Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Regulatory Standard

S–210

Maintenance Programs for Nuclear Power Plants

July 2007

Canada

TYPES OF REGULATORY DOCUMENTS

Regulatory documents support the Canadian Nuclear Safety Commission (CNSC) regulatory framework. By expanding on expectations set out in general terms in the *Nuclear Safety and Control Act* and associated regulations, regulatory documents provide one of the core management tools upon which the CNSC relies to fulfill its legislated obligations.

The regulatory documents most commonly published by the CNSC are *regulatory policies*, *regulatory standards*, and *regulatory guides*. At the highest level, regulatory policies provide the direction for regulatory standards and guides, which serve as the policy "instruments." A fourth type of regulatory document, the *regulatory notice*, is issued when warranted. Because the information in a *regulatory notice* must be conveyed with relative urgency, the development process is faster than that applied to the other documents.

Regulatory Policy (P): The regulatory policy describes the philosophy, principles or fundamental factors on which the regulatory activities associated with a particular topic or area of concern are based. It describes why a regulatory activity is warranted, and therefore promotes consistency in the interpretation of regulatory requirements.

Regulatory Standard (S): The regulatory standard clarifies CNSC expectations of what the licensee should do, and becomes a legal requirement when it is referenced in a licence or other legally enforceable instrument. The regulatory standard provides detailed explanation of the outcomes the CNSC expects the licensee to achieve.

Regulatory Guide (G): The regulatory guide informs licensees about how they can meet CNSC expectations and requirements. It provides licensees with a recommended approach for meeting particular aspects of the requirements and expectations associated with their respective licensed activities.

Regulatory Notice (N): The regulatory notice notifies licensees and other stakeholders about significant matters that warrant timely action.

Regulatory Standard

S–210

MAINTENANCE PROGRAMS FOR NUCLEAR POWER PLANTS

Published by the
Canadian Nuclear Safety Commission
July 2007

Maintenance Programs for Nuclear Power Plants

Regulatory Standard S–210

Published by the Canadian Nuclear Safety Commission

Catalogue number: CC173-3/3-210E-PDF
ISBN 978-0-662-46648-2

Ce document est également disponible en français sous le titre *Programmes d'entretien des centrales nucléaires*.

Document availability

The document can be viewed on the CNSC web site at www.nuclearsafety.gc.ca. Copies may be ordered in English or French using the contact information below:

Office of Communications and Regulatory Affairs
Canadian Nuclear Safety Commission
P.O. Box 1046, Station B
280 Slater Street
Ottawa, Ontario, CANADA, K1P 5S9

Telephone: 613-995-5894 or 1-800-668-5284 (Canada only)
Facsimile: 613-992-2915
E-mail: info@cnsc-ccsn.gc.ca

TABLE OF CONTENTS

MAINTENANCE PROGRAMS FOR NUCLEAR POWER PLANTS

1.0 PURPOSE

The purpose of this regulatory standard is to set out the expectations of the Canadian Nuclear Safety Commission (CNSC) with regard to maintenance program requirements that nuclear power plant (NPP) licensees shall implement.

When incorporated into a licence or other legally enforceable instrument, this regulatory standard becomes a legal requirement.

2.0 SCOPE

This regulatory standard sets out the elements of an NPP maintenance program. Such a program consists of policies, processes and procedures that provide direction for maintaining structures, systems or components (SSCs) of the plant.

The range of maintenance activities includes monitoring, inspecting, testing, assessing, calibrating, servicing, overhauling, repairing, and replacement of parts. The type of maintenance activity and frequency applied to each SSC shall be commensurate with importance to safety, design function and required performance.

It is not the intent of this standard to override requirements provided by other codes and standards but rather to provide the framework within which codes and standards are applied to ensure that SSCs function as per design.

