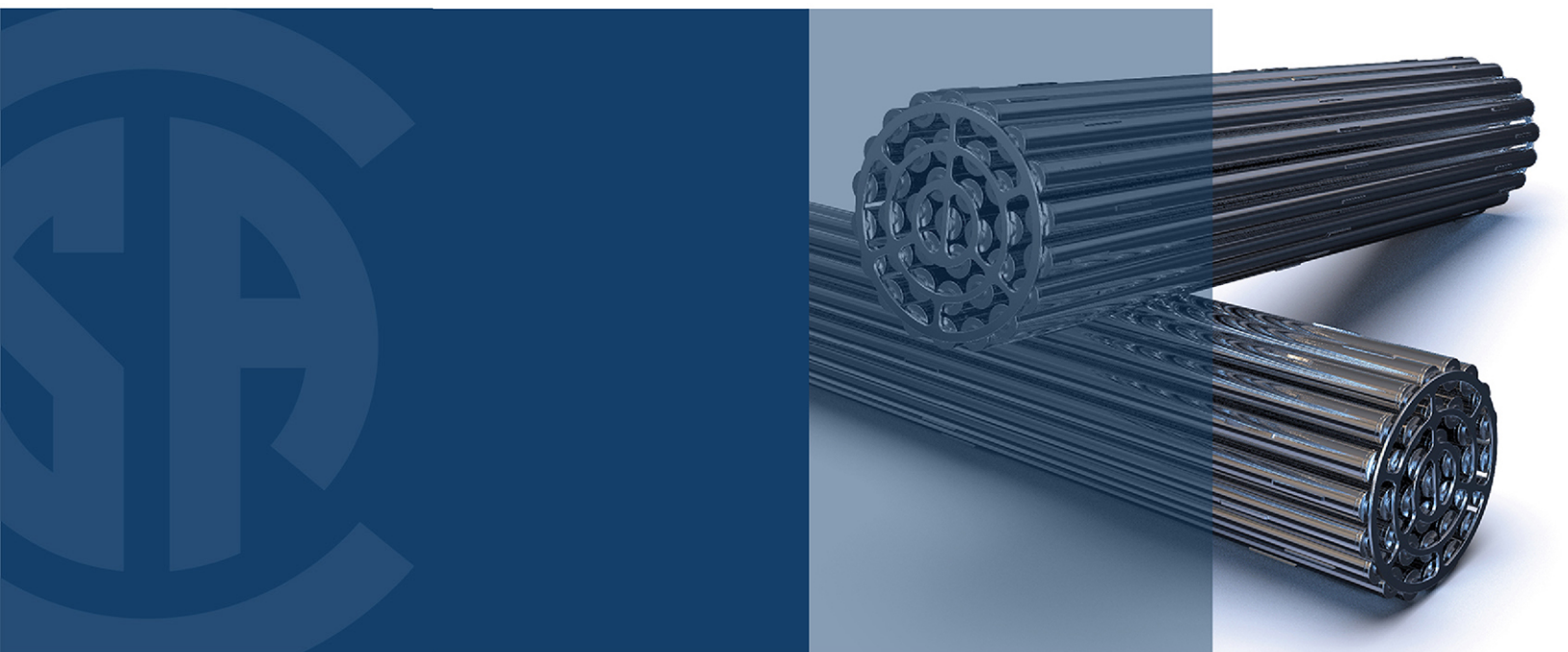


# **Periodic inspection of CANDU nuclear power plant balance of plant systems and components**



# 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 print 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 hereof, 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 N285.7:21*

*February 2021*

**Title:** *Periodic inspection of CANDU nuclear power plant balance of plant systems and components*

To register for e-mail notification about any updates to this publication

- go to [www.csagroup.org/store/](http://www.csagroup.org/store/)
- click on **Product Updates**

The **List ID** that you will need to register for updates to this publication is **2428528**.

If you require assistance, please e-mail [techsupport@csagroup.org](mailto:techsupport@csagroup.org) or call 416-747-2233.

Visit CSA Group's policy on privacy at [www.csagroup.org/legal](http://www.csagroup.org/legal) to find out how we protect your personal information.

