



Operating Performance  
**Conduct of Licensed Activities:  
Construction of Reactor Facilities**

---

REGDOC-2.3.1

**DRAFT**

April 2014





## **Construction of Reactor Facilities**

Regulatory Document REGDOC-2.3.1

© Canadian Nuclear Safety Commission (CNSC) 2014

PWGSC catalogue number XXXXX

ISBN XXXXX

Extracts from this document may be reproduced for individual use without permission provided the source is fully acknowledged. However, reproduction in whole or in part for purposes of resale or redistribution requires prior written permission from the Canadian Nuclear Safety Commission.

*Également publié en français sous le titre : Conduite d'exploitation : Construction des installations dotées de réacteurs*

### **Document availability**

This document can be viewed on the CNSC website at [nuclearsafety.gc.ca](http://nuclearsafety.gc.ca). To request a copy of the document in English or French, please contact:

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

Tel.: 613-995-5894 or 1-800-668-5284 (in Canada only)

Facsimile: 613-995-5086

Email: [info@cnsccsn.gc.ca](mailto:info@cnsccsn.gc.ca)

Website: [nuclearsafety.gc.ca](http://nuclearsafety.gc.ca)

Facebook: [facebook.com/CanadianNuclearSafetyCommission](https://facebook.com/CanadianNuclearSafetyCommission)

YouTube: [youtube.com/cnsccsn](https://youtube.com/cnsccsn)

### **Publishing history**

[Month 2014]

Version x.0

## Preface

This regulatory document is part of the CNSC's Operating Performance series of regulatory documents, which also covers commissioning of reactor facilities and accident management. The full list of regulatory document series is included at the end of this document and can also be found on the CNSC's website at [nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents](http://nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents)

*Construction of Reactor Facilities* is a companion piece to *Commissioning of Reactor Facilities*, which is also under development. Before publication, these two documents will be put together as discrete parts of a larger document entitled REGDOC-2.3.1, *Operating Performance: Conduct of Licensed Activities*.

*Construction of Reactor Facilities* sets out the CNSC's requirements for the construction of reactor facilities. This regulatory document identifies and explains safety-significant construction activities to be considered, checked and reviewed in order to ensure the quality and safety of a new or modified reactor facility.

This document provides a framework within which the requirements and guidance in other regulatory documents, codes and standards can be applied to construction management and activities. By implementing this framework, the licensee can ensure the physical construction of the plant is effectively managed and consistent with design requirements.

Reactor facilities will likely be constructed by contractors and sub-contractors with the licensee undertaking primarily an oversight role. Nonetheless the licensee has the primary responsibility for safety, and must ensure directly, or indirectly, that adequate provisions have been made for the safety of the public, workers and the environment for all construction activities. Effective oversight of construction activities is essential to maintain the construction safety case and to support the operations safety case.

**Important note:** Where referenced in a licence either directly or indirectly (such as through licensee-referenced documents), this document is part of the licensing basis for a regulated facility or activity.

The licensing basis sets the boundary conditions for acceptable performance at a regulated facility or activity, and establishes the basis for the CNSC's compliance program for that regulated facility or activity.

Where this document is part of the licensing basis, the word "shall" is used to express a requirement to be satisfied by the licensee or licence applicant. "Should" is used to express guidance or that which is advised. "May" is used to express an option or that which is advised or permissible within the limits of this regulatory document. "Can" is used to express possibility or capability.

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

## Table of Contents

<b>1.</b>	<b>Introduction.....</b>	<b>1</b>
1.1	Purpose.....	1
1.2	Scope.....	1
1.3	Relevant regulations .....	2
<b>2.</b>	<b>Licensee Responsibilities .....</b>	<b>2</b>
<b>3.</b>	<b>Management System.....</b>	<b>3</b>
3.1	Construction management .....	3
<b>4.</b>	<b>Readiness Review .....</b>	<b>4</b>
<b>5.</b>	<b>Personnel Qualification and Training.....</b>	<b>5</b>
<b>6.</b>	<b>Programs Supporting Construction Activities.....</b>	<b>6</b>
6.1	Security .....	6
6.2	Safeguards.....	6
6.3	Emergency preparedness .....	6
6.4	Effect on and from existing facilities.....	7
6.5	Fire protection.....	7
6.6	Environmental measures.....	7
6.7	Aging management .....	8
<b>7.</b>	<b>Construction Program.....</b>	<b>8</b>
7.1	Planning, scheduling and work sequence .....	8
7.2	Work and environmental conditions.....	8
7.3	Housekeeping, cleanliness and foreign material control.....	8
7.4	Chemical control.....	9
<b>8.</b>	<b>Structures, Systems and Components.....</b>	<b>9</b>
8.1	Manufacture and assembly .....	9
8.2	Long-lead items .....	10
8.3	Onsite construction activities.....	11
8.4	Completion assurance and readiness review.....	13
<b>9.</b>	<b>Transfer of Responsibility.....</b>	<b>14</b>
9.1	Transfers during construction .....	14

