Canada's Nuclear Regulator

Environmental Protection

Controlling Releases to the Environment

REGDOC-2.9.2

March 2021

DRAFT

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Canada

Environmental Protection: Controlling Releases to the Environment
Regulatory document REGDOC-2.9.2

Cat. No. NNNNN
ISBN NNNNN

Également publié en français sous le titre : Contrôle des rejets dans l'environnement

Document availability
This document can be viewed on the CNSC website. To request a copy of the document in English or French, please contact:

Canadian Nuclear Safety Commission
280 Slater Street
P.O. Box 1046, Station B
Ottawa, Ontario K1P 5S9
Canada

Tel.: 613-995-5894 or 1-800-668-5284 (in Canada only)
Fax: 613-995-5086
Email: cnsc.information.ccsn@canada.ca
Website: nuclearsafety.gc.ca
Facebook: facebook.com/CanadianNuclearSafetyCommission
YouTube: youtube.com/cnscccsn
Twitter: @CNSC_CCSN
LinkedIn: linkedin.com/company/cnsc-ccsn

Publishing history
[Month year] Version x.0

Preface

This regulatory document is part of the CNSC's environmental protection series of regulatory documents, which also covers environmental principles, assessments and protection measures. The full list of regulatory document series is included at the end of this document and can also be found on the CNSC Website.

Regulatory document REGDOC-2.9.2, *Controlling Releases to the Environment*, sets out the CNSC's requirements and guidance for controlling releases to the environment, through:

- applying the concept of best available technology and techniques, economically achievable (BATEA)
- establishing and implementing licensed release limits and action levels for releases to the environment
- commissioning a treatment system and confirming performance
- implementing adaptive management where required

This is the first published version of this regulatory document. It is meant to be used in conjunction with REGDOC-2.9.1, *Environmental Principles, Assessments and Protection Measures*, previously published by the CNSC.

Environmental protection for nuclear facilities and activities is done in accordance with the *Nuclear Safety and Control Act* and the regulations made under it. The CNSC requires the environmental effects of all nuclear facilities or activities to be considered and evaluated when licensing decisions are made.

CNSC staff will use these documents to assess the environmental protection measures for licence applications for proposed new nuclear facilities or activities, licence applications for licence renewals and amendments for existing facilities or activities (renewals and amendments), and environmental protection measures. For existing facilities and activities, this document will also be used to assess a licensee's environmental protection measures when an unreasonable risk has been identified and adaptive management is required.

Early engagement with CNSC staff is encouraged for facilities or activities with potential interactions with the environment or for applicants uncertain as to their facility's or activity's potential for interaction with the environment. CNSC staff can provide facility- or activity-specific guidance to assist applicants and licensees.

For information on the implementation of regulatory documents and on the graded approach, see REGDOC-3.5.3, *Regulatory Fundamentals*.

The words "shall" and "must" are used to express requirements to be satisfied by the licensee or licence applicant. "Should" is used to express guidance or that which is advised. "May" is used to express an option or that which is advised or permissible within the limits of this regulatory document. "Can" is used to express possibility or capability.

Nothing contained in this document is to be construed as relieving any licensee from any other pertinent requirements. It is the licensee's responsibility to identify and comply with all applicable regulations and licence conditions.

Table of Contents

Controlling Releases to the Environment

1. Introduction

1.1 Purpose

Environmental protection for nuclear facilities and activities is done in accordance with the *Nuclear Safety and Control Act* (NSCA) and the regulations made under it. This legislation includes provisions to ensure that licensees are meeting the CNSC's mandate to protect the environment and the health, safety and security of persons. The CNSC requires the environmental effects of all nuclear facilities or activities to be considered and evaluated when licensing decisions are made.

This regulatory document describes the CNSC's requirements and guidance to applicants and licensees for controlling releases to the environment, through:

- applying the concept of best available technology and techniques, economically achievable (BATEA)
- implementing licensed release limits and action levels for releases to the environment
- commissioning a treatment system and confirming performance
- implementing adaptive management where required

1.2 Scope

This document applies to nuclear facilities or activities that, under normal operation, release or intend to release nuclear substances or hazardous substances to the environment, either through direct releases to air, surface water, sewer, or through the ground, including where natural or engineered barriers for control are proposed or incorporated and require control.

This document is meant to be used in conjunction with REGDOC-2.9.1, *Environmental Principles, Assessments and Protection Measures* [1]:

- applicants and licensees will use these documents:
  - to develop/revise their environmental protection measures for normal operation
  - for existing facilities and activities, to develop additional environmental protection measures when adaptive management is required
- CNSC staff will use these documents to assess the environmental protection measures:
  - for proposed new nuclear facilities or activities
  - for licence renewals and amendments for existing facilities or activities
  - for existing facilities and activities, when an unreasonable risk has been identified and adaptive management is required

The CSA Group standards that are referenced in this regulatory document and in REGDOC-2.9.1 [1] apply to Class I nuclear facilities and uranium mines and mills. For facilities or activities other than Class I nuclear facilities and uranium mines and mills, the CNSC reviews every licence application to verify that there are no significant interactions with the environment (for example, for most Class II facilities, such as hospitals and universities, and for the use and

transport of nuclear substances and radiation devices, there is no interaction with the environment).

If the CNSC's review of the application determines that the facility or activity has potential interactions with the environment and that additional consideration of environmental protection measures is warranted, the information in this document may be applied in a graded manner. The applicant or licensee may demonstrate they meet the intent of this regulatory document as follows:

- for the control of nuclear substances, by comparing the proposed maximum quantities and concentrations to be released to the environment associated with the design of the facility or activity under normal operation:
  - to the exemption criteria or unconditional clearance levels specified under the *Nuclear Substances and Radiation Devices Regulations*, or
  - to the generic conditional clearance levels (CCLs) specified in appendix A
    - for each radionuclide that exceeds the generic CCLs, the CNSC may establish practice-specific CCLs that are applicable to the type of facility or activity
    - for any radionuclide where the proposed maximum release is below the applicable CCLs (either generic or practice-specific), the CCLs are applied as the licensed release limits
    - for any radionuclide where the proposed maximum release exceeds the CCLs (generic or practice-specific), the information in this document shall be applied
- for the control of hazardous substances, by comparing the proposed maximum quantities and concentrations to be released to the environment associated with the design of the facility or activity under normal operation:
  - to federal, provincial, territorial or municipal environmental quality guidelines
  - where any proposed maximum release exceeds the environmental quality guidelines, the information in this document shall be applied

If the CNSC's review of the application determines that the facility or activity does not interact with the environment, then only the CNSC's guiding principles for environmental protection (see REGDOC-2.9.1 [1]) are relevant as guidance for such facilities or activities

Appendix A provides additional information on generic and practice-specific CCLs.

Early engagement with CNSC staff is encouraged for facilities or activities with potential interactions with the environment or for applicants uncertain as to their facility's or activity's potential for interaction with the environment. CNSC staff can provide facility- or activity-specific guidance to assist applicants and licensees.

Note 1: This regulatory document does not address the management of spills, fugitive emissions or uncontrolled releases.

Note 2: The intent of these requirements is not to replace or duplicate requirements in other federal, provincial, territorial or municipal legislation with which licensees must comply. Where applicable, meeting the existing legislative requirements may be adequate for meeting the requirements of this regulatory document.

1.3 Relevant legislation

The following provisions of the NSCA and the regulations made under it are relevant to this document:

- NSCA:
  - subsection 24(4)
  - subsection 24(5)

- *General Nuclear Safety and Control Regulations*:
  - paragraph 3(1)(f)
  - paragraphs 12(1)(c) and (f)

- *Class I Nuclear Facilities Regulations*:
  - paragraphs 3(e), (g), (h) and (j)
  - paragraphs 4(b), (c) and (e)
  - paragraphs 5(b), (i), (j) and (k)
  - paragraphs 6(h), (i), (j) and (k)
  - paragraphs 7(e), (f), (g), (h), (i) and (k)
  - paragraph 8(b)

- *Class II Nuclear Facilities and Prescribed Equipment Regulations*:
  - paragraph 3(p)
  - paragraphs 5(e), (f), (h) and (i)

- *Radiation Protection Regulations*:
  - paragraphs 4(a) and (b)
  - subsections 6(1) and (2)
  - subsection 13(1)

- *Nuclear Substances and Radiation Devices Regulations*:
  - paragraphs 3(1)(b), (g) and (i)
  - paragraph 12(1)(k)

- *Uranium Mines and Mills Regulations*:
  - subparagraph 3(a)(v)
  - subparagraphs 3(c)(ii), (iii), (v), (vi), (vii), (viii), (ix) and (x)
  - subparagraphs 3(d)(i) and (vi)

The CNSC also considers pertinent legislation from other government departments, including:

- *Impact Assessment Act*
- *Canadian Environmental Assessment Act, 2012*
- *Canadian Environmental Protection Act, 1999*
- *Fisheries Act*
- *Species at Risk Act*
- *Migratory Birds Convention Act, 1994*

1.4 National and international standards

Key principles and elements used in developing this document are consistent with national and international standards.

The following standards from CSA Group are relevant to this regulatory document:

- CAN/CSA ISO-14001, *Environmental Management Systems – Requirements with Guidance for Use* (2004 edition or successor editions)
- CSA N288.1, *Guidelines for modelling radionuclide environmental transport, fate, and exposure associated with the normal operation of nuclear facilities* [2]
- CSA N288.3.4, *Performance testing of nuclear air-cleaning systems at nuclear facilities*
- CSA N288.4, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*
- CSA N288.5, *Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills*
- CSA N288.6, *Environmental risk assessment at Class I nuclear facilities and uranium mines and mills* [3]
- CSA N288.7, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills* [4]
- CSA N288.8, *Establishing and implementing action levels for releases to the environment from nuclear facilities* [5]

The International Atomic Energy Agency's general safety guide GSG-9, *Regulatory Control of Radioactive Discharges to the Environment* is also relevant to this regulatory document.

1.5 CNSC contact information

The applicant or licensee should engage with CNSC staff early in the planning process (before submission of a licence application) to identify the applicable regulatory documents and confirm an understanding of the CNSC's licensing process. To contact the CNSC, see the CNSC's website.

2. Background

Under paragraph 12(1)(f) of the *General Nuclear Safety and Control Regulations*, "every licensee shall take all reasonable precautions to control the release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment as a result of the licensed activity". For more information on how licensees can adequately control their releases of nuclear and hazardous substances to the environment, see REGDOC-2.9.1 [1].

2.1 Relationships and interactions between environmental protection measures

2.1.1 Radiation protection principles and controls on releases to the environment

Facilities and activities with radiation risks are required to be designed, built, authorized, operated and maintained in a manner that prevents or minimizes radioactive releases to the environment. The core radiation protection principles to be respected for all of these activities are limitation and optimization.

During normal operation, some facilities and activities generate airborne emissions and waterborne effluents containing small amounts of radionuclides that may expose the public and the environment to low levels of radiation. In many cases, the complete prevention of releases to the environment is technically difficult, extremely costly or disproportionately increases worker exposure. In all cases, a facility or activity must be designed, operated, and implemented so that resulting doses to members of the public not only respect the public dose limit (that is, limitation) but also demonstrate respect for the ALARA principle (as low as reasonably achievable, economic and social factors being taken into account).

Limitation is established by the dose limits prescribed in the *Radiation Protection Regulations*. The regulatory dose limit associated with the authorization of radioactive releases to the environment in a planned exposure is the public dose limit of 1 milliSievert (mSv) per year. The public dose limit represents the maximum acceptable dose to any member of the public from all authorized radiation sources to which they are exposed; therefore, authorization for releases by a single activity requires release limits representing a potential exposure to be lower than the public dose limit. For a definition of, and more information on limitation, refer to the glossary of this regulatory document.

Optimization involves the demonstration that releases are controlled such that "the magnitude of individual doses, the number of individuals (workers and members of the public) subject to exposure and the likelihood of exposure [are] 'as low as reasonably achievable, economic and social factors being taken into account' (ALARA)" [6]. From an applied perspective, the use of BATEA to prevent (where applicable) or to minimize (where prevention is not applicable) waste generation and discharges to the environment is considered evidence of an optimized practice where exposures of the public and the population as a whole are considered to have been reduced to levels respecting the ALARA principle.

Optimization is a core element of the design and planning process. Optimization of protection with respect to radioactive discharges is not simply a matter of considering the balance between the radiation risks associated with the discharges during normal operation and the costs of making any reductions. The effect of waste management decisions on the exposure of workers and on the safety of the facility or activity as a whole should also be considered. For example, a reduction in discharges may lead to an increase in radioactive waste stored on the site, with related increases in occupational exposures; therefore, such a reduction may not be the optimal solution.

Optimization and dose constraints

Public dose constraints are estimates of public dose, less than the regulatory public dose limit that are either established or approved by the CNSC for use in the optimization process. The dose constraint for each particular source is intended to ensure that the sum of doses from planned operations of that source and of all the authorized sources that may contribute to the exposure of the public remains within the dose limit (see figure 1).

Dose constraints may be generic (that is, applicable to a specific subsector of the nuclear fuel cycle) or specific to a facility or activity being regulated. The CNSC may specify a generic dose constraint for a subsector, or approve a facility- or activity-specific dose constraint based on an applicant or licensee's demonstration of BATEA with respect to facility design and control on releases. In situations where multiple licensees may be operating in close proximity (for example, nuclear research or energy parks), the CNSC may specify a facility- or activity-specific dose constraint as an upper bound for the optimization process (see figure 1). This factor ensures responsible apportionment of the 1 mSv/year dose limit to the public from all sources.