***CSA N285.7:21***  
***Periodic inspection of CANDU  
nuclear power plant balance of  
plant systems and components***



*®A trademark of the Canadian Standards Association, operating as "CSA Group"*

*Published in February 2021 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 [www.csagroup.org/store/](http://www.csagroup.org/store/)  
or call toll-free 1-800-463-6727 or 416-747-4044.*

*ICS 27.120.20  
ISBN 978-1-4883-3393-4*

*© 2021 Canadian Standards Association  
All rights reserved. No part of this publication may be reproduced in any form whatsoever  
without the prior permission of the publisher.*

# Contents

Technical Committee on Periodic Inspection of Nuclear Power Plant Components 4

Preface 7

**1 Scope 9**

**2 Reference publications 10**

**3 Definitions 11**

**4 General requirements 15**

4.1 Prerequisites 15

4.1.1 Nature of periodic inspection 15

4.1.2 Operation and maintenance 16

4.1.3 Power plant operation 16

4.2 Hazards 16

4.3 Radiation exposure 16

4.4 Program documents 16

4.5 Operating organization's responsibility 17

4.6 Accessibility 18

4.6.1 Access for periodic inspection 18

4.6.2 Existing plants 18

**5 Examination methods, qualification, and procedures 18**

5.1 Examination methods 18

5.2 Examination procedures 19

5.2.10 Volumetric methods 20

5.3 Inspection qualification 21

**6 Examination personnel and qualifications 21**

6.1 Training and certification 21

6.2 Qualification 21

6.3 Records 22

**7 Evaluation of examination results 22**

7.1 Evaluation 22

7.2 General acceptance standards 22

7.3 Visual examination 22

7.4 Surface examination 23

7.5 Volumetric examination 23

7.6 Dimensional examination 23

7.7 Integrative examination 23

7.8 Dispositioning 24

7.8.1 General 24

7.8.2 Dispositioning while reactor at power 24

7.8.3 Dispositioning while reactor not at power 24

7.8.4 Dispositioning of minor conditions 25

|           |  |           |
|-----------|--|-----------|
| <b>8</b>  | <b>Repairs and replacements</b>                  | <b>25</b> |
| <b>9</b>  | <b>Modifications</b>                             | <b>26</b> |
| <b>10</b> | <b>Recording requirements and reports</b>        | <b>26</b> |
| 10.1      | General requirements                             | 26        |
| 10.2      | Periodic inspection records                      | 27        |
| 10.3      | Periodic inspection reports                      | 27        |
| 10.3.1    | Inaugural inspection reports                     | 27        |
| 10.3.2    | Periodic inspection reports                      | 27        |
| <b>11</b> | <b>Periodic inspection regions</b>               | <b>28</b> |
| 11.1      | Systems  | 28        |
| 11.1.1    | Systems subject to periodic inspection           | 28        |
| 11.1.2    | Extent of systems subject to periodic inspection | 28        |
| 11.2      | Grouping of systems and components               | 28        |
| 11.3      | Consequence and potential of failure assessments | 28        |
| 11.3.1    | Consequence of failure assessment                | 28        |
| 11.3.2    | Potential of failure assessment                  | 28        |
| 11.4      | Segment risk categorization                      | 29        |
| 11.5      | Element assessment and selection                 | 29        |
| 11.6      | Change-in-risk assessment                        | 29        |
| <b>12</b> | <b>Periodic inspection intervals</b>             | <b>30</b> |
| 12.1      | Operating systems                                | 30        |
| 12.1.5    | Inaugural inspection                             | 31        |
| 12.1.6    | Dormant systems                                  | 31        |
| <b>13</b> | <b>Periodic and inaugural inspections</b>        | <b>31</b> |
| 13.1      | General requirements                             | 31        |
| 13.1.1    | General  | 31        |
| 13.1.2    | Extent of periodic inspection                    | 31        |
| 13.1.3    | Periodic inspection for corrosion and erosion    | 32        |
| 13.2      | Piping   | 33        |
| 13.2.1    | General requirements                             | 33        |
| 13.2.2    | Extent of periodic inspection and sample size    | 33        |
| 13.2.3    | Periodic inspection intervals                    | 34        |
| 13.2.4    | Examination methods and procedures               | 34        |
| 13.2.5    | Evaluation of results and dispositioning         | 35        |
| 13.2.6    | Records and reports                              | 35        |
| 13.3      | Vessels  | 35        |
| 13.3.1    | General requirements                             | 35        |
| 13.3.2    | Extent of periodic inspection and sample size    | 35        |
| 13.3.3    | Periodic inspection intervals                    | 36        |
| 13.3.4    | Examination methods and procedures               | 37        |
| 13.3.5    | Evaluation of results and dispositioning         | 37        |
| 13.3.6    | Records and reports                              | 37        |
| 13.4      | Mechanical couplings                             | 37        |
| 13.4.1    | General requirements                             | 37        |