9.2 Transfers to operations/commissioning ..... 14

**10. Configuration Control.....14**

**11. Construction Records .....15**

**Glossary .....16**

**References .....18**

**Additional Information .....19**

## Construction of Reactor Facilities

### 1. Introduction

#### 1.1 Purpose

REGDOC-2.3.1, *Construction of Reactor Facilities*, sets out the CNSC's requirements and guidance for the construction of reactor facilities in Canada. Reactor facilities include:

- nuclear power plants (NPPs) or small reactors for the generation of power or heat for industrial processes
- small reactors for non-power generation uses (e.g., isotope production, and research and development activities)

#### 1.2 Scope

This regulatory document is applicable to the activities carried out under a construction licence for a new reactor facility and to a major modification/refurbishment of an existing reactor facility. These activities include: manufacturing and assembling the components, carrying out of civil work, installing and maintaining structures, systems and components (SSCs), and testing.

This regulatory document identifies and explains construction management activities that shall be considered, checked and reviewed in order to ensure quality of a new or modified reactor facility.

Design and commissioning activities are not addressed in this regulatory document. See CNSC regulatory documents REGDOC-2.5.2, *Design of New Reactor Facilities* (draft) [1], and REGDOC-2.3.1, *Commissioning of Reactor Facilities* (draft) [2], for the CNSC's requirements and guidance on these related activities.

This regulatory document may be also used to:

- support the development, implementation, assessment and improvement of construction methods, procedures and techniques, thereby ensuring the quality of the end product to meet the design and safety intent
- assist licensee and construction organizations in developing technical specifications for contractors
- assist licensee and construction organizations in understanding the technical aspects that should be considered when assessing contractors' qualifications and performance
- assist stakeholders in understanding the roles and responsibilities of different types of contractors, which may include technical support organizations or consultants carrying out independent review and assessment or third party inspections

The Additional Information section lists codes, standards and guides that provide information on how to meet the requirements stated in this regulatory document. This section also includes links to industry and regulatory organizations that provide information on good industry practice and lessons learned from previous construction experience.

### 1.3 Relevant regulations

The sections of the regulations made under the *Nuclear Safety and Control Act* (NSCA) relevant to this document include:

- Paragraph 3(1)(d) of the *General Nuclear Safety and Control Regulations* stipulates: “the proposed quality assurance program for the activity to be licensed”.
- Paragraph 3(1)(k) of the *General Nuclear Safety and Control Regulations* stipulates: “the applicant’s organizational management structure insofar as it may bear on the applicant’s compliance with the Act and the regulations made under the Act, including the internal allocation of functions, responsibilities and authority”.
- Sub-section 12(1) of the *General Nuclear Safety and Control Regulations* stipulates “Every licensee shall:
  - ensure the presence of a sufficient number of qualified workers to carry on the licensed activity safely and in accordance with the Act, the regulations made under the Act and the licence;
  - train the workers to carry on the licensed activity in accordance with the Act, the regulations made under the Act and the licence;
  - take all reasonable precautions to protect the environment and the health and safety of persons and to maintain the security of nuclear facilities and of nuclear substances;”
- Paragraphs 5(c) and (i) of the *Class I Nuclear Facilities Regulations* state that “an application for a licence to construct a Class I nuclear facility shall contain the following information:
  - (c) the proposed construction program, including its schedule;
  - (i) the effects on the environment and the health and safety of persons that may result from the construction, operation and decommissioning of the nuclear facility, and the measures that will be taken to prevent or mitigate those effects;”

