



**Note: S-307 is temporarily on hold pending the outcome of proposed amendments to the *Nuclear Substances and Radiation Devices Regulations***

**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.

# **DRAFT REGULATORY STANDARD**

## **Requirements for the Disposal of Nuclear Substances**

**S-307**

Issued for Public Consultation  
November 2004

### **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](http://www.nuclearsafety.gc.ca)). To order a printed copy of the document in English or French, please contact:

Administrative Assistant  
Regulatory Standards and Research Division  
Directorate of Operational Strategies  
Canadian Nuclear Safety Commission  
P.O. Box 1046, Station B  
280 Slater Street  
Ottawa, Ontario K1P 5S9  
CANADA

Telephone: (613) 947-3981  
Fax: (613) 995-5086  
E-mail: [consultation@cnsccsn.gc.ca](mailto:consultation@cnsccsn.gc.ca)



**DRAFT REGULATORY STANDARD**

**S-307**

**REQUIREMENTS FOR THE DISPOSAL OF NUCLEAR  
SUBSTANCES**

Published by the  
Canadian Nuclear Safety Commission  
Month/Year of Publication



## TABLE OF CONTENTS

|             |   |           |
|-------------|---|-----------|
| <b>1.0</b>  | <b>PURPOSE</b> .....                          | <b>1</b>  |
| <b>2.0</b>  | <b>SCOPE</b> .....                            | <b>1</b>  |
| <b>3.0</b>  | <b>RELEVANT LEGISLATION</b> .....             | <b>1</b>  |
| <b>4.0</b>  | <b>DEFINITIONS</b> .....                      | <b>2</b>  |
| <b>5.0</b>  | <b>APPLICABILITY</b> .....                    | <b>2</b>  |
| <b>6.0</b>  | <b>DISPOSAL CRITERIA</b> .....                | <b>3</b>  |
| 6.1         | Nuclear Substances of Natural Origin .....    | 3         |
| 6.2         | Nuclear Substances of Artificial Origin ..... | 4         |
| 6.3         | Mixtures of Radionuclides .....               | 7         |
| 6.3.1       | Natural Origin .....                          | 7         |
| 6.3.2       | Artificial Origin .....                       | 8         |
| 6.3.3       | Both Natural and Artificial Origin.....       | 8         |
| 6.4         | Radioactive Liquids .....                     | 8         |
| 6.5         | Items with Surface Contamination.....         | 8         |
| <b>7.0</b>  | <b>MEASUREMENT</b> .....                      | <b>8</b>  |
| 7.1         | Strategy .....                                | 9         |
| 7.2         | Averaging .....                               | 9         |
| 7.3         | Equipment .....                               | 9         |
| <b>8.0</b>  | <b>QUALITY MANAGEMENT</b> .....               | <b>9</b>  |
| <b>9.0</b>  | <b>RECORDS</b> .....                          | <b>10</b> |
| <b>10.0</b> | <b>NOTIFICATION AND REPORTING</b> .....       | <b>10</b> |
|             | <b>REFERENCES</b> .....                       | <b>11</b> |



# 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:  $^{235}\text{U}$ ,  $^{238}\text{U}$ ,  $^{232}\text{Th}$ , 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  $\mu$ 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.

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

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

<sup>b</sup> 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.

| <b>Table 2: Radionuclide Concentration Levels (Artificial Origin)</b> |                                   |                     |                                   |                     |                                   |
|---|-----------------------------------|---------------------|-----------------------------------|---------------------|-----------------------------------|
| <b>Radionuclide</b>   | <b>Concentration Level (Bq/g)</b> | <b>Radionuclide</b> | <b>Concentration Level (Bq/g)</b> | <b>Radionuclide</b> | <b>Concentration Level (Bq/g)</b> |
| 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                                |

| <b>Table 2: Radionuclide Concentration Levels (Artificial Origin)</b> |                                   |                     |                                   |                     |                                   |
|---|-----------------------------------|---------------------|-----------------------------------|---------------------|-----------------------------------|
| <b>Radionuclide</b>   | <b>Concentration Level (Bq/g)</b> | <b>Radionuclide</b> | <b>Concentration Level (Bq/g)</b> | <b>Radionuclide</b> | <b>Concentration Level (Bq/g)</b> |
| 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                                |

| <b>Table 2: Radionuclide Concentration Levels (Artificial Origin)</b> |                                   |                     |                                   |                     |                                   |
|---|-----------------------------------|---------------------|-----------------------------------|---------------------|-----------------------------------|
| <b>Radionuclide</b>   | <b>Concentration Level (Bq/g)</b> | <b>Radionuclide</b> | <b>Concentration Level (Bq/g)</b> | <b>Radionuclide</b> | <b>Concentration Level (Bq/g)</b> |
| 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  $i^{\text{th}}$  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/cm<sup>2</sup>.

## 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 m<sup>3</sup> of material.

For surface contamination, the concentration shall be averaged over a maximum of 1 m<sup>2</sup>.

## 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.