|                       |  |     |
|-----------------------|--|-----|
| 13.4.2                | Extent of periodic inspection and sample size  | 37  |
| 13.4.3                | Inspection intervals   | 39  |
| 13.4.4                | Examination methods and procedures   | 39  |
| 13.4.5                | Evaluation of results and dispositioning   | 39  |
| 13.4.6                | Records and reports  | 39  |
| 13.5                  | Pumps  | 39  |
| 13.5.1                | General requirements   | 39  |
| 13.5.2                | Extent of inspection and sample size   | 39  |
| 13.5.3                | Periodic inspection intervals  | 40  |
| 13.5.4                | Examination methods and procedures   | 41  |
| 13.5.5                | Evaluation of results and dispositioning   | 41  |
| 13.5.6                | Records and reports  | 41  |
| 13.6                  | Valves   | 41  |
| 13.6.1                | General requirements   | 41  |
| 13.6.2                | Extent of periodic inspection and sample size  | 41  |
| 13.6.3                | Periodic inspection intervals  | 42  |
| 13.6.4                | Examination methods and procedures   | 42  |
| 13.6.5                | Evaluation of results and dispositioning   | 43  |
| 13.6.6                | Records and reports  | 43  |
| 13.7                  | Supports   | 43  |
| 13.7.1                | General requirements   | 43  |
| 13.7.2                | Extent of periodic inspection and sample size  | 43  |
| 13.7.3                | Periodic inspection intervals  | 45  |
| 13.7.4                | Examination methods and procedures   | 45  |
| 13.7.5                | Evaluation of results and dispositioning   | 45  |
| 13.7.6                | Records and reports  | 45  |
| 13.8                  | Rotating machinery   | 45  |
| 13.8.1                | General requirements   | 45  |
| 13.8.2                | Extent of periodic inspection and sample size  | 46  |
| 13.8.3                | Periodic inspection intervals  | 46  |
| 13.8.4                | Examination methods and procedures   | 46  |
| 13.8.5                | Evaluation of results and dispositioning   | 47  |
| 13.8.6                | Records and reports  | 47  |
| <hr/>                 |  |     |
| Annex A (informative) | — Guide for periodic inspection  | 56  |
| Annex B (normative)   | — Pre-screening process  | 59  |
| Annex C (normative)   | — Consequence of failure assessment  | 66  |
| Annex D (normative)   | — Potential of failure assessment  | 76  |
| Annex E (normative)   | — Risk categorization, sample size determination, and element selection  | 152 |
| Annex F (informative) | — Rationale for grouping identical elements  | 155 |
| Annex G (informative) | — Guidance on obtaining AHJ acceptance of non-destructive examination<br>personnel certified to an operating organization-specified standard | 160 |

# Preface

This is the second edition of CSA N285.7, *Periodic inspection of CANDU nuclear power plant balance of plant systems and components*. It supersedes the previous edition published in 2015.

This Standard is one of a series of Standards intended to provide uniform requirements for CANDU® nuclear power plants.

**Note:** *CANDU (CANada Deuterium Uranium) is a registered trademark of Atomic Energy of Canada Limited (AECL).*

This Standard provides requirements for the periodic inspection of balance of plant systems and components.

