



Radiation Protection and Dosimetry

Discussion Paper DIS-16-02

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Preface

Discussion papers play an important role in the selection and development of the regulatory framework and regulatory program of the Canadian Nuclear Safety Commission (CNSC). They are used to solicit early public feedback on CNSC policies or approaches.

The use of discussion papers early in the regulatory process underlines the CNSC's commitment to a transparent consultation process. The CNSC analyzes and considers preliminary feedback when determining the type and nature of requirements and guidance to issue.

Discussion papers are made available for public comment for a specified period of time. At the end of the first comment period, CNSC staff review all public input, which is then posted for feedback on the CNSC website for a second round of consultation.

The CNSC considers all feedback received from this consultation process in determining its regulatory approach.

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Executive Summary

The purpose of this discussion paper is to solicit feedback on the CNSC's proposal to create two new regulatory documents that will provide CNSC guidance for radiation protection and dosimetry. The new documents would supersede existing CNSC regulatory documentation, ensure guidance is aligned with the [Radiation Protection Regulations](#), and also provide consolidated guidance on dosimetry and radiation protection.

The regulatory documents have the following objectives:

- formally define CNSC guidance for radiation protection and dosimetry
- formally provide guidance for licensees on meeting CNSC requirements for radiation protection and dosimetry
- to align with and provide relevant information to licensees on meeting new requirements resulting from forthcoming amendments to the [Radiation Protection Regulations](#)
- update and consolidate existing CNSC regulatory information on radiation protection and dosimetry where possible

The CNSC identified the need for the regulatory documents based on an analysis of the proposed amendments to the [Radiation Protection Regulations](#), the current CNSC regulatory document framework and regulatory experience gained through 15 years of working with the [Radiation Protection Regulations](#).

The regulatory documents will formally outline CNSC guidance for meeting the regulatory requirements dictated by the [Radiation Protection Regulations](#) on radiation protection and dosimetry. This will be beneficial for CNSC licensees and stakeholders, especially for licensing and compliance verification activities, as CNSC requirements and guidance for radiation protection and dosimetry will be defined, clearly communicated and transparent.

CNSC Documentation on Radiation Protection and Dosimetry

1. Introduction

The CNSC is proposing to create two new regulatory documents that will provide CNSC guidance for radiation protection and dosimetry.

The regulatory documents have the following objectives:

- formally define CNSC guidance for radiation protection and dosimetry
- formally provide guidance for licensees on meeting CNSC requirements for radiation protection and dosimetry
- align with and provide relevant information to licensees for meeting new requirements resulting from forthcoming amendments to the [Radiation Protection Regulations](#)
- update and consolidate existing CNSC regulatory information on radiation protection and dosimetry where possible

The purpose of this discussion paper is to solicit feedback on the proposal to create the new regulatory documents on radiation protection and dosimetry.

2. Background

The CNSC's [Radiation Protection Regulations](#) define the requirements for radiation protection, including the "as low as reasonably achievable" (ALARA) principle, radiation protection programs, ascertaining and recording doses, radiation dose limits, action levels and radiation warning signage.

The CNSC has previously published requirements and guidance on radiation protection related topics, for example:

- G-129, Rev. 1, *Keeping Radiation Exposures and Doses "As Low as Reasonably Achievable (ALARA)"*
- G-228, *Developing and Using Action Levels*
- S-106 Rev. 1, *Technical and Quality Assurance Requirements for Dosimetry Services*

The CNSC has also published guidance on certain aspects of ascertaining doses, for example:

- G-91, *Ascertaining and Recording Radiation Doses to Individuals*
- GD-147, *Radiobioassay Protocols for Responding to Abnormal Intakes of Radionuclides*
- GD-150, *Designing and Implementing a Bioassay Program*

However, there are currently no regulatory documents that consolidate CNSC requirements and guidance for radiation protection and dosimetry. Such documents would benefit new applicants, CNSC licensees, the public and stakeholders, and would ensure clarity and transparency in CNSC licensing and compliance verification activities.

3. Need for Radiation Protection and Dosimetry Regulatory Documents

The CNSC identified the need for radiation protection and dosimetry regulatory documents based on the proposed amendments to the [Radiation Protection Regulations](#), as well as the need to

strengthen current CNSC regulatory documents based on an analysis of regulatory experience identified through 15 years of working with the *Radiation Protection Regulations*.

