

# Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills



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N288.5-11

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Class I nuclear facilities and  
uranium mines and mills***



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# ***Technical Committee on Environmental Management for Nuclear Facilities***

<b>J. Ryan</b>	CANDU Owners Group Inc., Toronto, Ontario	<i>Chair</i>
<b>A. Rosaasen</b>	AREVA Resources Canada Inc., Saskatoon, Saskatchewan	<i>Vice-Chair</i>
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<b>I. Benovich</b>	Enviro Health Physics Consulting Inc., Thornhill, Ontario	<i>Associate</i>
<b>H. Carisse</b>	Cameco Corporation, Port Hope, Ontario	
<b>R. Catalan</b>	Bruce Power, Tiverton, Ontario	
<b>D.B. Chambers</b>	SENEC Consultants Limited, Richmond Hill, Ontario	<i>Associate</i>
<b>G.M. Dolinar</b>	Atomic Energy of Canada Limited, Chalk River, Ontario	
<b>N.C. Garisto</b>	SENEC Consultants Limited, Richmond Hill, Ontario	
<b>M.G. Grey</b>	Candesco Corporation, Toronto, Ontario	
<b>M. Hamlat</b>	Canadian Nuclear Safety Commission, Ottawa, Ontario	<i>Associate</i>
<b>D. Hart</b>	EcoMetrix Incorporated, Mississauga, Ontario	
<b>T. Jerv</b>	Kinectrics Inc., Toronto, Ontario	
<b>J.F. Lafortune</b>	International Safety Research, Ottawa, Ontario	<i>Associate</i>

<b>F.J. Lemay</b>	International Safety Research, Ottawa, Ontario	
<b>J. McCulley</b>	NB Power Nuclear Corporation, Fredericton, New Brunswick	
<b>I. Mitchell</b>	Ontario Ministry of the Environment, Owen Sound, Ontario	
<b>S.T. Moulding</b>	Saskatchewan Ministry of Environment, Saskatoon, Saskatchewan	<i>Associate</i>
<b>T.J. Stocki</b>	Health Canada, Ottawa, Ontario	
<b>P. Thompson</b>	Canadian Nuclear Safety Commission, Ottawa, Ontario	
<b>A. Trudel</b>	TRIUMF, Vancouver, British Columbia	
<b>D. Villeneuve</b>	Hydro-Québec Production, Trois-Rivières, Québec	
<b>S. Oh</b>	Canadian Standards Association, Mississauga, Ontario	<i>Project Manager</i>

# ***Subcommittee on Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills***

<b>T.D. Le</b>	Ontario Power Generation Inc., Pickering, Ontario	<i>Chair</i>
<b>A. Rosaasen</b>	AREVA Resources Canada Inc., Saskatoon, Saskatchewan	<i>Vice-Chair</i>
<b>H. Carisse</b>	Cameco Corporation, Port Hope, Ontario	
<b>R. Catalan</b>	Bruce Power, Tiverton, Ontario	
<b>G.M. Dolinar</b>	Atomic Energy of Canada Limited, Chalk River, Ontario	
<b>C. Gallagher</b>	Atomic Energy of Canada Limited, Chalk River, Ontario	
<b>M. Greenall</b>	Ontario Power Generation Inc., Pickering, Ontario	
<b>M.G. Grey</b>	Candesco Corporation, Toronto, Ontario	
<b>D. Hart</b>	EcoMetrix Incorporated, Mississauga, Ontario	
<b>T. Jarv</b>	Kinectrics Inc., Toronto, Ontario	
<b>J.F. Lafortune</b>	International Safety Research, Ottawa, Ontario	
<b>R. Laporte</b>	Hydro-Québec Centrale nucléaire Gentilly-2, Bécancour, Québec	
<b>F.J. Lemay</b>	International Safety Research, Ottawa, Ontario	
<b>J. McCulley</b>	NB Power Nuclear Corporation, Fredericton, New Brunswick	
<b>R. Nicholson</b>	EcoMetrix Incorporated, Mississauga, Ontario	

