TITLE 25 HEALTH SERVICES
PART 1 DEPARTMENT OF STATE HEALTH SERVICES
CHAPTER 289 RADIATION CONTROL
SUBCHAPTER D GENERAL
SUBCHAPTER F LICENSE REGULATIONS

PROPOSAL PREAMBLE

The Executive Commissioner of the Texas Health and Human Services Commission (HHSC), on behalf of the Department of State Health Services (DSHS), proposes amendments to §289.201, concerning General Provisions for Radioactive Material; §289.202, concerning Standards for Protection Against Radiation from Radioactive Material; §289.253, concerning Radiation Safety Requirements for Well Logging Service Operations and Tracer Studies; §289.255, concerning Radiation Safety Requirements and Licensing and Registration Procedures for Industrial Radiography; §289.256, concerning Medical and Veterinary Use of Radioactive Material; §289.257, concerning Packaging and Transportation of Radioactive Material; and §289.258, concerning the Licensing and Radiation Safety Requirements for Irradiators.

BACKGROUND AND PURPOSE

The proposed amendments are necessary for Texas (an Agreement State) to comply with United States Nuclear Regulatory Commission (NRC) requirements, as identified in the Review Summary Sheets for Regulation Amendments (RATS Identification). The amendments update NRC information and result from the NRC's adoption of rules related to the use of digital output personnel dosimeters as an acceptable individual monitoring device.

Additional updates to NRC rules involve miscellaneous corrections, including references to the Council on Postdoctoral Training of the American Osteopathic Association and the Accreditation Council for Pharmacy Education, Exempt Material Activity Concentrations, and Exempt Consignment Activity Limits for Radionuclides. Updates also include the requirement to report transactions involving nationally tracked sources, the reference to the list of addresses of the governors' designees receiving advance notification of transportation of nuclear waste, and references to master material licensees and removal of permits issued under an NRC master material broad scope license.

The proposed amendments establish new definitions; qualify training requirements; and update license application processes, concerning use of field stations, material storage, and approved methods for waste disposal. Amendments update Radiation Safety Committee (RSC) requirements and transportation exemptions for medical and veterinary licensees, identify conditions under which medical licensees may revise their radiation protection programs without the department's approval, and update contamination control criteria and methods. Amendments clarify record retention requirements related to the receipt, transfer, and disposal of radioactive

material and devices and ensure compatibility with NRC requirements not specifically mentioned in the RATS Identification.

The proposed amendments update, correct, improve, and clarify the rule language and incorporate plain language where appropriate.

SECTION-BY-SECTION SUMMARY

Proposed amendment to §289.201(b)(7) deletes the definition of "agency." Proposed new §289.201(b)(33) adds the definition "department." Subsequent paragraphs in the definition subsection are renumbered.

Proposed amendments to §289.201(b)(21) and (22) and §289.201(b)(63) update the definitions to specify "permission to engage in regulated activities" as described in the certificate of registration or license.

Proposed amendment to renumbered §289.201(b)(27) updates the definition of "consortium" to meet HHSC plain language guidelines.

Proposed amendment to §289.201(b)(46) updates the definition of "exposure" to remove the obsolete term "negatrons" and conforms with the International Commission on Radiation Units and Measurements definition.

Proposed amendment to §289.201(b)(57) modifies the definition of "individual monitoring device" to ensure compatibility with NRC language and account for the accepted use of digital output personnel dosimeters by the NRC. The references to "pocket dosimeter" and "personal air sampling devices" are removed to mitigate confusion regarding acceptable personnel monitoring devices for well logging and irradiator operations.

Proposed amendment to §289.201(b)(66) deletes the definition of "licensing state," which is an obsolete term. Subsequent paragraphs in the definition subsection are renumbered.

Proposed amendments to renumbered §289.201(b)(84) and §289.201(b)(143) update the definitions of "physician" and "veterinarian" by specifying the Texas Occupations Code chapters extending the authority to practice medicine and veterinary medicine, respectively.

Proposed new §289.201(b)(85) adds the definition of "pocket dosimeter" based on the proposed update to the definition of "individual monitoring device." Adding a discrete definition will mitigate confusion regarding acceptable personnel monitoring devices to be used during well logging and irradiator operations.

Proposed amendment to §289.201(b)(114) changes the definition of "sealed source" to maintain compatibility with NRC language.

Proposed new §289.201(b)(129) adds a definition for "temporary job site" as it is also defined in §289.253 and §289.255. Subsequent paragraphs in the definition subsection are renumbered.

Proposed amendment to renumbered §289.201(b)(137), Type A quantity, removes the repeated "A_2" value and replaces it with the "A_1" value as necessary to maintain NRC compatibility.

Proposed amendment to §289.201(d)(1)(B), Records, clarifies the record retention requirement for the receipt, transfer, and disposal of radioactive material. The update differentiates receipt and transfer from disposal record requirements and maintains compatibility with NRC language.

Proposed amendment to §289.201(d)(5) modifies data retention requirements to account for all media types used to store records.

Proposed amendment to §289.201(g)(1)(A), Tests for leakage or contamination of sealed sources, corrects exception reference from §289.253(i) to §289.253(j) of this chapter.

Proposed amendment to §289.201(m), Open records, removes subsection (m) in its entirety because Texas Government Code and DSHS policy prescribe open records request procedures. Removing subsection (m) also removes Figure: 25 TAC 289.201(m)(2)(A)(ii). Subsequent subsections are renumbered accordingly, Figure 25 TAC §289.201(n)(1) is renumbered as Figure 25 TAC §289.201(m)(1), and Figure 25 TAC §289.201(n)(2) is renumbered as Figure 25 TAC §289.201(m)(2).

Proposed amendment to §289.202(p)(4) ensures compatibility with NRC language and accounts for the NRC's accepted use of digital output personnel dosimeters. Individual monitoring devices requiring processing are qualified, and the requirement they be processed and evaluated by an accredited laboratory is retained.

Proposed amendment to §289.202(r)(1)(F) ensures compatibility with NRC language and accounts for the accepted use of digital output personnel dosimeters by the NRC. The change specifies wear periods for individual monitoring devices requiring processing.

Proposed new §289.202(r)(1)(G) accounts for digital output personnel dosimeters not requiring processing and establishes the evaluation periodicity.

Proposed amendment to §289.202(r)(2) adds the term "as applicable" to account for devices not requiring processing.

Proposed new §289.202(ff)(1)(F) accounts for NRC regulation allowing for alternative radioactive material waste disposal procedures when reviewed and

approved by DSHS. Subsequent clauses outline documentation and conditions required to be submitted for DSHS's review.

Proposed amendment to §289.202(fff)(1)(A) and (B) ensures compatibility with NRC language by removing unnecessary references to "iodine-125" and "in vitro clinical or in vitro laboratory testing."

Proposed amendment to §289.202(ggg)(2)(B)(vi) removes Figure: 25 TAC§289.202(ggg)(2)(B)(vi) and replaces the figure with new rule text describing the use of stochastic and non-stochastic annual limits on intake (ALIs). The subsequent clauses of the subparagraph are renumbered and Figure:25 TAC §289.202(ggg)(2)(B)(viii) is renumbered as Figure:25 TAC §289.202(ggg)(2)(B)(vii).

Proposed amendment to §289.202(ggg)(5), in Figure: 25 TAC §289.202(ggg)(5), changes "(ll)(4)" to "(ll)(5)" in the left-hand column of the table and changes "Entries at no > 1 year intervals" to "Entries at not > 1 year intervals" in the right-hand column of the table.

Proposed amendment to §289.202(ggg)(6) adds that the sample area for acceptable surface contamination levels is "(per 100 cm^2)." The proposed amendment removes current Figure 25 TAC §289.202(ggg)(6) and replaces it with a new Figure 25 TAC §289.202(ggg)(6) that is based on Regulatory Guide 8.23 and is formatted similarly to Table R-3 of Consolidated Guidance About Material Licenses: Program-Specific Guidance About Medical Use Licenses, Final Report (NUREG 1556, Volume 9, Revision 3). Acceptable surface contamination levels are updated to coincide with NRC guidelines.

Proposed amendment deletes §289.202(hhh)(1)(H) and subsequent clauses are removed due to NRC compatibility requirements.

Proposed amendment to §289.253(g)(4), Storage precautions, removes language not included in the NRC rule and adds language consistent with NRC guidelines to ensure material may only be stored in locations "specifically authorized by the department."

Proposed amendment to §289.253(i)(1) and (3) ensure language is consistent with NRC rule by moving the language "capable of detecting beta and gamma radiation" from paragraph (3) and moving it to paragraph (1).

Proposed amendment to §289.253(o)(4) removes the reference to "licensing state," which is an obsolete term.

Proposed amendments to §289.253(p)(1)(A), Training requirements, and §289.255(e)(1)(A), Requirements for qualifications of radiographic personnel, remove the inference that the department accredits training courses by deleting the

language requiring courses to be "accepted by the agency, another agreement state, or the NRC."

Proposed amendments to §289.253(r)(1) and §289.255(p)(2)(I) ensure compatibility with updated NRC regulations removing the requirement for an accredited laboratory to process individual monitoring devices. Individual monitoring devices are qualified as those "requiring replacement" and those "requiring processing" to account for NRC acceptance of digital output personnel dosimeters not requiring processing. A requirement for all individual monitoring devices to "be evaluated at least quarterly or promptly after replacement, whichever is more frequent," is retained to account for devices not requiring processing.

Proposed amendment to §289.253(r)(2) changes "exposure to concentrations" to "intake" to clarify the requirement for circumstances requiring internal monitoring or bioassay.

Proposed amendment to §289.253(z)(3), Energy compensation source, replaces erroneous reference to subsection (cc)(4) with (ee)(4)(A), which ensures compatibility with the NRC equivalent requirement for operations not using a surface casing.

Proposed amendment to §289.253(dd)(4)(B), Notification of incidents and lost sources, updates well monitoring requirements to clarify the acceptable methods, and uses a "what/when/why/how" structure. This update meets compatibility requirements with the NRC.

Proposed amendment to Figure: 25 TAC §289.253(ee)(5) distinguishes the receipt and transfer records from the disposal records retention requirements and adds the reference to §289.201(d).

Proposed amendment to §289.255(c)(1) removes the definition of "additional authorized use/storage site" and places the definition of "field station" in §289.255(c)(16). Adopting "field station" directly from NRC rules with an additional reference to "radiation machines" ensures compatibility with NRC rules. Subsequent paragraphs are renumbered.

Proposed amendment to §289.255(c)(17) removes the definition of "fluoroscopic imaging assembly," as it does not exist in these rules.

Proposed amendment to §289.255(c)(18) removes the definition of "GED" due to proposed deletion of the General Education Development (GED) from the Radiation Safety Office training requirements of §289.255(e)(4)(B). Subsequent paragraphs are renumbered.

Proposed amendment to §289.255(c)(27) removes the definition of "permanent storage site," as it is no longer used in the rule based on the proposed deletion of

the definition of "storage facility" in §289.255(c)(48). Subsequent paragraphs are renumbered.

Proposed amendment to renumbered §289.255(c)(30) updates the compatibility with NRC language by clarifying that an individual "who provides visual surveillance of industrial radiographic operations while in attendance during transport or at the site where the sealed source or sources are being used" is defined as a radiographer.

Proposed amendment to renumbered §289.255(c)(43) for the definition of "storage area" replaces "used for radiographic operations" with "in use" to ensure compatibility with NRC language.

Proposed amendment to §289.255(c)(48) removes the unnecessary definition of "storage facility," which is not defined in NRC rules. Subsequent paragraphs are renumbered.

Proposed amendment to renumbered §289.255(c)(45) modifies the definition of "temporary job site" to ensure compatibility with the NRC definition.

Proposed amendment to §289.255(d)(4), Exemptions, updates several applicable references. Reference to subsection (k) is added to account for the exemption of radiation machines utilized for industrial radiography at permanent radiographic installations. Inventories of those machines must be conducted under §289.226(m)(9) as now specified in proposed amendment to §289.255(k).

Proposed amendment to §289.255(e)(2)(A)(ii), Requirements for qualifications of radiographic personnel, removes reference to "radiographer trainers authorized on a license or certificate of registration" as trainers are not listed on a license or certificate of registration. A reference to subsection "(e)(3) of this section" is added to clarify training requirements.

Proposed amendment to §289.255(e)(3)(A)(i)(II), Radiographer trainer, clarifies the training requirement by specifying "2000 hours of documented direct experience" instead of "one year" to qualify the necessary training for trainers.

Proposed amendment to §289.255(e)(4)(A) and (B), RSO for industrial radiography, revises training requirements to conform with 10 Code of Federal Regulations (CFR) §34.42 format and language. Changes and additions ensure compatibility with NRC rule. Language describing RSO designation on DSHS-issued licenses and certificates of registration has been moved to paragraph (4) of this subsection.

Proposed amendments to §289.255(i) and §289.255(i)(1), "industrial radiography sealed" and "radiography exposure" have been added to the subsection title and paragraph to clarify the applicability of the rule to industrial sources and devices using depleted uranium (DU) as shielding.

Proposed amendment to §289.255(k), changes the heading to "Inventory" to account for addition of exemption for radiation machines used in industrial radiography. Proposed amendment to §289.255(k)(1) adds language specifying the exemption of machines and prescribes inventory and record retention requirements of §289.226(m)(9).

Proposed amendment to §289.255(o), changes the heading to "Notifications" as the proposed additions of notifications to §289.255(o)(4) and (5) are not limited to incidents.

Proposed new §289.255(o)(4) and (5) adds requirements to notify DSHS when using or storing radioactive material at a location not listed on a license beyond 180 days in a calendar year or when using or storing radiation machines at a location not listed on a certificate of registration beyond 90 days in a calendar year. Proposed amendment to §289.255(t) – (u) deletes the notification language and moves it to subsection (o).

Proposed amendments to §289.255(p)(2)(A)(i) and §289.255(s)(1)(B), regarding the use of individual monitoring devices, updates the incorrect reference to §289.202(p)(3) and (4) and changes it to §289.202(p)(4) and (5).

Proposed amendment to §289.255(p)(2)(E)(i), Individual monitoring, adds "use or" storage "site" and removes the term "location" to clarify and maintain consistency with subsequent rules in the section.

Proposed amendment to §289.255(p)(2)(G), Individual monitoring, adjusts processing and evaluation requirements for an off-scale reading during industrial radiography operations. Devices are distinguished as those requiring processing and those not requiring processing to account for NRC acceptance of digital output personnel dosimeters.

Proposed amendment to §289.255(p)(6)(B), Individual monitoring, removes "received from the device processor" to comply with NRC acceptance of digital output personnel dosimeters.

Proposed amendment to §289.255(t)(1)(B)(iv), Registration requirements for industrial radiographic operations, adds a reference to "all field stations" being listed on the application for a certificate of registration. This precludes the need for the remaining language in clause (iv) and subclauses (I) – (III) of this clause. Language from subclause (IV) is moved to subsection (o).

Proposed amendment to §289.255(u)(1)(B)(iv), Licensing requirements for industrial radiographic operations, adds a reference to "all field stations" being listed on the application for a certificate of registration. This precludes the need for the remaining language in clause (iv) and subclauses (I) – (III) of this clause. Language from subclause (IV) is moved to subsection (o).

Proposed amendments to §289.255(u)(1)(B)(viii)(II) and §289.255(u)(9)(G) replace the terms "storage facilities" and "storage location" with "storage areas" and "storage area," respectively. The definition of "storage facility" is removed from subsection (c). "Storage area" is defined in the rule.

Proposed amendment to §289.255(u)(4)(B), Permanent storage precautions for the use of sealed sources, removes language not included in the equivalent NRC rule and adds the language "specifically authorized by the department," consistent with NRC guidelines, to ensure material is only stored at locations specifically authorized by the department.

Proposed amendment to §289.255(u)(5)(D)(iv), Performance requirements for industrial radiography equipment, adds the term "lock box," included in the equivalent NRC rule. To clarify language found in 10 CFR §34.20, the clause is restructured, and language is added to specify safety plugs or covers "be installed during storage and transportation to" protect the source assembly.

Proposed amendment to §289.255(u)(7)(D), Labeling and storage, adds the term "legible" to describe the required vehicle label used when transporting radioactive material.

Proposed amendments to §289.255(u)(8)(G) and §289.255(u)(8)(J), Operating and internal audit requirements for the use of sealed sources of radiation, updates the subparagraphs to meet compatibility requirements with equivalent NRC rule, specifically 10 CFR §34.41(a) and (b).

Proposed amendments to Figure: 25 TAC §289.255(v)(1), Record/document requirements, adds a separate requirement to retain material and device "disposal" records "until license termination." This is distinguished from "receipt and transfer" records and is updated for consistency with NRC rules, allowing agreement states to be more restrictive.

Proposed amendments to §289.255(x)(2)(B)(iv) and (v) and §289.255(x)(2)(C)(viii) and (ix), General requirements for inspection of industrial radiographic equipment, remove the requirement to inspect for the "presence of radioactive contamination" as this procedure is not included in the NRC guidelines. Additionally, paragraph (2)(A)(i) already requires licensees to survey the guide tube for radiation levels.

Proposed amendment to §289.256(h)(3)(C), Training for an RSO and ARSO, changes the language, "a NRC master material license" to "an NRC master material licensee," under NRC compatibility requirements.

Proposed amendment to §289.256(i), Radiation Safety Committee, adds a requirement that licensees authorized for two or more different types of radioactive material use requiring a "written directive" or two or more "therapeutic" units under subsection "(q)" must establish an RSC. This is consistent with the requirement to establish an RSC applicable to other licensees or registrants practicing under

provisions of subsections (kk), (rr), and (ddd) of this section. This addition is consistent with agreement state authorization to be more restrictive than the NRC.

Proposed amendment to §289.256(i)(2), Radiation Safety Committee, removes paragraph (2) of this subsection and adjusts paragraph (1) to ensure uniform membership requirements apply to all licensees requiring a radiation safety committee.

Proposed amendment to §289.256(l)(5)(B), Training for experienced RSO, teletherapy or medical physicist, authorized medical physicist, authorized user, nuclear pharmacist, and authorized nuclear pharmacist, is adjusted to replace "by" with "in accordance with" and reference to "NRC master material license of broad scope" is changed to "NRC master material broad scope license." This change ensures compatibility with equivalent NRC rule.

Proposed amendment to §289.256(p)(7), replaces "name and/or number" with "designation" to clarify the rule and remove use of "and/or."

Proposed amendment to §289.256(r)(2)(E), License amendments and notifications, corrects a typographical error by adding a new sentence beginning with "Other." This ensures compatibility with NRC language and clarifies the rule.

Proposed amendment to §289.256(r)(2)(G), License amendments and notifications, adds conditions under which a medical licensee may revise its radiation protection program without the department's approval as is consistent with 10 CFR §35.26.

Proposed amendment to §289.256(cc)(1), Release of individuals containing radioactive drugs or implants containing radioactive material, removes the obsolete requirement allowing release of patients treated with temporary eye plaques based on a less than 5 mrem per hour "exposure rate" at a distance of 1 meter from the plaque location.

Proposed amendment to §289.256(ii)(4), Permissible molybdenum-99, strontium-82, and strontium-85 concentrations, replaces reference to subsection "(www)" with "(xxx)" based on comment received from the NRC identifying the error.

Proposed amendment to §289.256(ii)(5), Permissible molybdenum-99, strontium-82, and strontium-85 concentrations, replaces the reference to subsection "(xxx)" with "(www)" based on comment received from the NRC identifying the error.

Proposed amendments to §§289.256(nn)(1)(A), 289.256(zz)(1)(A), 289.256(zz)(2)(B), 289.256(ttt)(1)(A), and 289.256(ttt)(2)(A)(iii) update the accrediting body reference to "the Council on Postdoctoral Training of the American Osteopathic Association" when referring to training requirements for Doctor of Osteopathic Medicine. This update ensures compatibility with the equivalent NRC rules.

Proposed amendment to §289.256(qq)(2)(C)(i) removes the redundant phrase, "and shall have experience in administering dosages in the same category or categories as the individual requesting authorized user status; or." This ensures compatibility with the equivalent NRC rule.

Proposed amendment to §289.256(tt)(3)(B), Brachytherapy sealed sources accountability, updates the last sentence to clarify that the date sealed sources "were returned to storage" must be recorded.

Proposed amendments to Figure: 25 TAC §289.256(xxx), Records/documents for department inspection, removes reference to "receipt, transfer, and disposal" of radioactive material and changes to distinguish "Records of receipt and transfer" from "Records of disposal of radioactive material." Time intervals are updated to "Until disposal of the records is authorized by the department" and "Until termination of the radioactive material license," respectively. Additionally, cross-references related to RSC meetings, procedures for administrations requiring a written directive, and service provider documentation have been updated or corrected. These changes clarify retention requirements and are compatible with NRC rules.

Proposed amendment to §289.257(g), Exemptions of physicians, adds "and veterinarians" to the title and updates references to "veterinarian" and "veterinary medicine" to include veterinarians to the exemption as they are licensed under the medical rule, §289.256.

Proposed amendment to §289.257(i)(1)(C)(iii), General license, adds "U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001" to the Document Control Desk address to correct omitted information.

Proposed amendment to §289.257(q)(4)(C)(i) removes the clause as required by NRC RATS ID 2020-3. Subsequent clauses to this subparagraph have been renumbered.

Proposed amendment to Figure: 25 TAC §289.257(ee)(6), Appendices for determination of A_1 and A_2, updates the "Specific activity" of Samarium-147 (Sm-147) in TBq/g (Terabecquerels/gram) from "$8.5X10^{-1}$" to "$8.5X10^{-10}$" as required to maintain NRC compatibility.

Proposed amendments to §§289.258(e)(8), 289.258(w)(1), and 289.258(w)(3) remove the reference to "licensing state," which is an obsolete term.

Proposed amendment to §289.258(u)(1), Personnel monitoring, is required to ensure compatibility with updated NRC regulations removing the requirement for an accredited laboratory to process individual monitoring devices. The previous requirement that the "personnel dosimeter processor must be accredited for" is replaced with "must be capable of detecting" photons in the normal and accident dose ranges. The term "personnel dosimeter" is replaced with "individual

monitoring device" to maintain consistency. Individual monitoring devices are qualified as those "requiring replacement" and those "requiring processing" to account for NRC acceptance of digital output personnel dosimeters not requiring processing. A requirement for all individual monitoring devices to "be evaluated at least quarterly or promptly after replacement, whichever is more frequent," is retained to account for devices not requiring processing.

Proposed amendment to §289.258(u)(2), Personnel monitoring, updates reference to "the paragraph" with "this paragraph."

Proposed amendment to §289.258(w)(1), Detection of leaking sources, replaces "the commission" with "the NRC" to maintain consistency when referencing the U.S. Nuclear Regulatory Commission (NRC).

Proposed amendment to §289.258(cc)(5), Records/documents, changes reference to "film badge, TLD, or OSL" to "individual monitoring device" so the record retention requirements will apply to digital output personnel dosimeters not requiring processing.

FISCAL NOTE

Christy Havel Burton, Chief Financial Officer, has determined that for each year of the first five years the rules will be in effect, enforcing or administering the rules does not have foreseeable implications relating to costs or revenues of state or local governments.

GOVERNMENT GROWTH IMPACT STATEMENT

DSHS has determined that during the first five years the rules will be in effect:

(1) the proposed rules will not create or eliminate a government program;

(2) implementation of the proposed rules will not affect the number of DSHS employee positions;

(3) implementation of the proposed rules will result in no assumed change in future legislative appropriations;

(4) the proposed rules will not affect fees paid to DSHS;

(5) the proposed rules will not create a new regulation;

(6) the proposed rules will not expand existing regulations;

(7) the proposed rules will not change the number of individuals subject to the rules; and

(8) the proposed rules will not affect the state's economy.

SMALL BUSINESS, MICRO-BUSINESS, AND RURAL COMMUNITY IMPACT ANALYSIS

Christy Havel Burton, Chief Financial Officer, has also determined there will be no significant adverse economic impact on small businesses, micro-businesses, or rural communities required to comply with the rules as proposed. Small businesses, micro-businesses, and rural communities may be required to make minor changes to their business practices to comply with the rules when license conditions are applicable.

LOCAL EMPLOYMENT IMPACT

The proposed rules will not affect the local economy.

COSTS TO REGULATED PERSONS

Texas Government Code §2001.0045 does not apply to these rules because these rules are necessary to protect the health, safety, and welfare of the residents of Texas.

PUBLIC BENEFITS AND COSTS

Dr. Timothy Stevenson, Associate Commissioner, Consumer Protection Division, has determined that for each year of the first five years the rules are in effect, the public will benefit from adopting the rules. The public benefit anticipated as the result of enforcing or administering the rules is to ensure continued enhanced protection of the public, patients, workers, and the environment from unnecessary exposure to ionizing radiation. This is accomplished when rules are understandable, effective, specific, and harmonious with NRC rules.

Christy Havel Burton, Chief Financial Officer, has also determined that for the first five years the rules are in effect, there are no anticipated economic costs to persons required to comply with the proposed rules because those persons are already required to follow NRC regulations.

TAKINGS IMPACT ASSESSMENT

DSHS has determined the proposal does not restrict or limit an owner's right to their property that would otherwise exist in the absence of government action and, therefore, does not constitute a taking under Texas Government Code §2007.043.

PUBLIC COMMENT

Written comments on the proposal may be submitted to Radiation Section, Consumer Protection Division, DSHS, Mail Code 1986, P.O. Box 149347, Austin, Texas 78714-9347, or street address 1100 West 49th Street, Austin, Texas, 78756; by fax to (512) 483-3430; or emailed to CPDRuleComments@dshs.texas.gov.

To be considered, comments must be submitted no later than 31 days after the date of this issue of the *Texas Register*. Comments must be (1) postmarked or shipped before the last day of the comment period; (2) hand-delivered before 5:00 p.m. on the last working day of the comment period; or (3) faxed or emailed before midnight on the last day of the comment period. If the last day to submit comments falls on a holiday, comments must be postmarked, shipped, or emailed before midnight or hand-delivered before 5:00 p.m. on the following business day to be accepted. When faxing or emailing comments, please indicate "Comments on Proposed Rule 23R011" in the subject line.

STATUTORY AUTHORITY

The amendments are authorized by Texas Health and Safety Code Chapter 401 (the Texas Radiation Control Act), which provides for DSHS radiation control rules and regulatory program to be compatible with federal standards and regulation; §401.051, which provides the required authority to adopt rules and guidelines relating to the control of sources of radiation; §401.052, which provides authority for rules providing for transportation and routing of radioactive material and waste in Texas; §401.103, which provides authority for licensing and registration for transportation of sources of radiation; §401.104 which provides for rulemaking authority for general or specific licensing of radioactive material and devices or equipment using radioactive material; §401.224, which provides rulemaking authority relating to the packaging of radioactive waste; Chapter 401, Subchapter J, which authorizes enforcement of the Act; Texas Government Code §531.0055; and Texas Health and Safety Code §1001.075, which authorizes the Executive Commissioner of HHSC to adopt rules and policies for the operation and provision of health and human services by DSHS and for the administration of Texas Health and Safety Code Chapter 1001.

The amendments also implement Texas Health and Safety Code Chapters 401 and 1001, and Texas Government Code Chapter 531.

The agency certifies that this proposal has been reviewed by legal counsel and found to be a valid exercise of the agency's legal authority.

ADDITIONAL INFORMATION

For further information, please call: (512) 834-6655.

TITLE 25 HEALTH SERVICES
PART 1 DEPARTMENT OF STATE HEALTH SERVICES
CHAPTER 289 RADIATION CONTROL
SUBCHAPTER D GENERAL

§289.201. General Provisions for Radioactive Material.

(a) Scope. Except as otherwise specifically provided, this section applies to all persons who receive, possess, use, transfer, or acquire any radioactive material unless the [~~provided, however, that nothing in this section shall apply to any person to the extent such~~] person is subject to regulation by the United States Nuclear Regulatory Commission (NRC). This section does not apply [~~or~~] to radioactive material in the possession of federal agencies. State regulation [~~Attention is directed to the fact that regulation by the state~~] of source material, byproduct material, and special nuclear material in quantities not sufficient to form a critical mass is subject to the provisions of the agreement between the state and NRC and to Part 150 of NRC regulations (10 Code of Federal Regulations (CFR) Part 150) [~~(Title 10, Code of Federal Regulations (CFR), Part 150)~~]. A person who receives, possesses, uses, owns, transfers, or acquires radioactive material before [~~prior to~~] receiving a license is subject to the requirements of this chapter.

(b) Definitions. The following words and terms when used in this chapter [~~shall~~] have the following meanings[~~,~~] unless the context clearly indicates otherwise.

(1) Absorbed dose--The energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the gray (Gy) and the rad.

(2) Accelerator-produced material--Any material made radioactive by exposing it to the radiation from a particle accelerator.

(3) Access control--A system for allowing only approved individuals to have unescorted access to the security zone and for ensuring that all other individuals are subject to escorted access.

(4) Act--Texas Radiation Control Act, Texas Health and Safety Code (HSC)[~~,~~] Chapter 401.

(5) Activity--The rate of disintegration or transformation or decay of radioactive material. The units of activity are the becquerel (Bq) and the curie (Ci).

(6) Adult--An individual 18 or more years of age.

[~~(7) Agency--The Department of State Health Services.~~]

(7) [~~(8)~~] Aggregated--Accessible by the breach of a single physical barrier that would allow access to radioactive material in any form, including any devices that contain the radioactive material, when the total activity equals or exceeds a category 2 quantity of radioactive material.

(8) [~~(9)~~] Agreement state--Any state with which NRC has entered into an effective agreement under Section 274 [~~§274b~~] of the Atomic Energy Act of 1954,

as amended [~~(73 [Stat.] 689)~~].

(9) [~~(10)~~] Airborne radioactive material--Any radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases.

(10) [~~(11)~~] Airborne radioactivity area--A room, enclosure, or area in which airborne radioactive materials exist in concentrations:

(A) over [~~in excess of~~] the derived air concentrations (DACs) specified in Table I, Column 3 of §289.202(ggg)(2)(F) of this subchapter [~~title~~] (relating to Standards for Protection Against Radiation from Radioactive Materials); or

(B) to such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent [~~0.6%~~] of the annual limit on intake (ALI) or 12 derived air concentration-hours (DAC-hours) [~~DAC-hours~~].

(11) [~~(12)~~] Approved individual--An individual whom the licensee has determined to be trustworthy and reliable for unescorted access as specified in §289.252(ii)(2)-(8) [~~in accordance with §289.252(ii)(2) - (8)~~] of this chapter [~~title~~] (relating to Licensing of Radioactive Material) and who has completed the training required by §289.252(ii)(10)(C) of this chapter [~~title~~].

(12) [~~(13)~~] As low as is reasonably achievable (ALARA)--Making every reasonable effort to maintain exposures to radiation as far below the dose limits in these regulations as is practical, consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to the state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of ionizing radiation and licensed sources of radiation in the public interest.

(13) [~~(14)~~] Background investigation--The investigation conducted by a licensee or applicant to support the determination of trustworthiness and reliability.

(14) [~~(15)~~] Background radiation--Radiation from cosmic sources; non-technologically enhanced, naturally occurring radioactive material, including radon, except as a decay product of source or special nuclear material;[~~,~~] and [~~including~~] global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents, such as Chernobyl, contributing [~~that contribute~~] to background radiation and [~~are~~] not under the control of the licensee. "Background radiation" does not include radiation from sources of radiation regulated by the department [~~agency~~].

(15) [~~(16)~~] Becquerel (Bq)--The International System of Units (SI) unit of activity. One becquerel is equal to one [~~1~~] disintegration or transformation per second (dps or tps). Commonly used multiples of the becquerel are the kBq (kilobecquerel, 10^3 Bq), MBq (megabecquerel, 10^6 Bq), GBq (gigabecquerel, 10^9 Bq), and TBq (terabecquerel, 10^{12} Bq). 1 Ci = 37 GBq.

(16) [~~(17)~~] Bioassay--The determination of kinds, quantities, or concentrations, and, in some cases, the locations of radioactive material in the human body, whether by direct measurement, in vivo counting, or by analysis and evaluation of materials excreted or removed from the human body. For purposes of this chapter, "radiobioassay" is an equivalent term.

(17) [~~(18)~~] Brachytherapy--A method of radiation therapy in which sealed sources are utilized to deliver a radiation dose at a distance of up to a few centimeters, by surface, intracavitary, or interstitial application.

(18) [~~(19)~~] Byproduct material--Byproduct material is defined as:

(A) any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material;

(B) the tailings or wastes produced by or resulting from the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by these solution extraction operations do not constitute "byproduct material" within this definition;

(C) any discrete source of radium-226 that is produced, extracted, or converted after extraction, before, on, or after August 8, 2005, for use for a commercial, medical, or research activity; [~~or~~]

(D) any material that has been made radioactive by use of a particle accelerator; and is produced, extracted, or converted after extraction, before, on, or after August 8, 2005, for use for a commercial, medical, or research activity; or [~~and~~]

(E) any discrete source of naturally occurring radioactive material, other than source material, that is extracted or converted after extraction before, on, or after August 8, 2005, for use in a commercial, medical, or research activity and that the United States NRC, in consultation with the Administrator of the United States Environmental Protection Agency (EPA), the United States Secretary of Energy, the United States Secretary of Homeland Security, and the head of any other appropriate federal [~~Federal~~] agency, determines would pose a threat similar to the threat posed by a discrete source of radium-226 to the public health and safety or the common defense and security.

(19) [~~(20)~~] Category 1 quantity of radioactive material--A quantity of radioactive material meeting or exceeding the category 1 threshold in §289.252(jj)(9) of this chapter [~~title~~]. This is determined by calculating the ratio of the total activity of each radionuclide to the category 1 threshold for that radionuclide and adding the ratios together. If the sum is equal to or exceeds one [~~1~~], the quantity would be considered a category 1 quantity. Category 1 quantities of radioactive material do not include the radioactive material contained in any fuel assembly, subassembly, fuel rod, or fuel pellet.

(20) [~~(21)~~] Category 2 quantity of radioactive material--A quantity of radioactive material meeting or exceeding the category 2 threshold but less than the category 1 threshold in §289.252(jj)(9) of this chapter [~~title~~]. This is determined by calculating the ratio of the total activity of each radionuclide to the category 2 threshold for that radionuclide and adding the ratios together. If the sum is equal to or exceeds one [~~1~~], the quantity would be considered a category 2 quantity. Category 2 quantities of radioactive material do not include the radioactive material contained in any fuel assembly, subassembly, fuel rod, or fuel pellet.

(21) [~~(22)~~] Certificate of registration--A form of permission to engage in regulated activities given by the department [~~agency~~] to an applicant who has met the requirements for registration or mammography system certification set out in the Act and this chapter.

(22) [~~(23)~~] Certification of mammography systems (state certification)--A form of permission to engage in regulated activities given by the department [~~agency~~] to an applicant who has met the requirements for mammography system certification set out in the Act and this chapter.

(23) [~~(24)~~] Collective dose--The sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation.

(24) [~~(25)~~] Commercial--Having financial profit as the primary aim.

(25) [~~(26)~~] Committed dose equivalent ($H_{T,50}$) [~~($H_{T,50}$)~~]--The dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

(26) [~~(27)~~] Committed effective dose equivalent ($H_{E,50}$) [~~($H_{E,50}$)~~]--The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to each of these organs or tissues ($H_{E,50} = \Sigma W_T H_{T,50}$) [~~($H_{E,50} = \Sigma W_T H_{T,50}$)~~].

(27) [~~(28)~~] Consortium--An association of medical use licensees and a Positron Emission Tomography (PET) radionuclide production facility in the same geographical area that jointly own or share in the operation and maintenance costs of the PET radionuclide production facility. The PET radionuclide production facility produces [~~that produces PET~~] radionuclides [~~for use in producing radioactive drugs~~] [~~within the consortium~~] for production and noncommercial distribution of radioactive drugs [~~distributions~~] among consortium members [~~its associated members~~] for medical use and is [~~. The PET radionuclide production facility within the consortium shall be~~] located at an educational institution or a medical facility.

(28) [~~(29)~~] Constraint (dose constraint)--A value above which specified licensee actions are required.

(29) [~~(30)~~] Critical group--The group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of

circumstances.

(30) [~~(31)~~] Curie (Ci)--A unit of measurement of radioactivity. One curie (Ci) is the [~~that~~] quantity of radioactive material that decays at the rate of 3.7×10^{10} disintegrations per second (dps). Commonly used submultiples of the curie are the millicurie (mCi) and the microcurie (μCi). One mCi = 1×10^{-3} Ci = 3.7×10^{7} dps. One μCi = 1×10^{-6} Ci = 3.7×10^{4} dps. One nanocurie (nCi) = 1×10^{-9} Ci = 3.7×10^{1} dps. One picocurie (pCi) = 1×10^{-12} Ci = 3.7×10^{-2} dps.

(31) [~~(32)~~] Decommission--To remove a facility or site safely from service and reduce residual radioactivity to a level that permits the following:

(A) release of the property for unrestricted use or [~~and/or~~] termination of license; or

(B) release of the property under alternate requirements for license termination.

(32) [~~(33)~~] Deep dose equivalent (H_d) [~~(H_d)~~], that applies to external whole body exposure--The dose equivalent at a tissue depth of 1 centimeter (cm) (1,000 milligrams per square centimeter (mg/cm^2) [~~(mg/cm^2)~~]).

(33) Department--The Department of State Health Services.

(34) Depleted uranium--The source material uranium in which the isotope uranium-235 is less than 0.711 weight percent of the total uranium present. Depleted uranium does not include special nuclear material.

(35) Discrete source--A radionuclide that has been processed so that its concentration within a material has been purposely increased for use for commercial, medical, or research activities.

(36) Distinguishable from background--The detectable concentration of a radionuclide is statistically different from the background concentration of that radionuclide in the vicinity of the site, or, in the case of structures or equipment, in similar materials using adequate measurement technology, survey, and statistical techniques.

(37) Distribution--The physical conveyance and authorized transfer of commodities from producers to consumers and any intermediate persons involved in that conveyance.

(38) Diversion--The unauthorized movement of radioactive material subject to §289.252(ii) of this chapter [~~title~~] to a location different from the material's authorized destination inside or outside of the site at which the material is used or stored.

(39) Dose--A generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, total organ dose equivalent, or total effective dose equivalent. For purposes of this

chapter, "radiation dose" is an equivalent term.

(40) Dose equivalent (H_T) [~~(H_T)~~]--The product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the sievert (Sv) and rem.

(41) Dose limits--The permissible upper bounds of radiation doses established as specified in [~~accordance with~~] this chapter. For purposes of this chapter, "limits" is an equivalent term.

(42) Effective dose equivalent (H_E) [~~(H_E)~~]--The sum of the products of the dose equivalent to each organ or tissue (H_T) [~~(H_T)~~] and the weighting factor (W_T) [~~(W_T)~~] applicable to each of the body organs or tissues that are irradiated ($H_E = \Sigma W_T H_T$) [~~($H_E = \Sigma W_T H_T$)~~].

(43) Embryo/fetus--The developing human organism from conception until the time of birth.

(44) Entrance or access point--Any opening through which an individual or extremity of an individual could gain access to radiation areas or to licensed sources of radiation. This includes portals of sufficient size to permit human access, irrespective of their intended use.

(45) Escorted access--Accompaniment while in a security zone by an approved individual who maintains continuous direct visual surveillance, at all times over an individual who is not approved for unescorted access.

(46) Exposure--The quotient of dQ by dm where "dQ" is the absolute value of the total charge of the ions of one sign produced in air when all the electrons and positrons [(~~negatrons and positrons~~)] liberated by photons in a volume element of air having mass "dm" are completely stopped in air. The SI unit of exposure is the coulomb per kilogram (C/kg). The roentgen is the special unit of exposure. For purposes of this chapter, this term is used as a noun.

(47) Exposure rate--The exposure per unit of time.

(48) External dose--That portion of the dose equivalent received from any source of radiation outside the body.

(49) Extremity--Hand, elbow, arm below the elbow, foot, knee, and leg below the knee. The arm above the elbow and the leg above the knee are considered part of the whole body.

(50) Fingerprint orders--The orders issued by the NRC or the legally binding requirements issued by agreement states that require fingerprints and criminal history records checks for individuals with unescorted access to category 1 and category 2 quantities of radioactive material or Safeguards Information-Modified Handling files [~~safeguards information-modified handling~~].

(51) Generally applicable environmental radiation standards--Standards issued

by the EPA [~~United States Environmental Protection Agency (EPA)~~] under the authority of the Atomic Energy Act of 1954, as amended, that impose limits on radiation exposures or levels, or concentrations or quantities of radioactive material, in the general environment outside the boundaries of locations under the control of persons possessing or using radioactive material.

(52) Gray (Gy)--The SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule per kilogram (J/kg) or 100 rad.

(53) High radiation area--An area, accessible to individuals, in which radiation levels from sources of radiation external to the body could result in an individual receiving a dose equivalent more than [~~in excess of~~] 0.1 rem (1 millisievert (mSv)) in one hour at 30 cm from any source of radiation or from any surface that the radiation penetrates.

(54) Human use--The internal or external administration of radiation or radioactive material to human beings for healing arts purposes or research and [~~and/or~~] development specifically authorized by the department [~~agency~~].

(55) Individual--Any human being.

(56) Individual monitoring--The assessment of:

(A) dose equivalent to an individual using [~~by the use of~~] individual monitoring devices; or

(B) committed effective dose equivalent to an individual by bioassay or by determination of the time-weighted air concentrations to which an individual has been exposed, that is, DAC-hours. (See the definition for DAC-hours in §289.202(c) of this subchapter [~~title~~]); or

(C) dose equivalent to an individual using [~~by the use of~~] survey data.

(57) Individual monitoring device [~~devices~~]--Device [~~Devices~~] designed to be worn by a single individual (such as a film badge, thermoluminescent dosimeter (TLD), optically stimulated luminescence dosimeter (OSL), or digital output personnel dosimeter) used for the assessment of dose equivalent. For purposes of this chapter, "personnel dosimeter" and "dosimeter" are equivalent terms. [~~Examples of individual monitoring devices include, but are not limited to, film badges, thermoluminescence dosimeters (TLDs), optically stimulated luminescence dosimeters (OSLs), pocket ionization chambers (pocket dosimeters), electronic personal dosimeters, and personal air sampling devices.~~]

(58) Inspection--An official examination or [~~and/or~~] observation, including [~~, but not limited to,~~] records, tests, surveys, and monitoring to determine compliance with the Act and rules, orders, requirements, and conditions of the department [~~agency~~].

(59) Internal dose--That portion of the dose equivalent received from radioactive material taken into the body.

(60) Ionizing radiation--Any electromagnetic or particulate radiation capable of producing ions, directly or indirectly, in its passage through matter. Ionizing radiation includes gamma rays and x-rays [~~x rays~~], alpha and beta particles, high-speed electrons, neutrons, and other nuclear particles.

(61) Land disposal facility--The land, buildings, and equipment that are intended to be used for the disposal of low-level radioactive waste (LLRW) into the subsurface of the land.

(62) Lens dose equivalent--The external dose equivalent to the lens of the eye at a tissue depth of 0.3 cm (300 mg/cm^2) [~~(300 mg/cm^2)~~].

(63) License--A form of permission to engage in regulated activities given by the department [~~agency~~] to an applicant who has met the requirements for licensing set out in the Act and this chapter.

(64) Licensed material--Radioactive material received, possessed, used, or transferred under a general or specific license issued by the department [~~agency~~].

(65) Licensee--Any person who is licensed by the department as specified in [~~agency in accordance with~~] the Act and this chapter.

[~~(66) Licensing state--Any state with rules equivalent to the Suggested State Regulations for Control of Radiation relating to, and having an effective program for, the regulatory control of naturally occurring or accelerator-produced radioactive material (NARM) and has been designated as such by the Conference of Radiation Control Program Directors, Inc. For the purposes of evaluation and/or distribution of sealed sources, this includes Licensing State Status: Product Review Only.~~]

(66) [~~(67)~~] Local law enforcement agency (LLEA)--A public or private organization that has been approved by a federal, state, or local government to carry firearms and make arrests, and is authorized and has the capability to provide an armed response in the jurisdiction where the licensed category 1 or category 2 quantity of radioactive material is used, stored, or transported.

(67) [~~(68)~~] Lost or missing radioactive material--Radioactive material whose location is unknown. This definition includes licensed material that has been shipped but has not reached its planned destination and whose location cannot be readily traced in the transportation system.

(68) [~~(69)~~] Low-level radioactive waste (LLRW)--Radioactive material that meets the following criteria:

(A) LLRW includes [~~is radioactive material that is~~]:

(i) discarded or unwanted radioactive material [~~and is~~] not exempt by rule adopted under the Texas Radiation Control Act (Act), specifically, HSC, §401.106;

(ii) waste, as that term is defined in 10 CFR §61.2 [~~Title 10, CFR, §61.2~~]; and

(iii) radioactive material subject to:

(I) concentration limits established in 10 CFR §61.55 [~~Title 10, CFR, §61.55~~], or compatible rules adopted by the department [~~agency~~] or the Texas Commission on Environmental Quality (TCEQ), as applicable; and

(II) disposal criteria established in Title 10 of the CFR[~~, CFR,~~] or established by the department [~~agency~~] or TCEQ, as applicable.

(B) LLRW does not include:

(i) high-level radioactive waste as defined by 10 CFR §60.2 [~~Title 10, CFR, §60.2~~];

(ii) spent nuclear fuel as defined by 10 CFR §72.3 [~~Title 10, CFR, §72.3~~];

(iii) byproduct material defined in HSC §401.003(3)(B) [~~the Act, HSC, §401.003(3)(B)~~];

(iv) naturally occurring radioactive material (NORM) waste that is not oil and gas NORM waste;

(v) oil and gas NORM waste; or

(vi) transuranics greater than 100 nanocuries per gram.

(69) [~~(70)~~] Manufacture--To fabricate or mechanically produce.

(70) [~~(71)~~] Member of the public--Any individual, except when that individual is receiving an occupational dose.

(71) [~~(72)~~] Minor--An individual less than 18 years of age.

(72) [~~(73)~~] Mobile device--A piece of equipment containing licensed radioactive material that either is mounted on a permanent base with wheels or [~~and/or~~] casters, or otherwise equipped for moving while completely assembled and without dismounting; or is a portable device. Mobile devices do not include stationary equipment installed in a fixed location.

(73) [~~(74)~~] Monitoring--The measurement of radiation, radioactive material concentrations, surface area activities, or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses. For purposes of this chapter, "radiation monitoring" and "radiation protection monitoring" are equivalent terms.

(74) [~~(75)~~] Movement control center--An operations center [~~that is~~] remote from the transport activity [~~and~~] that maintains position information on the movement of radioactive material, receives reports of attempted attacks or thefts, provides a means for reporting these and other problems to appropriate agencies, and can request and coordinate appropriate aid.

(75) [~~(76)~~] Naturally occurring or accelerator-produced radioactive material

(NARM) [~~NARM~~]--Any naturally occurring or accelerator-produced radioactive material except source material or special nuclear material.

(76) [~~(77)~~] Natural radioactivity--Radioactivity of naturally occurring nuclides whose location and chemical and physical form have not been altered by man.

(77) [~~(78)~~] No-later-than arrival time--The date and time that the shipping licensee and receiving licensee have established as the time at which an investigation will be initiated if the shipment has not arrived at the receiving facility. The no-later-than arrival time may not be more than six [~~6~~] hours after the estimated arrival time for shipments of category 2 quantities of radioactive material.

(78) [~~(79)~~] NRC--The United States Nuclear Regulatory Commission or its duly authorized representatives.

(79) [~~(80)~~] Occupational dose--The dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to sources of radiation from licensed/registered and unlicensed/unregistered sources of radiation, whether in the possession of the licensee/registrant or other person. Occupational dose does not include dose received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released as specified in [~~accordance with~~] this chapter, from voluntary participation in medical research programs, or as a member of the public.

(80) [~~(81)~~] Particle accelerator--Any machine capable of accelerating electrons, protons, deuterons, or other charged particles in a vacuum and designed to discharge the resultant particulate or other associated radiation at energies usually greater than [~~in excess of~~] 1 million electron volts (MeV).

(81) [~~(82)~~] Person--Any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, agency, local government, any other state or political subdivision or agency thereof, or any other legal entity, and any legal successor, representative, agent, or agency of the foregoing, other than NRC, and other than federal government agencies licensed or exempted by NRC.

(82) [~~(83)~~] Personnel monitoring equipment (See definition for individual monitoring devices.)

(83) [~~(84)~~] Pharmacist--An individual licensed by the Texas State Board of Pharmacy to compound and dispense drugs, prescriptions, and poisons.

(84) [~~(85)~~] Physician--An individual licensed by the Texas Medical Board to practice medicine under Texas Occupations Code Chapter 155.

(85) Pocket dosimeter--A small ionization detection instrument or electronic personal dosimeter that indicates ionizing radiation exposure directly. An auxiliary charging device may be necessary.

(86) Portable device--A piece of equipment containing licensed radioactive

material that is designed by the manufacturer to be hand carried during use.

(87) Positron emission tomography (PET) radionuclide production facility--A facility operating a cyclotron or accelerator for the purpose of producing PET radionuclides.

(88) Principal activities--Activities authorized by the license that are essential to achieving the purposes [~~purpose(s)~~] for which the license was issued or amended. Storage during which no licensed material is accessed for use or disposal and activities incidental to decontamination or decommissioning are not principal activities.

(89) Public dose--The dose received by a member of the public from exposure to sources of radiation released by a licensee, or to any other source of radiation under the control of a licensee/registrant. It does not include occupational dose or doses received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released as specified in [~~accordance with~~] this chapter, or from voluntary participation in medical research programs.

(90) Quality factor (Q)--The modifying factor listed in subsection (m)(1) and (2) [~~(n)(1) and (2)~~] of this section that is used to derive dose equivalent from absorbed dose.

(91) Quarter (calendar quarter)--A period of time equal to one-fourth of the year observed by the licensee, approximately 13 consecutive weeks, providing that the beginning of the first quarter in a year coincides with the starting date of the year and that no day is omitted or duplicated in consecutive quarters.

(92) Rad--The special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs per gram (erg/g) or 0.01 J/kg (0.01 Gy).

(93) Radiation--One or more of the following:

(A) gamma and x rays; alpha and beta particles and other atomic or nuclear particles or rays;

(B) emission of radiation from any electronic device to such energy density levels as to reasonably cause bodily harm; or

(C) sonic, ultrasonic, or infrasonic waves from any electronic device or resulting from the operation of an electronic circuit in an electronic device in the energy range to reasonably cause detectable bodily harm.

(94) Radiation area--Any area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent more than [~~in excess of~~] 0.005 rem (0.05 mSv) in one hour at 30 cm from the source of radiation or from any surface that the radiation penetrates.

(95) Radiation machine--Any device capable of producing ionizing radiation except those devices with radioactive material as the only source of radiation.

(96) Radiation safety officer (RSO)--An individual who has the [~~a~~] knowledge, [~~of and the~~] authority, and responsibility to apply appropriate radiation protection rules, standards, and practices, who is [~~must be~~] specifically authorized on a radioactive material license, and who is the primary contact with the department [~~agency~~]. Specific training and responsibilities for an RSO are listed in §289.252 of this chapter [~~title~~], §289.253 of this chapter [~~title~~] (relating to Radiation Safety Requirements for Well Logging Service Operations and Tracer Studies), §289.255 of this chapter [~~title~~] (relating to Radiation Safety Requirements and Licensing and Registration Procedures for Industrial Radiography), and §289.256 of this chapter [~~title~~] (relating to Medical and Veterinary Use of Radioactive Material).

(97) Radioactive material--Any material (solid, liquid, or gas) that emits radiation spontaneously.

(98) Radioactive waste--For purposes of this chapter, this term is equivalent to LLRW.

(99) Radioactivity--The disintegration of unstable atomic nuclei with the emission of radiation.

(100) Radiobioassay--See definition for bioassay. [~~(See definition for bioassay.)~~]

(101) Registrant--Any person issued a certificate of registration by the department as specified in [~~agency in accordance with~~] the Act and this chapter.

(102) Regulation--See definition for rule. [~~(See definition for rule.)~~]

(103) Regulations of the United States Department of Transportation (DOT)--The federal requirements in 49 CFR Parts 100 – 189 [~~Title 49, CFR, Parts 100 – 189~~].

(104) Rem--The special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rem is equal to the absorbed dose in rad multiplied by the quality factor (1 rem = 0.01 sievert (Sv)).

(105) Research and development--Research and development is defined as:

(A) theoretical analysis, exploration, or experimentation; or

(B) 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.

(106) Residential location--Any area where a structure or structures are located in which people [~~lodge or~~] live, and the grounds on which these structures are located, including [~~, but not limited to,~~] houses, apartments, condominiums, and garages.

(107) Residual radioactivity--The radioactivity in structures, materials, soils, groundwater, and other media at a site resulting from activities under the licensee's

control. This includes radioactivity from all licensed and unlicensed sources used by the licensee, but excludes background radiation. It also includes radioactive materials remaining at the site as a result of routine or accidental releases of radioactive material at the site and previous burials at the site, even if those burials were made as specified in 10 CFR Part 20 [~~in accordance with the provisions of Title 10, CFR, Part 20~~].

(108) Restricted area--An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to sources of radiation. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

(109) Reviewing official--The individual who makes [~~shall make~~] the trustworthiness and reliability determination of an individual to determine whether the individual may have, or continue to have, unescorted access to the category 1 or category 2 quantities of radioactive materials in the possession of [~~that are possessed by~~] the licensee.

(110) Roentgen (R)--The special unit of exposure. One roentgen (R) equals 2.58 x 10^{-4} C/kg of air. (See definition for exposure.)

(111) Rule (as defined in ~~the~~ Texas Government Code Chapter[~~, Chapters~~] 2001 [~~and 2002, as amended~~])--Any agency statement of general applicability that implements, interprets, or prescribes law or policy, or describes the procedure or practice requirements of an agency. The term includes the amendment or repeal of a prior rule and [~~section but~~] does not include a statement regarding [~~statements concerning~~] only the internal management or organization of a state [~~any~~] agency and not affecting private rights or procedures. The word "rule" was formerly referred to as "regulation."

(112) Sabotage--The deliberate damage, with malevolent intent, to a category 1 or category 2 quantity of radioactive material, a device that contains a category 1 or category 2 quantity of radioactive material, or the components of the security system protecting those materials.

(113) Safe haven--A readily recognizable and readily accessible site at which security is present or from which, in the event of an emergency, the transport crew can notify and wait for [~~the~~] local law enforcement authorities.

(114) Sealed source--Any radioactive or byproduct material that is encased in a capsule designed to prevent leakage or escape of the material [~~Radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material~~].

(115) Security zone--Any temporary or permanent area determined and established by the licensee for the physical protection of category 1 or category 2 quantities of radioactive material.

(116) Shallow dose equivalent (H_S) [~~(H_S)~~] (that applies to the external exposure of the skin of the whole body or the skin of an extremity)--The dose equivalent at a

tissue depth of 0.007 cm (7 mg/cm^2) [~~(7 mg/cm^2)~~].

(117) SI--The abbreviation for the International System of Units.

(118) Sievert--The SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sievert is equal to the absorbed dose in gray multiplied by the quality factor (1 Sv = 100 rem).

(119) Site boundary--That line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee.

(120) Source material--Source material is defined as:

(A) uranium or thorium, or any combination thereof, in any physical or chemical form; or

(B) ores that contain by weight 0.05 percent [~~0.05%~~] or more of uranium, thorium, or any combination thereof; and

(C) does not include special nuclear material.

(121) Source of radiation--Any radioactive material, or any device or equipment emitting or capable of producing radiation.

(122) Special form radioactive material--Radioactive material satisfying [~~that satisfies~~] the following conditions:[~~.~~]

(A) [~~It is~~] either a single solid piece or [~~is~~] contained in a sealed capsule only [~~that can be~~] opened [~~only~~] by destroying the capsule;

(B) the [~~The~~] piece or capsule has at least one dimension not less than 5 millimeters (mm) (0.2 inch); and

(C) [~~It~~] satisfies the requirements specified by NRC. A special form encapsulation designed as specified in [~~accordance with~~] NRC requirements in effect on June 30, 1983, and constructed before [~~prior to~~] July 1, 1985, may continue to be used. A special form encapsulation designed as specified in [~~accordance with~~] NRC requirements in effect on March 31, 1996, and constructed before [~~prior to~~] April 1, 1998, may continue to be used. A special form encapsulation either designed or constructed after April 1, 1998, must meet the requirements of this definition applicable at the time of its design or construction.

(123) Special nuclear material--Special nuclear material is defined as:

(A) plutonium (Pu), uranium-233 (U-233), uranium enriched in the isotope 233 or in the isotope 235, and any other material that NRC, as specified in [~~accordance with~~] the provisions of the Atomic Energy Act of 1954, §51 as amended, determines to be special nuclear material, but does not include source material; or

(B) any material artificially enriched by any of the foregoing, but does not include source material.

(124) Special nuclear material in quantities not sufficient to form a critical mass--Uranium enriched in the isotope 235 in quantities not exceeding 350 grams (g) of contained uranium-235; uranium-233 in quantities not exceeding 200 g; plutonium in quantities not exceeding 200 g; or any combination of them as specified in [~~accordance with~~] the following formula.

(A) For each kind of special nuclear material, determine the ratio between the quantity of that special nuclear material and the quantity specified above for the same kind of special nuclear material. The sum of such ratios for all [~~of the~~] kinds of special nuclear material in combination must [~~shall~~] not exceed "1" (i.e., unity).

(B) For example, the following quantities in combination would not exceed the limitation and are within the formula.[~~÷~~]

Figure: 25 TAC §289.201(b)(124)(B) (no change)

(125) Special units--The conventional units historically used by licensees, for example, curie (activity), rad (absorbed dose), and rem (dose equivalent).

(126) Stationary device--A piece of equipment containing licensed radioactive material that is installed in a fixed location.

(127) Survey--An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or [~~and/or~~] presence of sources of radiation. When appropriate, such survey includes [~~, but is not limited to,~~] tests, physical examination of location of materials and equipment, measurements of levels of radiation or concentration of radioactive material present, and evaluation of administrative and [~~and/or~~] engineered controls.

(128) Telemetric position monitoring system--A data transfer system that captures information by instrumentation or [~~and/or~~] measuring devices about the location and status of a transport vehicle or package between the departure and destination locations.

(129) Temporary job site--A location where licensed or registered sources of radiation are used or stored other than the specific use location or locations listed on a license or certificate of registration.

(130) [~~(129)~~] Termination--A release by the department [~~agency~~] of the obligations and authorizations of the licensee under the terms of the license. It does not relieve a person of duties and responsibilities imposed by law.

(131) [~~(130)~~] Test--A method of determining the characteristics or condition of sources of radiation or components thereof.

(132) [~~(131)~~] Texas Regulations for Control of Radiation (TRCR)--All sections of 25 Texas Administrative Code (TAC) Chapter 289 [~~Title 25 TAC, Chapter 289~~].

(133) [~~(132)~~] Total effective dose equivalent (TEDE)--The sum of the effective dose equivalent for external exposures and the committed effective dose equivalent

for internal exposures.

(134) [~~(133)~~] Total organ dose equivalent (TODE)--The sum of the deep dose equivalent and the committed dose equivalent to the organ receiving the highest dose as described in §289.202(rr)(1)(F) of this chapter [~~title~~].

(135) [~~(134)~~] Transport index--The dimensionless number (rounded up to the next tenth) placed on the label of a package, to designate the degree of control to be exercised by the carrier during transportation. The transport index is determined as follows:

(A) For non-fissile material packages, the number determined by multiplying the maximum radiation level in millisievert per hour (mSv/hr) at 1 meter (m) (3.3 feet) from the external surface of the package by 100 (equivalent to the maximum radiation level in millirem per hour (mrem/hr) at 1 m (3.3 feet).[~~; or~~]

(B) For fissile material packages, the number determined by multiplying the maximum radiation level in mSv/hr at 1 m (3.3 feet) from the external surface of the package by 100 (equivalent to the maximum radiation level in mrem/hr at 1 m (3.3 feet)), or, for criticality control purposes, the number obtained as described in 10 CFR §71.59 [~~Title 10, CFR, §71.59~~], whichever is larger.

(136) [~~(135)~~] Trustworthiness and reliability--Characteristics of an individual considered dependable in judgment, character, and performance, such that unescorted access to category 1 or category 2 quantities of radioactive material by that individual does not constitute an unreasonable risk to the public health and safety or security. A determination of trustworthiness and reliability for this purpose is based upon the results from a background investigation.

(137) [~~(136)~~] 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 [~~A_2~~] and A_2 are given in §289.257(ee) of this chapter [~~title~~] (relating to Packaging and Transportation of Radioactive Material) or may be determined by procedures described in §289.257(ee) of this chapter [~~title~~].

(138) [~~(137)~~] Type B quantity--A quantity of radioactive material greater than a type A quantity.

(139) [~~(138)~~] Unescorted access--Solitary access to an aggregated category 1 or category 2 quantity of radioactive material or the devices that contain the material.

(140) [~~(139)~~] Unrefined and unprocessed ore--Ore in its natural form before [~~prior to~~] any processing, such as grinding, roasting or beneficiating, or refining. Processing does not include sieving or encapsulation of ore or preparation of samples for laboratory analysis.

(141) [~~(140)~~] Unrestricted area (uncontrolled area)--An area, or access to, which is neither limited nor controlled by the licensee. For purposes of this chapter,

"uncontrolled area" is an equivalent term.

(142) [~~(141)~~] Very high radiation area--An area, accessible to individuals, in which radiation levels from sources of radiation external to the body could result in an individual receiving an absorbed dose more than [~~in excess of~~] 500 rads (5 Gy in one hour at 1 m) [~~meter (m)~~] from a source of radiation or from any surface that the radiation penetrates. At very high doses received at high dose rates, units of absorbed dose, gray and rad, are appropriate, rather than units of dose equivalent, Sv, and rem.

(143) [~~(142)~~] Veterinarian--An individual licensed by the Texas State Board of Veterinary Medical Examiners to practice veterinary medicine under Texas Occupations Code Chapter 801.

(144) [~~(143)~~] Waste--Low-level radioactive wastes containing source, special nuclear, or byproduct material that are acceptable for disposal in a land disposal facility. For the purposes of this definition, low-level radioactive waste means radioactive waste not classified as high-level radioactive waste, transuranic waste, spent nuclear fuel, or byproduct material as defined in paragraph (18)(B) - (E) [~~(19)(B) - (E)~~] of this subsection.

(145) [~~(144)~~] Week--Seven consecutive days starting on Sunday.

(146) [~~(145)~~] Whole body--For purposes of external exposure, head, trunk including male gonads, arms above the elbow, or legs above the knee.

(147) [~~(146)~~] Worker--An individual engaged in work under a license or certificate of registration issued by the department [~~agency~~] and controlled by a licensee or registrant[~~,~~] but does not include the licensee or registrant.

(148) [~~(147)~~] Working level (WL)--Any combination of short-lived radon daughters in 1 liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha particle energy. The short-lived radon daughters are--for radon-222: polonium-218, lead-214, bismuth-214, and polonium-214; and for radon-220: polonium-216, lead-212, bismuth-212, and polonium-212.

(149) [~~(148)~~] Working level month (WLM)--An exposure to one working level for 170 hours--2,000 working hours per year divided by 12 months per year is approximately equal to 170 hours per month.

(150) [~~(149)~~] Year--The period of time beginning in January used to determine compliance with the provisions of this chapter. The licensee may change the starting date of the year used to determine compliance by the licensee if [~~provided that~~] the change is made at the beginning of the year and that no day is omitted or duplicated in consecutive years.

(c) Exemptions.

(1) General provision. The department [~~agency~~] may, upon application [~~therefore~~] or [~~upon~~] its own initiative, exempt a source of radiation or a kind of use or user from the requirements of this chapter if the department [~~agency~~]

determines that the exemption is not prohibited by law and will not result in a significant risk to public health and safety, and the environment. In determining such exemptions, the department considers [~~agency will consider~~]:

(A) state of technology;

(B) economic considerations in relation to benefits to the public health and safety; and

(C) other societal, socioeconomic, or public health and safety considerations.

(2) United States Department of Energy (DOE) contractors and NRC contractors. Any DOE contractor or subcontractor and any NRC contractor or subcontractor of the following categories, operating within Texas, is exempt from this chapter, except [~~with the exception of~~] §289.204 of this subchapter [~~title~~] (relating to Fees for Certificates of Registration, Radioactive Material Licenses, Emergency Planning and Implementation, and Other Regulatory Services), to the extent that such contractor or subcontractor under that individual's contract, receives, possesses, uses, transfers, or acquires sources of radiation:

(A) prime contractors performing work for DOE at United States government-owned or controlled sites, including the transportation of sources of radiation to or from such sites and the performance of contract services during temporary interruptions of such transportation;

(B) prime contractors of DOE performing research in, or development, manufacture, storage, testing, or transportation of atomic weapons or components of atomic weapons [~~thereof~~];

(C) prime contractors of DOE using or operating nuclear reactors or other nuclear devices in a United States government-owned vehicle or vessel; and

(D) any other prime contractor or subcontractor of DOE or of NRC when Texas [~~the state~~] and NRC jointly determine that:

(i) the exemption of the prime contractor or subcontractor is authorized by law; and

(ii) as specified in [~~accordance with~~] 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 the environment.

(d) Records.

(1) Each licensee must [~~shall~~] maintain records showing the receipt, transfer, and disposal of all non-exempt sources of radiation.

(A) Records of receipt, transfer, and disposal of sources of radiation must [~~shall~~] include, as a minimum[~~, the following information~~]:

(i) a unique identification of each source of radiation, including:

(I) manufacturer's name;

(II) isotope;

(III) activity; and

(IV) if available, sealed source serial number;

(ii) the date of receipt, transfer, or disposal of each source of radiation;

(iii) for the licensee transferring the source of radiation, the name of the transferee, the number of the transferee's radioactive material license authorizing possession of the material, and the regulatory agency issuing the license to the transferee; and

(iv) for the licensee receiving the source of radiation, the name of the transferor, the number of the transferor's radioactive material license authorizing possession of the material, and the regulatory agency issuing the license to the transferor.

(B) Records of receipt and[~~,~~] transfer[~~, and disposal~~] of radioactive material must [~~shall~~] be retained [~~maintained~~] by the licensee until disposal of the records is authorized by the department [~~agency~~]. Records of radioactive material disposal must be retained by the licensee until termination of the license.

(2) Additional record requirements and retention periods are specified elsewhere in this chapter.

(3) All records required by this chapter must [~~shall~~] be accurate and factual.

(4) Records are only valid if stamped, initialed, or signed and dated by authorized personnel or otherwise authenticated.

(5) Each record required by this chapter must include all pertinent information and be stored in a legible and reproducible format [~~legible~~] throughout the retention period specified by the department [~~agency. The record may be the original or a reproduced copy or 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, or specifications, must include all pertinent information such as stamps, initials, and signatures.~~] The licensee must [~~shall~~] maintain adequate safeguards against tampering with and loss of records.

(e) Inspections.

(1) The department [~~agency~~] may enter public or private property at reasonable times to determine whether, in a matter under the department's [~~agency's~~]

jurisdiction, there is compliance with the Act, the department's [~~agency's~~] rules, license conditions, and orders issued by the department [~~agency~~].

(2) Each licensee must [~~shall~~] afford the department [~~agency~~], at all reasonable times, opportunity to inspect sources of radiation and the premises and facilities where [~~wherein such~~] sources of radiation are used or stored.

(3) Each licensee must [~~shall~~] make available to the department [~~agency~~] for inspection, upon reasonable notice, records maintained as specified in [~~accordance with~~] this chapter.

(f) Tests.

(1) Each licensee must [~~shall~~] perform, upon instructions from the department [~~agency~~], or must [~~shall~~] permit the department [~~agency~~] to perform, [~~such~~] reasonable tests [~~as~~] the department [~~agency~~] deems appropriate or necessary, including [~~, but not limited to,~~] tests of:

(A) sources of radiation;

(B) facilities where [~~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 sources of radiation.

(2) Each licensee is required to accept from the department [~~agency~~], samples collected from its facility [~~facility(ies)~~] or from areas that are radioactive resulting from [~~as a result of~~] its licensed activities.

(g) Tests for leakage or [~~and/or~~] contamination of sealed sources.

(1) The licensee possessing [~~in possession of~~] any sealed source must [~~shall~~] assure that:

(A) each sealed source, except as specified in paragraph (2) of this subsection and §289.253(j) [~~§289.253(i)~~] of this chapter [~~title~~], is tested for leakage or contamination and the test results are received before the sealed source is put into use unless the licensee has a certificate from the transferor indicating that the sealed source was tested within six [~~6~~] months before transfer to the licensee;

(B) each sealed source that is not designed to emit alpha particles is tested for leakage or contamination at intervals not to exceed six [~~6~~] months or at alternative intervals approved by the department [~~agency~~], the NRC, or any agreement state after evaluation of information specified in §289.252(v) of this chapter [~~title~~] or equivalent regulations of the NRC or any agreement state;

(C) each sealed source that is designed to emit alpha particles is tested for leakage or contamination at intervals not to exceed three [~~3~~] months or at

alternative intervals approved by the department [~~agency~~], the NRC, or any agreement state after evaluation of information specified in §289.252(v) of this chapter [~~title~~], or equivalent regulations of the NRC, or any agreement state;

(D) for each sealed source that is required to be tested for leakage or contamination, at any other time there is reason to suspect that the sealed source might have been damaged or might be leaking, [~~the licensee shall assure that~~] the sealed source is tested for leakage or contamination before further use;

(E) tests for leakage for all sealed sources, except brachytherapy sources manufactured to contain radium, are [~~shall be~~] capable of detecting the presence of 0.005 μCi (185 Bq) of radioactive material on a test sample. Test samples must [~~shall~~] be taken from the sealed source or from the surfaces of the container in which the sealed source is stored or mounted and at the nearest accessible point to the sealed source where contamination might accumulate. For a sealed source contained in a device, test samples are obtained when the source is in the "off" position;

(F) the test for leakage for brachytherapy sources manufactured to contain radium are [~~shall be~~] capable of detecting an absolute leakage rate of 0.001 μCi (37 Bq) of radon-222 in a 24-hour period when the collection efficiency for radon-222 and its daughters has been determined with respect to collection method, volume, and time;

(G) tests for contamination from radium daughters are [~~shall be~~] taken on the interior surface of brachytherapy source storage containers and are [~~shall be~~] capable of detecting the presence of 0.005 μCi (185 Bq) of a radium daughter that has a half-life greater than four [~~4~~] days; and

(H) tests for leakage or contamination are [~~shall be~~] performed using a leak test kit or method approved by the department [~~agency~~], the NRC, or any agreement state.

(2) A licensee need not perform tests for leakage or contamination on the following [~~sealed sources~~]:

(A) sealed sources containing only radioactive material with a half-life of less than 30 days;

(B) sealed sources containing only radioactive material as a gas;

(C) sealed sources containing 100 μCi (3.7 MBq) or less of beta or gamma-emitting material or 10 μCi (370 kBq) or less of alpha or neutron-emitting material;

(D) sealed sources containing only hydrogen-3 (tritium);

(E) seeds of iridium-192 encased in nylon ribbon; and

(F) sealed sources, except teletherapy and brachytherapy sources, that [~~which~~] are stored, not being used, and identified as in storage. However, the [~~The~~] licensee must [~~shall, however,~~] test each [~~such~~] sealed source for leakage or

contamination and receive the test results before any use or transfer, unless it has been tested for leakage or contamination in the [~~within~~] six months before the date of use or transfer.

(3) Analysis of tests for leakage or contamination from sealed sources must [~~shall~~] be performed by persons specifically authorized by the department [~~agency~~], the NRC, or any agreement state to perform such services.

(4) Test results must [~~shall~~] be kept in units of microcurie or becquerel and maintained for inspection by the department [~~agency~~].

(5) The following is [~~shall be~~] considered evidence that a sealed source is leaking:

(A) the presence of 0.005 µCi (185 Bq) or more of removable contamination on any test sample;

(B) leakage of 0.001 µCi (37 Bq) of radon-222 per 24 hours for brachytherapy sources manufactured to contain radium; or

(C) the presence of removable contamination resulting from the decay of 0.005 µCi (185 Bq) or more of radium.

(6) The licensee must [~~shall~~] immediately withdraw a leaking sealed source from use and must [~~shall~~] take action to prevent the spread of contamination. Within two years of the determination that a sealed source is leaking, the leaking sealed source must [~~shall~~] be repaired or transferred for disposal as specified in [~~accordance with~~] §289.202 of this subchapter [~~title~~]. The licensee must [~~shall~~] check the equipment associated with the leaking source for radioactive contamination and, if contaminated, have it decontaminated or disposed of as specified in [~~accordance with~~] §289.202 of this subchapter [~~title~~].

(7) Reports of test results for leaking or contaminated sealed sources must [~~shall~~] be made as specified in [~~accordance with~~] §289.202(bbb) of this subchapter [~~title~~].

(h) Additional requirements. The department [~~agency~~] may, by rule, order, or condition of license or general license acknowledgment, impose upon any licensee such requirements in addition to those established in this chapter as it deems appropriate or necessary to minimize danger to public health and safety or property or the environment.

(i) Violations. An injunction or other court order may be obtained prohibiting any violation of any provision of the Act or any rule or order issued thereunder. Any person who willfully violates any provision of the Act or any rule or order issued thereunder may be guilty of a misdemeanor and upon conviction, may be punished by fine or imprisonment or both, as provided by law.

(j) Impounding. Sources of radiation are [~~shall be~~] subject to impounding as specified in [~~accordance with~~] §401.068 of the Act and §289.205 of this subchapter [~~title~~] (relating to Hearing and Enforcement Procedures).

(k) Communications.

(1) Except where otherwise specified, all communications and reports concerning this chapter and applications filed under them should be addressed to Radiation Control, Department of State Health Services, P.O. Box 149347, Austin, Texas, 78714-9347. Communications, reports, and applications may be delivered in person to the department's [~~agency's~~] office located at 1100 West 49th Street [~~8407 Wall Street~~], Austin, Texas.

(2) Documents transmitted to the department [~~agency~~] will be deemed submitted on the date of the postmark[~~, facsimile,~~] or other electronic media transmission.

(l) Interpretations. Except as specifically authorized by the department [~~agency~~] in writing, no interpretation of the meaning of this chapter by any officer or employee of the department [~~agency~~] other than a written interpretation by the Office of General Counsel, Department of State Health Services, will be considered binding upon the department [~~agency~~].

(m) [~~(n)~~] Mean quality factors and absorbed dose equivalencies.

(1) As used in this chapter, the quality factors for converting absorbed dose to dose equivalent are shown in the following table:

Figure: 25 TAC §289.201(m)(1) [~~Figure: 25 TAC §289.201(n)(1)~~]

(2) If it is more convenient to measure the neutron fluence rate than to determine the neutron dose equivalent rate in sievert per hour or rem per hour, as provided in paragraph (1) of this subsection, 1 rem (0.01 Sv) of neutron radiation of unknown energies may, for purposes of this section, be assumed to result from a total fluence of 25 million neutrons per square centimeter incident upon the body. If sufficient information exists to estimate the approximate energy distribution of the neutrons, the licensee may use the fluence rate per unit dose equivalent or the appropriate Q value from the following table to convert a measured tissue dose in rad (gray) to dose equivalent in rem (Sv).

Figure: 25 TAC §289.201(m)(2) [~~Figure: 25 TAC §289.201(n)(2)~~]

[~~(m) Open records.~~]

[~~(1) Subject to the limitations provided in the Texas Public Information Act, Government Code, Chapter 552, all information and data collected, assembled, or maintained by the agency are public records open to inspection and copying during regular office hours.~~]

[~~(2) Any person who submits written information or data to the agency and requests that the information be considered confidential, privileged, or otherwise not available to the public under the Texas Public Information Act, shall justify such request in writing, including statutes and cases where applicable, addressed to the agency.~~]

[~~(A) Documents containing information that is claimed to fall within an exception to the Texas Public Information Act shall be marked to indicate that fact. Markings shall be placed on the document on origination or submission.~~]

[~~(i) The words "NOT AN OPEN RECORD" shall be placed conspicuously at the top and bottom of each page containing information claimed to fall within one of the exceptions.~~]

[~~(ii) The following wording shall be placed at the bottom of the front cover and title page, or first page of text if there is no front cover or title page:~~]

[~~Figure: 25 TAC §289.201(m)(2)(A)(ii)~~]

[~~(B) The agency requests, whenever possible, that all information submitted under the claim of an exception to the Texas Public Information Act be extracted from the main body of the application and submitted as a separate annex or appendix to the application.~~]

[~~(C) Failure to comply with any of the procedures described in subparagraphs (A) and (B) of this paragraph may result in all information in the agency file being disclosed upon an open records request.~~]

[~~(3) The agency will determine whether information falls within one of the exceptions to the Texas Public Information Act. The Office of General Counsel will be queried as to whether or not there has been a previous determination that the information falls within one of the exceptions to the Texas Public Information Act. If there has been no previous determination and the agency believes that the information falls within one of the exceptions, an opinion of the Attorney General will be requested. If the agency agrees in writing to the request, the information shall not be open for public inspection unless the Attorney General's office subsequently determines that it does not fall within an exception.~~]

[~~(4) Requests for information.~~]

[~~(A) All requests for open records information must be in writing and refer to documents currently in possession of the agency.~~]

[~~(B) The agency will ascertain whether the information may be released or whether it falls within an exception to the Texas Public Information Act.~~]

[~~(i) The agency may take a reasonable period of time to determine whether information falls within one of the exceptions to the Texas Public Information Act.~~]

[~~(ii) If the information is determined to be public, it will be presented for inspection and/or copies of documents will be furnished within a reasonable period of time. A fee will be charged to recover agency costs for copies.~~]

[~~(C) Original copies of public records may not be removed from the agency. Under no circumstances shall material be removed from existing records.~~]

(n) [~~(o)~~] Units of activity. For purposes of this chapter, activity is expressed in the special unit of curie (Ci), becquerel (Bq), or its multiples, or disintegrations or transformations per second (dps or tps).

(1) 1 Ci = 3.7×10^{10} dps or tps = 3.7×10^{10} Bq = 2.22×10^{12} disintegrations or transformations per minute (dpm or tpm).

(2) 1 Bq = 1 dps or tps.

§289.202. Standards for Protection Against Radiation from Radioactive Materials.

(a) Purpose.

(1) This section establishes standards for protection against ionizing radiation resulting from activities conducted under [~~in accordance with~~] licenses issued by the department [~~agency~~].

(2) The requirements in this section are designed to control the receipt, possession, use, and transfer of sources of radiation by any licensee so the total dose to an individual, including doses resulting from all sources of radiation other than background radiation, does not exceed the standards for protection against radiation prescribed in this section. However, nothing in this section may [~~shall~~] be construed as limiting actions that are [~~may be~~] necessary to protect health and safety in an emergency.

(b) Scope.

(1) Except as specifically provided in other sections of this chapter, this section applies to persons who receive, possess, use, or transfer sources of radiation, unless otherwise exempted. No person may use, manufacture, produce, transport, transfer, receive, acquire, own, possess, process, or dispose of sources of radiation unless that person has a license or exemption from the department [~~agency~~]. The dose limits in this section do not apply to doses due to background radiation, to exposure of patients to radiation for the purpose of medical diagnosis or therapy, to exposure from individuals administered radioactive material and released as specified in [~~accordance with~~] this chapter, or to voluntary participation in medical research programs. No [~~However, no~~] radiation may be deliberately applied to human beings except by or under the supervision of an individual authorized by and licensed as specified in [~~accordance with~~] Texas' statutes to engage in the healing arts.

(2) Licensees who are also registered by the department [~~agency~~] to receive, possess, use, and transfer radiation machines must [~~shall~~] also comply with the requirements of §289.231 of this chapter [~~title~~] (relating to General Provisions and Standards for Protection Against Machine-Produced Radiation).

(c) Definitions. The following words and terms when used in this section [~~shall~~] have the following meaning[~~,~~] unless the context clearly indicates otherwise.

(1) Air-purifying respirator--A respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the

air-purifying element.

(2) Annual limit on intake (ALI)--The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by Reference Man that would result in a committed effective dose equivalent of 5 rem [~~rems~~] (0.05 sievert (Sv)) or a committed dose equivalent of 50 rem [~~rems~~] (0.5 Sv) to any individual organ or tissue. ALI values for intake by ingestion and by inhalation of selected radionuclides are given in Columns 1 and 2 of Table I of subsection (ggg)(2) of this section.

(3) Assigned protection factor (APF)--The expected workplace level of respiratory protection that would be provided by a properly functioning respirator or a class of respirators to properly fitted and trained users. Operationally, the inhaled concentration can be estimated by dividing the ambient airborne concentration by the APF.

(4) Atmosphere-supplying respirator--A respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere and includes supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units.

(5) Class--A classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which apply to a range of clearance half-times: for Class D, Days, of less than 10 days; for Class W, Weeks, from 10 to 100 days, and for Class Y, Years, of greater than 100 days. For purposes of this section, lung class and inhalation class are equivalent terms.

(6) Debris--The remains of something destroyed, disintegrated, or decayed. Debris does not include soils, sludges, liquids, gases, naturally occurring radioactive material regulated as specified in [~~accordance with~~] §289.259 of this chapter [~~title~~] (relating to Licensing of Naturally Occurring Radioactive Material (NORM)), or low-level radioactive waste (LLRW) received from other persons.

(7) Declared pregnant woman--A woman who has voluntarily informed the licensee, in writing, of her pregnancy and the estimated date of conception. The declaration remains in effect until the declared pregnant woman voluntarily withdraws the declaration in writing or is no longer pregnant.

(8) Demand respirator--An atmosphere-supplying respirator that admits breathing air to the facepiece only when a negative pressure is created inside the facepiece by inhalation.

(9) Derived air concentration (DAC)--The concentration of a given radionuclide in air that, if breathed by Reference Man for a working year of 2,000 hours under conditions of light work, results in an intake of 1 ALI. For purposes of this section, the condition of light work is an inhalation rate of 1.2 cubic meters of air per hour for 2,000 hours in a year. DAC values are given in Column 3 of Table I of subsection (ggg)(2) of this section.

(10) Derived air concentration-hour (DAC-hour)--The product of the concentration of radioactive material in air, expressed as a fraction or multiple of the derived air concentration for each radionuclide, and the time of exposure to that radionuclide, in hours. A licensee may take 2,000 DAC-hours to represent ALI, equivalent to a committed effective dose equivalent of 5 rem [~~rems~~] (0.05 Sv).

(11) Disposable respirator--A respirator for which maintenance is not intended and that is designed to be discarded after excessive breathing resistance, sorbent exhaustion, physical damage, or end-of-service-life renders it unsuitable for use. Examples of this type of respirator are a disposable half-mask respirator or a disposable escape-only self-contained breathing apparatus.

(12) Dosimetry processor--A person that processes and evaluates personnel monitoring devices [~~in order~~] to determine the radiation dose delivered to the monitoring devices.

(13) Filtering facepiece (dust mask)--A negative pressure particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium, not equipped with elastomeric sealing surfaces and adjustable straps.

(14) Fit factor--A quantitative estimate of the fit of a particular respirator to a specific individual, and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn.

(15) Fit test--The use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual.

(16) Helmet--A rigid respiratory inlet covering that also provides head protection against impact and penetration.

(17) Hood--A respiratory inlet covering that completely covers the head and neck and may also cover portions of the shoulders and torso.

(18) Inhalation class (see definition for Class).

(19) Loose-fitting facepiece--A respiratory inlet covering that is designed to form a partial seal with the face.

(20) Lung class (see definition for Class).

(21) Nationally tracked source--A sealed source containing a quantity equal to or greater than category [~~Category~~] 1 or category [~~Category~~] 2 levels of any radioactive material listed in subsection (hhh)(2) of this section. In this context a sealed source is defined as radioactive material that is sealed in a capsule or closely bonded, in a solid form, and which is not exempt from regulatory control. It does not mean material encapsulated solely for disposal, or nuclear material contained in any fuel assembly, subassembly, fuel rod, or fuel pellet. Category 1 nationally tracked sources are those containing radioactive material at a quantity equal to or greater than the category [~~Category~~] 1 threshold. Category 2 nationally tracked sources are those containing radioactive material at a quantity equal to or greater

than the category [~~Category~~] 2 threshold but less than the category [~~Category~~] 1 threshold.

(22) Negative pressure respirator (tight fitting)--A respirator in which the air pressure inside the facepiece is negative during inhalation with respect to the ambient air pressure outside the respirator.

(23) Non-stochastic [~~Nonstochastic~~] effect--A health effect, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a non-stochastic [~~nonstochastic~~] effect. For purposes of this section, deterministic effect is an equivalent term.

(24) Planned special exposure--An infrequent exposure to radiation, separate from and in addition to the annual occupational dose limits.

(25) Positive pressure respirator--A respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.

(26) Powered air-purifying respirator--An air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.

(27) Pressure demand respirator--A positive pressure atmosphere-supplying respirator that admits breathing air to the facepiece when the positive pressure is reduced inside the facepiece by inhalation.

(28) Qualitative fit test--A pass/fail fit test to assess the adequacy of respirator fit that relies on the individual's response to the test agent.

(29) Quantitative fit test--An assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.

(30) Quarter--A period of time equal to one-fourth of the year observed by the licensee, approximately 13 consecutive weeks, providing that the beginning of the first quarter in a year coincides with the starting date of the year and that no day is omitted or duplicated in consecutive quarters.

(31) Reference man--A hypothetical aggregation of human physical and physiological characteristics determined by international consensus. These characteristics may be used by researchers and public health employees to standardize results of experiments and to relate biological insult to a common base. A description of Reference Man is contained in the International Commission on Radiological Protection Report, ICRP Publication 23, "Report of the Task Group on Reference Man."

(32) Respiratory protective equipment--An apparatus, such as a respirator, used to reduce an individual's intake of airborne radioactive materials.

(33) Sanitary sewerage--A system of public sewers for carrying off waste water and refuse, but excluding sewage treatment facilities, septic tanks, and leach fields owned or operated by the licensee or registrant.

(34) Self-contained breathing apparatus--An atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user.

(35) Stochastic effect--A health effect that occurs randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects. For purposes of this section probabilistic effect is an equivalent term.

(36) Supplied-air respirator or airline respirator--An atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user.

(37) Tight-fitting facepiece--A respiratory inlet covering that forms a complete seal with the face.

(38) User seal check (fit check)--An action conducted by the respirator user to determine if the respirator is properly seated to the face. Examples include negative pressure check, positive pressure check, irritant smoke check, or isoamyl acetate check.

(39) Weighting factor w_T for an organ or tissue (T)--The proportion of the risk of stochastic effects resulting from irradiation of that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly. For calculating the effective dose equivalent, the values of w_T are:

Figure: 25 TAC §289.202(c)(39) (no change)

(d) Implementation.

(1) Any existing license condition that is more restrictive than this section remains in force until there is an amendment or renewal of the license that modifies or removes this condition.

(2) If a license condition exempts a licensee from a provision of this section in effect on or before January 1, 1994, it also exempts the licensee from the corresponding provision of this section.

(3) If a license condition cites provisions of this section in effect before [~~prior to~~] January 1, 1994, that do not correspond to any provisions of this section, the license condition remains in force until there is an amendment or renewal of the license that modifies or removes this condition.

(e) Radiation protection programs.

(1) Each licensee must [~~shall~~] develop, document, and implement a radiation protection program sufficient to ensure compliance with the provisions of this section. See subsection (mm) of this section for recordkeeping requirements relating to these programs. Documentation of the radiation protection program may be incorporated in the licensee's operating, safety, and emergency procedures.

(2) The licensee must [~~shall~~] use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and public doses that are as low as is reasonably achievable (ALARA).

(3) The licensee must [~~shall~~], at intervals not to exceed 12 months, ensure the radiation protection program content and implementation is reviewed. The review must [~~shall~~] include a reevaluation of the assessments made to determine monitoring is not required, as specified in [~~accordance with~~] subsection (q)(1) and (3) of this section in conjunction with the licensee's current operating conditions.

(4) To implement the ALARA requirement in paragraph (2) of this subsection and notwithstanding the requirements in subsection (n) of this section, a constraint on air emissions of radioactive material to the environment, excluding radon-222 and its daughters, must [~~shall~~] be established by licensees such that the individual member of the public likely to receive the highest dose will not be expected to receive a total effective dose equivalent (TEDE) more than [~~in excess of~~] 10 millirem [~~millirems~~] (mrem) (0.1 millisievert (mSv)) per year, from these emissions. If a licensee subject to this requirement exceeds this dose constraint, the licensee must [~~shall~~] report the exceedance as required in subsection (yy) of this section and promptly take appropriate corrective action to ensure against recurrence.

(5) If monitoring is not required as specified in [~~accordance with~~] subsection (q)(1) and (3) of this section, the licensee must [~~shall~~] document assessments made to determine the requirements of subsection (q)(1) and (3) of this section are not applicable. The licensee must [~~shall~~] maintain the documentation as specified in [~~accordance with~~] subsection (rr)(5) of this section.

(f) Occupational dose limits for adults.

(1) The licensee must [~~shall~~] control the occupational dose to individuals, except for planned special exposures as specified in [~~accordance with~~] subsection (k) of this section, to the following dose limits.

(A) An annual limit that is [~~shall be~~] the lesser [~~more limiting~~] of:

(i) the total effective dose equivalent being equal to 5 rem [~~rems~~] (0.05 Sv); or

(ii) the sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue, other than the lens of the eye, being equal to 50 rem [~~rems~~] (0.5 Sv).

(B) The annual limits to the lens of the eye, to the skin of the whole body, and to the skin of the extremities are [~~shall be~~]:

(i) a lens dose equivalent of 15 rem [~~rems~~] (0.15 Sv); and

(ii) a shallow dose equivalent of 50 rem [~~rems~~] (0.5 Sv) to the skin of the whole body or to the skin of any extremity.

(2) Doses received over [~~in excess of~~] the annual limits, including doses received during accidents, emergencies, and planned special exposures, must [~~shall~~] be subtracted from the limits for planned special exposures that the individual may receive during the current year and during the individual's lifetime. See subsection (k)(6)(A) and (B) of this section.

(3) When the external exposure is determined by measurement with an external personal monitoring device, the deep-dose equivalent must [~~shall~~] be used in place of the effective dose equivalent, unless the effective dose equivalent is determined by a dosimetry method approved by the department [~~agency~~]. The assigned deep dose equivalent must [~~shall~~] be for the part [~~portion~~] of the body receiving the highest exposure. The assigned shallow-dose equivalent must [~~shall~~] be the dose averaged over the contiguous 10 square centimeters (cm^2) [~~(cm^2)~~] of skin receiving the highest exposure.

(4) The deep dose equivalent, lens dose equivalent, and shallow dose equivalent may be assessed from surveys[~~,~~] or other radiation measurements for the purpose of demonstrating compliance with the occupational dose limits, if the individual monitoring device was not in the region of highest potential exposure, or the results of individual monitoring are unavailable.

(5) DAC and ALI [~~Derived air concentration (DAC) and annual limit on intake (ALI)~~] values are specified in Table I of subsection (ggg)(2) of this section and may be used to determine the individual's dose and to demonstrate compliance with the occupational dose limits. See subsection (rr) of this section.

(6) Notwithstanding the annual dose limits, the licensee must [~~shall~~] limit the soluble uranium intake by an individual to 10 milligrams (mg) in a week, in consideration of chemical toxicity. See footnote 3 of subsection (ggg)(2) of this section.

(7) The licensee must [~~shall~~] reduce the dose that an individual may be allowed to receive in the current year by the amount of occupational dose received while employed by any other person. See subsection (j)(4) of this section.

(g) Compliance with requirements for summation of external and internal doses.

(1) If the licensee is required to monitor as specified in [~~accordance with both~~] subsection (q)(1) and (3) of this section, the licensee must [~~shall~~] demonstrate compliance with the dose limits by summing external and internal doses. If the licensee is required to monitor only as specified in [~~accordance with~~] subsection (q)(1) of this section or only as specified in [~~accordance with~~] subsection (q)(3) of this section, then summation is not required to demonstrate compliance with the dose limits. The licensee may demonstrate compliance with the requirements for summation of external and internal doses as specified in [~~accordance with~~] paragraphs (2) - (4) of this subsection. The dose equivalents for the lens of the eye, the skin, and the extremities are not included in the summation, but are subject to separate limits.

(2) If the only intake of radionuclides is by inhalation, the TEDE [~~total effective~~

~~dose equivalent~~] limit is not exceeded if the sum of the deep dose equivalent divided by the TEDE [~~total effective dose equivalent~~] limit, and one of the following, does not exceed unity:

(A) the sum of the fractions of the inhalation ALI for each radionuclide; or

(B) the total number of derived air concentration-hours (DAC-hours) for all radionuclides divided by 2,000; or

(C) the sum of the calculated committed effective dose equivalents to all significantly irradiated organs or tissues (T) calculated from bioassay data using appropriate biological models and expressed as a fraction of the annual limit. For purposes of this requirement, an organ or tissue is deemed to be significantly irradiated if, for that organ or tissue, the product of the weighting factors, w_T [w_T], and the committed dose equivalent, $H_{T,50}$ [$H_{T,50}$], per unit intake is greater than 10 percent [10%] of the maximum weighted value of $H_{T,50}$ [$H_{T,50}$], that is, $w_T H_{T,50}$ [$w_T H_{T,50}$], per unit intake for any organ or tissue.

(3) If the occupationally exposed individual receives an intake of radionuclides by oral ingestion greater than 10 percent [10%] of the applicable oral ALI, the licensee must [~~shall~~] account for this intake and include it in demonstrating compliance with the limits.

(4) The licensee must [~~shall~~] evaluate and, to the extent practical, account for intakes through wounds or skin absorption. The intake through intact skin has been included in the calculation of DAC for hydrogen-3 and does not need to be evaluated or accounted for as specified in [~~accordance with~~] this paragraph.

(h) Determination of external dose from airborne radioactive material.

(1) Licensees must [~~shall~~], when determining the dose from airborne radioactive material, include the contribution to the deep dose equivalent, eye dose equivalent, and shallow dose equivalent from external exposure to the radioactive cloud. See footnotes 1 and 2 of subsection (ggg)(2) of this section.

(2) Airborne radioactivity measurements and DAC values should [~~shall~~] not be used as the primary means to assess the deep dose equivalent when the airborne radioactive material includes radionuclides other than noble gases or if the cloud of airborne radioactive material is not relatively uniform. The determination of the deep dose equivalent to an individual should [~~shall~~] be based on [~~upon~~] measurements using instruments or individual monitoring devices.

(i) Determination of internal exposure.

(1) For purposes of assessing dose used to determine compliance with occupational dose equivalent limits, the licensee must [~~shall~~], when required as specified in [~~accordance with~~] subsection (q) of this section, take suitable and timely measurements of:

(A) concentrations of radioactive materials in air in work areas;

(B) quantities of radionuclides in the body;

(C) quantities of radionuclides excreted from the body; or

(D) combinations of these measurements.

(2) Unless respiratory protective equipment is used, as provided in subsection (x) of this section, or the assessment of intake is based on bioassays, the licensee must [~~shall~~] assume that an individual inhales radioactive material at the airborne concentration in which the individual is present.

(3) When specific information on the physical and biochemical properties of the radionuclides taken into the body or the behavior of the material in an individual is known, the licensee may:

(A) use that information to calculate the committed effective dose equivalent, and, if used, the licensee must [~~shall~~] document that information in the individual's record;

(B) upon prior approval from [~~of~~] the department [~~agency~~], adjust the DAC or ALI values to reflect the actual physical and chemical characteristics of airborne radioactive material, for example, aerosol size distribution or density; and

(C) separately assess the contribution of fractional intakes of Class D, W, or Y compounds of a given radionuclide to the committed effective dose equivalent. See subsection (ggg)(2) of this section.

(4) If the licensee chooses to assess intakes of Class Y material using the measurements given in paragraph (1)(A) or (B) of this subsection, the licensee may delay the recording and reporting of the assessments for periods up to seven months, unless otherwise required by subsections (xx) or (yy) of this section. This delay permits the licensee to make additional measurements basic to the assessments.

(5) If the identity and concentration of each radionuclide in a mixture are known, the fraction of the DAC applicable to the mixture for use in calculating DAC-hours must [~~shall~~] be either:

(A) the sum of the ratios of the concentration to the appropriate DAC value, that is, D, W, or Y, from subsection (ggg)(2) of this section for each radionuclide in the mixture; or

(B) the ratio of the total concentration for all radionuclides in the mixture to the most restrictive DAC value for any radionuclide in the mixture.

(6) 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 unknown [~~not known~~], the DAC for the mixture must [~~shall~~] be the most restrictive DAC of any radionuclide in the mixture.

(7) When a mixture of radionuclides in air exists, a licensee may disregard

certain radionuclides in the mixture if:

(A) the licensee uses the total activity of the mixture in demonstrating compliance with the dose limits in subsection (f) of this section and in complying with the monitoring requirements in subsection (q)(3) of this section;

(B) the concentration of any radionuclide disregarded is less than 10 percent [~~10%~~] of its DAC; and

(C) the sum of these percentages for all of the radionuclides disregarded in the mixture does not exceed 30 percent [~~30%~~].

(8) When determining the committed effective dose equivalent, the following information may be considered.

(A) To [~~In order to~~] calculate the committed effective dose equivalent, the licensee may assume that the inhalation of 1 ALI, or an exposure of 2,000 DAC-hours, results in a committed effective dose equivalent of 5 rem [~~rems~~] (0.05 Sv) for radionuclides that have their ALIs or DACs based on the committed effective dose equivalent.

(B) For an ALI and the associated DAC determined by the non-stochastic [~~nonstochastic~~] organ dose limit of 50 rem [~~rems~~] (0.5 Sv), the intake of radionuclides that would result in a committed effective dose equivalent of 5 rem [~~rems~~] (0.05 Sv), that is, the stochastic ALI, is listed in parentheses in Table I of subsection (ggg)(2) of this section. The licensee may, as a simplifying assumption, use the stochastic ALI to determine committed effective dose equivalent. However, if the licensee uses the stochastic ALI, the licensee must [~~shall also~~] demonstrate that the limit in subsection (f)(1)(A)(ii) of this section is met.

(j) Determination of occupational dose for the current year.

(1) For each individual who is likely to receive, in a year, an occupational dose requiring monitoring as specified in [~~accordance with~~] subsection (q) of this section, the licensee must [~~shall~~] determine the occupational radiation dose received during the current year.

(2) In complying with the requirements of paragraph (1) of this subsection, a licensee may:

(A) accept, as a record of the occupational dose that the individual received during the current year, RC Form 202-2 from previous [~~prior~~] or other current employers, or other clear and legible records [~~record~~], of all information required on that form and indicating any periods of time for which data are not available; or

(B) accept, as a record of the occupational dose that the individual received during the current year, a written, signed statement from the individual, or from the individual's previous [~~prior~~] or other current employer [~~employer(s)~~] for work involving radiation exposure, that discloses the nature and the amount of any occupational dose that the individual received during the current year; or

(C) obtain reports of the individual's dose equivalent from previous [~~prior~~] or other current employers [~~employer(s)~~] for work involving radiation exposure, or the individual's current employer, if the individual is not employed by the licensee, by telephone, [~~facsimile,~~] letter, or other electronic media transmission. The licensee must [~~shall~~] request a written verification of the dose data if the authenticity of the transmitted report cannot be established.

(3) The licensee must [~~shall~~] record the exposure data for the current year, as required by paragraph (1) of this subsection, on RC Form 202-3, or other clear and legible record, of all the information required on that form.

(4) If the licensee is unable to obtain a complete record of an individual's current occupational dose while employed by any other licensee, the licensee must [~~shall~~] assume in establishing administrative controls as specified in [~~accordance with~~] subsection (f)(7) of this section for the current year, [~~that~~] the allowable dose limit for the individual is reduced by 1.25 rem [~~rems~~] (12.5 mSv) for each quarter; or 416 mrem (4.16 mSv) for each month for which records were unavailable and the individual was engaged in activities that could have resulted in occupational radiation exposure.

(5) If an individual has incomplete (e.g., a lost or damaged personnel monitoring device) current occupational dose data for the current year and that individual is employed solely by the licensee during the current year, the licensee must [~~shall~~]:

(A) assume [~~that~~] the allowable dose limit for the individual is reduced by 1.25 rem [~~rems~~] (12.5 mSv) for each quarter;

(B) assume [~~that~~] the allowable dose limit for the individual is reduced by 416 mrem (4.16 mSv) for each month; or

(C) assess an occupational dose for the individual during the period of missing data using surveys, radiation measurements, or other comparable data for the purpose of demonstrating compliance with the occupational dose limits.

(6) Administrative controls established as specified in [~~accordance with~~] paragraph (4) of this subsection must [~~shall~~] be documented and maintained for inspection by the department [~~agency~~]. Occupational dose assessments made as specified in [~~accordance with~~] paragraph (5) of this subsection and records of data used to make the assessment must [~~shall~~] be maintained for inspection by the department [~~agency~~]. The licensee must [~~shall~~] retain the records as specified in [~~accordance with~~] subsection (rr) of this section.

(k) Planned special exposures. A licensee may authorize an adult worker to receive doses in addition to and accounted for separately from the doses received under the limits specified in subsection (f) of this section, if [~~provided that~~] each of the following conditions is satisfied.

(1) The licensee authorizes a planned special exposure only in an exceptional situation when alternatives that might avoid the doses estimated to result from the

planned special exposure are unavailable or impractical.

(2) The licensee and employer, if the employer is not the licensee, specifically authorizes the planned special exposure, in writing, before the exposure occurs.

(3) Before a planned special exposure, the licensee ensures that each individual involved is:

(A) informed of the purpose of the planned operation;

(B) informed of the estimated doses and associated potential risks and specific radiation levels or other conditions that might be involved in performing the task; and

(C) instructed in the measures to be taken to keep the dose ALARA considering other risks that may be present.

(4) Before [~~Prior to~~] permitting an individual to participate in a planned special exposure, the licensee must [~~shall~~] determine:

(A) the internal and external doses from all previous planned special exposures;

(B) all doses over [~~in excess of~~] the limits, including doses received during accidents and emergencies, received during the lifetime of the individual; and

(C) all lifetime cumulative occupational radiation doses.

(5) In complying with the requirements of paragraph (4)(C) of this subsection, a licensee may:

(A) accept, as the record of lifetime cumulative radiation dose, an up-to-date RC Form 202-2 or equivalent, signed by the individual and countersigned by an appropriate official of the most recent employer for work involving radiation exposure, or the individual's current employer, if the individual is not employed by the licensee; and

(B) obtain reports of the individual's dose equivalent from previous employers [~~prior employer(s)~~] for work involving radiation exposure, or the individual's current employer, if the individual is not employed by the licensee, by telephone, [~~facsimile,~~] letter, or other electronic media transmission. The licensee must [~~shall~~] request a written verification of the dose data if the authenticity of the transmitted report cannot be established.

(6) Subject to subsection (f)(2) of this section, the licensee must [~~shall~~] not authorize a planned special exposure that would cause an individual to receive a dose from all planned special exposures and all doses over [~~in excess of~~] the limits to exceed:

(A) the numerical values of any of the dose limits in subsection (f)(1) of this section in any year; and

(B) five times the annual dose limits in subsection (f)(1) of this section during the individual's lifetime.

(7) The licensee maintains records of the conduct of a planned special exposure as specified in [~~accordance with~~] subsection (qq) of this section and submits a written report to the department as specified in [~~agency in accordance with~~] subsection (zz) of this section.

(8) The licensee records the best estimate of the dose resulting from the planned special exposure in the individual's record and informs the individual, in writing, of the dose within 30 days of [~~from~~] the date of the planned special exposure. The dose from planned special exposures are [~~shall~~] not [~~be~~] considered in controlling future occupational dose of the individual as specified in [~~accordance with~~] subsection (f)(1) of this section but must [~~shall~~] be included in evaluations required by paragraphs (4) and (6) of this subsection.

(9) The licensee must [~~shall~~] record the exposure history, as required by paragraph (4) of this subsection, on RC Form 202-2, or other clear and legible record, of all the information required on that form. The form or record must [~~shall~~] show each period in which the individual received occupational exposure to radiation or radioactive material and must [~~shall~~] be signed by the individual who received the exposure. For each period for which the licensee obtains reports, the licensee must [~~shall~~] use the dose shown in the report in preparing RC Form 202-2, or equivalent.

(l) Occupational dose limits for minors. The annual occupational dose limits for minors are 10 percent [~~10%~~] of the annual occupational dose limits specified for adult workers in subsection (f) of this section.

(m) Dose equivalent to an embryo/fetus.

(1) If a woman declares her pregnancy, the licensee must [~~shall~~] ensure that the dose equivalent to an embryo/fetus during the entire pregnancy, due to occupational exposure [~~of a declared pregnant woman~~], does not exceed 0.5 rem (5 mSv). If a woman chooses not to declare pregnancy, the occupational dose limits specified in subsection (f)(1) of this section are applicable to the woman. See subsection (rr) of this section for recordkeeping requirements.

(2) The licensee must [~~shall~~] make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman [~~so as~~] to satisfy the limit in paragraph (1) of this subsection. The National Council on Radiation Protection and Measurements (NCRP) recommended in NCRP Report No. 91 "Recommendations on Limits for Exposure to Ionizing Radiation" (June 1, 1987), that no more than 0.05 rem (0.5 mSv) to the embryo/fetus be received in any one month.

(3) The dose equivalent to an embryo/fetus is [~~shall be~~] taken as:

(A) the dose equivalent to the embryo/fetus from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman; and

(B) the dose equivalent that is most representative of the dose equivalent to the embryo/fetus from external radiation, that is, in the mother's lower torso region.

(i) If multiple measurements have not been made, assignment of the highest deep dose equivalent for the declared pregnant woman is [~~shall be~~] the dose equivalent to the embryo/fetus.

(ii) If multiple measurements have been made, assignment of the deep dose equivalent for the declared pregnant woman from the individual monitoring device that is most representative of the dose equivalent to the embryo/fetus is [~~shall be~~] the dose equivalent to the embryo/fetus. Assignment of the highest deep dose equivalent for the declared pregnant woman to the embryo/fetus is not required unless that dose equivalent is also the most representative deep dose equivalent for the region of the embryo/fetus.

(4) If by the time the woman declares pregnancy to the licensee, the dose equivalent to the embryo/fetus has exceeded 0.45 rem (4.5 mSv), the licensee will be [~~shall be~~] deemed compliant [~~to be in compliance~~] with paragraph (1) of this subsection, if the additional dose equivalent to the embryo/fetus does not exceed 0.05 rem (0.5 mSv) during the remainder of the pregnancy.

(n) Dose limits for individual members of the public.

(1) Each licensee must [~~shall~~] conduct operations and ensure [~~so that~~]:

(A) the TEDE [~~The total effective dose equivalent~~] to individual members of the public from the licensed and [~~and/or~~] registered operation does not exceed 0.1 rem (1 mSv) in a year, exclusive of the dose contribution from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released as specified in [~~accordance with~~] §289.256 of this chapter [~~title~~] (relating to Medical and Veterinary Use of Radioactive Material), from voluntary participation in medical research programs, and from the licensee's disposal of radioactive material into sanitary sewerage as specified in [~~accordance with~~] subsection (gg) of this section; and

(B) the dose in any unrestricted area from licensed and [~~and/or~~] registered external sources, exclusive of the dose contributions from patients administered radioactive material and released as specified in [~~accordance with~~] §289.256 of this chapter [~~title~~], does not exceed 0.002 rem (0.02 mSv) in any one hour.

(2) If the licensee permits members of the public to have access to restricted areas, the limits for members of the public continue to apply to those individuals.

(3) A licensee or an applicant for a license may apply for prior department [~~agency~~] authorization to operate up to an annual dose limit for an individual member of the public of 0.5 rem (5 mSv). This application must [~~shall~~] include [~~the following information~~]:

(A) a demonstration of the need for and the expected duration of operations over [~~in excess of~~] the limit in paragraph (1) of this subsection;

(B) the licensee's program to assess and control dose within the 0.5 rem (5 mSv) annual limit; and

(C) the procedures [~~to be followed~~] to maintain the dose ALARA.

(4) In addition to the requirements of this section, a licensee subject to the provisions of the United States Environmental Protection Agency's (EPA) generally applicable environmental radiation standards in 40 Code of Federal Regulations (CFR)[~~,~~] §190, must also [~~shall~~] comply with those requirements.

(5) The department [~~agency~~] may impose additional restrictions on radiation levels in unrestricted areas and on the total quantity of radionuclides that a licensee may release in effluents [~~in order~~] to restrict the collective dose.

(6) Notwithstanding paragraph (1)(A) of this subsection, a licensee may permit visitors to an individual who cannot be released, as specified in [~~accordance with~~] §289.256 of this chapter [~~title~~], to receive a radiation dose greater than 0.1 rem (1 mSv) if:

(A) the radiation dose received does not exceed 0.5 rem (5 mSv); and

(B) the authorized user, as defined in §289.256 of this chapter [~~title~~], has determined before the visit that it is appropriate.

(o) Compliance with dose limits for individual members of the public.

(1) The licensee must [~~shall~~] make, or cause to be made, surveys of radiation levels in unrestricted areas and radioactive materials in effluents released to unrestricted areas to demonstrate compliance with the dose limits for individual members of the public as required in subsection (n) of this section.

(2) A licensee must [~~shall~~] show compliance with the annual dose limit in subsection (n) of this section by:

(A) demonstrating by measurement or calculation that the TEDE [~~total effective dose equivalent~~] to the individual likely to receive the highest dose from the licensed or registered operation, does not exceed the annual dose limit; or

(B) demonstrating that:

(i) the annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the values specified in Table II of subsection (ggg)(2) of this section; and

(ii) if an individual were continuously present in an unrestricted area, the dose from external sources of radiation would not exceed 0.002 rem (0.02 mSv) in an hour and 0.05 rem (0.5 mSv) in a year.

(3) Upon approval from the department [~~agency~~], the licensee may adjust the

effluent concentration values in Table II, of subsection (ggg)(2) of this section, for members of the public, to consider [~~take into account~~] the actual physical and chemical characteristics of the effluents, such as, aerosol size distribution, solubility, density, radioactive decay equilibrium, and chemical form.

