



DRAFT
REGULATORY
STANDARD

**Requirements for the Disposal of Nuclear
Substances**

S-307

ISSUED FOR PUBLIC CONSULTATION
November 2004

REGULATORY DOCUMENTS

The legal framework within which the Canadian Nuclear Safety Commission (CNSC) operates includes the *Nuclear Safety and Control Act (Act)*, its Regulations and other legal instruments such as licences, certificates and orders. The legal framework is supported by regulatory documents issued by the CNSC, the main classes of which are:

Regulatory Policy (P): a document that describes the philosophy, principles or fundamental factors that underlie the CNSC's approach to its regulatory mission. It provides direction to CNSC staff and information to stakeholders.

Regulatory Standard (S): a document that describes CNSC requirements. It imposes obligations on the regulated party, once it is referenced in a licence or other legally enforceable instrument.

Regulatory Guide (G): a document that indicates acceptable ways of meeting CNSC requirements, as expressed in the *Act*, Regulations, regulatory standard or other legally-enforceable instrument. It provides guidance to licensees and other stakeholders.

Regulatory Notice (N): a document that provides licensees and other stakeholders with information about significant matters that warrant timely action.

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About This Document

The purpose of the proposed Regulatory Standard, when incorporated in a licence or other legally enforceable instrument, is to set the terms and conditions by which the disposal of nuclear substances must take place.

Comments

The CNSC invites interested persons to assist in the further development of this document by commenting in writing on the document's content and usefulness. Please respond by February 4, 2005. Direct your comments to the postal or e-mail address below, referencing file 1-8-8-307.

The CNSC will take your comments into account when developing this draft further. All comments will be subject to the provisions of the federal *Access to Information Act*.

Document Availability

This and other similar documents can be viewed on the CNSC Web site at (www.nuclearsafety.gc.ca). To order a printed copy of the document in English or French, please contact:

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DRAFT REGULATORY STANDARD

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**REQUIREMENTS FOR THE DISPOSAL OF NUCLEAR
SUBSTANCES**

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REQUIREMENTS FOR THE DISPOSAL OF NUCLEAR SUBSTANCES

1.0 PURPOSE

The purpose of the proposed Regulatory Standard, when incorporated in a licence or other legally enforceable instrument, is to set the terms and conditions by which the disposal of nuclear substances must take place.

2.0 SCOPE

This document sets out the conditions, in terms of related circumstances, pathways, concentrations, or quantities, under which a licensee must dispose of nuclear substances when the standard is incorporated into the licence or other legally enforceable instrument.

3.0 RELEVANT LEGISLATION

The following provisions of the *Nuclear Safety and Control Act* (NSC Act) and *Regulations* are relevant to this standard:

Paragraphs 26 (a) and (b) stipulate that, subject to the regulations, no person shall, except in accordance with a licence, “(a) possess, transfer, import, export, use or abandon a nuclear substance, prescribed equipment or prescribed information,” or “(b) mine, produce, refine, convert, enrich, process, reprocess, package, transport, manage, store or dispose of a nuclear substance.”

Subsection 24(4) of the NSC Act states that “No licence may be issued, renewed, amended or replaced unless, in the opinion of the Commission, the applicant (a) is qualified to carry on the activity that the licence will authorize the licensee to carry on; and (b) will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons, and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.”

Subsection 24(5) of the NSC Act provides that a licence issued by the Canadian Nuclear Safety Commission “may contain any term or condition that the Commission considers necessary for the purposes of the *Act*.”

4.0 DEFINITIONS

For the purposes of this regulatory standard, the following definitions apply:

Disposal of nuclear substances

The removal of nuclear substances, that are associated with a licensed activity, from any further regulatory control by the CNSC.

Disposal event

A single occurrence of disposal of nuclear substances that takes place at one time, and where the material is disposed of by one method of disposal.

Effluent

The release of nuclear substances to the atmosphere, surface water or groundwater, resulting from routine operations.

Nuclear substance of natural origin

Potassium-40 and any radionuclide that is part of the following decay series: ^{235}U , ^{238}U , ^{232}Th , and that is or has been associated with the development, production or use of nuclear energy.

Quality assurance (QA) program

An integrated management system that consists of coordinated activities to direct and control an organization for the purpose of assuring quality in the interests of complying with the *Act*.

5.0 APPLICABILITY

This regulatory standard applies to all licences in which it is directly referenced. When reference to this standard has been included as a condition of a licence, the disposal of nuclear substances shall be in accordance with the terms of this standard.