<b>R. Parker</b>	Candesco Corporation, Toronto, Ontario	
<b>A.R. Ray</b>	Canadian Nuclear Safety Commission, Ottawa, Ontario	
<b>J. Ryan</b>	CANDU Owners Group Inc., Toronto, Ontario	
<b>E. Thomas</b>	Kinectrics Inc., Toronto, Ontario	
<b>A. Trudel</b>	TRIUMF, Vancouver, British Columbia	
<b>S. Oh</b>	Canadian Standards Association, Mississauga, Ontario	<i>Project Manager</i>

# Preface

This is the first edition of CSA N288.5, *Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills*. It is part of a series of Standards and guidelines on environmental management of nuclear facilities.

This Standard addresses the design, implementation, and management of an effluent monitoring program that meets legal and business requirements and incorporates current best practices and technologies used internationally.

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

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

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

April 2011

## Notes:

- (1) Use of the singular does not exclude the plural (and vice versa) when the sense allows.
- (2) Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.
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# N288.5-11

## ***Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills***

### **0 Introduction**

#### **0.1 Regulatory requirements for nuclear and hazardous substances**

##### **0.1.1**

Nuclear facilities or licensed activities can release hazardous or nuclear substances to the surrounding environment. Various federal and provincial/territorial regulations require licensees to monitor and report on the characteristics of airborne and waterborne effluents (e.g., the quantity and concentration of nuclear and hazardous substances that are emitted to the environment). This Standard expands on some of the basic regulatory requirements and provides specific details on developing acceptable effluent monitoring programs.

##### **0.1.2**

Licensees are required to comply with any statutes, regulations, licences, or permits that govern the operation of the nuclear facility or licensed activity. Examples of applicable regulations include

- (a) *Radiation Protection Regulations* (SOR/2000-203);
- (b) *General Nuclear Safety and Control Regulations* (SOR/2000-202);
- (c) *Class I Nuclear Facilities Regulations* (SOR/2000-204);
- (d) *Uranium Mines and Mills Regulations* (SOR/2000-206);
- (e) *Metal Mining Effluent Regulations* (SOR/2002-222); and
- (f) other applicable requirements (e.g., municipal or provincial/territorial requirements).

##### **0.1.3**

Section 4(b) of the *Radiation Protection Regulations* requires licensees to implement a radiation protection program and to “ascertain the quantity and concentration of any nuclear substance released as a result of the licensed activity (i) by direct measurement as a result of monitoring, or (ii) if the time and resources required for direct measurement as a result of monitoring outweigh the usefulness of ascertaining the quantity and concentration using that method, by estimating them” (SOR/2000-203). Section 4(b) of the *Radiation Protection Regulations* applies to all activities that are licensed with the Canadian Nuclear Safety Commission (CNSC).

##### **0.1.4**

Licensees are required by the *General Nuclear Safety and Control Regulations* to submit with the application for a licence, the proposed action levels. Action levels can be used to help monitor and maintain the effectiveness of the radiation protection program and environmental protection program implemented.

**Note:** CNSC G-228 provides guidance on how licensees can develop action levels for radiation protection purposes.

### 0.1.5

Licensees can also be bound by specific licence conditions. For example, derived release limits (DRLs), which place restrictions on the maximum quantity of nuclear substances that can be emitted from a facility, become regulatory requirements if they are written into the facility licence. A release permit can also contain conditions that place restrictions on the discharge of hazardous and/or nuclear substances.

#### Notes:

- (1) CSA N288.1 can be used by licensees to develop DRLs for releases to the atmosphere and to surface water (both fresh and marine).
- (2) A release permit is also known as an Air/Water Quality Approval to Operate (New Brunswick), Certificate of Approval (Ontario), Certificate of Authorization (Québec), or Approval to Operate a Pollutant Control Facility (Saskatchewan).

### 0.1.6

Licensees are required by regulations to keep the doses to workers and members of the public as low as reasonably achievable (ALARA), with social and economic factors being taken into account. It is insufficient to only respect the dose limits.