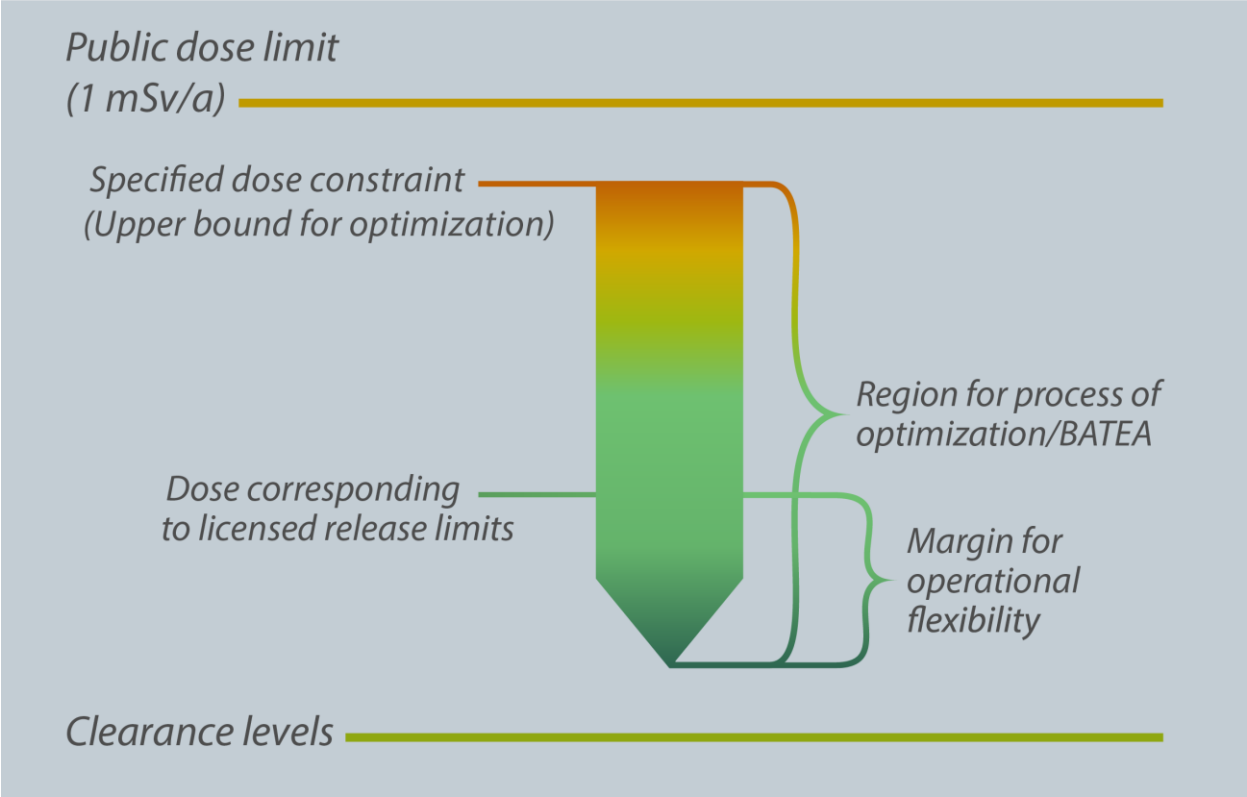
During the design phase, the review of modern facility designs incorporating BATEA that both minimize waste production and control releases, are used to establish a range of maximum predicted design quantities and concentrations of radionuclides that can be released during normal operation. For each design option, the site-specific public dose calculations, using these maximum design releases, provide the maximum equivalent doses associated with the various design options and feed into the overall optimization process that considers cost-benefit trade-offs between worker and public dose (see figure 1). The maximum predicted design quantities and concentrations corresponding to the best option (with respect to optimization), along with a margin of error to provide operational flexibility, establishes the licensed release limits. The public dose corresponding to the licensed release limits is determined through the application of these limits to the site-specific environmental transport and exposure model (e.g., N288.1). Thus, rather than the CNSC specifically defining dose constraints, the CNSC reviews and approves the facility or activity design and the controls on releases to determine the adequacy of the application of BATEA within the optimization process and the acceptability of the associated public dose outcomes.

Optimization and authorized releases to the environment (licensed release limits)

In practice, optimization is BATEA with respect to minimization of contaminant pollution and controls on the releases to the environment, with the additional concept of ensuring that any trade-offs associated with worker and public dose are balanced out (that is, the limit of release for a small reduction in public dose is not at the expense of a large increase in worker dose). The dose associated with the final optimized release is simply an artifact of optimization; it is not the target of the optimization (dose constraints are sometimes inappropriately interpreted as being site-specific dose limits or targets for establishing site-specific licensed release limits, rather than as tools for guiding optimization). Optimization of protection can be considered as complementary to the concept of pollution prevention (a core principle of the environmental protection measures described in REGDOC-2.9.1 [1]).

Figure 1 shows the relationship between optimization and the authorization of releases to the environment (that is, licensed release limits). Through optimization (demonstrated by the application of BATEA), licensed release limits for both nuclear and hazardous substances can be identified. Additionally, optimization requires the application of BATEA to control releases such that they represent a site-specific public dose or doses constrained to a region less than the public dose limit (specified dose constraint) but greater than doses considered to be “de minimis.” Internationally, effective doses of approximately 10 microSieverts (μSv) per year have been used to derive clearance levels (unconditional or conditional) representing radionuclide activities (total or concentrations) that can be cleared from any further regulatory control.

Figure 1: Relationship between optimization and the authorization of releases to the environment[1]



When applying the concept of optimization to establish licensed release limits, modelled doses approximating 10 µSv/year are recommended as the lower boundary for requiring further optimization and application of BATEA. However, it is necessary to make a distinction between this dose criterion (that is, 10 µSv/year) applied to a site-specific dose assessment associated with a licence application versus its use in developing exemption and clearance levels. The former tend to incorporate relatively realistic (but still conservative) site-specific transport and exposure scenarios. The latter are deliberately hyper-conservative to ensure that exemption from licensing or from discharge authorization can be safely given under a wide range of scenarios encompassing a range of potential site-specific variability. Authorized releases remain under regulatory control (including periodic re-evaluation, monitoring requirements and annual public dose calculations) while exemptions from licensing or authorization result in no further regulatory controls, post-release (that is, no licence requirements to receive the materials, and no environmental monitoring), hence the need for the hyper-conservatism.

Thus, licensees (other than Class I facilities and uranium mines and mills whose routine operational releases of radionuclides meet the radionuclide-specific conditional clearance values

[1] Figure adapted from IAEA, General Safety Guide No. GSG 9, *Regulatory Control of Radioactive dischages to the Environment, Vienna Austria 2018.*

and associated conditions identified in appendix A) may not require further regulatory authorization for their releases. For more information, see appendix A.

The approved facility or activity design will have demonstrated to the satisfaction of the CNSC that BATEA has been applied with respect to the minimization of waste production and the control of releases. The maximum releases associated with the approved optimized design (which includes the addition of a margin for operational flexibility) become the authorized licensed release limits (for more information, see section 5). The dose associated with these releases can then be determined through the application of the site-specific radionuclide transport and exposure pathway model. This calculated public dose can be used for public risk communication purposes indicating that releases have been constrained to levels representing exposures lower than the regulatory public dose limit.

As the licensed release limit is based on the expected maximum release (including a margin for operational flexibility), any exceedance of this limit represents a release outside of the licensing basis and demonstrates a lack of compliance with the licence, and therefore indicates a failure in the design or operation of the facility or activity. Thus, the licensee would be considered to be non-compliant under section 12(1)(f) of the *General Nuclear Safety and Control Regulations*. However, as the licensed release limit is based on the optimized design representing a public dose less than 1 mSv/year, the exceedance would not necessarily represent an exceedance of the *Radiation Protection Regulations* public dose limit and is in no way meant to replace that public dose limit. For more information, see section 5.

2.1.2 Relationships between environmental protection measures

REGDOC-2.9.1 [1] provides requirements and guidance for developing and implementing environmental protection measures to monitor and control releases to the environment (that is, effluent and emissions), to perform an environmental risk assessment (ERA), and to develop and implement an environmental management system (EMS).

This regulatory document provides requirements and guidance for additional environmental protection measures (such as action levels and licensed release limits) that are related to, affected by, and have an effect on the environmental protection measures described in REGDOC-2.9.1.

Effluent and emission monitoring and control

The effluent and emission monitoring measures are used to:

- inform the development of action levels and licensed release limits
- demonstrate compliance against those action levels and licensed release limits

Environmental risk assessment

The results of the ERA are used to identify what contaminants or physical stressors require mitigation measures and the environmental release targets used to inform the design of such mitigation measures (see appendix B). The ERA may also:

- identify nuclear and hazardous substances that merit action levels or licensed release limits
- identify supporting information about mixing zone models, or detailed environmental transport and pathway exposure models, that can be used:
  - in the calculation of exposure-based environmental release targets

    - to demonstrate that technology-based environmental release targets are acceptable
- identify the receptors and associated exposure scenarios used to determine appropriate benchmark value criteria (that is, to determine the release and exposure benchmarks that define the "limiting" release scenario)
- demonstrate that the proposed maximum predicted design releases are protective of people and the environment

The ERA also provides information that will be used in any decisions regarding adaptive management.

Environmental management system

An organization's environmental policy (documented in the EMS) includes the organization's commitment to sustainable development, continuous improvement, pollution prevention and (if it is identified as required through an ERA) adaptive management. These principles are the core components in controlling releases to the environment to ensure the application of ALARA and BATEA.

The EMS includes clearly defined release targets and objectives. The scope of these targets and objectives may include the following elements, which are described in this regulatory document:

- design related items such as environmental release targets (see appendix B)
- action levels (see section 6)
- other performance indicators (for example, continuous improvement initiatives) (see section 8)
- pollution prevention initiatives (see section 8)

Periodic safety review

A periodic safety review (PSR) is a comprehensive evaluation of the design, condition and operation of a reactor facility [7]. A PSR is an effective method to gain an overall view of actual facility safety and the quality of the safety documentation, and to determine reasonable and practical improvements to ensure safety until the new PSR or, where appropriate, the end of commercial operation.

For requirements and guidance for the conduct of PSRs, refer to CNSC REGDOC-2.3.3, *Periodic Safety Reviews*.

2.2 Upper values of normal operations, action levels and licensed release limits

For licensed facilities and activities, the CNSC uses regulatory instruments such as action levels and licensed release limits to monitor whether the licensee is operating within its licensing basis.

Figure 2 shows the relationship between the upper value of normal operation for a sample nuclear or hazardous substance, the action level for environmental releases, and the licensed release limit (based on the proposed maximum releases, and referred to as the maximum predicted design release). Figure 3 shows those values using operational performance data.

Note: These figures are conceptual and are not necessarily to scale. The actual range between the values depends on the site-specific design and operation of the facility or activity, and the expected variability in effluent and/or emission quality under normal operations.

Figure 2: Conceptual relationship between an upper value of normal operation for a nuclear or hazardous substance, an action level, and a licensed release limit

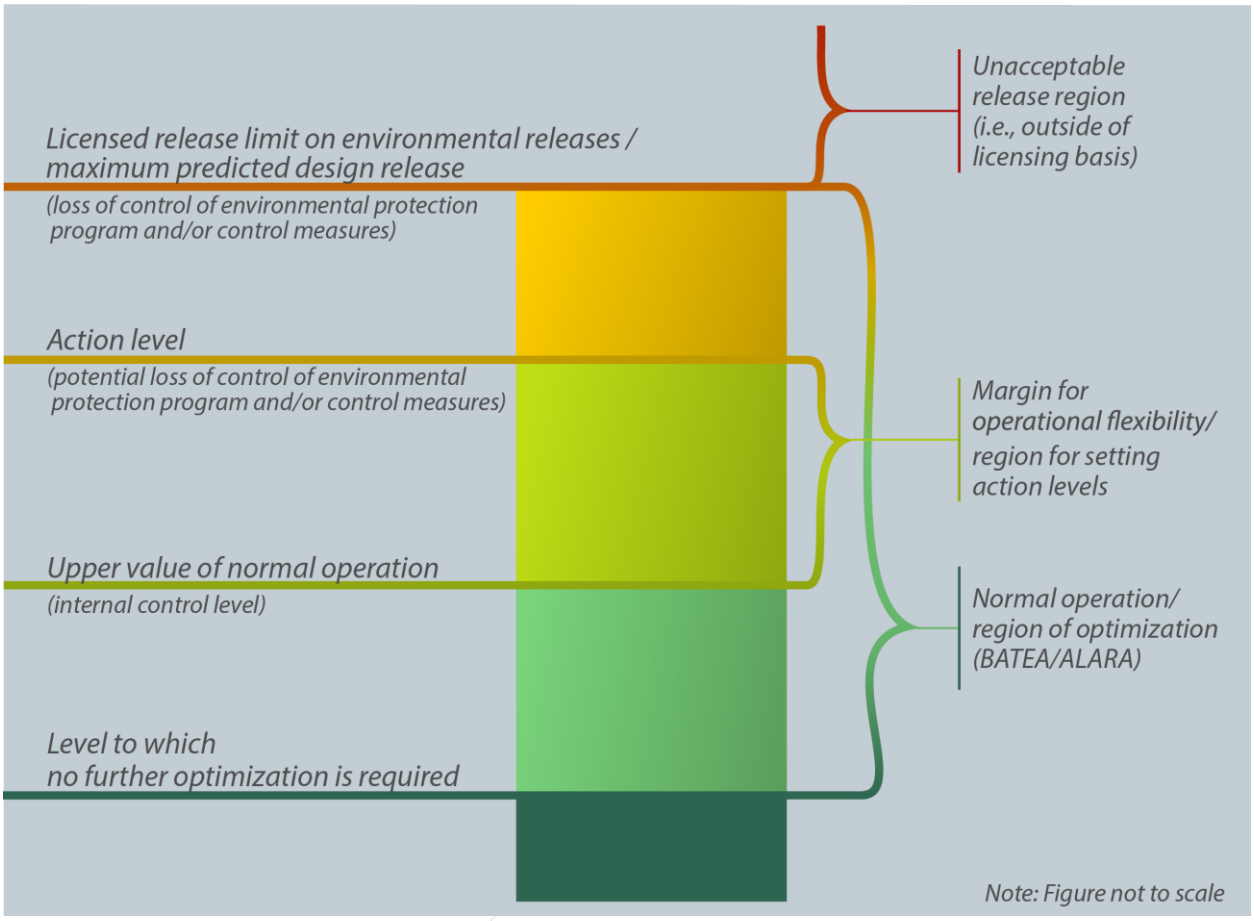
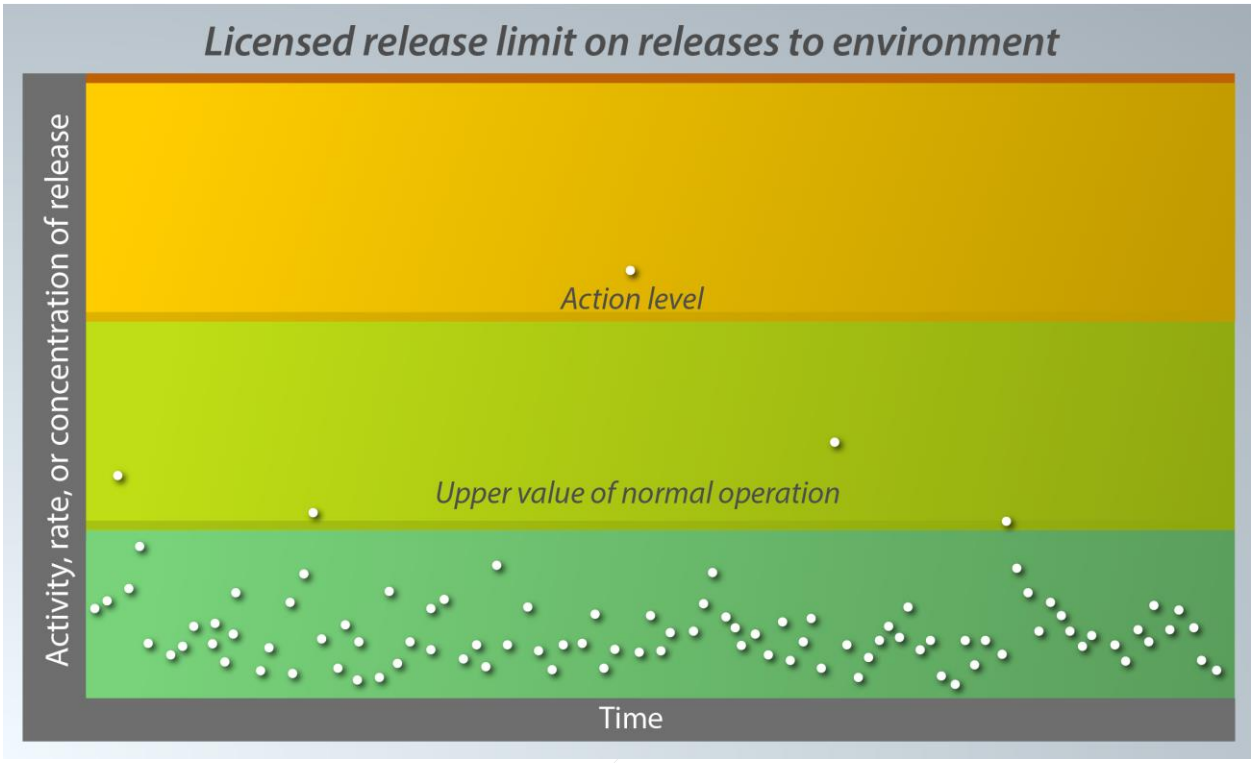


Figure 3: Release performance data for a quantity or concentration of a sample nuclear or hazardous substance over time, and the relationship between the upper value of normal operational release, the action level and the licensed release limit for that substance



2.2.1 Upper value of normal operation

The upper value of normal operation represents the expected upper bound release, based on the predicted or current operating conditions (for example, 95th percentile), and is typically determined using either:

- a prospective approach for a new facility or activity, based on the approved design and other relevant information
- a retrospective approach for an existing facility or activity, using all available performance data (including historical data)

The applicant or licensee may also use the upper value of normal operation as internal control levels (also called internal investigation levels or administrative levels). Exceeding the upper value of normal operation triggers internal action by the licensee. **Note:** Internal control levels are not a regulatory requirement. Their use is at the discretion of the licensee.