(p) General surveys and monitoring.

(1) Each licensee must [~~shall~~] make, or cause to be made, surveys of areas, including the subsurface that:

(A) are necessary for the licensee to comply with this chapter; and

(B) are necessary under the circumstances to evaluate:

(i) the magnitude and extent of radiation levels;

(ii) concentrations or quantities of residual radioactivity; and

(iii) the potential radiological hazards of the radiation levels and residual radioactivity detected.

(2) In addition to subsection (nn) of this section, records from surveys describing the location and amount of subsurface residual radioactivity identified at the site must [~~shall~~] be kept with records important for decommissioning, and such records must [~~shall~~] be maintained and retained as specified in [~~accordance with~~] §289.252(gg) of this chapter [~~title~~] (relating to Licensing of Radioactive Material).

(3) The licensee must [~~shall~~] ensure that instruments and equipment used for quantitative radiation measurements, for example, dose rate and effluent monitoring, are operable and calibrated:

(A) by a person licensed or registered by the department [~~agency~~], the United States Nuclear Regulatory Commission (NRC), or any agreement state to perform such service;

(B) at intervals not to exceed 12 months unless a different time interval is specified in another section of this chapter;

(C) after each instrument or equipment repair;

(D) for the types of radiation used and at energies appropriate for use; and

(E) at an accuracy within 20 percent [~~20%~~] of the true radiation level.

(4) All individual monitoring devices requiring processing to determine the radiation dose, except for [~~direct and indirect reading pocket dosimeters, electronic personal dosimeters, and~~] those individual monitoring devices used to measure the dose to any extremity, [~~that require processing to determine the radiation dose~~] and that are used by licensees to comply with subsection (f) of this section, with other applicable provisions of this chapter, or with conditions specified in a license, must [~~shall~~] be processed and evaluated by a dosimetry processor:

(A) holding current personnel dosimetry accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology; and

(B) approved in this accreditation process for the type of radiation or radiations included in the NVLAP program that most closely approximates the type of radiation or radiations for which the individual wearing the dosimeter is monitored.

(5) All individual monitoring devices must [~~shall~~] be appropriate for the environment in which they are used.

(q) Conditions requiring individual monitoring of external and internal occupational dose. Each licensee must [~~shall~~] monitor exposures from sources of radiation at levels sufficient to demonstrate compliance with the occupational dose limits of this section. As a minimum:

(1) each licensee must [~~shall~~] monitor occupational exposure to radiation and must [~~shall~~] supply and require the use of individual monitoring devices by:

(A) adults likely to receive, in one year from sources of radiation external to the body, a dose more than 10 percent [~~in excess of 10%~~] of the limits in subsection (f)(1) of this section;

(B) minors likely to receive, in one year from sources of radiation external to the body, a deep dose equivalent more than [~~in excess of~~] 0.1 rem (1 mSv), a lens dose equivalent more than [~~in excess of~~] 0.15 rem (1.5 mSv), or a shallow dose equivalent to the skin or to the extremities more than [~~in excess of~~] 0.5 rem (5 mSv);

(C) declared pregnant women likely to receive, during the entire pregnancy, from sources of radiation external to the body, a deep dose equivalent more than [~~in excess of~~] 0.1 rem (1 mSv); and

(D) individuals entering a high or very high radiation area;

(2) notwithstanding paragraph (1)(C) of this subsection, a licensee is exempt from supplying individual monitoring devices to healthcare personnel who may enter a high radiation area while providing patient care if:

(A) the personnel are not likely to receive, in one year from sources external to the body, a dose more than 10 percent [~~in excess of 10%~~] of the limits in subsection (f)(1) of this section; and

(B) the licensee complies with the requirements of subsection (e)(2) of this section; and

(3) each licensee must [~~shall~~] monitor, to determine compliance with subsection (i) of this section, the occupational intake of radioactive material by and assess the committed effective dose equivalent to:

(A) adults likely to receive, in one year, an intake more than 10 percent [~~in excess of 10%~~] of the applicable ALI in Columns 1 and 2 of Table I of subsection (ggg)(2) of this section;

(B) minors likely to receive, in one year, a committed effective dose equivalent more than [~~in excess of~~] 0.1 rem (1 mSv); and

(C) declared pregnant women likely to receive, during the entire pregnancy, a committed effective dose equivalent more than [~~in excess of~~] 0.1 rem (1 mSv).

(r) Location and use of individual monitoring devices.

(1) Each licensee must [~~shall~~] ensure that individuals who are required to monitor occupational doses as specified in [~~accordance with~~] subsection (q)(1) [~~(q)(l)~~] of this section wear and use individual monitoring devices as follows.

(A) An individual monitoring device used for monitoring the dose to the whole body is [~~shall be~~] worn at the unshielded location of the whole body likely to receive the highest exposure. When a protective apron is worn, the location of the individual monitoring device is typically at the neck (collar).

(B) If an additional individual monitoring device is used for monitoring the dose to an embryo/fetus of a declared pregnant woman, as specified in [~~accordance with~~] subsection (m)(1) of this section, it is [~~shall be~~] located at the waist under any protective apron being worn by the woman.

(C) An individual monitoring device used for monitoring the lens dose equivalent, to demonstrate compliance with subsection (f)(1)(B)(i) of this section, is [~~shall be~~] located at the neck (collar) or at a location closer to the eye, outside any protective apron being worn by the monitored individual.

(D) An individual monitoring device used for monitoring the dose to the skin of the extremities, to demonstrate compliance with subsection (f)(1)(B)(ii) of this section, is [~~shall be~~] worn on the skin of the extremity likely to receive the highest exposure. Each individual monitoring device, to the extent practicable, is [~~shall be~~] oriented to measure the highest dose to the skin of the extremity being monitored.

(E) An individual monitoring device is [~~shall be~~] assigned to and worn by only one individual.

(F) An individual monitoring device that requires processing is [~~shall be~~] worn for the period of time authorized by the dosimetry processor [~~processor's certificate of registration~~] or for no longer than three months, whichever is earlier [~~more restrictive~~].

(G) All individual monitoring devices are processed or evaluated at least quarterly or promptly after replacement, whichever is more frequent.

(2) Each licensee must [~~shall~~] ensure that individual monitoring devices are returned to the dosimetry processor for proper processing, as applicable.

(3) Each licensee must [~~shall~~] ensure that adequate precautions are taken to prevent a deceptive exposure of an individual monitoring device.

(s) Control of access to high radiation areas.

(1) The licensee must [~~shall~~] ensure that each entrance or access point to a high radiation area has one or more of the following features:

(A) a control device that, upon entry into the area, causes the level of radiation to be reduced below the [~~that~~] level at which an individual might receive a deep dose equivalent of 0.1 rem (1 mSv) in one hour at 30 centimeters (cm), from the source of radiation, from any surface that the radiation penetrates;

(B) a control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; or

(C) entryways that are locked, except during periods when access to the areas is required, with positive control over each individual entry.

(2) In place of the controls required by paragraph (1) of this subsection for a high radiation area, the licensee may substitute continuous direct or electronic surveillance that is capable of preventing unauthorized entry.

(3) The licensee may apply to the department [~~agency~~] for approval of alternative methods for controlling access to high radiation areas.

(4) The licensee must [~~shall~~] establish [~~the~~] controls required by paragraphs (1) and (3) of this subsection in a way that does not prevent individuals from leaving a high radiation area.

(5) The licensee is not required to control each entrance or access point to a room or other area that is a high radiation area solely because of the presence of radioactive materials prepared for transport and packaged and labeled as specified in [~~accordance with~~] the regulations of the United States Department of Transportation (DOT) if [~~provided that~~]:

(A) the packages do not remain in the area longer than three days; and

(B) the dose rate at 1 meter (m) from the external surface of any package does not exceed 0.01 rem (0.1 mSv) per hour.

(6) The licensee is not required to control entrance or access to rooms or other areas in hospitals solely because of the presence of patients containing radioactive material, if [~~provided that~~] there are personnel in attendance who are taking the necessary precautions to prevent the exposure of individuals to sources of radiation over [~~in excess of~~] the established limits in this section and who [~~to~~] operate within the ALARA provisions of the licensee's radiation protection program.

(t) Control of access to very high radiation areas. In addition to the requirements in subsection (s) of this section, the licensee must [~~shall~~] institute measures to ensure

that an individual is not able to gain unauthorized or inadvertent access to areas where [~~in which~~] radiation levels could be encountered at 500 rads (5 gray (Gy) [~~grays~~]) or more in one hour at 1 m from a source of radiation or any surface through which the radiation penetrates at this level.

(u) Control of access to very high radiation areas for irradiators.

(1) This subsection applies to licensees with sources of radiation in non-self-shielded irradiators. This subsection does not apply to sources of radiation that are used in teletherapy, [~~in~~] industrial radiography, or [~~in~~] completely self-shielded irradiators where [~~in which~~] the source of radiation 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.

(2) Each area in which there may exist radiation levels more than [~~in excess of~~] 500 rads (5 Gy [~~grays~~]) in one hour at 1 m from a source of radiation that is used to irradiate materials must [~~shall~~] meet the following requirements.

(A) Each entrance or access point is [~~shall be~~] equipped with entry control devices that:

(i) function automatically to prevent any individual from inadvertently entering a very high radiation area;

(ii) permit deliberate entry into the area only after a control device is actuated that causes the radiation level within the area, from the source of radiation, to be reduced below that at which it would be possible for an individual to receive a deep dose equivalent more than [~~in excess of~~] 0.1 rem (1 mSv) in one hour; and

(iii) prevent operation of the source of radiation if it would produce radiation levels in the area that could result in a deep dose equivalent to an individual more than [~~in excess of~~] 0.1 rem (1 mSv) in one hour.

(B) Additional control devices are [~~shall be~~] provided so that, upon failure of the entry control devices to function as required by subparagraph (A) of this paragraph:

(i) the radiation level within the area, from the source of radiation, is reduced below that at which it would be possible for an individual to receive a deep dose equivalent more than [~~in excess of~~] 0.1 rem (1 mSv) in one hour; and

(ii) conspicuous visible and audible alarm signals are generated to make an individual attempting to enter the area aware of the hazard and at least one other authorized individual, who is physically present, familiar with the activity, and prepared to render or summon assistance, aware of the failure of the entry control devices.

(C) The licensee provides [~~shall provide~~] control devices so that, upon failure or removal of physical radiation barriers other than the sealed source's shielded

storage container:

(i) the radiation level from the source of radiation is reduced below that at which it would be possible for an individual to receive a deep dose equivalent more than [~~in excess of~~] 0.1 rem (1 mSv) in one hour; and

(ii) conspicuous visible and audible alarm signals are generated to make potentially affected individuals aware of the hazard and the licensee or at least one other individual, who is familiar with the activity and prepared to render or summon assistance, is aware of the failure or removal of the physical barrier.

(D) When the shield for stored sealed sources is a liquid, the licensee provides [~~shall provide~~] means to monitor the integrity of the shield and to signal, automatically, loss of adequate shielding.

(E) Physical radiation barriers that comprise permanent structural components, such as walls, that have no credible probability of failure or removal in ordinary circumstances, are not required to comply with [~~need not meet the requirements of~~] subparagraphs (C) and (D) of this paragraph.

(F) Each area is [~~shall be~~] equipped with devices that [~~will~~] automatically generate conspicuous visible and audible alarm signals to alert personnel in the area before the source of radiation can be put into operation and in time for any individual in the area to operate a clearly identified control device, [~~which must be~~] installed in the area that [~~and which~~] can prevent the source of radiation from being put into operation.

(G) Each area is [~~shall be~~] controlled by use of [~~such~~] administrative procedures and [~~such~~] devices [~~as are~~] necessary to ensure that the area is cleared of personnel before [~~prior to~~] each use of the source of radiation.

(H) Each area is [~~shall be~~] checked by a radiation measurement to ensure that, before [~~prior to~~] the first individual's entry into the area after any use of the source of radiation, the radiation level from the source of radiation in the area is below that at which it would be possible for an individual to receive a deep dose equivalent more than [~~in excess of~~] 0.1 rem (1 mSv) in one hour.

(I) The entry control devices required in subparagraph (A) of this paragraph are [~~shall be~~] tested for proper functioning. See subsection (uu) of this section for recordkeeping requirements.

(i) Testing must [~~shall~~] be conducted before [~~prior to~~] initial operation of [~~with~~] the source of radiation on any day[~~,~~] unless operations were continued uninterrupted from the previous day.

(ii) Testing must [~~shall~~] be conducted before [~~prior to~~] resumption of operation of the source of radiation after any unintentional interruption.

(iii) The licensee must [~~shall~~] submit and adhere to a schedule for periodic tests of the entry control and warning systems.

(J) The licensee does [~~shall~~] not conduct operations, other than those necessary to place the source of radiation in safe condition or to effect repairs on controls, unless control devices are functioning properly.

(K) Entry and exit portals [~~that are~~] used to transport [~~in transporting~~] materials to and from the irradiation area, and [~~that are~~] not intended for use by individuals, are [~~shall be~~] controlled by such devices and administrative procedures as [~~are~~] necessary to physically protect and warn against inadvertent entry by any individual through these portals. Exit portals for irradiated materials are [~~shall be~~] equipped to automatically detect and signal the presence of any loose radioactive material that is carried toward such an exit to prevent [~~and automatically to prevent~~] loose radioactive material from being carried out of the area.

(3) Licensees or applicants for licenses for sources of radiation under [~~within the purview of~~] paragraph (2) of this subsection [~~that will be~~] used in a variety of positions or in locations, such as open fields or forests, making [~~which make~~] it impracticable to comply with certain requirements of paragraph (2) of this subsection, such as those for the automatic control of radiation levels, may apply to the department [~~agency~~] for approval of alternative safety measures. Alternative safety measures must [~~shall~~] provide personnel protection at least equivalent to those specified in paragraph (2) of this subsection. At least one of the alternative measures must [~~shall~~] include an entry-preventing interlock control based on a measurement of the radiation that ensures the absence of high radiation levels before an individual enters an [~~can gain access to the~~] area where [~~such~~] sources of radiation are used.

(4) The entry control devices required by paragraphs (2) and (3) of this subsection must [~~shall~~] be established so [~~in such a way that~~] no individual is [~~will be~~] prevented from leaving the area.

(v) Use of process or other engineering controls. The licensee must [~~shall~~] use, to the extent practicable, process or other engineering controls, such as containment, decontamination, or ventilation, to control the concentrations of radioactive material in air.

(w) Use of other controls.

(1) When it is not practicable to apply process or other engineering controls to ensure [~~control the~~] concentrations of radioactive material in air [~~to~~] values are below those that define an airborne radioactivity area, the licensee must [~~shall~~], consistent with maintaining the TEDE [~~total effective dose equivalent~~] ALARA, increase monitoring and limit intakes by one or more of the following means:

(A) control of access;

(B) limitation of exposure times;

(C) use of respiratory protection equipment; or

(D) other controls.

(2) If the licensee performs an ALARA analysis to determine whether respirators should be used, the licensee may consider safety factors other than radiological factors. The licensee must [~~shall also~~] consider the impact of respirator use on workers' industrial health and safety.

(x) Use of individual respiratory protection equipment.

(1) If the licensee uses respiratory protection equipment to limit intakes of radioactive material as specified in [~~accordance with~~] subsection (w) of this section, the licensee must: [~~shall do the following.~~]

(A) [~~Except as provided in subparagraph (B) of this paragraph, the licensee shall~~] use only respiratory protection equipment that is tested and certified by the National Institute for Occupational Safety and Health (NIOSH), except as provided in subparagraph (B) of this paragraph.

(B) [~~If the licensee wishes to use equipment that has not been tested or certified by the NIOSH, or for which there is no schedule for testing or certification, the licensee shall~~] submit an application to the department [~~agency~~] for authorized use of [~~that~~] equipment, including a demonstration by testing, or a demonstration on the basis of test information, that the material and performance characteristics of the equipment are capable of providing the proposed degree of protection under anticipated conditions of use, if the licensee wishes to use equipment that has not been tested or certified by the NIOSH, or for which there is no schedule for testing or certification.

(C) [~~The licensee shall~~] implement and maintain a respiratory protection program that includes:

(i) air sampling sufficient to identify the potential hazard, permit proper equipment selection, and estimate doses;

(ii) surveys and bioassays, as appropriate, to evaluate actual intakes;

(iii) testing of respirators for operability (user seal check for face sealing devices and functional check for others) immediately before [~~prior to~~] each use;

(iv) written procedures regarding the following:

(I) monitoring, including air sampling and bioassays;

(II) supervision and training of respirator users;

(III) fit testing;

(IV) respirator selection;

(V) breathing air quality;

(VI) inventory and control;

(VII) storage, issuance, maintenance, repair, testing, and quality

assurance of respiratory protection equipment;

(VIII) recordkeeping; and

(IX) limitations on periods of respirator use and relief from respirator use;

(v) determination by a physician before [~~prior to~~] initial fitting of a face-sealing [~~face-sealing~~] respirator and the first field use of non-face-sealing [~~non-face-sealing~~] respirators, and either, every 12 months thereafter or periodically at a frequency determined by a physician, [~~that~~] the individual user is medically fit to use the respiratory protection equipment; and

(vi) fit testing, with fit factor >10 times the APF for negative pressure devices, and a fit factor >500 [~~> 500~~] for any positive pressure, continuous flow, and pressure-demand devices, before the first field use of tight fitting, face-sealing respirators and periodically thereafter at a frequency not to exceed one [~~1~~] year. Fit testing must [~~shall~~] be performed with the facepiece operating in the negative pressure mode.

(D) [~~The licensee shall~~] advise each respirator user that the user may leave the area at any time for relief from respirator use in the event of equipment malfunction, physical or psychological distress, procedural or communication failure, significant deterioration of operating conditions, or any other conditions that might require [~~such~~] relief.

(E) [~~The licensee shall~~] use respiratory protection equipment within the equipment manufacturer's expressed limitations for type and mode of use and [~~shall~~] provide for vision correction, adequate communication, low-temperature work environment, and the concurrent use of other safety or radiological protection equipment. The licensee must [~~shall~~] use equipment so that it does not [~~in such a way as not to~~] interfere with the proper operation of the respirator.

(F) ensure standby [~~Standby~~] rescue persons are positioned to render aid [~~required~~] whenever one-piece atmosphere-supplying suits, or any combination of supplied air respiratory protection device and personnel protective equipment are used from which an unaided individual may have difficulty extricating himself or herself. The standby persons must [~~shall~~] be equipped with respiratory protection devices or other apparatus appropriate for the potential hazards. The standby rescue persons must [~~shall~~] observe or otherwise maintain continuous communication with the workers (visual, voice, signal line, telephone, radio, or other suitable means), and be immediately available to assist them in case of a failure of the air supply or for any other reason that requires relief from distress. A sufficient number of standby rescue persons must be immediately available to assist all users of this type of equipment and [~~to~~] provide effective emergency rescue, if needed.

(G) ensure atmosphere-supplying [~~Atmosphere-supplying~~] respirators are [~~shall be~~] supplied with respirable air of grade D quality, or better, as defined by the Compressed Gas Association in publication G-7.1, "Commodity Specification for

Air," 1997 and included in the regulations of the Occupational Safety and Health Administration (29 CFR §1910.134(i)(1)(ii)(A) - (E)) [~~(Title 29, CFR, §1910.134(i)(1)(ii)(A) through (E)~~]. Grade D quality air criteria include:

(i) oxygen content (volume/volume) of 19.5 – 23.5 percent [~~19.5-23.5%~~];

(ii) hydrocarbon (condensed) content of 5 mg per cubic meter of air or less;

(iii) carbon monoxide (CO) content of 10 parts per million (ppm) or less;

(iv) carbon dioxide content of 1,000 ppm or less; and

(v) lack of noticeable odor.

(H) [~~The licensee shall~~] ensure [~~that~~] no objects, materials, or substances, such as facial hair, or any conditions interfering [~~that interfere~~] with the facepiece [~~face-facepiece~~] seal or valve function, and that are under the control of the respirator wearer, are present between the skin of the wearer's face and the sealing surface of a tight-fitting respirator facepiece.

(I) when [~~In~~] estimating the dose to individuals from intake of airborne radioactive materials, initially assume the concentration of radioactive material in the air, [~~that is~~] inhaled when respirators are worn, is [~~initially assumed to be~~] the ambient concentration in air without respiratory protection, divided by the assigned protection factor. If the dose is later found to be greater than the estimated dose, the corrected value must [~~shall~~] be used. If the dose is later found to be less than the estimated dose, the corrected value may be used.

(2) The department [~~agency~~] may impose restrictions in addition to those in paragraph (1) of this subsection, subsection (w) of this section, and subsection (ggg)(1) of this section, [~~in order~~] to:

(A) ensure that the respiratory protection program of the licensee is adequate to limit doses to individuals from intakes of airborne radioactive materials consistent with maintaining TEDE [~~total effective dose equivalent~~] ALARA; and

(B) limit the extent to which a licensee may use respiratory protection equipment instead of process or other engineering controls.

(3) The licensee must [~~shall~~] obtain authorization from the department [~~agency~~] before assigning respiratory protection factors exceeding [~~in excess of~~] those specified in subsection (ggg)(1) of this section. The department [~~agency~~] may authorize a licensee to use higher protection factors on receipt of an application that:

(A) describes the situation for which a need exists for higher protection factors; and

(B) demonstrates that the respiratory protection equipment provides [~~these~~]

higher protection factors under the proposed conditions of use.

(y) Security and control of licensed sources of radiation.

(1) The licensee must [~~shall~~] secure radioactive material from unauthorized removal or access.

(2) The licensee must [~~shall~~] maintain constant surveillance, using devices or [~~and/or~~] administrative procedures to prevent unauthorized access to use of radioactive material [~~that is~~] in an unrestricted area and [~~that is~~] not in storage.

(3) Each portable gauge licensee must [~~shall~~] use a minimum of two independent physical controls that form tangible barriers to secure portable gauges from unauthorized removal, whenever portable gauges are not under the control and constant surveillance of the licensee.

(4) Utilization records must [~~shall~~] be maintained for portable and mobile devices containing [~~which contain~~] radioactive material[~~, and which are~~] transported from a licensed site temporarily for use by the licensee and then returned to the licensed site of origin. The information required by subparagraphs (A) - (D) of this paragraph must [~~shall~~] be recorded when a device is removed from the licensed site. The information in subparagraph (E) of this paragraph must [~~shall~~] be recorded when a device is returned to the licensed site:

(A) the manufacturer, model, and serial number of the device;

(B) the names [~~name~~] of personnel [~~the individual(s)~~] transporting and using the device;

(C) the locations [~~location(s)~~] where each device is used;

(D) the date each device is removed from storage; and

(E) the date each device is returned to storage.

(5) Utilization records must [~~shall~~] be maintained at the licensed site where the devices are stored for inspection by the department as specified in [~~agency in accordance with~~] subsection (ggg)(5) of this section.

(z) Caution signs.

(1) Unless otherwise authorized by the department [~~agency~~], the standard radiation symbol prescribed must [~~shall~~] use the colors magenta, or purple, or black on yellow background. The standard radiation symbol prescribed is the three-bladed design as follows:

Figure: 25 TAC §289.202(z)(1) (no change)

(A) the cross-hatched area of the symbol is [~~to be~~] magenta, or purple, or black; and

(B) the background of the symbol is [~~to be~~] yellow.

(2) Notwithstanding the requirements of paragraph (1) of this subsection, licensees are authorized to label sources, source holders, or device components containing sources of radiation that are subjected to high temperatures, with conspicuously etched or stamped radiation caution symbols and without a color requirement.

(aa) Posting requirements.

(1) The licensee must [~~shall~~] post each radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIATION AREA."

(2) The licensee must [~~shall~~] post each high radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, HIGH RADIATION AREA" or "DANGER, HIGH RADIATION AREA."

(3) The licensee must [~~shall~~] post each very high radiation area with a conspicuous sign or signs bearing the radiation symbol and words "GRAVE DANGER, VERY HIGH RADIATION AREA." If the very high radiation area involves medical treatment of patients, the licensee may omit the word "GRAVE" from the sign or signs.

(4) The licensee must [~~shall~~] post each airborne radioactivity area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, AIRBORNE RADIOACTIVITY AREA" or "DANGER, AIRBORNE RADIOACTIVITY AREA."

(5) The licensee must [~~shall~~] post each area or room where [~~in which~~] there is used or stored amounts [~~an amount~~] of licensed material exceeding 10 times the quantity of such material specified in subsection (ggg)(3) of this section, with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL(S)" or "DANGER, RADIOACTIVE MATERIAL(S)."

(bb) Exceptions to posting requirements.

(1) A licensee is not required to post caution signs in areas or rooms containing sources of radiation for periods of less than eight [~~8~~] hours, if each of the following conditions are [~~is~~] met:

(A) the sources of radiation are constantly attended during these periods by an individual who takes the precautions necessary to prevent the exposure of individuals to sources of radiation over [~~in excess of~~] the limits established in this section; and

(B) the area or room is subject to the licensee's control.

(2) Rooms or other areas in hospitals that are occupied by patients are not required to be posted with caution signs as specified in [~~accordance with~~] subsection (aa) of this section if [~~provided that~~] the patient could be released from licensee control as specified in [~~accordance with~~] this chapter.

(3) A room or area is not required to be posted with a caution sign because of the presence of a sealed source if [~~source(s) provided~~] the radiation level at 30 cm

from the surface of the sealed source container [~~container(s)~~] or housing [~~housing(s)~~] does not exceed 0.005 rem (0.05 mSv) per hour.

(4) Rooms in medical facilities [~~that are~~] used for teletherapy are exempt from the requirement to post caution signs as specified in [~~accordance with~~] subsection (aa) of this section if [~~provided~~] the following conditions are met.

(A) Access to the room is controlled as specified in [~~accordance with~~] this chapter; and

(B) Personnel in attendance take necessary precautions to prevent the inadvertent exposure of workers, other patients, and members of the public to radiation over [~~in excess of~~] the limits established in this section.

(cc) Labeling containers.

(1) The licensee must [~~shall~~] ensure that each container of licensed material bears a durable, clearly visible label bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL." The label must [~~shall~~] also provide information, such as the radionuclides present, an estimate of the quantity of radioactivity, the date [~~for which~~] the activity is estimated, radiation levels, kinds of materials, and mass enrichment, to permit individuals handling or using the containers, or working in the vicinity of the containers, to take precautions to avoid or minimize exposures.

(2) Each licensee must [~~shall~~], before [~~prior to~~] removal or disposal of empty uncontaminated containers to unrestricted areas, remove or deface the radioactive material label or otherwise clearly indicate that the container no longer contains radioactive materials.

(dd) Exemptions to labeling requirements. A licensee is not required to label:

(1) containers holding licensed material in quantities less than the quantities listed in subsection (ggg)(3) of this section;

(2) containers holding licensed material in concentrations less than those specified in Table III of subsection (ggg)(2) of this section;

(3) containers attended by an individual who takes the precautions necessary to prevent the exposure of individuals over [~~in excess of~~] the limits established by this section;

(4) containers when they are in transport and packaged and labeled as specified in [~~accordance with~~] the rules of the DOT (labeling of packages containing radioactive materials is required by the 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) [~~Title 49, CFR, §§173.403(m)~~] and (w) and §173.424 [~~173.424~~]);

(5) containers that are accessible only to individuals authorized to handle or use them, or to work in the vicinity of the containers, if the contents are identified to

these individuals by a readily available written record. Examples of containers of this type are containers in locations such as water-filled canals, storage vaults, or hot cells. The record must [~~shall~~] be retained while [~~as long as~~] the containers are in use for the purpose indicated on the record; or

(6) installed manufacturing or process equipment, such as piping and tanks.

(ee) Procedures for receiving and opening packages.

(1) Each licensee who expects to receive a package containing quantities of radioactive material more than [~~in excess of~~] a Type A quantity, as defined in §289.201(b) of this subchapter [~~title~~] (relating to General Provisions for Radioactive Material) and specified in §289.257(ee) of this chapter [~~title~~] (relating to Packaging and Transportation of Radioactive Material), must [~~shall~~] make arrangements to receive:

(A) the package when the carrier offers it for delivery; or

(B) the notification of the arrival of the package at the carrier's terminal and to take possession of the package expeditiously.

(2) Each licensee must [~~shall~~]:

(A) monitor the external surfaces of a labeled package, labeled with a Radioactive White I, Yellow II, or Yellow III label as specified in DOT regulations 49 CFR §§172.403 [~~Title 49, CFR, §§172.403~~] and 172.436 - 172.440 [~~172.436-440~~], for radioactive contamination unless the package contains only radioactive material in the form of gas or in special form as defined in §289.201(b) of this subchapter [~~title~~];

(B) monitor the external surfaces of a labeled package, labeled with a Radioactive White I, Yellow II, or Yellow III label as specified in DOT regulations 49 CFR §§172.403 [~~Title 49, CFR, §§172.403~~] and 172.436 - 172.440 [~~172.436-440~~], for radiation levels, unless the package contains quantities of radioactive material [~~that are~~] less than or equal to the Type A quantity, as defined in §289.201(b) of this subchapter [~~title~~] and specified in §289.257(ee) of this chapter [~~title~~]; and

(C) monitor all packages known to contain radioactive material for radioactive contamination and radiation levels if there is evidence of degradation of package integrity, such as packages that are crushed, wet, or damaged.

(3) The licensee must [~~shall~~] perform the monitoring required by paragraph (2) of this subsection as soon as practicable after receipt of the package, but not later than three hours after the package is received at the licensee's facility if it is received during the licensee's normal working hours. If a package is received after working hours, the package must [~~shall~~] be monitored no later than three hours from the beginning of the next working day. If the licensee discovers there is evidence of degradation of package integrity, such as a package that is crushed, wet, or damaged, the package must [~~shall~~] be surveyed immediately.

(4) The licensee must [~~shall~~] immediately notify the final delivery carrier and, by telephone[~~, facsimile,~~] or other electronic media transmission, the department [~~agency~~] when removable radioactive surface contamination or external radiation levels exceed the limits established in subparagraphs (A) and (B) of this paragraph.

(A) Limits for removable radioactive surface contamination levels.

(i) The level of removable radioactive contamination on the external surfaces of each package offered for shipment must [~~shall~~] be ALARA. The level of removable radioactive contamination may be determined by wiping an area of 300 square centimeters (cm^2) [(~~cm^2~~)] of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material. Sufficient measurements must [~~shall~~] be taken in the most appropriate locations to yield a representative assessment of the removable contamination levels. Except as provided in clause (iii) of this subparagraph, the amount of radioactivity measured on any single wiping material, when averaged over the surface wiped must [~~, shall~~] not be more than [~~exceed~~] the limits given in clause (ii) of this subparagraph at any time during transport. If other methods are used, the detection efficiency of the method used must [~~shall~~] be considered [~~taken into account~~] and [~~in no case may~~] the removable contamination on the external surfaces of the package must not be more than [~~exceed~~] 10 times the limits listed in clause (ii) of this subparagraph.

(ii) Removable external radioactive contamination wipe limits are as follows.

Figure: 25 TAC §289.202(ee)(4)(A)(ii) [~~Figure: 25 TAC §289.202(ee)(4)(A)(ii)~~]

(iii) In the case of packages transported as exclusive use shipments by rail or highway only, the removable radioactive contamination at any time during transport must not exceed 10 times the levels prescribed in clause (ii) of this subparagraph. The levels at the beginning of transport must not exceed the levels in clause (ii) of this subparagraph.

(B) Limits for external radiation levels.

(i) External radiation levels around the package and around the vehicle, if applicable, must not be more than [~~will not exceed~~] 200 millirem [~~millirems~~] per hour (mrem/hr) (2 millisieverts per hour (mSv/hr)) at any point on the external surface of the package at any time during transportation. The transport index must [~~shall~~] not be more than [~~exceed~~] 10.

(ii) For a package transported in exclusive use by rail, highway, or water, radiation levels external to the package may exceed the limits specified in clause (i) of this subparagraph but must [~~shall~~] not be more than [~~exceed~~] any of the following:

(I) 200 mrem/hr (2 mSv/hr) on the accessible external surface of the package unless the following conditions are met, in which case the limit is 1,000 mrem/hr (10 mSv/hr):

(-a-) the shipment is made in a closed transport vehicle;

(-b-) provisions are made to secure the package so that its position within the vehicle remains fixed during transportation; and

(-c-) there are no loading or unloading operations between the beginning and end of the transportation;

(II) 200 mrem/hr (2 mSv/hr) at any point on the outer surface of the vehicle, including the upper and lower surfaces, or, in the case of a flat-bed style vehicle, with a personnel barrier, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load (or enclosure, if used), and on the lower external surface of the vehicle (a flat-bed style vehicle with a personnel barrier must [~~shall~~] have radiation levels determined at vertical planes. If no personnel barrier, the package cannot exceed 200 mrem/hr (2 mSv/hr) at the surface.);

(III) 10 mrem/hr (0.1 mSv/hr) at any point 2 m from the vertical planes represented by the outer lateral surfaces of the vehicle, or, in the case of a flat-bed style vehicle, at any point 2 m from the vertical planes projected from the outer edges of the vehicle; and

(IV) 2 mrem/hr (0.02 mSv/hr) in any normally occupied positions of the vehicle, except that this provision does not apply to private motor carriers when persons occupying these positions are provided with special health supervision, personnel radiation exposure monitoring devices, and training as specified in [~~accordance with~~] §289.203(c) of this subchapter [~~title~~] (relating to Notices, Instructions, and Reports to Workers; Inspections).

(5) Each licensee must [~~shall~~]:

(A) establish, maintain, and retain written procedures for safely opening packages in which radioactive material is received; and

(B) ensure that the procedures are followed and that due consideration is given to special instructions for the type of package being opened.

(6) Licensees transferring special form sources in vehicles owned or operated by the licensee to and from a work site are exempt from the contamination monitoring requirements of paragraph (2) of this subsection, but are not exempt from the monitoring requirement in paragraph (2) of this subsection for measuring radiation levels ensuring [~~that ensures that~~] the source is still properly lodged in its shield.

(ff) General requirements for waste management.

(1) Unless otherwise exempted, a licensee may [~~shall~~] discharge, treat, or decay licensed material or transfer waste for disposal only:

(A) by transfer to an authorized recipient as provided in subsection (jj) of this section, §289.252 of this chapter [~~title~~], §289.257 of this chapter [~~title~~], §289.259 of this chapter [~~title~~], or to the United States Department of Energy

(DOE);

(B) by decay in storage with prior approval from the department [~~agency~~], except as authorized in §289.256(ee) of this chapter [~~title~~];

(C) by release in effluents within the limits in subsection (n) of this section as specified in [~~accordance with~~] the applicable requirements of the Texas Commission on Environmental Quality (TCEQ) or the Railroad Commission of Texas [~~(RRC)~~];

(D) as authorized in [~~in accordance with~~] paragraph (2) of this subsection, and subsections (gg), (hh), and (fff) of this section; [~~or~~]

(E) by transfer of residual radiopharmaceutical waste for decay in storage only to persons who manufactured, compounded, and supplied the radiopharmaceutical and who otherwise meet the requirements for exemption under 30 Texas Administrative Code (TAC) §336.1209 (relating to Exemptions) [~~Title 30, Texas Administrative Code (TAC), §336.1209~~]; or[~~.~~]

(F) by procedures reviewed and authorized by the department following approval of an application that includes:

(i) a description of the waste-containing licensed material to be disposed, including the physical and chemical properties important to risk evaluation, and the proposed manner and conditions of waste disposal;

(ii) an analysis and evaluation of pertinent information on the nature of the environment;

(iii) the nature and location of other potentially affected licensed and unlicensed facilities; and

(iv) analyses and procedures to ensure doses are maintained ALARA and within the dose limits in this chapter.

(2) Upon [~~agency~~] approval from the department, emission control dust and other material from electric arc furnaces or foundries contaminated because [~~as a result~~] of inadvertent melting of cesium-137 or americium-241 sources may be transferred for disposal to a hazardous waste disposal facility authorized by TCEQ or its successor, another state's regulatory agency with jurisdiction to regulate hazardous waste as classified under Subtitle C of the Resource Conservation and Recovery Act (RCRA), or the EPA. The material may be transferred for disposal without regard to its radioactivity if the following conditions are met.

(A) Contaminated material described in paragraph (2) of this subsection, whether packaged or unpackaged (i.e., bulk), must be treated through stabilization to comply with all waste treatment requirements of the appropriate state or federal regulatory agency as listed in this paragraph. The treatment operations must be undertaken by either of the following:

(i) the owner/operator of the electric arc furnace or foundry licensed to possess, treat, or transfer cesium-137 or americium-241 contaminated incident-

related material; or

(ii) a service contractor licensed by the department [~~agency~~], NRC, or an agreement state to possess, treat, or transfer cesium-137 or americium-241 contaminated incident-related material.

(B) The emission control dust and other incident-related materials have been stored (if applicable) and transferred as specified in [~~accordance with~~] operating and emergency procedures approved by the department [~~agency~~].

(C) The total cesium-137 or americium-241 activity contained in emission control dust and other incident-related materials to be transferred to a hazardous waste disposal facility has been specifically approved by NRC or the appropriate agreement state or states [~~state(s)~~] and does not exceed the total activity associated with the inadvertent melting incident.

(D) The hazardous waste disposal facility operator is [~~has been~~] notified, in writing, of the impending transfer of the incident-related materials and has agreed, in writing, to receive and dispose of the packaged or unpackaged materials. Copies of the notification and agreement must [~~shall~~] be submitted to the department [~~agency~~].

(E) The licensee, as listed in subparagraph (A)(i) or (ii) of this paragraph, notifies the NRC or agreement state or states where [~~state(s) in which~~] the transferor and transferee are located, in writing, of the impending transfer, at least 30 days before the transfer.

(F) The packaged stabilized material has been packaged for transportation and disposal in non-bulk steel packaging as defined in DOT regulations at 49 CFR §173.213 [~~Title 49, CFR, §173.213~~].

(G) The emission control dust and other incident-related materials that have been stabilized and packaged as described in subparagraph (F) of this paragraph [~~shall~~] contain pretreatment average concentrations of cesium-137 that do not exceed 130 picocuries per gram (pCi/g) [~~pCi/g~~] of material, above background, or pretreatment average concentrations of americium-241 that do not exceed 3 pCi/g of material, above background.

(H) The dose rate at 3.28 feet (1 m) from the surface of any package containing stabilized waste does [~~shall~~] not exceed 20 microrem (µrem) [~~µrem~~] per hour or 0.20 microsieverts (µSv) [~~µSv~~] per hour, above background.

(I) The unpackaged stabilized material contains [~~shall contain~~] pretreatment average concentrations of cesium-137 that do not exceed 100 pCi/g of material, above background, or pretreatment average concentrations of americium-241 that do not exceed 3 pCi/g of material, above background.

(J) The licensee transferring the cesium-137 or americium-241 contaminated incident-related material must [~~shall~~] consult with the department [~~agency~~], [~~the~~] TCEQ or its successor, another state's regulatory agency with jurisdiction to

regulate hazardous waste as classified under RCRA, or the EPA and other authorized parties, including state and local governments, and obtain all necessary approvals, in addition to those of the NRC or [~~and/or~~] any agreement state, for the transfers described in paragraph (2) of this subsection.

(K) Nothing in this subsection [~~shall be or~~] is intended to be construed as a waiver of any RCRA permit condition or term, of any state or local statute or regulation, or of any [~~federal~~] RCRA regulation.

(L) The total incident-related cesium-137 activity described in paragraph (2) of this subsection received by a facility over its operating life, is [~~shall~~] not more than [~~exceed~~] 1 curie (Ci) [~~Ci~~] (37 gigabequerels (GBq)). The total incident-related americium-241 activity described in paragraph (2) of this subsection received by a facility over its operating life, is not more than [~~shall not exceed~~] 30 millicuries (mCi) [~~mCi~~] (1.11 GBq). The department maintains [~~agency will maintain~~] a record of the total incident-related cesium-137 or americium-241 activity shipped by a person licensed by the department [~~agency~~]. Upon consultation with [~~the~~] TCEQ, the department determines [~~agency will determine~~] if the total incident-related activity received by a hazardous waste disposal facility over its operating life has reached 1 Ci (37 GBq) of cesium-137 or 30 mCi (1.11 GBq) of americium-241. The department does not [~~agency will not~~] approve shipments of cesium-137 or americium-241 contaminated incident-related material that will cause this limit to be exceeded.

(3) Radioactive waste exempted by TCEQ for disposal in a hazardous waste disposal facility holding [~~that holds~~] a TCEQ permit issued under Subtitle C of the RCRA may be transferred for disposal as authorized by TCEQ.

(4) A person must [~~shall~~] be specifically licensed to receive waste containing licensed material from other persons for:

(A) treatment before [~~prior to~~] disposal;

(B) treatment by incineration;

(C) decay in storage;

(D) disposal at an authorized land disposal facility; or

(E) storage until transferred to a storage or disposal facility authorized to receive the waste.

(5) Byproduct material as defined in §289.201(b)(18)(C) - (E) [~~§289.201(b)(19)(C) - (E)~~] of this subchapter [~~title~~] may be disposed of as specified in 10 CFR Part 61 [~~in accordance with Title 10, CFR, Part 61~~], even though it is not defined as low-level [~~low level~~] radioactive waste. Any [~~Therefore, any~~] byproduct material being disposed of at a facility, or transferred for ultimate disposal at a facility licensed under 10 CFR Part 61 [~~Title 10, CFR, Part 61~~], must [~~shall~~] meet the requirements of this chapter.

(6) A licensee may dispose of byproduct material, as defined in

§289.201(b)(18)(C) - (E) [~~§289.201(b)(19)(C) - (E)~~] of this subchapter [~~title~~], at a disposal facility authorized to dispose of such material [~~in accordance~~] with any federal [~~Federal~~] or state [~~State~~] solid or hazardous waste law.

(7) Any licensee shipping byproduct material as defined in §289.201(b)(18)(C) - (E) [~~§289.201(b)(19)(C) - (E)~~] of this subchapter [~~title~~] intended for ultimate disposal at a land disposal facility licensed under 10 CFR Part 61 must [~~Title 10, CFR, Part 61, shall~~] document the information required on the NRC's Uniform Low-Level Radioactive Waste Manifest and transfer this recorded manifest information to the intended consignee as specified in [~~accordance with~~] §289.257(gg) of this chapter [~~title~~].

(gg) Discharge by release into sanitary sewerage.

(1) A licensee may discharge licensed material into sanitary sewerage if each of the following conditions is satisfied:

(A) the material is readily soluble, or is readily dispersible biological material, in water;

(B) the quantity of licensed radioactive material that the licensee releases into the sewer in one month divided by the average monthly volume of water released into the sewer by the licensee is not more than [~~does not exceed~~] the concentration listed in Table III of subsection (ggg)(2) of this section; and

(C) if more than one radionuclide is released, the following additional conditions must also be satisfied:

(i) the fraction of the limit in Table III of subsection (ggg)(2) of this section represented by discharges into sanitary sewerage determined by dividing the actual monthly average concentration of each radionuclide released by the licensee into the sewer by the concentration of that radionuclide listed in Table III of subsection (ggg)(2) of this section; and

(ii) the sum of the fractions for each radionuclide required by clause (i) of this subparagraph is not more than [~~does not exceed~~] unity; and

(D) the total quantity of licensed radioactive material that the licensee releases into the sanitary sewerage in a year is not more than [~~does not exceed~~] 5 Ci [~~curies (Ci)~~] (185 GBq) of hydrogen-3, 1 Ci (37 GBq) of carbon-14, and 1 Ci (37 GBq) of all other radioactive materials combined.

(2) Excreta from individuals undergoing medical diagnosis or therapy with radioactive material are not subject to the limitations contained in paragraph (1) of this subsection.

(hh) Treatment by incineration. A licensee may treat licensed material by incineration only in the form and concentration specified in subsection (fff)(1) of this section or as authorized by the department [~~agency~~].

(ii) Discharge by release into septic tanks. Licensees must not [~~No licensee shall~~]

discharge radioactive material into a septic tank system except as specifically approved by the department [agency].

(jj) Transfer for disposal and manifests.

(1) The control of transfers of LLRW intended for disposal at a licensed low-level radioactive waste disposal facility, the establishment of a manifest tracking system, and additional requirements concerning transfers and recordkeeping for those wastes are found in §289.257(ff) of this chapter [title].

(2) Each person involved in the transfer of waste for disposal, including the waste generator, waste collector, and waste processor, must [shall] comply with the requirements specified in §289.257(ff) of this chapter [title].

(kk) Compliance with environmental and health protection regulations. Nothing in subsections (ff), (gg), (hh), or (jj) of this section relieves the licensee from complying with other applicable federal, state, and local regulations governing any other toxic or hazardous properties of materials that may be disposed of as specified in [accordance with] subsections (ff), (gg), (hh), or (jj) of this section.

(ll) General provisions for records.

(1) Each licensee must [shall] use the International System of Units (SI) units becquerel, gray, sievert, and coulomb per kilogram, or the special units curie, rad, rem, and roentgen, including multiples and subdivisions, and must [shall] clearly indicate the units of all quantities on records required by this section. Disintegrations per minute may be indicated on records of surveys performed to determine compliance with subsections (ee)(4) and (ggg)(6) of this section. To ensure compatibility with international transportation standards, all limits in this section are given in terms of dual units: The SI units followed or preceded by United States (U.S.) standard or customary units. The U.S. customary units are not exact equivalents, but are rounded to a convenient value, providing a functionally equivalent unit. For the purpose of this section, either unit may be used.

(2) Notwithstanding the requirements of paragraph (1) of this subsection, when recording information on shipment manifests, as required in §289.257 of this chapter [title], information must be recorded in SI units or in SI and units as specified in paragraph (1) of this subsection.

(3) The licensee must [shall] make a clear distinction among the quantities entered on the records required by this section, such as, total effective dose equivalent, total organ dose equivalent, shallow dose equivalent, lens dose equivalent, deep dose equivalent, or committed effective dose equivalent.

(4) Records required as specified in [accordance with] §289.201(d) of this subchapter [title], and subsections (mm) - (oo) and (ss) - (uu) of this section, must [shall] include the date and the identification of personnel [individual(s)] making the record, and, as applicable, a unique identification of survey instruments [instrument(s)] used, and an exact description of the location of the survey. Records of receipt, transfer, and disposal of sources of radiation must [shall]

uniquely identify the source of radiation.

(5) Copies of records required as specified in [~~accordance with~~] §289.201(d) of this subchapter [~~title~~], and subsections (mm) - (uu) of this section, and by license condition that are relevant to operations at an additional authorized use/storage site must [~~shall~~] be maintained at that site in addition to the main site specified on a license.

(mm) Records of radiation protection programs.

(1) Each licensee must [~~shall~~] maintain records of the radiation protection program, including:

(A) the provisions of the program; and

(B) audits and other reviews of program content and implementation.

(2) The licensee must [~~shall~~] make, maintain, and retain the records required by paragraphs (1)(A) and (1)(B) of this subsection for inspection by the department as specified in [~~agency in accordance with~~] subsection (ggg)(5) of this section.

(nn) Records of surveys.

(1) Each licensee must [~~shall~~] make, maintain, and retain records documenting the results of surveys and calibrations required by subsections (p) and (ee)(2) of this section and include a unique identification of survey instruments [~~instrument(s)~~]. The licensee must [~~shall~~] maintain these records for inspection by the department as specified in [~~agency in accordance with~~] subsection (ggg)(5) of this section.

(2) Record of the calibration must [~~shall~~] include:

(A) the manufacturer's name, model, and serial number of each calibrated source or [~~and/or~~] device;

(B) the complete date of the calibration; and

(C) the name of the individual recording the information.

(3) The licensee must [~~shall~~] make, maintain, and retain each of the following records for inspection by the department as specified in [~~agency in accordance with~~] subsection (ggg)(5) of this section:

(A) the results of surveys to determine the dose from external sources of radiation used, in the absence of or in combination with individual monitoring data, in the assessment of individual dose equivalents; [~~and~~]

(B) the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose; [~~and~~]

(C) the results of air sampling, surveys, and bioassays required as specified

in [~~accordance with~~] subsection (x)(1)(C)(i) and (ii) of this section; and

(D) the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment.

(oo) Records of tests for leakage or contamination of sealed sources. Records of tests for leakage or contamination of sealed sources required by §289.201(g) of this subchapter [~~title~~] must [~~shall~~] be kept in units of becquerel or microcurie and maintained and retained for inspection by the department as specified in [~~agency in accordance with~~] subsection (ggg)(5) of this section.

(pp) Records of lifetime cumulative occupational radiation dose. The licensee must [~~shall~~] make, maintain, and retain the records of lifetime cumulative occupational radiation dose as specified in subsection (k) of this section on RC Form 202-2, or equivalent, and the records used in preparing RC Form 202-2, or equivalent, for inspection by the department as specified in [~~agency in accordance with~~] subsection (ggg)(5) of this section.

(qq) Records of planned special exposures.

(1) For each use of the provisions of subsection (k) of this section for planned special exposures, the licensee must [~~shall~~] maintain records that describe:

(A) the exceptional circumstances requiring the use of a planned special exposure;

(B) the name of the management official who authorized the planned special exposure and a copy of the signed authorization;

(C) what actions were necessary;

(D) why the actions were necessary;

(E) what precautions were taken to assure that doses were maintained ALARA;

(F) what individual and collective doses were expected to result; and

(G) the doses actually received in the planned special exposure.

(2) The licensee must [~~shall~~] retain the records until the department [~~agency~~] terminates each pertinent license requiring these records.

(rr) Records of individual monitoring results.

(1) Each licensee must [~~shall~~] maintain records of doses received by all individuals for whom monitoring was required as specified in [~~accordance with~~] subsection (q) of this section, and records of doses received during planned special exposures, accidents, and emergency conditions. Assessments of dose equivalent and records made using units in effect before January 1, 1994, need not be changed. These records must [~~shall~~] include, when applicable:

(A) the deep dose equivalent to the whole body, lens dose equivalent, shallow dose equivalent to the skin, and shallow dose equivalent to the extremities;

(B) the estimated intake of radionuclides. See [~~, see~~] subsection (g) of this section;

(C) the committed effective dose equivalent assigned to the intake of radionuclides;

(D) the specific information used to calculate the committed effective dose equivalent as specified in [~~accordance with~~] subsection (i)(1) and (3) of this section and when required by subsection (q)(1) of this section;

(E) the TEDE [~~total effective dose equivalent~~] when required by subsection (g) of this section;

(F) the total of the deep dose equivalent and the committed dose to the organ receiving the highest total dose; and

(G) the data used to make occupational dose assessments as specified in [~~accordance with~~] subsection (j)(5) of this section.

(2) The licensee must [~~shall~~] make entries of the records specified in paragraph (1) of this subsection at intervals not more than one [~~to exceed 1~~] year and not later than [~~by~~] April 30 of the following year.

(3) The licensee must [~~shall~~] maintain the records specified in paragraph (1) of this subsection on RC Form 202-3, as specified in [~~accordance with~~] the instructions for RC Form 202-3, or in clear and legible records containing all the information required by RC Form 202-3.

(4) The licensee must [~~shall~~] maintain the records of dose to an embryo/fetus with the records of dose to the declared pregnant woman. The declaration of pregnancy, including the estimated date of conception, must [~~shall~~] also be kept on file, but may be maintained separately from the dose records.

(5) The licensee must [~~shall~~] retain each required form or record until the department [~~agency~~] terminates each pertinent license requiring the record. The licensee must [~~shall~~] retain records used in preparing RC Form 202-3 or equivalent for three years after the record is made.

(ss) Records of dose to individual members of the public.

(1) Each licensee must [~~shall~~] maintain records sufficient to demonstrate compliance with the dose limit for individual members of the public. See subsection (n) of this section.

(2) The licensee must [~~shall~~] retain the records required by paragraph (1) of this subsection until the department [~~agency~~] terminates each pertinent license requiring the record.

(tt) Records of discharge, treatment, or transfer for disposal.

(1) Each licensee must [~~shall~~] maintain records of the discharge or treatment of licensed materials made as specified in [~~accordance with~~] subsection (gg) and (hh) of this section and of transfers for disposal made as specified in [~~accordance with~~] subsection (jj) of this section and §289.257 of this chapter [~~title~~].

(2) The licensee must [~~shall~~] retain the records required by paragraph (1) of this subsection until the department [~~agency~~] terminates each pertinent license requiring the record.

(uu) Records of testing entry control devices for very high radiation areas.

(1) Each licensee must [~~shall~~] maintain records of tests made as specified in [~~accordance with~~] subsection (u)(2)(I) of this section on entry control devices for very high radiation areas. These records must include the date, time, and results of each such test of function.

(2) The licensee must [~~shall~~] retain the records required by paragraph (1) of this subsection for three years after the record is made.

(vv) Form of records. Each record required by this chapter must include all pertinent information and [~~shall~~] be stored in a legible and reproducible format [~~legible~~] throughout the specified retention period. [~~The record shall be the original or a reproduced copy or 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 or 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, shall include all pertinent information, such as stamps, initials, and signatures.~~] The licensee must [~~shall~~] maintain adequate safeguards against tampering with and loss of records.

(ww) Reports of stolen, lost, or missing licensed sources of radiation.

(1) Each licensee must [~~shall~~] report to the department [~~agency~~] by telephone as follows:

(A) immediately after its occurrence becomes known to the licensee, stolen, lost, or missing licensed radioactive material in an aggregate quantity equal to or greater than 1,000 times the quantity specified in subsection (ggg)(3) of this section, if [~~under such circumstances that~~] it appears to the licensee [~~that~~] an exposure could result to individuals in unrestricted areas; or

(B) within 30 days after the licensee knows [~~its occurrence becomes known to the licensee,~~] lost, stolen, or missing licensed radioactive material in an aggregate quantity greater than 10 times the quantity specified in subsection (ggg)(3) of this section [~~that~~] is still missing.

(2) Each licensee required to make a report as specified in [~~accordance with~~] paragraph (1) of this subsection must [~~shall~~], within 30 days after making the

telephone report, make a written report to the department, including [~~agency setting forth the following information~~]:

(A) a description of the licensed source of radiation involved, including, for radioactive material, the kind, quantity, chemical and physical form, source or [~~and/or~~] device manufacturer, model number, and serial number;

(B) a description of the circumstances under which the loss or theft occurred;

(C) a statement of disposition, or probable disposition, of the licensed source of radiation involved;

(D) exposures of individuals to radiation, circumstances under which the exposures occurred, and the possible TEDE [~~total effective dose equivalent~~] to persons in unrestricted areas;

(E) actions [~~that have been~~] taken, or to [~~will~~] be taken, to recover the source of radiation; and

(F) procedures or measures adopted [~~that have been~~], or to be [~~will be,~~] adopted, ensuring [~~to ensure~~] against a recurrence of the loss or theft of licensed sources of radiation.

(3) Subsequent to filing the written report, the licensee must [~~shall~~] also report additional substantive information on the loss or theft within 30 days after the licensee learns of such information.

(4) The licensee must [~~shall~~] prepare any report filed with the department as specified in [~~agency in accordance with~~] this subsection so that names of individuals who may have received exposure to radiation are stated in a separate and detachable portion of the report.

(xx) Notification of incidents.

(1) Notwithstanding other requirements for notification, each licensee must [~~shall~~] immediately report each event involving a source of radiation possessed by the licensee that may have caused or threatens to cause:

(A) an individual, except a patient administered radiation for purposes of medical diagnosis or therapy, to receive:

(i) a TEDE [~~total effective dose equivalent~~] of 25 rem [~~rems~~] (0.25 Sv) or more;

(ii) a lens dose equivalent of 75 rem [~~rems~~] (0.75 Sv) or more; or

(iii) a shallow dose equivalent to the skin or extremities or a total organ dose equivalent of 250 rads (2.5 Gy [~~grays~~]) or more; or

(B) the release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake five times the occupational ALI. This provision does not apply to

locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures.

(2) Each licensee must [~~shall~~], within 24 hours of discovery of the event, report to the department [~~agency~~] each event involving loss of control of a licensed source of radiation possessed by the licensee that may have caused, or threatens to cause:

(A) an individual to receive, in a period of 24 hours:

(i) a TEDE [~~total effective dose equivalent~~] exceeding 5 rem [~~rems~~] (0.05 Sv);

(ii) a lens dose equivalent exceeding 15 rem [~~rems~~] (0.15 Sv); or

(iii) a shallow dose equivalent to the skin or extremities or a total organ dose equivalent exceeding 50 rem [~~rems~~] (0.5 Sv); or

(B) the release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake more than [~~in excess of~~] one occupational ALI. This provision does not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures.

(3) Licensees must [~~shall~~] make the initial notification reports required by paragraphs (1) and (2) of this subsection by telephone to the department [~~agency~~] and must [~~shall~~] confirm the initial notification report within 24 hours by [~~facsimile or~~] other electronic media transmission to the department [~~agency~~].

(4) The licensee must [~~shall~~] prepare each report filed with the department as specified in [~~agency in accordance with~~] this section so that names of individuals who have received exposure to sources of radiation are stated in a separate and detachable portion of the report.

(5) The provisions of this section do not apply to doses that result from planned special exposures, provided such doses are within the limits for planned special exposures and are reported as specified in [~~accordance with~~] subsection (zz) of this section.

(6) Each licensee must [~~shall~~] notify the department [~~agency~~] as soon as possible, but not later than four hours after the discovery, of an event that prevents immediate protective actions necessary to avoid exposures to radioactive materials that could exceed regulatory limits, or releases of radioactive materials that could exceed regulatory limits (events may include fires, explosions, toxic gas releases, etc.).

(7) Each licensee must [~~shall~~] notify the department [~~agency~~] within 24 hours after the discovery of any of the following events involving radioactive material:

(A) an unplanned contamination event [~~that~~]:

(i) requiring [~~requires~~] access to the contaminated area[~~, by workers or the public,~~] to be restricted for more than 24 hours by imposing additional radiological controls or by prohibiting entry into the area;

(ii) involving [~~involves~~] a quantity of material greater than five times the lowest annual limit on intake specified in subsection (ggg)(2) of this section for the material; and

(iii) restricting [~~has~~] access to the area [~~restricted~~] for a reason other than to allow isotopes with a half-life of less than 24 hours to decay before [~~prior to~~] decontamination;

(B) an event in which equipment is disabled or fails to function as designed when:

(i) the equipment is required by rule or license condition to prevent releases exceeding regulatory limits, to prevent exposures to radioactive materials exceeding regulatory limits, or to mitigate the consequences of an accident;

(ii) the equipment is required to be available and operable when it is disabled or fails to function; and

(iii) no redundant equipment is available and operable to perform the required safety function;

(C) an event that requires unplanned medical treatment at a medical facility of an individual with spreadable radioactive contamination on the individual's clothing or body; or

(D) an unplanned fire or explosion damaging any radioactive material or any device, container, or equipment containing radioactive material when:

(i) the quantity of material involved is greater than five times the lowest annual limit on intake specified in subsection (ggg)(2) of this section for the material; and

(ii) the damage affects the integrity of the radioactive material or its container.

(8) Preparation and submission of reports. Reports made by licensees in response to the requirements of paragraphs (6) and (7) of this subsection must [~~shall~~] be made as follows.

(A) Licensees must [~~shall~~] make reports required by paragraphs (6) and (7) of this subsection by telephone to the department [~~agency~~]. To the extent that the information is available at the time of notification, the information provided in these reports must [~~shall~~] include:

(i) the caller's name and call back telephone number;

(ii) a description of the event, including date and time;

(iii) the exact location of the event;

(iv) the isotopes, quantities, and chemical and physical form of the radioactive material involved;

(v) any personnel radiation exposure data available; and

(vi) the source or [~~and/or~~] device manufacturer, model, and serial number.

(B) Each licensee who makes a report required by paragraphs (6) and (7) of this subsection must [~~shall~~] submit to the department [~~agency~~] a written follow-up report within 30 days of the initial report. Written reports prepared as specified in [~~accordance with~~] other requirements of this chapter may be submitted to fulfill this requirement if the reports contain all [~~of the~~] necessary information and the appropriate distribution is made. The reports must include [~~the following~~]:

(i) a description of the event, including the probable cause and the manufacturer and model number (if applicable) of any equipment that failed or malfunctioned;

(ii) the exact location of the event;

(iii) the isotopes, quantities, chemical and physical form of the radioactive material involved, and the source or [~~and/or~~] device manufacturer, model number, and serial number;

(iv) date and time of the event;

(v) corrective actions taken or planned and the results of any evaluations or assessments; and

(vi) the extent of exposure of individuals to radioactive materials without identification of individuals by name.

(yy) Reports of exposures, radiation levels, and concentrations of radioactive material exceeding the limits.

(1) In addition to the notification required by subsection (xx) of this section, each licensee must [~~shall~~] submit a written report within 30 days after becoming aware [~~learning~~] of [~~any of the following occurrences~~]:

(A) incidents for which notification is required by subsection (xx) of this section;

(B) doses exceeding [~~in excess of any of the following~~]:

(i) the occupational dose limits for adults in subsection (f) of this section;

(ii) the occupational dose limits for a minor in subsection (l) of this section;

(iii) the limits for an embryo/fetus of a declared pregnant woman in subsection (m) of this section;

(iv) the limits for an individual member of the public in subsection (n) of this section;

(v) any applicable limit in the license; or

(vi) the ALARA constraints for air emissions as required by subsection (e)(4) of this section;

(C) levels of radiation or concentrations of radioactive material in:

(i) a restricted area exceeding [~~in excess of~~] applicable limits in the license; or

(ii) an unrestricted area more than [~~in excess of~~] 10 times the applicable limit set forth in this section or in the license, whether or not involving exposure of any individual over [~~in excess of~~] the limits in subsection (n) of this section; or

(D) for licensees subject to the provisions of the EPA's generally applicable environmental radiation standards in 40 CFR §190 [~~Title 40, CFR, §190~~], levels of radiation or releases of radioactive material exceeding [~~in excess of~~] those standards, or of license conditions related to those requirements.

(2) Each report required by paragraph (1) of this subsection must [~~shall~~] describe the extent of exposure of individuals to radiation and radioactive material, including, as appropriate:

(A) estimates of each individual's dose;

(B) the levels of radiation, dose limit exceeded, concentrations of radioactive material involved, and the source or [~~and/or~~] device manufacturer, model number, and serial number;

(C) the cause of the elevated exposures, dose rates, or concentrations; and

(D) corrective steps taken or planned to ensure against a recurrence, including the schedule for achieving conformance with applicable limits, ALARA constraints, generally applicable environmental standards, and associated license conditions.

(3) Each report filed as specified in [~~accordance with~~] paragraph (1) of this subsection must [~~shall~~] include for each individual exposed: the name, identification number, and date of birth. With respect to the limit for the embryo/fetus in subsection (m) of this section, the identifiers should be those of the declared pregnant woman. The report must [~~shall~~] be prepared so that this information is stated in a separate and detachable portion of the report.

(4) All licensees who make reports as specified in [~~accordance with~~] paragraph (1) of this subsection must [~~shall~~] submit the report in writing to the department

[~~agency~~].

(zz) Reports of planned special exposures. The licensee must [~~shall~~] submit a written report to the department [~~agency~~] within 30 days following any planned special exposure conducted as specified in [~~accordance with~~] subsection (k) of this section, informing the department [~~agency that~~] a planned special exposure was conducted and indicating the date the planned special exposure occurred and the information required by subsection (qq) of this section.

(aaa) Notifications and reports to individuals.

(1) Requirements for notification and reports to individuals of exposure to sources of radiation are specified in §289.203 of this subchapter [~~title~~].

(2) When a licensee is required as specified in [~~accordance with~~] subsection (yy) or (zz) of this section to report to the department [~~agency~~] any exposure of an identified occupationally exposed individual, or an identified member of the public, to sources of radiation, the licensee must [~~shall~~] also notify the individual and provide a copy of the report submitted to the department [~~agency,~~] to the individual. Such notice must [~~shall~~] be transmitted [~~at a time~~] not later than the transmittal to the department [~~agency,~~] and must [~~shall~~] comply with the provisions of §289.203(d)(1) of this subchapter [~~title~~].

(bbb) Reports of leaking or contaminated sealed sources. The licensee must [~~shall~~] immediately notify the department [~~agency~~] if the test for leakage or contamination required as specified in [~~accordance with~~] §289.201(g) of this subchapter [~~title~~] indicates a sealed source is leaking or contaminated. A written report of a leaking or contaminated source must [~~shall~~] be submitted to the department [~~agency~~] within five [~~5~~] days. The report must [~~shall~~] include the equipment involved, including the device manufacturer, model and serial number; the test results; the date of the test; model and serial number,[~~:~~] if assigned, of the leaking source; [~~,~~] the radionuclide and its estimated activity; and the corrective action taken.

(ccc) Vacating premises.

(1) Each licensee or person possessing non-exempt sources of radiation must notify the department, in writing, at least [~~shall, no less than~~] 30 days before vacating and relinquishing possession or control of premises[~~, notify the agency, in writing, of the intent to vacate~~].

(2) The licensee or person possessing non-exempt radioactive material must [~~shall~~] decommission the premises to a degree consistent with subsequent use as an unrestricted area and as specified in [~~accordance with~~] the requirements of subsection (ddd) of this section.

(ddd) Radiological requirements for license termination.

(1) General provisions and scope.

(A) The requirements in this section apply to the decommissioning of facilities licensed as specified in [~~accordance with~~] §289.252 of this chapter [~~title~~],

§289.253 of this chapter [~~title~~] (relating to Radiation Safety Requirements for Well Logging Service Operations and Tracer Studies), §289.255 of this chapter [~~title~~] (relating to Radiation Safety Requirements and Licensing and Registration Procedures for Industrial Radiography), §289.258 of this chapter [~~title~~] (relating to Licensing and Radiation Safety Requirements for Irradiators), and §289.259 of this chapter [~~title~~] (relating to Licensing of Naturally Occurring Radioactive Material (NORM)).

(B) The requirements in this section do not apply to [~~the following~~]:

(i) sites that have been decommissioned before [~~prior to~~] October 1, 2000, as specified in [~~accordance with~~] requirements identified in this section and in §289.252 of this chapter [~~title~~]; or

(ii) sites that have previously submitted and received approval on a decommissioning plan before [~~by~~] October 1, 2000.

(C) After a site has been decommissioned and the license terminated as specified in [~~accordance with~~] the requirements in this [~~the~~] subsection, the department requires [~~agency will require~~] additional cleanup when [~~if~~] it determines that the requirements of this [~~the~~] subsection were not met and residual radioactivity remaining at the site could result in significant threat to public health and safety.

(D) When calculating TEDE to the average member of the critical group, the licensee must [~~shall~~] determine the peak annual TEDE dose expected within the first 1,000 years after decommissioning.

(2) Radiological requirements for unrestricted use. A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that is not more than [~~does not exceed~~] 25 mrem (0.25 mSv) per year, including [~~that~~] from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are ALARA. Determination of ALARA [~~the~~] levels must [~~that are ALARA shall~~] take into [~~account~~] consideration [~~of~~] any detriments, such as deaths from transportation accidents, that could [~~expected to potentially~~] result from decontamination and waste disposal.

(3) Criteria for license termination under restricted conditions. A site will be considered acceptable for license termination under restricted conditions if:

(A) the licensee demonstrates [~~can demonstrate that~~] further reductions in residual radioactivity necessary to comply with the requirements of paragraph (2) of this subsection would result in net public or environmental harm or were not being made because the residual levels associated with restricted conditions are ALARA. Determination of ALARA [~~the~~] levels must [~~which are ALARA shall~~] take into [~~account~~] consideration [~~of~~] any detriments, such as traffic accidents, expected to potentially result from decontamination and waste disposal;

(B) the licensee has made provisions for legally enforceable institutional

controls providing [~~that provide~~] reasonable assurance [~~that~~] the TEDE from residual radioactivity distinguishable from background to the average member of the critical group is not more than [~~will not exceed~~] 25 mrem (0.25 mSv) per year;

(C) the licensee has provided sufficient financial assurance enabling [~~to enable~~] an independent third party, including a governmental custodian of a site, to assume and carry out responsibilities for any necessary control and maintenance of the site. Acceptable financial assurance mechanisms include [~~are~~]:

(i) funds placed into a trust segregated from the licensee's assets and outside the licensee's administrative control, and in which the adequacy of the trust funds is [~~to be~~] assessed based on an assumed annual 1 percent [~~1%~~] real rate of return on investment;

(ii) a statement of intent in the case of federal, state, or local government licensees, as described in §289.252(gg) of this chapter [~~title~~]; or

(iii) when a governmental entity is assuming custody and ownership of a site, an arrangement that is deemed acceptable by such governmental entity.

(D) the licensee has submitted a decommissioning plan or License Termination Plan (LTP) to the department [~~agency~~] indicating the licensee's intent to decommission as specified in [~~accordance with~~] §289.252(y) of this chapter [~~title~~], and specifying that the licensee intends to decommission by restricting use of the site. The licensee must [~~shall~~] document in the LTP or decommissioning plan how the input [~~advice~~] of individuals and institutions in the community who may be affected by the decommissioning has been sought and incorporated, as appropriate, following analysis of that input [~~advice~~].

(i) Licensees proposing to decommission by restricting use of the site must [~~shall~~] seek input [~~advice~~] from [~~such~~] affected parties regarding the following [~~matters~~] concerning the proposed decommissioning:

(I) whether provisions for institutional controls proposed by the licensee;

(-a-) [~~will~~] provide reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 mrem (0.25 mSv) TEDE per year;

(-b-) are [~~will be~~] enforceable; and

(-c-) do [~~will~~] not impose undue burdens on the local community or other affected parties; and

(II) whether the licensee has provided sufficient financial assurance to enable an independent third party, including a governmental custodian of a site, to assume and carry out responsibilities for any necessary control and maintenance of the site.

(ii) In seeking input [~~advice~~] on the issues identified in clause (i) of this

subparagraph, the licensee must [~~shall~~] provide for:

(I) participation by representatives of a broad cross section of community interests who may be affected by the decommissioning;

(II) an opportunity for a comprehensive, collective discussion on the issues by the participants represented; and

(III) a publicly available summary of the results of all [~~such~~] discussions, including a description of the individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants on the issues; and

(E) residual radioactivity at the site has been reduced so that, if the institutional controls were no longer in effect, there is reasonable assurance [~~that~~] the TEDE from residual radioactivity distinguishable from background to the average member of the critical group is ALARA and would not exceed either:

(i) 100 mrem (1 mSv) per year; or

(ii) 500 mrem (5 mSv) per year provided the licensee:

(I) demonstrates that further reductions in residual radioactivity necessary to comply with the 1 mSv per year (100 mrem per year) [~~100 mrem/y (1 mSv/y)~~] value of clause (i) of this subparagraph are not technically achievable, are [~~would be~~] prohibitively expensive, or [~~would~~] result in net public or environmental harm;

(II) makes provisions for durable institutional controls; and

(III) provides sufficient financial assurance to enable a responsible government entity or independent third party, including a governmental custodian of a site, [~~both~~] to carry out periodic rechecks of the site no less frequently than every five [~~5~~] years to assure that the institutional controls remain in place as necessary to meet the criteria of paragraph (2) of this subsection, and to assume and carry out responsibilities for any necessary control and maintenance of those controls. Acceptable financial assurance mechanisms are those in subparagraph (C) of this paragraph.

(4) Alternate requirements for license termination.

(A) The department [~~agency~~] may terminate a license using alternate requirements greater than the dose requirements specified in paragraph (2) of this subsection if the licensee [~~does the following~~]:

(i) provides assurance that public health and safety would continue to be protected, and [~~that~~] it is unlikely [~~that~~] the dose from all man-made sources combined, other than medical, would be more than the 1 mSv per year (100 mrem per year) limit specified in subsection (o) of this section, by submitting an analysis of possible sources of exposure;

(ii) reduces doses to ALARA levels, taking into consideration any detriments such as traffic accidents that could [~~expected to potentially~~] result from decontamination and waste disposal;

(iii) submits [~~has submitted~~] a decommissioning plan to the department [~~agency~~] indicating the licensee's intent to decommission as specified in [~~accordance with~~] the requirements in §289.252(y) of this chapter [~~title~~], and specifying that the licensee proposes to decommission by use of alternate requirements. The licensee must [~~shall~~] document in the decommissioning plan how the input [~~advice~~] of individuals and institutions in the community who may be affected by the decommissioning has been sought and addressed, as appropriate, following analysis of that input [~~advice~~]. In seeking input [~~such advice~~], the licensee must [~~shall~~] provide for [~~the following~~]:

(I) participation by representatives of a broad cross section of community interests who may be affected by the decommissioning;

(II) an opportunity for a comprehensive, collective discussion on the issues by the participants represented; and

(III) a publicly available summary of the results of all such discussions, including a description of the individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants on the issues; and

(iv) has provided sufficient financial assurance in the form of a trust fund to enable an independent third party, including a governmental custodian of a site, to assume and carry out responsibilities for any necessary control and maintenance of the site.

(B) The use of alternate requirements to terminate a license requires the approval of the department [~~agency~~] after consideration of the department's [~~agency's~~] recommendations addressing [~~that will address~~] any comments provided by the EPA and any public comments submitted as specified in [~~accordance with~~] paragraph (5) of this subsection.

(5) Public notification and public participation. Upon receipt of a decommissioning plan from the licensee, or a proposal from the licensee for release of a site pursuant to paragraphs (3) and (4) of this subsection, or whenever the department [~~agency~~] deems such notice to be in the public interest, the department [~~agency will do the following~~]:

(A) notifies and solicits [~~notify and solicit~~] comments from [~~the following~~]:

(i) local and state governments in the vicinity of the site and any Indian Nation or other indigenous people having [~~that have~~] treaty or statutory rights that could be affected by the decommissioning; and

(ii) the EPA, for cases where the licensee proposes to release a site as specified in [~~accordance with~~] paragraph (4) of this subsection; and

(B) publishes [~~publish~~] a notice in the *Texas Register* and a forum, such as local newspapers, letters to state or local organizations, or other appropriate forum, that is readily accessible to individuals in the vicinity of the site, and solicit comments from affected parties.

(6) Minimization of contamination.

(A) Applicants for licenses, other than renewals, after October 1, 2000, must [~~shall~~] describe in the application how facility design and procedures for operation [~~will~~] minimize, to the extent practical, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practical, the generation of LLRW.

(B) Licensees must conduct operations [~~shall~~], to the extent practical, [~~conduct operations~~] to minimize the introduction of residual radioactivity into the site, including the subsurface, as specified in [~~accordance with~~] the existing radiation protection requirements and radiological criteria for license termination in this subsection.

(eee) Limits for contamination of soil, surfaces of facilities and equipment, and vegetation.

(1) Licensees must not [~~No licensee shall~~] possess, receive, use, or transfer radioactive material in [~~such~~] a manner causing [~~as to cause~~] contamination of surfaces of facilities or equipment in unrestricted areas to the extent that the contamination is more than [~~exceeds~~] the limits specified in subsection (ggg)(6) of this section.

(2) Licensees must not [~~No licensee shall~~] possess, receive, use, or transfer radioactive material in [~~such~~] a manner causing [~~as to cause~~] contamination of soil in unrestricted areas, to the extent that the contamination is more than [~~exceeds~~], on a dry weight basis, the concentration limits specified in:

(A) subsection (ddd) of this section; or

(B) the effluent concentrations in Table II, Column 2 of subsection (ggg)(2)(F) of this section, with the units changed from microcuries per milliliter to microcuries per gram, for radionuclides not specified in paragraph (4) of this subsection.

(3) Where combinations of radionuclides are involved, the sum of the ratios between the concentrations present and the limits specified in paragraph (2) of this subsection must [~~shall~~] not exceed one.

(4) Notwithstanding the limits specified in paragraph (2) of this subsection, licensees must not [~~no licensee shall~~] cause the concentration of radium-226 or radium-228 in soil in unrestricted areas, averaged over any 100 square meters (m^2) [(~~m^2~~)], to exceed the background level by more than:

(A) 5 pCi/g [~~picocuries per gram (pCi/g)~~] (0.185 becquerel per gram (Bq/g)),

averaged over the first 15 cm of soil below the surface; and

(B) 15 pCi/g (0.555 Bq/g), averaged over 15 cm thick layers of soil more than 15 cm below the surface.

(5) Licensees must not [~~No licensee shall~~] possess, receive, use, or transfer radioactive material in [~~such~~] a manner causing [~~as to cause~~] contamination of vegetation in unrestricted areas to be more than [~~exceed~~] 5 pCi/g (0.185 Bq/g), based on dry weight, for radium-226 or radium-228.

(6) Notwithstanding the limits specified in paragraph (2) of this subsection, licensees must not [~~no licensee shall~~] cause the concentration of natural uranium with no daughters present, based on dry weight and averaged over any 100 m^2 of area, to exceed the following limits:

(A) 30 pCi/g (1.11 Bq/g), averaged over the top 15 cm of soil below the surface; and

(B) 150 pCi/g (5.55 Bq/g), average concentration at depths greater than 15 cm [~~centimeters~~] below the surface so that no individual member of the public will receive an effective dose equivalent more than [~~in excess of~~] 100 mrem (1 mSv) per year.

(fff) Exemption of specific wastes.

(1) A licensee may discard the following licensed material without regard to its radioactivity:

(A) 0.05 microcurie (μCi) (1.85 kilobecquerels (kBq)), or less, of hydrogen-3 or carbon-14 [~~, carbon-14, or iodine-125~~] per gram of medium used for liquid scintillation counting [~~or in vitro clinical or in vitro laboratory testing~~]; and

(B) 0.05 μCi (1.85 kBq), or less, of hydrogen-3 or carbon-14 [~~, carbon-14, or iodine-125,~~] per gram of animal tissue[~~,~~] averaged over the weight of the entire animal.

(2) A licensee must [~~shall~~] not discard tissue as specified in [~~accordance with~~] paragraph (1)(B) of this subsection in a manner permitting [~~that would permit~~] its use either as food for humans or as animal feed.

(3) The licensee must [~~shall~~] maintain records as specified in [~~accordance with~~] subsection (tt) of this section.

(4) Any licensee may, upon [~~agency~~] approval from the department of procedures required in paragraph (6) of this subsection, discard licensed material included in subsection (ggg)(7) of this section, if [~~provided that~~] it does not exceed the concentration and total curie limits contained therein, in a Type I municipal solid waste site as defined in the Municipal Solid Waste Regulations of the authorized regulatory agency (30 TAC Chapter 330 (relating to Municipal Solid Waste [~~Title 30, Texas Administrative Code, Chapter 330~~]), unless such licensed material also contains hazardous waste, as defined in §361.003(12) of the Solid

Waste Disposal Act, Texas Health and Safety Code[~~,~~] Chapter 361. Any licensed material included in subsection (ggg)(7) of this section and which is a hazardous waste as defined in the Solid Waste Disposal Act~~,~~ may be discarded at a facility authorized to manage hazardous waste by the authorized regulatory agency.

(5) Each licensee discarding [~~who discards~~] material described in paragraphs (1) or (4) of this subsection must [~~shall~~]:

(A) make surveys adequate to assure that the limits of paragraphs (1) or (4) of this subsection are not exceeded; and

(B) remove or otherwise obliterate or obscure all labels, tags, or other markings that would indicate that the material or its contents is radioactive.

(6) Before [~~Prior to~~] authorizations as specified in [~~accordance with~~] paragraph (4) of this subsection, a licensee must [~~shall~~] submit procedures to the department [~~agency~~] for:

(A) the physical delivery of the material to the disposal site;

(B) surveys to be performed for compliance with paragraph (5)(A) of this subsection;

(C) maintaining secure packaging during transportation to the site; and

(D) maintaining records of any discards made under paragraph (4) of this subsection.

(7) Nothing in this section relieves the licensee of maintaining records showing the receipt, transfer, and discard of such radioactive material as specified in §289.201(d) of this subchapter [~~title~~].

(8) Nothing in this section relieves the licensee from complying with other applicable federal, state, and local regulations governing any other toxic or hazardous property of these materials.

(9) Licensed material discarded under this section is exempt from the requirements of §289.252(ff) of this chapter [~~title~~].

(ggg) Appendices.

(1) Assigned protection factors for respirators. The following table contains assigned protection factors for respirators[a] [~~respirators[a]~~]:

Figure: 25 TAC §289.202(ggg)(1) [~~Figure: 25 TAC §289.202(ggg)(1)~~]

(2) ALI and DAC [~~Annual limits on intake (ALI) and derived air concentrations (DAC)~~] of radionuclides for occupational exposure; effluent concentrations; concentrations for release to sanitary sewerage.

(A) Introduction.

(i) For each radionuclide, Table I of subparagraph (F) of this paragraph indicates the chemical form [~~that 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 micron, and for three classes (D, W, Y) of radioactive material, which refer to their retention (approximately days, weeks, or years) in the pulmonary region of the lung. This classification applies to a range of clearance half-times for D if less than 10 days, for W from 10 to 100 days, and for Y greater than 100 days. Table II of subparagraph (F) of this paragraph provides concentration limits for airborne and liquid effluents released to the general environment. Table III of subparagraph (F) of this paragraph provides concentration limits for discharges to sanitary sewerage.

(ii) The values in Tables I, II, and III of subparagraph (F) of this paragraph 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.

(B) Occupational values.

(i) Note that the columns in Table I of subparagraph (F) of this paragraph captioned "Oral Ingestion ALI," "Inhalation ALI," and "DAC," are applicable to occupational exposure to radioactive material.

(ii) The ALIs in subparagraph (F) of this paragraph are the annual intakes of given radionuclide by Reference Man [~~"Reference Man"~~] that would result in either a committed effective dose equivalent of 5 rem [~~rems~~] (0.05 Sv), stochastic ALI, or a committed dose equivalent of 50 rem [~~rems~~] (0.5 Sv) to an organ or tissue, non-stochastic ALI. The stochastic ALIs were derived to result in a risk, due to irradiation of organs and tissues, comparable to the risk associated with deep dose equivalent to the whole body of 5 rem [~~rems~~] (0.05 Sv). The derivation includes multiplying the committed dose equivalent to an organ or tissue by a weighting factor, w_T[~~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 subsection (c) of this section. The non-stochastic ALIs were derived to avoid non-stochastic effects, such as prompt damage to tissue or reduction in organ function.

(iii) 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. These [~~the following~~] portions of the gastrointestinal (GI) [~~GI~~] tract are treated as four separate organs:[~~,~~] stomach, small intestine, upper large intestine, and lower large intestine[~~, are to be treated as four separate organs~~].

(iv) The dose equivalents for an extremity, skin, and lens of the eye are not considered in computing the committed effective dose equivalent, but are subject to limits that must [~~shall~~] be met separately.

(v) 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 as follows:

(I) LLI wall = lower large intestine wall;

(II) St. wall = stomach wall;

(III) Blad wall = bladder wall; and

(IV) Bone surf = bone surface.

(vi) The use of the ALIs listed first, the more limiting of the stochastic and non-stochastic ALIs, will ensure non-stochastic effects are avoided and 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. The licensee must also ensure the 50 rem (0.5 Sv) dose equivalent limit for any organ or tissue is not exceeded by the sum of the external deep dose equivalent plus the internal committed dose equivalent to that organ, not the effective dose. For the case where there is no external dose contribution, this is demonstrated if the sum of the fractions of the non-stochastic ALIs (ALI_{ns}) contributing to the committed dose equivalent to the organ receiving the highest dose does not exceed unity, that is, Σ (intake in μCi of each radionuclide/ALI_{ns}) < 1.0. If there is an external deep dose equivalent contribution (H_d), then this sum must be less than 1 - (H_d/50), instead of < 1.0.

[~~Figure: 25 TAC §289.202(ggg)(2)(B)(vi)~~]

[~~(vii) The dose equivalents for an extremity, skin, and lens of the eye are not considered in computing the committed effective dose equivalent, but are subject to limits that must be met separately.~~]

(vii) [~~(viii)~~] The DAC values are derived limits intended to control chronic occupational exposures. The relationship between the DAC and the ALI is given by:

Figure: 25 TAC §289.202(ggg)(2)(B)(vii) [~~§289.202(ggg)(2)(B)(viii)~~]

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

(ix) [~~(x)~~] The ALI and DAC values include contributions to exposure by the single radionuclide named and any in-growth of daughter radionuclides produced in the body by decay of the parent. Intakes [~~However, intakes~~] that

include both the parent and daughter radionuclides are [~~should be~~] treated by the general method appropriate for mixtures.

(x) [~~(xi)~~] The values 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 subsection (g) of this section. When an individual is exposed to radioactive materials falling [~~which fall~~] under several of the translocation classifications of the same radionuclide, such as, Class D, [~~Class~~] W, or [~~Class~~] Y, the exposure may be evaluated as if it were a mixture of different radionuclides.

(xi) [~~(xii)~~] 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 consider [~~take into account~~] the radiological half-life of different radionuclides. For this reason, values are given for Class D, W, and Y compounds, even for very short-lived radionuclides.

(C) Effluent concentrations.

(i) The columns in Table II of subparagraph (F) of this paragraph 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 subsection (o) of this section. The concentration values given in Columns 1 and 2 of Table II of subparagraph (F) of this paragraph are equivalent to the radionuclide concentrations that [~~which~~], if inhaled or ingested continuously over the course of a year, would produce a TEDE [~~total effective dose equivalent~~] of 0.05 rem (0.5 mSv).

(ii) 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 or below the dose levels established for individual members of the public. For radionuclides, where the non-stochastic limit was governing in deriving the occupational DAC, the stochastic ALI was used in deriving the corresponding airborne effluent limit in Table II of subparagraph (F) of this paragraph. For this reason, the DAC and airborne effluent limits are not always proportional as they were in the previous radiation protection standards.

(iii) The air concentration values listed in Column I of Table II of subparagraph (F) of this paragraph 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 x 10^{9}[~~10^{9}~~], relating the inhalation ALI to the DAC, as explained in subparagraph (B)(viii) of this paragraph, and then divided by a factor of 300. The factor of 300 includes the following components:

(I) a factor of 50 to relate the 5 rem [~~rems~~] (0.05 Sv) annual occupational dose limit to the 0.1 rem limit for members of the public;

(II) 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

(III) a factor of 2 to adjust the occupational values, derived for adults, so that they are applicable to other age groups.

(iv) For those radionuclides for which submersion, that is external dose, is limiting, the occupational DAC in Column 3 of Table I of subparagraph (F) of this paragraph was divided by 219. The factor of 219 is composed of a factor of 50, as described in clause (iii) of this subparagraph, 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 two [~~2~~] for age considerations is not warranted in the submersion case.

(v) The water concentrations were derived by taking the most restrictive occupational stochastic oral ingestion ALI and dividing by 7.3×10^7 [~~7.3×10^7~~]. The factor of 7.3×10^7 milliliters (mL) [~~(ml)~~] includes the following components:

(I) the factors of 50 and two [~~2~~] described in clause (iii) of this subparagraph; and

(II) a factor of 7.3×10^5 mL [~~ml~~] which is the annual water intake of Reference Man. [~~"Reference Man."~~]

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

(D) Releases to sewers. The monthly average concentrations for release to sanitary sewerage are applicable to the provisions in subsection (gg) of this section. The concentration values were derived by taking the most restrictive occupational stochastic oral ingestion ALI and dividing by 7.3×10^6 mL [~~ml~~]. The factor of 7.3×10^6 ml is composed of a factor of 7.3×10^5 mL [~~ml~~], the annual water intake by Reference Man, [~~"Reference Man,"~~] and a factor of 10, such that the concentrations, if the sewage released by the licensee is [~~were~~] the only source of water ingested by a Reference Man [~~"Reference Man"~~] during a year, results [~~would result~~] in a committed effective dose equivalent of 0.5 rem.

(E) List of elements.

Figure: 25 TAC §289.202(ggg)(2)(E) (no change)

(F) Tables--Values for annual limits. The following tables contain values for ALI [~~annual limits on intake (ALI)~~] and DAC [~~derived air concentrations (DAC)~~] of radionuclides for occupational exposure,[~~;~~] effluent concentrations, and[~~;~~] concentrations for release to sanitary sewerage:

Figure: 25 TAC §289.202(ggg)(2)(F) [~~Figure: 25 TAC §289.202(ggg)(2)(F)~~]

(3) Quantities of licensed material requiring labeling. The following tables contain quantities of licensed material requiring labeling:

Figure: 25 TAC §289.202(ggg)(3) (no change)

(4) Classification and characteristics of LLRW [~~low-level radioactive waste (LLRW)~~].

(A) Classification of radioactive waste for land disposal.

(i) Considerations. Determination of the classification of LLRW involves two considerations. First, consideration must be given to the concentration of long-lived radionuclides (and their shorter-lived precursors) whose potential hazard persists [~~will persist~~] long after such precautions as institutional controls, improved waste form, and deeper disposal have ceased to be effective. These precautions delay the time when long-lived radionuclides could cause exposures. In addition, the magnitude of the potential dose is limited by the concentration and availability of the radionuclide at the time of exposure. Second, consideration must be given to the concentration of shorter-lived radionuclides for which requirements on institutional controls, waste form, and disposal methods are effective.

(ii) Classes of waste.

(I) Class A waste is waste that is usually segregated from other waste classes at the disposal site. The physical form and characteristics of Class A waste must meet the minimum requirements set forth in subparagraph (B)(i) of this paragraph. If Class A waste also meets the stability requirements set forth in subparagraph (B)(ii) of this paragraph, it is not necessary to segregate the waste for disposal.

(II) Class B waste is waste that must meet more rigorous requirements on waste form to ensure stability after disposal. The physical form and characteristics of Class B waste must meet both the minimum and stability requirements set forth in subparagraph (B) of this paragraph.

(III) Class C waste is waste that not only must meet more rigorous requirements on waste form to ensure stability but also requires additional measures at the disposal facility to protect against inadvertent intrusion. The physical form and characteristics of Class C waste must meet both the minimum and stability requirements set forth in subparagraph (B) of this paragraph.

(iii) Classification determined by long-lived radionuclides. If the radioactive waste contains only radionuclides listed in subclause (V) of this clause, classification must [~~shall~~] be determined as follows.

(I) If the concentration does not exceed 0.1 times the value in subclause (V) of this clause, the waste is Class A.

(II) If the concentration exceeds 0.1 times the value in Table I, but

does not exceed the value in subclause (V) of this clause, the waste is Class C.

(III) If the concentration exceeds the value in subclause (V) of this clause, the waste is not generally acceptable for land disposal.

(IV) For wastes containing mixtures of radionuclides listed in subclause (V) of this clause, the total concentration must [~~shall~~] be determined by the sum of fractions rule described in clause (vii) of this subparagraph.

(V) Classification table for long-lived radionuclides.

Figure: 25 TAC §289.202(ggg)(4)(A)(iii)(V) (no change)

(iv) Classification determined by short-lived radionuclides. If the waste does not contain any of the radionuclides listed in clause (iii)(V) of this subparagraph, classification must [~~shall~~] be determined based on the concentrations shown in subclause (VI) of this clause. As [~~However, as~~] specified in clause (vi) of this subparagraph, if radioactive waste does not contain any nuclides listed in either clause (iii)(V) of this subparagraph or subclause (VI) of this clause, it is Class A.

(I) If the concentration does not exceed the value in Column 1 of subclause (VI) of this clause, the waste is Class A.

(II) If the concentration exceeds the value in Column 1 of subclause (VI) of this clause but does not exceed the value in Column 2 of subclause (VI) of this clause, the waste is Class B.

(III) If the concentration exceeds the value in Column 2 of subclause (VI) of this clause but does not exceed the value in Column 3 of subclause (VI) of this clause, the waste is Class C.

(IV) If the concentration exceeds the value in Column 3 of subclause (VI) of this clause, the waste is not generally acceptable for near-surface disposal.

(V) For wastes containing mixtures of the radionuclides listed in subclause (VI) of this clause, the total concentration must [~~shall~~] be determined by the sum of fractions rule described in clause (vii) of this subparagraph.

(VI) Classification table for short-lived radionuclides.

Figure: 25 TAC §289.202(ggg)(4)(A)(iv)(VI) (no change)

(v) Classification determined by both long and short-lived radionuclides. If the radioactive waste contains a mixture of radionuclides, some of which are listed in clause (iii)(V) of this subparagraph and some of which are listed in clause (iv)(VI) of this subparagraph, classification must [~~shall~~] be determined as follows.

(I) If the concentration of a radionuclide listed in clause (iii)(V) of this subparagraph is less than 0.1 times the value listed in clause (iii)(V) of this subparagraph, the class must [~~shall~~] be that determined by the concentration of

radionuclides listed in clause (iv)(VI) of this subparagraph.

(II) If the concentration of a radionuclide listed in clause (iii)(V) of this subparagraph exceeds 0.1 times the value listed in clause (iii)(V) of this subparagraph, but does not exceed the value listed in clause (iii)(V) of this subparagraph, the waste is [~~shall be~~] Class C, provided the concentration of radionuclides listed in clause (iv)(VI) of this subparagraph does not exceed the value shown in Column 3 of clause (iv)(VI) of this subparagraph.

(vi) Classification of wastes with radionuclides other than those listed in clauses (iii)(V) and (iv)(VI) of this subparagraph. If the waste does not contain any radionuclides listed in either clause [~~clauses~~] (iii)(V) or [~~and~~] (iv)(VI) of this subparagraph, it is Class A.

(vii) The sum of the fractions rule for mixtures of radionuclides. When [~~For~~] determining classification for waste containing [~~that contains~~] a mixture of radionuclides, it is necessary to determine the sum of fractions by dividing each radionuclide's concentration by the appropriate limit and adding the resulting values. The appropriate limits must [~~shall~~] all be taken from the same column of the same table. The sum of the fractions for the column must [~~shall~~] be less than 1.0 if the waste class is to be determined by that column. Example: A waste contains strontium-90 (Sr-90) [~~Sr-90~~] in a concentration of 50 curies per cubic meter (Ci/m^3 (1.85 terabecquerels per cubic meter (TBq/m^3) [~~(TBq/m^3)~~]) and cesium-137 (Cs-137) [~~Cs-137~~] in a concentration of 22 Ci/m^3 (814 gigabecquerels per cubic meter (GBq/m^3) [~~(GBq/m^3)~~]). Since the concentrations both exceed the values in Column 1 of clause (iv)(VI) of this subparagraph, they must [~~shall~~] be compared to Column 2 values. For Sr-90 fraction, 50/150 = 0.33, for Cs-137 fraction, 22/44 = 0.5; the sum of the fractions = 0.83. Since the sum is less than 1.0, the waste is Class B.

(viii) Determination of concentrations in wastes. The concentration of a radionuclide may be determined by indirect methods such as use of scaling factors, which relate the inferred concentration of one radionuclide to another that is measured, or radionuclide material accountability, if there is reasonable assurance [~~that~~] the indirect methods can be correlated with actual measurements. The concentration of a radionuclide may be averaged over the volume of the waste, or weight of the waste if the units are expressed as nanocurie (becquerel) per gram.

(B) Radioactive waste characteristics.

(i) The following are minimum requirements for all classes of waste and are intended to facilitate handling and provide health and safety protections [~~protection of health and safety~~] of personnel at the disposal site.

(I) Wastes must [~~shall~~] be packaged in conformance with the conditions of the license issued to the site operator where [~~to which~~] the waste will be shipped. Where the conditions of the site license are more restrictive than the provisions of this section, the site license conditions [~~shall~~] govern.

(II) Wastes must [~~shall~~] not be packaged for disposal in cardboard or fiberboard boxes.

(III) Liquid waste must [~~shall~~] be packaged in sufficient absorbent material to absorb twice the volume of the liquid.

(IV) Solid waste containing liquid must [~~shall~~] contain as little free-standing and non-corrosive liquid as is reasonably achievable. The liquid must not [~~, but in no case shall the liquid~~] exceed 1 percent [~~1.0%~~] of the volume.

(V) Waste must [~~shall~~] not be readily capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures, or of explosive reaction with water.

(VI) Waste must [~~shall~~] not contain, or be capable of generating, quantities of toxic gases, vapors, or fumes harmful to persons transporting, handling, or disposing of the waste. This does not apply to radioactive gaseous waste packaged as specified in [~~accordance with~~] subclause (VIII) of this clause.

(VII) Waste must not be pyrophoric. Pyrophoric materials contained in wastes must [~~shall~~] be treated, prepared, and packaged to be nonflammable.

(VIII) Wastes in a gaseous form must [~~shall~~] be packaged at an absolute pressure that does not exceed 1.5 atmospheres at 20 degrees Celsius. Total activity must [~~shall~~] not exceed 100 Ci (3.7 TBq [~~terabecquerels (TBq)~~]) per container.

(IX) Wastes containing hazardous, biological, pathogenic, or infectious material must [~~shall~~] be treated to reduce, to the maximum extent practicable, the potential hazard from the non-radiological materials.

(ii) The following requirements are intended to provide stability of the waste. Stability is intended to ensure that the waste does not degrade and affect overall stability of the site through slumping, collapse, or other failure of the disposal unit and thereby lead to water infiltration. Stability is also a factor in limiting exposure to an inadvertent intruder[~~,~~] since it provides a recognizable and non-dispersible [~~nondispersible~~] waste.

(I) Waste must [~~shall~~] have structural stability. A structurally stable waste form [~~will~~] generally maintains [~~maintain~~] its physical dimensions and its form[~~,~~] under the expected disposal conditions such as weight of overburden and compaction equipment, the presence of moisture, [~~and~~] microbial activity, and internal factors such as radiation effects and chemical changes. Structural stability can be provided by the waste form itself, processing the waste to a stable form, or placing the waste in a disposal container or structure that provides stability after disposal.

(II) Notwithstanding the provisions in clause (i)(III) and (IV) of this subparagraph, liquid wastes, or wastes containing liquid, must [~~shall~~] be converted into a form that contains as little free-standing and non-corrosive liquid as is

reasonably achievable. The liquid must not[~~, but in no case shall the liquid~~] exceed 1 percent [~~1.0%~~] of the volume of the waste when the waste is in a disposal container designed to ensure stability, or 0.5 percent [~~0.5%~~] of the volume of the waste for waste processed to a stable form.

(III) Void spaces within the waste and between the waste and its package must [~~shall~~] be reduced to the extent practicable.

(C) Labeling. Each package of waste must [~~shall~~] be clearly labeled to identify whether it is Class A, Class B, or Class C waste, as specified in [~~accordance with~~] subparagraph (A) of this paragraph.

(5) Time requirements for record keeping.

Figure: 25 TAC §289.202(ggg)(5) [~~Figure: 25 TAC §289.202(ggg)(5)~~]

(6) Acceptable surface contamination levels (per 100 cm^2).

Figure: 25 TAC §289.202(ggg)(6) [~~Figure: 25 TAC §289.202(ggg)(6)~~]

(7) Concentration and activity limits of nuclides for disposal in a Type I municipal solid waste site or a hazardous waste facility (for use in subsection (fff) of this section). The following table contains concentration and activity limits of nuclides for disposal in a Type I municipal solid waste site or a hazardous waste facility.

Figure: 25 TAC §289.202(ggg)(7) (no change)

(8) Cumulative occupational exposure form. RC Form 202-2, found in the attached graphic, Figure: 25 TAC §289.202(ggg)(8), or other equivalent clear and legible record of all the required information [~~required on that form~~], must be used to document cumulative occupational exposure history:

Figure: 25 TAC §289.202(ggg)(8) (no change)

(9) Occupational exposure form. RC Form 202-3, found in the attached graphic, Figure: 25 TAC §289.202(ggg)(9), or other equivalent clear and legible record of all the required information [~~required on that form~~], must be used to document occupational exposure record for a monitoring period:

Figure: 25 TAC §289.202(ggg)(9) (no change)

(hhh) Requirements for nationally tracked sources.

(1) Reports of transactions involving nationally tracked sources. Each licensee who manufactures, transfers, receives, disassembles, or disposes of a nationally tracked source must [~~shall~~] complete and submit to NRC a National Source Tracking Transaction Report as specified in the following subparagraphs for each type of transaction.

(A) Each licensee who manufactures a nationally tracked source must [~~shall~~]

complete and submit to NRC a National Source Tracking Transaction Report. The report must [~~shall~~] include [~~the following information~~]:

(i) the name, address, and license number of the reporting licensee;

(ii) the name of the individual preparing the report;

(iii) the manufacturer, model, and serial number of the source;

(iv) the radioactive material in the source;

(v) the initial source strength in curies (becquerels) [~~becquerels (curies)~~] at the time of manufacture; and

(vi) the manufacture date of the source.

(B) Each licensee that transfers a nationally tracked source to another person must [~~shall~~] complete and submit to NRC a National Source Tracking Transaction Report. A source transfer transaction does not include transfers to a temporary domestic job site. Domestic transactions in which the nationally tracked source remains in the possession of the licensee do not require a report to the National Source Tracking System. The report must [~~shall~~] include [~~the following information~~]:

(i) the name, address, and license number of the reporting licensee;

(ii) the name of the individual preparing the report;

(iii) the name and license number of the recipient facility and the shipping address;

(iv) the manufacturer, model, and serial number of the source or, if not available, other information to uniquely identify the source;

(v) the radioactive material in the source;

(vi) the initial or current source strength in curies (becquerels) [~~becquerels (curies)~~];

(vii) the date for which the source strength is reported;

(viii) the shipping date;

(ix) the estimated arrival date; and

(x) for nationally tracked sources transferred as waste under a Uniform Low-Level Radioactive Waste Manifest, the waste manifest number and the container identification [~~of the container with the nationally tracked source~~].

(C) Each licensee that receives a nationally tracked source must [~~shall~~] complete and submit to NRC a National Source Tracking Transaction Report. The report must [~~shall~~] include [~~the following information~~]:

(i) the name, address, and license number of the reporting licensee;

(ii) the name of the individual preparing the report;

(iii) the name, address, and license number of the person that provided the source;

(iv) the manufacturer, model, and serial number of the source or, if not available, other information to uniquely identify the source;

(v) the radioactive material in the source;

(vi) the initial or current source strength in curies (becquerels) [~~becquerels (curies)~~];

(vii) the date for which the source strength is reported;

(viii) the date of receipt; and

(ix) for material received under a Uniform Low-Level Radioactive Waste Manifest, the waste manifest number and the container identification [~~with the nationally tracked source~~].

(D) Each licensee that disassembles a nationally tracked source must [~~shall~~] complete and submit to NRC a National Source Tracking Transaction Report. The report must [~~shall~~] include [~~the following information~~]:

(i) the name, address, and license number of the reporting licensee;

(ii) the name of the individual preparing the report;

(iii) the manufacturer, model, and serial number of the source or, if not available, other information to uniquely identify the source;

(iv) the radioactive material in the source;

(v) the initial or current source strength in curies (becquerels) [~~becquerels (curies)~~];

(vi) the date for which the source strength is reported; and

(vii) the disassemble date of the source.

(E) Each licensee disposing [~~who disposes of~~] a nationally tracked source must [~~shall~~] complete and submit to NRC a National Source Tracking Transaction Report. The report must [~~shall~~] include [~~the following information~~]:

(i) the name, address, and license number of the reporting licensee;

(ii) the name of the individual preparing the report;

(iii) the waste manifest number;

(iv) the container identification [~~with the nationally tracked source~~];

(v) the date of disposal; and

(vi) the method of disposal.

(F) The reports discussed in subparagraphs (A) - (E) of this paragraph must [~~shall~~] be submitted to NRC by the close of the next business day after the transaction. A single report may be submitted for multiple sources and transactions. The reports must [~~shall~~] be submitted to the National Source Tracking System by using the following:

(i) the on-line National Source Tracking System;

(ii) electronically, using a computer-readable format;

(iii) by other electronic media transmission [~~facsimile~~];

(iv) by mail to the address on the National Source Tracking Transaction Report Form (NRC Form 748); or

(v) by telephone with follow-up by other electronic media transmission [~~facsimile~~] or mail.

(G) Each licensee must [~~shall~~] correct any error in previously filed reports or file a new report for any missed transaction within five [~~5~~] business days of the discovery of the error or missed transaction. Such errors may be detected by a variety of methods such as administrative reviews or by physical inventories required by regulation. In addition, each licensee must [~~shall~~] reconcile the inventory of nationally tracked sources possessed by the licensee against that licensee's data in the National Source Tracking System. The reconciliation must [~~shall~~] be conducted during the month of January [~~in~~] each year. The reconciliation process must [~~shall~~] include resolving any discrepancies between the National Source Tracking System and the actual inventory by filing the reports identified by subparagraphs (A) - (E) of this paragraph. By January 31 of each year, each licensee must [~~shall~~] submit to the National Source Tracking System confirmation [~~that~~] the data in the National Source Tracking System is correct.

[~~(H) Each licensee that possesses Category 1 or Category 2 nationally tracked sources listed in paragraph (2) of this subsection shall report its initial inventory of Category 1 or Category 2 nationally tracked sources to the National Source Tracking System by January 31, 2009. The information may be submitted to NRC by using any of the methods identified by subparagraph (F)(i) - (iv) of this paragraph. The initial inventory report shall include the following information:~~]

[~~(i) the name, address, and license number of the reporting licensee;~~]

[~~(ii) the name of the individual preparing the report;~~]

[~~(iii) the manufacturer, model, and serial number of each nationally tracked source or, if not available, other information to uniquely identify the~~

~~source;~~]

[~~(iv) the radioactive material in the sealed source;~~]

[~~(v) the initial or current source strength in becquerels (curies); and~~]

[~~(vi) the date for which the source strength is reported.~~]

(2) Nationally tracked source thresholds. The TBq [~~Terabecquerel (TBq)~~] values are the regulatory standards. The Ci [~~curie (Ci)~~] values specified are obtained by converting from the TBq value. The Ci [~~curie~~] values are provided for practical usefulness only and are rounded after conversion.

Figure: 25 TAC §289.202(hhh)(2) (no change)

(3) Serialization of nationally tracked sources. Each licensee who manufactures a nationally tracked source after February 6, 2007 must [~~, shall~~] assign a unique serial number to each nationally tracked source. Serial numbers must [~~shall~~] be composed only of alpha-numeric characters.

TITLE 25 HEALTH SERVICES
PART 1 DEPARTMENT OF STATE HEALTH SERVICES
CHAPTER 289 RADIATION CONTROL
SUBCHAPTER F LICENSE REGULATIONS

§289.253. Radiation Safety Requirements for Well Logging Service Operations and Tracer Studies.

(a) Purpose. This section establishes radiation safety requirements for persons using sources of radiation for well logging service operations, including radioactive markers, mineral exploration, and tracer studies.

(b) Scope.

(1) This section applies to all persons who use sources of radiation for well logging service operations, radioactive markers, mineral exploration, and tracer studies.

(2) In addition to the requirements of this section, persons are subject to the requirements of:

(A) §289.201 of this chapter (relating to General Provisions for Radioactive Material);

(B) §289.202 of this chapter (relating to Standards for Protection Against Radiation from Radioactive Materials);

(C) §289.203 of this chapter (relating to Notices, Instructions, and Reports to Workers; Inspections);

(D) §289.204 of this chapter (relating to Fees for Certificates of Registration, Radioactive Material Licenses, Emergency Planning and Implementation, and Other Regulatory Services);

(E) §289.205 of this chapter (relating to Hearing and Enforcement Procedures);

(F) §289.226 of this chapter (relating to Registration of Radiation Machine Use and Services);

(G) §289.229 of this chapter (relating to Radiation Safety Requirements for Accelerators, Therapeutic Radiation Machines, Simulators, and Electronic Brachytherapy Devices);

(H) §289.231 of this chapter (relating to General Provisions and Standards for Protection Against Machine-Produced Radiation);

(I) §289.252 of this subchapter (relating to Licensing of Radioactive Material); and

(J) §289.257 of this subchapter (relating to Packaging and Transportation of Radioactive Material).

[~~This section applies to all persons who use sources of radiation for well logging service operations, radioactive markers, mineral exploration, and tracer studies. In addition to the requirements of this section, persons are subject to the requirements of §289.201 of this title (relating to General Provisions for Radioactive Material), §289.202 of this title (relating to Standards for Protection Against Radiation from Radioactive Materials), §289.203 of this title (relating to Notices, Instructions, and Reports to Workers; Inspections), §289.204 of this title (relating to Fees for Certificates of Registration, Radioactive Material Licenses, Emergency Planning and Implementation, and Other Regulatory Services), §289.205 of this title (relating to Hearing and Enforcement Procedures), §289.226 of this title (relating to Registration of Radiation Machine Use and Services), §289.229 of this title (relating to Radiation Safety Requirements for Accelerators, Therapeutic Radiation Machines, Simulators, and Electronic Brachytherapy Devices), §289.231 of this title (relating to General Provisions and Standards for Protection Against Machine-Produced Radiation), §289.252 of this title (relating to Licensing of Radioactive Material), and §289.257 of this title (relating to Packaging and Transportation of Radioactive Material).~~]

(c) Definitions. The following words and terms when used in this section [~~shall~~] have the following meaning unless the context clearly indicates otherwise.

(1) Energy compensation source (ECS)--A small, sealed source with an activity not exceeding 100 microcuries (μCi) (3.7 megabecquerel (MBq)), used within a logging tool or other tool component, to provide a reference standard to maintain the tool's calibration when in use.

(2) Field station (additional authorized use/storage location)--A facility where sources of radiation may be stored or used and from which equipment is dispatched to temporary job sites.

(3) Injection tool--A device used for subsurface or downhole controlled injection of radioactive tracer material.

(4) Logging assistant (equipment operator)--Any individual who, under the personal supervision of a logging supervisor, handles sealed sources or tracers that are not in logging tools or shipping containers or who performs surveys required by subsection (bb) of this section.

(5) Logging supervisor (field engineer)--The individual who provides personal supervision of the use of sources of radiation at temporary job sites.

(6) Logging tool--A device used subsurface to perform well logging.

(7) Mineral logging--Any logging performed for the purpose of mineral exploration other than oil or gas.

(8) Personal supervision--Guidance and instruction by the supervisor, who is physically present at the job site and in such proximity that visual contact can be maintained and immediate assistance given as required.

(9) Radiation safety officer--An individual named by the licensee or registrant and listed on the license or certificate of registration having [~~who has a~~] knowledge of, responsibility for, and authority to enforce appropriate radiation protection rules, standards, and practices on behalf of the licensee or [~~and/or~~] registrant, and who meets the requirements of subsection (s) of this section.