3.1 Amendments to the *Radiation Protection Regulations*

The CNSC initiated a review and is proceeding with select amendments to the *Radiation Protection Regulations* in light of various developments since they came into force in the year 2000. These activities were driven by the following:

- **Changes to international benchmarks**

In 2007, the [International Commission on Radiological Protection](#) (ICRP) published a revised set of recommendations for its system of radiological protection. These recommendations were published in [ICRP Publication 103](#) (ICRP 103), which incorporates updates based on more recent scientific information as well as new guidance on controlling radiation exposure. The current *Radiation Protection Regulations* are largely based on earlier ICRP recommendations: ICRP Publication 60.

In 2006, the [International Atomic Energy Agency](#) (IAEA) undertook a review and initiated a revision of the 1996 edition of its *Basic Safety Standards*, in cooperation with other organizations. The IAEA published the revised standard in 2014, incorporating the newer ICRP recommendations and other safety-related improvements. These revised international benchmarks need to be reflected in the *Radiation Protection Regulations*.

- **March 2011 nuclear event in Fukushima, Japan**

The nuclear event in Fukushima prompted the CNSC to examine its regulatory framework and identify how to strengthen it, particularly with respect to nuclear emergencies. The CNSC determined that the *Radiation Protection Regulations* need to more fully describe requirements for addressing radiological hazards during an emergency, and has therefore proposed amendments to the regulations.

- **Lessons learned**

Since the *Radiation Protection Regulations* came into force in May 2000, the CNSC has gained more than 15 years of regulatory experience. This has enabled it to identify opportunities to strengthen the regulations and provide additional clarity.

The CNSC issued [DIS-13-01, *Proposals to Amend the Radiation Protection Regulations*](#), for comment on August 9, 2013 for a 120-day period. The discussion paper sought input from stakeholders and the public. Overall, there was broad support for many of the proposals to modernize the *Radiation Protection Regulations*. Support was shown for clarifying the CNSC's regulatory requirements and guidance, updating terminology, and reducing regulatory burden. In contrast, stakeholders expressed concern with some of the proposals, questioning the benefit of the amendment, given the potential administrative and financial burden imposed by the change. There were also suggestions that clarity of requirements could be achieved through the use of CNSC's regulatory documents rather than through regulations.

The CNSC is proceeding with several of the regulatory amendments proposed as described in its recently published [What We Heard Report](#) for DIS-13-01 on October 6, 2015.

3.2 Strengthening existing CNSC documents

G-91, Ascertaining and Recording Radiation Doses to Individuals

Published in June 2003, G-91 is intended to help a CNSC licence applicant or holder to develop a program to ascertain and record radiation exposures and doses in accordance with section 27 of the *Nuclear Safety and Control Act*, section 3 of the [General Nuclear Safety and Control Regulations](#), and sections 5, 7, and 8 of the *Radiation Protection Regulations*.

G-91 provides guidance on methods for direct and indirect (estimates) measurement of exposures and doses, on determining when a licensed dosimetry service must be used, and on recording radiation doses. It also provides some examples of exposure scenarios and monitoring responses.

Although most of the information in G-91 is still relevant, revisions are proposed to provide additional guidance clarifying the interpretation of section 5 (e.g., “direct measurement” and “estimation”) and section 8 (i.e., use of licensed dosimetry services) of the *Radiation Protection Regulations*.

G-121, Radiation Safety in Educational, Medical and Research Institutions

Published in May 2000, G-121 is intended to help educational, medical, and research institutions to design and implement radiation protection programs that meet regulatory requirements.

G-121 provides sound guidance on the framework for radiation protection programs and most of the content remains applicable. However, the document was published by the former Atomic Energy Control Board, and most importantly, since 2000, CNSC regulatory requirements and guidance for radiation protection programs have been refined.

G-129, rev.1, Keeping Radiation Exposures and Doses “As Low as Reasonably Achievable (ALARA)”

Revision 1 of G-129 was published in October 2004, superseding the first publication from September 1997. G-129 provides guidance to assist CNSC-regulated persons, when implementing a radiation protection program, to keep the amount of exposure to radon progeny and the effective dose and equivalent dose received by and committed to persons ALARA, social and economic factors being taken into account.