3.0 RELEVANT LEGISLATION

The following provisions of the *Nuclear Safety and Control Act* (NSCA), and the regulations made under the NSCA are relevant to this standard:

1. Subsection 24(4) of the NSCA prohibits the Commission from issuing, renewing, amending or replacing a licence, unless in the opinion of the Commission, the applicant (a) "is qualified to carry on the activity that the licence will authorize the licensee to carry on", and (b) "will in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed";
2. Subsection 24(5) of the NSCA provides that a licence issued by Canadian Nuclear Safety Commission may contain any term or condition that the Commission considers necessary for the purposes of the NSCA;

3. Subsection 12(1) of the *General Nuclear Safety and Control Regulations* stipulates that every licensee shall "(a) ensure the presence of a sufficient number of qualified workers to carry on the licensed activity safely and in accordance with the NSCA, the regulations made under the act and the licence, (b) train the workers to carry on the licensed activity in accordance with the NSCA, the regulations made under the NSCA and the licence, (c) take all reasonable precautions to protect the environment and the health and safety of persons and to maintain security; (d) provide the devices required by the NSCA, the regulations made under the NSCA and the licence and maintain them within the manufacturer's specifications"; and "(e) require that every person at the site of the licensed activity use equipment, devices, clothing and procedures in accordance with the NSCA, the regulations made under the NSCA and the licence";
4. Paragraph 6(*d*) of the *Class I Nuclear Facilities Regulations* stipulates that an application for a licence to operate a Class I nuclear facility shall contain, in addition to other information, "the proposed measures, policies, methods and procedures for operating and maintaining the nuclear facility";
5. Paragraph 6(*m*) of the *Class I Nuclear Facilities Regulations* stipulates that an application for a licence to operate a Class I nuclear facility shall contain, in addition to other information, "the proposed responsibilities of and qualification requirements and training program for workers, including the procedures for the requalification of workers";
6. Paragraph 6(*n*) of the *Class I Nuclear Facilities Regulations* stipulates that an application for a licence to operate a Class I nuclear facility shall contain, in addition to other information, "the results that have been achieved in implementing the program for recruiting, training and qualifying workers in respect of the operation and maintenance of the nuclear facility";
7. Subsection 14(2) of the *Class I Nuclear Facilities Regulations* stipulates that every licensee who operates a Class I facility shall keep a record of (a) "operating and maintenance procedures" and (c) "the results of the inspection and maintenance programs referred to in the licence";
8. Subsection 14(4) of the *Class I Nuclear Facilities Regulations* requires that every person who is required by 14(2) of those regulations to keep records of the "operating and maintenance procedures" and "the results of the inspection and maintenance programs referred to in the licence," retain the required records "for 10 years after the expiry date of the licence to abandon issued in respect of the Class I facility."

4.0 BACKGROUND

Effective maintenance is essential for the safe operation of a nuclear power plant. The facility must be monitored, inspected, tested, assessed and maintained to ensure that SSCs function as per design. Various maintenance concepts can be used to form a maintenance strategy.

Figure 1 illustrates an example of the relationship of maintenance concepts and associated maintenance activities that provide the basis of a good maintenance strategy. This strategy would be supported by the maintenance program.

The majority of maintenance activities are traditionally allocated to the concept of preventive maintenance. These maintenance activities can be derived, for example, from the safety analysis assumptions, design or reliability requirements, codes and standards, and operating experience and are performed on the basis of time, actual condition or predicted condition. Where the performance or condition of an SSC does not allow it to function as per design, corrective action must be taken.

The results of all maintenance activities are fed back through an optimization process which enables the continuous improvement of the program.