2.2.2 Licensed release limits

Licensed release limits are applied to the final point of control from a facility or activity.

The applicant or licensee submits the proposed licensed release limits (for both nuclear and hazardous substances) as part of a licence application. When approved by the CNSC, the established licensed release limits form part of the licensing basis for the facility or activity. Licensed release limits are applicable under normal operation.

Implementing licensed release limits ensures that:

- the licensee applies appropriate control measures (including abatement strategies) for pollution prevention demonstrating the concept of optimization through the application of BATEA and ALARA
- human health and the environment are protected
- the licensee is operating within the licensing basis for normal operation

In establishing licensed release limits, the objective is to constrain the quantity or concentration of contaminants and physical stressors that may be released into the environment. In line with this objective, a licensed release limit is based on the proposed maximum quantities or concentrations as described in the licensee's design basis documentation. Therefore, exceeding a licensed release limit indicates there is a loss of control of part of the environmental protection program or control measures and that the licensee is operating outside the licensing basis for that facility or activity. It does not necessarily indicate an unreasonable risk to the environment or to the health and safety of persons.

Exceeding a licensed release limit demonstrates a lack of compliance with requirements, and is subject to enforcement action.

Licensed release limits are often site-specific or subsector-specific, because design characteristics vary across the nuclear industry and each facility or activity has a unique environmental protection program or control measures.

When a licence is issued, the licensee is authorized to release to the environment in accordance with the licensed release limits. **Note:** Authorization to release must be received from all applicable jurisdictions prior to any releases:

- authorization under other jurisdictions does not constitute authorization from the CNSC
- authorization from the CNSC does not constitute authorization under other jurisdictions

The CNSC will work with other jurisdictions to ensure that, to the extent possible, authorizations are acceptable to all applicable jurisdictions.

For more information, see section 5, on establishing licensed release limits.

2.2.3 Action levels for environmental protection

Action levels for environmental protection provide the licensee with a tool to demonstrate adequate control of their environmental protection program. Action levels are set below licensed release limits and above the upper value of normal operation, in order to serve as an early warning indicator of a potential loss of control of part of the environmental protection program or of control measures.

Exceeding an action level:

- indicates a potential loss of control of the licensee's environmental protection program
- signals a potential reduction in effectiveness of the environmental protection program or of the control measures
- may indicate a deviation from normal operation
- triggers a requirement for specific action to be taken by the licensee

Action levels are proposed by the licensee and submitted for review and approval by the CNSC.

Within the licensing basis for a specific site, the licensee should review action levels on a periodic basis and adjust them to reflect any changes to site activities, conditions, or processes. Any revisions to action levels are subject to CNSC review and approval.

Exceeding an action level triggers a requirement for a specific action to be taken. Exceeding an action level is not considered to be a lack of compliance; however, failure to respond appropriately is considered a lack of compliance. To respond to an exceedance, a licensee must follow:

- the steps in subsection 6(2) of the *Radiation Protection Regulations*
- requirements in the licensee's code of practice, as set out under subsection 4(2) of the *Uranium Mines and Mills Regulations*, where applicable
- additional requirements that may be included in the licensee's licensing basis

When responding to an action level exceedance, the successful implementation of the required follow-up activities (such as notification, investigation and corrective actions) is a clear demonstration of a well-maintained and managed environmental protection program and control measures.

Action levels are site-specific and operationally based. For more information, see:

- section 6, on setting action levels
- for nuclear power plants, REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants* [8]
- for Class I nuclear facilities (excluding power reactors) and uranium mines and mills, REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* [9]
- CSA N288.8, *Establishing and implementing action levels for releases to the environment from nuclear facilities* [5]

3. Environmental control measures

A loss of control of the environmental protection program occurs if releases are clearly outside the bounds established in the licensee's licensing basis. In normal operations, the licensing basis sets bounds on releases through:

- the maximum quantities and concentrations contained within the licensee's licensing basis documentation
- the predictions of environmental effects as described in the approved ERA or similar documentation, which is submitted as part of a licence application and forms part of the licensing basis

Figure 4 shows the process for establishing environmental control measures for a new facility or activity, or for an existing facility or activity that is undergoing a major modification, or for an existing facility or activity in normal operation.

Note: A major modification is one that requires a change in the licensing basis for the facility or activity. Some examples of major modifications are:

- changes to the licensed physical facility, or to facility or activity processes, that have the potential to change the nature of the effluents and/or emissions and the resulting risks to receptors
- a response to adaptive management
- a result of a PSR

Figure 4: Overview of the process for establishing environmental control measures for a facility or activity that is new or undergoing a major modification, or for an existing facility or activity in normal operation
Note: The following figures 4a, 4b and 4c show the details of each subsection of figure 4.

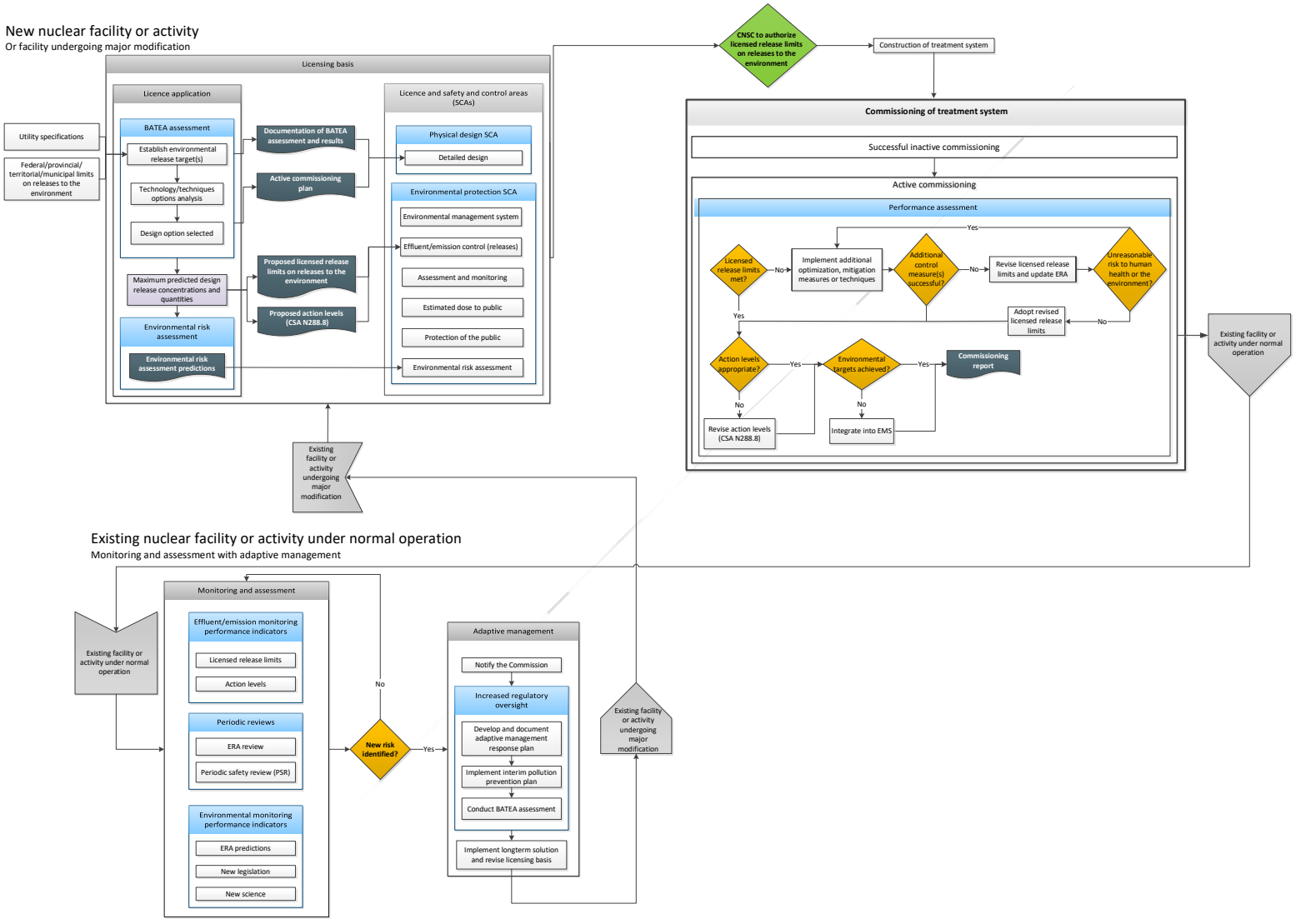


Figure 4a: The part of the overall process for establishing control measures that is specifically for a new facility or activity

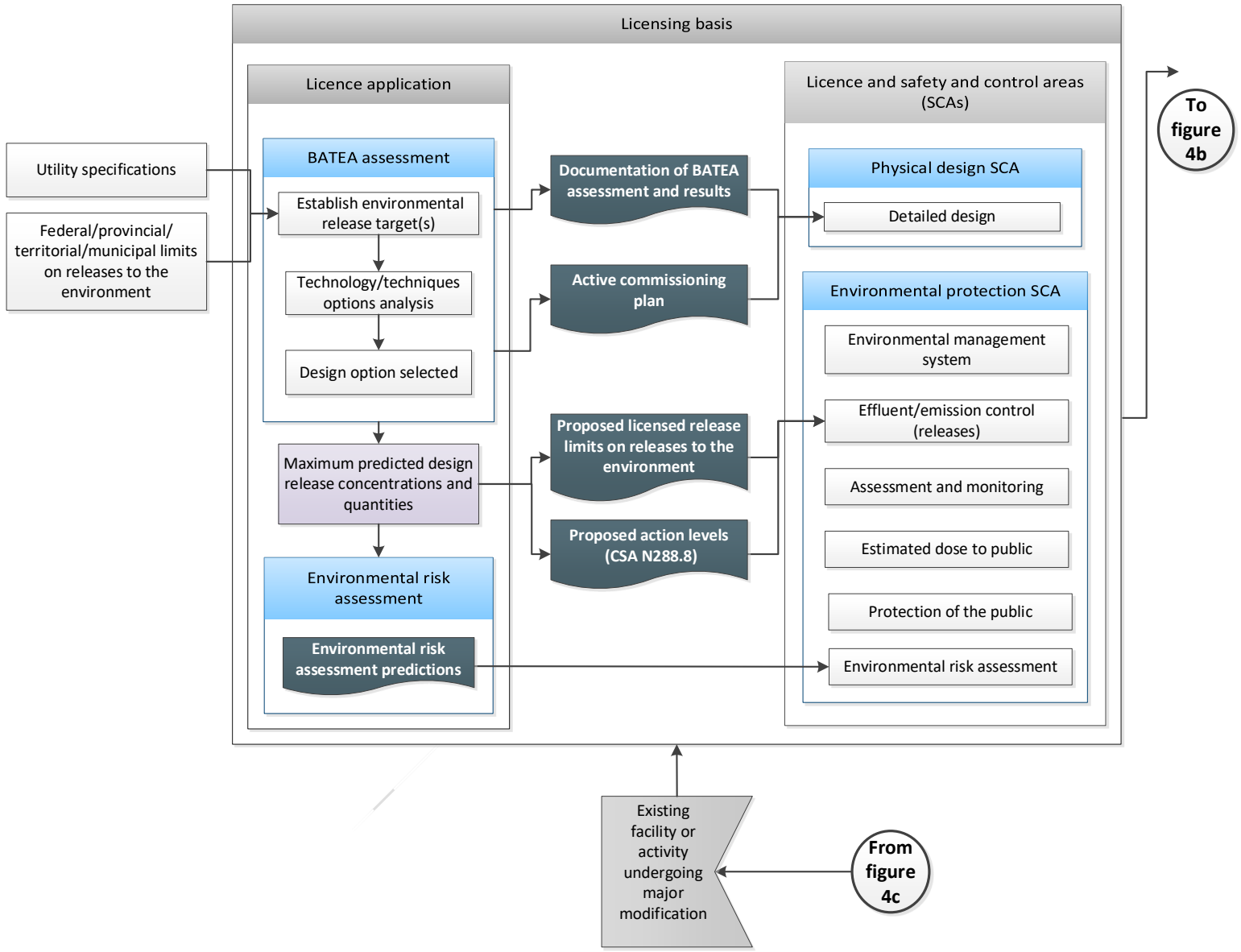


Figure 4b: The part of the overall process for establishing control measures that is specifically for an existing facility or activity undergoing a major modification

