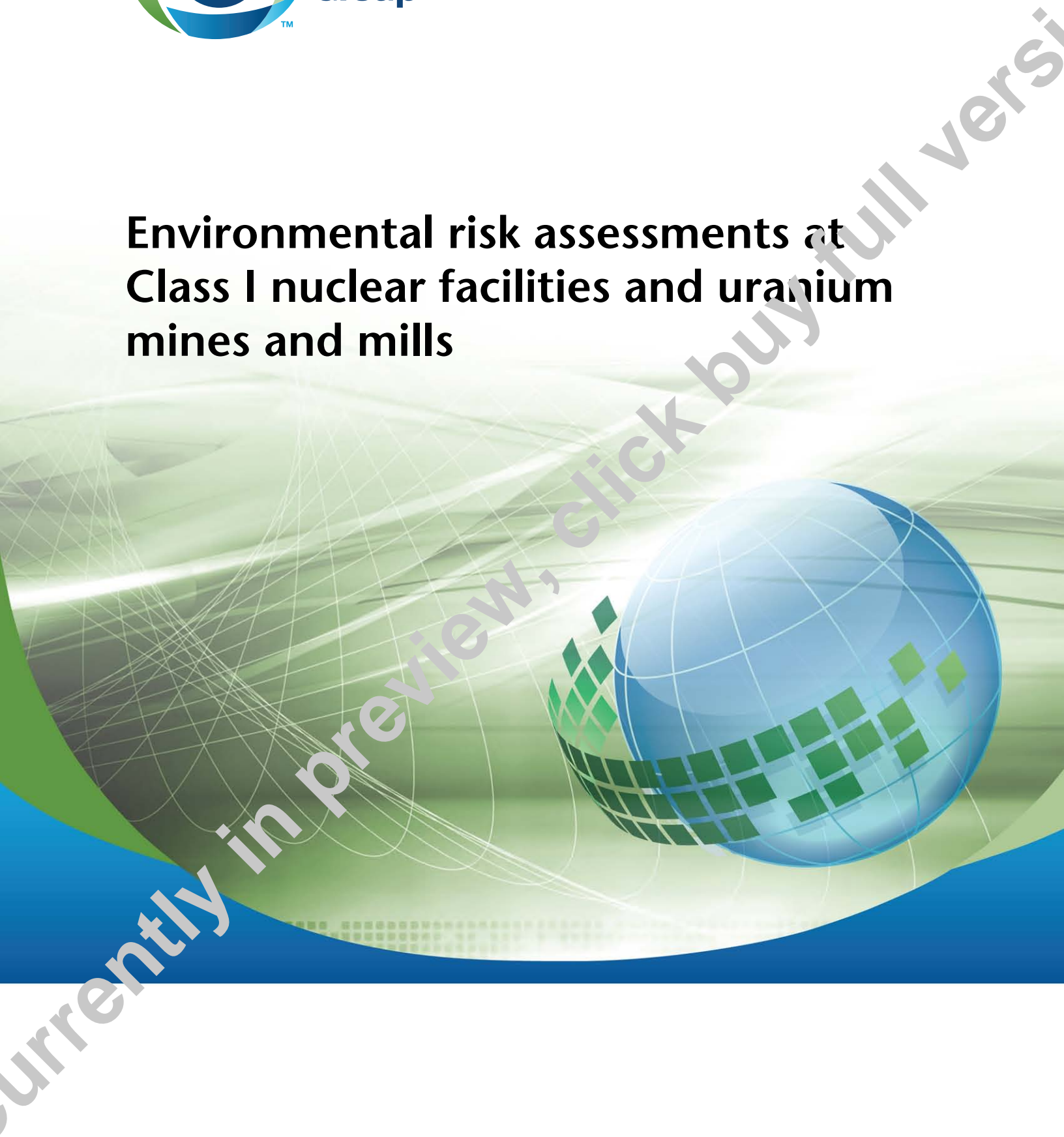




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N288.6-12

Environmental risk assessments at Class I nuclear facilities and uranium mines and mills



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Preface

This is the first edition of CSA N288.6, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*. It is part of the CSA N288 series of Standards and guidelines on environmental management of nuclear facilities.