This regulatory standard addresses the disposal of radioactive solids. It excludes nuclear substances in effluents, foodstuffs or animal feed (or any material intended for use in foods or animal feed) and drinking water. It also excludes radioactive residues in the environment; hence, the criteria in Section 6 of this standard are not intended to be compared to data resulting from environmental monitoring.

This standard addresses only the radiological properties of the substances being considered for disposal. Disposal of nuclear substances that also contain other hazardous substances or hazardous waste must also be carried out in accordance with other relevant standards and regulations.

The nuclear substances of natural origin considered in this standard are only those that are, or have been, associated with the development, production or use of nuclear energy.

The criteria stated in this standard may be incorporated into any type of CNSC licence.

6.0 DISPOSAL CRITERIA

This section states the values that are to be used for the disposal of the following substances:

1. Nuclear substances of natural origin;
2. Nuclear substances of artificial origin;
3. Nuclear substances with mixtures of radionuclides;
4. Nuclear substances dissolved in liquids; and
5. Items with nuclear substances as surface contamination.

The CNSC has adopted the activity concentration levels described in the International Atomic Energy Agency (IAEA) Safety Guide, *Application of the Concepts of Exclusion, Exemption and Clearance* (RSG1.7). The radiological basis used in RSG1.7 is as follows:

- a) The effective dose to an individual should be 10 μ Sv in a year or less; and
- b) For low probability events leading to higher radiation exposure, the effective dose should be less than 1 mSv in a year, and the equivalent dose to the skin should be less than 50 mSv in a year.

The tables in subsections 6.1 and 6.2 set out the radionuclide concentration levels below which natural and artificial nuclear substances are deemed suitable for disposal. Subsections 6.3, 6.4 and 6.5 describe how those tables apply to mixtures of radionuclides, radioactive liquids, and items with surface contamination.

6.1 Nuclear Substances of Natural Origin

Table 1 states the radionuclide concentration levels, measured in becquerels per gram (Bq/g), below which nuclear substances of natural origin may be disposed.

Table 1: Radionuclide Concentration Levels (Natural Origin)	
Radionuclide	Concentration Level (Bq/g)
K-40	10
Natural Thorium ^a	0.3
U-238, Th-234, Pa-234/234m, U-234 ^b	1

^a The concentration level applies to Th-232 and all progeny and refers to the activity concentration of any radionuclide in the decay chain.

^b The concentration level refers to the activity concentration of any of these radionuclides.

6.2 Nuclear Substances of Artificial Origin

Table 2, on the following page, states the radionuclide concentration levels below which nuclear substances of artificial origin may be disposed. The values marked with “+” take into account dose contributions from progeny radionuclides.

Table 2: Radionuclide Concentration Levels (Artificial Origin)					
Radionuclide	Concentration Level (Bq/g)	Radionuclide	Concentration Level (Bq/g)	Radionuclide	Concentration Level (Bq/g)
H-3	100	Co-58m	10000	Zr-95+	1
Be-7	10	Co-60	0.1	Zr-97+	10
C-14	1	Co-60m	1000	Nb-93m	10
F-18	10	Co-61	100	Nb-94	0.1
Na-22	0.1	Co-62m	10	Nb-95	1
Na-24	1	Ni-59	100	Nb-97+	10
Si-31	1000	Ni-63	100	Nb-98	10
P-32	1000	Ni-65	10	Mo-90	10
P-33	1000	Cu-64	100	Mo-93	10
S-35	100	Zn-65	0.1	Mo-99+	10
Cl-36	1	Zn-69	1000	Mo-101+	10
Cl-38	10	Zn-69m+	10	Tc-96	1
K-42	100	Ga-72	10	Tc-96m	1000
K-43	10	Ge-71	10000	Tc-97	10
Ca-45	100	As-73	1000	Tc-97m	100
Ca-47	10	As-74	10	Tc-99	1
Sc-46	0.1	As-76	10	Tc-99m	100
Sc-47	100	As-77	1000	Ru-97	10
Sc-48	1	Se-75	1	Ru-103+	1
V-48	1	Br-82	1	Ru-105+	10
Cr-51	100	Rb-86	100	Ru-106+	0.1
Mn-51	10	Sr-85	1	Rh-103m	10000
Mn-52	1	Sr-85m	100	Rh-105	100
Mn-52m	10	Sr-87m	100	Pd-103+	1000
Mn-53	100	Sr-89	1000	Pd-109	100
Mn-54	0.1	Sr-90+	1	Ag-105	1
Mn-56	10	Sr-91+	10	Ag-110m+	0.1
Fe-52+	10	Sr-92	10	Ag-111	100
Fe-55	1000	Y-90	1000	Cd-109+	1
Fe-59	1	Y-91	100	Cd-115+	10
Co-55	10	Y-91m	100	Cd-115m	100
Co-56	0.1	Y-92	100	In-111	10
Co-57	1	Y-93	100	In-113m	100
Co-58	1	Zr-93	10	In-114m+	10