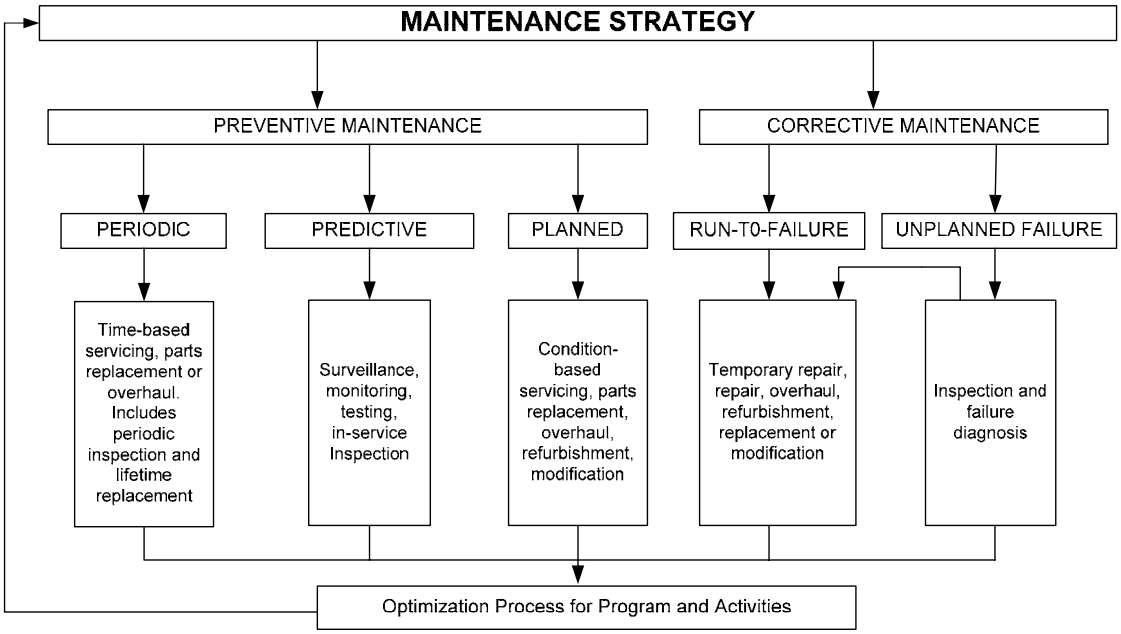

Figure 1: Relationship of Maintenance Concepts and Activities

5.0 MAINTENANCE PROGRAM ELEMENTS

In order to ensure that the overall maintenance strategy is effective, the maintenance program must be comprised of mutually supporting elements. These elements cover program basis, maintenance organization, maintenance activities, SSC monitoring, maintenance work, spare parts and procurement, management assessment and program review and record keeping.

Each program element will require sufficient resources governed by the licensee's approved policies, processes and procedures. These elements, when integrated, will form a comprehensive maintenance program as described in sections 5.1 to 5.8.

5.1 Program Basis

A systematic approach shall be taken to identify which maintenance activities are to be performed, on which SSCs, and at what intervals. The identification, selection and frequency of maintenance activities, as a minimum, shall take the following into account:

1. The relative SSC importance of the risks to national security, the health and safety of persons and the environment;
2. The technical basis for demonstrating that safety goals and performance criteria are met as described in the licence and supporting documentation;
3. The requirements of all applicable industry codes and standards;
4. The radiation protection principle As Low As Reasonably Achievable (ALARA);
5. Design and operating conditions;
6. Vendor recommendations;
7. Operating experience; and
8. Ageing management requirements.

Since the purpose of the maintenance program is to ensure that SSCs can function as per design, it follows that a maintenance strategy must have its basis in the approved plant design and safety analysis. Strategy development, therefore, requires a close liaison between the operating and design organizations to ensure that the strategy is based on a clear understanding of design philosophy and plant details.

The results of maintenance activities shall be used to provide feedback for program changes or design modifications. Program changes and design modifications must be controlled in accordance with the licensee's approved procedures and the maintenance program updated accordingly.

5.2 Maintenance Organization

The licensee shall establish a maintenance organization to effectively implement the maintenance program.

5.2.1 Organizational Structure

Senior plant management shall be responsible for establishing and implementing the maintenance program. They shall establish clear lines of authority and define the responsibilities of the various managerial and supervisory positions.

Functions necessary to meet program element requirements may not traditionally be performed by groups within the maintenance department. In such cases interfacing statements shall be made.

Engineering and technical support, with competence in all disciplines important for safety, shall be available throughout the lifetime of the plant.

Interfaces between trades groups and other work groups such as operations or radiation protection who interact with the maintenance organization shall be described.

5.2.2 Policies, Processes and Procedures

The licensee shall set out policies, processes and procedures that govern how the maintenance program is to be implemented.

The licensee shall ensure that the maintenance policies, processes and procedures are controlled, adhered to, and revised as necessary to reflect the current plant configuration.

The licensee shall have a process for ensuring that program documents are up-to-date.

5.2.3 Training and Qualification of Workers

The Maintenance Program shall be supported by sufficient numbers of trained and qualified personnel. The adequacy of these resources shall be determined based on maintenance program objectives.

The details and results of the training program and personnel qualifications shall be documented. Personnel training and qualifications shall be kept up-to-date.

All maintenance personnel shall be given facility specific training in plant systems, work control, radiation protection, safety rules, access control, security and emergency procedures commensurate with their responsibilities.

Where applicable to their duties, maintenance personnel shall be trained and qualified with respect to other plant programs such as configuration management and quality assurance.

Prior to performing special jobs with higher risk to plant and personnel safety, maintenance personnel shall receive additional training commensurate with the activity ranging from a special job briefing up to full scale mock-up.

