E-6 -	- 2E-8 - 2E-8	- 8E-5 -
52	Tellurium-132	D, see ^{116}Te W, see ^{116}Te	2E+2 Thyroid (7E+2) -	2E+2 Thyroid (8E+2) 2E+2 Thyroid (6E+2)	9E-8 - 9E-8 -	- 1E-9 - 9E-10	- 9E-6 -
52	Tellurium-133m ²	D, see ^{116}Te W, see ^{116}Te	3E+3 Thyroid (6E+3) -	5E+3 Thyroid (1E+4) 5E+3 Thyroid (1E+4)	2E-6 - 2E-6 -	- 2E-8 - 2E-8	- 9E-5 -

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
Atomic Radionuclide No.	Class	Col. 1 Oral Ingestion ALI (μCi)	Col. 2	Col. 3	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
			Inhalation				
			ALI (μCi)	DAC (μCi/ml)			
52	Tellurium-133 ²	D, see ¹¹⁶ Te	1E+4 Thyroid (3E+4)	2E+4 Thyroid (6E+4)	9E-6	-	-
		W, see ¹¹⁶ Te	-	2E+4 Thyroid (6E+4)	9E-6	8E-8	4E-4
			-	-	8E-8	-	-
52	Tellurium-134 ²	D, see ¹¹⁶ Te	2E+4 Thyroid (2E+4)	2E+4 Thyroid (5E+4)	1E-5	-	-
		W, see ¹¹⁶ Te	-	2E+4 Thyroid (5E+4)	1E-5	7E-8	3E-4
			-	-	7E-8	-	-
53	Iodine-120m ²	D, all compounds	1E+4 Thyroid (1E+4)	2E+4	9E-6	3E-8	-
			-	-	-	2E-4	2E-3
53	Iodine-120 ²	D, all compounds	4E+3 Thyroid (8E+3)	9E+3 Thyroid (1E+4)	4E-6	-	-
			-	-	2E-8	1E-4	1E-3
53	Iodine-121	D, all compounds	1E+4 Thyroid (3E+4)	2E+4 Thyroid (5E+4)	8E-6	-	-
			-	-	7E-8	4E-4	4E-3
53	Iodine-123	D, all compounds	3E+3 Thyroid (1E+4)	6E+3 Thyroid (2E+4)	3E-6	-	-
			-	-	2E-8	1E-4	1E-3
53	Iodine-124	D, all compounds	5E+1 Thyroid (2E+2)	8E+1 Thyroid (3E+2)	3E-8	-	-
			-	-	4E-10	2E-6	2E-5
53	Iodine-125	D, all compounds	4E+1 Thyroid (1E+2)	6E+1 Thyroid (2E+2)	3E-8	-	-
			-	-	3E-10	2E-6	2E-5
53	Iodine-126	D, all compounds	2E+1 Thyroid (7E+1)	4E+1 Thyroid (1E+2)	1E-8	-	-
			-	-	2E-10	1E-6	1E-5
53	Iodine-128 ²	D, all compounds	4E+4 St wall (6E+4)	1E+5	5E-5	2E-7	-
			-	-	-	8E-4	8E-3
53	Iodine-129	D, all compounds	5E+0 Thyroid (2E+1)	9E+0 Thyroid (3E+1)	4E-9	-	-
			-	-	4E-11	2E-7	2E-6
53	Iodine-130	D, all compounds	4E+2 Thyroid (1E+3)	7E+2 Thyroid (2E+3)	3E-7	-	-
			-	-	3E-9	2E-5	2E-4
53	Iodine-131	D, all compounds	3E+1 Thyroid (9E+1)	5E+1 Thyroid (2E+2)	2E-8	-	-
			-	-	2E-10	1E-6	1E-5
53	Iodine-132m ²	D, all compounds	4E+3 Thyroid (1E+4)	8E+3 Thyroid (2E+4)	4E-6	-	-
			-	-	3E-8	1E-4	1E-3
53	Iodine-132	D, all compounds	4E+3 Thyroid (9E+3)	8E+3 Thyroid (1E+4)	3E-6	-	-
			-	-	2E-8	1E-4	1E-3

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2	Col. 3	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
				Inhalation	DAC (μCi/ml)			
53	Iodine-133	D, all compounds	1E+2 Thyroid (5E+2)	3E+2 Thyroid (9E+2)	1E-7	-	-	-
53	Iodine-134 ²	D, all compounds	2E+4 Thyroid (3E+4)	5E+4	2E-5	6E-8	-	-
53	Iodine-135	D, all compounds	8E+2 Thyroid (3E+3)	2E+3 Thyroid (4E+3)	7E-7	-	-	-
54	Xenon-120 ²	Submersion ¹	-	-	1E-5	4E-8	-	-
54	Xenon-121 ²	Submersion ¹	-	-	2E-6	1E-8	-	-
54	Xenon-122	Submersion ¹	-	-	7E-5	3E-7	-	-
54	Xenon-123	Submersion ¹	-	-	6E-6	3E-8	-	-
54	Xenon-125	Submersion ¹	-	-	2E-5	7E-8	-	-
54	Xenon-127	Submersion ¹	-	-	1E-5	6E-8	-	-
54	Xenon-129m	Submersion ¹	-	-	2E-4	9E-7	-	-
54	Xenon-131m	Submersion ¹	-	-	4E-4	2E-6	-	-
54	Xenon-133m	Submersion ¹	-	-	1E-4	6E-7	-	-
54	Xenon-133	Submersion ¹	-	-	1E-4	5E-7	-	-
54	Xenon-135m ²	Submersion ¹	-	-	9E-6	4E-8	-	-
54	Xenon-135	Submersion ¹	-	-	1E-5	7E-8	-	-
54	Xenon-138 ²	Submersion ¹	-	-	4E-6	2E-8	-	-
55	Cesium-125 ²	D, all compounds	5E+4 St wall (9E+4)	1E+5	6E-5	2E-7	-	-
55	Cesium-127	D, all compounds	6E+4	9E+4	4E-5	1E-7	9E-4	9E-3
55	Cesium-129	D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
55	Cesium-130 ²	D, all compounds	6E+4 St wall (1E+5)	2E+5	8E-5	3E-7	-	-
55	Cesium-131	D, all compounds	2E+4	3E+4	1E-5	4E-8	3E-4	3E-3
55	Cesium-132	D, all compounds	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
55	Cesium-134m	D, all compounds	1E+5 St wall (1E+5)	1E+5	6E-5	2E-7	-	-
55	Cesium-134	D, all compounds	7E+1	1E+2	4E-8	2E-10	9E-7	9E-6
55	Cesium-135m ²	D, all compounds	1E+5	2E+5	8E-5	3E-7	1E-3	1E-2
55	Cesium-135	D, all compounds	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
55	Cesium-136	D, all compounds	4E+2	7E+2	3E-7	9E-10	6E-6	6E-5
55	Cesium-137	D, all compounds	1E+2	2E+2	6E-8	2E-10	1E-6	1E-5

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
Atomic Radionuclide No.	Class	Col. 1 Oral Ingestion ALI (μCi)	Col. 2	Col. 3	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)	
			Inhalation					
			ALI (μCi)	DAC (μCi/ml)				
55	Cesium-138 ²	D, all compounds	2E+4 St wall (3E+4)	6E+4	2E-5	8E-8	-	-
				-	-	-	4E-4	4E-3
56	Barium-126 ²	D, all compounds	6E+3	2E+4	6E-6	2E-8	8E-5	8E-4
56	Barium-128	D, all compounds	5E+2	2E+3	7E-7	2E-9	7E-6	7E-5
56	Barium-131m ²	D, all compounds	4E+5 St wall (5E+5)	1E+6	6E-4	2E-6	-	-
				-	-	-	7E-3	7E-2
56	Barium-131	D, all compounds	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
56	Barium-133m	D, all compounds	2E+3 LLI wall (3E+3)	9E+3	4E-6	1E-8	-	-
				-	-	-	4E-5	4E-4
56	Barium-133	D, all compounds	2E+3	7E+2	3E-7	9E-10	2E-5	2E-4
56	Barium-135m	D, all compounds	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
56	Barium-139 ²	D, all compounds	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
56	Barium-140	D, all compounds	5E+2 LLI wall (6E+2)	1E+3	6E-7	2E-9	-	-
				-	-	-	8E-6	8E-5
56	Barium-141 ²	D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
56	Barium-142 ²	D, all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
57	Lanthanum-131 ²	D, all compounds except those given for W W, oxides and hydroxides	5E+4 -	1E+5 2E+5	5E-5 7E-5	2E-7 2E-7	6E-4 -	6E-3 -
57	Lanthanum-132	D, see ¹³¹ La W, see ¹³¹ La	3E+3 -	1E+4 1E+4	4E-6 5E-6	1E-8 2E-8	4E-5 -	4E-4 -
57	Lanthanum-135	D, see ¹³¹ La W, see ¹³¹ La	4E+4 -	1E+5 9E+4	4E-5 4E-5	1E-7 1E-7	5E-4 -	5E-3 -
57	Lanthanum-137	D, see ¹³¹ La	1E+4	6E+1 Liver (7E+1)	3E-8	-	2E-4	2E-3
		W, see ¹³¹ La	-	3E+2 Liver (3E+2)	1E-7	1E-10 -	-	-
			-	-	-	4E-10	-	-
57	Lanthanum-138	D, see ¹³¹ La W, see ¹³¹ La	9E+2 -	4E+0 1E+1	1E-9 6E-9	5E-12 2E-11	1E-5 -	1E-4 -
57	Lanthanum-140	D, see ¹³¹ La W, see ¹³¹ La	6E+2 -	1E+3 1E+3	6E-7 5E-7	2E-9 2E-9	9E-6 -	9E-5 -
57	Lanthanum-141	D, see ¹³¹ La W, see ¹³¹ La	4E+3 -	9E+3 1E+4	4E-6 5E-6	1E-8 2E-8	5E-5 -	5E-4 -
57	Lanthanum-142 ²	D, see ¹³¹ La W, see ¹³¹ La	8E+3 -	2E+4 3E+4	9E-6 1E-5	3E-8 5E-8	1E-4 -	1E-3 -
57	Lanthanum-143 ²	D, see ¹³¹ La	4E+4 St wall (4E+4)	1E+5	4E-5	1E-7	-	-
		W, see ¹³¹ La	-	9E+4	4E-5	1E-7	5E-4 -	5E-3 -

23								
		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
Atomic No.	Radionuclide	Class	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration
			Oral Ingestion ALI (μCi)	Inhalation		Air ($\mu\text{Ci}/\text{ml}$)	Water ($\mu\text{Ci}/\text{ml}$)	($\mu\text{Ci}/\text{ml}$)
				ALI (μCi)	DAC ($\mu\text{Ci}/\text{ml}$)			
58	Cerium-134	W, all compounds except those given for Y	5E+2 LLI wall (6E+2)	7E+2	3E-7	1E-9	-	-
		Y, oxides, hydroxides, and fluorides	-	7E+2	3E-7	9E-10	8E-6	8E-5
58	Cerium-135	W, see ^{134}Ce	2E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		Y, see ^{134}Ce	-	4E+3	1E-6	5E-9	-	-
58	Cerium-137m	W, see ^{134}Ce	2E+3 LLI wall (2E+3)	4E+3	2E-6	6E-9	-	-
		Y, see ^{134}Ce	-	4E+3	2E-6	5E-9	3E-5	3E-4
58	Cerium-137	W, see ^{134}Ce	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
		Y, see ^{134}Ce	-	1E+5	5E-5	2E-7	-	-
58	Cerium-139	W, see ^{134}Ce	5E+3	8E+2	3E-7	1E-9	7E-5	7E-4
		Y, see ^{134}Ce	-	7E+2	3E-7	9E-10	-	-
58	Cerium-141	W, see ^{134}Ce	2E+3 LLI wall (2E+3)	7E+2	3E-7	1E-9	-	-
		Y, see ^{134}Ce	-	6E+2	2E-7	8E-10	3E-5	3E-4
58	Cerium-143	W, see ^{134}Ce	1E+3 LLI wall (1E+3)	2E+3	8E-7	3E-9	-	-
		Y, see ^{134}Ce	-	2E+3	7E-7	2E-9	2E-5	2E-4
58	Cerium-144	W, see ^{134}Ce	2E+2 LLI wall (3E+2)	3E+1	1E-8	4E-11	-	-
		Y, see ^{134}Ce	-	1E+1	6E-9	2E-11	3E-6	3E-5
59	Praseodymium-136 ²	W, all compounds except those given for Y	5E+4 St wall (7E+4)	2E+5	1E-4	3E-7	-	-
		Y, oxides, hydroxides, carbides, and fluorides	-	2E+5	9E-5	3E-7	1E-3	1E-2
59	Praseodymium-137 ²	W, see ^{136}Pr	4E+4	2E+5	6E-5	2E-7	5E-4	5E-3
		Y, see ^{136}Pr	-	1E+5	6E-5	2E-7	-	-
59	Praseodymium-138m	W, see ^{136}Pr	1E+4	5E+4	2E-5	8E-8	1E-4	1E-3
		Y, see ^{136}Pr	-	4E+4	2E-5	6E-8	-	-
59	Praseodymium-139	W, see ^{136}Pr	4E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		Y, see ^{136}Pr	-	1E+5	5E-5	2E-7	-	-
59	Praseodymium-142m ²	W, see ^{136}Pr	8E+4	2E+5	7E-5	2E-7	1E-3	1E-2
		Y, see ^{136}Pr	-	1E+5	6E-5	2E-7	-	-
59	Praseodymium-142	W, see ^{136}Pr	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
		Y, see ^{136}Pr	-	2E+3	8E-7	3E-9	-	-
59	Praseodymium-143	W, see ^{136}Pr	9E+2 LLI wall (1E+3)	8E+2	3E-7	1E-9	-	-
		Y, see ^{136}Pr	-	7E+2	3E-7	9E-10	2E-5	2E-4

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
Atomic Radionuclide No.	Class	Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC ($\mu\text{Ci/ml}$)	Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
59	Praseodymium-144 ² W, see ¹³⁶ Pr	3E+4 St wall (4E+4)	1E+5	5E-5	2E-7	-	-
	Y, see ¹³⁶ Pr	-	1E+5	5E-5	2E-7	6E-4	6E-3
59	Praseodymium-145 W, see ¹³⁶ Pr	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
	Y, see ¹³⁶ Pr	-	8E+3	3E-6	1E-8	-	-
59	Praseodymium-147 ² W, see ¹³⁶ Pr	5E+4 St wall (8E+4)	2E+5	8E-5	3E-7	-	-
	Y, see ¹³⁶ Pr	-	2E+5	8E-5	3E-7	1E-3	1E-2
60	Neodymium-136 ² W, all compounds except those given for Y	1E+4	6E+4	2E-5	8E-8	2E-4	2E-3
	Y, oxides, hydroxides, carbides, and fluorides	-	5E+4	2E-5	8E-8	-	-
60	Neodymium-138 W, see ¹³⁶ Nd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
	Y, see ¹³⁶ Nd	-	5E+3	2E-6	7E-9	-	-
60	Neodymium-139m W, see ¹³⁶ Nd	5E+3	2E+4	7E-6	2E-8	7E-5	7E-4
	Y, see ¹³⁶ Nd	-	1E+4	6E-6	2E-8	-	-
60	Neodymium-139 ² W, see ¹³⁶ Nd	9E+4	3E+5	1E-4	5E-7	1E-3	1E-2
	Y, see ¹³⁶ Nd	-	3E+5	1E-4	4E-7	-	-
60	Neodymium-141 W, see ¹³⁶ Nd	2E+5	7E+5	3E-4	1E-6	2E-3	2E-2
	Y, see ¹³⁶ Nd	-	6E+5	3E-4	9E-7	-	-
60	Neodymium-147 W, see ¹³⁶ Nd	1E+3 LLI wall (1E+3)	9E+2	4E-7	1E-9	-	-
	Y, see ¹³⁶ Nd	-	8E+2	4E-7	1E-9	2E-5	2E-4
60	Neodymium-149 ² W, see ¹³⁶ Nd	1E+4	3E+4	1E-5	4E-8	1E-4	1E-3
	Y, see ¹³⁶ Nd	-	2E+4	1E-5	3E-8	-	-
60	Neodymium-151 ² W, see ¹³⁶ Nd	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
	Y, see ¹³⁶ Nd	-	2E+5	8E-5	3E-7	-	-
61	Promethium-141 ² W, all compounds except those given for Y	5E+4 St wall (6E+4)	2E+5	8E-5	3E-7	-	-
	Y, oxides, hydroxides, carbides, and fluorides	-	2E+5	7E-5	-	8E-4	8E-3
61	Promethium-143 W, see ¹⁴¹ Pm	5E+3	6E+2	2E-7	8E-10	7E-5	7E-4
	Y, see ¹⁴¹ Pm	-	7E+2	3E-7	1E-9	-	-
61	Promethium-144 W, see ¹⁴¹ Pm	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
	Y, see ¹⁴¹ Pm	-	1E+2	5E-8	2E-10	-	-
61	Promethium-145 W, see ¹⁴¹ Pm	1E+4	2E+2	7E-8	-	1E-4	1E-3
	Y, see ¹⁴¹ Pm	-	Bone surf (2E+2)	-	3E-10	-	-
		-	2E+2	8E-8	3E-10	-	-
61	Promethium-146 W, see ¹⁴¹ Pm	2E+3	5E+1	2E-8	7E-11	2E-5	2E-4
	Y, see ¹⁴¹ Pm	-	4E+1	2E-8	6E-11	-	-
61	Promethium-147 W, see ¹⁴¹ Pm	4E+3 LLI wall (5E+3)	1E+2	5E-8	-	-	-
	Y, see ¹⁴¹ Pm	-	Bone surf (2E+2)	-	3E-10	7E-5	7E-4
		-	1E+2	6E-8	2E-10	-	-

Atomic Radionuclide No.	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
		Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)	
		Oral Ingestion	Inhalation		Air (μCi/ml)	Water (μCi/ml)		
		ALI (μCi)	ALI (μCi)	DAC (μCi/ml)				
61	Promethium-148m	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	7E+2 -	3E+2 3E+2	1E-7 1E-7	4E-10 5E-10	1E-5 -	1E-4 -
61	Promethium-148	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	4E+2 LLI wall (5E+2) -	5E+2 - 5E+2	2E-7 - 2E-7	8E-10 - 7E-10	- 7E-6 -	- 7E-5 -
61	Promethium-149	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	1E+3 LLI wall (1E+3) -	2E+3 - 2E+3	8E-7 - 8E-7	3E-9 - 2E-9	- 2E-5 -	- 2E-4 -
61	Promethium-150	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	5E+3 -	2E+4 2E+4	8E-6 7E-6	3E-8 2E-8	7E-5 -	7E-4 -
61	Promethium-151	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	2E+3 -	4E+3 3E+3	1E-6 1E-6	5E-9 4E-9	2E-5 -	2E-4 -
62	Samarium-141m ²	W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
62	Samarium-141 ²	W, all compounds	5E+4 St wall (6E+4) -	2E+5 - -	8E-5 - -	2E-7 - -	- 8E-4 -	- 8E-3 -
62	Samarium-142 ²	W, all compounds	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
62	Samarium-145	W, all compounds	6E+3	5E+2	2E-7	7E-10	8E-5	8E-4
62	Samarium-146	W, all compounds	1E+1 Bone surf (3E+1)	4E2 Bone surf (6E-2) -	1E-11 - -	- 9E-14 3E-7	- 3E-7 -	- 3E-6 -
62	Samarium-147	W, all compounds	2E+1 Bone surf (3E+1)	4E2 Bone surf (7E-2) -	2E-11 - -	- 1E-13 4E-7	- 4E-7 -	- 4E-6 -
62	Samarium-151	W, all compounds	1E+4 LLI wall (1E+4)	1E+2 Bone surf (2E+2) -	4E-8 - -	- 2E-10 2E-4	- 2E-4 -	- 2E-3 -
62	Samarium-153	W, all compounds	2E+3 LLI wall (2E+3)	3E+3 - -	1E-6 - -	4E-9 - 3E-5	- 3E-5 -	- 3E-4 -
62	Samarium-155 ²	W, all compounds	6E+4 St wall (8E+4) -	2E+5 - -	9E-5 - -	3E-7 - 1E-3	- 1E-3 -	- 1E-2 -
62	Samarium-156	W, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
63	Europium-145	W, all compounds	2E+3	2E+3	8E-7	3E-9	2E-5	2E-4
63	Europium-146	W, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
63	Europium-147	W, all compounds	3E+3	2E+3	7E-7	2E-9	4E-5	4E-4
63	Europium-148	W, all compounds	1E+3	4E+2	1E-7	5E-10	1E-5	1E-4
63	Europium-149	W, all compounds	1E+4	3E+3	1E-6	4E-9	2E-4	2E-3
63	Europium-150 (12.62 h)	W, all compounds	3E+3	8E+3	4E-6	1E-8	4E-5	4E-4
63	Europium-150 (34.2 y)	W, all compounds	8E+2	2E+1	8E-9	3E-11	1E-5	1E-4

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
Atomic Radionuclide No.	Class	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)	
		Oral Ingestion ALI (μCi)	Inhalation					
			ALI (μCi)	DAC ($\mu\text{Ci}/\text{ml}$)				
63	Europium-152m	W, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
63	Europium-152	W, all compounds	8E+2	2E+1	1E-8	3E-11	1E-5	1E-4
63	Europium-154	W, all compounds	5E+2	2E+1	8E-9	3E-11	7E-6	7E-5
63	Europium-155	W, all compounds	4E+3	9E+1	4E-8	-	5E-5	5E-4
			-	Bone surf (1E+2)	-	2E-10	-	-
63	Europium-156	W, all compounds	6E+2	5E+2	2E-7	6E-10	8E-6	8E-5
63	Europium-157	W, all compounds	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
63	Europium-158 ²	W, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
64	Gadolinium-145 ²	D, all compounds except those given for W	5E+4	2E+5	6E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	6E-4	6E-3
		W, oxides, hydroxides, and fluorides	-	2E+5	7E-5	2E-7	-	-
64	Gadolinium-146	D, see ¹⁴⁵ Gd	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
		W, see ¹⁴⁵ Gd	-	3E+2	1E-7	4E-10	-	-
64	Gadolinium-147	D, see ¹⁴⁵ Gd	2E+3	4E+3	2E-6	6E-9	3E-5	3E-4
		W, see ¹⁴⁵ Gd	-	4E+3	1E-6	5E-9	-	-
64	Gadolinium-148	D, see ¹⁴⁵ Gd	1E+1	8E+3	3E-12	-	-	-
		Bone surf (2E+1)	-	Bone surf (2E+2)	-	2E-14	3E-7	3E-6
		W, see ¹⁴⁵ Gd	-	3E-2	1E-11	-	-	-
			-	Bone surf (6E-2)	-	8E-14	-	-
64	Gadolinium-149	D, see ¹⁴⁵ Gd	3E+3	2E+3	9E-7	3E-9	4E-5	4E-4
		W, see ¹⁴⁵ Gd	-	2E+3	1E-6	3E-9	-	-
64	Gadolinium-151	D, see ¹⁴⁵ Gd	6E+3	4E+2	2E-7	-	9E-5	9E-4
		Bone surf (6E+2)	-	Bone surf (6E+2)	-	9E-10	-	-
		W, see ¹⁴⁵ Gd	-	1E+3	5E-7	2E-9	-	-
64	Gadolinium-152	D, see ¹⁴⁵ Gd	2E+1	1E-2	4E-12	-	-	-
		Bone surf (3E+1)	-	Bone surf (2E-2)	-	3E-14	4E-7	4E-6
		W, see ¹⁴⁵ Gd	-	4E-2	2E-11	-	-	-
			-	Bone surf (8E-2)	-	1E-13	-	-
64	Gadolinium-153	D, see ¹⁴⁵ Gd	5E+3	1E+2	6E-8	-	6E-5	6E-4
		Bone surf (2E+2)	-	Bone surf (2E+2)	-	3E-10	-	-
		W, see ¹⁴⁵ Gd	-	6E+2	2E-7	8E-10	-	-
64	Gadolinium-159	D, see ¹⁴⁵ Gd	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see ¹⁴⁵ Gd	-	6E+3	2E-6	8E-9	-	-
65	Terbium-147 ²	W, all compounds	9E+3	3E+4	1E-5	5E-8	1E-4	1E-3
65	Terbium-149	W, all compounds	5E+3	7E+2	3E-7	1E-9	7E-5	7E-4
65	Terbium-150	W, all compounds	5E+3	2E+4	9E-6	3E-8	7E-5	7E-4
65	Terbium-151	W, all compounds	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC ($\mu\text{Ci/ml}$)	Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
65	Terbium-153	W, all compounds	5E+3	7E+3	3E-6	1E-8	7E-5	7E-4
65	Terbium-154	W, all compounds	2E+3	4E+3	2E-6	6E-9	2E-5	2E-4
65	Terbium-155	W, all compounds	6E+3	8E+3	3E-6	1E-8	8E-5	8E-4
65	Terbium-156m (5.0 h)	W, all compounds	2E+4	3E+4	1E-5	4E-8	2E-4	2E-3
65	Terbium-156m (24.4 h)	W, all compounds	7E+3	8E+3	3E-6	1E-8	1E-4	1E-3
65	Terbium-156	W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
65	Terbium-157	W, all compounds	5E+4 LLI wall (5E+4)	3E+2 Bone surf (6E+2)	1E-7 -	- 8E-10	- 7E-4	- 7E-3
65	Terbium-158	W, all compounds	1E+3	2E+1	8E-9	3E-11	2E-5	2E-4
65	Terbium-160	W, all compounds	8E+2	2E+2	9E-8	3E-10	1E-5	1E-4
65	Terbium-161	W, all compounds	2E+3 LLI wall (2E+3)	2E+3 -	7E-7 -	2E-9 -	- 3E-5	- 3E-4
66	Dysprosium-155	W, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
66	Dysprosium-157	W, all compounds	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
66	Dysprosium-159	W, all compounds	1E+4	2E+3	1E-6	3E-9	2E-4	2E-3
66	Dysprosium-165	W, all compounds	1E+4	5E+4	2E-5	6E-8	2E-4	2E-3
66	Dysprosium-166	W, all compounds	6E+2 LLI wall (8E+2)	7E+2 -	3E-7 -	1E-9 -	- 1E-5	- 1E-4
67	Holmium-155 ²	W, all compounds	4E+4	2E+5	6E-5	2E-7	6E-4	6E-3
67	Holmium-157 ²	W, all compounds	3E+5	1E+6	6E-4	2E-6	4E-3	4E-2
67	Holmium-159 ²	W, all compounds	2E+5	1E+6	4E-4	1E-6	3E-3	3E-2
67	Holmium-161	W, all compounds	1E+5	4E+5	2E-4	6E-7	1E-3	1E-2
67	Holmium-162m ²	W, all compounds	5E+4	3E+5	1E-4	4E-7	7E-4	7E-3
67	Holmium-162 ²	W, all compounds	5E+5 St wall (8E+5)	2E+6 -	1E-3 -	3E-6 -	- 1E-2	- 1E-1
67	Holmium-164m ²	W, all compounds	1E+5	3E+5	1E-4	4E-7	1E-3	1E-2
67	Holmium-164 ²	W, all compounds	2E+5 St wall (2E+5)	6E+5 -	3E-4 -	9E-7 -	- 3E-3	- 3E-2
67	Holmium-166m	W, all compounds	6E+2	7E+0	3E-9	9E-12	9E-6	9E-5
67	Holmium-166	W, all compounds	9E+2 LLI wall (9E+2)	2E+3 -	7E-7 -	2E-9 -	- 1E-5	- 1E-4
67	Holmium-167	W, all compounds	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3
68	Erbium-161	W, all compounds	2E+4	6E+4	3E-5	9E-8	2E-4	2E-3

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
Atomic Radionuclide No.	Class	Col. 1 Oral Ingestion ALI (μCi)	Col. 2	Col. 3	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)	
			Inhalation					
			ALI (μCi)	DAC (μCi/ml)				
68	Erbium-165	W, all compounds	6E+4	2E+5	8E-5	3E-7	9E-4	9E-3
68	Erbium-169	W, all compounds	3E+3	3E+3	1E-6	4E-9	-	-
		LLI wall (4E+3)	-	-	-	5E-5	5E-4	
68	Erbium-171	W, all compounds	4E+3	1E+4	4E-6	1E-8	5E-5	5E-4
68	Erbium-172	W, all compounds	1E+3	1E+3	6E-7	2E-9	-	-
		LLI wall (E+3)	-	-	-	2E-5	2E-4	
69	Thulium-162 ²	W, all compounds	7E+4	3E+5	1E-4	4E-7	-	-
		St wall (7E+4)	-	-	-	1E-3	1E-2	
69	Thulium-166	W, all compounds	4E+3	1E+4	6E-6	2E-8	6E-5	6E-4
69	Thulium-167	W, all compounds	2E+3	2E+3	8E-7	3E-9	-	-
		LLI wall (2E+3)	-	-	-	3E-5	3E-4	
69	Thulium-170	W, all compounds	8E+2	2E+2	9E-8	3E-10	-	-
		LLI wall (1E+3)	-	-	-	1E-5	1E-4	
69	Thulium-171	W, all compounds	1E+4	3E+2	1E-7	-	-	-
		LLI wall (1E+4)	-	Bone surf (6E+2)	-	8E-10	2E-4	2E-3
69	Thulium-172	W, all compounds	7E+2	1E+3	5E-7	2E-9	-	-
		LLI wall (8E+2)	-	-	-	1E-5	1E-4	
69	Thulium-173	W, all compounds	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
69	Thulium-175 ²	W, all compounds	7E+4	3E+5	1E-4	4E-7	-	-
		St wall (9E+4)	-	-	-	1E-3	1E-2	
70	Ytterbium-162 ²	W, all compounds except those given for Y Y, oxides, hydroxides, and fluorides	7E+4	3E+5	1E-4	4E-7	1E-3	1E-2
			-	3E+5	1E-4	4E-7	-	-
70	Ytterbium-166	W, see ¹⁶² Yb Y, see ¹⁶² Yb	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
			-	2E+3	8E-7	3E-9	-	-
70	Ytterbium-167 ²	W, see ¹⁶² Yb Y, see ¹⁶² Yb	3E+5	8E+5	3E-4	1E-6	4E-3	4E-2
			-	7E+5	3E-4	1E-6	-	-
70	Ytterbium-169	W, see ¹⁶² Yb Y, see ¹⁶² Yb	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
			-	7E+2	3E-7	1E-9	-	-
70	Ytterbium-175	W, see ¹⁶² Yb	3E+3	4E+3	1E-6	5E-9	-	-
		LLI wall (3E+3)	-	-	-	4E-5	4E-4	
	Y, see ¹⁶² Yb	-	3E+3	1E-6	5E-9	-	-	
70	Ytterbium-177 ²	W, see ¹⁶² Yb Y, see ¹⁶² Yb	2E+4	5E+4	2E-5	7E-8	2E-4	2E-3
			-	5E+4	2E-5	6E-8	-	-
70	Ytterbium-178 ²	W, see ¹⁶² Yb Y, see ¹⁶² Yb	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
			-	4E+4	2E-5	5E-8	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC ($\mu\text{Ci/ml}$)	Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
71	Lutetium-169	W, all compounds except those given for Y Y, oxides, hydroxides, and fluorides	3E+3 -	4E+3 4E+3	2E-6 2E-6	6E-9 6E-9	3E-5 -	3E-4 -
71	Lutetium-170	W, see ^{169}Lu Y, see ^{169}Lu	1E+3 -	2E+3 2E+3	9E-7 8E-7	3E-9 3E-9	2E-5 -	2E-4 -
71	Lutetium-171	W, see ^{169}Lu Y, see ^{169}Lu	2E+3 -	2E+3 2E+3	8E-7 8E-7	3E-9 3E-9	3E-5 -	3E-4 -
71	Lutetium-172	W, see ^{169}Lu Y, see ^{169}Lu	1E+3 -	1E+3 1E+3	5E-7 5E-7	2E-9 2E-9	1E-5 -	1E-4 -
71	Lutetium-173	W, see ^{169}Lu Y, see ^{169}Lu	5E+3 - -	3E+2 Bone surf (5E+2) 3E+2	1E-7 - 1E-7	- 6E-10 4E-10	7E-5 - -	7E-4 - -
71	Lutetium-174m	W, see ^{169}Lu Y, see ^{169}Lu	2E+3 LLI wall (3E+3) -	2E+2 Bone surf (3E+2) 2E+2	1E-7 - 9E-8	- 5E-10 3E-10	- 4E-5 -	- 4E-4 -
71	Lutetium-174	W, see ^{169}Lu Y, see ^{169}Lu	5E+3 - -	1E+2 Bone surf (2E+2) 2E+2	5E-8 - 6E-8	- 3E-10 2E-10	7E-5 - -	7E-4 - -
71	Lutetium-176m	W, see ^{169}Lu Y, see ^{169}Lu	8E+3 -	3E+4 2E+4	1E-5 9E-6	3E-8 3E-8	1E-4 -	1E-3 -
71	Lutetium-176	W, see ^{169}Lu Y, see ^{169}Lu	7E+2 - -	5E+0 Bone surf (1E+1) 8E+0	2E-9 - 3E-9	- 2E-11 1E-11	1E-5 - -	1E-4 - -
71	Lutetium-177m	W, see ^{169}Lu Y, see ^{169}Lu	7E+2 - -	1E+2 Bone surf (1E+2) 8E+1	5E-8 - 3E-8	- 2E-10 1E-10	1E-5 - -	1E-4 - -
71	Lutetium-177	W, see ^{169}Lu Y, see ^{169}Lu	2E+3 LLI wall (3E+3) -	2E+3 - 2E+3	9E-7 - 9E-7	3E-9 - 3E-9	- 4E-5 -	- 4E-4 -
71	Lutetium-178m ²	W, see ^{169}Lu Y, see ^{169}Lu	5E+4 St. wall (6E+4) -	2E+5 - 2E+5	8E-5 - 7E-5	3E-7 - 2E-7	- 8E-4 -	- 8E-3 -
71	Lutetium-178 ²	W, see ^{169}Lu Y, see ^{169}Lu	4E+4 St wall (4E+4) -	1E+5 - 1E+5	5E-5 - 5E-5	2E-7 - 2E-7	- 6E-4 -	- 6E-3 -
71	Lutetium-179	W, see ^{169}Lu Y, see ^{169}Lu	6E+3 -	2E+4 2E+4	8E-6 6E-6	3E-8 3E-8	9E-5 -	9E-4 -
72	Hafnium-170	D, all compounds except those given for W W, oxides, hydroxides, carbides, and nitrates	3E+3 -	6E+3 5E+3	2E-6 2E-6	8E-9 6E-9	4E-5 -	4E-4 -