Table 2: Radionuclide Concentration Levels (Artificial Origin)					
Radionuclide	Concentration Level (Bq/g)	Radionuclide	Concentration Level (Bq/g)	Radionuclide	Concentration Level (Bq/g)
In-115m	100	Cs-135	100	Yb-175	100
Sn-113+	1	Cs-136	1	Lu-177	100
Sn-125	10	Cs-137+	0.1	Hf-181	1
Sb-122	10	Cs-138	10	Ta-182	0.1
Sb-124	1	Ba-131	10	W-181	10
Sb-125+	0.1	Ba-140	1	W-185	1000
Te-123m	1	La-140	1	W-187	10
Te-125m	1000	Ce-139	1	Re-186	1000
Te-127	1000	Ce-141	100	Re-188	100
Te-127m+	10	Ce-143	10	Os-185	1
Te-129	100	Ce-144+	10	Os-191	100
Te-129m+	10	Pr-142	100	Os-191m	1000
Te-131	100	Pr-143	1000	Os-193	100
Te-131m+	10	Nd-147	100	Ir-190	1
Te-132+	1	Nd-149	100	Ir-192	1
Te-133	10	Pm-147	1000	Ir-194	100
Te-133m	10	Pm-149	1000	Pt-191	10
Te-134	10	Sm-151	1000	Pt-193m	1000
I-123	100	Sm-153	100	Pt-197	1000
I-125	100	Eu-152	0.1	Pt-197m	100
I-126	10	Eu-152m	100	Au-198	10
I-129	0.01	Eu-154	0.1	Au-199	100
I-130	10	Eu-155	1	Hg-197	100
I-131	10	Gd-153	10	Hg-197m	100
I-132	10	Gd-159	100	Hg-203	10
I-133	10	Tb-160	1	Tl-200	10
I-134	10	Dy-165	1000	Tl-201	100
I-135	10	Dy-166	100	Tl-202	10
Cs-129	10	Ho-166	100	Tl-204	1
Cs-131	1000	Er-169	1000	Pb-203	10
Cs-132	10	Er-171	100	Bi-206	1
Cs-134	0.1	Tm-170	100	Bi-207	0.1
Cs-134m	1000	Tm-171	1000	Po-203	10

Table 2: Radionuclide Concentration Levels (Artificial Origin)					
Radionuclide	Concentration Level (Bq/g)	Radionuclide	Concentration Level (Bq/g)	Radionuclide	Concentration Level (Bq/g)
Po-205	10	Np-240	10	Cm-245	0.1
Po-207	10	Pu-234	100	Cm-246	0.1
At-211	1000	Pu-235	100	Cm-247+	0.1
Ra-225	10	Pu-236	1	Cm-248	0.1
Ra-227	100	Pu-237	100	Bk-249	100
Th-226	1000	Pu-238	0.1	Cf-246	1000
Th-229	0.1	Pu-239	0.1	Cf-248	1
Pa-230	10	Pu-240	0.1	Cf-249	0.1
Pa-233	10	Pu-241	10	Cf-250	1
U-230	10	Pu-242	0.1	Cf-251	0.1
U-231	100	Pu-243	1000	Cf-252	1
U-232+	0.1	Pu-244+	0.1	Cf-253	100
U-233	1	Am-241	0.1	Cf-254	1
U-236	10	Am-242	1000	Es-253	100
U-237	100	Am-242m+	0.1	Es-254+	0.1
U-239	100	Am-243+	0.1	Es-254m+	10
U-240+	100	Cm-242	10	Fm-254	10000
Np-237+	1	Cm-243	1	Fm-255	100
Np-239	100	Cm-244	1		

6.3 Mixtures of Radionuclides

Nuclear substances may contain mixtures of radionuclides of natural origin, artificial origin or a combination of both. The following considerations apply to disposal of these substances.

6.3.1 Natural Origin

For nuclear substances containing mixtures of radionuclides of natural origin, the concentration of each nuclear substance shall be less than the concentration levels given in Table 1.