The CSA N series of Standards provides an interlinked set of requirements for the management of nuclear facilities and activities. CSA N286-05 (R2010), *Management system requirements for nuclear power plants*, provides overall direction to management to develop and implement sound management practices and controls, while the other CSA nuclear Standards provide specific technical requirements and guidance that support the management system. This Standard, which addresses the design, implementation, and management of an environmental risk assessment program that incorporates best practices used in Canada and internationally, works in harmony with CSA N286 and does not duplicate the generic requirements of CSA N286; however, it may provide more specific direction for those requirements.

Users of this Standard are reminded that additional and site-specific requirements might be specified by federal, provincial/territorial, or municipal authorities. This Standard should not be considered a replacement for the requirements contained in any

- (a) applicable federal or provincial/territorial statute, including the *Nuclear Safety and Control Act*; or
- (b) regulation, licence, or permit issued pursuant to an applicable statute.

This Standard was prepared by the Subcommittee on Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills, under the jurisdiction of the Technical Committee on Environmental Management for Nuclear Facilities and the Nuclear Strategic Steering Committee, and has been formally approved by the Technical Committee.

Notes:

- (1) Use of the singular does not exclude the plural (and vice versa) when the sense allows.
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N288.6-12

Environmental risk assessments at Class I nuclear facilities and uranium mines and mills

0 Introduction

0.1 Environmental risk assessment

0.1.1 General

0.1.1.1

Environmental risk assessment (ERA) of nuclear facilities is a systematic process used to identify, quantify, and characterize the risk posed by contaminants and physical stressors in the environment on biological receptors, including the magnitude and extent of the potential effects associated with a facility. Receptors should include humans as well as non-human biota (see [Clause 0.5.3](#)). Human receptors are addressed through a human health risk assessment (HHRA) and non-human biota are addressed through an ecological risk assessment (EcoRA).

0.1.1.2

An ERA should

- (a) identify and prioritize the contaminants and physical stressors of concern;
- (b) identify and prioritize the sources or points of release of the contaminants and physical stressors of concern;
- (c) identify and prioritize the potential receptors (human and non-human biota) of concern;
- (d) include a conceptual model of the environment representing the relationship between sources and receptors;
- (e) provide an assessment of the exposure to the contaminants and physical stressors of concern (to be used with the benchmark value [BV] to assess the risk);
- (f) identify the BVs used to assess the potential effects of the contaminants and physical stressors of concern on the receptors;
- (g) provide an assessment of the environmental risk to receptors posed by the facility; and
- (h) identify and, if possible, quantify the uncertainties in the assessment of the environmental risk.

0.1.1.3

The ERA approach takes into consideration the fact that many contaminants can be present simultaneously in several media such as food, air, water, soil, dust, or consumer products and that they can reach the receptors through multiple exposure pathways. An ERA can have both predictive and retrospective elements (as defined in [Clause 3.1](#)).

0.1.2 Need for an ERA

The need to conduct an ERA arises from one or more of the following factors:

- (a) a desire for risk-based environmental management;
- (b) a desire to address stakeholder concerns about environmental protection; and
- (c) regulatory requirements for characterization of environmental risks.

0.1.3 Human health risk assessment

0.1.3.1

Human health risk assessment (HHRA) focuses on the identification, quantification, and characterization of the risks to individual human receptors resulting from exposure to contaminants and physical stressors released into the environment throughout the lifecycle of a nuclear facility. An HHRA can be completed as a component of an ERA or as a stand-alone assessment.

0.1.3.2

The objectives of an HHRA are to evaluate the risks to relevant human receptors resulting from exposure to contaminants and stressors related to a site and its activities. Based on the results of the HHRA, further assessment and possible further action might be deemed necessary.

0.1.4 Ecological risk assessment

0.1.4.1

Ecological risk assessment (EcoRA) focuses on the identification, quantification, and characterization of the risks to ecological receptors resulting from exposure to contaminants and stressors released into the environment throughout the lifecycle of a nuclear facility. Ecological receptors can include non-human biota at the individual, population, or community level (see [Clause 7.2.3](#)). An EcoRA can be completed as a component of an ERA or as a stand-alone assessment.

0.1.4.2

The objectives of an EcoRA are to evaluate the risks to relevant ecological receptors resulting from exposure to contaminants and stressors related to a site and its activities. Based on the results of the EcoRA, further assessment and possible further action might be deemed necessary.

0.1.5 Risk-based recommendations

The end product of an ERA is a determination of the risk to human and non-human biota. This end product is the basis for risk-informed recommendations (e.g., risk control actions or remediation). The end product can also inform recommendations about monitoring to reduce uncertainty in the risk estimation. However, this Standard does not provide guidance on monitoring programs or risk management decisions.