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

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
Atomic Radionuclide No.	Class	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)
		Oral Ingestion ALI (μCi)	Inhalation		Air (μCi/ml)	Water (μCi/ml)	
			ALI (μCi)	DAC (μCi/ml)			
73	Tantalum-175	W, see ¹⁷² Ta Y, see ¹⁷² Ta	6E+3 -	2E+4 1E+4	7E-6 6E-6	2E-8 2E-8	8E-4 -
73	Tantalum-176	W, see ¹⁷² Ta Y, see ¹⁷² Ta	4E+3 -	1E+4 1E+4	5E-6 5E-6	2E-8 2E-8	5E-4 -
73	Tantalum-177	W, see ¹⁷² Ta Y, see ¹⁷² Ta	1E+4 -	2E+4 2E+4	8E-6 7E-6	3E-8 2E-8	2E-3 -
73	Tantalum-178	W, see ¹⁷² Ta Y, see ¹⁷² Ta	2E+4 -	9E+4 7E+4	4E-5 3E-5	1E-7 1E-7	2E-3 -
73	Tantalum-179	W, see ¹⁷² Ta Y, see ¹⁷² Ta	2E+4 -	5E+3 9E+2	2E-6 4E-7	8E-9 1E-9	3E-3 -
73	Tantalum-180m	W, see ¹⁷² Ta Y, see ¹⁷² Ta	2E+4 -	7E+4 6E+4	3E-5 2E-5	9E-8 8E-8	3E-3 -
73	Tantalum-180	W, see ¹⁷² Ta Y, see ¹⁷² Ta	1E+3 -	4E+2 2E+1	2E-7 1E-8	6E-10 3E-11	2E-4 -
73	Tantalum-182m ²	W, see ¹⁷² Ta	2E+5 St wall (2E+5)	5E+5 -	2E-4 -	8E-7 -	- 3E-2
		Y, see ¹⁷² Ta	-	4E+5	2E-4	6E-7	-
73	Tantalum-182	W, see ¹⁷² Ta Y, see ¹⁷² Ta	8E+2 -	3E+2 1E+2	1E-7 6E-8	5E-10 2E-10	1E-4 -
73	Tantalum-183	W, see ¹⁷² Ta	9E+2 LLI wall (1E+3)	1E+3 -	5E-7 -	2E-9 -	- 2E-4
		Y, see ¹⁷² Ta	-	1E+3	4E-7	1E-9	-
73	Tantalum-184	W, see ¹⁷² Ta Y, see ¹⁷² Ta	2E+3 -	5E+3 5E+3	2E-6 2E-6	8E-9 7E-9	3E-4 -
73	Tantalum-185 ²	W, see ¹⁷² Ta Y, see ¹⁷² Ta	3E+4 -	7E+4 6E+4	3E-5 3E-5	1E-7 9E-8	4E-3 -
73	Tantalum-186 ²	W, see ¹⁷² Ta	5E+4 St wall (7E+4)	2E+5 -	1E-4 -	3E-7 -	- 1E-2
		Y, see ¹⁷² Ta	-	2E+5	9E-5	3E-7	-
74	Tungsten-176	D, all compounds	1E+4	5E+4	2E-5	7E-8	1E-3
74	Tungsten-177	D, all compounds	2E+4	9E+4	4E-5	1E-7	3E-3
74	Tungsten-178	D, all compounds	5E+3	2E+4	8E-6	3E-8	7E-4
74	Tungsten-179 ²	D, all compounds	5E+5	2E+6	7E-4	2E-6	7E-2
74	Tungsten-181	D, all compounds	2E+4	3E+4	1E-5	5E-8	2E-3
74	Tungsten-185	D, all compounds	2E+3 LLI wall (3E+3)	7E+3 -	3E-6 -	9E-9 -	- 4E-5
74	Tungsten-187	D, all compounds	2E+3	9E+3	4E-6	1E-8	3E-4
74	Tungsten-188	D, all compounds	4E+2 LLI wall (5E+2)	1E+3 -	5E-7 -	2E-9 -	- 7E-6

Atomic Radionuclide No.	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
		Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)	
75	Rhenium-177 ²	D, all compounds except those given for W	9E+4 St wall (1E+5)	3E+5	1E-4	4E-7	-	-
		W, oxides, hydroxides, and nitrates	-	4E+5	1E-4	5E-7	-	2E-2
75	Rhenium-178 ²	D, see ¹⁷⁷ Re	7E+4 St wall (1E+5)	3E+5	1E-4	4E-7	-	-
		W, see ¹⁷⁷ Re	-	3E+5	1E-4	4E-7	1E-3	1E-2
75	Rhenium-181	D, see ¹⁷⁷ Re	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
		W, see ¹⁷⁷ Re	-	9E+3	4E-6	1E-8	-	-
75	Rhenium-182 (12.7 h)	D, see ¹⁷⁷ Re	7E+3	1E+4	5E-6	2E-8	9E-5	9E-4
		W, see ¹⁷⁷ Re	-	2E+4	6E-6	2E-8	-	-
75	Rhenium-182 (64.0 h)	D, see ¹⁷⁷ Re	1E+3	2E+3	1E-6	3E-9	2E-5	2E-4
		W, see ¹⁷⁷ Re	-	2E+3	9E-7	3E-9	-	-
75	Rhenium-184m	D, see ¹⁷⁷ Re	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ¹⁷⁷ Re	-	4E+2	2E-7	6E-10	-	-
75	Rhenium-184	D, see ¹⁷⁷ Re	2E+3	4E+3	1E-6	5E-9	3E-5	3E-4
		W, see ¹⁷⁷ Re	-	1E+3	6E-7	2E-9	-	-
75	Rhenium-186m	D, see ¹⁷⁷ Re	1E+3 St wall (2E+3)	2E+3 St wall (2E+3)	7E-7	-	-	-
		W, see ¹⁷⁷ Re	-	2E+2	6E-8	3E-9 2E-10	2E-5	2E-4
75	Rhenium-186	D, see ¹⁷⁷ Re	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ¹⁷⁷ Re	-	2E+3	7E-7	2E-9	-	-
75	Rhenium-187	D, see ¹⁷⁷ Re	6E+5 St wall	8E+5	4E-4	-	8E-3	8E-2
		W, see ¹⁷⁷ Re	-	(9E+5) 1E+5	- 4E-5	1E-6 1E-7	-	-
75	Rhenium-188m ²	D, see ¹⁷⁷ Re	8E+4	1E+5	6E-5	2E-7	1E-3	1E-2
		W, see ¹⁷⁷ Re	-	1E+5	6E-5	2E-7	-	-
75	Rhenium-188	D, see ¹⁷⁷ Re	2E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		W, see ¹⁷⁷ Re	-	3E+3	1E-6	4E-9	-	-
75	Rhenium-189	D, see ¹⁷⁷ Re	3E+3	5E+3	2E-6	7E-9	4E-5	4E-4
		W, see ¹⁷⁷ Re	-	4E+3	2E-6	6E-9	-	-
76	Osmium-180 ²	D, all compounds except those given for W and Y	1E+5	4E+5	2E-4	5E-7	1E-3	1E-2
		W, halides and nitrates	-	5E+5	2E-4	7E-7	-	-
		Y, oxides and hydroxides	-	5E+5	2E-4	6E-7	-	-
76	Osmium-181 ²	D, see ¹⁸⁰ Os	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ¹⁸⁰ Os	-	5E+4	2E-5	6E-8	-	-
		Y, see ¹⁸⁰ Os	-	4E+4	2E-5	6E-8	-	-
76	Osmium-182	D, see ¹⁸⁰ Os	2E+3	6E+3	2E-6	8E-9	3E-5	3E-4
		W, see ¹⁸⁰ Os	-	4E+3	2E-6	6E-9	-	-
		Y, see ¹⁸⁰ Os	-	4E+3	2E-6	6E-9	-	-
76	Osmium-185	D, see ¹⁸⁰ Os	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
		W, see ¹⁸⁰ Os	-	8E+2	3E-7	1E-9	-	-
		Y, see ¹⁸⁰ Os	-	8E+2	3E-7	1E-9	-	-

Atomic Radionuclide No.	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
		Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC ($\mu\text{Ci/ml}$)	Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
76 Osmium-189m	D, see ^{180}Os	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
	W, see ^{180}Os	-	2E+5	9E-5	3E-7	-	-
	Y, see ^{180}Os	-	2E+5	7E-5	2E-7	-	-
76 Osmium-191m	D, see ^{180}Os	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
	W, see ^{180}Os	-	2E+4	8E-6	3E-8	-	-
	Y, see ^{180}Os	-	2E+4	7E-6	2E-8	-	-
76 Osmium-191	D, see ^{180}Os	2E+3	2E+3	9E-7	3E-9	-	-
	LLI wall (3E+3)	-	-	-	-	3E-5	3E-4
	W, see ^{180}Os	-	2E+3	7E-7	2E-9	-	-
76 Osmium-193	D, see ^{180}Os	2E+3	5E+3	2E-6	6E-9	-	-
	LLI wall (2E+3)	-	-	-	-	2E-5	2E-4
	W, see ^{180}Os	-	3E+3	1E-6	4E-9	-	-
76 Osmium-194	D, see ^{180}Os	4E+2	4E+1	2E-8	6E-11	-	-
	LLI wall (6E+2)	-	-	-	-	8E-6	8E-5
	W, see ^{180}Os	-	6E+1	2E-8	8E-11	-	-
77 Iridium-182 ²	D, all compounds except those given for W and Y	4E+4	1E+5	6E-5	2E-7	-	-
	St wall (4E+4)	-	-	-	-	6E-4	6E-3
	W, halides, nitrates, and metallic iridium	-	2E+5	6E-5	2E-7	-	-
77 Iridium-184	D, see ^{182}Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
	W, see ^{182}Ir	-	3E+4	1E-5	5E-8	-	-
	Y, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
77 Iridium-185	D, see ^{182}Ir	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
	W, see ^{182}Ir	-	1E+4	5E-6	2E-8	-	-
	Y, see ^{182}Ir	-	1E+4	4E-6	1E-8	-	-
77 Iridium-186	D, see ^{182}Ir	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
	W, see ^{182}Ir	-	6E+3	3E-6	9E-9	-	-
	Y, see ^{182}Ir	-	6E+3	2E-6	8E-9	-	-
77 Iridium-187	D, see ^{182}Ir	1E+4	3E+4	1E-5	5E-8	1E-4	1E-3
	W, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
	Y, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
77 Iridium-188	D, see ^{182}Ir	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
	W, see ^{182}Ir	-	4E+3	1E-6	5E-9	-	-
	Y, see ^{182}Ir	-	3E+3	1E-6	5E-9	-	-
77 Iridium-189	D, see ^{182}Ir	5E+3	5E+3	2E-6	7E-9	-	-
	LLI wall (5E+3)	-	-	-	-	7E-5	7E-4
	W, see ^{182}Ir	-	4E+3	2E-6	5E-9	-	-
77 Iridium-190m ²	D, see ^{182}Ir	2E+5	2E+5	8E-5	3E-7	2E-3	2E-2
	W, see ^{182}Ir	-	2E+5	9E-5	3E-7	-	-
	Y, see ^{182}Ir	-	2E+5	8E-5	3E-7	-	-

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
Atomic Radionuclide No.	Class	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)	
		Oral Ingestion ALI (μCi)	Inhalation					
			ALI (μCi)	DAC ($\mu\text{Ci}/\text{ml}$)				
					Air ($\mu\text{Ci}/\text{ml}$)	Water ($\mu\text{Ci}/\text{ml}$)		
77	Iridium-190	D, see ^{182}Ir	1E+3	9E+2	4E-7	1E-9	1E-5	1E-4
	W, see ^{182}Ir	-	-	1E+3	4E-7	1E-9	-	-
	Y, see ^{182}Ir	-	-	9E+2	4E-7	1E-9	-	-
77	Iridium-192m	D, see ^{182}Ir	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
	W, see ^{182}Ir	-	-	2E+2	9E-8	3E-10	-	-
	Y, see ^{182}Ir	-	-	2E+1	6E-9	2E-11	-	-
77	Iridium-192	D, see ^{182}Ir	9E+2	3E+2	1E-7	4E-10	1E-5	1E-4
	W, see ^{182}Ir	-	-	4E+2	2E-7	6E-10	-	-
	Y, see ^{182}Ir	-	-	2E+2	9E-8	3E-10	-	-
77	Iridium-194m	D, see ^{182}Ir	6E+2	9E+1	4E-8	1E-10	9E-6	9E-5
	W, see ^{182}Ir	-	-	2E+2	7E-8	2E-10	-	-
	Y, see ^{182}Ir	-	-	1E+2	4E-8	1E-10	-	-
77	Iridium-194	D, see ^{182}Ir	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
	W, see ^{182}Ir	-	-	2E+3	9E-7	3E-9	-	-
	Y, see ^{182}Ir	-	-	2E+3	8E-7	3E-9	-	-
77	Iridium-195m	D, see ^{182}Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
	W, see ^{182}Ir	-	-	3E+4	1E-5	4E-8	-	-
	Y, see ^{182}Ir	-	-	2E+4	9E-6	3E-8	-	-
77	Iridium-195	D, see ^{182}Ir	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
	W, see ^{182}Ir	-	-	5E+4	2E-5	7E-8	-	-
	Y, see ^{182}Ir	-	-	4E+4	2E-5	6E-8	-	-
78	Platinum-186	D, all compounds	1E+4	4E+4	2E-5	5E-8	2E-4	2E-3
78	Platinum-188	D, all compounds	2E+3	2E+3	7E-7	2E-9	2E-5	2E-4
78	Platinum-189	D, all compounds	1E+4	3E+4	1E-5	4E-8	1E-4	1E-3
78	Platinum-191	D, all compounds	4E+3	8E+3	4E-6	1E-8	5E-5	5E-4
78	Platinum-193m	D, all compounds	3E+3 LLI wall (3E+4)	6E+3	3E-6	8E-9	-	-
			-	-	-	-	4E-5	4E-4
78	Platinum-193	D, all compounds	4E+4 LLI wall (5E+4)	2E+4	1E-5	3E-8	-	-
			-	-	-	-	6E-4	6E-3
78	Platinum-195m	D, all compounds	2E+3 LLI wall (2E+3)	4E+3	2E-6	6E-9	-	-
			-	-	-	-	3E-5	3E-4
78	Platinum-197m ²	D, all compounds	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
78	Platinum-197	D, all compounds	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
78	Platinum-199 ²	D, all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
78	Platinum-200	D, all compounds	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
79	Gold-193	D, all compounds except those given for W and Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
	W, halides and nitrates	-	-	2E+4	9E-6	3E-8	-	-
	Y, oxides and hydroxides	-	-	2E+4	8E-6	3E-8	-	-
79	Gold-194	D, see ^{193}Au	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
	W, see ^{193}Au	-	-	5E+3	2E-6	8E-9	-	-
	Y, see ^{193}Au	-	-	5E+3	2E-6	7E-9	-	-

Atomic Radionuclide No.	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
		Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC ($\mu\text{Ci}/\text{ml}$)	Col. 1 Air ($\mu\text{Ci}/\text{ml}$)	Col. 2 Water ($\mu\text{Ci}/\text{ml}$)	Monthly Average Concentration ($\mu\text{Ci}/\text{ml}$)
79 Gold-195	D, see ^{193}Au	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
	W, see ^{193}Au	-	1E+3	6E-7	2E-9	-	-
	Y, see ^{193}Au	-	4E+2	2E-7	6E-10	-	-
79 Gold-198m	D, see ^{193}Au	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
	W, see ^{193}Au	-	1E+3	5E-7	2E-9	-	-
	Y, see ^{193}Au	-	1E+3	5E-7	2E-9	-	-
79 Gold-198	D, see ^{193}Au	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
	W, see ^{193}Au	-	2E+3	8E-7	3E-9	-	-
	Y, see ^{193}Au	-	2E+3	7E-7	2E-9	-	-
79 Gold-199	D, see ^{193}Au	3E+3	9E+3	4E-6	1E-8	-	-
		LLI wall (3E+3)	-	-	-	4E-5	4E-4
	W, see ^{193}Au	-	4E+3	2E-6	6E-9	-	-
79 Gold-200m	D, see ^{193}Au	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
	W, see ^{193}Au	-	3E+3	1E-6	4E-9	-	-
	Y, see ^{193}Au	-	2E+4	1E-6	3E-9	-	-
79 Gold-200 ²	D, see ^{193}Au	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
	W, see ^{193}Au	-	8E+4	3E-5	1E-7	-	-
	Y, see ^{193}Au	-	7E+4	3E-5	1E-7	-	-
79 Gold-201 ²	D, see ^{193}Au	7E+4	2E+5	9E-5	3E-7	-	-
		St wall (9E+4)	-	-	-	1E-3	1E-2
	W, see ^{193}Au	-	2E+5	1E-4	3E-7	-	-
80 Mercury-193m	Vapor	-	8E+3	4E-6	1E-8	-	-
	Organic D	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
	D, sulfates	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
80 Mercury-193	W, oxides, hydroxides, halides, nitrates, and sulfides	-	8E+3	3E-6	1E-8	-	-
	Vapor	-	3E+4	1E-5	4E-8	-	-
	Organic D	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
80 Mercury-194	D, see $^{193\text{m}}\text{Hg}$	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
	W, see $^{193\text{m}}\text{Hg}$	-	4E+4	2E-5	6E-8	-	-
	Vapor	-	3E+1	1E-8	4E-11	-	-
80 Mercury-195m	Organic D	2E+1	3E+1	1E-8	4E-11	2E-7	2E-6
	D, see $^{193\text{m}}\text{Hg}$	8E+2	4E+1	2E-8	6E-11	1E-5	1E-4
	W, see $^{193\text{m}}\text{Hg}$	-	1E+2	5E-8	2E-10	-	-
80 Mercury-195	Vapor	-	4E+3	2E-6	6E-9	-	-
	Organic D	3E+3	6E+3	3E-6	8E-9	4E-5	4E-4
	D, see $^{193\text{m}}\text{Hg}$	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
80 Mercury-197m	W, see $^{193\text{m}}\text{Hg}$	-	4E+3	2E-6	5E-9	-	-
	Vapor	-	3E+4	1E-5	4E-8	-	-
	Organic D	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
80 Mercury-197m	D, see $^{193\text{m}}\text{Hg}$	1E+4	4E+4	1E-5	5E-8	2E-4	2E-3
	W, see $^{193\text{m}}\text{Hg}$	-	3E+4	1E-5	5E-8	-	-
	Vapor	-	5E+3	2E-6	7E-9	-	-
80 Mercury-197m	Organic D	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
	D, see $^{193\text{m}}\text{Hg}$	3E+3	7E+3	3E-6	1E-8	4E-5	4E-4
	W, see $^{193\text{m}}\text{Hg}$	-	5E+3	2E-6	7E-9	-	-

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
Atomic Radionuclide No.	Class	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)	
		Oral Ingestion ALI (μCi)	Inhalation		Air (μCi/ml)	Water (μCi/ml)		
			ALI (μCi)	DAC (μCi/ml)				
80	Mercury-197	Vapor	-	8E+3	4E-6	1E-8	-	-
	Organic D	7E+3	1E+4	6E-6	2E-8	9E-5	9E-4	
	D, see ^{193m} Hg	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4	
	W, see ^{193m} Hg	-	9E+3	4E-6	1E-8	-	-	
80	Mercury-199m ²	Vapor	-	8E+4	3E-5	1E-7	-	-
	Organic D	6E+4	2E+5	7E-5	2E-7	-	-	
	St wall (1E+5)	-	-	-	-	1E-3	1E-2	
	D, see ^{193m} Hg	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3	
	W, see ^{193m} Hg	-	2E+5	7E-5	2E-7	-	-	
80	Mercury-203	Vapor	-	8E+2	4E-7	1E-9	-	-
	Organic D	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5	
	D, see ^{193m} Hg	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4	
	W, see ^{193m} Hg	-	1E+3	5E-7	2E-9	-	-	
81	Thallium-194m ²	D, all compounds	5E+4	2E+5	6E-5	2E-7	-	-
	St wall (7E+4)	-	-	-	-	1E-3	1E-2	
81	Thallium-194 ²	D, all compounds	3E+5	6E+5	2E-4	8E-7	-	-
	St wall (3E+5)	-	-	-	-	4E-3	4E-2	
81	Thallium-195 ²	D, all compounds	6E+4	1E+5	5E-5	2E-7	9E-4	9E-3
81	Thallium-197	D, all compounds	7E+4	1E+5	5E-5	2E-7	1E-3	1E-2
81	Thallium-198m ²	D, all compounds	3E+4	5E+4	2E-5	8E-8	4E-4	4E-3
81	Thallium-198	D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
81	Thallium-199	D, all compounds	6E+4	8E+4	4E-5	1E-7	9E-4	9E-3
81	Thallium-200	D, all compounds	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
81	Thallium-201	D, all compounds	2E+4	2E+4	9E-6	3E-8	2E-4	2E-3
81	Thallium-202	D, all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
81	Thallium-204	D, all compounds	2E+3	2E+3	9E-7	3E-9	2E-5	2E-4
82	Lead-195m ²	D, all compounds	6E+4	2E+5	8E-5	3E-7	8E-4	8E-3
82	Lead-198	D, all compounds	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
82	Lead-199 ²	D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
82	Lead-200	D, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
82	Lead-201	D, all compounds	7E+3	2E+4	8E-6	3E-8	1E-4	1E-3
82	Lead-202m	D, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
82	Lead-202	D, all compounds	1E+2	5E+1	2E-8	7E-11	2E-6	2E-5
82	Lead-203	D, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
82	Lead-205	D, all compounds	4E+3	1E+3	6E-7	2E-9	5E-5	5E-4
82	Lead-209	D, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
82	Lead-210	D, all compounds	6E1 Bone surf (1E+0)	2E1 Bone surf (4E-1)	1E-10	-	-	-
				-	6E-13	1E-8	1E-7	

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
Atomic Radionuclide No.	Class	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)	
		Oral Ingestion	Inhalation					
		ALI (μCi)	ALI (μCi)	DAC (μCi/ml)				
82	Lead-211 ²	D, all compounds	1E+4	6E+2	3E-7	9E-10	2E-4	2E-3
82	Lead-212	D, all compounds	8E+1 Bone surf (1E+2)	3E+1	1E-8	5E-11	-	-
82	Lead-214 ²	D, all compounds	9E+3	8E+2	3E-7	1E-9	1E-4	1E-3
83	Bismuth-200 ²	D, nitrates W, all other compounds	3E+4 -	8E+4 1E+5	4E-5 4E-5	1E-7 1E-7	4E-4 -	4E-3 -
83	Bismuth-201 ²	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	1E+4 -	3E+4 4E+4	1E-5 2E-5	4E-8 5E-8	2E-4 -	2E-3 -
83	Bismuth-202 ²	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	1E+4 -	4E+4 8E+4	2E-5 3E-5	6E-8 1E-7	2E-4 -	2E-3 -
83	Bismuth-203	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	2E+3 -	7E+3 6E+3	3E-6 3E-6	9E-9 9E-9	3E-5 -	3E-4 -
83	Bismuth-205	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	1E+3 -	3E+3 1E+3	1E-6 5E-7	3E-9 2E-9	2E-5 -	2E-4 -
83	Bismuth-206	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	6E+2 -	1E+3 9E+2	6E-7 4E-7	2E-9 1E-9	9E-6 -	9E-5 -
83	Bismuth-207	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	1E+3 -	2E+3 4E+2	7E-7 1E-7	2E-9 5E-10	1E-5 -	1E-4 -
83	Bismuth-210m	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	4E+1 Kidneys (6E+1) -	5E+0 Kidneys (6E+0) 7E-1	2E-9 - 3E-10	- 9E-12 9E-13	- 8E-7 -	- 8E-6 -
83	Bismuth-210	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	8E+2 - -	2E+2 Kidneys (4E+2) 3E+1	1E-7 - 1E-8	- 5E-10 4E-11	1E-5 - -	1E-4 - -
83	Bismuth-212 ²	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	5E+3 -	2E+2 3E+2	1E-7 1E-7	3E-10 4E-10	7E-5 -	7E-4 -
83	Bismuth-213 ²	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	7E+3 -	3E+2 4E+2	1E-7 1E-7	4E-10 5E-10	1E-4 -	1E-3 -
83	Bismuth-214 ²	D, see ²⁰⁰ Bi W, see ²⁰⁰ Bi	2E+4 St wall (2E+4) -	8E+2 - 9E-2	3E-7 - 4E-7	1E-9 - 1E-9	- 3E-4 -	- 3E-3 -
84	Polonium-203 ²	D, all compounds except those given for W W, oxides, hydroxides, and nitrates	3E+4 -	6E+4 9E+4	3E-5 4E-5	9E-8 1E-7	3E-4 -	3E-3 -
84	Polonium-205 ²	D, see ²⁰³ Po W, see ²⁰³ Po	2E+4 -	4E+4 7E+4	2E-5 3E-5	5E-8 1E-7	3E-4 -	3E-3 -
84	Polonium-207	D, see ²⁰³ Po W, see ²⁰³ Po	8E+3 -	3E+4 3E+4	1E-5 1E-5	3E-8 4E-8	1E-4 -	1E-3 -
84	Polonium-210	D, see ²⁰³ Po W, see ²⁰³ Po	3E+0 -	6E-1 6E-1	3E-10 3E-10	9E-13 9E-13	4E-8 -	4E-7 -
85	Astatine-207 ²	D, halides W	6E+3 -	3E+3 2E+3	1E-6 9E-7	4E-9 3E-9	8E-5 -	8E-4 -

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
Atomic Radionuclide No.	Class	Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)	
		ALI (μCi)	DAC (μCi/ml)					
85	Astatine-211	D, halides	1E+2	8E+1	3E-8	1E-10	2E-6	2E-5
		W	-	5E+1	2E-8	8E-11	-	-
86	Radon-220	With daughters removed	-	2E+4	7E-6	2E-8	-	-
		With daughters present	-	2E+1 (or 12 working level months)	9E-9	3E-11 (or 1.0 working level)	-	-
86	Radon-222	With daughters removed	-	1E+4	4E-6	1E-8	-	-
		With daughters present	-	1E+2 (or 4 working level months)	3E-8	1E-10 (or 0.33 working level)	-	-
87	Francium-222 ²	D, all compounds	2E+3	5E+2	2E-7	6E-10	3E-5	3E-4
87	Francium-223 ²	D, all compounds	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
88	Radium-223	W, all compounds	5E+0 Bone surf (9E+0)	7E-1	3E-10	9E-13	-	-
			-	-	-	1E-7	1E-6	
88	Radium-224	W, all compounds	8E+0 Bone surf (2E+1)	2E+0	7E-10	2E-12	-	-
			-	-	-	2E-7	2E-6	
88	Radium-225	W, all compounds	8E+0 Bone surf (2E+1)	7E-1	3E-10	9E-13	-	-
			-	-	-	2E-7	2E-6	
88	Radium-226	W, all compounds	2E+0 Bone surf (5E+0)	6E-1	3E-10	9E-13	-	-
			-	-	-	6E-8	6E-7	
88	Radium-227 ²	W, all compounds	2E+4 Bone surf (2E+4)	1E+4 Bone surf (2E+4)	6E-6	-	-	-
			-	-	3E-8	3E-4	3E-3	
88	Radium-228	W, all compounds	2E+0 Bone surf (4E+0)	1E+0	5E-10	2E-12	-	-
			-	-	-	6E-8	6E-7	
89	Actinium-224	D, all compounds except those given for W and Y	2E+3 LLI wall (2E+3)	3E+1 Bone surf (4E+1)	1E-8	-	-	-
		W, halides and nitrates	-	5E+1	2E-8	5E-11	3E-5	3E-4
		Y, oxides and hydroxides	-	5E+1	2E-8	7E-11	-	-
			-	-	6E-11	-	-	
89	Actinium-225	D, see ²²⁴ Ac	5E+1 LLI wall (5E+1)	3E-1 Bone surf (5E-1)	1E-10	-	-	-
		W, see ²²⁴ Ac	-	6E-1	3E-10	7E-13	7E-7	7E-6
		Y, see ²²⁴ Ac	-	6E-1	3E-10	9E-13	-	-
89	Actinium-226	D, see ²²⁴ Ac	1E+2 LLI wall (1E+2)	3E+0 Bone surf (4E+0)	1E-9	-	-	-
		W, see ²²⁴ Ac	-	5E+0	2E-9	5E-12	2E-6	2E-5
		Y, see ²²⁴ Ac	-	5E+0	2E-9	7E-12	-	-
			-	-	6E-12	-	-	

Atomic Radionuclide No.	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
		Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration ($\mu\text{Ci/ml}$)
		Oral Ingestion ALI (μCi)	Inhalation ALI (μCi)	DAC ($\mu\text{Ci/ml}$)	Air ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)	
89 Actinium-227	D, see ^{224}Ac	2E-1 Bone surf (4E-1)	4E-4 Bone surf (8E-4)	2E-13	-	-	-
	W, see ^{224}Ac	-	2E-3 Bone surf (3E-3)	7E-13	1E-15	5E-9	5E-8
	Y, see ^{224}Ac	-	4E-3	2E-12	4E-15 6E-15	-	-
89 Actinium-228	D, see ^{224}Ac	2E+3	9E+0 Bone surf (2E+1)	4E-9	-	3E-5	3E-4
	W, see ^{224}Ac	-	4E+1 Bone surf (6E+1)	2E-8	2E-11	-	-
	Y, see ^{224}Ac	-	4E+1	2E-8	8E-11 6E-11	-	-
90 Thorium-226 ²	W, all compounds except those given for Y	5E+3 St wall (5E+3)	2E+2	6E-8	2E-10	-	-
	Y, oxides and hydroxides	-	1E+2	6E-8	2E-10	7E-5	7E-4
90 Thorium-227	W, see ^{226}Th	1E+2	3E-1	1E-10	5E-13	2E-6	2E-5
	Y, see ^{226}Th	-	3E-1	1E-10	5E-13	-	-
90 Thorium-228	W, see ^{226}Th	6E+0 Bone surf (1E+1)	1E-2 Bone surf (2E-2)	4E-12	-	-	-
	Y, see ^{226}Th	-	2E-2	7E-12	3E-14 2E-14	2E-7	2E-6
90 Thorium-229	W, see ^{226}Th	6E-1 Bone surf (1E+0)	9E-4 Bone surf (2E-3)	4E-13	-	-	-
	Y, see ^{226}Th	-	2E-3 Bone surf (3E-3)	1E-12	3E-15	2E-8	2E-7
		-	-	-	4E-15	-	-
90 Thorium-230	W, see ^{226}Th	4E+0 Bone surf (9E+0)	6E-3 Bone surf (2E-2)	3E-12	-	-	-
	Y, see ^{226}Th	-	2E-2 Bone surf (2E-2)	6E-12	2E-14	1E-7	1E-6
		-	-	-	3E-14	-	-
90 Thorium-231	W, see ^{226}Th	4E+3	6E+3	3E-6	9E-9	5E-5	5E-4
	Y, see ^{226}Th	-	6E+3	3E-6	9E-9	-	-
90 Thorium-232	W, see ^{226}Th	7E-1 Bone surf (2E+0)	1E-3 Bone surf (3E-3)	5E-13	-	-	-
	Y, see ^{226}Th	-	3E-3 Bone surf (4E-3)	1E-12	4E-15	3E-8	3E-7
		-	-	-	6E-15	-	-
90 Thorium-234	W, see ^{226}Th	3E+2 LLI wall (4E+2)	2E+2	8E-8	3E-10	-	-
	Y, see ^{226}Th	-	2E+2	6E-8	2E-10	5E-6	5E-5
91 Protactinium-227 ²	W, all compounds except those given for Y	4E+3	1E+2	5E-8	2E-10	5E-5	5E-4
	Y, oxides and hydroxides	-	1E+2	4E-8	1E-10	-	-
91 Protactinium-228	W, see ^{227}Pa	1E+3	1E+1	5E-9	-	2E-5	2E-4
		-	Bone surf (2E+1)	-	3E-11	-	-

