CSA N288.4:19

Environmental monitoring programs at nuclear facilities and uranium mines and mills

Legal Notice for Standards

Canadian Standards Association (operating as "CSA Group") develops standards through a consensus standards development process approved by the Standards Council of Canada. This process brings together volunteers representing varied viewpoints and interests to achieve consensus and develop a standard. Although CSA Group administers the process and establishes rules to promote fairness in achieving consensus, it does not independently test, evaluate, or verify the content of standards.

Disclaimer and exclusion of liability

This document is provided without any representations, warranties, or conditions of any kind, express or implied, including, without limitation, implied warranties or conditions concerning this document's fitness for a particular purpose or use, its merchantability, or its non-infringement of any third party's intellectual property rights. CSA Group does not warrant the accuracy, completeness, or currency of any of the information published in this document. CSA Group makes no representations or warranties regarding this document's compliance with any applicable statute, rule, or regulation.

IN NO EVENT SHALL CSA GROUP, ITS VOLUNTEERS, MEMBERS, SUBSIDIARIES, OR AFFILIATED COMPANIES, OR THEIR EMPLOYEES, DIRECTORS, OR OFFICERS, BE LIABLE FOR ANY DIRECT, INDIRECT, OR INCIDENTAL DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES, HOWSOEVER CAUSED, INCLUDING BUT NOT LIMITED TO SPECIAL OR CONSEQUENTIAL DAMAGES, LOST REVENUE, BUSINESS INTERRUPTION, LOST OR DAMAGED DATA, OR ANY OTHER COMMERCIAL OR ECONOMIC LOSS, WHETHER BASED IN CONTRACT, TORT (INCLUDING NEGLIGENCE), OR ANY OTHER THEORY OF LIABILITY, ARISING OUT OF OR RESULTING FROM ACCESS TO OR POSSESSION OR USE OF THIS DOCUMENT, EVEN IF CSA GROUP HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES.

In publishing and making this document available, CSA Group is not undertaking to render professional or other services for or on behalf of any person or entity or to perform any duty owed by any person or entity to another person or entity. The information in this document is directed to those who have the appropriate degree of experience to use and apply its contents, and CSA Group accepts no responsibility whatsoever arising in any way from any and all use of or reliance on the information contained in this document.

CSA Group is a private not-for-profit company that publishes voluntary standards and related documents. CSA Group has no power, nor does it undertake, to enforce compliance with the contents of the standards or other documents it publishes.

Intellectual property rights and ownership

As between CSA Group and the users of this document (whether it be in printed or electronic form), CSA Group is the owner, or the authorized licensee, of all works contained herein that are protected by copyright, all trade-marks (except as otherwise noted to the contrary), and all inventions and trade secrets that may be contained in this document, whether or not such inventions and trade secrets are protected by patents and applications for patents. Without limitation, the unauthorized use, modification, copying, or disclosure of this document may violate laws that protect CSA Group's and/or others' intellectual property and may give rise to a right in CSA Group and/or others to seek legal redress for such use, modification, copying, or disclosure. To the extent permitted by licence or by law, CSA Group reserves all intellectual property rights in this document.

Patent rights

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights. CSA Group shall not be held responsible for identifying any or all such patent rights. Users of this standard are expressly advised that determination of the validity of any such patent rights is entirely their own responsibility.

Authorized use of this document

This document is being provided by CSA Group for informational and non-commercial use only. The user of this document is authorized to do only the following:

If this document is in electronic form:

- load this document onto a computer for the sole purpose of reviewing it;
- search and browse this document; and
- print this document if it is in PDF format.

Limited copies of this document in printed or paper form may be distributed only to persons who are authorized by CSA Group to have such copies, and only if this Legal Notice appears on each such copy.

In addition, users may not and may not permit others to

- alter this document in any way or remove this Legal Notice from the attached standard;
- sell this document without authorization from CSA Group; or
- make an electronic copy of this document.

If you do not agree with any of the terms and conditions contained in this Legal Notice, you may not load or use this document or make any copies of the contents thereof, and if you do make such copies, you are required to destroy them immediately. Use of this document constitutes your acceptance of the terms and conditions of this Legal Notice.

Standards Update Service

CSA N288.4:19
September 2019

Title: *Environmental monitoring programs at nuclear facilities and uranium mines and mills*

To register for e-mail notification about any updates to this publication
- go to **store.csagroup.org**
- click on **Product Updates**

The **List ID** that you will need to register for updates to this publication is **2427[illegible]**

If you require assistance, please e-mail **techsupport@csagroup.org** or call 4[illegible]-747-2233.

Visit CSA Group's policy on privacy at **www.csagroup.org/legal** to find out how we protect your personal information.

CSA N288.4:19

Environmental monitoring programs at nuclear facilities and uranium mines and mills

Published in September 2019 by CSA Group
A not-for-profit private sector organization
178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3

To purchase standards and related publications, visit our Online Store at ***store.csagroup.org***
or call toll-free 1-800-463-6727 or 416-747-4044.