(10) Radioactive marker--Radioactive material placed subsurface or upon a structure intended for subsurface use for the purpose of depth determination or direction orientation.

(11) Residential location--Any area where a structure or structures are located, in which people [~~lodge or~~] live [~~are located~~], and the grounds on which these structures are located, including [~~, but not limited to,~~] houses, apartments, condominiums, and garages.

(12) Screenout--A situation in which radioactive tracer material is reversed out of an oil or gas well (well returns).

(13) Service company--Any contracted or subcontracted company that is present at the temporary job site[~~,~~] specifically, a [~~that~~] company whose equipment is connected to [~~which the~~] licensee's equipment [~~is connected~~] and [~~that is~~] exposed to 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.

(15) Storage container--A container used to secure and store radioactive sources [~~designed to provide radiation safety and security when sources of radiation are being stored~~].

(16) Temporary job site--A location where well logging or tracer studies are performed other than the specific locations [~~location(s)~~] listed on a license or certificate of registration.

(17) 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 wellbore, at the wellhead, or adjacent formation.

(18) Transport container--A container that meets the requirements of the United States Department of Transportation (DOT) and is designed to provide radiation safety and security when sources of radiation are being transported.

(19) Tritium neutron generator target source--A tritium source used within a neutron generator tube to produce neutrons for use in well logging applications.

(20) Uranium sinker bar--A weight containing depleted uranium used to aid in the descent of a logging tool down toward the bottom of a wellbore.

(21) Wellbore--A drilled hole in which wireline service operations are performed.

(22) Well logging--All operations involving the lowering and raising of measuring

devices or logging tools (that may or may not contain sources of radiation) into wellbores or cavities for the purpose of obtaining information about the well or [~~and/or~~] adjacent formations.

(23) Wireline--An armored steel cable, containing one or more electrical conductors, used to lower and raise logging tools in the wellbore.

(24) Wireline service operation--Any mechanical or electronic service that is performed in the wellbore using devices that are lowered into the well on a wireline for purposes of evaluation.

(d) Specific licenses for well logging.

(1) The applicant must [~~shall~~] satisfy the general requirements specified in this subsection and in §289.252(e) of this subchapter [~~title~~].

(2) The applicant must [~~shall~~] develop a program for training logging supervisors and logging assistants and submit to the department [~~agency~~] a description of this program which specifies [~~the~~]:

(A) initial training;

(B) on-the-job training;

(C) annual safety reviews provided by the licensee;

(D) how [~~means~~] the applicant will [~~use to~~] demonstrate the logging supervisor's knowledge and understanding of and ability to comply with the department's [~~agency's~~] regulations and licensing requirements and the applicant's operating and emergency procedures; and

(E) how [~~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.

(3) The applicant must [~~shall~~] submit to the department [~~agency~~] written operating and emergency procedures as described in subsection (ee)(4) of this section.

(4) The applicant must [~~shall~~] establish and submit to the department [~~agency~~] its program for annual inspections of the job performance of each logging supervisor to ensure [~~that~~] the department's [~~agency'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.

(5) The applicant must [~~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.

(6) If an applicant wants to perform leak testing of sealed sources, the applicant

must [~~shall~~] identify the manufacturers and the model numbers of the leak test kits [~~to be~~] used. If the applicant wants to analyze its own wipe samples, the applicant must [~~shall~~] establish procedures to follow [~~be followed~~] and submit a description of these procedures to the department [~~agency~~]. The description must include the:

(A) instruments [~~to be~~] used;

(B) methods of performing the analysis; and

(C) pertinent experience of the person who will analyze the wipe samples.

(e) Prohibitions.

(1) Licensees must not [~~No licensee shall~~] perform well logging service operations with a sealed source [~~source(s)~~] in any well or wellbore unless, before [~~prior to~~] commencement of the operation, the licensee has a written agreement with the well operator, well owner, drilling contractor, or land owner, that specifies who will be responsible for ensuring [~~the following requirements are met~~]:

(A) a reasonable effort at recovery will be made in the event a sealed source is lost or lodged downhole;

(B) a person does [~~shall~~] not attempt to recover a sealed source in a manner that, in the licensee's opinion, could result in a source rupture;

(C) if [~~in the event~~] the environment, any equipment, or personnel are contaminated with radioactive material, decontamination to levels specified in §289.202(f), (n), and (eee) of this chapter are [~~title shall~~ be] performed; and

(D) the requirements of subsection (dd)(4) of this section are [~~shall~~ be] met if [~~in the event~~] a decision is made to abandon the sealed source downhole.

(2) Licensees must not [~~No licensee shall~~] perform tracer study operations with a substance tagged with radioactive material in any well or wellbore unless, before [~~prior to~~] commencement of the operation, the licensee has a written agreement with the well operator, well owner, drilling contractor, or land owner, and the service company to which the licensee's equipment is connected, as applicable, specifying [~~that specifies~~] who is [~~will be~~] responsible for ensuring [~~the following requirements are met~~]:

(A) in the event the service company's personnel or equipment are contaminated with radioactive material, they will [~~shall~~] be decontaminated as specified in [~~accordance with~~] §289.202(n) or (ddd) of this chapter [~~title~~] before release from the job site or release for unrestricted use, respectively;

(B) in the event the well head or job site is contaminated with radioactive material, it will [~~shall~~] be decontaminated as specified in [~~accordance with~~] §289.202(ddd) of this chapter [~~title~~]; and

(C) in the event radioactive material is [~~to be~~] reversed from the well or the well screens out, the licensee will [~~shall~~] have established procedures and

equipment or facilities to [~~do the following~~]:

(i) reverse material into a preconstructed steel or lined pit that is specifically established in the event of a screen out; or

(ii) reverse material into a suitable transport container or containers [~~container(s)~~] in the event of a screen out.

(3) The licensee must [~~shall~~] maintain, as specified in [~~accordance with~~] subsection (ee)(5) of this section, a copy of the written agreement specified in paragraph (1) or (2) of this subsection.

(f) Limits on levels of radiation. Sources of radiation must [~~shall~~] be used, stored, and transported in such a manner that the requirements of §289.202 of this chapter [~~title~~], §289.231 of this chapter [~~title~~], and §289.257 of this subchapter [~~title~~], as applicable, are met.

(g) Storage precautions.

(1) Each source of radiation, except accelerators, must [~~shall~~] be provided with a storage or [~~and/or~~] transport container. Each container must [~~shall~~] have a lock (or tamper seal for calibration sources) to prevent unauthorized removal of, or exposure to, the source of radiation.

(2) Each area or room in which sources of radiation are stored must [~~shall~~] be posted as specified in [~~accordance with~~] §289.202(aa)(5) or §289.231(x) of this chapter [~~title~~], as applicable.

(3) Sources of radiation, except accelerators, must [~~shall~~] be stored downhole or in a bunker [~~in order~~] to minimize the danger from explosion or [~~and/or~~] fire.

(4) Sources of radiation may not be stored in residential locations unless specifically authorized by the department. [~~This section does not apply to storage of radioactive material in a vehicle in transit for use at temporary job sites, if the licensee complies with subsection (bb)(2) of this section.~~]

(5) Sources of radiation in storage must [~~shall~~] be secured to prevent tampering[~~,~~] or removal by unauthorized individuals.

(h) Transport precautions. Transport containers must [~~shall~~] be locked and physically secured to the transporting vehicle to prevent shifting during transport, accidental loss, tampering, or unauthorized removal.

(i) Radiation survey instruments.

(1) The licensee or registrant must [~~shall~~] maintain a sufficient number of calibrated and operable radiation survey instruments capable of detecting beta and gamma radiation at each location where sources of radiation are stored or used to make physical radiation surveys, as required by this section and by §289.202(p) or §289.231(s)[~~,~~] of this chapter [~~title~~], as applicable. Instrumentation must [~~shall~~] be capable of measuring 0.1 milliroentgen per hour (mR/hr) (1 microsievert per hour

(μSv/hr)) through at least 50 mR/hr (500 μSv/hr). (Instrumentation capable of measuring 0.1 mR/hr (1 μSv/hr) through 50 mR/hr (500 μSv/hr) may not be sufficient to determine compliance with DOT requirements.)

(2) A licensee using tracer material must [~~shall~~] have available at each additional authorized use/storage location and temporary job site, additional calibrated and operable radiation survey instruments sensitive enough to detect the radioactive surface contamination limits specified in §289.202(eee) of this chapter [~~title~~].

(3) Each radiation survey instrument required under paragraph (1) of this subsection must [~~capable of detecting beta and gamma radiation shall~~] be calibrated:

(A) by a person specifically licensed or registered by the department [~~agency~~], another agreement state, or the United States Nuclear Regulatory Commission (NRC) to perform such service;

(B) at intervals not to exceed six months and after each survey instrument repair;

(C) for the types of radiation used and at energies appropriate for use; and

(D) at an accuracy within plus or minus 20 percent [~~±20%~~] of the true radiation level at each calibration point.

(4) The licensee or registrant must [~~shall~~] maintain calibration records as specified in [~~accordance with~~] subsection (ee)(5) of this section.

(j) Leak testing of sealed sources.

(1) Testing and record keeping. Sealed sources must [~~shall~~] be tested for leakage and contamination as specified in [~~accordance with~~] this section and §289.201(g) of this chapter [~~title~~]. The licensee must [~~shall~~] maintain records of leak tests as specified in [~~accordance with~~] subsection (ee)(5) of this section.

(2) Each energy compensation source that is not exempt from testing as specified in [~~accordance with~~] §289.201(g)(2) of this chapter must [~~title shall~~] be tested at intervals not to exceed three years. In the absence of a certificate from a transferor that a test has been made within the three years before the transfer, the energy compensation source must [~~may~~] not be used until tested as specified in [~~accordance with~~] §289.201(g) of this chapter [~~title~~].

(3) If a sealed source is found to be leaking as specified in [~~accordance with~~] §289.201(g) of this chapter [~~title~~], the licensee must [~~shall~~] check the equipment associated with the leaking source for radioactive contamination and, if contaminated, have it decontaminated or disposed of by persons specifically authorized by the department [~~agency~~], the NRC, or an agreement state, to perform such services.

(k) Quarterly inventory. Each licensee or registrant must [~~shall~~] conduct a physical

inventory to account for all sources of radiation received or possessed at intervals not to exceed three months. The licensee or registrant must [~~shall~~] make and maintain records of inventories as specified in [~~accordance with~~] subsection (ee)(5) of this section and must [~~shall~~] include [~~the following~~]:

(1) the quantities and kinds of sources of radiation;

(2) the location where sources of radiation are assigned;

(3) the [~~a~~] unique identification of each source of radiation;

(4) the date of the inventory; and

(5) the name of the individual conducting the inventory.

(l) Utilization records. For each source of radiation, utilization [~~Utilization~~] records must [~~shall~~] be maintained by each licensee or registrant as specified in [~~accordance with~~] subsection (ee)(5) of this section and must [~~shall~~] include [~~the following information for each source of radiation~~]:

(1) identification of each source of radiation, including [~~to include~~]:

(A) the make and model number or [~~and/or~~] serial number (or if absent, a description) of each sealed source used; or

(B) the radionuclide and activity of tracer materials and radioactive markers used at a particular well site and the disposition of any unused tracer materials.

(2) the identity of the logging supervisor or individual who is responsible for receiving sources of radiation, to whom assigned; and

(3) the locations where used and dates of use.

(m) Design and performance criteria for sealed sources used in well logging operations.

(1) Each sealed source used in well logging applications must [~~shall~~] meet the following minimum criteria.

(A) The sealed source is of doubly encapsulated construction.

(B) The sealed source contains radioactive material with a chemical/physical form as insoluble and non-dispersible [~~nondispersible~~] as practicable.

(C) The sealed source meets one of the following requirements:

(i) for a sealed source manufactured on or before July 14, 1989, the requirements from the United States of America Standards Institute (USASI) N5.10-1968, "Classification of Sealed Radioactive Sources," or the requirements in clause (ii) or (iii) of this subparagraph;

(ii) for a sealed source manufactured after July 14, 1989, the oil-well logging requirements from the American National Standards Institute/Health

Physics Society (ANSI/HPS) N43.6-1997, "Sealed Radioactive Sources-Classification;" or

(iii) for a sealed source manufactured after July 14, 1989, the sealed source's prototype has been tested and found to maintain its integrity after each of the following tests:

(I) Temperature. The test source must [~~shall~~] be held at negative 40 [~~-40~~] degrees Celsius for 20 minutes, 600 degrees Celsius for one hour, and then be subjected to a thermal shock test with a temperature drop from 600 degrees Celsius to 20 degrees Celsius within 15 seconds.

(II) Impact. A 5 kilogram (kg) steel hammer, 2.5 centimeters (cm) in diameter, must [~~shall~~] be dropped from a height of 1 meter (m) onto the test source.

(III) Vibration. The test source must [~~shall~~] be subjected to a vibration from 25 Hertz (Hz) to 500 Hz with a peak amplitude of five times the acceleration of gravity for 30 minutes.

(IV) Puncture. A 1 gram (g) [~~(gm)~~] hammer and pin, 0.3 cm pin diameter, must [~~shall~~] be dropped from a height of 1 m onto the test source.

(V) Pressure. The test source must [~~shall~~] be subjected to an external pressure of 24,600 pounds per square inch absolute (1.695×10^7 pascals) [~~(1.695 x 107 pascals)~~] without leakage.

(2) The requirements in paragraph (1) of this subsection do not apply to sealed sources containing [~~that contain~~] radioactive material in gaseous form.

(3) The requirements in this subsection do not apply to energy compensation sources.

(n) Labeling.

(1) Each source, source holder, or logging tool containing radioactive material in other than an exempt quantity must[~~, shall~~] bear a durable, legible, and clearly visible marking or label, including [~~that has~~], as a minimum, the standard radiation caution symbol with no color requirement, and the wording DANGER (or CAUTION), RADIOACTIVE--DO NOT HANDLE, NOTIFY CIVIL AUTHORITIES (OR NAME OF COMPANY).

(2) The labeling specified in paragraph (1) of this subsection must [~~shall~~] be on the smallest component, source, source holder, or logging tool that is transported as a separate piece of equipment.

(3) Each transport container must [~~shall~~] have permanently attached [~~to it~~] a durable, legible, and clearly visible label having [~~that has~~], as a minimum, the standard radiation caution symbol and the wording DANGER (or CAUTION), RADIOACTIVE, NOTIFY CIVIL AUTHORITIES (OR NAME OF COMPANY).

(4) Each transport container must [~~shall~~] have attached [~~to it~~] a durable, legible, and clearly visible label having [~~label(s) that has~~], at [~~as~~] a minimum, the licensee's name, address, and telephone number, the radionuclide, its activity, and assay date.

(o) Inspection and maintenance.

(1) Each licensee or registrant must [~~shall~~] conduct, at intervals not to exceed six months, a program of visual inspection and maintenance of source holders (or sealed source, if there is no source holder), logging tools, source handling tools, storage containers, transport containers, and injection tools to assure proper labeling and physical condition. The inspection program may be performed concurrently with routine leak testing of sealed sources. Records of inspection and maintenance must [~~shall~~] be made and maintained by the licensee or registrant as specified in [~~accordance with~~] subsection (ee)(5) of this section.

(2) If any inspection conducted as specified in [~~accordance with~~] paragraph (1) of this subsection reveals damage to labeling or components critical to radiation safety, the device must [~~shall~~] be removed from service at the time the damage is discovered and until repairs have been made.

(3) Any operation, such as drilling, cutting, or chiseling on a source holder containing a sealed source, must [~~shall~~] be performed on the source holder only by persons specifically licensed to do so by the department [~~agency~~], another agreement state, or the NRC. The provisions of this paragraph do not apply to logging tool recovery (fishing) operations conducted as specified in [~~accordance with~~] the provisions of subsection (dd)(4) of this section.

(4) The repair, opening, or modification of any sealed source must [~~shall~~] be performed only by persons specifically licensed to do so by the department [~~agency~~], another agreement [~~or licensing~~] state, or the NRC.

(p) Training requirements.

(1) Licensees or registrants must not [~~No licensee or registrant shall~~] permit any individual to act as a logging supervisor until such individual has [~~met the following requirements~~]:

(A) [~~successfully~~] completed [~~an agency-accepted course or~~] a course [~~recognized by another agreement state, or the NRC,~~] including at least 24 hours of formal training in the subjects outlined in subsection (ee)(1) of this section;

(B) received copies of and instruction in [~~the following~~]:

(i) the requirements contained in this section and the applicable subsections of §§289.201, 289.202, 289.203, and 289.231 of this chapter [~~title~~] or their equivalent;

(ii) the conditions of the appropriate license or certificate of registration; and

(iii) the licensee's or registrant's operating, safety, and emergency procedures;

(C) demonstrated understanding of the requirements in subparagraphs (A) and (B) of this paragraph by successfully completing a written examination administered by the licensee or registrant;

(D) completed two months of on-the-job training under the supervision of a logging supervisor; and

(E) demonstrated, through a field evaluation, competence in the use of sources of radiation, related handling tools, and the type of radiation survey instruments that will be used in the job assignment.

(2) Licensees or registrants must not [~~No licensee or registrant shall~~] permit any individual to act as a logging assistant until such individual has [~~met the following requirements~~]:

(A) received copies of and instruction in the applicable subsections of §§289.201, 289.202, 289.203, and 289.231 of this chapter [~~title~~] or their equivalent, and the licensee's or registrant's operating, safety, and emergency procedures;

(B) demonstrated understanding of the requirements in subparagraph (A) of this paragraph by successfully completing a written examination administered by the licensee or registrant; and

(C) demonstrated competence to use, under the personal supervision of the logging supervisor, the sources of radiation, related handling tools, and radiation survey instruments [~~that will be~~] used in the job assignment.

(3) The licensee or registrant must [~~shall~~] provide an annual radiation safety review for logging supervisors and logging assistants.

(4) Each licensee or registrant must [~~shall~~] maintain records documenting [~~that document that~~] the requirements of paragraphs (1) - (3) of this subsection are met. Such records must [~~shall~~] be maintained as specified in [~~accordance with~~] subsection (ee)(5) of this section.

(q) Operating, safety, and emergency procedures. The licensee or registrant must [~~shall~~] maintain written operating, safety, and emergency procedures that include descriptions of and directions in at least the items listed in subsection (ee)(4) of this section.

(r) Personnel monitoring.

(1) In addition to the requirements of §289.202(p)(4) and (q) of this chapter [~~title~~] or §289.231(n) and (s)(3) of this chapter [~~title~~], as applicable, no licensee or registrant may [~~shall~~] permit any individual to act as a logging supervisor or logging assistant unless that individual wears an individual monitoring device [~~that is processed and evaluated by an accredited National Voluntary Laboratory~~

~~Accreditation Program (NVLAP) processor,~~] at all times during well logging service operations or [~~and/or~~] tracer studies utilizing sources of radiation. Each individual monitoring device must [~~shall~~] be assigned to and worn by only one individual. Film badges must [~~shall~~] be replaced at least monthly. Other individual monitoring devices requiring replacement must [~~shall~~] be replaced at least quarterly. After replacement, each individual monitoring device requiring processing must [~~shall~~] be returned to the supplier for processing within 14 calendar days or as soon as practicable. All individual monitoring devices must be evaluated at least quarterly or promptly after replacement, whichever is more frequent. Circumstances preventing meeting these time limits must be documented, and those records must be available for review by the department. [~~In circumstances that make it impossible to return each individual monitoring device to the supplier for processing within 14 calendar days, such circumstances shall be documented and available for review by the agency.~~]

(2) When necessary [~~in order~~] to aid in determining the extent of an individual's intake [~~exposure to concentrations~~] of radioactive material, the department [~~agency~~] may require a licensee or registrant to make available to the individual, appropriate bioassay services and to furnish a copy of the reports of such services to the department [~~agency~~].

(3) Personnel monitoring records must [~~shall~~] be maintained by the licensee or registrant as specified in [~~accordance with~~] subsection (ee)(5) of this section.

(s) Radiation safety officer.

(1) A radiation safety officer (RSO) must [~~shall~~] be designated for every license and certificate of registration issued by the department [~~agency~~].

(2) The RSO's documented qualifications must [~~shall~~] include:

(A) possession of a high school diploma or a certificate of high school equivalency based on the General Education Development (GED) test;

(B) completion of the training and testing requirements of subsection (o)(1) of this section; and

(C) two years of experience as a logging supervisor, including [~~to include~~] knowledge of well logging service operations and tracer studies.

(3) The duties of the RSO include [~~, but are not limited to, the following~~]:

(A) establishing and overseeing operating, safety, [~~and~~] emergency, and as low as reasonably achievable (ALARA) procedures, and reviewing [~~to review~~] them regularly to ensure [~~that~~] the procedures are current and conform with this chapter;

(B) overseeing and approving all phases of the training program for well logging service operations and [~~and/or~~] tracer studies personnel so that appropriate and effective radiation protection practices are taught;

(C) ensuring [~~that~~] required radiation surveys and leak tests are performed and documented as specified in [~~accordance with~~] this chapter, including any corrective measures when levels of radiation exceed established limits;

(D) ensuring [~~that~~] personnel monitoring is used properly by occupationally exposed [~~occupationally exposed~~] personnel, [~~that~~] records are kept of the monitoring results, and [~~that~~] timely notifications are made, as required by §289.203 of this chapter [~~title~~];

(E) investigating and reporting to the department [~~agency~~] each known or suspected case of radiation exposure to an individual or radiation level detected over the [~~in excess of~~] limits established by this chapter and each theft or loss of each source [~~source(s)~~] of radiation, determining [~~to determine~~] the cause, and taking [~~to take~~] steps to prevent its recurrence;

(F) having a thorough knowledge of management policies and administrative procedures of the licensee or registrant;

(G) assuming control and having the authority to institute corrective actions including shutdown of operations, when necessary in emergency situations or unsafe conditions;

(H) maintaining records as required by this chapter (see subsection (ee)(5) of this section);

(I) ensuring the proper storing, labeling, transport, and use of sources of radiation, storage, and [~~and/or~~] transport containers;

(J) ensuring [~~that~~] inventories are performed as specified in [~~accordance with~~] subsection (k) of this section;

(K) ensuring [~~that~~] personnel are complying with this chapter, the conditions of the license or the registration, and the operating, safety, and emergency procedures of the licensee or registrant; and

(L) serving as the primary contact with the department [~~agency~~].

(t) Security.

(1) A logging supervisor must be physically present at a temporary job site [~~jobsite~~] whenever radioactive material is being handled or is not stored and locked in a vehicle or storage place. The logging supervisor may leave the job site [~~jobsite in order~~] to obtain assistance if a sealed source becomes lodged in a well.

(2) During well logging, except when sealed sources are below ground or in shipping or storage containers, the logging supervisor or other individual designated by the logging supervisor must [~~shall~~] maintain direct surveillance of the operation to prevent unauthorized entry into a restricted area, as defined in §289.201(b) of this chapter [~~title~~], or §289.231(c) of this chapter [~~title~~], as applicable.

(u) Handling tools. The licensee must [~~shall~~] provide and require the use of tools that [~~will~~] assure remote handling of sealed sources, other than low activity calibration sources.

(v) Tracer studies.

(1) Appropriate protective clothing and equipment must [~~shall~~] be used by all personnel handling radioactive tracer material. Precautions must [~~shall~~] be taken to avoid ingestion or inhalation of radioactive material and to avoid contamination of field stations, temporary job sites, vehicles, associated equipment, and clothing.

(2) Licensees may not [~~No licensee shall~~] permit the injection of radioactive material into usable quality groundwater (3,000 parts per million (ppm) total dissolved solids or less) without prior written authorization from the department [~~agency~~].

(3) The well operator must [~~shall~~] contact the licensee when a decision is made to reverse the radioactive tracer material out of a well. The licensee must [~~shall~~] be onsite [~~on site~~] and present at the well when radioactive tracer material is reversed out of a well.

(w) Particle accelerators. Licensees or registrants must not [~~No licensee or registrant shall~~] permit above-ground testing of particle accelerators that results in the production of radiation except in areas or facilities controlled or shielded to meet the requirements of §289.202(f) or (n) of this chapter [~~title~~], or §289.231(m) or (o) of this chapter [~~title~~], as applicable.

(x) 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 §289.251(l)(2) of this subchapter (relating to Exemptions, General Licenses, and General License Acknowledgements) [~~title~~]. The use of markers is subject only to the provisions of this subsection and subsection (k) of this section.

(y) Uranium sinker bars. The licensee may use a depleted uranium sinker bar in well logging service operations only if it is legibly impressed with the wording "DANGER (or CAUTION), RADIOACTIVE-DEPLETED URANIUM, NOTIFY CIVIL AUTHORITIES (OR NAME OF COMPANY) IF FOUND."

(z) Energy compensation source (ECS).

(1) The licensee may use an ECS [~~energy compensation source~~] that is contained within a logging tool or other tool components.

(2) For well logging applications with a surface casing for protecting freshwater [~~fresh water~~] aquifers, use of the ECS is only subject to the requirements of subsections (j), (k), and (l) of this section.

(3) For well logging applications without a surface casing for protecting freshwater [~~fresh water~~] aquifers, use of the ECS is only subject to the requirements of subsections (e), (j), (k), (l), (dd), and (ee)(4)(A) [~~(cc)(4) and~~

~~(dd)~~] of this section.

(aa) Tritium neutron generator target source.

(1) Use of a tritium neutron generator target source, containing quantities not exceeding 30 curies (Ci) (1,110 gigabecquerels (GBq)) and in a well with a surface casing to protect freshwater [~~fresh water~~] aquifers, is subject to the requirements of this section, except subsections (e), (m), and (dd) of this section.

(2) Use of a tritium neutron generator target source, containing quantities exceeding 30 Ci (1,110 GBq) or in a well without a surface casing to protect freshwater [~~fresh water~~] aquifers, is subject to the requirements of this section, except subsection (m) of this section.

(bb) Radiation surveys.

(1) Radiation surveys (and calculations for neutron sources) must [~~shall~~] be made and recorded for each area where radioactive materials are stored.

(2) Radiation surveys (and calculations for neutron sources) of the radiation levels in occupied positions and on the exterior of each vehicle used to transport radioactive materials must [~~shall~~] be made and recorded. Such surveys (and calculations for neutron sources) must [~~shall~~] include all sources of radiation transported in the vehicle.

(3) If the sealed source assembly is removed from the logging tool before departing the job site, a survey of the tool to verify that the logging tool is free of contamination must [~~shall~~] be made and recorded.

(4) If the encapsulation of the sealed source has been damaged by an operation or is likely to have been damaged by an operation, the licensee must [~~shall~~] immediately conduct a radiation survey and make a record of that survey, including a contamination survey, during and after the operation.

(5) Radiation surveys must [~~shall~~] be made and recorded at the job site and [~~and/or~~] well head for each tracer operation except for those utilizing hydrogen-3, carbon-14, sulfur-35, or krypton-85. These surveys must [~~shall~~] include measurements of radiation levels before and after the operation.

(6) Records required as specified in [~~accordance with~~] paragraphs (1) - (5) of this subsection must [~~shall also~~] include the dates, the identification of personnel [~~individual(s)~~] making the survey, the unique identification of survey instruments [~~instrument(s)~~] used, radiation measurements in milliroentgen per hour (mR/hr), calculations in millirem per hour (mrem/hr) or microsievert per hour (µSv/hr) [~~(microsievert per hour (µSv/hr))~~], and an exact description of the location of the survey. Each licensee or registrant must [~~shall~~] make and maintain records of these surveys as specified in [~~accordance with~~] subsection (ee)(5) of this section.

(cc) Records/documents for inspection by the department [~~agency~~].

(1) Each licensee or registrant must [~~shall~~] maintain the records/documents

specified in subsection (ee)(5) of this section [~~for inspection by the agency~~].

(2) Each licensee or registrant maintaining additional authorized use/storage locations from which well logging service operations are conducted must [~~shall~~] have copies of the records/documents specified in subsection (ee)(5)(B) - (E) and (G) - (O) of this section that are specific to the site, available at each site [~~for inspection by the agency~~].

(3) Records/documents required as specified in [~~accordance with~~] paragraph (2) of this subsection must [~~shall~~] be maintained as specified in [~~accordance with~~] subsection (ee)(5) of this section.

(4) Each licensee or registrant conducting well logging service operations at a temporary job site must [~~shall~~] have copies of the records/documents specified in subsection (ee)(5)(B), (C), (I), (K), (L), and (N) of this section available at that site [~~for inspection by the agency~~].

(5) Records/documents required by paragraph (4) of this subsection must [~~shall~~] be maintained at the temporary job site for the period of operation at that site [~~for inspection by the agency~~].

(dd) Notification of incidents and lost sources; abandonment procedures for irretrievable sources.

(1) Notification of incidents and sources lost in other than downhole well logging operations must [~~shall~~] be made as specified in [~~accordance with~~] appropriate provisions of §289.202 of this chapter [~~title~~], or §289.231 of this chapter [~~title~~], as applicable.

(2) Whenever a sealed source or a device containing radioactive material has been ruptured or is likely to have been ruptured, the licensee must [~~shall~~] notify the department [~~agency~~] immediately by telephone and submit written notification within 30 days. The written notification must [~~shall~~] designate [~~the following~~]:

(A) the well or other location;

(B) [~~a description of~~] the magnitude and extent of the escape of radioactive material;

(C) [~~an assessment of~~] the consequences of the rupture; and

(D) [~~an explanation of~~] the efforts planned or being taken to mitigate these consequences.

(3) Whenever a sealed source is separated from the logging tool and is lost downhole, the licensee must [~~shall~~] notify the department [~~agency~~] immediately by telephone before [~~prior to~~] beginning source recovery operations.

(4) Whenever a sealed source or device containing radioactive material is lost downhole, the licensee must [~~shall do the following~~]:

(A) consult with the well operator, well owner, drilling contractor, or landowner [~~land owner~~] regarding methods to retrieve the source or device that may reduce the likelihood that the source or device will be damaged or ruptured during the logging tool recovery (fishing) operations;

(B) continuously monitor the circulating fluids from the well, if any, during logging tool recovery (fishing) operations to check for contamination resulting from damage to the sealed source with an appropriate radiation detection instrument or a logging tool with a radiation detector [~~monitor with a radiation survey instrument (or logging tool adjusted to detect gamma emissions from source(s) lost downhole), at the surface for the presence of radioactive contamination during logging tool recovery (fishing) operations~~]; and

(C) notify the department [~~agency~~] immediately by telephone and submit written notification within 30 days if radioactive contamination is detected at the surface or if the source appears to be damaged.

(5) When efforts to recover the radioactive source are not successful, the licensee must [~~shall do the following~~]:

(A) notify the department [~~agency~~] by telephone of the circumstances that resulted in the inability to retrieve the source and obtain [~~agency~~] approval from the department to implement abandonment procedures, or that the licensee implemented abandonment before receiving [~~agency~~] approval from the department because the licensee believed there was an immediate threat to public health and safety; and

(B) advise the well operator of the Railroad Commission of Texas requirements regarding abandonment and an appropriate method of abandonment, that includes [~~shall include the following~~]:

(i) the immobilization and sealing in place of the radioactive source with a cement plug;

(ii) a means to prevent inadvertent intrusion on the source, such as the setting of a whipstock or other deflection device, unless the source is not accessible to any subsequent drilling operations; and

(iii) the mounting of a permanent identification plaque, containing information required by paragraph (6) of this subsection, at the surface of the well;

(C) notify the department [~~agency~~] by telephone, giving the circumstances of the loss; and

(D) file a written report with the department [~~agency~~] within 30 days of the abandonment, providing [~~the following information~~]:

(i) the date of occurrence;

(ii) a description of the radioactive source involved, including radionuclide, activity, chemical and physical form, and manufacturer, model number and serial

number;

(iii) the surface location and identification of the well;

(iv) the results of efforts to immobilize and seal the source in place;

(v) the depth of the radioactive source;

(vi) the depth of the top of the cement plug;

(vii) the depth of the well; and

(viii) the information contained on the permanent identification plaque.

(6) Whenever a sealed source containing radioactive material is abandoned downhole, the licensee must [~~shall~~] provide a permanent plaque (an example of a suggested plaque is shown in subsection (ee)(3) of this section) for posting on the well or wellbore. This plaque must [~~shall meet the following requirements~~]:

(A) be constructed of long-lasting material such as stainless steel, brass, bronze, or monel. The size of the plaque should be convenient for use on active or inactive wells; for example, a 7-inch (17 cm) square. Letter size of the word "CAUTION" should be approximately twice the letter size of the rest of the information; for example, 1/2 inch (1.27 cm) and 1/4 inch (0.63 cm) letter size, respectively; and

(B) contain the following engraved information on its face:

(i) the word "CAUTION;"

(ii) the radiation symbol (color not required);

(iii) the date of abandonment;

(iv) the name of the well operator or well owner;

(v) the well name and well identification number [~~number(s)~~] or other designation;

(vi) radionuclides [~~radionuclide(s)~~] and activities [~~activity(ies)~~] of the sources [~~source(s)~~];

(vii) the source depth and the plug back depth (depth to the top of the plug); and

(viii) an appropriate warning, depending on the specific circumstances of each abandonment, such as [~~the following~~]:

(I) "Do not drill below plug back depth;"

(II) "Do not enlarge casing;" or

(III) "Do not re-enter hole before contacting Radiation Control, Texas

Department of State Health Services."

(7) The licensee must [~~shall~~] immediately notify the department [~~agency~~] by telephone and confirming letter if the licensee knows or has reason to believe that radioactive material has been lost in or to an underground potable water source. Such notice must [~~shall~~] designate well location and describe the magnitude and extent of loss of radioactive material, consequences of such loss, and efforts taken or planned to mitigate these consequences.

(8) In the event of an uncontrolled release of radioactive tracer material to the environment, the licensee must [~~shall~~] notify the department [~~agency~~] by telephone within 24 hours and submit written notification within 30 days.

(ee) Appendices.

(1) Subjects to be included in training courses for well logging service operations and [~~and/or~~] tracer studies are as follows:

(A) fundamentals of radiation safety that include:

(i) characteristics of radiation;

(ii) units of radiation dose (rem) and activity;

(iii) significance of radiation dose specifying radiation protection standards and biological effects of radiation;

(iv) levels of radiation from sources of radiation;

(v) methods of controlling radiation dose specifying time, distance, and shielding;

(vi) radiation safety practices, specifying prevention of contamination and methods of decontamination; and

(vii) discussion of ingestion and [~~,~~] inhalation pathways;

(B) radiation detection instrumentation to be used that includes:

(i) use of radiation survey instruments specifying operation, calibration, and limitations;

(ii) survey techniques; and

(iii) use of individual monitoring devices;

(C) equipment to be used that specifies;

(i) handling equipment and remote handling tools;

(ii) sources of radiation;

(iii) storage control, disposal, and transport of equipment and sources of

radiation;

(iv) operation and control of equipment; and

(v) maintenance of equipment;

(D) pertinent federal and state requirements;

(E) the licensee's or registrant's written operating, safety, and emergency procedures;

(F) the licensee's or registrant's record keeping procedures; and

(G) case histories and potential consequences of accidents in well logging service operations and tracer studies.

(2) In addition to the subjects for training courses required in paragraph (1) of this subsection, individuals performing tracer studies must also complete training in the following subjects:

(A) sources of contamination;

(B) contamination detection and control;

(C) decontamination techniques and limits;

(D) survey techniques for tracer materials; and

(E) packaging requirements for transportation of radioactive materials, especially residual materials from tracer studies.

(3) The following is an example of a plaque for identifying wells containing sealed sources of radioactive material abandoned downhole:

Figure: 25 TAC §289.253(ee)(3) (no change)

(4) The licensee's or registrant's operating, safety, and emergency procedures must [~~shall~~] include descriptions of and instructions in [~~at least the following~~]:

(A) the handling and use of sources of radiation in wells without surface casing for protecting freshwater [~~fresh water~~] aquifers, if appropriate;

(B) the handling and use of sources of radiation to be employed so that no individual is likely to be exposed to radiation doses over [~~in excess of~~] the limits established in §289.202 of this chapter [~~title~~], or §289.231 of this chapter [~~title~~], as applicable. Every reasonable effort must [~~shall~~] be made to keep radiation exposures and releases of radioactive material in soils and effluents to unrestricted areas as low as is reasonably achievable;

(C) methods and occasions for conducting radiation surveys;

(D) methods and occasions for locking and securing sources of radiation;

(E) personnel monitoring, including bioassays, and the use of individual monitoring devices;

(F) removing [~~removal of~~] radioactive material from storage, transporting [~~transportation of~~] radioactive material to field locations and temporary job sites, including packaging of sources of radiation in the vehicles, placarding of vehicles, securing sources of radiation during transportation, and returning [~~return~~] to storage;

(G) minimizing exposure of individuals during routine use and in the event of an accident;

(H) [~~procedures for~~] notifying proper personnel in the event of an accident or well excursion;

(I) maintaining [~~maintenance of~~] records;

(J) using, inspecting, and maintaining [~~use, inspection, and maintenance of~~] source holders, logging tools, source handling tools, storage containers, transport containers, and injection tools;

(K) actions to be taken if [~~procedures to be followed in the event~~] a sealed source is lost or lodged downhole;

(L) [~~procedures to be used for~~] picking up, receiving, handling, and opening packages containing radioactive material;

(M) surveying [~~procedures to be used for surveys of~~] temporary job sites and equipment, and decontamination of vehicles, associated equipment, and clothing following tracer studies;

(N) storing and disposing [~~storage and disposal~~] of radioactive waste;

(O) [~~procedures for~~] laundering contaminated clothing, if applicable;

(P) the licensee's or registrant's management structure;

(Q) posting of radiation areas and labeling radioactive material containers;

(R) actions to be taken if there is [~~procedures to be followed in the event of~~] an uncontrolled release of radioactive tracer material to the environment; and

(S) actions to be taken if a sealed source is ruptured, including actions preventing [~~to prevent~~] the spread of contamination and minimizing [~~minimize~~] inhalation and ingestion of radioactive material, and actions to obtain suitable radiation survey instruments as required by subsection (i) of this section.

(5) The following records/documents must [~~shall~~] be maintained by the licensee or registrant for inspection by the department [~~agency~~].

Figure: 25 TAC §289.253(ee)(5) [~~Figure: 25 TAC §289.253(ee)(5)~~]

§289.255. Radiation Safety Requirements and Licensing and Registration Procedures for Industrial Radiography.

(a) Purpose.

(1) The requirements in this section establish radiation safety requirements and licensing and registration procedures for using sources of radiation for industrial radiography and for certification of industrial radiographers.

(2) The requirements in this section apply to licensees and registrants who possess sources of radiation for industrial radiography, including radiation machines, accelerators, and sealed radioactive sources.

(3) Each licensee and registrant is responsible for ensuring compliance with this chapter, license and registration conditions, and orders of the department [~~agency~~].

(4) Each licensee and registrant is responsible for ensuring [~~that~~] radiographic personnel performing activities under a license or registration comply with this chapter, license and registration conditions, and orders of the department [~~agency~~].

(b) Scope.

(1) The requirements of this section are in addition to and not in substitution for other applicable requirements of this chapter.

(2) The requirements of the following sections of this chapter apply to all licensed industrial radiographic operations:

(A) §289.201 of this chapter [~~title~~] (relating to General Provisions for Radioactive Material);

(B) §289.202 of this chapter [~~title~~] (relating to Standards for Protection Against Radiation from Radioactive Materials);

(C) §289.203 of this chapter [~~title~~] (relating to Notices, Instructions, and Reports to Workers; Inspections);

(D) §289.204 of this chapter [~~title~~] (relating to Fees for Certificates of Registration, Radioactive Material Licenses, Emergency Planning and Implementation, and Other Regulatory Services);

(E) §289.205 of this chapter [~~title~~] (relating to Hearing and Enforcement Procedures);

(F) §289.251 of this subchapter [~~title~~] (relating to Exemptions, General Licenses, and General License Acknowledgements);

(G) §289.252 of this subchapter [~~title~~] (relating to Licensing of Radioactive Material); and

(H) §289.257 of this subchapter [~~title~~] (relating to Packaging and Transportation of Radioactive Material).

(3) The requirements of the following sections of this chapter apply to all registered industrial radiographic operations:

(A) §289.203 of this chapter [~~title~~];

(B) §289.204 of this chapter [~~title~~];

(C) §289.205 of this chapter [~~title~~];

(D) §289.226 of this chapter [~~title~~] (relating to Registration of Radiation Machine Use and Services); and

(E) §289.231 of this chapter [~~title~~] (relating to General Provisions and Standards for Protection Against Machine-Produced Radiation).

(4) The requirements of §289.228 of this chapter [~~title~~] (relating to Radiation Safety Requirements for Industrial Radiation Machines) apply to persons using analytical and other industrial radiation machines subject to this section.

(5) The requirements of §289.229 of this chapter [~~title~~] (relating to Radiation Safety Requirements for Accelerators, Therapeutic Radiation Machines, Simulators and Electronic Brachytherapy Devices) apply to persons using accelerators subject to this section.

(c) Definitions. The following words and terms[~~,~~] when used in this section[~~, shall~~] have the following meaning[~~,~~] unless the context clearly indicates otherwise.

[(~~1) Additional authorized use/storage site--Authorized use/storage locations specifically named on a license or certificate of registration other than the main site specified on a license or certificate of registration or other than temporary job sites.~~]

(1) [~~(2)~~] ANSI--American National Standards Institute.

(2) [~~(3)~~] Annual refresher safety training--A review conducted or provided by the licensee or registrant for its employees on radiation safety aspects of industrial radiography. The review may include, as appropriate, the results of internal audits, new procedures or equipment, new or revised regulations, accidents or errors that have been observed, and should also provide opportunities for employees to ask safety questions.

(3) [~~(4)~~] Associated equipment--Equipment, [~~that is~~] used in conjunction with a radiographic exposure device used to make radiographic exposures, that drives, guides, or comes in contact with the source, (such as, guide tube, control tube, control cable (drive cable), removable source stop, "J" tube, and collimator when it is used as an exposure head).

(4) [~~(5)~~] Cabinet x-ray system--An x-ray system with the x-ray tube installed in an enclosure independent of existing architectural structures except the floor on which it may be placed. An x-ray tube used within a shielded part of a building, or x-ray equipment that may temporarily or occasionally incorporate portable

shielding, is not considered a cabinet x-ray system. The cabinet x-ray system is intended to:

(A) contain at least that portion of a material being irradiated;

(B) provide radiation attenuation; and

(C) exclude personnel from its interior during generation of radiation.

(5) [~~(6)~~] Certifiable cabinet x-ray system--An existing uncertified x-ray system [~~that has been~~] modified to meet the certification requirements specified in 21 Code of Federal Regulations (CFR) [~~Title 21, Code of Federal Regulations (CFR),~~] §1020.40.

(6) [~~(7)~~] Certification identification (ID) card--The document issued by the department [~~agency~~] to individuals who have completed the requirements stated in subsection (e)(2)(A) of this section.

(7) [~~(8)~~] Certified cabinet x-ray system--An x-ray system that has been certified as specified in [~~accordance with~~] 21 CFR [~~Title 21, CFR,~~] §1010.2 as being manufactured and assembled on or after April 10, 1975, as specified in [~~according to~~] the provisions of 21 CFR [~~Title 21, CFR,~~] §1020.40.

(8) [~~(9)~~] Certifying entity--An entity that is:

(A) an independent certifying organization;

(B) an Agreement State whose industrial radiographer certification program meets the applicable parts of 10 CFR [~~Title 10, CFR,~~] Part 34, Appendix A, Parts II and III for radioactive material; or

(C) a radiation control agency whose x-ray or [~~and/or~~] combination certification requirements are found to be equivalent to criteria established by the Conference of Radiation Control Program Directors [~~Directions~~], Inc. [~~(CRCPD)~~].

(9) [~~(10)~~] Collimator--A radiation shield [~~that is~~] placed on the end of a guide tube or directly onto a radiographic exposure device to restrict the size of the radiation beam when the sealed source is cranked into position to make a radiographic exposure.

(10) [~~(11)~~] Conference of Radiation Control Program Directors, Inc. (CRCPD)--A 501(c)(3) nonprofit, non-governmental, professional organization dedicated to radiation protection to serve as a common forum for the many governmental radiation protection agencies to communicate with each other and to promote uniform radiation protection regulations and activities.

(11) [~~(12)~~] Control cable (drive cable)--The cable [~~that is~~] connected to the source assembly and used to drive the source from and return it to the shielded position.

(12) [~~(13)~~] Control mechanism (drive mechanism)--A device enabling [~~that~~

~~enables~~] the source assembly to be moved from and returned to the shielded position. A drive mechanism is also known as a crank assembly.

(13) [~~(14)~~] Control tube--A protective sheath for guiding the control cable. The control tube connects the control drive mechanism to the radiographic exposure device.

(14) [~~(15)~~] Crank-out device--The control cable, control tube, and drive mechanism used to move the sealed source to and from the shielded position to make an industrial radiographic exposure.

(15) [~~(16)~~] Exposure head--A device that locates the gamma radiography sealed source in the selected working position. An exposure head is also known as a source stop.

(16) Field station--A facility where licensed material or radiation machines are stored or used and from which equipment is dispatched to temporary job sites.

[~~(17) Fluoroscopic imaging assembly--A subsystem in which x-ray photons produce a fluoroscopic image. It includes the image receptors such as the image intensifier and spot-film device, electrical interlocks, if any, and structural material providing linkage between the image receptor and source assembly.~~]

[~~(18) GED--General educational development.~~]

(17) [~~(19)~~] Guide tube--A flexible or rigid tube, such as a "J" tube, for guiding the source assembly and the attached control cable from the exposure device to the exposure head. The guide tube may also include the connections necessary for attachment to the exposure device and to the exposure head.

(18) [~~(20)~~] Independent certifying organization--An independent organization meeting [~~that meets all of~~] the criteria of 10 CFR [~~Title 10, CFR,~~] Part 34, Appendix A, for radioactive material, or comparable standards for x-ray machines.

(19) [~~(21)~~] Industrial radiography (radiography)--A non-destructive [~~nondestructive~~] testing method using ionizing radiation, such as gamma rays or x-rays [~~x rays~~], to make radiographic images for the purpose of detecting flaws in objects without destroying them.

(20) [~~(22)~~] Lay-barge radiography--Industrial radiography performed on any water vessel used for laying pipe.

(21) [~~(23)~~] Lock-out survey--A radiation survey performed to determine [~~that~~] a sealed source is in its fully shielded position before moving the radiographic exposure device or source changer to a different temporary job site or before securing the radiographic exposure device or source changer against unauthorized removal.

(22) [~~(24)~~] Offshore--Within the territorial waters of the State of Texas. The territorial waters of Texas extend to the three marine league line or nine nautical miles from the Texas coast.

(23) [~~(25)~~] On-the-job training (hands-on experience)--Experience in all [~~of the~~] areas considered to be directly involved in the radiography process. The hours of on-the-job training do not include safety meetings, classroom training, travel, darkroom activities, film development and interpretation, or use of a cabinet x-ray unit.

(24) [~~(26)~~] Permanent radiographic installation--An enclosed [~~A~~] shielded room, cell, or vault, not located at a temporary job site [~~jobsite~~], in which radiography is performed and meets the criteria of subsection (n) of this section.

[~~(27) Permanent storage site--Any location that is specifically named on a license or certificate of registration and that is used only for storage of sources of radiation.~~]

(25) [~~(28)~~] Personal supervision--Guidance and instruction provided to a radiographer trainee by a radiographer trainer [~~who is~~] present at the site, in visual contact with the trainee while the trainee is using sources of radiation, associated equipment, and survey meters, and in such proximity that immediate assistance can be given, if required.

(26) [~~(29)~~] Pipeliners--A directional beam radiographic exposure device.

(27) [~~(30)~~] Platform radiography--Industrial radiography performed on an offshore platform or other structure over a body of water.

(28) [~~(31)~~] Practical examination--A demonstration through practical application of the safety rules and principles in industrial radiography including use of all appropriate equipment and procedures.

(29) [~~(32)~~] Radiation safety officer (RSO)--An individual named by the licensee or registrant and listed on the license or certificate of registration having [~~who has~~] a knowledge of, responsibility for, and authority to enforce appropriate radiation protection rules, standards, and practices on behalf of the licensee or registrant and who meets the requirements of subsection (e)(4) of this section.

(30) [~~(33)~~] Radiographer--Any individual who has successfully completed the [~~training, testing, and documentation~~] requirements of subsection (e)(2)(A) of this section, performs industrial radiographic operations, or provides visual surveillance of industrial radiographic operations while in attendance during transport or at the site where the sealed source or sources are being used, and [~~who~~] is responsible to the licensee or registrant for assuring compliance with the requirements of the department's [~~agency's~~] regulations and conditions of the license or certificate of registration. These individuals may be referred to as certified industrial radiographers or certified radiographers. [~~The individual may also:~~]

[~~(A) perform industrial radiographic operations; or~~]

[~~(B) be in attendance at the site where the sources of radiation are being used.~~]

(31) [~~(34)~~] Radiographer certification--Written approval received from a

certifying entity stating [~~that~~] an individual has satisfactorily met certain established radiation safety, testing, and experience criteria.

(32) [~~(35)~~] Radiographer trainee--Any individual who has successfully completed the training and documentation requirements of subsection (e)(1)(A) of this section and uses [~~who shall use~~] sources of radiation and associated equipment or radiation survey instruments under the personal supervision of a radiographer trainer.

(33) [~~(36)~~] Radiographer trainer--A radiographer who instructs and supervises radiographer trainees during on-the-job training and [~~who~~] meets the requirements of subsection (e)(3) of this section.

(34) [~~(37)~~] Radiographic exposure device--Any instrument containing a sealed source fastened or contained therein, where [~~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 (e.g., camera).

(35) [~~(38)~~] Radiographic operations--All activities associated with the presence of x-ray machines or radioactive sources in a radiographic exposure device during the use of the machine or device or transport (except when being transported by a common or contract transport). Radiographic operations include surveys to confirm the adequacy of boundaries, setting up equipment, and any activity inside restricted area boundaries.

(36) [~~(39)~~] Radiographic personnel--Any radiographer, radiographer trainer, or radiographer trainee.

(37) [~~(40)~~] Residential location--Any area where a structure or structures are located, in which people [~~lodge or~~] live, and the grounds on which these structures are located, including [~~, but not limited to,~~] houses, apartments, condominiums, and garages.

(38) [~~(41)~~] S-tube--A tube through which the radioactive source travels when inside a radiographic exposure device.

(39) [~~(42)~~] Shielded position--The location within the radiographic exposure device or source changer where the sealed source is secured and restricted from movement.

(40) [~~(43)~~] Shielded-room radiography--Industrial radiography conducted in a room shielded so radiation levels at every location on the exterior meet the limitations specified in §289.202(n) of this chapter [~~title~~] or §289.231(o) of this chapter [~~title~~], as applicable. A shielded room is also known as a bay or bunker.

(41) [~~(44)~~] Source assembly (pigtail)--An assembly consisting [~~that consists~~] of the sealed source and a connector that attaches the source to the control cable. The source assembly may also include a ball stop used to secure the source in the shielded position.

(42) [~~(45)~~] Source changer--A device designed and used to replace sealed

sources in radiographic exposure devices, including those used to transport and store sealed sources.

(43) [~~(46)~~] Storage area--Any location, facility, or vehicle [~~that is~~] used to store and secure a radiation machine, radiographic exposure device, a storage container, or a sealed source when it is not in use [~~used for radiographic operations~~]. Storage areas are locked or have a physical barrier to prevent accidental exposure, tampering, or unauthorized removal of the machine, device, container, or source.

(44) [~~(47)~~] Storage container--A device in which the sealed source is secured and stored.

[~~(48) Storage facility--A structure designed to house one or more sources of radiation to provide security and shielding at a permanent storage site. A storage facility is also known as a vault.~~]

(45) [~~(49)~~] Temporary job site--A [~~Any~~] location where radiographic operations are conducted and where licensed or registered sources of radiation may be stored [~~industrial radiography is performed~~] other than the specific use location or locations [~~location(s)~~] listed on a license or certificate of registration. [~~If use of sources of radiation is authorized at a temporary job site, storage incident to that use is also authorized.~~]

(46) [~~(50)~~] Trainee status card--The document issued by the department [~~agency~~] following completion of the requirements of subsection (e)(1)(A) of this section.

(47) [~~(51)~~] 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 United States Department of Transportation (DOT).

(48) [~~(52)~~] Underwater radiography--Industrial radiography performed when the radiographic exposure device or [~~and/or~~] related equipment are beneath the surface of the water.

(d) Exemptions.

(1) Uses of certified and certifiable cabinet x-ray systems are exempt from the requirements of this section except for the requirements of subsections (a), (b)(3), (c), and (t)(8) of this section.

(2) Industrial uses of hand-held light intensified imaging devices are exempt from the requirements in this section if the exposure rate 18 inches from the source of radiation to any individual does not exceed 2 millirem per hour (mrem/hr) (0.02 millisievert per hour (mSv/hr)). Devices with exposure rates that exceed the 2 mrem/hr (0.02 mSv/hr) level must [~~shall~~] meet the applicable requirements of this section and §289.252 of this subchapter [~~title~~] or §289.226 of this chapter [~~title~~], as applicable. This exemption will apply only to those radiation machines that do not allow a person or body part to be exposed to the radiation beam.

(3) Radiation machines determined by the department [~~agency~~] to constitute a

minimal threat to human health and safety as specified in [~~accordance with~~] §289.231(ll)(3) of this chapter [~~title,~~] are exempt from the requirements in this section except for the requirements of paragraph (1) of this subsection.

(4) Facilities that utilize radiation machines for industrial radiography only at permanent radiographic installations are exempt from the requirements of this section except for the requirements of subsections (a), (b)(1), (b)(3) - (5), (c), (e) [~~(e)(1)~~], (j), (k), (n), (o), (t)(1), (t)(2), (t)(5), and (t)(7).

(e) Requirements for qualifications of radiographic personnel.

(1) Radiographer trainee. Licensees or registrants must not [~~No licensee or registrant shall~~] permit any individual to act as a radiographer trainee until the individual possesses the original or a copy of a department-issued [~~an agency-issued~~] trainee status card or certification ID card.

(A) To obtain a department-issued [~~an agency-issued~~] trainee status card, the licensee, registrant, or the individual must [~~shall~~] document to the department [~~agency~~] on RC Form 255-E, or equivalent, that such individual has successfully completed a course of at least 40 hours on the applicable subjects outlined in subsection (x)(1) of this section. [~~The course shall be one accepted by the agency, another agreement state, or the United States Nuclear Regulatory Commission (NRC).~~]

(B) The trainee must [~~shall~~] carry a copy of the completed RC Form 255-E[~~,~~] in the interim period after submitting documentation to the department [~~agency~~] and before receiving a trainee status card. The copy of the completed RC Form 255-E [~~that was~~] submitted to the department [~~agency~~] may be used in lieu of the trainee status card for a period of 30 days from the date recorded by the trainee on the documentation.

(C) The individual must [~~shall~~] notify the department, [~~agency~~] in writing, of the need for a replacement trainee status card. The individual must [~~shall~~] carry a copy of documentation of the request while performing industrial radiographic operations until a replacement trainee status card is received from the department [~~agency~~].

(D) Records required by subparagraph (A) of this paragraph must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section.

(E) Each licensee and registrant must [~~shall~~] maintain, for [~~agency~~] inspection by the department, clear and legible records demonstrating all [~~that demonstrate that~~] the applicable requirements of this paragraph are met. A copy of the trainee status card will satisfy the documentation requirements of this paragraph.

(2) Radiographer. Licensees or registrants must not [~~No licensee or registrant shall~~] permit any individual to act as a radiographer until the individual possesses a valid radiographer certification.

(A) To obtain a radiographer certification, an individual must [~~shall~~] submit the fee as prescribed in subsection (h)(1) of this section and [~~comply with the following~~]:

(i) complete the requirements of paragraph (1)(A) of this subsection;

(ii) document to the department [~~Agency~~] on RC Form 255-R[~~,~~] completion of on-the-job training as a radiographer trainee supervised by a radiographer trainer who meets the requirements of subsection (e)(3) of this section [~~one or more radiographer trainers authorized on a license or certificate of registration~~];

(I) The radiographer trainee must [~~shall~~] carry a legible trainee status card as specified in [~~accordance with~~] paragraph (1) of this subsection while obtaining the on-the-job training specified in subclauses (II) - (VII) of this clause.

(II) The on-the-job training must [~~shall~~] include at least 200 hours of active participation in radioactive materials industrial radiographic operations or 120 hours of active participation in x-ray industrial radiographic operations, as applicable.

(III) Individuals performing industrial radiography utilizing radioactive materials and x-ray machines must [~~shall~~] complete both segments (320 hours) of on-the-job training.

(IV) The hours of on-the-job training do not include safety meetings, classroom training, travel, darkroom activities, film development and interpretation, or use of a cabinet x-ray unit.

(V) One year of documented experience of on-the-job training as authorized by another agreement state or the United States Nuclear Regulatory Commission (NRC) [~~NRC~~] may be substituted for the requirements of subclauses (II) or (III) of this clause. The documentation must [~~shall~~] be submitted to the department [~~agency~~] on RC Form 255-OS or equivalent.

(VI) The trainee must [~~shall~~] be under the personal supervision of a radiographer trainer whenever a radiographer trainee:

(-a-) uses radiation machines, radiographic exposure devices, or associated equipment; or

(-b-) performs radiation surveys required by:

(-1-) subsection (t)(6) of this section to determine [~~that~~] the radiation machine has stopped producing radiation; or

(-2-) subsection (u)(9) of this section to determine [~~that~~] the sealed source has returned to the shielded position after an exposure.

(VII) The personal supervision must [~~shall~~] include [~~the following.~~]:

(-a-) the [~~The~~] radiographer trainer's physical presence at the site where the sources of radiation are being used;

(-b-) the [~~The~~] availability of the radiographer trainer to give immediate assistance if required; and

(-c-) the [~~The~~] radiographer trainer's direct observation of the trainee's performance of the operations referred to in this section.

(iii) successfully complete within the last five years the appropriate department-administered [~~agency-administered~~] examination prescribed in subsection (g)(2) of this section or the appropriate examination of another certifying entity that affords the same or comparable certification standards as those afforded by this clause and clauses (i) and (ii) of this subparagraph; and

(iv) possesses a current certification ID card issued as specified in [~~accordance with~~] subsection (h)(2) of this section or by another certifying entity affording [~~that affords~~] the same or comparable certification standards as those afforded by this clause or clauses (i) - (iii) of this subparagraph.

(B) Reciprocal recognition by the department [~~agency~~] of an individual radiographer certification may be granted as specified in [~~according to~~] subsection (h)(5)(A) and (B) of this section.

(C) Once an individual has completed the requirements of paragraph (2)(A)(iv) of this subsection, the licensee or registrant is not required to submit the documentation referenced in paragraph (2)(A)(i) and (ii) of this subsection for renewal of a radiographer certification.

(D) Records required by subparagraph (A) of this paragraph must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section.

(E) Each licensee and registrant must [~~shall~~] maintain for [~~agency~~] inspection by the department, clear and legible records demonstrating [~~that demonstrate that~~] the applicable requirements of this paragraph are met for all industrial radiographic personnel. A copy of the certification ID card will satisfy the documentation requirements of this paragraph.

(3) Radiographer trainer.

(A) Licensees or registrants must not [~~No licensee or registrant shall~~] permit any individual to act as a radiographer trainer until:

(i) it has been documented to the department [~~agency~~] on RC Form 255-T or equivalent the [~~that such~~] individual has:

(I) met the radiographer certification requirements of paragraph (2)(A) of this subsection; and

(II) documented 2000 hours [~~one year~~] of direct [~~documented~~]

experience as a certified radiographer.

(ii) the [~~such~~] individual is in receipt of a valid trainer certification ID card issued by the department [~~agency~~] and under which the individual is acting as a radiographer trainer; and

(iii) determination is made by the department [~~agency that~~] the individual is not currently under order from the department [~~agency~~] prohibiting the individual from acting as a radiographer trainer.

(B) The specific duties of the radiographer trainer include[~~, but are not limited to, the following~~]:

(i) providing personal supervision to any radiographer trainee at the site where the sources of radiation are being used; and

(ii) preventing any unauthorized use of a source of radiation by a radiographer trainee.

(4) RSO for industrial radiography.

[~~(A)~~] An RSO must [~~shall~~] be designated on every industrial radiography license and certificate of registration issued by the department [~~agency~~]. The RSO's qualifications must be submitted to the department. A single individual may be designated as RSO for more than one license or certificate of registration if authorized by the department [~~agency~~].

(A) The minimum qualifications for industrial radiography RSOs are:

(i) completion of requirements for a radiographer trainer of subsection (e)(3)(A) of this section; and

(ii) formal training in the establishment and maintenance of a radiation protection program.

(B) The department considers alternatives when the RSO has appropriate training and experience in the field of ionizing radiation and has adequate formal training with respect to the establishment and maintenance of a radiation safety protection program.

[~~(B) The RSO's qualifications shall be submitted to the agency and shall include as a minimum:~~]

[~~(i) possession of a high school diploma or a certificate of high school equivalency based on the GED test;~~]

[~~(ii) completion of the training and testing requirements of paragraphs (1)(A) and (2)(A)(iii) of this subsection; and~~]

[~~(iii) two years of documented radiation protection experience, including knowledge of industrial radiographic operations with at least 40 hours of active participation in industrial radiographic operations.~~]

(C) The specific duties of the RSO include[~~, but are not limited to, the following~~]:

(i) establishing and overseeing operating, safety, emergency, and as low as reasonably achievable (ALARA) procedures, and to review them regularly to ensure that the procedures are current and conform with the requirements of this chapter;

(ii) overseeing and approving all phases of the training program for radiographic personnel so that appropriate and effective radiation protection practices are taught;

(iii) ensuring [~~that~~] required radiation surveys and leak tests are performed and documented as specified in [~~accordance with~~] this chapter, including any corrective measures when levels of radiation exceed established limits;

(iv) ensuring [~~that~~] personnel monitoring devices are calibrated and used properly by occupationally exposed [~~occupationally-exposed~~] personnel;

(v) ensuring [~~that~~] timely notifications to employees are made as specified in [~~required by~~] §289.203 of this chapter [~~title~~];

(vi) ensuring [~~that~~] timely notifications to the department [~~agency~~] are made as specified in [~~required by~~] this section and §289.202 of this chapter [~~title~~] or §289.231 of this chapter [~~title~~], as applicable;

(vii) ensuring [~~that~~] any required interlock switches and warning signals are functioning and [~~that~~] radiation signs, ropes, and barriers are properly posted and positioned;

(viii) investigating, determining the cause, taking steps to prevent the recurrence, and reporting to the department [~~agency~~] each:

(I) known or suspected case of radiation exposure to an individual or radiation level detected over the [~~in excess of~~] limits established by this chapter; and

(II) theft or loss of sources [~~a source(s)~~] of radiation;

(ix) having a thorough knowledge of management policies and administrative procedures of the licensee or registrant;

(x) assuming control and having the authority to institute corrective actions, including shutdown of operations, when necessary, in emergency situations or unsafe conditions;

(xi) maintaining records as specified in [~~as required by this chapter in accordance with~~] subsection (v)(1) of this section;

(xii) ensuring the proper storing, labeling, transport, and use of exposure devices and sources of radiation;

(xiii) ensuring [~~that~~] inventory and inspection and maintenance programs are performed as specified in [~~accordance with~~] subsections (k) and (m) of this section;

(xiv) ensuring [~~that~~] personnel are complying with the requirements of this chapter and the conditions of the license or the certificate of registration; and

(xv) ensuring [~~that~~] the operating, safety, and emergency procedures of the licensee or registrant are met as specified in [~~accordance with~~] subsections (t)(5)(A) - (C) and (G) and (u)(8)(A) - (C) and (I) of this section.

(f) Additional requirements.

(1) Licensees or registrants must not [~~No licensee or registrant shall~~] permit any individual to act as a radiographer trainee, radiographer, radiographer trainer, or RSO until the [~~such~~] individual has met the certification requirements as specified in [~~accordance with~~] subsection (e) of this section, as applicable, and has:

(A) received copies of and demonstrated an understanding of the following by successful completion of a written or oral examination administered by the licensee or registrant covering this material:

(i) the requirements contained in this section and the applicable requirements of §289.201 of this chapter [~~title~~], §289.202 of this chapter [~~title~~], §289.203 of this chapter [~~title~~], §289.231 of this chapter [~~title~~], and §289.257 of this subchapter [~~title~~];

(ii) the appropriate license and certificate of registration conditions [~~of the license(s) and certificate(s) of registration~~];

(iii) the licensee's or registrant's operating, safety, and emergency procedures; and

(B) demonstrated competence in the use of sources of radiation, radiographic exposure devices, associated equipment, related handling tools, and radiation survey instruments[~~,~~] that may be employed in industrial radiographic assignments by successful completion of a practical examination administered by the licensee or registrant covering such use.

(2) A radiographer and radiographer trainer must [~~shall~~] ensure [~~that~~] radiographic operations to which the individual is assigned are conducted as specified in [~~accordance with~~] the requirements of this section.

(3) Records of the administration of and the examinations required by paragraph (1) of this subsection must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section. Records must [~~shall~~] include [~~the following~~]:

(A) copies of written tests administered by the licensee or registrant;

(B) dates of oral and practical examinations and names of individuals

conducting and receiving the oral and practical examinations; and

(C) a list of items tested and the results of the oral and practical examinations.

(g) Application and fee for radiographer certification examinations.

(1) Application.

(A) An application for taking the examination must [~~shall~~] be on forms prescribed and furnished by the department [~~agency~~].

(B) The non-refundable and non-transferable application fee for examination is [~~shall be~~] $120.

(C) The appropriate fee must [~~shall~~] be submitted with the application for examination [~~when filing with the agency~~].

(D) The application and the non-refundable and non-transferable fee must [~~shall~~] be submitted to the department [~~agency~~] on or before the dates specified by the department [~~agency~~].

(E) Applicants who fail to appear at a scheduled exam and do not reschedule 48 hours before [~~prior to~~] their assigned exam session must [~~shall~~] apply for a future exam session and submit the appropriate fee, as specified in [~~accordance with~~] subparagraphs (A) - (D) of this paragraph.

(2) Examination. The examination must [~~shall~~] be given for the purpose of determining the qualifications of applicants.

(A) The scope of the examination and the methods of procedure, including determination of the passing score, are [~~shall be~~] prescribed by the department [~~agency~~]. The examination assesses [~~will assess~~] the applicant's knowledge to safely use sources of radiation and related equipment and the applicant's knowledge of this section, and the applicable requirements of §289.201 of this chapter [~~title~~], §289.202 of this chapter [~~title~~], and §289.231 of this chapter [~~title~~].

(B) The examination is [~~will be~~] administered by the department [~~agency~~] or persons authorized by the department [~~agency~~].

(C) A candidate failing an examination may apply for re-examination as specified in [~~accordance with~~] paragraph (1) of this subsection [~~and will be re-examined~~]. A candidate may [~~shall~~] not retake the same version of the department-administered [~~agency-administered~~] examination.

(D) The examination is [~~shall~~] normally [~~be~~] offered once each month. Times, dates, and locations of the examination are [~~will be~~] furnished by the department [~~agency~~].

(E) The examination is [~~will be~~] in the English language.

(F) To take the examination, an individual must [~~shall~~] present a

government-issued photo identification card, such as a driver's license, at the time of the examination.

(G) Calculators will be permitted during the examination. Calculators [~~However, calculators~~] or computers with preprogrammed data or formulas, including exposure calculators, are [~~will~~] not [~~be~~] permitted during the examination.

(H) The examination is [~~will be~~] a "closed-book" examination.

(I) Any individual observed by a department [~~an agency~~] proctor [~~to be~~] compromising the integrity of the examination will [~~shall~~] be required to surrender the examination, the answer sheet, and all scratch paper. The [~~Such~~] individual is [~~will~~] not [~~be~~] allowed to complete the examination, forfeits [~~will forfeit~~] the examination fee, and leaves [~~will leave~~] the examination site to avoid disturbing other examinees. The [~~Such~~] individual must [~~shall~~] wait 90 days before taking a new examination and must [~~shall~~] resubmit a new application and a $120 non-refundable and non-transferable examination fee.

(J) Examination material must [~~shall~~] be returned to the department [~~agency~~] at the end of the examination. No photographic or other copying of examination questions or materials is [~~shall be~~] permitted. Disclosure by any individual of the contents of any examination before [~~prior to~~] its administration is prohibited.

(K) The names and scores of individuals taking the examination are [~~shall be~~] a public record.

(h) Radiographer certification.

(1) An application for radiographer certification must [~~shall~~] be on RC Form 255-R, RC Form 255-OS, or equivalent.

(A) The non-refundable fee for radiographer certification is [~~shall be~~] $110.

(B) The appropriate fee must [~~shall~~] be submitted with the application for radiographer certification when filing with the department [~~agency~~].

(2) A certification ID card will [~~shall~~] be issued to each individual [~~who~~] successfully completing [~~completes~~] the requirements of subsection (e)(2)(A)(i) - (iii) of this section.

(A) Each individual's certification ID card contains [~~shall contain~~] the individual's photograph. The department takes [~~agency will take~~] the photograph at the time the examination is administered.

(B) The certification ID card remains the property of the department [~~agency~~] and may be revoked or suspended under the provisions of paragraph (4) of this subsection.

(C) Any individual who needs to replace a certification ID card must [~~shall~~] submit to the department [~~agency~~] a written request for a replacement certification

ID card, stating the reason a replacement certification ID card is needed. A non-refundable fee of $35 must [~~shall~~] be paid to the department [~~agency~~] for each replacement of a certification ID card. The prescribed fee must [~~shall~~] be submitted with the written request for a replacement certification ID card. The individual must [~~shall~~] carry a copy of the request while performing industrial radiographic operations until a replacement certification ID card is received from the department [~~agency~~].

(D) Each certification ID card is valid for a period of five years, unless revoked or suspended as specified in [~~accordance with~~] paragraph (4) of this subsection. Each certification ID card expires at the end of the calendar day, in the month and year stated on the certification ID card.

(3) Renewal of a radiographer certification.

(A) Applications for examination to renew a radiographer certification must [~~shall~~] be filed as specified in [~~accordance with~~] subsection (g)(1) of this section.

(B) The examination for renewal of a radiographer certification must [~~shall~~] be administered as specified in [~~accordance with~~] subsection (g)(2) of this section.

(C) A renewal certification ID card will [~~shall~~] be issued as specified in [~~accordance with~~] paragraph (2) of this subsection.

(4) Suspension or revocation of a radiographer certification.

(A) Any radiographer violating [~~who violates~~] the requirements of this chapter, or providing [~~provides~~] any material false statement in the application or any statement of fact required by [~~in accordance with~~] this chapter, may be required to show cause at a formal hearing why the radiographer certification should not be suspended or revoked as specified in [~~accordance with~~] §289.205 of this chapter [~~title~~].

(B) When a department [~~an agency~~] order has been issued for an industrial radiographer to cease and desist from the use of sources of radiation or the department [~~agency~~] suspends or revokes the individual's radiographer certification, the radiographer must [~~shall~~] surrender the certification ID card to the department [~~agency~~] until the order is changed or the suspension expires.

(C) An individual whose radiographer certification has been suspended or revoked by the department [~~agency~~] or another certifying entity must [~~shall~~] comply with the process and [~~and/or~~] conditions of the suspension or revocation orders before certification is reinstated[~~,~~] or the individual is permitted [~~by the agency~~] to apply for a new certification.

(5) Reciprocity of a radiographer certification.

(A) Reciprocal recognition by the department [~~agency~~] of an individual radiographer certification is [~~will be~~] granted if [~~provided that~~]:

(i) the individual holds a valid certification in the appropriate category and

class issued by a certifying entity, as defined in subsection (c) of this section;

(ii) the requirements and procedures of the certifying entity issuing the certification afford the same or comparable certification standards as those afforded by subsection (e)(2)(A)(i) - (iii) of this section; and

(iii) the individual submits a legible copy of the certification to the department before conducting radiographic operations in [~~agency prior to entry into~~] Texas.

(B) Enforcement actions with the department [~~agency~~], another agreement state, or the NRC or sanctions by an independent certifying entity are [~~may be~~] considered when reviewing a request for reciprocal recognition from a licensee, registrant, or certified radiographer.

(C) Certified radiographers [~~who are~~] granted reciprocity by the department must [~~agency shall~~] maintain the certification upon which the reciprocal recognition was granted, or before [~~prior to~~] the expiration of such certification, must [~~shall~~] meet the requirements of paragraph (3) of this subsection.

(i) Receipt, transfer, and disposal of industrial radiography sealed sources [~~of radiation~~] and radiography exposure devices using depleted uranium (DU) for shielding.

(1) Each licensee and registrant must [~~shall~~] make and maintain records as specified in [~~accordance with~~] subsection (v)(1) of this section, showing the receipt, transfer, and disposal of industrial radiography sealed sources [~~of radiation~~] and radiography exposure devices using DU for shielding.

(2) These records must [~~shall~~] include [~~the following~~], as appropriate:

(A) date of receipt, transfer, or disposal;

(B) name of the individual making the record;

(C) radionuclide;

(D) number of curies (becquerels) or mass (for DU);

(E) manufacturer, model, and serial number of each source of radiation or [~~and/or~~] device;

(F) for the person transferring the source of radiation, the name of the transferee, the number of the transferee's radioactive material license authorizing possession of the material, and the regulatory agency issuing the license to the transferee; and

(G) for the person receiving the source of radiation, the name of the transferor, the number of the transferor's radioactive material license authorizing possession of the material, and the regulatory agency issuing the license to the transferor.

(j) Radiation survey instruments.

(1) Each licensee and registrant must [~~shall~~] have a sufficient number of calibrated, appropriate, and operable radiation survey instruments at each location where sources of radiation are present to perform the radiation surveys required by this section and §289.202(p)(1) and (3) of this chapter [~~title~~] and §289.231(s)(1) and (2) of this chapter [~~title~~], as applicable. These radiation survey instruments must [~~shall~~] be capable of measuring a range from 2 mrem/hr (0.002 mSv/hr) through 1 rem per hour (rem/hr) (0.01 sievert per hour (Sv/hr)).

(2) Each radiation survey instrument must [~~shall~~] be calibrated:

(A) by a person licensed or registered by the department [~~agency~~], another agreement state, or the NRC to perform such service;

(B) at energies appropriate for the licensee's or registrant's use;

(C) at intervals not to exceed six months and after each instrument servicing other than battery replacement;

(D) at two points located approximately one-third and two-thirds of full-scale on each scale for linear scale instruments; for logarithmic scale instruments, at mid-range of each decade, and at two points of at least one decade; and for digital instruments, at three points between 2 and 1,000 mrem/hr (0.02 and 10 mSv/hr); and

(E) to demonstrate an accuracy within plus or minus 20 percent [~~20%~~] of the true radiation level at each point checked.

(3) Each radiation survey instrument must [~~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.

(4) Records of the calibrations required by paragraph (2) of this subsection must [~~shall~~] be maintained as specified in [~~accordance with~~] subsection (v)(1) of this section.

(k) Inventory [~~Quarterly inventory~~].

(1) Each licensee and registrant must [~~shall~~] perform a physical inventory at intervals not to exceed three months to account for all sources of radiation and for devices containing DU received or possessed except for radiation machines utilized for industrial radiography at permanent radiographic installations. Each registrant utilizing radiation machines for industrial radiography at permanent radiographic installations must perform physical inventories and maintain inventory records as required by §289.226(m)(9) of this chapter.

(2) Records of the quarterly inventories required by paragraph (1) of this subsection must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section.

(3) The record must [~~shall~~] include, [~~the following~~] for each source of radiation, as appropriate:

(A) manufacturer, model, and serial number;

(B) radionuclide;

(C) number of curies (except for DU);

(D) location of each source of radiation;

(E) date of the inventory; and

(F) name of the individual making the inventory.

(l) Utilization logs.

(1) Each licensee and registrant must [~~shall~~] make and maintain current logs of the use, removal, and return to storage of each source of radiation. The information must [~~shall~~] be recorded in the log when the source is removed from and returned to storage. The logs must [~~shall~~] include:

(A) a unique identification, for example, make, model, and serial number, of [~~the following~~]:

(i) each radiation machine;

(ii) each radiographic exposure device containing a sealed source or transport and storage container in which the sealed source is located; and

(iii) each sealed source;

(B) the name and signature of the radiographer using the source of radiation;

(C) the locations [~~location(s)~~] and dates [~~date(s)~~] where each source of radiation is used; and

(D) the dates [~~date(s)~~] each source of radiation is removed from storage and returned to storage.

(2) Utilization logs must [~~may~~] be kept on clear legible records containing all the information required by paragraph (1) of this subsection.

(3) Records of utilization logs must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section.

(m) Inspection and maintenance of radiation machines, radiographic exposure devices, transport and storage containers, associated equipment, source changers, and survey instruments.

(1) Each day before using equipment, the radiographer must [~~shall~~]:

(A) perform visual and operational checks on radiation machines, survey instruments, radiographic exposure devices, transport and storage containers, associated equipment, and source changers to ensure [~~that~~]:

(i) the equipment is in good working condition;

(ii) the sources are adequately shielded in radiographic exposure devices; and

(iii) required labeling is present and legible;

(B) determine the survey instrument is responding using check sources or other appropriate means; and

(C) remove the equipment from service until repaired if equipment problems are found.

(2) Each licensee and registrant must [~~shall~~] perform and must [~~shall~~] have written procedures for the following:

(A) inspection and routine maintenance of radiation machines, radiographic exposure devices, source changers, associated equipment, transport and storage containers, and survey instruments at intervals not to exceed three months to ensure the proper functioning of components important to safety. All appropriate components must [~~shall~~] be maintained as specified in [~~accordance with~~] manufacturers' specifications. Radiation machines, radiographic exposure devices, transport containers, and source changers being stored are exempted from this requirement provided [~~that~~] each radiation machine, radiographic exposure device, transport container, or source changer is inspected and repaired before [~~prior to~~] being returned to service. This inspection and maintenance program must [~~shall~~] cover, at [~~as~~] a minimum, the items listed in subsection (x)(2) of this section; and

(B) inspection and maintenance necessary to maintain the Type B packaging used to transport radioactive material. The inspection and maintenance program must [~~shall~~] include procedures to assure [~~that~~] Type B packages are shipped and maintained as specified in [~~accordance with~~] the certificate of compliance or other approval.

(3) Records of daily checks of equipment, equipment problems found in daily checks and quarterly inspections, and of any maintenance performed as specified in [~~accordance with~~] paragraph (1) of this subsection must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section.

(4) The record must [~~shall~~] include [~~the following~~]:

(A) date of check or inspection;

(B) name of inspector;

(C) equipment involved;

(D) any problems found; and

(E) what repairs or maintenance, if any, were done.

(n) Permanent radiographic installations.

(1) Permanent radiographic installations must [~~shall~~] have high radiation area entrance controls (for example, a control device that energizes a conspicuous visible and audible alarm signal or [~~and/or~~] continuous direct or electronic surveillance) as described in §289.202(s)(1) - (4) of this chapter [~~title~~] or §289.231(t)(1) - (4) of this chapter [~~title~~], or, if applicable, §289.229 of this chapter [~~title~~].

(2) The entrance controls must [~~shall~~] be tested for proper operation at the beginning of each day of equipment use.

(3) The alarm system must [~~shall~~] be tested for proper operation with a source of radiation each day before the installation is used for radiographic operations. The test must [~~shall~~] include a check for the visible and audible signals.

(4) Entrance control devices reducing [~~that reduce~~] the radiation level upon entry (designated in paragraph (1) of this subsection) must [~~shall~~] be tested monthly.

(5) If an entrance control device or alarm is operating improperly, it must [~~shall~~] be immediately labeled as defective and repaired within seven calendar days. The facility may continue to be used during this seven-day period, provided the licensee or registrant implements the continuous surveillance requirements of subsection (q) of this section, ensures [~~that~~] radiographic personnel use an alarming ratemeter, and complies with the requirements of subsection (u)(8)(G) of this section.

(6) Records of alarm systems and entrance control tests and repairs required by this subsection must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section.

(o) Notifications [~~Notification of incidents~~].

(1) The department must [~~agency shall~~] be notified of the loss or theft of sources of radiation, overexposures, and excessive levels as specified in [~~accordance with~~] §289.202(ww) - (yy)[~~,~~] and (bbb) of this chapter [~~title~~] or §289.231(gg) - (jj) of this chapter [~~title~~], as applicable.

(2) In addition, whenever one of the following events occurs, each licensee or registrant must [~~shall~~] make the initial notification report by telephone to the department [~~agency~~] within 24 hours and submit a written report to the department [~~agency~~] within 30 days:

(A) a source assembly cannot be returned to the fully shielded [~~fully-shielded~~] position and properly secured;

(B) the source assembly becomes unintentionally disconnected from the

control cable;

(C) any component critical to safe operation of the radiographic exposure device fails to properly perform its intended function;

(D) an indicator on a radiation machine fails to show that radiation is being produced;

(E) an exposure switch on a radiation machine fails to terminate production of radiation when turned to the off position; or

(F) a safety interlock fails to terminate x-ray production.

(3) As specified in paragraph (2) of this subsection, the [~~The~~] licensee or registrant must [~~shall~~] include [~~the following information~~] in each report submitted [~~in accordance with paragraph (2) of this subsection~~]:

(A) a description of the equipment problem;

(B) the cause of each incident, if known;

(C) the manufacturer and model and serial number of equipment involved in the incident;

(D) the location, time, and date of the incident;

(E) the action [~~actions~~] taken to establish normal operations;

(F) the corrective action [~~actions~~] taken or planned to prevent recurrence; and

(G) the names of personnel involved in the incident.

(4) Any licensee conducting radiographic operations or storing radioactive material at any location not listed on the license for a period more than 180 days in a calendar year must notify the department before exceeding the 180 days.

(5) Any registrant conducting radiographic operations or storing radiation machines at any location not listed on the certificate of registration for a period more than 90 days in a calendar year must notify the department before exceeding the 90 days.

(p) Individual monitoring.

(1) The individual monitoring program must [~~shall~~] meet the applicable requirements of §289.202 of this chapter [~~title~~] or §289.231 of this chapter [~~title~~].

(2) During industrial radiographic operations, the following applies: [~~shall apply.~~]

(A) Licensees or registrants must not [~~No licensee or registrant shall~~] permit an individual to act as a radiographer, radiographer trainer, or radiographer trainee unless each individual wears, on the trunk of the body at all times during

radiographic operations:

(i) an individual monitoring device meeting [~~that meets~~] the applicable requirements of §289.202(p)(4) and (5) [~~§289.202(p)(3) and (4~~)], (q), and (r) of this chapter [~~title~~] or §289.231(s)(3) of this chapter [~~title~~];

(ii) a direct-reading pocket dosimeter or an electronic personal dosimeter; and

(iii) an operable alarming ratemeter.

(B) For permanent radiographic installations where other appropriate alarming or warning devices are in routine use, the wearing of an alarming ratemeter is not required.

(C) Pocket dosimeters must [~~shall~~] meet the criteria in ANSI 13.5-1972 at the time of manufacture and must [~~shall~~] have a range of zero to 200 mrem (2 mSv). Electronic personal dosimeters may only be used in place of ion-chamber pocket dosimeters.

(D) Pocket dosimeters must [~~shall~~] be recharged at the start of each work shift.

(E) As a minimum, direct-reading pocket dosimeters must [~~shall~~] be recharged and electronic personal dosimeters reset, and "start" readings recorded:

(i) immediately before checking out any source of radiation from an authorized use or storage site [~~location~~] for the purposes of conducting industrial radiographic operations; and

(ii) before beginning radiographic operations on any subsequent calendar day (if the source of radiation has not been checked back into an authorized use or storage site).

(F) Whenever radiographic operations are concluded for the day, the "end" readings on pocket dosimeters or electronic personal dosimeters must [~~shall~~] be recorded and the accumulated occupational doses for that day determined and recorded.

(G) If an individual's pocket dosimeter is discharged beyond its range (for example, goes "off-scale"), or if an individual's electronic personal dosimeter reads greater than 200 mrem (2 mSv) and the possibility of radiation exposure cannot be ruled out as the cause, industrial radiographic operations by that individual must [~~shall~~] cease and the individual's monitoring device requiring processing must be sent for processing [~~shall be processed~~] immediately. The individual's monitoring device not requiring processing must be evaluated immediately. The individual must [~~shall~~] not return to work with sources of radiation until a determination of the radiation exposure has been made. This determination must [~~shall~~] be made by the RSO or the RSO's designee. The results of this determination must [~~shall~~] be included in the records maintained as specified in [~~accordance with~~] paragraphs (5) and (6) of this subsection and subsection (v)(1) of this section.

(H) Each individual monitoring device must [~~shall~~] be assigned to and worn by only one individual.

(I) Film badges must [~~shall~~] be replaced at periods not to exceed one month and all other individual monitoring devices requiring replacement must [~~personnel dosimeters processed and evaluated by an accredited National Voluntary Laboratory Accreditation Program (NVLAP) processor shall~~] be replaced at least quarterly [~~periods not to exceed three months~~]. After replacement, each individual monitoring device requiring processing must [~~shall~~] be returned to the supplier for processing within 14 calendar days of the exchange date specified by the [~~personnel monitoring~~] supplier or as soon as practicable. All individual monitoring devices must be evaluated at least quarterly or promptly after replacement, whichever is more frequent. Circumstances preventing meeting these time limits must be documented, and those records must be available for review by the department. [~~In circumstances that make it impossible to return each individual monitoring device within 14 calendar days, such circumstances shall be documented and available for review by the agency.~~]

(J) If an individual monitoring device is lost or damaged, the worker must [~~shall~~] cease work immediately until a replacement individual monitoring device is provided and the exposure is calculated for the time period from issuance to loss or damage of the individual monitoring device. The results of the calculated exposure and the time period for which the individual monitoring device was lost or damaged must [~~shall~~] be included in the records maintained as specified in [~~accordance with~~] paragraph (6) of this subsection and subsection (v)(1) of this section.

(3) Pocket dosimeters or electronic personal dosimeters must [~~shall~~] be checked for correct response to radiation at periods not to exceed one year. Acceptable dosimeters must [~~shall~~] read within plus or minus 20 percent [~~20%~~] of the true radiation exposure.

(4) Each alarming ratemeter must [~~shall~~]:

(A) be checked without being exposed to radiation before [~~prior to~~] use at the start of each work shift, to ensure [~~that~~] the audible alarm is functioning properly;

(B) be set to give an alarm signal at a preset dose rate of 500 mrem/hr (5 mSv/hr) or lower with an accuracy of plus or minus 20 percent [~~20%~~] of the true radiation dose rate;

(C) require special means to change the preset alarm function;

(D) be calibrated for correct response to radiation at intervals not to exceed one year; and

(E) have an audible alarm sufficient to be heard by the individual wearing the alarming ratemeter in a work environment or have other visual or physical notification of alarming conditions.

(5) The following records required by this subsection must [~~shall~~] be made and maintained by the licensee or registrant for inspection by the department [~~agency~~] as specified in [~~accordance with~~] the following time requirements and subsection (v)(1) of this section.

(A) Records of pocket dosimeter or electronic personal dosimeter readings and yearly operational response checks must [~~shall~~] be maintained for three years. If the dosimeter readings were used to determine external radiation dose (for example, no individual monitoring device exposure records exist), the records must [~~shall~~] be maintained for department [~~agency~~] inspection until disposal is authorized by the department [~~agency~~].

(B) Records of pocket dosimeter and electronic personal dosimeter readings of personnel exposures must [~~shall~~] be maintained for three years.

(C) Records of estimates of exposures resulting from [~~as a result of~~] off-scale personal direct-reading dosimeters[~~,~~] or lost or damaged individual monitoring devices must [~~shall~~] be maintained until disposal is authorized by the department [~~agency~~].

(6) The following records required by this subsection must [~~shall~~] be maintained as specified in [~~accordance with~~] the following time requirements and subsection (v)(1) of this section.

(A) Records of alarming ratemeter calibrations must [~~shall~~] be maintained for three years.

(B) Records of individual monitoring device results must [~~received from the device processor shall~~] be maintained until disposal is authorized by the department [~~agency~~].

(q) Access control.

(1) During each industrial radiographic operation, radiographic personnel must [~~shall~~] maintain continuous visual surveillance of the operation to protect against unauthorized entry into a radiation area or high radiation area, except at permanent radiographic installations where all entryways are locked and the requirements of subsection (n) of this section are met.

(2) Radiographic exposure devices must [~~shall~~] not be left unattended except when in storage or physically secured against unauthorized removal or tampering.

(r) Posting. All areas where [~~in which~~] industrial radiography is being performed must [~~shall~~] be posted conspicuously as specified in [~~accordance with~~] §289.202 of this chapter [~~title~~] or §289.231 of this chapter [~~title~~], as applicable, including the following.

(1) Radiation areas. Each radiation area must [~~shall~~] be posted conspicuously with a sign or signs [~~sign(s)~~] displaying the radiation caution symbol and the words "CAUTION, RADIATION AREA" or "DANGER, RADIATION AREA."

(2) High radiation area. Each high radiation area must [~~shall~~] be posted conspicuously with a sign or signs [~~sign(s)~~] displaying the radiation caution symbol and the words "CAUTION, HIGH RADIATION AREA" or "DANGER, HIGH RADIATION AREA."

(3) Whenever practicable, ropes or [~~and/or~~] barriers must [~~shall~~] be used in addition to appropriate signs to designate areas as specified in [~~accordance with~~] §289.202(n)(1) of this chapter [~~title~~] or §289.231(o)(1) of this chapter [~~title~~], as applicable, and to help prevent unauthorized entry.

(4) During pipeline industrial radiographic operations, sufficient radiation signs and other barriers must [~~shall~~] be posted to prevent unmonitored individuals from entering the area as specified in [~~accordance with~~] §289.202(n)(1) of this chapter [~~title~~] or §289.231(o)(1) of this chapter [~~title~~], as applicable.

(5) In lieu of the requirements of subsection (r)(1) and (2) of this section, a restricted area may be established as specified in [~~accordance with~~] §289.202(n)(1) of this chapter [~~title~~] or §289.231(o)(1) of this chapter [~~title~~], as applicable, and be posted as specified in [~~accordance with~~] subsection (r)(1) and (2) of this section; [~~,~~] for example, both signs may be posted at the same location at the boundary of the restricted area.

(6) Exceptions listed in §289.202(bb) of this chapter [~~title~~] or §289.231(y) of this chapter [~~title~~], as applicable, do not apply to industrial radiographic operations.

(s) Specific requirements for radiographic personnel performing industrial radiography.

(1) At a job site, the following must [~~shall~~] be supplied by the licensee or registrant:

(A) at least one operable, calibrated survey instrument for each exposure device or radiation machine in use;

(B) an individual monitoring device that meets the requirements of §289.202(p)(4) and (5) [~~§289.202(p)(3) and (4)~~], (q), and (r) of this chapter [~~title~~] or §289.231(s)(3) of this chapter [~~title~~], as applicable, for each worker;

(C) an operable, calibrated pocket dosimeter or electronic personal dosimeter with a range of zero to 200 mrem (2 mSv) for each worker;

(D) an operable, calibrated, alarming ratemeter for each worker; and

(E) the appropriate barrier ropes and signs.

(2) Each radiographer at a job site must [~~shall~~] carry a valid certification ID card issued by the department [~~agency~~] or another certifying entity whose certification offers the same or comparable certification standards.

(3) Each radiographer trainee at a job site must [~~shall~~] carry a trainee status card issued by the department [~~agency~~] or equivalent documentation as specified in

[~~accordance with~~] subsection (e)(1) of this section.

(4) Radiographic personnel must [~~shall~~] not perform radiographic operations if any of the items in paragraphs (1) - (3) of this subsection are not available at the job site or are inoperable. Radiographic personnel must [~~shall~~] ensure [~~that~~] the items listed in paragraph (1) of this subsection, radiographic exposure devices, and radiation machines are used as specified in [~~accordance with~~] the requirements of this section.

(5) During an inspection by the department [~~agency~~], a department [~~an agency~~] inspector may terminate an operation if any of the items in paragraphs (1) - (3) of this subsection are not available and operable or if the required number of radiographic personnel are not present. Operations must [~~shall~~] not resume [~~be resumed~~] until all required conditions are met.

(t) Radiation safety and registration requirements for the use of radiation machines.

(1) Registration requirements for industrial radiographic operations.

(A) Radiation machines used in industrial radiographic operations must [~~shall~~] be registered as specified in [~~accordance with~~] §289.226 of this chapter [~~title~~].

(B) In addition to the registration requirements in §289.226(e) and (i) of this chapter [~~title~~], an application for a certificate of registration must [~~shall~~] include: [~~the following information.~~]

(i) a [~~A~~] schedule or description of the program for training radiographic personnel that specifies:

(I) initial training;

(II) annual refresher training;

(III) on-the-job training;

(IV) procedures for administering the oral and written examination to determine the knowledge, understanding, and ability of radiographic personnel to comply with the requirements of this chapter, the conditions of the certificate of registration, and the registrant's operating, safety, and emergency procedures; and

(V) procedures for administering the practical examination to demonstrate competence in the use of sources of radiation and radiation survey instruments [~~that may be~~] employed in industrial radiographic assignments.

(ii) written [~~Written~~] operating, safety, and emergency procedures [~~that are made~~] available to each individual operating a radiation machine, including any restrictions of the operating technique required for the safe operation of the particular x-ray system;

(I) The registrant must [~~shall~~] document that each individual operating

a radiation machine has read the operating and safety procedures and must [~~shall~~] maintain this documentation for inspection by the department [~~agency~~]. The documentation must [~~shall~~] include [~~the following~~]:

(-a-) name and signature of the individual;

(-b-) date the individual read the operating and safety procedures; and

(-c-) initials of the RSO;

(II) The operating and safety procedures must [~~shall~~] include[~~, but are not limited to,~~] the items listed in subsection (x)(3) of this section;

(iii) a [~~A~~] description of the internal audit program to ensure [~~that~~] radiographic personnel follow the requirements of this chapter, the conditions of the certificate of registration, and the registrant's operating, safety, and emergency procedures at intervals not to exceed six months;

(iv) a [~~A~~] list and description of all field stations and permanent radiographic installations [~~, descriptions of permanent storage use sites, and the location(s) where all records required by this section and other sections of this chapter will be maintained. Radiographic equipment shall not be stored or used at a permanent site unless such site is specifically authorized by the certificate of registration. A storage site is permanent if radiation machines are stored at that location and if one or more of the following applies:~~]

[~~(I) the registrant establishes telephone service that is used for contracting or providing industrial radiographic services for the registrant;~~]

[~~(II) industrial radiographic services are advertised for or from the site;~~]

[~~(III) radiation machines stored at that location are used for industrial radiographic operations conducted at other sites; or~~]

[~~(IV) the registrant conducts radiographic operations or stores radiation machines at any location not listed on the certificate of registration for a period in excess of 90 days in a calendar year, in which case the registrant shall notify the agency prior to exceeding the 90 days~~];

(v) a [~~A~~] description of the organization of the industrial radiographic program, including delegations of authority and responsibility for operation of the radiation safety program; and

(vi) procedures [~~Procedures~~] for verifying and documenting the certification status of radiographers and for ensuring that the certification of individuals acting as radiographers remains valid.

(C) A certificate of registration is [~~will be~~] issued if the requirements of this paragraph of this subsection and §289.226(e) and (i) of this chapter [~~title~~] are met.

(2) Locking of radiation machines. The control panel of each radiation machine must [~~shall~~] be equipped with a locking device preventing [~~that will prevent~~] the unauthorized use of an x-ray system or the accidental production of radiation. The radiation machine must [~~shall~~] be kept locked and the key removed [~~at all times~~] except when under the direct visual surveillance of a radiographer.

(3) Permanent storage precautions for the use of radiation machines. Radiation machines must [~~shall~~] be secured while in storage to prevent tampering or removal by unauthorized individuals.

(4) Requirements for radiation machines used in industrial radiographic operations.

(A) Equipment used in industrial radiographic operations involving radiation machines manufactured after October 1, 1987 must [~~, shall~~] be certified at the time of manufacture to meet the criteria set forth by ANSI N43.5 (relating to Radiological Safety Standards for the Design of Radiographic and Industrial X-Ray Equipment), except accelerators used in industrial radiography.

(B) The registrant's name and city or town of an authorized use site listed on the certificate of registration must [~~shall~~] be prominently displayed with a durable, legible, clearly visible label [~~label(s)~~] on both sides of all vehicles used to transport radiation machines for temporary job site use.

(5) Operating and internal audit requirements for the use of radiation machines.

(A) Each registrant must [~~shall~~] conduct an internal audit program to ensure [~~that~~] the requirements of this chapter, the conditions of the certificate of registration, and the registrant's operating, safety, and emergency procedures are followed by radiographic personnel.

(B) Each radiographer's and radiographer trainee's performance during an actual radiographic operation must [~~shall~~] be audited and documented at intervals not to exceed six months.

(C) If a radiographer or a radiographer trainee has not participated in a radiographic operation during the six months since the last audit, the radiographer or the radiographer trainee must [~~shall~~] demonstrate knowledge of the training requirements of subsection (f)(1) of this section by an oral or written and practical examination administered by the registrant before the individual can next participate in a radiographic operation.

(D) The department [~~agency~~] may consider alternatives in those situations where the individual serves as both radiographer and RSO.

(E) In those operations where a single individual serves as both radiographer and RSO and performs all radiography operations, an audit program is not required.

(F) The registrant must [~~shall~~] provide annual refresher safety training, as defined in subsection (c) of this section, for each radiographer trainee, radiographer, or radiographer trainer at intervals not to exceed 12 months.

(G) Individuals [~~No individual~~], other than a radiographer or a radiographer trainee, [~~who is~~] under the personal supervision of a radiographer trainer, must not [~~shall~~] manipulate controls or operate radiation machines used in industrial radiographic operations. Only one radiographer is required to operate radiation machines during industrial radiography.

(H) Radiographic operations must [~~shall~~] not be conducted at storage sites unless specifically authorized by the certificate of registration.

(I) Records of annual refresher training and audits of job performance specified in this subsection must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section.

(J) Records of annual refresher safety training and audits of job performance made as specified in [~~accordance with~~] this subsection must [~~shall~~] include [~~the following~~]:

(i) list of the topics discussed during the refresher safety training;

(ii) dates the annual refresher safety training was conducted;

(iii) names of the instructors and attendees; and

(iv) for audits of job performance, [~~the~~] records must [~~shall also~~] include a list showing the items checked and any non-compliance observed by the RSO or designee.

(6) Radiation surveys for the use of radiation machines.

(A) Industrial radiographic operations must not [~~No industrial radiographic operation shall~~] be conducted unless at least one calibrated and operable radiation survey instrument, as described in subsection (j) of this section, is used for each radiation machine energized.

(B) A physical radiation survey must [~~shall~~] be made after each radiographic exposure using radiation machines to determine [~~that~~] the machine is "off."

(C) All potential radiation areas where industrial radiographic operations are [~~to be~~] performed must [~~shall~~] be posted as specified in [~~accordance with~~] subsection (r) of this section, based on estimated dose rates, before industrial radiographic operations begin. An area survey must [~~shall~~] be performed during the first radiographic exposure to confirm the requirements of [~~that~~] subsection (r) of this section [~~requirements~~] have been met and [~~that~~] unrestricted areas do not have radiation levels over [~~in excess of~~] the limits specified in §289.231(o)(1)(B) of this chapter [~~title~~].

(D) Records of the surveys required by subparagraph (C) of this paragraph must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section. If a survey was used to determine an individual's exposure due to loss of personnel monitoring data, the records of the survey must [~~shall~~] be maintained for [~~agency~~] inspection by the department until disposal is authorized

by the department [~~agency~~].

(7) Requirements for radiation machines in shielded rooms.

(A) Radiation machines in shielded rooms must[~~, shall~~] comply with all applicable requirements of this section.

(B) Radiation machines in shielded rooms must [~~shall~~] be evaluated at intervals not to exceed one year to ensure compliance with the applicable requirements of this section and §289.231(o)(1) - (3) of this chapter [~~title~~].

(C) Records of the annual evaluation of radiation machines in shielded rooms required by subparagraph (B) of this paragraph must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section.

(8) Requirements for certified and certifiable cabinet x-ray systems.

(A) Certified and certifiable cabinet x-ray systems, including those designed to allow admittance of individuals, are exempt from the requirements of this section except [~~that~~]:

(i) Registrants must not [~~No registrant shall~~] permit any individual to operate a cabinet x-ray system until the individual has received a copy of and instruction in the operating procedures for the unit.

(ii) Tests for proper operation of interlocks must [~~shall~~] be conducted and recorded at intervals not to exceed 12 months.

(iii) The registrant must [~~shall~~] perform an evaluation to determine compliance with §289.231(o)(1) - (3) of this chapter [~~title~~] and 21 CFR [~~Title 21, CFR,~~] §1020.40 at intervals not to exceed one year.

(B) Records of operating instructions in cabinet x-ray systems required by subparagraph (A)(i) of this paragraph and interlock tests required by subparagraph (A)(ii) of this paragraph must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section.

(C) Records of the evaluation of certified cabinet x-ray systems required by subparagraph (A)(iii) of this paragraph must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section.

(9) All reciprocal recognition of certificates of registration by the department are [~~agency will be~~] granted as specified in [~~accordance with~~] §289.226(s) of this chapter [~~title~~].

(u) Radiation safety and licensing requirements for the use of sealed sources.

(1) Licensing requirements for industrial radiographic operations.

(A) Sealed sources used in industrial radiographic operations must [~~shall~~] be licensed as specified in [~~accordance with~~] §289.252 of this subchapter [~~title~~].

(B) In addition to the licensing requirements in §289.252 of this subchapter [~~title~~], an application for a license must [~~shall~~] include [~~the following information~~].

(i) A schedule or description of the program for training radiographic personnel specifying [~~that specifies~~]:

(I) initial training;

(II) annual refresher training;

(III) on-the-job training;

(IV) procedures for administering the oral and written examinations to determine the knowledge, understanding, and ability of radiographic personnel to comply with the requirements of this chapter, the conditions of the license, and the licensee's operating, safety, and emergency procedures; and

(V) procedures for administering the practical examination to demonstrate competence in the use of sources of radiation, radiographic exposure devices, related handling tools, and radiation survey instruments [~~that may be~~] employed in industrial radiographic assignments.

(ii) Written operating, safety, and emergency procedures [~~that~~] are made available to each individual operating a sealed source in radiographic operations, including any restrictions of the operating technique required for the safe operation of the particular sealed source.

(I) The licensee must [~~shall~~] document [~~that~~] each individual operating a sealed source in radiographic operations has read the operating and safety procedures and must [~~shall~~] maintain this documentation for inspection by the department [~~agency~~]. The documentation must [~~shall~~] include [~~the following~~]:

(-a-) name and signature of the individual;

(-b-) date the individual read the operating and safety procedures; and

(-c-) initials of the RSO.[~~;~~]

(II) The operating and safety procedures must [~~shall~~] include[~~, but are not limited to,~~] the items listed in subsection (x)(3) of this section.[~~;~~]

(iii) A description of the internal audit program to ensure [~~that~~] radiographic personnel follow the requirements of this chapter, the conditions of the license, and the licensee's operating, safety, and emergency procedures at intervals not to exceed six months.

(iv) A list and description of all field stations and permanent radiographic installations.[~~, descriptions of permanent storage and use sites, and the location(s) where all records required by this section and other sections of this chapter will be maintained. If records are to be maintained at a headquarters office in Texas and~~

~~no use or storage is authorized for the site, this site will be designated as the main site. Radioactive material shall not be stored or used at a permanent use site unless such site is specifically authorized by the license. Any licensee conducting radiographic operations or storing radioactive material at any location not listed on the license for a period in excess of 180 days in a calendar year, shall notify the agency prior to exceeding the 180 days. A storage site is permanent if radioactive material is stored at that location and if any one or more of the following applies:~~]

[~~(I) the licensee establishes telephone service that is used for contracting or providing industrial radiographic services for the licensee;~~]

[~~(II) industrial radiographic services are advertised for or from the site;~~]

[~~(III) radioactive material stored at that location is used for industrial radiographic operations conducted at other sites; or~~]

[~~(IV) the licensee conducts radiographic operations or stores radioactive material at any location not listed on the license for a period in excess of 180 days in a calendar year.~~]

(v) A description of the organization of the industrial radiographic program, including delegations of authority and responsibility for operation of the radiation safety program.

(vi) A description of the program for inspection and maintenance of radiographic exposure devices and transport and storage containers, including items in subsection (x)(2) of this section and the applicable items in subsection (m) of this section.

(vii) If a license application includes underwater radiography, as a minimum~~,~~ a description of:

(I) radiation safety procedures and radiographer responsibilities unique to the performance of underwater radiography;

(II) radiographic equipment and radiation safety equipment unique to underwater radiography; and

(III) methods for gas-tight encapsulation of equipment.

(viii) If a license application includes offshore platform or [~~and/or~~] lay-barge radiography, as a minimum~~,~~ a description of:

(I) transport procedures for radioactive material to be used in industrial radiographic operations;

(II) storage areas [~~facilities~~] for radioactive material; and

(III) methods for restricting access to radiation areas.[~~;~~]

(ix) Procedures [~~for~~] verifying and documenting the certification status of

radiographers and [~~for~~] ensuring that the certification of individuals acting as radiographers remains valid.

(x) If the applicant intends to perform leak testing of sealed sources or exposure devices containing DU shielding, the applicant must [~~shall~~] describe the procedures for performing the leak test and the qualifications of the person authorized to do the leak test.

(xi) If the applicant intends to analyze its own wipe samples, the application must [~~shall~~] include a description of the procedures to be followed. The description must [~~shall~~] include [~~at least the following~~]:

(I) instruments to be used;

(II) methods of performing the analysis; and

(III) pertinent experience of the individual or individuals analyzing [~~person(s) who will analyze~~] the wipe samples.[~~; and~~]

(xii) If the applicant intends to perform "in-house" calibrations of survey instruments, the applicant must [~~shall~~] describe methods to be used and the relevant experience of the individual or individuals performing [~~person(s) who will perform~~] the calibrations. All calibrations must [~~shall~~] be performed as specified in [~~accordance with~~] subsection (j) of this section.

(C) A license is [~~will be~~] issued if the requirements of this paragraph [~~of this subsection~~] and §289.252 of this subchapter [~~title~~] are met.

(2) Limits on external radiation levels from storage containers and source changers. The maximum exposure rate limits for storage containers and source changers are 200 mrem/hr (2 mSv/hr) at any exterior surface, and 10 mrem/hr (0.1 mSv/hr) at 1 meter from any exterior surface with the sealed source in the shielded position.

(3) Locking of radiographic exposure devices, storage containers, and source changers.

(A) Each radiographic exposure device, storage container, and source changer must [~~shall~~] have a lock or outer locked container designed to prevent unauthorized or accidental removal or exposure of a sealed source. Each exposure device and source changer must [~~shall~~] be kept locked and, if a keyed lock, the key removed [~~at all times~~] except when under the direct visual surveillance of a radiographer or an individual specifically authorized by the department [~~agency~~], except at a permanent radiographic installation.

(B) Each radiographic exposure device, storage container, and source changer must [~~shall~~] be locked and the key removed from any keyed lock before [~~prior to~~] being transported from one location to another and before [~~also prior to~~] being stored at a given location.

(4) Permanent storage precautions for the use of sealed sources.

(A) Radiographic exposure devices, source changers, and transport containers containing [~~that contain~~] sealed sources must [~~shall~~] be secured while in storage to prevent tampering or removal by unauthorized individuals.

(B) Radiographic exposure devices, source changers, or transport containers containing [~~that contain~~] radioactive material must [~~may~~] not be stored in residential locations unless specifically authorized by the department. [~~This section does not apply to storage of radioactive material in a vehicle in transit for use at temporary job sites, if the licensee complies with paragraph (9)(G) of this subsection and if the vehicle does not constitute a permanent storage location as described in paragraph (1)(B)(iv) of this subsection.~~]

(5) Performance requirements for industrial radiography equipment. Equipment used in industrial radiographic operations must [~~shall~~] meet the following minimum criteria.

(A) Each radiographic exposure device, source assembly, sealed source, and associated equipment must [~~shall~~] meet the criteria set forth by ANSI N432-1980. This publication is available online at http://pbadupws.nrc.gov/docs/ML0508/ML050840139.pdf and may be purchased from the American National Standards Institute, Inc., 25 West 43rd Street, New York, New York 10036; Telephone (212) 642-4900.

(i) All newly manufactured radiographic exposure devices and associated equipment acquired by licensees after September 1, 1993, must [~~shall~~] comply with the requirements of this section.

(ii) All radiographic exposure devices and associated equipment in use after January 1, 1996, must [~~shall~~] comply with the requirements of this section.

(iii) In lieu of subparagraph (A) of this paragraph, equipment used in industrial radiographic operations need not comply with §8.9.2(c) of the Endurance Test in ANSI 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.

(B) Engineering analysis may be submitted by a licensee to demonstrate the applicability of previously performed testing on similar individual radiography equipment components. Upon review, the department [~~agency~~] may find this an acceptable alternative to actual testing of the component as specified in [~~accordance with~~] subparagraph (A) of this paragraph.

(C) In addition to the requirements specified in subparagraph (A) of this paragraph the following requirements apply to radiographic exposure devices, source changers, source assemblies, and sealed sources.

(i) Radiographic exposure devices intended for use as Type B transport containers must [~~shall~~] meet the applicable requirements of §289.257 of this subchapter [~~title~~].

(ii) Modification of radiographic exposure devices, source changers, source assemblies, and associated equipment is prohibited, unless the design of any replacement component, including source holder, source assembly, controls, or guide tubes does [~~would~~] not compromise the design safety features of the system.

(D) In addition to the requirements specified in subparagraphs (A) - (C) of this paragraph, radiographic exposure devices, source assemblies, and associated equipment allowing [~~that allow~~] the source to move outside the device must [~~shall~~] meet the following criteria.

(i) The source assembly must [~~shall~~] be designed so [~~that~~] the source does [~~will~~] not become disconnected if cranked outside the guide tube. The source assembly [~~shall be such that it~~] cannot be unintentionally disconnected under normal and reasonably foreseeable abnormal conditions.