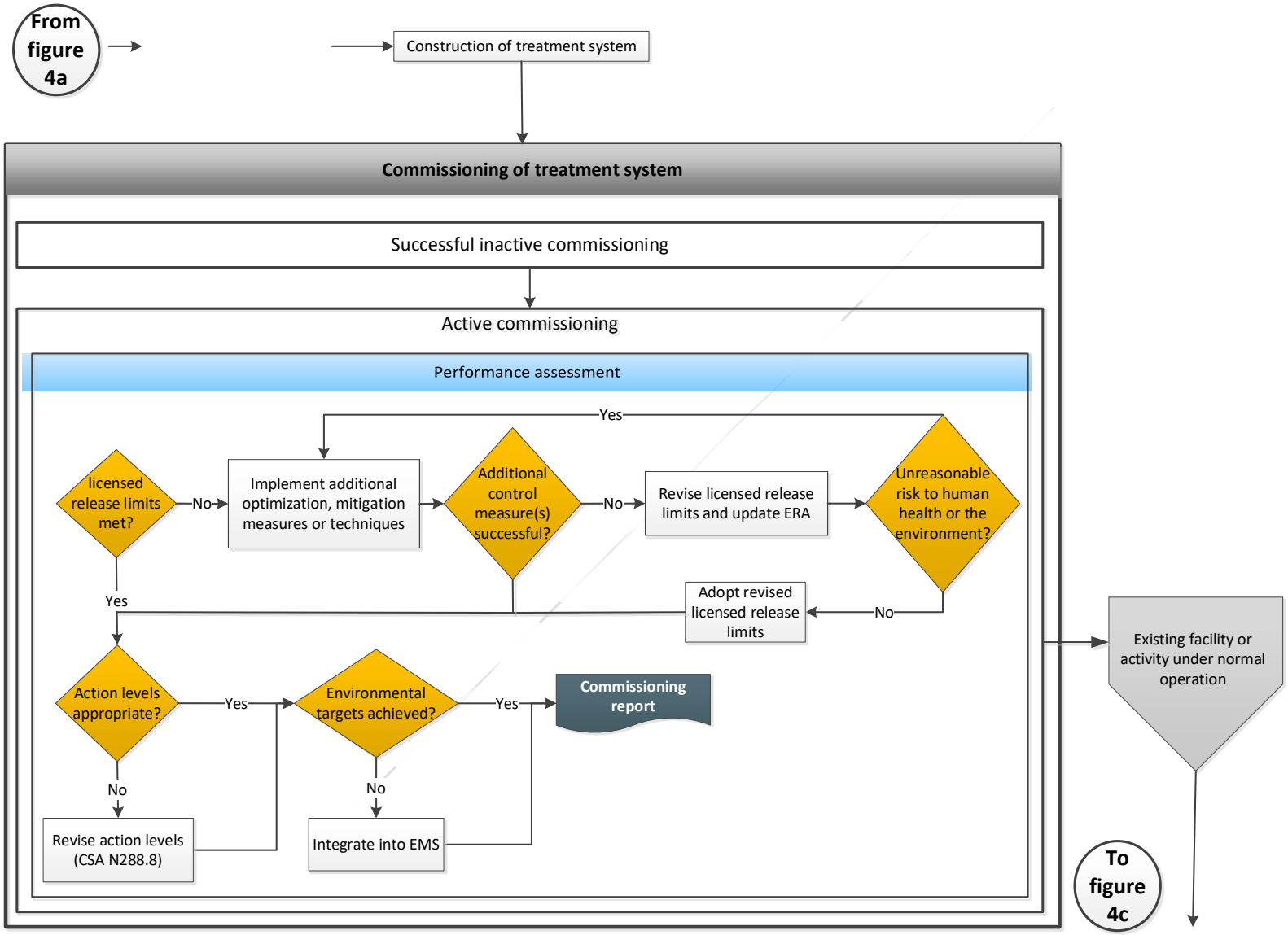
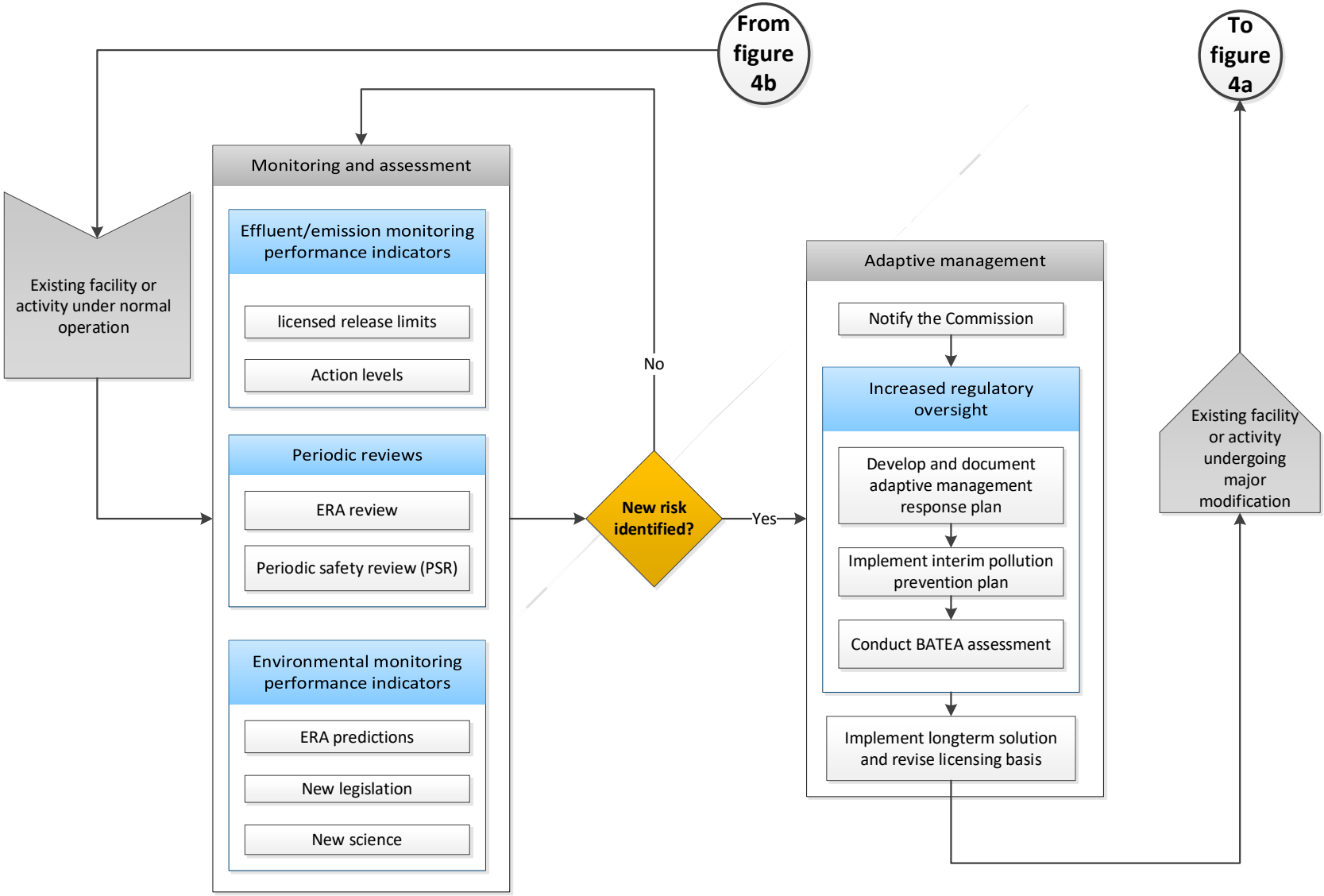


Figure 4c: The part of the overall process for establishing control measures that is specifically for a nuclear facility or activity under normal operation



3.1 Controlling releases to the environment (from all facilities and activities)

The following requirements and guidance apply to all facilities and activities. For additional requirements and guidance for controlling releases to the environment:

- from a new facility or activity, or an existing facility or activity that is undergoing a major modification (see section 3.2)
- from an existing facility or activity under normal operation (see section 3.3)

Requirements

The applicant or licensee shall:

- describe the control measures that will be taken for the protection of the environment, including the pollution control and abatement technologies and techniques
- demonstrate that reasonable precautions have been taken:
  - to prevent or mitigate physical disturbances and releases of nuclear or hazardous substances
  - to prevent or minimize any effects associated with those disturbances and releases
- demonstrate that the principles of ALARA and BATEA have been incorporated (based on the approved design; see section 4) to:
  - minimize controlled releases and prevent uncontrolled releases of nuclear and hazardous substances to the environment
  - mitigate physical effects such as impingement and entrainment of biota
  - reduce exposures of radiation
- ensure that releases are not acutely lethal, in accordance with federal, provincial and territorial requirements

For more information, see REGDOC-2.9.1, *Environmental Principles, Assessments and Protection Measures* [1].

Guidance

The description of the control measures should include:

- a list of all structures, systems and components that are important control measures (for example, engineered barriers, wastewater treatment systems, air pollution control technology systems, liquid waste monitoring equipment and stack monitoring equipment)
- the maintenance program established to ensure the sustained operational performance of preventive and control measures
- any alarm systems to be installed to respond to failure of control measures
- the methods to be used:
  - to prepare, store and retain records of releases that will be made routinely from the site
  - to compare those records of releases to available performance indicators (for example, internal investigation levels, administrative levels, and other environmental monitoring objectives and targets)
- identification of the measures that will be taken to make appropriate information available to the authorities and the public (for more information, see REGDOC-3.2.1, *Public Information and Disclosure* [10])

3.2 New facility or activity, or existing facility or activity undergoing a major modification

Requirements

As part of the licence application for a new facility or activity, or for an existing facility or activity that is undergoing a major modification, the applicant or licensee shall:

- conduct a BATEA assessment to determine the maximum predicted design release characteristics (see section 4)
- establish the proposed licensed release limits (see section 5)
- establish the action levels (see section 6)
- conduct an ERA in accordance with REGDOC-2.9.1
- establish a commissioning plan and implement commissioning of the treatment system and control measures (see section 7)

3.3 Existing facility or activity under normal operation

For an existing facility or activity under normal operation, a comprehensive BATEA assessment is not required unless a new risk has been identified in the ERA that merits adaptive management.

Requirements

For an existing facility or activity under normal operation, and in line with its environmental protection program, the licensee shall:

- conduct routine effluent and/or emission and environmental monitoring as described in the licensee's approved environmental protection program
- assess effluent and/or effluent monitoring results against the licensed release limits and action levels
- assess the environmental monitoring results against:
  - the predictions in the ERA
  - any new or changes in legislation
- update the site-specific ERA and characterize the risks to the environment (as per ERA periodic update requirements)
- if a previously unmanaged risk is identified in the ERA, and adaptive management is required to restore the effectiveness of the environmental protection program, immediately notify the Commission
  Note: Some examples of unmanaged risks are those arising as the result of new science or new legislation, or evidence of a significant increase in magnitude or spatial extent of a previously known risk

Where adaptive management is required, the licensee shall:

- develop and document an adaptive management response plan (see section 8)
- implement an interim pollution prevention plan, as applicable (see section 8)
- conduct a BATEA assessment to determine the maximum predicted design release characteristics to be used in the new or revised ERA (see section 4)
- submit the information for the proposed revision to the licensing basis to the CNSC

- as applicable, implement the long-term solution arising from the BATEA assessment (see section 8)

Guidance

Similar to applying the ALARA concept, the licensee should apply the BATEA concept throughout the lifecycle of the facility or activity. Best practice for licensees is to periodically re-evaluate the adequacy of their technology and techniques; for example, when managing the aging of structures, systems and components, or making improvements to an existing facility or activity that could affect releases to the environment. For more information, see section 4.

Evaluation of the adequacy of the licensee's technologies involves consideration of component lifecycle upgrades and other cost-effective refinements to the existing facility or activity. These considerations are often already considered as continuous improvements and documented within the EMS or integrated management system. For NPPs, the periodic evaluation of major pollution prevention and control treatment systems and measures should be addressed as part of the PSR. For more information, see:

- REGDOC-2.3.3, *Periodic Safety Reviews* [7]
- REGDOC-2.6.3, *Aging Management* [11]

4. Best Available Technology and Techniques Economically Available (BATEA)

For a BATEA assessment, the applicant or licensee reviews new and existing technology and techniques to:

- determine an adequate design of pollution control technologies and techniques to reduce releases to the environment, to ensure that:
  - appropriate control measures (including abatement strategies) for pollution prevention are applied
  - risks are mitigated to protect human health and the environment
- identify the maximum predicted design release characteristics to:
  - be used as the source term in the ERA
  - set licensed release limits
  - develop action levels

The outcome of the BATEA assessment determines what is "adequate", based on the weight of evidence and in consultation with CNSC staff.

The maximum predicted design release characteristics include the location of the points of release, the maximum quantities and concentrations, and the anticipated volume and flow rate of nuclear and hazardous substances expected to be released to the environment. The maximum predicted design release characteristics correspond to the residual release; that is, the remaining release of a nuclear or hazardous substance, after accounting for all treatment and mitigation.

4.1 Requirements for conducting a BATEA assessment

For facilities and activities that are new or are undergoing major modifications that have the potential to increase or change the nature of releases to the environment and the resulting risks to receptors, the applicant or licensee shall conduct an assessment to identify the best available

technologies, or the best available techniques for control, that have been demonstrated on an industrial scale to reduce the release of contaminants or physical stressors to the environment.
Note: Demonstration of a technology or technique as a best practice on a similar industry or activity indicates that the technology or technique is economically achievable. The applicant or licensee may decide to assess the use of emerging technologies, with justification that a similar or better outcome is achieved.

The applicant or licensee shall document the BATEA assessment and results, and shall submit them to the CNSC (see figure 4a). This document may form part of the licensing basis for the facility or activity.

4.2 Required elements of a BATEA assessment

A BATEA assessment shall contain the following elements:

- characterization of pollutant source or sources
- identification of contaminants and physical stressors that will require control
- establishment of environmental release targets
- analysis of options for technology and techniques
- identification of the maximum predicted design release characteristics
- analysis of benefits
- selection of best BATEA option

4.3 Guidance for a BATEA assessment

The applicant or licensee should use a systematic approach to conduct a BATEA assessment.

Characterization of pollutant sources

Characterization of the pollutant sources includes identifying the expected nature, quality and quantity to be treated prior to release to the environment from the facility or activity.

Some examples of pollutant sources are process waters, untreated collection waters, gaseous releases and other waste streams.

The quantity should be calculated using the average and maximum predicted influent concentrations over the operating lifecycle of the facility or activity.

Identification of contaminants and physical stressors

A screening assessment identifies the contaminants and physical stressors that will require control (that is, treatment or management).

The contaminants and physical stressors that require control include the pollutant sources that are:

- subject to existing federal, provincial, territorial or municipal requirements
- identified as potentially exceeding federal, provincial, or territorial environmental quality guidelines before consideration of treatment
- identified within the ERA as meriting control

Establishment of environmental release targets

See appendix B for more information on establishing the environmental release targets.

Analysis of options for technology and techniques

Analysis of the technology options identifies:

- available technologies
- their performance in reducing source contaminants and physical stressors (that is, treatment efficiencies and expected concentrations)
- their associated benefits and drawbacks

A techniques analysis identifies areas of optimization that may have a direct effect on reducing releases to the environment. A techniques analysis should include:

- the engineering aspects of applying various types of control techniques
- different configurations of a technology
- the processes employed and the process changes
- human factors
- management oversight and process
- water management
- how contaminants and physical stressors are released to the environment
- trade-offs associated with applying a given technique (for example, energy requirements, air pollution, waste generation, worker exposure and public exposure)
- other site-specific factors, as appropriate to the facility or activity

The analysis should review top-performing similar facilities or activities to identify technologies and techniques that should be considered as part of the BATEA assessment. The analysis should demonstrate that the selected technologies and techniques meet the environmental release targets.

This analysis may be supported by any bench-scale, laboratory-scale, or pilot project-scale testing to confirm treatment efficiencies and expected treated effluent and/or emission concentrations.

Some examples of techniques are:

- improved procedures for changing filters
- faster mixing through the use of diffusers
- discharging into fast- versus slow-moving water bodies
- limiting or preventing discharge during environmentally sensitive time periods
- use of high stack height and/or reduced diameter for the stack
- improvement in the chemical reagents used
- increased certainty in orebody concentrations
- minimizing human errors through improvement in the training programs
- optimizing operating conditions

Identification of the maximum predicted design release characteristics

For the combination of technologies and techniques under consideration, determination of the maximum predicted design release characteristics includes the concentration and quantities expected to be released from the facility or activity.

When determining the maximum predicted design release characteristics, the applicant or licensee should consider:

- the maximum expected influent characteristics
- the anticipated treatment efficiencies for full-scale operations
- a margin of operational flexibility

Analysis of benefits

An analysis of benefits (for example, cost-benefit analysis, or a multi-value criteria analysis) supports the selection of an appropriate technology or technique.

Selection of most applicable BATEA option

Based on the assessments described above, the applicant or licensee should select the most applicable BATEA option for the facility or activity.