0.2 Relationship to monitoring programs

0.2.1 General

ERAs provide the basis for the scope and complexity of monitoring programs, including effluent and environmental monitoring programs. Effluent monitoring programs and environmental monitoring programs are covered by CSA N288.5 and CSA N288.4, respectively.

0.2.2 Effluent monitoring programs

An ERA can provide input into an effluent monitoring program by identifying and prioritizing the specific radioactive and non-radioactive contaminants and physical stressors and the sources or release points from the nuclear facility or licensed activity. An ERA can contribute to the development of effluent objectives that can be the focus of monitoring programs. The effluent monitoring program can inform the ERA by providing the effluent characteristics used in estimating environmental exposure concentrations of contaminants.

Note: Non-radioactive contaminants include for example toxic, corrosive, or environmentally deleterious substances.

0.2.3 Environmental monitoring programs

The decision criteria for the scope and complexity of an environmental monitoring program (EMP) necessitate an understanding of the environmental risk posed by the facility (see CSA N288.4). The results of the ERA can be used to identify monitoring requirements for normal operating conditions (as defined in [Clause 3.1](#)). The EMP can inform the ERA by providing the data on contaminant and receptor distribution for use in calibrating and validating the ERA models.

0.3 Relationship to environmental assessment

The ERA can be part of an environmental assessment (EA) report or any other document that contains the required information. An ERA is usually triggered during the EA process.

Note: All references to ERAs in this Standard are intended to refer to any document that contains the required information.

0.4 Levels of complexity

The nature and complexity of ERAs will vary according to the nature and complexity of the subject (site, scenario, magnitude, facility, etc.). An ERA should follow a tiered approach starting from a broad evaluation using protective generic parameters and a high degree of conservatism and advancing towards more precise analysis involving site-specific, realistic parameters and less conservatism. Such a tiered approach facilitates early identification of potential issues. Lower-tier assessments are the least detailed. More detailed or higher-tier assessments may be conducted to determine whether an issue originates from overly conservative assumptions or parameters or is indicative of potential effects.

0.5 Basic concepts

0.5.1 Radiation dose limits

0.5.1.1 Dose limits for humans

Dose limits are radiation dose criteria set by regulatory agencies. In Canada, dose limits for members of the public and nuclear energy workers (NEWs) are set by the Canadian Nuclear Safety Commission (CNSC). Dose limits set by the CNSC are regulatory requirements and cannot be exceeded. For detailed information on radiation dose limits used in HHRAs, see [Clause 6.4.5](#).

0.5.1.2 Dose limits for non-human biota

Currently, dose limits for non-human biota have not been set by the CNSC or other regulatory agencies in Canada. Various organizations such as the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), National Council on Radiation Protection and Measurements (NCRP), and Advisory Committee on Radiological Protection (ACRP) have recommended dose benchmarks for categories of non-human biota. For detailed information on radiation dose benchmarks recommended for use in EcoRAs, see [Clause 7.4.2](#).

0.5.2 Benchmark values

A BV is a level of exposure (concentration or dose) below which meaningful effects are unlikely and above which there is a potential for meaningful effects. BVs exist for exposure to radiological and non-radiological contaminants and physical stressors. These values are often derived by evaluating laboratory studies, exposure investigations, epidemiological studies, and other sources of information. EcoRA benchmark values are referred to as BVs while HHRA benchmark values are referred to as toxicity reference values (TRVs). For detailed information on TRVs used in HHRAs, see [Clause 6.4.4](#). For detailed information on BVs used in EcoRAs, see [Clause 7.4.3](#).

0.5.3 Receptors

0.5.3.1 Human receptors

Human receptors are individuals who can, in some manner, be exposed to contaminants or physical stressors. Human receptors are described or characterized using numerical values referred to as exposure factors (see [Clause 6.3.5.2](#)). Individuals who form a homogeneous group with respect to exposure factors can be grouped together. An individual with characteristics that reflect those of the group is known as the “representative person” (see CSA N288.1). For detailed information, see [Clause 6.2.3](#).