### 0.1.7

The description of regulations discussed in [Clause 0.1](#) is not extensive, but has been included for information purposes. Depending on the licensed activity, there might be additional requirements or some of the identified regulations might not be applicable. The operator of the nuclear facility or licensed activity is responsible for ensuring compliance with the statutes, regulations, licences, or permits that govern the operation of the nuclear facility or licensed activity.

## 0.2 Effluent monitoring

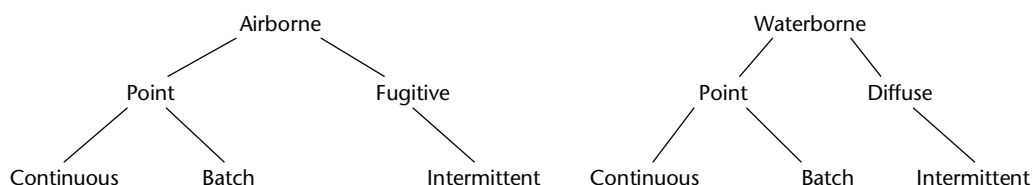
### 0.2.1 General

#### 0.2.1.1

Effluent monitoring is a regulated and risk-informed activity that quantifies or estimates the nuclear/hazardous substances being released into the environment as a result of the licensed activity.

#### 0.2.1.2

For the purposes of this Standard, effluent monitoring includes airborne and waterborne effluents. The various types of effluent streams can be categorized as illustrated in [Figure 0.1](#). Airborne effluents are often called emissions, and can be point source or fugitive emissions. Fugitive emissions (e.g., dust from a storage area) can be characterized in general as intermittent; they occur frequently from an area but are usually not continuous, and when they occur the duration of emission is usually not known in advance. Similarly, waterborne effluents can be point source or diffuse effluents. Diffuse effluents (e.g., seepages) can be characterized in general as intermittent; they occur frequently from an area but are usually not continuous, and when they occur the duration of flow is usually not known in advance. Point source emissions for air and water can be continuous (generally) or can be batch emissions.



**Figure 0.1**  
**Effluent types considered**  
 (See [Clause 0.2.1.2.](#))

## 0.2.2 Monitoring

### 0.2.2.1 General

Effluent monitoring can include

- (a) compliance monitoring;
- (b) process monitoring; and
- (c) supplementary studies.

**Note:** A single monitoring system can serve more than one function (e.g., pre-release sampling of a liquid waste storage tank could be used for both compliance monitoring and process monitoring purposes).

### 0.2.2.2 Compliance monitoring

Compliance monitoring is performed for regulatory purposes; it is intended to verify that releases are below the authorized limits imposed by any statute, regulation, licence, or permit that governs the operation of the nuclear facility or licensed activity. Compliance monitoring can include

- (a) real-time (or near real-time) measurements of effluent parameters (either instantaneous or time-averaged);
- (b) a posterior laboratory analysis of effluent samples; or
- (c) estimation of emissions.

**Note:** Effluent emissions can also be estimated without sampling or measurement. According to the Radiation Protection Regulations, estimation methods can be used if the time and resources required for direct measurement as a result of monitoring outweigh the usefulness of ascertaining the emissions through sampling or measurement (see [Clauses 7.5.2.3](#) and [7.5.3.3](#) for more guidance on estimation methods).

### 0.2.2.3 Process monitoring

#### 0.2.2.3.1

Process monitoring is performed to assist the licensee by ascertaining whether or not emissions control and pollution abatement systems are functioning as intended.

#### 0.2.2.3.2

Process monitoring is intended to allow operators to take timely action to ensure that effluent releases remain in control. As such, it generally requires the real-time (or near real-time) measurement of the instantaneous or short-term value of selected effluent parameters. For example, process monitoring could provide an indication that self-imposed limits such as investigation levels are being exceeded or that there are changes in effluent volumes or nuclear/hazardous substance concentrations that might require

- (a) shutdown or postponement of a release;
- (b) processing of an effluent to reduce the concentration of nuclear/hazardous substances prior to release; or
- (c) equipment upgrade or maintenance.