4.3.1 Documentation of the BATEA assessment and results

The applicant or licensee should document the following information about the BATEA assessment and results:

- a summary of the results of the characterization of pollutant sources, including:
  - the nature of the source
  - the average and maximum predicted influent concentrations
  - quantities to be treated
- the established environmental release targets and the methodology used in their derivation
- a summary of the results of the technology options analysis, including a list of the technologies assessed and their expected performance (that is, the expected treatment efficiency) in treating identified contaminants and physical stressors
- a description of the techniques to be applied
- if applicable, a summary of the results of the cost-benefit analysis, or the multi-value criteria analysis
- the final proposed design and its justification as the BATEA option
- the predicted treatment efficiencies, maximum predicted design release characteristics, and a comparison to the established environmental release targets

For more information on how the CNSC considers cost-benefit information, refer to REGDOC-3.5.3, *Regulatory Fundamentals*.

5. Licensed Release Limits

A licensed release limit applies to releases to the environment from that facility or activity. A licensed release limit is used to constrain the quantity and concentration of contaminants and physical stressors released to the environment.

The implementation of licensed release limits ensures:

- the application of acceptable control measures (including abatement strategies) for pollution prevention
- the protection of human health and the environment
- that the licensee is operating within the licensing basis for normal operation for that facility or activity

Unless specified by other governmental requirements (for example, existing federal, provincial, territorial, and municipal requirements), a licensed release limit is set at the maximum predicted design release concentration and/or quantity. Exceeding a licensed release limit signals a loss of control of the environmental protection program and/or control measure(s) and that the licensee is operating outside the licensing basis.

Exceeding a licensed release limit demonstrates a lack of compliance with requirements and is subject to enforcement action. Enforcement action will be commensurate with the level of release, associated risks to human health and the environment, and prior compliance history. Enforcement action may include any of the CNSC's graduated enforcement tools. For more information, see the CNSC's approach to compliance verification and enforcement.

5.1 Requirements for establishing and documenting licensed release limits

The applicant or licensee shall submit to the CNSC:

- the locations of the proposed controlled release points
- the proposed licensed release limit associated with each proposed controlled release point for each contaminant and/or physical stressor
- the methodology used to establish the proposed licensed release limits

The proposed site-specific licensed release limits:

- shall be at or below any applicable release limits found in existing legislation
- are subject to approval by the Commission (and therefore become part of the licensing basis)

For contaminants and physical stressors that do not have established limits on releases, the applicant or licensee shall use the maximum predicted design release concentrations or quantities to establish appropriate licensed release limits.

For all nuclear substances released from the facility or activity, the applicant or licensee shall demonstrate that, based on the proposed licensed release limits, the maximum predicted annual total effective dose to a member of the public is less than the regulatory public dose limit.

To establish the licensed release limits that will be proposed to the CNSC, the applicant or licensee shall:

- identify the release points where licensed release limits will apply
- identify each contaminant and physical stressor that requires a licensed release limit
- identify and adopt any other governmental requirements (for example, existing federal, provincial, territorial, and municipal requirements) or
- establish the proposed licensed release limit based on the maximum predicted design release concentration or quantity
- demonstrate that the proposed licensed release limits respect the regulatory public dose limit and do not pose an unreasonable risk to human health or the environment

Guidance

The applicant or licensee should use a systematic, structured process to establish the proposed licensed release limits.

Identify all release points where licensed release limits will apply

The list of points of release should be in alignment with those established in the effluent and/or emissions monitoring program.

Identify each contaminant and physical stressor that requires a licensed release limit

All contaminants and physical stressors should be identified that are:

- subject to existing federal, provincial, territorial or municipal requirements
- identified as potentially exceeding federal, provincial, or territorial environmental quality guidelines
- identified within the ERA as requiring control

A licensed release limit may not be required where the applicant or licensee can demonstrate that, for controlled releases under all foreseeable circumstances (as identified in the ERA):

- for the combination of all nuclear substances released at their maximum predicted design release from the licensed facility or activity under normal operations, the maximum predicted total effective annual dose to the public does not exceed 0.01 mSv/year
- for a hazardous substance, the maximum predicted design release is lower than the applicable federal, provincial, territorial or municipal standards, guidelines or objectives (for example, Canadian Council of Ministers of the Environment)

If a licensed release limit is not required, the licensee or applicant:

- is still required to demonstrate (through monitoring or modelling) that the total effective annual dose is below 0.01 mSv and therefore does not exceed the regulatory public dose limit of 1 mSv
- may be required to conduct routine effluent and/or emissions, and environmental monitoring (as described in REGDOC-2.9.1 [1])

Identify other requirements of other jurisdictions

Where other government requirements exist (such as a limit on releases in other federal, provincial, territorial or municipal requirements), the applicant or licensee may harmonize with those requirements (in particular, with any reporting processes and procedures) and propose this as the licensed release limit. Some examples include federal or provincial regulations; municipal bylaws; and provincial or territorial permits, authorizations, or licences.

The applicant or licensee should demonstrate that a review has been completed of existing legislation, regulation, and associated limits or controls applicable to the facility or activity that should be considered when proposing licensed release limits (note that this review is already required for a licensee's environmental management system).

Note: Where existing requirements do not adequately protect the environment, the applicant or licensee should propose licensed release limit(s) based on the maximum predicted design release concentration or quantity that have been demonstrated through the ERA to be protective.

Establish the licensed release limit to be proposed

The applicant or licensee should establish the proposed licensed release limits as follows:

- identify the maximum predicted design release concentrations and quantities:
  - for a new facility or activity, or for an existing facility or activity that is undergoing major modifications, this information is documented as part of the BATEA assessment and results
  - for an existing facility or activity under normal operation:
    - this information may be documented in the approved design documentation for normal operation
    - otherwise, the licensed release limits should be established by using historical performance data
      Note: The applicant or licensee may use the methodology described in CSA N288.8, *Establishing and implementing action levels for releases to the environment from nuclear facilities* [5], for a retrospective approach, using a percentile that represents a clear loss of control (for example, 99.99%)
- for each contaminant, set the licensed release limit at the maximum predicted design release concentration that applies to the maximum monthly mean concentration
  Note: To allow for operational flexibility, a licensed release limit for waterborne releases may be applied for a composite sample at 1.5 times the maximum monthly mean concentration, or to a "grab sample" at 2 times the maximum monthly mean concentration. The application of these factors is a common regulatory approach.
- where a licensed release limit is to be established on the quantity of the contaminant released in a given period (that is, rate/loading), multiply the maximum predicted design release concentration by the maximum design flow rate over the specific period

Demonstrate that the proposed licensed release limits respect the regulatory public dose limit and do not pose an unreasonable risk to human health or the environment

For all nuclear substances released from the facility or activity, the maximum predicted annual total effective dose (based on the proposed licensed release limits) to a member of the public is required to be less than the regulatory public dose limit and demonstrate that releases have been optimized.

To demonstrate this, the applicant or licensee should:

- identify the information from the most recent ERA, where available
- estimate the information using an appropriate environmental transport and exposure pathway model

For nuclear and hazardous substances, the applicant or licensee should use the licensed release limits in the ERA to demonstrate that, at the level of the proposed licensed release limits, there is no unreasonable risk to human health or to the environment.

Note: The maximum predicted annual total effective dose includes direct gamma exposure.

For more information on the role and development of environmental transport and exposure pathway models, see:

- REGDOC-2.9.1, *Environmental Principles, Assessments and Protection Measures* [1]
- CSA N288.1, *Guidelines for modelling radionuclide environmental transport, fate, and exposure associated with the normal operation of nuclear facilities* [2]
- CSA N288.6, *Environmental risk assessment at Class I nuclear facilities and uranium mines and mills* [3]

5.2 Requirements for responding to licensed release limit exceedances

When a licensee becomes aware that a licensed release limit has been exceeded, the licensee shall:

- limit, to the extent possible, the effect and magnitude of the exceedance
- conduct an investigation to establish the cause and determine the magnitude of the exceedance
- assess the potential effects on human health and the environment
- identify and take any action to restore the effectiveness of the environmental protection program and/or control measure(s) implemented, and prevent recurrence (this may include the application of adaptive management; see section 8)
- follow the reporting requirements described in the REGDOC applicable to the facility or activity:
  - REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants* [8]
  - REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Facilities and Uranium Mines and Mills* [9]
  - REGDOC-3.1.3, *Reporting Requirements for Waste Nuclear Substance Licensees, Class II Nuclear Facilities and Users of Prescribed Equipment, Nuclear Substances and Radiation Devices* [13]

5.3 Requirements for revising licensed release limits

Licensed release limits shall be revised in response to:

- a major modification of the operations of the facility, leading to a change in the licensing basis
- new or updated governmental requirements (for example, federal, provincial, territorial, and municipal requirements)

6. Action Levels for Environmental Protection

An action level is defined as a specific dose of radiation or other parameter that, if reached, may indicate a loss of control of part of a licensee's radiation protection program or environmental protection program, and triggers a requirement for specific action to be taken [14].

An action level is an indicator of a potential loss of control of part of a program and/or control measure(s). Exceeding an action level signals a potential reduction in the effectiveness of the program and/or control measure(s) and may indicate a deviation from normal operation.

6.1 Requirements for setting action levels

The applicant or licensee shall develop and set action levels appropriate to the type of nuclear facility or activity.

6.1.1 Contaminants and physical stressors

For contaminants and physical stressors released to the environment, the licensee shall establish the need for action levels, and shall implement them in accordance with CSA N288.8, *Establishing and implementing action levels for releases to the environment from nuclear facilities* [5].

6.1.2 Other environmental controls

The applicant or licensee shall establish and implement action levels on other environmental controls that are necessary to ensure the effectiveness of the environmental protection program and control measures. For example, action levels may be established on:

- flow (to ensure adequate control of flow into a watershed in order to prevent downstream flooding or stream channel disruption)
- hydraulic head across engineered or natural barriers (to ensure adequate control of containment of contaminants and physical stressors)

6.1.3 Documenting development of the action levels

The applicant or licensee shall:

- document the development of the action levels in accordance with CSA N288.8, *Establishing and implementing action levels for releases to the environment from nuclear facilities* [5]
- submit this documentation and the proposed action levels to the CNSC

This documentation will form part of the licensing basis for the nuclear facility or activity.

The action levels are expected to change over time as they reflect actual operating conditions. The licensee shall submit any changes to the action levels and to the supporting documentation to the CNSC.

6.2 Requirements for responding to action level exceedances

When an action level is exceeded, the licensee shall:

- notify and report to the Commission as specified in the licence or licence conditions handbook
- conduct an investigation to identify the basis for exceeding the action level
- where necessary, take action to restore the effectiveness of the program or control measures that have been implemented

6.3 Guidance for action levels

Within the licensing basis for a specific site, action levels should be adjusted depending on changes to site activities or processes. The licensee should:

- review the action levels periodically in accordance with CSA N288.8, *Establishing and implementing action levels for releases to the environment from nuclear facilities* [5]
- revise them if appropriate, taking into account:
  - data collected from operations and performance of the nuclear facility or activity from start of operation to the current date (also called a retrospective approach)
  - current operations and performance of the nuclear facility or activity

Where appropriate, the applicant or licensee may adapt the performance-based approach described in CSA N288.8 [5] to establish action levels on other environmental controls (for example, engineered or natural barriers, or flow control).

7. Commissioning a Treatment System

Commissioning is essential to verify performance against the approved design and to ensure that the licensed release limits are achievable and are set at a level that is protective of the environment.

All new treatment systems must be commissioned to verify:

- whether the system has been constructed and will operate in accordance with the design basis before commencing releases to the environment
- that the system is not exceeding the maximum predicted design release characteristics
- that the previously established action levels and licensed release limits are appropriate

Wherever possible, the CNSC harmonizes this process with that of any other approving jurisdiction (for example, with the Ontario Ministry of the Environment, Conservation and Parks).

Requirements

For any facility or activity that has a new treatment system to be commissioned, or a major modification to an existing treatment system, the licensee shall submit a commissioning plan to the CNSC.

The licensee shall commission the treatment system and control measures in accordance with the approved commissioning plan.

After the treatment system is commissioned, the licensee shall submit a commissioning report that:

- includes an assessment of the operating performance of the treatment system against the licensed release limits and maximum predicted design release characteristics to ensure the operating performance is within the licensed release limits
- confirms whether the proposed action levels remain appropriate

If the licensee discovers that a specific licensed release limit on releases to the environment cannot be met, the licensee shall:

- notify the Commission
- determine the nature of the unexpected performance or behaviour
- assess whether the licensed release limit can be met through further optimization or application of additional mitigation measures or techniques to reduce releases below the licensed release limits

If the licensee determines that the treatment system performance is unable to meet a specific licensed release limit, the licensee shall:

- establish a revised licensed release limit based on achievable technology
- reassess the ERA to determine whether the predictions of the ERA remain valid
- If the reassessment of the ERA:
  - identifies an unreasonable risk to human health or the environment, then the licensee shall repeat the three bullets above
  - determines there is no unreasonable risk to human health or to the environment, then the licensee shall:
    - request the CNSC to amend the licensing basis
    - submit the revised ERA and proposed licensed release limits

Guidance

The applicant or licensee should submit the commissioning plan at the end of their construction phase. The licensee's commissioning plan should include the following information:

- commissioning schedule and process
- responsibilities
- transitioning to the next stage of commissioning ("package turnover")
- operational performance
- performance assessment
- management system (particularly quality assurance and quality control (QA/QC))
- safety (occupational health and safety, and radiation protection)
- training
- records and records maintenance
- site plan and sample locations

To confirm the performance of the treatment system, the licensee should assess the operating performance against the environmental targets established in section 4.2.1.

For more information on the components of a commissioning plan and on confirming the performance of the treatment system, see appendix C.

For more information on commissioning of a wastewater treatment system, see:

- REGDOC-2.3.1, *Conduct of Licensed Activities: Construction and Commissioning Programs* [15]
- guidance from the U.S. Department of Defense, *Planning and Commissioning Wastewater Treatment Plants* [16]

8. Adaptive Management

Adaptive management involves, among other things, the implementation of new or modified mitigation measures over the life of a project to address unanticipated environmental effects. [14]

Adaptive management ensures that licensees take corrective actions to mitigate an identified unreasonable risk or a potential unreasonable risk to the environment to a level accepted by the CNSC. The CNSC expects licensees to take a proactive approach if an unreasonable risk or a potential unreasonable risk to the environment has been identified.

An adaptive management plan may be considered analogous to a corrective action plan that is implemented in response to a non-conformance with the licensing basis.

8.1 Requirements for adaptive management

Adaptive management is required in response to:

- identification of an unreasonable risk or a potential unreasonable risk through the ERA or through monitoring; for example, as a result of:
  - changes to the operation or to the licensed activity
  - changes in the scientific understanding of a substance's toxicity or physical effect
- changes in the regulatory status of a substance (for example, Environment and Climate Change Canada classification of a substance as toxic under the *Canadian Environmental Protection Act, 1999*)
- new or updated regulatory requirements

When a requirement for adaptive management is identified, the licensee shall:

- notify the Commission
- develop, document and implement an adaptive management plan to:
  - reduce releases of the identified contaminants and physical stressors to the environment
  - mitigate any potential effects to the environment
- provide periodic updates as needed to reflect the current operation

The interim period is the time from when adaptive management is triggered through to completion of commissioning of the new treatment system or other control measures. During this interim period, at a frequency specified by the CNSC, the periodic updates shall include:

- a summary of the technology and techniques being applied and their performance on reducing the contaminants and physical stressors
- for each contaminant and physical stressor:
  - an assessment of the historic and current effluent and/or emission performance data
  - an assessment of the predicted future trends in effluent and/or emission performance
- an update summarizing the potential and residual risks to the environment
- the status of implementation of the long-term adaptive management plan

8.2 Guidance for adaptive management

Early engagement with CNSC staff is encouraged for adaptive management plans. CNSC staff can provide facility- or activity-specific guidance to assist applicants and licensees.