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
Atomic Radionuclide No.	Class	Col. 1 Oral Ingestion ALI (μCi)	Col. 2	Col. 3	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
			Inhalation				
			ALI (μCi)	DAC (μCi/ml)			
91	Protactinium-230 W, see ²²⁷ Pa	-	1E+1	5E-9	2E-11	-	-
	Y, see ²²⁷ Pa	6E+2	5E+0	2E-9	7E-12	-	-
	Bone surf (9E+2)	-	-	-	-	1E-5	1E-4
91	Protactinium-231 W, see ²²⁷ Pa	-	4E+0	1E-9	5E-12	-	-
	Y, see ²²⁷ Pa	2E-1	2E-3	6E-13	-	-	-
	Bone surf (5E-1)	-	Bone surf (4E-3)	-	6E-15	6E-9	6E-8
91	Protactinium-232 W, see ²²⁷ Pa	-	4E-3	2E-12	-	-	-
	Y, see ²²⁷ Pa	-	Bone surf (6E-3)	-	8E-15	-	-
	Bone surf (6E-3)	-	-	-	-	-	-
91	Protactinium-233 W, see ²²⁷ Pa	1E+3	2E+1	9E-9	-	2E-5	2E-4
	Y, see ²²⁷ Pa	-	Bone surf (6E+1)	-	8E-11	-	-
	Bone surf (6E+1)	-	6E+1	2E-8	-	-	-
91	Protactinium-233 W, see ²²⁷ Pa	-	Bone surf (7E+1)	-	1E-10	-	-
	Y, see ²²⁷ Pa	1E+3	7E+2	3E-7	1E-9	-	-
	LLI wall (2E+3)	-	-	-	-	2E-5	2E-4
91	Protactinium-234 W, see ²²⁷ Pa	-	6E+2	2E-7	8E-10	-	-
	Y, see ²²⁷ Pa	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
	Bone surf (6E+0)	-	7E+3	3E-6	9E-9	-	-
92	Uranium-230 D, UF, UOF, UO(NO)	4E+0	4E-1	2E-10	-	-	-
	W, UO, UF, UCL	-	Bone surf (6E-1)	-	8E-13	8E-8	8E-7
	Y, UO, UO	-	4E-1	1E-10	5E-13	-	-
92	Uranium-231 D, see ²³⁰ U	-	3E-1	1E-10	4E-13	-	-
	W, see ²³⁰ U	5E+3	8E+3	3E-6	1E-8	-	-
	Y, see ²³⁰ U	LLI wall (4E+3)	-	-	-	6E-5	6E-4
92	Uranium-232 D, see ²³⁰ U	-	6E+3	2E-6	8E-9	-	-
	W, see ²³⁰ U	-	5E+3	2E-6	6E-9	-	-
	Y, see ²³⁰ U	2E+0	2E-1	9E-11	-	-	-
92	Uranium-233 D, see ²³⁰ U	Bone surf (4E+0)	Bone surf (4E-1)	-	6E-13	6E-8	6E-7
	W, see ²³⁰ U	-	4E-1	2E-10	5E-13	-	-
	Y, see ²³⁰ U	-	8E-3	3E-12	1E-14	-	-
92	Uranium-233 D, see ²³⁰ U	1E+1	1E+0	5E-10	-	-	-
	W, see ²³⁰ U	Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
	Y, see ²³⁰ U	-	7E-1	3E-10	1E-12	-	-
92	Uranium-234 ³ D, see ²³⁰ U	-	4E-2	2E-11	5E-14	-	-
	W, see ²³⁰ U	1E+1	1E+0	5E-10	-	-	-
	Y, see ²³⁰ U	Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
92	Uranium-235 ³ D, see ²³⁰ U	-	7E-1	3E-10	1E-12	-	-
	W, see ²³⁰ U	-	4E-2	2E-11	5E-14	-	-
	Y, see ²³⁰ U	-	8E-1	3E-10	1E-12	-	-
92	Uranium-235 ³ D, see ²³⁰ U	-	4E-2	2E-11	6E-14	-	-
	W, see ²³⁰ U	1E+1	1E+0	6E-10	-	-	-
	Y, see ²³⁰ U	Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 DAC ($\mu\text{Ci/ml}$)	Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
92	Uranium-236	D, see ^{230}U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	5E-10	-	-	-
		W, see ^{230}U	-	8E-1	3E-10	3E-12	3E-7	3E-6
		Y, see ^{230}U	-	4E-2	2E-11	1E-12	-	-
			-	-	-	6E-14	-	-
92	Uranium-237	D, see ^{230}U	2E+3 LLI wall (2E+3)	3E+3	1E-6	4E-9	-	-
		W, see ^{230}U	-	2E+3	7E-7	-	3E-5	3E-4
		Y, see ^{230}U	-	2E+3	6E-7	2E-9	-	-
92	Uranium-238 ³	D, see ^{230}U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	6E-10	-	-	-
		W, see ^{230}U	-	8E-1	3E-10	3E-12	3E-7	3E-6
		Y, see ^{230}U	-	4E-2	2E-11	1E-12	-	-
			-	-	-	6E-14	-	-
92	Uranium-239 ²	D, see ^{230}U	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
		W, see ^{230}U	-	2E+5	7E-5	2E-7	-	-
		Y, see ^{230}U	-	2E+5	6E-5	2E-7	-	-
92	Uranium-240	D, see ^{230}U	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		W, see ^{230}U	-	3E+3	1E-6	4E-9	-	-
		Y, see ^{230}U	-	2E+3	1E-6	3E-9	-	-
92	Uranium-natural ³	D, see ^{230}U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	5E-10	-	-	-
		W, see ^{230}U	-	8E-1	3E-10	3E-12	3E-7	3E-6
		Y, see ^{230}U	-	5E-2	2E-11	9E-13	-	-
			-	-	-	9E-14	-	-
93	Neptunium-232 ²	W, all compounds	1E+5	2E+3 Bone surf (5E+2)	7E-7	-	2E-3	2E-2
			-	-	-	6E-9	-	-
93	Neptunium-233 ²	W, all compounds	8E+5	3E+6	1E-3	4E-6	1E-2	1E-1
93	Neptunium-234	W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
93	Neptunium-235	W, all compounds	2E+4 LLI wall (2E+4)	8E+2 Bone surf (1E+3)	3E-7	-	-	-
			-	-	-	2E-9	3E-4	3E-3
93	Neptunium-236 (1.15E+5 y)	W, all compounds	3E+0 Bone surf (6E+0)	2E-2 Bone surf (5E-2)	9E-12	-	-	-
			-	-	-	8E-14	9E-8	9E-7
93	Neptunium-236 (22.5 h)	W, all compounds	3E+3 Bone surf (4E+3)	3E+1 Bone surf (7E+1)	1E-8	-	-	-
			-	-	-	1E-10	5E-5	5E-4
93	Neptunium-237	W, all compounds	5E-1 Bone surf (1E+0)	4E-3 Bone surf (1E-2)	2E-12	-	-	-
			-	-	-	1E-14	2E-8	2E-7
93	Neptunium-238	W, all compounds	1E+3	6E+1 Bone surf (2E+2)	3E-8	-	2E-5	2E-4
			-	-	-	2E-10	-	-
93	Neptunium-239	W, all compounds	2E+3 LLI wall (2E+3)	2E+3	9E-7	3E-9	-	-
			-	-	-	-	2E-5	2E-4
93	Neptunium-240 ²	W, all compounds	2E+4	3E+4	3E-5	1E-7	3E-4	3E-3

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
Atomic Radionuclide No.	Class	Col. 1 Oral Ingestion ALI (μCi)	Col. 2	Col. 3	Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
			Inhalation ALI (μCi)	DAC ($\mu\text{Ci/ml}$)			
94	Plutonium-234	W, all compounds except PuO Y, PuO	8E+3 -	2E+2 2E+2 9E-8 8E-8	3E-10 3E-10	1E-4 -	1E-3 -
94	Plutonium-235 ²	W, see ²³⁴ Pu Y, see ²³⁴ Pu	9E+5 -	3E+6 3E+6 1E-3 1E-3	4E-6 3E-6	1E-2 -	1E-1 -
94	Plutonium-236	W, see ²³⁴ Pu Y, see ²³⁴ Pu	2E+0 Bone surf (4E+0) -	2E-2 Bone surf (4E-2) 4E-2 2E-11	- 5E-14 6E-14	- 6E-8 -	- 6E-7 -
94	Plutonium-237	W, see ²³⁴ Pu Y, see ²³⁴ Pu	1E+4 -	3E+3 3E+3 1E-6 1E-6	5E-9 4E-9	2E-4 -	2E-3 -
94	Plutonium-238	W, see ²³⁴ Pu Y, see ²³⁴ Pu	9E-1 Bone surf (2E+0) -	7E-3 Bone surf (1E-2) 2E-2 8E-12	- 2E-14 2E-14	- 2E-8 -	- 2E-7 -
94	Plutonium-239	W, see ²³⁴ Pu Y, see ²³⁴ Pu	8E-1 Bone surf (1E+0) -	6E-3 Bone surf (1E-2) 2E-2 Bone surf (2E-2) -	- 2E-14 -	- 2E-8 -	- 2E-7 -
94	Plutonium-240	W, see ²³⁴ Pu Y, see ²³⁴ Pu	8E-1 Bone surf (1E+0) -	6E-3 Bone surf (1E-2) 2E-2 Bone surf (2E-2) -	- 2E-14 -	- 2E-8 -	- 2E-7 -
94	Plutonium-241	W, see ²³⁴ Pu Y, see ²³⁴ Pu	4E+1 Bone surf (7E+1) -	3E-1 Bone surf (6E-1) 8E-1 Bone surf (1E+0) -	- 8E-13 -	- 1E-6 -	- 1E-5 -
94	Plutonium-242	W, see ²³⁴ Pu Y, see ²³⁴ Pu	8E-1 Bone surf (1E+0) -	7E-3 Bone surf (1E-2) 2E-2 Bone surf (2E-2) -	- 2E-14 -	- 2E-8 -	- 2E-7 -
94	Plutonium-243	W, see ²³⁴ Pu Y, see ²³⁴ Pu	2E+4 -	4E+4 4E+4 2E-5 2E-5	5E-8 5E-8	2E-4 -	2E-3 -
94	Plutonium-244	W, see ²³⁴ Pu Y, see ²³⁴ Pu	8E-1 Bone surf (2E+0) -	7E-3 Bone surf (1E-2) 2E-2 Bone surf (2E-2) -	- 2E-14 -	- 2E-8 -	- 2E-7 -
94	Plutonium-245	W, see ²³⁴ Pu Y, see ²³⁴ Pu	2E+3 -	5E+3 4E+3 2E-6 2E-6	6E-9 6E-9	3E-5 -	3E-4 -
94	Plutonium-246	W, see ²³⁴ Pu Y, see ²³⁴ Pu	4E+2 LLI wall (4E+2) -	3E+2 - 3E+2 1E-7 1E-7	4E-10 -	- 6E-6 -	- 6E-5 -

		43 Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers	
Atomic Radionuclide No.	Class	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)	
		Oral Ingestion ALI (μCi)	Inhalation					Air (μCi/ml)
			ALI (μCi)	DAC (μCi/ml)				
95	Americium-237 ²	W, all compounds	8E+4	3E+5	1E-4	4E-7	1E-3	1E-2
95	Americium-238 ²	W, all compounds	4E+4	3E+3	1E-6	-	5E-4	5E-3
			-	Bone surf (6E+3)	-	9E-9	-	-
95	Americium-239	W, all compounds	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
95	Americium-240	W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
95	Americium-241	W, all compounds	8E-1	6E-3	3E-12	-	-	-
		Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7	
95	Americium-242m	W, all compounds	8E-1	6E-3	3E-12	-	-	-
		Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7	
95	Americium-242	W, all compounds	4E+3	8E+1	4E-8	-	5E-5	5E-4
		-	Bone surf (9E+1)	-	1E-10	-	-	
95	Americium-243	W, all compounds	8E-1	6E-3	3E-12	-	-	-
		Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7	
95	Americium-244m ²	W, all compounds	6E+4	4E+3	2E-6	-	-	-
		St wall (8E+4)	Bone surf (7E+3)	-	1E-8	1E-3	1E-2	
95	Americium-244	W, all compounds	3E+3	2E+2	8E-8	-	4E-5	4E-4
		-	Bone surf (3E+2)	-	4E-10	-	-	
95	Americium-245	W, all compounds	3E+4	8E+4	3E-5	1E-7	4E-4	4E-3
95	Americium-246m ²	W, all compounds	5E+4	2E+5	8E-5	3E-7	-	-
		St wall (6E+4)	-	-	-	8E-4	8E-3	
95	Americium-246 ²	W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
96	Curium-238	W, all compounds	2E+4	1E+3	5E-7	2E-9	2E-4	2E-3
96	Curium-240	W, all compounds	6E+1	6E-1	2E-10	-	-	-
		Bone surf (8E+1)	Bone surf (6E-1)	-	9E-13	1E-6	1E-5	
96	Curium-241	W, all compounds	1E+3	3E+1	1E-8	-	2E-5	2E-4
		-	Bone surf (4E+1)	-	5E-11	-	-	
96	Curium-242	W, all compounds	3E+1	3E-1	1E-10	-	-	-
		Bone surf (5E+1)	Bone surf (3E-1)	-	4E-13	7E-7	7E-6	
96	Curium-243	W, all compounds	1E+0	9E-3	4E-12	-	-	-
		Bone surf (2E+0)	Bone surf (2E-2)	-	2E-14	3E-8	3E-7	
96	Curium-244	W, all compounds	1E+0	1E-2	5E-12	-	-	-
		Bone surf (3E+0)	Bone surf (2E-2)	-	3E-14	3E-8	3E-7	
96	Curium-245	W, all compounds	7E-1	6E-3	3E-12	-	-	-
		Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7	

Table 1
Occupational ValuesTable 2
Effluent
ConcentrationsTable 3
Releases to
Sewers

Atomic Radionuclide No.	Class	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)
		Oral Ingestion	Inhalation		Air (μCi/ml)	Water (μCi/ml)	
		ALI (μCi)	ALI (μCi)	DAC (μCi/ml)			
96	Curium-246	W, all compounds	7E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12 -	- 2E-14	- 2E-8 2E-7
96	Curium-247	W, all compounds	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12 -	- 2E-14	- 2E-8 2E-7
96	Curium-248	W, all compounds	2E-1 Bone surf (4E-1)	2E-3 Bone surf (3E-3)	7E-13 -	- 4E-15	- 5E-9 5E-8
96	Curium-249 ²	W, all compounds	5E+4 -	2E+4 Bone surf (3E+4)	7E-6 -	- 4E-8	7E-4 -
96	Curium-250	W, all compounds	4E-2 Bone surf (6E-2)	3E-4 Bone surf (5E-4)	1E-13 -	- 8E-16	- 9E-10 9E-9
97	Berkelium-245	W, all compounds	2E+3	1E+3	5E-7	2E-9	3E-5 3E-4
97	Berkelium-246	W, all compounds	3E+3	3E+3	1E-6	4E-9	4E-5 4E-4
97	Berkelium-247	W, all compounds	5E-1 Bone surf (1E+0)	4E-3 Bone surf (9E-3)	2E-12 -	- 1E-14	- 2E-8 2E-7
97	Berkelium-249	W, all compounds	2E+2 Bone surf (5E+2)	2E+0 Bone surf (4E+0)	7E-10 -	- 5E-12	- 6E-6 6E-5
97	Berkelium-250	W, all compounds	9E+3 -	3E+2 Bone surf (7E+2)	1E-7 -	- 1E-9	1E-4 -
98	Californium-244 ²	W, all compounds except those given for Y	3E+4 St wall (3E+4)	6E+2 -	2E-7 -	8E-10 -	- 4E-4 4E-3
	Y, oxides and hydroxides		-	6E+2	2E-7	8E-10	-
98	Californium-246	W, see ²⁴⁴ Cf Y, see ²⁴⁴ Cf	4E+2 -	9E+0 9E+0	4E-9 4E-9	1E-11 1E-11	5E-6 -
98	Californium-248	W, see ²⁴⁴ Cf Y, see ²⁴⁴ Cf	8E+0 Bone surf (2E+1) -	6E-2 Bone surf (1E-1) 1E-1	3E-11 - 4E-11	- 2E-13 1E-13	- 2E-7 -
98	Californium-249	W, see ²⁴⁴ Cf Y, see ²⁴⁴ Cf	5E-1 Bone surf (1E+0) -	4E-3 Bone surf (9E-3) 1E-2 Bone surf (1E-2)	2E-12 - 4E-12 -	- 1E-14 2E-14	- 2E-8 -
98	Californium-250	W, see ²⁴⁴ Cf Y, see ²⁴⁴ Cf	1E+0 Bone surf (2E+0) -	9E-3 Bone surf (2E-2) 3E-2	4E-12 - 1E-11	- 3E-14 4E-14	- 3E-8 -

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Inhalation		Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
				Col. 2 ALI (μCi)	Col. 3 DAC ($\mu\text{Ci/ml}$)			
98	Californium-251	Y, see ^{244}Cf W, see ^{244}Cf Y, see ^{244}Cf	- 5E-1 Bone surf (1E+0) - -	3E-2 4E-3 Bone surf (9E-3) 1E-2 Bone surf (1E-2)	1E-11 2E-12 - 4E-12 -	4E-14 - 1E-14 - 2E-14	- - 2E-8 - -	- - 2E-7 - -
98	Californium-252	W, see ^{244}Cf Y, see ^{244}Cf	2E+0 Bone surf (5E+0) -	2E-2 Bone surf (4E-2) 3E-2	8E-12 - 1E-11	- 5E-14 5E-14	- 7E-8 -	- 7E-7 -
98	Californium-253	W, see ^{244}Cf Y, see ^{244}Cf	2E+2 Bone surf (4E+2) -	2E+0 - 2E+0	8E-10 - 7E-10	3E-12 - 2E-12	- 5E-6 -	- 5E-5 -
98	Californium-254	W, see ^{244}Cf Y, see ^{244}Cf	2E+0 -	2E-2 2E-2	9E-12 7E-12	3E-14 2E-14	3E-8 -	3E-7 -
99	Einsteinium-250	W, all compounds	4E+4 -	5E+2 Bone surf (1E+3)	2E-7 -	- 2E-9	6E-4 -	6E-3 -
99	Einsteinium-251	W, all compounds	7E+3 -	9E+2 Bone surf (1E+3)	4E-7 -	- 2E-9	1E-4 -	1E-3 -
99	Einsteinium-253	W, all compounds	2E+2	1E+0	6E-10	2E-12	2E-6	2E-5
99	Einsteinium-254m	W, all compounds	3E+2 LLI wall (3E+2)	1E+1 -	4E-9 -	1E-11 -	- 4E-6	- 4E-5
99	Einsteinium-254	W, all compounds	8E+0 Bone surf (2E+1)	7E-2 Bone surf (1E-1)	3E-11 -	- 2E-13	- 2E-7	- 2E-6
100	Fermium-252	W, all compounds	5E+2	1E+1	5E-9	2E-11	6E-6	6E-5
100	Fermium-253	W, all compounds	1E+3	1E+1	4E-9	1E-11	1E-5	1E-4
100	Fermium-254	W, all compounds	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
100	Fermium-255	W, all compounds	5E+2	2E+1	9E-9	3E-11	7E-6	7E-5
100	Fermium-257	W, all compounds	2E+1 Bone surf (4E+1)	2E-1 Bone surf (2E-1)	7E-11 - -	- 3E-13	- 5E-7	- 5E-6
101	Mendelevium-257	W, all compounds	7E+3 -	8E+1 Bone surf (9E+1)	4E-8 - -	- 1E-10	1E-4 -	1E-3 -
101	Mendelevium-258	W, all compounds	3E+1 Bone surf (5E+1)	2E-1 Bone surf (3E-1)	1E-10 - -	- 5E-13	- 6E-7	- 6E-6

		Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
Atomic Radionuclide No.	Class	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration ($\mu\text{Ci/ml}$)
		Oral Ingestion	Inhalation		Air ($\mu\text{Ci/ml}$)	Water ($\mu\text{Ci/ml}$)	
		ALI (μCi)	ALI (μCi)	DAC ($\mu\text{Ci/ml}$)			
-	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 ¹ -	2E+2	1E-7	1E-9	-	-
-	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	. . . . -	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	. . . . -	4E-4	2E-13	1E-15	2E-9	2E-8

Atomic Radionuclide No.	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
		Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)
		Oral Ingestion ALI (μCi)	Inhalation		Air (μCi/ml)	Water (μCi/ml)	
			ALI (μCi)	DAC (μCi/ml)			
If it is known that Ac-227-D and Cm-250-W are not present							
-			7E-4	3E-13	-	-	-
If, in addition, it is known that Ac-227-W,Y, Th-229-W,Y, Th-230-W, Th-232-W,Y, Pa-231-W,Y, Np-237-W, Pu-239-W, Pu-240-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							
-			7E-3	3E-12	-	-	-
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-232-Y, U-233-Y, U-234-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-254-W,Y are not present							
-			7E-2	3E-11	-	-	-
If, in addition, it is known that 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, 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							
-			7E-1	3E-10	-	-	-
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, Hf-182-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							
-			7E+0	3E-9	-	-	-
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							
-			-	-	-	1E-14	-
If, in addition, it is known that Sm-146-W, Gd-148-D,W, Gd-152-D, Th-228-W,Y, Th-230-W,Y, U-232-Y, U-233-Y, U-234-Y, U-235-Y, U-236-Y, U-238-Y, U-Nat-Y, Np-236-W, Np-237-W, Pu-236-W,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-W, Cf-249-W,Y, Cf-250-W,Y, Cf-251-W,Y, Cf-252-W,Y, and Cf-254-W,Y are not present							
-			-	-	1E-13	-	-
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							
-			-	-	-	1E-12	-
If, in addition it is known that Fe-60, Sr-90, Cd-113m, Cd-113, In-115, I-129, Cs-134, Sm-145, Sm-147, 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, Es-254, Fm-257, and Md-258 are not present							
-			-	-	-	1E-6	1E-5

FOOTNOTES:

¹"Submersion" means that values given are for submersion in a hemispherical semi-infinite cloud of airborne material.

²These 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 $1\text{E-}7 \mu\text{Ci/ml}$ for the listed DAC to account for the submersion dose prospectively, but should use individual monitoring devices or other radiation measuring instruments that measure external exposure to demonstrate compliance with the limits. (See RH-1202)

³For soluble mixtures of U-238, U-234, and U-235 in air, chemical toxicity may be the limiting factor (See RH-1200). If the percent by weight (enrichment) of 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 $8\text{E-}3 \text{ (SA)} \mu\text{Ci-hr/ml}$, where SA is the specific activity of the uranium inhaled. The specific activity for natural uranium is $6.77\text{E-}7$ curies per gram U. The specific activity for other mixtures of U-238, U-235, and U-234, if not known, shall be:

$$\text{SA} = 3.6\text{E-}7 \text{ curies/gram U} \quad \text{U-depleted}$$

$$\text{SA} = [0.4 + 0.38 (\text{enrichment}) + 0.0034 (\text{enrichment})^2] \text{E-}6, \text{ enrichment} \geq 0.72$$

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 absent from the mixture; or
3. If a mixture of radionuclides consists of uranium and its daughters in ore dust ($10 \mu\text{m}$ 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: $6\text{E-}11 \mu\text{Ci}$ of gross alpha activity from uranium-238, uranium-234, thorium-230, and radium-226 per milliliter of air; $3\text{E-}11 \mu\text{Ci}$ of natural uranium per milliliter 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 in Appendix E to RH-1000 to RH-2110 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:

$$\frac{C_A}{\text{DAC}_A} + \frac{C_B}{\text{DAC}_B} + \frac{C_C}{\text{DAC}_C} \leq 1$$

APPENDIX H TO RH-1000 THROUGH RH-2110
QUANTITIES¹ OF LICENSED MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μ Ci)	Radionuclide	Quantity (μ Ci)
Hydrogen-3	1,000	Chromium-48	1,000
Beryllium-7	1,000	Chromium-49	1,000
Beryllium-10	1	Chromium-51	1,000
Carbon-11	1,000	Manganese-51	1,000
Carbon-14	1,000	Manganese-52m	1,000
Fluorine-18	1,000	Manganese-52	100
Sodium-22	10	Manganese-53	1,000
Sodium-24	100	Manganese-54	100
Magnesium-28	100	Manganese-56	1,000
Aluminum-26	10	Iron-52	100
Silicon-31	1,000	Iron-55	100
Silicon-32	1	Iron-59	10
Phosphorus-32	10	Iron-60	1
Phosphorus-33	100	Cobalt-55	100
Sulfur-35	100	Cobalt-56	10
Chlorine-36	10	Cobalt-57	100
Chlorine-38	1,000	Cobalt-58m	1,000
Chlorine-39	1,000	Cobalt-58	100
Argon-39	1,000	Cobalt-60m	1,000
Argon-41	1,000	Cobalt-60	1
Potassium-40	100	Cobalt-61	1,000
Potassium-42	1,000	Cobalt-62m	1,000
Potassium-43	1,000	Nickel-56	100
Potassium-44	1,000	Nickel-57	100
Potassium-45	1,000	Nickel-59	100
Calcium-41	100	Nickel-63	100
Calcium-45	100	Nickel-65	1,000
Calcium-47	100	Nickel-66	10
Scandium-43	1,000	Copper-60	1,000
Scandium-44m	100	Copper-61	1,000
Scandium-44	100	Copper-64	1,000
Scandium-46	10	Copper-67	1,000
Scandium-47	100	Zinc-62	100
Scandium-48	100	Zinc-63	1,000
Scandium-49	1,000	Zinc-65	10
Titanium-44	1	Zinc-69m	100
Titanium-45	1,000	Zinc-69	1,000
Vanadium-47	1,000	Zinc-71m	1,000
Vanadium-48	100	Zinc-72	100
Vanadium-49	1,000	Gallium-65	1,000

m = metastable state

QUANTITIES¹ OF LICENSED MATERIAL REQUIRING LABELING (Continued)

Radionuclide	Quantity (μ Ci)	Radionuclide	Quantity (μ Ci)
Gallium-66	100	Krypton-85	1,000
Gallium-67	1,000	Krypton-87	1,000
Gallium-68	1,000	Krypton-88	1,000
Gallium-70	1,000	Rubidium-79	1,000
Gallium-72	100	Rubidium-81m	1,000
Gallium-73	1,000	Rubidium-81	1,000
Germanium-66	1,000	Rubidium-82m	1,000
Germanium-67	1,000	Rubidium-83	100
Germanium-68	10	Rubidium-84	100
Germanium-69	1,000	Rubidium-86	100
Germanium-71	1,000	Rubidium-87	100
Germanium-75	1,000	Rubidium-88	1,000
Germanium-77	1,000	Rubidium-89	1,000
Germanium-78	1,000	Strontium-80	100
Arsenic-69	1,000	Strontium-81	1,000
Arsenic-70	1,000	Strontium-83	100
Arsenic-71	100	Strontium-85m	1,000
Arsenic-72	100	Strontium-85	100
Arsenic-73	100	Strontium-87m	1,000
Arsenic-74	100	Strontium-89	10
Arsenic-76	100	Strontium-90	0.1
Arsenic-77	100	Strontium-91	100
Arsenic-78	1,000	Strontium-92	100
Selenium-70	1,000	Yttrium-86m	1,000
Selenium-73m	1,000	Yttrium-86	100
Selenium-73	100	Yttrium-87	100
Selenium-75	100	Yttrium-88	10
Selenium-79	100	Yttrium-90m	1,000
Selenium-81m	1,000	Yttrium-90	10
Selenium-81	1,000	Yttrium-91m	1,000
Selenium-83	1,000	Yttrium-91	10
Bromine-74m	1,000	Yttrium-92	100
Bromine-74	1,000	Yttrium-93	100
Bromine-75	1,000	Yttrium-94	1,000
Bromine-76	100	Yttrium-95	1,000
Bromine-77	1,000	Zirconium-86	100
Bromine-80m	1,000	Zirconium-88	10
Bromine-80	1,000	Zirconium-89	100
Bromine-82	100	Zirconium-93	1
Bromine-83	1,000	Zirconium-95	10
Bromine-84	1,000	Zirconium-97	100
Krypton-74	1,000	Niobium-88	1,000
Krypton-76	1,000	Niobium-89m	
Krypton-77	1,000	(66 min)	1,000
Krypton-79	1,000	Niobium-89	
Krypton-81	1,000	(122 min)	1,000
Krypton-83m	1,000	Niobium-90	100
Krypton-85m	1,000	Niobium-93m	10

m = metastable state

QUANTITIES¹ OF LICENSED MATERIAL REQUIRING LABELING (Continued)

Radionuclide	Quantity (μ Ci)	Radionuclide	Quantity (μ Ci)
Niobium-94	1	Silver-104	1,000
Niobium-95m	100	Silver-105	100
Niobium-95	100	Silver-106m	100
Niobium-96	100	Silver-106	1,000
Niobium-97	1,000	Silver-108m	1
Niobium-98	1,000	Silver-110m	10
Molybdenum-90	100	Silver-111	100
Molybdenum-93m	100	Silver-112	100
Molybdenum-93	10	Silver-115	1,000
Molybdenum-99	100	Cadmium-104	1,000
Molybdenum-101	1,000	Cadmium-107	1,000
Technetium-93m	1,000	Cadmium-109	1
Technetium-93	1,000	Cadmium-113m	0.1
Technetium-94m	1,000	Cadmium-113	100
Technetium-94	1,000	Cadmium-115m	10
Technetium-96m	1,000	Cadmium-115	100
Technetium-96	100	Cadmium-117m	1,000
Technetium-97m	100	Cadmium-117	1,000
Technetium-97	1,000	Indium-109	1,000
Technetium-98	10	Indium-110m	
Technetium-99m	1,000	(69.1m)	1,000
Technetium-99	100	Indium-110	
Technetium-101	1,000	(4.9h)	1,000
Technetium-104	1,000	Indium-111	100
Ruthenium-94	1,000	Indium-112	1,000
Ruthenium-97	1,000	Indium-113m	1,000
Ruthenium-103	100	Indium-114m	10
Ruthenium-105	1,000	Indium-115m	1,000
Ruthenium-106	1	Indium-115	100
Rhodium-99m	1,000	Indium-116m	1,000
Rhodium-99	100	Indium-117m	1,000
Rhodium-100	100	Indium-117	1,000
Rhodium-101m	1,000	Indium-119m	1,000
Rhodium-101	10	Tin-110	100
Rhodium-102m	10	Tin-111	1,000
Rhodium-102	10	Tin-113	100
Rhodium-103m	1,000	Tin-117m	100
Rhodium-105	100	Tin-119m	100
Rhodium-106m	1,000	Tin-121m	100
Rhodium-107	1,000	Tin-121	1,000
Palladium-100	100	Tin-123m	1,000
Palladium-101	1,000	Tin-123	10
Palladium-103	100	Tin-125	10
Palladium-107	10	Tin-126	10
Palladium-109	100	Tin-127	1,000
Silver-102	1,000	Tin-128	1,000
Silver-103	1,000	Antimony-115	1,000
Silver-104m	1,000	Antimony-116m	1,000

m = metastable state

QUANTITIES¹ OF LICENSED MATERIAL REQUIRING LABELING (Continued)

Radionuclide	Quantity (μ Ci)	Radionuclide	Quantity (μ Ci)
Antimony-116	1,000	Iodine-131	1
Antimony-117	1,000	Iodine-132m	100
Antimony-118m	1,000	Iodine-132	100
Antimony-119	1,000	Iodine-133	10
Antimony-120		Iodine-134	1,000
(16m)	1,000	Iodine-135	100
Antimony-120		Xenon-120	1,000
(5.76d)	100	Xenon-121	1,000
Antimony-122	100	Xenon-122	1,000
Antimony-124m	1,000	Xenon-123	1,000
Antimony-124	10	Xenon-125	1,000
Antimony-125	100	Xenon-127	1,000
Antimony-126m	1,000	Xenon-129m	1,000
Antimony-126	100	Xenon-131m	1,000
Antimony-127	100	Xenon-133m	1,000
Antimony-128		Xenon-133	1,000
(10.4m)	1,000	Xenon-135m	1,000
Antimony-128		Xenon-135	1,000
(9.01h)	100	Xenon-138	1,000
Antimony-129	100	Cesium-125	1,000
Antimony-130	1,000	Cesium-127	1,000
Antimony-131	1,000	Cesium-129	1,000
Tellurium-116	1,000	Cesium-130	1,000
Tellurium-121m	10	Cesium-131	1,000
Tellurium-121	100	Cesium-132	100
Tellurium-123m	10	Cesium-134m	1,000
Tellurium-123	100	Cesium-134	10
Tellurium-125m	10	Cesium-135m	1,000
Tellurium-127m	10	Cesium-135	100
Tellurium-127	1,000	Cesium-136	10
Tellurium-129m	10	Cesium-137	10
Tellurium-129	1,000	Cesium-138	1,000
Tellurium-131m	10	Barium-126	1,000
Tellurium-131	100	Barium-128	100
Tellurium-132	10	Barium-131m	1,000
Tellurium-133m	100	Barium-131	100
Tellurium-133	1,000	Barium-133m	100
Tellurium-134	1,000	Barium-133	100
Iodine-120m	1,000	Barium-135m	100
Iodine-120	100	Barium-139	1,000
Iodine-121	1,000	Barium-140	100
Iodine-123	100	Barium-141	1,000
Iodine-124	10	Barium-142	1,000
Iodine-125	1	Lanthanum-131	1,000
Iodine-126	1	Lanthanum-132	100
Iodine-128	1,000	Lanthanum-135	1,000
Iodine-129	1	Lanthanum-137	10
Iodine-130	10	Lanthanum-138	100

m = metastable state

QUANTITIES¹ OF LICENSED MATERIAL REQUIRING LABELING (Continued)

Radionuclide	Quantity (μ Ci)	Radionuclide	Quantity (μ Ci)
Lanthanum-140	100	Samarium-153	100
Lanthanum-141	100	Samarium-155	1,000
Lanthanum-142	1,000	Samarium-156	1,000
Lanthanum-143	1,000	Europium-145	100
Cerium-134	100	Europium-146	100
Cerium-135	100	Europium-147	100
Cerium-137m	100	Europium-148	10
Cerium-137	1,000	Europium-149	100
Cerium-139	100	Europium-150	
Cerium-141	100	(12.62h)	100
Cerium-143	100	Europium-150	
Cerium-144	1	(34.2y)	1
Praseodymium-136	1,000	Europium-152m	100
Praseodymium-137	1,000	Europium-152	1
Praseodymium-138m	1,000	Europium-154	1
Praseodymium-139	1,000	Europium-155	10
Praseodymium-142m	1,000	Europium-156	100
Praseodymium-142	100	Europium-157	100
Praseodymium-143	100	Europium-158	1,000
Praseodymium-144	1,000	Gadolinium-145	1,000
Praseodymium-145	100	Gadolinium-146	10
Praseodymium-147	1,000	Gadolinium-147	100
Neodymium-136	1,000	Gadolinium-148	0.001
Neodymium-138	100	Gadolinium-149	100
Neodymium-139m	1,000	Gadolinium-151	10
Neodymium-139	1,000	Gadolinium-152	100
Neodymium-141	1,000	Gadolinium-153	10
Neodymium-147	100	Gadolinium-159	100
Neodymium-149	1,000	Terbium-147	1,000
Neodymium-151	1,000	Terbium-149	100
Promethium-141	1,000	Terbium-150	1,000
Promethium-143	100	Terbium-151	100
Promethium-144	10	Terbium-153	1,000
Promethium-145	10	Terbium-154	100
Promethium-146	1	Terbium-155	1,000
Promethium-147	10	Terbium-156m	
Promethium-148m	10	(5.0h)	1,000
Promethium-148	10	Terbium-156	
Promethium-149	100	(24.4h)	1,000
Promethium-150	1,000	Terbium-156	100
Promethium-151	100	Terbium-157	10
Samarium-141m	1,000	Terbium-158	1
Samarium-141	1,000	Terbium-160	10
Samarium-142	1,000	Terbium-161	100
Samarium-145	100	Dysprosium-155	1,000
Samarium-146	1	Dysprosium-157	1,000
Samarium-147	100	Dysprosium-159	100
Samarium-151	10	Dysprosium-165	1,000

m = metastable state

QUANTITIES¹ OF LICENSED MATERIAL REQUIRING LABELING (Continued)

Radionuclide	Quantity (μ Ci)	Radionuclide	Quantity (μ Ci)
Lanthanum-140	100	Samarium-153	100
Lanthanum-141	100	Samarium-155	1,000
Lanthanum-142	1,000	Samarium-156	1,000
Lanthanum-143	1,000	Europium-145	100
Cerium-134	100	Europium-146	100
Cerium-135	100	Europium-147	100
Cerium-137m	100	Europium-148	10
Cerium-137	1,000	Europium-149	100
Cerium-139	100	Europium-150	
Cerium-141	100	(12.62h)	100
Cerium-143	100	Europium-150	
Cerium-144	1	(34.2y)	1
Praseodymium-136	1,000	Europium-152m	100
Praseodymium-137	1,000	Europium-152	1
Praseodymium-138m	1,000	Europium-154	1
Praseodymium-139	1,000	Europium-155	10
Praseodymium-142m	1,000	Europium-156	100
Praseodymium-142	100	Europium-157	100
Praseodymium-143	100	Europium-158	1,000
Praseodymium-144	1,000	Gadolinium-145	1,000
Praseodymium-145	100	Gadolinium-146	10
Praseodymium-147	1,000	Gadolinium-147	100
Neodymium-136	1,000	Gadolinium-148	0.001
Neodymium-138	100	Gadolinium-149	100
Neodymium-139m	1,000	Gadolinium-151	10
Neodymium-139	1,000	Gadolinium-152	100
Neodymium-141	1,000	Gadolinium-153	10
Neodymium-147	100	Gadolinium-159	100
Neodymium-149	1,000	Terbium-147	1,000
Neodymium-151	1,000	Terbium-149	100
Promethium-141	1,000	Terbium-150	1,000
Promethium-143	100	Terbium-151	100
Promethium-144	10	Terbium-153	1,000
Promethium-145	10	Terbium-154	100
Promethium-146	1	Terbium-155	1,000
Promethium-147	10	Terbium-156m	
Promethium-148m	10	(5.0h)	1,000
Promethium-148	10	Terbium-156	
Promethium-149	100	(24.4h)	1,000
Promethium-150	1,000	Terbium-156	100
Promethium-151	100	Terbium-157	10
Samarium-141m	1,000	Terbium-158	1
Samarium-141	1,000	Terbium-160	10
Samarium-142	1,000	Terbium-161	100
Samarium-145	100	Dysprosium-155	1,000
Samarium-146	1	Dysprosium-157	1,000
Samarium-147	100	Dysprosium-159	100
Samarium-151	10	Dysprosium-165	1,000

m = metastable state

QUANTITIES¹ OF LICENSED MATERIAL REQUIRING LABELING (Continued)