The major changes to this edition include the following:

- a) an update to the definitions, specifically the definitions related to “inspection” and “examination”, affecting most clauses;
- b) general harmonization with CSA N285.4-19 and N285.5-18;
- c) revisions to Annexes [B](#), [C](#), and [D](#) for clarity of requirements based on application of risk informed rules to select locations for periodic inspection;
- d) improved clarity of pre-screening requirements for raw water systems to account for in-service inspection programs, availability of back-up systems and independent trains, evaluation of external events, and internal flooding probabilistic safety assessments (IFPSA);
- e) clarified timeline for notifying the authority having jurisdiction (AHJ) and obtaining AHJ acceptance of dispositions (Clause [7.8](#));
- f) clarified periodic inspection requirements for replaced components (Clause [8](#));
- g) added reporting requirements for confirmatory inspections (Clause [10.3](#));
- h) clarified requirements to defining a weld examination area that include a reasonable amount of base metal (Clause [13.1.2.3](#));
- i) clarified examination requirements for mechanical couplings, including removal of requirement to examine threaded ligaments (Clause [13.4.2](#));
- j) added guidance on approach to evaluation of examination results and use of acceptance standards (Clause [A.2](#)); and
- k) added provisions for use of non-destructive examination personnel certified to other than CGSB standards (new Annex [G](#)).

The CSA N-Series of Standards provides 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 might provide more specific direction for those requirements.

Users of this Standard are reminded that the operation of nuclear facilities in Canada is subject to the requirements of the *Nuclear Safety and Control Act* and Regulations. The Canadian Nuclear Safety Commission may impose additional requirements to those specified in this Standard.

Portions of this Standard have been developed using the Risk Informed In-service Inspection (RI-ISI) methodologies and definitions from ASME *BPVC* Section XI with 2011 Addenda, Code Case N-578-1, ASME RA-Sa-2009 and EPRI RI-ISI TR-112657 Rev B-A. Excerpts are reprinted with permission from The American Society of Mechanical Engineers, Electric Power Research Institute, Inc., and International Atomic Energy Agency.



In order to facilitate adoption by the authority having jurisdiction, this Standard includes some regulatory provisions.

This Standard was prepared by the Technical Committee on Periodic Inspection of Nuclear Power Plant Components, under the jurisdiction of the Strategic Steering Committee on Nuclear Standards, 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](mailto: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](http://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](mailto: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 N285.7:21

## ***Periodic inspection of CANDU nuclear power plant balance of plant systems and components***

### **1 Scope**

#### **1.1**

This Standard defines requirements for the periodic inspection of balance of plant pressure-retaining systems, components, and supports that form part of a CANDU nuclear power plant using a risk informed in-service inspection (RI-ISI) methodology. Periodic inspection (see Annex [A](#) for additional guidance) is considered to include the fluid boundary portions of balance of plant systems, components, and piping, including their supports that comprise a complete nuclear power plant, excluding the following systems or portions thereof:

- a) Systems, and systems connected thereto, containing the fluid that, under normal conditions, directly transports heat from nuclear fuel, and other systems whose failure can result in a significant release of radioactive substances.

**Note:** *These systems or portions of systems are subject to periodic inspection in accordance with Clause 3.3.1 a) in CSA N285.4.*

- b) Systems essential for the safe shutdown of the reactor and/or the safe cooling of the nuclear fuel in the event of a process system failure.

**Note:** *These systems or portions of systems are subject to periodic inspection in accordance with Clause 3.3.1 b) in CSA N285.4.*

Compressors, turbines, generators, engines, internal components of vessels and heat exchangers, and hydraulic or pneumatic cylinders are exempt from the periodic inspection requirements of this Standard. This includes piping internal to equipment or mounted upon equipment that carries fluid from one chamber to another on the same foundation.

**Note:** *To arrive at a periodic inspection program, the user should consider the examinations and tests performed by other programs such as pipe wall thinning, vessel examinations, equipment reliability, and maintenance programs in addition to RI-ISI. Examinations performed as part of supporting programs are not expected to be repeated in this periodic inspection program, but should be credited to this periodic inspection program to provide assurance that the program satisfies the intended purpose as described in Annex [A](#).*

#### **1.2**

This Standard addresses the following requirements:

- a) failure aspects;
- b) classification of areas subject to periodic inspection;
- c) provision for access;
- d) examination techniques and procedures;
- e) personnel qualifications;
- f) frequency of periodic inspection;
- g) responsibilities;
- h) documentation;