ISBN 978-1-4883-2236-5

Contents

Technical Committee on Environmental Management for Nuclear Facilities and the Strategic Steering Committee

C. Elwood	Bruce Power, Tiverton, Ontario, Canada *Category: Owner/Operator/Producer*	*Chair*
D.R. Hart	EcoMetrix Incorporated, Mississauga, Ontario, Canada *Category: Supplier/Fabricator/Contractor*	*Vice Chair*
K.T. Nagy	Cameco Corporation, Saskatoon, Saskatchewan, Canada *Category: Supplier/Fabricator/Contractor*	*Vice Chair*
N. Ali	Environment and Climate Change Canada, Toronto, Ontario, Canada *Category: Government and/or Regulatory Authority*	
D.B. Chambers	ARCADIS Canada Inc, Richmond Hill, Ontario, Canada	*Non-voting*
D. Chin-Cheong	Toronto, Ontario, Canada *Category: General Interest*	
E. Dagher	Canadian Nuclear Safety Commission (CNSC), Ottawa, Ontario, Canada	*Non-voting*
J. DeWilde	Golder Associates Ltd., Whitby, Ontario, Canada	*Non-voting*
G.M. Dolinar	Canadian Nuclear Laboratories Limited (CNL), Chalk River, Ontario, Canada *Category: Owner/Operator/Producer*	
K. England	Cameco Corporation, Saskatoon, Saskatchewan, Canada	*Non-voting*
P.C. Ernst	CANDU Owners Group Inc., Toronto, Ontario, Canada *Category: General Interest*	

C.M. Fietsch	Bruce Power, Tiverton, Ontario, Canada	*Non-voting*
C. Gallagher	Canadian Nuclear Laboratories Limited (CNL), Chalk River, Ontario, Canada	*Non-voting*
N.C. Garisto	ARCADIS Canada Inc, Richmond Hill, Ontario, Canada *Category: Supplier/Fabricator/Contractor*	
M. Gerchikov	AECOM, Guelph, Ontario, Canada *Category: Service Industry*	
M.G. Grey	Kinectrics Inc, Toronto, Ontario, Canada *Category: Service Industry*	
M. Hamlat	Canadian Nuclear Safety Commission, Ottawa, Ontario, Canada *Category: Government and/or Regulatory Authority*	
F.J. Lemay	Calian Group Ltd, Ottawa, Ontario, Canada *Category: Service Industry*	
R. McCalla	Ontario Power Generation, Pickering, Ontario, Canada *Category: Owner/Operator/Producer*	
J. McCulley	NB Power Corporation, Fredericton, New Brunswick, Canada *Category: Owner/Operator/Producer*	
I. Mitchell	Ministry of Environment, Conservation and Parks, Owen Sound, Ontario, Canada *Category: Government and/or Regulatory Authority*	
S.T. Mahlong	Saskatchewan Ministry of Environment, Saskatoon, Saskatchewan, Canada *Category: Government and/or Regulatory Authority*	
K. Parker	EcoMetrix Incorporated, Mississauga, Ontario, Canada	*Non-voting*

T. Repaso-Subang	Ramboll Environ, Mississauga, Ontario, Canada	*Non-voting*
A. Rosaasen	Orano Canada, Saskatoon, Saskatchewan, Canada *Category: Supplier/Fabricator/Contractor*	
C. Seymour	McMaster University, Hamilton, Ontario, Canada *Category: General Interest*	
E. Thomas	Kinectrics Inc., Toronto, Ontario, Canada	*Non-voting*
A. Trudel	TRIUMF, Vancouver, British Columbia, Canada *Category: General Interest*	
J. Lee	CSA Group, Toronto, Ontario, Canada	*Project Manager*

Subcommittee on Environmental Monitoring at Nuclear Facilities and Uranium Mines and Mills

C.M. Fietsch	Bruce Power, Tiverton, Ontario, Canada	*Co-Chair*
R. Kovacs	ARCADIS Canada Inc, Richmond Hill, Ontario, Canada	*Co-Chair*
B. Balicki	Cameco Corporation, Saskatoon, Saskatchewan, Canada	
M.K. Boileau	Canadian Nuclear Laboratories, Chalk River, Ontario, Canada	
M. Curtis	Ontario Power Generation, Pickering, Ontario, Canada	
P.C. Ernst	CANDU Owners Group Inc., Toronto, Ontario, Canada	
N.C. Garisto	ARCADIS Canada Inc, Richmond Hill, Ontario, Canada	
R. Goulet	Canadian Nuclear Safety Commission (CNSC), Ottawa, Ontario, Canada	
M.G. Grey	Kinectrics Inc, Toronto, Ontario, Canada	
J. Jacyk	Nuclear Waste Management Organization (NWMO), Toronto, Ontario, Canada	
D. Kim	Environment and Climate Change Canada, Toronto, Ontario, Canada	
T. Mahilrajan	BWXT Isotope Technologies, Ottawa, Ontario, Canada	

J. McCulley	NB Power Corporation, Fredericton, New Brunswick, Canada	
J. Mildenberger	TRIUMF, Vancouver, British Columbia, Canada	
A. Rosaasen	Orano Canada, Saskatoon, Saskatchewan, Canada	
C. Smith	Bruce Power, Tiverton, Ontario, Canada	
J. Tetreault	EcoMetrix Incorporated, Mississauga, Ontario, Canada	
J. Lee	CSA Group, Toronto, Ontario, Canada	*Project Manager*

Preface

This is the third edition of CSA N288.4, *Environmental monitoring programs at nuclear facilities and uranium mines and mills*. It supersedes the previous editions, published in 2010 under the title *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*, and in 1990 *under the title Guidelines for Radiological Monitoring of the Environment*.