Radionuclide	Quantity (μ Ci)	Radionuclide	Quantity (μ Ci)
Dysprosium-166	100	Hafnium-173	1,000
Holmium-155	1,000	Hafnium-175	100
Holmium-157	1,000	Hafnium-177m	1,000
Holmium-159	1,000	Hafnium-178m	0.1
Holmium-161	1,000	Hafnium-179m	10
Holmium-162m	1,000	Hafnium-180m	1,000
Holmium-162	1,000	Hafnium-181	10
Holmium-164m	1,000	Hafnium-182m	1,000
Holmium-164	1,000	Hafnium-182	0.1
Holmium-166m	1	Hafnium-183	1,000
Holmium-166	100	Hafnium-184	100
Holmium-167	1,000	Tantalum-172	1,000
Erbium-161	1,000	Tantalum-173	1,000
Erbium-165	1,000	Tantalum-174	1,000
Erbium-169	100	Tantalum-175	1,000
Erbium-171	100	Tantalum-176	100
Erbium-172	100	Tantalum-177	1,000
Thulium-162	1,000	Tantalum-178	1,000
Thulium-166	100	Tantalum-179	100
Thulium-167	100	Tantalum-180m	1,000
Thulium-170	10	Tantalum-180	100
Thulium-171	10	Tantalum-182m	1,000
Thulium-172	100	Tantalum-182	10
Thulium-173	100	Tantalum-183	100
Thulium-175	1,000	Tantalum-184	100
Ytterbium-162	1,000	Tantalum-185	1,000
Ytterbium-166	100	Tantalum-186	1,000
Ytterbium-167	1,000	Tungsten-176	1,000
Ytterbium-169	100	Tungsten-177	1,000
Ytterbium-175	100	Tungsten-178	1,000
Ytterbium-177	1,000	Tungsten-179	1,000
Ytterbium-178	1,000	Tungsten-181	1,000
Lutetium-169	100	Tungsten-185	100
Lutetium-170	100	Tungsten-187	100
Lutetium-171	100	Tungsten-188	10
Lutetium-172	100	Rhenium-177	1,000
Lutetium-173	10	Rhenium-178	1,000
Lutetium-174m	10	Rhenium-181	1,000
Lutetium-174	10	Rhenium-182	
Lutetium-176m	1,000	(12.7h)	1,000
Lutetium-176	100	Rhenium-182	
Lutetium-177m	10	(64.0h)	100
Lutetium-177	100	Rhenium-184m	10
Lutetium-178m	1,000	Rhenium-184	100
Lutetium-178	1,000	Rhenium-186m	10
Lutetium-179	1,000	Rhenium-186	100
Hafnium-170	100	Rhenium-187	1,000
Hafnium-172	1	Rhenium-188m	1,000

m = metastable state

QUANTITIES¹ OF LICENSED MATERIAL REQUIRING LABELING (Continued)

Radionuclide	Quantity (μ Ci)	Radionuclide	Quantity (μ Ci)
Rhenium-188	100	Mercury-194	1
Rhenium-189	100	Mercury-195m	100
Osmium-180	1,000	Mercury-195	1,000
Osmium-181	1,000	Mercury-197m	100
Osmium-182	100	Mercury-197	1,000
Osmium-185	100	Mercury-199m	1,000
Osmium-189m	1,000	Mercury-203	100
Osmium-191m	1,000	Thallium-194m	1,000
Osmium-191	100	Thallium-194	1,000
Osmium-193	100	Thallium-195	1,000
Osmium-194	1	Thallium-197	1,000
Iridium-182	1,000	Thallium-198m	1,000
Iridium-184	1,000	Thallium-198	1,000
Iridium-185	1,000	Thallium-199	1,000
Iridium-186	100	Thallium-200	1,000
Iridium-187	1,000	Thallium-201	1,000
Iridium-188	100	Thallium-202	100
Iridium-189	100	Thallium-204	100
Iridium-190m	1,000	Lead-195m	1,000
Iridium-190	100	Lead-198	1,000
Iridium-192m	10	Lead-199	1,000
Iridium-192	1	Lead-200	100
Iridium-194m	10	Lead-201	1,000
Iridium-194	100	Lead-202m	1,000
Iridium-195m	1,000	Lead-202	10
Iridium-195	1,000	Lead-203	1,000
Platinum-186	1,000	Lead-205	100
Platinum-188	100	Lead-209	1,000
Platinum-189	1,000	Lead-210	0.01
Platinum-191	100	Lead-211	100
Platinum-193m	100	Lead-212	1
Platinum-193	1,000	Lead-214	100
Platinum-195m	100	Bismuth-200	1,000
Platinum-197m	1,000	Bismuth-201	1,000
Platinum-197	100	Bismuth-202	1,000
Platinum-199	1,000	Bismuth-203	100
Platinum-200	100	Bismuth-205	100
Gold-193	1,000	Bismuth-206	100
Gold-194	100	Bismuth-207	10
Gold-195	10	Bismuth-210m	0.1
Gold-198m	100	Bismuth-210	1
Gold-198	100	Bismuth-212	10
Gold-199	100	Bismuth-213	10
Gold-200m	100	Bismuth-214	100
Gold-200	1,000	Polonium-203	1,000
Gold-201	1,000	Polonium-205	1,000
Mercury-193m	100	Polonium-207	1,000
Mercury-193	1,000	Polonium-210	0.1

m = metastable state

QUANTITIES¹ OF LICENSED MATERIAL REQUIRING LABELING (Continued)

Radionuclide	Quantity (μ Ci)	Radionuclide	Quantity (μ Ci)
Astatine-207	100	Neptunium-234	100
Astatine-211	10	Neptunium-235	100
Radon-220	1	Neptunium-236	0.001
Radon-222	1	(1.15×10^6)	
Francium-222	100	Neptunium-236	1
Francium-223	100	(22.5h)	0.001
Radium-223	0.1	Neptunium-237	10
Radium-224	0.1	Neptunium-238	100
Radium-225	0.1	Neptunium-239	1,000
Radium-226	0.1	Neptunium-240	10
Radium-227	1,000	Plutonium-234	1,000
Radium-228	0.1	Plutonium-235	0.001
Actinium-224	1	Plutonium-236	100
Actinium-225	0.01	Plutonium-237	0.001
Actinium-226	0.1	Plutonium-238	0.001
Actinium-227	0.001	Plutonium-239	0.001
Actinium-228	1	Plutonium-240	0.01
Thorium-226	10	Plutonium-241	0.001
Thorium-227	0.01	Plutonium-242	1,000
Thorium-228	0.001	Plutonium-243	0.001
Thorium-229	0.001	Plutonium-244	100
Thorium-230	0.001	Plutonium-245	1,000
Thorium-231	100	Americium-237	100
Thorium-232	100	Americium-238	1,000
Thorium-233	10	Americium-239	100
Thorium-234	100	Americium-240	0.001
Thorium-natural	10	Americium-241	0.001
Protactinium-227	1	Americium-242m	10
Protactinium-228	0.1	Americium-242	0.001
Protactinium-230	0.001	Americium-243	100
Protactinium-231	1	Americium-244m	10
Protactinium-232	100	Americium-244	1,000
Protactinium-233	100	Americium-245	1,000
Protactinium-234	0.01	Americium-246m	1,000
Uranium-230	100	Americium-246	100
Uranium-231	0.001	Curium-238	0.1
Uranium-232	0.001	Curium-240	1
Uranium-233	0.001	Curium-241	0.01
Uranium-234	0.001	Curium-242	0.001
Uranium-235	0.001	Curium-243	0.001
Uranium-236	100	Curium-244	0.001
Uranium-237	100	Curium-245	0.001
Uranium-238	1,000	Curium-246	0.001
Uranium-239	100	Curium-247	0.001
Uranium-240	100	Curium-248	1,000
Uranium-natural	100	Curium-249	100
Neptunium-232	1,000	Berkelium-245	
Neptunium-233			

m = metastable state

QUANTITIES¹ OF LICENSED MATERIAL REQUIRING LABELING (Continued)

Radionuclide	Quantity (μCi)	Radionuclide	Quantity (μCi)
Berkelium-246	100	Einsteinium-250	100
Berkelium-247	0.001	Einsteinium-251	100
Berkelium-249	0.1	Einsteinium-253	0.1
Berkelium-250	10	Einsteinium-254m	1
Californium-244	100	Einsteinium-254	0.01
Californium-246	1	Fermium-252	1
Californium-248	0.01	Fermium-253	1
Californium-249	0.001	Fermium-254	10
Californium-250	0.001	Fermium-255	1
Californium-251	0.001	Fermium-257	0.01
Californium-252	0.001	Mendelevium-257	10
Californium-253	0.1	Mendelevium-258	0.01
Californium-254	0.001		
Any radionuclide other than alpha emitting radionuclides not listed above, or mixtures of beta emitters of unknown composition	0.01		
m = metastable state			

¹ The quantities listed above were derived by taking 1/10th of the most restrictive ALI listed in Table 1, Columns 1 and 2, of Appendix G to RH-1000 through RH-2110 of this Part, rounding to the nearest factor of 10, and arbitrarily constraining the values listed between 0.001 and 1,000 μCi . Values of 100 μCi have been assigned for radionuclides having a radioactive half-life in excess of 10^9 years (except Rhenium, 1000 μCi) to take into account their low specific activity.

NOTE: For purposes of Part F and RH-1304, where there is involved a combination of radionuclides in known amounts, the limit for the combination should be derived as follows: Determine, for each radionuclide in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific radionuclide when not in combination. The sum of such ratios for all radionuclides in the combination may not exceed "1" (i.e., "unity").

APPENDIX I

UNITED STATES NUCLEAR REGULATORY COMMISSION REGIONAL OFFICES

Region I: Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont

Address: U.S. Nuclear Regulatory Commission, Region I
475 Allendale Road
King of Prussia, PA 19406-1415

Telephone: (800) 432-1156

Region II: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virginia, Virgin Islands, and West Virginia

Address: U.S. Nuclear Regulatory Commission, Region II
101 Marietta Street, Northwest, Suite 2900
Atlanta, GA 30323-0199

Telephone: (800) 577-8510

Region III: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin

Address: U.S. Nuclear Regulatory Commission, Region III
801 Warrenville Road
Lisle, IL 60532-4351

Telephone: (800) 522-3025

Revision of January 1, 1997

APPENDIX I

UNITED STATES NUCLEAR REGULATORY COMMISSION REGIONAL OFFICES
(Continued)

*Region IV: Alaska, Arizona, **ARKANSAS**, California, Colorado, Hawaii, Idaho, Kansas, Louisiana, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, Wyoming, and U.S. territories and possessions in the Pacific

==> Region V was combined with Region IV <==

*Address: U.S. Nuclear Regulatory Commission, Region IV
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011-8064

*Telephone: (800) 952-9677

Walnut Creek Field Office: U.S. Nuclear Regulatory Commission
1450 Maria Lane
Walnut Creek, CA 94596-5368

Telephone: (800) 882-4672

Region V: *==> Region V was combined with Region IV <==*

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Revision of January 1, 1997

APPENDIX J TO RH-1000 THROUGH RH-2110

REQUIREMENTS FOR LOW-LEVEL WASTE TRANSFER FOR
DISPOSAL AT LAND DISPOSAL FACILITIES AND MANIFESTS

I. MANIFEST

The shipment manifest shall contain the name, address, and telephone number of the person generating the waste. The manifest shall also include the name, address, and telephone number or the name and EPA hazardous waste identification number of the person transporting the waste to the land disposal facility. The manifest must also indicate as completely as practicable: a physical description of the waste, the volume, radionuclide identity and quantity, the total radioactivity, and the principal chemical form. The solidification agent must be specified. Waste containing more than 0.1% chelating agents by weight must be identified and the weight percentage of the chelating agent estimated. Wastes classified as Class A, Class B, or Class C in RH-407 must be clearly identified as such in the manifest. The total quantity of the radionuclides H-3, C-14, Tc-99, and I-129 must be shown. The manifest required by this Paragraph may be shipping papers used to meet Department of Transportation or Environmental Protection Agency regulations or requirements of the receiver, provided all the required information is included. Copies of manifests required by this Section may be legible carbon copies or legible photocopies.

II. CERTIFICATION

The waste generator shall include in the shipment manifest a certification that the transported materials are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation and the Department. An authorized representative of the waste generator shall sign and date the manifest.

III. CONTROL AND TRACKING

- A. Any generating 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 8 of this Section. Any generating licensee who transfers waste to a licensed waste processor who treats or repackages waste shall comply with the requirements of Paragraphs A.4 through 8 of this Section.

APPENDIX J TO RH-1000 THROUGH RH-2110

**REQUIREMENTS FOR LOW-LEVEL WASTE TRANSFER FOR
DISPOSAL AT LAND DISPOSAL FACILITIES AND MANIFESTS**

(Continued)

A licensee shall:

1. Prepare all wastes so that the waste is classified according to RH-1400 and meets the waste characteristics requirements;
2. Label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, in accordance with RH-1400;
3. Conduct a quality control program to ensure compliance with RH-1400; the program must include management evaluation of audits;
4. Prepare shipping manifests to meet the requirements of Sections I and II of this Appendix;
5. Forward a copy of the manifest to the intended recipient, at the time of shipment, or deliver to a collector at the time the waste is collected, obtaining acknowledgment of receipt in the form of a signed copy of the manifest or equivalent documentation from the collector;
6. Include one copy of the manifest with the shipment;
7. Retain a copy of the manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by RH-1400; and
8. 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 section, conduct an investigation in accordance with Paragraph E of this Appendix.

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

1. Acknowledge receipt of the waste from the generator within one week of receipt by returning a signed copy of the manifest or equivalent documentation;
2. Prepare a new manifest to reflect consolidated shipments; the new manifest shall serve as a listing or index for the detailed generator manifests. Copies of the generator manifests shall be a part of the new manifest. The waste collector may prepare a new manifest without attaching the generator manifests, provided the new manifest contains for each package the information specified in Section I of this Appendix. The

APPENDIX J TO RH-1000 THROUGH RH-2110

REQUIREMENTS FOR LOW-LEVEL WASTE TRANSFER FOR
DISPOSAL AT LAND DISPOSAL FACILITIES AND MANIFESTS

(Continued)

collector licensee shall certify that nothing has been done to the waste that would invalidate the generator's certification;

3. Forward a copy of the new manifest to the land disposal facility operator at the time of shipment;
 4. Include the new manifest with the shipment to the disposal site;
 5. Retain a copy of the manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by RH-1401, and retain information from generator manifest until disposition is authorized by the Department; and
 6. For any shipments or any part of a shipment for which acknowledgment of receipt is not received within the times set forth in this section, conduct an investigation in accordance with Paragraph E of this Section.
- C. Any licensed waste processor who treats or repackages wastes shall:
1. Acknowledge receipt of the waste from the generator within one week of receipt by returning a signed copy of the manifest or equivalent documentation;
 2. Prepare a new manifest that meets the requirements of Sections I and II of this Appendix. Preparation of the new manifest reflects that the processor is responsible for the waste;
 3. Prepare all wastes so that the waste is classified according to RH-1401 and meets the waste characteristics requirements;
 4. Label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, in accordance with RH-1401;
 5. Conduct a quality control program to ensure compliance with RH-1401. The program shall include management evaluation of audits;
 6. Forward a copy of the new manifest to the disposal site operator or waste collector at the time of shipment, or deliver to a collector at the time the waste is collected, obtaining acknowledgment of receipt in the form of a signed copy of the manifest or equivalent documentation by the collector;

APPENDIX J TO RH-1000 THROUGH RH-2110

REQUIREMENTS FOR LOW-LEVEL WASTE TRANSFER FOR
DISPOSAL AT LAND DISPOSAL FACILITIES AND MANIFESTS

(Continued)

7. Include the new manifest with the shipment;
 8. Retain copies of original manifests and new manifests and documentation of acknowledgment of receipt as the record of transfer of licensed material required by RH-1401; and
 9. For any shipment or part of a shipment for which acknowledgment is not received within the times set forth in this section, conduct an investigation in accordance with Paragraph E of this section.
- D. The land disposal facility operator shall:
1. Acknowledge receipt of the waste within one week of receipt by returning a signed copy of the manifest or equivalent documentation to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the operator. The returned copy of the manifest or equivalent documentation shall indicate any discrepancies between materials listed on the manifest and materials received;
 2. Maintain copies of all completed manifests or equivalent documentation until the Department authorizes their disposition; and
 3. Notify the shipper (i.e., the generator, the collector, or processor) and the Director of the Division of Radiation Control when any shipment or part of a shipment has not arrived within 60 days after the advance manifest was received.
- E. Any shipment or part of a shipment for which acknowledgment is not received within the times set forth in this section must:
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 Director of the Division of Radiation Control. Each licensee who conducts a trace investigation shall file a written report with the Director of the Division of Radiation Control within two weeks of completion of the investigation.

PART N. NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS, INSPECTIONS

RH-2801. Purpose and Scope.

This Part establishes requirements for notices, instructions and reports by licensees or registrants to individuals engaged in work under a license or registration; and options available to such individuals in connection with Department inspection of licensees or registrants to ascertain compliance with the provisions of the Act and the regulations, orders and licenses issued thereunder regarding radiological working conditions. The Regulations in this Part apply to all persons who receive, possess, use, own or transfer sources of radiation licensed by or registered with the Department pursuant to these Regulations in Section 1 and Section 2.

RH-2802. Posting of Notices to Workers.

- a. Each licensee or registrant shall post current copies of the following documents:
 1. A copy of these Regulations;
 2. The license or certificate of registration, conditions or documents incorporated into the license by reference and amendments thereto;
 3. The operating procedures applicable to work under the license or registration; and
 4. Any notice of violation involving radiological working conditions or order issued pursuant to Section 5 and any response from the licensee or registrant.
- b. If posting of a document specified in RH-2802.a.1, 2 or 3 is not practicable, the licensee or registrant may post a notice which describes the document and states where it may be examined.
- c. Department Form RH-11 "Notice to Employees" shall be posted by each licensee or registrant wherever individuals work in or frequent any portion of a restricted area.
- d. Documents, notices or forms posted pursuant to this Section shall appear in a sufficient number of places to permit individuals engaged in work under the license or registration to observe them on the way to or from any particular work location to which the document applies, shall be conspicuous, and shall be replaced if defaced or altered.

RH-2802 (Cont'd)

- e. Department documents posted pursuant to RH-2802.a.4 shall be posted within two (2) working days after receipt of the documents from the Department; the licensee's or registrant's response, if any, shall be posted within two (2) working days after dispatch from the licensee or registrant. Such documents shall remain posted for a minimum of five (5) working days or until action correcting the violation has been completed, whichever is later.

RH-2803. Instructions to Workers.

- a. All individuals working in or frequenting any portion of a restricted area:
 - 1. Shall be kept informed of the storage, transfer or use of radioactive materials or of radiation in such portions of the restricted area;
 - 2. Shall be instructed in the health protection problems associated with exposure to such radioactive material or radiation in precautions or procedures to minimize exposure and the purposes and functions of protective devices employed;
 - 3. Shall be instructed in, and instructed to observe, to the extent within the worker's control, the applicable provisions of Department Regulations and licenses or registration for the protection of personnel from exposures to radiation or radioactive material occurring in such areas;
 - 4. Shall be instructed of their responsibility to report promptly to the licensee or registrant any condition which may lead to or cause a violation of Department Regulations and licenses or unnecessary exposure to radiation or radioactive material;
 - 5. 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
 - 6. Shall be advised as to the radiation exposure reports which workers may request pursuant to RH-2804.
- b. The extent of these instructions shall be commensurate with potential radiological health protection problems in the restricted area.

RH-2804. Notifications and Reports to Individuals.

- a. Radiation exposure data for an individual and the results of any measurements, analyses and calculations of radioactive material deposited or retained in the body of an individual shall be reported to the individual as specified in this Section. The information reported shall include data and results obtained pursuant to Department Regulations, orders or license conditions, as shown in records maintained by the licensee or registrant pursuant to Department Regulations. Each notification and report shall:
 1. Be in writing;
 2. Include appropriate identifying data such as the name of the licensee or registrant, the name of the individual, the individual's date of birth and the individual's social security number;
 3. Include the individual's exposure information; and
 4. Contain the following statement:

"This report is furnished to you under the provisions of Arkansas Department of Health Regulations entitled 'Standards for Protection Against Radiation.' You should preserve this report for further reference."
- b. Each licensee or registrant shall advise each worker annually of the worker's exposure to radiation or radioactive material as shown in records maintained by the licensee or registrant pursuant to RH-1301. This annual notification shall be dated and signed by the worker. Copies of the notification shall be retained by the licensee or registrant for inspection by the Department.
- c. At the request of a worker formerly engaged in work controlled by the licensee or the registrant, each licensee or registrant shall furnish to the worker a report of the worker's exposure to radiation or radioactive material. Such report shall:
 1. Be furnished within thirty (30) days from the time the request is made or within thirty (30) days after the exposure of the individual has been determined by the licensee or registrant, whichever is later;

2. Cover, within the period of time specified in the request, each calendar year in which the worker's activities involved exposure to radiation from radioactive material licensed by, or radiation machines registered with the Department; and
 3. Include the dates and locations of work under the license or registration in which the worker participated during this period.
- d. Each licensee or registrant shall furnish to each worker a report of the worker's exposure to radiation or radioactive material upon termination of employment. Such report shall be furnished within thirty (30) days from the time of termination of employment or within thirty (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 year 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.
- e. At the request of a worker who is terminating employment 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 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 year 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.
- f. When a licensee or registrant is required pursuant to RH-1504 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 his/her exposure data included therein. Such reports shall be transmitted at a time not later than the transmittal to the Department.

RH-2805. Presence of Representatives of Licensees or Registrants and Workers During Inspection.

- a. 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.
- b. During an inspection, Department inspectors may consult privately with workers as specified in RH-2806. The licensee or registrant may accompany Department inspectors during other phases of an inspection.
- c. 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.
- d. Each workers' representative shall be routinely engaged in work under control of the licensee or registrant and shall have received instructions as specified in RH-2803.
- e. 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 inspections. However, only one workers' representative at a time may accompany the inspectors.
- f. With the approval of the licensee or registrant and the workers' representative, an individual who is not routinely engaged in work under control of the licensee or registrant, for example, 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.
- g. Notwithstanding the other provisions of this Section, Department inspectors are authorized to refuse to permit accompaniment by any individual who deliberately interferes with a fair and orderly inspection. 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.

RH-2806. Consultation With Workers During Inspections.

- a. Department inspectors may consult privately with workers concerning matters of occupational radiation protection and other matters related to applicable provisions of Department Regulations and licenses to the extent the inspectors deem necessary for the conduct of an effective and thorough inspection.
- b. 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 he/she has reason to believe may have contributed to or caused any violation of the Act, these Regulations, or license condition, or any unnecessary exposure of an individual to radiation from licensed radioactive material or a registered radiation machine under the licensee's or registrant's control. Any such notice in writing shall comply with the requirements of RH-2807.a.

RH-2807. Requests by Workers for Inspections.

- a. Any worker or representative of workers who believes 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 the inspection except that, upon the request of the worker giving such notice, his/her name and the name of individuals referred to therein shall not appear in such copy or on any record published, released or made available by the Department, except for good cause shown.
- b. If, upon receipt of such notice, the Department determines that the complaint meets the requirements set forth in RH-2807.a, 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.

- c. No licensee or registrant shall discharge or in any manner discriminate against any worker because such worker has filed complaint or instituted or caused to be instituted any proceeding under these Regulations or has testified or is about to testify in any such proceeding or because of the exercise by such worker on behalf of himself/herself or others of any option afforded by this Part.

RH-2808. Inspections Not Warranted: Informal Review.

- a. If the Department determines, with respect to a complaint under RH-2807 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.
 - 1. The complainant may obtain review of such determination by submitting a written statement of position with the Director who will provide the licensee or registrant with a copy of such statement by certified mail, excluding, at the request of the complainant, the name of the complainant.
 - 2. The licensee or registrant may submit an opposing written statement of position with the Director who will provide the complainant with a copy of such statement by certified mail.
 - 3. Upon the request of the complainant, the Director 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.
 - 4. After considering all written or oral views presented, the Director shall affirm, modify or reverse the determination of the Department and furnish the complainant and the licensee or registrant a written notification of his/her decision and the reason therefor.
- b. If the Director determines that an inspection is not warranted because the requirements of RH-2807.a have not

been met, he/she shall notify the complainant in writing of such determination. Such determination shall be without prejudice to the filing of a new complaint meeting the requirements of RH-2807.a.

PART O. RADIATION SAFETY REQUIREMENTS FOR ANALYTICAL X-RAY EQUIPMENT

RH-2900. Scope and Purpose. This Part provides special requirements for analytical x-ray equipment. The requirements of this Part are in addition to, and not in substitution for applicable requirements in other parts of these Regulations.

RH-2901. Definitions.

- a. Analytical x-ray equipment - X-Ray equipment used for x-ray diffraction fluorescence analysis or spectroscopy.
- b. Analytical x-ray system - A group of local and remote components utilizing x-rays to determine the elemental composition or to examine the microstructure of materials. Local components include those that are struck by x-rays such as radiation source housings, port and shutter assemblies, collimators, sample holders, cameras, goniometers, detectors and shielding. Remote components include power supplies, transformers, amplifiers, readout devices, and control panels.
- c. Fail-safe characteristics - A design feature which causes beam port shutters to close or otherwise prevents emergence of the primary beam, upon the failure of a safety or warning device.
- d. Local components - Part of an analytical x-ray system and include areas exposed to x-rays, such as radiation source housings, port and shutter assemblies, collimators, sample holders, cameras, goniometers, detectors and shielding but does not include power supplies, transformers, amplifiers, readout devices and control panels.
- e. Normal operating procedures - Operating procedures for conditions suitable for analytical purposes with shielding and barriers in place. These do not include maintenance but do include routine alignment procedures. Routine and emergency radiation safety considerations are part of these procedures.
- f. Open-beam configuration - An analytical x-ray system in which an individual could accidentally place some part of his/her body in the primary beam path during normal operation.
- g. Primary beam - Ionizing radiation which passes through an aperture of the source housing by a direct path from the x-ray tube located in the radiation source housing.

RH-2902. Equipment Requirements.

- a. Safety device. A device which prevents the entry of any portion of an individual's body into the primary x-ray beam path or which causes the beam to be shut off upon entry into its path shall be provided on all open-beam configurations. A registrant may apply to the Department for an exemption from the requirement of a safety device. Such application shall include:
 1. A description of the various safety devices that have been evaluated;
 2. The reason each of these devices cannot be used; and
 3. A description of the alternative methods that will be employed to minimize the possibility of an accidental exposure, including procedures to assure that operators and others in the area will be informed of the absence of safety devices.
- b. Warning devices.
 1. Open-beam configurations shall be provided with a readily discernible indication of:
 - A. X-ray tube status (ON-OFF) located near the radiation source housing, if the primary beam is controlled in this manner/ and/or
 - B. Shutter status (OPEN-CLOSED) located near each port on the radiation source housings, if the primary beam is controlled in this manner.
 2. Warning devices shall be labeled so that their purpose is easily identified. On equipment installed after January 1, 1979, warning devices shall have fail-safe characteristics.
- c. Ports. Unused ports on radiation machine source housings shall be secured in the closed position in a manner which will prevent casual opening.
- d. Labeling. All analytical x-ray equipment shall be labeled with a readily discernible sign or signs bearing the radiation symbol and the words:
 1. "CAUTION - HIGH INTENSITY X-RAY BEAM," or words having a similar intent, on the x-ray source housing; and

2. **"CAUTION RADIATION - THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED,"** or words having a similar intent, near any switch that energizes an x-ray tube.
- e. Shutters. On open-beam configurations installed after January 1, 1979, each port on the radiation source housing shall be equipped with a shutter that cannot be opened unless a collimator or a coupling has been connected to the port.
- f. Warning lights.
 1. An easily visible warning light labeled with the words **"X-RAY ON,"** or words having a similar intent, shall be located near any switch that energizes an x-ray tube and shall be illuminated only when the tube is energized.
 2. On equipment installed after January 1, 1979, warning lights shall have fail-safe characteristics.
- g. Radiation source housing. Each radiation source housing shall be subject to the following requirements:
 1. Each x-ray tube housing shall be equipped with an interlock that shuts off the tube if it is removed from the radiation source housing or if the housing is disassembled.
- h. Generator cabinet. Each x-ray generator shall be supplied with a protective cabinet which limits leakage radiation measured at a distance of 5 centimeters from its surface such that it is not capable of producing a dose in excess of 0.25 millirem in one hour.

RH-2903. Area Requirements.

- a. Radiation levels. The local components of an analytical x-ray system shall be located and arranged and shall include sufficient shielding or access control such that no radiation levels exist in any area surrounding the local component group which could result in a dose to an individual present therein in excess of the dose limits given in RH-1208. These levels shall be met at any specified tube rating.

RH-2903 (Cont'd)

b. Surveys.

1. Radiation surveys, as required by RH-1300, of all analytical x-ray systems sufficient to show compliance with RH-2903.a shall be performed:
 - A. Upon installation of the equipment;
 - B. Following any change in the initial arrangement, number or type of local components in the system;
 - C. Following any maintenance requiring the disassembly or removal of a local component in the system;
 - D. During the performance of maintenance and alignment procedures if the procedures require the presence of a primary x-ray beam when any local component in the system is disassembled or removed;
 - E. Any time a visual inspection of the local components in the system reveals an abnormal condition; and
 - F. Whenever personnel monitoring devices show a significant increase over the previous monitoring period or the readings are approaching the limits specified in RH-1200.
2. Radiation survey measurements shall not be required if a registrant can demonstrate compliance to the satisfaction of the Department with RH-2903.a in some other manner.

- c. Posting. Each area or room containing analytical x-ray equipment shall be conspicuously posted with a sign or signs bearing the radiation symbol and the words "**CAUTION - X-RAY EQUIPMENT**," or words having a similar intent.

RH-2904. Operating Requirements.

- a. Procedures. Normal operating procedures shall be written and available to all analytical x-ray equipment workers. No person shall be permitted to operate

analytical x-ray equipment in any manner other than that specified in the procedures unless such person has obtained written approval of the radiation safety officer.

- b. Bypassing. No person shall bypass a safety device unless such person has obtained the approval of the Radiation Safety Officer. When a safety device has been bypassed, a readily discernible sign bearing the words "**SAFETY DEVICE NOT WORKING**," or words having a similar intent, shall be placed on the radiation source housing.
- c. Repair or modification of x-ray tube systems. Except as specified in RH-2904.b no operation involving removal of covers, shielding materials or tube housings or modifications to shutters, collimators or beam stops shall be performed without ascertaining that the tube is off and will remain off until safe conditions have been restored. The main switch, rather than interlocks, shall be used for routine shutdown in preparation for repairs.

RH-2905. Personnel Requirements.

a. Instruction.

- 1. No person shall be permitted to operate or maintain analytical x-ray equipment unless such person has received instruction in and demonstrated competence as to:

- A. Identification of radiation hazards associated with the use of the equipment;
- B. Significance of the various radiation warning and safety devices incorporated into the equipment or the reasons they have not been installed on certain pieces of equipment and the extra precautions required in such cases;
- C. Proper operating procedures for the equipment;
- D. Symptoms of an acute localized exposure; and
- E. Proper procedures for reporting an actual or suspected exposure.

b. Personnel monitoring.

1. Finger or wrist dosimetric devices shall be provided to and shall be used by:
 - A. Analytical x-ray equipment workers using systems having an open-beam configuration and not equipped with a safety device; and
 - B. Personnel maintaining analytical x-ray equipment if the maintenance procedures require the presence of a primary x-ray beam when any local component in the analytical x-ray system is disassembled or removed.
2. Reported dose values shall not be used for the purpose of determining compliance with RH-1200 and RH-1208 unless evaluated by a qualified expert.

FOOTNOTES TO SECTION 3

- ^{1/} An organ or tissue is deemed to be significantly irradiated if, for that organ or tissue, the product of the weighting factors, w_T , and the committed dose equivalent, H_{T50} , per unit intake is greater than 10 percent of the maximum weighted value of H_{T50} (i.e., $w_T H_{50,T}$) per unit intake for any organ or tissue. H_{T50} was H_{50}
- ^{2/} This Section applies to radiation from byproduct, source, or special nuclear materials that are used in sealed sources in non-self-shielded irradiators. This Section does not apply to radioactive sources that are used in teletherapy, in radiography, or in completely self-shielded irradiators in which the source is both stored and operated within the same shielding radiation barrier and, in the designed configuration of the irradiator, is always physically inaccessible to any individual and cannot create high levels of radiation in an area that is accessible to any individual. This Section also does not apply to sources from which the radiation is incidental to some other use or to nuclear reactor-generated radiation.
- ^{3/} As appropriate, the information will include radiation levels, kinds of material, estimate of activity, date for which activity is estimated, etc.
- ^{4/} Labeling of packages containing radioactive materials is required by the Department of Transportation (DOT) if the amount and type of radioactive material exceeds the limits for an excepted quantity or article as defined and limited by DOT regulations 49 CFR 173.403(m) and (w) and 173.421-424.
- ^{5/} For example, containers in locations such as water-filled canals, storage vaults, or hot cells.
- ^{6/} Licensees are not required to reevaluate the separate external dose equivalents and internal committed dose equivalents or intakes of radionuclides assessed under RH-102 through RH-1308. Further, occupational exposure histories obtained and recorded on Department Form Z before January 1, 1994, would not have included effective dose equivalent, but may be used in the absence of specific information on the intake of radionuclides by the individual.
- ^{7/} Assessments of dose equivalent and records made using units in effect before the licensee's adoption of this Part need not be changed.
- ^{8/} A previous RH-407 permitted burial of small quantities of licensed materials in soil before January 28, 1981, without specific Department authorization.
- ^{9/} With respect to the limit for the embryo/fetus (RH-1027), the identifiers should be those of the declared pregnant woman.