8.2.1 Components of an adaptive management plan

An adaptive management plan should include:

- an interim pollution prevention plan (IPPP)
- a BATEA assessment to identify and implement a long-term treatment solution
- the schedule of expected timelines for the implementation of the adaptive management plan

8.2.2 Components of an interim pollution prevention plan

The intent of the IPPP is to focus on short-term mitigation while long-term solutions are evaluated (that is, to mitigate any potential risks in the short term, until a viable long-term treatment solution is implemented). The licensee should consider the full scope of treatment options that were identified within the BATEA assessment.

The IPPP should include:

- an assessment of any upstream processes that may affect the concentration of each contaminant entering the treatment system
- a description of the technology and techniques that have been implemented to reduce contaminant concentrations and loadings to the environment
- a description of any technology and techniques that have been assessed but not yet implemented, with a schedule outlining their expected implementation dates
- the technology and techniques that will be assessed for continuous improvement to control releases to the environment during the period of the BATEA assessment
- any changes, including any special field studies, to:
  - the effluent and/or emission monitoring programs
  - the environmental monitoring programs

Within the interim period, updates to the IPPP should identify:

- the existing continuous improvement techniques being applied
- any new continuous improvement techniques that are being assessed to reduce the levels of the contaminants and physical stressors in the environment

Updates to the IPPP may be submitted as a separate report, or as a section of a routine compliance report.

Appendix A: Standard Conditional Clearance Levels

This appendix provides information on the application of unconditional and conditional (generic conditional and practice-specific conditional) clearance levels as they relate to the need for site-specific environmental risk assessments and authorization of operational releases to the environment for facilities other than Class I facilities and uranium mines and mills. As described in section 2, licensees (other than Class I facilities and uranium mines and mills) whose routine operational releases of radionuclides meet the radionuclide-specific unconditional and/or conditional clearance values and associated conditions identified in this appendix) may not require a site-specific environmental risk assessments and/or site-specific licensed release limits.

To provide further clarification and to ensure that the social benefits associated with these activities are not overly burdened with regulatory requirements out of proportion to the associated radiological risk, the CNSC has developed its environmental protection (EP) decision framework as outlined in REGDOC-2.9.1.

Environmental protection (EP) requirements for licensed activities limited to the use of sealed sources

Licensed activities limited to the use of sealed sources are characterized by the following elements with respect to releases of nuclear substances to the environment:

- there are NO routine interactions with, or releases to, the environment
- sealed source leak testing requirements within the *Nuclear Substance and Radiation Devices Regulations* (NSRDR) and *Class II Nuclear Facilities and Prescribed Equipment Regulations* adequately address potential breaches of sealed source encapsulation, including regulatory requirements for periodic testing, mitigation and reporting
- the *Packaging and Transport of Nuclear Substances Regulations, 2015* adequately address similar considerations for dealing with either sealed sources or unsealed radioactive materials involved in transport incidents, which could potentially result in releases to the environment

Based on these characteristics the following conclusions are drawn with respect to EP requirements for these licenses:

- as there are no routine interaction with the environment and leaks and accidents are otherwise addressed in regulation there is no need for a site-specific ERA
- as there are no planned releases there is no need for authorization of releases

EP requirements for licences involving the use of limited quantities of unsealed nuclear substances

The following criteria apply with respect to disposal or releases related to the use of unsealed sources:

- standard exemption quantity (EQ) and unconditional clearance levels (UCLs) specified in Schedules 1 and 2, respectively of the NSRDR
- generic conditional clearance levels (CCLs) documented in table A.A), on the condition that releases occur only though the specified pathway (i.e., solids to municipal landfill, gases to atmosphere, liquid to municipal sewer)
- practice-specific conditional clearance, which are CCLs which are only applicable to a defined practice or activity that have been developed by the CNSC for application to multiple licensees carrying out the specific practice or activity

As the activities and/or concentrations associated with the above criteria were derived from conservative public exposure risk assessment modelling (using dose criteria associated with *de minimis* risk ~ 10 µSv/year) there is no need for further facility/activity-specific risk assessment(s). In other words, the dose calculations associated with their derivation serves as a generic radiological ERA applicable to the facility/activity (see subsection A.1).

The aforementioned criteria pertaining to unsealed sources also serve as the basis for determining whether an authorization of disposal/discharge(s) is required, inform the nature or complexity of the authorization and support determination of associated compliance activities.

Based on these criteria, where a proponent or licensee can demonstrate (i.e., at the licence application stage), that releases will not exceed:

- Criteria i): if standard EQs and UCLs identified in the NSRDR, then:
    - there is no requirement to authorize a release within a licence condition or the licence
    - there is no need to monitor or record releases beyond the nuclear substance record-keeping requirements specified in the NSRDRs.
    - the CNSC may require notification of any change in practice or activity with the potential to result in releases greater than the specified exemption quantities or UCLs.

- Criteria ii): if generic CCLs (see table A.A), then:
    - a licence condition is applied using the generic CCLs as licensed release limit, conditional to the specified release pathway (i.e., to atmosphere, municipal sewer, municipal solid waste stream);
    - the compliance verification methodology is determined by licensing specialists using a graded, risk informed approach as appropriate to the facility/activity. Potential mechanisms include:
        - review of release or disposal records during an inspection
        - simple confirmation, e.g., via the annual compliance reports that the total quantity acquired/used over one year is less than the corresponding generic CCL

- Criteria iii): the practice specific CCLs applicable to the facility/activity
    - a licence condition is applied to limit key release parameters to the levels and under the conditions incorporated within the public dose calculations used to derive the practice-specific levels CCL(s)
    - a monitoring program including annual reporting of releases and any associated parameters (e.g., flow rates) should be required

Note: Subsection A.1 provides further clarification related to the application of the CCLs where the release contains more than one radionuclide.

Where a proponent or licensee is handling or producing sufficiently high activities of unsealed nuclear substances under circumstances where potential releases could exceed the above criteria (i–iii) then environmental protection measures are required in accordance with the environmental protection regulatory documents REGDOC-2.9.1 and REGDOC-2.9.2. Examples of such protection measures could include, but are not limited to, a site-specific ERA, radiological release limits, and monitoring and reporting requirements.

Note: The levels in table A.A are considered to be screening levels below which no site-specific authorization is required. Disposal or discharge above these levels may be acceptable but requires

authorization and the additional site-specific supporting information and consideration of the range of environmental protection measures documented in REGDOC-2.9.1.

A.1 Basis for the calculation of the generic conditional clearance levels

To ensure a uniform approach to the application of EP requirements as they relate to extremely low risk disposals/releases, the CNSC has developed generic conditional clearance levels (CCLs). These were developed to identify levels of releases representing such low exposures and associated risks to the public/environment that there was no need for authorization for a licensee to dispose or discharge the materials through the specified pathway.

These CCLs were developed to be:

- as simple as possible but as complex as necessary
- respect current national and international practices on disposal and discharge of radioactive material including the requirements for disposal and discharge of radioactive material in the International Atomic Energy Agency (IAEA) GSR Part 3, *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards* [17]
- have regard to currently available methodologies and international experience in dealing with disposal and discharge of radioactive material by users in hospitals, universities, etc. as specified in IAEA-TECDOC-1000, *Clearance of materials resulting from the use of radionuclides in medicine, industry and research* [18]
- take account of likely exposure of people and of the environment
- be based on conservative but reasonably foreseeable exposure scenarios and modelling considered applicable to Canadian conditions
- formally document and where necessary refine current regulatory practices

Disposal and/or discharges above CCLs requires site-specific regulatory approvals.

Core international radiation protection concepts associated with the derivation of the CCLs

The IAEA radiation protection framework and that of the *Nuclear Safety and Control Act* are built on a hierarchical structure incorporating radiation protection concepts of Exclusion, Exemption, Clearance (either unconditional or conditional) and authorization of discharge (i.e., release in parlance of regulations made under the NSCA).

The various IAEA concepts can be summarized as follows. Exclusion is for sources/exposures where it is impossible to exert control over them. As such, they are completely outside of the law and warrant no further legal considerations (e.g., natural background exposures – cosmic radiation, potassium-40 in foods, terrestrial radiation), as expressed in section 10 of the *General Nuclear and Safety Control Regulations* (GNSCR). Exemption is for sources/exposures where control is potentially feasible but it is considered unnecessary or unwarranted and a decision is made *a priory* to exempt it from regulatory control (e.g., GNSCR s.10. NSRDR s.5(1)). Clearance can be thought of as "exemption from within" where it serves as permission for the materials developed or arising from a regulated activity to exit the regulatory system with no further regulatory requirements or oversight (NSRDR s.5.1).

Authorization for discharge is a separate but related concept which allows the release (i.e., discharge to the environment) of the substance while continuing to maintain regulatory control and oversite of the release through the maintenance of additional regulatory requirements; such as periodic re-evaluation of the adequacy of control measures, the monitoring of releases and where necessary, monitoring of the receiving environment. Authorization for discharge is not necessary for releases meeting unconditional

clearance levels. Conversely, "conditional" clearance levels inherently require a defined set of "conditions" which constrain the releases, including but not necessarily limited to controlling the release pathway such that the basis for the CCL remains valid. This in turn implies that some form of "authorization for discharge" is generally required, and necessary requirements can be incorporated using a graded approach, as a condition of the licence.

The International Atomic Energy Agency (IAEA), in TECDOC-1000, provides:

- "…. guidance on regulatory considerations in granting clearances and on the nature and scope of radiation dose calculations which must be performed in deriving clearance levels" and
- "… conservatively derived generic clearance levels …"

These generic CCLs are describes as radioisotope-specific "values, expressed in terms of release rates of radionuclides to the environment or activity concentrations in solid materials, below which there is no need for further regulatory control". These are conditional clearance levels as the specific releases are restricted to specified release pathways, namely, solids to municipal landfill, gaseous wastes to atmosphere and water soluble liquid wastes to sewer.

The CNSC CCLs presented here have been derived using the same basic methodology as IAEA TECDOC-1000, the basics of which are provided below.

Dose criterion for deriving generic CCLs

The CCLS are:

- IAEA *de minimis* dose concept of 10 µSv/year for a member of the public (and
- 10 µGy/hour for the non-human biota.

For a member of the public, this is the same public dose value used internationally for the development of the exemption quantities and clearance levels in IAEA GSR part III and adopted by the NSCA for the *Nuclear Substances and Radiation Devices Regulations* as EQs and Unconditional Clearance Levels, respectively.

For non-human biota an environmental dose rate of 10 µGy/hour was adopted as being representative of no-effect level below which environmental risks would be negligible (Andersson et al 2009). This is the dose rate used by the ERICA Assessment tool (Brown et al 2008, 2016) for calculating media specific screening criteria based on the limiting organism (i.e., most sensitive). This dose rate is the lowest recommended internationally (i.e., < than ICRP, AIAEA, UNSCEAR and U.S. DOE) and is thus considered an appropriate proxy screening value representing *de minimis* exposure for non-human biota.

Exposure scenarios

Following the release of radionuclides, radioactive decay during the transport from the point of release to the exposure location was taken into account. Following release to the atmosphere, buildup and decay of deposited activity on the ground was calculated over a 30-year operating period of the facility. Deposition on food crops and forage, as well as transfer to milk and meat was calculated as per IAEA Safety Series No. 19, *Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment* [19]. Transfer to crops occurs only during growing seasons, which were taken to be 30 days per year for forage and 60 days per year for food crops. Decay from the time of harvest to consumption was considered, assuming hold-up times of 14 days for food crops, 90 days for stored animal feed and 0 days for forage. The decay time between collecting fresh milk and consumption is 1 day and for meat

consumption, the decay time is 20 days. These decay times are consistent with those recommended in IAEA Safety Series 19 [19].

Two main categories of exposure were considered:

- external exposure from radionuclides present in the air or in material incorporated in, for example, soils or sediment
- internal exposure from the inhalation or ingestion of radionuclides present in air or incorporated in water or foods respectively

The relative importance of different exposure pathways were dependent on the:

- magnitude of the discharge
- route of discharge
- physical and chemical characteristics of the radionuclides discharged
- characteristics of the radioactive decay

Disposal to municipal landfill

As recommended in TECDOC-1000, the CNSC has chosen to adopt the exemption and unconditional clearance levels in the NSRDR as appropriate CCLs for release to municipal landfills. These values are based on the most restrictive exposures associated with such scenarios as public exposure from tampering with the radioactive source and from inhalation, ingestion and skin exposure pathways.

Release to atmosphere

The licensed limits for the release of radionuclides to the atmosphere assume that the release is from a vent from the side of a building. The receptor is assumed to reside in a building 20 metres (m) away from the source. In addition, the receptor is assumed to consume all vegetables and other crops from a location 100 m away from the source of the atmospheric releases, and that meat and milk that are consumed are from a location 800 m from the source of the releases. The licensed release limits consider the following exposure pathways:

- Inhalation of radionuclides released to air
- External dose from the cloud (immersion)
- External dose from material deposited on the ground
- Ingestion of radionuclides in food

Release to sewer

For discharges to municipal sewer systems, the licensed release limits are based on two main groups of pathways: those resulting from the retention of radionuclides in sewage sludge at the wastewater treatment plant (WTP), and those from the wastewater treatment plant effluent discharged to a river.

The sewage sludge pathways assume that all radionuclides are retained in sludge at the WTP. The concentration in sludge is calculated assuming that the WTP serves a population of 20,000. This is a conservative assumption since large WTPs would allow for greater dilution with waste not affected by radionuclides. Two exposure pathways to WTP workers are included:

- external exposure to sludge
- inhalation of re-suspended activity

The pathways related to discharges to a river conservatively assume that all radionuclides received at the WTP are eventually discharged to the river with no radionuclides retained in sludge. The following pathways are included in this group:

- Ingestion of radionuclides in drinking water
- Ingestion of radionuclides in fish
- External dose from radionuclides in sediment

Licensed release limits are calculated separately for both groups of pathways; namely those resulting from the retention of radionuclides in sewage sludge and those from the WTP effluent discharged to a river. The limits are calculated so that the annual effective dose to the receptor is 10 μSv from each of the two groups of pathways. The smaller of the two limits calculated in this manner was rounded to the nearest multiple of 10 and selected as the CCL for sewer release.

Table A.1 lists the resultant concentrations of radionuclides at the input of the wastewater treatment plant (WWTP). These values were calculated for a reference WWTP serving a population of 20,000, as per IAEA TECDOC-1000. The influent flow rate (in m^3/year) for this reference WWTP was estimated by considering Canadian WWTP influent rates for 2016 – 2018 for three WWTPs at Toronto and 5 WWTPs in Vancouver. The "per capita" annual average inflow rate was approximately 130 m^3/a, which is equivalent to 2.6 million m^3/a for a population of 20,000. The values in column 4 of table A.1 were divided by 2.6 million m^3/a to obtain the resultant concentrations.