**Note:** For example, on-line monitoring of the concentration of a nuclear/hazardous substance in the gases vented from a system might reveal unexpected releases of a nuclear/hazardous substance, which could necessitate the shutdown of venting; or flow measurements might indicate that the volume of effluent being discharged will exceed permit limits.

#### 0.2.2.3.3

The results of process monitoring are generally not required for regulatory reporting (although performing process monitoring can be part of a licence requirement) so it might not be necessary to apply the same degree of rigour or quality assurance (QA) to process monitoring as would be necessary for compliance monitoring (which is performed for regulatory purposes).

**Note:** In some cases, a single measurement or a measurement process could serve as either process monitoring or compliance monitoring depending on the circumstances. For example, a single pre-release sample of the liquid waste in a storage tank could be analyzed to

- (a) determine if the concentrations of nuclear/hazardous substance in the waste are such that further processing is required before the contents of the tank could be discharged to the environment (process monitoring); or
- (b) measure the concentration of nuclear/hazardous substance for regulatory reporting purposes (compliance monitoring).

*In this case, the sampling and analysis would have to meet all of the requirements applicable to compliance monitoring, although it is also serving a process monitoring function.*

### **0.2.3 Supplementary studies**

Supplementary studies can occasionally be conducted to achieve specific, well-defined objectives such as

- (a) determining site-specific emissions factors, for use in subsequent estimation of emissions;
- (b) verifying the homogeneity of batch releases and confirming that the sampling being performed remains adequate;
- (c) verifying that the effluent flow rate can be considered constant; and
- (d) performing a toxicity identification evaluation (TIE).

## **0.3 Types of monitoring**

### **0.3.1**

Several different types of monitoring might be possible for any of the specific release scenarios, as follows:

- (a) continuous effluent monitoring (real-time measurement of the relevant parameters as the release occurs);
- (b) continuous or intermittent sampling followed by laboratory analysis of the sample(s); or
- (c) prediction of emissions based on site-specific emissions factors, mass balance considerations, or generic emissions factors.

**Note:** CCME PN 1423 gives examples of the types of monitoring for airborne effluents currently in use in Canada. Environment Canada EPS 2/MM/5 has information for monitoring waterborne effluents.

### **0.3.2**

The choice of the monitoring technique depends on the

- (a) characteristics and anticipated quantities of the nuclear/hazardous substances;
- (b) sensitivity of the available measurement systems;
- (c) expected variation with time, if any, of the release rates of the nuclear/hazardous substances; and
- (d) likelihood of unplanned releases that would require prompt detection and corrective action.

**Note:** Certain regulations prescribe specific monitoring techniques to be used.

### **0.3.3**

Monitoring should be performed at the point of release or before dilution occurs, but after any effluent treatment. In the case of batch releases, a sample can be taken from the reservoir containing the homogenized batch prior to release. Actions should be taken to ensure samples are representative.

### **0.3.4**

It might also be necessary to make provision for the accurate determination of the volume of effluent released over time so that the total quantity or loading of a nuclear or hazardous substance released can be determined from measurements of the concentration of a nuclear or hazardous substance in the effluent.

### **0.3.5**

Additional monitoring can be required, such as measuring flow rate and determining whether effluents are toxic and subject to routine toxicity testing (e.g., acute lethality tests on rainbow trout or *Daphnia magna*).

## **0.4 Relationship to environmental management system**

### **0.4.1**

An environmental management system (EMS) is a managed process used to develop and implement an environmental policy and manage significant environmental aspects. Environmental aspects are elements of an organization's activities, products, or services that can interact with the environment (ISO 14001).

An EMS provides an organization with a systematic method of managing those activities of its operations that interact with the environment and achieving its environmental obligations and performance goals.

### **0.4.2**

The ISO 14001 framework is based on the Plan-Do-Check-Act methodology, which

- (a) establishes the objectives and processes required to implement the organization's environmental policy;
- (b) implements the processes, monitors and measures processes against environmental policies, objectives, targets, legal, and other requirements, and reports results; and
- (c) takes actions to continually improve EMS performance.