0.5.3.2 Ecological receptors

In this Standard, ecological receptors are biological entities that can be exposed to contaminants or physical stressors and can be subject to the resulting effects. Ecological receptors can be indicator species used to represent valued ecosystem components (VECs) in an EA. The selection of ecological receptors requires knowledge of the site ecology. Such knowledge is generally obtained from observations of the species and habitats present in the areas and can be facilitated by consultation with local stakeholders. The use of representative and indicator species helps focus the ERA; it is not practical or necessary to assess all of the species present in the environment. A subset of species (i.e., representative receptors) that represent the main exposure pathways, habitats, feeding habits, etc. may be chosen. This subset should include the species with the highest exposures or greatest sensitivity. Protection of the selected species should provide reasonable assurance that all species are protected. For detailed information, see [Clause 7.2.3](#).

0.5.4 Conceptual models

Conceptual models are descriptive tools used to succinctly describe the relationship between contaminants/physical stressors and receptors, emphasizing the pathways through which exposure will occur. Conceptual models provide a blueprint for the subsequent exposure assessment and risk characterization. Formats for conceptual models are not prescribed since their level of detail and complexity should be commensurate with the complexity of the site, scenario, or project.

Conceptual models are described in [Clause 6.2.7](#) for HHRAs and [Clause 7.2.7](#) for EcoRAs and sample portions of the conceptual site model section of an ERA are provided in [Annex E](#). Site-specific conceptual models should be prepared during the problem formulation phase of the ERA.

Conceptual models rely on graphics, figures, tables, maps, and descriptive text, singly or in combination (as appropriate), to convey information related to

- (a) the identified receptors;
- (b) the identified contaminants and physical stressors (including the release source and release mechanism);
- (c) the exposure pathways (including fate and transport pathways); and
- (d) other characteristics of the exposure setting that the risk assessor deems necessary.

Notes:

- (1) *Contaminants should include radiological progeny and chemical degradation products that are likely to occur at a location given the exposure scenario and timeframe for ingrowth and accumulation in each medium.*
- (2) *Decay chains that are considered relevant to a location, exposure scenario, and timeframe should be addressed.*

0.5.5 Assessment and measurement endpoints

0.5.5.1 Human health risk assessment endpoints

For HHRAs, the assessment endpoint is no meaningful effects on human individuals. This endpoint is often firmly described by regulatory limits and procedures. HHRAs calculate risks to human individuals, not risks to human populations. As a result, there is no need to relate measurement endpoints at the individual level to assessment endpoints at the population level.

0.5.5.2 Ecological risk assessment endpoints

For EcoRAs, endpoints are explicit expressions of the environmental values that environmental managers wish to protect. The assessment endpoints are directly related to management goals but are usually stated in terms of the attributes of populations and communities. However, it is not always practical to quantify those attributes, in which case more readily measured or predicted surrogates, called measurement endpoints, may be selected.

Note: For example, the environmental value to be protected might be “game fishing,” the assessment endpoint might be “probability that game fish populations will be reduced,” and the measurement endpoint might be “percentage mortality of game fish in exposed habitats”.

1 Scope

1.1 Facilities

1.1.1 Types of facilities

1.1.1.1

This Standard addresses ERAs for Class I nuclear facilities and uranium mines and mills. These facilities include

- (a) nuclear reactors;
- (b) uranium mines, mills, refineries, and conversion plants;
- (c) uranium fuel fabrication plants;
- (d) isotope processing facilities;
- (e) particle accelerators with a beam energy equal to or greater than 50 MeV; and
- (f) waste management facilities.

Note: In this Standard, all of these facilities are included in the term “nuclear facilities”.

1.1.1.2

Parts of this Standard might also be relevant to ERAs for other facilities such as

- (a) Class II nuclear facilities;
- (b) institutions operating under the authority of a Nuclear Substances and Radiation Devices licence; and
- (c) facilities that use or store naturally occurring radioactive materials.

However, in these cases, the holder of the facility licence is responsible for determining the applicability and suitability of this Standard.

1.1.2 Facility lifecycle

The nature and extent of an ERA will change during the lifecycle of the facility. This Standard addresses ERAs performed during

- (a) site preparation, construction, and commissioning;
- (b) operations;
- (c) refurbishment or restarting after a prolonged shut-down; and
- (d) decommissioning.

1.2 Operating conditions

The ERA process described in this Standard is applicable where human and/or non-human biota might routinely be exposed to

- (a) low-level emissions of nuclear and hazardous substances released to the environment as a result of the normal operation (as defined in Clause 3.1) of a nuclear facility; or
- (b) physical stressors imposed on the environment as a result of the normal operation of a nuclear facility.