Releases containing more than one radioisotope

When more than one radionuclide is released via one mode of release (i.e., releases to municipal landfills, releases to the atmosphere or releases to the municipal sewer system), for each mode release, the following condition applies:

$$\sum_{i=1}^{n} \frac{Q_{i,k}}{CCL_{i,k}} \leq 1$$

In the above expression:

- $Q_{i,k}$ represents the activity or activity concentration, as applicable, of radionuclide *i* that is released via mode of release *k* in one calendar year
- $CCL_{i,k}$ is the corresponding conditional clearance level for radionuclide *i*, and release mode *k*, as listed in table A.1
- *n* is the number of radionuclides released via mode of release *k* in one calendar year

Table A.1: Conditional clearance levels (CCLs) for liquids to municipal sewer based on conservative dose modelling approximating a *de minimis* dose of 10 µSv/year (5 – 20 µSv/year)

Column 1	**Column 2**	**Column 3**	**Column 4**
Radionuclide	**Municipal landfill (Bq/g)** **Note: 1**	**Annual activity released to atmosphere (MBq)** **Note: 2**	**Annual activity released to municipal sewer (MBq)** **Note: 2, 3**
H-3	1,000,000	100,000	1,000,000
C-11	10	100,000	-
C-14	10,000	10,000	10,000
F-18	10	10,000	0.1
Na-22	10	1	0.1
Na-24	10	1,000	100
P-32	1000	100	1
P-33	100,000	1,000	10
S-35	100,000	100	1,000
Cl-36	10,000	10	10,000
Ar-37	-	1.00E+11	-
K-42	100	10,000	1,000
Ca-45	10,000	1,000	10,000
Ca-47	10	1,000	100
Sc-46	10	-	0.1
Cr-51	1,000	1,000	100
Mn-54	10	-	1
Mn-56	10	-	0.1
Fe-55	10,000	-	10,000
Fe-59	10	100	1
Co-57	100	1,000	1,000
Co-58	10	1,000	100

Column 1	Column 2	Column 3	Column 4
Radionuclide	**Municipal landfill (Bq/g)** **Note: 1**	**Annual activity released to atmosphere (MBq)** **Note: 2**	**Annual activity released to municipal sewer (MBq)** **Note: 2, 3**
Co-60	10	1	0.1
Ni-63	100,000	-	10,000
Cu-64	100	-	1
Zn-65	10	10	1
Ga-67	100	10,000	100
Ge-68+	10	-	0.1
Se-75	100	100	1
Br-82	10	-	0.1
Rb-83	100	1,000	1
Rb-86	100	-	10
Sr-82+	10	100	0.1
Sr-85	100	100	1
Sr-89	1,000	100	1,000
Sr-90+	100	1	1
Y-88	10	10	0.1
Y-90	1,000	10,000	10,000
Mo-99	100	1,000	100
Tc-99	10,000	10	10,000
Tc-99m	100	100,000	1,000
Pd-103	1,000	-	10
Ag-110m	10	-	0.1
Cd-109	10,000	100	10
In-111	100	1,000	100
Sb-124	10	-	0.1

Column 1	Column 2	Column 3	Column 4
Radionuclide	**Municipal landfill (Bq/g)** **Note: 1**	**Annual activity released to atmosphere (MBq)** **Note: 2**	**Annual activity released to municipal sewer (MBq)** **Note: 2, 3**
Sb-125	100	100	1
I-123	100	10,000	1,000
I-124	10	100	10
I-125	1,000	100	100
I-131	100	100	10
Xe-127	-	100,000	-
Xe-133	-	1,000,000	-
Cs-125	10	-	100,000
Cs-134	10	-	0.1
Cs-137	10	-	1
Ba-133	100	-	1
La-140	10	-	0.1
Ce-139	100	100	1
Ce-141	100	-	10
Ce-143	100	-	1
Nd-147	100	-	1
Pm-147	10,000	10,000	10,000
Sm-153	100	-	10
Eu-152	10	1	1
Eu-154	10	1	1
Gd-153	100	-	10
Er-169	10,000	10,000	10,000
Tm-170	1,000	1,000	100
Yb-169	100	100	1

Column 1	Column 2	Column 3	Column 4
Radionuclide	**Municipal landfill (Bq/g)** **Note: 1**	**Annual activity released to atmosphere (MBq)** **Note: 2**	**Annual activity released to municipal sewer (MBq)** **Note: 2, 3**
Lu-177	1,000	1,000	10
Lu-177m	10	-	0.1
Re-186	1,000	1,000	10
Ir-192	10	-	1
Au-198	100	1,000	100
Hg-194	10	-	10
Hg-197	100	10,000	1,000
Hg-203	100	100	10
Tl-201	100	10,000	100
Tl-204	10,000	-	100
Pb-210+	10	-	1
Bi-210	1,000	-	10
Po-208	10	-	10
Po-209	10	-	10
Po-210	10	-	10
Ra-223+	100	-	1
Ra-224+	10	-	0.1
Ra-226	10	1	1
Ra-228+	10	0.1	0.1
Ac-227+	0.1	-	1
Th-230	1	-	100
Th-228	1	-	100
Th-228+	1	0.1	0.1
Th-229	1	-	1

Column 1	Column 2	Column 3	Column 4
Radionuclide	**Municipal landfill (Bq/g)** **Note: 1**	**Annual activity released to atmosphere (MBq)** **Note: 2**	**Annual activity released to municipal sewer (MBq)** **Note: 2, 3**
Th-232	1	0.1	1
U-232+	1	-	0.1
U-233	10	1	
U-235	10	1	
U-234	10	1	
U-238	10	1	
Np-237	1	-	10
Pu-238	1	0.01	1
Pu-239	1	-	1
Pu-240	1	-	1
Am-241	1	0.1	10
Am-243+	1	-	1
Cm-244+	10	0.1	0.1

Notes:

1. Standard licence condition includes a limit of 3 tonnes per building per year and requirement for demonstration of uniformity of distribution of the radionuclide

2. The CCLs apply to a site that may consist of several buildings. For example, a hospital to university may be considered to be a site, from which there could be several points of release to a sewer or to the atmosphere.

3. The CCLs for releases to the sewer apply only to water soluble liquids.

Appendix B: Establishing Environment Release Targets

This appendix provides guidance on establishing environmental release targets.

B.1 Introduction

Environmental release targets apply during the design and commissioning phases. If these targets cannot be met, they become integrated as targets or objectives in the environmental management system (EMS). Environmental release targets are not licensed release limits, but are guides in the design and development of the maximum predicted design release concentrations or the quantities that become the licensed release limits.

Environmental release targets are used as criteria to inform the design of wastewater treatment systems or air pollution control systems, in order to constrain the quantity and concentration of contaminants and physical stressors released into the environment. Environmental release targets ensure:

- risks to human health and the environment are mitigated
- the identification of acceptable control measures (including abatement strategies) for pollution prevention (for example, to establish a minimum level of protection across a specified industrial sector)
- continuous improvement for proactive pollution prevention and control (for example, for those adopted into the environmental management system (EMS) as continuous improvement objectives or targets)

To meet these objectives, environmental release targets are established using one of the following approaches:

- an exposure-based approach (to meet protective environmental quality guidelines at an acceptable location within the receiving environment)
- a technology-based approach (to meet technology-based licensed release limits or design requirements existing in federal, provincial/territorial or municipal requirements), or as specified by the CNSC
- a combination of exposure-based and technology-based approaches

The most restrictive environmental release targets should be used.

B.2 Overview of the process

The licensee should establish environmental release targets using a systematic and informed process.

A summary of a sample systematic and informed process is:

1. identify the final effluent or emission release points
2. identify the contaminants and physical stressors that require environmental release targets
3. where appropriate, identify existing federal, provincial, territorial and municipal requirements, and harmonize with those requirements
4. where step 3 does not apply:
    a. calculate the proposed environmental release targets for each contaminant and physical stressor, using one of the following approaches:
        i. an exposure-based approach for nuclear substances

ii. an exposure-based approach for hazardous substances
iii. a technology-based approach for nuclear and hazardous substances
Note: For substances that are considered both a nuclear substance and a hazardous substance (for example, uranium), calculate the proposed environmental release targets using all applicable approaches.

b. select the most restrictive environmental release targets identified in step a

5. document and justify selection of the proposed environmental release targets

For additional details on each step, see the following sections.

B.3 Identify final release points

The licensee should identify all points of controlled releases (effluent or emission) from the facility or activity to the environment.

B.4 Identify contaminants and physical stressors that require control

The licensee should conduct a screening assessment, as described in section 4.3, to identify the contaminants and physical stressors that require control, such as those that are:

- subject to existing federal, provincial, territorial or municipal requirements
- potentially exceeding federal, provincial or territorial environmental quality criteria prior to the consideration of treatment
- identified as exceeding standard conditional clearance levels established by the CNSC (see appendix A)
- meriting control (according to the environmental risk assessment (ERA))

B.5 Calculate the proposed environmental release target

The licensee should calculate a proposed environmental release target for each contaminant and physical stressor that has been identified.

The licensee should use either an exposure-based approach for nuclear substances, an exposure-based approach for hazardous substances, a technology-based approach, or a combination of all applicable approaches.

B.5.1 Exposure-based approach for nuclear substances

For nuclear substances, the licensee should develop environmental release targets using a structured approach. The following is a sample methodology:

- Identify an appropriate dose constraint to a representative person or critical group based on the historic performance of the facility or activity, or of existing similar facilities or activities
- For each radionuclide that may be released, calculate an environmental release target from the dose constraint to the effluent or emission source (back calculation) using an appropriate environmental transport and pathway exposure model

For additional guidance on appropriate environmental transport and exposure pathway models, see:

- REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures* [1]
- CSA N288.1, *Guidelines for modelling radionuclide environmental transport, fate, and exposure associated with the normal operation of nuclear facilities* [2]
- CSA N288.6, *Environmental risk assessment at Class I nuclear facilities and uranium mines and mills* [3]
- IAEA, TECDOC 1714, *Management of Discharge of Low Level Liquid Radioactive Waste Generated in Medical, Educational, Research and Industrial Facilities* [12]

Note: CNSC staff may accept the use of alternate methodologies based on the nature of the nuclear facility or activity.

B.5.2 Exposure-based approach for hazardous substances

For hazardous substances, the licensee should develop environmental release targets using a structured approach. The following is a sample methodology:

1. For each release point and contaminant or physical stressor identified as requiring control, identify the most restrictive criteria for each of the following:
   - most sensitive species or human receptors (generic or site-specific)
   - most reasonable end-use (for example, drinking water, recreational waters)
2. Determine the specific point within the environment at which the selected environmental quality criteria is expected to be achieved
3. Identify an appropriate environmental transport and exposure pathway model whose complexity is determined by the receptor or end-use as follows:
   - for releases to surface waters for the protection of aquatic life, protection of drinking water, or protection of recreational use, a simple mixing zone approach is acceptable
   - for releases to ambient air for the protection of human health, a point-of-impingement (POI) approach is acceptable
   - for all other releases, including those to groundwater for the protection of drinking water or other end-uses, the licensee should propose an appropriate model
4. Calculate the environmental release target from the receptor or end-use to the final point of release; this release target cannot be acutely lethal at the point of discharge (see section 3.1)

The most restrictive criteria may include:

- federal environmental quality guidelines; for example:
  - CCME *Guidance on the Site-Specific Application of Water Quality Guidelines in Canada* [20]
  - CCME *A Protocol for the Derivation of Water Quality Guidelines for the Protection of Aquatic Life 2007* [21]
- provincial or territorial standards, objectives, criteria or guidelines

The most sensitive site-specific species may be identified as a valued component and is generally informed by an ERA

For a POI approach, the POI is defined to align with the Ontario Ministry of Environment and Climate Change.

For more information about releases to groundwater, see CSA N288.7, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills* [4].

Mixing zones

For calculating the environmental release targets:

- where federal, provincial or territorial guidance exists for mixing zones, the licensee should follow that guidance
- where such guidance does not exist for mixing zones, the licensee should apply the general mixing zone rules shown in table A

Table A: General rules for using mixing zones for calculating environmental release targets (adapted from *Calculation and Interpretation of Effluent Discharge Objectives for Contaminants in the Aquatic Environmen*t, 2nd Edition [22])

Release point	Maximum mixing zone dilution factor
Lake	1 in 10
Slow-moving stream or river	1 in 100
Fast-moving stream or river	1 in 100 (based on critical low flow)
Groundwater	Modelled based on distance to the designated end use
Ambient air	Modelled based on distance from the stack to the POI using an acceptable dispersion model (for example, the AERMOD air dispersion model)

For more information on site-specific determination of the aerial extant of the initial mixing zone (also called a dilution zone), see provincial mixing zone guidance (for example, reference [22] and CCME *Guidance on the Site-Specific Application of Water Quality Guidelines in Canada)* [20]).

Releases to sewer

Releases to sewer are considered a special case.

For releases to sewer:

- the licensee should use applicable municipal bylaw limits as the environment release targets
- for substances where no limit is specified by the municipality, the licensee should use an exposure-based approach, where the calculation considers:
  - an appropriate mixing zone in the final receiving waterbody applied only to the volume of effluent released into the sewer by the licensee
  - additional dilution from the collection of other municipal waters by the municipal wastewater treatment plant

  Note: The calculation of the environmental release targets should not consider any treatment provided by the municipal wastewater treatment plant.

The mixing zone:

- applies only to the controlled volume regulated by the CNSC
- does not apply to the collection of other municipal waters, as they are not regulated by the CNSC

B.5.3 Technology-based approach

The licensee should develop the environmental release targets to ensure that acceptable control measures (including abatement strategies) for pollution prevention are applied by considering:

- any technology-based release limits or targets that already exist in other international, federal, provincial, territorial or municipal requirements and guidance
- any technology-based release targets established by the CNSC
- historical performance of the facility or activity, including known or identified loss-of-control events

Note 1: Technology-based release limits are included in federal and provincial legislation. For example, the *Metal and Diamond Mining Effluent Regulations* (SOR/2002-222) use technology-based release limits to establish a baseline level of protection across a specified industrial sector.

Note 2: When necessary, the CNSC may develop technology-based licensed release limits for substances of common concern within a sector.

B.6 Select the most restrictive environmental release targets

To ensure that all intended objectives are met, the licensee should review the environmental release targets that have been identified, and select the most restrictive ones.

B.7 Document and justify the selection

The licensee should document:

- the environmental release targets that have been selected
- the methodology used to establish them
- justification for selection of the final values

Appendix C: Guidance on Developing a Commissioning Plan and on Confirming Performance of a Treatment System

Some examples of treatment systems are wastewater control treatment systems and air pollution control treatment systems.

C.1 Additional guidance for developing a commissioning plan for a treatment system

As described in section 7, the applicant or licensee submits a commissioning plan to the CNSC. The commissioning plan should consider the following information.

Commissioning schedule and process

The applicant or licensee should establish a schedule (an expected timeframe) for completion of commissioning. The schedule should:

- consider seasonal variations and their effects on operations and process (for example, effects of levels of contaminants and physical stressors; volume of effluent)
- indicate the commissioning dates of different subsystems (for example, water treatment subsystems, residual solids management) and identify where limitations may be encountered (for example, delays in testing or delivery of specialty parts or equipment)

The applicant or licensee should describe the overall commissioning process; for example:

- factory acceptance testing
- installation acceptance inspection (also referred to as site acceptance testing (SAT))
- start-up testing
- non-active functional testing
- non-active operational training
- transition from non-active to active
- active operational training
- active performance testing

Description of responsibilities

The applicant or licensee should provide a list of position titles, a list of any external personnel involved in commissioning activities, and descriptions of their responsibilities.