Effluent monitoring falls under the checking phase, which requires an organization to monitor and measure on a regular basis the key characteristics of its operations that can have a significant environmental impact (see Clause 4.5.1 of ISO 14001).

## **0.5 Relationship to environmental risk assessment**

### **0.5.1**

An environmental risk assessment (ERA) is a process for identifying potential adverse environmental effects and for predicting the magnitude, probability, and significance of the identified effects associated with the nuclear facility or licensed activity. The ERA, or equivalent risk assessment, can be part of an environmental assessment (EA) or any other document that contains the required information.

### **0.5.2**

An ERA should provide input into the effluent monitoring program by identifying the specific nuclear/hazardous substances of concern and the sources or release points from the nuclear facility or licensed activity. An ERA also contributes to the development of effluent limits that are the focus of compliance monitoring.

### **0.5.3**

The effluent monitoring program can inform the ERA by providing the effluent loading that was used in estimating environmental exposure concentrations of nuclear and hazardous substances.

## **0.6 Relationship to environmental monitoring program**

### **0.6.1**

An environmental monitoring program (EMP) consists of a risk-informed set of integrated and documented activities to sample, measure, process, interpret, and report

- (a) the concentration of hazardous and/or nuclear substances in environmental media to assess one or both of
  - (i) exposure of receptors to those substances; and
  - (ii) the potential effects on human health, safety, and the environment;
- (b) the intensity of physical stressors and/or their potential effect on human health and the environment; and
- (c) the physical, chemical, and biological parameters of the environment pertinent to the design of the EMP.

**Note:** Further information on EMPs can be found in CSA N288.4.

### **0.6.2**

There should be integration between the effluent monitoring program and the EMP. The information obtained from one program can be used to provide a better understanding of and complement the other program. Effluent monitoring data can supplement existing EMP information or provide an alternative to environmental monitoring through modelling effluent dilution and resulting environmental concentrations, especially when concentrations are very low.

### 0.6.3

The division between environmental monitoring and effluent monitoring is often subjective and can be based on factors such as proximity to source, ability to control the release, and purpose of monitoring. The monitoring of some emissions, such as emissions from diffuse non-point sources (e.g., seepage into groundwater, runoff into surface water, and fugitive emissions to air), might legitimately be addressed through either environmental monitoring or effluent monitoring. The decision of where to address these emissions should be based on

- (a) consideration of the objectives of the two programs (one objective of both programs is to demonstrate compliance with applicable regulatory limits);
- (b) consideration of any other relevant technological, operational, economic, or site-specific factors (effluent monitoring is usually in or near a known source area and the source is often subject to operational controls);
- (c) consideration of the need for timely measurement results (i.e., when results might be required to take corrective action); and
- (d) professional judgment.

The primary consideration should be to ensure that all emissions that are identified as being of concern in an ERA are adequately assessed through either environmental monitoring or effluent monitoring.

**Note:** For example, the monitoring of fugitive dust emissions from a waste rock pile could be based on optical scattering measurements around the perimeter of the pile (effluent monitoring) or high volume air sampling in the surrounding environment (environmental monitoring). Either (or both) methods might be acceptable but there are differences, including capital cost, sensitivity, completeness of coverage, and the ability to uniquely identify the source of the particulates that could make one method preferable in a particular situation. Monitoring of air close to a source for the purpose of understanding fugitive emissions can be part of an effluent monitoring program.

## 1 Scope

### 1.1 Facilities

#### 1.1.1 Types of facilities

##### 1.1.1.1

This Standard addresses the design and operation of effluent monitoring programs for Class I nuclear facilities and uranium mines and mills. These facilities include

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

##### 1.1.1.2

Parts of this Standard could also be relevant to the design and operation of effluent monitoring programs for

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

However, in these situations, the operator of the facility or institution is responsible for determining the applicability and suitability of this Standard.

#### 1.1.2 Facility lifecycle

The nature and extent of effluent monitoring requirements change over the lifecycle of the facility. This Standard addresses monitoring performed during

- (a) site preparation, construction, and commissioning;