5.2.4 Maintenance Facilities

Maintenance facilities and work areas shall be provided including housing for the shipping, receiving, handling and storing of spare parts, tools and equipment. Where necessary, the facilities shall be access controlled and operated in a manner that preserves the correct environmental conditions and guards against hazards such as fire and chemical spills.

5.2.5 Contract Workers

The licensee shall ensure that contractors comply with work procedures and standards that are higher than or equal to those applicable to plant staff, particularly in the areas of professional competence, adherence to procedures and evaluation of performance. Suitable steps shall be taken to ensure that contract workers conform to equivalent technical standards of the operating organization.

The licensee shall be responsible for assuring the quality of contractor work. Processes shall be in place to control and verify activities performed by contract workers.

5.3 Maintenance Activities

The licensee shall include activities aimed at avoiding, detecting and repairing failures of SSCs. As illustrated in Figure 1, maintenance activities aimed at avoiding and detecting incipient failures are considered preventive maintenance activities. Activities aimed at repairing failed SSCs are considered corrective maintenance activities. These activities can be combined at various levels to form a maintenance strategy to meet the program objectives.

5.3.1 Preventive Maintenance

Preventive maintenance activities are categorized as periodic (time-based), planned or predictive. Results from periodic or predictive activities may result in additional planned activities. These activities shall include accepted industry standards, such as Canadian Standards Association (CSA) and American Society of Mechanical Engineers requirements for inspections, assessments, calibrations, and function and performance testing.

Time-based preventive maintenance should not be scheduled just prior to performance or functional testing as this may mask equipment degradation. However, if the conditions dictate, other preventive maintenance activities should be performed as appropriate.

5.3.2 Corrective Maintenance

The licensee shall have processes in place for initiating corrective maintenance and performing failure diagnosis of equipment. The processes shall include evaluating the impact of failed equipment and prioritizing the repair work with respect to ongoing maintenance activities.

The licensee shall have a process in place for controlling and performing temporary repairs including proper approvals, equivalency assessments and time period until the permanent repair can be implemented or an approved modification made.

5.3.3 Ageing Management

The licensee shall have a process to detect, assess, and manage deterioration of SSCs as a result of ageing effects such as irradiation, corrosion, erosion, fatigue, and other material degradation. The type and frequency of maintenance activities shall be modified to accommodate such effects.

5.3.4 Activity Optimization

A process shall be in place to optimize the maintenance activities based on results from items such as the following - note that this is not intended to be considered an all inclusive list:

1. Failures in operation;
2. The as-found condition;
3. Failures discovered during maintenance activities;
4. Frequency of faults and related information;
5. Maintainability improvements; and
6. Operating experience in other plants.

5.4 SSC Monitoring

The licensee shall establish baseline criteria against which the function and performance of SSCs can be measured. These criteria shall include reliability, availability, function and performance requirements and assumptions used in the plant design and safety analysis.

The licensee shall include processes and procedures for evaluating whether or not SSCs continue to perform within the baseline criteria and for initiating corrective actions. These processes and procedures shall include condition monitoring, surveillance and testing.

5.4.1 Condition Monitoring

The licensee shall have processes and procedures for carrying out condition monitoring. These consist of such things as periodic and in-service inspections, measurements or trending of SSC performance or physical characteristics to indicate current condition and future potential for failure. This monitoring is usually conducted on a non-intrusive basis and includes the use of specialized equipment. Vibration analysis, tribology and thermography are all examples of condition monitoring techniques.

The extent and frequency of monitoring may vary but should reflect the ability for early detection and correction of negative trends. SSCs performing standby functions shall have condition monitoring requirements that indicate operational readiness.

A process shall be in place to ensure that equipment qualification is maintained.

A process shall be implemented to ensure that all instrumentation remains within the calibration tolerances as required for it to perform as per design.

5.4.2 Surveillance

The licensee shall have processes and procedures for carrying out SSC surveillance. Examples of surveillance are process system configuration checks, system walkdowns, trending, sampling, operator rounds and routine readings. Parameter expectations should be provided to allow verification of correct operational states and to detect any abnormal conditions. Results shall be documented.

5.4.3 Testing

The licensee shall have processes and procedures for performance and function testing to verify that SSCs are in good working order and are in a state of readiness to perform their functions. The licensee shall prepare test plans and such plans shall include the test frequency and acceptance criteria.