(ii) The control cable must [~~shall~~] be positively connected to the source assembly before the source assembly can be driven out of the fully shielded position in a radiographic exposure device or source changer.

(iii) The radiographic exposure device must [~~shall~~] automatically secure the source assembly when it is cranked back into the fully shielded position within the radiographic exposure device. This securing system may [~~shall~~] only be released by means of a deliberate operation on the radiographic exposure device.

(iv) The outlet nipple, lock box, and control cable fittings of each radiographic exposure device must [~~shall~~] be equipped with safety plugs or covers installed during storage and transportation to [~~that will~~] protect the source assembly from damage and from other foreign matter, such as water, mud, or sand[~~, during storage and transportation~~].

(v) Each sealed source or source assembly must [~~shall~~] have attached to it or engraved on it, a durable, legible, visible label with the words "DANGER. RADIOACTIVE." The label may not interfere with the safe operation of the exposure device or associated equipment.

(vi) Guide tubes must [~~shall~~] be used when moving the source out of the radiographic exposure device.

(vii) Guide tubes must [~~shall~~] be able to withstand a crushing test [~~that~~] closely approximating [~~approximates~~] the crushing forces [~~that are~~] likely to be encountered during use, and be able to withstand a kinking resistance test [~~that~~] closely approximating [~~approximates~~] the kinking forces [~~that are~~] likely to be encountered during use.

(viii) An exposure head, endcap, or similar device designed to prevent the source assembly from extending beyond the end of the guide tube must [~~shall~~] be attached to the outermost end of the guide tube during radiographic operations.

(ix) The guide tube exposure head connection must [~~shall~~] be able to withstand the tensile test for control units as specified in ANSI N432-1980.

(x) Source changers must [~~shall~~] provide a system for ensuring [~~that~~] the source is [~~will~~] not [~~be~~] accidentally withdrawn from the changer when connecting or disconnecting the control cable to or from a source assembly.

(6) Leak testing, repair, opening, and replacement of sealed sources and devices. Leak testing, repair, opening, and replacement of sealed sources and devices must [~~shall~~] be performed according to the following criteria.

(A) Leak testing of sealed sources must [~~shall~~] be done as specified in [~~accordance with~~] §289.201(g) of this chapter [~~title~~], except records of leak tests must [~~shall~~] be maintained as specified in [~~accordance with~~] subsection (v)(1) of this section.

(B) The replacement, leak testing analysis, repair, opening, or any modification of a sealed source must [~~shall~~] be performed only by persons specifically authorized to do so by the department [~~agency~~], the NRC, or another agreement state.

(C) Each exposure device using DU shielding and an "S" tube configuration must [~~shall~~] be tested for DU contamination.

(i) Tests for DU contamination must [~~shall~~] be performed at intervals not to exceed 12 months.

(ii) The analysis must [~~shall~~] be capable of detecting the presence of 0.005 microcuries (185 becquerels (Bq)) [~~(185 Bq)~~] of radioactive material on the test sample and must [~~shall~~] be performed by a person specifically authorized by the department [~~agency~~], the NRC, or an agreement state to perform the analysis.

(iii) Should such testing reveal the presence of DU contamination, the exposure device must [~~shall~~] be removed from use until an evaluation of the wear of the S-tube has been made.

(iv) Should the evaluation reveal [~~that~~] the S-tube is worn through, the device may not be used again.

(v) DU-shielded [~~DU shielded~~] devices do not have to be tested for DU contamination while in storage and not in use.

(vi) The device must [~~shall~~] be tested for DU contamination before using or transferring the [~~such a~~] device, if the interval of storage exceeds 12 months.

(D) A record of the DU leak test must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section.

(7) Labeling and storage.

(A) Each transport container must [~~shall~~] have permanently attached to it a durable, legible, clearly visible label having [~~label(s) that has~~], at [~~as~~] a minimum, the standard trefoil radiation caution symbol conventional colors[~~,~~] (for example, magenta, purple, or black on a yellow background), having a minimum diameter of

25 millimeters, and the following wording: "CAUTION. RADIOACTIVE MATERIAL. NOTIFY CIVIL AUTHORITIES (OR NAME OF COMPANY)" or "DANGER. RADIOACTIVE MATERIAL. NOTIFY CIVIL AUTHORITIES (OR NAME OF COMPANY)." In addition, transport containers must [~~shall~~] meet applicable requirements of the DOT.

(B) Radiographic exposure devices, source changers, and storage containers must [~~shall~~] be physically secured to prevent tampering or removal by unauthorized personnel. The licensee must [~~shall~~] store radioactive material in a manner that will minimize danger from explosion or fire.

(C) The licensee must [~~shall~~] lock and physically secure the transport package containing radioactive material in the transporting vehicle to prevent accidental loss, tampering, or unauthorized removal.

(D) The licensee's name and city or town of an authorized use site listed on the license must [~~shall~~] be prominently displayed with a durable, legible, and clearly visible label [~~label(s)~~] on both sides of all vehicles used to transport radioactive material for temporary job site use.

(E) The licensee must [~~shall~~] ensure [~~that~~] each radiographic exposure device has attached to it a durable, legible, and clearly visible label bearing [~~the following~~]:

(i) the chemical symbol and mass number of the radionuclide in the device;

(ii) the activity and the date on which this activity was last measured;

(iii) the manufacturer, model, and serial number of the sealed source;

(iv) the licensee's name, address, and telephone number; and

(v) at [~~as~~] a minimum, the standard radiation caution symbol as defined in §289.202 of this chapter [~~title~~], and the following wording: "CAUTION. RADIOACTIVE MATERIAL--DO NOT HANDLE. NOTIFY CIVIL AUTHORITIES (OR NAME OF COMPANY)" or "DANGER. RADIOACTIVE MATERIAL--DO NOT HANDLE. NOTIFY CIVIL AUTHORITIES (OR NAME OF COMPANY)."

(F) Each radiographic exposure device must [~~shall~~] have a permanently stamped, legible, and clearly visible unique serial number.

(8) Operating and internal audit requirements for the use of sealed sources of radiation.

(A) Each licensee must [~~shall~~] conduct an internal audit program to ensure [~~that~~] the requirements of this chapter, the conditions of the license, and the licensee's operating, safety, and emergency procedures are followed by radiographic personnel.

(B) Each radiographer's and radiographer trainee's performance during an actual radiographic operation must [~~shall~~] be audited and documented at intervals

not to exceed six months.

(C) If a radiographer or a radiographer trainee has not participated in a radiographic operation during the six months since the last audit, the radiographer or the radiographer trainee must [~~shall~~] demonstrate knowledge of the training requirements of subsection (f)(1) of this section by an oral or written and practical examination administered by the licensee before these individuals can next participate in a radiographic operation.

(D) The department [~~agency~~] may consider alternatives in those situations where the individual serves as both radiographer and RSO.

(E) In those operations where a single individual serves as both radiographer and RSO, and performs all radiography operations, an audit program is not required.

(F) Each licensee must [~~shall~~] provide annual refresher safety training, as defined in subsection (c) of this section, for each radiographer and radiographer trainee at intervals not to exceed 12 months.

(G) Whenever radiographic operations are performed at a location other than a permanent radiographic installation, the radiographer must be accompanied by at least one other qualified radiographer or an individual who has, at minimum, met the requirements of subsection (e)(1) of this section. The additional qualified individual must observe the operations and be capable of providing immediate assistance to prevent unauthorized entry. Radiographic operations must not be performed if only one qualified individual is present.

[~~(G) Each licensee shall provide, as a minimum, two radiographic personnel for each exposure device in use for any industrial radiography conducted at a location other than at a permanent radiographic installation (shielded room, bay, or bunker) meeting the requirements of subsection (n)(1) of this section. If one of the personnel is a radiographer trainee, the other shall be a radiographer trainer authorized by the license.~~]

(H) Collimators must [~~shall~~] be used in industrial radiographic operations using [~~that use~~] crank-out devices except when physically impossible.

(I) Individuals [~~No individual~~] other than a radiographer or a radiographer trainee, [~~who is~~] under the personal supervision of a radiographer trainer, must not [~~shall~~] manipulate controls or operate radiographic exposure devices and associated equipment used in industrial radiographic operations.

(J) All radiographic operations conducted at locations of use authorized on the license must be conducted in a permanent radiographic installation, unless specifically authorized by the department.

[~~(J) Radiographic operations shall not be conducted at storage sites unless specifically authorized by the license.~~]

(K) Records of annual refresher training and audits of job performance

specified in this subsection must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section.

(L) Records of annual refresher safety training and audits of job performance made as specified in [~~accordance with~~] this subsection must [~~shall~~] include [~~the following~~]:

(i) list of the topics discussed during the refresher safety training;

(ii) dates the annual refresher safety training was conducted;

(iii) names of the instructors and attendees; and

(iv) for audits of job performance, the records must [~~shall~~] also include a list showing the items checked and any non-compliance observed by the RSO or designee.

(9) Radiation surveys for the use of sealed sources of radiation.

(A) Industrial radiographic operations must not [~~No industrial radiographic operation shall~~] be conducted unless at least one calibrated and operable radiation survey instrument, as described in subsection (j) of this section, is used at each site where radiographic exposures are made.

(B) A survey with a radiation survey instrument meeting the requirements of subsection (j)(1) - (3) of this section must [~~shall~~] be made after each radiographic exposure to determine [~~that~~] the sealed source has been returned to its fully shielded position, and before exchanging films, repositioning the exposure head, or dismantling equipment. The entire circumference of the radiographic exposure device must [~~shall~~] be surveyed. If the radiographic exposure device has a source guide tube, the survey must [~~shall~~] also include the source guide tube and any collimator.

(C) All potential radiation areas where industrial radiographic operations are [~~to be~~] performed must [~~shall~~] be posted as specified in [~~accordance with~~] subsection (r) of this section, based on calculated dose rates, before industrial radiographic operations begin. An area survey must [~~shall~~] be performed during the first radiographic exposure (for example, with the sealed source in the exposed position) to confirm [~~that~~] the requirements of subsection (r) of this section have been met.

(D) Each time re-establishment of the restricted area is required, the requirements of subparagraph (C) of this paragraph must [~~shall~~] be met.

(E) The requirements of subparagraph (D) of this paragraph do not apply to pipeline industrial radiographic operations when the conditions of exposure, including[~~, but not limited to,~~] the radiographic exposure device, duration of exposure, source strength, pipe size, and pipe thickness, remain constant.

(F) A lock-out survey, in which all accessible surfaces of the radiographic exposure device or source changer are surveyed, must [~~shall~~] be performed.

(G) Surveys must [~~shall~~] be performed in the storage area [~~location~~] to ensure [~~that~~] radiation levels do not exceed the limits specified in §289.202(n)(1) of this chapter [~~title~~]. These surveys must [~~shall~~] be performed initially with the maximum amount of radioactive material present in the storage area [~~location~~] and thereafter at the time of the quarterly inventory and whenever storage conditions change.

(H) A survey meeting the requirements of subparagraph (B) of this paragraph must [~~shall~~] be performed on the radiographic exposure device and the source changer after every sealed source exchange.

(I) Records of the surveys required by subparagraphs (C), (D), and (F) - (H) of this paragraph must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section. If a survey was used to determine an individual's exposure due to loss of personnel monitoring data, the records of the survey must [~~shall~~] be maintained for [~~agency~~] inspection by the department until disposal is authorized by the department [~~agency~~].

(10) Requirements for shielded rooms containing sealed sources.

(A) Shielded rooms containing sealed sources must [~~shall~~] comply with all applicable requirements of this section.

(B) Shielded rooms containing sealed sources must [~~shall~~] be evaluated at intervals not to exceed one year to ensure compliance with the applicable requirements of this section and §289.202(n)(1) - (3) of this chapter [~~title~~].

(C) Tests for proper operation of interlocks must [~~shall~~] be conducted and recorded as specified in [~~accordance with~~] subsection (n) of this section.

(D) Records of evaluations required by subparagraph (B) of this paragraph must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section.

(E) Records of interlock tests required by subparagraph (C) of this paragraph must [~~shall~~] be made and maintained as specified in [~~accordance with~~] subsection (v)(1) of this section.

(11) Underwater, offshore platform, and lay-barge radiography.

(A) Underwater, offshore platform, and [~~and/or~~] lay-barge radiography must [~~shall~~] not be performed unless specifically authorized in a license issued by the department as specified [~~agency~~] in [~~accordance with~~] paragraph (1) of this subsection.

(B) In addition to the other requirements of this section, the following requirements apply to the performance of offshore platform or lay-barge radiography.

(i) Cobalt-60 sources with activities more than [~~in excess of~~] 20 curies (Ci) (nominal) (3.7 terabecquerels) and iridium-192 sources with activities more

than [~~in excess of~~] 100 Ci [~~curies~~] (nominal) (740 gigabecquerels) must [~~shall~~] not be used in the performance of offshore platform or lay-barge radiography.

(ii) Collimators must [~~shall~~] be used for all industrial radiographic operations performed on offshore platforms or lay-barges.

(12) Prohibitions.

(A) Industrial radiography performed with a sealed source [~~that is~~] not fastened to or contained in a radiographic exposure device (fishpole technique) is prohibited unless specifically authorized in a license issued by the department [~~agency~~].

(B) Retrieval of disconnected sources or sources that cannot be returned by normal means to a fully shielded position or automatically secured in the radiographic exposure device must [~~, shall~~] not be performed unless specifically authorized by a license condition.

(13) All reciprocal recognition of licenses by the department are [~~agency will be~~] granted as specified in [~~accordance with~~] §289.252(ee) of this subchapter [~~title~~].

(v) Record/document requirements. Each licensee and registrant must [~~shall~~] maintain the following records/documents at each site at the time intervals specified and make them available to the department [~~agency~~] for inspection.

(1) Time requirements for record keeping. The following are time requirements for record keeping.

Figure: 25 TAC §289.255(v)(1) [~~Figure: 25 TAC §289.255(v)(1)~~]

(2) Records and documents required at additional authorized use/storage sites.

(A) Each licensee or registrant maintaining additional authorized use/storage sites where industrial radiography operations are performed must [~~shall~~] maintain copies of the following records and documents specific to that site available at each site for inspection by the department [~~agency~~] for a period of three years:

(i) a copy of the appropriate license or certificate of registration authorizing the use of licensed or registered sources of radiation;

(ii) operating, safety, and emergency procedures as specified in [~~accordance with~~] subsection (x)(3) of this section;

(iii) applicable sections of this chapter as listed in the license or certificate of registration;

(iv) records of receipt, transfer, and disposal of sources of radiation and devices using DU for shielding at the additional site as specified in [~~accordance with~~] subsection (i) of this section;

(v) records of the latest survey instrument calibrations in use at the site as specified in [~~accordance with~~] subsection (j) of this section;

(vi) records of the latest calibrations of alarming ratemeters and operational checks of pocket dosimeters and [~~and/or~~] electronic personal dosimeters as specified in [~~accordance with~~] subsection (p) of this section;

(vii) inventories as specified in [~~accordance with~~] subsection (k) of this section;

(viii) utilization records for each radiographic exposure device and radiation machine dispatched from that location as specified in [~~accordance with~~] subsection (l) of this section;

(ix) records of equipment problems identified in daily checks of equipment as specified in [~~accordance with~~] subsection (m) of this section, if applicable;

(x) records of alarm systems and entrance control checks as specified in [~~accordance with~~] subsection (n) of this section;

(xi) training records as specified in [~~accordance with~~] subsection (f) of this section;

(xii) records of direct-reading dosimeter readings as specified in [~~accordance with~~] subsection (p) of this section;

(xiii) audits as specified in [~~accordance with~~] subsections (t)(5)(A) - (C) and (u)(8)(A) - (C) of this section;

(xiv) latest radiation survey records as specified in [~~accordance with~~] subsections (t)(6)(D) and (u)(9)(I) of this section;

(xv) records of interlock testing as specified in [~~accordance with~~] subsections (t)(8)(A)(ii) and (u)(10)(C) of this section;

(xvi) records of annual evaluation of cabinet x-ray systems as specified in [~~accordance with~~] subsection (t)(7)(C) of this section;

(xvii) records of leak tests for specific devices and sources at the additional site as specified in [~~accordance with~~] subsection (u)(6) of this section;

(xviii) shipping papers for the transportation of sources of radiation as specified in [~~accordance with~~] §289.257 of this subchapter [~~title~~];

(xix) a copy of the NRC license, agreement state license, or state certificate of registration authorizing the use of sources of radiation, when operating under reciprocity as specified in [~~accordance with~~] §289.226 of this chapter [~~title~~] and §289.252 of this subchapter [~~title~~]; and

(xx) individual monitoring records as specified in [~~accordance with~~] subsection (p) of this section.

(B) The following records required for each additional authorized use site as specified in [~~accordance with~~] this subsection must [~~shall~~] also be maintained at the main authorized site:

(i) records of receipt, transfer, and disposal of sources of radiation and devices using DU for shielding at the additional site as specified in [~~accordance with~~] subsection (i) of this section;

(ii) inventories as specified in [~~accordance with~~] subsection (k) of this section; and

(iii) individual monitoring records as specified in [~~accordance with~~] subsection (p) of this section.

(3) Records required at temporary job sites. Each licensee and registrant conducting industrial radiography at a temporary job site must [~~shall~~] have the following records available at that site for [~~agency~~] inspection by the department:

(A) a copy of the appropriate license or certificate of registration or equivalent document authorizing the use of sources of radiation;

(B) operating, safety, and emergency procedures as specified in [~~accordance with~~] subsection (x)(3) of this section;

(C) applicable sections of this chapter as listed in the license or certificate of registration;

(D) latest radiation survey records required as specified in [~~accordance with~~] subsections (t)(6)(D) and (u)(9)(I) of this section for the period of operation at the site;

(E) the daily pocket dosimeter records for the period of operation at the site;

(F) utilization records for each radiographic exposure device or radiation machine used at that location as specified in [~~accordance with~~] subsection (l) of this section;

(G) the latest instrument calibration and leak test records for devices at the site. Acceptable records include tags or labels [~~that are~~] attached to the devices or survey instruments and decay charts for sources [~~that have been~~] manufactured within the last six months; and

(H) a copy of the NRC license, agreement state license, or state certificate of registration authorizing the use of sources of radiation, when operating under reciprocity as specified in [~~accordance with~~] §289.226 of this chapter [~~title~~] or §289.252 of this subchapter [~~title~~].

(w) Form of records. Each record required by this chapter must include all pertinent information and be stored in a legible and reproducible format throughout the specified retention period. The licensee or registrant must maintain adequate safeguards against tampering with and loss of records.

[~~(1) Each record required by this section shall be legible throughout the specified retention period.~~]

[~~(2) The record shall be the original or a reproduced copy or a microform provided that the copy or microform is authenticated by authorized personnel and that the microform is capable of reproducing a clear copy throughout the required retention period.~~]

[~~(3) The record may also be stored in electronic media with the capability for producing legible, accurate, and complete records during the required retention period.~~]

[~~(4) Records, such as letters, drawings, and specifications, shall include all pertinent information, such as stamps, initials, and signatures.~~]

[~~(5) The licensee or registrant shall maintain adequate safeguards against tampering with and loss of records.~~]

(x) Appendices.

(1) Subjects to be included in training courses for radiographer trainees. Training provided to qualify individuals as radiographer trainees in compliance with subsection (e)(1)(A) of this section must [~~shall~~] be presented on a formal basis. The training must [~~shall~~] include the following subjects.

(A) Fundamentals of radiation safety, including [~~to include the following~~]:

(i) characteristics of radiation;

(ii) units of radiation dose in rem [~~rems~~] (sieverts) and quantity of radioactivity in curies (becquerels);

(iii) significance of radiation dose, including [~~to include~~]:

(I) radiation protection standards;

(II) biological effects of radiation dose;

(III) hazards of exposure to radiation; and

(IV) case histories of radiography accidents;

(iv) levels of radiation from sources of radiation; and

(v) methods of controlling radiation dose, including [~~to include~~]:

(I) working time;

(II) working distances; and

(III) shielding.

(B) Radiation detection instrumentation, including [~~to include the following~~]:

(i) use, operation, calibration, and limitations of radiation survey instruments;

(ii) survey techniques; and

(iii) use of individual monitoring devices.

(C) Radiographic equipment to be used, including [~~the following~~]:

(i) remote handling equipment;

(ii) operation and control of radiographic exposure devices and sealed sources, including pictures or models of source assemblies (pigtails);

(iii) storage and transport containers, source changers;

(iv) operation and control of x-ray equipment;

(v) collimators;

(vi) storage, control, and disposal of radioactive material; and

(vii) inspection and maintenance of equipment.

(D) Requirements of pertinent federal and state regulations.

(E) Generic written operating, safety, and emergency procedures (see subsection (x)(3) of this section).

(2) General requirements for inspection of industrial radiographic equipment.

(A) Radiographic exposure devices must [~~shall~~] be inspected for:

(i) abnormal surface radiation levels anywhere on camera, collimator, or guide tube;

(ii) condition of safety plugs;

(iii) proper operation of locking mechanism;

(iv) condition of pigtail connector;

(v) condition of carrying device (straps, handle, etc.); and

(vi) proper and legible labeling.

(B) Guide tubes must [~~shall~~] be inspected for:

(i) rust, dirt, or sludge buildup inside the guide tube;

(ii) condition of guide tube connector;

(iii) condition of source stop; and

(iv) kinks or damage that could prevent proper operation.[~~; and~~]

[~~(v) presence of radioactive contamination.~~]

(C) Control cables and drive mechanisms must [~~shall~~] be inspected for:

(i) proper drive mechanism with camera, as appropriate;

(ii) changes in general operating characteristics;

(iii) condition of connector on control cable;

(iv) control cable flexibility, wear, and rust;

(v) excessive wear or damage to crank-out devices;

(vi) damage to control cable conduit that could prevent the cable from moving freely;

(vii) proper connector mating between the control cable and the pigtail; and

(viii) proper operation of source position indicator, if applicable.[~~; and~~]

[~~(ix) presence of radioactive contamination.~~]

(D) Pipeliners must [~~shall~~] be inspected for:

(i) abnormal surface radiation;

(ii) changes in the general operating characteristics of the unit;

(iii) proper operation of shutter mechanism;

(iv) chafing or binding of shutter mechanism;

(v) damage to the device that might impair its operation;

(vi) proper operation of locking mechanism;

(vii) proper drive mechanism with camera, as appropriate;

(viii) condition of carrying device (strap, handle, etc.); and

(ix) proper and legible labeling.

(E) X-ray equipment must [~~shall~~] be inspected for:

(i) change in the general operating characteristics of the unit;

(ii) wear of electrical cables and connectors;

(iii) proper and legible labeling of console;

(iv) proper console with machine, as appropriate;

(v) proper operation of locking mechanism;

(vi) proper operation of timer run-down cutoff; and

(vii) damage to tube head housing that might result in excessive radiation levels.

(3) Operating, safety, and emergency procedures. The licensee's or registrant's operating, safety, and emergency procedures must [~~shall~~] include instructions in [~~at least the following~~]:

(A) handling and use of sources of radiation for industrial radiography so [~~such that~~] no individual is likely to be exposed to radiation doses more than [~~that exceed~~] the limits established in §289.202 of this chapter [~~title~~];

(B) methods and occasions for conducting radiation surveys, including lock-out survey requirements;

(C) methods for controlling access to industrial radiography areas;

(D) methods and occasions for locking and securing sources of radiation;

(E) personnel monitoring and the use of personnel monitoring equipment, including steps to be taken immediately, by industrial radiographic personnel, in the event a pocket dosimeter is found to be off-scale (see subsection (p)(2)(G) of this section);

(F) methods of transporting equipment to field locations, including packing of sources of radiation in the vehicles, placarding of vehicles, and controlling of sources of radiation during transportation, including applicable DOT requirements;

(G) methods [~~or procedures~~] for minimizing exposure of individuals in the event of an accident, including procedures for a disconnect accident, a transportation accident, and loss of a sealed source;

(H) [~~procedures for~~] notifying proper personnel in the event of an accident;

(I) specific posting requirements;

(J) maintenance of records (see subsection (v)(1) of this section);

(K) inspection, maintenance, and operational checks of radiographic exposure devices, source changers, storage containers, transport containers, source guide tubes, crank-out devices, and radiation machines;

(L) method of testing and training as specified in [~~accordance with~~] subsections (e) and (f) of this section; and

(M) source recovery [~~procedures~~] if the licensee is authorized to perform source recovery.

§289.256. Medical and Veterinary Use of Radioactive Material.

(a) Purpose.

(1) This section establishes requirements for [~~the~~] medical and veterinary use of

radioactive material and [~~for~~] the issuance of specific licenses authorizing [~~the~~] medical and veterinary use of radioactive material. Unless otherwise exempted, persons must not [~~no person shall~~] manufacture, produce, receive, possess, use, transfer, own, or acquire radioactive material for medical or veterinary use except as authorized in a license issued as specified in [~~accordance with~~] this section.

(2) A person who manufactures, produces, receives, possesses, uses, transfers, owns, or acquires radioactive material before [~~prior to~~] receiving a license is subject to the requirements of this chapter.

(3) A specific license is not needed for a person who:

(A) receives, possesses, uses, or transfers radioactive material as specified in [~~accordance with the regulations in~~] this chapter under the supervision of an authorized user as provided in subsection (s) of this section, unless prohibited by license condition; or

(B) prepares unsealed radioactive material for medical or veterinary use as specified in [~~accordance with the regulations in~~] this chapter under the supervision of an authorized nuclear pharmacist or authorized user as provided in subsection (s) of this section, unless prohibited by license condition.

(b) Scope.

(1) In addition to the requirements of this section, all licensees, unless otherwise specified, are subject to the requirements of:

(A) §289.201 of this chapter (relating to General Provisions for Radioactive Material);

(B) §289.202 of this chapter (relating to Standards for Protection Against Radiation from Radioactive Materials);

(C) §289.203 of this chapter (relating to Notices, Instructions, and Reports to Workers; Inspections);

(D) §289.204 of this chapter (relating to Fees for Certificates of Registration, Radioactive Material Licenses, Emergency Planning and Implementation, and Other Regulatory Services);

(E) §289.205 of this chapter (relating to Hearing and Enforcement Procedures);

(F) §289.252 of this subchapter (relating to Licensing of Radioactive Material); and

(G) §289.257 of this subchapter (relating to Packaging and Transportation of Radioactive Material).

[~~§289.201 of this title (relating to General Provisions for Radioactive Material), §289.202 of this title (relating to Standards for Protection Against Radiation from~~

~~Radioactive Materials), §289.203 of this title (relating to Notices, Instructions, and Reports to Workers; Inspections), §289.204 of this title (relating to Fees for Certificates of Registration, Radioactive Material Licenses, Emergency Planning and Implementation, and Other Regulatory Services), §289.205 of this title (relating to Hearing and Enforcement Procedures), §289.252 of this title (relating to Licensing of Radioactive Material), and §289.257 of this title (relating to Packaging and Transportation of Radioactive Material).~~]

(2) Veterinarians who receive, possess, use, transfer, own, or acquire radioactive material in the practice of veterinary medicine must [~~shall~~] comply with the requirements of this section except for subsections (d), (dd)~~,~~ and (uuu) of this section.

(3) An entity that is a "covered entity" as that term is defined in HIPAA (the Health Insurance Portability and Accountability Act of 1996, 45 Code of Federal Regulations (CFR) [~~Title 45, Code of Federal Regulations (CFR),~~] Parts 160 and 164) may be subject to privacy standards governing how information identifying [~~that identifies~~] a patient can be used and disclosed. Failure to follow HIPAA requirements may result in the department making a referral of a potential violation to the United States Department of Health and Human Services.

(4) In accordance with the requirements of the Texas Medical Board, 22 Texas Administrative Code (TAC) [~~Title 22, Texas Administrative Code (TAC),~~] Chapter 160, medical licensees must use the services of a licensed medical physicist for activities falling within the medical physicist scope of practice as identified in 22 TAC §160.17 unless exempted under 22 TAC §160.5.

(c) Definitions. The following words and terms when used in this section [~~shall~~] have the following meaning unless the context clearly indicates otherwise.

(1) Address of use--The building or buildings [~~that are~~] identified on the license [~~and~~] where radioactive material may be prepared, received, used, or stored.

(2) Area of use--A portion of an address of use [~~that has been~~] set aside for the purpose of preparing, receiving, using, or storing radioactive material.

(3) Associate radiation safety officer (ARSO)--An individual who:

(A) meets the requirements in subsections (h) and (m) of this section; and

(B) is currently identified as an ARSO for the types of use of radioactive material for which the individual has been assigned duties and tasks by the radiation safety officer (RSO) on:

(i) a specific medical or veterinary use license issued by the department, the United States Nuclear Regulatory Commission (NRC), or an agreement state; or

(ii) a medical use permit issued by an NRC master material licensee.

(4) Authorized medical physicist--An individual who [~~meets the following~~]:

(A) meets the requirements in subsections (j) and (m) of this section; or

(B) is identified as an authorized medical physicist or teletherapy physicist on [~~one of the following~~]:

(i) a specific medical or veterinary use license issued by the department, the NRC, or an agreement state;

(ii) a medical use permit issued by an NRC master material licensee;

(iii) a permit issued by an NRC[~~,~~] or agreement state broad scope medical use licensee; or

(iv) a permit issued by an NRC master material license broad scope medical use permittee; and

(C) holds a current Texas license under the Medical Physics Practice Act, Texas Occupations Code[~~,~~] Chapter 602, in therapeutic radiological physics for uses in subsections (rr) and (ddd) of this section.

(5) Authorized nuclear pharmacist--A pharmacist who [~~meets the following~~]:

(A) meets the requirements in subsections (k) and (m) of this section; or

(B) is identified as an authorized nuclear pharmacist on [~~one of the following~~]:

(i) a specific license issued by the department, the NRC, or an agreement state authorizing [~~that authorizes~~] medical use or the practice of nuclear pharmacy;

(ii) a permit issued by an NRC master material licensee authorizing [~~that authorizes~~] medical use or the practice of nuclear pharmacy;

(iii) a permit issued by the department, the NRC, or an agreement state licensee of broad scope authorizing [~~that authorizes~~] medical use or the practice of nuclear pharmacy; or

(iv) a permit issued by an NRC master material license broad scope medical use permittee authorizing [~~that authorizes~~] medical use or the practice of nuclear pharmacy; or

(C) is identified as an authorized nuclear pharmacist by a commercial nuclear pharmacy [~~that has been~~] authorized to identify authorized nuclear pharmacists; or

(D) is designated as an authorized nuclear pharmacist as specified in [~~accordance with~~] §289.252(r) of this subchapter [~~title~~]; and

(E) holds a current Texas license under the Texas Pharmacy Act, Texas Occupations Code[~~,~~] Chapters 551 - 566, 568, and 569, as amended, and who is certified as an authorized nuclear pharmacist by the Texas State Board of Pharmacy.

(6) Authorized user--An authorized user is defined as follows:

(A) for human use, a physician licensed by the Texas Medical Board; or a dentist licensed by the Texas State Board of Dental Examiners; or a podiatrist licensed by the Texas State Board of Podiatric Medicine who:

(i) meets the requirements in subsection (m) and subsections (gg), (jj), (nn) - (qq), (zz), (aaa), (ccc), or (ttt) of this section; or

(ii) is identified as an authorized user on [~~any of the following~~]:

(I) a department [~~an agency~~], NRC, or agreement state license authorizing [~~that authorizes~~] the medical use of radioactive material;

(II) a permit issued by an NRC master material licensee authorizing [~~that is authorized to permit~~] the medical use of radioactive material;

(III) a permit issued by a specific licensee of broad scope issued by the department, the NRC, or an agreement state authorizing the medical use of radioactive material; or

(IV) a permit issued by an NRC master material licensee of broad scope authorizing [~~that is authorized to permit~~] the medical use of radioactive material.

(B) for veterinary use, an individual who is[~~,~~] a veterinarian licensed by the Texas State Board of Veterinary Medical Examiners; and

(i) is certified by the American College of Veterinary Radiology for the use of radioactive materials in veterinary medicine; or

(ii) has received training as specified in [~~accordance with~~] subsections (gg), (jj), (nn) - (qq), (zz), (aaa), (ccc), and (ttt) of this section as applicable; or

(iii) is identified as an authorized user on [~~any of the following~~]:

(I) a department [~~an agency~~], NRC, or agreement state license authorizing [~~that authorizes~~] the veterinary use of radioactive material;

(II) a permit issued by an NRC master material licensee authorizing [~~that is authorized to permit~~] the medical use of radioactive material;

(III) a permit issued by a specific licensee of broad scope issued by the department, the NRC, or an agreement state authorizing the medical or veterinary use of radioactive material; or

(IV) a permit issued by an NRC master material licensee of broad scope authorizing [~~that authorizes~~] the medical use of radioactive material.

(7) Brachytherapy--A method of radiation therapy in which plated, embedded, activated, or sealed sources are utilized to deliver a radiation dose at a distance of up to a few centimeters, by surface, intracavitary, intraluminal, or interstitial

application.

(8) Brachytherapy sealed source--A sealed source or a manufacturer-assembled source train[~~,~~] or a combination of these sources [~~that is~~] designed to deliver a therapeutic dose within a distance of a few centimeters.

(9) High dose-rate remote afterloader--A device [~~that~~] remotely delivering [~~delivers~~] a dose rate more than [~~in excess of~~] 1200 rads (12 gray (Gy)) per hour at the point or surface where the dose is prescribed.

(10) Institutional Review Board (IRB)--Any board, committee, or other group formally designated by an institution and approved by the United States Food and Drug Administration (FDA) to review, approve the initiation of, and conduct periodic review of biomedical research involving human subjects.

(11) Low dose-rate remote afterloader--A device [~~that~~] remotely delivering [~~delivers~~] a dose rate of less than or equal to 200 rads (2 Gy) per hour at the point or surface where the dose is prescribed.

(12) Management--The chief executive officer or other individual delegated the authority to manage, direct, or administer the licensee's activities.

(13) Manual brachytherapy--A type of brachytherapy in which the sealed sources, for example, seeds and ribbons, are manually inserted either into the body cavities [~~that are~~] in close proximity to a treatment site or directly in the tissue volume.

(14) Medical event--An event meeting [~~that meets~~] the criteria in subsection (uuu)(1) of this section.

(15) Medical institution--An organization in which several medical disciplines are practiced.

(16) Medical use--The intentional internal or external administration of radioactive material, or the radiation from radioactive material, to patients or human research subjects under the supervision of an authorized user.

(17) Medium dose-rate afterloader--A device [~~that~~] remotely delivering [~~delivers~~] a dose rate greater than 200 rads (2 Gy) and less than or equal to 1200 rads (12 Gy) per hour at the point or surface where the dose is prescribed.

(18) Mobile nuclear medicine service--A licensed service authorized to transport radioactive material to, and medical or veterinary use of the material at, the client's address. Services transporting calibration sources only are not considered mobile nuclear medicine licensees.

(19) Ophthalmic physicist--An individual who:

(A) meets the requirements in subsections (m) and (xx)(1)(B) of this section; and

(B) is identified as an ophthalmic physicist on:

(i) a specific medical use license issued by the department, the NRC, or an agreement state;

(ii) a permit issued by a department [~~an agency~~], NRC, or agreement state broad scope medical use licensee;

(iii) a medical use permit issued by an NRC master material licensee; or

(iv) a permit issued by an NRC master material licensee broad scope medical use permittee.

(20) Output--The exposure rate, dose rate, or a quantity related in a known manner to these rates from a teletherapy unit, a brachytherapy source, a remote afterloader unit, or a gamma stereotactic radiosurgery unit, for a specified set of exposure conditions.

(21) Patient--A human or animal under medical care and treatment.

(22) Patient intervention--Actions by the patient or human research subject, whether intentional or unintentional, such as dislodging or removing treatment devices or prematurely terminating the administration.

(23) Permanent facility--A building or buildings [~~that are~~] identified on the license within the State of Texas and where radioactive material may be prepared, received, used, or stored. This may also include an area or areas where administrative activities related to the license are performed.

(24) Preceptor--An individual who provides, directs, or verifies the training and experience required for an individual to become an authorized user, an authorized medical physicist, an authorized nuclear pharmacist, an RSO, or an ARSO.

(25) Prescribed dosage--The specified activity or range of activity of unsealed radioactive material as documented in a written directive or specified in [~~accordance with~~] the directions of the authorized user for procedures in subsections (ff) and (hh) of this section.

(26) Prescribed dose--Prescribed dose means [~~one of the following~~]:

(A) for gamma stereotactic radiosurgery, the total dose as documented in the written directive;

(B) for teletherapy, the total dose and dose per fraction as documented in the written directive;

(C) for brachytherapy, either the total sealed source strength and exposure time, or the total dose, as documented in the written directive; or

(D) for remote afterloaders, the total dose and dose per fraction as documented in the written directive.

(27) Pulsed dose-rate remote afterloader--A special type of remote afterloading device using [~~that uses~~] a single sealed source capable of delivering dose rates greater than 1200 rads (12 Gy) per hour, but is approximately one-tenth of the activity of typical high dose-rate remote afterloader sealed sources and is used to simulate the radiobiology of a low dose-rate [~~dose rate~~] remote afterloader treatment by inserting the sealed source for a given fraction of each hour.

(28) Radiation safety officer (RSO)--For purposes of this section, an individual who:

(A) meets the requirements in subsections (h) and (m) of this section; or

(B) is identified as an RSO on [~~one of the following~~]:

(i) a specific license issued by the department, the NRC, or an agreement state authorizing [~~that authorizes~~] the medical or veterinary use of radioactive material; or

(ii) a permit issued by an NRC master material licensee authorizing [~~that authorizes~~] the medical or veterinary use of radioactive material.

(29) Sealed source and device registry--The national registry containing [~~that contains~~] all [~~the~~] registration certificates, generated by both the NRC and [~~the~~] agreement states, summarizing [~~that summarize~~] the radiation safety information for sealed sources and devices and describing [~~describe~~] the licensing and use conditions approved for the product.

(30) Stereotactic radiosurgery--The use of external radiation in conjunction with a guidance device to very precisely deliver a dose to a tissue volume using [~~by the use of~~] three-dimensional coordinates.

(31) Technologist--A person (nuclear medicine technologist) skilled in the performance of nuclear medicine procedures under the supervision of a physician.

(32) Teletherapy--Therapeutic irradiation in which the sealed source is at a distance from the patient or human or animal research subject.

(33) Therapeutic dosage--The specified activity or range of activity of radioactive material [~~that is~~] intended to deliver a radiation dose to a patient or human or animal research subject for palliative or curative treatment.

(34) Therapeutic dose--A radiation dose delivered from a sealed source containing radioactive material to a patient or human or animal research subject for palliative or curative treatment.

(35) Treatment site--The anatomical description of [~~the~~] tissue intended to receive a radiation dose, as described in a written directive.

(36) Type of use--Use of radioactive material as specified under [~~the following subsections~~]:

(A) uptake, dilution, and excretion studies in subsection (ff) of this section;

(B) imaging and localization studies in subsection (hh) of this section;

(C) therapy with unsealed radioactive material in subsection (kk) of this section;

(D) manual brachytherapy with sealed sources in subsection (rr) of this section;

(E) sealed sources for diagnosis in subsection (bbb) of this section;

(F) sealed source in a remote afterloader unit, teletherapy unit, or gamma stereotactic radiosurgery unit in subsection (ddd) of this section; or

(G) other medical or veterinary uses of radioactive material or a radiation source approved for medical or veterinary use in subsection (q) of this section.

(37) Unit dosage--A dosage prepared for medical or veterinary use for administration as a single dosage to a patient or human or animal research subject without any further modification of the dosage after it is initially prepared.

(38) Veterinary use--The intentional internal or external administration of radioactive material, or the radiation from radioactive material, to animal patients under the supervision of an authorized user.

(39) Written directive--An authorized user's written order for the administration of radioactive material or radiation from radioactive material to a specific patient or human research subject, as specified in subsection (t) of this section.

(d) Provisions for research involving human subjects.

(1) A licensee may conduct research involving human subjects only if it uses the radioactive materials specified on its license for the uses authorized on the license.

(2) The licensee may conduct research specified in paragraph (1) of this subsection provided [~~that~~]:

(A) the research is conducted, funded, supported, or regulated by a federal agency implementing [~~that has implemented~~] the Federal Policy for the Protection of Human Subjects as required by 10 CFR [~~Title 10, CFR,~~] §35.6 (Federal Policy); or

(B) the licensee has applied for and received approval of a specific amendment to its license before conducting the research.

(3) Before conducting research as specified in paragraph (1) of this subsection, the licensee must [~~shall~~] obtain [~~the following~~]:

(A) "informed consent," as defined and described in the Federal Policy, from the human research subjects; and

(B) review and approval of the research from an Institutional Review Board

(IRB) [~~IRB~~] as required by 45 CFR [~~Title 45, CFR,~~] Part 46, and 21 CFR [~~Title 21, CFR,~~] Part 56, and in accordance with the Federal Policy.

(4) Nothing in this subsection relieves licensees from complying with the other requirements of this chapter.

(e) Implementation.

(1) If a license condition exempted a licensee from a provision of this section or §289.252 of this subchapter [~~title~~] on the effective date of this rule, then the license condition continues to exempt the licensee from the requirements in the corresponding provision until there is a license amendment or license renewal modifying or removing [~~that modifies or removes~~] the license condition.

(2) When a requirement in this section differs from the requirement in an existing license condition, the requirement in this section governs [~~shall govern~~].

(3) Licensees must [~~shall~~] continue to comply with any license condition requiring [~~that requires~~] implementation of procedures required by subsections (ggg) and (mmm) - (ooo) of this section until there is a license amendment or renewal modifying [~~that modifies~~] the license condition.

(f) Specific requirements for the issuance of licenses. In addition to the requirements in §289.252(e) of this subchapter [~~title~~] and subsections (n) - (q) of this section, as applicable, a license is [~~will be~~] issued if the department determines [~~that~~]:

(1) the applicant satisfies any applicable special requirement in this section;

(2) qualifications of the designated RSO as specified in subsection (h) of this section are adequate for the purpose requested in the application; and

(3) the [~~following~~] information submitted by the applicant is approved~~,~~ including:

(A) an operating, safety, and emergency procedures manual to include specific information on [~~the following~~]:

(i) radiation safety precautions and instructions;

(ii) methodology for measurement of dosages or doses to be administered to patients or human or animal research subjects;

(iii) calibration, maintenance, and repair of instruments and equipment necessary for radiation safety; and

(iv) waste disposal procedures; and

(B) any additional information required by this chapter [~~that is~~] requested by the department to assist in its review of the application; and

(C) qualifications of the [~~following~~]:

(i) RSO as specified in [~~accordance with~~] subsection (c)(28) of this section;

(ii) authorized users as specified [~~user(s)~~] in [~~accordance with~~] subsection (c)(6) of this section as applicable to the uses [~~use(s)~~] being requested;

(iii) authorized medical physicist as specified in [~~accordance with~~] subsection (c)(4) of this section, if applicable;

(iv) authorized nuclear pharmacist as specified in [~~accordance with~~] subsection (c)(5) of this section, if applicable;

(v) ophthalmic physicist as specified in [~~accordance with~~] subsection (c)(19) of this section, if applicable;

(vi) Radiation Safety Committee (RSC), as specified in [~~accordance with~~] subsection (i) of this section, if applicable; and

(vii) ARSO as specified in [~~accordance with~~] subsection (c)(3) of this section, if applicable; and

(4) the applicant's permanent facility is located in Texas.

(g) Authority and responsibilities for the radiation protection program.

(1) In addition to the radiation protection program requirements of §289.202(e) of this chapter [~~title~~], a licensee's management must [~~shall~~] approve in writing:

(A) requests for a license application, renewal, or amendment before submittal to the department; and

(B) any individual before being allowed [~~allowing that individual~~] to work as an authorized user, authorized nuclear pharmacist, or authorized medical physicist.

(2) A licensee's management must [~~shall~~] appoint an RSO who agrees, in writing, to be responsible for implementing the radiation protection program. The licensee, through the RSO, must [~~shall~~] ensure [~~that~~] radiation safety activities are being performed according to [~~in accordance with~~] licensee-approved procedures and regulatory requirements. A licensee's management may appoint, in writing, one or more ARSO to support the RSO. The RSO, with written agreement of the licensee's management, must assign the specific duties and tasks to each ARSO. These duties and tasks are restricted to the types of use for which the ARSO is listed on a license. The RSO may delegate duties and tasks to the ARSO but must [~~shall~~] not delegate the authority or responsibilities for implementing the radiation protection program.

(3) Every licensee must [~~shall~~] establish in writing the authority, duties, and responsibilities of the RSO and ensure [~~that~~] the RSO is provided sufficient authority, organizational freedom, time, resources, and management prerogative to perform the following duties:

(A) establish and oversee operating, safety, emergency, and as low as reasonably achievable (ALARA) procedures, and to review them at least annually to ensure [~~that the~~] procedures are current and conform with this chapter;

(B) ensure [~~that~~] required radiation surveys and leak tests are performed and documented as specified in [~~accordance with~~] this chapter, including any corrective measures when levels of radiation exceed established limits;

(C) ensure [~~that~~] individual monitoring devices are used properly by occupationally exposed [~~occupationally exposed~~] personnel, [~~that~~] records are kept of the monitoring results, and [~~that~~] timely notifications are made as specified in [~~accordance with~~] §289.203 of this chapter [~~title~~];

(D) investigate and [~~cause a~~] report [~~to be submitted~~] to the department for each known or suspected case of radiation exposure to an individual or radiation level detected over the [~~in excess of~~] limits established by this chapter and each theft or loss of sources [~~source(s)~~] of radiation, to determine the causes [~~cause(s)~~], and [~~to~~] take steps to prevent a recurrence;

(E) investigate and [~~cause a~~] report [~~to be submitted~~] to the department for each known or suspected case of release of radioactive material to the environment over the [~~in excess of~~] limits established by this chapter;

(F) have a thorough knowledge of management policies and administrative procedures of the licensee;

(G) identify radiation safety problems;

(H) assume control and initiate, recommend, or provide corrective actions, including shutdown of operations when necessary, in emergency situations or unsafe conditions;

(I) verify implementation of corrective actions;

(J) ensure [~~that~~] records are maintained as required by this chapter;

(K) ensure [~~the~~] proper storing, labeling, transport, use, and disposal of sources of radiation, storage, and [~~and/or~~] transport containers;

(L) ensure [~~that~~] inventories are performed in accordance with the activities for which the license application is submitted;

(M) ensure [~~that~~] personnel are complying with this chapter, the conditions of the license, and the operating, safety, and emergency procedures of the licensee; and

(N) serve as the primary contact with the department.

(4) The RSO must [~~shall~~] ensure [~~that the~~] duties listed in paragraph (3)(A) - (N) of this subsection are performed.

(5) The RSO must [~~shall~~] be onsite [~~on site~~] periodically, commensurate with

the scope of licensed activities, to satisfy the requirements of paragraphs (3) and (4) of this subsection.

(6) The RSO, or staff designated by the RSO, must [~~shall~~] be capable of physically arriving at the licensee's authorized use sites [~~site(s)~~] within a reasonable time of being notified of an emergency situation or unsafe condition.

(7) For up to 60 days each calendar year, a licensee may permit an authorized user or an individual qualified to be an RSO, under subsections (h) and (m) of this section, to function as a temporary RSO and to perform the duties of an RSO as specified in [~~accordance with~~] paragraph (3) of this subsection, provided the licensee takes the actions required in paragraphs (2), (3), and (9) of this subsection, and notifies the department as specified in [~~accordance with~~] subsection (r)(5) of this section. Records of qualifications and dates of service must [~~shall~~] be maintained as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department.

(8) A licensee may simultaneously appoint more than one temporary RSO as specified in [~~accordance with~~] paragraph (7) of this subsection, if needed to ensure [~~that~~] the licensee has a temporary RSO satisfying [~~that satisfies~~] the requirements to be an RSO for each of the different types of uses of radioactive material permitted by the license.

(9) The licensee must [~~shall~~] maintain records, as specified in [~~accordance with~~] subsection (xxx) of this section, as follows.

(A) A licensee must [~~shall~~] retain a record of actions taken by the licensee's management as specified in [~~accordance with~~] paragraph (1) of this subsection. The record must include a summary of the actions taken and a signature of licensee management.

(B) The authority, duties, and responsibilities of the RSO as required by paragraph (3) of this subsection, and a signed copy of each RSO's agreement to be responsible for implementing the radiation safety program, as required by paragraph (2) of this subsection. The records must include the signature of the RSO and licensee management.

(C) A copy of the written document appointing the ARSO, for each ARSO appointed under paragraph (2) of this subsection. The record must include the signature of licensee management.

(h) Training for an RSO and ARSO. Except as provided in subsection (l) of this section, the licensee must [~~shall~~] require the individual fulfilling the responsibilities of an RSO or an individual assigned duties and tasks as an ARSO as specified in [~~accordance with~~] subsection (g) of this section for licenses for medical or veterinary use of radioactive material, to be an individual who:

(1) is certified by a specialty board whose certification process has been recognized by the department, the NRC, or an agreement state and who meets the requirements in paragraph (4) of this subsection. The names of board certifications

[~~that have been~~] recognized by the department, the NRC, or an agreement state are posted on the NRC's Medical Uses Licensee Toolkit web page.[~~:~~]

(A) To [~~to~~] have its certification process recognized, a specialty board must [~~shall~~] require all candidates for certification to:

(i) hold a bachelor's or graduate degree from an accredited college or university in physical science or engineering or biological science with a minimum of 20 college credits in physical science;

(ii) have five or more years of professional experience in health physics (graduate training may be substituted for no more than two years of the required experience) including at least three years in applied health physics; and

(iii) pass an examination, administered by diplomates of the specialty board evaluating[~~, which evaluates~~] knowledge and competence in radiation physics and instrumentation, radiation protection, mathematics pertaining to the use and measurement of radioactivity, radiation biology, and radiation dosimetry; or

(B) to have its certification process recognized, a specialty board must [~~shall~~] require all candidates for certification to:

(i) hold a master's or doctoral [~~doctor's~~] degree in physics, medical physics, other physical science, engineering, or applied mathematics from an accredited college or university;

(ii) have two years of full-time practical training or [~~and/or~~] supervised experience in medical physics as follows:

(I) under the supervision of a medical physicist who is certified in medical physics by a specialty board recognized by the department, the NRC, or an agreement state; or

(II) in clinical nuclear medicine facilities providing diagnostic or [~~and/or~~] therapeutic services under the direction of physicians who meet the requirements for authorized users in subsections (l), (jj), or (nn) of this section; and

(iii) pass an examination, administered by diplomates of the specialty board, assessing [~~that assesses~~] knowledge and competence in clinical diagnostic radiological or nuclear medicine physics and in radiation safety; or

(2) has [~~completed all of the following~~]:

(A) completed a structured educational program consisting of both:

(i) 200 hours of classroom and laboratory training in [~~the following areas~~]:

(I) radiation physics and instrumentation;

(II) radiation protection;

(III) mathematics pertaining to the use and measurement of radioactivity;

(IV) radiation biology; and

(V) radiation dosimetry; and

(ii) one year of full-time radiation safety experience under the supervision of the individual identified as the RSO on a department [~~an agency~~], NRC, or agreement state license or on a permit issued by an NRC master material licensee authorizing [~~that authorizes~~] similar types [~~type(s)~~] of use [~~use(s)~~] of radioactive material. An ARSO may provide supervision for those areas for which the ARSO is authorized on a department [~~an agency~~], NRC, or an agreement state license or a permit issued by an NRC master material licensee. The full-time radiation safety experience must involve [~~the following~~]:

(I) shipping, receiving, and performing related radiation surveys;

(II) using and performing checks for proper operation of instruments used to determine the activity of dosages, survey meters, and instruments [~~instrument~~] used to measure radionuclides;

(III) securing and controlling radioactive material;

(IV) using administrative controls to avoid mistakes in the administration of radioactive material;

(V) using procedures to prevent or minimize radioactive contamination and using proper decontamination procedures;

(VI) using emergency procedures to control radioactive material; and

(VII) disposing of radioactive material; and

(B) [~~has~~] obtained written attestation, signed by a preceptor RSO or ARSO experienced [~~who has experience~~] with the radiation safety aspects of similar types of use of radioactive material for which the individual is seeking approval as an RSO or an ARSO. The[~~, and the~~] written attestation must state [~~that~~] the individual has satisfactorily completed the requirements in paragraphs (2)(A) and (4) of this subsection, and is able to independently fulfill the radiation safety-related duties as an RSO or as an ARSO for a medical or veterinary use license; or

(3) meets one of the following:

(A) is a medical physicist [~~who has been~~] certified by a specialty board whose certification process has been recognized by the department, the NRC, or an agreement state as specified in [~~accordance with~~] subsection (j)(1) of this section, [~~and~~] has experience with the radiation safety aspects of similar types of use of radioactive material for which the licensee is seeking [~~the~~] approval of the individual as the RSO or [~~an~~] ARSO, and [~~who~~] meets the requirements in paragraph (4) of this subsection;

(B) is an authorized user, authorized medical physicist, or authorized nuclear pharmacist identified on a department [~~an agency~~], NRC, or another agreement state's license; [~~,~~] a permit issued by an [~~a~~] NRC master material licensee; [~~,~~] a permit issued by the department, the NRC, or another agreement state licensee of broad scope; [~~,~~] or a permit issued by an [~~a~~] NRC master material license broad scope permittee, has experience with the radiation safety aspects of similar types of use of radioactive material for which the licensee is seeking the approval of the individual as the RSO or ARSO, and who meets the requirements in paragraph (4) of this subsection; or

(C) has experience with the radiation safety aspects of the types of use of radioactive material for which the individual is seeking simultaneous approval both as the RSO and the authorized user on the same new medical or veterinary use license or new medical use permit issued by an [~~a~~] NRC master material licensee [~~license~~]. The individual must also meet the requirements in paragraph (4) of this subsection; and

(4) has training in the radiation safety, regulatory issues, and emergency procedures for the types of use for which a licensee seeks approval, and this training requirement may be satisfied by completing training [~~that is~~] supervised by an RSO, an ARSO, authorized medical physicist, authorized nuclear pharmacist, or authorized user, as appropriate, who is authorized for the types [~~type(s)~~] of use for which the licensee is seeking approval.

(i) Radiation safety committee (RSC). Licensees of broad scope and licensees who are authorized for two or more different types of uses of radioactive material requiring a written directive under [~~in accordance with~~] subsections (q), (kk), (rr), and (ddd) of this section, or two or more types of therapeutic units under subsections (q) and [~~subsection~~] (ddd) of this section, must [~~shall~~] establish an RSC to oversee all uses of radioactive material permitted by the license.

(1) The RSC must [~~for licenses for medical use with broad scope authorization shall~~] be composed of the following individuals as approved by the department:

(A) an authorized user of [~~users from~~] each type of use permitted by [~~of radioactive material authorized on~~] the license;

(B) the RSO;

(C) a representative of the nursing service, if applicable;

(D) a representative of management who is neither an authorized user nor the RSO; and

(E) [~~may include~~] other members as the licensee deems appropriate.

[~~(2) The RSC for licenses for medical and veterinary use authorized for two or more different types of uses of radioactive material in accordance with subsections (kk), (rr), and (ddd) of this section, or two or more types of units in accordance with subsection (ddd) of this section shall be composed of the following individuals~~

~~as approved by the department:~~]

[~~(A) an authorized user of each type of use permitted by the license;~~]

[~~(B) the RSO;~~]

[~~(C) a representative of nursing service, if applicable;~~]

[~~(D) a representative of management who is neither an authorized user nor the RSO; and~~]

[~~(E) may include other members as the licensee deems appropriate.~~]

(2) [~~(3)~~] Duties and responsibilities of the RSC.

(A) For licensees without broad scope authorization, the duties and responsibilities of the RSC include [~~the following~~]:

(i) meeting as often as necessary to conduct business but no less than three times a year;

(ii) reviewing summaries of [~~the following~~] information presented by the RSO, including:

(I) doses over the occupational or public limits [~~over-exposures~~];

(II) significant incidents, including spills, contamination, or medical events; and

(III) items of non-compliance following an inspection;

(iii) reviewing the program for maintaining doses ALARA, and providing any necessary recommendations to ensure doses are ALARA; and

(iv) reviewing the audit of the radiation safety program and acting upon the findings.

(B) For licensees of broad scope, the duties and responsibilities of the RSC include the items in subparagraph (A) of this paragraph and [~~the following~~]:

(i) reviewing the overall compliance status for authorized users;

(ii) sharing responsibility with the RSO to conduct periodic audits of the radiation safety program;

(iii) developing criteria to evaluate training and experience of new authorized user applicants;

(iv) evaluating and approving authorized user applicants who request authorization to use radioactive material at the facility; and

(v) reviewing and approving permitted program and procedural changes before implementation.

(3) [~~(4)~~] Records documenting the RSC meetings must [~~shall~~] be made and maintained for inspection by the department as specified in [~~accordance with~~] subsection (xxx) of this section. The record must [~~shall~~] include the date, names of individuals in attendance, minutes of the meeting, and any actions taken.

(j) Training for an authorized medical physicist. Except as provided in subsection (l) of this section, the licensee must [~~shall~~] require the authorized medical physicist to be:

(1) an individual [~~who is~~] certified by a specialty board whose certification process has been recognized by the department, the NRC, or an agreement state and who meets the requirements in paragraph (3) of this subsection. The names of board certifications [~~that have been~~] recognized by the department, the NRC, or an agreement state are posted on the NRC's Medical Uses Licensee Toolkit web page. To have its certification process recognized, a specialty board must [~~shall~~] require all candidates [~~for certification~~] to [~~meet the following~~]:

(A) hold a master's or doctoral [~~doctor's~~] degree in physics, medical physics, other physical science, engineering, or applied mathematics from an accredited college or university;

(B) complete two years of full-time practical training or [~~and/or~~] supervised experience in medical physics as follows:

(i) under the supervision of a medical physicist who is certified in medical physics by a specialty board whose certification process has been recognized by the department, the NRC, or an agreement state; or

(ii) in clinical radiation facilities providing high-energy, external beam therapy (photons and electrons with energies greater than or equal to 1 million electron volts) and brachytherapy services under the direction of physicians meeting [~~who meet~~] the requirements for authorized users in subsections (l), (zz), or (ttt) of this section; and

(C) pass an examination, administered by diplomates of the specialty board, assessing [~~that assesses~~] knowledge and competence in clinical radiation therapy, radiation safety, calibration, quality assurance, and treatment planning for external beam therapy, brachytherapy, and stereotactic radiosurgery; or

(2) an individual who:

(A) holds a post graduate degree and experience, including [~~to include~~]:

(i) a master's or doctoral [~~doctor's~~] degree in physics, medical physics, other physical science, engineering, or applied mathematics from an accredited college or university; and

(ii) completion of one year of full-time training in medical physics and an additional year of full-time work experience under the supervision of an individual meeting [~~who meets~~] the requirements for an authorized medical physicist for the types [~~type(s)~~] of use for which the individual is seeking authorization. This[~~, and~~

~~this~~] training and work experience must [~~shall~~] be conducted in clinical radiation facilities providing [~~that provide~~] high-energy, external beam therapy (photons and electrons with energies greater than or equal to 1 million electron volts) and brachytherapy services and must [~~shall~~] include:

(I) performing sealed source leak tests and inventories;

(II) performing decay corrections;

(III) performing full calibration and periodic spot checks of external beam treatment units, stereotactic radiosurgery units, and remote afterloading units as applicable; and

(IV) conducting radiation surveys around external beam treatment units, stereotactic radiosurgery units, and remote afterloading units as applicable; and

(B) has obtained written attestation [~~that~~] the individual has satisfactorily completed the requirements in paragraphs (2)(A) and (3) of this subsection[~~,~~] and is able to independently fulfill the radiation safety-related duties as an authorized medical physicist for each type of therapeutic medical unit for which the individual is requesting authorized medical physicist status. The[~~, and the~~] written attestation must [~~shall~~] be signed by a preceptor authorized medical physicist meeting [~~who meets~~] the requirements in subsection (l) of this section, this subsection, or equivalent NRC or agreement state requirements for an authorized medical physicist for each type of therapeutic medical unit for which the individual is requesting authorized medical physicist status; and

(3) an individual trained [~~who has training~~] for the types [~~type(s)~~] of use for which authorization is sought, including [~~that includes~~] hands-on device operation, safety procedures, clinical use, and the operation of a treatment planning system. This training requirement may be satisfied by satisfactorily completing either a training program provided by the vendor or by training supervised by an authorized medical physicist authorized for the types [~~type(s)~~] of use for which the individual is seeking authorization.

(k) Training for an authorized nuclear pharmacist. Except as provided in subsection (l) of this section, the licensee must [~~shall~~] require the authorized nuclear pharmacist to be a pharmacist who:

(1) is certified by a specialty board whose certification process has been recognized by the department, the NRC, or an agreement state. The names of board certifications [~~that have been~~] recognized by the department, the NRC, or an agreement state are posted on the NRC's Medical Uses Licensee Toolkit web page. To have its certification process recognized, a specialty board must [~~shall~~] require all candidates for certification to:

(A) have graduated from a pharmacy program accredited by the Accreditation Council for Pharmacy Education [~~(ACPE)~~] or have passed the Foreign Pharmacy Graduate Examination Committee [~~(FPGEC)~~] examination;

(B) hold a current, active license to practice pharmacy in the State of Texas;

(C) provide evidence of having acquired at least 4000 hours of training/experience in nuclear pharmacy practice. Academic training may be substituted for no more than 2000 hours of the required training and experience; and

(D) pass an examination in nuclear pharmacy, administered by diplomates of the specialty board, assessing [~~that assesses~~] knowledge and competency in procurement, compounding, quality assurance, dispensing, distribution, health and safety, radiation safety, provision of information and consultation, monitoring patient outcomes, and research and development; or

(2) has [~~completed~~]:

(A) completed a 700-hour structured educational program, including both:

(i) 200 hours of classroom and laboratory training in [~~the following areas~~]:

(I) radiation physics and instrumentation;

(II) radiation protection;

(III) mathematics pertaining to the use and measurement of radioactivity;

(IV) chemistry of radioactive material for medical use; and

(V) radiation biology; and

(ii) supervised practical experience in a nuclear pharmacy involving [~~the following~~]:

(I) shipping, receiving, and performing related radiation surveys;

(II) using and performing checks for proper operation of instruments used to determine the activity of dosages, survey meters, and, if appropriate, instruments used to measure alpha- or beta-emitting radionuclides;

(III) calculating, assaying, and safely preparing dosages for patients or human research subjects;

(IV) using administrative controls to avoid medical events in the administration of radioactive material; and

(V) using procedures to prevent or minimize radioactive contamination and using proper decontamination procedures; and

(B) [~~has~~] obtained written attestation, signed by a preceptor authorized nuclear pharmacist, [~~that~~] the individual has satisfactorily completed the requirements in paragraph (2)(A) of this subsection and is able to independently

fulfill the radiation safety-related duties as an authorized nuclear pharmacist.

(l) Training for experienced RSO, teletherapy or medical physicist, authorized medical physicist, authorized user, nuclear pharmacist, and authorized nuclear pharmacist.

(1) An individual identified on a department [~~an agency~~], NRC, or an agreement state license or a permit issued by the department, the NRC, or an agreement state broad scope licensee or master material license permit, or by a master material license permittee of broad scope as an RSO, a teletherapy or medical physicist, an authorized medical physicist, a nuclear pharmacist, or an authorized nuclear pharmacist on or before January 14, 2019, need not comply with the training requirements of subsections (h), (j), and (k) of this section, respectively, except the RSO and authorized medical physicists identified in this paragraph must meet the training requirements in subsections (h)(4) or (j)(3) of this section, as appropriate, for any material or uses for which they were not authorized before this date.

(2) Any individual certified by the American Board of Health Physics in Comprehensive Health Physics; American Board of Radiology; American Board of Nuclear Medicine; American Board of Science in Nuclear Medicine; Board of Pharmaceutical Specialties in Nuclear Pharmacy; American Board of Medical Physics in radiation oncology physics; Royal College of Physicians and Surgeons of Canada in nuclear medicine; American Osteopathic Board of Radiology; or American Osteopathic Board of Nuclear Medicine on or before October 24, 2005, need not comply with the training requirements of subsection (h) of this section to be identified as an RSO or as an ARSO on a department [~~an agency~~], NRC, or agreement state license or NRC master material license permit for those materials and uses [~~that~~] these individuals performed on or before October 24, 2005.

(3) Any individual certified by the American Board of Radiology in therapeutic radiological physics, Roentgen ray and gamma ray physics, x-ray [~~xray~~] and radium physics, or radiological physics, or certified by the American Board of Medical Physics in radiation oncology physics, on or before October 24, 2005, need not comply with the training requirements for an authorized medical physicist described in subsection (j) of this section, for those materials and uses [~~that~~] these individuals performed on or before October 24, 2005.

(4) An RSO, a medical physicist, or a nuclear pharmacist[~~,~~] who used only accelerator-produced radioactive materials, discrete sources of radium-226, or both, for medical or veterinary uses or in the practice of nuclear pharmacy at a government agency or federally recognized Indian Tribe before November 30, 2007, or at all other locations of use before August 8, 2009, or an earlier date as noticed by the NRC, need not comply with the training requirements of subsections (h), (j), or (k) of this section, respectively, when performing the same uses. A nuclear pharmacist[~~,~~] who prepared only radioactive drugs containing accelerator-produced radioactive materials, or a medical physicist[~~,~~] who used only accelerator-produced radioactive materials, at the locations and during the time period identified in this paragraph, qualifies as an authorized nuclear pharmacist or an

authorized medical physicist, respectively, for those materials and uses performed before these dates, for the purposes of this chapter.

(5) An individual identified as a physician, dentist, podiatrist, or veterinarian authorized for the medical or veterinary use of radioactive material.

(A) Physicians, dentists, [~~or~~] podiatrists, or veterinarians identified as authorized users for the medical or veterinary use of radioactive material on a license issued by the department, the NRC, or an agreement state; [~~,~~] a permit issued by an NRC master material licensee; [~~,~~] a permit issued by the department, the NRC, or an agreement state broad scope licensee; [~~,~~] or a permit issued by an NRC master material license broad scope permittee on or before January 14, 2019, who perform only those medical or veterinary uses for which they were authorized on or before that date need not comply with the training requirements of subsections (gg) through (ttt) of this section.

(B) Physicians, dentists, [~~or~~] podiatrists, or veterinarians identified as authorized users for the medical or veterinary use of radioactive material on a license issued by the department, the NRC, or an agreement state; [~~,~~] a permit issued by an NRC master material licensee; [~~,~~] a permit issued by the department, the NRC, or an agreement state broad scope licensee; [~~,~~] or a permit issued under [~~by~~] an NRC master material broad scope license [~~of broad scope~~] on or before October 24, 2005, need not comply with the training requirements of subsections (gg) through (ttt) of this section for those materials and uses [~~that~~] these individuals performed on or before October 24, 2005, as follows:

(i) for [~~For~~] uses authorized under subsections (ff) or (hh) of this section, or oral administration of sodium iodide I-131 requiring a written directive for imaging and localization purposes, a physician who was certified on or before October 24, 2005, in nuclear medicine by the American Board of Nuclear Medicine; diagnostic radiology by the American Board of Radiology; diagnostic radiology or radiology by the American Osteopathic Board of Radiology; nuclear medicine by the Royal College of Physicians and Surgeons of Canada; or American Osteopathic Board of Nuclear Medicine in nuclear medicine;

(ii) for [~~For~~] uses authorized under subsection (kk) of this section, a physician who was certified on or before October 24, 2005, by the American Board of Nuclear Medicine; the American Board of Radiology in radiology, therapeutic radiology, or radiation oncology; nuclear medicine by the Royal College of Physicians and Surgeons of Canada; or the American Osteopathic Board of Radiology after 1984;

(iii) for [~~For~~] uses authorized under subsections (rr) or (ddd) of this section, a physician who was certified on or before October 24, 2005, in radiology, therapeutic radiology, or radiation oncology by the American Board of Radiology; radiation oncology by the American Osteopathic Board of Radiology; radiology, with specialization in radiotherapy, as a British "Fellow of the Faculty of Radiology" or "Fellow of the Royal College of Radiology"; or therapeutic radiology by the Canadian Royal College of Physicians and Surgeons; and

(iv) for [~~For~~] uses authorized under subsection (bbb) of this section, a physician who was certified on or before October 24, 2005, in radiology, diagnostic radiology, therapeutic radiology, or radiation oncology by the American Board of Radiology; nuclear medicine by the American Board of Nuclear Medicine; diagnostic radiology or radiology by the American Osteopathic Board of Radiology; or nuclear medicine by the Royal College of Physicians and Surgeons of Canada.

(C) Physicians, dentists, [~~or~~] podiatrists, or veterinarians who used only accelerator-produced radioactive materials, discrete sources of radium-226, or both, for medical or veterinary uses performed at a government agency or federally recognized Indian Tribe before November 30, 2007, or at all other locations of use before August 8, 2009, or an earlier date as noticed by the NRC, need not comply with the training requirements of subsections (gg) through (ttt) of this section when performing the same medical or veterinary uses. A physician, dentist, [~~or~~] podiatrist, or veterinarian who used only accelerator-produced radioactive materials, discrete sources of radium-226, or both, for medical or veterinary uses at the locations and time period identified in this paragraph, qualifies as an authorized user for those materials and uses performed before these dates, for the purposes of this chapter.

(6) Individuals who need not comply with training requirements in this subsection may serve as preceptors for, and supervisors of, applicants seeking authorization on a department [~~an agency~~], NRC, or agreement state license for the same uses for which these individuals are authorized.

(m) Recentness of training. The training and experience specified in subsections (h), (j), and (gg) - (ttt) of this section for medical and veterinary use must [~~shall~~] have been obtained within the seven years preceding the date of application or the individual must [~~shall~~] have had related continuing education and experience since the required training and experience was completed.

(n) Licenses for medical and veterinary [~~veterinarian~~] uses of radioactive material without broad scope authorization. In addition to the requirements of subsection (f) of this section, a license for medical and veterinary [~~veterinarian~~] use of radioactive material as described in the applicable subsections (ff), (hh), (kk), (rr), (bbb), and (ddd) of this section is [~~will be~~] issued if the department approves [~~the following~~] documentation showing [~~submitted by the applicant~~]:

(1) [~~that~~] the physicians [~~physician(s)~~] or veterinarians [~~veterinarian(s)~~] designated on the application as the authorized users are [~~user(s) is~~] qualified as specified in [~~accordance with~~] subsections (gg), (jj), (nn) - (qq), (zz), (aaa), (ccc), and (ttt) of this section, as applicable;

(2) [~~that~~] the radiation detection and measuring instrumentation is appropriate for performing surveys and procedures for the uses involved;

(3) [~~that~~] the radiation safety operating procedures are adequate for the handling and disposal of the radioactive material involved in the uses; and

(4) [~~that~~] an RSC has been established as specified in [~~accordance with~~]

subsection (i)(2) of this section, if applicable.

(o) License for medical and veterinary uses of radioactive material with broad scope authorization. In addition to the requirements of subsection (f) of this section, a license for medical or veterinary use of radioactive material with broad scope authorization is [~~will be~~] issued if the department approves [~~the following~~] documentation showing [~~submitted by the applicant~~]:

(1) [~~that~~] the review of authorized user qualifications by the RSC is as specified in [~~accordance with~~] subsections (gg), (jj), (nn) - (qq), (zz), (aaa), (ccc), and (ttt) of this section, as applicable;

(2) [~~that~~] the application is for a license authorizing unspecified forms or [~~and/or~~] multiple types of radioactive material for medical research, diagnosis, and therapy;

(3) [~~that~~] the radiation detection and measuring instrumentation is appropriate for performing surveys and procedures for the uses involved;

(4) [~~that~~] the radiation safety operating procedures are adequate for the handling and disposal of the radioactive material involved in the uses;

(5) [~~that~~] staff has substantial experience in the use of a variety of radioactive material for a variety of human and animal uses;

(6) [~~that~~] the full-time RSO meets the requirements of subsection (h) of this section; and

(7) [~~that~~] an RSC has been established as specified in [~~accordance with~~] subsection (i)(1) of this section.

(p) License for the use of remote afterloader units, teletherapy units, or gamma stereotactic radiosurgery units. In addition to the requirements of subsection (f) of this section, a license for the use of remote afterloader units, teletherapy units, or gamma stereotactic radiosurgery units is [~~will be~~] issued if the department approves [~~the following~~] documentation showing [~~submitted by the applicant~~]:

(1) [~~that~~] the physicians [~~physician(s)~~] designated on the application as the authorized users are [~~user(s) is~~] qualified as specified in [~~accordance with~~] subsection (ttt) of this section;

(2) [~~that~~] the radiation detection and measuring instrumentation is appropriate for performing surveys and procedures for the uses involved;

(3) [~~that~~] the radiation safety operating procedures are adequate for the handling and disposal of the radioactive material involved in the uses;

(4) [~~of~~] the radioactive isotopes to be possessed;

(5) [~~of~~] the sealed source manufacturer names [~~manufacturer(s) name(s)~~] and the model numbers [~~number(s)~~] of the sealed sources [~~source(s)~~] to be installed;

(6) [~~of~~] the maximum number of sealed sources of each isotope to be possessed, including the activity of each sealed source;

(7) [~~of~~] the manufacturer and model designation [~~name and/or number~~] of the following units, as applicable:

(A) remote afterloader unit;

(B) teletherapy unit; or

(C) gamma stereotactic radiosurgery unit;

(8) [~~that~~] the authorized medical physicist designated on the application is qualified as specified in [~~accordance with~~] subsection (j) of this section;

(9) [~~of~~] the safety procedures and instructions as required by subsection (ggg) of this section;

(10) [~~of~~] the spot check procedures as required by subsections (mmm) - (ooo) of this section, as applicable; and

(11) [~~that~~] an RSC has been established as specified in [~~accordance with~~] subsection (i)(1) or (2) of this section, if applicable.

(q) License for other medical or veterinary uses of radioactive material or a radiation source approved for medical or veterinary use [~~that is~~] not specifically addressed in this section. In addition to the requirements of subsection (f) of this section, a licensee may use radioactive material or a radiation source approved for medical or veterinary use [~~which is~~] not specifically addressed in this section if:

(1) the department approves the following documentation submitted by the applicant:

(A) any additional aspects of the medical or veterinary use of the material [~~that are~~] applicable to radiation safety [~~that are~~] not addressed in, or different [~~differ~~] from, requirements in this section;

(B) identification of and commitment to follow the applicable radiation safety program requirements in this section [~~that are~~] appropriate for the specific medical or veterinary use;

(C) any additional specific information on:

(i) radiation safety precautions and instructions;

(ii) methodology for measurement of dosages or doses to be administered to patients or human or animal research subjects; and

(iii) calibration, maintenance, and repair of instruments and equipment necessary for radiation safety; and

(D) any other information requested by the department in its review of the

application; and

(2) the applicant or licensee has received written approval from the department in a license or license amendment and the licensee uses the material in accordance with the regulations and specific conditions the department considers necessary for the medical or veterinary use of the material.

(r) License amendments and notifications.

(1) Requests for amendment of a license or deletion of an authorized use site must [~~shall~~] be filed as specified in [~~accordance with~~] §289.252(aa) of this subchapter [~~title~~].

(2) A licensee must [~~shall~~] apply for and must [~~shall~~] receive a license amendment before [~~the following~~]:

(A) receiving or using radioactive material for a type of use [~~that is~~] authorized by [~~in accordance with~~] this section, but [~~is~~] not authorized on their current license issued under [~~in accordance with~~] this section;

(B) permitting anyone to work as an authorized user, authorized nuclear pharmacist, authorized medical physicist, or ophthalmic physicist[~~,~~] under the license except an individual who is identified as an authorized user, an authorized nuclear pharmacist, authorized medical physicist, or an ophthalmic physicist:

(i) on a department [~~an agency~~], NRC, or agreement state license or other equivalent permit or license recognized by the department authorizing [~~that authorizes~~] the use of radioactive material in medical or veterinary use or in the practice of nuclear pharmacy;

(ii) on a permit issued by a department [~~an agency~~], NRC, or agreement state specific license of broad scope [~~that is~~] authorized to permit the use of radioactive material in medical or veterinary use or in the practice of nuclear pharmacy;

(iii) on a permit issued by an NRC master material licensee [~~that is~~] authorized to permit the use of radioactive material in medical use or in the practice of nuclear pharmacy; or

(iv) by a commercial nuclear pharmacy [~~that has been~~] authorized to identify authorized nuclear pharmacists.

(C) changing RSOs, except as provided in subsection (g)(7) of this section;

(D) receiving radioactive material more than [~~in excess of~~] the amount or in a different form, or receiving a different radionuclide than [~~is~~] authorized on the license;

(E) adding or changing the areas where [~~in which~~] radioactive material is used or stored and [~~are~~] identified in the application or on the license, including areas used as specified in [~~accordance with~~] subsection (ff) or (hh) of this section if

the change includes addition or relocation of either an area where positron emission tomography (PET) radionuclides are produced or a PET radioactive drug delivery line from the PET radionuclide/PET radioactive drug production area. Other [~~, and other~~] areas of use where radioactive material is used only as specified in [~~accordance with~~] either subsection (ff) or (hh) of this section, are exempt;

(F) changing the addresses [~~address(es)~~] of use identified in the application or on the license;

(G) changing operating, safety, and emergency procedures; however, a licensee may revise its radiation protection program without the department's approval if the revision does not require a license amendment under the other provisions of this paragraph; and

(i) the revision does not reduce the safety of an affected facility;

(ii) the revision is in compliance with the rules in this chapter and the license;

(iii) the revision has been reviewed and approved by the RSO and licensee management;

(iv) the affected individuals are instructed on the revised program before the changes are implemented;

(v) all changes to the radiation protection program are submitted to the department after the provisions of this subparagraph are completed; and

(vi) the licensee retains a record of each change to the radiation protection program as specified in §289.202(mm) of this chapter.

(H) before permitting anyone to work as an ARSO, or before the RSO assigns duties and tasks to an ARSO differing [~~that differ~~] from those for which this individual is authorized on the license; and

(I) before receiving a sealed source from a different manufacturer or of a different model number than authorized by its license unless the sealed source is used for manual brachytherapy, is listed in the Sealed Source and Device Registry, and is in a quantity and for an isotope authorized by the license.

(3) A licensee possessing a Type A specific license of broad scope for medical or veterinary use, issued under §289.252(h)(2) of this subchapter [~~title~~], is exempt from:

(A) the provisions of subsection (q)(1) of this section regarding the need to file an amendment to the license for medical or veterinary use of radioactive material;

(B) the provisions of paragraph (2)(B) of this subsection;

(C) the provisions of paragraph (2)(E) of this subsection regarding additions

to or changes in the areas of use at the addresses identified in the application or on the license;

(D) the provisions of paragraph (4) of this subsection;

(E) the provisions of paragraph (5)(A) of this subsection for an authorized user, an authorized nuclear pharmacist, an authorized medical physicist, or an ophthalmic physicist;

(F) the provisions of paragraph (5)(C) of this subsection; and

(G) the provisions of subsection (u)(1) of this section.

(4) A licensee must [~~shall~~] notify the department in the form of a license amendment request[~~,~~] no later than 30 days after the date that the licensee permits an individual to work under the provisions of this subsection [~~§289.256(r)~~] as an authorized user, authorized medical physicist, ophthalmic physicist, or authorized nuclear pharmacist providing [~~that~~] the individual is authorized on a license for the same use. A licensee includes with the notification the following documentation:

(A) a copy of the department, NRC, or agreement state license;

(B) the permit issued by an NRC master material licensee;

(C) the permit issued by the department, the NRC, or an agreement state licensee of broad scope; or

(D) the permit issued by an NRC master material license broad scope permittee.

(5) A licensee must [~~shall~~] notify the department in the form of a license amendment request no later than 30 days after:

(A) an authorized user, an authorized nuclear pharmacist, an RSO, an ARSO, an authorized medical physicist, or an ophthalmic physicist permanently discontinues performance of duties under the license or has a name change;

(B) the licensee permits an individual qualified to be an RSO under subsections (h) and (m) of this section to function as a temporary RSO and to perform the functions of an RSO as specified in [~~accordance with~~] subsection (g)(6) of this section;

(C) the licensee has added to or changed the areas of use identified in the application or on the license where byproduct material is used as specified in [~~accordance with~~] either subsection (ff) or (hh) of this section, if the change does not include addition or relocation of either an area where PET radionuclides are produced or a PET radioactive drug delivery line from the PET radionuclide/PET radioactive drug production area; or

(D) the licensee obtains a sealed source for use in manual brachytherapy

from a different manufacturer or with a different model number than authorized by its license for which it did not require a license amendment as provided in paragraph (1) of this subsection. The notification must include the manufacturer and model number of the sealed source, the isotope, and the quantity per sealed source.

(s) Supervision. A licensee may permit the receipt, possession, use, or transfer of radioactive material by an individual under the supervision of an authorized user, unless prohibited by license condition.

(1) A licensee who permits the receipt, possession, use, or transfer of radioactive material by an individual under the supervision of an authorized user must [~~shall do the following~~]:

(A) instruct the supervised individual in the licensee's written operating, safety, and emergency procedures, written directive procedures, requirements of this chapter, and license conditions with respect to the use of radioactive material; and

(B) require the supervised individual to follow the instructions of the supervising authorized user for medical or veterinary uses of radioactive material, written operating, safety, and emergency procedures established by the licensee, written directive procedures, requirements of this chapter, and license conditions with respect to the medical or veterinary use of radioactive material.

(2) A licensee who permits the preparation of radioactive material for medical or veterinary use by an individual under the supervision of an authorized nuclear pharmacist or authorized user must[~~, shall do the following~~]:

(A) instruct the supervised individual in the preparation of radioactive material for medical or veterinary use, as appropriate to that individual's involvement with radioactive material; and

(B) require the supervised individual to follow the instructions of the supervising authorized user or authorized nuclear pharmacist regarding the preparation of radioactive material for medical or veterinary use, the written operating, safety, and emergency procedures established by the licensee, the requirements of this chapter, and license conditions.

(3) A licensee who permits supervised activities as specified in [~~accordance with~~] paragraphs (1) and (2) of this subsection is responsible for the acts and omissions of the supervised individual.

(4) Only an authorized user may authorize the medical or veterinary use of radioactive material.

(t) Written directives.

(1) A written directive must [~~shall~~] be dated and signed by an authorized user before any administration of sodium iodide I-131 greater than 30 microcuries (μCi) (1.11 megabequerels (MBq)), administration of any therapeutic dosage of unsealed

radioactive material, or administration of any therapeutic dose of radiation from radioactive material. 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 is acceptable. The information contained in the oral directive must [~~shall~~] be documented in writing as soon as possible in the patient's record. A written directive must [~~shall~~] be prepared and signed by the authorized user within 48 hours of the oral directive.

(2) The written directive must [~~shall~~] contain the patient or human research subject's name and the following information for each application.

(A) For any administration of quantities greater than 30 μCi (1.11 MBq) of sodium iodide I-131: the dosage.

(B) For an administration of a therapeutic dosage of a radiopharmaceutical other than sodium iodide I-131: the radiopharmaceutical, the dosage, and the route of administration.

(C) For gamma stereotactic radiosurgery: the total dose, the treatment site, and the values for the target coordinate settings per treatment for each anatomically distinct treatment site.

(D) For teletherapy: the total dose, the dose per fraction, the number of fractions, and the treatment site.

(E) For high-dose rate remote afterloading brachytherapy: the radionuclide, the treatment site, the dose per fraction, the number of fractions, and the total dose.

(F) For permanent implant brachytherapy:

(i) before implantation: the treatment site, the radionuclide, and the total source strength; and

(ii) after implantation but before the patient leaves the post-treatment recovery area: the treatment site, the number of sources implanted, the total source strength implanted, and the date.

(G) For all other brachytherapy, including low, medium, and pulsed rate afterloaders:

(i) before implantation: the treatment site, the radionuclide, and the dose;

(ii) after implantation but before completion of the procedure: the radionuclide, the treatment site, the number of sealed sources, the total sealed source strength, exposure time (or the total dose), and the date.

(3) A written revision to an existing written directive.

(A) A written revision to an existing written directive may be made if the

revision is dated and signed by an authorized user before the administration of the dosage of unsealed radioactive material, the brachytherapy dose, the gamma stereotactic radiosurgery dose, the teletherapy dose, or the next fractional dose.

(B) 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 is acceptable. The oral revision must be documented as soon as possible in the patient's record. A revised written directive must be signed by the authorized user within 48 hours of the oral revision.

(4) The licensee must [~~shall~~] retain the written directive as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department.

(5) Procedures for administrations requiring a written directive.

(A) For any administration requiring a written directive, the licensee must [~~shall~~] develop, implement, and maintain written procedures to provide high confidence [~~that~~]:

(i) the patient's or human research subject's identity is verified before each administration; and

(ii) each administration is in accordance with the written directive.

(B) The procedures required by subparagraph (A) of this paragraph must [~~shall~~], at a minimum, address the following items [~~that are~~] applicable for the licensee's use of radioactive material:

(i) verifying the identity of the patient or human research subject;

(ii) verifying [~~that~~] the administration is in accordance with the treatment plan, if applicable, and the written directive;

(iii) checking both manual and computer-generated dose calculations; [~~and~~]

(iv) verifying [~~that~~] any computer-generated dose calculations are correctly transferred into the consoles of therapeutic medical units authorized by subsections (q) and (ddd) of this section;

(v) determining if a medical event, as defined in subsection (uuu) of this section, has occurred; and

(vi) determining, for permanent implant brachytherapy, within 60 calendar days from the date the implant was performed, the total source strength administered outside of the treatment site compared to the total source strength documented in the post-implantation portion of the written directive, unless a written justification of patient unavailability is documented.

(C) A licensee must [~~shall~~] maintain a copy of the procedures required by

subparagraph (A) of this paragraph as specified in [~~accordance with~~] subsection (xxx) of this section.

(u) Suppliers for sealed sources or devices for medical or veterinary use. A licensee may only use the following for medical or veterinary use:

(1) sealed sources or devices manufactured, labeled, packaged, and distributed as specified in [~~accordance with~~] a license issued under §289.252(o) of this subchapter [~~title~~] or equivalent requirements of the NRC or an agreement state;

(2) sealed sources or devices non-commercially transferred from an NRC or agreement state medical or veterinary use licensee; or

(3) teletherapy sources manufactured and distributed as specified in [~~accordance with~~] a license issued by the department, the NRC, or an agreement state.

(v) Possession, use, and calibration of dose calibrators to measure the activity of unsealed radioactive material.

(1) For direct measurements performed as specified in [~~accordance with~~] subsection (x) of this section, the licensee must [~~shall~~] possess and use instrumentation to measure the activity of unsealed radioactive material before it is administered to each patient or human or animal research subject.

(2) The licensee must [~~shall~~] calibrate the instrumentation specified in paragraph (1) of this subsection in accordance with nationally recognized standards or the manufacturer's instructions.

(3) The calibration required by paragraph (2) of this subsection must [~~shall~~] include tests for constancy, accuracy, linearity, and geometry dependence, as appropriate to demonstrate proper operation of the instrument. The tests for constancy, accuracy, linearity, and geometry dependence must [~~shall~~] be conducted at the following intervals:

(A) constancy at least once each day before assay of patient dosages;

(B) linearity at installation, repair, relocation, and at least quarterly thereafter;

(C) geometry dependence at installation; and

(D) accuracy at installation and at least annually thereafter.

(4) The licensee must [~~shall~~] maintain a record of each instrument calibration as specified in [~~accordance with~~] subsection (xxx) of this section. The record must [~~shall~~] include [~~the following~~]:

(A) model and serial number of the instrument and calibration sources;

(B) complete date of the calibration including the month, day, and year;

(C) results of the calibration; and

(D) name of the individual who performed the calibration.

(w) Calibration of survey instruments. A licensee must [~~shall~~] calibrate the survey instruments used to show compliance with this subsection and with §289.202 of this chapter [~~title~~] before first use, annually, and following a repair affecting [~~that affects~~] the calibration. A licensee must [~~shall~~]:

(1) calibrate all scales with readings up to 10 millisieverts (mSv) (1000 millirem (mrem)) per hour with a radiation source;

(2) calibrate two separated readings on each scale or decade [~~that will be~~] used to show compliance;

(3) conspicuously note on the instrument the complete date of the calibration including the month, day, and year;

(4) not use survey instruments if the difference between the indicated exposure rate and the calculated exposure rate is more than 20 percent; and

(5) maintain a record of each survey instrument calibration as specified in [~~accordance with~~] subsection (xxx) of this section.

(x) Determination of dosages of unsealed radioactive material for medical or veterinary use.

(1) Before medical or veterinary use, the licensee must [~~shall~~] determine and record the activity of each dosage.

(2) For a unit dosage, this determination must [~~shall~~] be made by:

(A) direct measurement of radioactivity; or

(B) a decay correction, based on the activity or activity concentration determined by [~~the following~~]:

(i) a manufacturer or preparer licensed as specified in [~~accordance with~~] §289.252(r) of this subchapter [~~title~~], or under an equivalent NRC or agreement state license;

(ii) an NRC or agreement state licensee for use in research in accordance with a Radioactive Drug Research Committee-approved protocol or an Investigational New Drug (IND) protocol accepted by the FDA; or

(iii) a PET radioactive drug producer licensed as specified in [~~accordance with~~] §289.252(kk) of this subchapter [~~title~~] or equivalent NRC or agreement state requirements.

(3) For other than unit dosages, this determination must [~~shall~~] be made by:

(A) direct measurement of radioactivity;

(B) combination of measurement of radioactivity and mathematical calculations; or

(C) combination of volumetric measurements and mathematical calculations, based on the measurement made by:

(i) a manufacturer or preparer licensed as specified in [~~accordance with~~] §289.252(r) of this subchapter [~~title~~], or under an equivalent NRC or agreement state license; or

(ii) a PET radioactive drug producer licensed as specified in [~~accordance with~~] §289.252(kk) of this subchapter [~~title~~] or equivalent NRC or agreement state requirements.

(4) Unless otherwise directed by the authorized user, a licensee must [~~shall~~] not use a dosage if the dosage does not fall within the prescribed dosage range or if the dosage differs from the prescribed dosage by more than 20 percent.

(5) A licensee restricted to only unit doses prepared as specified in [~~accordance with~~] §289.252(r) of this subchapter [~~title~~] need not comply with paragraph (2) of this subsection unless the administration time of the unit dose deviates from the nuclear pharmacy's pre-calibrated time by 15 minutes or more.

(6) A licensee must [~~shall~~] maintain a record of the dosage determination required by this subsection as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department. The record must include [~~shall contain the following~~]:

(A) the radiopharmaceutical;

(B) patient's or human or animal research subject's name or identification number, if one has been assigned;

(C) prescribed dosage;

(D) determined dosage or a notation [~~that~~] the total activity is less than 30 µCi (1.1 MBq);

(E) the date and time of the dosage determination; and

(F) the name of the individual who determined the dosage.

(y) Authorization for calibration, transmission, and reference sources.

(1) Any licensee authorized by subsections (n), (o), (p), or (q) of this section for medical or veterinary use of radioactive material may receive, possess, and use any of the following radioactive material for check, calibration, transmission, and reference use:

(A) sealed sources, not exceeding 30 millicuries (mCi) (1.11 gigabecquerel (GBq)) each, manufactured and distributed by a person licensed under §289.252(o) of this subchapter [~~title~~] or equivalent NRC or agreement state regulations;

(B) sealed sources, not exceeding 30 mCi [~~millicuries (mCi)~~] (1.11 GBq [~~gigabecquerel (GBq)~~]) each, redistributed by a licensee authorized to redistribute the sealed sources manufactured and distributed by a person licensed under §289.252(o) of this subchapter [~~title~~] or equivalent NRC or agreement state regulations, provided the redistributed sealed sources are in the original packaging and shielding and are accompanied by the manufacturer's approved instructions;

(C) any radioactive material with a half-life not longer than 120 days in individual amounts not to exceed 15 mCi (0.56 GBq);

(D) any radioactive material with a half-life longer than 120 days in individual amounts not to exceed the smaller of 200 μCi (7.4 MBq) or 1000 times the quantities in §289.202(ggg)(3) of this chapter [~~title~~]; and

(E) technetium-99m in amounts as needed.

(2) Radioactive material in sealed sources authorized by this subsection must [~~shall~~] not be:

(A) used for medical or veterinary use as defined in subsection (c) of this section except as specified in [~~accordance with~~] the requirements in subsection (bbb) of this section; or

(B) combined (i.e., bundled or aggregated) to create an activity greater than the maximum activity of any single sealed source authorized under this section.

(3) A licensee using calibration, transmission, and reference sources as specified in [~~accordance with~~] the requirements in paragraph (1) or (2) of this subsection need not list these sources on a specific medical or veterinary use license.

(z) Requirements for possession of sealed sources and brachytherapy sealed sources. A licensee in possession of any sealed source or brachytherapy source must [~~shall~~]:

(1) follow the radiation safety and handling instructions supplied by the manufacturer and the leakage test requirements as specified in [~~accordance with~~] §289.201(g) of this chapter [~~title~~] and reporting requirements in §289.202(bbb) of this chapter [~~title~~]; and

(2) conduct a physical inventory at intervals not to exceed six months to account for all sealed sources in its possession. Records of the inventory must [~~shall~~] be made and maintained for inspection by the department as specified in [~~accordance with~~] subsection (xxx) of this section and must [~~shall~~] include [~~the following~~]:

(A) model number of each source and serial number if one has been assigned;

(B) identity of each source and its nominal activity;

(C) location of each source;

(D) date of the inventory; and

(E) name [identification] of the individual who performed the inventory.

(aa) Labeling of vials and syringes. Each syringe and vial containing [that contains] a radiopharmaceutical must [shall] be labeled to identify the radioactive drug. Each syringe shield and vial shield must [shall] also be labeled unless the label on the syringe or vial is visible when shielded.

(bb) Surveys for ambient radiation exposure rate.

(1) In addition to the requirements of §289.202(p) of this chapter [title] and except as provided in paragraph (2) of this subsection, a licensee must [shall] survey, with a radiation detection survey instrument, at the end of each day of use, all areas where radioactive material requiring a written directive was prepared for use or administered.

(2) A licensee is not required to [does not need to] perform the surveys required by paragraph (1) of this subsection in an area [area(s)] where patients or human research subjects are confined when they cannot be released as specified in [accordance with] subsection (cc) of this section or an animal that is confined. Once the patient or human or animal research subject is released from confinement, the licensee must [shall] survey with a radiation survey instrument[,] the area in which the patient or human or animal research subject was confined.

(3) A record of each survey must [shall] be retained as specified in [accordance with] subsection (xxx) of this section for inspection by the department. The record must [shall] include [the following]:

(A) date of the survey;

(B) results of the survey;

(C) manufacturer's name, model, and serial number of the instrument used to make the survey; and

(D) name of the individual who performed the survey.

(cc) Release of individuals containing radioactive drugs or implants containing radioactive material.

(1) The licensee may authorize the release from its control, any individual [who has been] administered radioactive drugs or implants containing radioactive material if the total effective dose equivalent (TEDE) to any other individual from exposure to the released individual is not likely to exceed 0.5 rem (5 mSv). [Patients treated with temporary eye plaques may be released from the hospital provided that the procedures ensure that the exposure rate from the patient is less than 5 mrem (0.05 mSv) per hour at a distance of 1 meter from the eye plaque location.]

(2) The licensee must [shall] provide the released individual, or the individual's

parent or guardian, with written instructions on actions recommended to maintain doses to other individuals ALARA if the TEDE to any other individual is likely to exceed 0.1 rem (1 mSv). If the TEDE to a nursing infant or child could exceed 0.1 rem (1 mSv), assuming there was no interruption of breast-feeding, the instructions must [~~shall also~~] include [~~the following~~]:

(A) guidance on the interruption or discontinuation of breast-feeding; and

(B) information on the potential consequences, if any, of failure to follow the guidance.

(3) The licensee must [~~shall~~] maintain for inspection by the department, a record as specified in [~~accordance with~~] subsection (xxx) of this section of each patient released according to [~~in accordance with~~] paragraph (1) of this subsection. The record must [~~shall~~] include [~~the following~~]:

(A) the basis for authorizing the release of an individual; and

(B) the instructions provided to a breast-feeding woman[~~.~~] if the radiation dose to the infant or child from continued breast-feeding could result in a TEDE exceeding 0.5 rem (5 mSv).

(dd) Mobile nuclear medicine service. A license for a mobile nuclear medicine service for medical or veterinary use of radioactive material is [~~will be~~] issued if the department approves the documentation submitted by the applicant as specified in [~~accordance with~~] the requirements of subsections (f) and (n) of this section. The clients of the mobile nuclear medicine service must [~~shall~~] be licensed if the client receives or possesses radioactive material to be used by the mobile nuclear medicine service.

(1) A licensee providing mobile nuclear medicine service must [~~shall~~]:

(A) obtain a letter signed by the management of each client for which services are rendered permitting [~~that permits~~] the use of radioactive material at the client's address and clearly delineating [~~delineates~~] the authority and responsibility of the licensee and the client;

(B) check instruments used to measure the activity of unsealed radioactive material for proper function before medical or veterinary use at each client's address or on each day of use, whichever is more frequent. As [~~At~~] a minimum, the check for proper function required by this subparagraph must [~~shall~~] include a constancy check;

(C) have at least one fixed facility where records are [~~may be~~] maintained and radioactive material is [~~may be~~] delivered by manufacturers or distributors each day before the mobile nuclear medicine licensee dispatches [~~dispatching~~] its vehicles [~~vans~~] to client sites;

(D) agree to have an authorized physician user directly supervise each technologist at a reasonable frequency;

(E) check survey instruments for proper operation with a dedicated check source before use at each client's address; and

(F) before leaving a client's address, survey all areas of use to ensure compliance with the requirements of §289.202 of this chapter [~~title~~].

(2) A mobile nuclear medicine service must [~~shall~~] not have radioactive material delivered from the manufacturer or the distributor to the client unless the client has a license allowing possession of the radioactive material. Radioactive material delivered to the client must [~~shall~~] be received and handled in conformance with the client's license.

(3) A licensee providing mobile nuclear medicine services must [~~shall~~] maintain records, for inspection by the department, as specified in [~~accordance with~~] subsection (xxx) of this section including the letter required in paragraph (1)(A) of this subsection and the record of each survey required in paragraph (1)(F) of this subsection.

(ee) Decay-in-storage.

(1) The licensee may hold radioactive material with a physical half-life of less than or equal to 120 days for decay-in-storage and dispose of it without regard to its radioactivity if the licensee [~~does the following~~]:

(A) monitors radioactive material at the surface before disposal and determines [~~that~~] its radioactivity cannot be distinguished from the background radiation level with an appropriate radiation detection survey meter set on its most sensitive scale and with no interposed shielding; and

(B) removes or obliterates all radiation labels, except for radiation labels on materials [~~that are~~] within containers and [~~that will be~~] handled as biomedical waste after it has been released from the licensee.

(2) The licensee must [~~shall~~] retain a record of each disposal as required by paragraph (1) of this subsection as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department. The record must [~~shall~~] include [~~the following~~]:

(A) date of the disposal;

(B) manufacturer's name, model number, and serial number of the survey instrument used;

(C) background radiation level;

(D) radiation level measured at the surface of each waste container; and

(E) name of the individual who performed the survey.

(ff) Use of unsealed radioactive material for uptake, dilution, and excretion studies [~~that do~~] not requiring [~~require~~] a written directive. Except for quantities that

require a written directive as specified in [~~accordance with~~] subsection (t) of this section, a licensee may use any unsealed radioactive material prepared for medical or veterinary use for uptake, dilution, or excretion studies [~~that meets the following~~]:

(1) [~~is~~] obtained from:

(A) a manufacturer or preparer licensed as specified in [~~accordance with~~] §289.252(r) of this subchapter [~~title~~] or equivalent NRC or agreement state requirements; or

(B) a PET radioactive drug producer licensed as specified in [~~accordance with~~] §289.252(kk) of this subchapter [~~title~~] or equivalent NRC or agreement state requirements; or

(2) excluding production of PET radionuclides, prepared by:

(A) an authorized nuclear pharmacist; or

(B) a physician or veterinarian who is an authorized user and who meets the requirements specified in subsections (jj) or (nn) and (jj)(3)(A)(ii)(VII) of this section; or

(C) an individual under the supervision, as specified in subsection (s) of this section, of the authorized nuclear pharmacist in subparagraph (A) of this paragraph, or the physician or veterinarian who is an authorized user in subparagraph (B) of this paragraph; or

(3) [~~is~~] obtained from and prepared by an NRC or agreement state licensee for use in research in accordance with a Radioactive Drug Research Committee-approved protocol or an IND protocol accepted by the FDA; or

(4) [~~is~~] prepared by the licensee for use in research in accordance with a Radioactive Drug Research Committee-approved application or an IND protocol accepted by the FDA.

(gg) Training for uptake, dilution, and excretion studies. Except as provided in subsection (l) of this section, the licensee must [~~shall~~] require an authorized user of unsealed radioactive material for the uses authorized in subsection (ff) of this section to be [~~a physician who~~]:

(1) a physician [~~is~~] certified by a medical specialty board whose certification process is [~~has been~~] recognized by the department, the NRC, or an agreement state. The names of board certifications [~~that have been~~] recognized by the department, the NRC, or an agreement state are posted on the NRC's Medical Uses Licensee Toolkit web page. To have its certification recognized, a specialty board must [~~shall~~] require all candidates for certification to:

(A) complete 60 hours of training and experience in basic radionuclide handling techniques and radiation safety applicable to the medical use of unsealed radioactive material for uptake, dilution, and excretion studies as described in

paragraph (3)(A) of this subsection; and

(B) pass an examination, administered by diplomates of the specialty board, assessing [~~that assesses~~] knowledge and competence in radiation safety, radionuclide handling, and quality control; or

(2) [~~is~~] an authorized user as specified in [~~accordance with~~] subsections (jj) or (nn) of this section or equivalent NRC or agreement state requirements; or

(3) a physician or veterinarian who: [~~has completed 60 hours of training and experience, including a minimum of eight hours of classroom and laboratory training, in basic radionuclide handling techniques applicable to the medical use of unsealed radioactive material for uptake, dilution, and excretion studies.~~]

(A) completes 60 hours of training and experience, including a minimum of eight hours of classroom and laboratory training, in basic radionuclide handling techniques applicable to the medical or veterinary use of unsealed radioactive material for uptake, dilution, and excretion studies. The training and experience must [~~shall~~] include [~~the following~~]:

(i) classroom and laboratory training in [~~the following areas~~]:

(I) radiation physics and instrumentation;

(II) radiation protection;

(III) mathematics pertaining to the use and measurement of radioactivity;

(IV) chemistry of radioactive material for medical or veterinary use; and

(V) radiation biology; and

(ii) work experience, under the supervision of an authorized user meeting [~~who meets~~] the requirements of this subsection, subsections (l), (jj), or (nn) of this section, or equivalent NRC or agreement state requirements involving [~~the following~~]:

(I) ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;

(II) performing quality control procedures on instruments used to determine the activity of dosages and performing checks for proper operation of survey meters;

(III) calculating, measuring, and safely preparing patient or human or animal research subject dosages;

(IV) using administrative controls to prevent a medical event involving the use of unsealed radioactive material;

(V) using procedures to contain spilled radioactive material safely and using proper decontamination procedures; and

(VI) administering dosages of radioactive drugs to patients or human or animal research subjects; and

(B) obtains [~~has obtained~~] written attestation [~~that~~] the individual has satisfactorily completed the requirements in subparagraph (A) of this paragraph and is able to independently fulfill the radiation safety-related duties as an authorized user for the medical or veterinary uses authorized under subsection (ff) of this section. The attestation must be obtained from either:

(i) a preceptor authorized user who meets the requirements of subsection (l) of this section, this subsection, or subsections (jj) or (nn) of this section, or equivalent NRC or agreement state requirements; or

(ii) a residency program director affirming [~~who affirms~~] in writing [~~that~~] the attestation represents the consensus of the residency program faculty where at least one faculty member is an authorized user who meets the requirements in subsections (l), (gg), (jj), or (nn) of this section, or equivalent NRC or agreement state requirements, and concurs with the attestation provided by the residency program director. The residency training program must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, [~~or~~] the Royal College of Physicians and Surgeons of Canada, or the Council on Postdoctoral Training of the American Osteopathic Association and must include training and experience specified in subparagraph (A) of this paragraph.

(hh) Use of unsealed radioactive material for imaging and localization studies [~~that do~~] not requiring [~~require~~] a written directive. Except for quantities requiring [~~that require~~] a written directive as specified in [~~accordance with~~] subsection (t) of this section, a licensee may use any unsealed radioactive material prepared for medical or veterinary use for imaging and localization studies [~~that meets the following~~]:

(1) [~~is~~] obtained from:

(A) a manufacturer or preparer licensed as specified in [~~accordance with~~] §289.252(r) of this subchapter [~~title~~] or equivalent NRC or agreement state requirements; or

(B) a PET radioactive drug producer licensed as specified in [~~accordance with~~] §289.252(kk) of this subchapter [~~title~~] or equivalent NRC or agreement state requirements; or

(2) excluding production of PET radionuclides[~~,~~] prepared by:

(A) an authorized nuclear pharmacist; or

(B) a physician or veterinarian who is an authorized user and who meets the requirements specified in subsections (jj) or (nn) and (jj)(3)(A)(ii)(VII) of this section; or

(C) an individual under the supervision, as specified in subsection (s) of this section, of the authorized nuclear pharmacist in subparagraph (A) of this paragraph, or the physician or veterinarian who is an authorized user in subparagraph (B) of this paragraph; or

(3) [~~is~~] obtained from and prepared by an NRC or agreement state licensee for use in research in accordance with a Radioactive Drug Research Committee-approved protocol or an IND protocol accepted by the FDA; or

(4) [~~is~~] prepared by the licensee for use in research in accordance with a Radioactive Drug Research Committee-approved application or an IND protocol accepted by the FDA.

(ii) Permissible molybdenum-99, strontium-82, and strontium-85 concentrations.

(1) The licensee may not administer to humans a radiopharmaceutical containing [~~that contains~~]:

(A) more than 0.15 μCi of molybdenum-99 per mCi of technetium-99m (0.15 kilobecquerel (kBq) of molybdenum-99 per MBq of technetium-99m); or

(B) more than 0.02 μCi of strontium-82 per mCi of rubidium-82 chloride (0.02 kBq of strontium-82 per MBq of rubidium-82 chloride) injection; or

(C) more than 0.2 μCi of strontium-85 per mCi of rubidium-82 (0.2 kBq of strontium-85 per MBq of rubidium-82 chloride) injection.

(2) The licensee using [~~who uses~~] molybdenum-99/technetium-99m generators for preparing a technetium-99m radiopharmaceutical must [~~shall~~] measure the molybdenum-99 concentration in each eluate from a generator to demonstrate compliance with paragraph (1) of this subsection.

(3) The licensee using [~~who uses~~] a strontium-82/rubidium-82 generator for preparing a rubidium-82 radiopharmaceutical must [~~shall~~], before the first patient use of the day, measure the concentration of radionuclides strontium-82 and strontium-85 to demonstrate compliance with paragraph (1) of this subsection.

(4) If the licensee is required to measure the molybdenum-99 or strontium-82 and strontium-85 concentrations, the licensee must [~~shall~~] retain a record of each measurement as specified in [~~accordance with~~] subsection (xxx) [~~(www)~~] of this section for inspection by the department. The record must [~~shall~~] include [~~the following~~]:

(A) for each measured elution of technetium-99m:

(i) the ratio of the measures expressed as μCi of molybdenum-99 per mCi of technetium-99m (kBq of molybdenum-99 per MBq of technetium-99m);

(ii) time and date of the measurement; and

(iii) name of the individual who made the measurement.

(B) for each measured elution of rubidium-82:

(i) the ratio of the measures expressed as μCi of strontium-82 per mCi of rubidium (kBq of strontium-82 per MBq of rubidium-82);

(ii) the ratio of the measures expressed as μCi of strontium-85 per mCi of rubidium (kBq of strontium-85 per MBq of rubidium-82);

(iii) time and date of the measurement; and

(iv) name of the individual who made the measurement.

(5) The licensee must [~~shall~~] report any measurement that exceeds the limits in paragraph (1) of this subsection at the time of generator elution, as specified in [~~accordance with~~] subsection (www) [~~(xxx)~~] of this section.