FOOTNOTES TO SECTION 3
(Continued)

- 10/ If, because of the patient's condition, a delay in order to provide a written revision to an existing written directive would jeopardize the patient's health, an oral revision to an existing written directive will be acceptable, provided that the oral revision is documented immediately in the patient's record and a revised written directive is signed by the authorized user within 48 hours of the oral revision.

Also, a written revision to an existing written directive may be made for any diagnostic or therapeutic procedure provided that the revision is dated and signed by an authorized user prior to the administration of the radiopharmaceutical dosage, the brachytherapy dose, the gamma stereotactic radiosurgery dose, the teletherapy dose, or the next teletherapy fractional dose.

If, because of the emergent nature of the patient's condition, a delay in order to provide a written directive would jeopardize the patient's health, an oral directive will be acceptable, provided that the information contained in the oral directive is documented immediately in the patient's record and a written directive is prepared within 24 hours of the oral directive.

- 11/ The nominal chemical composition of type 1100 aluminum alloy is 99.00 percent (99%) minimum aluminum, 0.12 percent copper.

- 12/ The radiation detectors specified in RH-1608.b.6 may form part of this system.

- 13/ The calibration protocol published by the AAPM is accepted as an established protocol. Other protocols which are equivalent will be accepted, but the user should submit that protocol to the Department for concurrence that the protocol is equivalent.

- 14/ An example of a suggested plaque is shown in this Part.

- 15/ Appropriate warnings may include:

- a. "Do not drill below plug back depth";
- b. "Do not enlarge casing"; or
- c. "Do not re-enter the hole", followed by the words, "before contacting the Arkansas Department of Health."

FOOTNOTES TO SECTION 3
(Continued)

16/ Soluble (S); Insoluble (I)

17/ "Sub" means that values given are for submersion in a semi-spherical infinite cloud of airborne material.

18/ For purposes of these Regulations, it may be assumed that the daughter activity concentrations in the following table are equivalent to an air concentration of 10^{-7} microcuries of Radon-222 per milliliter of air in equilibrium with the daughters RaA, RaB, RaC and RaC'.

18a/ The duration of sample collection and the duration of measurement should be sufficiently short compared to the time between collection and measurement, as not to have a statistically significant effect upon the results.

19/ 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) of U-235 is less than 5, the concentration value for a 40-hour work week, Table I, is 0.2 milligrams Uranium per cubic meter or air average. For any enrichment, the product of the average of concentration and time of exposure during a 40-hour work week shall not exceed 8×10^{-3} SA $\mu\text{Ci-hr/ml}$, where SA is the specific activity of the Uranium inhaled. The concentration value for Table II is 0.007 milligrams Uranium per cubic meter of air. The specific activity for natural Uranium is 6.77×10^{-7} curies per gram U. The specific activity for other mixtures of U-238, U-235 and U-234, if not known, shall be:

$$\text{SA} = 3.6 \times 10^{-7} \text{ curies/gram U}$$

U-depleted

$$\text{SA} = [0.4 + 0.38 (\text{enrichment}) + 0.0034 (\text{enrichment})^2] \times 10^{-6} \geq 0.72$$

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

20/ Based on alpha disintegration rate of Th-232, Th-230, and their daughter products.

21/ Based on alpha disintegration rate of U-238, U-234, and U-235.

SECTION 4.

TRANSPORTATION OF RADIOACTIVE MATERIALS

(FOOTNOTES APPEAR AT THE END OF THIS SECTION)

PART A. GENERAL

- RH-3000. Authority. Act 8 of Second Extraordinary Session of 1961, as amended.
- RH-3001. Effective Date. The provisions of these Regulations shall become operative on the effective date of an agreement executed by the State of Arkansas and the Federal Government under the provisions of Section 274 of the Atomic Energy Act of 1954 as amended (73 STAT. 689).
- RH-3002. Purpose and Scope. The provisions of this Section apply to transportation of radioactive material or the delivery of radioactive material to a carrier for transportation, which is not subject to the rules and regulations of the U.S. Department of Transportation and other agencies of the United States having jurisdiction.
- RH-3003. Communications. All communications concerning these Regulations shall be addressed to the Division of Radiation Control and Emergency Management, Arkansas Department of Health, Division of Radiation Control and Emergency Management, 4815 West Markham, Mail Slot 30, Little Rock, Arkansas 72205-3867.

PART B. DEFINITIONS

RH-3100. General Definitions.

These Regulations - The Arkansas State Board of Health Rules and Regulations for Control of Sources of Ionizing Radiation, Section 4.

- a. A_1 - Maximum activity of special form of radioactive material permitted in a Type A package.

A_2 - Maximum activity of radioactive material, permitted in a Type A package.

These values may be derived in accordance with the procedure prescribed in RH-2700, Appendix C.

- b. Carrier - A person engaged in the transportation of passengers or property by land or water as a common, contract, or private carrier, or by civil aircraft.

- c. CFR - Code of Federal Regulations.

- d. Exclusive use (also referred to in other regulations as "sole use" or "full load") - The sole use of a conveyance by a single consignor and for which all initial, intermediate, and final loading and unloading are carried out in accordance with the direction of the consignor or consignee.

- e. Normal form radioactive material - Radioactive material which has not been demonstrated to qualify as "special form radioactive material".

- f. Package - Packaging together with its radioactive contents as presented for transport.

- g. Packaging - Assembly of components necessary to ensure compliance with the packaging requirements of this Part. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks. The vehicle, tie-down system, and auxiliary equipment may be designated as part of the packaging.

- h. Special form radioactive material - Radioactive material which satisfies the following conditions:
 - 1. It is either a single solid piece or is contained in a selected capsule that can be opened only by destroying the capsule;
 - 2. The piece or capsule has at least one dimension not less than 5 millimeters (0.197 inch); and
 - 3. It satisfies the test requirements of 10 CFR 71.75

 - i. Type B package - Type B package together with its radioactive contents. On approval, a Type B package design is designated by NRC as B(U) unless the package has a maximum normal operating pressure of more than 700 kilopascal (100 lb/in²) gauge or a pressure relief device which would allow the release of radioactive material to the environment under the tests specified in 10 CFR 71.73 (hypothetical accident conditions), in which case it will receive a designation B(M). B(U) refers to the need for unilateral approval of international shipments: B(M) refers to the need for multilateral approval. There is no distinction made in how packages with these designations may be used in domestic transportation. To determine their distinction for international transportation, see DOT regulations in 49 CFR Part 173. A Type B package approved prior to September 6, 1983, was designated only as Type B. Limitations on its use are specified in 10 CFR 71.73.

 - j. Type A quantity - A quantity of radioactive material, the aggregate radioactivity of which does not exceed A_1 for special form radioactive material or A_2 for normal form radioactive material, where A_1 and A_2 are given in Section 3, RH-2700, Table C-1 of this Part or may be determined by procedures described in this Part.
- Type B quantity means a quantity of radioactive material greater than a Type A quantity.

**PART C. REQUIREMENTS FOR INTRASTATE TRANSPORTATION OF
RADIOACTIVE MATERIALS**

- RH-3200. Transportation of Radioactive Material. No person shall deliver radioactive material to a carrier for transport or transport radioactive material except as authorized in a general or specific license issued by the Department or as exempted in RH-3300.
- RH-3201. Intrastate Transport of Radioactive Materials.
- a. A general license is hereby issued to any common or contract carrier 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 of the regulations, appropriate to the mode of transport, of the U.S. Department of Transportation insofar as such regulations relate to the loading and storage of packages, placarding carding of the transporting vehicle and incident reporting.^{1/}
 - b. A general license is hereby issued to any private carrier to transport radioactive material, provided the transportation is in accordance with the applicable requirements of these Regulations, appropriate to the mode of transport, of the U.S. Department of Transportation insofar as such regulations relate to the loading and storage of packages, placarding of the transporting vehicle, and incident reporting.^{1/}
 - c. Persons who transport radioactive material pursuant to the general licenses in RH-3201.a or b are exempt from the requirements of Section 3 of these Regulations to the extent that they transport radioactive material.
- RH-3202. Preparation of Radioactive Material for Transport. A general license is hereby issued to deliver radioactive material to a carrier^{2/} for transport provided that:
- a. The licensee complies with the applicable requirements of the Regulations, appropriate to the mode of transport, of the U.S. Department of Transportation insofar as such regulations relate to the packaging of radioactive material and to the monitoring, marking and labeling of those packages.

- b. The licensee has established 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.
- c. Prior to delivery of a package to a carrier for transport, the licensee shall assure that any special instructions needed to safely open the packages are sent to or have been made available to the consignee.

RH-3203. Advance Notification of Transport of Nuclear Waste.^{3/}

- a. Prior to the transport of any nuclear waste outside of the confines of the licensee's facility or other place of use or storage, or prior to the delivery of any nuclear waste to a carrier for transport, each licensee shall provide advance notification of such transport to the Governor (or Governor's designee) of each State through which the waste will be transported.
- b. Advance notification is required only when:
 - 1. The nuclear waste is required to be in Type B packaging for transportation;
 - 2. The nuclear 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;
 - 3. The quantity of licensed material in a single package exceeds:
 - i. 5,000 curies of special form radionuclides;
 - ii. 5,000 curies of uncompressed gases of Argon-41, Krypton-85m, Krypton-87, Xenon-131m, or Xenon-135;
 - iii. 50,000 curies of Argon-37, or of uncompressed gases of Krypton-85 or Xenon-133, or of Hydrogen-3 as a gas, as luminous paint, or absorbed on solid material;

- iv. 20 curies of other non-special form radionuclides for which A_2 is less than or equal to 4 curies; or
 - v. 200 curies of other non-special form radionuclides for which A_2 is greater than 4 curies (148 GBq).
- c. Each advance notification required by RH-3203.a. shall contain the following information:
- 1. The name, address and telephone number of the shipper, carrier and receiver of the shipment;
 - 2. A description of the nuclear waste contained in the shipment as required by these Regulations or the U.S. Department of Transportation in 49 CFR 172.202 and 172.203.d;
 - 3. The point of origin of the shipment and the seven-day period during which departure of the shipment is estimated to occur;
 - 4. The seven-day period during which arrival of the shipment at State boundaries is estimated to occur;
 - 5. The destination of the shipment and the seven-day period during which arrival of the shipment is estimated to occur; and
 - 6. A point of contact with a telephone number for current shipment information.
- d. The notification required by RH-3203.a. 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 seven days before the beginning of the seven-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 four days before the beginning of the seven-day period during which departure of the shipment is estimated to occur. A copy of the notification shall be retained by the licensee for one year.

- e. The licensee shall notify each appropriate Governor (or Governor's designee) and the Department of any changes to schedule information provided pursuant to RH-3203. Such notification shall be by telephone to a responsible individual in the Office of the Governor (or Governor's designee) of the appropriate state or states.

Each licensee shall maintain for one year a record of the name of the individual contacted.

- f. Each licensee who cancels a nuclear 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 one year.

PART D. EXEMPTIONS AND ADDITIONAL REQUIREMENTS

RH-3300. Exemptions.

- a. Common and contract carriers, freight forwarders and warehousemen who are subject to the rules and regulation of the U.S. Department of Transportation or the U.S. Postal Service 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 rules and regulations of the U.S. Department of Transportation or U.S. Postal Service are subject to RH-3200 and other applicable Sections of these Regulations.
- b. Physicians, as defined in RH-200, are exempt from the requirements of RH-3202 to the extent that they transport radioactive material for use in the practice of medicine.
- c. Any licensee is exempt from RH-3200 to the extent that he/she delivers to a carrier for transport packages each of which contains no radioactive material having a specific activity in excess of 0.002 microcurie per gram.
- d. Any licensee who delivers radioactive material to a carrier for transport, where such transport is subject to the regulations of the U.S. Postal Service, is exempt from the provisions of RH-3200.

RH-3301. Additional Requirements. The Department may, by rule, regulation or order, impose upon any licensee or registrant such requirements in addition to those established in these Regulations as it deems appropriate or necessary to minimize danger to public health and safety or property.

PART E. ENFORCEMENT

RH-3400. Violations.

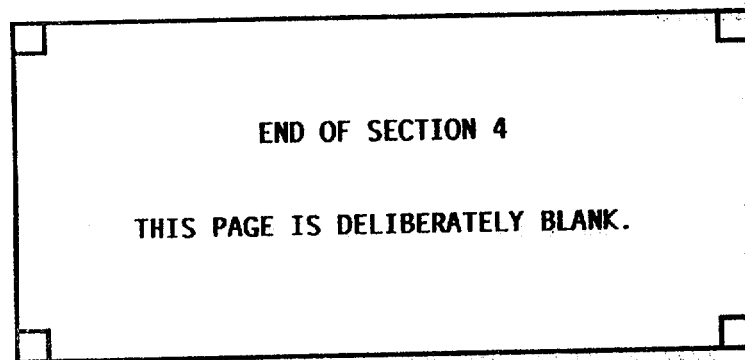
- a. Any person who violates any of the provisions of the Act or rules, regulations or orders in effect pursuant thereto of the Department, shall, upon conviction thereof, be punished by a fine not less than one hundred dollars (\$100.00) nor more than two thousand dollars (\$2,000.00) or by imprisonment for not more than six (6) months, or be both so fined and imprisoned.

Impounding.

- b. Sources of radiation shall be subject to impounding pursuant to Section 5 of these Regulations.

FOOTNOTES FOR SECTION 4.

- ^{1/} Any notification of incidents referred to in those requirements shall be filed with or made to, the Department.
- ^{2/} For the purpose of these Regulations, a licensee who transports his own licensed material as a private carrier is considered to have delivered such material to a carrier for transport.
- ^{3/} For the purpose of this Section, "nuclear waste" means any large quantity of source, byproduct, or special nuclear material required to be in Type B packaging while transported to, through or across State boundaries to a disposal site, or to a collection point for transport to a disposal site.



Revision effective January 1, 1997

SECTION 5. RULES OF PRACTICE

PART A. GENERAL

- RH-4000. Authority. Act 8 of Second Extraordinary Session of 1961, as amended.
- RH-4001. Effective Date. January 1, 1963.
- RH-4002. Scope. This Section contains the requirements applicable to and governing the proceeding of any administrative hearing pertinent these Regulations.
- RH-4003. Communications.
- a. All communications concerning this Regulation shall be addressed to the Division of Radiation Control and Emergency Management, Arkansas Department of Health, Division of Radiation Control and Emergency Management, 4815 West Markham, Mail Slot 30, Little Rock, Arkansas 72205-1867.
 - b. The Director of the Arkansas Department of Health or a duly appointed Hearing Officer shall specify the time and place of all hearings.

PART B. ADMINISTRATION

RH-4005. Administrative Examination of Applications. Applications for the issuance of a license, amendment of a license at the request of the holder and renewal of a license will be given a docket or other identifying number for administrative examination. The applicant may be required to submit additional information and may be requested to confer informally regarding the application. The Department will give to others such notice of the filing of applications as is required under the applicable provisions of these Regulations and such additional notices as it deems appropriate.

RH-4006. Action on Application, Hearings.

- a. The Department will, upon request of the applicant or intervenor and may upon its own initiative, direct the holding of a formal hearing prior to taking action on the application. If no prior formal hearing has been held and no notice of proposed action has been served as provided in Subparagraph b of this Paragraph, the Department will direct the holding of a formal hearing upon receipt of a request therefor from the applicant or intervenor within thirty (30) days after the issuance of a license or other approval or a notice of denial.
- b. In such cases as it deems appropriate, the Department may cause to be served upon the applicant a notice of proposed action upon his/her application and shall cause copies thereof to be served upon intervenors or others entitled to or requesting notification. The notice shall state the terms of the proposed action. If a formal hearing has not been held prior to the issuance of the notice, the Department will direct the holding of a formal hearing upon the request of the applicant or an intervenor received within fifteen (15) days following the service of the notice.

RH-4007. Effect of Timely Renewal Applications. In the case of an application for renewal, if the licensee has made application for the renewal of a subsisting license at least thirty (30) days prior to its expiration date, the license shall not be deemed to have expired until such application shall have been determined.

RH-4008. Notice of Violation.

- a. Prior to the institution of any proceeding for the suspension or revocation of a license for alleged violation of any provision of the Act, Regulations or conditions of a license, the licensee shall be served

with a written notice calling the facts to his/her attention and requesting a written explanation or statement in reply. Within fifteen (15) days of the receipt of such notice, the licensee shall send his/her reply to the Department. If the notice relates to conditions or conduct which may be susceptible to correction or to being brought into full compliance by action of the licensee, he/she shall state in his/her reply the corrective steps taken or to be instituted in achieving correction and preventing further violations and the date when such correction and full compliance will be achieved.

- b. Where, in the opinion of the Department, the public health, interest or safety requires; or the failure to be in compliance is willful; the notice provided for in this Section may be omitted.

RH-4009. Orders. In any case described in RH-4008 of this Regulation, the Department may issue to the licensee a notice to comply with the applicable provisions of the Act or the rules and regulations of the Arkansas State Board of Health or any order issued by the Department. The order shall apprise the licensee that he/she has the right to request a hearing within thirty (30) days by making a written request therefor to the Director. In the event a request for a hearing is received by the Director within the time specified, a notice of hearing shall be issued by the Department in accordance with RH-4028 of these Regulations.

RH-4010. Emergency Orders. Whenever the Department finds that an emergency exists requiring immediate action to protect the public health and safety, the Department may, without notice or hearing, issue a regulation or order reciting the existence of such emergency and requiring that such action be taken as is necessary to meet the emergency. Notwithstanding any provision of the Act (Act 8 of Second Extraordinary Session of 1961), such regulation or order shall be effective immediately. Any person to whom such regulation or order is directed shall comply therewith immediately, but on application to the Department shall be afforded a hearing within ten (10) days. On the basis of such hearing, the emergency regulation or order shall be continued, modified or revoked within thirty (30) days after such hearing. Any final order entered in any proceeding under this Paragraph may be appealed within twenty (20) days from the date of issuance thereof, to the Circuit Court of Pulaski County.

- RH-4011. Enforcement of Obedience to Orders. In case of the failure on the part of any person, firm or corporation to comply with any lawful order of the Director or with process or in case of the refusal of any witness to testify concerning any matter on which he/she may be lawfully interrogated, the Circuit Court or a Judge thereof having jurisdiction may, on application of the Director, compel obedience by proceeding as in contempt cases.
- RH-4012. Impounding Materials. The Department shall have the authority in the event of an emergency to impound or order the impounding of sources of ionizing radiation in the possession of any person who is not equipped to observe or fails to observe the provisions of the Act or any rules or regulations issued thereunder. As promptly as possible and not later than ten (10) days from the impounding, the Department shall serve upon the licensee or registrant an appropriate order for revocation of his/her license or registration together with a notice which shall give the licensee or registrant the right to request a formal hearing concerning the revocation of his/her license or registration and the restoration of the material of which he/she has been deprived.
- RH-4013. Filing of Papers. Unless otherwise specified, papers required to be filed with the Department shall be filed with the Radiation Control Programs, Arkansas Department of Health, 4815 West Markham, Mail Slot #30, Little Rock, Arkansas 72205-3867. Papers required to be filed with the Department shall be deemed filed upon actual receipt with the Department at the place specified; accompanied by proof of service upon the parties required to be served as provided in RH-4016 of these Regulations. Unless otherwise specified, the filing, when by mail or telegram, shall, upon actual receipt, be deemed complete as of the date of deposit in the mail or with the telegraph company. Papers may be filed in person at the Department's offices at Little Rock, Arkansas.
- RH-4014. Computation of Time. The time within which any Act under these Regulations is to be accomplished shall be computed by excluding the first day and including the last, unless the last day is Sunday or is a holiday as defined or fixed by statutes now or hereafter in force in this State, and then it shall also be excluded. If the day succeeding such Sunday or holiday is also a holiday or a Sunday, then such succeeding day shall also be excluded.
- RH-4015. Extension of Time. Extensions of time for filing or performing any Act required or allowed to be accomplished, and continuances of any proceeding or hearing, may be granted at the discretion of the Department upon application and good cause shown by any party, or upon the initiative of the Department or stipulation of all parties. Where a Hearing

Officer has been designated for hearing, the discretion in granting extensions of time and continuances in matters relating to the hearing shall rest with the Hearing Officer.

RH-4016. Subpoenas, Service and Papers. Subpoenas for the attendance of witnesses from any place in the State of Arkansas or the production of books, papers, accounts or documents at a hearing in a pending proceeding will be issued by the Department upon its own motion or upon application in writing incorporating a showing that such subpoena is reasonably required.

a. Service.

1. Service shall be made by delivering in person or by depositing in the United States Mail, properly addressed with postage prepaid, one copy to each party, if entitled thereto. When any party or parties have appeared by attorney, service upon the attorney shall be deemed service upon such party or parties.
2. Proof of service shall be by certificate of attorney affidavit or acknowledgement.

RH-4017. Representation.

- a. Except as provided in Subparagraph b of this Paragraph, any person appearing before the Department may do so in person or by a representative. Any person transacting business with the Department in a representative capacity may be required to show his/her authority to act in that capacity.
- b. In a formal hearing a person may appear in person or be represented by an Attorney-at-Law.

RH-4018. Intervention.

- a. Any person whose interests may be affected by a proceeding may file a petition to intervene not later than five (5) days before the commencement of the hearing or within such other time as may be specified in the notice, or as permitted by the Hearing Officer, describing his/her interest, how it may be affected by Department action and the position he/she is taking in the matter. Service of copies of the petition shall be made upon all parties to the proceeding. The Department, licensee, registrant, or applicant, upon

notice and motion and other parties by leave, may contest the right of the petitioner to intervene. A petition for leave to intervene which is not timely filed will be dismissed unless the petitioner shows good cause for failure to file it on time.

- b. As soon as it is practicable after filing of a petition for intervention and a hearing of argument, if any, the Director or Hearing Officer will issue and serve an order either permitting or denying intervention. If the order is a denial of intervention, it shall contain a statement of the grounds. An order permitting intervention may be conditioned upon such terms as the Director or Hearing Officer may direct.

RH-4019. Effect of Intervention or Denial Thereof. A person permitted to intervene becomes a party to the proceeding.

- a. Where a notice of hearing has been issued or a hearing has begun, the admission thereafter of an intervenor shall not of itself enlarge or alter the issues without amendment as provided in Subparagraph c of this Paragraph.
- b. An order denying intervention will be without prejudice to any proposed limited appearance by the petitioner as one who is not party for the purposes provided in RH-4023 of these Regulations.
- c. At any time prior to the time fixed for hearing but not later than five days prior, the party concerned may amend the petition for intervention by filing an amendment and serving it upon the parties. At any time thereafter, amendments may be permitted in the discretion of the Hearing Officer upon such terms as he/she shall prescribe.

RH-4020. Consolidation. Upon motion and good cause shown or upon its own initiative, the Department or Hearing Officer may consolidate two or more proceedings.

RH-4021. Hearings - Formal and Informal.

- a. Formal hearings will be held in cases of adjudication of rights.
- b. Informal hearings will normally be held for the purposes of obtaining necessary or useful information.

- RH-4022. Authority to Administer Oaths. Any oath or affirmation required by or pursuant to the provisions of these Regulations may be administered by any person authorized to administer oaths by the laws of the State of Arkansas.
- RH-4023. Informal Hearings Procedure. The procedure to be followed in informal hearings shall be such as will best serve the purpose of the hearing. For example, an informal hearing may consist of the submission of written data, views or arguments with or without oral argument, or may partake of the nature of a conference or may assume some of the aspects of a formal hearing in which the subpoena of witnesses and the production of evidence may be permitted or directed. A formal transcript is not necessarily required.
- RH-4024. Formal Hearings. The parties to a formal hearing shall be the Department, the licensee, registrant or applicant as the case may be and any person permitted to intervene pursuant to RH-4018 of these Regulations.
- RH-4025. Limited Appearances by Persons Not Parties. With the consent of the Hearing Officer, limited appearances may be entered by persons who are not parties to a hearing without request for or grant of permission to intervene. With the consent of the Hearing Officer and on due notice to the parties, such persons may make oral or written statements of their position on the issues involved in the proceeding, but may not otherwise participate in the hearing.
- RH-4026. Designation of Hearing Officer. The hearings herein provided for may be conducted by the Director or the Director may designate Hearing Officers who shall have the power and authority to conduct hearings in the name of the Department at any reasonable time and place.
- RH-4027. Function of Hearing Officer. The function of the Hearing Officer is to schedule and conduct hearings on behalf and in the name of the Department on all matters referred for hearing by the Director. It is the duty of the Hearing Officer to cause to be prepared and furnished to the Director for decision, a complete written transcript of the record of the hearing which contains all evidence introduced at the hearing and all pleas, motions, objections and ruling of the Hearing Officer.
- RH-4028. Notice of Hearing.
- a. Whenever a hearing is granted, the Department will give timely notice of the hearing to all parties and to other persons, if any, entitled to notice. Such notice will state the time, place and nature of the hearing; the legal authority and jurisdiction under which the hearing

is to be held; the matters of fact and law asserted or to be considered; and a request for an answer. The time and place for hearing will be fixed with due regard for the convenience and necessity of the parties or their representatives.

- b. The notice of hearing may be a separate notice or when appropriate may be embodied in the order issued pursuant to RH-4009.

RH-4029. Answer.

- a. Within the time allowed by the notice of hearing for filing and serving an answer, and as required, the answer of a licensee or applicant shall fully advise the Department and any other parties as to the nature of the defense or other position of the answering party, the issues he/she proposes to controvert and those he/she does not controvert, and whether or not he/she proposes to appear and present evidence. If facts are alleged the answer shall admit or deny specifically each allegation of fact; or where knowledge is lacking, the answer may so state and the statement shall operate as a denial. Allegations of fact not denied shall be deemed to be admitted. Matters alleged as affirmative defenses or positions shall be separately stated and identified and, in the absence of a reply, shall be deemed to be controverted. The answer of an intervenor shall fully advise the Department and other parties of his/her position and whether or not he/she proposes to appear and present evidence.
- b. If a party does not oppose any order or proposed action of the Department embodied in or accompanying the notice of hearing or does not wish to appear and give evidence at the hearing, the answer shall so state. In lieu of appearing, the party may, if he/she chooses, submit a notarized statement of reasons why the proposed order or sanction should not be issued or should be different than proposed and the Department will attribute such weight as it deems deserving to the written reasons.

RH-4030. Reply. In appropriate cases the Department may file and serve a reply to the answer or, if the answer affects other parties to the proceeding, the Director or the Hearing Officer may permit such parties to file and serve a reply.

RH-4031. Default. Failure of a party to file and serve an answer within the time provided in the notice of hearing or as

prescribed herein or to appear at a hearing, shall be deemed to authorize the Department at its discretion, as to such party:

- a. To find the facts alleged to be true and to enter such finding or order as may be appropriate, without further notice or hearing; or
- b. To proceed to take proof, without further notice, on the Allegations or issues set forth in the Specification of Issues.

RH-4032. Admissions. After answer has been filed, any party may file and serve upon the opposing side a written request for the admission of the genuineness and authenticity of any relevant documents described in or attached to the request or for the admission of the truth of any relevant matters of fact stated in the request. Each matter for which an admission is requested shall be deemed admitted unless within the time designated in the request, but not less than ten (10) days after service thereof or such further time as the Hearing Officer may allow upon motion and notice, the party to whom the request is directed serves upon motion and notice, the party to whom the request is directed serves upon the requesting party a sworn statement either denying the matters upon which the admission is requested or setting up the reasons why he/she cannot truthfully admit or deny such matters.

RH-4033. Prehearing Conferences.

- a. In order to provide opportunity for the settlement of a proceeding or any of the issues therein or for agreement upon procedural and other matters, there may be held at any time prior to or during a hearing, upon due notice of the time and place given to all parties, such conferences of the parties as, in the discretion of the Hearing Officer, time, the nature of the proceeding, and the public interest may permit.
- b. Action taken at a prehearing conference may be recorded for appropriate use at the hearing in the form of a written stipulation among the parties reciting the matters upon which there has been an agreement. The stipulation shall be binding upon the parties thereto.

RH-4034. Public Hearings. All formal hearings shall be public except in cases involving restricted data.

RH-4035. Evidence in Formal Hearings.

- a. Every party to the hearing shall have the right to present such oral or documentary evidence and rebuttal evidence and conduct such cross-examination as may be required for a full and true disclosure of the facts. The parties shall be encouraged to present evidence in written form.
- b. The Hearing Officer shall exclude all irrelevant, immaterial, or unduly repetitious evidence.
- c. Objections to the admission or exclusion of evidence shall state the grounds of objections. The transcript shall include the objections, the grounds and the rulings, but not the argument of the grounds, unless ordered by the Hearing Officer.
- d. Any offer of proof made in connection with an objection taken to the ruling of the Hearing Officer, excluding or rejecting proffered oral testimony, shall consist of a statement of substance of the evidence which the party contends would be adduced by such testimony. If the excluded material is documentary or written, a copy of such material shall be marked for identification and shall constitute the offer of proof.
- e. An official record of a governmental agency or an entry in such record, when admissible, may be evidenced by an official publication thereof or by a copy attested as a true copy by the officer having legal custody of the record, or by his/her deputy and accompanied by a certificate that such officer has the custody.

RH-4036. Briefs. Briefs may be filed within ten (10) days after the close of the hearing provided, however, that the Director may, upon written application, grant an additional period of time not in excess of sixty (60) days within which briefs may be filed.

RH-4037. Findings and Order. The Director shall, after reviewing the entire record of the hearing, make his/her findings and enter his/her order. The findings and order shall be in writing and shall contain a statement of findings and conclusions upon all material issues of fact and law and shall be signed by the Director. The original thereof shall be filed as a part of the record of the case which shall be retained in the custody of the Director unless an appeal is taken therefrom and one certified copy of the findings and order shall be served on all parties to the proceeding.

RH-4038. Appeals from Decision of Director. Any person who is aggrieved by any ruling, decision, or action of the Director may appeal to the State Board of Health within thirty (30) days after service of said ruling, decision, or action by filing with the President of the State Board of Health a written complaint setting out the ruling, decision, or action complained of, the reason that such person is aggrieved and the relief sought by such person. A copy of such complaint shall also be served by the appealing party upon any other party in interest. No new evidence shall be introduced and the appeal shall be tried upon the record prepared by the Director or Hearing Officer. Additional briefs and oral arguments may be granted by the State Board of Health. The State Board of Health may affirm the Findings and Order of the Director or may reverse, modify, or remand the case for further proceedings. Copies of the State Board of Health Order shall be served upon the parties in interest as provided in RH-4037 of this Regulation.

RH-4039. Waiver of Procedures. The parties to any hearing may agree to waive any one or more of the procedural steps which would otherwise precede the reaching of a final decision by the Department.

RH-4040. Public Records - Exceptions. Except as provided below, all records shall be deemed public records and shall be open to inspection by the public. The following are not to be considered public records which are available for public inspection:

- a. Documents relating to personnel matters and medical and other personal information, which, under general government personnel practices, are not normally made public.
- b. Intra-agency and inter-agency communications, including memoranda, reports, correspondence and staff papers prepared by members of the Department personnel or by any other government agency for use within the Department or within the executive branch of the Government.
- c. Records and reports of investigations.
- d. Documents classified as restricted data under the Atomic Energy Act of 1954, as amended, or classified under Executive Order of the President of the United States as restricted data.
- e. Correspondence received in confidence by the Department relating to an alleged or possible violation of any statute, rule, regulation, order, license, registration, or permit.

- f. Any other document involving matters of internal Department management.
- g. Any other matter required by law to be kept confidential or not available to public inspection.
- h. The Department may withhold any document or part thereof from public inspection if disclosure of its contents is not required in the public interest and would adversely affect the interest of a person concerned. Such withholding from public inspection shall not, however, affect the right of persons properly and directly concerned to inspect the document. Persons requesting that documents or information therein be withheld from public disclosure shall make prompt application identifying the material and giving the reasons. Where the applicant is responsible for the preparation of the document, he/she shall, insofar as is possible, segregate in a separate paper the information for which the special treatment is requested. The Department may honor the request upon a finding that public inspection is not required in the public interest and would adversely affect the interest of the person concerned. If the request is denied, the applicant will be notified thereof with a statement of the reasons.

SECTION 6.

PARTICLE ACCELERATORS

PART A. GENERAL

- RH-5000. Authority. Act 8 of Second Extraordinary Session of 1961, as amended.
- RH-5001. Effective Date. January 1, 1972.
- RH-5002. Purpose and Scope. These Regulations establish procedures for the licensing and the use of particle accelerators.
- RH-5003. Fees. In accordance with Act 504 of 1987 - Codified as ACA 20-21 - Subchapter 2, annual fees for licensing shall be paid. Nonpayment of fees shall result in escalated enforcement action and/or revocation of license.
- RH-5004. Communications. All communications concerning this Regulation shall be addressed to the Division of Radiation Control and Emergency Management, Arkansas Department of Health, 4815 West Markham, Mail Slot 30, Little Rock, Arkansas 72205-3867.

PART B. DEFINITIONS

RH-5100. General Definitions. Additional definitions used only in a certain Part will be found in that Part.

- a. Accelerator or Particle Accelerator - Any machine capable of accelerating electrons, protons, deuterons or other charged particles in a vacuum and of discharging the resultant particulate or other radiation into a medium at energies usually in excess of 1 MeV.
- b. Accelerator License - Except where otherwise specified, a license issued pursuant to these Regulations.
- c. Approved qualified expert - An individual who has, prior to offering health physics services, registered with and has demonstrated to the satisfaction of the Department that he/she possesses the knowledge and training to measure ionizing radiation parameters, to evaluate safety techniques, and to advise regarding radiation protection matters.
- d. Calibration - The determination of the response or reading of an instrument relative to a series of known radiation values over the range of the instrument, or the strength of a source of radiation relative to a standard.
- e. Department - Arkansas Department of Health.
- f. High Radiation Area - Any area in which there exists radiation at such levels that a major portion of the body could receive in any one (1) hour a dose in excess of 100 millirems.
- g. Human use - The internal or external administration of radiation or radioactive material to human beings.
- h. Individual - Any human being.
- i. Industrial radiography - The examination of the structure of materials by non-destructive methods utilizing a particle accelerator.
- j. Interlock - A device for precluding access to an area of radiation hazard either by preventing entry or by automatically removing the hazard.
- k. Licensee - Any person who is licensed by the Department in accordance with these Regulations and the Act.