Instrumentation and test equipment used in performing the test program shall have the range and accuracy required to demonstrate that acceptance criteria have been met. All such test equipment shall be properly calibrated in accordance with a recognized national standard.

Where appropriate, the test program results shall be provided to the reliability program.

5.5 Maintenance Work

The licensee shall have processes and procedures for initiating, managing, assessing, prioritizing, planning and scheduling maintenance work. The resulting maintenance activity schedules shall be reviewed routinely and revised to account for changing conditions, operating experiences, and modifications.

The licensee must undertake and accomplish maintenance activities in a manner that is commensurate with the safety significance of the SSC and with effective allocation of resources.

Unit and equipment identification must be clear in work procedures and in the field to ensure that the proper equipment is isolated, maintained, and returned to service. Appropriate personal protection procedures shall be implemented before carrying out maintenance activities.

5.5.1 Work Assessment

The licensee shall implement a process for assessing maintenance activities. In addition to job tasks, the process shall assess the impact of maintenance activities on safety including such things as regulatory requirements, operating policies and principles[1], potential industrial and radiological hazards to site personnel, the public and the environment.

The assessment shall also take into account the cumulative effect of all plant equipment that is out of service on performance of safety functions.

5.5.2 Work Planning and Scheduling

The licensee shall implement processes and procedures for planning and scheduling all maintenance activities. Work planning shall take place at the overall plant level and at the individual job level. Procedures to deal with any deferral or omission of a scheduled maintenance activity shall be included.

All maintenance personnel shall be made aware of the importance to safety of the tasks they are performing and of the potential safety consequences of technical or procedural errors. Clear equipment identification procedures shall be used.

Coordination of work groups shall be incorporated into work planning and scheduling. Where appropriate, pre- and post-job briefings shall be included.

A process for foreign material exclusion shall be implemented as appropriate for all maintenance work. This is particularly important when opening up closed systems such as process piping and mechanical equipment.

5.5.3 Outage Management

The licensee shall have a process in place to appropriately manage the increased maintenance activities during plant outages. Effective work group coordination shall be established.

The plan to take equipment out of service for maintenance during an outage shall include measures to deal with all possible consequences of an event occurring while the equipment is out of service. This is particularly important when the equipment in question has a specific safety function or heat sink implication.

When planning and scheduling outage work, an assessment of the cumulative effect of all plant equipment that is out of service shall be undertaken to ensure no adverse effects on the performance of safety functions.

[1] "Operating policies and principles" is standard Canadian terminology that is equivalent to the IAEA's terminology of "operating limits and conditions".

5.5.4 Maintenance Procedures

Maintenance shall be performed in accordance with approved written procedures, instructions or drawings as appropriate to the situation.

The licensee shall have a process in place for controlling procedure preparation, review, validation, issue, modification and revision. Where appropriate, acceptance criteria shall be defined and actions clearly specified in case acceptance criteria cannot be met.

When a procedure for carrying out a maintenance activity is found to be inadequate, there shall be measures to ensure that the activity is halted or safely managed until such time as the inadequacy in the procedure is corrected. If the inadequacy is not unique to the situation, a means of permanently correcting the procedure shall be provided.

Procedures shall include specific provisions when particular hazards are envisaged.

Temporary changes to procedures shall be properly controlled, be subject to review and licensee approval and specify the period over which the change is to apply.

Procedures shall be in place for the turnover of maintenance activities to relieving work crews.

5.5.5 Post-Maintenance Verification and Testing

Before returning equipment to an operational state, the licensee shall ensure that post-maintenance verification has been completed, the affected configuration is verified, all relevant records are reviewed for completeness and any unexpected findings have been assessed and dispositioned. Where appropriate, post-maintenance testing will be conducted and a fitness for service assessment shall be completed.

A process shall be in place to periodically verify maintenance activities have been carried out within licensee expectations. This work shall be done by appropriately qualified individuals who do not have direct responsibility for performing the work. Verification shall include direct observation of the specific maintenance activity as well as examination of the documentation.

5.6 Spare Parts and Procurement

The licensee shall establish processes and procedures to procure, receive, store, secure and issue spare parts, tools and materials.

Authority for specifying technical and quality assurance requirements shall be clearly defined when procuring spare parts. The spares, as a minimum, shall meet the same technical standards and quality assurance requirements as the installed plant items. The licensee shall have a change control process in place to deal with non-identical replacement parts and deviations from the original specifications.