(jj) Training for imaging and localization studies. Except as provided in subsection (l) of this section, the licensee must [~~shall~~] require an authorized user of unsealed radioactive material for the uses authorized in subsection (hh) of this section to be [~~a physician who~~]:

(1) a physician [~~is~~] certified by a medical specialty board whose certification process is [~~has been~~] recognized by the department, the NRC, or an agreement state. The names of board certifications [~~that have been~~] recognized by the department, the NRC, or an agreement state are posted on the NRC's Medical Uses Licensee Toolkit web page. To have its certification process recognized, a specialty board must [~~shall~~] require all candidates for certification to:

(A) complete 700 hours of training and experience in basic radionuclide handling techniques and radiation safety applicable to the medical use of unsealed radioactive material for imaging and localization studies as described in paragraph (3) of this subsection; and

(B) pass an examination, administered by diplomates of the specialty board, assessing [~~that assesses~~] knowledge and competence in radiation safety, radionuclide handling, and quality control; or

(2) [~~is~~] an authorized user as specified in [~~accordance with~~] subsection (nn) of this section and who meets the requirements of paragraph (3)(A)(ii)(VII) of this subsection or equivalent NRC or agreement state requirements; or

(3) a physician or veterinarian who: [~~has completed 700 hours of training and experience, including a minimum of 80 hours of classroom and laboratory training, in basic radionuclide handling techniques applicable to the medical use of unsealed radioactive material for imaging and localization studies.~~]

(A) completes 700 hours of training and experience, including a minimum of 80 hours of classroom and laboratory training, in basic radionuclide handling techniques applicable to the medical or veterinary use of unsealed radioactive material for imaging and localization studies. The training and experience must [~~shall~~] include [~~the following~~]:

(i) classroom and laboratory training in [~~the following areas~~]:

(I) radiation physics and instrumentation;

(II) radiation protection;

(III) mathematics pertaining to the use and measurement of radioactivity;

(IV) chemistry of radioactive material for medical or veterinary use; and

(V) radiation biology; and

(ii) work experience under the supervision of an authorized user who meets the requirements in subsection (l) of this section, this subsection, or paragraph (3)(A)(ii)(VII) of this section, and subsection (nn) of this section, or equivalent NRC or agreement state requirements. An authorized nuclear pharmacist who meets the requirements in subsections (k) or (l) of this section may provide the supervised work experience for subclause (VII) of this clause. Work experience must involve [~~the following~~]:

(I) ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;

(II) performing quality control procedures on instruments used to determine the activity of dosages and performing checks for proper operation of survey meters;

(III) calculating, measuring, and safely preparing patient or human or animal research subject dosages;

(IV) using administrative controls to prevent a medical event involving the use of unsealed radioactive material;

(V) using procedures to contain spilled radioactive material safely and using proper decontamination procedures;

(VI) administering dosages of radioactive drugs to patients or human or animal research subjects; and

(VII) eluting generator systems appropriate for preparation of radioactive drugs for imaging and localization studies, measuring and testing the eluate for radionuclide purity, and processing the eluate with reagent kits to prepare labeled radioactive drugs; and

(B) obtains [~~has obtained~~] written attestation [~~that~~] the individual has satisfactorily completed the requirements in this paragraph and is able to independently fulfill the radiation safety-related duties as an authorized user for the medical or veterinary uses authorized under subsections (ff) and (hh) of this section. The attestation must be obtained from either:

(i) a preceptor authorized user meeting [~~who meets~~] the requirements of subsection (l) of this section, this subsection, or paragraph (3)(A)(ii)(VII) of this subsection, and subsection (nn) of this section, or equivalent NRC or agreement state requirements; or

(ii) a residency program director affirming [~~who affirms~~] in writing [~~that~~] the attestation represents the consensus of the residency program faculty where at least one faculty member is an authorized user meeting [~~who meets~~] the requirements in subsections (l), [~~or~~] (jj), or (nn) of this section and paragraph (3)(A)(ii)(VII) of this subsection, or equivalent NRC or agreement state requirements, and concurs with the attestation provided by the residency program director. The residency training program must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, [~~or~~] the Royal College of Physicians and Surgeons of Canada, or the Council on Postdoctoral Training of the American Osteopathic Association and must include training and experience specified in this paragraph.

(kk) Use of unsealed radioactive material requiring [~~that requires~~] a written directive. A licensee may use any unsealed radioactive material identified in subsection (nn)(2)(A)(ii)(VI) of this section prepared for medical or veterinary use requiring [~~that requires~~] a written directive [~~that meets the following~~]:

(1) [~~is~~] obtained from:

(A) a manufacturer or preparer licensed as specified in [~~accordance with~~] §289.252(r) of this subchapter [~~title~~] or equivalent NRC or agreement state requirements;

(B) a PET radioactive drug producer licensed as specified in [~~accordance with~~] §289.252(kk) of this subchapter [~~title~~] or equivalent NRC or agreement state requirements; or

(2) excluding production of PET radionuclides[~~,~~] prepared by:

(A) an authorized nuclear pharmacist; or

(B) a physician or veterinarian who is an authorized user and [~~who~~] meets the requirements specified in subsections (jj) or (nn) of this section; or

(C) an individual under the supervision, as specified in subsection (s) of this section, of the authorized nuclear pharmacist in subparagraph (A) of this paragraph, or the physician or veterinarian who is an authorized user in subparagraph (B) of this paragraph; or

(3) [~~is~~] obtained from and prepared by an NRC or agreement state licensee for use in research in accordance with an IND protocol accepted by the FDA; or

(4) [~~is~~] prepared by the licensee for use in research in accordance with an IND protocol accepted by the FDA.

(ll) Safety instruction to personnel.

(1) The licensee must [~~shall~~] provide radiation safety instruction, initially and at least annually, to personnel caring for patients or human or animal research subjects who cannot be released as specified in [~~accordance with~~] subsection (cc) of this section. The instruction must [~~shall~~] be appropriate to the personnel's assigned duties and include [~~the following~~]:

(A) patient or human or animal research subject control; and

(B) visitor control, including [~~to include the following~~]:

(i) routine visitation to hospitalized individuals or animals as specified in [~~accordance with~~] §289.202(n) of this chapter [~~title~~];

(ii) contamination control;

(iii) waste control; and

(iv) notification of the RSO, or his or her designee, and an authorized user if the patient or the human or animal research subject has a medical emergency or dies.

(2) The licensee must [~~shall~~] maintain a record for inspection by the department, as specified in [~~accordance with~~] subsection (xxx) of this section, of individuals receiving instruction. The record must [~~shall~~] include [~~the following~~]:

(A) list of the topics covered;

(B) date of the instruction or training;

(C) names [~~name(s)~~] of the attendees [~~attendee(s)~~]; and

(D) names [~~name(s)~~] of the personnel [~~individual(s)~~] who provided the instruction.

(mm) Safety precautions. For each human patient or human research subject who cannot be released as specified in [~~accordance with~~] subsection (cc) of this section, the licensee must [~~shall do the following~~]:

(1) provide a private room with a private sanitary facility; or

(2) provide a room with a private sanitary facility with another individual who also has received therapy with an unsealed radioactive material and who also cannot be released as specified in [~~accordance with~~] subsection (cc) of this section;

(3) post the patient's or the research subject's room with a "Radioactive Materials" sign and note on the door and in the patient's or research subject's chart where and how long visitors may stay in the patient's or the research subject's room; and

(4) either monitor material and items removed from the patient's or the research subject's room to determine [~~that~~] their radioactivity cannot be distinguished from the natural background radiation level with a radiation detection

survey instrument set on its most sensitive scale and with no interposed shielding, or, handle such material and items as radioactive waste; and

(5) notify the RSO, or his or her designee, and the authorized user immediately if the patient or research subject has a medical emergency or dies.

(nn) Training for use of unsealed radioactive material requiring [~~that requires~~] a written directive. Except as provided in subsection (l) of this section, the licensee must [~~shall~~] require an authorized user of unsealed radioactive material for the uses authorized in subsection (kk) of this section to be [~~a physician who~~]:

(1) a physician [~~is~~] certified by a medical specialty board whose certification process is [~~has been~~] recognized by the department, the NRC, or an agreement state and who meets the requirements in paragraph (2)(A)(ii)(VI) of this subsection. The names of board certifications [~~that have been~~] recognized by the department, the NRC, or an agreement state are posted on the NRC's Medical Uses Licensee Toolkit web page. To be recognized, a specialty board must [~~shall~~] require all candidates for certification to:

(A) successfully complete residency training in a radiation therapy or nuclear medicine training program or a program in a related medical specialty. These residency training programs must [~~shall~~] include 700 hours of training and experience as described in paragraph (2)(A)(i) - (2)(A)(ii)(V) of this subsection. Eligible training programs must [~~shall~~] be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, the Royal College of Physicians and Surgeons of Canada, or the Council on Postdoctoral [~~Committee on Post-Graduate~~] Training of the American Osteopathic Association; and

(B) pass an examination, administered by diplomates of the specialty board assessing[~~, which tests~~] knowledge and competence in radiation safety, radionuclide handling, quality assurance, and clinical use of unsealed radioactive material for which a written directive is required; or

(2) a physician or veterinarian who: [~~has completed 700 hours of training and experience, including a minimum of 200 hours of classroom and laboratory training, in basic radionuclide handling techniques applicable to the medical use of unsealed radioactive material requiring a written directive.~~]

(A) completes 700 hours of training and experience, including a minimum of 200 hours of classroom and laboratory training, in basic radionuclide handling techniques applicable to the medical or veterinary use of unsealed radioactive material requiring a written directive. The training and experience must [~~shall~~] include: [~~the following.~~]

(i) classroom and laboratory training in [~~the following areas~~]:

(I) radiation physics and instrumentation;

(II) radiation protection;

(III) mathematics pertaining to the use and measurement of radioactivity;

(IV) chemistry of radioactive material for medical or veterinary use; and

(V) radiation biology; and

(ii) work experience, under the supervision of an authorized user meeting [~~who meets~~] the requirements of subsection (l) of this section, this subsection, or equivalent NRC or agreement state requirements. A supervising authorized user meeting[~~, who meets~~] the requirements of this paragraph must [~~shall also~~] have experience in administering dosages in the same dosage category or categories (i.e., subclause (VI) of this clause) as the individual requesting authorized user status. The work experience must [~~shall~~] involve [~~the following~~]:

(I) ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;

(II) performing quality control procedures on instruments used to determine the activity of dosages and performing checks for proper operation of survey meters;

(III) calculating, measuring, and safely preparing patient or human or animal research subject dosages;

(IV) using administrative controls to prevent a medical event involving the use of unsealed radioactive material;

(V) using procedures to contain spilled radioactive material safely and using proper decontamination procedures; and

(VI) administering dosages of radioactive drugs to patients or human or animal research subjects from the three categories in the following items. Radioactive drugs containing radionuclides in categories not included in this paragraph are regulated under subsection (q) of this section. For each category in which the individual is requesting authorized user status, the [~~This~~] work experience must involve a minimum of three cases in [~~each of the following categories for which the individual is requesting authorized user status~~]:

(-a-) oral administration of less than or equal to 33 mCi (1.22 GBq) of sodium iodide I-131, for which a written directive is required;

(-b-) oral administration of greater than 33 mCi (1.22 GBq) of sodium iodide I-131 (experience with at least three cases in this item also satisfies the requirement of item (-a-) of this subclause); and

(-c-) parenteral administration of any radioactive drug that contains a radionuclide [~~that is~~] primarily used for its electron emission, beta radiation characteristics, alpha radiation characteristics, or photon energy of less than 150 kiloelectron volts (keV) for which a written directive is required; and

(B) obtains [~~has obtained~~] written attestation [~~that~~] the individual has satisfactorily completed the requirements of paragraph (2)(A) of this subsection[~~,~~] and is able to independently fulfill the radiation safety-related duties as an authorized user for the medical or veterinary uses authorized under subsection (kk) of this section for which the individual is requesting authorized user status. The attestation must be obtained from either:

(i) a preceptor authorized user meeting [~~who meets~~] the requirements of subsection (l) of this section, this subsection, or equivalent NRC or agreement state requirements and has experience in administering dosages in the same dosage category or categories as the individual requesting authorized user status; or

(ii) a [~~A~~] residency program director affirming [~~who affirms~~] in writing [~~that~~] the attestation represents the consensus of the residency program faculty where at least one faculty member is an authorized user meeting [~~who meets~~] the requirements in subsections (l) or (nn) of this section, or equivalent NRC or agreement state requirements, has experience in administering dosages in the same dosage category or categories as the individual requesting authorized user status, and concurring [~~concurs~~] with the attestation provided by the residency program director. The residency training program must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, [~~or~~] the Royal College of Physicians and Surgeons of Canada, or the Council on Postdoctoral Training of the American Osteopathic Association and must include training and experience specified in this paragraph.

(oo) Training for the oral administration of sodium iodide I-131 requiring a written directive in quantities less than or equal to 33 mCi (1.22 GBq). Except as provided in subsection (l) of this section, the licensee must [~~shall~~] require an authorized user for the oral administration of sodium iodide I-131 requiring a written directive in quantities less than or equal to 33 mCi (1.22 GBq) to be [~~a physician who~~]:

(1) a physician [~~is~~] certified by a medical specialty board whose certification process includes all [~~of~~] the requirements of paragraph (3)(A) of this subsection and whose certification is [~~has been~~] recognized by the department, the NRC, or an agreement state[~~. The~~] (names of board certifications [~~that have been~~] recognized by the department, the NRC, or an agreement state are posted on the NRC's Medical Uses Licensee Toolkit web page); or

(2) [~~is~~] an authorized user as specified in [~~accordance with~~] subsection (nn) of this section for uses listed in subsection (nn)(2)(A)(ii)(VI)(-a-) or (-b-) of this section, or subsection (pp) of this section, or equivalent NRC or agreement state requirements; or

(3) a physician or veterinarian who: [~~has successfully completed 80 hours of classroom and laboratory training and work experience applicable to the medical use of sodium iodide I-131 for procedures requiring a written directive.~~]

(A) successfully completes 80 hours of classroom and laboratory training and work experience applicable to the medical or veterinary use of sodium iodide I-131

for procedures requiring a written directive. The training and experience must [~~shall~~] include: [~~the following.~~]

(i) classroom and laboratory training, including [~~shall include the following~~]:

(I) radiation physics and instrumentation;

(II) radiation protection;

(III) mathematics pertaining to the use and measurement of radioactivity;

(IV) chemistry of radioactive material for medical or veterinary use; and

(V) radiation biology; and

(ii) work experience, under the supervision of an authorized user meeting [~~who meets~~] the requirements of subsection (l) of this section, this subsection, subsection (nn) or subsection (pp) of this section, or equivalent NRC or agreement state requirements. A supervising authorized user meeting [~~who meets~~] the requirements in subsection (nn)(2) of this section must[~~, shall~~] also have experience in administering dosages as specified in subsection (nn)(2)(A)(ii)(VI)(-a-) or (-b-) of this section. The work experience must [~~shall~~] involve [~~the following~~]:

(I) ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;

(II) performing quality control procedures on instruments used to determine the activity of dosages and performing checks for proper operation of survey meters;

(III) calculating, measuring, and safely preparing patient or human or animal research subject dosages;

(IV) using administrative controls to prevent a medical event involving the use of unsealed radioactive material;

(V) using procedures to contain spilled radioactive material safely and using proper decontamination procedures; and

(VI) administering dosages of radioactive drugs to patients or human or animal research subjects that includes at least three cases involving the oral administration of less than or equal to 33mCi (1.22 GBq) of sodium iodide I-131; and

(B) obtains [~~has obtained~~] written attestation [~~that~~] the individual has satisfactorily completed the requirements of paragraph (3)(A) of this subsection[~~,~~] and is able to independently fulfill the radiation safety-related duties as an authorized user for oral administration of less than or equal to 33 mCi (1.22 GBq)

of sodium iodide I-131 for medical or veterinary uses authorized under subsection (kk) of this section. The attestation must be obtained from either:

(i) a preceptor authorized user meeting [~~who meets~~] the requirements of subsection (l) of this section, this subsection, subsection (nn) or subsection (pp) of this section, or equivalent NRC or agreement state requirements and has experience in administering dosages as specified in subsection (nn)(2)(A)(ii)(VI)(-a-) or (-b-) of this section; or

(ii) a residency program director affirming [~~who affirms~~] in writing that the attestation represents the consensus of the residency program faculty where at least one faculty member is an authorized user meeting [~~who meets~~] the requirements in subsections (l), (nn), (oo), or (pp) of this section, or equivalent NRC or agreement state requirements, has experience in administering dosages as specified in subsection (nn)(2)(A)(ii)(VI)(-a-) or (-b-), and concurring [~~concurs~~] with the attestation provided by the residency program director. The residency training program must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, [~~or~~] the Royal College of Physicians and Surgeons of Canada, or the Council on Postdoctoral Training of the American Osteopathic Association and must include training and experience specified in this paragraph.

(pp) Training for the oral administration of sodium iodide I-131 requiring a written directive in quantities greater than 33 mCi (1.22 GBq). Except as provided in subsection (l) of this section, the licensee must [~~shall~~] require an authorized user for the oral administration of sodium iodide I-131 requiring a written directive in quantities greater than 33 mCi (1.22 GBq) to be [~~a physician who~~]:

(1) a physician [~~is~~] certified by a medical specialty board whose certification process includes all [~~of~~] the requirements in paragraph (3)(A) of this subsection and whose certification is [~~has been~~] recognized by the department, the NRC, or an agreement state[~~. The~~] (names of board certifications [~~that have been~~] recognized by the department, the NRC, or an agreement state are posted on the NRC's Medical Uses Licensee Toolkit web page); or

(2) [~~is~~] an authorized user as specified in [~~accordance with~~] subsection (nn) of this section or equivalent NRC or agreement state requirements for uses listed in subsection (nn)(2)(A)(ii)(VI)(-b-) of this section; or

(3) a physician or veterinarian who: [~~has training and experience including, successful completion of 80 hours of classroom and laboratory training applicable to the medical use of sodium iodide I-131 for procedures requiring a written directive.~~]

(A) successfully completes 80 hours of classroom and laboratory training applicable to the medical or veterinary use of sodium iodide I-131 for procedures requiring a written directive. The training and experience must [~~shall~~] include: [~~the following.~~]

(i) classroom and laboratory training, including [~~shall include the following~~]:

(I) radiation physics and instrumentation;

(II) radiation protection;

(III) mathematics pertaining to the use and measurement of radioactivity;

(IV) chemistry of radioactive material for medical or veterinary use; and

(V) radiation biology; and

(ii) work experience, under the supervision of an authorized user meeting [~~who meets~~] the requirements of subsection (l) of this section, subsections (nn) or (pp) of this section, or equivalent NRC or agreement state requirements. A supervising authorized user meeting [~~who meets~~] the requirements of subsection (nn)(2) of this section must[~~, shall~~] also have experience in administering dosages as specified in subsection (nn)(2)(A)(ii)(VI)(-b-) of this section. The work experience must [~~shall~~] involve [~~the following~~]:

(I) ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;

(II) performing quality control procedures on instruments used to determine the activity of dosages and performing checks for proper operation of survey meters;

(III) calculating, measuring, and safely preparing patient or human or animal research subject dosages;

(IV) using administrative controls to prevent a medical event involving the use of unsealed radioactive material;

(V) using procedures to contain spilled radioactive material safely and using proper decontamination procedures; and

(VI) administering dosages of radioactive drugs to patients or human or animal research subjects that includes at least three cases involving the oral administration of greater than 33 mCi (1.22 GBq) of sodium iodide I-131; and

(B) obtains [~~has obtained~~] written attestation [~~that~~] the individual has satisfactorily completed the requirements of paragraph (3)(A) of this subsection[~~,~~] and is able to independently fulfill the radiation safety-related duties as an authorized user for oral administration of greater than 33 mCi (1.22 GBq) of sodium iodide I-131 for medical or veterinary uses authorized under subsection (kk) of this section. The attestation must be obtained from either:

(i) a preceptor authorized user meeting [~~who meets~~] the requirements in subsections (l) or (nn) of this section, this subsection, or equivalent NRC or agreement state requirements[~~,~~] and has experience in administering dosages as specified in subsection (nn)(2)(A)(ii)(VI)(-b-) of this section; or

(ii) a residency program director affirming [~~who affirms~~] in writing that the attestation represents the consensus of the residency program faculty where at least one faculty member is an authorized user meeting [~~who meets~~] the requirements in subsections (l), (nn), or (pp) of this section, or equivalent NRC[~~,~~] or agreement state requirements, has experience in administering dosages as specified in subsection (nn)(2)(A)(ii)(VI)(-b-) of this section, and concurring [~~concurs~~] with the attestation provided by the residency program director. The residency training program must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, [~~or~~] the Royal College of Physicians and Surgeons of Canada, or the Council on Postdoctoral Training of the American Osteopathic Association and must include training and experience specified in this paragraph.

(qq) Training for the parenteral administration of unsealed radioactive material requiring a written directive.

(1) Except as provided in subsection (l) of this section, the licensee must [~~shall~~] require an authorized user for the parenteral administration of unsealed radioactive materials requiring a written directive to be [~~a physician who~~]:

(A) [~~is~~] an authorized user as specified in [~~accordance with~~] subsection (nn) of this section for uses listed in subsection (nn)(2)(A)(ii)(VI)(-c-) of this section or equivalent NRC or agreement state requirements; or

(B) [~~is~~] an authorized user under subsections (zz) or (ttt) of this section or equivalent NRC or agreement state requirements and meeting [~~who meets~~] the requirements of paragraph (2) of this subsection; or

(C) a physician [~~is~~] certified by a medical specialty board whose certification process is [~~has been~~] recognized by the department, the NRC, or an agreement state as specified in [~~accordance with~~] subsections (zz) or (ttt) of this section, and [~~who~~] meets the requirements of paragraph (2) of this subsection.

(2) The physician or veterinarian must also [~~meet the following requirements~~]:

(A) [~~has~~] successfully complete [~~completed~~] 80 hours of classroom and laboratory training applicable to parenteral administrations listed in subsection (nn)(2)(A)(ii)(VI)(-c-) of this section.

(B) complete [~~has the~~] training and experience to [~~that shall~~] include [~~the following~~]:

(i) classroom and laboratory training, including [~~shall include the following~~]:

(I) radiation physics and instrumentation;

(II) radiation protection;

(III) mathematics pertaining to the use and measurement of radioactivity;

(IV) chemistry of radioactive material for medical use; and

(V) radiation biology; and

(ii) work experience, under the supervision of an authorized user meeting [~~who meets~~] the requirements of subsection (l) of this section, this subsection, or subsection (nn) of this section, or equivalent NRC or agreement state requirements in the parenteral administration listed in subsection (nn)(2)(A)(ii)(VI)(-c-) of this section. A supervising authorized user meeting [~~who meets~~] the requirements of subsection (nn) of this section, this subsection, or equivalent NRC or agreement state requirements must [~~shall~~] have experience in administering dosages in the same category or categories as the individual requesting authorized user status. The work experience must [~~shall~~] involve [~~the following~~]:

(I) ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;

(II) performing quality control procedures on instruments used to determine the activity of dosages and performing checks for proper operation of survey meters;

(III) calculating, measuring, and safely preparing patient or human or animal research subject dosages;

(IV) using administrative controls to prevent a medical event involving the use of unsealed radioactive material;

(V) using procedures to contain spilled radioactive material safely and using proper decontamination procedures; and

(VI) administering dosages to patients or human or animal research subjects that include at least three cases involving the parenteral administration specified in subsection (nn)(2)(A)(ii)(VI)(-c-) of this section; and

(C) obtain [~~has obtained~~] written attestation [~~that~~] the individual has satisfactorily completed the requirements of paragraph (2)(A) and (B) of this subsection[~~,~~] and is able to independently fulfill the radiation safety-related duties as an authorized user for the parenteral administration of unsealed radioactive material requiring a written directive. The attestation must be obtained from either:

(i) a preceptor authorized user meeting [~~who meets~~] the requirements of subsection (l) of this section, subsection (nn) of this section, or this subsection, or equivalent NRC or agreement state requirements. A preceptor authorized user meeting [~~who meets~~] the requirements in subsection (nn) of this section, this section, or equivalent agreement state [~~Agreement State~~] requirements, must have experience in administering dosages in the same category or categories as the individual requesting authorized user status; or[~~, and shall have experience in administering dosages in the same category or categories as the individual requesting authorized user status; or~~]

(ii) a [~~A~~] residency program director affirming [~~who affirms~~] in writing

that the attestation represents the consensus of the residency program faculty where at least one faculty member is an authorized user meeting [~~who meets~~] the requirements in subsections (l), (nn), or (qq) of this section, or equivalent NRC or agreement state requirements, has experience in administering dosages in the same dosage category or categories as the individual requesting authorized user status, and concurring [~~concurs~~] with the attestation provided by the residency program director. The residency training program must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, [~~or~~] the Royal College of Physicians and Surgeons of Canada, or the Council on Postdoctoral Training of the American Osteopathic Association and must include training and experience specified in this paragraph.

(rr) Use of sealed sources for manual brachytherapy. The licensee must [~~shall~~] use only brachytherapy sources as follows:

(1) as approved in the Sealed Source and Device Registry for manual brachytherapy medical or veterinary use. The manual brachytherapy sources may be used for manual brachytherapy uses [~~that are~~] not explicitly listed in the Sealed Source and Device Registry, but must be used according to [~~in accordance with~~] the radiation safety conditions and limitations described in the Sealed Source and Device Registry; or

(2) in research to deliver therapeutic doses for medical or veterinary use in accordance with an active Investigational Device Exemption application accepted by the FDA provided the requirements of subsection (u)(1) of this section are met.

(ss) Surveys after sealed source implants and removal.

(1) Immediately after implanting sealed sources in a patient or a human or animal research subject, the licensee must [~~shall~~] perform a survey to locate and account for all sealed sources [~~that have~~] not [~~been~~] implanted.

(2) Immediately after removing the last temporary implant sealed source from a patient or a human or animal research subject, the licensee must [~~shall~~] perform a survey of the patient or the human or animal research subject with a radiation detection survey instrument to confirm [~~that~~] all sealed sources are [~~have been~~] removed.

(3) A record of each survey must [~~shall~~] be retained, for inspection by the department, as specified in [~~accordance with~~] subsection (xxx) of this section. The record must [~~shall~~] include [~~the following~~]:

(A) date of the survey;

(B) results of the survey;

(C) manufacturer's name and model and serial number of the instrument used to make the survey; and

(D) name of the individual who performed the survey.

(tt) Brachytherapy sealed sources accountability.

(1) The licensee must [~~shall~~] maintain accountability at all times for all brachytherapy sealed sources in storage or use.

(2) Promptly after removing sealed sources from a patient or a human or animal research subject, the licensee must [~~shall~~] return brachytherapy sealed sources to a secure storage area.

(3) The licensee must [~~shall~~] maintain a record of the brachytherapy sealed source accountability as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department.

(A) When removing temporary implants from storage, the licensee must [~~shall~~] record the number and activity of sources, time and date the sources were removed, the name of the individual who removed the sources, and the location of use. When temporary implants are returned to storage, the licensee must record the number and activity of sources, the time and date, and the name of the individual who returned them.

(B) When removing permanent implants from storage, the licensee must [~~shall~~] record the number and activity of sources, the date, the name of the individual who removed the sources, and the number and activity of sources permanently implanted in the patient or human or animal research subject. The licensee must record [~~Record~~] the number and activity of sources not implanted and returned to storage, the date they were returned to storage, and the name of the individual who returned them to storage.

(uu) Safety instruction to personnel. The licensee must [~~shall~~] provide radiation safety instruction, initially and at least annually, to personnel caring for patients or human or animal research subjects [~~who are~~] receiving brachytherapy and who cannot be released as specified in [~~accordance with~~] subsection (cc) of this section or animals that are confined.

(1) The instruction must [~~shall~~] be appropriate to the personnel's assigned duties and include [~~the following~~]:

(A) size and appearance of brachytherapy sources;

(B) safe handling and shielding instructions;

(C) patient or human or animal research subject control;

(D) visitor control, including [~~to include~~] visitation to hospitalized patients [~~individuals~~] as specified in [~~accordance with~~] §289.202(n) of this chapter [~~title~~]; and

(E) notification of the RSO, or his or her designee, and an authorized user if the patient or the human or animal research subject has a medical emergency or dies.

(2) A licensee must [~~shall~~] maintain a record, for inspection by the department, as specified in [~~accordance with~~] subsection (xxx) of this section, of individuals receiving instruction. The record must [~~shall~~] include [~~the following~~]:

(A) list of the topics covered;

(B) date of the instruction or training;

(C) names [~~name(s)~~] of the attendees [~~attendee(s)~~]; and

(D) names [~~name(s)~~] of the personnel [~~individual(s)~~] who provided the instruction.

(vv) Safety precautions for the use of brachytherapy.

(1) For each patient or human research subject [~~who is~~] receiving brachytherapy and who cannot be released as specified in [~~accordance with~~] subsection (cc) of this section the licensee must [~~shall~~]:

(A) provide a private room with a private sanitary facility;

(B) post the patient's or the research subject's room with a "Radioactive Materials" sign and note on the door or in the patient's or research subject's chart where and how long visitors may stay in the patient's or the research subject's room; and

(C) have available near each treatment room, applicable emergency response equipment to respond to a sealed source [~~that is~~] inadvertently dislodged from the patient or inadvertently lodged within the patient following removal of the sealed source applicators.

(2) The RSO, or his or her designee, and the authorized user must [~~shall~~] be notified if the patient or research subject has a medical emergency, and[~~,~~] immediately[~~,~~] if the patient dies.

(ww) Calibration measurements of brachytherapy sealed sources.

(1) Before the first medical or veterinary use of a brachytherapy sealed source [~~on or after October 1, 2000~~], the licensee must [~~shall do the following~~]:

(A) determine the sealed source output or activity using a dosimetry system meeting [~~that meets~~] the requirements of subsection (iii)(1) of this section;

(B) determine sealed source positioning accuracy within applicators; and

(C) use published protocols accepted by nationally recognized bodies to meet the requirements of subparagraphs (A) and (B) of this paragraph.

(2) Instead of the licensee making its own measurements as required in paragraph (1) of this subsection, the licensee may use measurements provided by the source manufacturer or by a calibration laboratory accredited by the American Association of Physicists in Medicine [~~that are~~] made as specified in [~~accordance~~

~~with~~] paragraph (1) of this subsection.

(3) The licensee must [~~shall~~] mathematically correct the outputs or activities determined in paragraph (1) of this subsection for physical decay at intervals consistent with one percent physical decay.

(4) The licensee must [~~shall~~] retain a record of each calibration as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department. The record must [~~shall~~] include [~~the following~~]:

(A) complete date of the calibration including the month, day, and year;

(B) manufacturer's name and model and serial number for the sealed source and instruments used to calibrate the sealed source;

(C) sealed source output or activity;

(D) sealed source positioning accuracy within applicators; and

(E) name of the individual, the source manufacturer, or the calibration laboratory that performed the calibration.

(xx) Strontium-90 sources for ophthalmic treatments.

(1) A licensee using [~~who uses~~] strontium-90 for ophthalmic treatments must ensure [~~that~~] certain activities as specified in paragraph (2) of this subsection are performed by either:

(A) an authorized medical physicist; or

(B) an individual who:

(i) is identified as an ophthalmic physicist on a specific medical use license issued by the department, the NRC, or an agreement state; permit issued by the department, the NRC, or an agreement state broad scope medical use licensee; medical use permit issued by an NRC master material licensee; or permit issued by an NRC master material licensee broad scope medical use permittee; and

(ii) holds a master's or doctoral [~~doctor's~~] degree in physics, medical physics, other physical sciences, engineering, or applied mathematics from an accredited college or university; and

(iii) has successfully completed one year of full-time training in medical physics and an additional year of full-time work experience under the supervision of a medical physicist; and

(iv) has documented training in:

(I) the creation, modification, and completion of written directives;

(II) procedures for administrations requiring a written directive; and

(III) performing the calibration measurements of brachytherapy

sources as detailed in subsection (ww) of this section.

(2) The individual [~~who is~~] identified in paragraph (1) of this subsection must:

(A) calculate the activity of each strontium-90 source [~~that is~~] used to determine the treatment times for ophthalmic treatments, and the decay must be based on the activity determined under subsection (ww) of this section; and

(B) assist the licensee in developing, implementing, and maintaining written procedures to provide high confidence [~~that~~] the administration is in accordance with the written directive. These procedures must include the frequencies [~~that~~] the individual meeting the requirements in paragraph (1) of this subsection will:

(i) observe treatments;[~~,~~]

(ii) review the treatment methodology;[~~,~~]

(iii) calculate treatment time for the prescribed dose;[~~,~~] and

(iv) review records to verify [~~that~~] the administrations were in accordance with the written directives.

(3) A licensee must [~~shall~~] maintain a record of the activity of a strontium-90 source as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department. The record must [~~shall~~] include [~~the following~~]:

(A) date and initial activity of the source as determined under subsection (ww) of this section; and

(B) for each decay calculation, the date and the source activity as determined under this subsection.

(yy) Therapy-related computer systems for manual brachytherapy. The licensee must [~~shall~~] perform acceptance testing on the treatment planning system of therapy-related computer systems in accordance with published protocols accepted by nationally recognized bodies. At a minimum, the acceptance testing must [~~shall~~] include, as applicable, verification of [~~the following~~]:

(1) the sealed source-specific input parameters required by the dose calculation algorithm;

(2) the accuracy of dose, dwell time, and treatment time calculations at representative points;

(3) the accuracy of isodose plots and graphic displays; and

(4) the accuracy of the software used to determine radioactive sealed source positions from radiographic images.

(zz) Training for use of manual brachytherapy sealed sources. Except as provided in subsection (l) of this section, the licensee must [~~shall~~] require an authorized user of a manual brachytherapy source for the uses authorized in subsection (rr) of this

section to be a physician or veterinarian who:

(1) is certified by a medical specialty board whose certification process is [~~has been~~] recognized by the department, the NRC, or an agreement state. The names of board certifications [~~that have been~~] recognized by the department, the NRC, or an agreement state are posted on the NRC's Medical Uses Licensee Toolkit web page. To have its certification recognized, a specialty board must [~~shall~~] require all candidates for certification to:

(A) successfully complete a minimum of three years of residency training in a radiation oncology program approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, the Royal College of Physicians and Surgeons of Canada, or the Council on Postdoctoral [~~Committee on Post-Graduate~~] Training of the American Osteopathic Association; and

(B) pass an examination[~~,~~] administered by diplomates of the specialty board assessing [~~, that assesses~~] knowledge and competence in radiation safety, radionuclide handling, treatment planning, quality assurance, and clinical use of manual brachytherapy; or

(2) has [~~completed~~]:

(A) completed a structured educational program in basic radionuclide handling techniques applicable to the use of manual brachytherapy sources, including [~~the following~~]:

(i) 200 hours of classroom and laboratory training in [~~the following areas~~]:

(I) radiation physics and instrumentation;

(II) radiation protection;

(III) mathematics pertaining to the use and measurement of radioactivity; and

(IV) radiation biology; and

(ii) 500 hours of work experience, under the supervision of an authorized user meeting [~~who meets~~] the requirements of subsection (l) of this section, this subsection, or equivalent NRC or agreement state requirements at a medical facility authorized to use radioactive material under subsection (rr) of this section, involving [~~the following~~]:

(I) ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;

(II) checking survey meters for proper operation;

(III) preparing, implanting, and removing brachytherapy sources;

(IV) maintaining running inventories of material on hand;

(V) using administrative controls to prevent a medical event involving the use of radioactive material; and

(VI) using emergency procedures to control radioactive material; and

(B) three years of supervised clinical experience in radiation oncology, under an authorized user meeting [~~who meets~~] the requirements of subsection (l) of this section, this subsection, or equivalent NRC or agreement state requirements, as part of a formal training program approved by the Residency Review Committee for Radiation Oncology of the Accreditation Council for Graduate Medical Education, the Royal College of Physicians and Surgeons of Canada, or the Council [~~Committee~~] on Postdoctoral Training of the American Osteopathic Association. This experience may be obtained concurrently with the supervised work experience required by subparagraph (A)(ii) of this paragraph; and

(C) [~~(3)~~] [~~has~~] obtained written attestation [~~that~~] the individual has satisfactorily completed the requirements in paragraph (2) of this subsection and is able to independently fulfill the radiation safety-related duties as an authorized user of manual brachytherapy sources for the medical or veterinary uses authorized under subsection (rr) of this section. The attestation must be obtained from either:

(i) [~~(A)~~] a preceptor authorized user meeting [~~who meets~~] the requirements of subsection (l) of this section, this subsection, or equivalent NRC or agreement state requirements; or

(ii) [~~(B)~~] a residency program director affirming [~~who affirms~~] in writing that the attestation represents the consensus of the residency program faculty where at least one faculty member is an authorized user meeting [~~who meets~~] the requirements in subsection (l) of this section, this subsection, or equivalent NRC or agreement state requirements, and concurring [~~concurs~~] with the attestation provided by the residency program director. The residency training program must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, [~~or~~] the Royal College of Physicians and Surgeons of Canada, or the Council on Postdoctoral Training of the American Osteopathic Association and must include training and experience specified in paragraph (2) of this subsection.

(aaa) Training for ophthalmic use of strontium-90. Except as provided in subsection (l) of this section, the licensee must [~~shall~~] require an authorized user of strontium-90 for ophthalmic radiotherapy to be a physician or veterinarian who:

(1) is an authorized user under subsection (zz) of this section or equivalent NRC or agreement state requirements; or

(2) has completed 24 hours of classroom and laboratory training applicable to the medical or veterinary use of strontium-90 for ophthalmic radiotherapy.

(A) The training must [~~shall~~] include: [~~the following.~~]

(i) classroom training in [~~shall include the following~~]:

(I) radiation physics and instrumentation;

(II) radiation protection;

(III) mathematics pertaining to the use and measurement of radioactivity; and

(IV) radiation biology; and

(ii) supervised clinical training in ophthalmic radiotherapy under the supervision of an authorized user at a medical institution, clinic, or private practice that includes the use of strontium-90 for the ophthalmic treatment of five patients [~~individuals~~]. This supervised clinical training must [~~shall~~] involve:

(I) examination of each patient [~~individual~~] to be treated;

(II) calculation of the dose to be administered;

(III) administration of the dose; and

(IV) follow-up and review of each patient's [~~individual's~~] case history; and

(3) has obtained written attestation, signed by a preceptor authorized user meeting [~~who meets~~] the requirements of subsection (l) of this section, subsection (zz) of this section, or this subsection, or equivalent NRC or agreement state requirements, that the individual has satisfactorily completed the requirements of paragraph (2)(A) of this subsection and is able to independently fulfill the radiation safety-related duties as an authorized user of strontium-90 for ophthalmic use.

(bbb) Use of sealed sources and medical devices for diagnosis.

(1) The licensee must [~~shall~~] use only sealed sources [~~that are~~] not in medical devices for diagnostic medical uses if the sealed sources are approved in the Sealed Source and Device Registry for diagnostic medicine. The sealed sources may be used for diagnostic medical uses [~~that are~~] not explicitly listed in the Sealed Source and Device Registry but must be used in accordance with the radiation safety conditions and limitations described in the Sealed Source and Device Registry.

(2) The licensee must only use medical devices containing sealed sources for diagnostic medical uses if both the sealed sources and medical devices are approved in the Sealed Source and Device Registry for diagnostic medical uses. The diagnostic medical devices may be used for diagnostic medical uses [~~that are~~] not explicitly listed in the Sealed Source and Device Registry but must be used in accordance with the radiation safety conditions and limitations described in the Sealed Source and Device Registry.

(3) Sealed sources and devices for diagnostic medical uses may be used in research in accordance with an active Investigational Device Exemption (IDE) application accepted by the FDA provided the requirements of subsection (u)(1) of this section are met.

(4) The licensee must [~~shall~~] ensure [~~that~~] installation or exchange of sealed sources [~~source(s)~~] in medical imaging equipment is performed only by the manufacturer or persons specifically authorized to perform these services by the department, the NRC, or another agreement state. The licensee must [~~shall~~] maintain a record for each installation or exchange for inspection by the department as specified in [~~accordance with~~] subsection (xxx) of this section. The record must [~~shall~~] include the date, the installer's radioactive material license number, and the regulatory agency that issued the license to the installer.

(ccc) Training for use of sealed sources for diagnosis. Except as provided in subsection (l) of this section, the licensee must [~~shall~~] require the authorized user of a diagnostic sealed source or a device authorized as specified in [~~accordance with~~] subsection (bbb) of this section to be a physician, dentist, [~~or~~] podiatrist, or veterinarian who:

(1) is certified by a specialty board whose certification process includes all [~~of~~] the requirements of paragraphs (3) and (4) of this subsection and whose certification is [~~has been~~] recognized by the department, the NRC, or an agreement state[~~. The~~] (names of board certifications [~~that have been~~] recognized by the department, the NRC, or an agreement state are posted on the NRC's Medical Uses Licensee Toolkit web page); or

(2) is an authorized user for uses listed in subsection (hh) of this section or equivalent NRC or agreement state requirements; or

(3) has completed eight hours of classroom and laboratory training in basic radionuclide handling techniques specifically applicable to the use of the device. The training must [~~shall~~] include:

(A) radiation physics and instrumentation;

(B) radiation protection;

(C) mathematics pertaining to the use and measurement of radioactivity; and

(D) radiation biology; and

(4) has completed training in the use of the device for the uses requested.

(ddd) Use of a sealed source in a remote afterloader unit, teletherapy unit, or gamma stereotactic radiosurgery unit.

(1) The licensee must [~~shall~~] only use sealed sources:

(A) as approved and as provided for in the Sealed Source and Device Registry in photon-emitting remote afterloader units, teletherapy units, or gamma stereotactic radiosurgery units to deliver therapeutic doses for medical uses; or

(B) in research involving photon-emitting remote afterloader units, teletherapy units, or gamma stereotactic radiosurgery units in accordance with an

active IDE application accepted by the FDA, provided the requirements of subsection (u)(1) of this section are met.

(2) A licensee must [~~shall~~] use photon-emitting remote afterloader units, teletherapy units, or gamma stereotactic radiosurgery units:

(A) approved in the Sealed Source and Device Registry to deliver a therapeutic dose for medical use. These devices may be used for therapeutic medical treatments [~~that are~~] not explicitly provided for in the Sealed Source and Device Registry, but must be used in accordance with radiation safety conditions and limitations described in the Sealed Source and Device Registry; or

(B) in research in accordance with an active IDE application accepted by the FDA, provided the requirements of subsection (u)(1) of this section are met.

(eee) Surveys of patients and human research subjects treated with a remote afterloader unit.

(1) Before releasing a patient or a human research subject from licensee control, the licensee must [~~shall~~] perform a survey of the patient or the human research subject and the remote afterloader unit with a portable radiation detection survey instrument to confirm [~~that~~] the sealed source or sources have [~~source(s) has~~] been removed from the patient or human research subject and returned to the safe shielded position.

(2) The licensee must [~~shall~~] maintain a record of the surveys as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department. The record must [~~shall~~] include [~~the following~~]:

(A) date of the survey;

(B) results of the survey;

(C) manufacturer's name, model, and serial number of the survey instrument used; and

(D) name of the individual who made the survey.

(fff) Installation, maintenance, adjustment, and repair.

(1) Only a person specifically licensed by the department, the NRC, or an agreement state may [~~shall~~] install, maintain, adjust, or repair a remote afterloader unit, teletherapy unit, or gamma stereotactic radiosurgery unit that involves work on the sealed source [~~source(s)~~] shielding, the sealed source [~~source(s)~~] driving unit, or other electronic or mechanical component that could expose the sealed source or sources [~~source(s)~~], reduce the shielding around the sealed source or sources [~~source(s)~~], or compromise the radiation safety of the unit or the sealed source or sources [~~source(s)~~].

(2) Except for low dose-rate remote afterloader units, only a person specifically licensed by the department, the NRC, or an agreement state may [~~shall~~] install,

replace, relocate, or remove a sealed source or sealed source contained in other remote afterloader units, teletherapy units, or gamma stereotactic units.

(3) For a low dose-rate remote afterloader unit, only a person specifically licensed by the department, the NRC, an agreement state, or an authorized medical physicist may [~~shall~~] install, replace, relocate, or remove a sealed source [~~source(s)~~] contained in the unit.

(4) The licensee must [~~shall~~] maintain a record of the installation, maintenance, adjustment, and repair done on remote afterloader units, teletherapy units, and gamma stereotactic radiosurgery units as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department. For each installation, maintenance, adjustment, and repair, the record must [~~shall~~] include the date, description of the service, and names [~~name(s)~~] of the individuals [~~individual(s)~~] who performed the work.

(ggg) Safety procedures and instructions for remote afterloader units, teletherapy units, and gamma stereotactic radiosurgery units.

(1) A licensee must [~~shall do the following~~]:

(A) secure the unit, the console, the console keys, and the treatment room when not in use or unattended;

(B) permit only individuals approved by the authorized user, RSO, or authorized medical physicist to be present in the treatment room during treatment with the sealed source or sources [~~source(s)~~];

(C) prevent dual operation of more than one radiation producing device in a treatment room, if applicable; and

(D) develop, implement, and maintain written procedures for responding to an abnormal situation when the operator is unable to place the sealed source or sources [~~source(s)~~] in the shielded position, or remove the patient or human research subject from the radiation field with controls from outside the treatment room. The procedures must [~~shall~~] include [~~the following~~]:

(i) instructions for responding to equipment failures and the names of the individuals responsible for implementing corrective actions;

(ii) the process for restricting access to and posting of the treatment area to minimize the risk of inadvertent exposure; and

(iii) the names and telephone numbers of the authorized users, the authorized medical physicist, and the RSO to be contacted if the unit or console operates abnormally;

(2) A copy of the procedures required by paragraph (1)(D) of this subsection must be physically located at the unit console.

(3) The licensee must [~~shall~~] post instructions at the unit console to inform the

operator of [~~the following~~]:

(A) the location of the procedures required by paragraph (1)(D) of this subsection; and

(B) the names and telephone numbers of the authorized users, the authorized medical physicist, and the RSO to be contacted if the unit or console operates abnormally.

(4) Before the first use for patient treatment of a new unit or an existing unit with a manufacturer upgrade affecting [~~that affects~~] the operation and safety of the unit:

(A) a licensee must [~~shall~~] ensure [~~that~~] vendor operational and safety training is provided to all individuals who will operate the unit. The vendor operational and safety training must be provided by the device manufacturer or by an individual certified by the device manufacturer to provide the operational and safety training.

(B) a licensee must [~~shall~~] provide operational and safety instructions initially and at least annually [~~,~~] to all individuals who operate the unit at the facility, as appropriate to the individual's assigned duties, to include:

(i) procedures identified in paragraph (1)(D) of this subsection; and

(ii) operating procedures for the unit.

(5) A licensee must [~~shall~~] ensure [~~that~~] operators, authorized medical physicists, and authorized users participate in drills of the emergency procedures, initially and at least annually. [~~; and~~]

(6) A licensee must [~~shall~~] maintain records of the procedures required by paragraphs (1)(D) and (4)(B)(ii) of this subsection as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department.

(7) A licensee must [~~shall~~] maintain records of individuals receiving instruction and participating in drills required by paragraphs (4) and (5) of this subsection as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department. The record must [~~shall~~] include [~~the following~~]:

(A) a list of the topics covered;

(B) date of the instruction or drill;

(C) names [~~name(s)~~] of the attendees [~~attendee(s)~~]; and

(D) names [~~name(s)~~] of the personnel [~~individual(s)~~] who provided the instruction.

(hhh) Safety precautions for remote afterloader units, teletherapy units, and gamma stereotactic radiosurgery units. The licensee must [~~shall do the following~~]:

(1) control access to the treatment room by a door at each entrance;

(2) equip each entrance to the treatment room with an electrical interlock system that will [~~do the following~~]:

(A) prevent the operator from initiating the treatment cycle unless each treatment room entrance door is closed;

(B) cause the sealed source or sources [~~source(s)~~] to be shielded promptly when an entrance door is opened; and

(C) prevent the sealed source or sources [~~source(s)~~] from being exposed following an interlock interruption until all treatment room entrance doors are closed and the sealed source [~~source(s)~~] "on-off" control is reset at the console;

(3) require any individual entering the treatment room to assure, through the use of appropriate radiation monitors, [~~that~~] radiation levels have returned to ambient levels;

(4) except for low-dose remote afterloader units, construct or equip each treatment room with viewing and intercom systems to permit continuous observation of the patient or the human research subject from the treatment console during irradiation;

(5) for licensed activities when [~~where~~] sealed sources are placed within the patient's or human research subject's body, only conduct treatments allowing [~~that allow for~~] expeditious removal of a decoupled or jammed sealed source;

(6) in addition to the requirements specified in paragraphs (1) - (5) of this subsection, require [~~the following~~]:

(A) for low dose-rate, medium dose-rate, and pulsed dose-rate remote afterloader units:

(i) an authorized medical physicist [~~,~~] and either an authorized user or a physician, under the supervision of an authorized user, [~~who has been~~] trained in the operation and emergency response for the unit, be physically present during the initiation of all patient treatments involving the unit; and

(ii) an authorized medical physicist [~~,~~] and either an authorized user or an individual, under the supervision of an authorized user, [~~who has been~~] trained to remove the sealed source applicator [~~applicator(s)~~] in the event of an emergency involving the unit, be immediately available during continuation of all patient treatments involving the unit;

(B) for high dose-rate remote afterloader units:

(i) an authorized user and an authorized medical physicist be physically present during the initiation of all patient treatments involving the unit; and

(ii) an authorized medical physicist [~~,~~] and either an authorized user or a

physician, under the supervision of an authorized user, [~~who has been~~] trained in the operation and emergency response for the unit, be physically present during continuation of all patient treatments involving the unit;

(C) for gamma stereotactic radiosurgery units and teletherapy units, require [~~that~~] an authorized user and an authorized medical physicist be physically present throughout all patient treatments [~~involving gamma stereotactic radiosurgery units and teletherapy units~~]; and

(D) notify the RSO, or his or her designee, and an authorized user as soon as possible [~~,~~] if the patient or human research subject has a medical emergency or dies; and

(7) have applicable emergency response equipment available near each treatment room to respond to a sealed source that remains in the unshielded position or lodges within the patient following completion of the treatment.

(iii) Dosimetry equipment.

(1) Except for low dose-rate remote afterloader sealed sources where the sealed source output or activity is determined by the manufacturer, the licensee must [~~shall~~] have a calibrated dosimetry system available for use. To satisfy this requirement, one of the following two conditions are required [~~shall be met~~]:

(A) the system was [~~shall have been~~] calibrated using a system or sealed source traceable to the National Institute of Standards and Technology (NIST) and published protocols accepted by nationally recognized bodies; or by a calibration laboratory accredited by the American Association of Physicists in Medicine (AAPM). The calibration was [~~shall have been~~] performed within the previous two years and after any servicing that may have affected system calibration; or

(B) the system was [~~shall have been~~] calibrated within the previous four years. Eighteen to 30 months after that calibration, the system was [~~shall have been~~] intercompared with another dosimetry system [~~that was~~] calibrated within the past 24 months by NIST or by a calibration laboratory accredited by the AAPM. The results of the intercomparison must have indicated [~~shall have indicated that~~] the calibration factor of the licensee's system had not changed by more than two percent. The licensee may not use the intercomparison result to change the calibration factor. When intercomparing dosimetry systems [~~to be~~] used for calibrating sealed sources for therapeutic units [~~unit~~], the licensee must [~~shall~~] use a comparable unit with beam attenuators or collimators, as applicable, and sealed sources of the same radionuclide as the sealed source used at the licensee's facility.

(2) The licensee must [~~shall~~] have available for use a dosimetry system for spot check output measurements, if such measurements are required by this section. To satisfy this requirement, the system may be compared with a system [~~that has been~~] calibrated as specified in [~~accordance with~~] paragraph (1) of this subsection. This comparison must [~~shall~~] have been performed within the previous year and after each servicing that may have affected system calibration. The spot check system may be the same system used to meet the requirements of paragraph (1)

of this subsection.

(3) The licensee must [~~shall~~] retain a record of each calibration, intercomparison, and comparison of dosimetry equipment as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department. The record must [~~shall~~] include [~~the following~~]:

(A) complete date of the calibration including the month, day, and year;

(B) manufacturer's model and serial numbers of the instruments that were calibrated, intercompared, or compared;

(C) the correction factor that was determined from the calibration or comparison or the apparent correction factor that was determined from an intercomparison; and

(D) the names of the individuals who performed the calibration, intercomparison, or comparison.

(jjj) Full calibration measurements on teletherapy units.

(1) A licensee authorized to use a teletherapy unit for medical use must [~~shall~~] perform full calibration measurements on each teletherapy unit as follows:

(A) before the first medical use of the unit; and

(B) before medical use under any of the following conditions:

(i) whenever spot check measurements indicate [~~that~~] the output differs by more than five percent from the output obtained at the last full calibration corrected mathematically for radioactive decay;

(ii) following replacement of the sealed source or following reinstallation of the teletherapy unit in a new location;

(iii) following any repair of the teletherapy unit that includes removal of the sealed source or major repair of the components associated with the sealed source exposure assembly; and

(C) at intervals not to exceed one year.

(2) Full calibration measurements must [~~shall~~] include determination of [~~the following~~]:

(A) the output within plus or minus three percent for the range of field sizes and for the distance or range of distances used for medical use;

(B) the coincidence of the radiation field and the field indicated by the light beam localizing device;

(C) uniformity of the radiation field and its dependence on the orientation of the useful beam;

(D) timer accuracy and linearity over the range of use;

(E) "on-off" error; and

(F) the accuracy of all distance measuring and localization devices in medical use.

(3) The licensee must [~~shall~~] use the dosimetry system described in subsection (iii)(1) of this section to measure the output for one set of exposure conditions. The remaining radiation measurements required in paragraph (2)(A) of this subsection may be made using a dosimetry system indicating [~~that indicates~~] relative dose rates.

(4) The licensee must [~~shall~~] make full calibration measurements required by paragraph (1) of this subsection in accordance with published protocols accepted by nationally recognized bodies.

(5) The licensee must [~~shall~~] mathematically correct the outputs determined in paragraph (2)(A) of this subsection for physical decay at intervals not to exceed one month for cobalt-60, six months for cesium-137, or at intervals consistent with one percent decay for all other nuclides.

(6) Full calibration measurements required by paragraph (1) of this subsection and physical decay corrections required by paragraph (5) of this subsection must [~~shall~~] be performed by an authorized medical physicist.

(7) The licensee must [~~shall~~] retain a record of each calibration as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department. The record must [~~shall~~] include [~~the following~~]:

(A) complete date of the calibration including the month, day, and year;

(B) manufacturer's name, model number, and serial number of the teletherapy unit's sealed source and the instruments used to calibrate the unit;

(C) results and an assessment of the full calibrations; and

(D) name and signature of the authorized medical physicist who performed the full calibration.

(kkk) Full calibration measurements on remote afterloader units.

(1) A licensee authorized to use a remote afterloader for medical use must [~~shall~~] perform full calibration measurements on each unit [~~as follows~~]:

(A) before the first medical use of the unit;

(B) before medical use under any of the following conditions:

(i) following replacement of the sealed source;

(ii) following reinstallation of the unit in a new location outside the facility;

and

(iii) following any repair of the unit that includes removal of the sealed source or major repair of the components associated with the sealed source exposure assembly;

(C) at intervals not to exceed three months for high dose-rate, medium dose-rate, and pulsed dose-rate remote afterloader units with sealed sources whose half-life exceeds 75 days; and

(D) at intervals not to exceed one year for low dose-rate afterloader units.

(2) Full calibration measurements must [~~shall~~] include, as applicable, determination of [~~the following~~]:

(A) the output within plus or minus five percent;

(B) sealed source positioning accuracy to within plus or minus 1 millimeter (mm);

(C) sealed source retraction with backup battery upon power failure;

(D) length of the sealed source transfer tubes;

(E) timer accuracy and linearity over the typical range of use;

(F) length of the applicators; and

(G) function of the sealed source transfer tubes, applicators, and transfer tube-applicator interfaces.

(3) A licensee must [~~shall~~] use the dosimetry system described in subsection (iii)(1) of this section to measure the output.

(4) A licensee must [~~shall~~] make full calibration measurements required by paragraph (1) of this subsection in accordance with published protocols accepted by nationally recognized bodies.

(5) In addition to the requirements for full calibrations for low dose-rate remote afterloader units in paragraph (2) of this subsection, a licensee must [~~shall~~] perform an autoradiograph of the sealed source or sources [~~source(s)~~] to verify inventory and sealed source [~~source(s)~~] arrangement at intervals not to exceed three months.

(6) For low dose-rate remote afterloader units, a licensee may use measurements provided by the sealed source manufacturer that are made as specified in [~~accordance with~~] paragraphs (1) - (5) of this subsection.

(7) The licensee must [~~shall~~] mathematically correct the outputs determined in paragraph (2)(A) of this subsection for physical decay at intervals consistent with one percent physical decay.

(8) Full calibration measurements required by paragraph (1) of this subsection and physical decay corrections required by paragraph (7) of this subsection must [~~shall~~] be performed by an authorized medical physicist.

(9) The licensee must [~~shall~~] retain a record of each calibration as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department. The record must [~~shall~~] include [~~the following~~]:

(A) complete date of the calibration including the month, day, and year;

(B) manufacturer's name, model number, and serial number of the remote afterloader unit's sealed source, and the instruments used to calibrate the unit;

(C) results and an assessment of the full calibrations;

(D) name and signature of the authorized medical physicist who performed the full calibration [~~of this section~~]; and

(E) results of the autoradiograph required for low dose-rate remote afterloader unit.

(lll) Full calibration measurements on gamma stereotactic radiosurgery units.

(1) A licensee authorized to use a gamma stereotactic radiosurgery unit for medical use must [~~shall~~] perform full calibration measurements on each gamma stereotactic radiosurgery unit [~~as follows~~]:

(A) before the first medical use of the unit;

(B) before medical use under the following conditions:

(i) whenever spot check measurements indicate [~~that~~] the output differs by more than five percent from the output obtained at the last full calibration corrected mathematically for radioactive decay;

(ii) following replacement of the sealed sources or following reinstallation of the gamma stereotactic radiosurgery unit in a new location; and

(iii) following any repair of the gamma stereotactic radiosurgery unit that includes removal of the sealed sources or major repair of the components associated with the sealed source exposure assembly; and

(C) at intervals not to exceed one year, with the exception that relative helmet factors need only be determined before the first medical use of a helmet and following any damage to a helmet.

(2) Full calibration measurements must [~~shall~~] include determination of [~~the following~~]:

(A) the output within plus or minus three percent;

(B) relative helmet factors;

(C) isocenter coincidence;

(D) timer accuracy and linearity over the range of use;

(E) "on-off" error;

(F) trunnion centricity;

(G) treatment table retraction mechanism, using backup battery power or hydraulic backups with the unit "off";

(H) helmet microswitches;

(I) emergency timing circuits; and

(J) stereotactic frames and localizing devices (trunnions).

(3) The licensee must [~~shall~~] use the dosimetry system described in subsection (iii)(1) of this section to measure the output for one set of exposure conditions. The remaining radiation measurements required in paragraph (2)(A) of this subsection may be made using a dosimetry system indicating [~~that indicates~~] relative dose rates.

(4) The licensee must [~~shall~~] make full calibration measurements required by paragraph (1) of this subsection in accordance with published protocols accepted by nationally recognized bodies.

(5) The licensee must [~~shall~~] mathematically correct the outputs determined in paragraph (2)(A) of this subsection at intervals not to exceed one month for cobalt-60 and at intervals consistent with one percent physical decay for all other radionuclides.

(6) Full calibration measurements required by paragraph (1) of this subsection and physical decay corrections required by paragraph (5) of this subsection must [~~shall~~] be performed by an authorized medical physicist.

(7) The licensee must [~~shall~~] retain a record of each calibration as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department. The record must [~~shall~~] include [~~the following~~]:

(A) complete date of the calibration including the month, day, and year;

(B) manufacturer's name, model number, and serial number for the unit and the unit's sealed source and the instruments used to calibrate the unit;

(C) results and an assessment of the full calibration; and

(D) name and signature of the authorized medical physicist who performed the full calibration.

(mmm) Periodic spot checks for teletherapy units.

(1) A licensee authorized to use teletherapy units for medical use must [~~shall~~]

perform output spot checks on each teletherapy unit once in each calendar month, including [~~that include~~] determination of [~~the following~~]:

(A) timer constancy and linearity over the range of use;

(B) "on-off" error;

(C) the coincidence of the radiation field and the field indicated by the light beam localizing device;

(D) the accuracy of all distance measuring and localization devices used for medical use;

(E) the output for one typical set of operating conditions measured with the dosimetry system described in subsection (iii)(2) of this section; and

(F) the difference between the measurement made in subparagraph (E) of this paragraph and the anticipated output, expressed as a percentage of the anticipated output, the value obtained at last full calibration corrected mathematically for physical decay.

(2) The licensee must [~~shall~~] perform measurements required by paragraph (1) of this subsection in accordance with written procedures established by an authorized medical physicist. That authorized medical physicist need not actually perform the spot check measurements. The licensee must [~~shall~~] maintain a copy of the written procedures as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department.

(3) The licensee authorized to use a teletherapy unit for medical use must [~~shall~~] perform safety spot checks of each teletherapy facility once in each calendar month and after each sealed source installation to assure proper operation of [~~the following~~]:

(A) electrical interlocks at each teletherapy room entrance;

(B) electrical or mechanical stops installed for the purpose of limiting use of the primary beam of radiation (restriction of sealed source housing angulation or elevation, carriage or stand travel, and operation of the beam "on-off" mechanism);

(C) sealed source exposure indicator lights on the teletherapy unit, on the control console, and in the facility;

(D) viewing and intercom systems;

(E) treatment room doors from inside and outside the treatment room; and

(F) electrically assisted treatment room doors with the teletherapy unit electrical power turned "off." [~~"off".~~]

(4) The licensee must [~~shall~~] have an authorized medical physicist review the results of each spot check and submit a written report to the licensee within 15 days of the spot check.

(5) If the results of the checks required in paragraph (3) of this subsection indicate the malfunction of any system, the licensee must [~~shall~~] lock the control console in the "off" position and not use the unit except as may be necessary to repair, replace, or check the malfunctioning system.

(6) The licensee must [~~shall~~] retain a record of each spot check required by paragraphs (1) and (3) of this subsection, as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department. The record must [~~shall~~] include [~~the following~~]:

(A) date of the spot-check;

(B) manufacturer's name and model and serial number for the teletherapy unit, and sealed source and instrument used to measure the output of the teletherapy unit;

(C) assessment of timer linearity and constancy;

(D) calculated "on-off" error;

(E) determination of the coincidence of the radiation field and the field indicated by the light beam localizing device;

(F) the determined accuracy of each distance measuring and localization device;

(G) the difference between the anticipated output and the measured output;

(H) notations indicating the operability of each entrance door electrical interlock, each electrical or mechanical stop, each sealed source exposure indicator light, and the viewing and intercom system and doors;

(I) name of the individual who performed the periodic spot-check; and

(J) the name and signature of the authorized medical physicist who reviewed the record of the spot check.

(nnn) Periodic spot checks for remote afterloader units.

(1) A licensee authorized to use a remote afterloader unit for medical use must [~~shall~~] perform spot checks of each remote afterloader facility and on each unit [~~as follows~~]:

(A) before the first use each day [~~of use~~] of a high dose-rate, medium dose-rate, or pulsed dose-rate remote afterloader unit;

(B) before each patient treatment with a low dose-rate remote afterloader unit; and

(C) after each sealed source installation.

(2) The licensee must [~~shall~~] perform the measurements required by paragraph

(1) of this subsection in accordance with written procedures established by an authorized medical physicist. That individual need not actually perform the spot check measurements. The licensee must [~~shall~~] maintain a copy of the written procedures as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department.

(3) The licensee must [~~shall~~] have an authorized medical physicist review the results of each spot check and submit a written report to the licensee within 15 days of the spot check.

(4) To satisfy the requirements of paragraph (1) of this subsection, spot checks must [~~shall~~], at a minimum, assure proper operation of [~~the following~~]:

(A) electrical interlocks at each remote afterloader unit room entrance;

(B) sealed source exposure indicator lights on the remote afterloader unit, on the control console, and in the facility;

(C) viewing and intercom systems in each high dose-rate, medium dose-rate, and pulsed dose-rate remote afterloader facility;

(D) emergency response equipment;

(E) radiation monitors used to indicate the sealed source position;

(F) timer accuracy;

(G) clock (date and time) in the unit's computer; and

(H) decayed sealed source [~~source(s)~~] activity in the unit's computer.

(5) If the results of the checks required in paragraph (4) of this subsection indicate the malfunction of any system, the licensee must [~~shall~~] lock the control console in the "off" position and not use the unit except as may be necessary to repair, replace, or check the malfunctioning system.

(6) The licensee must [~~shall~~] maintain a record, as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department, of each check required by paragraph (4) of this subsection. The record must [~~shall~~] include [~~the following~~], as applicable:

(A) date of the spot-check;

(B) manufacturer's name and model and serial number for the remote afterloader unit and sealed source;

(C) an assessment of timer accuracy;

(D) notations indicating the operability of each entrance door electrical interlock, radiation monitors, sealed source exposure indicator lights, viewing and intercom systems, clock, and decayed sealed source activity in the unit's computer;

(E) name of the individual who performed the periodic spot-check; and

(F) the signature of an authorized medical physicist who reviewed the record of the spot-check.

(ooo) Periodic spot checks for gamma stereotactic radiosurgery units.

(1) A licensee authorized to use a gamma stereotactic radiosurgery unit for medical use must [~~shall~~] perform spot checks of each gamma stereotactic radiosurgery facility and on each unit [~~as follows~~]:

(A) monthly;

(B) before the first use of the unit on each day of use; and

(C) after each source installation.

(2) The licensee must [~~shall~~] perform the measurements required by paragraph (1) of this subsection in accordance with written procedures established by an authorized medical physicist with a specialty in therapeutic radiological physics. That individual need not actually perform the spot check measurements. The licensee must [~~shall~~] maintain a copy of the written procedures as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department.

(3) The licensee must [~~shall~~] have an authorized medical physicist review the results of each spot check and submit a written report to the licensee within 15 days of the spot check.

(4) To satisfy the requirements of paragraph (1)(A) of this subsection, spot checks must [~~shall~~], at a minimum, achieve [~~the following by~~]:

(A) assurance of proper operation of these items:

(i) treatment table retraction mechanism, using backup battery power or hydraulic backups with the unit "off;"

(ii) helmet microswitches;

(iii) emergency timing circuits; and

(iv) stereotactic frames and localizing devices (trunnions); and

(B) determination of [~~the following~~]:

(i) the output for one typical set of operating conditions measured with the dosimetry system described in subsection (iii)(2) of this section;

(ii) the difference between the measurement made in clause (i) of this subparagraph and the anticipated output, expressed as a percentage of the anticipated output, (i.e., the value obtained at last full calibration corrected mathematically for physical decay);

(iii) sealed source output against computer calculation;

(iv) timer accuracy and linearity over the range of use;

(v) "on-off" error; and

(vi) trunnion centricity.

(5) To satisfy the requirements of paragraph (1)(B) and (C) of this subsection, spot checks must [~~shall~~] assure proper operation of [~~the following~~]:

(A) electrical interlocks at each gamma stereotactic radiosurgery room entrance;

(B) sealed source exposure indicator lights on the gamma stereotactic radiosurgery unit, on the control console, and in the facility;

(C) viewing and intercom systems;

(D) timer termination;

(E) radiation monitors used to indicate room exposures; and

(F) emergency "off" buttons.

(6) The licensee must [~~shall~~] arrange for prompt repair of any system identified in paragraph (4) of this subsection [~~that is~~] not operating properly.

(7) If the results of the checks required in paragraph (5) of this subsection indicate the malfunction of any system, the licensee must [~~shall~~] lock the control console in the "off" position and not use the unit except as may be necessary to repair, replace, or check the malfunctioning system.

(8) The licensee must [~~shall~~] retain a record of each check required by paragraphs (4) and (5) of this subsection as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department. The record must [~~shall~~] include [~~the following~~]:

(A) date of the spot check;

(B) manufacturer's name, and model and serial number for the gamma stereotactic radiosurgery unit and the instrument used to measure the output of the unit;

(C) an assessment of timer linearity and accuracy;

(D) the calculated "on-off" error;

(E) a determination of trunnion centricity;

(F) the difference between the anticipated output and the measured output;

(G) an assessment of sealed source output against computer calculations;

(H) notation [~~notations~~] indicating the operability of radiation monitors,

helmet microswitches, emergency timing circuits, emergency "off" buttons, electrical interlocks, sealed source exposure indicator lights, viewing and intercom systems, timer termination, treatment table retraction mechanism, and stereotactic frames and localizing devices (trunnions);

(I) the name of the individual who performed the periodic spot check; and

(J) the name and signature of an authorized medical physicist who reviewed the record of the spot check.

(ppp) Additional technical requirements for mobile remote afterloader units.

(1) A licensee providing mobile remote afterloader service must [~~shall do the following~~]:

(A) check survey instruments before medical use at each address of use or on each day of use, whichever is more frequent; and

(B) account for all sealed sources before departure from a client's address of use.

(2) In addition to the periodic spot checks required by subsection (nnn) of this section, a licensee authorized to use remote afterloaders for medical use must [~~shall~~] perform checks on each remote afterloader unit before use at each address of use. At a minimum, checks must [~~shall~~] be made to verify the operation of [~~the following~~]:

(A) electrical interlocks on treatment area access points;

(B) sealed source exposure indicator lights on the remote afterloader unit, on the control console, and in the facility;

(C) viewing and intercom systems;

(D) applicators, sealed source transfer tubes, and transfer tube-applicator interfaces;

(E) radiation monitors used to indicate room exposures;

(F) sealed source positioning (accuracy); and

(G) radiation monitors used to indicate whether the sealed source has returned to a safe shielded position.

(3) In addition to the requirements for checks in paragraph (2) of this subsection, the licensee must [~~shall~~] ensure overall proper operation of the remote afterloader unit by conducting a simulated cycle of treatment before use at each address of use.

(4) If the results of the checks required in paragraph (2) of this subsection indicate the malfunction of any system, the licensee must [~~shall~~] lock the control console in the "off" position and not use the unit except as may be necessary to

repair, replace, or check the malfunctioning system.

(5) The licensee must [~~shall~~] maintain a record for inspection by the department, as specified in [~~accordance with~~] subsection (xxx) of this section, of each check required by paragraph (2) of this subsection. The record must [~~shall~~] include [~~the following~~]:

(A) date of the check;

(B) manufacturer's name, model number, and serial number of the remote afterloader unit;

(C) notations accounting for all sealed sources before the licensee departs from a facility;

(D) notations indicating the operability of each entrance door electrical interlock, radiation monitors, sealed source exposure indicator lights, viewing and intercom system, applicators and sealed source transfer tubes, and sealed source positioning accuracy; and

(E) the name and signature of the individual who performed the check.

(qqq) Radiation surveys.

(1) In addition to the survey requirements of §289.202(p) of this chapter [~~title~~], a person licensed to use sealed sources in this section must [~~shall~~] make surveys to ensure [~~that~~] the maximum radiation levels and average radiation levels, from the surface of the main sealed source safe with the sealed source or sources [~~source(s)~~] in the shielded position, do not exceed the levels stated in the Sealed Source and Device Registry.

(2) The licensee must [~~shall~~] make the survey required by paragraph (1) of this subsection at installation of a new sealed source and following repairs to the sealed source [~~source(s)~~] shielding, the sealed source [~~source(s)~~] driving unit, or other electronic or mechanical component that could expose the sealed source or sources, reduce the shielding around the sealed source or sources [~~source(s)~~], or compromise the radiation safety of the unit or the sealed source or sources [~~source(s)~~].

(3) The licensee must [~~shall~~] maintain a record for inspection by the department, as specified in [~~accordance with~~] subsection (xxx) of this section, of the radiation surveys required by paragraph (1) of this subsection. The record must [~~shall~~] include:

(A) date of the measurements;

(B) manufacturer's name, model number, and serial number of the treatment unit, sealed source, and instrument used to measure radiation levels;

(C) each dose rate measured around the sealed source while the unit is in the "off" position and the average of all measurements; and

(D) the name and signature of the individual who performed the test.

(rrr) Full-inspection servicing for teletherapy and gamma stereotactic radiosurgery units.

(1) The licensee must [~~shall~~] have each teletherapy unit and gamma stereotactic radiosurgery unit fully inspected and serviced during each sealed source replacement to ensure proper functioning of the sealed source exposure mechanism and other safety components. The interval between each full-inspection servicing must [~~shall~~] not exceed five years for each teletherapy unit and must [~~shall~~] not exceed seven years for each gamma stereotactic radiosurgery unit.

(2) This inspection and servicing must [~~may~~] only be performed by persons specifically licensed to do so by the department, the NRC, or an agreement state.

(3) The licensee must [~~shall~~] maintain a record of the inspection and servicing as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department. The record must [~~shall~~] include [~~the following~~]:

(A) date of inspection;

(B) manufacturer's name, [~~and~~] model, and serial number of both the treatment unit and the sealed source;

(C) a list of components inspected and serviced, and the type of service;

(D) the inspector's radioactive material license number; and

(E) the name and signature of the inspector.

(sss) Therapy-related computer systems for photon-emitting remote afterloader units, teletherapy units, and gamma stereotactic radiosurgery units. The licensee must [~~shall~~] perform acceptance testing on the treatment planning system of therapy-related computer systems in accordance with published protocols accepted by nationally recognized bodies. At a minimum, the acceptance testing must [~~shall~~] include, as applicable, verification of [~~the following~~]:

(1) the sealed source-specific input parameters required by the dose calculation algorithm;

(2) the accuracy of dose, dwell time, and treatment time calculations at representative points;

(3) the accuracy of isodose plots and graphic displays;

(4) the accuracy of the software used to determine sealed source positions from radiographic images; and

(5) the accuracy of electronic transfer of the treatment delivery parameters to the treatment delivery unit from the treatment planning system.

(ttt) Training for use of remote afterloader units, teletherapy units, and gamma

stereotactic radiosurgery units. Except as provided in subsection (l) of this section, the licensee must [~~shall~~] require an authorized user of a sealed source for a use authorized in subsection (ddd) of this section to be [~~for~~]:

(1) a physician who is certified by a medical specialty board whose certification process is [~~has been~~] recognized by the department, the NRC, or an agreement state and who meets the requirements of paragraph (3) of this subsection. The names of board certifications [~~that have been~~] recognized by the department, the NRC, or an agreement state are posted on the NRC's Medical Uses Licensee Toolkit web page. To have its certification recognized, a specialty board must [~~shall~~] require all candidates for certification to:

(A) successfully complete a minimum of three years of residency training in a radiation therapy program approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, the Royal College of Physicians and Surgeons of Canada, or the Council on Postdoctoral [~~Committee on Post-Graduate~~] Training of the American Osteopathic Association; and

(B) pass an examination, administered by diplomates of the specialty board, assessing [~~that assesses~~] knowledge and competence in radiation safety, radionuclide handling, treatment planning, quality assurance, and clinical use of stereotactic radiosurgery, remote afterloaders, and external beam therapy; or

(2) a [~~the~~] physician who [~~must meet the following requirements~~]:

(A) has completed a structured educational program in basic radionuclide handling techniques applicable to the use of a sealed source in a therapeutic medical unit, including [~~the following~~]:

(i) 200 hours of classroom and laboratory training in [~~the following areas~~]:

(I) radiation physics and instrumentation;

(II) radiation protection;

(III) mathematics pertaining to the use and measurement of radioactivity; and

(IV) radiation biology; and

(ii) 500 hours of work experience, under the supervision of an authorized user meeting [~~who meets~~] the requirements of subsection (l) of this section, this subsection, or equivalent NRC or agreement state requirements at a medical facility [~~that is~~] authorized to use radioactive material in subsection (ddd) of this section involving [~~the following~~]:

(I) reviewing full calibration measurements and periodic spot checks;

(II) preparing treatment plans and calculating treatment times;

(III) using administrative controls to prevent a medical event involving the use of radioactive material;

(IV) implementing emergency procedures to be followed in the event of the abnormal operation of a medical unit or console;

(V) checking and using survey meters; and

(VI) selecting the proper dose and how it is to be administered; and

(iii) completion of three years of supervised clinical experience in radiation therapy, under an authorized user meeting [~~who meets~~] the requirements of subsection (l) of this section, this subsection, or equivalent NRC or agreement state requirements, as part of a formal training program approved by the Residency Review Committee for Radiation Oncology of the Accreditation Council for Graduate Medical Education, the Royal College of Physicians and Surgeons of Canada, or the Council [~~Committee~~] on Postdoctoral Training of the American Osteopathic Association. This experience may be obtained concurrently with the supervised work experience required by clause (ii) of this subparagraph; and

(B) has obtained written attestation [~~that~~] the individual has satisfactorily completed the requirements of paragraphs (2)(A) and (3) of this subsection[~~,~~] and is able to independently fulfill the radiation safety-related duties as an authorized user of each type of therapeutic medical unit for which the individual is requesting authorized user status. The attestation must be obtained from either:

(i) a preceptor authorized user meeting [~~who meets~~] the requirements in subsection (l) of this section, this subsection, or equivalent NRC or agreement state requirements for the types [~~type(s)~~] of therapeutic medical units [~~unit~~] for which the individual is requesting authorized user status; or

(ii) a residency program director affirming [~~who affirms~~] in writing [~~that~~] the attestation represents the consensus of the residency program faculty where at least one faculty member is an authorized user meeting [~~who meets~~] the requirements in subsection (l) of this section, this subsection, or equivalent NRC or agreement state requirements, for the types [~~type(s)~~] of therapeutic medical units [~~unit~~] for which the individual is requesting authorized user status, and concurring [~~concurs~~] with the attestation provided by the residency program director. The residency training program must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, [~~or~~] the Royal College of Physicians and Surgeons of Canada, or the Council on Postdoctoral Training of the American Osteopathic Association and must include training and experience specified in subparagraph (A) of this paragraph; and

(3) a [~~the~~] physician who has received training in device operation, safety procedures, and clinical use for the types [~~type(s)~~] of use for which authorization is sought. This training requirement may be satisfied by satisfactory completion of a training program provided by the vendor for new users or by receiving training supervised by an authorized user or authorized medical physicist, as appropriate, [~~who is~~] authorized for the types [~~type(s)~~] of use for which the individual is seeking

authorization.

(uuu) Report and notification of a medical event.

(1) The licensee must [~~shall~~] report any event as a medical event, except for an event resulting [~~that results~~] from patient intervention, in which the administration of radioactive material, or radiation from radioactive material, except permanent implant brachytherapy, results in [~~the following~~]:

(A) a dose differing [~~that differs~~] from the prescribed dose or dose that would have resulted from the prescribed dosage by more than 5 rem (0.05 sievert [~~Sievert~~] (Sv)) effective dose equivalent, 50 rem (0.5 Sv) to an organ or tissue, or 50 rem (0.5 Sv) shallow dose equivalent to the skin; and

(i) the total dose delivered differs from the prescribed dose by 20 percent or more;

(ii) the total dosage delivered differs from the prescribed dosage by 20 percent or more or falls outside the prescribed dosage range; or

(iii) the fractionated dose delivered differs from the prescribed dose, for a single fraction, by 50 percent or more;

(B) a dose that exceeds 5 rem (0.05 Sv) effective dose equivalent, 50 rem (0.5 Sv) to an organ or tissue, or 50 rem (0.5 Sv) shallow dose equivalent to the skin from [~~any of the following~~]:

(i) an administration of a wrong radioactive drug containing radioactive material or the wrong radionuclide for a brachytherapy procedure;

(ii) an administration of a radioactive drug containing radioactive material by the wrong route of administration;

(iii) an administration of a dose or dosage to the wrong individual or human research subject;

(iv) an administration of a dose or dosage delivered by the wrong mode of treatment; or

(v) a leaking sealed source; or

(C) a dose to the skin or an organ or tissue other than the treatment site that is more than: [~~exceeds by~~]

(i) 50 rem (0.5 Sv) or more the expected dose to that site from the procedure if the administration had been given in accordance with the written directive prepared or revised before administration; and

(ii) 50 percent or more of the expected dose to that site from the procedure if the administration had been given in accordance with the written directive prepared or revised before administration.

(2) For permanent implant brachytherapy, the licensee must [~~shall~~] report the administration of radioactive material or radiation from radioactive material (excluding sources that were implanted in the correct site but migrated outside the treatment site) resulting [~~that results~~] in:

(A) the total source strength administered differing by 20 percent or more from the total source strength documented in the post-implantation portion of the written directive;

(B) the total source strength administered outside of the treatment site exceeding 20 percent of the total source strength documented in the post-implantation portion of the written directive; or

(C) an administration, including [~~that includes any of the following~~]:

(i) the wrong radionuclide;

(ii) the wrong individual or human research subject;

(iii) sealed source or sources [~~source(s)~~] implanted directly into a location discontiguous from the treatment site, as documented in the post-implantation portion of the written directive; or

(iv) a leaking sealed source resulting in a dose that exceeds 50 rem (0.5 Sv) to an organ or tissue.

(3) The licensee must [~~shall~~] report any event resulting from patient intervention in which the administration of radioactive material, or radiation from radioactive material, results or will result in an unintended permanent functional damage to an organ or a physiological system, as determined by a physician.

(4) The licensee must [~~shall~~] notify the department by telephone no later than the next calendar day after discovery of the medical event.

(5) The licensee must [~~shall~~] submit a written report to the department within 15 calendar days after discovery of the medical event. The written report must [~~shall~~] include [~~the following~~], excluding the individual's name or any other information that could lead to identification of the individual:

(A) the licensee's name and radioactive material license number;

(B) a description of the licensed source of radiation involved, including, for radioactive material, the kind, quantity, chemical and physical form, source and device manufacturer, model number, and serial number, if applicable;

(C) the name of the prescribing physician;

(D) a brief description of the medical event;

(E) why the event occurred;

(F) the effect, if any, on the individual [~~individual(s)~~] who received the

administration;

(G) actions, if any, [~~that have been~~] taken[~~,~~] or [~~are~~] planned[~~,~~] to prevent recurrence; and

(H) certification [~~that~~] the licensee notified the individual (or the individual's responsible relative or guardian), and if not, why not.

(6) The licensee must [~~shall~~] notify the referring physician and [~~also notify~~] the individual who is the subject of the medical event no later than 24 hours after its discovery, unless the referring physician personally informs the licensee either that he or she will inform the individual or [~~that~~], based on medical judgment, telling the individual would be harmful. The licensee is not required to notify the individual without first consulting the referring physician. If the referring physician or the affected individual cannot be reached within 24 hours, the licensee must [~~shall~~] notify the individual as soon as possible thereafter. The licensee may [~~shall~~] not delay any appropriate medical care for the individual, including any necessary remedial care resulting from [~~as a result of~~] the medical event, due to a [~~because of any~~] delay in notification. To meet the requirements of this subsection, the notification of the individual who is the subject of the medical event may be made instead to that individual's responsible relative or guardian. If a verbal notification is made, the licensee must [~~shall~~] inform the individual or appropriate responsible relative or guardian[~~,~~] that a written description of the event can be obtained from the licensee upon request. The licensee must [~~shall~~] provide the written description if requested.

(7) Aside from the notification requirement, nothing in this section affects any rights or duties of licensees and physicians in relation to each other, to individuals affected by the medical event, or to that individual's responsible relatives or guardians.

(8) The licensee must [~~shall~~] annotate a copy of the report provided to the department with [~~the following information~~]:

(A) the name of the individual who is the subject of the event; and

(B) an identification number or if no other identification number is available, the social security number of the individual who is the subject of the event.

(9) The licensee must [~~shall~~] provide a copy of the annotated report to the referring physician, if other than the licensee, no later than 15 calendar days after the discovery of the event.

(10) The licensee must [~~shall~~] retain a copy of the annotated report of the medical event as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department.

(vvv) Report and notification of a dose to an embryo/fetus or nursing child.

(1) The licensee must [~~shall~~] report any dose to an embryo/fetus [~~that is~~] greater than 5 rem (50 mSv) dose equivalent resulting from [~~that is a result of~~] an

administration of radioactive material or radiation from radioactive material to a woman [~~pregnant individual~~], unless the dose to the embryo/fetus was specifically approved, in advance, by the authorized user.

(2) The licensee must [~~shall~~] report any dose to a nursing child resulting from [~~that is a result of~~] an administration of radioactive material to a breast-feeding woman [~~individual that~~]:

(A) [~~is~~] greater than 5 rem (50 mSv) TEDE; or

(B) resulting [~~has resulted~~] in unintended permanent functional damage to an organ or a physiological system, as determined by a physician.

(3) The licensee must [~~shall~~] notify the department by telephone no later than the next calendar day after discovery of a dose to the embryo/fetus or nursing child requiring [~~that requires~~] a report as specified in [~~accordance with~~] paragraphs (1) or (2) of this subsection.

(4) The licensee must [~~shall~~] submit a written report to the department no later than 15 calendar days after discovery of a dose to the embryo/fetus or nursing child that requires a report as specified in [~~accordance with~~] paragraphs (1) or (2) of this subsection. The written report must [~~shall~~] include [~~the following~~], excluding the individual's or child's name or any other information that could lead to identification of the individual or child:

(A) the licensee's name and radioactive material license number;

(B) a description of the licensed source of radiation involved, including, for radioactive material, the kind, quantity, chemical and physical form, source and [~~and/or~~] device manufacturer, model number, and serial number, if applicable;

(C) the name of the prescribing physician;

(D) a brief description of the event;

(E) why the event occurred;

(F) the effect, if any, on the embryo/fetus or the nursing child;

(G) actions, if any, [~~that have been~~] taken[~~,~~] or [~~are~~] planned[~~,~~] to prevent recurrence; and

(H) certification that the licensee notified the pregnant woman [~~individual or mother~~] (or the pregnant woman's [~~mother's~~] or child's responsible relative or guardian), and if not, why not.

(5) The licensee must [~~shall~~] notify the referring physician and also notify the pregnant woman [~~individual or mother~~], [~~both~~] hereafter referred to as the mother, no later than 24 hours after discovery of an event requiring [~~that would require~~] reporting as specified in [~~accordance with~~] paragraphs (1) or (2) of this subsection, unless the referring physician personally informs the licensee either that he or she

will inform the mother or [~~that~~], based on medical judgment, telling the mother would be harmful. The licensee is not required to notify the mother without first consulting with the referring physician. If the referring physician or mother cannot be reached within 24 hours, the licensee must [~~shall~~] make the appropriate notifications as soon as possible thereafter. The licensee may not delay any appropriate medical care for the embryo/fetus or for the nursing child, including any necessary remedial care resulting from [~~as a result of~~] the event, due to a [~~because of any~~] delay in notification. To meet the requirements of this subsection, the notification may be made to the mother's or child's responsible relative or guardian instead of the mother, when appropriate. If a verbal notification is made, the licensee must [~~shall~~] inform the mother, or the mother's or child's responsible relative or guardian, that a written description of the event can be obtained from the licensee upon request. The licensee must [~~shall~~] provide such a written description if requested.

(6) The licensee must [~~shall~~] annotate a copy of the report provided to the department with [~~the following information~~]:

(A) the name of the individual or the nursing child who is the subject of the event; and

(B) an identification number or if no other identification number is available, the social security number of the individual who is the subject of the event.

(7) The licensee must [~~shall~~] provide a copy of the annotated report as described in paragraph (6) of this subsection to the referring physician, if other than the licensee, no later than 15 days after the discovery of the event.

(8) The licensee must [~~shall~~] retain a copy of the annotated report as described in paragraph (6) of this subsection of a dose to an embryo/fetus or a nursing child as specified in [~~accordance with~~] subsection (xxx) of this section for inspection by the department.

(www) Report and notification for an eluate exceeding permissible molybdenum-99, strontium-82, and strontium-85 concentrations.

(1) The licensee must [~~shall~~] notify [~~by telephone~~] the department by telephone at (512) 458-7460 and the distributor of the generator within seven calendar days after discovery that an eluate exceeded the permissible concentration listed in subsection (ii) of this section at the time of generator elution. The telephone report to the department must include the manufacturer, model number, and serial number (or lot number) of the generator; the results of the measurement; the date of the measurement; whether dosages were administered to patients or human research subjects;[~~,~~] when the distributor was notified;[~~,~~] and the action taken.

(2) The licensee must [~~shall~~] submit a written report to the department within 30 calendar days after discovery of an eluate exceeding the permissible concentration at the time of generator elution. The written report must include the action taken by the licensee; the patient dose assessment; the methodology used to make this dose assessment if the eluate was administered to patients or human

research subjects; [~~and~~] the probable cause and an assessment of failure in the licensee's equipment, procedures, or training that contributed to the excessive readings if an error occurred in the licensee's breakthrough determination; and the information in the telephone report as required by paragraph (1) of this subsection.

(xxx) Records/documents for department inspection. Each licensee must [~~shall~~] maintain copies of the following records/documents at each authorized use site and make them available to the department for inspection, upon reasonable notice.

Figure: 25 TAC §289.256(xxx) [~~Figure: 25 TAC §289.256(xxx)~~]

§289.257. Packaging and Transportation of Radioactive Material.

(a) Purpose.

(1) This section establishes requirements for packaging, preparation for shipment, and transportation of radioactive material including radioactive waste.

(2) In addition to the requirements of this section, the [~~The~~] packaging and transport of radioactive material are [~~also~~] subject to the requirements of:

(A) §289.201 of this chapter (relating to General Provisions for Radioactive Material);

(B) §289.202 of this chapter (relating to Standards for Protection Against Radiation from Radioactive Materials);

(C) §289.203 of this chapter (relating to Notices, Instructions, and Reports to Workers; Inspections);

(D) §289.204 of this chapter (relating to Fees for Certificates of Registration, Radioactive Material Licenses, Emergency Planning and Implementation, and Other Regulatory Services);

(E) §289.205 of this chapter (relating to Hearing and Enforcement Procedures);

(F) §289.251 of this subchapter (relating to Exemptions, General Licenses, and General License Acknowledgements);

(G) §289.252 of this subchapter (relating to Licensing of Radioactive Material);

(H) §289.256 of this subchapter (relating to Medical and Veterinary Use of Radioactive Material); and

(I) the regulations of other agencies (e.g., the United States Department of Transportation (DOT) and the United States Postal Service) having jurisdiction over means of transport.

[~~§289.201 of this title (relating to General Provisions for Radioactive Material), §289.202 of this title (relating to Standards for Protection Against Radiation from~~

~~Radioactive Materials), §289.203 of this title (relating to Notices, Instructions, and Reports to Workers; Inspections), §289.204 of this title (relating to Fees for Certificates of Registration, Radioactive Material Licenses, Emergency Planning and Implementation, and Other Regulatory Services), §289.205 of this title (relating to Hearing and Enforcement Procedures), §289.251 of this title (relating to Exemptions, General Licenses, and General License Acknowledgements), §289.252 of this title (relating to Licensing of Radioactive Material), and §289.256 of this title (relating to Medical and Veterinary Use of Radioactive Material) and to the regulations of other agencies (e.g., the United States Department of Transportation (DOT) and the United States Postal Service) having jurisdiction over means of transport. The requirements of this section are in addition to, and not in substitution for, other requirements.~~]

(b) Scope.

(1) The requirements of this section apply to any licensee authorized by a specific or general license issued by the department to receive, possess, use, or transfer radioactive material, if the licensee delivers [~~that~~] material to a carrier for transport, transports the material outside the site of usage, as specified in the department license, or transports [~~that~~] material on public highways. No provision of this section authorizes possession of radioactive material.

(2) Exemptions from the requirements for a license in subsection (c) of this section are specified in subsection (f) of this section. The general license in subsection (i)(2), (3), and (4) of this section requires that a United States Nuclear Regulatory Commission (NRC) certificate of compliance or other package approval be issued for the package [~~to be~~] used as specified in [~~accordance with~~] the general license. A licensee transporting radioactive material, or delivering radioactive material to a carrier for transport, must [~~shall~~] comply with the operating control requirements of subsections (l) - (q) of this section; the quality assurance (QA) requirements of subsections (s) - (u) and (w) - (bb) of this section; and the general provisions of subsections (a) - (e) of this section, including DOT regulations referenced in subsection (e) of this section.

(c) Requirement for license. Except as authorized in a general or specific license issued by the department, or as exempted as specified in [~~accordance with~~] this section, no licensee may transport radioactive material or deliver radioactive material to a carrier for transport.

(d) Definitions. The following words and terms when used in this section [~~shall~~] have the following meaning [~~,~~] unless the context clearly indicates otherwise. To ensure compatibility with international transportation standards, all limits in this section are given in terms of dual units: The International System of Units (SI) followed or preceded by United States (U.S.) standard or customary units. The U.S. customary units are not exact equivalents, but are rounded to a convenient value, providing a functionally equivalent unit. In [~~For the purpose of~~] this section, SI units are [~~shall be~~] used.

(1) A_1-- [~~A_1 --~~]The maximum activity of special form radioactive material

permitted in a Type A package. This value is either listed in Table 257-3 of subsection (ee)(6) of this section, or may be derived as specified in [~~accordance with~~] the procedure prescribed in subsection (ee) of this section.

(2) A_2-- [~~A_2 --~~]The maximum activity of radioactive material, other than special form, low specific activity (LSA), and surface contaminated object (SCO) material, permitted in a Type A package. This value is either listed in Table 257-3 of subsection (ee)(6) of this section, or may be derived as specified in [~~accordance with~~] the procedure prescribed in subsection (ee) of this section.

(3) 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.

(4) Certificate holder--A person who has been issued a certificate of compliance or other package approval by the department.

(5) Certificate of compliance (CoC)--The certificate issued by the NRC that approves the design of a package for the transportation of radioactive materials.

(6) Chelating agent--Amine polycarboxylic acids (e.g., ethylenediaminetetraacetic acid (EDTA) and diethylenetriaminepentaacetic acid (DTPA)) [~~(e.g., EDTA, DTPA)~~], hydroxy-carboxylic acids, and polycarboxylic acids (e.g., citric acid, carbolic acid, and glucinic acid).

(7) Chemical description--A description of the principal chemical characteristics of low-level radioactive waste (LLRW).

(8) Consignee--The designated receiver of the shipment of low-level radioactive waste.

(9) Consignment--Each shipment of a package or groups of packages or load of radioactive material offered by a shipper for transport.

(10) Containment system--The assembly of components of the packaging intended to retain the radioactive material during transport.

(11) Contamination--The presence of a radioactive substance on a surface in quantities more than [~~in excess of~~] 0.4 becquerel per square centimeter (Bq/cm^2) [~~(Bq/cm^2)~~] (10^{-5} microcurie per square centimeter ($\mu Ci/cm^2$) [~~($\mu Ci/cm^2$)~~]) for beta and gamma emitters and low toxicity alpha emitters, or 0.04 Bq/cm^2 (10^{-6} $\mu Ci/cm^2$) [~~(10^{-6} $\mu Ci/cm^2$)~~] for all other alpha emitters.

(A) Fixed contamination means contamination that cannot be removed from a surface during normal conditions of transport.

(B) Non-fixed contamination means contamination that can be removed from a surface during normal conditions of transport.

(12) Conveyance--For transport on:

(A) public highway or rail by transport vehicle or large freight container;

(B) water by vessel, or any hold, compartment, or defined deck area of a vessel including any transport vehicle on board the vessel; and

(C) aircraft.

(13) Criticality Safety Index (CSI)--The dimensionless number (rounded up to the next tenth) assigned to and placed on the label of a fissile material package[~~,~~] to designate the degree of control of accumulation of packages, overpacks, or freight containers containing fissile material during transportation. Determination of the criticality safety index is described in subsection (i) of this section and 10 Code of Federal Regulations (CFR) §§71.22, 71.23, and 71.59 [~~Title 10, Code of Federal Regulations (CFR), §71.22, §71.23, and §71.59~~]. The criticality safety index for an overpack, freight container, consignment, or conveyance containing fissile material packages is the arithmetic sum of the criticality safety indices of all the fissile material packages contained within the overpack, freight container, consignment, or conveyance.

(14) Decontamination facility--A facility operating under [~~in accordance with~~] an NRC, agreement state, or department license whose principal purpose is decontamination of equipment or materials to accomplish recycle, reuse, or other waste management objectives, and, for purposes of this section, is not considered to be a consignee for LLRW shipments.

(15) Deuterium--In [~~For the purposes of~~] this section, this means deuterium and any deuterium compound, including heavy water, in which the ratio of deuterium atoms to hydrogen atoms is greater than [~~exceeds~~] 1:5000.

(16) Disposal container--A transport container principally used to confine LLRW during disposal operations at a land disposal facility (also see definition for high integrity container). Note that for some shipments, the disposal container may be the transport package.

(17) Environmental Protection Agency (EPA) identification number--The number received by a transporter following application to the administrator of EPA as required by 40 CFR [~~Title 40, CFR,~~] Part 263.

(18) Exclusive use--The sole use by a single consignor of a conveyance for which all initial, intermediate, and final loading and unloading are carried out as specified in [~~accordance with~~] the direction of the consignor or consignee. The consignor and the carrier must [~~shall~~] ensure [~~that~~] any loading or unloading is performed by personnel having radiological training and resources appropriate for safe handling of the consignment. The consignor issues [~~shall issue~~] specific instructions, in writing, for maintenance of exclusive use shipment controls, and includes [~~include~~] them with the shipping paper information provided to the carrier by the consignor.

(19) Fissile material--The radionuclides plutonium-239, plutonium-241, uranium-233, uranium-235, or any combination of these radionuclides. Fissile material means the fissile nuclides themselves, not material containing fissile nuclides. Unirradiated natural uranium and depleted uranium, and natural uranium

or depleted uranium [~~that has been~~] irradiated in thermal reactors only, are not included in this definition. The department's [~~Agency~~] jurisdiction extends only to special nuclear material in quantities not sufficient to form a "critical mass" as defined in §289.201(b) of this chapter [~~title~~]. Certain exclusions from fissile material controls are provided in subsection (h) of this section.

(20) Freight forwarder--A person or entity holding [~~which holds~~] itself out to the general public to provide transportation of property for compensation and in the ordinary course of its business:

(A) assembles and consolidates, or provides for assembling and consolidating, shipments and performs break-bulk and distribution operations of the shipments;

(B) assumes responsibility for the transportation from the place of receipt to the place of destination; and

(C) uses for any part of the transportation a rail, motor, or water carrier subject to the jurisdiction of either the Federal Motor Carrier Safety Administration or the Surface Transportation Board.

(21) Generator--A licensee operating under a department [~~in accordance with an agency~~], NRC, or agreement state license who:

(A) is a waste generator as defined in this section; or

(B) is the licensee to whom waste can be attributed within the context of the Low-Level Radioactive Waste Policy Amendments Act of 1985 (e.g., waste generated from [~~as a result of~~] decontamination or recycle activities).

(22) Graphite--In [~~For the purposes of~~] this section, this means graphite with a boron equivalent content of less than 5 parts per million and density greater than 1.5 grams (g) per cubic centimeter.

(23) High integrity container (HIC)--A container commonly designed to meet the structural stability requirements of 10 CFR [~~Title 10, CFR,~~] §61.56, and to meet DOT requirements for a Type A package.

(24) Indian Tribe--An Indian or Alaska Native Tribe, band, nation, pueblo, village, or community that the Secretary of the Interior acknowledges to exist as an Indian Tribe pursuant to the Federally Recognized Indian Tribe List Act of 1994, 25 United States Code (U.S.C.) [~~U.S.C.~~] §479a.

(25) Low-level radioactive waste (LLRW)--Radioactive material that meets the following criteria:

(A) LLRW is radioactive material [~~that is~~]:

(i) discarded or unwanted and [~~is~~] not exempt by rule adopted as specified in [~~accordance with~~] the Texas Radiation Control Act (Act), Texas Health and Safety Code[~~,~~] §401.106;

(ii) waste, as that term is defined in 10 CFR [~~Title 10, CFR,~~] §61.2; and

(iii) subject to:

(I) concentration limits established in 10 CFR [~~Title 10, CFR,~~] §61.55, or compatible rules adopted by the department or the Texas Commission on Environmental Quality (TCEQ), as applicable; and

(II) disposal criteria established in 10 CFR [~~Title 10, CFR,~~] or established by the department or TCEQ, as applicable.

(B) LLRW does not include:

(i) high-level radioactive waste as defined in 10 CFR [~~Title 10, CFR,~~] §60.2;

(ii) spent nuclear fuel as defined in 10 CFR [~~Title 10, CFR,~~] §72.3;

(iii) byproduct material defined in the Act, Texas Health and Safety Code[~~,~~] §401.003(3)(B);

(iv) naturally occurring radioactive material (NORM) waste that is not oil and gas NORM waste;

(v) oil and gas NORM waste; or

(vi) transuranics greater than 100 nanocuries (3.7 kilobecquerels) per gram (g).

(26) Low specific activity (LSA) material--Radioactive material with limited specific activity that [~~which~~] is non-fissile [~~non fissile~~] or is excepted as specified in [~~accordance with~~] subsection (h) of this section, and [~~which~~] satisfies the following descriptions and limits set forth in this section. Shielding materials surrounding the LSA material is [~~may~~] not [~~be~~] considered in determining the estimated average specific activity of the package contents. LSA material is [~~shall be~~] in one of the following three groups:

(A) LSA-I.

(i) Uranium and thorium ores, concentrates of uranium and thorium ores, and other ores containing naturally occurring radionuclides [~~that are~~] intended to be processed for the use of these radionuclides; [~~or~~]

(ii) Natural uranium, depleted uranium, natural thorium, or their compounds or mixtures, provided they are unirradiated and in solid or liquid form; [~~or~~]

(iii) Radioactive material other than fissile material for which the A_2 value is unlimited; or

(iv) Other radioactive material (e.g., [~~:~~] mill tailings, contaminated earth, concrete, rubble, other debris, and activated material) in which the radioactivity is

distributed throughout, and the estimated average specific activity is not more than [does not exceed] 30 times the value for exempt material activity concentration determined in accordance with subsection (ee) of this section.

(B) LSA-II.

(i) Water with tritium concentration up to 0.8 terabecquerel per liter (TBq/l) (20.0 curies per liter (Ci/l)); or

(ii) Other material in which the radioactivity is distributed throughout, and the average specific activity is not greater than [does not exceed] 10^{-4} A_2/g [A_2/g] for solids and gases[,] and 10^{-5} A_2/g [A_2/g] for liquids.

(C) LSA-III. Solids (e.g., consolidated wastes, activated materials), excluding powders, satisfying [that satisfy] the requirements of 10 CFR [Title 10, CFR,] §71.77 in which:

(i) the radioactive material is distributed throughout a solid or a collection of solid objects, or is essentially uniformly distributed in a solid compact binding agent (such as concrete, bitumen, ceramic, etc.); [and]

(ii) the radioactive material is relatively insoluble, or it is intrinsically contained in a relatively insoluble material, so that[,] even with a loss of packaging, the loss of radioactive material per package by leaching, when placed in water for seven [7] days, is not greater than [will not exceed] 0.1 A_2; [A_2;] and

(iii) the estimated average specific activity of the solid, excluding any shielding material, is not greater than [does not exceed] 2×10^{-3} A_2/g [A_2/g].

(27) Low toxicity alpha emitters--Natural uranium, depleted uranium, natural thorium; uranium-235, uranium-238, thorium-232, thorium-228, or thorium-230 when contained in ores or physical or chemical concentrates or tailings; or alpha emitters with a half-life of less than 10 days.

(28) Maximum normal operating pressure--The maximum gauge pressure that would develop in the containment system in a period of one [1] year under the heat condition specified in 10 CFR [Title 10, CFR,] §71.71(c)(1), in the absence of venting, external cooling by an ancillary system, or operational controls during transport.

(29) Natural thorium--Thorium with the naturally occurring distribution of thorium isotopes (essentially 100 weight percent thorium-232).

(30) Normal form radioactive material--Radioactive material [that has] not [been] demonstrated to qualify as special form radioactive material.

(31) NRC Forms 540, 540A, 541, 541A, 542, and 542A--Official NRC forms referenced in subsection (ff) of this section that include [which includes] the information required by DOT in 49 CFR [Title 49, CFR,] Part 172. Licensees need

not use originals of these forms if [~~as long as~~] any substitute forms contain the equivalent information. Licensees may include additional information deemed relevant to the licensee's shipment of low-level radioactive waste. Upon agreement between the shipper and consignee, NRC Forms 541 (and 541A) and NRC Forms 542 (and 542A) or equivalent documents may be completed, transmitted, and stored in electronic media. The electronic media must [~~shall~~] have the capability for producing legible, accurate, and complete records in the format of the uniform manifest.

(32) Package--The packaging together with its radioactive contents as presented for transport.

(A) Fissile material package, Type AF package, Type BF package, Type B(U)F package, or Type B(M)F package--A fissile material packaging together with its fissile material contents.

(B) Type A package--A Type A packaging together with its radioactive contents. A Type A package is defined and complies [~~shall comply~~] with [~~the~~] DOT regulations in 49 CFR [~~Title 49, CFR,~~] Part 173.

(C) Type B package--A Type B packaging together with its radioactive contents. On approval by the NRC, 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 kilopascals (kPa) (100 pounds per square inch (lbs/in^2) [(~~lb/ in^2~~)]) gauge or a pressure relief device allowing [~~that would allow~~] the release of radioactive material to the environment under the tests specified in 10 CFR [~~Title 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 of international shipments. 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 [~~Title 49, CFR,~~] Part 173. A Type B package approved before September 6, 1983, was designated only as Type B. Limitations on its use are specified in 10 CFR [~~Title 10, CFR,~~] §71.19.

(33) Packaging--The assembly of components necessary to ensure compliance with the packaging requirements of this section. 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.

(34) Physical description--The items called for on NRC Form 541 to describe an [~~a~~] LLRW.

(35) Registered freight forwarder--A freight forwarder having [~~that has~~] an emergency plan approved as specified in [~~accordance with~~] subsection (r) of this section and [~~has been~~] issued a registration letter.

(36) Registered shipper--A shipper having [~~that has~~] an emergency plan approved as specified in [~~accordance with~~] subsection (r) of this section[~~,~~] and

shipping containers approved as specified in [~~accordance with~~] subsection(cc)(8) of this section and [~~been~~] issued a registration letter.

(37) Registered transporter--A transporter having [~~that has~~] an emergency plan approved as specified in [~~accordance with~~] subsection (r) of this section[~~,~~] and proof of financial responsibility submitted and approved as specified in [~~accordance with~~] subsection(e)(4) of this section and [~~has been~~] issued a registration letter.

(38) Residual waste--LLRW resulting from processing or decontamination activities that cannot be easily separated into distinct batches attributable to specific waste generators. This waste is attributable to the processor or decontamination facility, as applicable.

(39) Shipper--The licensed entity (i.e., the waste generator, waste collector, or waste processor) offering [~~who offers~~] LLRW for transportation, typically consigning this type of waste to a licensed waste collector, waste processor, or land disposal facility operator. This definition applies only to shipments of LLRW shipped to a Texas LLRW disposal facility.

(40) Site of usage--The licensee's facility, including all buildings and structures between which radioactive material is transported and all roadways [~~that are~~] not within the public domain on which radioactive material can be transported.

(41) Special form radioactive material--Radioactive material satisfying [~~that satisfies~~] the following conditions:

(A) [~~it is~~] either a single solid piece or [~~is~~] contained in a sealed capsule that can be opened only by destroying the capsule;

(B) the piece or capsule has at least one dimension not less than 5 [~~five~~] millimeters (0.2 inches (in)) [~~(0.2 in)~~]; and

(C) [~~it~~] satisfies the requirements of 10 CFR [~~Title 10, CFR,~~] §71.75. A special form encapsulation designed as specified in [~~accordance with~~] the requirements of this subsection in effect on or after June 30, 1983 (see 10 CFR [~~Title 10, CFR,~~] Part 71, revised as of January 1, 1983), and constructed before July 1, 1985; a special form encapsulation designed as specified in [~~accordance with~~] the requirements of this subsection in effect on or after March 31, 1996 (see 10 CFR [~~Title 10, CFR,~~] Part 71, revised as of January 1, 1996), and constructed before April 1, 1998; and

(D) special form material [~~that was~~] successfully tested before September 10, 2015, as specified in [~~accordance with~~] the requirements of 10 CFR [~~Title 10, CFR,~~] §71.75(d) in effect before September 10, 2015, may continue to be used. Any other special form encapsulation must meet the specifications of this definition.

(42) Specific activity of a radionuclide--The radioactivity of the radionuclide per unit mass of that nuclide. The specific activity of a material in which the radionuclide is essentially uniformly distributed is the radioactivity per unit mass of the material.

(43) Spent nuclear fuel or spent fuel--Fuel [~~that has been~~] withdrawn from a nuclear reactor following irradiation, [~~has~~] undergone at least one year's decay since being used as a source of energy in a power reactor, and [~~has~~] not [~~been~~] chemically separated into its constituent elements by reprocessing. Spent fuel includes the special nuclear material, byproduct material, source material, and other radioactive materials associated with fuel assemblies.

(44) Surface contaminated object (SCO)--A solid object [~~that is~~] not itself classed as radioactive material, but which has radioactive material distributed on any of its surfaces. An [~~A~~] SCO must [~~shall~~] be in one of the following two groups with surface activity not greater than [~~exceeding~~] the following limits:

(A) SCO-I--A solid object on which:

(i) the non-fixed contamination on the accessible surface averaged over 300 square centimeters (cm^2) [~~(cm^2)~~] (or the area of the surface if less than 300 cm^2) [~~(cm^2)~~] is not greater than [~~does not exceed~~] 4 Bq/cm^2 [~~becquerels per square centimeter (Bq/cm^2)~~] (10^{-4} $\mu Ci/cm^2$ [~~microcurie per square centimeter (μCi/cm^2)~~]) for beta and gamma and low toxicity alpha emitters, or 4 x 10^{-1} Bq/cm^2 [~~Bq/cm2~~] (10^{-5} $\mu Ci/cm^2$) [~~(μCi/cm^2)~~] for all other alpha emitters;

(ii) the fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) [~~(cm^2)~~] is not greater than [~~does not exceed~~]4 x 10^4 Bq/cm^2 (1 $\mu Ci/cm^2$) [~~(μCi/cm^2)~~] for beta and gamma and low toxicity alpha emitters, or 4 x 10^3 Bq/cm^2 (10^{-1} $\mu Ci/cm^2$) [~~(μCi/cm^2)~~] for all other alpha emitters; and

(iii) the non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) [~~(cm^2)~~] is not greater than [~~does not exceed~~] 4 x 10^4 Bq/cm^2 (1 $\mu Ci/cm^2$) [~~(μCi/cm^2)~~] for beta and gamma and low toxicity alpha emitters, or 4 x 10^3 Bq/cm^2 (10^{-1} $\mu Ci/cm^2$) [~~(μCi/cm^2)~~] for all other alpha emitters.

(B) SCO-II--A solid object on which the limits for SCO-I are exceeded and on which the following limits are not exceeded:

(i) the non-fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) [~~(cm^2)~~] is not greater than [~~does not exceed~~] 400 Bq/cm^2 (10^{-2} $\mu Ci/cm^2$) [~~(μCi/cm^2)~~] for beta and gamma and low toxicity alpha emitters, or 40 Bq/cm^2 (10^{-3} $\mu Ci/cm^2$) [~~(μCi/cm^2)~~] for all other alpha emitters;

(ii) the fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) [~~(cm^2)~~] is not greater than [~~does not exceed~~] 8 x 10^5 Bq/cm^2 (20 $\mu Ci/cm^2$) [~~(μCi/cm^2)~~] for beta and gamma and low toxicity alpha emitters, or 8 x 10^4 Bq/cm^2 (2 $\mu Ci/cm^2$) [~~(μCi/cm^2)~~] for all other alpha emitters; and

(iii) the non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) [~~cm^2~~)] is not greater than [~~does not exceed~~] 8 x 10^5 Bq/cm^2 (20 µCi/cm^2) [~~µCi/cm^2~~)] for beta and gamma and low toxicity alpha emitters, or 8 x 10^4 Bq/cm^2 (2 µCi/cm^2) [~~µCi/cm^2~~)] for all other alpha emitters.