- l. Misadministration - A therapy radiation dose from a particle accelerator such that errors in time of exposure or dose rate and/or treatment geometry result in a calculated total treatment dose differing from the final prescribed total treatment dose by more than 10 percent.
- m. Operator - A person qualified by training and experience to assume responsibility for the safe operation of a particle accelerator.
- n. Person - Any individual, corporation, partnership, firm, agency, political subdivision or agency thereof and any legal successor, representative, agent or agency of the foregoing, other than the U.S. Nuclear Regulatory Commission and other federal government agencies.
- o. Personnel monitoring equipment - Devices designed to be worn or carried by an individual for the purpose of estimating the dose received by the individual (e.g., film badges, pocket chambers, pocket dosimeters, film rings, thermoluminescent dosimeters, et al).
- p. Radiation - Ionizing radiation, i.e., gamma rays and x-rays, alpha and beta particles, high speed electrons, neutrons and other nuclear particles; but not sound or radio waves or visible, infrared, or ultraviolet light.
- q. Radiation Safety Officer - That individual who is responsible for the radiation protection program.
- r. Research and Development:
 - 1. Theoretical analysis, exploration, or experimentation; or
 - 2. The extension of investigative findings and theories of a scientific or technical nature into practical application for experimental and demonstration purposes, including the experimental production and testing of models, devices, equipment, materials, and processes.

Research and Development, as used in this Regulation, does not include the external administration of radiation to human beings.
- s. Test - The process of verifying compliance with an applicable regulation.

RH-5100 (Cont'd)

- t. These Regulations - Section 6 of the Rules and Regulations for Control of Sources of Ionizing Radiation of the State Board of Health, Standards for Protection Against Radiation.

PART C. LICENSES

RH-5200. License Requirement. No person shall receive, possess, use, transfer, own or acquire a particle accelerator except as authorized in a license issued pursuant to these Regulations or as otherwise provided in these Regulations.

RH-5201. Licensing Procedures.

- a. Application for accelerator licenses shall be filed on forms supplied by the Division of Radiation Control and Emergency Management, Arkansas Department of Health, 4815 West Markham, Mail Slot #30, Little Rock, Arkansas 72205-3867. The application shall set forth all applicable information called for by the form.
- b. The Department may at any time after the filing of the original application and before the expiration of the license, require further statements in order to enable the Department to determine whether the license should be modified or revoked.
- c. Each application shall be signed by the applicant or licensee or an individual duly authorized to act for and on his/her behalf.
- d. In his/her application, the applicant may incorporate, by reference, information contained in previous applications, statements or reports filed with the Department: Provided, that such references are clear and specific.
- e. Applications and documents submitted to the Department may be made available for public inspection except that the Department may withhold any document or part thereof from public inspection if disclosure of its contents is not required in the public interest and would adversely affect the interest of a person concerned.
- f. The Department may verify information contained in applications and secure additional information deemed necessary to make a reasonable determination as to whether to issue a license and whether special conditions should be attached thereto by visiting the facility or location where a particle accelerator would be located and used and by discussing details of proposed use of the particle accelerator with the applicant or his/her designated representative.
- g. Every person possessing a particle accelerator on the effective date of these Regulations shall have a period of ninety (90) days in which to make application for a license.

RH-5202. General Requirements for the Issuance of a License for Particle Accelerators. A license application will be approved if the Department determines that:

- a. The applicant is qualified by reason of training and experience to use the accelerator in question for the purpose requested in accordance with these Regulations and Section 3 in such a manner as to minimize danger to public health and safety or property; and
- b. The applicant's proposed equipment, facilities, operating and emergency procedures are adequate to protect health and minimize danger to public health and safety or property; and
- c. The issuance of the license will not be inimical to the health and safety of the public; and the applicant satisfies any applicable special requirements in RH-5203 of these Regulations.

RH-5203. Special Requirements for Issuance of a License for Particle Accelerators.

- a. Human use of particle accelerators in medical institutions. In addition to the requirements set forth in Part C, RH-5202, a license for use of a particle accelerator in medical institutions will be issued only if:
 1. Whenever deemed necessary by the Department, the applicant has appointed a medical committee of at least three members to evaluate all proposals for research, diagnostic and therapeutic use of a particle accelerator within that institution. Membership of the committee should include physicians expert in internal, hematology, therapeutic radiology and a person experienced in depth dose calculations and protection against radiation.
 2. The individuals designated on the application as the users have substantial experience in deep therapy techniques or in the use of particle accelerators to treat humans.
 3. The individual designated on the application as the user must be a physician.
 4. Whenever deemed necessary by the Department, the applicant has developed a training program for particle accelerators operators in accordance with the provisions of RH-5411.

- b. Use of particle accelerators in research and development. In addition to the requirements of Part C, RH-5202, a license for the use of a particle accelerator in research and development will be issued only if:
1. The applicant and/or his or her staff have substantial experience in the use of particle accelerators for a variety of research and development uses;
 2. The applicant has appointed a Radiation Safety Officer;
 3. Whenever deemed necessary by the Department, the applicant has established a Radiation Safety Committee to approve, in advance, proposals for uses of particle accelerators in research and development; and
 4. When deemed necessary by the Department, the applicant has developed a training program for particle accelerator operators in accordance with the provisions of RH-5411.
- c. Particle accelerators for the production of radioactive materials. In addition to the requirements of Part C, RH-5202, a license for the use of a particle accelerator to produce multiple quantities or types of radioactive material will be issued only if:
1. The applicant and/or his or her staff has substantial experience in the use of particle accelerators to produce a variety of radioactive materials;
 2. The applicant has appointed a Radiation Safety Officer;
 3. The applicant has an adequate training program for particle accelerator operators in accordance with the provisions of RH-5411; and
 4. The applicant has applied for a radioactive material license in accordance with the requirements of Section 2 of these Regulations.
- d. Use of particle accelerators in industrial radiography. In addition to the requirements of Part C, RH-5202, a license for the use of a particle accelerator in industrial radiography will be issued only if:

1. The applicant will have an adequate program for training radiographers and radiographers assistants in accordance with the provisions of RH-5411;
2. The applicant has appointed a Radiation Safety Officer; and
3. The applicant has established and submits to the Department satisfactory written operating and emergency procedures as described in RH-5409.

RH-5204. Issuance of Particle Accelerator Licenses.

- a. Upon a determination that an application meets the requirements of the Act and the Regulation of the Department, the Department will issue a specific license authorizing the proposed activity in such form and containing such conditions and limitations as it deems appropriate or necessary to effectuate the purposes of the Act.
- b. The Department may incorporate in any license at the time of issuance, or thereafter by appropriate rule, regulation or order, such additional requirements and conditions with respect to the licensee's use of a particle accelerator as it deems appropriate or necessary in order to:
 1. Protect health or to minimize danger to life or property;
 2. Require such reports and the keeping of such reports and to provide for such inspection of activities under the license as may be necessary or appropriate to effectuate the purposes of the Act and Regulations thereunder.

RH-5205. Specific Terms and Conditions of Licenses.

- a. Each license issued pursuant to this Regulation shall be subject to all the provisions of the Act now or hereafter in effect and to all rules, regulations, and orders of the Department.
- b. Neither the license nor any right under the license shall be assigned or otherwise transferred in violation of the provisions of the Act.

- c. Each person licensed by the Department pursuant to this Regulation shall confine his/her use and possession of the particle accelerator licensed to the locations and purposes authorized in the license. Any change in facility or location must be approved by the Department.
- d. Bankruptcy Notification
 - 1. Each licensee shall notify the Department, in writing, immediately following the filing of a voluntary or involuntary petition for bankruptcy under any Chapter of Title II (Bankruptcy) of the United States Code by or against:
 - A. The licensee;
 - B. An entity [as that term is defined in 11 U.S.C. 101(14)] controlling the licensee or listing the license or licensee as property of the estate; or
 - C. An affiliate [as that term is defined in 11 U.S.C. 101 (2)] of the licensee.
 - 2. This notification must indicate:
 - A. The bankruptcy court in which the petition for bankruptcy court was filed; and
 - B. The date of the filing of the petition.

RH-5206. Expiration of Licenses. Except as provided in Part C, RH-5207, each accelerator license shall expire at the end of the day, in the month and year stated therein.

RH-5207. Renewal of License.

- a. Application for renewal of an accelerator license shall be filed in accordance with Part C, RH-5201.
- b. In any case in which a licensee, not less than thirty (30) days prior to expiration of this existing license, has filed an application in proper form for renewal or for a new license authorizing the same activities, such existing license shall not expire until the application has been finally approved or disapproved by the Department.

RH-5208. Amendment of License at Request of Licensee. Applications for amendment of a license shall be filed in accordance with Part C, RH-5201 and shall specify the amendments desired and the reasons therefor.

RH-5209. Department Action on Application to Renew or Amend. In considering an application by a licensee to renew or amend his/her license, the Department will apply the criteria set forth in Part C, RH-5202 and RH-5203, as applicable.

RH-5210. Inalienability of Licenses. No license issued or granted under these Regulations and no right to utilize a particle accelerator granted by any license issued pursuant to this Regulation shall be transferred, assigned, or in any manner disposed of either voluntarily or involuntarily, directly or indirectly, through transfer of control of any license to any person unless the Department shall, after securing full information, find that the transfer is in accordance with the provisions of the Act and shall give its consent in writing.

RH-5211. Modification, Revocation, and Termination of Licenses.

- a. The terms and conditions of all licenses shall be subject to amendment, revision or modification and the license may be suspended or revoked by reason of amendments to the Act, or by reason of rules, regulations and orders issued by the Department.
- b. Any license may be revoked, suspended or modified, in whole or in part, for any material false statement in the application or any statement of fact required under provisions of the Act or of this Regulation, or because of conditions revealed by such application or statement of fact or any report, record or inspection or other means which would warrant the Department to refuse to grant a license on an original application, or for violation of, or failure to observe any of, the terms and conditions of the Act, or the license, or of any rule, regulation or order of the Department.
- c. Except in cases of willful violation or those in which the public health, interest or safety required otherwise, no license shall be modified, suspended or revoked unless, prior to the institution of proceedings therefor, facts or conduct which may warrant such action shall have been called to the attention of the licensee in writing and the licensee shall have been accorded opportunity to demonstrate or achieve compliance with all lawful requirements.

- d. The Department may terminate a specific license upon request submitted by the licensee to the Department in writing.

PART D. EXCLUSIONS FROM LICENSING

RH-5300. Excluded Devices.

- a. The following devices are exempt from the licensing requirements of these Regulations:
 - 1. Electrical equipment that produces radiation incidental to its operation for other purposes, but does not produce radiation at the point of nearest approach such that there is a reasonable likelihood that any individual will receive a radiation dose to the whole body, head and trunk, gonads or lens of the eye in excess of 0.5 rems in a year; and
 - 2. Those radiation machines that are covered under the provisions of Section 1 of these Regulations.

RH-5301. Excluded Possessors.

- a. Common and contract carriers are exempt from the requirement to license to the extent that they transport or store particle accelerators in the regular course of their carriage for another or storage incident thereto.
- b. Any U.S. Nuclear Regulatory Commission contractor or subcontractor of the following categories operating within this State is exempt from this Part to the extent that such contractor or subcontractor under his/her contract receives, possesses, uses, transfers, owns or acquires particle accelerators:
 - 1. Prime contractors performing work for the U.S. Department of Energy at the U.S. Government-owned or controlled sites;
 - 2. Prime contractors performing research in or development, manufacture, storage, testing or transportation of, atomic weapons or components thereof;
 - 3. Prime contractors using or operating nuclear reactors or other nuclear devices in a U.S. Government-owned vehicle or vessel; and
 - 4. Any other prime contractor or subcontractor, when the state and the NRC jointly determine that under the terms of the contract or subcontract, there is adequate assurance that the work thereunder can be accomplished without undue risk to the public health and safety and that the exemption of such contractor or subcontractor is otherwise appropriate.

**PART E. RADIATION SAFETY REQUIREMENTS FOR THE
USE OF PARTICLE ACCELERATORS**

RH-5400. General Provisions.

- a. This Part establishes radiation safety requirements for the use of particle accelerators. The provisions of this Part are in addition to, and not in substitution for, other applicable provisions of these Regulations set out in Sections 1 and 3.
- b. The Department may waive compliance with the specific requirements of this Part by an existing accelerator or installation if:
 - 1. Such compliance would require replacement or substantial modification of the accelerator or installation; and
 - 2. The licensee demonstrates to the Department's satisfaction achievement through other means of radiation protection equivalent to that required by these Regulations.
- c. The licensee shall be responsible for assuring that all requirements of this Part are met.

RH-5401. Limitations.

- a. No licensee shall permit any person(s) to act as an accelerator operator until such person(s):
 - 1. Has been instructed in the subjects in RH-5410 and shall have demonstrated an understanding thereof;
 - 2. Has received copies of and instructions in this Part and the applicable requirements of Section 3, pertinent license conditions and the licensee's operating and emergency procedures, and shall have demonstrated understanding thereof; and,
 - 3. Has demonstrated competence to use the particle accelerator, related equipment and survey instruments which will be employed in his/her assignment.
- b. Either the Radiation Safety Committee or the Radiation Safety Officer shall have the authority to terminate the operations at an accelerator facility if such action is deemed necessary to protect health and minimize danger to public health and safety or property.

RH-5402. Shielding Requirements.

- a. An approved qualified expert shall be consulted in the design of a particle accelerator installation and called upon to perform a radiation survey when the accelerator is first capable of producing radiation.
- b. Each accelerator installation shall be provided with such primary and/or secondary barriers as are necessary to assure compliance with RH-1200 and RH-1208.

RH-5403. Accelerator Controls and Interlock Systems.

- a. Instrumentation, readouts, and controls on the accelerator control console shall be clearly identified and easily discernible.
- b. All entrances into a target room or other high radiation area shall be provided with safety interlocks that shut down the machine under conditions of barrier penetration.
- c. When an interlock system has been tripped, it shall only be possible to resume operation of the accelerator by manually resetting controls at the position where the interlock has been tripped and lastly at the main control console.
- d. Each safety interlock shall be on an independent single circuit and shall operate independently of all other safety interlocks.
- e. All safety interlocks shall be fail safe, i.e., designed so that any defect or component failure in the interlock system prevents operation of the accelerator.
- f. A scram button or other emergency power cut-off switch shall be located and easily identifiable in all high radiation areas. Such a cut-off switch shall include a manual reset so that the accelerator can not be restarted from the accelerator control console without resetting the cut-off switch.

RH-5404. Warning Devices.

- a. All locations designated as high radiation areas and entrances to such locations shall be equipped with easily observable flashing or rotating warning lights that operate when, and only when, radiation is being produced.

RH-5404 (Cont'd)

- b. Except in facilities designed for human exposure, each high radiation area shall have an audible warning device which shall be activated for 15 seconds prior to the possible creation of such high radiation area. Such warning device shall be clearly discernible in all high radiation areas.
- c. Barriers, temporary or otherwise, and pathways leading to high radiation areas, shall be identified in accordance with RH-1303.

RH-5405. Operating Procedures.

- a. Particle accelerators, when not in operation, shall be secured to prevent unauthorized use.
- b. Only a switch on the accelerator control console shall be routinely used to turn the accelerator beam on and off. The safety interlock system shall not be used to turn off the accelerator beam except in an emergency.
- c. All safety and warning devices, including interlocks, shall be checked for proper operability at intervals not to exceed three (3) months. Results of such tests shall be maintained at the accelerator facility.
- d. Electrical circuit diagrams of the accelerator and the associated interlock systems shall be kept current and on file at each accelerator facility.
- e. If for any reason, it is necessary to intentionally bypass a safety interlock or interlocks, such action shall be:
 - 1. Authorized by the Radiation Safety Committee and/or the Radiation Safety Officer;
 - 2. Recorded in a permanent log and a notice posted at the accelerator control console; and
 - 3. Terminated as soon as possible.
- f. Deleted.

RH-5406. Personnel Monitoring Requirements.

- a. The Radiation Safety Officer shall supply appropriate personnel monitoring devices and shall require the use

of such devices in accordance with the provisions of RH-1301.

- b. Each licensee shall maintain records showing the radiation exposures of all individuals for whom personnel monitoring is required under RH-1301. Such records shall be kept in accordance with the provisions of RH-1500.

RH-5407. Radiation Monitoring Requirements.

- a. There shall be available at each accelerator facility, appropriate portable monitoring equipment which is operable and has been calibrated for the appropriate radiations being produced at the facility. Such equipment shall be tested for proper operation and calibrated for the appropriate radiations at intervals specified by the Department, after each servicing, and repair which could affect instrument calibration.
- b. A radiation protection survey shall be performed and documented by a qualified expert specifically approved by the Department when changes have been made in shielding, operation, equipment, or occupancy of adjacent areas; and periodically to check for unknown changes and malfunctioning equipment.
- c. Radiation levels in all high radiation areas shall be continuously monitored. The monitoring devices shall be electrically independent of the accelerator control and safety interlock system. The monitoring devices shall be capable of providing a remote and local readout with visual and/or audible alarms at both the control panel and monitoring stations. The monitoring devices shall be set to activate at a level at least 100 mrem/hr.
- d. All area monitors shall be checked for proper operation before each day of use.
- e. Whenever applicable, periodic surveys shall be made to determine the amount of airborne particulate radioactivity present in areas of airborne hazards.
- f. Whenever applicable, periodic smear surveys shall be made to determine the degree of contamination in target and scattering chamber areas.
- g. All area surveys shall be made in accordance with the written procedures established by a qualified expert,

RH-5407 (Cont'd)

specifically approved by the Department or the Radiation Safety Officer of the accelerator facility.

- h. Records of all radiation protection surveys, calibration results, instrumentation tests and smear results shall be kept current and on file at each accelerator facility.

RH-5408. Ventilation and Waste Disposal Systems.

- a. Adequate ventilation shall be accomplished in irradiated areas where exposures to airborne radioactivity exceed the limits specified in RH-2200, Appendix A, Table I.
- b. A licensee shall not vent, release or otherwise discharge airborne radioactive materials from irradiated areas to an uncontrolled area which exceed the limits specified in RH-2200, Appendix A, Table II, except as authorized pursuant to RH-1401. For purposes of this Paragraph, concentrations may be averaged over a period not greater than one (1) year.
- c. All solid and liquid radioactive wastes produced at an accelerator facility must be disposed of in accordance with the provisions of RH-1402 and RH-1403.

RH-5409. Operating and Emergency Procedures.

- a. The licensee's operating and emergency procedure shall include instructions in at least the following:
 - 1. The use of particle accelerators such that no person is likely to be exposed to radiation doses in excess of the limits established in Section 3 "Standards for Protection Against Radiation;"
 - 2. Methods and occasions for conducting radiation surveys;
 - 3. Personnel monitoring and the use of personnel monitoring equipment;
 - 4. Minimizing exposures to persons in the event of an accident;
 - 5. Safety procedures to be employed whenever an interlock has been either tripped or intentionally bypassed;

6. The procedures for notifying proper persons in the event of an accident; and
7. Maintenance of records.

RH-5410. Minimum Subjects to be Covered in Training Operators.

a. Fundamentals of Radiation Safety.

1. Characteristics of particulate and electromagnetic radiation.
2. Units of radiation dose and quantity of radioactivity.
3. Biological hazards of exposure to radiation.
4. Measurement of radiation.
5. Methods of controlling radiation dose.
6. Radiation safety procedures, interlock systems and warning systems.

b. Fundamentals of Radiation Safety.

1. Use of radiation survey instruments.
2. Survey technique.
3. Use of personnel monitoring equipment.

c. Equipment.

1. Remote handling equipment.
2. Handling of activated materials.
3. Use of shielding.

RH-5411. Minimum Training Program for Particle Accelerator Operators.

- a. A training program for accelerator operators should consist of at least the following:
 1. Initial training;
 2. Periodic training;

3. On-the-job training; and
4. A means to be used by the licensee to determine the operator's knowledge and understanding of and ability to comply with, Department Regulations and requirements, and the operating and emergency procedures of the applicant.

**PART F. EXEMPTIONS, ADDITIONAL REQUIREMENTS,
INSPECTIONS, AND TESTS**

RH-5500. Exemptions.

The Department may, upon application therefor, or upon its own initiative, grant such exemptions or exceptions from the requirements of this Regulation as it determines are authorized by law and will not result in undue hazard to public health and safety or property.

RH-5501. Additional Requirements.

The Department may, by rule, regulation or order, impose upon any licensee such requirements in addition to those established in these Regulations as it deems appropriate or necessary to minimize danger to public health and safety or property.

RH-5502. Inspections.

- a. Each licensee and registrant shall afford the Agency at all reasonable times opportunity to inspect sources of radiation and the premises and facilities wherein such sources of radiation are used or stored.
- b. Each licensee and registrant shall make available to the Agency for inspection, upon reasonable notice, records maintained pursuant to these Regulations.

RH-5503. Tests. Each licensee and registrant shall perform upon instructions from the Department or shall permit the Department to perform, such reasonable tests as the Department deems appropriate or necessary including, but not limited to, tests of:

- a. Sources of radiation;
- b. Facilities wherein sources of radiation are used or stored;
- c. Radiation detection and monitoring instruments; and
- d. Other equipment and devices used in connection with utilization or storage of licensed or registered sources of radiation.

RH-5504. Records and Reports of Misadministration

- a. When a misadministration occurs the licensee shall notify the Department by telephone. The licensee shall

also notify the referring physician of the affected patient and the patient or a responsible relative (or guardian), unless the referring physician agrees to inform the patient or believes, based on medical judgment, that telling the patient or the patient's responsible relative (or guardian) would be harmful to one or the other, respectively. These notifications must be made within 24 hours after the licensee discovers the misadministration. If the referring physician, patient, or the patient's responsible relative (or guardian) cannot be reached within 24 hours, the licensee shall notify them as soon as practicable. The licensee is not required to notify the patient or patient's responsible relative (or guardian) without first consulting the referring physician; however, the licensee shall not delay medical care for the patient because of this.

- b. Within 15 days after an initial therapy misadministration report to the Department, the licensee shall report, in writing, to the Department and to the referring physician, and furnish a copy of the report to the patient or the patient's responsible relative (or guardian) if either was previously notified by the licensee under RH-5504.a.. The written report must include the licensee's name; the referring physician's name; a brief description of the event; the effect on the patient; the action taken to prevent recurrence; whether the licensee informed the patient or the patient's responsible relative (or guardian), and if not, why not. The report must not include the patient's name or other information that could lead to identification of the patient.
- c. Each licensee shall retain a record of each misadministration for ten years. The record must contain the names of all individuals involved in the event (including the physician, allied health personnel, the patient, and the patient's referring physician), the patient's social security number or identification number if one has been assigned, a brief description of the event, the effect on the patient, and the action taken, if any, to prevent recurrence.
- d. Aside from the notification requirement, nothing in this Section affects any rights or duties of licensees and physicians in relation to each other, patients, or responsible relatives (or guardians).

PART G. ENFORCEMENT

RH-5600. Violations.

- a. Any person who violates any of the provisions of the Act or rules, regulations or orders in effect pursuant thereto of the Department, shall, upon conviction thereof, be punished by a fine not less than one hundred dollars (\$100.00) nor more than two thousand dollars (\$2,000.00) or by imprisonment for not more than six (6) months, or be both so fined and imprisoned.

Impounding.

- a. Sources of radiation shall be subject to impounding pursuant to Section 5 of these Regulations.

SECTION 7. NATURALLY OCCURRING RADIOACTIVE MATERIAL (NORM)

PART A. GENERAL

- RH-6000. Authority. Act 8 of the Second Extraordinary Session of 1961 as amended (ACA 1987 Title 20 Chapter 21.)
- RH-6001. Effective Date. The provisions and requirements of this Section shall take effect on June 1, 1992 and shall apply to all facilities or sites owned or controlled by a person on that date. Products distributed and disposals made prior to that date are not subject to the provisions of this section.
- RH-6002. Purpose. This Section establishes radiation protection standards for the possession, use, transfer, and disposal of naturally occurring radioactive materials (NORM) not subject to regulation by the U.S. Nuclear Regulatory Commission.
- RH-6003. Scope. These Regulations apply to any person who engages in the extraction, mining, beneficiating, processing, use, transfer, or disposal of NORM in such a manner as to alter the chemical properties or physical state of the NORM or its potential exposure pathway to humans.

The Regulations in this Section address the introduction of NORM into products in which neither the NORM nor the radiation emitted from the NORM is considered to be beneficial to the products. The manufacture and distribution of products containing NORM in which the NORM and/or its associated radiation(s) is considered to be a beneficial attribute are licensed under the provisions of Section 2.

This Section also addresses waste management and disposal standards.

PART B. DEFINITIONS

RH-6004. General Definitions. As used in this Section, the following definitions apply:

- a. Beneficial attribute or beneficial to the product - The radioactivity of the product is necessary to the use of the product.
- b. Beneficiating - The processing of materials for the purpose of altering the chemical or physical properties to improve the quality, purity, or assay grade.
- c. Breathing zone - Used in determining respiratory requirements, the area of the body within one (1) foot of the mouth and nose of a worker.
- d. Confirmatory survey - A survey by the potential general licensee of potentially contaminated land, equipment, or sites in order to establish, with reasonable certainty, the absence or magnitude of NORM contamination.
- e. Designated facility - A specific-licensed facility capable of receiving NORM shipments for the purpose of processing, storage, or disposal of NORM.
- f. Department - Arkansas Department of Health.
- g. Dose commitment - The total radiation dose to a section of the body that will result from retention in the body of radioactive material. For purposes of estimating the dose commitment, it is assumed that from the time of intake the period of exposure to retained material will not exceed 50 years.
- h. General environment - The total terrestrial, atmospheric, and aquatic environments outside sites within which any activity, operation, or process authorized by a general or specific license issued under this Section is performed.
- i. Licensing State - Means any State with regulations equivalent to the Suggested State Regulation for Control of Radiation relating to, and an effective program for, the regulatory control of NORM and which has been granted final designation by the Conference of Radiation Control Program Directors, Inc..

Revision effective January 1, 1997

- j. Major processor - A user processing, handling, or manufacturing radioactive material exceeding Type A quantities as unsealed sources or material, or exceeding four (4) times Type B quantities as sealed sources. Type A and B quantities are defined in RH-3100.j.
- k. Natural radioactivity - Radioactivity of naturally occurring nuclides.
- l. Naturally occurring radioactive material (NORM) - Any nuclide which is radioactive in its natural physical state (i.e., not man-made), but does not include byproduct, source, or special nuclear material.
- m. NORM facility identification number - The number assigned by the Department to a specific facility of a NORM general licensee having more than one site possessing radioactive material exceeding the exemption criteria specified in RH-6005.
- n. NORM field supervisor - An individual who answers to the corporate NORM RSO approved by the Department as being qualified to oversee radiation protection of workers after attending at least forty (40) hours of classroom training in NORM-related health physics and six (6) months documented on-the-job training with a Department-approved qualified third party Radiation Safety Officer.
- o. NORM general license number - The number assigned by the Department to the generator or other responsible party possessing radioactive material exceeding the exemption criteria specified in RH-6005.
- p. NORM Radiation Safety Officer (RSO) - An individual approved by the Department as being qualified to oversee radiation protection of workers after attending at least forty (40) hours of classroom training in NORM-related health physics and six (6) months documented on-the-the job training with a Department-approved qualified third party Radiation Safety Officer.
- q. NORM surveyor - An individual who has completed at least sixteen (16) hours of classroom training and three (3) months documented on-the-job training in NORM-related surveying techniques and health physics approved by the State as being qualified to perform NORM confirmatory and release surveys at NORM job sites.

Revision effective January 1, 1997

- r. NORM waste management plan - The plan for the management, i.e., handling, interim storage and disposal, of NORM.
- s. NORM worker - An individual who has completed at least eight (8) hours of classroom training in NORM-related health physics concerning the protection of the worker, hazards involved in dealing with NORM, and other subjects outlined in RH-6018.
- t. Notifier - The person or party meeting the definition of a general licensee according to RH-6010 and therefore, subject to the notification requirement stated in RH-6010.a.1.
- u. Product - Something produced, made, manufactured, refined, or benefited.
- v. Regulations of the U.S. Department of Transportation - The regulations in 49 CFR Parts 100-189.
- w. Release survey - The survey required to release either equipment or land for unrestricted use. A land release survey must be approved by the Department before land will be released for unrestricted use.
- x. Working Level (WL) - Any combination of short-lived Radon decay products in one liter of air that will result in the ultimate emission of alpha particles with a total energy of 130 billion electron volts.

Revision effective January 1, 1997

PART C. EXEMPTIONS

RH-6005. Exemptions.

- a. Persons who receive, possess, use, process, transfer, distribute, and dispose of NORM are exempt from the requirements of these Regulations if:

The materials contain or are contaminated at concentrations less than 5 picocuries per gram of Radium-226 and/or Radium-228, 0.05% by weight of Uranium or Thorium, or 150 picocuries per gram of any other NORM radionuclide, provided that these concentrations are not exceeded at any time.
- b. Persons who receive products or materials containing NORM distributed in accordance with a specific license issued by the Department pursuant to RH-6022.c or an equivalent license issued by another Licensing State are exempt from these Regulations.
- c. The manufacturing, distribution, use, and disposal of the following products/materials are exempt from the requirements of these Regulations:
 1. Potassium and Potassium compounds which have not been isotopically enriched in the radionuclide K-40; and
 2. Brazil nuts.
- d. The wholesale and retail distribution (including custom blending), possession, and use of the following products/materials are exempt from the requirements of these Regulations:
 1. Phosphate and potash fertilizer;
 2. Phosphogypsum for agricultural uses if it has not been technologically enhanced; and
 3. Materials used for building and highway construction if such materials contain NORM which has not been technologically enhanced.

Revision effective January 1, 1997

RH-6005 Cont'd

- e. The possession and use of natural gas and natural gas products and crude oil and crude oil products as fuel are exempt from the requirements of these Regulations. The distribution of natural gas and crude oil and the manufacturing and distribution of natural gas and crude oil products are exempt from the specific license requirements of this Section but are subject to the general license requirements in RH-6010.

RH-6006-

RH-6009 Reserved.

Revision effective January 1, 1997

PART D. LICENSES

RH-6010. General License.

- a. 1. A general license is hereby issued to mine, extract, receive, possess, own, use, process, and dispose of NORM not exempted in RH-6005 without regard to quantity. This general license does not authorize the manufacturing or distribution of products containing NORM in concentrations greater than those specified in RH-6005.a nor the disposal of wastes from other entities. Persons subject to the general license shall notify the Department by filing the Notification of a NORM Facility Form with the Department. The Notification of NORM Facility Form is available from the Department.

NOTE: The Department recommends a general licensee under RH-6010.a.1 conduct or arrange to have conducted a confirmatory survey to determine the extent and magnitude of the NORM contamination at the general licensee's facility.

2. Each general licensee performing on-site maintenance of contaminated facilities, sites, or equipment or the excavation of land shall establish and submit to the Department for approval written procedures as outlined in RH-6019 to ensure worker protection and survey (or screening) of sites and equipment as outlined in RH-6018.
 3. On-site maintenance is authorized only if the maximum radiation level does not exceed 2 millirem per hour at any accessible point of the work area.
- b. Facilities and equipment contaminated with NORM in excess of the levels set forth in Appendix A of this Section, or if the maximum radiation exposure level exceeds 50 microrentgen per hour including background at any accessible point shall not be released for unrestricted use. The decontamination of equipment and facilities shall be performed only by persons specifically licensed by the Department or another Licensing State to conduct such work. Each general licensee shall establish for approval written procedures for the evaluation (or screening) of equipment, components, and facilities prior to release for unrestricted use to ensure that the levels in Appendix A of this Section are not exceeded.

Revision effective January 1, 1997

- c. No person shall transfer land for unrestricted use where the concentration of Radium-226 or Radium-228 in soil averaged over any 100 square meters exceeds the background level by more than:
 - 1. 5 pCi/g, averaged over the first 15 cm of soil below the surface; and
 - 2. 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.
- d. Equipment contaminated with NORM is exempt from the requirements of these Regulations if the maximum radiation exposure level does not exceed 50 microroentgen per hour including background at any accessible point, and radioactive contamination levels do not exceed levels set forth in Appendix A of this Section.
- e. The decontamination of equipment, facilities and land, as described in RH-6020.b shall only be performed by persons specifically licensed by the Department or another Licensing State to conduct such work.
- f.
 - 1. The transfer of NORM not exempt from these Regulations from one general licensee to another general licensee may be authorized by the Department if:
 - A. The equipment and facilities containing NORM are to be used by the recipient for the same purpose or at the same site;
 - B. The transfer of control or ownership of land containing NORM includes an annotation of the deed records to indicate the presence and quantity of NORM; or
 - C. The materials being transferred are ores or raw materials for processing or refinement.
 - 2. Transfers made under RH-6010.f.1 do not relieve the general licensee who makes the transfer from the responsibilities of assessing the extent of NORM contamination or material present, evaluating the hazards of the NORM, informing the general licensee receiving the NORM of these assessments and evaluations, and maintaining records required by these Regulations.

g. Storage of NORM and NORM waste from remediation.

1. A general licensee is authorized to store NORM waste generated during remediation in a container for ninety (90) days from the date of generation. After such time, the NORM waste must be transferred to an authorized facility for the purposes of treatment, storage, or disposal unless otherwise exempted in writing by the Department.
2. To store NORM waste in an approved container for up to one (1) year from generation, a general licensee must first submit a written NORM waste management plan to the Department and receive authorization from the Department. The general licensee may store NORM waste in an approved container up to one (1) year [365 days] from generation under the written NORM waste management plan while waiting for Department determination unless otherwise exempted in writing by the Department.

RH-6011. Protection of Workers During Operations. Each person subject to the general license in RH-6010 or a specific license shall conduct operations in compliance with the standards for radiation protection set out in Section 2 and 3, except for releases of radioactivity in effluents, which shall be regulated by RH-6012 and disposal, which shall be governed by RH-6013.

RH-6012. Protection of the General Population from Releases of Radioactivity. Each person subject to the general license in RH-6010 or a specific license shall conduct operations such that concentrations of radioactive material which are released to the general environment in groundwater, surface water, air, soil, plants, and animals do not result in an annual dose above the limits specified in RH-1208 and RH-1209. Doses due to Radon-220, Radon-222, and their respective decay products, are excluded from these limits.

RH-6013. Disposal and Transfer of Waste for Disposal.

- a. Each person subject to the general license in RH-6010 or a specific license shall manage and dispose of wastes containing NORM:

Revision effective January 1, 1997

1. In accordance with the applicable requirements of the U.S. Environmental Protection Agency for disposal of such wastes;
 2. By transfer of the wastes for disposal to a land disposal facility licensed by the U.S. Nuclear Regulatory Commission, an Agreement State, or a Licensing State; or
 3. In accordance with alternate methods authorized by the Department upon application or upon the Department's initiative.
- b. Records of disposal, including manifests, shall be maintained pursuant to the provisions of Section 3, Part E of these Regulations.
- c. Transfers of waste containing NORM for disposal shall be made to a person specifically authorized to receive such waste.

RH-6014. Containers.

- a. NORM and NORM waste shall be kept in a container that is in good and safe condition.
- b. The licensee shall use a container made of, or lined with, materials that will not react with, or be incompatible with, the NORM waste to be stored so that the ability of the container to contain the waste is not impaired or compromised.
- c. A container holding NORM waste shall always be closed and sealed during storage, except when it is necessary to add or remove waste.
- d. A container holding NORM waste shall not be opened, handled, or stored in a manner that may rupture the container or cause it to leak.
- e. At least quarterly, the licensee shall inspect areas where containers of NORM waste are stored, looking for leaking or deteriorating containers or containment systems. Records of these inspections shall be made.