Procurement processes shall include requirements for qualified suppliers. The receipt and acceptance procedures shall include a requirement to label, tag and quarantine items that are non-conforming.

Parts which have a limited lifetime shall be replaced accordingly. This is to ensure suitability for the expected service when needed. Defective parts which are not suitable for reuse shall be disposed of following a documented process to prevent reuse.

5.7 Management Assessment and Program Review

The licensee shall establish a continuous process for assessment, review and improvement of the maintenance program to ensure that the maintenance strategy is effective, meets its objectives and has been implemented in accordance with applicable industry codes and standards.

Whenever a maintenance program deficiency is identified, its significance shall be assessed and where appropriate a cause determination shall be conducted and corrective actions taken. All reviews and assessments shall be properly documented and recorded.

Feedback from the improvement process shall be incorporated into the maintenance training program.

5.8 Record Keeping

In addition to complying with the NSCA, regulations, and any other reporting and record-keeping requirements (such as CNSC regulatory standard S-99, *Reporting Requirements for Operating Nuclear Power Plants*), the records and reports shall include sufficient information to provide objective evidence that the maintenance program is being fully implemented and in accordance with the quality assurance program.

The licensee shall document a description of repairs carried out, identifying the component that failed, the cause of failure, the remedial action taken, and the state of the system after repairs. The licensee shall periodically review the maintenance results for evidence of incipient or recurring failures.

GLOSSARY

Ageing management
The process of ensuring that SSCs continue to function as per design given that, with time or use, their characteristics can change or their performance can degrade.

Baseline criteria
A set of measurements (or metrics) representing the starting level of performance for an SSC. Baseline criteria are derived from design requirements and are usually established during commissioning and after replacement, overhaul or refurbishment.

Calibration
The process to verify that with a known precision input, an instrument or channel gives the required output.

Condition monitoring
Continuous or periodic inspections, measurements or trending of the performance or physical characteristics of SSCs to indicate current or future performance and the potential for failure.

Condition-based overhaul
An overhaul based on the condition of an SSC.

Condition-based servicing
Maintenance that is planned and performed after identification or diagnosis of SSC degradation but before failure occurs.

Corrective maintenance
Actions that, by means of repair, overhaul or replacement, restore the capability of a failed SSC to perform its defined function within acceptance criteria.

Failure
The inability of an SSC to function as per design.

Failure diagnosis
A structured process for determining the cause or causes of an SSC's failure.

Function testing
Testing done to verify that an SSC is capable of performing its design function.

In-service inspection
A periodic non-destructive examination of nuclear power plant SSCs in order to provide information about their current condition and damage, defect or degradation that might occur.

Inspection
An examination, observation, measurement or test undertaken to assess an SSC's condition.

Lifetime replacement
A replacement that is carried out based on an SSC reaching its design life.

Maintenance
The organized activities, both administrative and technical, to keep SSCs in good operating condition, and to ensure that they function as per design.

Modification
Any alteration or addition that is temporary or permanent, to an SSC's physical configuration or design requirements.

Monitoring
See Condition Monitoring

Nuclear power plant (NPP)
Any nuclear fission reactor installation that has been constructed to generate electricity on a commercial scale and is a Class IA nuclear facility, as defined in the *Class I Nuclear Facilities Regulations*.

Overhaul
The comprehensive inspection and restoration of an SSC in order to maintain it in good operating condition or to restore its ability to function as per design. Includes such things as disassembly, cleaning, lubricating, adjusting, parts inspection or replacement and testing.

Parameter expectations
Measures of criteria against which the performance of an SSC can be judged.

Performance testing
Testing done to determine whether a system meets specified acceptance criteria.

Periodic inspection
Mandatory inspection of components carried out at intervals following the start-up of a Nuclear Power Plant as governed by CSA standards.

Periodic maintenance
Form of preventive maintenance consisting of servicing, parts replacement, surveillance, or testing at predetermined intervals of calendar time, operating time or number of cycles. Also known as time-based maintenance.

Permanent repair
Any activity that restores a failed or degraded SSC to function within its original design.

Planned maintenance
Form of preventive maintenance consisting of refurbishment or replacement that is scheduled and performed prior to unacceptable degradation of an SSC.

Plant configuration
The physical, functional and operational characteristics of the SSCs and parts of a facility, including the organizational structure.