(45) Transporter--A carrier who transports radioactive material.

(46) Tribal official--The highest ranking individual representing [~~that represents~~] Tribal leadership, such as the Chief, President, or Tribal Council leadership.

(47) Uniform Low-Level Radioactive Waste Manifest or uniform manifest--The combination of NRC Forms 540, 541, and, if necessary, 542, and their respective continuation sheets as needed, or equivalent.

(48) Unirradiated uranium--Uranium containing not more than 2 x 10^3 Bq (0.054 µCi) of plutonium per gram of uranium-235, not more than 9 x 10^6 Bq (243 µCi) of fission products per gram of uranium-235, and not more than 5 x 10^{-3} g of uranium-236 per gram of uranium-235.

(49) Uranium--Natural, depleted, enriched:

(A) Natural uranium--Uranium that [~~(which~~] may be chemically separated[~~)~~] with the naturally occurring distribution of uranium isotopes (approximately 0.711 weight percent uranium-235, and the remainder by weight essentially uranium-238).

(B) Depleted uranium--Uranium containing less uranium-235 than the naturally occurring distribution of uranium isotopes.

(C) Enriched uranium--Uranium containing more uranium-235 than the naturally occurring distribution of uranium isotopes.

(50) Waste collector--An entity, operating under [~~in accordance with~~] a department [~~an agency~~], NRC, or agreement state license, whose principal purpose is to collect and consolidate waste generated by others, and to transfer this waste, without processing or repackaging the collected waste, to another licensed waste collector, licensed waste processor, or licensed land disposal facility.

(51) Waste description--The physical, chemical, and radiological description of an [~~a~~] LLRW as called for on NRC Form 541.

(52) Waste generator--An entity, operating under [~~in accordance with~~] a department [~~an agency~~], NRC, or agreement state license, who:

(A) possesses any material or component that contains radioactivity or is radioactively contaminated for which the licensee foresees no further use; and

(B) transfers this material or component to a licensed land disposal facility or to a licensed waste collector or processor for handling or treatment before disposal.

A licensee performing processing or decontamination services may be a waste generator if the transfer of LLRW from its facility is defined as residual waste.

(53) Waste processor--An entity, operating under [~~in accordance with~~] an NRC or agreement state license, whose principal purpose is to process, repackage, or otherwise treat LLRW or waste generated by others before eventual transfer of waste to a licensed LLRW land disposal facility.

(54) Waste type--A waste within a disposal container having a unique physical description (i.e., a specific waste descriptor code or description; or a waste sorbed on or solidified in a specifically defined [~~specifically defined~~] media).

(e) Transportation of radioactive material.

(1) Each licensee transporting [~~who transports~~] radioactive material outside the site of usage as specified in the department license, transporting [~~transports~~] on public highways, or delivering [~~delivers~~] radioactive material to a carrier for transport must[~~, shall~~] comply with the applicable requirements of [~~the~~] DOT regulations in 49 CFR [~~Title 49, CFR,~~] Part 107, Parts 171 – 180, and Parts 390 - 397 appropriate to the mode of transport. The licensee must [~~shall~~] particularly note DOT regulations in the following areas:

(A) Packaging - 49 CFR [~~Title 49, CFR,~~] Part 173: Subparts A, B, and I.

(B) Marking and labeling - 49 CFR [~~Title 49, CFR,~~] Part 172: Subpart D, and §§172.400 - 172.407 and §§172.436 - 172.441 of Subpart E.

(C) Placarding - 49 CFR [~~Title 49, CFR,~~] Part 172: Subpart F, especially §§172.500 - 172.519 and §172.556, and Appendices B and C.

(D) Accident reporting - 49 CFR [~~Title 49, CFR,~~] Part 171: §171.15 and §171.16.

(E) Shipping papers and emergency information - 49 CFR [~~Title 49, CFR,~~] Part 172: Subparts C and G.

(F) Hazardous material employee training - 49 CFR [~~Title 49, CFR,~~] Part 172: Subpart H.

(G) Hazardous material shipper/carrier registration - 49 CFR [~~Title 49, CFR,~~] Part 107: Subpart G.

(H) Security Plans - 49 CFR [~~Title 49, CFR,~~] Part 172: Subpart I.

(2) The licensee must comply with [~~shall also note~~] DOT regulations pertaining to the following modes of transportation:

(A) Rail: 49 CFR [~~Title 49, CFR~~] Part 174: Subparts A through D and K.

(B) Air: 49 CFR [~~Title 49, CFR~~] Part 175.

(C) Vessel: 49 CFR [~~Title 49, CFR~~] Part 176: Subparts A through F and M.

(D) Public Highway: 49 CFR [~~Title 49, CFR~~] Part 177 and Parts 390 through 397.

(3) If DOT regulations are not applicable to a shipment of radioactive material (i.e., DOT does not have jurisdiction), the licensee must [~~shall~~] conform to DOT standards and requirements specified in paragraph (1) of this subsection to the same extent as if the shipment or transportation were subject to DOT regulations. A request for modification, waiver, or exemption from those requirements must [~~shall~~] be filed and approved by the department. Any notification referred to in those requirements must[~~, shall~~] be submitted to the department.

(4) Transporter proof of financial responsibility.

(A) Transporters of LLRW [~~low-level radioactive waste~~] to a Texas LLRW [~~low-level radioactive waste~~] disposal site must [~~shall~~] submit proof of financial responsibility required by 49 CFR [~~Title 49, CFR,~~] §387.7 and §387.9[~~,~~] to the department and receive a registration letter from the department before initial shipment.

(B) The transporter registration expires on the expiration date of the proof of financial responsibility or in 10 years[~~,~~] if the proof of financial responsibility does not have an expiration date.

(C) To renew a transporter's registration, the transporter must [~~shall~~] submit to the department new proof of financial responsibility.

(D) The transporter must [~~shall~~] submit to the department new proof of financial responsibility any time the amount of liability coverage is reduced or a new policy is purchased.

(5) The department must [~~shall~~] review and determine alternate routes for the transportation and routing of radioactive material as specified in [~~accordance with~~] 49 CFR[~~,~~] §397.103.

(f) Exemption for low-level radioactive materials.

(1) A licensee is exempt from all requirements of this section with respect to shipment or carriage of the following low-level materials:

(A) Natural material and ores containing naturally occurring radionuclides [~~that are~~] either in their natural state, or [~~have~~] only [~~been~~] processed for purposes other than for the extraction of the radionuclides, and [~~which are~~] not intended to be processed for use of these radionuclides, provided the activity concentration of the material is not greater than [~~does not exceed~~] 10 times the applicable radionuclide activity concentration values specified in subsection (ee), (ee)(7), and (ee)(8) of this section.

(B) Materials for which the activity concentration is not greater than the activity concentration values specified in subsection (ee), (ee)(7), and (ee)(8) of this section, or for which the consignment activity is not greater than the limit for an exempt consignment found in subsection (ee), (ee)(7), and (ee)(8) of this

section.

(C) Non-radioactive solid objects with radioactive substances present on any surfaces in quantities not over [~~in excess of~~] the levels cited in the definition of contamination in subsection (d) of this section.

(2) Common and contract carriers, freight forwarders, warehousemen, and the United States Postal Service are exempt from the regulations in this subchapter to the extent [~~that~~] they transport or store radioactive material in the regular course of their carriage for another, or storage incident thereto.

(3) Persons who discard licensed material as specified in [~~accordance with~~] §289.202(fff) of this chapter [~~title~~] are exempt from all requirements of this section.

(g) Exemption of physicians and veterinarians. Any physician or veterinarian licensed by a state [~~State~~] to dispense drugs in the practice of medicine or veterinary medicine is exempt from subsection (e) of this section with respect to transport by the physician or veterinarian of licensed material for use in the practice of medicine or veterinary medicine. However, any physician or veterinarian operating under this exemption must [~~shall~~] be licensed under [~~in accordance with~~] §289.256 of this subchapter [~~title~~] or the equivalent NRC or agreement state regulations.

(h) Exemption from classification as fissile material. Fissile materials meeting the requirements of at least one of [~~the~~] paragraphs (1) through (6) of this subsection are exempt from classification as fissile material and from the fissile material package standards of 10 CFR [~~Title 10, CFR~~] §71.55 and §71.59, but are subject to all other requirements of this section, except as noted.

(1) An individual package containing 2 g [~~grams~~] or less fissile material.

(2) Individual or bulk packaging containing 15 g [~~grams~~] or less of fissile material provided the package has at least 200 g [~~grams~~] of solid non-fissile [~~nonfissile~~] material for every gram of fissile material. Lead, beryllium, graphite, and hydrogenous material enriched in deuterium may be present in the package but must [~~shall~~] not be included in determining the required mass for solid non-fissile [~~nonfissile~~] material.

(3) Solid fissile material commingled with solid non-fissile material.

(A) Low concentrations of solid fissile material commingled with solid non-fissile [~~nonfissile~~] material provided:

(i) [~~that~~] there is at least 2000 g [~~grams~~] of solid non-fissile [~~nonfissile~~] material for every gram of fissile material; and

(ii) there is no more than 180 g [~~grams~~] of fissile material distributed within 360 kilograms (kg) [~~kg~~] of contiguous non-fissile material.

(B) Lead, beryllium, graphite, and hydrogenous material enriched in

deuterium may be present in the package but must [~~shall~~] not be included in determining the required mass of solid non-fissile [~~nonfissile~~] material.

(4) Uranium enriched in uranium-235 to a maximum of one percent by weight, and with total plutonium and uranium-233 content of up to one percent of the mass of uranium-235, provided [~~that~~] the mass of any beryllium, graphite, and hydrogenous material enriched in deuterium constitutes less than five percent of the uranium mass, and [~~that~~] the fissile material is distributed homogeneously and does not form a lattice arrangement within the package.

(5) Liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of two percent by mass, with a total plutonium and uranium-233 content not greater than [~~exceeding~~] 0.002 percent of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2. The material must [~~shall~~] be contained in at least a DOT Type A package.

(6) Packages containing, individually, a total plutonium mass of not more than 1000 g [~~grams~~], of which not more than 20 percent by mass may consist of plutonium-239, plutonium-241, or any combination of these radionuclides.

(i) General license.

(1) NRC-approved package.

(A) A general license is issued to any licensee of the department to transport, or to deliver to a carrier for transport, radioactive material in a package for which a license, CoC [~~certificate of compliance (CoC)~~], or other approval has been issued by the NRC.

(B) This general license applies only to a licensee who has a QA [~~quality assurance~~] program approved by the NRC as satisfying the provisions of 10 CFR [~~Title 10, CFR,~~] Part 71:[~~,~~] Subpart H.

(C) This general license applies only to a licensee who [~~meets the following requirements~~]:

(i) has a copy of the CoC or other approval by the NRC of the package, and has the drawings and other documents referenced in the approval relating to the use and maintenance of the packaging and to the actions to be taken before shipment; and

(ii) complies with the terms and conditions of the specific license, certificate, or other approval by the NRC, as applicable, and the applicable requirements in 10 CFR [~~of Title 10, CFR,~~] Part 71:[~~,~~] Subparts A, G, and H; and

(iii) before the licensee's first use of the package, submits in writing to: ATTN: Document Control Desk, Director, Division of Fuel Management, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001 using an appropriate method listed in 10 CFR [~~Title 10, CFR,~~] Part 71, the licensee's name and license number and the package identification number specified in the package approval.

(D) This general license applies only when the package approval authorizes use of the package as specified in [~~accordance with~~] this general license.

(E) For a Type B or fissile material package, the design of which was approved by NRC before April 1, 1996, the general license is subject to the additional restrictions of paragraph (2) of this subsection.

(F) For radiography containers, a program for transport container inspection and maintenance limited to radiographic exposure devices, source changers, or packages transporting these devices and meeting the requirements of §289.255(m)(2)(B) of this chapter [~~title~~] (relating to Radiation Safety Requirements and Licensing and Registration Procedures for Industrial Radiography), is deemed to satisfy the requirements of subparagraph (B) of this paragraph.

(2) Use of foreign approved package.

(A) A general license is issued to any licensee to transport, or to deliver to a carrier for transport, licensed material in a package the design of which has been approved in a foreign national competent authority certificate [~~that has been~~] revalidated by the DOT as meeting the applicable requirements of 49 CFR [~~Title 49, CFR,~~] §171.23.

(B) Except as otherwise provided by this section, the general license applies only to a licensee having [~~who has~~] a QA [~~quality assurance~~] program approved by the department as satisfying the applicable provisions of subsection (s) - (u) and (w) - (bb) of this section.

(C) This general license applies only to shipments made to or from locations outside the United States.

(D) Each licensee issued a general license under subparagraph (A) of this paragraph must [~~shall~~]:

(i) maintain a copy of the applicable certificate, the revalidation, and the drawings and other documents referenced in the certificate relating to the use and maintenance of the packaging and [~~to~~] the actions [~~to be~~] taken before shipment; and

(ii) comply with the terms and conditions of the certificate and revalidation, and with the applicable requirements of §289.205(j) and (k) of this chapter [~~title~~] and subsections (a) - (e), (j) - (q), (s) - (u), and (w) - (bb) of this section.

(3) Fissile material.

(A) A general license is issued to any licensee to transport fissile material, or to deliver fissile material to a carrier for transport, if the material is shipped as specified in [~~accordance with~~] this section. The fissile material need not be contained in a package meeting [~~that meets~~] the standards of this section. The[~~; however, the~~] material must [~~shall~~] be contained in a Type A package. The Type A

package must [~~shall~~] also meet [~~the~~] DOT requirements in 49 CFR [~~of Title 49, CFR,~~] §173.417(a).

(B) The general license applies only to a licensee having [~~who has~~] a QA [~~quality assurance~~] program approved by the NRC as satisfying the provisions of 10 CFR [~~Title 10, CFR,~~] Part 71.

(C) The general license applies only when a package's contents:

(i) contain no more than a Type A quantity of radioactive material; and

(ii) contain less than 500 total grams of beryllium, graphite, or hydrogenous material enriched in deuterium.

(D) The general license applies only to packages containing fissile material [~~that are~~] labeled with a CSI [~~that~~]:

(i) [~~has been~~] determined as specified in [~~accordance with~~] paragraph (E) of this subsection;

(ii) with [~~has~~] a value less than or equal to 10.0; and

(iii) for a shipment of multiple packages containing fissile material, with a [~~the~~] sum of the CSIs [~~shall be~~] less than or equal to 50.0 [~~(~~]for shipment on a nonexclusive use conveyance[~~)~~] and less than or equal to 100.0 [~~(~~]for shipment on an exclusive use conveyance[~~)~~].

(E) The CSI must [~~shall~~] be as follows:

(i) the value for the CSI is [~~shall be~~] greater than or equal to the number calculated by the following equation:

Figure: 25 TAC §289.257(i)(3)(E)(i) (no change)

(ii) the calculated CSI is [~~shall be~~] rounded up to the first decimal place;

(iii) the values of X, Y, and Z used in the CSI equation is [~~shall be~~] taken from Tables 257-1 or 257-2 of this clause, as appropriate;

Figure: 25 TAC §289.257(i)(3)(E)(iii) (no change)

(iv) if Table 257-2 of clause (iii) of this subparagraph is used to obtain the value of X, then the values for the terms in the equation for uranium-233 and plutonium must [~~shall~~] be assumed to be zero; and

(v) Table 257-1 values of clause (iii) of this subparagraph for X, Y, and Z are [~~shall be~~] used to determine the CSI if:

(I) uranium-233 is present in the package;

(II) the mass of plutonium is greater than [~~exceeds~~] one percent of the mass of uranium-235;

(III) the uranium is of unknown uranium-235 enrichment, or greater than 24 weight percent enrichment; or

(IV) substances having a moderating effectiveness (i.e., an average hydrogen density greater than H_2O [~~H_2O~~]) (e.g., certain hydrocarbon oils or plastics) are present in any form, except as polyethylene used for packing or wrapping.

(4) Plutonium-beryllium special form material.

(A) A general license is issued to any licensee to transport fissile material in the form of plutonium-beryllium (Pu-Be) special form sealed sources, or to deliver Pu-Be sealed sources to a carrier for transport, if the material is shipped as specified in [~~accordance with~~] this section. This material need not be contained in a package meeting [~~that meets~~] the standards of 10 CFR [~~Title 10, CFR,~~] Part 71;[~~,~~] however, the material must [~~shall~~] be contained in a Type A package. The Type A package must [~~shall~~] also meet [~~the~~] DOT requirements in 49 CFR [~~of Title 49, CFR,~~] §173.417(a).

(B) The general license applies only to a licensee having [~~who has~~] a QA [~~quality assurance~~] program approved by the NRC as satisfying the provisions of 10 CFR [~~Title 10, CFR,~~] Part 71.

(C) The general license applies only when a package's contents:

(i) contain no more than a Type A quantity of material; and

(ii) contain less than 1000 g [~~1000g~~] of plutonium, provided [~~that~~] plutonium-239, plutonium-241, or any combination of these radionuclides, constitutes less than 240 g of the total quantity of plutonium in the package.

(D) The general license applies only to packages labeled with a CSI [~~that~~]:

(i) [~~has been~~] determined as specified in [~~accordance with~~] subparagraph (E) of this paragraph;

(ii) with [~~has~~] a value less than or equal to 100.0; and

(iii) for a shipment of multiple packages containing Pu-Be sealed sources, with a [~~the~~] sum of the CSIs [~~shall be~~] less than or equal to 50.0 [~~(~~]for shipment on a nonexclusive use conveyance[~~)~~] and less than or equal to 100.0 [~~(~~]for shipment on or exclusive use conveyance[~~)~~].

(E) The value for the CSI must [~~shall be as follows~~]:

(i) [~~the CSI shall~~] be greater than or equal to the number calculated by the following equation:

Figure: 25 TAC §289.257(i)(4)(E)(i) (no change)

(ii) [~~the calculated CSI shall~~] be rounded up to the first decimal place once calculated.

(j) Assumptions as to unknown properties. When the isotopic abundance, mass, concentration, degree of irradiation, degree of moderation, or other pertinent property of fissile material in any package is not known, the licensee must [~~shall~~] package the fissile material as if the unknown properties have credible values causing [~~that will cause~~] the maximum neutron multiplication.

(k) Preliminary determinations. Before the first use of any packaging for the shipment of licensed material, the licensee must [~~shall~~] ascertain [~~that~~] the determinations were [~~have been~~] made as specified in 10 CFR [~~in accordance with Title 10, CFR,~~] §71.85.

(l) Routine determinations. Before each shipment of radioactive material, the licensee must [~~shall~~] ensure [~~that~~] the package with its contents satisfies the applicable requirements of this section and of the license. The licensee must [~~shall~~] determine [~~that~~]:

(1) the package is proper for the contents to be shipped;

(2) the package is in unimpaired physical condition except for superficial defects such as marks or dents;

(3) each closure device of the packaging, including any required gasket, is properly installed, secured, and free of defects;

(4) any system for containing liquid is adequately sealed and has adequate space or other specified provision for expansion of the liquid;

(5) any pressure relief device is operable and set as specified in [~~accordance with~~] written procedures;

(6) the package has been loaded and closed as specified in [~~accordance with~~] written procedures;

(7) for fissile material, any moderator or neutron absorber, if required, is present and in proper condition;

(8) any structural part of the package [~~that could be~~] used to lift or tie down the package during transport is rendered inoperable for that purpose, unless it satisfies the design requirements of 10 CFR [~~Title 10, CFR,~~] §71.45;

(9) the level of non-fixed (removable) radioactive contamination on the external surfaces of each package offered for shipment is as low as reasonably achievable (ALARA), and within the limits specified in DOT regulations 49 CFR [~~in Title 49, CFR,~~] §173.443;

(10) external radiation levels around the package and around the vehicle, if applicable, are not greater than [~~will not exceed~~] the following limits at any time during transportation:

(A) Except as provided in subparagraph (B) of this paragraph, each package of radioactive materials offered for transportation must [~~shall~~] be designed and

prepared for shipment so, [~~that~~] under conditions normally incident to transportation, the radiation level is not greater than [~~does not exceed~~] 2 millisieverts per hour (mSv/hr) (200 millirem per hour (mrem/hr)) [~~mSv/hr (200 mrem/hr)~~] at any point on the external surface of the package, and the transport index is not greater than [~~does not exceed~~] 10.

(B) A package that exceeds the radiation level limits specified in subparagraph (A) of this paragraph must [~~shall~~] be transported by exclusive use shipment only, and the radiation levels for such shipment must [~~shall~~] not be greater than [~~exceed~~] the following during transportation:

(i) 2 mSv/hr (200 mrem/hr) on the external surface of the package, unless the following conditions are met, in which case the limit is 10 mSv/hr (1000 mrem/hr) [(~~1,000 mrem/hr~~)]:

(I) the shipment is made in a closed transport vehicle;

(II) the package is secured within the vehicle so [~~that~~] its position remains fixed during transportation; and

(III) there are no loading or unloading operations between the beginning and end of the transportation;

(ii) 2 mSv/hr (200 mrem/hr) at any point on the outer surface of the vehicle, including the top and underside of the vehicle; or in the case of a flat-bed style vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load or enclosure, if used, and on the lower external surface of the vehicle; and

(iii) 0.1 mSv/hr (10 mrem/hr) at any point 2 meters (m) (6.6 feet (ft)) from the outer lateral surfaces of the vehicle (excluding the top and underside of the vehicle); or in the case of a flat-bed style vehicle, at any point 2 m (6.6 ft) from the vertical planes projected by the outer edges of the vehicle (excluding the top and underside of the vehicle); and

(iv) 0.02 mSv/hr (2 mrem/hr) in any normally occupied space, except [~~that~~] this provision does not apply to private carriers, if exposed personnel under their control wear radiation dosimetry devices in conformance with §289.202(q) of this chapter [~~title~~].

(C) For shipments made as specified in [~~accordance with~~] the provisions of subparagraph (B) of this paragraph, the shipper must [~~shall~~] provide specific written instructions to the carrier for maintenance of the exclusive use shipment controls. The instructions must [~~shall~~] be included with the shipping paper information.

(D) The written instructions required for exclusive use shipments must [~~shall~~] be sufficient so [~~that~~], when followed, they will cause the carrier to avoid actions [~~that will~~] unnecessarily delaying [~~delay~~] delivery or unnecessarily resulting [~~result~~] in increased radiation levels or radiation exposures to transport workers or

members of the general public.

(m) Air transport of plutonium.

(1) Notwithstanding the provisions of any general licenses and notwithstanding any exemptions stated directly in this section or included in 49 CFR [~~indirectly by citation of Title 49, CFR,~~] Chapter I, as may be applicable, the licensee must [~~shall~~] assure [~~that~~] plutonium in any form, whether for import, export, or domestic shipment, is not transported by air or delivered to a carrier for air transport unless:

(A) the plutonium is contained in a medical device designed for individual human application; or

(B) the plutonium is contained in a material in which the specific activity is less than or equal to the activity concentration values for plutonium specified in Table 257-4 of subsection (ee)(7) of this section, and in which the radioactivity is essentially uniformly distributed; or

(C) the plutonium is shipped in a single package containing no more than an A_2 quantity of plutonium in any isotope or form, and is shipped as specified in [~~accordance with~~] subsection (e) of this section; or

(D) the plutonium is shipped in a package specifically authorized for the shipment of plutonium by air in the CoC [~~Certificate of Compliance~~] for that package issued by the NRC.

(2) Nothing in paragraph (1) of this subsection is [~~to be~~] interpreted as removing or diminishing the requirements of 10 CFR [~~Title 10, CFR,~~] §73.24.

(3) For a shipment of plutonium by air [~~which is~~] subject to paragraph (1) of this subsection, the licensee must [~~shall~~], through special arrangement with the carrier, require compliance with 49 CFR [~~Title 49, CFR,~~] §175.704, DOT regulations applicable to the air transport of plutonium.

(n) Opening instructions. Before delivery of a package to a carrier for transport, the licensee must [~~shall~~] ensure [~~that~~] any special instructions needed to safely open the package are [~~have been~~] sent to, or otherwise made available to, the consignee for the consignee's use as specified in [~~accordance with~~] §289.202(ee)(5) of this chapter [~~title~~].

(o) Records.

(1) For a period of three years after shipment, each licensee must [~~shall~~] maintain, for inspection by the department, a record of each shipment of radioactive material not exempt under subsection (f) of this section, including~~,~~ [~~the following~~] where applicable:

(A) identification of the packaging by model number and serial number;

(B) verification [~~that~~] there are no significant defects in the packaging, as shipped;

(C) volume and identification of coolant;

(D) type and quantity of radioactive material in each package, and the total quantity of each shipment;

(E) for each item of irradiated fissile material:

(i) identification by model number and serial number;

(ii) irradiation and decay history to the extent appropriate to demonstrate [~~that~~] its nuclear and thermal characteristics comply with license conditions; and

(iii) any abnormal or unusual condition relevant to radiation safety;

(F) date of the shipment;

(G) for fissile packages and for Type B packages, any special controls exercised;

(H) name and address of the transferee;

(I) address to which the shipment was made; and

(J) results of the determinations required by subsection (l) of this section and by the conditions of the package approval.

(2) The licensee, certificate holder, and an applicant for a CoC must[~~, shall~~] make available to the department for inspection, upon reasonable notice, all records required by this section. Records are only valid if stamped, initialed, or signed and dated by authorized personnel, or otherwise authenticated.

(3) The licensee, certificate holder, and an applicant for a CoC must [~~shall~~] maintain sufficient written records to furnish evidence of the quality of packaging.

(A) The records [~~to be~~] maintained include:

(i) results of the determinations required by subsection (k) of this section;

(ii) design, fabrication, and assembly records;

(iii) results of reviews, inspections, tests, and audits;

(iv) results of monitoring work performance and materials analyses; and

(v) results of maintenance, modification, and repair activities.

(B) Inspection, test, and audit records must identify the:

(i) inspector or data recorder;

(ii) type of observation;

(iii) results;

(iv) acceptability; and

(v) action taken in connection with any deficiencies noted.

(C) These records must be retained for three years after the life of the packaging to which they apply.

(p) Reports. The transporter and shipper must [~~shall~~] immediately report by telephone all radioactive waste transportation accidents to the department, at (512) 458-7460, and the local emergency management officials in the county where the radioactive waste accident occurs. All other accidents involving radioactive material must [~~shall~~] be reported as specified in [~~accordance with~~] §289.202(xx) and (yy) of this chapter [~~title~~].

(q) Advance notification of transport of irradiated reactor fuel and certain radioactive waste.

(1) As specified in paragraphs (3) - (5) of this subsection, each licensee must [~~shall~~] provide advance notification to the governor of a state[~~,~~] or the governor's designee, of the shipment of radioactive waste[~~,~~] within or across the boundary of the state[~~,~~] before the transport[~~,~~] or delivery to a carrier, for transport[~~,~~] of radioactive waste outside the confines of the licensee's facility or other place of use or storage.

(2) As specified in paragraphs (3) - (5) of this subsection, after June 11, 2013, each licensee must [~~shall~~] provide advance notification to the Tribal official of participating Tribes referenced in paragraph (4)(C)(iii) of this subsection[~~,~~] or the official's designee, of the shipment of radioactive waste[~~,~~] within or across the boundary of the Tribe's reservation[~~,~~] before the transport[~~,~~] or delivery to a carrier, for transport[~~,~~] of radioactive waste outside the confines of the licensee's facility or other place of use or storage.

(3) Advanced notification is also required under this subsection for the shipment of licensed radioactive material, other than irradiated fuel, meeting the following three conditions:

(A) the radioactive waste is required by this section to be in Type B packaging for transportation;

(B) the radioactive waste is being transported to or across a state boundary en route to a disposal facility or to a collection point for transport to a disposal facility; and

(C) the quantity of radioactive waste in a single package is not greater than [~~exceeds~~] the least of [~~the following~~]:

(i) 3000 [~~3,000~~] times the A_1 value of the radionuclides as specified in subsection (ee) of this section for special form radioactive material;

(ii) 3000 [~~3,000~~] times the A_2 value of the radionuclides as specified in subsection (ee) of this section for normal form radioactive material; or

(iii) 1000 [~~1,000~~] terabecquerels (TBq) (27,000 curies (Ci)).

(4) Procedures [~~The following are procedures~~] for submitting advance notification:

(A) The notification must [~~shall~~] be made in writing, to:

(i) the office of each appropriate governor or governor's designee and to the department;

(ii) the office of each appropriate Tribal official or Tribal official's designee; and

(iii) the Director, Office of Nuclear Security and Incident Response.

(B) A notification delivered by mail must [~~shall~~] be postmarked at least seven days before the beginning of the seven-day period during which departure of the shipment is estimated to occur.

(C) A notification delivered by any means other [~~means~~] than mail must [~~shall~~] reach the office of the governor or of the governor's designee or the Tribal official or Tribal official's designee at least four days before the beginning of the seven-day period during which departure of the shipment is estimated to occur.

[~~(i) A list of the names and mailing addresses of the governors' designees receiving advance notification of transportation of radioactive waste was published in the Federal Register on June 30, 1995 (60 FR 34306).~~]

(i) [~~(ii)~~] Contact information for each state, including telephone and mailing addresses of governors and governors' designees, and participating Tribes, including telephone and mailing addresses of Tribal officials and Tribal official's designees, is available on the NRC website at: https://scp.nrc.gov/special/designee.pdf.

(ii) [~~(iii)~~] A list of the names and mailing addresses of the governors' designees and Tribal officials' designees of participating Tribes is available on request from the Director, Division of Materials Safety, Security, State, and Tribal Programs, Office of Nuclear Material Safety and Safeguards, United States Nuclear Regulatory Commission, Washington, DC 20555-0001.

(D) The licensee must [~~shall~~] retain a copy of the notification for inspection by the department [~~as a record~~] for three years.

(5) Each advance notification of shipment of irradiated reactor fuel or radioactive waste must [~~shall~~] contain [~~the following information~~]:

(A) the name, address, and telephone number of the shipper, carrier, and receiver of the irradiated reactor fuel or radioactive waste shipment;

(B) a description of the irradiated reactor fuel or radioactive waste contained in the shipment, as specified in the regulations of DOT in 49 CFR [~~Title 49, CFR,~~]

§172.202 and §172.203(d);

(C) the point of origin of the shipment and the seven-day period during which departure of the shipment is estimated to occur;

(D) the seven-day period during which arrival of the shipment at state boundaries or Tribal reservation is estimated to occur;

(E) the destination of the shipment, and the seven-day period during which arrival of the shipment is estimated to occur; and

(F) a point of contact, with a telephone number, for current shipment information.

(6) A licensee who finds [~~that~~] schedule information previously furnished to a governor or governor's designee or a Tribal official or Tribal official's designee, as specified in [~~accordance with~~] this section, is [~~will~~] not [~~be~~] met, must [~~shall~~] telephone a responsible individual in the office of the governor of the state or of the governor's designee or the Tribal official or the Tribal official's designee and inform that individual of the extent of the delay beyond the schedule originally reported. The licensee must [~~shall~~] maintain a record of the name of the individual contacted for three years.

(7) Procedures [~~The following are procedures~~] for a cancellation notice.

(A) Each licensee canceling [~~who cancels~~] an irradiated reactor fuel or radioactive waste shipment for which advance notification was [~~has been~~] sent must [~~shall~~] send a cancellation notice to the governor of each state or to the governor's designee previously notified, to each Tribal official or to the Tribal official's designee previously notified, [~~and~~] to the Director, Office of Nuclear Security and Incident Response, and to the department.

(B) The licensee must [~~shall~~] state in the notice [~~that~~] it is a cancellation and identify the advance notification [~~that is~~] being canceled. The licensee must [~~shall~~] retain a copy of the notice for inspection by the department [~~as a record~~] for three years.

(r) Emergency plan registration requirements.

(1) Each shipper and transporter of radioactive waste must [~~shall~~] submit an emergency plan to the department and receive a registration letter from the department before initial shipment.

(2) A freight forwarder must submit an emergency plan [~~in order~~] to become a registered freight forwarder.

(3) Each shipper, transporter, or freight forwarder applying for registration must [~~shall~~] submit a Business Information Form (RC 252-1).

(4) Shipper and freight forwarder registrations expire 10 years from the date of issuance. New documentation to renew the registration must be submitted at least

30 days before the expiration date.

(s) QA [~~quality assurance~~] requirements.

(1) Purpose. This subsection describes QA [~~quality assurance~~] requirements applying to the design, purchase, fabrication, handling, shipment [~~shipping~~], storage [~~storing~~], cleaning, assembly, inspection, testing, operation, maintenance, repair, and modification of components of packaging that are important to safety.

(A) QA [~~Quality assurance~~] comprises all those planned and systematic actions necessary to provide adequate confidence [~~that~~] a system or component performs [~~will perform~~] satisfactorily in service.

(B) QA [~~quality assurance~~] includes quality control, which comprises those QA [~~quality assurance~~] actions related to control of the physical characteristics and quality of the material or component to predetermined requirements.

(C) The licensee, certificate holder, and applicant for a CoC are responsible for [~~the following~~]:

(i) the QA [~~quality assurance~~] requirements as they apply to the design, fabrication, testing, and modification of packaging; and

(ii) the QA [~~quality assurance~~] provision applicable to its use of a packaging for the shipment of licensed material under subsections (s) - (bb) and (ee) of this section.

(2) Establishment of program. Each licensee, certificate holder, and applicant for a CoC must [~~shall~~]:

(A) establish [~~Establish~~], maintain, and execute a QA [~~quality assurance~~] program satisfying each of the applicable criteria of this subsection, subsections (s) and (t) of this section, and 10 CFR [~~Title 10, CFR,~~] §§71.101 – [~~through~~] 71.137 and satisfying any specific provisions [~~that are~~] applicable to the licensee's activities including procurement of packaging; and

(B) execute [~~Execute~~] the applicable criteria in a graded approach to an extent [~~that is~~] commensurate with the QA [~~quality assurance~~] requirement's importance to safety.

(3) Approval of program. Before the use of any package for the shipment of licensed material subject to this subsection, each licensee must [~~shall~~]:

(A) obtain department approval of its QA [~~quality assurance~~] program; and

(B) file a description of its QA [~~quality assurance~~] program, including a discussion of which requirements of this subsection and subsections (t) and (u) are applicable and how they will be satisfied.

(4) Radiography containers. A program for transport container inspection and maintenance limited to radiographic exposure devices, source changers, or

packages transporting these devices and meeting the requirements of §289.255(m) of this subchapter [~~title~~], is deemed to satisfy the requirements of subsection (i)(1)(B) of this section and paragraph (2) of this subsection.

(t) QA [~~quality assurance~~] organization. The licensee, certificate holder, and applicant for a CoC must [~~shall~~] (while the term "licensee" is used in these criteria, the requirements are applicable to the [~~whatever~~] design, fabrication [~~fabricating~~], assembly, and testing of the package [~~is~~] accomplished [~~with respect to a package~~] before the time a package approval is issued):

(1) be responsible for establishing and executing [~~the establishment and execution of~~] the QA [~~quality assurance~~] program. The licensee, certificate holder, and applicant for a CoC may delegate to others, such as contractors, agents, or consultants, the work of establishing and executing the QA [~~quality assurance~~] program, or any part of the QA [~~quality assurance~~] program, but must [~~shall~~] retain responsibility for the program; [~~and~~]

(2) clearly establish and delineate, in writing, the authority and duties of persons and organizations performing activities affecting the functions of structures, systems, and components [~~that are~~] important to safety. These activities include performing the functions associated with attaining quality objectives and the QA [~~quality assurance~~] functions; and [~~.~~]

(3) establish QA [~~quality assurance~~] functions as follows:

(A) assuring [~~that~~] an appropriate QA [~~quality assurance~~] program is established and effectively executed; and

(B) verifying, by procedures such as checking, auditing, and inspecting [~~inspection~~], [~~that~~] activities affecting the functions [~~that are~~] important to safety are [~~have been~~] correctly performed; and[~~.~~]

(4) assure [~~that~~] persons and organizations performing QA [~~quality assurance~~] functions have sufficient authority and organizational freedom to:

(A) identify quality problems;

(B) initiate, recommend, or provide solutions; and

(C) verify implementation of solutions.

(u) QA [~~quality assurance~~] program. A QA [~~quality assurance~~] program must [~~shall~~] be maintained as follows:

(1) The licensee, certificate holder, and applicant for a CoC must [~~shall~~]:

(A) establish, at the earliest practicable time consistent with the schedule for accomplishing the activities, a QA [~~quality assurance~~] program complying [~~that complies~~] with the requirements of this section and 10 CFR [~~Title 10, CFR,~~] §§71.101 – [~~through~~] 71.137;

(B) document the QA [~~quality assurance~~] program by written procedures or instructions and [~~shall~~] carry out the program as specified in [~~accordance with~~] those procedures throughout the period during which the packaging is used; and

(C) identify the material and components [~~to be~~] covered by the QA [~~quality assurance~~] program, the major organizations participating in the program, and the designated functions of these organizations.

(2) The licensee, certificate holder, and applicant for a CoC, through its QA [~~quality assurance~~] program, must [~~shall~~]:

(A) provide control over activities affecting the quality of the identified materials and components to an extent consistent with their importance to safety, and as necessary to assure conformance to the approved design of each individual package used for the shipment of radioactive material;

(B) assure [~~that~~] activities affecting quality are accomplished under suitable controlled conditions, including [~~which include~~]:

(i) the use of appropriate equipment;

(ii) suitable environmental conditions for accomplishing the activity, such as adequate cleanliness; and

(iii) all prerequisites for the given activity are [~~have been~~] satisfied; and

(C) consider [~~take into account~~] the need for special controls, processes, test equipment, tools, and skills to attain the required quality, and the need for verification of quality by inspection and test.

(3) The licensee, certificate holder, and applicant for a CoC must [~~shall~~] base the requirements and procedures of its QA [~~quality assurance~~] program on [~~the following~~] considerations concerning the complexity and proposed use of the package and its components, including: [~~.~~]

(A) the [~~The~~] impact of malfunction or failure of the item to safety;

(B) the [~~The~~] design and fabrication complexity or uniqueness of the item;

(C) the [~~The~~] need for special controls and surveillance over processes and equipment;

(D) the [~~The~~] degree to which functional compliance can be demonstrated by inspection or test; and

(E) the [~~The~~] quality history and degree of standardization of the item.

(4) The licensee, certificate holder, and applicant for a CoC must [~~shall~~] provide for indoctrination and training of personnel performing activities affecting quality, as necessary to assure [~~that~~] suitable proficiency is achieved and maintained.

(5) The licensee, certificate holder, and applicant for a CoC must [~~shall~~] review

the status and adequacy of the QA [~~quality assurance~~] program at established intervals. Management of other organizations participating in the QA [~~quality assurance~~] program must [~~shall~~] review regularly the status and adequacy of that part of the QA [~~quality assurance~~] program they are executing.

(6) Changes to QA [~~quality assurance~~] program.

(A) Each QA [~~quality assurance~~] program approval holder must [~~shall~~] submit, as specified in [~~accordance with~~] §289.201(k) of this chapter [~~title~~], a description of a proposed change to its department-approved QA [~~agency-approved quality assurance~~] program reducing [~~that will reduce~~] commitments in the program description as approved by the department. The QA [~~quality assurance~~] program approval holder must [~~shall~~] not implement the change before receiving [~~agency~~] approval from the department. The description of a proposed change to the department-approved QA [~~agency-approved quality assurance~~] program must identify the change, the reason for the change, and the basis for concluding [~~that~~] the revised program incorporating the change continues to satisfy the applicable requirements of subsections (s) - (bb) of this section.

(B) Each QA [~~quality assurance~~] program approval holder may change a previously approved QA [~~quality assurance~~] program without prior [~~agency~~] approval from the department[~~,~~] if the change does not reduce the commitments in the QA [~~quality assurance~~] program previously approved by the department. Changes to the QA [~~quality assurance~~] program that do not reduce the commitments must [~~shall~~] be submitted to the department every 24 months as specified in [~~accordance with~~] §289.201(k) of this chapter [~~title~~]. In addition to QA [~~quality assurance~~] program changes involving administrative improvements and clarifications, spelling corrections, and non-substantive changes to punctuation or editorial items, the following changes are not considered reductions in commitment:

(i) the use of a QA [~~quality assurance~~] standard approved by the department [~~that is~~] more recent than the QA [~~quality assurance~~] standard in the certificate holder's or applicant's current QA [~~quality assurance~~] program at the time of the change;

(ii) the use of generic organizational position titles [~~that~~] clearly denoting [~~denote~~] the position function, supplemented as necessary by descriptive text, rather than specific titles, provided [~~that~~] there is no substantive change to either the functions of the position or reporting responsibilities;

(iii) the use of generic organizational charts to indicate functional relationships, authorities, and responsibilities, or alternatively, the use of descriptive text, provided [~~that~~] there is no substantive change to the functional relationships, authorities, or responsibilities;

(iv) the elimination of QA [~~quality assurance~~] program information duplicating [~~that duplicates~~] language in QA [~~quality assurance~~] regulatory guides and [~~quality assurance~~] standards to which the QA [~~quality assurance~~] program approval holder has committed [~~to~~] on record; and

(v) organizational revisions ensuring [~~that ensure that~~] persons and organizations performing QA [~~quality assurance~~] functions continue to have the requisite authority and organizational freedom, including sufficient independence from cost and schedule when opposed to safety considerations.

(C) Each QA [~~quality assurance~~] program approval holder must [~~shall~~] maintain records of QA [~~quality assurance~~] program changes.

(v) Quality control program. Each shipper must [~~shall~~] adopt a quality control program ensuring [~~to include verification of the following to ensure that~~] shipping containers are suitable for shipments to a licensed disposal facility by verifying:

(1) identification of appropriate containers [~~container(s)~~];

(2) container testing documentation is adequate;

(3) appropriate container used;

(4) container packaged appropriately;

(5) container labeled appropriately;

(6) manifest filled out appropriately; and

(7) documentation maintained of each step.

(w) Handling, storage, and shipping control. The licensee, certificate holder, and applicant for a CoC must [~~shall~~] establish measures to control, as specified in [~~accordance with~~] instructions, the handling, storing [~~storage~~], shipping, cleaning, and preserving [~~preservation~~] of materials and equipment [~~to be~~] used in packaging to prevent damage or deterioration. When necessary for particular products, special protective environments, such as inert gas atmosphere, and specific moisture content and temperature levels must [~~shall~~] be specified and provided.

(x) Inspection, test, and operating status. Measures to track inspection, test, and operating status must [~~shall~~] be established [~~as follows~~].

(1) The licensee, certificate holder, and applicant for a CoC must [~~shall~~] establish measures to indicate, using [~~by the use of~~] markings such as stamps, tags, labels, routing cards, or other suitable means, the status of inspections and tests performed upon individual items of the packaging. These measures must [~~shall~~] provide for the identification of items having [~~that have~~] satisfactorily passed required inspections and tests[~~,~~] where necessary to preclude inadvertent bypassing of the inspections and tests; and

(2) The licensee must [~~, shall~~] establish measures to identify the operating status of components of the packaging, such as tagging valves and switches, to prevent inadvertent operation.

(y) Non-conforming [~~Non-conforming~~] materials, parts, or components. The

licensee, certificate holder, and applicant for a CoC must [~~shall~~] establish measures to control materials, parts, or components [~~that do~~] not conforming [~~conform~~] to the licensee's requirements to prevent their inadvertent use or installation. These measures must [~~shall~~] include [~~the following~~], as appropriate:

(1) procedures for identification, documentation, segregation, disposition, and notification to affected organizations; and

(2) non-conforming [~~nonconforming~~] items must [~~shall~~] be reviewed and accepted, rejected, repaired, or reworked as specified in [~~accordance with~~] documented procedures.

(z) Corrective action. The licensee, certificate holder, and applicant for a CoC must [~~shall~~] establish measures to assure [~~that~~] conditions adverse to quality, such as deficiencies, deviations, defective material and equipment, and non-conformances [~~nonconformances~~], are promptly identified and corrected.

(1) In the case of a significant condition adverse to quality, the measures must [~~shall~~] assure [~~that~~] the cause of the condition is determined and corrective action taken prevents [~~to preclude~~] repetition.

(2) The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken must [~~shall~~] be documented and reported to appropriate levels of management.

(aa) QA [~~quality assurance~~] records. The licensee, certificate holder, and applicant for a CoC must [~~shall~~] maintain written records sufficient to describe the activities affecting quality for inspection by the department for three years beyond the date when the licensee, certificate holder, and applicant for a CoC last engaged [~~engage~~] in the activity for which the QA [~~quality assurance~~] program was developed. If any portion of the written procedures or instructions is superseded, the licensee, certificate holder, and applicant for a CoC must [~~shall~~] retain the superseded material for three years after it is superseded. The records must include [~~the following~~]:

(1) instructions, procedures, and drawings to prescribe QA [~~quality assurance~~] activities, and closely related specifications such as required qualifications of personnel, procedures, and equipment;

(2) instructions or procedures establishing [~~which~~ establish] a records retention program [~~that is~~] consistent with applicable regulations and designating [~~designates~~] factors such as duration, location, and assigned responsibility; and

(3) changes to the QA [~~quality assurance~~] program as required by subsection (u)(6) of this section.

(bb) Audits. The licensee, certificate holder, and applicant for a CoC must [~~shall~~] carry out a comprehensive system of planned and periodic audits, verifying [~~to verify~~] compliance with all aspects of the QA [~~quality assurance~~] program, and determining [~~to determine~~] the effectiveness of the program. The audit program

must [~~shall~~] include:

(1) performance as specified in [~~accordance with~~] written procedures or checklists by appropriately trained personnel not having direct responsibilities in the area being audited;

(2) documented results [~~that are~~] reviewed by management having responsibility in the area audited; and

(3) follow-up action, including reaudit of deficient areas, [~~shall be~~] taken where indicated.

(cc) Transfer for disposal and manifests.

(1) The requirements of this section and subsection (ff) of this section are designed to:

(A) control transfers of LLRW by any waste generator, waste collector, or waste processor licensee, as defined in this section, shipping [~~who ships~~] LLRW either directly[~~,~~] or indirectly through a waste collector or waste processor[~~,~~] to a licensed LLRW land disposal facility, as defined in §289.201(b) of this chapter [~~title~~];

(B) establish a manifest tracking system; and

(C) supplement existing requirements concerning transfers and recordkeeping for those wastes.

(2) Beginning March 1, 1998, all affected licensees must [~~shall~~] use subsection (ff) of this section.

(3) Each shipment of LLRW intended for disposal at a licensed land disposal facility must [~~shall~~] be accompanied by a shipment manifest as specified in [~~accordance with~~] subsection (ff)(1) of this section.

(4) Any licensee shipping LLRW intended for ultimate disposal at a licensed land disposal facility must [~~shall~~] document the information required on the uniform manifest and transfer this recorded manifest information to the intended consignee as specified in [~~accordance with~~] subsection (ff) of this section.

(5) Each shipment manifest must [~~shall~~] include a certification by the waste generator as specified in subsection (ff)(10) of this section, as appropriate.

(6) Each person involved in the transfer for disposal and disposal of LLRW, including the waste generator, waste collector, waste processor, and disposal facility operator, must [~~shall~~] comply with the requirements specified in subsection (ff) of this section, as appropriate.

(7) Any licensee shipping LLRW to a licensed Texas LLRW disposal facility must [~~shall~~] comply with the waste acceptance criteria in 30 Texas Administrative Code [~~Title 30, Texas Administrative Code, Part 1,~~] Chapter 336.

(8) Each shipper must [~~shall~~] submit a list for approval by the department of shipping containers [~~that~~] they intend to use to ship LLRW to the Texas LLRW site. If the shipper is licensed in Texas and is the holder of a CoC, the shipper must [~~shall~~] also submit written documentation of its program for QA [~~quality assurance~~] and control and handling, shipping, and control measures complying [~~that comply~~] with the requirements of subsections (s), (t), and (v) - (bb) of this section.

(dd) Fees.

(1) Each shipper is [~~shall be~~] assessed a fee for shipments of LLRW originating in Texas or originating out-of-state being shipped to a licensed Texas LLRW disposal facility and these fees are [~~shall~~]:

(A) [~~be~~] $10 per cubic foot of shipped LLRW;

(B) [~~be~~] collected by the department and deposited to the credit of the department's Radiation and Perpetual Care Account;

(C) [~~be~~] used by the department for emergency planning for and response to transportation accidents involving LLRW, including first responder training in counties through which transportation routes are designated as specified in [~~accordance with~~] this section; and

(D) not [~~be~~] collected on waste disposed of at a federal waste disposal facility.

(2) Fee assessments are suspended from imposition against a party state compact waste generator when the amount in the department's Radiation and Perpetual Care Account attributable to those fees reaches $500,000. If the amount in that account attributable to those fees is reduced to $350,000 or less, the fee is reinstated until the amount reaches $500,000.

(3) Money expended from the department's Radiation and Perpetual Care Account to respond to accidents involving LLRW are [~~shall be~~] reimbursed to the department's Radiation and Perpetual Care Account by the responsible shipper or transporter according to this section.

(4) For purposes of this subsection, "shipper" means a person who generates LLRW [~~low-level radioactive waste~~] and ships, or arranges with others to ship, [~~the~~] waste to a disposal site.

(5) This subsection does not relieve a generator from liability for a transportation accident involving LLRW.

(ee) Appendices for determination of A_1 and A_2. [~~A_2.~~]

(1) Values of A_1 and A_2. [~~A_2.~~] Values of A_1 and A_2 for individual radionuclides, which are the bases for many activity limits elsewhere in these rules, are given in Table 257-3 of paragraph (6) of this subsection. The Ci [~~curie (Ci)~~] values specified are obtained by converting from the TBq [~~terabecquerel (TBq)~~] value. The TBq values are the regulatory standard. The Ci [~~curie~~] values are for information only

and are not intended to be the regulatory standard. Where values of A_1 or A_2 are unlimited, it is for radiation control purposes only. For nuclear criticality safety, some materials are subject to controls placed on fissile material.

(2) Values of radionuclides not listed.

(A) For individual radionuclides whose identities are known[~~,~~] but are not listed in Table 257-3 of paragraph (6) of this subsection, the A_1 and A_2 values contained in Table 257-5 of paragraph (8) of this subsection may be used. Otherwise, the licensee must [~~shall~~] obtain prior department or NRC approval of the A_1 and A_2 values for radionuclides not listed in Table 257-3 of paragraph (6) of this subsection[~~,~~] before shipping the material.

(B) For individual radionuclides whose identities are known[~~,~~] but [~~that are~~] not listed in Table 257-4 of paragraph (7) of this subsection, the exempt material activity concentration and exempt consignment activity values contained in Table 257-5 of paragraph (8) of this subsection may be used. Otherwise, the licensee must [~~shall~~] obtain prior department or NRC approval of the exempt material activity concentration and exempt consignment activity values[~~,~~] for radionuclides not listed in Table 257-4 of paragraph (7) of this subsection[~~,~~] before shipping the material.

(C) The licensee must [~~shall~~] submit requests for prior approval, described in subparagraphs (A) and (B) of this paragraph~~,~~ to the department or the NRC.

(3) Calculations of A_1 and A_2 for a radionuclide not in Table 257-3 of paragraph (6) of this subsection. In the calculations of A_1 and A_2 for a radionuclide not in Table 257-3 of paragraph (6) of this subsection, a single radioactive decay chain[~~,~~] in which radionuclides are present in their naturally occurring proportions[~~,~~] and in which no daughter radionuclide has a half-life either longer than 10 days[~~,~~] or longer than [~~that of~~] the parent radionuclide, must [~~shall~~] be considered as a single radionuclide, and the activity to be taken into account and the A_1 and A_2 value to be applied must [~~shall~~] be those corresponding to the parent radionuclide of that chain. In the case of radioactive decay chains in which any daughter radionuclide has a half-life either longer than 10 days, or greater than [~~that of~~] the parent radionuclide, the parent and those daughter radionuclides must [~~shall~~] be considered as mixtures of different radionuclides.

(4) Determination for mixtures of radionuclides whose identities and respective activities are known. For mixtures of radionuclides whose identities and respective activities are known, the following conditions apply.

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

Figure: 25 TAC §289.257(ee)(4)(A) (no change)

(B) For normal form radioactive material, the maximum quantity transported in a Type A package is as follows:

Figure: 25 TAC §289.257(ee)(4)(B) (no change)

(C) If the package contains both special and normal form radioactive material, the activity that may be transported in a Type A package is as follows:

Figure: 25 TAC §289.257(ee)(4)(C) (no change)

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

Figure: 25 TAC §289.257(ee)(4)(D) (no change)

(E) Alternatively, an A_2 value for mixtures of normal form material may be determined as follows:

Figure: 25 TAC §289.257(ee)(4)(E) (no change)

(F) The exempt activity concentration for mixtures of nuclides may be determined as follows:

Figure: 25 TAC §289.257(ee)(4)(F) (no change)

(G) The activity limit for an exempt consignment for mixtures of radionuclides may be determined as follows:

Figure: 25 TAC §289.257(ee)(4)(G) (no change)

(5) Determination when individual activities of some of the radionuclides are not known.

(A) When the identity of each radionuclide is known[~~,~~] but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped and the lowest A_1 or A_2 value, as appropriate, for the radionuclides in each group may be used in applying the formulas in paragraph (4) of this subsection. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest A_1 or A_2 values for the alpha emitters and beta/gamma emitters.

(B) When the identity of each radionuclide is known but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped and the lowest [A] (activity concentration for exempt material) or A (activity limit for exempt consignment) value, as appropriate, for the radionuclides in each group may be used in applying the formulas in paragraph (4) of this subsection. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest [A] or A values for the alpha emitters and beta/gamma emitters, respectively.

(6) A_1 and A_2 values for radionuclides. [~~The following~~]Table 257-3 contains A_1 and A_2 values for radionuclides.

Figure: 25 TAC §289.257(ee)(6) [~~Figure: 25 TAC §289.257(ee)(6)~~]

(7) Exempt material activity concentrations and exempt consignment activity limits for radionuclides. [~~The following~~] Table 257-4 contains exempt material activity concentrations and exempt consignment activity limits for radionuclides:

Figure: 25 TAC §289.257(ee)(7) (no change)

(8) General values for A_1 and A_2. [~~A_2 .~~] [~~The following~~] Table 257-5 contains general values for A_1 and A_2: [~~A_2 :~~]

Figure: 25 TAC §289.257(ee)(8) (no change)

(9) Activity-mass relationships for uranium. [~~The following~~] Table 257-6 contains activity-mass relationships for uranium:

Figure: 25 TAC §289.257(ee)(9) [~~Figure: 25 TAC §289.257(ee)(9)~~]

(ff) Appendices for the requirements for transfers of LLRW intended for disposal at licensed land disposal facilities and manifests.

(1) Manifest. A waste generator, collector, or processor who transports, or offers for transportation, LLRW intended for ultimate disposal at a licensed LLRW land disposal facility must [~~shall~~] prepare a manifest reflecting information requested on applicable NRC Forms 540 (Uniform Low-Level Radioactive Waste Manifest (Shipping Paper)) and 541 (Uniform Low-Level Radioactive Waste Manifest (Container and Waste Description)) and, if necessary, on an applicable NRC Form 542 (Uniform Low-Level Radioactive Waste Manifest (Manifest Index and Regional Compact Tabulation)) or their equivalent. NRC Forms 540 and 540A must [~~shall~~] be completed and [~~shall~~] physically accompany the pertinent LLRW shipment. Upon agreement between shipper and consignee, NRC Forms 541, 541A, [~~and~~] 542, and 542A may be completed, transmitted, and stored in electronic media with the capability for producing legible, accurate, and complete records on the respective forms. Licensees are not required by the department to comply with the manifesting requirements of this section when they ship:

(A) LLRW for processing and expect its return (i.e., for storage under [~~in accordance with~~] their license) before disposal at a licensed land disposal facility;

(B) LLRW [~~that is~~] being returned to the licensee who is the waste generator or generator, as defined in this section; or

(C) radioactively contaminated material to a waste processor that becomes the processor's residual waste.

(2) Form instructions. For guidance in completing these forms, refer to the instructions accompanying [~~that accompany~~] the forms. Copies of manifests required by this subsection may be legible carbon copies, photocopies, or computer printouts reproducing [~~that reproduce~~] the data in the format of the uniform manifest.

(3) Forms. NRC Forms 540, 540A, 541, 541A, 542, and 542A, and the accompanying instructions, in hard copy, may be obtained by writing or calling the Office of the Chief Information Officer, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; telephone (301) 415-5877; or by visiting the NRC's website [~~Web site~~] at http://www.nrc.gov and selecting forms from the index found on the NRC home page or at www.nrc.gov/reading-rm/doc-collections/forms/#NRC.

(4) Information requirements of the DOT. This subsection includes information requirements of the DOT, [~~as codified~~] in 49 CFR [~~Title 49, CFR,~~] Part 172. Information on hazardous, medical, or other waste[~~,~~] required to meet EPA regulations[~~, as codified~~] in 40 CFR [~~Title 40, CFR,~~] Parts 259 and 261 or elsewhere, are [~~is~~] not addressed in this section[~~,~~] and must [~~shall~~] be provided on the required EPA forms. The [~~However, the~~] required EPA forms must [~~shall~~] accompany the uniform manifest required by this section.

(5) General information. The shipper of the LLRW must include [~~, shall provide the following information~~] on the uniform manifest:

(A) the name, facility address, and telephone number of the licensee shipping the waste;

(B) an explicit declaration indicating whether the shipper is acting as a waste generator, collector, processor, or a combination of these identifiers for purposes of the manifested shipment; and

(C) the name, address, and telephone number, or the name and EPA identification number, for the carrier transporting the waste.

(6) Shipment information. The shipper of the LLRW must [~~shall~~] provide [~~the following~~] information regarding the waste shipment on the uniform manifest, including:

(A) the date of the waste shipment;

(B) the total number of packages/disposal containers;

(C) the total disposal volume and disposal weight in the shipment;

(D) the total radionuclide activity in the shipment;

(E) the activity of each of the radionuclides hydrogen-3, carbon-14, technetium-99, and iodine-129 contained in the shipment; and

(F) the total masses of uranium-233, uranium-235, and plutonium in special nuclear material, and the total mass of uranium and thorium in source material.

(7) Disposal container and waste information. The shipper of the LLRW must [~~shall~~] provide [~~the following~~] information on the uniform manifest regarding the waste and each disposal container of waste in the shipment, including:

(A) an alphabetic or numeric identification [~~that~~] uniquely identifying

[~~identifies~~] each disposal container in the shipment;

(B) a physical description of the disposal container, including the manufacturer and model of any high integrity container;

(C) the volume displaced by the disposal container;

(D) the gross weight of the disposal container, including the waste;

(E) for waste consigned to a disposal facility, the maximum radiation level at the surface of each disposal container;

(F) a physical and chemical description of the waste;

(G) the total weight percentage of chelating agent for any waste containing more than 0.1 percent chelating agent by weight, plus the identity of the principal chelating agent;

(H) the approximate volume of waste within a container;

(I) the sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name;

(J) the identities and activities of individual radionuclides contained in each container, the masses of uranium-233, uranium-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material. For discrete waste types (i.e., activated materials, contaminated equipment, mechanical filters, sealed source/devices, and wastes in solidification/stabilization media), the identities and activities of individual radionuclides associated with or contained on these waste types within a disposal container must [~~shall~~] be reported;

(K) the total radioactivity within each container; and

(L) for wastes consigned to a disposal facility, the classification of the waste as specified in [~~accordance with~~] §289.202(ggg)(4)(A) of this chapter [~~title~~]. Waste not meeting the structural stability requirements of §289.202(ggg)(4)(B)(ii) of this chapter must [~~title shall~~] be identified.

(8) Uncontainerized waste information. The shipper of the LLRW must [~~shall~~] provide [~~the following~~] information on the uniform manifest regarding a waste shipment delivered without a disposal container including:

(A) the approximate volume and weight of the waste;

(B) a physical and chemical description of the waste;

(C) the total weight percentage of chelating agent if the chelating agent is not greater than [~~exceeds~~] 0.1 percent by weight, plus the identity of the principal chelating agent;

(D) for waste consigned to a disposal facility, the classification of the waste

as specified in [~~accordance with~~] §289.202(ggg)(4)(A) of this chapter [~~title~~]. Waste not meeting the structural stability requirements of §289.202(ggg)(4)(B)(ii) of this chapter must [~~title shall~~] be identified;

(E) the identities and activities of individual radionuclides contained in the waste, the masses of uranium-233, uranium-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material; and

(F) for wastes consigned to a disposal facility, the maximum radiation levels at the surface of the waste.

(9) Multi-generator disposal container information. This paragraph applies to disposal containers enclosing mixtures of waste originating from different generators. (Note: The origin of the LLRW resulting from a processor's activities may be attributable to one or more generators (including waste generators) as defined in this section). It also applies to mixtures of wastes shipped in an uncontainerized form, for which portions of the mixture within the shipment originate from different generators.

(A) For homogeneous mixtures of waste, such as incinerator ash, provide the waste description applicable to the mixture and the volume of the waste attributed to each generator.

(B) For heterogeneous mixtures of waste, such as the combined products from a large compactor, identify each generator contributing waste to the disposal container, and, for discrete waste types (i.e., activated materials, contaminated equipment, mechanical filters, sealed source/devices, and wastes in solidification/stabilization media), the identities and activities of individual radionuclides contained on these waste types within the disposal container. For each generator, provide [~~the following~~]:

(i) the volume of waste within the disposal container;

(ii) a physical and chemical description of the waste, including the solidification agent, if any;

(iii) the total weight percentage of chelating agents for any disposal container containing more than 0.1 percent chelating agent by weight, plus the identity of the principal chelating agent;

(iv) the sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name if the media is claimed to meet stability requirements in §289.202(ggg)(4)(B)(ii) of this chapter [~~title~~]; and

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

(10) Certification. An authorized representative of the waste generator, processor, or collector must [~~shall~~] certify by signing and dating the shipment

manifest [~~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 DOT and the department. A collector in signing the certification is certifying [~~that~~] nothing has been done to the collected waste invalidating [~~that would invalidate~~] the waste generator's certification.

(11) Control and tracking.

(A) Any licensee transferring [~~who transfers~~] LLRW to a land disposal facility or a licensed waste collector must [~~shall~~] comply with the requirements in clauses (i) - (ix) of this subparagraph. Any licensee transferring [~~who transfers~~] waste to a licensed waste processor for waste treatment or repackaging must [~~shall~~] comply with the requirements of clauses (iv) - (ix) of this subparagraph. A licensee must [~~shall~~]:

(i) prepare all wastes so [~~that~~] the waste is classified according to §289.202(ggg)(4)(A) of this chapter [~~title~~] and meets the waste characteristic requirements in §289.202(ggg)(4)(B) of this chapter [~~title~~];

(ii) label each disposal container (or transport package if potential radiation hazards preclude labeling of the individual disposal container) of waste to identify whether it is Class A waste, Class B waste, Class C waste, or greater than Class C waste, as specified in [~~accordance with~~] §289.202(ggg)(4)(A) of this chapter [~~title~~];

(iii) conduct a QA [~~quality assurance~~] program to assure compliance with §289.202(ggg)(4)(A) and (B) of this chapter [~~title~~];

(iv) prepare the uniform manifest as required by this subsection;

(v) forward a copy or electronically transfer the uniform manifest to the intended consignee so that either:

(I) receipt of the manifest precedes the LLRW shipment; and

(II) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both subclauses (I) and (II) of this clause are also acceptable;

(vi) include the uniform manifest with the shipment regardless of the option chosen in clause (v) of this subparagraph;

(vii) receive acknowledgement of the receipt of the shipment in the form of a signed copy of the uniform manifest;

(viii) retain a copy of or electronically store the uniform manifest and documentation of acknowledgement of receipt as the record of transfer of radioactive material as required by §289.251 of this subchapter [~~title~~] and §289.252 of this subchapter [~~title~~]; and

(ix) for any shipments or any part of a shipment for which

acknowledgement of receipt is [~~has~~] not [~~been~~] received within the times set forth in this subsection, conduct an investigation as specified in [~~accordance with~~] subparagraph (D) of this paragraph.

(B) Any waste collector licensee handling [~~who handles~~] only prepackaged waste must [~~shall~~]:

(i) acknowledge receipt of the waste from the shipper within one week of receipt by returning a signed copy of the uniform manifest;

(ii) prepare a new uniform manifest to reflect consolidated shipments meeting [~~that meet~~] the requirements of this subsection. The waste collector must [~~shall~~] ensure [~~that~~], for each container of waste in the shipment, the uniform manifest identifies the generator of that container of waste;

(iii) forward a copy or electronically transfer the uniform manifest to the intended consignee so [~~that~~] either:

(I) receipt of the uniform manifest precedes the LLRW shipment; or

(II) the uniform manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both subclauses (I) and (II) of this clause are also acceptable;

(iv) include the uniform manifest with the shipment regardless of the option chosen in clause (iii) of this subparagraph;

(v) receive acknowledgement of the receipt of the shipment in the form of a signed copy of the uniform manifest;

(vi) retain a copy of or electronically store the uniform manifest and documentation of acknowledgement of receipt as the record of transfer of radioactive material as required by §289.251 of this subchapter [~~title~~] and §289.252 of this subchapter [~~title~~];

(vii) conduct an investigation as specified in subparagraph (D) of this paragraph for any shipments or any part of a shipment for which acknowledgement of receipt is not [~~has not been~~] received within the times set forth as specified in [~~accordance with~~] this clause[~~, conduct an investigation in accordance with subparagraph (D) of this paragraph~~]; and

(viii) notify the shipper and the department when any shipment, or part of a shipment, does [~~has~~] not arrive [~~arrived~~] within 60 days after receipt of an advance uniform manifest, unless notified by the shipper [~~that~~] the shipment has been cancelled.

(C) Any licensed waste processor treating [~~who treats~~] or repackaging [~~repackages~~] waste must [~~shall~~]:

(i) acknowledge receipt of the waste from the shipper within one week of receipt by returning a signed copy of the uniform manifest;

(ii) prepare a new uniform manifest meeting [~~that meets~~] the requirements of this subsection. Preparation of the new uniform manifest reflects [~~that~~] the processor's responsibility [~~processor is responsible~~] for meeting these requirements. For each container of waste in the shipment, the manifest must [~~shall~~] identify the waste generators, the preprocessed waste volume, and the other information as required in clause (i) of this subparagraph;

(iii) prepare all wastes so [~~that~~] the waste is classified according to §289.202(ggg)(4)(A) of this chapter [~~title~~] and meets the waste characteristics requirements in §289.202(ggg)(4)(B) of this chapter [~~title~~];

(iv) label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, as specified in [~~accordance with~~] §289.202(ggg)(4)(A) and (C) of this chapter [~~title~~];

(v) conduct a QA [~~quality assurance~~] program to assure compliance with §289.202(ggg)(4)(A) and (B) of this subchapter [~~title~~];

(vi) forward a copy or electronically transfer the uniform manifest to the intended consignee so [~~that~~] either:

(I) receipt of the uniform manifest precedes the LLRW shipment; or

(II) the uniform manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both subclause (I) of this clause and this subclause is also acceptable;

(vii) include the uniform manifest with the shipment regardless of the option chosen in clause (vi) of this subparagraph;

(viii) receive acknowledgement of the receipt of the shipment in the form of a signed copy of the uniform manifest;

(ix) retain a copy of or electronically store the uniform manifest and documentation of acknowledgement of receipt as the record of transfer of radioactive material as required by §289.251 of this subchapter [~~title~~] and §289.252 of this subchapter [~~title~~];

(x) conduct an investigation as specified in clause (v) of this subparagraph for any shipment or any part of a shipment for which acknowledgement of receipt is [~~has~~] not [~~been~~] received within the times set forth as specified in [~~accordance with~~] this clause[~~, conduct an investigation in accordance with clause (v) of this subparagraph~~]; and

(xi) notify the shipper and the department when any shipment, or part of a shipment, does [~~has~~] not arrive [~~arrived~~] within 60 days after receipt of an advance uniform manifest, unless notified by the shipper [~~that~~] the shipment has been cancelled.

(D) Any shipment or part of a shipment for which acknowledgement is not received within the times set forth as specified in [~~accordance with~~] this section

must be [~~shall undergo the following~~]:

(i) [~~be~~] investigated by the shipper if the shipper has not received notification or receipt within 20 days after transfer; and

(ii) [~~be~~] traced and reported. The investigation must [~~shall~~] include tracing the shipment and filing a report with the department. Each licensee who conducts a trace investigation must [~~shall~~] file a written report with the department within two weeks of completion of the investigation.

§289.258. Licensing and Radiation Safety Requirements for Irradiators.

(a) Purpose. This section contains requirements for the issuance of a license authorizing the use of sealed sources containing radioactive material used in irradiating [~~irradiators that irradiate~~] objects or materials using gamma radiation. This section also contains radiation safety requirements for operating irradiators.

(b) Scope.

(1) In addition to the requirements of this section, all licensees, unless otherwise specified, are subject to the requirements of:

(A) §289.201 of this chapter (relating to General Provisions for Radioactive Material);

(B) §289.202 of this chapter (relating to Standards for Protection Against Radiation from Radioactive Materials);

(C) §289.203 of this chapter (relating to Notices, Instructions, and Reports to Workers; Inspections);

(D) §289.204 of this chapter (relating to Fees for Certificates of Registration, Radioactive Material Licenses, Emergency Planning and Implementation, and Other Regulatory Services);

(E) §289.205 of this chapter (relating to Hearing and Enforcement Procedures);

(F) §289.252 of this subchapter (relating to Licensing of Radioactive Material); and

(G) §289.257 of this subchapter (relating to Packaging and Transportation of Radioactive Material).

[~~§289.201 of this title (relating to General Provisions for Radioactive Material), §289.202 of this title (relating to Standards for Protection Against Radiation from Radioactive Material), §289.203 of this title (relating to Notices, Instructions, and Reports to Workers; Inspections), §289.204 of this title (relating to Fees for Certificates of Registration, Radioactive Material Licenses, Emergency Planning and Implementation, and Other Regulatory Services), §289.205 of this title (relating to Hearing and Enforcement Procedures), §289.252 of this title (relating to Licensing~~

~~of Radioactive Material), and §289.257 of this title (relating to Packaging and Transportation of Radioactive Material). 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.~~]

(2) 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.

(3) [~~(2)~~] The requirements in this section apply to panoramic irradiators having [~~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 are greater than [~~exceed~~] 500 rads (5 grays) per hour at 1 meter (m) from the radioactive sealed sources in air or in water, as applicable for the irradiator type, are covered by this section.

(4) [~~(3)~~] The requirements 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 materials for non-destructive [~~nondestructive~~] testing purposes), gauging, or open-field (agricultural) irradiations.

(c) Definitions. The following words and terms [~~,~~] when used in this section [~~, shall~~] have the following meanings [~~,~~] unless the context clearly indicates otherwise.

(1) Annually--At intervals not greater than [~~to exceed~~] 390 days.

(2) 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.

(3) Category I self-contained, dry-source irradiator--An irradiator in which the sealed source is completely contained in a dry container constructed of solid materials and [~~is~~] shielded at all times, and in which human access to the sealed source and the volume undergoing irradiation is not physically possible in its designed configuration.

(4) Irradiator--A facility using [~~that uses~~] radioactive sealed sources for the irradiation of objects or materials and in which radiation dose rates are greater than [~~exceeding~~] 500 rads (5 grays) per hour exist at 1 m 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.

(5) Irradiator operator--An individual who [~~has~~] successfully completed the training and testing described in subsection (s) of this section and is authorized by the terms of the license to operate the irradiator without the presence of a supervisor who [~~has~~] completed the requirements of subsection (s)(1) - (3) of this section.

(6) Onsite--A physical presence within the building housing the irradiator or on property controlled by the licensee [~~that is~~] contiguous with the building housing the irradiator.

(7) 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.

(8) Panoramic irradiator--An irradiator in which the irradiations are done in air in areas potentially accessible to personnel. The term includes beam-type irradiators.

(9) Panoramic wet-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 under water in a storage pool.

(10) Pool irradiator--Any irradiator in which the sources are stored or used in a pool of water, including panoramic wet-source-storage irradiators and underwater irradiators.

(11) Product conveyor system--A system for moving the product to be irradiated to, from, and within the area where irradiation takes place.

(12) Radiation room--A shielded room in which irradiations take place. Underwater irradiators do not have radiation rooms.

(13) Seismic area--Any area where the probability of horizontal acceleration in rock of more than 0.3 times the acceleration of gravity in 250 years is greater than 10 percent [~~10%~~], as designated by the United States Geological Survey.

(14) 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.

(d) Application for a specific license. Applications for specific licenses must [~~shall~~] be filed as specified in [~~accordance with~~] §289.252(d) of this subchapter [~~title~~].

(e) Specific licenses for irradiators.

(1) The department approves [~~agency 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.

(2) The applicant must [~~shall~~] satisfy the general requirements specified in §289.252 of this subchapter [~~title~~] and the requirements contained in this section.

(3) The application must [~~shall~~] describe the training provided to irradiator operators including:

(A) classroom training;

(B) on-the-job or simulator training;

(C) safety reviews;

(D) means employed by the applicant to test each operator's understanding of the department's [~~agency's~~] rules and licensing requirements and the irradiator operating, safety, and emergency procedures; and

(E) minimum training and experience of personnel providing [~~who may provide~~] training.

(4) The application must [~~shall~~] include a copy of the written operating, safety, and emergency procedures as outlined in subsection (t) of this section describing [~~that describes~~] the radiation safety aspects of the procedures.

(5) The application must [~~shall~~] describe the organizational structure for managing the irradiator, specifically the radiation safety responsibilities and authorities of the radiation safety officer (RSO) and those management personnel having [~~who have~~] radiation safety responsibilities or authorities. In particular, the application must [~~shall~~] specify who, within the management structure, has the authority to stop unsafe operations. The application must [~~shall~~] also describe the training and experience required for the position of RSO.

(6) The application must [~~shall~~] include a description of the access control systems required by subsection (i) of this section, the radiation monitors required by subsection (l) of this section, the method of detecting leaking sources required by subsection (w) of this section, including the sensitivity of the method, and a diagram of the facility showing [~~that shows~~] the locations of all required interlocks and radiation monitors.

(7) If the applicant intends to perform and analyze leak tests of dry-source-storage sealed sources, the applicant must [~~shall~~] establish procedures for leak testing and submit a description of these procedures to the department [~~agency~~]. The description must [~~shall~~] include at least [~~the following~~]:

(A) the instruments to be used;

(B) the methods of performing the analysis; and

(C) the pertinent experience of the individual analyzing [~~who analyzes~~] the samples.

(8) If licensee personnel are to load or unload sources, the applicant must [~~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 [~~shall~~] be done by a person specifically authorized by the department [~~agency~~], the United States Nuclear Regulatory Commission (NRC), or an agreement state[~~, or a licensing state~~] to load or unload irradiator sources.

(9) The applicant must [~~shall~~] describe the inspection and maintenance checks,

including the frequency of the checks required by subsection (x) of this section.

(f) Start of construction. The applicant must [~~may~~] not begin construction of a new irradiator before [~~prior to~~] the submission to the department [~~agency~~] of both an application for a license for the irradiator and the fee required by §289.204 of this chapter [~~title~~]. 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 preparation; site excavation; construction of warehouse or auxiliary structures; and other similar tasks. Any construction activities undertaken before [~~prior to~~] the issuance of a license are entirely at the risk of the applicant and have no bearing on the issuance of a license with respect to the requirements of the Texas Radiation Control Act (Act), rules, and orders issued as specified in [~~accordance with~~] the Act.

(g) Applications for exemptions. Any applications 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 approves [~~agency 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.

(h) Performance criteria for sealed sources.

(1) Cesium-137 must [~~shall~~] not be used in any irradiator other than a Category I self-contained, dry-source irradiator as defined in subsection (c) of this section.

(2) Sealed sources. Sealed sources installed after August 1, 1996, must [~~shall meet the following requirements~~]:

(A) be [~~have been~~] evaluated as specified in [~~accordance with~~] §289.252(v) of this subchapter [~~title~~];

(B) be doubly encapsulated;

(C) use radioactive material [~~that is~~] as non-dispersible [~~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;

(D) be encapsulated in a material resistant to general corrosion and to localized corrosion, such as 316L stainless steel or other material with equivalent resistance if the sources are for use in irradiator pools; and

(E) be [~~have been~~] leak tested and found leak-free in prototype testing of the sealed source after each of the tests described in paragraphs (3) - (8) of this subsection.

(3) Temperature. The test source must [~~shall~~] be held at negative 40 [~~-40~~] degrees Celsius for 20 minutes, 600 degrees Celsius for one hour, and then [~~be~~] subjected to thermal shock test with a temperature drop from 600 degrees Celsius

to 20 degrees Celsius within 15 seconds.

(4) Pressure. The test source must [~~shall~~] be [~~twice~~] subjected twice, for at least five minutes, to an external pressure (absolute) of 2 million newtons per square meter.

(5) Impact. A 2-kilogram steel weight, 2.5 centimeters (cm) in diameter, must [~~shall~~] be dropped from a height of 1 m onto the test source.

(6) Vibration. The test source must [~~shall~~] be subjected three times for ten minutes each to vibrations sweeping from 25 hertz to 500 hertz with a peak amplitude of five times the acceleration of gravity. In addition, each test source must [~~shall~~] be vibrated for 30 minutes at each resonant frequency found.

(7) Puncture. A 50-gram weight and pin, 0.3-centimeter pin diameter, must [~~shall~~] be dropped from a height of 1 m onto the test source.

(8) Bend. If the length of the source is more than 15 times larger than the minimum cross-sectional dimension, the test source must [~~shall~~] be subjected to a force of 2,000 newtons at its center equidistant from two support cylinders, the distance between which is 10 times the minimum cross-sectional dimension of the source.

(i) Access control requirements in addition to the requirements of §289.202(u) of this chapter [~~title~~].

(1) Each entrance to a radiation room at a panoramic irradiator must [~~shall~~] 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 if [~~as long as~~] they reliably and consistently function as a barrier. It must [~~shall~~] 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 [~~shall~~] cause the sources to return promptly to the shielded position. The personnel entrance door or barrier must [~~shall~~] have a lock [~~that is~~] operated by the same key used to move the sources. The doors and barriers must [~~shall~~] not prevent any individual in the radiation room from leaving.

(2) In addition, each entrance to a radiation room at a panoramic irradiator must [~~shall~~] have an independent backup access control to detect personnel entry while the sources are exposed. Detection of entry while the sources are exposed must [~~shall~~] cause the sources to return to their fully shielded position and must [~~shall~~] also activate a visible and audible alarm to make the individual entering the room aware of the hazard. The alarm must [~~shall~~] also make at least one other individual [~~who is~~] onsite aware of the entry. That individual must [~~shall~~] be trained on how to respond to the alarm and be prepared to promptly render or summon assistance.

(3) A radiation monitor must [~~shall~~] be provided to detect the presence of high radiation levels in the radiation room of a panoramic irradiator before personnel entry. The monitor must [~~shall~~] 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 [~~shall~~] activate the alarm described in paragraph (2) of this subsection. The monitor may be located in the entrance (normally referred to as the maze) but not in the direct radiation beam.

(4) Before the sources move from their shielded position in a panoramic irradiator, the source control must [~~shall~~] 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 [~~shall~~] give individuals enough time to leave the room and to operate the control described in paragraph (5) of this subsection before the sources leave the shielded position.

(5) Each radiation room at a panoramic irradiator must [~~shall~~] have a clearly visible and readily accessible control allowing [~~that allows~~] an individual in the room to return the sources to their fully shielded position.

(6) Each radiation room of a panoramic irradiator must [~~shall~~] contain a control preventing [~~that prevents~~] the sources from moving from the shielded position unless the control is [~~has been~~] activated and the door or barrier to the radiation room has been closed within a preset time after activation of the control.

(7) 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 [~~shall~~] have a sign bearing the radiation symbol and the words, "CAUTION (or DANGER), RADIOACTIVE MATERIAL." Panoramic irradiators must [~~shall~~] also have a sign stating "CAUTION (or DANGER), HIGH RADIATION AREA," as defined in §289.201(b) of this chapter [~~title~~], or "GRAVE DANGER, VERY HIGH RADIATION AREA," as defined in §289.201(b) of this chapter [~~title~~], whichever is applicable, but the sign may be removed, covered, or otherwise made inoperative when the sources are fully shielded.

(8) If the radiation room of a panoramic irradiator has roof plugs or other movable shielding, it must [~~shall~~] not be possible to operate the irradiator unless the shielding is in its proper location. The requirement may be met by interlocks preventing [~~that prevent~~] operation if shielding is not placed properly or by an operating procedure requiring inspection of shielding before operating.

(9) Underwater irradiators must [~~shall~~] have a personnel access barrier around the pool [~~that shall 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 [~~shall~~] be an intrusion alarm to detect unauthorized entry when the personnel access barrier is locked. Activation of the intrusion alarm must [~~shall~~] alert an individual (not necessarily onsite) [~~who is~~] prepared to respond or summon assistance.

(j) Shielding.

(1) The radiation dose rate in areas [~~that are~~] normally occupied during operation of a panoramic irradiator must [~~may~~] not be greater than [~~exceed~~] 2 millirem [~~millirems~~] (mrem) (0.02 millisievert (mSv)) per hour at any location 30

cm [~~centimeters (cm)~~] or more from the wall of the room when the sources are exposed. The dose rate must [~~shall~~] be averaged over an area not greater than [~~to exceed~~] 100 square centimeters (cm^2) [~~(cm^2)~~] having no linear dimension greater than 20 cm. Areas where the radiation dose rate is greater than [~~exceeds~~] 2 mrem (0.02 mSv) per hour must [~~shall~~] be locked, roped off, or posted.

(2) The radiation dose at 30 cm over the edge of the pool of a pool irradiator may not be greater than [~~exceed~~] 2 mrem (0.02 mSv) per hour when the sources are in the fully shielded position.

(3) The radiation dose rate at 1 m from the shield of a dry-source-storage panoramic irradiator when the source is shielded must [~~may~~] not be greater than [~~exceed~~] 2 mrem (0.02 mSv) per hour and at 5 cm from the shield, [~~may~~] not greater than [~~exceed~~] 20 mrem (0.2 mSv) per hour.

(k) Fire protection.

(1) The radiation room at a panoramic irradiator must [~~shall~~] have heat and smoke detectors. The detectors must [~~shall~~] activate an audible alarm. The alarm must [~~shall~~] be capable of alerting a person [~~who is~~] prepared to summon assistance promptly. The sources must [~~shall~~] automatically become fully shielded if a fire is detected.

(2) The radiation room at a panoramic irradiator must [~~shall~~] be equipped with a fire extinguishing system capable of extinguishing a fire without the entry of personnel into the room. If water is used, the system for the radiation room must [~~shall~~] have a shut-off valve to control flooding into unrestricted areas.

(l) Radiation monitors.

(1) Irradiators with automatic product conveyor systems must [~~shall~~] 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 [~~shall~~] sound and product conveyors must [~~shall~~] stop automatically. The alarm must [~~shall~~] be capable of alerting an individual in the facility [~~who is~~] prepared to summon assistance. Underwater irradiators in which the product moves within an enclosed stationary tube are exempt from the requirements of this paragraph.

(2) Underwater irradiators [~~that are~~] not in a shielded radiation room must [~~shall~~] have a radiation monitor over the pool to detect abnormal radiation levels. The monitor must [~~shall~~] 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 [~~shall~~] be capable of alerting an individual [~~who is~~] prepared to respond promptly.

(m) Control of source movement.

(1) The mechanism moving [~~that moves~~] the sources of a panoramic irradiator must [~~shall~~] require a key to actuate. Actuation of the mechanism must [~~shall~~]

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 [~~shall~~] be attached to a portable radiation survey meter by a chain or cable. The lock for source control must [~~shall~~] 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 [~~shall~~] require the same key.

(2) The console of a panoramic irradiator must [~~shall~~] have a source position indicator indicating [~~that indicates~~] when the sources are in the fully shielded position, when they are in transit, and when the sources are in the fully exposed position.

(3) The control console of a panoramic irradiator must [~~shall~~] have a control that, when activated, must [~~shall~~] return the source to its fully shielded position within its normal transit time.

(4) Each control for a panoramic irradiator must [~~shall~~] be clearly marked as to its function.

(n) Irradiator pools.

(1) For licenses initially issued after August 1, 1996, irradiator pools must [~~shall~~] either:

(A) have a water-tight stainless steel liner or a liner metallurgically compatible with other components in the pool; or

(B) 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 must [~~shall~~] have a method to safely store the sources during repairs of the pool.

(2) For licenses initially issued after August 1, 1996, irradiator pools must [~~shall~~] have no outlets more than 0.5 m below the normal low water level that could allow water to drain out of the pool. Pipes having [~~that have~~] openings more than 0.5 m below the normal low water level and that could act as siphons must [~~shall~~] have siphon breakers to prevent the siphoning of pool water.

(3) A means must [~~shall~~] be provided to replenish water losses from the pool.

(4) A visible indicator must [~~shall~~] 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.

(5) Irradiator pools must [~~shall~~] be equipped with a purification system designed to maintain [~~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.

(6) A physical barrier, such as a railing or cover, must [~~shall~~] be used around or

over irradiator pools during normal operation preventing [~~to prevent~~] personnel from accidentally falling into the pool. The barrier may be removed during maintenance, inspection, and service operations.

(7) If long-handled tools or poles are used in irradiator pools, the radiation dose rate on the handling areas of the tools may not be greater than [~~exceed~~] 2 mrem (0.02 mSv) per hour.

(o) Source rack protection. If the product to be irradiated moves on a product conveyor system, the source rack and the mechanism moving [~~that moves~~] the rack must [~~shall~~] be protected by a carrier or guides to prevent products and product carriers from hitting or touching the rack or mechanism.

(p) Power failures.

(1) If electrical power at a panoramic irradiator is lost for longer than 10 seconds, the sources must [~~shall~~] automatically return to the shielded position.

(2) The lock on the door of the radiation room of a panoramic irradiator must [~~shall~~] not be deactivated by a power failure.

(3) 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.

(q) Design requirements for irradiators. The following are design requirements for irradiators [~~that have construction~~] beginning construction after August 1, 1996.

(1) Shielding. For panoramic irradiators, the licensee must [~~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 subsection (j) of this section. If the irradiator will use more than 5 million curies (2×10^{17} becquerels) of activity, the licensee must [~~shall~~] evaluate the effects of heating of the shielding walls by the irradiator sources.

(2) Foundations. For panoramic irradiators, the licensee must [~~shall~~] design the foundation, with consideration given to soil characteristics, ensuring [~~to ensure~~] it is adequate to support the weight of the facility shield walls.

(3) Pool integrity. For pool irradiators, the licensee must [~~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 subsection (n)(2) of this section, and [~~that~~] metal components are metallurgically compatible with other components in the pool.

(4) Water handling system. For pool irradiators, the licensee must [~~shall~~] verify [~~that~~] the design of the water purification system is adequate to meet the requirements of subsection (n)(5) of this section. The system must [~~shall~~] be designed so [~~that~~] water leaking from the system does not drain to unrestricted areas without being monitored.

(5) Radiation monitors. For all irradiators, the licensee must [~~shall~~] evaluate the location and sensitivity of the monitor to detect sources carried by the product conveyor system as required by subsection (l)(1) of this section. The licensee must [~~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 as specified in [~~accordance with~~] subsection (w)(2) of this section, the licensee must [~~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.

(6) Source rack. For pool irradiators, the licensee must [~~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 must [~~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) do [~~will~~] not cause loss of integrity of sealed sources. For panoramic irradiators, the licensee must [~~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.

(7) Access control. For panoramic irradiators, the licensee must [~~shall~~] verify from the design and logic diagram [~~that~~] the access control system meets [~~will meet~~] the requirements of subsection (i) of this section.

(8) Fire protection. For panoramic irradiators, the licensee must [~~shall~~] verify [~~that~~] the number, locations, 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 must [~~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.

(9) Source return. For panoramic irradiators, the licensee must [~~shall~~] verify [~~that~~] the source rack will automatically return to the fully shielded position if power is lost for more than 10 seconds.

(10) Seismic. For panoramic irradiators to be built in seismic areas, the licensee must [~~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.

(11) Wiring. For panoramic irradiators, the licensee must [~~shall~~] verify [~~that~~] electrical wiring and electrical equipment in the radiation room are selected to minimize failures due to prolonged exposure to radiation.

(r) Construction monitoring and acceptance testing requirements. The requirements

for [~~following are~~] construction monitoring and acceptance testing must be [~~requirements to be~~] met before [~~prior to~~] loading sources in irradiators that began [~~have begun~~] construction after August 1, 1996.

(1) Shielding. For panoramic irradiators, the licensee must [~~shall~~] monitor the construction of the shielding to verify [~~that~~] its construction meets design specifications and generally accepted building code requirements for reinforced concrete.

(2) Foundations. For panoramic irradiators, the licensee must [~~shall~~] monitor the construction of the foundations to verify [~~that~~] the foundation construction meets design specifications.

(3) Pool integrity. For pool irradiators, the licensee must [~~shall~~] verify [~~that~~] the pool meets design specifications and must [~~shall~~] test the integrity of the pool. The licensee must [~~shall~~] verify [~~that~~] outlets and pipes meet the requirements of subsection (n)(2) of this section.

(4) Water handling system. For pool irradiators, the licensee must [~~shall~~] verify [~~that~~] the water purification system, the conductivity meter, and the water level indicators operate properly.

(5) Radiation monitors. For all irradiators, the licensee must [~~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 subsection (l)(1) of this section. For pool irradiators, the licensee must [~~shall~~] verify the proper operation of the radiation monitors and the related alarm if used to meet subsection (w)(2) of this section. For underwater irradiators, the licensee must [~~shall~~] verify the proper operation of the over-the-pool monitor, alarms, and interlocks required by subsection (l)(2) of this section.

(6) Source rack. For panoramic irradiators, the licensee must [~~shall~~] test the movement of the source racks for proper operation before [~~prior to~~] source loading. Testing must [~~shall~~] include source rack lowering due to simulated loss of power. For all irradiators with product conveyor systems, the licensee must [~~shall~~] observe and test the operation of the conveyor system to assure [~~that~~] the requirements in subsection (o) of this section are met for protection of the source rack and the mechanism moving [~~that moves~~] the rack. Testing must [~~shall~~] include tests of any limit switches and interlocks protecting [~~used to protect~~] the source rack and mechanism moving [~~that moves~~] that rack from moving product carriers.

(7) Access control. For panoramic irradiators, the licensee must [~~shall~~] test the completed access control system to assure [~~that~~] it functions as designed and [~~that~~] all alarms, controls, and interlocks work properly.

(8) Fire protection. For panoramic irradiators, the licensee must [~~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 must [~~shall~~] test the operability of the fire extinguishing system.

(9) Source return. For panoramic irradiators, the licensee must [~~shall~~] demonstrate [~~that~~] the source racks can be returned to their fully shielded positions without power.

(10) Computer systems. For panoramic irradiators using [~~that use~~] a computer system to control the access control system, the licensee must [~~shall~~] verify [~~that~~] the access control system operates [~~will operate~~] properly if power is lost and must [~~shall~~] verify [~~that~~] the computer has security features preventing [~~that prevent~~] an irradiator operator from commanding the computer to override the access control system when it is required to be operable.

(11) Wiring. For panoramic irradiators, the licensee must [~~shall~~] verify [~~that~~] the electrical wiring and electrical equipment [~~that were~~] installed meet the design specifications.

(s) Training.

(1) Before an individual is permitted to operate an irradiator without a supervisor present[~~,~~] who has completed the requirements of this paragraph and paragraphs (2) and (3) of this subsection, the individual must [~~shall~~] be instructed in:

(A) the fundamentals of radiation protection applied to irradiators (including the differences between external radiation and radioactive contamination, units of radiation dose, dose limits, why large radiation doses must [~~shall~~] 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 individual monitoring devices, other radiation safety features of an irradiator, and the basic function of the irradiator);

(B) the requirements of this section and §289.203 of this chapter [~~title that are~~] relevant to the irradiator;

(C) the operation of the irradiator;

(D) those operating, safety, and emergency procedures listed in subsection (t) of this section [~~that~~] the individual is responsible for performing; and

(E) case histories of accidents or problems involving irradiators.

(2) Before an individual is permitted to operate an irradiator without a supervisor present[~~,~~] who has completed the requirements of this paragraph and paragraphs (1) and (3) of this subsection, the individual must [~~shall~~] pass a written test on the instruction received consisting primarily of questions based on the licensee's operating, safety, and emergency procedures [~~that~~] the individual is responsible for performing and other operations necessary to safely operate the irradiator without supervision.

(3) Before an individual is permitted to operate an irradiator without a supervisor present[~~,~~] who has completed the requirements of this paragraph and paragraphs (1) and (2) of this subsection, the individual must [~~shall~~] have received

on-the-job training or simulator training in the use of the irradiator as described in the license application. The individual must [~~shall~~] also demonstrate the ability to perform those portions of the operating, safety, and emergency procedures [~~that~~] he or she is to perform.

(4) The licensee must [~~shall~~] conduct safety reviews for irradiator operators at least annually. The licensee must [~~shall~~] give each operator a brief written test on the information. Each safety review must [~~shall~~] include, to the extent appropriate[~~, each of the following~~]:

(A) changes in operating, safety, and emergency procedures since the last review, if any;

(B) changes in rules and license conditions since the last review, if any;

(C) reports on recent accidents, mistakes, or problems that have occurred at irradiators, if any;

(D) relevant results of inspections of operator safety performance;

(E) relevant results of the facility's inspection and maintenance checks; and

(F) a drill to practice an emergency or abnormal event procedure.

(5) The licensee must [~~shall~~] evaluate the safety performance of each irradiator operator at least annually ensuring the department's [~~to ensure that agency~~] rules, license conditions, and operating, safety, and emergency procedures are followed. The licensee must [~~shall~~] discuss the results of the evaluation with the operator and must [~~shall~~] instruct the operator [~~on~~] how to correct any mistakes or deficiencies observed.

(6) 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 RSO, must [~~shall~~] be instructed and tested in any precautions they should take to avoid radiation exposure, any procedures or parts of procedures listed in subsection (t) of this section [~~that~~] they are expected to [~~perform or~~] comply with or perform, and their proper response to alarms required in this section. Tests may be oral.

(7) Individuals required [~~who shall be prepared~~] to respond to alarms [~~required~~] by subsections (i)(2) and (9), (k), (l), and (w)(2) of this section must [~~shall~~] be trained and tested on how to respond. Each individual must [~~shall~~] be retested at least once a year. Tests may be oral.

(t) Operating, safety, and emergency procedures.

(1) The licensee must [~~shall~~] have and follow written operating, safety, and emergency procedures for:

(A) operation of the irradiator, including entering and leaving the radiation room;

(B) use of individual monitoring devices;

(C) surveying the shielding of panoramic irradiators;

(D) monitoring pool water for contamination while the water is in the pool and before release of pool water to unrestricted areas;

(E) leak testing of sources;

(F) inspection and maintenance checks required by subsection (x) of this section;

(G) loading, unloading, and repositioning sources, if the operations are [~~will be~~] performed by the licensee; and

(H) inspection of movable shielding required by subsection (i)(8) of this section, if applicable.

(2) The licensee must [~~shall~~] have and follow emergency or abnormal event procedures, appropriate for the irradiator type, for:

(A) sources stuck in the unshielded position;

(B) personnel overexposures;

(C) a radiation alarm from the product exit portal monitor or pool monitor;

(D) detection of leaking source, pool contamination, or alarm caused by contamination of pool water;

(E) a low or high water level indicator, an abnormal water loss, or leakage from the source storage pool;

(F) a prolonged loss of electrical power;

(G) a fire alarm or explosion in the radiation room;

(H) an alarm indicating unauthorized entry into the radiation room, area around pool, or another alarmed area;

(I) natural phenomena, including an earthquake, a tornado, flooding, or other phenomena [~~as~~] appropriate for the geographical location of the facility; and

(J) the jamming of automatic conveyor systems.

(3) The licensee may revise operating, safety, and emergency procedures without [~~agency~~] approval from the department only if all these [~~of the following~~] conditions are met:

(A) the revisions do not reduce the safety of the facility;

(B) the revisions are consistent with the outline or summary of procedures including procedures for changes to operating, safety, and emergency procedures

submitted with the license application;

(C) the revisions are [~~have been~~] reviewed and approved by the radiation safety officer (RSO); and

(D) the users or operators are instructed and tested on the revised procedures before they are put into use.

(4) Changes to operating, safety, and emergency procedures must [~~shall~~] be submitted to the department [~~agency~~] after the provisions of paragraph (3) of this subsection are completed.

(u) Personnel monitoring.

(1) Irradiator operators must [~~shall~~] wear an individual monitoring device [~~that is processed and evaluated by an accredited National Voluntary Laboratory Accreditation Program (NVLAP) processor~~] while operating a panoramic irradiator or while in the area around the pool of an underwater irradiator. The individual monitoring device [~~personnel dosimeter processor~~] must be capable of detecting [~~accredited for~~] high-energy photons in the normal and accident dose ranges [(~~see §289.202(p)(3) of this title~~)]. Each individual monitoring device [~~personnel dosimeter~~] must be assigned to and worn by only one individual. Film badges must be replaced [~~processed~~] at least monthly, and all other individual monitoring devices requiring replacement [~~personnel dosimeters~~] must be replaced [~~processed~~] at least quarterly. After replacement, individual monitoring devices requiring processing must [~~each film badge, a thermoluminescent dosimeter (TLD), or optically stimulated luminescence device (OSL) shall~~] be returned to the supplier for processing within 14 calendar days of the exchange date specified by the [~~personnel monitoring~~] supplier, or as soon as practicable. All individual monitoring devices must be evaluated at least quarterly or promptly after replacement, whichever is more frequent. Circumstances preventing meeting these time limits must be documented, and those records must be available for review by the department. [~~In circumstances that make it impossible to return each film badge, TLD, or OSL within 14 calendar days, such circumstances shall be documented and available for review by the agency.~~]

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

(v) Radiation surveys.

(1) A radiation survey of the area outside the shielding of the radiation room of a panoramic irradiator must [~~shall~~] be conducted with the sources in the exposed position before the facility starts operations [~~to operate~~]. A radiation survey of the area above the pool of pool irradiators must [~~shall~~] be conducted after the sources

are loaded but before the facility starts operations [~~to operate~~]. Additional radiation surveys of the shielding must [~~shall~~] be performed at intervals not greater than [~~to exceed~~] three years and before resuming operations [~~operation~~] after addition of new sources or any modification to the radiation room shielding or structure that might increase dose rates.

(2) If the radiation levels specified in subsection (j) of this section are exceeded, the facility must [~~shall~~] be modified to comply with the requirements in subsection (j) of this section.

(3) Portable radiation survey meters must [~~shall~~] be calibrated at least annually to an accuracy of plus or minus 20 percent [~~20%~~] for the gamma energy of the sources in use. The calibration must [~~shall~~] 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 [~~shall~~] be of a type that does not saturate and read zero at high radiation dose rates.

(4) Water from the irradiator pool, other potentially contaminated liquids, and sediments from pool vacuuming must [~~shall~~] be monitored for radioactive contamination before release to unrestricted areas. Radioactive concentrations must [~~shall~~] not be greater than [~~exceed~~] those specified in Table 2, Column 2, or Table 3 of §289.202(ggg)(2) of this chapter [~~title~~].

(5) Before releasing resins for unrestricted use, the resins must [~~they shall~~] be monitored in an area with a background level less than 0.05 mrem (0.5 microsieverts (μSv)) [~~(0.5 μSv)~~] 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 [~~shall~~] be capable of detecting radiation levels of 0.05 mrem (0.5 μSv) per hour.

(w) Detection of leaking sources.

(1) Each dry-source-storage sealed source must [~~shall~~] be tested for leakage at intervals not greater than [~~to exceed~~] six months using a leak test kit or method approved by the department [~~agency~~], the NRC [~~the commission~~], or an agreement state[~~, or a licensing state~~]. In the absence of a certificate from a transferor that a test was [~~has been~~] made within the six months before the transfer, the sealed source must [~~may~~] not be used until tested. The test must [~~shall~~] be capable of detecting the presence of 0.005 microcurie (200 becquerels) of radioactive material and must [~~shall~~] be performed by a person approved by the department [~~agency~~], the NRC, or an agreement state[~~, or a licensing state to perform the test~~].

(2) For pool irradiators, sources must [~~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 was [~~has been~~] done within the six months before the transfer. Water from the pool must [~~shall~~] 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 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 [~~shall~~] 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 [~~shall~~] activate an alarm. The alarm set-point must [~~shall~~] 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 clear up contamination in the pool if specifically provided for in written emergency procedures.

(3) If a leaking source is detected, the licensee must [~~shall~~] arrange to remove the leaking source from service and decontaminate, repair, or dispose [~~have it decontaminated, repaired, or disposed~~] of it by a department [~~an agency~~], NRC, or agreement state[~~, or licensing state~~] licensee [~~who is~~] authorized to perform these functions. The licensee must [~~shall~~] promptly check its personnel, equipment, facilities, and irradiated product for radioactive contamination. No product may be shipped until the product is [~~has been~~] checked and found free of contamination. If a product is [~~has been~~] shipped and [~~that~~] may have been inadvertently contaminated, the licensee must [~~shall~~] arrange to locate and survey that product for contamination. If any personnel are found to be contaminated, decontamination must [~~shall~~] be performed promptly. If contaminated equipment, facilities, or products are found, the licensee must [~~shall~~] arrange to have them decontaminated or disposed of by a department [~~an agency~~], NRC, or agreement state[~~, or licensing state~~] licensee [~~who is~~] authorized to perform these functions. If a pool is contaminated, the licensee must [~~shall~~] arrange to clean the pool until the contamination levels are [~~do~~] not greater than [~~exceed~~] the appropriate concentration in Table 2, Column 2 of §289.202(ggg)(2) of this chapter [~~title~~]. (See §289.202(xx) and (yy) of this chapter [~~title~~] for reporting requirements.)

(x) Inspection and maintenance.

(1) The licensee must [~~shall~~] perform inspection and maintenance checks, including [~~that include~~], at [~~as~~] a minimum, each of the following, at the frequency specified in the license or license application:

(A) operability of each aspect of the access control system required by subsection (i) of this section;

(B) functionality [~~functioning~~] of the source position indicator required by subsection (m) (2) of this section;

(C) operability of the radiation monitor for radioactive contamination in pool water required by subsection (w)(2) of this section using a radiation check source, if applicable;

(D) operability of the over-pool radiation monitor at underwater irradiators as required by subsection (l)(2) of this section;

(E) operability of the product exit monitor required by subsection (l)(1) of this section;

(F) operability of the emergency source return control required by subsection (m)(3) of this section;

(G) leak-tightness of systems through which pool water circulates (visual inspection);

(H) operability of the heat and smoke detectors and extinguisher system required by subsection (k) of this section (but without turning extinguishers on);

(I) operability of the means of pool water replenishment required by subsection (n)(3) of this section;

(J) operability of the indicators of high and low pool water levels required by subsection (n)(4) of this section;

(K) operability of the intrusion alarm required by subsection (i)(8) of this section, if applicable;

(L) functionality [~~functioning~~] and wear of the system, mechanisms, and cables used to raise and lower sources;

(M) condition of the barrier to prevent products from hitting the sources or source mechanism as required by subsection (o) of this section;

(N) amount of water added to the pool to determine if the pool is leaking;

(O) electrical wiring on required safety systems for radiation damage;

(P) pool water conductivity measurements and analysis as required by subsection (y)(2) of this section; and

(Q) operability of automatic communications systems used to alert individuals to alarms, emergencies, or abnormal event conditions if required by subsection (z)(2)(A) of this section.

(2) Malfunctions and defects found during inspection and maintenance checks must [~~shall~~] be repaired without undue delay. If repairs are required, the irradiator must [~~shall~~] not be operated unless alternative methods are utilized to provide an equivalent level of safety until repairs are completed.

(y) Pool water purity.

(1) Pool water purification system must [~~shall~~] be run sufficiently to maintain the conductivity of the pool water below 20 microsiemens per centimeter under normal circumstances. If pool water conductivity rises above 20 microsiemens per centimeter, the licensee must [~~shall~~] take prompt actions to lower the pool water conductivity and must [~~shall~~] take corrective actions to prevent future recurrences.

(2) The licensee must [~~shall~~] measure the pool water conductivity no less than weekly[~~,~~] to assure [~~that~~] the conductivity remains below 20 microsiemens per centimeter. Conductivity meters must [~~shall~~] be calibrated at least annually.

(z) Attendance during operation.

(1) Both an irradiator operator and at least one other individual, [~~who is~~] trained

[~~on how~~] to respond to alarms as specified in [~~accordance with~~] subsection (s)(7) of this section and [~~is~~] prepared to promptly render or summon assistance, must [~~shall~~] be present onsite whenever it is necessary to enter the radiation room.

(2) At least one individual trained [~~who has received the training on how~~] to respond to alarms described in subsection (s)(7) of this section must [~~shall~~] be available and prepared to promptly respond to alarms, emergencies, or abnormal event conditions at any time a panoramic irradiator is operating. If the individual is not onsite, the following requirements must [~~shall~~] be met.

(A) Automatic means of communications must [~~shall~~] be provided from the irradiator control system to alert the individual to alarms, emergencies, or abnormal event conditions. As a minimum, the automatic communication system must [~~shall~~] alert the individual to those emergency or abnormal events listed in subsection (t)(2) of this section.

(B) The irradiator control system must [~~shall~~] be secured from unauthorized access at any time an irradiator operator is not onsite. This security must [~~shall~~] include physically securing the key described in subsection (m)(1) of this section to ensure the key is not removed from the control console.

(3) At an underwater irradiator, an irradiator operator must [~~shall~~] 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 [~~shall~~] have received the training described in subsection (s)(6) and (7) of this section. Static irradiations may be performed without a person present at the facility.

(aa) Entering and leaving the radiation room.

(1) Upon first entering the radiation room of a panoramic irradiator after an irradiation, the irradiator operator must [~~shall~~] use a survey meter to determine [~~that~~] the source has returned to its fully shielded position. The operator must [~~shall~~] check the functioning of the survey meter with a radiation check source before [~~prior to~~] entry.

(2) Before exiting from and locking the door to the radiation room of a panoramic irradiator before [~~prior to~~] a planned irradiation, the irradiator operator must [~~shall do the following~~]:

(A) visually inspect the entire radiation room to verify [~~that~~] no one else is in it; and

(B) activate a control in the radiation room permitting [~~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.

(3) During a power failure, the area around the pool of an underwater irradiator must [~~may~~] not be entered without using an operable and calibrated radiation survey meter unless the over-the-pool monitor required by subsection (l)(2) of this

section is operating with backup power.

(bb) Irradiation of explosive or flammable materials.

(1) Irradiation of explosive material is prohibited unless the licensee has received prior written authorization from the department [~~agency~~]. Authorization is [~~will~~] not [~~be~~] granted unless the licensee can demonstrate [~~that~~] detonation of the explosive would not rupture the sealed sources, injure personnel, damage safety systems, or cause radiation overexposures of personnel.

(2) Irradiation of more than small quantities of flammable material (flash point below 140 degrees Fahrenheit) is prohibited in panoramic irradiators unless the licensee receives [~~has received~~] prior written authorization from the department [~~agency~~]. Authorization is [~~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.

(cc) Records/documents. The licensee must [~~shall~~] maintain [~~the following~~] records/documents at the irradiator for the time intervals indicated for inspection by the department, including [~~agency~~]:

(1) a copy of the license, license conditions, documents incorporated into a license by reference, and amendments to the license until superseded by new documents or until the department [~~agency~~] terminates the license;

(2) records of each individual's training, tests, and safety reviews provided meeting [~~to meet~~] the requirements of subsection (s)(1) - (4), (6), and (7) of this section until three years after the individual terminates work;

(3) records of the annual evaluations of the safety performance of irradiator operators required by subsection (s)(5) of this section for three years after the evaluation;

(4) a copy of the current operating, safety, and emergency procedures required by subsection (t) of this section until superseded or the department [~~agency~~] terminates the license. Records of the RSO review and approval of changes in procedures as required by subsection (t)(3)(C) of this section, retained for three years from the date of the change;

(5) individual monitoring device [~~film badge, TLD, or OSL~~] results required by subsection (u) of this section until the department [~~agency~~] terminates the license;

(6) records of radiation surveys required by subsection (v) of this section for three years from the date of the survey;

(7) records of radiation survey meter calibrations required by subsection (v) of this section and pool water conductivity meter calibrations required by subsection (y)(2) of this section until three years from the date of calibration;

(8) records of the results of leak tests required by subsection (w)(1) of this

section and the results of contamination checks required by subsection (w)(2) of this section for three years from the date of each test;

(9) records of inspection and maintenance checks required by subsection (x) of this section for three years;

(10) records of major malfunctions, significant defects, operating difficulties or irregularities, and major operating problems involving [~~that involve~~] required radiation safety equipment for three years after repairs are completed;

(11) records of the receipt, transfer, and disposal[~~,~~] of all licensed sealed sources as required by §289.201(d) and §289.252(x) and (cc) of this chapter [~~title~~];

(12) records on the design checks required by subsection (q) of this section and the construction control checks [~~as~~] required by subsection (r) of this section until the license is terminated. The records must [~~shall~~] be signed and dated. The title or qualification of the person signing must [~~shall~~] be included; and

(13) records related to decommissioning of the irradiator [~~as~~] required by §289.252(gg)(7) of this subchapter [~~title~~].

(dd) Reports.

(1) In addition to the reporting requirements in other sections of this chapter [~~title~~], the licensee must [~~shall~~] report the following events if not reported as specified in [~~accordance with~~] other sections of this chapter [~~title~~]:

(A) source stuck in an unshielded position;

(B) any fire or explosion in a radiation room;

(C) damage to the source racks;

(D) failure of the cable or drive mechanism used to move the source racks;

(E) inoperability of the access control system;

(F) detection of radiation source by the product exit monitor;

(G) detection of radioactive contamination attributable to licensed radioactive material;

(H) structural damage to the pool liner or walls;

(I) abnormal water loss or leakage from the source storage pool; and

(J) pool water conductivity greater than [~~exceeding~~] 100 microsiemens per centimeter during normal operations.