G-129 provides a sound overview of the ALARA concept and the guidance remains valid today. However, the document could be improved to provide additional guidance for ALARA consistent with current best practices and international recommendations, such as the use of dose constraints as an ALARA tool.

G-147, Radiobioassay Protocols for Responding to Abnormal Intakes of Radionuclides

Published in June 2003, G-147 describes radiobioassay protocols that may be used by CNSC licensees to respond to situations where persons who perform duties in connection with activities authorized by the *Nuclear Safety and Control Act* and regulations may have experienced an abnormal intake of radioactive material. It also provides advice on how to collect and handle radiobioassay samples.

No specific update is currently required on the content of G-147, as it is not dependent on dosimetry or biokinetic models, which are updated from time to time. However, there may be opportunities for improving the content with additional guidance.

GD-150, Designing and Implementing a Bioassay program

Published in May 2010, GD-150 details fundamental concepts for CNSC licensees in determining the need for a bioassay program, selecting participants for the program, and determining the optimal sampling frequency. GD-150 also suggests methods of interpreting and recording results.

GD-150 requires revisions, mainly focused on aligning with current international recommendations such as the ICRP series of publications, “Occupational Intakes of Radionuclides” (OIR). It is also proposed to include radionuclide-specific dose assessment methods (for example, transuranics, uranium, and tritium) for both routine and non-routine exposures. Guidance on dose assessment for intakes of uranium should be included specifically in relation to limiting risks of chemical toxicity due to uranium. This radionuclide-specific content would generally reflect current international recommendations.

G-218, Preparing Codes of Practice to Control Radiation Doses at Uranium Mines and Mills

Published in October 2003, G-218 is intended to help applicants for CNSC uranium mining and milling facility licences to develop codes of practice in accordance with the [Uranium Mines and Mills Regulations](#), for the purpose of controlling radiation doses to workers.

G-218 provides a sound overview of preparing codes of practice, and the majority of the guidance remains valid today. However, the document could be improved to expand upon the concept of codes of practice, and provide more guidance on the development of meaningful action levels consistent with current best practices.

G-228, Developing and Using Action Levels

Published in March 2001, G-228 describes how CNSC licence applicants can develop action levels that provide for the radiation protection of workers and the public during conduct of CNSC-licensed activities.

G-228 provides a sound overview of developing and using action levels, and the majority of the guidance remains valid today. Notwithstanding, the document could be improved to expand upon the concept of action levels and provide more guidance on the development of meaningful action levels consistent with current best practices.

G-313. Radiation Safety Training Programs for Workers Involved in Licensed Activities with Nuclear Substances and Radiation Devices, and with Class II Nuclear Facilities and Prescribed Equipment

Published in July 2006, G-313 describes a method for developing a typical radiation safety training program for workers involved in activities licensed by the CNSC pursuant to the [Nuclear Substances and Radiation Devices Regulations](#) and [Class II Nuclear Facilities and Prescribed Equipment Regulations](#).

With the publication of REGDOC-2.2.2: *Personnel Training* in August 2014, most of the training program content within G-313 is deemed to be redundant. However, G-313 still identifies

categories of workers, and training topic areas (skills and knowledge) that may be considered during the development of licensees' radiation protection training programs, and these topic areas could be included in the new radiation protection regulatory document.

GD-314, Radiation Protection Programs for the Transport of Nuclear Substances

Published in February 2012, GD-314 describes a typical radiation protection program that carriers of nuclear substances can implement to comply with the requirements of the [Packaging and Transport of Nuclear Substances Regulations](#). The document is intended to assist carriers who are regulated under the [Nuclear Safety and Control Act](#) but are not licensed by the CNSC. As such, the content of GD-314 will be consolidated in the Packaging and Transport regulatory document.

RD-58, Thyroid Screening for Radioiodine

Published in July 2008, RD-58 describes the recommended elements of an effective thyroid screening program for volatile radioiodines. It includes recommendations for selecting participants in the screening program, instrument selection, the screening method, monitoring periods, interpretation of results, validation of procedures, and record keeping.

The document focuses on presenting the technical basis for licensees who are required to monitor workers for intakes of radioiodines. Revisions should be made based on the recommendations of the OIR series of ICRP documents.