For example, the applicant or licensee may include a description of the commissioning team, operations staff, licensing representatives, facility manager, management system personnel (in particular, those responsible for QA/QC), and external organizations.

Transitioning to the next stage of commissioning ("package turnover")

The applicant or licensee should describe the turnover process from inactive commissioning to active commissioning, and from active commissioning to operations. The description should include the contents of the turnover package.

Typical contents of a turnover package may include:

- operations and maintenance manuals and data
- standard operating procedures (SOPs)
- as-built drawings and specifications
- installation checklists, product information and data, and performance verification records
- spare parts, special tools, and maintenance materials
- materials samples and finishes, and related information
- training manuals and resources
- results of SAT and factory acceptance testing (FAT)
- inspection and manufacturer's certificates
- a final site survey

Operational performance

The applicant or licensee should describe the operational performance for commissioning activities, including:

- checking process systems and unit operations to ensure they are operating correctly
- an ongoing assessment of influent/effluent and/or emission quality, removal efficiencies, flow rates and total loadings
- any revisions to the operation and maintenance manual that reflect actual operating experiences
- operator training
- engineering consultation
- reviewing laboratory procedures
- other activities as appropriate to the facility or activity

Performance assessment

The applicant or licensee should describe the performance assessment, including an assessment of operational performance against the performance criteria developed during the design of the facility or activity (including all performance criteria, not specific to effluent or emissions quality).

With respect to effluent or emissions quality and regulatory requirements, the proposed licensed release limits and environmental release targets should be used as the criteria to assess the performance.

Management system (particularly quality assurance / quality control)

The applicant or licensee should provide a description of how the management system (particularly quality assurance and quality control) will be applied to commissioning. **Note:** Not all facilities or activities require a full management system.

Safety

The applicant or licensee should reference any occupational health and safety (OHS) and radiation protection requirements relevant during commissioning. In particular, any new safety aspects arising from the commissioning and eventual operation of the new system should be identified and addressed.

Training

The applicant or licensee should describe a training plan for the commissioning and operation of the treatment system that ensures the staff are trained appropriately. For more information, see REGDOC-2.2.2, *Personnel Training* [23].

Records and records maintenance

The applicant or licensee should provide references for records and records maintenance; for example:

- the SOPs that will be developed
- the process for revising, finalizing and maintaining the SOPs for each process or system as part of the systems operations and maintenance manuals, to reflect actual operating experience
- the results of SAT and FAT
- site drawings
- verification reports
- product information

Site plan and sample locations

The applicant or licensee should provide a site plan that includes:

- a process diagram of the treatment system
- the location of the influent and effluent and/or emissions sampling points (to assess the performance of pertinent unit operations)

C.2 Additional guidance for confirming performance of the treatment system

As described in section 7, the licensee confirms the performance of the treatment system.

Confirm whether the action levels remain appropriate

The licensee should review the commissioning performance results to confirm that the action levels remain indicative of a potential loss of control of the environmental protection program or control measures.

If the action levels do not remain appropriate, the licensee should revise them in accordance with CSA N288.8, *Establishing and implementing action levels for releases to the environment from nuclear facilities* [5].

The licensee may use the prospective approach and should update the action level documentation accordingly.

Assess the operating performance against the environmental targets

The licensee should assess the operating performance against the environmental targets. If any environmental targets cannot be met, the licensee should integrate them as objectives for continuous improvement within the licensee's environmental management system.

Develop a commissioning report

The commissioning report should include the following information:

- influent and effluent and/or emissions performance data
- calculated treatment efficiencies
- a comparison of actual performance data to the maximum predicted design releases
- trending of data over time
- a comparison of performance data to the environmental release targets
- confirmation that the action levels are appropriate
- confirmation that the licensed release limits are being met

Note: CNSC staff may conduct a commissioning inspection that includes taking independent influent and effluent samples to confirm the performance results.

Glossary

For definitions of terms used in this document, see REGDOC-3.6, *Glossary of CNSC Terminology*, which includes terms and definitions used in the *Nuclear Safety and Control Act* (NSCA) and the regulations made under it, and in CNSC regulatory documents and other publications. REGDOC-3.6 is provided for reference and information.

The following terms are either new terms being defined, or include revisions to the current definition for that term. Following public consultation, the final terms and definitions will be submitted for inclusion in the next revision of REGDOC-3.6, Glossary of CNSC Terminology.

action level *(French)*
An indicator of a potential loss of control of part of a licensee's program(s) or control measure(s). Exceeding an action level signals a potential reduction in effectiveness of the program and/or control measure(s) and may indicate a deviation from normal operation. Exceeding an action level is not a non-compliance, but triggers a requirement for specific action to be taken.

constraint *(French)*
From the *IAEA Safety Glossary*
A prospective and source related value of individual dose (see dose constraint) or of individual risk (see risk constraint) that is used in planned exposure situations as a parameter for the optimization of protection and safety for the source, and that serves as a boundary in defining the range of options in optimization

interim period *(French)*
With respect to environmental protection, the time from when adaptive management is triggered through to the completion of commissioning of the new treatment system or other control measures.

licensed limit *(French)*
A limit that is part of the licensing basis and, if exceeded, represents a loss of control of part of the licensee's program(s) or control measure(s). Exceeding a licensed release limit indicates that the licensee is operating outside their licensing basis for normal operation but does not necessarily imply an unreasonable risk to the environment, to the health and safety of persons or to national security. Exceeding a licensed release limit is a non-compliance and triggers a requirement for the licensee to take specific action. **Note:** The licensed release limits may include any limits specified in the licensing basis.

limitation *(French)*
With respect to environmental protection, a radiation protection principle that specifies the value of a quantity used in certain specified activities or circumstances that must not be exceeded such as the public dose limit.

major modification *(French)*
A modification that requires a change in the licensing basis for the facility or activity. Some examples of major modifications are:

- changes to the licensed physical facility, or to facility or activity processes, that have the potential to increase or change the nature of releases to the environment and the resulting risks to receptors
- a response to adaptive management
- a result of a periodic safety review (PSR)

maximum predicted design release *(French)*
The residual release characteristics (that is, quantities, concentrations and volumes) that are anticipated, following treatment and mitigation through the application of BATEA, to the maximum expected pollutant source characteristics.

mixing zone *(French)*
An area where an effluent discharge undergoes initial dilution and is extended to cover the secondary mixing in the ambient water body. A mixing zone is an allocated impact zone where water quality criteria can be exceeded as long as acutely toxic conditions are prevented. At the end of this zone, which determined the volume of water allotted for effluent dilution, the specified water quality criteria must be respected. The allocation of a mixing zone rests on the principle that a small zone of degradation can exist without harming the sustainability of the ecosystem as a whole.

optimization *(French)*
With respect to environmental protection, the process of determining what level of protection and safety makes exposures and the probability and magnitude of potential exposures, as low as reasonably achievable, economic and social factors being taken into account.

planned exposure *(French)*
The situation of exposure that arises from the planned operation of a source or from a planned activity that results in an exposure due to a source.

- Since provision for protection and safety can be made before embarking on the activity concerned, associated exposures and their probabilities of occurrence can be restricted from the outset.
- The primary means of controlling exposure in planned exposure situations is by good design of installations, equipment and operating procedures. In planned exposure situations, a certain level of exposure is expected to occur.

point of impingement (POI) *(French)*
The nearest point where air contamination emitted by a source impinges on a building or beyond the property line; any point on the ground or on a receptor, such as nearby buildings, at which the highest concentration of a contaminant caused by the aggregate emission of that contaminant from a facility or activity is expected to occur. **Note:** For a facility, the point of impingement occurs outside the facility's property boundaries.

regulatory public dose limit *(French)*
The prescribed limit for the general public; as specified in the *Radiation Protection Regulations*, this limit is 1 milliSievert (mSv) per calendar year. This dose limit protects the public from radiation resulting from the normal operation of a nuclear facility or activity regulated under the *Nuclear Safety and Control Act*.

References

The CNSC may include references to information on best practices and standards such as those published by CSA Group. With permission of the publisher, CSA Group, all nuclear-related CSA standards may be viewed at no cost through the CNSC Web page "How to gain free access to all nuclear-related CSA standards".

1. Canadian Nuclear Safety Commission (CNSC), REGDOC-2.9.1, *Environmental Principles, Assessments and Protection Measures* 1.1, Ottawa, Canada, 2017.
2. CSA Group, CSA N288.1, *Guidelines for modelling radionuclide environmental transport, fate, and exposure associated with the normal operation of nuclear facilities*.
3. CSA Group, CSA N288.6, *Environmental risk assessment at Class I nuclear facilities and uranium mines and mills*.
4. CSA Group, CSA N288.7, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills*.
5. CSA Group, CSA N288.8, *Establishing and implementing action levels for releases to the environment from nuclear facilities*.
6. IAEA, IAEA GSG-9: *Regulatory control of discharges to the environment: General Safety Guide*, Vienna, Austria, 2018.
7. CNSC, REGDOC-2.3.3, *Periodic Safety Reviews*, Ottawa, Canada, 2015.
8. CNSC, REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*, Ottawa, Canada, 2016.
9. CNSC, REGDOC-3.1.2, Reporting Requirements, Volume 1: *Non-Power Reactor Class I Facilities and Uranium Mines and Mills*, Ottawa, Canada, 2018.
10. CNSC, REGDOC-3.2.1, *Public Information and Disclosure*, Ottawa, Canada, 2018.
11. CNSC, REGDOC-2.6.3, *Aging Management*, Ottawa, Canada, 2014.
12. IAEA, IAEA TECDOC 1714, *Management of Discharge of Low Level Liquid Radioactive Waste Generated in Medical, Educational, Research and Industrial Facilities*, Vienna, Austria, 2013
13. CNSC, REGDOC-3.1.3, *Reporting Requirements for Waste Nuclear Substance Licensees, Class II Nuclear Facilities and Users of Prescribed Equipment, Nuclear Substances and Radiation Devices*, Ottawa, Canada, 2020.
14. CNSC, REGDOC-3.6, *Glossary of CNSC Terminology*, Ottawa, Canada, 2018.
15. CNSC, REGDOC-2.3.1, *Conduct of Licensed Activities: Construction and Commissioning Programs*, Ottawa, Canada, 2016.
16. U.S. Department of Defense, Military Handbook: *Planning and Commissioning Wastewater Treatment Plants*, MIL-HDBK-353, United States of America, 1996.
17. IAEA, GSR Part 3, *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards*, Vienna, Austria, 2014.
18. IAEA, TECDOC-1000, *Clearance of Materials Resulting from the Use of Radionuclides in Medicine, Industry and Research*, Vienna, Austria, 1998.
19. IAEA, Safety Series No. 19, *Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment*, Vienna, Austria, 2001.

20. Canadian Council of Ministers of the Environment (CCME), Canadian Water Quality Guidelines for the Protection of Aquatic Life, *Guidance on the Site-Specific Application of Water Quality Guidelines in Canada*, 2003.

21. CCME, Canadian Water Quality Guidelines for the Protection of Aquatic Life, *A Protocol for the Derivation of Water Quality Guidelines for the Protection of Aquatic Life*, 2007.

22. Ministère du Développement durable, Environnement et Parcs Québec, *Calculation and Interpretation of Effluent Discharge Objectives for Contaminants in the Aquatic Environment*, 2nd Edition, 2007 (translation, 2008).

23. CNSC, REGDOC-2.2.2, *Personnel Training*, Ottawa, Canada, 2016.

Additional Information

The CNSC may recommend additional information on best practices and standards such as those published by CSA Group. With permission of the publisher, CSA Group, all nuclear-related CSA standards may be viewed at no cost through the CNSC webpage "How to gain free access to all nuclear-related CSA standards".

The following documents provide additional information that may be relevant and useful for understanding the requirements and guidance provided in this regulatory document:

- International Atomic Energy Agency (IAEA), *Clearance of Materials Resulting from the Use of Radionuclides in Medicine, Industry and Research*, IAEA-TECDOC-1000, 1998.
- IAEA, *Application of the Concepts of Exclusion, Exemption and Clearance*, IAEA Safety Guide No. RS-G-1.7., 2004.
- IAEA, *Generic Models for use in Assessing the Impact of Discharges of Radioactive Substances to the Environment*, Safety Series No. 19, 2001.
- Canadian Environmental Assessment Agency, *Practitioners Glossary for the Environmental Assessment of Designated Projects Under the Canadian Environmental Assessment Act, 2012*, Ottawa, Canada
- CNSC, process map (a detailed process flowchart for new facilities or activities; for existing facilities or activities that are undergoing major modifications; and for existing facilities or activities under normal operations).
- CSA Group, CAN/CSA ISO 14001, *Environmental Management Systems – Requirements with Guidance for Use*, 2004 (1st edition).
  or
  CSA Group, CAN/CSA ISO 14001, *Environmental Management Systems – Requirements with Guidance for Use* (successor editions).
- CSA Group, CSA N288.3.4, *Performance testing of nuclear air-cleaning systems at nuclear facilities*, reaffirmed in 2018.
- CSA Group, CSA N288.4, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills.*
- CSA Group, CSA N288.5, *Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills.*
- Government of Canada, A Framework for the Application of Precaution in Science-based Decision Making about Risk, Ottawa Canada, 2003.
- International Atomic Energy Agency (IAEA), General Safety Guide No. GSG-9, *Regulatory Control of Radioactive Discharges to the Environment*, Vienna, Austria, 2018.
- IAEA, General Safety Requirements No. GSR Part 3, *Radiation Protection and Safety of Radiation Sources: International Basis Safety Standards*, Vienna, Austria, 2014.
- United States Environmental Protection Agency (USEP), *Guidance on the Development, Evaluation, and Application of Environmental Models*, Washington, DC, USA, 2009.

CNSC Regulatory Document Series

Facilities and activities within the nuclear sector in Canada are regulated by the CNSC. In addition to the *Nuclear Safety and Control Act* and associated regulations, these facilities and activities may also be required to comply with other regulatory instruments such as regulatory documents or standards.

CNSC regulatory documents are classified under the following categories and series:

1.0 Regulated facilities and activities

Series 1.1 Reactor facilities
1.2 Class IB facilities
1.3 Uranium mines and mills
1.4 Class II facilities
1.5 Certification of prescribed equipment
1.6 Nuclear substances and radiation devices

2.0 Safety and control areas

Series 2.1 Management system
2.2 Human performance management
2.3 Operating performance
2.4 Safety analysis
2.5 Physical design
2.6 Fitness for service
2.7 Radiation protection
2.8 Conventional health and safety
2.9 Environmental protection
2.10 Emergency management and fire protection
2.11 Waste management
2.12 Security
2.13 Safeguards and non-proliferation
2.14 Packaging and transport

3.0 Other regulatory areas

Series 3.1 Reporting requirements
3.2 Public and Indigenous engagement
3.3 Financial guarantees
3.4 Commission proceedings
3.5 CNSC processes and practices
3.6 Glossary of CNSC terminology

Note: The regulatory document series may be adjusted periodically by the CNSC. Each regulatory document series listed above may contain multiple regulatory documents. Visit the CNSC's website for the latest list of regulatory documents.