(2) The report must [~~shall~~] include a telephone report within 24 hours as described in §289.202(xx)(8)(A) of this chapter [~~title~~], and a written report within 30 days as described in §289.202(xx)(8)(B) of this chapter [~~title~~].

Figure: 25 TAC §289.201(m)(1) [~~Figure: 25 TAC §289.201(n)(1)~~]

MEAN QUALITY FACTORS AND ABSORBED DOSE EQUIVALENCIES

TYPE OF RADIATION	Quality Factor (Q)	Absorbed Dose Equal to a Unit Dose Equivalent*
X, gamma, or beta radiation and high-speed electrons	1	1
Alpha particles, multiple-charged particles, fission fragments, and heavy particles of unknown charge	20	0.05
Neutrons of unknown energy	10	0.1
High-energy protons	10	0.1

*Absorbed dose in gray equal to 1 Sv or the absorbed dose in rad equal to 1 rem.

Figure: 25 TAC §289.201(m)(2) [~~Figure: 25 TAC §289.201(n)(2)~~]

MEAN QUALITY FACTORS, Q, AND FLUENCE PER UNIT
DOSE EQUIVALENT FOR MONOENERGETIC NEUTRONS

Neutron Energy (MeV)	Quality Factor** (Q)	Fluence per Unit Dose Equivalent* (neutrons $cm^{-2}rem^{-1}$)	Fluence per Unit Dose Equivalent* (neutrons $cm^{-2}Sv^{-1}$)
(thermal) 2.5×10^{-8}	2	980×10^6	980×10^8
1.0×10^{-7}	2	980×10^6	980×10^8
1.0×10^{-6}	2	810×10^6	810×10^8
1.0×10^{-5}	2	810×10^6	810×10^8
1.0×10^{-4}	2	840×10^6	840×10^8
1.0×10^{-3}	2	980×10^6	980×10^8
1.0×10^{-2}	2.5	$1{,}010 \times 10^6$	$1{,}010 \times 10^8$
1.0×10^{-1}	7.5	170×10^6	170×10^8
5.0×10^{-1}	11	39×10^6	39×10^8
1.0	11	27×10^6	27×10^8
2.5	9	29×10^6	29×10^8
5.0	8	23×10^6	23×10^8
7.0	7	24×10^6	24×10^8
10	6.5	24×10^6	24×10^8
14	7.5	17×10^6	17×10^8
20	8	16×10^6	16×10^8
40	7	14×10^6	14×10^8
60	5.5	16×10^6	16×10^8
1.0×10^2	4	20×10^6	20×10^8
2.0×10^2	3.5	19×10^6	19×10^8
3.0×10^2	3.5	16×10^6	16×10^8
4.0×10^2	3.5	14×10^6	14×10^8

*Monoenergetic neutrons incident normally on a 30-centimeter diameter cylinder tissue-equivalent phantom.

**Value of quality factor (Q) at the point where the dose equivalent [~~DE~~] is maximum in a 30-centimeter diameter cylinder tissue-equivalent phantom.

[Figure: 25 TAC §289.201(m)(2)(A)(ii)

"INFORMATION FALLING WITHIN EXCEPTION OF THE TEXAS PUBLIC INFORMATION ACT, GOVERNMENT CODE, CHAPTER 552 --- CONFIDENTIAL

This document contains information submitted to Radiation Control, Department of State Health Services by] [_____
(Name of Company) (Name of Submitter)

that is claimed to fall within the following exception to the Texas Public Information Act, Government Code, Chapter 552, Subchapter C] [_____
(Appropriate Subsection)

WITHHOLD FROM PUBLIC DISCLOSURE

(Signature and Title) (Office) (Date)"]

Figure: 25 TAC §289.202(ee)(4)(A)(ii)

Contaminant	Maximum Permissible Limits	
	pCi/cm2 *	dpm/cm2 **
Beta-gamma emitting radionuclides; all radionuclides with half-lives less than 10 days; natural uranium; natural thorium, uranium-235; uranium-238; thorium-232; thorium-228; and thorium-230 when contained in ores or physical concentrates….	100	220
All other alpha emitting radionuclides….	10	22

* To convert picocuries (pCi) to SI units of millibecquerels, multiply the values by 37.

** disintegrations per minute (dpm)

Figure: 25 TAC §289.202(ggg)(1)

	Operating Mode	Assigned Protection Factors
I. Air Purifying Respirators (Particulate[b] only)[c]:		
Filtering faceplate disposable[d]	Negative Pressure	([d])
Facepiece, half[e]	Negative Pressure	10
Facepiece, full	Negative Pressure	100
Facepiece, half	Powered air-purifying respirators	50
Facepiece, full	Powered air-purifying respirators	1000
Helmet/hood	Powered air-purifying respirators	1000
Facepiece, loose-fitting	Powered air-purifying respirators	25
II. Atmosphere Supplying Respirators (particulate, gases and vapors[f]):		
1. Air-line respirator		
Facepiece, half	Demand	10
Facepiece, half	Continuous Flow	50
Facepiece, half	Pressure Demand	50
Facepiece, full	Demand	100
Facepiece, full	Continuous Flow	1000
Facepiece, full	Pressure Demand	1000
Helmet/hood	Continuous Flow	1000
Facepiece, loose-fitting	Continuous Flow	25
Suit	Continuous Flow	([g])
2. Self-contained breathing apparatus (SCBA):		
Facepiece, full	Demand	[h]100
Facepiece, full	Pressure Demand	[i]10,000
Facepiece, full	Demand, Recirculating	[h]100
Facepiece, full	Positive Pressure Recirculating	[i]10,000
III. Combination Respirators		
Any combination of air-purifying atmosphere-supplying respirators	Assigned protection factor for type and mode of operation as listed above	

[a]These assigned protection factors apply only in a respiratory protection program that meets the requirements of this section. They are applicable only to airborne radiological hazards and may not be appropriate to circumstances when chemical or other respiratory hazards exist instead of, or in addition to, radioactive hazards. Selection and use of respirators for such circumstances shall also comply with Department of Labor regulations.

Radioactive contaminants for which the concentration values in Table 1, Column 3 of subsection (ggg)(2)(F) of this section 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.

[b]Air purifying respirators with APF < 100 must be equipped with particulate filters that are at least 95 percent [~~%~~] efficient. Air purifying respirators with APF = 100 shall be equipped with particulate filters that are at least 99 percent [~~%~~] efficient. Air purifying respirators with APFs > 100 shall be equipped with particulate filters that are at least 99.97 percent [~~%~~] efficient.

[c]The licensee may apply to the agency for the use of an APF greater than 1 for sorbent cartridges as protection against airborne radioactive gases and vapors (e.g., radioiodine).

[d]Licensees may permit individuals to use this type of respirator who have not been medically screened or fit tested on the device provided that no credit be taken for their use in estimating intake or dose. It is also recognized that it is difficult to perform an effective positive or negative pressure pre-use seal check on this type of device. All other respiratory protection program requirements listed in subsection (x) of this section apply. An assigned protection factor has not been assigned for these devices. However, an APF equal to 10 may be used if the licensee can demonstrate a fit factor of at least 100 by use of a validated or evaluated, qualitative or quantitative fit test.

[e]Under-chin type only. No distinction is made in this paragraph between elastomeric half-masks with replaceable cartridges and those designed with the filter medium as an integral part of the facepiece (e.g., disposable or reusable disposable). Both types are acceptable so long as the seal area of the latter contains some substantial type of seal-enhancing material such as rubber or plastic, the two or more suspension straps are adjustable, the filter medium is at least 95 percent [~~%~~] efficient, and all other requirements of this section are met.

[f]The assigned protection factors for gases and vapors are not applicable to radioactive contaminants that present an absorption or submersion hazard. For tritium oxide vapor, approximately one-third of the intake occurs by absorption through the skin so that an overall protection factor of 3 is appropriate when atmosphere-supplying respirators are used to protect against tritium oxide. Exposure to radioactive noble gases is not considered a significant respiratory hazard, and protective actions for these contaminants should be based on external (submersion) dose considerations.

[g]No NIOSH approval schedule is currently available for atmosphere supplying suits. This equipment may be used in an acceptable respiratory protection program as long as all the other minimum program requirements, with the exception of fit testing, are met, for example, subsection (x) of this section.

[h]The licensee should implement institutional controls to assure that these devices are not used in areas immediately dangerous to life or health (IDLH).

[i]This type of respirator may 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 shall be taken into account in these circumstances. This device may not be used by any individual who experiences perceptible outward leakage of breathing gas while wearing the device.

[~~Figure: 25 TAC §289.202(ggg)(2)(B)(vi)~~

~~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 efective dose equivalent. However, the licensee shall also ensure that the 50 rems (0.5 sievert) dose equivalent limit for any organ or tissue it not exceeded by the sum of the external deep dose equivalent plus the internal committed dose equivalent to that organ, not the effective dose. For the case where there is no external dose contribution, this would be demonstrated if the sum of the fractions of the nonstochastic ALIs (ALI_{ns}) that contribute to the committed dose equivalent to the organ receiving the highest dose does not exceed unity, that is, Σ (intake in μCi) of each radionuclide/ALI_{ns}) $\leq$ 1.0. If there is an external deep dose equivalent contribution to H_d, then this sum must be less than 1 - (H_d/50), instead of $\leq$ 1.0.~~]

Figure: 25 TAC §289.202(ggg)(2)(B)(vii) [~~§289.202(ggg)(2)(B)(viii)~~]

DAC = ALI(in μCi)/(2000 hours per working year x 60 minutes/hour x 2 x 10^4 milliliters (mL) [~~ml~~] per minute) = [ALI/2.4 x 10^9]
μCi/mL [~~μCi/ml~~],

where 2 x 10^4 mL [~~milliliter~~] is the volume of air breathed per minute at work by Reference Man under working conditions of light work.

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/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 HTO.						
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 LLI wall	2E+2	6E-8	2E-10	-	-
			(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
7	Nitrogen-13[2]	Submersion[1]	–	4E-6	2E-8	–	–	–
8	Oxygen-15[2]	Submersion[1]	–	4E-6	2E-8	–	–	–
9	Fluorine-18[2]	D, fluorides of H, Li, Na, K, Rb, Cs, and Fr	5E+4 St wall	7E+4	3E-5	1E-7	-	
			(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	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
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 LLI wall	2E+2	1E-7	3E-10	-	-
			(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	-	-
15	Phosphorus-32	D, all compounds except phosphates given for W	6E+2	9E+2	4E-7	1E-9	9E-6	9E-5
		W, phosphates of Zn^{2+},S^{3+}, Mg^{2+}, Fe^{3+}, Bi^{3+}, and lanthanides	-	4E+2	2E-7	5E-10	-	-
15	Phosphorus-33	D, see ^{32}P	6E+3	8E+3	4E-6	1E-8	8E-5	8E-4
		W, see ^{32}P	-	3E+3	1E-6	4E-9	-	-
16	Sulfur-35	Vapor	-	1E+4	6E-6	2E-8	-	-
		D, sulfides and sulfates except those given for W	1E+4 LLI wall	2E+4	7E-6	2E-8	-	-
			(8E+3)	-	-	-	1E-4	1E-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	6E+3 -	2E+3	9E-7	3E-9	-	-
17	Chlorine-36	D, chlorides of H, Li, Na, K, Rb, Cs, and Fr	2E+3	2E+3	1E-6	3E-9	2E-5	2E-4
		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+2	1E-7	3E-10	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
17	Chlorine-38[2]	D, see ^{36}Cl	2E+4 St wall	4E+4	2E-5	6E-8	-	-
			(3E+4)	-	-	-	3E-4	3E-3
		W, see ^{36}Cl	-	5E+4	2E-5	6E-8	-	-
17	Chlorine-39[2]	D, see ^{36}Cl	2E+4 St wall	5E+4	2E-5	7E-8	-	-
			(4E+4)	-	-	-	5E-4	5E-3
		W, see ^{36}Cl	-	6E+4	2E-5	8E-8	-	-
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	2E+4 St wall	7E+4	3E-5	9E-8	-	-
			(4E+4)	-	-	-	5E-4	5E-3
19	Potassium-45[2]	D, all compounds	3E+4 St wall	1E+5	5E-5	2E-7	-	-
			(5E+4)	-	-	-	7E-4	7E-3
20	Calcium-41	W, all compounds	3E+3 Bone surf	4E+3 Bone surf	2E-6	-	-	-
			(4E+3)	(4E+3)	-	5E-9	6E-5	6E-4
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 LLI wall	3E+3	1E-6	4E-9	-	-
			(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, $SrTi0_3$	-	6E+0	2E-9	8E-12	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
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 St wall	8E+4	3E-5	1E-7	-	-
			(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 LLI wall	3E+4 Bone surf	1E-5	-	-	-
			(9E+4)	(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	-	-
25	Manganese-52m[2]	D, see ^{51}Mn	3E+4 St wall	9E+4	4E-5	1E-7	-	-
			(4E+4)	-	-	-	5E-4	5E-3
		W, see ^{51}Mn	-	1E+5	4E-5	1E-7	-	-
25	Manganese-52	D, see ^{51}Mn	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
		W, see ^{51}Mn	-	9E+2	4E-7	1E-9	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
25	Manganese-53	D, see ^{51}Mn	5E+4	1E+4 Bone surf	5E-6	-	7E-4	7E-3
				(2E+4)	-	3E-8	-	-
25	Manganese-54	D, see ^{51}Mn	2E+3	9E+2	4E-7	1E-9	3E-5	3E-4
		W, see ^{51}Mn	-	8E+2	3E-7	1E-9	-	-
25	Manganese-56	D, see ^{51}Mn	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
		W, see ^{51}Mn	-	2E+4	9E-6	3E-8	-	-
26	Iron-52	D, all compounds except those given for W	9E+2	3E+3	1E-6	4E-9	1E-5	1E-4
		W, oxides, hydroxides, and halides	-	2E+3	1E-6	3E-9	-	-
26	Iron-55	D, see ^{52}Fe	9E+3	2E+3	8E-7	3E-9	1E-4	1E-3
		W, see ^{52}Fe	-	4E+3	2E-6	6E-9	-	-
26	Iron-59	D, see ^{52}Fe	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
		W, see ^{52}Fe	-	5E+2	2E-7	7E-10	-	-
26	Iron-60	D, see ^{52}Fe	3E+1	6E+0	3E-9	9E-12	4E-7	4E-6
		W, see ^{52}Fe	-	2E+1	8E-9	3E-11	-	-
27	Cobalt-55	W, all compounds except those given for Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, oxides, hydroxides,halides, and nitrates	-	3E+3	1E-6	4E-9	-	-
27	Cobalt-56	W, see ^{55}Co	5E+2	3E+2	1E-7	4E-10	6E-6	6E-5
		Y, see ^{55}Co	4E+2	2E+2	8E-8	3E-10	-	-
27	Cobalt-57	W, see ^{55}Co	8E+3	3E+3	1E-6	4E-9	6E-5	6E-4
		Y, see ^{55}Co	4E+3	7E+2	3E-7	9E-10	-	-
27	Cobalt-58m	W, see ^{55}Co	6E+4	9E+4	4E-5	1E-7	8E-4	8E-3
		Y, see ^{55}Co	-	6E+4	3E-5	9E-8	-	-
27	Cobalt-58	W, see ^{55}Co	2E+3	1E+3	5E-7	2E-9	2E-5	2E-4
		Y, see ^{55}Co	1E+3	7E+2	3E-7	1E-9	-	-
27	Cobalt-60m[2]	W, see ^{55}Co	1E+6 St wall	4E+6	2E-3	6E-6	-	-
			(1E+6)	-	-	-	2E-2	2E-1
		Y, see ^{55}Co	-	3E+6	1E-3	4E-6	-	-
27	Cobalt-60	W, see ^{55}Co	5E+2	2E+2	7E-8	2E-10	3E-6	3E-5
		Y, see ^{55}Co	2E+2	3E+1	1E-8	5E-11	-	-
27	Cobalt-61[2]	W, see ^{55}Co	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		Y, see ^{55}Co	2E+4	6E+4	2E-5	8E-8	-	-
27	Cobalt-62m[2]	W, see ^{55}Co	4E+4 St wall	2E+5	7E-5	2E-7	-	-
			(5E+4)	-	-	-	7E-4	7E-3
		Y, see ^{55}Co	-	2E+5	6E-5	2E-7	-	-

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

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
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
31	Gallium-65[2]	D, all compounds except those given for W	5E+4 St wall	2E+5	7E-5	2E-7	-	-
			(6E+4)	-	-	-	9E-4	9E-3
		W, oxides, hydroxides, carbides, halides, and nitrates	-	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	2E+5	7E-5	2E-7	-	-
			(7E+4)	-	-	-	1E-3	1E-2
		W, see ^{65}Ga	-	2E+5	8E-5	3E-7	-	-
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	9E+4	4E-5	1E-7	-	-
			(4E+4)	-	-	-	6E-4	6E-3
		W, see ^{66}Ge	-	1E+5	4E-5	1E-7	-	-
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	8E+4	3E-5	1E-7	-	-
			(7E+4)	-	-	-	9E-4	9E-3
		W, see ^{66}Ge	-	8E+4	4E-5	1E-7	-	-
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	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
32	Germanium-78[2]	D, see ^{66}Ge	2E+4 St wall	2E+4	9E-6	3E-8	-	-
			(2E+4)	-	-	-	3E-4	3E-3
		W, see ^{66}Ge	-	2E+4	9E-6	3E-8	-	-
33	Arsenic-69[2]	W, all compounds	3E+4 St wall	1E+5	5E-5	2E-7	-	-
			(4E+4)	-	-	-	6E-4	6E-3
33	Arsenic-70[2]	W, all compounds	1E+4	5E+4	2E-5	7E-8	2E-4	2E-3
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	2E-6	7E-9	-	-
			(5E+3)	-	-	-	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	2E+4	4E+4	2E-5	5E-8	1E-4	1E-3
		W, oxides, hydroxides, carbides, and elemental Se	1E+4	4E+4	2E-5	6E-8	-	-
34	Selenium-73m[2]	D, see ^{70}Se	6E+4	2E+5	6E-5	2E-7	4E-4	4E-3
		W, see ^{70}Se	3E+4	1E+5	6E-5	2E-7	-	-
34	Selenium-73	D, see ^{70}Se	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
		W, see ^{70}Se	-	2E+4	7E-6	2E-8	-	-
34	Selenium-75	D, see ^{70}Se	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
		W, see ^{70}Se	-	6E+2	3E-7	8E-10	-	-
34	Selenium-79	D, see ^{70}Se	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
		W, see ^{70}Se	-	6E+2	2E-7	8E-10	-	-
34	Selenium-81m[2]	D, see ^{70}Se	4E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		W, see ^{70}Se	2E+4	7E+4	3E-5	1E-7	-	-
34	Selenium-81[2]	D, see ^{70}Se	6E+4 St wall	2E+5	9E-5	3E-7	-	-
			(8E+4)	-	-	-	1E-3	1E-2
		W, see ^{70}Se	-	2E+5	1E-4	3E-7	-	-
34	Selenium-83[2]	D, see ^{70}Se	4E+4	1E+5	5E-5	2E-7	4E-4	4E-3
		W, see ^{70}Se	3E+4	1E+5	5E-5	2E-7	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
35	Bromine-74m[2]	D, bromides of H, Li, Na, K, Rb, Cs, and Fr	1E+4 St wall	4E+4	2E-5	5E-8	-	-
			(2E+4)	-	-	-	3E-4	3E-3
		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	-	4E+4	2E-5	6E-8	-	-
35	Bromine-74[2]	D, see ^{74m}Br	2E+4 St wall	7E+4	3E-5	1E-7	-	-
			(4E+4)	-	-	-	5E-4	5E-3
		W, see ^{74m}Br	-	8E+4	4E-5	1E-7	-	-
35	Bromine-75[2]	D, see ^{74m}Br	3E+4 St wall	5E+4	2E-5	7E-8	-	-
			(4E+4)	-	-	-	5E-4	5E-3
		W, see ^{74m}Br	-	5E+4	2E-5	7E-8	-	-
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	2E+5	8E-5	3E-7	-	-
			(9E+4)	-	-	-	1E-3	1E-2
		W, see ^{74m}Br	-	2E+5	9E-5	3E-7	-	-
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	6E+4	3E-5	9E-8	-	-
			(7E+4)	-	-	-	9E-4	9E-3
		W, see ^{74m}Br	-	6E+4	3E-5	9E-8	-	-
35	Bromine-84[2]	D, see ^{74m}Br	2E+4 St wall	6E+4	2E-5	8E-8	-	-
			(3E+4)	-	-	-	4E-4	4E-3
		W, see ^{74m}Br	-	6E+4	3E-5	9E-8	-	-
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	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
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	1E+5	5E-5	2E-7	-	-
			(6E+4)	-	-	-	8E-4	8E-3
37	Rubidium-81m[2]	D, all compounds	2E+5 St wall	3E+5	1E-4	5E-7	-	-
			(3E+5)	-	-	-	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
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 St wall	6E+4	3E-5	9E-8	-	-
			(3E+4)	-	-	-	4E-4	4E-3
37	Rubidium-89[2]	D, all compounds	4E+4 St wall	1E+5	6E-5	2E-7	-	-
			(6E+4)	-	-	-	9E-4	9E-3
38	Strontium-80[2]	D, all soluble compounds except $SrTiO_3$	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		Y, all insoluble compounds and $SrTi0_3$	-	1E+4	5E-6	2E-8	-	-
38	Strontium-81[2]	D, see ^{80}Sr	3E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		Y, see ^{80}Sr	2E+4	8E+4	3E-5	1E-7	-	-
38	Strontium-82	D, see ^{80}Sr	3E+2 LLI wall	4E+2	2E-7	6E-10	-	-
			(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	3E+3	7E+3	3E-6	1E-8	3E-5	3E-4
		Y, see ^{80}Sr	2E+3	4E+3	1E-6	5E-9	-	-
38	Strontium-85m[2]	D, see ^{80}Sr	2E+5	6E+5	3E-4	9E-7	3E-3	3E-2
		Y, see ^{80}Sr	-	8E+5	4E-4	1E-6	-	-
38	Strontium-85	D, see ^{80}Sr	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
		Y, see ^{80}Sr	-	2E+3	6E-7	2E-9	-	-
38	Strontium-87m	D, see ^{80}Sr	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		Y, see ^{80}Sr	4E+4	2E+5	6E-5	2E-7	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
38	Strontium-89	D, see ^{80}Sr	6E+2 LLI wall	8E+2	4E-7	1E-9	-	-
			(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 Bone surf	2E+1 Bone surf	8E-9	-	-	-
			(4E+1)	(2E+1)	-	3E-11	5E-7	5E-6
		Y, see ^{80}Sr	-	4E+0	2E-9	6E-12	-	-
38	Strontium-91	D, see ^{80}Sr	2E+3	6E+3	2E-6	8E-9	2E-5	2E-4
		Y, see ^{80}Sr	-	4E+3	1E-6	5E-9	-	-
38	Strontium-92	D, see ^{80}Sr	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		Y, see ^{80}Sr	-	7E+3	3E-6	9E-9	-	-
39	Yttrium-86m[2]	W, all compounds except those given for Y	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
		Y, oxides and hydroxides	-	5E+4	2E-5	8E-8	-	-
39	Yttrium-86	W, see ^{86m}Y	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
		Y, see ^{86m}Y	-	3E+3	1E-6	5E-9	-	-
39	Yttrium-87	W, see ^{86m}Y	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
		Y, see ^{86m}Y	-	3E+3	1E-6	5E-9	-	-
39	Yttrium-88	W, see ^{86m}Y	1E+3	3E+2	1E-7	3E-10	1E-5	1E-4
		Y, see ^{86m}Y	-	2E+2	1E-7	3E-10	-	-
39	Yttrium-90m	W, see ^{86m}Y	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
		Y, see ^{86m}Y	-	1E+4	5E-6	2E-8	-	-
39	Yttrium-90	W, see ^{86m}Y	4E+2 LLI wall	7E+2	3E-7	9E-10	-	-
			(5E+2)	-	-	-	7E-6	7E-5
		Y, see ^{86m}Y	-	6E+2	3E-7	9E-10	-	-
39	Yttrium-91m[2]	W, see ^{86m}Y	1E+5	2E+5	1E-4	3E-7	2E-3	2E-2
		Y, see ^{86m}Y	-	2E+5	7E-5	2E-7	-	-
39	Yttrium-91	W, see ^{86m}Y	5E+2 LLI wall	2E+2	7E-8	2E-10	-	-
			(6E+2)	-	-	-	8E-6	8E-5
		Y, see ^{86m}Y	-	1E+2	5E-8	2E-10	-	-
39	Yttrium-92	W, see ^{86m}Y	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		Y, see ^{86m}Y	-	8E+3	3E-6	1E-8	-	-
39	Yttrium-93	W, see ^{86m}Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, see ^{86m}Y	-	2E+3	1E-6	3E-9	-	-
39	Yttrium-94[2]	W, see ^{86m}Y	2E+4 St wall	8E+4	3E-5	1E-7	-	-
			(3E+4)	-	-	-	4E-4	4E-3
		Y, see ^{86m}Y	-	8E+4	3E-5	1E-7	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
39	Yttrium-95[2]	W, see ^{86m}Y	4E+4 St wall	2E+5	6E-5	2E-7	-	-
			(5E+4)	-	-	-	7E-4	7E-3
		Y, see ^{86m}Y	-	1E+5	6E-5	2E-7	-	-
40	Zirconium-86	D, all compounds except those given for W and Y	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
		W, oxides, hydroxides, halides, and nitrates	-	3E+3	1E-6	4E-9	-	-
		Y, carbide	-	2E+3	1E-6	3E-9	-	-
40	Zirconium-88	D, see ^{86}Zr	4E+3	2E+2	9E-8	3E-10	5E-5	5E-4
		W, see ^{86}Zr	-	5E+2	2E-7	7E-10	-	-
		Y, see ^{86}Zr	-	3E+2	1E-7	4E-10	-	-
40	Zirconium-89	D, see ^{86}Zr	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ^{86}Zr	-	2E+3	1E-6	3E-9	-	-
		Y, see ^{86}Zr	-	2E+3	1E-6	3E-9	-	-
40	Zirconium-93	D, see ^{86}Zr	1E+3 Bone surf	6E+0 Bone surf	3E-9	-	-	-
			(3E+3)	(2E+1)	-	2E-11	4E-5	4E-4
		W, see ^{86}Zr	-	2E+1 Bone surf	1E-8	-	-	-
			-	(6E+1)	-	9E-11	-	-
		Y, see ^{86}Zr	-	6E+1 Bone surf	2E-8	-	-	-
			-	(7E+1)	-	9E-11	-	-
40	Zirconium-95	D, see ^{86}Zr	1E+3	1E+2 Bone surf	5E-8	-	2E-5	2E-4
			-	(3E+2)	-	4E-10	-	-
		W, see ^{86}Zr	-	4E+2	2E-7	5E-10	-	-
		Y, see ^{86}Zr	-	3E+2	1E-7	4E-10	-	-
40	Zirconium-97	D, see ^{86}Zr	6E+2	2E+3	8E-7	3E-9	9E-6	9E-5
		W, see ^{86}Zr	-	1E+3	6E-7	2E-9	-	-
		Y, see ^{86}Zr	-	1E+3	5E-7	2E-9	-	-
41	Niobium-88[2]	W, all compounds except those given for Y	5E+4 St wall	2E+5	9E-5	3E-7	-	-
			(7E+4)	-	-	-	1E-3	1E-2
		Y, oxides and hydroxides	-	2E+5	9E-5	3E-7	-	-
41	Niobium-89m[2] (66 min)	W, see ^{88}Nb	1E+4	4E+4	2E-5	6E-8	1E-4	1E-3
		Y, see ^{88}Nb	-	4E+4	2E-5	5E-8	-	-
41	Niobium-89 (122 min)	W, see ^{88}Nb	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
		Y, see ^{88}Nb	-	2E+4	6E-6	2E-8	-	-
41	Niobium-90	W, see ^{88}Nb	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		Y, see ^{88}Nb	-	2E+3	1E-6	3E-9	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
41	Niobium-93m	W, see ^{88}Nb	9E+3 LLI wall	2E+3	8E-7	3E-9	-	-
			(1E+4)	-	-	-	2E-4	2E-3
		Y, see ^{88}Nb	-	2E+2	7E-8	2E-10	-	-
41	Niobium-94	W, see ^{88}Nb	9E+2	2E+2	8E-8	3E-10	1E-5	1E-4
		Y, see ^{88}Nb	-	2E+1	6E-9	2E-11	-	-
41	Niobium-95m	W, see ^{88}Nb	2E+3 LLI wall	3E+3	1E-6	4E-9	-	-
			(2E+3)	-	-	-	3E-5	3E-4
		Y, see ^{88}Nb	-	2E+3	9E-7	3E-9	-	-
41	Niobium-95	W, see ^{88}Nb	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
		Y, see ^{88}Nb	-	1E+3	5E-7	2E-9	-	-
41	Niobium-96	W, see ^{88}Nb	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, see ^{88}Nb	-	2E+3	1E-6	3E-9	-	-
41	Niobium-97[2]	W, see ^{88}Nb	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		Y, see ^{88}Nb	-	7E+4	3E-5	1E-7	-	-
41	Niobium-98[2]	W, see ^{88}Nb	1E+4	5E+4	2E-5	8E-8	2E-4	2E-3
		Y, see ^{88}Nb	-	5E+4	2E-5	7E-8	-	-
42	Molybdenum-90	D, all compounds except those given for Y	4E+3	7E+3	3E-6	1E-8	3E-5	3E-4
		Y, oxides, hydroxides, and MoS_2	2E+3	5E+3	2E-6	6E-9	-	-
42	Molybdenum-93m	D, see ^{90}Mo	9E+3	2E+4	7E-6	2E-8	6E-5	6E-4
		Y, see ^{90}Mo	4E+3	1E+4	6E-6	2E-8	-	-
42	Molybdenum-93	D, see ^{90}Mo	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4
		Y, see ^{90}Mo	2E+4	2E+2	8E-8	2E-10	-	-
42	Molybdenum-99	D, see ^{90}Mo	2E+3 LLI wall	3E+3	1E-6	4E-9	-	-
			(1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{90}Mo	1E+3	1E+3	6E-7	2E-9	-	-
42	Molybdenum-101[2]	D, see ^{90}Mo	4E+4 St wall	1E+5	6E-5	2E-7	-	-
			(5E+4)	-	-	-	7E-4	7E-3
		Y, see ^{90}Mo	-	1E+5	6E-5	2E-7	-	-
43	Technetium-93m[2]	D, all compounds except those given for W	7E+4	2E+5	6E-5	2E-7	1E-3	1E-2
		W, oxides, hydroxides, halides, and nitrates	-	3E+5	1E-4	4E-7	-	-
43	Technetium-93	D, see ^{93m}Tc	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
		W, see ^{93m}Tc	-	1E+5	4E-5	1E-7	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
43	Technetium-94m[2]	D, see ^{93m}Tc	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
		W, see ^{93m}Tc	-	6E+4	2E-5	8E-8	-	-
43	Technetium-94	D, see ^{93m}Tc	9E+3	2E+4	8E-6	3E-8	1E-4	1E-3
		W, see ^{93m}Tc	-	2E+4	1E-5	3E-8	-	-
43	Technetium-95m	D, see ^{93m}Tc	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4
		W, see ^{93m}Tc	-	2E+3	8E-7	3E-9	-	-
43	Technetium-95	D, see ^{93m}Tc	1E+4	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{93m}Tc	-	2E+4	8E-6	3E-8	-	-
43	Technetium-96m[2]	D, see ^{93m}Tc	2E+5	3E+5	1E-4	4E-7	2E-3	2E-2
		W, see ^{93m}Tc	-	2E+5	1E-4	3E-7	-	-
43	Technetium-96	D, see ^{93m}Tc	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
		W, see ^{93m}Tc	-	2E+3	9E-7	3E-9	-	-
43	Technetium-97m	D, see ^{93m}Tc	5E+3	7E+3 St wall	3E-6	-	6E-5	6E-4
			-	(7E+3)	-	1E-8	-	-
		W, see ^{93m}Tc	-	1E+3	5E-7	2E-9	-	-
43	Technetium-97	D, see ^{93m}Tc	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
		W, see ^{93m}Tc	-	6E+3	2E-6	8E-9	-	-
43	Technetium-98	D, see ^{93m}Tc	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
		W, see ^{93m}Tc	-	3E+2	1E-7	4E-10	-	-
43	Technetium-99m	D, see ^{93m}Tc	8E+4	2E+5	6E-5	2E-7	1E-3	1E-2
		W, see ^{93m}Tc	-	2E+5	1E-4	3E-7	-	-
43	Technetium-99	D, see ^{93m}Tc	4E+3	5E+3 St wall	2E-6	-	6E-5	6E-4
			-	(6E+3)	-	8E-9	-	-
		W, see ^{93m}Tc	-	7E+2	3E-7	9E-10	-	-
43	Technetium-101[2]	D, see ^{93m}Tc	9E+4 St wall	3E+5	1E-4	5E-7	-	-
			(1E+5)	-	-	-	2E-3	2E-2
		W, see ^{93m}Tc	-	4E+5	2E-4	5E-7	-	-
43	Technetium-104[2]	D, see ^{93m}Tc	2E+4 St wall	7E+4	3E-5	1E-7	-	-
			(3E+4)	-	-	-	4E-4	4E-3
		W, see ^{93m}Tc	-	9E+4	4E-5	1E-7	-	-
44	Ruthenium-94[2]	D, all compounds except those given for W and Y	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, halides	-	6E+4	3E-5	9E-8	-	-
		Y, oxides and hydroxides	-	6E+4	2E-5	8E-8	-	-
44	Ruthenium-97	D, see ^{94}Ru	8E+3	2E+4	8E-6	3E-8	1E-4	1E-3
		W, see ^{94}Ru	-	1E+4	5E-6	2E-8	-	-
		Y, see ^{94}Ru	-	1E+4	5E-6	2E-8	-	-
44	Ruthenium-103	D, see ^{94}Ru	2E+3	2E+3	7E-7	2E-9	3E-5	3E-4
		W, see ^{94}Ru	-	1E+3	4E-7	1E-9	-	-
		Y, see ^{94}Ru	-	6E+2	3E-7	9E-10	-	-

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

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
45	Rhodium-107[2]	D, see ^{99m}Rh	7E+4 St wall	2E+5	1E-4	3E-7	-	-
			(9E+4)	-	-	-	1E-3	1E-2
		W, see ^{99m}Rh	-	3E+5	1E-4	4E-7	-	-
		Y, see ^{99m}Rh	-	3E+5	1E-4	3E-7	-	-
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 LLI wall	6E+3	3E-6	9E-9	-	-
			(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 LLI wall	2E+4 Kidneys	9E-6	-	-	-
			(4E+4)	(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 St wall	2E+5	8E-5	2E-7	-	-
			(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	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
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 St. wall	2E+5	8E-5	3E-7	-	-
			(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	-	-
47	Silver-111	D, see ^{102}Ag	9E+2 LLI wall	2E+3 Liver	6E-7	-	-	-
			(1E+3)	(2E+3)	-	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	9E+4	4E-5	1E-7	-	-
			(3E+4)	-	-	-	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	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
48	Cadmium-109	D, see ^{104}Cd	3E+2 Kidneys	4E+1 Kidneys	1E-8	-	-	-
			(4E+2)	(5E+1)	-	7E-11	6E-6	6E-5
		W, see ^{104}Cd	-	1E+2 Kidneys	5E-8	-	-	-
			-	(1E+2)	-	2E-10	-	-
		Y, see ^{104}Cd	-	1E+2	5E-8	2E-10	-	-
48	Cadmium-113m	D, see ^{104}Cd	2E+1 Kidneys	2E+0 Kidneys	1E-9	-	-	-
			(4E+1)	(4E+0)	-	5E-12	5E-7	5E-6
		W, see ^{104}Cd	-	8E+0 Kidneys	4E-9	-	-	-
			-	(1E+1)	-	2E-11	-	-
		Y, see ^{104}Cd	-	1E+1	5E-9	2E-11	-	-
48	Cadmium-113	D, see ^{104}Cd	2E+1 Kidneys	2E+0 Kidneys	9E-10	-	-	-
			(3E+1)	(3E+0)	-	5E-12	4E-7	4E-6
		W, see ^{104}Cd	-	8E+0 Kidneys	3E-9	-	-	-
			-	(1E+1)	-	2E-11	-	-
		Y, see ^{104}Cd	-	1E+1	6E-9	2E-11	-	-
48	Cadmium-115m	D, see ^{104}Cd	3E+2	5E+1 Kidneys	2E-8	-	4E-6	4E-5
			-	(8E+1)	-	1E-10	-	-
		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	6E-7	2E-9	-	-
			(1E+3)	-	-	-	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	-	-
48	Cadmium-117	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	-	-
49	Indium-109	D, all compounds except those given for W	2E+4	4E+4	2E-5	6E-8	3E-4	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-4	2E-3
		W, see ^{109}In	-	6E+4	2E-5	8E-8	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
49	Indium-110 (4.9 h)	D, see ^{109}In	5E+3	2E+4	7E-6	2E-8	7E-5	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-5	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-3	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-4	7E-3
		W, see ^{109}In	-	2E+5	8E-5	3E-7	-	-
49	Indium-114m	D, see ^{109}In	3E+2 LLI wall	6E+1	3E-8	9E-11	-	-
			(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-4	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-7	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-4	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-4	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-4	8E-3
		W, see ^{109}In	-	2E+5	9E-5	3E-7	-	-
49	Indium-119m[2]	D, see ^{109}In	4E+4 St wall	1E+5	5E-5	2E-7	-	-
			(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-5	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-3	1E-2
		W, see ^{110}Sn	-	3E+5	1E-4	4E-7	-	-
50	Tin-113	D, see ^{110}Sn	2E+3 LLI wall	1E+3	5E-7	2E-9	-	-
			(2E+3)	-	-	-	3E-5	3E-4
		W, see ^{110}Sn	-	5E+2	2E-7	8E-10	-	-
50	Tin-117m	D, see ^{110}Sn	2E+3 LLI wall	1E+3 Bone surf	5E-7	-	-	-
			(2E+3)	(2E+3)	-	3E-9	3E-5	3E-4
		W, see ^{110}Sn	-	1E+3	6E-7	2E-9	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
50	Tin-119m	D, see ^{110}Sn	3E+3 LLI wall	2E+3	1E-6	3E-9	-	-
			(4E+3)	-	-	-	6E-5	6E-4
		W, see ^{110}Sn	-	1E+3	4E-7	1E-9	-	-
50	Tin-121m	D, see ^{110}Sn	3E+3 LLI wall	9E+2	4E-7	1E-9	-	-
			(4E+3)	-	-	-	5E-5	5E-4
		W, see ^{110}Sn	-	5E+2	2E-7	8E-10	-	-
50	Tin-121	D, see ^{110}Sn	6E+3 LLI wall	2E+4	6E-6	2E-8	-	-
			(6E+3)	-	-	-	8E-5	8E-4
		W, see ^{110}Sn	-	1E+4	5E-6	2E-8	-	-
50	Tin-123m[2]	D, see ^{110}Sn	5E+4	1E+5	5E-5	2E-7	7E-4	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	3E-7	9E-10	-	-
			(6E+2)	-	-	-	9E-6	9E-5
		W, see ^{110}Sn	-	2E+2	7E-8	2E-10	-	-
50	Tin-125	D, see ^{110}Sn	4E+2 LLI wall	9E+2	4E-7	1E-9	-	-
			(5E+2)	-	-	-	6E-6	6E-5
		W, see ^{110}Sn	-	4E+2	1E-7	5E-10	-	-
50	Tin-126	D, see ^{110}Sn	3E+2	6E+1	2E-8	8E-11	4E-6	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-5	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-4	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-3	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-4	3E-3
		W, see ^{115}Sb	-	1E+5	6E-5	2E-7	-	-
51	Antimony-116[2]	D, see ^{115}Sb	7E+4 St wall	3E+5	1E-4	4E-7	-	-
			(9E+4)	-	-	-	1E-3	1E-2
		W, see ^{115}Sb	-	3E+5	1E-4	5E-7	-	-
51	Antimony-117	D, see ^{115}Sb	7E+4	2E+5	9E-5	3E-7	9E-4	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-5	7E-4
		W, see ^{115}Sb	5E+3	2E+4	9E-6	3E-8	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
51	Antimony-119	D, see ^{115}Sb	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{115}Sb	2E+4	3E+4	1E-5	4E-8	-	-
51	Antimony-120[2] (16 min)	D, see ^{115}Sb	1E+5 St wall	4E+5	2E-4	6E-7	-	-
			(2E+5)	-	-	-	2E-3	2E-2
		W, see ^{115}Sb	-	5E+5	2E-4	7E-7	-	-
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	2E+3	1E-6	3E-9	-	-
			(8E+2)	-	-	-	1E-5	1E-4
		W, see ^{115}Sb	7E+2	1E+3	4E-7	2E-9	-	-
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	2E+5	8E-5	3E-7	-	-
			(7E+4)	-	-	-	9E-4	9E-3
		W, see ^{115}Sb	-	2E+5	8E-5	3E-7	-	-
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	2E+3	9E-7	3E-9	-	-
			(8E+2)	-	-	-	1E-5	1E-4
		W, see ^{115}Sb	7E+2	9E+2	4E-7	1E-9	-	-
51	Antimony-128[2] (10.4 min)	D, see ^{115}Sb	8E+4 St wall	4E+5	2E-4	5E-7	-	-
			(1E+5)	-	-	-	1E-3	1E-2
		W, see ^{115}Sb	-	4E+5	2E-4	6E-7	-	-
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 Thyroid	1E-5	-	-	-
			(2E+4)	(4E+4)	-	6E-8	2E-4	2E-3
		W, see ^{115}Sb	-	2E+4 Thyroid	1E-5		-	-
			-	(4E+4)	-	6E-8	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
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	2E+2 Bone surf	8E-8	-	-	-
			(7E+2)	(4E+2)	-	5E-10	1E-5	1E-4
		W, see ^{116}Te	-	4E+2	2E-7	6E-10	-	-
52	Tellurium-121	D, see ^{116}Te	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
		W, see ^{116}Te	-	3E+3	1E-6	4E-9	-	-
52	Tellurium-123m	D, see ^{116}Te	6E+2 Bone surf	2E+2 Bone surf	9E-8	-	-	-
			(1E+3)	(5E+2)	-	8E-10	1E-5	1E-4
		W, see ^{116}Te	-	5E+2	2E-7	8E-10	-	-
52	Tellurium-123	D, see ^{116}Te	5E+2 Bone surf	2E+2 Bone surf	8E-8	-	-	-
			(1E+3)	(5E+2)	-	7E-10	2E-5	2E-4
		W, see ^{116}Te	-	4E+2 Bone surf	2E-7	-	-	-
			-	(1E+3)	-	2E-9	-	-
52	Tellurium-125m	D, see ^{116}Te	1E+3 Bone surf	4E+2 Bone surf	2E-7	-	-	-
			(1E+3)	(1E+3)	-	1E-9	2E-5	2E-4
		W, see ^{116}Te	-	7E+2	3E-7	1E-9	-	-
52	Tellurium-127m	D, see ^{116}Te	6E+2	3E+2 Bone surf	1E-7	-	9E-6	9E-5
			-	(4E+2)	-	6E-10	-	-
		W, see ^{116}Te	-	3E+2	1E-7	4E-10	-	-
52	Tellurium-127	D, see ^{116}Te	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{116}Te	-	2E+4	7E-6	2E-8	-	-
52	Tellurium-129m	D, see ^{116}Te	5E+2	6E+2	3E-7	9E-10	7E-6	7E-5
		W, see ^{116}Te	-	2E+2	1E-7	3E-10	-	-
52	Tellurium-129[2]	D, see ^{116}Te	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
		W, see ^{116}Te	-	7E+4	3E-5	1E-7	-	-
52	Tellurium-131m	D, see ^{116}Te	3E+2 Thyroid	4E+2 Thyroid	2E-7	-	-	-
			(6E+2)	(1E+3)	-	2E-9	8E-6	8E-5
		W, see ^{116}Te	-	4E+2 Thyroid	2E-7	-	-	-
			-	(9E+2)	-	1E-9	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
52	Tellurium-131[2]	D, see ^{116}Te	3E+3 Thyroid	5E+3 Thyroid	2E-6	-	-	-
			(6E+3)	(1E+4)	-	2E-8	8E-5	8E-4
		W, see ^{116}Te	-	5E+3 Thyroid	2E-6	-	-	-
			-	(1E+4)	-	2E-8	-	-
52	Tellurium-132	D, see ^{116}Te	2E+2 Thyroid	2E+2 Thyroid	9E-8	-	-	-
			(7E+2)	(8E+2)	-	1E-9	9E-6	9E-5
		W, see ^{116}Te	-	2E+2 Thyroid	9E-8	-	-	-
			-	(6E+2)	-	9E-10	-	-
52	Tellurium-133m[2]	D, see ^{116}Te	3E+3 Thyroid	5E+3 Thyroid	2E-6	-	-	-
			(6E+3)	(1E+4)	-	2E-8	9E-5	9E-4
		W, see ^{116}Te	-	5E+3 Thyroid	2E-6	-	-	-
			-	(1E+4)	-	2E-8	-	-
52	Tellurium-133[2]	D, see ^{116}Te	1E+4 Thyroid	2E+4 Thyroid	9E-6	-	-	-
			(3E+4)	(6E+4)	-	8E-8	4E-4	4E-3
		W, see ^{116}Te	-	2E+4 Thyroid	9E-6	-	-	-
			-	(6E+4)	-	8E-8	-	-
52	Tellurium-134[2]	D, see ^{116}Te	2E+4 Thyroid	2E+4 Thyroid	1E-5	-	-	-
			(2E+4)	(5E+4)	-	7E-8	3E-4	3E-3
		W, see ^{116}Te	-	2E+4 Thyroid	1E-5	-	-	-
			-	(5E+4)	-	7E-8	-	-
53	Iodine-120m[2]	D, all compounds	1E+4 Thyroid	2E+4	9E-6	3E-8	-	-
			(1E+4)	-	-	-	2E-4	2E-3
53	Iodine-120[2]	D, all compounds	4E+3 Thyroid	9E+3 Thyroid	4E-6	-	-	-
			(8E+3)	(1E+4)	-	2E-8	1E-4	1E-3
53	Iodine-121	D, all compounds	1E+4 Thyroid	2E+4 Thyroid	8E-6	-	-	-
			(3E+4)	(5E+4)	-	7E-8	4E-4	4E-3
53	Iodine-123	D, all compounds	3E+3 Thyroid	6E+3 Thyroid	3E-6	-	-	-
			(1E+4)	(2E+4)	-	2E-8	1E-4	1E-3
53	Iodine-124	D, all compounds	5E+1 Thyroid	8E+1 Thyroid	3E-8	-	-	-
			(2E+2)	(3E+2)	-	4E-10	2E-6	2E-5

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
53	Iodine-125	D, all compounds	4E+1 Thyroid	6E+1 Thyroid	3E-8	-	-	-
			(1E+2)	(2E+2)	-	3E-10	2E-6	2E-5
53	Iodine-126	D, all compounds	2E+1 Thyroid	4E+1 Thyroid	1E-8	-	-	-
			(7E+1)	(1E+2)	-	2E-10	1E-6	1E-5
53	Iodine-128[2]	D, all compounds	4E+4 St wall	1E+5	5E-5	2E-7	-	-
			(6E+4)	-	-	-	8E-4	8E-3
53	Iodine-129	D, all compounds	5E+0 Thyroid	9E+0 Thyroid	4E-9	-	-	-
			(2E+1)	(3E+1)	-	4E-11	2E-7	2E-6
53	Iodine-130	D, all compounds	4E+2 Thyroid	7E+2 Thyroid	3E-7	-	-	-
			(1E+3)	(2E+3)	-	3E-9	2E-5	2E-4
53	Iodine-131	D, all compounds	3E+1 Thyroid	5E+1 Thyroid	2E-8	-	-	-
			(9E+1)	(2E+2)	-	2E-10	1E-6	1E-5
53	Iodine-132m[2]	D, all compounds	4E+3 Thyroid	8E+3 Thyroid	4E-6	-	-	-
			(1E+4)	(2E+4)	-	3E-8	1E-4	1E-3
53	Iodine-132	D, all compounds	4E+3 Thyroid	8E+3 Thyroid	3E-6	-	-	-
			(9E+3)	(1E+4)	-	2E-8	1E-4	1E-3
53	Iodine-133	D, all compounds	1E+2 Thyroid	3E+2 Thyroid	1E-7	-	-	-
			(5E+2)	(9E+2)	-	1E-9	7E-6	7E-5
53	Iodine-134[2]	D, all compounds	2E+4 Thyroid	5E+4	2E-5	6E-8	-	-
			(3E+4)	-	-	-	4E-4	4E-3
53	Iodine-135	D, all compounds	8E+2 Thyroid	2E+3 Thyroid	7E-7	-	-	-
			(3E+3)	(4E+3)	-	6E-9	3E-5	3E-4
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	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
54	Xenon-138[2]	Submersion[1]	-	-	4E-6	2E-8	-	-
55	Cesium-125[2]	D, all compounds	5E+4 St wall	1E+5	6E-5	2E-7	-	-
			(9E+4)	-	-	-	1E-3	1E-2
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	2E+5	8E-5	3E-7	-	-
			(1E+5)	-	-	-	1E-3	1E-2
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	6E-5	2E-7	-	-
			(1E+5)	-	-	-	2E-3	2E-2
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
55	Cesium-138[2]	D, all compounds	2E+4 St wall	6E+4	2E-5	8E-8	-	-
			(3E+4)	-	-	-	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	1E+6	6E-4	2E-6	-	-
			(5E+5)	-	-	-	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	9E+3	4E-6	1E-8	-	-
			(3E+3)	-	-	-	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	1E+3	6E-7	2E-9	-	-
			(6E+2)	-	-	-	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	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		W, oxides and hydroxides	-	2E+5	7E-5	2E-7	-	-
57	Lanthanum-132	D, see ^{131}La	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
		W, see ^{131}La	-	1E+4	5E-6	2E-8	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
57	Lanthanum-135	D, see ^{131}La	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
		W, see ^{131}La	-	9E+4	4E-5	1E-7	-	-
57	Lanthanum-137	D, see ^{131}La	1E+4	6E+1 Liver	3E-8	-	2E-4	2E-3
			-	(7E+1)	-	1E-10	-	-
		W, see ^{131}La	-	3E+2 Liver	1E-7	-	-	-
			-	(3E+2)	-	4E-10	-	-
57	Lanthanum-138	D, see ^{131}La	9E+2	4E+0	1E-9	5E-12	1E-5	1E-4
		W, see ^{131}La	-	1E+1	6E-9	2E-11	-	-
57	Lanthanum-140	D, see ^{131}La	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
		W, see ^{131}La	-	1E+3	5E-7	2E-9	-	-
57	Lanthanum-141	D, see ^{131}La	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
		W, see ^{131}La	-	1E+4	5E-6	2E-8	-	-
57	Lanthanum-142[2]	D, see ^{131}La	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{131}La	-	3E+4	1E-5	5E-8	-	-
57	Lanthanum-143[2]	D, see ^{131}La	4E+4 St wall	1E+5	4E-5	1E-7	-	-
			(4E+4)	-	-	-	5E-4	5E-3
		W, see ^{131}La	-	9E+4	4E-5	1E-7	-	-
58	Cerium-134	W, all compounds except those given for Y	5E+2 LLI wall	7E+2	3E-7	1E-9	-	-
			(6E+2)	-	-	-	8E-6	8E-5
		Y, oxides, hydroxides, and fluorides	-	7E+2	3E-7	9E-10	-	-
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	4E+3	2E-6	6E-9	-	-
			(2E+3)	-	-	-	3E-5	3E-4
		Y, see ^{134}Ce	-	4E+3	2E-6	5E-9	-	-
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	7E+2	3E-7	1E-9	-	-
			(2E+3)	-	-	-	3E-5	3E-4
		Y, see ^{134}Ce	-	6E+2	2E-7	8E-10	-	-
58	Cerium-143	W, see ^{134}Ce	1E+3 LLI wall	2E+3	8E-7	3E-9	-	-
			(1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{134}Ce	-	2E+3	7E-7	2E-9	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
58	Cerium-144	W, see ^{134}Ce	2E+2 LLI wall	3E+1	1E-8	4E-11	-	-
			(3E+2)	-	-	-	3E-6	3E-5
		Y, see ^{134}Ce	-	1E+1	6E-9	2E-11	-	-
59	Praseodymium-136[2]	W, all compounds except those given for Y	5E+4 St wall	2E+5	1E-4	3E-7	-	-
			(7E+4)	-	-	-	1E-3	1E-2
		Y, oxides, hydroxides, carbides, and fluorides	-	2E+5	9E-5	3E-7	-	-
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	8E+2	3E-7	1E-9	-	-
			(1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{136}Pr	-	7E+2	3E-7	9E-10	-	-
59	Praseodymium-144[2]	W, see ^{136}Pr	3E+4 St wall	1E+5	5E-5	2E-7	-	-
			(4E+4)	-	-	-	6E-4	6E-3
		Y, see ^{136}Pr	-	1E+5	5E-5	2E-7	-	-
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	2E+5	8E-5	3E-7	-	-
			(8E+4)	-	-	-	1E-3	1E-2
		Y, see ^{136}Pr	-	2E+5	8E-5	3E-7	-	-
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	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
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	9E+2	4E-7	1E-9	-	-
			(1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{136}Nd	-	8E+2	4E-7	1E-9	-	-
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	2E+5	8E-5	3E-7	-	-
			(6E+4)	-	-	-	8E-4	8E-3
		Y, oxides, hydroxides, carbides, and fluorides	-	2E+5	7E-5	2E-7	-	-
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 Bone surf	7E-8	-	1E-4	1E-3
			-	(2E+2)	-	3E-10	-	-
		Y, see ^{141}Pm	-	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	1E+2 Bone surf	5E-8	-	-	-
			(5E+3)	(2E+2)	-	3E-10	7E-5	7E-4
		Y, see ^{141}Pm	-	1E+2	6E-8	2E-10	-	-
61	Promethium-148m	W, see ^{141}Pm	7E+2	3E+2	1E-7	4E-10	1E-5	1E-4
		Y, see ^{141}Pm	-	3E+2	1E-7	5E-10	-	-
61	Promethium-148	W, see ^{141}Pm	4E+2 LLI wall	5E+2	2E-7	8E-10	-	-
			(5E+2)	-	-	-	7E-6	7E-5
		Y, see ^{141}Pm	-	5E+2	2E-7	7E-10	-	-
61	Promethium-149	W, see ^{141}Pm	1E+3 LLI wall	2E+3	8E-7	3E-9	-	-
			(1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{141}Pm	-	2E+3	8E-7	2E-9	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
61	Promethium-150	W, see ^{141}Pm	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
		Y, see ^{141}Pm	-	2E+4	7E-6	2E-8	-	-
61	Promethium-151	W, see ^{141}Pm	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		Y, see ^{141}Pm	-	3E+3	1E-6	4E-9	-	-
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	2E+5	8E-5	2E-7	-	-
			(6E+4)	-	-	-	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	4E•2 Bone surf	1E-11	-	-	-
			(3E+1)	(6E-2)	-	9E-14	3E-7	3E-6
62	Samarium-147	W, all compounds	2E+1 Bone surf	4E•2 Bone surf	2E-11	-	-	-
			(3E+1)	(7E-2)	-	1E-13	4E-7	4E-6
62	Samarium-151	W, all compounds	1E+4 LLI wall	1E+2 Bone surf	4E-8	-	-	-
			(1E-4)	(2E+2)	-	2E-10	2E-4	2E-3
62	Samarium-153	W, all compounds	2E+3 LLI wall	3E+3	1E-6	4E-9	-	-
			(2E+3)	-	-	-	3E-5	3E-4
62	Samarium-155[2]	W, all compounds	6E+4 St wall	2E+5	9E-5	3E-7	-	-
			(8E+4)	-	-	-	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
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 Bone surf	4E-8	-	5E-5	5E-4
			-	(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

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
64	Gadolinium-145[2]	D, all compounds except those given for W	5E+4 St wall	2E+5	6E-5	2E-7	-	-
			(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 Bone surf	8E-3 Bone surf	3E-12	-	-	-
			(2E+1)	(2E-2)	-	2E-14	3E-7	3E-6
		W, see ^{145}Gd	-	3E-2 Bone surf	1E-11	-	-	-
			-	(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 Bone surf	2E-7	-	9E-5	9E-4
			-	(6E+2)	-	9E-10	-	-
		W, see ^{145}Gd	-	1E+3	5E-7	2E-9	-	-
64	Gadolinium-152	D, see ^{145}Gd	2E+1 Bone surf	1E-2 Bone surf	4E-12	-	-	-
			(3E+1)	(2E-2)	-	3E-14	4E-7	4E-6
		W, see ^{145}Gd	-	4E-2 Bone surf	2E-11	-	-	-
			-	(8E-2)	-	1E-13	-	-
64	Gadolinium-153	D, see ^{145}Gd	5E+3	1E+2 Bone surf	6E-8	-	6E-5	6E-4
			-	(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
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

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
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	3E+2 Bone surf	1E-7	-	-	-
			(5E+4)	(6E+2)	-	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	7E-7	2E-9	-	-
			(2E+3)	-	-	-	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	7E+2	3E-7	1E-9	-	-
			(8E+2)	-	-	-	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	2E+6	1E-3	3E-6	-	-
			(8E+5)	-	-	-	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	6E+5	3E-4	9E-7	-	-
			(2E+5)	-	-	-	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	2E+3	7E-7	2E-9	-	-
			(9E+2)	-	-	-	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
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 LLI wall	3E+3	1E-6	4E-9	-	-
			(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 LLI wall	1E+3	6E-7	2E-9	-	-
			(1E+3)	-	-	-	2E-5	2E-4

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

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
71	Lutetium-170	W, see ^{169}Lu	1E+3	2E+3	9E-7	3E-9	2E-5	2E-4
		Y, see ^{169}Lu	-	2E+3	8E-7	3E-9	-	-
71	Lutetium-171	W, see ^{169}Lu	2E+3	2E+3	8E-7	3E-9	3E-5	3E-4
		Y, see ^{169}Lu	-	2E+3	8E-7	3E-9	-	-
71	Lutetium-172	W, see ^{169}Lu	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
		Y, see ^{169}Lu	-	1E+3	5E-7	2E-9	-	-
71	Lutetium-173	W, see ^{169}Lu	5E+3	3E+2 Bone surf	1E-7	-	7E-5	7E-4
			-	(5E+2)	-	6E-10	-	-
		Y, see ^{169}Lu	-	3E+2	1E-7	4E-10	-	-
71	Lutetium-174m	W, see ^{169}Lu	2E+3 LLI wall	2E+2 Bone surf	1E-7	-	-	-
			(3E+3)	(3E+2)	-	5E-10	4E-5	4E-4
		Y, see ^{169}Lu	-	2E+2	9E-8	3E-10	-	-
71	Lutetium-174	W, see ^{169}Lu	5E+3	1E+2 Bone surf	5E-8	-	7E-5	7E-4
			-	(2E+2)	-	3E-10	-	-
		Y, see ^{169}Lu	-	2E+2	6E-8	2E-10	-	-
71	Lutetium-176m	W, see ^{169}Lu	8E+3	3E+4	1E-5	3E-8	1E-4	1E-3
		Y, see ^{169}Lu	-	2E+4	9E-6	3E-8	-	-
71	Lutetium-176	W, see ^{169}Lu	7E+2	5E+0 Bone surf	2E-9	-	1E-5	1E-4
			-	(1E+1)	-	2E-11	-	-
		Y, see ^{169}Lu	-	8E+0	3E-9	1E-11	-	-
71	Lutetium-177m	W, see ^{169}Lu	7E+2	1E+2 Bone surf	5E-8	-	1E-5	1E-4
			-	(1E+2)	-	2E-10	-	-
		Y, see ^{169}Lu	-	8E+1	3E-8	1E-10	-	-
71	Lutetium-177	W, see ^{169}Lu	2E+3 LLI wall	2E+3	9E-7	3E-9	-	-
			(3E+3)	-	-	-	4E-5	4E-4
		Y, see ^{169}Lu	-	2E+3	9E-7	3E-9	-	-
71	Lutetium-178m[2]	W, see ^{169}Lu	5E+4 St. wall	2E+5	8E-5	3E-7	-	-
			(6E+4)	-	-	-	8E-4	8E-3
		Y, see ^{169}Lu	-	2E+5	7E-5	2E-7	-	-
71	Lutetium-178[2]	W, see ^{169}Lu	4E+4 St. wall	1E+5	5E-5	2E-7	-	-
			(4E+4)	-	-	-	6E-4	6E-3
		Y, see ^{169}Lu	-	1E+5	5E-5	2E-7	-	-
71	Lutetium-179	W, see ^{169}Lu	6E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		Y, see ^{169}Lu	-	2E+4	6E-6	3E-8	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
72	Hafnium-170	D, all compounds except those given for W	3E+3	6E+3	2E-6	8E-9	4E-5	4E-4
		W, oxides, hydroxides, carbides, and nitrates	-	5E+3	2E-6	6E-9	-	-
72	Hafnium-172	D, see ^{170}Hf	1E+3	9E+0 Bone surf	4E-9	-	2E-5	2E-4
			-	(2E+1)	-	3E-11	-	-
		W, see ^{170}Hf	-	4E+1 Bone surf	2E-8	-	-	-
			-	(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 Bone surf	4E-7	-	4E-5	4E-4
			-	(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 Bone surf	5E-10	-	3E-6	3E-5
			-	(2E+0)	-	3E-12	-	-
		W, see ^{170}Hf	-	5E+0 Bone surf	2E-9	-	-	-
			-	(9E+0)	-	1E-11	-	-
72	Hafnium-179m	D, see ^{170}Hf	1E+3	3E+2 Bone surf	1E-7	-	1E-5	1E-4
			-	(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 Bone surf	7E-8	-	2E-5	2E-4
			-	(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 Bone surf	8E-1 Bone surf	3E-10	-	-	-
			(4E+2)	(2E+0)	-	2E-12	5E-6	5E-5
		W, see ^{170}Hf	-	3E+0 Bone surf	1E-9	-	-	-
			-	(7E+0)	-	1E-11	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
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	4E+4	1E+5	5E-5	2E-7	5E-4	5E-3
		Y, elemental Ta, oxides, hydroxides, halides, carbides, nitrates, and nitrides	-	1E+5	4E-5	1E-7	-	-
73	Tantalum-173	W, see ^{172}Ta	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		Y, see ^{172}Ta	-	2E+4	7E-6	2E-8	-	-
73	Tantalum-174[2]	W, see ^{172}Ta	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
		Y, see ^{172}Ta	-	9E+4	4E-5	1E-7	-	-
73	Tantalum-175	W, see ^{172}Ta	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
		Y, see ^{172}Ta	-	1E+4	6E-6	2E-8	-	-
73	Tantalum-176	W, see ^{172}Ta	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
		Y, see ^{172}Ta	-	1E+4	5E-6	2E-8	-	-
73	Tantalum-177	W, see ^{172}Ta	1E+4	2E+4	8E-6	3E-8	2E-4	2E-3
		Y, see ^{172}Ta	-	2E+4	7E-6	2E-8	-	-
73	Tantalum-178	W, see ^{172}Ta	2E+4	9E+4	4E-5	1E-7	2E-4	2E-3
		Y, see ^{172}Ta	-	7E+4	3E-5	1E-7	-	-
73	Tantalum-179	W, see ^{172}Ta	2E+4	5E+3	2E-6	8E-9	3E-4	3E-3
		Y, see ^{172}Ta	-	9E+2	4E-7	1E-9	-	-
73	Tantalum-180m	W, see ^{172}Ta	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		Y, see ^{172}Ta	-	6E+4	2E-5	8E-8	-	-
73	Tantalum-180	W, see ^{172}Ta	1E+3	4E+2	2E-7	6E-10	2E-5	2E-4
		Y, see ^{172}Ta	-	2E+1	1E-8	3E-11	-	-
73	Tantalum-182m[2]	W, see ^{172}Ta	2E+5 St wall	5E+5	2E-4	8E-7	-	-
			(2E+5)	-	-	-	3E-3	3E-2
		Y, see ^{172}Ta	-	4E+5	2E-4	6E-7	-	-
73	Tantalum-182	W, see ^{172}Ta	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
		Y, see ^{172}Ta	-	1E+2	6E-8	2E-10	-	-
73	Tantalum-183	W, see ^{172}Ta	9E+2 LLI wall	1E+3	5E-7	2E-9	-	-
			(1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{172}Ta	-	1E+3	4E-7	1E-9	-	-
73	Tantalum-184	W, see ^{172}Ta	2E+3	5E+3	2E-6	8E-9	3E-5	3E-4
		Y, see ^{172}Ta	-	5E+3	2E-6	7E-9	-	-
73	Tantalum-185[2]	W, see ^{172}Ta	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
		Y, see ^{172}Ta	-	6E+4	3E-5	9E-8	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
73	Tantalum-186[2]	W, see ^{172}Ta	5E+4 St wall	2E+5	1E-4	3E-7	-	-
			(7E+4)	-	-	-	1E-3	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-4	1E-3
74	Tungsten-177	D, all compounds	2E+4	9E+4	4E-5	1E-7	3E-4	3E-3
74	Tungsten-178	D, all compounds	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
74	Tungsten-179[2]	D, all compounds	5E+5	2E+6	7E-4	2E-6	7E-3	7E-2
74	Tungsten-181	D, all compounds	2E+4	3E+4	1E-5	5E-8	2E-4	2E-3
74	Tungsten-185	D, all compounds	2E+3 LLI wall	7E+3	3E-6	9E-9	-	-
			(3E+3)	-	-	-	4E-5	4E-4
74	Tungsten-187	D, all compounds	2E+3	9E+3	4E-6	1E-8	3E-5	3E-4
74	Tungsten-188	D, all compounds	4E+2 LLI wall	1E+3	5E-7	2E-9	-	-
			(5E+2)	-	-	-	7E-6	7E-5
75	Rhenium-177[2]	D, all compounds except those given for W	9E+4 St wall	3E+5	1E-4	4E-7	-	-
			(1E+5)	-	-	-	2E-3	2E-2
		W, oxides, hydroxides, and nitrates	-	4E+5	1E-4	5E-7	-	-
75	Rhenium-178[2]	D, see ^{177}Re	7E+4 St wall	3E+5	1E-4	4E-7	-	-
			(1E+5)	-	-	-	1E-3	1E-2
		W, see ^{177}Re	-	3E+5	1E-4	4E-7	-	-
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 St wall	7E-7	-	-	-
			(2E+3)	(2E+3)	-	3E-9	2E-5	2E-4
		W, see ^{177}Re	-	2E+2	6E-8	2E-10	-	-
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	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
75	Rhenium-187	D, see ^{177}Re	6E+5	8E+5 St wall	4E-4	-	8E-3	8E-2
			-	(9E+5)	-	1E-6	-	-
		W, see ^{177}Re	-	1E+5	4E-5	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	-	-
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 LLI wall	2E+3	9E-7	3E-9	-	-
			(3E+3)	-	-	-	3E-5	3E-4
		W, see ^{180}Os	-	2E+3	7E-7	2E-9	-	-
		Y, see ^{180}Os	-	1E+3	6E-7	2E-9	-	-
76	Osmium-193	D, see ^{180}Os	2E+3 LLI wall	5E+3	2E-6	6E-9	-	-
			(2E+3)	-	-	-	2E-5	2E-4
		W, see ^{180}Os	-	3E+3	1E-6	4E-9	-	-
		Y, see ^{180}Os	-	3E+3	1E-6	4E-9	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
76	Osmium-194	D, see ^{180}Os	4E+2 LLI wall	4E+1	2E-8	6E-11	-	-
			(6E+2)	-	-	-	8E-6	8E-5
		W, see ^{180}Os	-	6E+1	2E-8	8E-11	-	-
		Y, see ^{180}Os	-	8E+0	3E-9	1E-11	-	-
77	Iridium-182[2]	D, all compounds except those given for W and Y	4E+4 St wall	1E+5	6E-5	2E-7	-	-
			(4E+4)	-	-	-	6E-4	6E-3
		W, halides, nitrates, and metallic iridium	-	2E+5	6E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	5E-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 LLI wall	5E+3	2E-6	7E-9	-	-
			(5E+3)	-	-	-	7E-5	7E-4
		W, see ^{182}Ir	-	4E+3	2E-6	5E-9	-	-
		Y, see ^{182}Ir	-	4E+3	1E-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	-	-
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	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
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	6E+3	3E-6	8E-9	-	-
			LLI wall					
			(3E+4)	-	-	-	4E-5	4E-4
78	Platinum-193	D, all compounds	4E+4	2E+4	1E-5	3E-8	-	-
			LLI wall					
			(5E+4)	-	-	-	6E-4	6E-3
78	Platinum-195m	D, all compounds	2E+3	4E+3	2E-6	6E-9	-	-
			LLI wall					
			(2E+3)	-	-	-	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	-	-
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	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
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	-	-
		Y, see ^{193}Au	-	4E+3	2E-6	5E-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	-	-
		Y, see ^{193}Au	-	2E+5	9E-5	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
		W, oxides, hydroxides, halides, nitrates, and sulfides	-	8E+3	3E-6	1E-8	-	-
80	Mercury-193	Vapor	-	3E+4	1E-5	4E-8	-	-
		Organic D	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		D, see ^{193m}Hg	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{193m}Hg	-	4E+4	2E-5	6E-8	-	-
80	Mercury-194	Vapor	-	3E+1	1E-8	4E-11	-	-
		Organic D	2E+1	3E+1	1E-8	4E-11	2E-7	2E-6
		D, see ^{193m}Hg	8E+2	4E+1	2E-8	6E-11	1E-5	1E-4
		W, see ^{193m}Hg	-	1E+2	5E-8	2E-10	-	-
80	Mercury-195m	Vapor	-	4E+3	2E-6	6E-9	-	-
		Organic D	3E+3	6E+3	3E-6	8E-9	4E-5	4E-4
		D, see ^{193m}Hg	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
		W, see ^{193m}Hg	-	4E+3	2E-6	5E-9	-	-
80	Mercury-195	Vapor	-	3E+4	1E-5	4E-8	-	-
		Organic D	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
		D, see ^{193m}Hg	1E+4	4E+4	1E-5	5E-8	2E-4	2E-3
		W, see ^{193m}Hg	-	3E+4	1E-5	5E-8	-	-
80	Mercury-197m	Vapor	-	5E+3	2E-6	7E-9	-	-
		Organic D	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
		D, see ^{193m}Hg	3E+3	7E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{193m}Hg	-	5E+3	2E-6	7E-9	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (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 St wall	2E+5	7E-5	2E-7	-	-
			(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 St wall	2E+5	6E-5	2E-7	-	-
			(7E+4)	-	-	-	1E-3	1E-2
81	Thallium-194[2]	D, all compounds	3E+5 St wall	6E+5	2E-4	8E-7	-	-
			(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	6E-1 Bone surf	2E-1 Bone surf	1E-10	-	-	-
			(1E+0)	(4E-1)	-	6E-13	1E-8	1E-7
82	Lead-211[2]	D, all compounds	1E+4	6E+2	3E-7	9E-10	2E-4	2E-3

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

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
84	Polonium-210	D, see ^{203}Po	3E+0	6E-1	3E-10	9E-13	4E-8	4E-7
		W, see ^{203}Po	-	6E-1	3E-10	9E-13	-	-
85	Astatine-207[2]	D, halides	6E+3	3E+3	1E-6	4E-9	8E-5	8E-4
		W	-	2E+3	9E-7	3E-9	-	-
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 (or 1.0 working level)	3E-11	-	-
86	Radon-222	With daughters removed	-	1E+4	4E-6	1E-8	-	-
		With daughters present	-	1E+2 (or 4 working level months)	3E-8 (or 0.33 working level)	1E-10	-	-
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	7E-1	3E-10	9E-13	-	-
			(9E+0)	-	-	-	1E-7	1E-6
88	Radium-224	W, all compounds	8E+0 Bone surf	2E+0	7E-10	2E-12	-	-
			(2E+1)	-	-	-	2E-7	2E-6
88	Radium-225	W, all compounds	8E+0 Bone surf	7E-1	3E-10	9E-13	-	-
			(2E+1)	-	-	-	2E-7	2E-6
88	Radium-226	W, all compounds	2E+0 Bone surf	6E-1	3E-10	9E-13	-	-
			(5E+0)	-	-	-	6E-8	6E-7
88	Radium-227[2]	W, all compounds	2E+4 Bone surf	1E+4 Bone surf	6E-6	-	-	-
			(2E+4)	(2E+4)	-	3E-8	3E-4	3E-3
88	Radium-228	W, all compounds	2E+0 Bone surf	1E+0	5E-10	2E-12	-	-
			(4E+0)	-	-	-	6E-8	6E-7

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
89	Actinium-224	D, all compounds except those given for W and Y	2E+3 LLI wall	3E+1 Bone surf	1E-8	-	-	-
			(2E+3)	(4E+1)	-	5E-11	3E-5	3E-4
		W, halides and nitrates	-	5E+1	2E-8	7E-11	-	-
		Y, oxides and hydroxides	-	5E+1	2E-8	6E-11	-	-
89	Actinium-225	D, see ^{224}Ac	5E+1 LLI wall	3E-1 Bone surf	1E-10	-	-	-
			(5E+1)	(5E-1)	-	7E-13	7E-7	7E-6
		W, see ^{224}Ac	-	6E-1	3E-10	9E-13	-	-
		Y, see ^{224}Ac	-	6E-1	3E-10	9E-13	-	-
89	Actinium-226	D, see ^{224}Ac	1E+2 LLI wall	3E+0 Bone surf	1E-9	-	-	-
			(1E+2)	(4E+0)	-	5E-12	2E-6	2E-5
		W, see ^{224}Ac	-	5E+0	2E-9	7E-12	-	-
		Y, see ^{224}Ac	-	5E+0	2E-9	6E-12	-	-
89	Actinium-227	D, see ^{224}Ac	2E-1 Bone surf	4E-4 Bone surf	2E-13	-	-	-
			(4E-1)	(8E-4)	-	1E-15	5E-9	5E-8
		W, see ^{224}Ac	-	2E-3	7E-13	-	-	-
			-	(3E-3)	-	4E-15	-	-
		Y, see ^{224}Ac	-	4E-3	2E-12	6E-15	-	-
89	Actinium-228	D, see ^{224}Ac	2E+3	9E+0 Bone surf	4E-9	-	3E-5	3E-4
			-	(2E+1)	-	2E-11	-	-
		W, see ^{224}Ac	-	4E+1 Bone surf	2E-8	-	-	-
			-	(6E+1)	-	8E-11	-	-
		Y, see ^{224}Ac	-	4E+1	2E-8	6E-11	-	-
90	Thorium-226[2]	W, all compounds except those given for Y	5E+3 St wall	2E+2	6E-8	2E-10	-	-
			(5E+3)	-	-	-	7E-5	7E-4
		Y, oxides and hydroxides	-	1E+2	6E-8	2E-10	-	-
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-2 Bone surf	4E-12	-	-	-
			(1E+1)	(2E-2)	-	3E-14	2E-7	2E-6
		Y, see ^{226}Th	-	2E-2	7E-12	2E-14	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
90	Thorium-229	W, see ^{226}Th	6E-1 Bone surf	9E-4 Bone surf	4E-13	-	-	-
			(1E+0)	(2E-3)	-	3E-15	2E-8	2E-7
		Y, see ^{226}Th	-	2E-3 Bone surf	1E-12	-	-	-
			-	(3E-3)	-	4E-15	-	-
90	Thorium-230	W, see ^{226}Th	4E+0 Bone surf	6E-3 Bone surf	3E-12	-	-	-
			(9E+0)	(2E-2)	-	2E-14	1E-7	1E-6
		Y, see ^{226}Th	-	2E-2 Bone surf	6E-12	-	-	-
			-	(2E-2)	-	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	1E-3 Bone surf	5E-13	-	-	-
			(2E+0)	(3E-3)	-	4E-15	3E-8	3E-7
		Y, see ^{226}Th	-	3E-3 Bone surf	1E-12	-	-	-
			-	(4E-3)	-	6E-15	-	-
90	Thorium-234	W, see ^{226}Th	3E+2 LLI wall	2E+2	8E-8	3E-10	-	-
			(4E+2)	-	-	-	5E-6	5E-5
		Y, see ^{226}Th	-	2E+2	6E-8	2E-10	-	-
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 Bone surf	5E-9	-	2E-5	2E-4
			-	(2E+1)	-	3E-11	-	-
		Y, see ^{227}Pa	-	1E+1	5E-9	2E-11	-	-
91	Protactinium-230	W, see ^{227}Pa	6E+2 Bone surf	5E+0	2E-9	7E-12	-	-
			(9E+2)	-	-	-	1E-5	1E-4
		Y, see ^{227}Pa	-	4E+0	1E-9	5E-12	-	-
91	Protactinium-231	W, see ^{227}Pa	2E-1 Bone surf	2E-3 Bone surf	6E-13	-	-	-
			(5E-1)	(4E-3)	-	6E-15	6E-9	6E-8
		Y, see ^{227}Pa	-	4E-3 Bone surf	2E-12	-	-	-
			-	(6E-3)	-	8E-15	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
91	Protactinium-232	W, see ^{227}Pa	1E+3	2E+1 Bone surf	9E-9	-	2E-5	2E-4
			-	(6E+1)	-	8E-11	-	-
		Y, see ^{227}Pa	-	6E+1 Bone surf	2E-8	-	-	-
			-	(7E+1)	-	1E-10	-	-
91	Protactinium-233	W, see ^{227}Pa	1E+3 LLI wall	7E+2	3E-7	1E-9	-	-
			(2E+3)	-	-	-	2E-5	2E-4
		Y, see ^{227}Pa	-	6E+2	2E-7	8E-10	-	-
91	Protactinium-234	W, see ^{227}Pa	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		Y, see ^{227}Pa	-	7E+3	3E-6	9E-9	-	-
92	Uranium-230	D, UF_6, UO_2F_2, $UO_2(NO_3)_2$	4E+0 Bone surf	4E-1 Bone surf	2E-10	-	-	-
			(6E+0)	(6E-1)	-	8E-13	8E-8	8E-7
		W, UO_3, UF_4, UCl_4	-	4E-1	1E-10	5E-13	-	-
		Y, UO_2, U_3O_8	-	3E-1	1E-10	4E-13	-	-
92	Uranium-231	D, see ^{230}U	5E+3 LLI wall	8E+3	3E-6	1E-8	-	-
			(4E+3)	-	-	-	6E-5	6E-4
		W, see ^{230}U	-	6E+3	2E-6	8E-9	-	-
		Y, see ^{230}U	-	5E+3	2E-6	6E-9	-	-
92	Uranium-232	D, see ^{230}U	2E+0 Bone surf	2E-1 Bone surf	9E-11	-	-	-
			(4E+0)	(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 Bone surf	1E+0 Bone surf	5E-10	-	-	-
			(2E+1)	(2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	7E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	5E-14	-	-
92	Uranium-234[3]	D, see ^{230}U	1E+1 Bone surf	1E+0 Bone surf	5E-10	-	-	-
			(2E+1)	(2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	7E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	5E-14	-	-
92	Uranium-235[3]	D, see ^{230}U	1E+1 Bone surf	1E+0 Bone surf	6E-10	-	-	-
			(2E+1)	(2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	8E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	6E-14	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
92	Uranium-236	D, see ^{230}U	1E+1 Bone surf	1E+0 Bone surf	5E-10	-	-	-
			(2E+1)	(2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	8E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-237	D, see ^{230}U	2E+3 LLI wall	3E+3	1E-6	4E-9	-	-
			(2E+3)	-	-	-	3E-5	3E-4
		W, see ^{230}U	-	2E+3	7E-7	2E-9	-	-
		Y, see ^{230}U	-	2E+3	6E-7	2E-9	-	-
92	Uranium-238[3]	D, see ^{230}U	1E+1 Bone surf	1E+0 Bone surf	6E-10	-	-	-
			(2E+1)	(2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	8E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	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	1E+0 Bone surf	5E-10	-	-	-
			(2E+1)	(2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	8E-1	3E-10	9E-13	-	-
		Y, see ^{230}U	-	5E-2	2E-11	9E-14	-	-
93	Neptunium-232[2]	W, all compounds	1E+5	2E+3 Bone surf	7E-7	-	2E-3	2E-2
			-	(5E+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	8E+2 Bone surf	3E-7	-	-	-
			(2E+4)	(1E+3)	-	2E-9	3E-4	3E-3
93	Neptunium-236 (1.15E+5 y)	W, all compounds	3E+0 Bone surf	2E-2 Bone surf	9E-12	-	-	-
			(6E+0)	(5E-2)	-	8E-14	9E-8	9E-7
93	Neptunium-236m (22.5 h)	W, all compounds	3E+3 Bone surf	3E+1 Bone surf	1E-8	-	-	-
			(4E+3)	(7E+1)	-	1E-10	5E-5	5E-4
93	Neptunium-237	W, all compounds	5E-1 Bone surf	4E-3 Bone surf	2E-12	-	-	-
			(1E+0)	(1E-2)	-	1E-14	2E-8	2E-7

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
93	Neptunium-238	W, all compounds	1E+3	6E+1 Bone surf	3E-8	-	2E-5	2E-4
			-	(2E+2)	-	2E-10	-	-
93	Neptunium-239	W, all compounds	2E+3 LLI wall	2E+3	9E-7	3E-9	-	-
			(2E+3)	-	-	-	2E-5	2E-4
93	Neptunium-240[2]	W, all compounds	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
94	Plutonium-234	W, all compounds except PuO_2	8E+3	2E+2	9E-8	3E-10	1E-4	1E-3
		Y, PuO_2	-	2E+2	8E-8	3E-10	-	-
94	Plutonium-235[2]	W, see ^{234}Pu	9E+5	3E+6	1E-3	4E-6	1E-2	1E-1
		Y, see ^{234}Pu	-	3E+6	1E-3	3E-6	-	-
94	Plutonium-236	W, see ^{234}Pu	2E+0 Bone surf	2E-2 Bone surf	8E-12	-	-	-
			(4E+0)	(4E-2)	-	5E-14	6E-8	6E-7
		Y, see ^{234}Pu	-	4E-2	2E-11	6E-14	-	-
94	Plutonium-237	W, see ^{234}Pu	1E+4	3E+3	1E-6	5E-9	2E-4	2E-3
		Y, see ^{234}Pu	-	3E+3	1E-6	4E-9	-	-
94	Plutonium-238	W, see ^{234}Pu	9E-1 Bone surf	7E-3 Bone surf	3E-12	-	-	-
			(2E+0)	(1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2	8E-12	2E-14	-	-
94	Plutonium-239	W, see ^{234}Pu	8E-1 Bone surf	6E-3 Bone surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2 Bone surf	7E-12	-	-	-
			-	(2E-2)	-	2E-14	-	-
94	Plutonium-240	W, see ^{234}Pu	8E-1 Bone surf	6E-3 Bone surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2 Bone surf	7E-12	-	-	-
			-	(2E-2)	-	2E-14	-	-
94	Plutonium-241	W, see ^{234}Pu	4E+1 Bone surf	3E-1 Bone surf	1E-10	-	-	-
			(7E+1)	(6E-1)	-	8E-13	1E-6	1E-5
		Y, see ^{234}Pu	-	8E-1 Bone surf	3E-10	-	-	-
			-	(1E+0)	-	1E-12	-	-
94	Plutonium-242	W, see ^{234}Pu	8E-1 Bone surf	7E-3 Bone surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2 Bone surf	7E-12	-	-	-
			-	(2E-2)	-	2E-14	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
94	Plutonium-243	W, see ^{234}Pu	2E+4	4E+4	2E-5	5E-8	2E-4	2E-3
		Y, see ^{234}Pu	-	4E+4	2E-5	5E-8	-	-
94	Plutonium-244	W, see ^{234}Pu	8E-1 Bone surf	7E-3 Bone surf	3E-12	-	-	-
			(2E+0)	(1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2 Bone surf	7E-12	-	-	-
			-	(2E-2)	-	2E-14	-	-
94	Plutonium-245	W, see ^{234}Pu	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
		Y, see ^{234}Pu	-	4E+3	2E-6	6E-9	-	-
94	Plutonium-246	W, see ^{234}Pu	4E+2 LLI wall	3E+2	1E-7	4E-10	-	-
			(4E+2)	-	-	-	6E-6	6E-5
		Y, see ^{234}Pu	-	3E+2	1E-7	4E-10	-	-
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 Bone surf	1E-6	-	5E-4	5E-3
			-	(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 Bone surf	6E-3 Bone surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
95	Americium-242m	W, all compounds	8E-1 Bone surf	6E-3 Bone surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
95	Americium-242	W, all compounds	4E+3	8E+1 Bone surf	4E-8	-	5E-5	5E-4
			-	(9E+1)	-	1E-10	-	-
95	Americium-243	W, all compounds	8E-1 Bone surf	6E-3 Bone surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
95	Americium-244m[2]	W, all compounds	6E+4 St wall	4E+3 Bone surf	2E-6	-	-	-
			(8E+4)	(7E+3)	-	1E-8	1E-3	1E-2
95	Americium-244	W, all compounds	3E+3	2E+2 Bone surf	8E-8	-	4E-5	4E-4
			-	(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 St wall	2E+5	8E-5	3E-7	-	-
			(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

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
96	Curium-240	W, all compounds	6E+1 Bone surf	6E-1 Bone surf	2E-10	-	-	-
			(8E+1)	(6E-1)	-	9E-13	1E-6	1E-5
96	Curium-241	W, all compounds	1E+3	3E+1 Bone surf	1E-8	-	2E-5	2E-4
			-	(4E+1)	-	5E-11	-	-
96	Curium-242	W, all compounds	3E+1 Bone surf	3E-1 Bone surf	1E-10	-	-	-
			(5E+1)	(3E-1)	-	4E-13	7E-7	7E-6
96	Curium-243	W, all compounds	1E+0 Bone surf	9E-3 Bone surf	4E-12	-	-	-
			(2E+0)	(2E-2)	-	2E-14	3E-8	3E-7
96	Curium-244	W, all compounds	1E+0 Bone surf	1E-2 Bone surf	5E-12	-	-	-
			(3E+0)	(2E-2)	-	3E-14	3E-8	3E-7
96	Curium-245	W, all compounds	7E-1 Bone surf	6E-3 Bone surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
96	Curium-246	W, all compounds	7E-1 Bone surf	6E-3 Bone surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
96	Curium-247	W, all compounds	8E-1 Bone surf	6E-3 Bone surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
96	Curium-248	W, all compounds	2E-1 Bone surf	2E-3 Bone surf	7E-13	-	-	-
			(4E-1)	(3E-3)	-	4E-15	5E-9	5E-8
96	Curium-249[2]	W, all compounds	5E+4	2E+4 Bone surf	7E-6	-	7E-4	7E-3
			-	(3E+4)	-	4E-8	-	-
96	Curium-250	W, all compounds	4E-2 Bone surf	3E-4 Bone surf	1E-13	-	-	-
			(6E-2)	(5E-4)	-	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	4E-3 Bone surf	2E-12	-	-	-
			(1E+0)	(9E-3)	-	1E-14	2E-8	2E-7
97	Berkelium-249	W, all compounds	2E+2 Bone surf	2E+0 Bone surf	7E-10	-	-	-
			(5E+2)	(4E+0)	-	5E-12	6E-6	6E-5
97	Berkelium-250	W, all compounds	9E+3	3E+2 Bone surf	1E-7	-	1E-4	1E-3
			-	(7E+2)	-	1E-9	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
98	Californium-244[2]	W, all compounds except those given for Y	3E+4 St wall	6E+2	2E-7	8E-10	-	-
			(3E+4)	-	-	-	4E-4	4E-3
		Y, oxides and hydroxides	-	6E+2	2E-7	8E-10	-	-
98	Californium-246	W, see ^{244}Cf	4E+2	9E+0	4E-9	1E-11	5E-6	5E-5
		Y, see ^{244}Cf	-	9E+0	4E-9	1E-11	-	-
98	Californium-248	W, see ^{244}Cf	8E+0 Bone surf	6E-2 Bone surf	3E-11	-	-	-
			(2E+1)	(1E-1)	-	2E-13	2E-7	2E-6
		Y, see ^{244}Cf	-	1E-1	4E-11	1E-13	-	-
98	Californium-249	W, see ^{244}Cf	5E-1 Bone surf	4E-3 Bone surf	2E-12	-	-	-
			(1E+0)	(9E-3)	-	1E-14	2E-8	2E-7
		Y, see ^{244}Cf	-	1E-2 Bone surf	4E-12	-	-	-
			-	(1E-2)	-	2E-14	-	-
98	Californium-250	W, see ^{244}Cf	1E+0 Bone surf	9E-3 Bone surf	4E-12	-	-	
			(2E+0)	(2E-2)	-	3E-14	3E-8	3E-7
		Y, see ^{244}Cf	-	3E-2	1E-11	4E-14	-	-
98	Californium-251	W, see ^{244}Cf	5E-1 Bone surf	4E-3 Bone surf	2E-12	-	-	-
			(1E+0)	(9E-3)	-	1E-14	2E-8	2E-7
		Y, see ^{244}Cf	-	1E-2 Bone surf	4E-12	-	-	-
			-	(1E-2)	-	2E-14	-	-
98	Californium-252	W, see ^{244}Cf	2E+0 Bone surf	2E-2 Bone surf	8E-12	-	-	-
			(5E+0)	(4E-2)	-	5E-14	7E-8	7E-7
		Y, see ^{244}Cf	-	3E-2	1E-11	5E-14	-	-
98	Californium-253	W, see ^{244}Cf	2E+2 Bone surf	2E+0	8E-10	3E-12	-	-
			(4E+2)	-	-	-	5E-6	5E-5
		Y, see ^{244}Cf	-	2E+0	7E-10	2E-12	-	-
98	Californium-254	W, see ^{244}Cf	2E+0	2E-2	9E-12	3E-14	3E-8	3E-7
		Y, see ^{244}Cf	-	2E-2	7E-12	2E-14	-	-
99	Einsteinium-250	W, all compounds	4E+4	5E+2 Bone surf	2E-7	-	6E-4	6E-3
			-	(1E+3)	-	2E-9	-	-
99	Einsteinium-251	W, all compounds	7E+3	9E+2 Bone surf	4E-7	-	1E-4	1E-3
			-	(1E+3)	-	2E-9	-	-
99	Einsteinium-253	W, all compounds	2E+2	1E+0	6E-10	2E-12	2E-6	2E-5

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
99	Einsteinium-254m	W, all compounds	3E+2 LLI wall	1E+1	4E-9	1E-11	-	-
			(3E+2)	-	-	-	4E-6	4E-5
99	Einsteinium-254	W, all compounds	8E+0 Bone surf	7E-2 Bone surf	3E-11	-	-	-
			(2E+1)	(1E-1)	-	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	2E-1 Bone surf	7E-11	-	-	-
			(4E+1)	(2E-1)	-	3E-13	5E-7	5E-6
101	Mendelevium-257	W, all compounds	7E+3	8E+1 Bone surf	4E-8	-	1E-4	1E-3
			-	(9E+1)	-	1E-10	-	-
101	Mendelevium-258	W, all compounds	3E+1 Bone surf	2E-1 Bone surf	1E-10	-	-	-
			(5E+1)	(3E-1)	-	5E-13	6E-7	6E-6
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours		Submersion[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

FOOTNOTES:

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

[Atomic No.]	[Radionuclide]	[Class]	[Table I] [Occupational Values] [Col. 1] [Oral Ingestion] [ALI] [(µCi)]	[Col. 2] [Inhalation] [ALI] [(µCi)]	[Col. 3] [Inhalation] [DAC] [(µCi/ml)]	[Table II] [Effluent Concentrations] [Col. 1] [Air] [(µCi/ml)]	[Col. 2] [Water] [(µCi/ml)]	[Table III] [Release to Sewers] [Monthly Average Concentrations] [(µCi/ml)]

[2] These radionuclides have radiological half-lives of less than 2 hours. The total effective dose equivalent received during operations with these radionuclides might include a significant contribution from external exposure. The DAC values for all radionuclides, other than those designated Class "Submersion," are based upon the committed effective dose equivalent due to the intake of the radionuclide into the body and do NOT include potentially significant contributions to dose equivalent from external exposures. The licensee may substitute 1E-7 µCi/ml for the listed DAC to account for the submersion dose prospectively, but should use individual monitoring devices or other radiation measuring instruments that measure external exposure to demonstrate compliance with the limits. (See §289.202(h).)

[3] For soluble mixtures of U-238, U-234, and U-235 in air, chemical toxicity may be the limiting factor (see §289.202(f)(6)). 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 8E-3 (SA) µCi-hr/ml, where SA is the specific activity of the uranium inhaled. The specific activity for natural uranium is 6.77E-7 curies per gram U. The specific activity for other mixtures of U-238, U-235, and U-234, if not known, shall be:

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

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

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

NOTES:

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

continued

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (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	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col. 2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentrations (µCi/ml)
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

3 If a mixture of radionuclides consists of uranium and its daughters in ore dust (10 µm AMAD particle distribution assumed) prior to chemical separation of the uranium from the ore, the following values may be used for the DAC of the mixture: 6E-11 µCi of gross alpha activity from uranium-238, uranium-234, thorium-230, and radium-226 per milliliter of air; 3E-11 µCi of natural uranium 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 this subsection for the specific radionuclide when not in a mixture. The sum of such ratios for all of the radionuclides in the mixture may not exceed "1" (i.e., "unity").

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

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

Figure: 25 TAC §289.202(ggg)(5)

Specific Subsection	Name of Record	Time Interval Required for Record Keeping
(y)(5)	Utilization Records for Portable and Mobile Devices	3 years after the record is made
(ll)(5) ([~~ll)(4)~~])	Records at Authorized Use/ Storage Sites	While site is authorized on license/registration
(mm)(1)(A)	Radiation Protection Programs	Until termination of license/registration
(mm)(1)(B)	Program Audits	3 years after the record is made
(nn)(1)	Routine Surveys, Instrument Calibrations, and Package Monitoring	3 years after the record is made
(nn)(3)	Surveys; Measurements and/or Calculations Used for Dose Determination; Results of Air Sampling, Surveys, and Bioassays; Measurements, Calculations Used to Determine Release of Radioactive Effluents	Until termination of license/registration
(oo)	Tests for Leakage / Contamination of Sealed Sources[~~leakage / contamination of sealed sources~~]	5 years after the record is made
(pp)	Lifetime Cumulative Occupational Radiation Dose, RC Form 202-2	Until termination of license
(pp)	Records Used to Prepare RC Form 202-2	3 years after the record is made
(qq)	Planned Special Exposures	Until termination of license
(rr)(1) - (3)	Individual Monitoring Results; RC Form 202-3	Entries at not [~~no~~] > 1 year intervals, by April 30 each year; Maintain until termination of license/registration

(rr)(5)	Records Used to Prepare RC Form 202-3	3 years after the record is made
(rr)(4)	Embryo/Fetus Dose	Until termination of license/registration
(ss)	Dose to Individual Members of the Public	Until termination of license/registration
(tt)	Discharge, Treatment, or Transfer for Disposal	Until termination of license/registration
(uu)	Entry Control Device Testing for Very High Radiation Areas	3 years after the record is made

Figure: 25 TAC §289.202(ggg)(6)

NUCLIDE[1]	AVERAGE[2, 3, 6]	MAXIMUM[2, 4, 6]	REMOVABLE[2, 3, 5, 6]
U-nat, U-235, U-238, and associated decay products	5,000 dpm	15,000 dpm	1,000 dpm
Transuranics, I-125, I-129, Ra-228, Pa-231, Ac-227, Th-230, Th-228, Ra-226	100 dpm	300 dpm	20 dpm
I-126, I-131, I-133, Ra-223, Ra-224, Sr-90, U-232, Th-nat, Th-232	1,000 dpm	3,000 dpm	200 dpm
Other alpha emitters[1]	500 dpm	1,500 dpm	100 dpm
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except those noted above	5,000 dpm	15,000 dpm	1,000 dpm
Tritium (applicable to surface and subsurface)[7]	NA	NA	10,000 dpm

[1] Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides are applied independently.

[2] As used in this table, disintegrations per minute (dpm) 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.

[3] Measurements of average contamination level should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each object.

[4] The maximum contamination level applies to an area of not more than 100 cm^2.

[5] The amount of removable radioactive material per 100 cm^2 of surface area shall 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 shall be reduced proportionally, and the entire surface shall be wiped.

[6] The radiation levels associated with surface contamination resulting from beta-gamma emitters shall not exceed 0.2 millirad per hour (mrad/hr) at 1 centimeter for an average and shall not exceed 1.0 mrad/hr at 1 centimeter as a maximum, as measured through not more than 7 mg/cm^2 of total absorber. The external gamma exposure rate shall not exceed 5 microroentgen/hr above background at 1 meter from the surface, and for soil, 10 microroentgen/hr above background at 1 meter.

[7] Property recently exposed or decontaminated shall have measurements (smears) at regular time intervals to ensurethat there is not a build-up of contamination over time. Because tritium typically penetrates material it contacts, the surface guidelines in group five are not applicable to tritium. The department has reviewed the analysis conducted by the Department of Energy Tritium Surface Contamination Limits Committee ("Recommended Tritium Surface Contamination Release Guides," February 1991), and has assessed potential doses associated with the release of property containing residual tritium. The department recommends the use of the stated guideline as an interim value for removable tritium. Measurements demonstrating compliance of the removable fraction of tritium on surfaces with this guideline are acceptable to ensure that non- removable fractions and residual tritium in mass will not cause exposures that exceed dose limits as specified in this section and department constraints.

Figure: 25 TAC §289.202(ggg)(6)

NUCLIDE[a]	AVERAGE[bcf]	MAXIMUM[bdf]	REMOVABLE[bcef]
U-nat, U-235,U-238, and associated decay products 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
Transuranics, Ra-223, Ra-224, Ra-226, Ra-228, Th-nat, Th-228, Th-230, Th-232, U-232, Pa-231, Ac-227, Sr-90, I-129	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) except Sr-90 and others noted above	5,000 dpm beta, gamma/100 cm^2	15,000 dpm beta, gamma/100 cm^2	1,000 dpm beta,M gamma/100 cm^2
Tritium (applicable to surface and subsurface)[g]	NA	NA	10,000 dpm/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 shall 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 1 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 cm^2.

e The amount of removable radioactive material per 100 cm^2 of surface area shall 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 shall be reduced proportionally and the entire surface shall be wiped.

[f] The radiation levels associated with surface contamination resulting from beta-gamma emitters shall not exceed 0.2 mrad/hr at 1 centimeter for an average and shall not exceed 1.0 mrad/hr at 1 centimeter as a maximum, as measured through not more than 7 mg/cm^2 of total absorber. The external gamma exposure rate shall not exceed 5 microentgen per hour above background at 1 meter from the surface, and for soil 10 microentgen per hour above background at 1 meter.

[g] Property recently exposed or decontaminated, shall have measurements (smears) at regular time intervals to ensure that there is not a build-up of contamination over time. Because tritium typically penetrates material it contacts, the surface guidelines in group 4 are not applicable to tritium. The agency has reviewed the analysis conducted by the Department of Energy Tritium Surface Contamination Limits Committee ("Recommended Tritium Surface Contamination Release Guides," February 1991), and has assessed potential doses associated with the release of property containing residual tritium. The agency recommends the use of the stated guideline as an interim value for removable tritium. Measurements demonstrating compliance of the removable fraction of tritium on surfaces with this guideline are acceptable to ensure that non-removable fractions and residual tritium in mass will not cause exposures that exceed dose limits as specified in this section and agency constraints.