S-106, rev. 1, Technical and Quality Assurance Requirements for Dosimetry Services

Published in May 2006, S-106 revision 1 superseded the first publication in 1998. S-106 sets out the technical and quality assurance requirements that a licensed dosimetry service must meet when referenced in a dosimetry licence.

A number of improvements are proposed to S-106 revision 1. New performance criteria for bioassay have recently been published by the American National Standards Institute in 2011, which the CNSC is proposing as a replacement for existing performance criteria for independent tests in S-106, rev. 1. In addition, clarifications regarding CNSC expectations with respect to quality assurance programs for licensed dosimetry services are proposed to be included in the REGDOC on dosimetry.

S-260, Making Changes to Dose-Related Information Filed With the National Dose Registry

Published in October 2004, S-260 sets out the requirements to be met by CNSC licensees, including the process to be followed and the information to be provided to the CNSC and workers, when seeking CNSC approval of proposed changes to dose-related information previously filed with the National Dose Registry of Health Canada.

S-260 requires revisions as it currently does not address "mass changes" to dose records. The document could be improved by adding guidance related to aspects of dose changes that are not currently addressed, such as the addition of a dose record (as opposed to a change to an existing record) and service standards for the dosimetry service to make the related dose changes.

For this section on “Strengthening existing CNSC documents”, the CNSC would like to hear:

- comments on the CNSC’s assessment of each existing documentation for inclusion in the regulatory documents and the proposed updates
- comments on other existing CNSC documentation that should be considered for inclusion in the regulatory documents

3.3 Improvement opportunities identified through regulatory experience

The CNSC has gained 15 years of regulatory experience with the [Radiation Protection Regulations](#). This has enabled it to identify the need for formal regulatory guidance in several areas, including the following topics:

- radiation protection program design and associated processes
- calibration and maintenance of radiation protection equipment and instrumentation
- radiation dose rate and contamination control programs
- ascertaining radiation doses to workers, when no licensed dosimetry service is utilized
- use of monitoring results from direct reading dosimeters
- dose calculation methods for skin contamination, multiple badging and non-uniform exposures
- radionuclide-specific methods for internal dosimetry (for example, dose assessment for transuranics, uranium compounds, and tritium)
- ascertaining the equivalent dose to the lens of the eye
- methods for monitoring neutron exposures
- controlling intakes of radionuclides by workers who are breastfeeding infants
- use of radiation personal protective equipment and respiratory protection

For this section on “Improvement opportunities identified through regulatory experience”, the CNSC would like to hear comments on the proposed topics listed, and if additional guidance topics should be considered.

4. Proposed Content of Radiation Protection and Dosimetry Regulatory Documents

The proposed content of the radiation protection and dosimetry regulatory documents will be a combination of the integration of existing CNSC content, as well as new content not previously formally published by the CNSC.

Proposed table of contents for the regulatory documents are provided in Appendix A of this discussion paper.

4.1 Integrate existing content

The proposed radiation protection regulatory document will integrate existing published CNSC content on the following topics:

- Content from CNSC’s G-129, rev. 1 will be adopted and refined to provide guidance on the framework for radiation protection including the application of the ALARA principle

- CNSC guidance for radiation protection programs required by section 4 of the [Radiation Protection Regulations](#) will be established and aligned with content on radiation protection programs from CNSC’s RD/GD-369, *Licence Application Guide: Licence to Construct a Nuclear Power Plant* (section 11) and G-121
- Content from CNSC’s G-218 on guidance for developing and using codes of practice for uranium mines and mills will be adopted and refined
- Content from G-228 on guidance for developing and using action levels will be adopted and refined
- Content from G-313 on categories of workers and corresponding radiation protection training topic areas (skills and knowledge) will be adopted and refined
- CNSC guidance for principles of worker dose control will be established and aligned with CNSC’s G-91, RD-58, G-121, G-147, G-150, and RD/GD-369 (section 11)
- CNSC guidance for principles of radiological hazard control will be established and aligned with CNSC’s G-121, RD/GD-369 (section 11), REGDOC-2.5.2, and RD-367

The objective of the proposed Dosimetry REGDOC will be to integrate existing published CNSC content on the following topics:

- Content from G-91 will include the interpretation of section 5 of the [Radiation Protection Regulations](#) (e.g. “direct measurement” and “estimation”), and section 8 of the [Radiation Protection Regulations](#) (when a licensed dosimetry service must be used to ascertain workers’ doses)
- Most of the content of RD-58 will be included, with changes reflecting the updates described in section 3.2 of this discussion paper
- Guidance on ascertaining doses from intakes of radionuclides will be aligned with GD-150 and G-147
- S-106 Rev. 1 will be incorporated, with changes reflecting the updates described in section 3.2 of the discussion paper
- S-260 will be incorporated, with changes reflecting the updates described in section 3.2 of the discussion paper

For this section on “Integrate existing content”, the CNSC would like to hear:

- comments on the content to be integrated into the proposed regulatory documents
- comments on additional content that should be integrated into the proposed regulatory documents

4.2 New content

The proposed radiation protection and dosimetry regulatory documents will establish and formally define CNSC guidance on the following topics, which are not included in existing documents:

- Provide guidance for new requirements stemming from the amendments to the [Radiation Protection Regulations](#):
 - limiting intakes of radionuclides by workers who are breastfeeding infants
 - use of licensed dosimetry services for annual doses to extremities greater than 50 mSv
 - radiation protection equipment and instrumentation
- Provide guidance for radiation protection programs required by section 4 of the [Radiation Protection Regulations](#)

- Provide guidance for principles of worker dose control. Topics will include ascertaining and recording radiation doses, dose control devices (i.e. direct reading dosimeters), nuclear energy worker classifications, radiation work planning, bioassays, respiratory protection programs, radiation personal protective equipment, emergency situations, and external and internal personal contamination
- Provide guidance for ascertaining and recording the equivalent dose to the lens of the eye and methods to afford worker protection with regard to the lens of the eye
- Provide guidance for principles of radiological hazard control. Topics will include engineered controls/design for radiation protection, radiation dose rate monitoring and control, radioactive contamination monitoring and control, airborne radioactivity monitoring and control, and classification of areas and zoning
- Provide guidance on methods for monitoring for neutron exposures
- Provide guidance on the use of certain dosimetry types that are not typically part of a licensed dosimetry service to ascertain worker dose
- Provide guidance on the wearing of multiple external dosimeters by a single individual (i.e. multiple badging)
- Provide guidance on ascertaining the equivalent dose to the skin as a result of nuclear substances deposited on or absorbed in the skin (i.e. skin contamination)

For this section on “New content”, the CNSC would like to hear:

- comments on the new content proposed to be included in the regulatory documents
- comments on any additional topics that should be included in the regulatory documents

5. Impact of proposed changes

The radiation protection and dosimetry regulatory documents will formally outline CNSC guidance for achieving the regulatory requirements dictated by the *Radiation Protection Regulations* on radiation protection and dosimetry. This will be beneficial for CNSC licensees and stakeholders, especially for licensing and compliance verification activities, as CNSC requirements and guidance for radiation protection and dosimetry will be defined, clearly communicated and transparent.

Radiation protection is not a new concept. Every CNSC licensee must implement a radiation protection program as required by Regulation. CNSC requirements for radiation protection in licensing and compliance activities have been consistently applied over the years; however, there is no consolidated and CNSC-endorsed regulatory instrument which sets out CNSC guidance for radiation protection. With amendments to the [Radiation Protection Regulations](#) forthcoming, it is an opportune time to consolidate and update the CNSC’s suite of documentation on radiation protection and dosimetry.

Overall, the proposed methods for ascertaining dose are expected to be generally consistent with the methods currently used. The main differences between current methods and those recommended in the dosimetry regulatory document will consist of changes related to revisions of ICRP dosimetric and biokinetic models, as presented in the ICRP OIR series of documents and ascertaining equivalent doses to the lens of the eye.

5.1 Operational and administrative burden

The radiation protection and dosimetry regulatory documents are not expected to introduce large operational or administrative burdens for CNSC licensees. However, with the forthcoming amendments to the *Radiation Protection Regulations*, every licensee will be required to conduct a review of their radiation protection programs to ensure they align with new and revised regulatory requirements. These regulatory documents will be available to assist CNSC licensees during this review of their programs to ensure that CNSC requirements will be met.

For this section on “Impact of proposed changes”, the CNSC would like feedback on additional or reduced regulatory burden that may be associated with the proposed new regulatory documents.