Predictive maintenance
Form of preventive maintenance performed continuously or at intervals governed by observed condition to monitor, diagnose or trend an SSC's condition indicators. Results indicate current and future functional ability or the nature of and schedule for planned maintenance. Also known as condition based maintenance.

Preventive maintenance
Actions that detect, preclude or mitigate degradation of a functional SSC to sustain or extend its useful life by controlling degradation and failures to an acceptable level. Preventive maintenance may be periodic, planned or predictive.

Qualification
A formal statement that an individual or team possesses the education, training and experience required to meet specified job performance requirements. A formal statement of competence.

Refurbishment
An activity or set of activities aimed at restoring the condition of an SSC to a state that is comparable to the condition of a new SSC.

Repair
Any activity that allows a failed or degraded SSC to function as per original design. May be permanent or temporary.

Replacement
The substitution of an SSC with an identical SSC or an SSC that has been approved as equivalent through an equivalency process.

Run-to-failure
An equipment maintenance strategy, where a conscious decision (based on a defined set of criteria) is made not to perform maintenance until the equipment has suffered a failure.

Servicing
Routine maintenance activities such as cleaning, lubricating, adjusting, testing and replacement of minor parts.

Structures, systems or components (SSCs)
Physical items designed, built, or installed to support the operation of the facility. A structure is an element or a collection of elements to provide support or enclosure. A system is a collection of components assembled to perform a function. A component is an item of equipment.

Surveillance
Activities carried out to confirm compliance with operating policies and principles, to verify correct operational states and to detect any abnormal condition before it can impair the SSC's ability to meet its design intent.

Temporary repair
A repair that temporarily enables a failed or degraded SSC to function within its original design until a permanent repair or a replacement can be completed.

Testing
Periodic verification that SSCs continue to function or are in a state of readiness to perform their functions.

Thermography
A diagnostic technique which uses a thermograph to record the heat produced by different components.

Time-based overhaul
An overhaul performed based on a set time period.

Time-based preventive maintenance
Maintenance performed on equipment in accordance with a set time period (predefined) or given amount of operation.

Trained and qualified
An individual who has achieved the specified level of knowledge, skills, attitudes and experience required to meet job performance requirements.

Training
A combination of activities with the purpose of providing the knowledge, skills and attitudes to individuals or teams in order to allow performance of activities in an effective and efficient manner and to identified standards.

Tribology
The systematic study of friction and its effects.

Unplanned failure
Unanticipated failure of an SSC.

ASSOCIATED DOCUMENTS

Reference documents cited in this regulatory standard and listed below are for the assistance of licensees and licence applicants, and do not signify that the CNSC has necessarily adopted those publications as its own criteria for its regulatory functions.

1. Canadian Nuclear Safety Commission INFO-0729, *Standards for Regulatory Documents*, February 2002.

2. Canadian Nuclear Safety Commission S-98 Revision 1, *Reliability Programs for Nuclear Power Plants*, June 2005.

3. Canadian Nuclear Safety Commission S-99, *Reporting Requirements for Operating Nuclear Power Plants*, March 2003.

4. IAEA TECDOC-658, *Safety Related Maintenance in the Framework of the Reliability Centered Maintenance Concept*, Vienna, July 1992.

5. IAEA TECDOC-928, *Good Practices for Cost Effective Maintenance of Nuclear Power Plants*, Vienna, February 1997.

6. IAEA TECDOC-960, *Regulatory Surveillance of Safety Related Maintenance at Nuclear Power Plants*, Vienna, August 1997.

7. IAEA TECDOC-1383, *Guidance for Optimizing Nuclear Power Plant Maintenance Programmes*, Vienna, December 2003.

8. IAEA Safety Standards Series, No. NS-G-2.6, *Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants*, Vienna, October 2002.

9. IAEA Safety Standards Series, No. NS-R-2, *Safety of Nuclear Power Plants: Operations*, Vienna, September 2000.

10. IAEA Safety Standards Series, No. 50-SG-07, *Maintenance of Nuclear Power Plants*, Vienna, January 1990.

11. IAEA Safety Standards Series, No. 42, *Safety Culture in the Maintenance of Nuclear Power Plants*, Vienna, 2005.

12. IAEA Safety Standards Series, No. 110, *The Safety of Nuclear Installations*, Vienna, 1993.
CAN/CSA-N286.05, Management System Requirements for Nuclear Power Plants, February 2005.