Figure: 25 TAC §289.253(ee)(5)

	Name of Record/Document	*Rule Cross-Reference (this section unless otherwise noted)*	*Time Interval for Keeping Record/Document*
(A)	Inspection records	(d)(4)	3 years after each annual internal inspection
(B)	Agreement with well operator, owner, drilling contractor, or land owner	(e)	5 years following completion of the well logging service operation or tracer study
(C)	Survey instrument calibration	(i)	3 years
(D)	Leak test	(j)	3 years
(E)	Quarterly inventory	(k)	3 years
(F)	Utilization record	(l)	3 years
(G)	Certification document	(m)	3 years
(H)	Inspection and maintenance	(o)	3 years
(I)	Training and Testing	(p)	3 years after employee terminates employment with the licensee or registrant
(J)	Current operating, safety, and emergency procedures	(q)	Until termination of license or certificate of registration
(K)	Personnel monitoring	(r)	Until disposal is authorized by the department [~~agency~~]
(L)	Radiation surveys	(bb)	3 years after completion of the survey
(M)	Current License or Certificate of Registration	(cc)	Until termination of license or certificate of registration
(N)	Receipt and Transfer [~~Receipt, transfer, and disposal~~]	§289.201(d)	Until disposal of the records is authorized by the department [~~agency~~]
(O)	Disposal	§289.201(d)	Until termination of license
(P) [~~(O)~~]	Shipping papers for transportation	§289.257(e)	3 years
(Q) [~~(P)~~]	Current 25 TAC §289.253 of this title and other applicable sections as listed in the license or certificate of registration	(cc)	Until termination of license or certificate of registration

Figure: 25 TAC §289.255(v)(1)

Specific Subsection	Name of Record	Time Interval Required for Record Keeping
(e)(1)(A) and (2)(A) and (f)(1)	Training and Certification Records	5 years
(i)	Receipt and Transfer [~~Receipt, Transfer, and Disposal of DU~~]	3 years
(i)	Disposal	Until license termination
(j)(2)	Survey Instrument Calibrations	3 years
(k)	Quarterly Inventory	3 years
(l)	Utilization Logs	3 years
(m)	Inspection and Maintenance	3 years
(n)	Permanent Radiographic Installation Tests	3 years
(p)	Individual Monitoring Devices	Until disposal is authorized by the department [~~agency~~]
(p)	Estimates of Exposure	Until disposal is authorized by the department [~~agency~~]
(p)	Direct-Reading Pocket or Electronic Personal Dosimeter Readings	3 years or until disposal is authorized by the department [~~agency~~] if dosimeters were used to determine external radiation dose
(p)	Pocket Dosimeter Calibrations and Yearly Response Checks	3 years
(p)	Alarming Ratemeter Calibrations	3 years
(t)(5) and (u)(8)	Internal Audit Program	3 years
(t)(5)(F) and (u)(8)(F)	Annual Refresher Training	3 years
(t)(6) and (u)(9)	Radiation Surveys	3 years or until disposal is authorized by the department [~~agency~~] if a survey was used to determine an individual's exposure
(t)(7)(C)	Annual Evaluation of Radiation Machines in Shielded Rooms	3 years
(t)(8)(A)(i)	Operating Instructions in Cabinet X-Ray Systems	3 years

(t)(8)(A)(ii)	Tests of X-Ray Interlocks	3 years
(t)(8)(A)(iii)	Evaluation of Certified Cabinet X-Ray Systems	3 years
(u)(6)	Leak Tests	3 years
(u)(10)(D)	Annual Evaluation of Shielded Rooms Containing Sealed Sources	3 years
(u)(10)(E)	Test of Sealed Source Interlocks	3 years
(v)(3)	Records at Temporary Job Sites	During temporary job site operations

Figure: 25 TAC §289.256(xxx)

Rule Cross Reference	Name of Records/Documents	Time Interval for Keeping Records/Documents
§289.201(d)(1)	Records of receipt and transfer [~~receipt, transfer, and disposal~~] of radioactive material	Until disposal of the records is authorized by the department [~~agency~~]
§289.201(d)(1)	Records of disposal of radioactive material	Until termination of the radioactive material license
§289.203(b)(1)(B)	Current applicable sections of this chapter as listed in the radioactive material license	Until termination of the radioactive material license
§289.203(b)(1)(B)	Copy of the current radioactive material license	Until termination of the radioactive material license
§289.203(b)(1)(C), §289.256(f)(3)(A)	Current operating, safety, and emergency procedures	Until termination of the radioactive material license
§289.256 (f)(3)(C)(i)	Qualifications of RSO	Duration of employment
§289.256(f)(3)(C)(ii)	Qualifications of authorized users	Duration of employment
§289.256(f)(3)(C)(iii)	Qualifications of authorized medical physicist	Duration of employment
§289.256(f)(3)(C)(iv)	Qualifications of authorized nuclear pharmacist, if applicable	Duration of employment
§289.256(g)(7)	Qualifications and dates of service for temporary RSO	3 years
§289.256(g)(9)(A)	Actions taken by the licensee's management	5 years
§289.256(g)(9)(B)	Authority, duties, and responsibilities of the RSO and the RSO's agreement to implement the radiation safety program[~~.~~]	Until termination of the radioactive material license
§289.256(g)(9)(C)	Document appointing the ARSO	5 years after the ARSO is removed from the license
§289.256(i)(3[4])	RSC meetings	3 years
§289.256(t)(3)	Written directives	3 years
§289.256(t)(5[4])(C)	Procedures for administrations requiring a written directive	Until termination of the radioactive material license
§289.256(v)(4)	Calibration of instruments (dose calibrators)	3 years
§289.256(w)(5)	Calibration of survey instruments	3 years
§289.256(x)(6)	Dosage determinations of unsealed radioactive material for medical use	3 years
§289.256(z)(2)	Physical inventory for all sealed source/brachytherapy inventory	3 years
§289.256(bb)(3)	Surveys for ambient radiation exposure rate	3 years

Rule Cross Reference	Name of Records/Documents	Time Interval for Keeping Records/Documents
§289.256(cc)(3) §289.256(eee)(2)	Patient release	3 years after date of release
§289.256(dd)(3)	Mobile nuclear medicine service client letters	Duration of licensee/client relationship
§289.256(dd)(3)	Mobile nuclear medicine service surveys	3 years
§289.256(ee)(2)	Decay in storage/disposal	3 years
§289.256(ii)(4)	Permissible Molybdenum-99, Strontium-82, and Strontium-85 concentrations	3 years
§289.256(ll)(2)	Safety instructions – unsealed radioactive materials	3 years
§289.256(ss)(3)	Surveys after sealed source implant and removal	3 years
§289.256(tt)(3)	Brachytherapy sealed sources accountability	3 years
§289.256(uu)(2)	Safety instruction to personnel	3 years
§289.256(ww)(4)	Calibration measurements of brachytherapy sealed sources	3 years
§289.256(xx)(3)	Activity of each Strontium 90 source	Duration of life of source
§289.256(bbb)(4[~~2~~])	Service provider documentation	3 years
§289.256(fff)(4)	Installation, maintenance, adjustment, and repair - remote afterloader units, teletherapy units, and gamma stereotactic radiosurgery units	3 years
§289.256(ggg)(6)	Written safety and operating procedures	Until licensee no longer possesses unit
§289.256(ggg)(7)	Instruction/drills for remote afterloader units, teletherapy units, and gamma stereotactic radiosurgery units	3 years
§289.256(iii)(3)	Dosimetry equipment calibration, intercomparison, and comparison	Until termination of the radioactive material license
§289.256(jjj)(7)	Calibration – teletherapy units	3 years
§289.256(kkk)(9)	Calibration – remote afterloader units	3 years

Rule Cross Reference	Name of Records/Documents	Time Interval for Keeping Records/Documents
§289.256(lll)(7)	Calibration – gamma stereotactic radiosurgery units	3 years
§289.256(mmm)(2)	Written procedures for spot checks - teletherapy units	Until licensee no longer possesses unit
§289.256(mmm)(6)	Spot checks - teletherapy units	Until licensee no longer possesses unit
§289.256(nnn)(2)	Written procedures for spot checks - remote afterloaders	3 years
§289.256(nnn)(6)	Spot checks - remote afterloader	3 years
§289.256(ooo)(2)	Written procedures for spot checks - gamma stereotactic radiosurgery units	3 years
§289.256(ooo)(8)	Spot checks - gamma stereotactic radiosurgery units	3 years
§289.256(ppp)(5)	Technical requirements for mobile remote afterloader units	3 years
§289.256(qqq)(3)	Radiation surveys	Duration of the use of the unit
§289.256(rrr)(3)	Full-inspection servicing records for teletherapy and gamma stereotactic radiosurgery units	Duration of the use of the unit
§289.256(uuu)(9)	Annotated report – medical event	Until termination of the radioactive material license
§289.256(vvv)(8)	Annotated report – dose to embryo/fetus or nursing child	Until termination of the radioactive material license

Figure: 25 TAC §289.257(ee)(6)

Table 257-3 - A_1 and A_2 Values for Radionuclides

Symbol of radionuclide [~~Radionuclide~~]	Element and atomic number	A_1 (TBq)	A_1(Ci)[b]	A_2 (TBq)	A_2(Ci)[b]	Specific activity	
						(TBq/g)	(Ci/g)
Ac-225 (a)	Actinium (89)	$8.0X10^{-1}$	$2.2X10^{1}$	$6.0X10^{-3}$	$1.6X10^{-1}$	$2.1X10^{3}$	$5.8X10^{4}$
Ac-227 (a)		$9.0X10^{-1}$	$2.4X10^{1}$	$9.0X10^{-5}$	$2.4X10^{-3}$	2.7	$7.2X10^{1}$
Ac-228		$6.0X10^{-1}$	$1.6X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$8.4X10^{4}$	$2.2X10^{6}$
Ag-105	Silver (47)	2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$1.1X10^{3}$	$3.0X10^{4}$
Ag-108m (a)		$7.0X10^{-1}$	$1.9X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$9.7X10^{-1}$	$2.6X10^{1}$
Ag-110m (a)		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.8X10^{2}$	$4.7X10^{3}$
Ag-111		2.0	$5.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$5.8X10^{3}$	$1.6X10^{5}$
Al-26	Aluminum (13)	$1.0X10^{-1}$	2.7	$1.0X10^{-1}$	2.7	$7.0X10^{-4}$	$1.9X10^{-2}$
Am-241	Americium (95)	$1.0X10^{1}$	$2.7X10^{2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$1.3X10^{-1}$	3.4
Am-242m (a)		$1.0X10^{1}$	$2.7X10^{2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$3.6X10^{-1}$	$1.0X10^{1}$
Am-243 (a)		5.0	$1.4X10^{2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$7.4X10^{-3}$	$2.0X10^{-1}$
Ar-37	Argon (18)	$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$3.7X10^{3}$	$9.9X10^{4}$
Ar-39		$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{1}$	$5.4X10^{2}$	1.3	$3.4X10^{1}$
Ar-41		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$1.5X10^{6}$	$4.2X10^{7}$
As-72	Arsenic (33)	$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$6.2X10^{4}$	$1.7X10^{6}$
As-73		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$8.2X10^{2}$	$2.2X10^{4}$
As-74		1.0	$2.7X10^{1}$	$9.0X10^{-1}$	$2.4X10^{1}$	$3.7X10^{3}$	$9.9X10^{4}$
As-76		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$5.8X10^{4}$	$1.6X10^{6}$

Symbol of radionuclide [~~Radionuclide~~]	Element and atomic number	A_1 (TBq)	A_1(Ci)[b]	A_2 (TBq)	A_2(Ci)[b]	Specific activity	
						(TBq/g)	(Ci/g)
As-77		$2.0X10^{1}$	$5.4X10^{2}$	$7.0X10^{-1}$	$1.9X10^{1}$	$3.9X10^{4}$	$1.0X10^{6}$
At-211 (a)	Astatine (85)	$2.0X10^{1}$	$5.4X10^{2}$	$5.0X10^{-1}$	$1.4X10^{1}$	$7.6X10^{4}$	$2.1X10^{6}$
Au-193	Gold (79)	7.0	$1.9X10^{2}$	2.0	$5.4X10^{1}$	$3.4X10^{4}$	$9.2X10^{5}$
Au-194		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$1.5X10^{4}$	$4.1X10^{5}$
Au-195		$1.0X10^{1}$	$2.7X10^{2}$	6.0	$1.6X10^{2}$	$1.4X10^{2}$	$3.7X10^{3}$
Au-198		1.0	$2.7X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$9.0X10^{3}$	$2.4X10^{5}$
Au-199		$1.0X10^{1}$	$2.7X10^{2}$	$6.0X10^{-1}$	$1.6X10^{1}$	$7.7X10^{3}$	$2.1X10^{5}$
Ba-131 (a)	Barium (56)	2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$3.1X10^{3}$	$8.4X10^{4}$
Ba-133		3.0	$8.1X10^{1}$	3.0	$8.1X10^{1}$	9.4	$2.6X10^{2}$
Ba-133m		$2.0X10^{1}$	$5.4X10^{2}$	$6.0X10^{-1}$	$1.6X10^{1}$	$2.2X10^{4}$	$6.1X10^{5}$
Ba-140 (a)		$5.0X10^{-1}$	$1.4X10^{1}$	$3.0X10^{-1}$	8.1	$2.7X10^{3}$	$7.3X10^{4}$
Be-7	Beryllium (4)	$2.0X10^{1}$	$5.4X10^{2}$	$2.0X10^{1}$	$5.4X10^{2}$	$1.3X10^{4}$	$3.5X10^{5}$
Be-10		$4.0X10^{1}$	$1.1X10^{3}$	$6.0X10^{-1}$	$1.6X10^{1}$	$8.3X10^{-4}$	$2.2X10^{-2}$
Bi-205	Bismuth (83)	$7.0X10^{-1}$	$1.9X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$1.5X10^{3}$	$4.2X10^{4}$
Bi-206		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$3.8X10^{3}$	$1.0X10^{5}$
Bi-207		$7.0X10^{-1}$	$1.9X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	1.9	$5.2X10^{1}$
Bi-210		1.0	$2.7X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$4.6X10^{3}$	$1.2X10^{5}$
Bi-210m (a)		$6.0X10^{-1}$	$1.6X10^{1}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$2.1X10^{-5}$	$5.7X10^{-4}$
Bi-212 (a)		$7.0X10^{-1}$	$1.9X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$5.4X10^{5}$	$1.5X10^{7}$
Bk-247	Berkelium (97)	8.0	$2.2X10^{2}$	$8.0X10^{-4}$	$2.2X10^{-2}$	$3.8X10^{-2}$	1.0
Bk-249 (a)		$4.0X10^{1}$	$1.1X10^{3}$	$3.0X10^{-1}$	8.1	$6.1X10^{1}$	$1.6X10^{3}$

Symbol of radionuclide [~~Radionuclide~~]	Element and atomic number	A_1 (TBq)	A_1(Ci)[b]	A_2 (TBq)	A_2(Ci)[b]	Specific activity	
						(TBq/g)	(Ci/g)
Br-76	Bromine (35)	$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$9.4X10^{4}$	$2.5X10^{6}$
Br-77		3.0	$8.1X10^{1}$	3.0	$8.1X10^{1}$	$2.6X10^{4}$	$7.1X10^{5}$
Br-82		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{4}$	$1.1X10^{6}$
C-11	Carbon (6)	1.0	$2.7X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$3.1X10^{7}$	$8.4X10^{8}$
C-14		$4.0X10^{1}$	$1.1X10^{3}$	3.0	$8.1X10^{1}$	$1.6X10^{-1}$	4.5
Ca-41	Calcium (20)	Unlimited	Unlimited	Unlimited	Unlimited	$3.1X10^{-3}$	$8.5X10^{-2}$
Ca-45		$4.0X10^{1}$	$1.1X10^{3}$	1.0	$2.7X10^{1}$	$6.6X10^{2}$	$1.8X10^{4}$
Ca-47 (a)		3.0	$8.1X10^{1}$	$3.0X10^{-1}$	8.1	$2.3X10^{4}$	$6.1X10^{5}$
Cd-109	Cadmium (48)	$3.0X10^{1}$	$8.1X10^{2}$	2.0	$5.4X10^{1}$	$9.6X10^{1}$	$2.6X10^{3}$
Cd-113m		$4.0X10^{1}$	$1.1X10^{3}$	$5.0X10^{-1}$	$1.4X10^{1}$	8.3	$2.2X10^{2}$
Cd-115 (a)		3.0	$8.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.9X10^{4}$	$5.1X10^{5}$
Cd-115m		$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$9.4X10^{2}$	$2.5X10^{4}$
Ce-139	Cerium (58)	7.0	$1.9X10^{2}$	2.0	$5.4X10^{1}$	$2.5X10^{2}$	$6.8X10^{3}$
Ce-141		$2.0X10^{1}$	$5.4X10^{2}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.1X10^{3}$	$2.8X10^{4}$
Ce-143		$9.0X10^{-1}$	$2.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$2.5X10^{4}$	$6.6X10^{5}$
Ce-144 (a)		$2.0X10^{-1}$	5.4	$2.0X10^{-1}$	5.4	$1.2X10^{2}$	$3.2X10^{3}$
Cf-248	Californium (98)	$4.0X10^{1}$	$1.1X10^{3}$	$6.0X10^{-3}$	$1.6X10^{-1}$	$5.8X10^{1}$	$1.6X10^{3}$
Cf-249		3.0	$8.1X10^{1}$	$8.0X10^{-4}$	$2.2X10^{-2}$	$1.5X10^{-1}$	4.1
Cf-250		$2.0X10^{1}$	$5.4X10^{2}$	$2.0X10^{-3}$	$5.4X10^{-2}$	4.0	$1.1X10^{2}$
Cf-251		7.0	$1.9X10^{2}$	$7.0X10^{-4}$	$1.9X10^{-2}$	$5.9X10^{-2}$	1.6
Cf-252		$1.0X10^{-2}$	2.7	$3.0X10^{-3}$	$8.1X10^{-2}$	$2.0X10^{1}$	$5.4X10^{2}$

Symbol of radionuclide [~~Radionuclide~~]	Element and atomic number	A_1 (TBq)	A_1(Ci)[b]	A_2 (TBq)	A_2(Ci)[b]	Specific activity	
						(TBq/g)	(Ci/g)
Cf-253 (a)		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{-2}$	1.1	$1.1X10^{3}$	$2.9X10^{4}$
Cf-254		$1.0X10^{-3}$	$2.7X10^{-2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$3.1X10^{2}$	$8.5X10^{3}$
Cl-36	Chlorine (17)	$1.0X10^{1}$	$2.7X10^{2}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.2X10^{-3}$	$3.3X10^{-2}$
Cl-38		$2.0X10^{-1}$	5.4	$2.0X10^{-1}$	5.4	$4.9X10^{6}$	$1.3X10^{8}$
Cm-240	Curium (96)	$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$7.5X10^{2}$	$2.0X10^{4}$
Cm-241		2.0	$5.4X10^{1}$	1.0	$2.7X10^{1}$	$6.1X10^{2}$	$1.7X10^{4}$
Cm-242		$4.0X10^{1}$	$1.1X10^{3}$	$1.0X10^{-2}$	$2.7X10^{-1}$	$1.2X10^{2}$	$3.3X10^{3}$
Cm-243		9.0	$2.4X10^{2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$1.9X10^{-3}$	$5.2X10^{1}$
Cm-244		$2.0X10^{1}$	$5.4X10^{2}$	$2.0X10^{-3}$	$5.4X10^{-2}$	3.0	$8.1X10^{1}$
Cm-245		9.0	$2.4X10^{2}$	$9.0X10^{-4}$	$2.4X10^{-2}$	$6.4X10^{-3}$	$1.7X10^{-1}$
Cm-246		9.0	$2.4X10^{2}$	$9.0X10^{-4}$	$2.4X10^{-2}$	$1.1X10^{-2}$	$3.1X10^{-1}$
Cm-247 (a)		3.0	$8.1X10^{1}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$3.4X10^{-6}$	$9.3X10^{-5}$
Cm-248		$2.0X10^{-2}$	$5.4X10^{-1}$	$3.0X10^{-4}$	$8.1X10^{-3}$	$1.6X10^{-4}$	$4.2X10^{-3}$
Co-55	Cobalt (27)	$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$1.1X10^{5}$	$3.1X10^{6}$
Co-56		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$1.1X10^{3}$	$3.0X10^{4}$
Co-57		$1.0X10^{1}$	$2.7X10^{2}$	$1.0X10^{1}$	$2.7X10^{2}$	$3.1X10^{2}$	$8.4X10^{3}$
Co-58		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$1.2X10^{3}$	$3.2X10^{4}$
Co-58m		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$2.2X10^{5}$	$5.9X10^{6}$
Co-60		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$4.2X10^{1}$	$1.1X10^{3}$
Cr-51	Chromium (24)	$3.0X10^{1}$	$8.1X10^{2}$	$3.0X10^{1}$	$8.1X10^{2}$	$3.4X10^{3}$	$9.2X10^{4}$
Cs-129	Cesium (55)	4.0	$1.1X10^{2}$	4.0	$1.1X10^{2}$	$2.8X10^{4}$	$7.6X10^{5}$

Symbol of radionuclide [~~Radionuclide~~]	Element and atomic number	A_1 (TBq)	A_1(Ci)[b]	A_2 (TBq)	A_2(Ci)[b]	Specific activity	
						(TBq/g)	(Ci/g)
Cs-131		$3.0X10^{1}$	$8.1X10^{2}$	$3.0X10^{1}$	$8.1X10^{2}$	$3.8X10^{3}$	$1.0X10^{5}$
Cs-132		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$5.7X10^{3}$	$1.5X10^{5}$
Cs-134		$7.0X10^{-1}$	$1.9X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$4.8X10^{1}$	$1.3X10^{3}$
Cs-134m		$4.0X10^{1}$	$1.1X10^{3}$	$6.0X10^{-1}$	$1.6X10^{1}$	$3.0X10^{5}$	$8.0X10^{6}$
Cs-135		$4.0X10^{1}$	$1.1X10^{3}$	1.0	$2.7X10^{1}$	$4.3X10^{-5}$	$1.2X10^{-3}$
Cs-136		$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$2.7X10^{3}$	$7.3X10^{4}$
Cs-137 (a)		2.0	$5.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	3.2	$8.7X10^{1}$
Cu-64	Copper (29)	6.0	$1.6X10^{2}$	1.0	$2.7X10^{1}$	$1.4X10^{5}$	$3.9X10^{6}$
Cu-67		$1.0X10^{1}$	$2.7X10^{2}$	$7.0X10^{-1}$	$1.9X10^{1}$	$2.8X10^{4}$	$7.6X10^{5}$
Dy-159	Dysprosium (66)	$2.0X10^{1}$	$5.4X10^{2}$	$2.0X10^{1}$	$5.4X10^{2}$	$2.1X10^{2}$	$5.7X10^{3}$
Dy-165		$9.0X10^{-1}$	$2.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$3.0X10^{5}$	$8.2X10^{6}$
Dy-166 (a)		$9.0X10^{-1}$	$2.4X10^{1}$	$3.0X10^{-1}$	8.1	$8.6X10^{3}$	$2.3X10^{5}$
Er-169	Erbium (68)	$4.0X10^{1}$	$1.1X10^{3}$	1.0	$2.7X10^{1}$	$3.1X10^{3}$	$8.3X10^{4}$
Er-171		$8.0X10^{-1}$	$2.2X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$9.0X10^{4}$	$2.4X10^{6}$
Eu-147	Europium (63)	2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$1.4X10^{3}$	$3.7X10^{4}$
Eu-148		$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$6.0X10^{2}$	$1.6X10^{4}$
Eu-149		$2.0X10^{1}$	$5.4X10^{2}$	$2.0X10^{1}$	$5.4X10^{2}$	$3.5X10^{2}$	$9.4X10^{3}$
Eu-150 (short lived)		2.0	$5.4X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$6.1X10^{4}$	$1.6X10^{6}$
Eu-150 (long lived)		$7.0X10^{-1}$	$1.9X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$6.1X10^{4}$	$1.6X10^{6}$
Eu-152		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	6.5	$1.8X10^{2}$
Eu-152m		$8.0X10^{-1}$	$2.2X10^{1}$	$8.0X10^{-1}$	$2.2X10^{1}$	$8.2X10^{4}$	$2.2X10^{6}$

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						(TBq/g)	(Ci/g)
Eu-154		$9.0X10^{-1}$	$2.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	9.8	$2.6X10^{2}$
Eu-155		$2.0X10^{1}$	$5.4X10^{2}$	3.0	$8.1X10^{1}$	$1.8X10^{1}$	$4.9X10^{2}$
Eu-156		$7.0X10^{-1}$	$1.9X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$2.0X10^{3}$	$5.5X10^{4}$
F-18	Fluorine (9)	1.0	$2.7X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$3.5X10^{6}$	$9.5X10^{7}$
Fe-52 (a)	Iron (26)	$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$2.7X10^{5}$	$7.3X10^{6}$
Fe-55		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$8.8X10^{1}$	$2.4X10^{3}$
Fe-59		$9.0X10^{-1}$	$2.4X10^{1}$	$9.0X10^{-1}$	$2.4X10^{1}$	$1.8X10^{3}$	$5.0X10^{4}$
Fe-60 (a)		$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{-1}$	5.4	$7.4X10^{-4}$	$2.0X10^{-2}$
Ga-67	Gallium (31)	7.0	$1.9X10^{2}$	3.0	$8.1X10^{1}$	$2.2X10^{4}$	$6.0X10^{5}$
Ga-68		$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$1.5X10^{6}$	$4.1X10^{7}$
Ga-72		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.1X10^{5}$	$3.1X10^{6}$
Gd-146 (a)	Gadolinium (64)	$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$6.9X10^{2}$	$1.9X10^{4}$
Gd-148		$2.0X10^{1}$	$5.4X10^{2}$	$2.0X10^{-3}$	$5.4X10^{-2}$	1.2	$3.2X10^{1}$
Gd-153		$1.0X10^{1}$	$2.7X10^{2}$	9.0	$2.4X10^{2}$	$1.3X10^{2}$	$3.5X10^{3}$
Gd-159		3.0	$8.1X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$3.9X10^{4}$	$1.1X10^{6}$
Ge-68 (a)	Germanium (32)	$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$2.6X10^{2}$	$7.1X10^{3}$
Ge-71		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$5.8X10^{3}$	$1.6X10^{5}$
Ge-77		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$1.3X10^{5}$	$3.6X10^{6}$
Hf-172 (a)	Hafnium (72)	$6.0X10^{-1}$	$1.6X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$4.1X10^{1}$	$1.1X10^{3}$
Hf-175		3.0	$8.1X10^{1}$	3.0	$8.1X10^{1}$	$3.9X10^{2}$	$1.1X10^{4}$
Hf-181		2.0	$5.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$6.3X10^{2}$	$1.7X10^{4}$

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						(TBq/g)	(Ci/g)
Hf-182		Unlimited	Unlimited	Unlimited	Unlimited	$8.1X10^{-6}$	$2.2X10^{-4}$
Hg-194 (a)	Mercury (80)	1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$1.3X10^{-1}$	3.5
Hg-195m (a)		3.0	$8.1X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$1.5X10^{4}$	$4.0X10^{5}$
Hg-197		$2.0X10^{1}$	$5.4X10^{2}$	$1.0X10^{1}$	$2.7X10^{2}$	$9.2X10^{3}$	$2.5X10^{5}$
Hg-197m		$1.0X10^{1}$	$2.7X10^{2}$	$4.0X10^{-1}$	$1.1X10^{1}$	$2.5X10^{4}$	$6.7X10^{5}$
Hg-203		5.0	$1.4X10^{2}$	1.0	$2.7X10^{1}$	$5.1X10^{2}$	$1.4X10^{4}$
Ho-166	Holmium (67)	$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$2.6X10^{4}$	$7.0X10^{5}$
Ho-166m		$6.0X10^{-1}$	$1.6X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$6.6X10^{-2}$	1.8
I-123	Iodine (53)	6.0	$1.6X10^{2}$	3.0	$8.1X10^{1}$	$7.1X10^{4}$	$1.9X10^{6}$
I-124		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$9.3X10^{3}$	$2.5X10^{5}$
I-125		$2.0X10^{1}$	$5.4X10^{2}$	3.0	$8.1X10^{1}$	$6.4X10^{2}$	$1.7X10^{4}$
I-126		2.0	$5.4X10^{1}$	1.0	$2.7X10^{1}$	$2.9X10^{3}$	$8.0X10^{4}$
I-129		Unlimited	Unlimited	Unlimited	Unlimited	$6.5X10^{-6}$	$1.8X10^{-4}$
I-131		3.0	$8.1X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$4.6X10^{3}$	$1.2X10^{5}$
I-132		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$3.8X10^{5}$	$1.0X10^{7}$
I-133		$7.0X10^{-1}$	$1.9X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$4.2X10^{4}$	$1.1X10^{6}$
I-134		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$9.9X10^{5}$	$2.7X10^{7}$
I-135 (a)		$6.0X10^{-1}$	$1.6X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.3X10^{5}$	$3.5X10^{6}$
In-111	Indium (49)	3.0	$8.1X10^{1}$	3.0	$8.1X10^{1}$	$1.5X10^{4}$	$4.2X10^{5}$
In-113m		4.0	$1.1X10^{2}$	2.0	$5.4X10^{1}$	$6.2X10^{5}$	$1.7X10^{7}$
In-114m (a)		$1.0X10^{1}$	$2.7X10^{2}$	$5.0X10^{-1}$	$1.4X10^{1}$	$8.6X10^{2}$	$2.3X10^{4}$

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In-115m		7.0	$1.9X10^2$	1.0	$2.7X10^1$	$2.2X10^5$	$6.1X10^6$
Ir-189 (a)	Iridium (77)	$1.0X10^1$	$2.7X10^2$	$1.0X10^1$	$2.7X10^2$	$1.9X10^3$	$5.2X10^4$
Ir-190		$7.0X10^{-1}$	$1.9X10^1$	$7.0X10^{-1}$	$1.9X10^1$	$2.3X10^3$	$6.2X10^4$
Ir-192		[c] 1.0	[c] $2.7x10^1$	$6.0X10^{-1}$	$1.6X10^1$	$3.4X10^2$	$9.2X10^3$
Ir-194		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$3.1X10^4$	$8.4X10^5$
K-40	Potassium (19)	$9.0X10^{-1}$	$2.4X10^1$	$9.0X10^{-1}$	$2.4X10^1$	$2.4X10^{-7}$	$6.4X10^{-6}$
K-42		$2.0X10^{-1}$	5.4	$2.0X10^{-1}$	5.4	$2.2X10^5$	$6.0X10^6$
K-43		$7.0X10^{-1}$	$1.9X10^1$	$6.0X10^{-1}$	$1.6X10^1$	$1.2X10^5$	$3.3X10^6$
Kr-79	Krypton (36)	4.0	$1.1X10^2$	2.0	$5.4X10^1$	$4.2X10^4$	$1.1X10^6$
Kr-81		$4.0X10^1$	$1.1X10^3$	$4.0X10^1$	$1.1X10^3$	$7.8X10^{-4}$	$2.1X10^{-2}$
Kr-85		$1.0X10^1$	$2.7X10^2$	$1.0X10^1$	$2.7X10^2$	$1.5X10^1$	$3.9X10^2$
Kr-85m		8.0	$2.2X10^2$	3.0	$8.1X10^1$	$3.0X10^5$	$8.2X10^6$
Kr-87		$2.0X10^{-1}$	5.4	$2.0X10^{-1}$	5.4	$1.0X10^6$	$2.8X10^7$
La-137	Lanthanum (57)	$3.0X10^1$	$8.1X10^2$	6.0	$1.6X10^2$	$1.6X10^{-3}$	$4.4X10^{-2}$
La-140		$4.0X10^{-1}$	$1.1X10^1$	$4.0X10^{-1}$	$1.1X10^1$	$2.1X10^4$	$5.6X10^5$
Lu-172	Lutetium (71)	$6.0X10^{-1}$	$1.6X10^1$	$6.0X10^{-1}$	$1.6X10^1$	$4.2X10^3$	$1.1X10^5$
Lu-173		8.0	$2.2X10^2$	8.0	$2.2X10^2$	$5.6X10^1$	$1.5X10^3$
Lu-174		9.0	$2.4X10^2$	9.0	$2.4X10^2$	$2.3X10^1$	$6.2X10^2$
Lu-174m		$2.0X10^1$	$5.4X10^2$	$1.0X10^1$	$2.7X10^2$	$2.0X10^2$	$5.3X10^3$
Lu-177		$3.0X10^1$	$8.1X10^2$	$7.0X10^{-1}$	$1.9X10^1$	$4.1X10^3$	$1.1X10^5$
Mg-28 (a)	Magnesium (12)	$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$2.0X10^5$	$5.4X10^6$

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Mn-52	Manganese (25)	$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$1.6X10^{4}$	$4.4X10^{5}$
Mn-53		Unlimited	Unlimited	Unlimited	Unlimited	$6.8X10^{-5}$	$1.8X10^{-3}$
Mn-54		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$2.9X10^{2}$	$7.7X10^{3}$
Mn-56		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$8.0X10^{5}$	$2.2X10^{7}$
Mo-93	Molybdenum (42)	$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{1}$	$5.4X10^{2}$	$4.1X10^{-2}$	1.1
Mo-99 (a) (h)		1.0	$2.7X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.8X10^{4}$	$4.8X10^{5}$
N-13	Nitrogen (7)	$9.0X10^{-1}$	$2.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$5.4X10^{7}$	$1.5X10^{9}$
Na-22	Sodium (11)	$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$2.3X10^{2}$	$6.3X10^{3}$
Na-24		$2.0X10^{-1}$	5.4	$2.0X10^{-1}$	5.4	$3.2X10^{5}$	$8.7X10^{6}$
Nb-93m	Niobium (41)	$4.0X10^{1}$	$1.1X10^{3}$	$3.0X10^{1}$	$8.1X10^{2}$	8.8	$2.4X10^{2}$
Nb-94		$7.0X10^{-1}$	$1.9X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$6.9X10^{-3}$	$1.9X10^{-1}$
Nb-95		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$1.5X10^{3}$	$3.9X10^{4}$
Nb-97		$9.0X10^{-1}$	$2.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$9.9X10^{5}$	$2.7X10^{7}$
Nd-147	Neodymium (60)	6.0	$1.6X10^{2}$	$6.0X10^{-1}$	$1.6X10^{1}$	$3.0X10^{3}$	$8.1X10^{4}$
Nd-149		$6.0X10^{-1}$	$1.6X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$4.5X10^{5}$	$1.2X10^{7}$
Ni-59	Nickel (28)	Unlimited	Unlimited	Unlimited	Unlimited	$3.0X10^{-3}$	$8.0X10^{-2}$
Ni-63		$4.0X10^{1}$	$1.1X10^{3}$	$3.0X10^{1}$	$8.1X10^{2}$	2.1	$5.7X10^{1}$
Ni-65		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$7.1X10^{5}$	$1.9X10^{7}$
Np-235	Neptunium (93)	$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$5.2X10^{1}$	$1.4X10^{3}$
Np-236 (short-lived)		$2.0X10^{1}$	$5.4X10^{2}$	2.0	$5.4X10^{1}$	$4.7X10^{-4}$	$1.3X10^{-2}$
Np-236 (long-lived)		$9.0X10^{0}$	$2.4X10^{2}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$4.7X10^{-4}$	$1.3X10^{-2}$

Symbol of radionuclide [~~Radionuclide~~]	Element and atomic number	A_1 (TBq)	A_1(Ci)[b]	A_2 (TBq)	A_2(Ci)[b]	Specific activity	
						(TBq/g)	(Ci/g)
Np-237		$2.0X10^{1}$	$5.4X10^{2}$	$2.0X10^{-3}$	$5.4X10^{-2}$	$2.6X10^{-5}$	$7.1X10^{-4}$
Np-239		7.0	$1.9X10^{2}$	$4.0X10^{-1}$	$1.1X10^{1}$	$8.6X10^{3}$	$2.3X10^{5}$
Os-185	Osmium (76)	1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$2.8X10^{2}$	$7.5X10^{3}$
Os-191		$1.0X10^{1}$	$2.7X10^{2}$	2.0	$5.4X10^{1}$	$1.6X10^{3}$	$4.4X10^{4}$
Os-191m		$4.0X10^{1}$	$1.1X10^{3}$	$3.0X10^{1}$	$8.1X10^{2}$	$4.6X10^{4}$	$1.3X10^{6}$
Os-193		2.0	$5.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$2.0X10^{4}$	$5.3X10^{5}$
Os-194 (a)		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$1.1X10^{1}$	$3.1X10^{2}$
P-32	Phosphorus (15)	$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$1.1X10^{4}$	$2.9X10^{5}$
P-33		$4.0X10^{1}$	$1.1X10^{3}$	1.0	$2.7X10^{1}$	$5.8X10^{3}$	$1.6X10^{5}$
Pa-230 (a)	Protactinium (91)	2.0	$5.4X10^{1}$	$7.0X10^{-2}$	1.9	$1.2X10^{3}$	$3.3X10^{4}$
Pa-231		4.0	$1.1X10^{2}$	$4.0X10^{-4}$	$1.1X10^{-2}$	$1.7X10^{-3}$	$4.7X10^{-2}$
Pa-233		5.0	$1.4X10^{2}$	$7.0X10^{-1}$	$1.9X10^{1}$	$7.7X10^{2}$	$2.1X10^{4}$
Pb-201	Lead (82)	1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$6.2X10^{4}$	$1.7X10^{6}$
Pb-202		$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{1}$	$5.4X10^{2}$	$1.2X10^{-4}$	$3.4X10^{-3}$
Pb-203		4.0	$1.1X10^{2}$	3.0	$8.1X10^{1}$	$1.1X10^{4}$	$3.0X10^{5}$
Pb-205		Unlimited	Unlimited	Unlimited	Unlimited	$4.5X10^{-6}$	$1.2X10^{-4}$
Pb-210 (a)		1.0	$2.7X10^{1}$	$5.0X10^{-2}$	1.4	2.8	$7.6X10^{1}$
Pb-212 (a)		$7.0X10^{-1}$	$1.9X10^{1}$	$2.0X10^{-1}$	5.4	$5.1X10^{4}$	$1.4X10^{6}$
Pd-103 (a)	Palladium (46)	$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$2.8X10^{3}$	$7.5X10^{4}$
Pd-107		Unlimited	Unlimited	Unlimited	Unlimited	$1.9X10^{-5}$	$5.1X10^{-4}$
Pd-109		2.0	$5.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$7.9X10^{4}$	$2.1X10^{6}$

Symbol of radionuclide [~~Radionuclide~~]	Element and atomic number	A_1 (TBq)	A_1(Ci)[b]	A_2 (TBq)	A_2(Ci)[b]	Specific activity	
						(TBq/g)	(Ci/g)
Pm-143	Promethium (61)	3.0	$8.1X10^{1}$	3.0	$8.1X10^{1}$	$1.3X10^{2}$	$3.4X10^{3}$
Pm-144		$7.0X10^{-1}$	$1.9X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$9.2X10^{1}$	$2.5X10^{3}$
Pm-145		$3.0X10^{1}$	$8.1X10^{2}$	$1.0X10^{1}$	$2.7X10^{2}$	5.2	$1.4X10^{2}$
Pm-147		$4.0X10^{1}$	$1.1X10^{3}$	2.0	$5.4X10^{1}$	$3.4X10^{1}$	$9.3X10^{2}$
Pm-148m (a)		$8.0X10^{-1}$	$2.2X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$7.9X10^{2}$	$2.1X10^{4}$
Pm-149		2.0	$5.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.5X10^{4}$	$4.0X10^{5}$
Pm-151		2.0	$5.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$2.7X10^{4}$	$7.3X10^{5}$
Po-210	Polonium (84)	$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$1.7X10^{2}$	$4.5X10^{3}$
Pr-142	Praseodymium (59)	$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$4.3X10^{4}$	$1.2X10^{6}$
Pr-143		3.0	$8.1X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$2.5X10^{3}$	$6.7X10^{4}$
Pt-188 (a)	Platinum (78)	1.0	$2.7X10^{1}$	$8.0X10^{-1}$	$2.2X10^{1}$	$2.5X10^{3}$	$6.8X10^{4}$
Pt-191		4.0	$1.1X10^{2}$	3.0	$8.1X10^{1}$	$8.7X10^{3}$	$2.4X10^{5}$
Pt-193		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	1.4	$3.7X10^{1}$
Pt-193m		$4.0X10^{1}$	$1.1X10^{3}$	$5.0X10^{-1}$	$1.4X10^{1}$	$5.8X10^{3}$	$1.6X10^{5}$
Pt-195m		$1.0X10^{1}$	$2.7X10^{2}$	$5.0X10^{-1}$	$1.4X10^{1}$	$6.2X10^{3}$	$1.7X10^{5}$
Pt-197		$2.0X10^{1}$	$5.4X10^{2}$	$6.0X10^{-1}$	$1.6X10^{1}$	$3.2X10^{4}$	$8.7X10^{5}$
Pt-197m		$1.0X10^{1}$	$2.7X10^{2}$	$6.0X10^{-1}$	$1.6X10^{1}$	$3.7X10^{5}$	$1.0X10^{7}$
Pu-236	Plutonium (94)	$3.0X10^{1}$	$8.1X10^{2}$	$3.0X10^{-3}$	$8.1X10^{-2}$	$2.0X10^{1}$	$5.3X10^{2}$
Pu-237		$2.0X10^{1}$	$5.4X10^{2}$	$2.0X10^{1}$	$5.4X10^{2}$	$4.5X10^{2}$	$1.2X10^{4}$
Pu-238		$1.0X10^{1}$	$2.7X10^{2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$6.3X10^{-1}$	$1.7X10^{1}$
Pu-239		$1.0X10^{1}$	$2.7X10^{2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$2.3X10^{-3}$	$6.2X10^{-2}$

Symbol of radionuclide [~~Radionuclide~~]	Element and atomic number	A_1 (TBq)	A_1(Ci)[b]	A_2 (TBq)	A_2(Ci)[b]	Specific activity	
						(TBq/g)	(Ci/g)
Pu-240		$1.0X10^{1}$	$2.7X10^{2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$8.4X10^{-3}$	$2.3X10^{-1}$
Pu-241 (a)		$4.0X10^{1}$	$1.1X10^{3}$	$6.0X10^{-2}$	1.6	3.8	$1.0X10^{2}$
Pu-242		$1.0X10^{1}$	$2.7X10^{2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$1.5X10^{-4}$	$3.9X10^{-3}$
Pu-244 (a)		$4.0X10^{-1}$	$1.1X10^{1}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$6.7X10^{-7}$	$1.8X10^{-5}$
Ra-223 (a)	Radium (88)	$4.0X10^{-1}$	$1.1X10^{1}$	$7.0X10^{-3}$	$1.9X10^{-1}$	$1.9X10^{3}$	$5.1X10^{4}$
Ra-224 (a)		$4.0X10^{-1}$	$1.1X10^{1}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$5.9X10^{3}$	$1.6X10^{5}$
Ra-225 (a)		$2.0X10^{-1}$	5.4	$4.0X10^{-3}$	$1.1X10^{-1}$	$1.5X10^{3}$	$3.9X10^{4}$
Ra-226 (a)		$2.0X10^{-1}$	5.4	$3.0X10^{-3}$	$8.1X10^{-2}$	$3.7X10^{-2}$	1.0
Ra-228 (a)		$6.0X10^{-1}$	$1.6X10^{1}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$1.0X10^{1}$	$2.7X10^{2}$
Rb-81	Rubidium (37)	2.0	$5.4X10^{1}$	$8.0X10^{-1}$	$2.2X10^{1}$	$3.1X10^{5}$	$8.4X10^{6}$
Rb-83 (a)		2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$6.8X10^{2}$	$1.8X10^{4}$
Rb-84		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$1.8X10^{3}$	$4.7X10^{4}$
Rb-86		$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$3.0X10^{3}$	$8.1X10^{4}$
Rb-87		Unlimited	Unlimited	Unlimited	Unlimited	$3.2X10^{-9}$	$8.6X10^{-8}$
Rb(nat)		Unlimited	Unlimited	Unlimited	Unlimited	$6.7X10^{6}$	$1.8X10^{8}$
Re-184	Rhenium (75)	1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$6.9X10^{2}$	$1.9X10^{4}$
Re-184m		3.0	$8.1X10^{1}$	1.0	$2.7X10^{1}$	$1.6X10^{2}$	$4.3X10^{3}$
Re-186		2.0	$5.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$6.9X10^{3}$	$1.9X10^{5}$
Re-187		Unlimited	Unlimited	Unlimited	Unlimited	$1.4X10^{-9}$	$3.8X10^{-8}$
Re-188		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$3.6X10^{4}$	$9.8X10^{5}$
Re-189 (a)		3.0	$8.1X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$2.5X10^{4}$	$6.8X10^{5}$

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						(TBq/g)	(Ci/g)
Re(nat)		Unlimited	Unlimited	Unlimited	Unlimited	0.0	$2.4X10^{-8}$
Rh-99	Rhodium (45)	2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$3.0X10^{3}$	$8.2X10^{4}$
Rh-101		4.0	$1.1X10^{2}$	3.0	$8.1X10^{1}$	$4.1X10^{1}$	$1.1X10^{3}$
Rh-102		$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$4.5X10^{1}$	$1.2X10^{3}$
Rh-102m		2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$2.3X10^{2}$	$6.2X10^{3}$
Rh-103m		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$1.2X10^{6}$	$3.3X10^{7}$
Rh-105		$1.0X10^{1}$	$2.7X10^{2}$	$8.0X10^{-1}$	$2.2X10^{1}$	$3.1X10^{4}$	$8.4X10^{5}$
Rn-222 (a)	Radon (86)	$3.0X10^{-1}$	8.1	$4.0X10^{-3}$	$1.1X10^{-1}$	$5.7X10^{3}$	$1.5X10^{5}$
Ru-97	Ruthenium (44)	5.0	$1.4X10^{2}$	5.0	$1.4X10^{2}$	$1.7X10^{4}$	$4.6X10^{5}$
Ru-103 (a)		2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$1.2X10^{3}$	$3.2X10^{4}$
Ru-105		1.0	$2.7X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$2.5X10^{5}$	$6.7X10^{6}$
Ru-106 (a)		$2.0X10^{-1}$	5.4	$2.0X10^{-1}$	5.4	$1.2X10^{2}$	$3.3X10^{3}$
S-35	Sulfur (16)	$4.0X10^{1}$	$1.1X10^{3}$	3.0	$8.1X10^{1}$	$1.6X10^{3}$	$4.3X10^{4}$
Sb-122	Antimony (51)	$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.5X10^{4}$	$4.0X10^{5}$
Sb-124		$6.0X10^{-1}$	$1.6X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$6.5X10^{2}$	$1.7X10^{4}$
Sb-125		2.0	$5.4X10^{1}$	1.0	$2.7X10^{1}$	$3.9X10^{1}$	$1.0X10^{3}$
Sb-126		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$3.1X10^{3}$	$8.4X10^{4}$
Sc-44	Scandium (21)	$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$6.7X10^{5}$	$1.8X10^{7}$
Sc-46		$5.0X10^{-1}$	$1.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$1.3X10^{3}$	$3.4X10^{4}$
Sc-47		$1.0X10^{1}$	$2.7X10^{2}$	$7.0X10^{-1}$	$1.9X10^{1}$	$3.1X10^{4}$	$8.3X10^{5}$
Sc-48		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$5.5X10^{4}$	$1.5X10^{6}$

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						(TBq/g)	(Ci/g)
Se-75	Selenium (34)	3.0	$8.1X10^{1}$	3.0	$8.1X10^{1}$	$5.4X10^{2}$	$1.5X10^{4}$
Se-79		$4.0X10^{1}$	$1.1X10^{3}$	2.0	$5.4X10^{1}$	$2.6X10^{-3}$	$7.0X10^{-2}$
Si-31	Silicon (14)	$6.0X10^{-1}$	$1.6X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.4X10^{6}$	$3.9X10^{7}$
Si-32		$4.0X10^{1}$	$1.1X10^{3}$	$5.0X10^{-1}$	$1.4X10^{1}$	3.9	$1.1X10^{2}$
Sm-145	Samarium (62)	$1.0X10^{1}$	$2.7X10^{2}$	$1.0X10^{1}$	$2.7X10^{2}$	$9.8X10^{1}$	$2.6X10^{3}$
Sm-147		Unlimited	Unlimited	Unlimited	Unlimited	$8.5X10^{-10}$ [~~$8.5X10^{-1}$~~]	$2.3X10^{-8}$
Sm-151		$4.0X10^{1}$	$1.1X10^{3}$	$1.0X10^{1}$	$2.7X10^{2}$	$9.7X10^{-1}$	$2.6X10^{1}$
Sm-153		9.0	$2.4X10^{2}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.6X10^{4}$	$4.4X10^{5}$
Sn-113 (a)	Tin (50)	4.0	$1.1X10^{2}$	2.0	$5.4X10^{1}$	$3.7X10^{2}$	$1.0X10^{4}$
Sn-117m		7.0	$1.9X10^{2}$	$4.0X10^{-1}$	$1.1X10^{1}$	$3.0X10^{3}$	$8.2X10^{4}$
Sn-119m		$4.0X10^{1}$	$1.1X10^{3}$	$3.0X10^{1}$	$8.1X10^{2}$	$1.4X10^{2}$	$3.7X10^{3}$
Sn-121m (a)		$4.0X10^{1}$	$1.1X10^{3}$	$9.0X10^{-1}$	$2.4X10^{1}$	2.0	$5.4X10^{1}$
Sn-123		$8.0X10^{-1}$	$2.2X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$3.0X10^{2}$	$8.2X10^{3}$
Sn-125		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{3}$	$1.1X10^{5}$
Sn-126 (a)		$6.0X10^{-1}$	$1.6X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.0X10^{-3}$	$2.8X10^{-2}$
Sr-82 (a)	Strontium (38)	$2.0X10^{-1}$	5.4	$2.0X10^{-1}$	5.4	$2.3X10^{3}$	$6.2X10^{4}$
Sr-85		2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$8.8X10^{2}$	$2.4X10^{4}$
Sr-85m		5.0	$1.4X10^{2}$	5.0	$1.4X10^{2}$	$1.2X10^{6}$	$3.3X10^{7}$
Sr-87m		3.0	$8.1X10^{1}$	3.0	$8.1X10^{1}$	$4.8X10^{5}$	$1.3X10^{7}$
Sr-89		$6.0X10^{-1}$	$1.6X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.1X10^{3}$	$2.9X10^{4}$
Sr-90 (a)		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	5.1	$1.4X10^{2}$

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						(TBq/g)	(Ci/g)
Sr-91 (a)		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$1.3X10^{5}$	$3.6X10^{6}$
Sr-92 (a)		1.0	$2.7X10^{1}$	$3.0X10^{-1}$	8.1	$4.7X10^{5}$	$1.3X10^{7}$
T(H-3)	Tritium (1)	$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$3.6X10^{2}$	$9.7X10^{3}$
Ta-178 (long-lived)	Tantalum (73)	1.0	$2.7X10^{1}$	$8.0X10^{-1}$	$2.2X10^{1}$	$4.2X10^{6}$	$1.1X10^{8}$
Ta-179		$3.0X10^{1}$	$8.1X10^{2}$	$3.0X10^{1}$	$8.1X10^{2}$	$4.1X10^{1}$	$1.1X10^{3}$
Ta-182		$9.0X10^{-1}$	$2.4X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$2.3X10^{2}$	$6.2X10^{3}$
Tb-157	Terbium (65)	$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$5.6X10^{-1}$	$1.5X10^{1}$
Tb-158		1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$5.6X10^{-1}$	$1.5X10^{1}$
Tb-160		1.0	$2.7X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$4.2X10^{2}$	$1.1X10^{4}$
Tc-95m (a)	Technetium (43)	2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$8.3X10^{2}$	$2.2X10^{4}$
Tc-96		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.2X10^{4}$	$3.2X10^{5}$
Tc-96m (a)		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.4X10^{6}$	$3.8X10^{7}$
Tc-97		Unlimited	Unlimited	Unlimited	Unlimited	$5.2X10^{-5}$	$1.4X10^{-3}$
Tc-97m		$4.0X10^{1}$	$1.1X10^{3}$	1.0	$2.7X10^{1}$	$5.6X10^{2}$	$1.5X10^{4}$
Tc-98		$8.0X10^{-1}$	$2.2X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$3.2X10^{-5}$	$8.7X10^{-4}$
Tc-99		$4.0X10^{1}$	$1.1X10^{3}$	$9.0X10^{-1}$	$2.4X10^{1}$	$6.3X10^{-4}$	$1.7X10^{-2}$
Tc-99m		$1.0X10^{1}$	$2.7X10^{2}$	4.0	$1.1X10^{2}$	$1.9X10^{5}$	$5.3X10^{6}$
Te-121	Tellurium (52)	2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$2.4X10^{3}$	$6.4X10^{4}$
Te-121m		5.0	$1.4X10^{2}$	3.0	$8.1X10^{1}$	$2.6X10^{2}$	$7.0X10^{3}$
Te-123m		8.0	$2.2X10^{2}$	1.0	$2.7X10^{1}$	$3.3X10^{2}$	$8.9X10^{3}$
Te-125m		$2.0X10^{1}$	$5.4X10^{2}$	$9.0X10^{-1}$	$2.4X10^{1}$	$6.7X10^{2}$	$1.8X10^{4}$

Symbol of radionuclide [~~Radionuclide~~]	Element and atomic number	A_1 (TBq)	A_1(Ci)[b]	A_2 (TBq)	A_2(Ci)[b]	Specific activity	
						(TBq/g)	(Ci/g)
Te-127		$2.0X10^{1}$	$5.4X10^{2}$	$7.0X10^{-1}$	$1.9X10^{1}$	$9.8X10^{4}$	$2.6X10^{6}$
Te-127m (a)		$2.0X10^{1}$	$5.4X10^{2}$	$5.0X10^{-1}$	$1.4X10^{1}$	$3.5X10^{2}$	$9.4X10^{3}$
Te-129		$7.0X10^{-1}$	$1.9X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$7.7X10^{5}$	$2.1X10^{7}$
Te-129m (a)		$8.0X10^{-1}$	$2.2X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.1X10^{3}$	$3.0X10^{4}$
Te-131m (a)		$7.0X10^{-1}$	$1.9X10^{1}$	$5.0X10^{-1}$	$1.4X10^{1}$	$3.0X10^{4}$	$8.0X10^{5}$
Te-132 (a)		$5.0X10^{-1}$	$1.4X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$1.1X10^{4}$	$3.0X10^{5}$
Th-227	Thorium (90)	$1.0X10^{1}$	$2.7X10^{2}$	$5.0X10^{-3}$	$1.4X10^{-1}$	$1.1X10^{3}$	$3.1X10^{4}$
Th-228 (a)		$5.0X10^{-1}$	$1.4X10^{1}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$3.0X10^{1}$	$8.2X10^{2}$
Th-229		5.0	$1.4X10^{2}$	$5.0X10^{-4}$	$1.4X10^{-2}$	$7.9X10^{-3}$	$2.1X10^{-1}$
Th-230		$1.0X10^{1}$	$2.7X10^{2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$7.6X10^{-4}$	$2.1X10^{-2}$
Th-231		$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$2.0X10^{4}$	$5.3X10^{5}$
Th-232		Unlimited	Unlimited	Unlimited	Unlimited	$4.0X10^{-9}$	$1.1X10^{-7}$
Th-234 (a)		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$8.6X10^{2}$	$2.3X10^{4}$
Th(nat)		Unlimited	Unlimited	Unlimited	Unlimited	$8.1X10^{-9}$	$2.2X10^{-7}$
Ti-44 (a)	Titanium (22)	$5.0X10^{-1}$	$1.4X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	6.4	$1.7X10^{2}$
Tl-200	Thallium (81)	$9.0X10^{-1}$	$2.4X10^{1}$	$9.0X10^{-1}$	$2.4X10^{1}$	$2.2X10^{4}$	$6.0X10^{5}$
Tl-201		$1.0X10^{1}$	$2.7X10^{2}$	4.0	$1.1X10^{2}$	$7.9X10^{3}$	$2.1X10^{5}$
Tl-202		2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$2.0X10^{3}$	$5.3X10^{4}$
Tl-204		$1.0X10^{1}$	$2.7X10^{2}$	$7.0X10^{-1}$	$1.9X10^{1}$	$1.7X10^{1}$	$4.6X10^{2}$
Tm-167	Thulium (69)	7.0	$1.9X10^{2}$	$8.0X10^{-1}$	$2.2X10^{1}$	$3.1X10^{3}$	$8.5X10^{4}$
Tm-170		3.0	$8.1X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$2.2X10^{2}$	$6.0X10^{3}$

Symbol of radionuclide [~~Radionuclide~~]	Element and atomic number	A_1 (TBq)	A_1(Ci)[b]	A_2 (TBq)	A_2(Ci)[b]	Specific activity	
						(TBq/g)	(Ci/g)
Tm-171		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$
U-230 (fast lung absorption) (a)(d)	Uranium (92)	$4.0X10^{1}$	$1.1X10^{3}$	$1.0X10^{-1}$	2.7	$1.0X10^{3}$	$2.7X10^{4}$
U-230 (medium lung absorption) (a)(e)		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{-3}$	$1.1X10^{-1}$	$1.0X10^{3}$	$2.7X10^{4}$
U-230 (slow lung absorption) (a)(f)		$3.0X10^{1}$	$8.1X10^{2}$	$3.0X10^{-3}$	$8.1X10^{-2}$	$1.0X10^{3}$	$2.7X10^{4}$
U-232 (fast lung absorption) (d)		$4.0X10^{1}$	$1.1X10^{3}$	$1.0X10^{-2}$	$2.7X10^{-1}$	$8.3X10^{-1}$	$2.2X10^{1}$
U-232 (medium lung absorption) (e)		$4.0X10^{1}$	$1.1X10^{3}$	$7.0X10^{-3}$	$1.9X10^{-1}$	$8.3X10^{-1}$	$2.2X10^{1}$
U-232 (slow lung absorption) (f)		$1.0X10^{1}$	$2.7X10^{2}$	$1.0X10^{-3}$	$2.7X10^{-2}$	$8.3X10^{-1}$	$2.2X10^{1}$
U-233 (fast lung absorption) (d)		$4.0X10^{1}$	$1.1X10^{3}$	$9.0X10^{-2}$	2.4	$3.6X10^{-4}$	$9.7X10^{-3}$
U-233 (medium lung absorption) (e)		$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$3.6X10^{-4}$	$9.7X10^{-3}$
U-233 (slow lung absorption) (f)		$4.0X10^{1}$	$1.1X10^{3}$	$6.0X10^{-3}$	$1.6X10^{-1}$	$3.6X10^{-4}$	$9.7X10^{-3}$
U-234 (fast lung absorption) (d)		$4.0X10^{1}$	$1.1X10^{3}$	$9.0X10^{-2}$	2.4	$2.3X10^{-4}$	$6.2X10^{-3}$
U-234 (medium lung absorption) (e)		$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$2.3X10^{-4}$	$6.2X10^{-3}$

Symbol of radionuclide [~~Radionuclide~~]	Element and atomic number	A_1 (TBq)	A_1(Ci)[b]	A_2 (TBq)	A_2(Ci)[b]	Specific activity	
						(TBq/g)	(Ci/g)
U-234 (slow lung absorption) (f)		$4.0X10^{1}$	$1.1X10^{3}$	$6.0X10^{-3}$	$1.6X10^{-1}$	$2.3X10^{-4}$	$6.2X10^{-3}$
U-235 (all lung absorption types) (a),(d),(e),(f)		Unlimited	Unlimited	Unlimited	Unlimited	$8.0X10^{-8}$	$2.2X10^{-6}$
U-236 (fast lung absorption) (d)		Unlimited	Unlimited	Unlimited	Unlimited	$2.4X10^{-6}$	$6.5X10^{-5}$
U-236 (medium lung absorption) (e)		$4.0X10^{1}$	$1.1X10^{3}$	$2.0X10^{-2}$	$5.4X10^{-1}$	$2.4X10^{-6}$	$6.5X10^{-5}$
U-236 (slow lung absorption) (f)		$4.0X10^{1}$	$1.1X10^{3}$	$6.0X10^{-3}$	$1.6X10^{-1}$	$2.4X10^{-6}$	$6.5X10^{-5}$
U-238 (all lung absorption types) (d),(e),(f)		Unlimited	Unlimited	Unlimited	Unlimited	$1.2X10^{-8}$	$3.4X10^{-7}$
U (nat)		Unlimited	Unlimited	Unlimited	Unlimited	$2.6X10^{-8}$	$7.1X10^{-7}$
U (enriched to 20% or less) (g)		Unlimited	Unlimited	Unlimited	Unlimited	See Table 257-6	See Table 257-6
U (dep)		Unlimited	Unlimited	Unlimited	Unlimited	See Table 257-6	See Table 257-5
V-48	Vanadium (23)	$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$6.3X10^{3}$	$1.7X10^{5}$
V-49		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$3.0X10^{2}$	$8.1X10^{3}$
W-178 (a)	Tungsten (74)	9.0	$2.4X10^{2}$	5.0	$1.4X10^{2}$	$1.3X10^{3}$	$3.4X10^{4}$
W-181		$3.0X10^{1}$	$8.1X10^{2}$	$3.0X10^{1}$	$8.1X10^{2}$	$2.2X10^{2}$	$6.0X10^{3}$
W-185		$4.0X10^{1}$	$1.1X10^{3}$	$8.0X10^{-1}$	$2.2X10^{1}$	$3.5X10^{2}$	$9.4X10^{3}$
W-187		2.0	$5.4X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$2.6X10^{4}$	$7.0X10^{5}$

Symbol of radionuclide [~~Radionuclide~~]	Element and atomic number	A_1 (TBq)	A_1(Ci)[b]	A_2 (TBq)	A_2(Ci)[b]	Specific activity	
						(TBq/g)	(Ci/g)
W-188 (a)		$4.0X10^{-1}$	$1.1X10^{1}$	$3.0X10^{-1}$	8.1	$3.7X10^{2}$	$1.0X10^{4}$
Xe-122 (a)	Xenon (54)	$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$4.8X10^{4}$	$1.3X10^{6}$
Xe-123		2.0	$5.4X10^{1}$	$7.0X10^{-1}$	$1.9X10^{1}$	$4.4X10^{5}$	$1.2X10^{7}$
Xe-127		4.0	$1.1X10^{2}$	2.0	$5.4X10^{1}$	$1.0X10^{3}$	$2.8X10^{4}$
Xe-131m		$4.0X10^{1}$	$1.1X10^{3}$	$4.0X10^{1}$	$1.1X10^{3}$	$3.1X10^{3}$	$8.4X10^{4}$
Xe-133		$2.0X10^{1}$	$5.4X10^{2}$	$1.0X10^{1}$	$2.7X10^{2}$	$6.9X10^{3}$	$1.9X10^{5}$
Xe-135		3.0	$8.1X10^{1}$	2.0	$5.4X10^{1}$	$9.5X10^{4}$	$2.6X10^{6}$
Y-87 (a)	Yttrium (39)	1.0	$2.7X10^{1}$	1.0	$2.7X10^{1}$	$1.7X10^{4}$	$4.5X10^{5}$
Y-88		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$5.2X10^{2}$	$1.4X10^{4}$
Y-90		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$2.0X10^{4}$	$5.4X10^{5}$
Y-91		$6.0X10^{-1}$	$1.6X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$9.1X10^{2}$	$2.5X10^{4}$
Y-91m		2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$1.5X10^{6}$	$4.2X10^{7}$
Y-92		$2.0X10^{-1}$	5.4	$2.0X10^{-1}$	5.4	$3.6X10^{5}$	$9.6X10^{6}$
Y-93		$3.0X10^{-1}$	8.1	$3.0X10^{-1}$	8.1	$1.2X10^{5}$	$3.3X10^{6}$
Yb-169	Ytterbium (70)	4.0	$1.1X10^{2}$	1.0	$2.7X10^{1}$	$8.9X10^{2}$	$2.4X10^{4}$
Yb-175		$3.0X10^{1}$	$8.1X10^{2}$	$9.0X10^{-1}$	$2.4X10^{1}$	$6.6X10^{3}$	$1.8X10^{5}$
Zn-65	Zinc (30)	2.0	$5.4X10^{1}$	2.0	$5.4X10^{1}$	$3.0X10^{2}$	$8.2X10^{3}$
Zn-69		3.0	$8.1X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.8X10^{6}$	$4.9X10^{7}$
Zn-69m (a)		3.0	$8.1X10^{1}$	$6.0X10^{-1}$	$1.6X10^{1}$	$1.2X10^{5}$	$3.3X10^{6}$
Zr-88	Zirconium (40)	3.0	$8.1X10^{1}$	3.0	$8.1X10^{1}$	$6.6X10^{2}$	$1.8X10^{4}$
Zr-93		Unlimited	Unlimited	Unlimited	Unlimited	$9.3X10^{-5}$	$2.5X10^{-3}$

Symbol of radionuclide [~~Radionuclide~~]	Element and atomic number	A_1 (TBq)	A_1(Ci)[b]	A_2 (TBq)	A_2(Ci)[b]	Specific activity	
						(TBq/g)	(Ci/g)
Zr-95 (a)		2.0	$5.4X10^{1}$	$8.0X10^{-1}$	$2.2X10^{1}$	$7.9X10^{2}$	$2.1X10^{4}$
Zr-97 (a)		$4.0X10^{-1}$	$1.1X10^{1}$	$4.0X10^{-1}$	$1.1X10^{1}$	$7.1X10^{4}$	$1.9X10^{6}$

[a] A_1 and/or A_2 values include contributions from daughter nuclides with half-lives less than 10 days, as listed in the following:

Mg-28	Al-28
Ca-47	Sc-47
Ti-44	Sc-44
Fe-52	Mn-52m
Fe-60	Co-60m
Zn-69m	Zn-69
Ge-68	Ga-68
Rb-83	Kr-83m
Sr-82	Rb-82
Sr-90	Y-90
Sr-91	Y-91m
Sr-92	Y-92
Y-87	Sr-87m
Zr-95	Nb-95m
Zr-97	Nb-97m, Nb-97
Mo-99	Tc-99m
Tc-95m	Tc-95
Tc-96m	Tc-96
Ru-103	Rh-103m

Ru-106	Rh-106
Pd-103	Rh-103m
Ag-108m	Ag-108
Ag-110m	Ag-110
Cd-115	In-115m
In-114m	In-114
Sn-113	In-113m
Sn-121m	Sn-121
Sn-126	Sb-126m
Te-127m	Te-127
Te-129m	Te-129
Te-131m	Te-131
Te-132	I-132
I-135	Xe-135m
Xe-122	I-122
Cs-137	Ba-137m
Ba-131	Cs-131
Ba-140	La-140
Ce-144	Pr-144m, Pr-144
Pm-148m	Pm-148
Gd-146	Eu-146
Dy-166	Ho-166
Hf-172	Lu-172
W-178	Ta-178
W-188	Re-188
Re-189	Os-189m

Os-194	Ir-194
Ir-189	Os-189m
Pt-188	Ir-188
Hg-194	Au-194
Hg-195m	Hg-195
Pb-210	Bi-210
Pb-212	Bi-212, Tl-208, Po-212
Bi-210m	Tl-206
Bi-212	Tl-208, Po-212
At-211	Po-211
Rn-222	Po-218, Pb-214, At-218, Bi-214, Po-214
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Po-211, Tl-207
Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Ra-225	Ac-225, Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209
Ra-226	Rn-222, Po-218, Pb-214, At-218, Bi-214, Po-214
Ra-228	Ac-228
Ac-225	Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209
Ac-227	Fr-223
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Th-234	Pa-234m, Pa-234
Pa-230	Ac-226, Th-226, Fr-222, Ra-222, Rn-218, Po-214
U-230	Th-226, Ra-222, Rn-218, Po-214
U-235	Th-231
Pu-241	U-237
Pu-244	U-240, Np-240m
Am-242m	Am-242, Np-238

Am-243	Np-239
Cm-247	Pu-243
Bk-249	Am-245
Cf-253	Cm-249

[b] The values of A_1 and A_2 in Curies (Ci) are approximate and for information only; the regulatory standard units are Terabecquerels (TBq), (see subsection (ee)(1) of this section - Determination of A_1 and A_2).
[c] The activity of Ir-192 in special form may be determined from a measurement of the rate of decay or a measurement of the radiation level at a prescribed distance from the source.
[d] These values apply only to compounds of uranium that take the chemical form of UF_6, UO_2F_2 and $UO_2(NO_3)_2$ in both normal and accident conditions of transport.
[e] These values apply only to compounds of uranium that take the chemical form of UO_3, UF_4, UCl_4, and hexavalent compounds in both normal and accident conditions of transport.
[f] These values apply to all compounds of uranium other than those specified in notes (d) and (e) of this table.
[g] These values apply to unirradiated uranium only.
[h.] A_2 = 0.74 TBq (20 Ci) for Mo-99 for domestic use.

Figure: 25 TAC §289.257(ee)(9)

Table 257-6: Activity-mass Relationships for Uranium

Uranium Enrichment* weight [~~wt~~] % U-235 present	Specific Activity TBq/g	Specific Activity Ci/g
0.45	1.8×10^{-8}	5.0×10^{-7}
0.72	2.6×10^{-8}	7.1×10^{-7}
1.0	2.8×10^{-8}	7.6×10^{-7}
1.5	3.7×10^{-8}	1.0×10^{-6}
5.0	1.0×10^{-7}	2.7×10^{-6}
10.0	1.8×10^{-7}	4.8×10^{-6}
20.0	3.7×10^{-7}	1.0×10^{-5}
35.0	7.4×10^{-7}	2.0×10^{-5}
50.0	9.3×10^{-7}	2.5×10^{-5}
90.0	2.2×10^{-6}	5.8×10^{-5}
93.0	2.6×10^{-6}	7.0×10^{-5}
95.0	3.4×10^{-6}	9.1×10^{-5}

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

Figure: 25 TAC §289.201(b)(124)(B)

$$\frac{175\,(\text{grams contained U} - 235)}{350} + \frac{50\,(\text{grams U} - 233)}{200} + \frac{50\,(\text{grams Pu})}{200} = 1$$

Figure: 25 TAC §289.202(c)(39)

ORGAN DOSE WEIGHTING FACTORS

Organ or Tissue	w_T
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder	0.30*
Whole Body	1.00**

* 0.30 results from 0.06 for each of five "remainder" organs, excluding the skin and the lens of the eye, that receive the highest doses.

** For the purpose of weighting the external whole body dose, for adding it to the internal dose, a single weighting factor, $w_T = 1.0$, has been specified. The use of other weighting factors for external exposure will be approved on a case-by-case basis until such time as specific guidance is issued.

Figure: 25 TAC §289.202(z)(1)

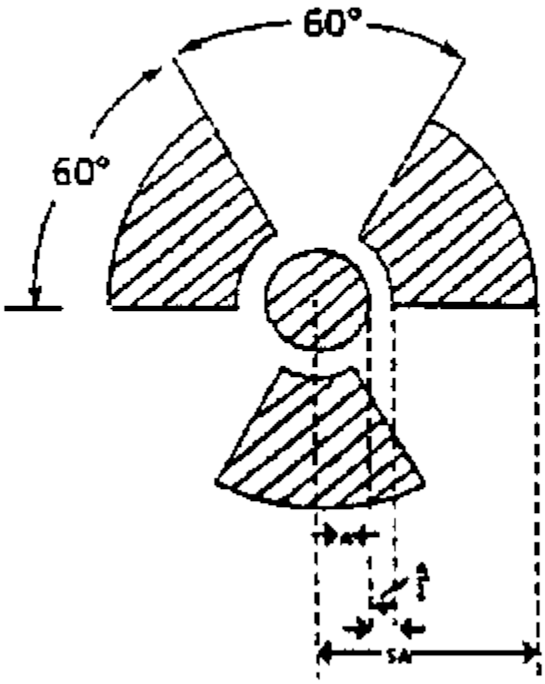

Figure: 25 TAC §289.202(ggg)(2)(E)

Name	Symbol	Atomic Number	Name	Symbol	Atomic 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	Nitrogen	N	7
Barium	Ba	56	Osmium	Os	76
Berkelium	Bk	97	Oxygen	O	8
Beryllium	Be	4	Palladium	Pd	46
Bismuth	Bi	83	Phosphorus	P	15
Bromine	Br	35	Platinum	Pt	78
Cadmium	Cd	48	Plutonium	Pu	94
Calcium	Ca	20	Polonium	Po	84
Californium	Cf	98	Potassium	K	19
Carbon	C	6	Praseodymium	Pr	59
Cerium	Ce	58	Promethium	Pm	61
Cesium	Cs	55	Protactinium	Pa	91
Chlorine	Cl	17	Radium	Ra	88
Chromium	Cr	24	Radon	Rn	86
Cobalt	Co	27	Rhodium	Rh	45
Copper	Cu	29	Rubidium	Rb	37
Curium	Cm	96	Ruthenium	Ru	44
Dysprosium	Dy	66	Samarium	Sm	62
Einsteinium	Es	99	Scandium	Sc	21
Erbium	Er	68	Selenium	Se	34
Europium	Eu	63	Silicon	Si	14
Fermium	Fm	100	Silver	Ag	47
Fluorine	F	9	Sodium	Na	11
Francium	Fr	87	Strontium	Sr	38
Gadolinium	Gd	64	Sulfur	S	16
Gallium	Ga	31	Tantalum	Ta	73
Germanium	Ge	32	Technetium	Tc	43
Gold	Au	79	Tellurium	Te	52
Hafnium	Hf	72	Terbium	Tb	65
Holmium	Ho	67	Thallium	Tl	81
Hydrogen	H	1	Thorium	Th	90
Indium	In	49	Thulium	Tm	69
Iodine	I	53	Tin	Sn	50
Iridium	Ir	77	Titanium	Ti	22

Iron	Fe	26	Tungsten	W	74
Krypton	Kr	36	Uranium	U	92
Lanthanum	La	57	Vanadium	V	23
Lead	Pb	82	Xenon	Xe	54
Lutetium	Lu	71	Ytterbium	Yb	70
Magnesium	Mg	12	Yttrium	Y	39
Manganese	Mn	25	Zinc	Zn	30
Mendelevium	Md	101	Zirconium	Zr	40

Figure: 25 TAC §289.202(ggg)(3)

Quantities[1] of licensed material requiring labeling.

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

Zinc-65	10
Zinc-69m	100
Zinc-69	1,000
Zinc-71m	1,000
Zinc-72	100
Gallium-65	1,000
Gallium-66	100
Gallium-67	1,000
Gallium-68	1,000
Gallium-70	1,000
Gallium-72	100
Gallium-73	1,000
Germanium-66	1,000
Germanium-67	1,000
Germanium-68	10
Germanium-69	1,000
Germanium-71	1,000
Germanium-75	1,000
Germanium-77	1,000
Germanium-78	1,000
Arsenic-69	1,000
Arsenic-70	1,000
Arsenic-71	100
Arsenic-72	100
Arsenic-73	100
Arsenic-74	100
Arsenic-76	100
Arsenic-77	100
Arsenic-78	1,000
Selenium-70	1,000
Selenium-73m	1,000
Selenium-73	100
Selenium-75	100
Selenium-79	100
Selenium-81m	1,000
Selenium-81	1,000
Selenium-83	1,000
Bromine-74m	1,000
Bromine-74	1,000
Bromine-75	1,000
Bromine-76	100
Bromine-77	1,000
Bromine-80m	1,000
Bromine-80	1,000
Bromine-82	100
Bromine-83	1,000
Bromine-84	1,000
Krypton-74	1,000
Krypton-85	1,000
Krypton-87	1,000
Krypton-88	1,000
Rubidium-79	1,000
Rubidium-81m	1,000
Rubidium-81	1,000
Rubidium-82m	1,000
Rubidium-83	100
Rubidium-84	100
Rubidium-86	100
Rubidium-87	100
Rubidium-88	1,000
Rubidium-89	1,000
Strontium-80	100
Strontium-81	1,000
Strontium-83	100
Strontium-85m	1,000
Strontium-85	100
Strontium-87m	1,000
Strontium-89	10
Strontium-90	0.1
Strontium-91	100
Strontium-92	100
Yttrium-86m	1,000
Yttrium-86	100
Yttrium-87	100

Yttrium-88	10
Yttrium-90m	1,000
Yttrium-90	10
Yttrium-91m	1,000
Yttrium-91	10
Yttrium-92	100
Yttrium-93	100
Yttrium-94	1,000
Yttrium-95	1,000
Zirconium-86	100
Zirconium-88	10
Zirconium-89	100
Zirconium-93	1
Zirconium-95	10
Zirconium-97	100
Niobium-88	1,000
Krypton-76	1,000
Krypton-77	1,000
Krypton-79	1,000
Krypton-81	1,000
Krypton-83m	1,000
Krypton-85m	1,000
Niobium-94	1
Niobium-95m	100
Niobium-85	100
Niobium-96	100
Niobium-97	1,000
Niobium-98	1,000
Molybdenum-90	100
Molybdenum-93m	100
Molybdenum-93	10
Molybdenum-99	100
Molybdenum-101	1,000
Technitium-93m	1,000
Technitium-93	1,000
Technitium-94m	1,000
Technitium-94	1,000
Technitium-96m	1,000
Technitium-96	100
Technitium-97m	100
Technitium-97	1,000
Technitium-98	10
Technitium-99m	1,000
Technitium-99	100
Technitium-101	1,000
Technitium-104	1,000
Ruthenium-94	1,000
Ruthenium-97	1,000
Ruthenium-103	100
Ruthenium-105	1,000
Ruthenium-106	1
Rhodium-99m	1,000
Rhodium-99	100
Rhodium-100	100
Rhodium-101m	1,000
Rhodium-101	10
Rhodium-102m	10
Rhodium-102	10
Niobium-89 (66 min)	1,000
Niobium-89 (122 min)	1,000
Niobium-90	100
Niobium-93m	10
Silver-104	1,000
Silver-105	100
Silver-106m	100
Silver-106	1,000
Silver-108m	1
Silver-110m	10
Silver-111	100
Silver-112	100
Silver-115	1,000
Cadmium-104	1,000

Cadmium-107	1,000
Cadmium-109	1
Cadmium-113m	0.1
Cadmium-113	100
Cadmium-115m	10
Cadmium-115	100
Cadmium-117m	1,000
Cadmium-117	1,000
Indium-109	1,000
Indium-110m (69.1m)	1,000
Indium-110m (4.9h)	1,000
Indium-111	100
Indium-112	1,000
Indium-113m	1,000
Indium-114m	10
Indium-115m	1,000
Indium-115	100
Indium-116m	1,000
Indium-117m	1,000
Indium-117	1,000
Indium-119m	1,000
Tin-110	100
Tin-111	1,000
Tin-113	100
Rhodium-103m	1,000
Rhodium-105	100
Rhodium-106m	1,000
Rhodium-107	1,000
Palladium-100	100
Palladium-101	1,000
Palladium-103	100
Palladium-107	10
Palladium-109	100
Silver-102	1,000
Silver-103	1,000
Silver-104m	1,000
Antimony-116	1,000
Antimony-117	1,000
Antimony-118m	1,000
Antimony-119	1,000
Antimony-120 (16m)	1,000
Antimony-120 (5.76d)	100
Antimony-122	100
Antimony-124m	1,000
Antimony-124	10
Antimony-125	100
Antimony-126m	1,000
Antimony-126	100
Antimony-127	100
Antimony-128 (10.4m)	1,000
Antimony-128 (9.01h)	100
Antimony-129	100
Antimony-130	1,000
Antimony-131	1,000
Tellurium-116	1,000
Tellurium-121m	10
Tellurium-121	100
Tellurium-123m	10
Tellurium-123	100
Tellurium-125m	10
Tellurium-127m	10
Tellurium-127	1,000
Tellurium-129m	10
Tin-117m	100
Tin-119m	100
Tin-121m	100
Tin-121	1,000
Tin-123m	1,000

Tin-123	10
Tin-125	10
Tin-126	10
Tin-127	1,000
Tin-128	1,000
Antimony-115	1,000
Antimony-116m	1,000
Iodine-131	1
Iodine-132m	100
Iodine-132	100
Iodine-133	10
Iodine-134	1,000
Iodine-135	100
Xenon-120	1,000
Xenon-121	1,000
Xenon-122	1,000
Xenon-123	1,000
Xenon-125	1,000
Xenon-127	1,000
Xenon-129m	1,000
Xenon-131m	1,000
Xenon-133m	1,000
Xenon-133	1,000
Xenon-135m	1,000
Xenon-135	1,000
Xenon-138	1,000
Cesium-125	1,000
Cesium-127	1,000
Cesium-129	1,000
Cesium-130	1,000
Cesium-131	1,000
Cesium-132	100
Cesium-134m	1,000
Cesium-134	10
Cesium-135m	1,000
Cesium-135	100
Cesium-136	10
Cesium-137	10
Tellurium-129	1,000
Tellurium-131m	10
Tellurium-131	100
Tellurium-132	10
Tellurium-133m	100
Tellurium-133	1,000
Tellurium-134	1,000
Iodine-120m	1,000
Iodine-120	100
Iodine-121	1,000
Iodine-123	100
Iodine-124	10
Iodine-125	1
Iodine-126	1
Iodine-128	1,000
Iodine-129	1
Iodine-130	10
Lanthanum-140	100
Lanthanum-141	100
Lanthanum-142	1,000
Lanthanum-143	1,000
Cerium-134	100
Cerium-135	100
Cerium-137m	100
Cerium-137	1,000
Cerium-139	100
Cerium-141	100
Cerium-143	100
Cerium-144	1
Praseodymium-136	1,000
Praseodymium-137	1,000
Praseodymium-138m	1,000
Praseodymium-139	1,000
Praseodymium-142m	1,000
Praseodymium-142	100
Praseodymium-143	100

Praseodymium-144	1,000
Praseodymium-145	100
Praseodymium-147	1,000
Neodymium-136	1,000
Neodymium-138	100
Neodymium-139m	1,000
Neodymium-139	1,000
Cesium-138	1,000
Barium-126	1,000
Barium-128	100
Barium-131m	1,000
Barium-131	100
Barium-133m	100
Barium-133	100
Barium-135m	100
Barium-139	1,000
Barium-140	100
Barium-141	1,000
Barium-142	1,000
Lanthanum-131	1,000
Lanthanum-132	100
Lanthanum-135	1,000
Lanthanum-137	10
Lanthanum-138	100
Samarium-153	100
Samarium-155	1,000
Samarium-156	1,000
Europium-145	100
Europium-146	100
Europium-147	100
Europium-148	10
Europium-149	100
Europium-150 (12.62h)	100
Europium-150 (34.2y)	1
Europium-152m	100
Europium-152	1
Europium-154	1
Europium-155	10
Europium-156	100
Europium-157	100
Europium-158	1,000
Gadolinium-145	1,000
Gadolinium-146	10
Gadolinium-147	100
Gadolinium-148	0.001
Gadolinium-149	100
Gadolinium-151	10
Gadolinium-152	100
Neodymium-141	1,000
Neodymium-147	100
Neodymium-149	1,000
Neodymium-151	1,000
Promethium-141	1,000
Promethium-143	100
Promethium-144	10
Promethium-145	10
Promethium-146	1
Promethium-147	10
Promethium-148m	10
Promethium-148	10
Promethium-149	100
Promethium-150	1,000
Proemthium-151	100
Samarium-141m	1,000
Samarium-141	1,000
Samarium-142	1,000
Samarium-145	100
Samarium-146	1
Samarium-147	100
Samarium-151	10
Dysprosium-166	100
Holmium-1155	1,000

Holmium-157	1,000	Dysprosium-155	1,000
Holmium-159	1,000	Dysprosium-157	1,000
Holmium-161	1,000	Dysprosium-159	100
Holmium-162m	1,000	Dysprosium-165	1,000
Holmium-162	1,000	Hafnium-173	1,000
Holmium-164m	1,000	Hafnium-175	100
Holmium-164	1,000	Hafnium-177m	1,000
Holmium-166m	1	Hafnium-178m	0.1
Holmium-166	100	Hafnium-179m	10
Holmium-167	1,000	Hafnium-180m	1,000
Erbium-161	1,000	Hafnium-181	10
Erbium-165	1,000	Hafnium-182m	1,000
Erbium-169	100	Hafnium-182	0.1
Erbium-171	100	Hafnium-183	1,000
Erbium-172	100	Hafnium-184	100
Thulium-162	1,000	Tantalum-172	1,000
Thulium-166	100	Tantalum-173	1,000
Thulium-167	100	Tantalum-174	1,000
Thulium-170	10	Tantalum-175	1,000
Gadolinium-153	10	Tantalum-176	100
Gadolinium-159	100	Tantalum-177	1,000
Terbium-147	1,000	Tantalum-178	1,000
Terbium-149	100	Tantalum-179	100
Terbium-150	1,000	Tantalum-180m	1,000
Terbium-151	100	Tantalum-180	100
Terbium-153	1,000	Thulium-171	10
Terbium-154	100	Thulium-172	100
Terbium-155	1,000	Thulium-173	100
Terbium-156m (5.0h)	1,000	Thulium-175	1,000
		Ytterbium-162	1,000
Terbium-156m (24.4h)	1,000	Ytterbium-166	100
		Ytterbium-167	1,000
Terbium-156	100	Ytterbium-169	100
Terbium-157	10	Ytterbium-175	100
Terbium-158	1	Ytterbium-177	1,000
Terbium-160	10	Ytterbium-178	1,000
Terbium-161	100	Lutetium-169	100

Lutetium-170	100
Lutetium-171	100
Lutetium-172	100
Lutetium-173	10
Lutetium-174m	10
Lutetium-174	10
Lutetium-176m	1,000
Lutetium-176	100
Lutetium-177m	10
Lutetium-177	100
Lutetium-178m	1,000
Lutetium-178	1,000
Lutetium-179	1,000
Hafnium-170	100
Hafnium-172	1
Rhenium-188	100
Rhenium-189	100
Osmium-180	1,000
Osmium-181	1,000
Osmium-182	100
Osmium-185	100
Osmium-189m	1,000
Osmium-191m	1,000
Osmium-191	100
Osmium-193	100
Osmium-194	100
Iridium-182	1,000
Iridium-184	1,000
Iridium-185	1,000
Iridium-186	100
Iridium-187	1,000
Tantalum-182m	1,000
Tantalum-182	10
Tantalum-183	100
Tantalum-184	100
Tantalum-185	1,000
Tantalum-186	1,000
Tungsten-176	1,000
Tungsten-177	1,000
Tungsten-178	1,000
Tungsten-179	1,000
Tungsten-181	1,000
Tungsten-185	100
Tungsten-187	100
Tungsten-188	10
Rhenium-177	1,000
Rhenium-178	1,000
Rhenium-181	1,000
Rhenium-182 (12.7h)	1,000
Rhenium-182 (64.0h)	100
Rhenium-184m	10
Rhenium-184	100
Rhenium-186m	10
Rhenium-186	100
Rhenium-187	1,000
Rhenium-188m	1,000
Mercury-194	1
Mercury-195m	100
Mercury-195	1,000
Mercury-197m	100
Mercury-197	1,000
Mercury-199m	1,000
Mercury-203	100
Thallium-194m	1,000
Thalllium-194	1,000
Thallium-195	1,000
Thallium-197	1,000
Thallium-198m	1,000
Thallium-198	1,000
Thallium-199	1,000
Thallium-200	1,000
Thallium-201	1,000

Iridium-188	100
Iridium-189	100
Iridium-190m	1,000
Iridium-190	100
Iridium-192m	1
Iridium-192	10
Iridium-194m	10
Iridium-194	100
Iridium-195m	1,000
Iridium-195	1,000
Platinum-186	1,000
Platinum-188	100
Platinum-189	1,000
Platinum-191	100
Platinum-193m	100
Platinum-193	1,000
Platinum-195m	100
Platinum-197m	1,000
Platinum-197	100
Platinum-199	1,000
Platinum-200	100
Gold-193	1,000
Gold-194	100
Gold-195	10
Gold-198m	100
Gold-198	100
Gold-199	100
Gold-200m	100
Gold-200	1,000
Gold-201	1,000
Mercury-193m	100
Mercury-193	1,000
Astatine-207	100
Astatine-211	10
Radon-220	1
Radon-222	1
Francium-222	100
Francium-223	100
Radium-223	0.1
Radium-224	0.1
Radium-225	0.1
Radium-226	0.1
Radium-227	1,000
Thallium-202	100
Thallium-204	100
Lead-195m	1,000
Lead-198	1,000
Lead-199	1,000
Lead-200	100
Lead-201	1,000
Lead-202m	1,000
Lead-202	10
Lead-203	1,000
Lead-205	100
Lead-209	1,000
Lead-210	0.01
Lead-211	100
Lead-212	1
Lead-214	100
Bismuth-200	1,000
Bismuth-201	1,000
Bismuth-202	1,000
Bismuth-203	100
Bismuth-205	100
Bismuth-206	100
Bismuth-207	10
Bismuth-210m	0.1
Bismuth-210	1
Bismuth-212	10
Bismuth-213	10
Bismuth-214	100
Polonium-203	1,000
Polonium-205	1,000
Polonium-207	1,000

Polonium-210	0.1
Neptunium-234	100
Neptunium-235	100
Neptunium-236 (1.15x10y)	0.001
Neptunium-236 (22.5h)	1
Neptunium-237	0.001
Neptunium-238	10
Neptunium-239	100
Neptunium-240	1,000
Plutonium-234	10
Radium-228	0.1
Actinium-224	1
Actinium-225	0.01
Actinium-226	0.1
Actinium-227	0.001
Actinium-228	1
Thorium-226	10
Thorium-227	0.01
Thorium-228	0.001
Thorium-229	0.001
Thorium-230	0.001
Thorium-231	100
Thorium-232	100
Thorium-234	10
Thorium-natural	100
Protactinium-227	10
Protactinium-228	1
Protactinium-230	0.1
Protactinium-231	0.001
Protactinium-232	1
Protactinium-233	100
Protactinium-234	100
Uranium-230	0.01
Uranium-231	100
Uranium-232	0.001
Uranium-233	0.001
Uranium-234	0.001
Uranium-235	0.001
Uranium-236	0.001
Uranium-237	100
Uranium-238	100
Uranium-239	1,000
Uranium-240	100
Uranium-natural	100
Neptunium-232	100
Neptunium-233	1,000
Berkelium-246	100
Berkelium-247	0.001
Berkelium-249	0.1
Berkelium-250	10
Californium-244	100
Californium-246	1
Californium-248	0.01
Plutonium-235	1,000
Plutonium-236	0.001
Plutonium-237	100
Plutonium-238	0.001
Plutonium-239	0.001
Plutonium-240	0.001
Plutonium-241	0.01
Plutonium-242	0.001
Plutonium-243	1,000
Plutonium-244	0.001
Plutonium-245	100
Americium-237	1,000
Americium-238	100
Americium-239	1,000
Americium-240	100
Americium-241	0.001
Americium-242m	0.001
Americium-242	10
Americium-243	0.001

Americium-244m	100	Einsteinium-251	100
Americium-244	10	Einsteinium-253	0.1
Americium-245	1,000	Einsteinium-254m	1
Americium-246m	1,000	Einsteinium-254	0.01
Americium-246	1,000	Fermium-252	1
Curium-238	100	Fermium-253	1
Curium-240	0.1	Californium-249	0.001
Curium-241	1	Californium-250	0.001
Curium-242	0.01	Californium-251	0.001
Curium-243	0.001	Californium-252	0.001
Curium-244	0.001	Californium-253	0.1
Curium-245	0.001	Californium-254	0.001
Curium-246	0.001	Fermium-254	10
Curium-247	0.001	Fermium-255	1
Curium-248	0.001	Fermium-257	0.01
Curium-249	1,000	Mendelevium-257	10
Berkelium-245	100	Mendelevium-258	0.01
Einsteinium-250	100		

Any alpha-emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	0.001	Any radionuclide other than alpha-emitting radionuclides not listed above, or mixtures of beta emitters of unknown composition	0.01

NOTE: For purposes of subsections (aa)(5), (dd)(1), and (ww)(1) of this section 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" -- that is, unity.

[1]The quantities listed above were derived by taking 1/10th of the most restrictive ALI listed in Columns 1 and 2 of Table I of paragraph (2)(F) of this subsection, rounding to the nearest factor of 10, and constraining the values listed between 0.001 and 1,000 microcuries (37 becquerels and 37 megabecquerels). Values of 100 microcuries (3.7 megabecquerels) have been assigned for radionuclides having a radioactive half-life in excess of E+9 years, except rhenium, 1,000 microcuries (37 megabecquerels), to take into account their low specific activity.

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* To convert microcurie (μCi) to kilobecquerel, multiply the microcurie value by 37.

Figure: 25 TAC §289.202(ggg)(4)(A)(iii)(V)

Concentration Radionuclide	curie/cubic meter *	nanocurie/gram **
C-14	8	
C-14 in activated metal	80	
Ni-59 in activated metal	220	
Nb-94 in activated metal	0.2	
Tc-99	3	
I-129	0.08	
Alpha emitting transuranic radionuclides with half life greater than 5 years		100
Pu-241		3,500
Cm-242		20,000
Ra-226		100

* To convert the Ci/ m^3 values to gigabecquerel (GBq) per cubic meter, multiply the Ci/ m^3 value by 37.

** To convert the nCi/g values to Becquerel (Bq) per gram, multiply the nCi/g value by 37.

Figure: 25 TAC §289.202(ggg)(4)(A)(iv)(VI)

Radionuclide	Concentration, curie/cubic meter*		
	Column 1	Column 2	Column 3
Total of all radionuclides with less than 5-year half-life	700	*	*
H-3	40	*	*
Co-60	700	*	*
Ni-63	3.5	70	700
Ni-63 in activated metal	35	700	7,000
Sr-90	0.04	150	7,000
Cs-137	1	44	4,600

* To convert the Ci/m^3 values to gigabecquerel (GBq) per cubic meter, multiply the Ci/m^3 value by 37. There are no limits established for these radionuclides in Class B or C wastes. Practical considerations such as the effects of external radiation and internal heat generation on transportation, handling, and disposal will limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of other radionuclides in this table determine the waste to be Class C independent of these radionuclides.

Nuclides	Concentrations Limit (Ci/m^3)	Annual Generator Disposal Limit (Ci/yr)
F-18	3×10^{-1}	8
Si-31	$1 \times 10^{+2}$	$3 \times 10^{+3}$
Na-24	9×10^{-4}	2×10^{-2}
P-32	2	$5 \times 10^{+1}$
P-33	10	$3 \times 10^{+2}$
S-35	9	$2 \times 10^{+2}$
Ar-41	3×10^{-1}	8
K-42	2×10^{-2}	5×10^{-1}
Ca-45	4	$1 \times 10^{+2}$
Ca-47	2×10^{-2}	5×10^{-1}
Sc-46	2×10^{-3}	5×10^{-2}
Cr-51	6×10^{-1}	$2 \times 10^{+1}$
Fe-59	5×10^{-3}	1×10^{-1}
Co-57	6×10^{-2}	2
Co-58	1×10^{-2}	3×10^{-1}
Zn-65	7×10^{-3}	2×10^{-1}
Ga-67	3×10^{-1}	8
Se-75	5×10^{-2}	1
Br-82	2×10^{-3}	5×10^{-2}
Rb-86	4×10^{-2}	1
Sr-85	2×10^{-2}	5×10^{-1}
Sr-89	8	$2 \times 10^{+2}$
Y-90	4	$1 \times 10^{+2}$
Y-91	4×10^{-1}	10
Zr-95	8×10^{-3}	2×10^{-1}
Nb-95	8×10^{-3}	2×10^{-1}
Mo-99	5×10^{-2}	1
Tc-99m	1	$3 \times 10^{+1}$
Rh-106	1	$3 \times 10^{+1}$
Ag-110m	2×10^{-3}	5×10^{-2}
Cd-115m	2×10^{-1}	5
In-111	9×10^{-2}	2

Nuclides	Concentrations Limit (Ci/m^3)	Annual Generator Disposal Limit (Ci/yr)
In-113m	9	$2 \times 10^{+2}$
Sn-113	6×10^{-2}	2
Sn-119	$2 \times 10^{+1}$	$5 \times 10^{+2}$
Sb-124	2×10^{-3}	5×10^{-2}
Te-129	2×10^{-1}	5
I-123	4×10^{-1}	$1 \times 10^{+1}$
I-125	7×10^{-1}	$2 \times 10^{+1}$
I-131	4×10^{-2}	1
I-133	2×10^{-2}	5×10^{-1}
Xe-127	8×10^{-2}	2
Xe-133	1	$3 \times 10^{+1}$
Ba-140	2×10^{-3}	5×10^{-2}
La-140	2×10^{-3}	5×10^{-2}
Ce-141	4×10^{-1}	$1 \times 10^{+1}$
Ce-144	1×10^{-3}	3×10^{-2}
Pr-143	6	$2 \times 10^{+2}$
Nd-147	7×10^{-2}	2
Yb-169	6×10^{-2}	2
Ir-192	1×10^{-2}	3×10^{-1}
Au-198	3×10^{-2}	8×10^{-1}
Hg-197	8×10^{-1}	$2 \times 10^{+1}$
Tl-201	4×10^{-1}	$1 \times 10^{+1}$
Hg-203	1×10^{-1}	3

NOTE: In any case where there is a mixture in waste of more than one radionuclide, the limiting values for purposes of this paragraph shall be determined as follows.

For each radionuclide in the mixture, calculate the ratio between the quantity present in the mixture and the limit established in this paragraph 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").

Examples: If radionuclides a, b, and c are present in concentrations C_a, C_b, and C_c, and if the applicable concentrations are CL_a, CL_b, and CL_c respectively, then the concentrations shall be limited so that the following relationship exists:

$$(C_a/CL_a) + (C_b/CL_b) + (C_c/CL_c) \leq 1$$

If the total curies for radionuclides a, b, and c are represented A_a, A_b, and A_c, and the annual curie limit for each radionuclide is AL_a, AL_b, and AL_c, then the generator is limited to the following:

$$(A_a/AL_a) + (A_b/AL_b) + (A_c/AL_c) \leq 1$$

Figure: 25 TAC §289.202(ggg)(8)

RC Form 202-2 Texas Department of State Health Services/Radiation Control

CUMULATIVE OCCUPATIONAL EXPOSURE HISTORY

1. NAME (LAST, FIRST, MIDDLE INITIAL)	2. IDENTIFICATION NUMBER	3. ID TYPE	4. SEX MALE ☐ FEMALE ☐	5. DATE OF BIRTH

6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ ☐
11. DDE	12. LDE	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 PSE ☐
11. DDE	12. LDE	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. LDE	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. LDE	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. LDE	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. LDE	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 RC FORM 202-2
(All doses should be stated in rems)

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 (LDE) recorded for the lens of the eye.

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

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

15. Enter the committed effective dose equivalent (CEDE).

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.

Figure: 25 TAC §289.202(ggg)(9)

PAGE _____ OF _____

RC Form 202-3 Texas Department of State Health Services/Radiation Control

OCCUPATIONAL EXPOSURE RECORD FOR A MONITORING PERIOD

1. NAME (LAST, FIRST, MIDDLE INITIAL)	2. IDENTIFICATION NUMBER	3. ID TYPE	4. SEX ☐ MALE ☐ FEMALE	5. DATE OF BIRTH

6. MONITORING PERIOD	7. LICENSEE OR REGISTRANT NAME	8. LICENSE OR REGISTRATION NUMBER(S)	9A. ☐ RECORD ☐ ESTIMATE	9B. ☐ ROUTINE ☐ PSE

10A. RADIONUCLIDE	10B. CLASS	10C. MODE	10D. INTAKE IN ΦCi
INTAKES			

DOSES (in rem)	
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 RC FORM 202-3

(All doses should be stated in rems)

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, Cs-137 or Tc-99m.

10B. Enter the lung clearance class as listed in subsection (ggg)(2)(F) of this section for all intakes by inhalation.

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

10D. Enter the intake of each radionuclide in ΦCi.

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

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

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

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

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

16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ or "NR" for "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. 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.

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

21. Enter the date this form was prepared.

Figure: 25 TAC §289.202(hhh)(2)

Radioactive Material	Category 1 (TBq)	Category 1 (Ci)	Category 2 (TBq)	Category 2 (Ci)
Actinium-227	20	540	0.2	5.4
Americium-241	60	1,600	0.6	16.0
Americium-241/Be	60	1,600	0.6	16.0
Californium-252	20	540	0.2	5.4
Cobalt-60	30	810	0.3	8.1
Curium-244	50	1,400	0.5	14.0
Cesium-137	100	2,700	1.0	27.0
Gadolinium-153	1,000	27,000	10.0	270.0
Iridium-192	80	2,200	0.8	22.0
Plutonium-238	60	1,600	0.6	16.0
Plutonium-239/Be	60	1,600	0.6	16.0
Polonium-210	60	1,600	0.6	16.0
Promethium-147	40,000	1,100,000	400.0	11,000.0
Radium-226	40	1,100	0.4	11.0
Selenium-75	200	5,400	2.0	54.0
Strontium-90	1,000	27,000	10.0	270.0
Thorium-228	20	540	0.2	5.4
Thorium-229	20	540	0.2	5.4
Thulium-170	20,000	540,000	200.0	5,400.0
Ytterbium-169	300	8,100	3.0	81.0

Figure: 25 TAC §289.253(ee)(3)

X.Y.Z. OIL COMPANY
UNIVERSITY NO. 1234

CAUTION

ONE 2 CURIE CS 137 RADIOACTIVE SOURCE ABANDONED
3-3-75 AT 8400 FT. PLUG BACK DEPTH 8200 FT.
DO NOT RE-ENTER THIS WELL BEFORE CONTACTING

RADIATION CONTROL
TEXAS DEPARTMENT OF STATE HEALTH
SERVICES

Figure: 25 TAC §289.257(i)(3)(E)(i)

$$CSI = 10\left[\frac{grams^{235}U}{X} + \frac{grams^{233}U}{Y} + \frac{gramsPu}{Z}\right]$$

Figure: 25 TAC §289.257(i)(3)(E)(iii)

Table 257-1
Mass Limits for General License Packages Containing Mixed Quantities of Fissile Material or Uranium-235 of Unknown Enrichment per §289.257(i)(3)(E)

Fissile Material	Fissile material mass mixed with moderating substances having an average hydrogen density less than or equal to H_2O. (grams)	Fissile material mass mixed with moderating substances having an average hydrogen density greater than H_2O [a]. (grams)
^{235}U (X).....	60	38
^{233}U (Y).....	43	27
^{239}PU or ^{241}PU (Z).....	37	24

[a]When mixtures of moderating substances are present, the lower mass limits shall be used if more than 15% of the moderating substance has an average hydrogen density greater than H_2O.

Table 257-2
Mass Limits for General License Packages Containing Uranium-235 of Known Enrichment per §289.257(i)(3)(E)

Uranium enrichment in weight percent of ^{235}U not exceeding	Fissile material mass of ^{235}U (X). (grams)
24.....	60
20.....	63
15.....	67
11.....	72
10.....	76
9.5.....	78
9.....	81
8.5.....	82
8.....	85
7.5.....	88
7.....	90
6.5.....	93
6.....	97

5.5.....	102
5.....	108
4.5.....	114
4.....	120
3.5.....	132
3.....	150
2.5.....	180
2.....	246
1.5.....	408
1.35.....	480
1.....	1,020
0.92.....	1,800

Figure: 25 TAC §289.257(i)(4)(E)(i)

$$CSI = 10\left[\frac{grams^{239}Pu + grams^{241}Pu}{24}\right]; \text{ and}$$

Figure: 25 TAC §289.257(ee)(4)(A)

$$\sum_i \frac{B(i)}{A_1(i)} \leq 1$$

where B(i) is the activity of radionuclide i, and $A_1(i)$ is the A_1 value for radionuclide i.

Figure: 25 TAC §289.257(ee)(4)(B)

$$\sum_i \frac{B(i)}{A_2(i)} \leq 1$$

where B(i) is the activity of radionuclide i in normal form and $A_2(i)$ is the A_2 value for radionuclide i.

Figure: 25 TAC §289.257(ee)(4)(C)

$$\sum_i \frac{B(i)}{A_1(i)} + \sum_j \frac{C(j)}{A_2(j)} \leq 1$$

where B(i) is the activity of radionuclide i as special form radioactive material, $A_1(i)$ is the A_1 value for radionuclide i, C(j) is the activity of radionuclide j as normal form radioactive material, and $A_2(j)$ is the A_2 value for radionuclide j.

Figure: 25 TAC §289.257(ee)(4)(D)

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

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

Figure: 25 TAC §289.257(ee)(4)(E)

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

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

Figure: 25 TAC §289.257(ee)(4)(F)

$$\textit{Exempt activity concentration for mixture} = \frac{1}{\sum_i \frac{f(i)}{[A]\ (i)}}$$

where f(i) is the fraction of activity concentration of radionuclide i in the mixture, and [A](i) is the activity concentration for exempt material containing radionuclide i.

Figure: 25 TAC §289.257(ee)(4)(G)

$$\textit{Exempt consignment activity limit for mixture} = \frac{1}{\sum_i \frac{f(i)}{A\ (i)}}$$

where f(i) is the fraction of activity of radionuclide i in the mixture, and A is the activity limit for exempt consignments for radionuclide i.

Figure: 25 TAC §289.257(ee)(7)

Table 257-4 - Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Ac-225	Actinium (89)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Ac-227		$1.0X10^{-1}$	$2.7X10^{-12}$	$1.0X10^{3}$	$2.7X10^{-8}$
Ac-228		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ag-105	Silver (47)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ag-108m (b)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ag-110m		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ag-111		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Al-26	Aluminum (13)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Am-241	Americium (95)	1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Am-242m (b)		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Am-243 (b)		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Ar-37	Argon (18)	$1.0X10^{6}$	$2.7X10^{-5}$	$1.0X10^{8}$	$2.7X10^{-3}$
Ar-39		$1.0X10^{7}$	$2.7X10^{-4}$	$1.0X10^{4}$	$2.7X10^{-7}$
Ar-41		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{9}$	$2.7X10^{-2}$
As-72	Arsenic (33)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
As-73		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
As-74		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
As-76		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
As-77		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
At-211	Astatine (85)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Au-193	Gold (79)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Au-194		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Au-195		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Au-198		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Au-199		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ba-131	Barium (56)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ba-133		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ba-133m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ba-140 (b)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Be-7	Beryllium (4)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Be-10		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{6}$	$2.7X10^{-5}$
Bi-205	Bismuth (83)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Bi-206		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Bi-207		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Bi-210		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Bi-210m		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Bi-212 (b)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Bk-247	Berkelium (97)	1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Bk-249		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Br-76	Bromine (35)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Br-77		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Br-82		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
C-11	Carbon (6)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
C-14		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Ca-41	Calcium (20)	$1.0X10^{5}$	$2.7X10^{-6}$	$1.0X10^{7}$	$2.7X10^{-4}$
Ca-45		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Ca-47		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Cd-109	Cadmium (48)	$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{6}$	$2.7X10^{-5}$
Cd-113m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Cd-115		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Cd-115m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ce-139	Cerium (58)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ce-141		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Ce-143		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ce-144 (b)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cf-248	Californium (98)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Cf-249		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Cf-250		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Cf-251		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Cf-252		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Cf-253		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cf-254		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Cl-36	Chlorine (17)	$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{6}$	$2.7X10^{-5}$
Cl-38		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cm-240	Curium (96)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cm-241		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Cm-242		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cm-243		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Cm-244		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Cm-245		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Cm-246		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Cm-247		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Cm-248		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Co-55	Cobalt (27)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Co-56		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Co-57		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Co-58		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Co-58m		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Co-60		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cr-51	Chromium (24)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Cs-129	Cesium (55)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cs-131		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Cs-132		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cs-134		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Cs-134m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cs-135		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Cs-136		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Cs-137 (b)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Cu-64	Copper (29)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Cu-67		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Dy-159	Dysprosium (66)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Dy-165		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Dy-166		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Er-169	Erbium (68)	$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Er-171		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Eu-147	Europium (63)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Eu-148		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Eu-149		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Eu-150 (short lived)		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Eu-150 (long lived)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Eu-152		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Eu-152m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Eu-154		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Eu-155		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Eu-156		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
F-18	Fluorine (9)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Fe-52	Iron (26)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Fe-55		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{6}$	$2.7X10^{-5}$
Fe-59		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Fe-60		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Ga-67	Gallium (31)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ga-68		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Ga-72		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Gd-146	Gadolinium (64)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Gd-148		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Gd-153		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Gd-159		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Ge-68	Germanium (32)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Ge-71		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{8}$	$2.7X10^{-3}$
Ge-77		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Hf-172	Hafnium (72)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Hf-175		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Hf-181		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Hf-182		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Hg-194	Mercury (80)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Hg-195m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Hg-197		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Hg-197m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Hg-203		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Ho-166	Holmium (67)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{5}$	$2.7X10^{-6}$
Ho-166m		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
I-123	Iodine (53)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
I-124		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
I-125		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
I-126		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
I-129		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
I-131		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
I-132		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
I-133		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
I-134		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
I-135		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
In-111	Indium (49)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
In-113m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
In-114m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
In-115m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ir-189	Iridium (77)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Ir-190		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ir-192		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Ir-194		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
K-40	Potassium (19)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
K-42		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
K-43		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Kr-79	Krypton (36)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{5}$	$2.7X10^{-6}$
Kr-81		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Kr-85		$1.0X10^{5}$	$2.7X10^{-6}$	$1.0X10^{4}$	$2.7X10^{-7}$
Kr-85m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{10}$	$2.7X10^{-1}$
Kr-87		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{9}$	$2.7X10^{-2}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
La-137	Lanthanum (57)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
La-140		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Lu-172	Lutetium (71)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Lu-173		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Lu-174		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Lu-174m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Lu-177		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Mg-28	Magnesium (12)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Mn-52	Manganese (25)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Mn-53		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{9}$	$2.7X10^{-2}$
Mn-54		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Mn-56		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Mo-93	Molybdenum (42)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{8}$	$2.7X10^{-3}$
Mo-99		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
N-13	Nitrogen (7)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{9}$	$2.7X10^{-2}$
Na-22	Sodium (11)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Na-24		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Nb-93m	Niobium (41)	$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Nb-94		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Nb-95		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Nb-97		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Nd-147	Neodymium (60)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Nd-149		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ni-59	Nickel (28)	$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{8}$	$2.7X10^{-3}$
Ni-63		$1.0X10^{5}$	$2.7X10^{-6}$	$1.0X10^{8}$	$2.7X10^{-3}$
Ni-65		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Np-235	Neptunium (93)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Np-236 (short-lived)		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Np-236 (long-lived)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Np-237 (b)		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Np-239		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Os-185	Osmium (76)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Os-191		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Os-191m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Os-193		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Os-194		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
P-32	Phosphorus (15)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{5}$	$2.7X10^{-6}$
P-33		$1.0X10^{5}$	$2.7X10^{-6}$	$1.0X10^{8}$	$2.7X10^{-3}$
Pa-230	Protactinium (91)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pa-231		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Pa-233		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Pb-201	Lead (82)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pb-202		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pb-203		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pb-205		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Pb-210 (b)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Pb-212 (b)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Pd-103	Palladium (46)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{8}$	$2.7X10^{-3}$
Pd-107		$1.0X10^{5}$	$2.7X10^{-6}$	$1.0X10^{8}$	$2.7X10^{-3}$
Pd-109		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pm-143	Promethium (61)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pm-144		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pm-145		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Pm-147		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Pm-148m		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pm-149		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pm-151		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Po-210	Polonium (84)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Pr-142	Praseodymium (59)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Pr-143		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{6}$	$2.7X10^{-5}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Pt-188	Platinum (78)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pt-191		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pt-193		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Pt-193m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Pt-195m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pt-197		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pt-197m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Pu-236	Plutonium (94)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Pu-237		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Pu-238		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Pu-239		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Pu-240		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Pu-241		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Pu-242		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Pu-244		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Ra-223 (b)	Radium (88)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Ra-224 (b)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Ra-225		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Ra-226 (b)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Ra-228 (b)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Rb-81	Rubidium (37)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Rb-83		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Rb-84		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Rb-86		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Rb-87		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Rb(nat)		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Re-184	Rhenium (75)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Re-184m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Re-186		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Re-187		$1.0X10^{6}$	$2.7X10^{-5}$	$1.0X10^{9}$	$2.7X10^{-2}$
Re-188		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Re-189		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Re(nat)		$1.0X10^{6}$	$2.7X10^{-5}$	$1.0X10^{9}$	$2.7X10^{-2}$
Rh-99	Rhodium (45)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Rh-101		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Rh-102		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Rh-102m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Rh-103m		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{8}$	$2.7X10^{-3}$
Rh-105		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Rn-222 (b)	Radon (86)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{8}$	$2.7X10^{-3}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Ru-97	Ruthenium (44)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Ru-103		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ru-105		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ru-106 (b)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
S-35	Sulfur (16)	$1.0X10^{5}$	$2.7X10^{-6}$	$1.0X10^{8}$	$2.7X10^{-3}$
Sb-122	Antimony (51)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{4}$	$2.7X10^{-7}$
Sb-124		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sb-125		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sb-126		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Sc-44	Scandium (21)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Sc-46		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sc-47		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sc-48		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Se-75	Selenium (34)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Se-79		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Si-31	Silicon (14)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Si-32		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sm-145	Samarium (62)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Sm-147		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Sm-151		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{8}$	$2.7X10^{-3}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Sm-153		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sn-113	Tin (50)	$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Sn-117m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sn-119m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Sn-121m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Sn-123		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sn-125		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Sn-126		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Sr-82	Strontium (38)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Sr-85		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sr-85m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Sr-87m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sr-89		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Sr-90 (b)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{4}$	$2.7X10^{-7}$
Sr-91		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Sr-92		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
T(H-3)	Tritium (1)	$1.0X10^{6}$	$2.7X10^{-5}$	$1.0X10^{9}$	$2.7X10^{-2}$
Ta-178 (long-lived)	Tantalum (73)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Ta-179		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Ta-182		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Tb-157	Terbium (65)	$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Tb-158		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tb-160		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tc-95m	Technetium (43)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tc-96		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tc-96m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Tc-97		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{8}$	$2.7X10^{-3}$
Tc-97m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Tc-98		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tc-99		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
Tc-99m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Te-121	Tellurium (52)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Te-121m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Te-123m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Te-125m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Te-127		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Te-127m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Te-129		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Te-129m		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Te-131m		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Te-132		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Th-227	Thorium (90)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Th-228 (b)		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Th-229 (b)		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Th-230		1.0	$2.7X10^{-11}$	$1.0X10^{4}$	$2.7X10^{-7}$
Th-231		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Th-232		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
Th-234 (b)		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{5}$	$2.7X10^{-6}$
Th (nat) (b)		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
Ti-44	Titanium (22)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
Tl-200	Thallium (81)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tl-201		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tl-202		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tl-204		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{4}$	$2.7X10^{-7}$
Tm-167	Thulium (69)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tm-170		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Tm-171		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{8}$	$2.7X10^{-3}$
U-230 (fast lung absorption) (b),(d)	Uranium (92)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
U-230 (medium lung absorption) (e)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
U-230 (slow lung absorption) (f)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U-232 (fast lung absorption) (b),(d)		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
U-232 (medium lung absorption) (e)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U-232 (slow lung absorption) (f)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U-233 (fast lung absorption) (d)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U-233 (medium lung absorption) (e)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
U-233 (slow lung absorption) (f)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
U-234 (fast lung absorption) (d)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U-234 (medium lung absorption) (e)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
U-234 (slow lung absorption) (f)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
U-235 (all lung absorption types) (b),(d),(e),(f)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
U-236 (fast lung absorption) (d)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U-236 (medium lung absorption) (e)		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
U-236 (slow lung absorption) (f)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U-238 (all lung absorption types) (b),(d),(e),(f)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{4}$	$2.7X10^{-7}$
U (nat) (b)		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
U (enriched to 20% or less) (g)		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
U (dep)		1.0	$2.7X10^{-11}$	$1.0X10^{3}$	$2.7X10^{-8}$
V-48	Vanadium (23)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$
V-49		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
W-178	Tungsten (74)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
W-181		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
W-185		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{7}$	$2.7X10^{-4}$
W-187		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
W-188		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Xe-122	Xenon (54)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{9}$	$2.7X10^{-2}$
Xe-123		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{9}$	$2.7X10^{-2}$

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Xe-127		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{5}$	$2.7X10^{-6}$
Xe-131m		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{4}$	$2.7X10^{-7}$
Xe-133		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{4}$	$2.7X10^{-7}$
Xe-135		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{10}$	$2.7X10^{-1}$
Y-87	Yttrium (39)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Y-88		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Y-90		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{5}$	$2.7X10^{-6}$
Y-91		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{6}$	$2.7X10^{-5}$
Y-91m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Y-92		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Y-93		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{5}$	$2.7X10^{-6}$
Yb-169	Ytterbium (70)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{7}$	$2.7X10^{-4}$
Yb-175		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Zn-65	Zinc (30)	$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Zn-69		$1.0X10^{4}$	$2.7X10^{-7}$	$1.0X10^{6}$	$2.7X10^{-5}$
Zn-69m		$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Zr-88	Zirconium (40)	$1.0X10^{2}$	$2.7X10^{-9}$	$1.0X10^{6}$	$2.7X10^{-5}$
Zr-93 (b)		$1.0X10^{3}$	$2.7X10^{-8}$	$1.0X10^{7}$	$2.7X10^{-4}$
Zr-95		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{6}$	$2.7X10^{-5}$
Zr-97 (b)		$1.0X10^{1}$	$2.7X10^{-10}$	$1.0X10^{5}$	$2.7X10^{-6}$

[a][Reserved]

[b] Parent nuclides and their progeny included in secular equilibrium are listed in the following:

Sr-90	Y-90
Zr-93	Nb-93m
Zr-97	Nb-97
Ru-106	Rh-106
Cs-137	Ba-137m
Ce-144	Pr-144
Ba-140	La-140
Bi-212	Tl-208 (0.36), Po-212 (0.64)
Pb-210	Bi-210, Po-210
Pb-212	Bi-212, Tl-208 (0.36), Po-212 (0.64)
Rn-222	Po-218, Pb-214, Bi-214, Po-214
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Tl-207
Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208(0.36), Po-212 (0.64)
Ra-226	Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
Ra-228	Ac-228
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Th-229	Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209
Th-nat	Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 0.36), Po-212 (0.64)
Th-234	Pa-234m
U-230	Th-226, Ra-222, Rn-218, Po-214
U-232	Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
U-235	Th-231
U-238	Th-234, Pa-234m
U-nat	Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
U-240	Np-240m
Np-237	Pa-233
Am-242m	Am-242
Am-243	Np-239

[c][Reserved]

[d] These values apply only to compounds of uranium that take the chemical form of UF_6, UO_2F_2 and $UO_2(NO_3)_2$ in both normal and accident conditions of transport.

[e] These values apply only to compounds of uranium that take the chemical form of UO_3, UF_4, UCl_4 and hexavalent compounds in both normal and accident conditions of transport.

[f] These values apply to all compounds of uranium other than those specified in notes (d) and (e) of this table.

[g] These values apply to unirradiated uranium only.

Figure: 25 TAC §289.257(ee)(8)

Table 257-5: General Values For A_1 And A_2

Contents	A_1		A_2		Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limits for exempt consignments (Bq)	Activity limits for exempt consignments (Ci)
	(TBq)	(Ci)	(TBq)	(Ci)				
Only beta or gamma emitting radionuclides are known to be present	1×10^{-1}	2.7×10^{0}	2×10^{-2}	5.4×10^{-1}	1×10^{1}	2.7×10^{-10}	1×10^{4}	2.7×10^{-7}
Alpha emitting nuclides, but no neutron emitters, are known to be present[a]	2×10^{-1}	5.4×10^{0}	9×10^{-5}	2.4×10^{-3}	1×10^{-1}	2.7×10^{-12}	1×10^{3}	2.7×10^{-8}
Neutron emitting nuclides are known to be present or no relevant data are available	1×10^{-3}	2.7×10^{-2}	9×10^{-5}	2.4×10^{-3}	1×10^{-1}	2.7×10^{-12}	1×10^{3}	2.7×10^{-8}

[a] If beta or gamma emitting nuclides are known to be present, the A1 value of 0.1 TBq (2.7 Ci) should be used.