## 2. Licensee Responsibilities

The licensee has the primary responsibility for the safety and security of its licensed reactor facility, including responsibility for activities carried out by contractors. This responsibility covers all aspects related to the facility’s construction and includes:

1. being an intelligent customer<sup>1</sup>, through having a clear understanding and knowledge of the reactor technology and services being supplied
2. ensuring contractors and sub-contractors have shared goals and processes to promote collaboration
3. conducting oversight to verify that contractors’ activities are in compliance with all relevant safety requirements
4. confirming the facility is being built in accordance with the design basis, regulatory requirements, and applicable codes and standards
5. maintaining ownership of the safety case, including the information provided by the design and construction organizations and contractors
6. providing a point of contact for communicating with the CNSC on all matters related to the facility’s construction
7. preparing and updating construction program documents

---

<sup>1</sup> In the context of nuclear safety, an organization that knows what is required, fully understands the need for a vendor’s services, specifies requirements, supervises the work and technically reviews the output before, during and after implementation.



8. establishing construction instructions and procedures
9. performing inspections, tests and verification of items important to safety
10. reporting safety-significant design changes, non-compliances and events to the CNSC
11. evaluating inspection findings and reporting the evaluation results to the CNSC
12. identifying jurisdictional boundaries and responsibilities where there is more than one regulatory body governing a particular area

### **3. Management System**

All construction and related activities shall be developed and implemented under the control of the licensee using a management system meeting the requirements of CSA N286-12, *Management system requirements for nuclear facilities* [3].

#### **3.1 Construction management**

##### **3.1.1 Regulatory and other requirements**

The licensee shall identify health and safety, environmental, and other requirements applicable to construction activities. Relevant requirements shall be communicated to all parties and taken into account when establishing, implementing and maintaining management practices and controls. Conflicting requirements shall be identified and resolved.

##### **3.1.2 Interface arrangements**

Interfaces between the licensee, reactor designer, manufacturers, construction organizations, contractors, the CNSC and other regulatory authorities shall be defined, agreed upon and understood before construction starts. Measures shall be established to resolve conflicts and misunderstandings between organizations; for instance, conflicts related to construction schedules, activities, tools and work spaces.

##### **3.1.3 Oversight of contractors**

The licensee shall develop measures to ensure that contractors and sub-contractors meet their respective contractual obligations that include:

1. for selection of contractors:
  - a. confirmation that the contractors have the ability to supply the goods or service
  - b. acceptance of the contractor's management system through review of documentation and audit
  - c. confirmation that the contractor understands all regulatory requirements
  - d. resolution of any exceptions the contractor has to the licensee's requirements
  - e. reviews of contractor submissions against requirements
2. for contract management:
  - a. evidence of a positive safety culture
  - b. evidence that the contractor satisfies all contractual requirements related to health and safety, environment, security, and quality
  - c. communication and relationships among all parties that are open and constructive, and identification of problems before they become serious
  - d. contract is administered through management of change, performance monitoring and monitoring of work progress
  - e. problem identification and resolution, and effective corrective action programs

- f. control of emergent work
- g. processes to manage claims and disputes
- 3. for contractor supply chain (manufacturing and construction) activities:
  - a. pre-screening of sub-contractors used by the contractor, to ensure the sub-contractors are acceptable and to incorporate them into the licensee's supply chain program
  - b. review of contractor purchasing documentation to confirm design requirements are met
  - c. review of contractor manufacturing or construction documentation, including quality plans/manufacturing and inspection and test plans, and special process procedures
  - d. source verification and audits, during manufacturing and construction, to verify compliance of the contractor or its sub-contractors
  - e. review and disposition of any contractor non-conformances to requirements

The above requirements shall also extend to the contractor's measures to ensure its sub-contractors meet their respective contractual obligations.

The licensee shall maintain records of its oversight activities and report to the CNSC relevant contractor performance that has affected, or has the potential to affect, the quality of construction and future operational safety.

#### 4. Readiness Review

Before construction starts, a readiness review shall be performed to confirm that the licensee and contractors are prepared to successfully manage and carry out construction activities.