The first edition of this Standard addressed only the monitoring of radioactive contaminants in the environment in pathways leading to human exposure. The scope of the second edition of this Standard was expanded to include protection of the environment in conformance with the regulations under the *Nuclear Safety and Control Act*, which came into force on May 31, 2000. As a result, the scope of the second edition was updated to include monitoring of radioactive and non-radioactive contaminants, physical stressors, potential biological effects, and pathways for both human and non-human biota.

This edition of this Standard has been updated to reflect current industry practice, and include new research and analysis methods. Major changes to this edition include the following:

a) The structure of the Standard and definitions have been updated for consistency with the CSA N288 series of Standards.
b) Administrative provisions (e.g., the term “Class 1”) were removed.
c) The duplicate generic requirements of CSA N286 were removed, with more specific direction for those requirements provided where necessary.
d) References to recently issued CSA N288 Standards are included to provide further clarification, and replace duplicated content (i.e., CSA N288.6, CSA N288.7, and CSA N288.9).
e) Additional guidance on analytical results that are below the decision threshold is provided in alignment with current industry standards.
f) New guidance from relevant publications addressing sampling, analysis, and quality assurance/ quality control has been incorporated.
g) Additional references and guidance on representative sampling, sampling media, and annual reviews have been included.
h) The former informative Annex A was removed, as it is addressed by CSA N288.6.

This Standard is part of the N288 series of Standards and Guidelines on environmental management for nuclear facilities.

The CSA N-Series Standards provide an interlinked set of requirements for the management of nuclear facilities and activities. CSA N286 provides overall direction to management to develop and implement sound management practices and controls, while the other CSA Group nuclear Standards provide technical requirements and guidance that support the management system. This Standard works in harmony with CSA N286 and does not duplicate the generic requirements of CSA N286; however, it may provide more specific direction for those requirements.

Users of this Standard are reminded that the design, manufacture, construction, commissioning, operation, and decommissioning of nuclear facilities in Canada are subject to the provisions of the *Nuclear Safety and Control Act* and its supporting Regulations.

This Standard was prepared by the Subcommittee on Environmental Monitoring at Nuclear Facilities and Uranium Mines and Mills, under the jurisdiction of the Technical Committee on Environmental

Management for Nuclear Facilities and the Strategic Steering Committee, and has been formally approved by the Technical Committee.

Notes:

1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
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.*
3) *This Standard was developed by consensus, which is defined by CSA Policy governing standardization — Code of good practice for standardization as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*
4) *To submit a request for interpretation of this Standard, please send the following information to inquiries@csagroup.org and include "Request for interpretation" in the subject line:*
   a) *define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*
   b) *provide an explanation of circumstances surrounding the actual field condition; and*
   c) *where possible, phrase the request in such a way that a specific "yes" or "no" answer will address the issue.*

   *Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization and are available on the Current Standards Activities page at **standardsactivities.csa.ca**.*
5) *This Standard is subject to review within five years from the date of publication. Suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line:*
   a) *Standard designation (number);*
   b) *relevant clause, table, and/or figure number;*
   c) *wording of the proposed change; and*
   d) *rationale for the change.*

CSA N288.4:19
Environmental monitoring programs at nuclear facilities and uranium mines and mills

0 Introduction

0.1 Background

0.1.1 Facility interactions with the environment

Throughout the course of its lifecycle, a nuclear facility can interact with the surrounding environment by

a) releasing hazardous and/or nuclear substances; and
b) imposing physical stressors.

0.1.2 Environmental protection framework

Nuclear facilities are required by the Authority Having Jurisdiction (AHJ) to demonstrate, through performance assessments, monitoring, or other activities, that they have made adequate provision for the protection of the environment, human health, and safety. Consequently, nuclear facilities can be required to perform a number of interrelated activities within their environmental protection programs.

Note: *A typical environmental protection framework is presented in Figure 1.*

An environmental protection framework typically encompasses an environmental assessment (EA) for the activity, or any other document that contains the required information. The EA typically includes a predictive environmental risk assessment (ERA). If the ERA identifies potential risk to humans or the environment, additional programs are implemented, such as

a) an effluent monitoring program to demonstrate controls on releases;
b) an environmental monitoring program (EMP) to confirm EA predictions are met;
c) supplementary studies to reduce uncertainties with the ERA;
d) a review of current science and potential implications to the ERA;
e) any other assessment and monitoring activity (e.g., entrainment, impingement, bird-structure mortality, or temperature changes); and
f) periodic updates of the ERA.

All of the above activities are integrated into an environmental management system (EMS).

Note: *See CNSC REGDOC-2.9.1 for information on environmental protection programs.*