6.3.2 Artificial Origin

For nuclear substances containing mixtures of radionuclides of artificial origin, the following formula shall be used:

$$\sum_{i=1}^n \frac{C_i}{\text{Concentration Level}_i} \leq 1$$

Where C_i is the concentration (Bq/g) of the i^{th} radionuclide of artificial origin in the material, $\text{Concentration Level}_i$ is the level, from Table 2, for that radionuclide in the material, and n is the number of radionuclides present.

6.3.3 Both Natural and Artificial Origin

For nuclear substances containing mixtures of radionuclides of both natural and artificial origin, the conditions stated in 6.3.1 and 6.3.2 shall be satisfied.

6.4 Radioactive Liquids

Liquid solutions containing dissolved radionuclides are subject to this regulatory standard. The activity concentration level stated in Tables 1 and 2 shall apply to the solid residue that remains after evaporation of the solution.

6.5 Items with Surface Contamination

In the case of a contaminated surface, the licensee shall apply the levels expressed in Tables 1 and 2 to surface contamination, with values expressed as Bq/g being read as Bq/cm².

7.0 MEASUREMENT

Prior to disposal, the licensee shall measure the concentrations of nuclear substances to verify their conformance with the disposal criteria defined in Section 6, "Disposal Criteria." Radiological measurements performed for the purpose of nuclear substance disposal shall include direct measurements, laboratory analysis of representative samples, or a combination of both.

7.1 Strategy

The licensee shall develop a measurement strategy that ensures radiological measurements are statistically representative of the substance being considered for disposal. To validate the statistical relevance of the measurement results, the strategy shall include the rationale for sample size and location and for the analysis type.

The measurement strategy shall take the following elements into consideration:

1. Probability of contamination with any radionuclides with activity concentration values above the disposal criteria;
2. Relevant history of the nuclear substances to identify the known or potentially present radionuclides and associated concentration activity levels;
3. Potential radionuclide distribution (surface contamination or volumetric contamination (or both), uniformity, etc.);
4. Size, geometry, physical properties and measurement accessibility of the substance; and
5. Associated radionuclides.

7.2 Averaging

When contamination is not uniformly distributed throughout the material, the values to be compared against the *Disposal Criteria* shall be the average concentrations. No single measurement may exceed 10 times the concentration levels indicated in Tables 1 and 2.

For volumetric contamination, the concentration shall be averaged over a maximum of 1 m³ of material.

For surface contamination, the concentration shall be averaged over a maximum of 1 m².

7.3 Equipment

Measurement of activity concentration levels shall be performed using equipment that is

1. Capable of detecting the presence of radionuclides at or below the disposal criteria levels;
2. Calibrated for the known or potential radionuclide spectrum and distribution; and
3. Capable of measuring the quantity of radionuclides on and in the substance.

8.0 QUALITY MANAGEMENT

The licensee shall ensure that quality management processes in support of this regulatory standard are incorporated into their Quality Assurance program.

9.0 RECORDS

For each disposal event, the licensee shall create and retain a *Record of Disposal* that includes, at a minimum, the following information:

1. A list of the radionuclides in the disposed nuclear substance;
2. The measurement results, including the associated average values compared against the *Disposal Criteria*;
3. The form of the nuclear substance (i.e., liquid, solid, surface, etc.);
4. For volumetric contamination, the mass or the volume of the material disposed;
5. For surface contamination, the mass (or volume) and surface area measured;
6. The method of disposal; and
7. The date on which the disposal occurred.

10.0 NOTIFICATION AND REPORTING

The licensee shall notify the CNSC prior to disposal of nuclear substances in excess of 1000 kg per disposal event, unless otherwise specified in the licence.

The licensee shall report on all *Disposal Events* to the CNSC on at least an annual basis. At a minimum, this report shall include the following information:

1. Total number of disposal events for the reporting period;
2. Dates of disposal events; and
3. Total weight (or volume) and type of material disposed of during each disposal event.

REFERENCES

The following publications provide additional information that is relevant to this regulatory standard.

1. *Nuclear Safety and Control Act and the General Nuclear Safety and Control Regulations*, published by the Canadian Nuclear Safety Commission, Ottawa, 2000.
2. *Application of the Concepts of Exclusion, Exemption and Clearance*, Safety Standards Series No. RS-G-1.7, published by the International Atomic Energy Agency, Vienna, 2004.
3. *Clearance Levels for Radionuclides in Solid Materials*, TECDOC Series No. 855, published by the International Atomic Energy Agency, Vienna, 1996.
4. *Clearance of Materials Resulting from the Use of Radionuclides in Medicine, Industry and Research*, TECDOC Series No. 1000, published by the International Atomic Energy Agency, Vienna, 1998.