Revision effective January 1, 1997

- f. All containers of NORM waste shall be stacked in such a manner that each container identification label can be read from the access aisle or area.
- g. Each container of NORM shall be labeled with the following information prior to storage:
 - 1. Name and address of generator.
 - 2. Type of material (i.e., sludge, scale, dirt, scrap metal, et cetera).
 - 3. Date stored.
 - 4. Microrentgen per hour exposure readings on contact and at one (1) meter. (These exposure readings shall be updated if NORM waste is added to the container.)
 - 5. Labeled as Radioactive Material.
- h. Records of inspections shall be maintained by the licensee for inspection by the Department for five (5) years.

RH-6015. Tanks Containing NORM. The licensee shall develop a schedule and procedure for assessing the condition of each tank containing NORM waste. The schedule and procedure must be adequate to detect cracks, leaks, corrosion and erosion that may lead to cracks, leaks, or wall thinning to less than the required thickness to maintain vessel integrity. Procedures for emptying a tank to allow entry, procedures for personnel protection, and inspection of the interior must be established when necessary to detect corrosion of the tank sides and bottom. The frequency of these inspections will be determined based on the type of NORM material being stored and the tank construction material and the type of erosion/corrosion that may exist.

Revision effective January 1, 1997

RH-6016. Transportation of NORM. Transportation of NORM contaminated equipment and/or waste shall be subject to the applicable parts of Section 4 of these Regulations and the requirements listed below.

- a. Each shipment of NORM waste and NORM contaminated equipment to a facility specifically licensed for treatment, decontamination, storage, or disposal shall be accompanied by a manifest.
- b. The manifest form must consist of, at a minimum, the number of copies that will provide the licensee, each transporter, and the operator of the designated facility with one (1) copy each for their records with at least one (1) copy signed by all parties involved returned to the generator/shipper for their records.
- c. General requirements.
 1. A licensee who transports, or offers for transportation, NORM waste and/or NORM contaminated equipment to a facility specifically licensed for treatment, decontamination, storage, or disposal must prepare and sign sufficient copies of a manifest before transporting the NORM off-site.
 2. A licensee must designate on the manifest one facility which is permitted to handle the NORM described on the manifest.
 3. If the transporter is unable to deliver the NORM to the designated facility, the licensee must either designate another facility or instruct the transporter to return the NORM.
 4. Licensees must provide a statement concerning the nature of the material and general guidelines for an emergency situation involving this waste to accompany the manifest on shipments and loads.
 5. If the NORM is to be transported out-of-state, the licensee will be responsible for receiving the completed signed manifest from the out-of-state treatment, decontamination, storage, or disposal facility.
 6. Before initiating the shipment, licensees shall obtain written confirmation of the acceptability of the NORM, NORM contaminated equipment, or NORM waste from the operation of the specifically licensed commercial facility. The confirmation must be maintained with the licensee's manifest records.

7. The licensee receiving the shipment is required to report to the Department and to the licensee initiating the shipment any discrepancies between the NORM actually received by the designated facility and the NORM described on the manifest, or any other irregularities, within fifteen (15) days. If the designated facility or receiving licensee is located outside the State of Arkansas, the generating or originating licensee must report the irregularities to the Department.

d. Required information.

1. The manifest must contain all of the following information prior to leaving the licensee's site:
 - A. The licensee's (generator's) name, mailing address, and telephone number;
 - B. The name, address, and telephone number of each transporter;
 - C. The name, address, telephone number, and NORM specific license number of the designated facility, if applicable;
 - D. The description of the waste(s) [e.g., scale soil, sludge, et cetera]; and
 - E. The total quantity of all NORM by units of weight in tons or pounds, and the type and number of containers as loaded into or onto the transport vehicle. If the weight is unknown, the volume and estimated weight should be provided.
2. The following certification must appear on the manifest, and must read, and be signed and dated by the licensee as follows:

"I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled, and are in all respects in proper condition for transport according to applicable international and national government regulations."

Revision effective January 1, 1997

e. Use of the manifest.

1. The licensee must:
 - A. Sign and date the manifest certification by hand when the initial transporter accepts the shipment;
 - B. Obtain a handwritten signature of the initial transporter and date of the acceptance of the manifest; and
 - C. Retain one copy.
2. The licensee must give the transporter the remaining copies of the manifest.
3. The licensee must receive the fully signed copy of the manifest from the designated facility within 45 days from the delivery to the initial transporter. In the event the licensee does not receive the signed manifest, the licensee shall:
 - A. Notify the Department within seven (7) days;
 - B. Conduct an investigation into the reasons why the manifest was not received; and
 - C. Report the results of the investigation to the Department.

f. Transporters.

1. A transporter may not accept NORM for transportation unless the NORM is accompanied by sufficient copies of a manifest properly prepared, with each copy signed and dated by the licensee and each previous transporter in accordance with these Regulations.
2. Before transporting the NORM, the transporter must sign and date each copy of the manifest acknowledging acceptance of the NORM from the licensee or previous transporter and return a signed copy to the licensee or previous transporter.

Revision effective January 1, 1997

3. A transporter who delivers NORM to a designated facility or another transporter must obtain the signature and date of the accepting party and retain one copy of the manifest for their records.
- g. The designated facility should fill out their portion of the manifest, retain a copy for their files, and send all remaining copies to the licensee no later than fifteen (15) days after delivery of the NORM waste or contaminated equipment.

RH-6017. Radiation Survey and Counting Instrumentation.

- a. Survey instrumentation used at NORM sites shall consist of, but not be limited to, a minimum of the following:
 1. Instrumentation to determine rates pursuant to this Section shall be capable of measuring 1 microrentgen per hour through at least 500 microrentgen per hour; and
 2. Instrumentation utilized to determine potential contamination, whether wipe tests or airborne, pursuant to this Section shall be able to measure gross alpha (Radium-226) and gross beta (Radium-228) quantitatively.
- b. Each radiation/contamination survey meter shall be calibrated:
 1. At intervals not to exceed one (1) year, any time the instrument is found to respond inconsistently to a known source or shows any indication of physical damage, and after each instrument servicing;
 2. At energies and radiation levels appropriate for use; and
 3. So that accuracy within plus or minus 20 percent ($\pm 20\%$) of the true radiation level can be demonstrated on each scale.

Revision effective January 1, 1997

RH-6018. Site Surveys and Training. This Section describes the requirements for confirmatory site release surveys, and the training required before an individual may use survey instruments to release a NORM site or previously NORM contaminated equipment.

a. Surveys.

1. Upon completion of land remediation operations or equipment decontamination, a confirmatory survey shall be performed to verify that NORM regulated in this Section is not present, and therefore, the land or equipment in question is exempt from the requirements of this Section pursuant to RH-6005.
2. Any survey submitted to the Department or kept by the specific licensee for review by the Department must include the qualifications of the individual performing the survey. Individuals performing and documenting surveys shall demonstrate understanding of the subjects outlined in RH-6018.b.

b. The following outline describes the subjects that individuals must demonstrate competence in prior to being approved as a NORM surveyor.

1. Fundamentals of Radiation Safety.
 - A. Characteristics of radiation.
 - B. Units of radiation dose and quantity of radioactivity.
 - C. Levels of radiation from sources of radiation.
 - D. Methods of minimizing radiation dose:
 - i. Working time.
 - ii. Working distance.
 - iii. Shielding.
 - iv. Respiratory precautions.
 - v. Use of anti-contamination clothing.

Revision effective January 1, 1997

2. Radiation Detection Instrumentation to be Used:
 - A. Use of radiation survey instruments:
 - i. Operation
 - ii. Calibration
 - iii. Limitations
 - B. Survey techniques.
 - C. Use of personnel-monitoring equipment.
3. The Requirements of Pertinent State Regulations.

RH-6019. Worker Protection Plans.

A Worker Protection Plan must be submitted to the Department which includes, but may not be limited to, the following items:

- a. Posting procedures. How an area will be posted to alert the general public of NORM contamination or NORM storage areas.
- b. Dosimetry procedures/program. Including how determination of potential internal dose associated with NORM will be calculated (i.e., bioassay, whole body counting; et cetera).
- c. Contamination control procedures. Including:
 1. Personnel exit procedures from a NORM contaminated area (i.e., frisking, et cetera).
 2. Protective clothing requirements depending on the work to be performed.
 3. Instrumentation to be used by the licensee to perform surveys and counting procedures, including manufacturer, model number, type of survey meter or counting instrument, probe type, and ranges of detection as well as calibration certificates.

Revision effective January 1, 1997

4. Surveying and Counting Procedures - This Section should include the proper procedure for personnel and equipment exit surveys, as well as procedures for land surveys, airborne contamination surveys (air sampling), and counting procedures. This Section should also include the licensee's action levels and limits, if more conservative than the Department's outlined in Section 3 or Section 7 of these Regulations.
5. Operational Procedures - This Section should encompass any operations that might involve the spread of NORM contamination or the potential for internal dose to the worker and how each operation should be handled.
6. Respiratory Protection Program - For operations that have a potential to produce NORM contaminated dusts (i.e., cutting, grinding, sandblasting, welding, drilling, polishing, or handling dry soil) or when loose contamination is suspected, the following additional items should be addressed in the Worker Protection Plan:

The use of a respirator appropriate for radioactive particulates shall be worn or engineering controls should be utilized to prevent the potential airborne contaminants.

7. ALARA Procedures - An explanation of how the licensee will attempt to maintain worker's exposure As Low As Reasonably Achievable with regard to engineering controls and the use of time, distance, and shielding.
- d. Training Program. Including but not limited to the following requirements:
1. NORM Worker - 8 Classroom Hours.
 - A. Fundamentals of Radiation Safety.
 - i. Characteristics of radiation.
 - ii. Units of radiation dose and definitions of radioactivity, including different sources of radioactivity (including NORM).

Revision effective January 1, 1997

- iii. Levels of radiation from different sources of radiation.
 - iv. Methods of minimizing radiation exposure dose.
 - (a). Working time
 - (b). Working distance
 - (c). Shielding
 - (d). Respiratory precautions
 - (e). Use of anti-contamination clothing
 - v. Use and types of personnel-monitoring equipment.
 - vi. Personnel exit contamination surveys, including meter operation and surveying techniques.
 - vii. Personnel general decontamination procedures.
 - viii. Biological effects of ionizing radiation (including effects on the embryo or fetus).
 - ix. Risks associated with working with NORM.
 - x. Requirements of pertinent State regulations concerning worker's rights and responsibilities.
2. Radiation Safety Officer - 40 classroom hours plus 6 months on-the-job training.
- A. Fundamentals of Radiation Safety.
 - i. Characteristics of radiation.
 - ii. Units of radiation dose and definitions of radioactivity, including different sources of radioactivity (including NORM).
 - iii. Levels of radiation from different sources of radiation.

- iv. Methods of minimizing radiation exposure dose.
 - (a). Working time
 - (b). Working distance
 - (c). Shielding
 - (d). Respiratory precautions
 - (e). Use of anti-contamination clothing
- v. Use and types of personnel-monitoring equipment.
- vi. Biological effects of ionizing radiation (including the effects on embryo or fetus).
- vii. Risks associated with working with NORM.
- viii. Requirements of pertinent State regulations concerning worker's rights and responsibilities.
- B. Radiation Detection Instrumentation.
 - i. Use of survey instruments.
 - (a). Operation
 - (b). Calibration requirements
 - (c). Limitations
 - ii. Survey techniques.
 - (a). Personnel contamination surveys
 - (b). Equipment surveys
 - (c). Land surveys
 - (d). Documentation and record retention requirements
- C. Use of counting instrumentation for wipes and air sample filter papers.

- D. Personnel decontamination techniques.
 - E. Air sampling techniques and equipment.
 - F. Shipping requirements for NORM and NORM-contaminated equipment.
 - G. Pertinent State regulations.
 - H. Six (6) months on-the-job training with a State-qualified third party Radiation Safety Officer or Health Physicist documented.
3. NORM Field Supervisor - Forty (40) hours classroom and six (6) months on-the-job training.
- A. Fundamentals of Radiation Safety.
 - i. Characteristics of radiation.
 - ii. Units of radiation dose and definitions of radioactivity, including different sources of radioactivity (including NORM).
 - iii. Levels of radiation from different sources of radiation.
 - iv. Methods of minimizing radiation exposure dose.
 - (a). Working time
 - (b). Working distance
 - (c). Shielding
 - (d). Respiratory precautions
 - (e). Use of anti-contamination clothing
 - v. Use and types of personnel-monitoring equipment.
 - vi. Biological effects of ionizing radiation (including effects on the embryo or fetus).

Revision effective January 1, 1997

- vii. Risks associated with working with NORM.
- viii. Requirements of pertinent State regulations concerning worker's rights and responsibilities.
- B. Radiation Detection Instrumentation.
 - i. Use of survey instruments.
 - (a). Operation
 - (b). Calibration requirements
 - (c). Limitations
 - ii. Survey techniques.
 - (a). Personnel contamination surveys
 - (b). Equipment surveys
 - (c). Land surveys
 - (d). Documentation and record retention requirements
- C. Use of counting instrumentation for wipes and air sample filter papers.
- D. Personnel decontamination techniques.
- E. Air sampling techniques and equipment.
- F. Shipping requirements for NORM and NORM-contaminated equipment.
- G. Pertinent State regulations.
- H. Six (6) months on-the-job training with a State-qualified Radiation Safety Officer or Health Physicist documented.

RH-6020. Specific Licenses.

- a. Unless otherwise exempted under the provisions of RH-6005 or licensed under the provisions of Section 2 of the Regulations, the manufacturing and distribution of any material or product containing NORM shall be specifically licensed pursuant to the requirements of this Section or pursuant to equivalent regulations of another Licensing State.
- b. Persons conducting the following activities involving equipment or facilities contaminated with NORM in excess of the levels set forth in Appendix A of this Section or land contaminated in excess of the limits set forth in RH-6010 shall be specifically licensed pursuant to the requirements of this section:
 - 1. Decontamination of equipment, facilities, and land;
or
 - 2. Disposal of the resulting waste.

Revision effective January 1, 1997

RH-6021. Filing Application for Specific Licenses.

- a. Applications for specific licenses shall be filed in a manner and on a form prescribed by the Department.
- b. The Department may at any time after the filing of the original application, and before the expiration of the license, require further statements in order to enable the Department to determine whether the application should be granted or denied or whether a license should be modified or revoked.

Revision effective January 1, 1997

RH-6021 (Cont'd)

- c. Each application shall be signed by the applicant or licensee or a person duly authorized to act for and on the licensee's behalf.
- d. An application for a license may include a request for a license authorizing one or more activities.
- e. In an application, the applicant may incorporate by reference information contained in previous applications, statements, or reports filed with the Department provided such references are clear and specific.
- f. Applications and documents submitted to the Department may be made available for public inspection except that the Department may withhold any document or Part thereof from public inspection if disclosure of its contents is not required in the public interest and would adversely affect the interest of a person concerned.

RH-6022. Requirements for the Issuance of Specific Licenses.

- a. A license application will be approved if the Department determines that:
 - 1. The applicant is qualified by reason of training and experience to use the NORM in question for the purpose requested in accordance with these rules in such a manner as to minimize danger to public health and safety or property;
 - 2. The applicant's proposed equipment, facilities, and procedures are adequate to minimize the danger to public health and safety or property;
 - 3. The issuance of the license will not be inimical to the health and safety of the public;
 - 4. The applicant satisfies any applicable special requirements in this Part; and
 - 5. The applicant has met the financial surety requirements of RH-6033.

Revision effective January 1, 1997

- b. An application for a specific license to decontaminate equipment and/or facilities contaminated with NORM in excess of the levels set forth in RH-6005.a., RH-6010.c., or Appendix A of this Part, as applicable, and to dispose of the resulting waste will be approved if:
 - 1. The applicant satisfies the general requirements specified in RH-6022.a.; and
 - 2. The applicant has adequately addressed the following items in the application:
 - A. Procedures and equipment for protection of workers;
 - B. An evaluation of the radiation levels and concentrations of contamination expected during normal operations;
 - C. Operating and emergency procedures, including procedures for waste reduction and quality assurance of items released for unrestricted use; and
 - D. Method of disposing of the NORM removed from contaminated equipment, facilities, and/or land.
- c. An application for a specific license to manufacture and/or initially transfer products or materials containing NORM to persons exempted from these Regulations pursuant to RH-6005.b. will be approved if:
 - 1. The applicant satisfies the general requirements specified in RH-6022.a.;
 - 2. The NORM is not contained in any food, beverage, cosmetic, drug, or other commodity designed for ingestion or inhalation by, or application to, a human being; and
 - 3. The applicant submits sufficient information relating to the design, manufacture, prototype testing, quality control procedures, labeling or marking, and conditions of handling, storage, use, and disposal of the NORM material or product to demonstrate that the material or product will meet the safety criteria set forth in RH-6023. The information shall include:

- A. A description of the material or product and its intended use or uses;
- B. The type, quantity, and concentration of NORM in each material or product;
- C. The chemical and physical form of the NORM in the material or product, and changes in chemical and physical form that may occur during the useful life of the material or product;
- D. An analysis of the solubility in water and body fluids of the NORM in the material or product;
- E. The details of manufacture and design of the material or product relating to containment and shielding of the NORM and other safety features under normal and severe conditions of handling, storage, use, reuse, and disposal of the material or product;
- F. The degree of access of human beings to the material or product during normal handling, use, and disposal;
- G. The total quantity of NORM expected to be distributed annually in the material or product;
- H. The expected useful life of the material or product;
- I. The proposed method of labeling or marking each unit of the material or product with identification of the manufacturer and/or initial transferor of the product and the radionuclide(s) and quantity of NORM in the material or product;
- J. The procedures for prototype testing of the material or product to demonstrate the effectiveness of the containment, shielding, and other safety features under both normal and severe conditions of handling, storage, use, reuse, and disposal;

- K. The results of the prototype testing of the material or product, including any change in the form of the NORM contained in it, the extent to which the NORM may be released to the environment, any change in radiation levels, and any other changes in safety features;
 - L. The estimated external radiation doses and dose commitments relevant to the safety criteria in RH-6023 and the basis for such estimates;
 - M. A determination that the probabilities with respect to doses referred to in RH-6023 meet the safety criteria;
 - N. The quality control procedures to be followed in the production of production lots of the material or product, and the quality control standards the material or product will be required to meet; and
 - O. Any additional information, including experimental studies and tests, required by the Department to facilitate a determination of the radiation safety of the material or product.
- d. Notwithstanding the provisions of RH-6023.b., the Department may deny an application for a specific license if the end uses of the product are frivolous or cannot be reasonably foreseen.

RH-6023. Safety Criteria.

An applicant for a license under RH-6022.b. shall demonstrate that the product is designed and will be manufactured so that:

- a. In normal use and disposal, it is unlikely that the external radiation dose in any one year, or the dose commitment resulting from the intake of NORM, excluding the Radon and Radon decay products, in any one year, to a suitable sample of the group of individuals expected to be most highly exposed to radiation or NORM from the material or product, will exceed the doses in Column I of RH-6024.
- b. In normal handling and storage of the quantities of the material or product likely to accumulate in one location during marketing, distribution, installation, and servicing

of the material or product, it is unlikely that the external radiation dose in any one year, or the dose commitment resulting from the intake of NORM, excluding Radon, in any one year, to a suitable sample of the group of individuals expected to be most highly exposed to radiation or NORM from the material or product, will exceed the doses in Column II of RH-6024.

- c. In normal use, disposal, handling, and storage, it is unlikely that the Radon released from the material or product will result in an increase in the average Radon concentration in air of more than 0.4 picocurie per liter.
- d. It is unlikely that a significant reduction will occur in the effectiveness of the containment, shielding, or other safety features of the material or product (from wear and abuse in normal handling and use of the material or product during its useful life).

RH-6024. Table of Organ Doses.

Part of Body	Column I* Dose in Rem	Column II* Dose in Rem
Whole body; head and trunk; active blood-forming organs; gonads, or lens of eye	0.005	0.5
Hands and forearms; feet and ankles; localized area of skin averaged over areas no larger than 1 square centimeter	0.075	7.5
Other organs	0.015	1.5

* Dose limit is the dose above background from the product.

RH-6025. Issuance of Specific Licenses.

- a. Upon determination that an application meets the requirements of the Act and rules of the Department, the Department will issue a specific license authorizing the proposed activity in such form and containing such conditions and limitations as it deems appropriate or necessary.

- b. The Department may incorporate in any license at the time of issuance, or thereafter by amendment, such additional requirements and conditions with respect to the licensee's receipt, possession, use, and transfer of NORM subject to this Section as it deems appropriate or necessary in order to:
 - 1. Minimize danger to public health and safety of property;
 - 2. Require such reports and the keeping of such records, and to provide for such inspections of activities under the license as may be appropriate or necessary; and
 - 3. Prevent loss or theft of NORM subject to this section.

RH-6026. Conditions of Licenses Issued Under RH-6022.

- a. General Terms and Conditions
 - 1. Each license issued pursuant to this Section shall be subject to all the provisions of the Act, now or hereafter in effect, and to all rules, regulations, and orders of the Department.
 - 2. No license issued or granted under this Section and no right to possess or utilize NORM granted by any license issued pursuant to this Section shall be transferred, assigned, or in any manner disposed of, either voluntarily or involuntarily, directly or indirectly, through transfer of control of any license to any person unless the Department shall, after securing full information, find that the transfer is in accordance with the provisions of the Act, and shall give its consent in writing.
 - 3. Each person licensed by the Department pursuant to this Section shall confine use and possession of the NORM licensed to the locations and purposes authorized in the license.
 - 4. Each person licensed by the Department pursuant to this Section is subject to the general license provisions of RH-6011, RH-6012, and RH-6013.

5. Bankruptcy (of Licensee)

A. Each licensee shall notify the Department, in writing, immediately following the filing of a voluntary or involuntary petition for bankruptcy under any Chapters of Title 11 (Bankruptcy) of the United States Code (11 U.S.C.) by or against:

- i. A licensee;
- ii. An entity [as that term is defined in 11 U.S.C. 101 (14)] controlling a licensee or listing the license or licensee as property of the estate; or
- iii. An affiliate [as that term is defined in 11 U.S.C. 101(2)] of the licensee.

B. This notification must indicate:

- i. The bankruptcy court in which the petition for bankruptcy was filed; and
- ii. The date of the filing of the petition.

b. Quality Control, Labeling, and Reports of Transfer. Each person licensed under RH-6022.c shall:

1. Carry out adequate control procedures in the manufacture of the material or product to assure that each production lot meets the quality control standards approved by the Department;
2. Label or mark each unit so that the manufacturer, processor, producer, or initial transferor of the material or product and the NORM in the material or product can be identified; and
3. Maintain records identifying, by name and address, each person to whom NORM is transferred for use under RH-6005.b. or the equivalent regulations of another Licensing State, and stating the kinds, quantities, and uses of NORM transferred. An annual summary report stating the total quantity of each radionuclide transferred under the specific license shall be filed with the Department. Each report shall cover the year ending December 31, and shall be filed within 30 days thereafter. If no transfers of NORM have been made pursuant to RH-6022.c. during the reporting period, the report shall so indicate.

RH-6027. Expiration and Termination of License.

- a. Except as provided in RH-6027.d.3. and RH-6028.b., each specific license shall expire at the end of the specified day in the month and year stated therein.
- b. Each licensee shall notify the Department in writing and request termination of the license when the licensee decides to terminate all activities involving NORM authorized under the license. This notification and request for termination of the license must include the reports and information specified in RH-6027.d.1.D. The licensee is subject to the provisions of RH-6027.d. and e., as applicable.
- c. No less than 30 days before the expiration date specified in a specific license, the licensee shall either:
 1. Submit an application for license renewal under RH-6028; or
 2. Notify the Department in writing, under RH-6027.b., if the licensee decides to discontinue all activities involving NORM.
- d.
 1. If a licensee does not submit an application for license renewal under RH-6028, the licensee shall on or before the expiration date specified in the license:
 - A. Terminate use of NORM;
 - B. Remove NORM contamination to the extent practicable;
 - C. Properly dispose of NORM; and
 - D. Submit a report of disposal of NORM and radiation survey(s) to confirm the absence of NORM or to establish the levels of residual NORM contamination. The licensee shall, as appropriate:
 - i. Report levels of radiation in units of microrads per hour of beta and gamma radiation at one centimeter and gamma radiation at one meter from surfaces and report levels of radioactivity in units of disintegrations per minute (or microcuries) per 100 square centimeters removable and fixed on surfaces, microcuries per milliliter in water, and picocuries per gram in contaminated solids such as soils or concrete; and

- ii. Specify the instrument(s) used and certify that each instrument is properly calibrated and tested.
 2. If no radioactivity attributable to activities conducted under the license is detected, the licensee shall submit a certification that no detectable NORM contamination was found. If the Department determines that the information submitted under RH-6027.d.1.D and d.2 and is adequate and surveys confirm the findings, the Department will notify the licensee in writing that the license is terminated.
 3. If detectable levels of residual NORM attributable to activities conducted under the license are found, the license continues in effect beyond the expiration date, if necessary, with respect to possession of residual NORM until the Department notifies the licensee in writing that the license is terminated. During this time, the licensee is subject to the provisions of RH-6027.e. In addition to the information submitted under RH-6027.d.1.D, the licensee shall submit a plan, if appropriate, for decontaminating the location(s) and disposing of the residual NORM.
- e. Each licensee who possesses residual NORM under RH-6027.d.3, following the expiration date specified in the license, shall:
1. Be limited to actions involving NORM related to preparing the location(s) for release for unrestricted use; and
 2. Continue to control entry to restricted areas until the location(s) are suitable for release for unrestricted use and the Department notifies the licensee in writing that the license is terminated.

RH-6028. Renewal of Licenses.

- a. Applications for renewal of specific licenses shall be filed in accordance with RH-6021.
- b. In any case in which a licensee, not less than 30 days prior to expiration of an existing license, has filed an application in proper form for renewal or for a new license authorizing the same activities, such existing license shall not expire until final action by the Department.

RH-6029. Amendment of Licenses at Request of Licensee.

Applications for amendment of a license shall be filed in accordance with RH-6021 and shall specify the respects in which the licensee desires the license to be amended and the grounds for such amendment.

RH-6030. Department Action on Applications to Renew and Amend.

In considering an application by a licensee to renew or amend the license, the Department will apply the criteria set for in RH-6022.

RH-6031. Modification and Revocation of Licenses.

- a. The terms and conditions of all licenses shall be subject to amendment, revision, or modification or the license may be suspended or revoked by reason of amendments to the Act, or by reason of rules, regulations, and orders issued by the Department.
- b. Any license may be revoked, suspended, or modified, in whole or in part, for any material false statement in the application or any statement of fact required under provisions of the Act, or because of conditions revealed by such application or statements of fact or any report, record, or inspection or other means which would warrant the Department to refuse to grant a license on an original application, or for violation of, or failure to observe any of the terms and conditions of the Act, or of the license, or of any rules, regulation, or order of the Department.
- c. Except in cases of willfulness or those in which the public health, interest or safety requires otherwise, no license shall be modified, suspended, or revoked unless, prior to the institution of proceedings therefore, facts or conduct which may warrant such action shall have been called to the attention of the licensee in writing and the licensee shall have been accorded an opportunity to demonstrate or achieve compliance with all lawful requirements.

Revision effective January 1, 1997

RH-6032. Vacating Premises.

Each specific licensee shall, no less than thirty (30) days before vacating or relinquishing possession or control of premises which may have been contaminated with Naturally Occurring Radioactive Material as a result of the activities, notify the Department in writing of intent to vacate. When deemed necessary by the Department, the licensee shall decontaminate the premises in such a manner as the Department may specify.

RH-6033. Financial Assurance and Recordkeeping for Decommissioning. Each specific licensee shall be subject to the financial assurance and recordkeeping for decommissioning under RH-409.h of these Regulations.

RH-6034-
RH-6039 Reserved.

Revision effective January 1, 1997

PART E. RECIPROCITY

RH-6040. Reciprocal Recognition of Licenses. Subject to these regulations, any person who holds a specific license from a Licensing State, and issued by the agency having jurisdiction where the licensee maintains an office for directing the licensed activity and at which radiation safety records are normally maintained, is hereby granted a general license to conduct the activities authorized in such licensing document within this State for a period not in excess of 180 days in any calendar year provided that:

- a. The licensing document does not limit the activity authorized by such document to specific installations or locations;
- b. The out-of-state licensee notifies the Department in writing at least two (2) days prior to engaging in such activity. Such notification shall indicate the location, period, and type of proposed possession and use within the State, and shall be accompanied by a copy of the pertinent licensing document. If, for a specific case, the two (2) day period would impose an undue hardship on the out-of-state licensee, the licensee may, upon application to the Department, obtain permission to proceed sooner;
- c. The out-of-state licensee complies with all applicable regulations of the Department and with all the terms and conditions of the licensing document, except any such terms and conditions which may be inconsistent with applicable regulations of the Department;
- d. The out-of-state licensee supplies such other information as the Department may request; and
- e. The out-of-state licensee shall not transfer or dispose of NORM possessed or used under the general license provided in RH-6040.a except by transfer to a person:
 1. Specifically licensed by the Department or by another Licensing State to receive such NORM; or
 2. Exempt from the requirements for a license for such NORM under RH-6005.

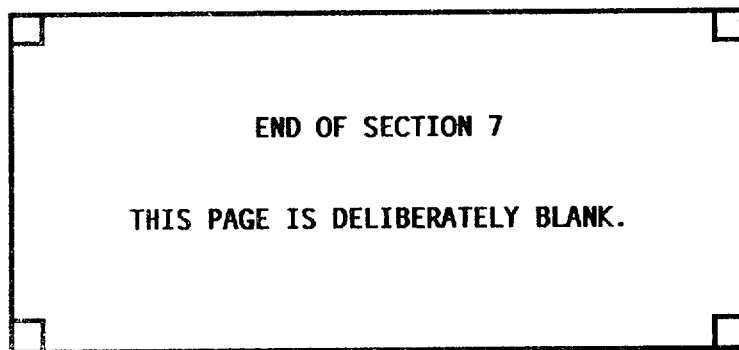
RH-6050. Deleted.

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ACCEPTABLE SURFACE CONTAMINATION LEVELS FOR NORM

<u>NUCLIDE</u> ^a	<u>AVERAGE</u> ^{b,c,f}	<u>MAXIMUM</u> ^{b,d,f}	<u>REMOVABLE</u> ^{b,c,e,f}
U-nat, U-235, & U-238 and associated products (including Po-210) except Ra-226, Th-230, Ac-227, and Pa-231	5,000 dpm alpha/ 100 cm ²	15,000 dpm alpha/ 100 cm ²	1,000 dpm alpha/ 100 cm ²
Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227	100 dpm/100 cm ²	300 dpm/100 cm ²	20 dpm/100 cm ²
Th-nat, Th-232, Ra-223, Ra-224, U-232	1,000 dpm/100 cm ²	3,000 dpm/100 cm ²	200 dpm/100 cm ²
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission, including Pb-210), except others noted above.	5,000 dpm beta, gamma/100 cm ²	15,000 dpm beta, gamma/100 cm ²	1,000 dpm beta, gamma/100 cm ²

-
- a Where surface contamination by both alpha and beta-gamma emitting nuclides exists, the limits established for alpha and beta-gamma emitting nuclides should apply independently.
- b As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
- c Measurements of average contamination level should not be averaged over more than one square meter. For objects of less surface area, the average should be derived for each object.
- d The maximum contamination level applies to an area of not more than 100 cm².
- e The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.
- f The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.



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SECTION 8. LICENSES AND RADIATION SAFETY REQUIREMENTS FOR IRRADIATORS

PART A. GENERAL

RH-7000. Reserved.

RH-7001. Purpose and Scope.

- a. This Section contains requirements for the issuance of a license authorizing the use of sealed sources containing radioactive materials in irradiators used to irradiate objects or materials using gamma radiation. This Section also contains radiation safety requirements for operating irradiators. The requirements of this Section are in addition to and not in substitution for other requirements of these Regulations. Nothing in this Section relieves the licensee from complying with other applicable Federal, State and local regulations governing the siting, zoning, land use, and building code requirements for industrial facilities.
- b. The Regulations in this Section apply to panoramic irradiators that have either dry or wet storage of the radioactive sealed sources and to underwater irradiators in which both the source and the product being irradiated are under water. Irradiators whose dose rates exceed 5 grays (500 rads) per hour at one (1) meter from the radioactive sealed sources in air or in water, as applicable for the irradiator type, are covered by this Section.
- c. The Regulations in this Section do not apply to self-contained dry-source-storage irradiators (those in which both the source and the area subject to irradiation are contained within a device and are not accessible by personnel), medical radiology or teletherapy, radiography (the irradiation of material for nondestructive testing purposes), gauging, or open-field (agricultural) irradiation.

RH-7002. Definitions.

- a. Annually - Either:
 1. At intervals not to exceed one (1) year, or
 2. Once per year, at about the same time each year (plus or minus one [1] month).

- b. Doubly encapsulated sealed source - A sealed source in which the radioactive material is sealed within a capsule and that capsule is sealed within another capsule.
- c. Irradiator - A facility that uses radioactive sealed sources for the irradiation of objects or materials and in which radiation dose rates exceeding 5 grays (550 rads) per hour exist at one (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.
- d. Irradiator operator - An individual who has successfully completed the training and testing described in RH-7051 and is authorized by the terms of the license to operate the irradiator without a supervisor present.
- e. Panoramic dry-source-storage irradiator - An irradiator in which the irradiations occur 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 for performing irradiations.
- f. Panoramic irradiator - An irradiator in which the irradiations are done in air in areas potentially accessible to personnel. The term includes beam-type irradiators.
- g. Panoramic wet-source-storage irradiator - An irradiator in which the irradiations are done in air in areas potentially accessible to personnel and in which the sources are stored under water in a storage pool.
- h. Pool irradiator - Any irradiator at which the sources are stored or used in a pool of water including panoramic wet-source-storage irradiators and underwater irradiators.
- i. Product conveyor system - A system for moving the product to be irradiated to, from, and within the area where irradiation takes place.
- j. Radiation room - A shielded room in which irradiations take place. Underwater irradiators do not have radiation rooms.

Added - effective January 1, 1997

RH-7002 (Cont'd)

- k. Radiation safety officer - An individual with responsibility for the overall radiation safety program at the facility.
- l. Sealed source - Any radioactive material that is used as a source of radiation and is encased in a capsule designed to prevent leakage or escape of the byproduct material.
- m. Seismic area - 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.
- n. Underwater irradiator - An irradiator in which the sources always remain shielded under water and humans do not have access to the sealed sources or the space subject to irradiation without entering the pool.

RH-7003 -
RH-7004 Reserved.