6. Implementation

The CNSC is committed to developing a practical implementation strategy using a risk based graded approach for all licensees, and as such, anticipates a phased implementation of the radiation protection and dosimetry regulatory documents, once published.

It is anticipated that the regulatory documents will be incorporated in CNSC licences or other legally enforceable instrument (e.g., licence condition handbooks) upon which the documents will serve as tools for CNSC regulatory licensing and compliance activities.

For this section on “Implementation”, the CNSC would like feedback on implementation challenges that may be associated with the proposed new regulatory documents.

7. Stakeholder Feedback on the Radiation Protection and Dosimetry Regulatory Documents

The CNSC actively encourages the nuclear industry, other stakeholders and the public to voice their views on the proposed radiation protection and dosimetry regulatory documents. Specifically, the CNSC is seeking feedback on the following:

- appropriateness of proposed content for the regulatory documents, as described in the preceding sections and as presented in Appendix A
- additional content for the regulatory documents not described in the preceding sections or as presented in Appendix A
- feedback on implementation challenges associated with the regulatory documents

8. How to Participate

Please submit your comments or feedback to:

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Please indicate clearly which discussion paper you are commenting on.

Appendix A: Proposed Table of Contents for Radiation Protection and Dosimetry Regulatory Documents

A.1 REGDOC-2.7.1, *Radiation Protection*

Introduction

Purpose

Scope

Objectives

Relevant legislation

Principles of Radiation Protection

Justification

Limitation

Optimization

Application of the ALARA Principle

Social and economic factors

Approach to ALARA

Judgment of reasonableness

Dose constraints

Management Control Over Work Practices

Organization and Administration for Radiation Protection

Radiation Protection Training and Qualification

Quality Management of Radiation Protection Program

Radiation Protection Performance Objectives, Monitoring and Trending

Classification of Workers:

Nuclear energy workers (NEWs)

 Pregnant NEWs

 Breastfeeding NEWs

 Provision of information to NEWs

Non-NEWs

 Provision of information to non-NEWs

Control of Radiation Exposures and Doses

 Monitoring radiation exposures and doses

Dosimetry

Passive

Real-time (Dose control devices)

Bioassay programs

Radiation dose limits

Effective dose limits

Equivalent dose limits

Emergency dose limits

Exceedances of dose limits

Authorizations of return to work

Action levels

Developing action levels

Monitoring action levels

Responding to action level exceedances

Codes of practice at uranium mines and mills

Radiation work planning

Radiological personal protective equipment

Respiratory protection for airborne nuclear substances

Emergency situations

Control of Radiological Hazards

Design features/engineered controls for radiation protection

Shielding

Ventilation

Dust control

Radiological hazard characterization

Classification of areas and access control

Posting of radiation warning signs

Labelling of containers and devices containing nuclear substances

Radiation dose rate monitoring and control

Radioactive contamination monitoring and control

Airborne radioactivity monitoring and control

Radiation protection equipment and instrumentation

Clearance of persons and materials from regulatory control

A.2 REGDOC-2.7.2, *Dosimetry*

Introduction

- Purpose
- Scope
- Relevant regulations
- National and international standards

Requirements for Licensed Dosimetry Services

- Technical requirements
- Dosimetry services for external radiation
- Dosimetry services for internal radiation
- Dosimetry services for radon progeny and radon gas
- Dosimetry services for intakes of airborne radioactive material
- Quality assurance requirements

Ascertaining Dose Without a Dosimetry Service Licence

- Elements of a program to ascertain doses to workers
- Characterization of radiological conditions
- Selection of appropriate dosimetry methods
- Selection of workers for dose assessment
- Submitting doses to the National Dose Registry
- Quality assurance

Specific Issues Related to the Design of a Dosimetry Program

External dosimetry

- The use of monitoring results from personal alarming dosimeters
- Skin contamination
- Multiple badging

Internal dosimetry

General recommendations related to bioassay measurements and internal dose calculations for:

- Intakes of transuranics (alpha emitters)
- Uranium compounds
- Tritium
- Radioiodines
- Mixed fission and activation products

Air monitoring to ascertain worker dose

Limiting intakes of radionuclides by workers who are breastfeeding infants

Ascertaining the dose resulting from an intake of nuclear substances via a wound