RH-7005. Interpretations.

Except as specifically authorized by the Department in writing, no interpretation of the meaning of the Regulations in this Section by any officer or employee of the Department, other than a written interpretation by the Department, will be recognized to be binding upon the Department.

RH-7006 -
RH-7009 Reserved.

Added - effective January 1, 1997

PART B. SPECIFIC LICENSING REQUIREMENTS

RH-7010. Reserved.

RH-7011. Application for a Specific License.

A person, as defined in RH-1100.bc of these Regulations, shall file an application for a specific license authorizing the use of radioactive material or radiation producing machines in well logging in accordance with RH-403 and RH-404.

RH-7012. Reserved.

RH-7013. Specific Licenses for Irradiators.

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.

- a. The applicant shall satisfy the general requirements specified in RH-404 of these Regulations and the requirements contained in this Section.
- b. The application must describe the training provided to irradiator operators including:
 1. Classroom training;
 2. On-the-job or simulator training;
 3. Safety reviews;
 4. Means employed by the applicant to test each operator's understanding of the Department's Regulations and licensing requirements and the irradiator operating and emergency procedures; and
 5. Minimum training and experience of personnel who may provide training.
- c. The application must include an outline of the written operating and emergency procedures listed in RH-7053 that describes the radiation safety aspects of the procedure.

Added - effective January 1, 1997

RH-7013 (Cont'd)

- d. The application must describe the organizational structure for managing the irradiator, specifically the radiation safety officer and those management personnel who have important radiation safety responsibilities or authorities. In particular, the application must specify who, within the management structure, has the authority to stop unsafe operations. The application must also describe the training and experience required for the position of radiation safety officer.
- e. The application must include a description of the access control systems required by RH-7023, the radiation monitors required by RH-7029, the method of detecting leaking sources required by RH-7059 including the sensitivity of the method, and a diagram of the facility that shows the locations of all required interlocks and radiation monitors.
- f. 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. The description must include the:
 - 1. Instruments to be used;
 - 2. Methods of performing the analysis; and
 - 3. Pertinent experience of the individual who analyzes the samples.
- g. If licensee personnel are to load or unload sources, the applicant shall describe the qualifications and training of the personnel and the procedures to be used. If the applicant intends to contract for source loading or unloading at its facility, the loading or unloading must be done by an organization specifically authorized by the Department, U.S. Nuclear Regulatory Commission, or an Agreement State to load or unload irradiator sources.
- h. The applicant shall describe the inspection and maintenance checks, including the frequency of the checks required by RH-7061.

RH-7014. Reserved.

Added - effective January 1, 1997

RH-7015. Start of Construction.

The applicant may not begin construction of a new irradiator prior to the submission to the Department of both an application for a license for the irradiator and the fee required. As used in this Section, the term "construction" includes the construction of any portion of the permanent irradiator structure on the site but does not include: Engineering and design work, purchase of a site, site surveys or soil testing, site preparations, site excavation, construction of warehouse or auxiliary structures, and other similar tasks. Any activities undertaken prior to the issuance of a license are entirely at the risk of the applicant and having no bearing on the issuance of a license with respect to the requirements of the Atomic Energy Act of 1954, as amended, and rules, regulations, and orders issued under the Act.

RH-7016. Reserved.

RH-7017. Applications for Exemptions.

- a. The Department may, upon application of any interested person or upon its own initiative, grant any exemptions from the requirements in this Section that it determines are authorized by law and will not endanger life or property or the common defense and security and are otherwise in the public interest.
- b. Any application for a license or for amendment of a license authorizing use of a teletherapy-type unit for irradiation of materials or objects may include proposed alternatives for the requirements of this Section. The Department will approve the proposed alternatives if the applicant provides adequate rationale for the proposed alternatives and demonstrates that they are likely to provide an adequate level of safety for workers and the public.

RH-7018. Reserved.

RH-7019. Request for Written Statements.

- a. After the filing of the original application, the Department may request further information necessary to enable the Department to determine whether the application should be granted or denied.
- b. Each license is issued with the condition that the licensee will, at any time before expiration of the license, upon the Department's request, submit written statements to enable the Department to determine whether the license should be modified, suspended, or revoked.

Part C. DESIGN AND PERFORMANCE REQUIREMENTS FOR IRRADIATORS

RH-7020. Reserved.

RH-7021. Performance Criteria for Sealed Sources.

- a. Requirements. Sealed sources installed after July 1, 1993:
 1. Must have a certificate of registration issued by the U.S. Nuclear Regulatory Commission pursuant to 10 CFR 32.210 of 10 CFR Part 32;
 2. Must be doubly encapsulated;
 3. Must use radioactive material that is as nondispersible as practical and that is as insoluble as practical if the source is used in a wet-source-storage or wet-source-change irradiator;
 4. Must be encapsulated in a material resistant to general corrosion, such 316L stainless steel or other material with equivalent resistance if the sources are for use in irradiator pools; and
 5. In prototype testing of the sealed source, must have been leak tested and found leak-free after each of the tests described in RH-7021.b through RH-7021.g.
- b. Temperature. The test source must be held at -40°C for 20 minutes, 600°C for one (1) hour, and then be subjected to a thermal shock test with a temperature drop from 600°C to 20°C within 15 seconds.
- c. Pressure. The test source must be twice subjected for at least 5 minutes to an external pressure (absolute) of 2 million newtons per square meter.
- d. Impact. A 2-kilogram steel weight, 2.5 centimeters in diameter, must be dropped from a height of one (1) meter onto the test source.
- e. Vibration. The test source must be subjected three (3) times for 10 minutes each to vibrations sweeping from 25 hertz to 500 hertz with a peak amplitude of five (5) times the acceleration of gravity. In addition, each test source must be vibrated for 30 minutes at each resonant frequency found.

Added - effective January 1, 1997

RH-7021 (Cont'd)

- f. Puncture. A 50-gram weight and pin, 0.30-centimeter pin diameter, must be dropped from a height of one (1) meter onto the test source.
- g. Bend. If the length of the source is more than 15 (fifteen) 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 (2) support cylinders, the distance between which is 10 (ten) times the minimum cross-sectional dimension of the source.

RH-7022. Reserved.

RH-7023. Access Control.

- a. Each entrance to a radiation room at a panoramic irradiator must have a door or other physical barrier to prevent inadvertent entry of personnel if the sources are not in the shielded position. Product conveyor systems may 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 the door or barrier is open. Opening the door or barrier while the sources are exposed must cause the sources to return promptly to their shielded position. The personnel entrance door or barrier must have a lock that is operated by the same key used to move the sources. The doors and barriers must not prevent any individual in the radiation room from leaving.
- b. In addition, each entrance to a radiation room at a panoramic irradiator must have an independent backup access control to detect personnel entry while the sources are exposed. Detection of entry while the sources are exposed must cause the sources to return to their fully shielded position and must also activate a visible and audible alarm to make the individual entering the room aware of the hazard. The alarm must also alert at least one other individual who is onsite of the entry. That individual shall be trained on how to respond to the alarm and prepared to promptly render or summon assistance.

Added - effective January 1, 1997

- c. A radiation monitor must be provided to detect the presence of high radiation levels in the radiation room of a panoramic irradiator before personnel entry. The monitor must be integrated with personnel access door locks to prevent room access when radiation levels are high. Attempted personnel entry while the monitor measures high radiation levels, must activate the alarm described in RH-7023.b. The monitor may be located in the entrance (normally referred to as the maze) but not in the direct radiation beam.
- d. Before the sources move from their shielded position in a panoramic irradiator, the source control must automatically 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 at a panoramic irradiator must have a clearly visible and readily accessible control that would allow an individual in the room to make the sources return to their fully shielded position.
- f. Each radiation room of a panoramic irradiator must contain a control that prevents the sources from moving from the shielded position unless the control has been activated and the door or barrier to the radiation room has been closed within a preset time after activation of the control.
- g. Each entrance to the radiation room of a panoramic irradiator and each entrance to the area within the personnel access barrier of an underwater irradiator must have a sign bearing the radiation symbol and the words, **"Caution (or Danger) Radioactive Material"**. Panoramic irradiators must also have a sign stating **"High Radiation Area"**, but the sign may be removed, covered, or otherwise made inoperative when the sources are fully shielded.
- h. If the radiation room of a panoramic irradiator 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 may be met by interlocks that prevent operation if shielding is not placed properly or by an operating procedure requiring inspection of shielding before operating.

Added - effective January 1, 1997

RH-7023 (Cont'd)

- i. 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 may 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 onsite) who is prepared to respond or summon assistance.

RH-7024. Reserved.

RH-7025. Shielding.

- a. The radiation dose rate in areas that are normally occupied during operation of a panoramic irradiator may not exceed 0.02 millisievert (2 millirems) per hour at any location 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 rate exceeds 0.02 millisievert (2 millirems) per hour must be locked, roped off, or posted.
- b. The radiation dose at 30 centimeters over the edge of the pool of a pool irradiator may not exceed 0.02 millisievert (2 millirems) per hour when the sources are in fully shielded position.
- c. The radiation dose rate at one (1) meter from the shield of a dry-source-storage panoramic irradiator when the source is shielded may not exceed 0.02 millisievert (2 millirems) per hour and at 5 centimeters from the shield must not exceed 0.02 millisievert (20 millirems) per hour.

RH-7026. Reserved.

Added - effective January 1, 1997

RH-7027. Fire Protection.

- a. 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 automatically become fully shielded if a fire is detected.
- b. The radiation room at a panoramic irradiator must be equipped with a fire 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.

RH-7028. Reserved.

RH-7029. Radiation Monitors.

- a. Irradiators with automatic product conveyor systems must have a radiation monitor with an audible alarm located to detect loose radioactive sources that 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.
- b. Underwater irradiators that 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 may have a manual shut-off. The alarm must be capable of alerting an individual who is prepared to respond promptly.

RH-7030. Reserved.

Added - effective January 1, 1997

RH-7031. Control of Source Movement.

- a. The mechanism that moves the sources of a panoramic irradiator must require a key to actuate. Actuation of the mechanism must cause an audible signal to indicate that the sources are leaving the shielded position. Only one key may be in use at any time, and only operators or facility management may possess it. The key must be attached to a portable radiation survey meter by a chain or cable. The lock for source control must be designed so that the key may not be removed if the sources are in an unshielded position. The door to the radiation room must require the same key.
- b. The console of a panoramic irradiator must have a source position indicator that indicates when the sources are in the fully shielded position, when they are in transit, and when the sources are exposed.
- c. The control console of a panoramic irradiator must have a control that promptly returns the sources to the shielded position.
- d. Each control for a panoramic irradiator must be clearly marked as to its function.

RH-7032. Reserved.

RH-7033. Irradiator Pools.

- a. For licenses initially issued after July 1, 1993, irradiator pools must either:
 1. Have a water-tight stainless steel liner or a liner metallurgically compatible with other components in the pool; or
 2. Be constructed so that there is a low likelihood of substantial leakage and have a surface designed to facilitate decontamination.

In either case, the licensee shall have a method to safely store the sources during repairs of the pool.

Added - effective January 1, 1997

RH-7033 (Cont'd)

- b. For licenses initially issued after July 1, 1993, irradiator pools must have no outlets more than 0.5 meter below the normal low water level that could allow water to drain out of the pool. Pipes that have intakes more than 0.5 meter below the normal low water level and that could act as siphons must have siphons breakers to prevent the siphoning of pool water.
- c. A means must be provided to replenish water losses from the pool.
- d. A visible indicator must be provided in a clearly visible location to indicate if the pool water level is below the normal low water level or above the normal high water level.
- e. Irradiator pools must be equipped with a purification system designed to be capable of maintaining the water during normal operation at a conductivity of 20 microsiemens per centimeter or less and with a clarity so that the sources can be seen clearly.
- f. A physical barrier, such as a railing or cover, must be used around or over irradiator pools during normal operation to prevent personnel from accidentally falling into the pool. The barrier may be removed during maintenance, inspection, and service operations.
- g. If long-handled tools or poles are used in irradiator pools, the radiation dose rate on the handling areas of the tools may not exceed 0.02 millisievert (2 millirems) per hour.

RH-7034. Reserved.

RH-7035. Source Rack Protection.

If the product to be irradiated moves on a product conveyor system, the source rack and the mechanism that 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.

RH-7036. Reserved.

Added - effective January 1, 1997

RH-7037. Power Failures.

- a. If electrical power at a panoramic irradiator is lost for longer than 10 (ten) seconds, the sources must automatically return to the shielded position.
- b. The lock on the door of the radiation room of a panoramic irradiator may not be deactivated by power failure.
- c. During a power failure, the area of any irradiator where sources are located may be entered only when using an operable and calibrated radiation survey meter.

RH-7038. Reserved.

RH-7039. Design Requirements.

Irradiators whose construction begins after July 1, 1993, must meet the design requirements of this Section.

- a. Shielding. For panoramic irradiators, the licensee shall design shielding walls to meet generally accepted building code requirements for reinforced concrete and design the walls, wall penetrations, and entrance ways to meet the radiation shielding requirements of RH-7025. If the irradiator will use more than 2×10^{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. For panoramic irradiators, the licensee shall design the foundation, with consideration given to soil characteristics, to ensure it is adequate to support the weight of the facility shield walls.
- c. Pool integrity. For pool irradiators, 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 outlets or pipes meet the requirements of RH-7033.b, and that metal components are metallurgically compatible with other components in the pool.

Added - effective January 1, 1997

- d. Water handling system. For pool irradiators, the licensee shall verify that the design of the water purification system is adequate to meet the requirements of RH-7033.e, the system must be designed so that water leaking from the system does not drain to unrestricted areas without being monitored.
- e. Radiation monitors. For all irradiators, the licensee shall evaluate the location and sensitivity of the monitor to detect sources carried by the product conveyor system as required by RH-7029.a. The licensee shall verify that the product conveyor is designed to stop before a source on the product conveyor would cause a radiation overexposure to any person. For pool irradiators, if the licensee uses radiation monitors to detect contamination under RH-7059.b, the licensee shall verify that the design of radiation monitoring systems to detect pool contamination includes sensitive detectors located close to where contamination is likely to concentrate.
- f. Source rack. For pool irradiators, 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. For panoramic irradiators, 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. For panoramic irradiators, the licensee shall review the design of the mechanism that moves the sources to assure that the likelihood of a stuck source is low and that, if the rack sticks, a means exists to free it with minimal risk to personnel.
- g. Access control. For panoramic irradiators, the licensee shall verify from the design and logic diagram that the access control system will meet the requirements of RH-7023.
- h. Fire protection. For panoramic irradiators, the licensee shall verify that the number, location, and spacing of the smoke and heat detectors 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.

RH-7039 (Cont'd)

- i. Source return. For panoramic irradiators, the licensee shall verify that the source rack will automatically return to the fully shielded position if offsite power is lost for more than 10 seconds.
- j. Seismic. 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 the seismic requirements of an appropriate source such as American Concrete Institute Standard ACI 318-89, "Building Code Requirements for Reinforced Concrete," Chapter 21, "Special Provisions for Seismic Design," or local building codes, if current.
- k. Wiring. For panoramic irradiators, 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.

RH-7040. Reserved.

RH-7041. Construction Monitoring and Acceptance Testing.

These requirements must be met for irradiators whose construction begins after July 1, 1993. The requirements must be met prior to loading sources.

- a. Shielding. For panoramic irradiators, the licensee shall monitor the construction of the shielding to verify that its construction meets design specifications and generally accepted building code requirements for reinforced concrete.
- b. Foundations. For panoramic irradiators, the licensee shall monitor the construction of the foundations to verify that their construction meets design specifications.
- c. Pool integrity. For pool irradiators, the licensee shall verify that the pool meets design specifications and shall test the integrity of the pool. The licensee shall verify that outlets and pipes meet the requirements of RH-7033.b.

Added - effective January 1, 1997

- d. Water handling system. For pool irradiators, the licensee shall verify that the water purification system, the conductivity meter, and the water level indicators operate properly.
- e. 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 the related alarms and interlocks required by RH-7029.a. For pool irradiators, the licensee shall verify the proper operation of the radiation monitors and the related alarm if used to meet RH-7059.b. For underwater irradiators, the licensee shall verify the proper operation of the over-the-pool monitor, alarms, and interlocks required by RH-7029.b.
- f. Source rack. For panoramic irradiators, the licensee shall test the movement of the source racks for proper operation prior to 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 RH-7035 are met for protection of the source rack and the mechanism that moves the rack; testing must include tests of any limit switches and interlocks used to protect the source rack and mechanism that moves the rack from moving product carriers.
- g. Access control. For panoramic irradiators, the licensee shall test the completed access control system to assure that it functions as designed and that all alarms, controls, and interlocks work properly.
- h. Fire protection. For panoramic irradiators, the licensee shall test the ability of the heat and smoke detectors to detect a fire, to activate alarms, and to cause the source rack to automatically become fully shielded. The licensee shall test the operability of the fire extinguishing system.
- i. Source return. For panoramic irradiators, the licensee shall demonstrate that the source racks can be returned to their fully shielded positions without offsite power.

Added - effective January 1, 1997

- j. Computer systems. For panoramic irradiators that use a computer system to control the access control system, the licensee shall verify that the access control system will operate properly if offsite power is lost and shall verify that the computer has security features that prevent an irradiator operator from commanding the computer to override the access control system when it is required to be operable.
- k. Wiring. For panoramic irradiators, the licensee shall verify that the electrical wiring and electrical equipment that were installed meet the design specifications.

RH-7042-
RH-7049 Reserved.

Added - effective January 1, 1997

PART D. OPERATION OF IRRADIATORS

RH-7050. Reserved.

RH-7051. Training.

- a. Before an individual is permitted to operate an irradiator without a supervisor present, the individual must be instructed in:
 1. The fundamentals of radiation protection applied to irradiators (including the differences between external radiation and radioactive contamination, units of radiation dose, Department dose limits, why large radiation doses must be avoided, how shielding and access controls prevent large doses, how an irradiator is designed to prevent contamination, the proper use of survey meters and personnel dosimeters, other radiation safety features of an irradiator, and the basic function of the irradiator);
 2. The requirements of Section 3 of these Regulations that are relevant to the irradiator;
 3. The operation of the irradiator;
 4. Those operating and emergency procedures listed in RH-7053 that the individual is responsible for performing; and
 5. Case histories of accidents or problems involving irradiators.
- b. 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 safely operate the irradiator without supervision.
- c. Before an individual is permitted to operate an irradiator without a supervisor present, the individual must have received on-the-job training or simulator training in the use of the irradiator as described in the license application. The individual shall also demonstrate the ability to perform those portions of the operating and emergency procedures that he or she is to perform.

Added - effective January 1, 1997

- d. The licensee shall conduct safety reviews 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:
 - 1. Changes in operating and emergency procedures since the last review, if any;
 - 2. Changes in regulations and license conditions since the last review, if any;
 - 3. Reports on recent accidents, mistakes, or problems that have occurred at irradiators, if any;
 - 4. Relevant results of inspections of operator safety performance;
 - 5. Relevant results of the facility's inspection and maintenance checks; and
 - 6. A drill to practice an emergency or abnormal event procedure.
- e. The licensee shall evaluate the safety performance of each irradiator operator at least annually to ensure that Regulations, 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.
- f. Individuals who will be permitted unescorted access to the radiation room of the irradiator or the area around the pool of an underwater irradiator, but who have not received the training required for operators and the radiation safety officer, shall be instructed and tested in any precautions they should take to avoid radiation exposure, any procedures or parts of procedures listed in RH-7053 that they are expected to perform or comply with, and their proper response to alarms required in this Section. Tests may be oral.
- g. Individuals who must be prepared to respond to alarms required by RH-7023.b, RH-7023.i, RH-7027.a, RH-7029.a, RH-7029.b, and RH-7059.b shall be trained and tested on how to respond. Each individual shall be retested at least once a year. Tests may be oral.

RH-7052. Reserved.

RH-7053. Operating and Emergency Procedures.

- a. The licensee shall have and follow written operating procedures for:
 - 1. Operation of the irradiator, including entering and leaving the radiation room;
 - 2. Use of personnel dosimeters;
 - 3. Surveying the shielding of panoramic irradiators;
 - 4. Monitoring pool water for contamination while the water is in the pool and before release of pool water to unrestricted areas;
 - 5. Leak testing of sources;
 - 6. Inspection and maintenance checks required by RH-7061;
 - 7. Loading, unloading, and repositioning sources, if the operations will be performed by the licensee; and
 - 8. Inspection of movable shielding required by RH-7023.h, if applicable.
- b. The licensee shall have and follow emergency or abnormal event procedures, appropriate for the irradiator type, for:
 - 1. Sources stuck in the unshielded position;
 - 2. Personnel overexposures;
 - 3. A radiation alarm from the product exit portal monitor or pool monitor;
 - 4. Detection of leaking sources, pool contamination, or alarm caused by contamination of pool water;
 - 5. A low or high water level indicator, an abnormal water loss, or leakage from the source storage pool;
 - 6. A prolonged loss of electrical power;
 - 7. A fire alarm or explosion in the radiation room;

Added - effective January 1, 1997

RH-7053 (Cont'd)

8. An alarm indicating unauthorized entry into the radiation room, area around pool, or another alarm area;
 9. Natural phenomena, including an earthquake, a tornado, flooding, or other phenomena as appropriate for the geographical location of the facility; and
 10. The jamming of automatic conveyor systems.
- c. The licensee may revise operating and emergency procedures without Department approval only if all of the following conditions are met:
1. The revisions do not reduce the safety of the facility;
 2. The revisions are consistent with the outline or summary of procedures submitted with the license application;
 3. The revisions have been reviewed and approved by the radiation safety officer; and
 4. The users or operators are instructed and tested on the revised procedures before they are put into use.

RH-7054. Reserved.

RH-7055. Personnel Monitoring.

- a. Irradiator operators shall wear either a film badge or a thermoluminescent dosimeter (TLD) while operating a panoramic irradiator or while in the area around the pool of an underwater irradiator. The film badge or TLD processor must be accredited by the National Voluntary Laboratory Accreditation Program for high energy photons in the normal and accident dose ranges (**See RH-1301.a**). Each film badge or TLD must be assigned to and worn by only one individual. Film badges must be processed at least monthly, and TLDs must be processed at least quarterly.

Added - effective January 1, 1997

RH-7055 (Cont'd)

- b. Other individuals who enter the radiation room of a panoramic irradiator shall wear a dosimeter, which may be a pocket dosimeter. For groups of visitors, only two people who enter the radiation room are required to wear dosimeters. If pocket dosimeters are used to meet the requirements of this paragraph, a check of their response to radiation must be done at least annually. Acceptable dosimeters must read within plus or minus 30 percent ($\pm 30\%$) of the true radiation dose.

RH-7056. Reserved.

RH-7057. Radiation Surveys.

- a. A radiation survey of the area outside the shielding of the radiation room of a panoramic irradiator must be conducted with the sources in the exposed position before the facility starts to operate. A radiation survey of the area above the pool of pool irradiators must be conducted after the sources are loaded but before the facility starts to operate. Additional radiation surveys of the shielding must be performed at intervals not to exceed three (3) years and before resuming operation after addition of new sources or any modification to the radiation room shielding or structure that might increase dose rates.
- b. If the radiation levels specified in RH-7025 are exceeded, the facility must be modified to comply with the requirements in RH-7025.
- c. Portable radiation survey meters must be calibrated at least annually to an accuracy of plus or minus 20 percent ($\pm 20\%$) 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.

Added - effective January 1, 1997

- d. Water from the irradiator pool, 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 Section 3 of these Regulations, Table 2, Column 2 or Table 3 of Appendix G, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage".
- e. Before releasing resins for unrestricted use, they must be monitored before release in an area with a background level less than 0.5 microsievert (0.05 millirem) per hour. The resins may be released only if the survey does not detect radiation levels above background radiation levels. The survey meter used must be capable of detecting radiation levels of 0.05 microsievert (0.05 millirem) per hour.

RH-7058. Reserved.

RH-7059. Detection of Leaking Sources.

- a. Each dry-source-storage sealed source must be tested for leakage at intervals not to exceed six (6) months using a leak test kit or method approved by the Department, U.S. Nuclear Regulatory Commission, or an Agreement State. In the absence of a certificate from a transferor that a test has been made within the six (6) months before the transfer, the sealed source may not be used until tested. The test must be capable of detecting the presence of 200 becquerels (0.005 microcurie) of radioactive material and must be performed by a person approved by the Department, U.S. Nuclear Regulatory Commission, or an Agreement State to perform the test.
- b. For pool irradiators, sources may not be put into the pool unless the licensee tests the sources for leaks or has a certificate from a transferor that a leak test has been done within six (6) months before the transfer. Water from the pool must be checked for contamination each day the irradiator operates. The check may be done either by using a radiation monitor on a pool water circulating

Added - effective January 1, 1997

system or by analysis of a sample of pool water. If a check for contamination is done by analysis of a sample 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 of 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 may 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.

- c. If a leaking source is detected, the licensee shall arrange to remove the leaking source from service and have it decontaminated, repaired, or disposed of by a Department, U.S. Nuclear Regulatory Commission, or Agreement State licensee that is authorized to perform these functions. The licensee shall promptly check its personnel, equipment, facilities, and irradiated product for radioactive contamination. No product may be shipped until the product has been checked and found free of contamination. If a product has been shipped that may have been inadvertently contaminated, the licensee shall arrange to locate and survey that product for contamination. If any personnel are found to be contaminated, decontamination must be performed promptly. If contaminated equipment, facilities, or products are found, the licensee shall arrange to have them decontaminated or disposed of by a Department, U.S. Nuclear Regulatory Commission, or Agreement State licensee that is authorized to perform these functions. If a pool is contaminated, the licensee shall arrange to clean the pool until the contamination levels do not exceed the appropriate concentration in Section 3 of these Regulations, Table 2, Column 2, Appendix G. (See RH-1502.e through RH-1502.g for reporting requirements.)

RH-7060. Reserved.

Added - effective January 1, 1997

RH-7061. Inspection and Maintenance.

- a. 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:
1. Operability of each aspect of the access control system required by RH-7023.
 2. Functioning of the source position indicator required by RH-7031.b.
 3. Operability of the radiation monitor for radioactive contamination in pool water required by RH-7059.b using a radiation check source, if applicable.
 4. Operability of the over-pool radiation monitor at underwater irradiators as required by RH-7029.b.
 5. Operability of the product exit monitor required by RH-7029.a.
 6. Operability of the emergency source return control required by RH-7031.c.
 7. Leak-tightness of systems through which pool water circulates (visual inspection).
 8. Operability of the heat and smoke detectors and extinguisher system required by RH-7027 (but without turning extinguishers on).
 9. Operability of the means of pool water replenishment required by RH-7033.c.
 10. Operability of the indicators of high and low pool water levels required by RH-7033.d.
 11. Operability of the intrusion alarm required by RH-7023.1, if applicable.
 12. Functioning and wear of the system, mechanisms, and cables used to raise and lower sources.
 13. Condition of the barrier to prevent products from hitting the sources or source mechanism as required by RH-7035.

Added - effective January 1, 1997

RH-7061 (Con't)

14. Amount of water added to the pool to determine if the pool is leaking.
 15. Electrical wiring on required safety systems for radiation damage.
 16. Pool water conductivity measurements and analysis as required by RH-7063.b.
- b. Malfunctions and defects found during inspection and maintenance checks must be repaired without undue delay.

RH-7062. Reserved.

RH-7063. Pool Water Purity.

- a. Pool water purification system must be run sufficiently to maintain the conductivity of the pool water below 20 microsiemens per centimeter under norm 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.
- b. 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.

RH-7064. Reserved.

Added - effective January 1, 1997

RH-7065. Attendance During Operation.

- a. Both an irradiator operator and at least one other individual, who is trained on how to respond and prepared to promptly render or summon assistance if the access control alarm sounds, shall be present onsite:
 1. Whenever the irradiator is operated using an automatic product conveyor system; and
 2. Whenever the product is moved into or out of the radiation room when the irradiator is operated in a batch mode.
- b. At a panoramic irradiator at which static irradiations (no movement of the product) are occurring, a person who has received the training on how to respond to alarms described in RH-7051.g must be onsite.
- c. At an underwater irradiator, an irradiator operator must be present at the facility 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 RH-7051.f and RH-7051.g. Static irradiations may be performed without a person present at the facility.

RH-7066. Reserved.

RH-7067. Entering and Leaving the Radiation Room.

- a. 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 prior to entry.
- b. Before exiting from and locking the door to the radiation room of a panoramic irradiator prior to a planned irradiation, the irradiator operator shall:
 1. Visually inspect the entire radiation room to verify that no one else is in it; and

Added - effective January 1, 1997

RH-7067 (Cont'd)

2. Activate a control in the radiation room that 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 may not be entered without using an operable and calibrated radiation survey meter unless the over-the-pool monitor required by RH-7029.b is operating with backup power.

RH-7068. Reserved.

RH-7069. Irradiation of Explosive or Flammable Materials.

- a. Irradiation of explosive material 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.
- b. Irradiation of more than small quantities of flammable material (flash point below 140°F) 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.

RH-7070-

RH-7079 Reserved.

Added - effective January 1, 1997

PART E. RECORDS

RH-7080. Reserved.

RH-7081. Records and Retention Periods.

The licensee shall maintain the following records at the irradiator for the periods specified.

- a. A copy of the license, license conditions, documents incorporated into a license by reference, and amendments thereto until superseded by new documents or until the Department terminates the license for documents not superseded.
- b. Records of each individual's training, tests, and safety reviews provided to meet the requirements of RH-7051.a through RH-7051.d, RH-7051.f and RH-7051.g until three (3) years after the individual terminates work.
- c. Records of the annual evaluations of the safety performance or irradiator operators required by RH-7051.e for three (3) years after the evaluation.
- d. A copy of the current operating and emergency procedures required by RH-7053 until superseded or the Department terminates the license. Records of the radiation safety officer's review and approval of changes in procedures as required by RH-7053.c.3 retained for three (3) years from the date of the change.
- e. Film badge and TLD results required by RH-7055 until the Department terminates the license.
- f. Records of radiation surveys required by RH-7057 for three (3) years from the date of the survey.
- g. Records of radiation survey meter calibrations required by RH-7057 and pool water conductivity meter calibrations required by RH-7063.b until three (3) years from the date of calibration.
- h. Records of the results of leak tests required by RH-7059.a and the results of contamination checks required by RH-7059.b for three (3) years from the date of each test.

Added - effective January 1, 1997

RH-7081 (Cont'd)

- i. Records of inspection and maintenance checks required by RH-7061 for three (3) years.
- j. Records of major malfunctions, significant defects, operating difficulties or irregularities, and major operating problems that involve required radiation safety equipment for three (3) years after repairs are completed.
- k. Records of the receipt, transfer and disposal, of all licensed sealed sources as required by Part E and RH-600 of Section 2 of these Regulations.
- l. Records on the design checks required by RH-7039 and the construction control checks as required by RH-7041 until the license is terminated. The records must be signed and dated. The title or qualification of the person signing must be included.
- m. Records related to decommissioning of the irradiator as required by RH-409.h.

RH-7082. Reserved.

RH-7083. Reports.

- a. In addition to the reporting requirements in other Parts of these Regulations, the licensee shall report the following events if not reported under other parts of the Department Regulations:
 1. Source stuck in an unshielded position.
 2. Any fire or explosion in a radiation room.
 3. Damage to the source racks.
 4. Failure of the cable or drive mechanism used to move the source racks.
 5. Inoperability of the access control system.

Added - effective January 1, 1997

6. Detection of radiation source by the product exit monitor.
 7. Detention of radioactive contamination attributable to licensed radioactive material.
 8. Structural damage to the pool liner or walls.
 9. Abnormal water loss or leakage from the source storage pool.
 10. Pool water conductivity exceeding 100 microsiemens per centimeter.
- b. The report must include a telephone report within 24 (twenty-four) hours as described in RH-1502.g.1, and a written report within thirty (30) days as described in RH-1502.g.2.

RH-7084-
RH-7089. Reserved.

Added - effective January 1, 1997

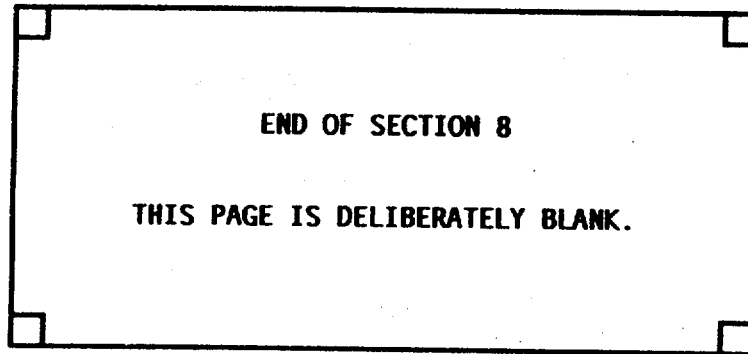
PART F. ENFORCEMENT

RH-7090. Reserved.

RH-7091. Violations.

- a. Any person who violates any of the provisions of the Act or rules, Regulations or orders in effect pursuant thereto of the Department shall, upon conviction thereof, be punished by a fine of not less than one hundred dollars (\$100.00) nor more than two thousand dollars (\$2,000.00) or by imprisonment for not more than six (6) months or be both so fined and imprisoned.
- b. Impounding. Sources of radiation shall be subject to impounding pursuant to Section 5 of these Regulations.

Added - effective January 1, 1997



Added - effective January 1, 1997

SEVERABILITY

If any provisions of these Rules and Regulations or the application thereof to any person or circumstance is held invalid, such invalidity shall not affect other provisions or applications of these Rules and Regulations which can give effect without the invalid provisions or applications. To this end, the provisions hereto are declared to be severable.

REPEAL

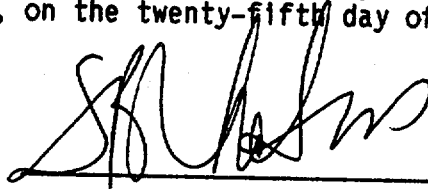
All Regulations and parts of Regulations in conflict herewith are hereby repealed.

Added January 1, 1997

CERTIFICATION

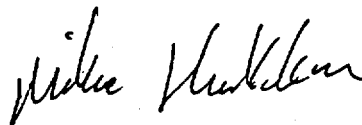
This will certify that the foregoing Amendment to the Rules and Regulations for Control of Sources of Ionizing Radiation was adopted by the Arkansas State Board of Health at regular executive session of said Board held in:

Little Rock, Arkansas, on the twenty-eighth day of October, 1993; and
Heber Springs, Arkansas, on the twenty-fifth day of July, 1996.



Sandra B. Nichols, M.D.
Secretary, Arkansas State Board of Health
Director, Arkansas Department of Health

The foregoing Rules and Regulations, having been filed in my Office,
are hereby in compliance with the Administrative Procedures Act on
this 16th day of December, 1996.



Mike Huckabee
Governor of the State of Arkansas

Added January 1, 1997