##### Guidance

The readiness review should include confirmation that:

1. all required licences and permits have been obtained
2. site security is established
3. the design is sufficiently complete, and any incomplete areas have been identified<sup>2</sup>
4. all major safety issues are resolved
5. any remaining design and engineering work, and necessary resources are agreed to and monitored by the licensee as construction proceeds
6. lessons learned from previous construction projects have been addressed
7. contingency plans are in place to cope with electrical power outages, loss of water supply, disruption to concrete batching or pumping, and any other interruptions that may cause a deterioration in work quality
8. all the necessary controls are in place to support the principles of configuration management; i.e., identification (baseline), change control, status accounting, and audits
9. an information lifecycle strategy, including identification of the complete set of required facility configuration information required for operations, is established
10. alignment and interoperability of hardware, software, information communications, and the information technology environment are reviewed to ensure timely creation and delivery of quality information between all parties, in the proper form and format to facilitate the reactor facilities' lifecycle information strategy

---

<sup>2</sup> See RD/GD-369, *Licence Application Guide, Licence to Construct a Nuclear Power Plant* (2011) [4], and REGDOC-2.5.2, *Design of Reactor Facilities: Nuclear Power Plants* (draft) [1]

11. transportation routes for large components, to and from the site, are available
12. the site boundary is clearly marked
13. a radiation protection program is in place:
  - a. at existing nuclear facilities where construction sites are located, to ensure protection of workers during construction activities
  - b. for any activity involving a nuclear substance or radiation device, such as industrial radiography
14. infrastructure support systems – including required electricity, gas and water supply, fire protection, protection or coverage of SSCs after work installation (including maintaining environmental qualification) – are in place
15. construction processes and equipment, such as cranes, scaffolding, temporary structures, portable equipment, and flammable equipment, are all designed to withstand meteorological and hydrological hazards
16. contractors are established on the site in a controlled manner in allocated areas and are provided with the necessary site services, information and instructions with regard to the applicable radiation protection and industrial safety requirements
17. occupational health and safety controls, including work hazard identification and risk assessment, and worker fatigue prevention measures, have been established
18. environmental controls, including those to minimize impacts to the environment, have been established
19. the responsibilities of all parties are agreed to
20. new methods of construction, transportation, inspection and testing are qualified

## 5. Personnel Qualification and Training

A sufficient number of qualified and experienced workers shall be available as required by the construction program. To ensure workers are qualified, measures shall include:

1. identification of the required qualifications and competencies, including site-specific requirements
2. verification of workers' qualifications and competencies against defined qualification and competency requirements prior to permitting personnel to perform work on the site
3. documentation and maintenance of personnel qualification and competency records

The training programs shall emphasize the importance of adhering to established programs, processes and procedures in assuring nuclear safety in future phases of the project (for example, commissioning and operation). Training programs shall also emphasize that everyone working at the site is responsible for safety in all construction activities.

Licensee personnel involved in project contract management, quality management, human resource management, communications management and risk management shall be trained in accordance with their area of expertise and professional qualifications. In addition, they shall be trained in the skills and knowledge required to manage and oversee the design, construction, and commissioning of a reactor facility.

Personnel who will be involved in commissioning, operation, maintenance and technical support activities shall undergo hands-on training as early as practicable to gain expertise in their future discipline.

REGDOC-2.2.2, *Human Performance Management: Personnel Training* (draft), [5] provides specific requirements for training programs.

## **6. Programs Supporting Construction Activities**

### **6.1 Security**

Site security measures shall include the actions to be taken during the construction phase, including measures to protect SSCs under construction, to detect and deter conditions that would otherwise impair site security. The security program for the construction site and cyber security measures shall be integrated.

#### **Guidance**

Security measures should include:

1. access control of personnel, materials and vehicles
2. scheduled and random patrols and inspections
3. screening (pre-employment and gate clearance) for access to work areas
4. physical barriers, fencing, surveillance and monitoring capability
5. cyber-security controls to protect computer-based systems important to safety and security
6. response capability

### **6.2 Safeguards**

As required by the safeguards program, the International Atomic Energy Agency shall have access to the site and information about site buildings and structures, operational parameters, flow and storage of nuclear material, and installation of safeguards surveillance and monitoring equipment.

### **6.3 Emergency preparedness**

Measures shall be established to prepare for, respond to and recover from an emergency. For sites at existing nuclear facilities, emergency preparedness shall consider:

1. the average and peak employment at the site throughout the construction or modification project
2. training of construction site personnel
3. provision of alarms to alert all onsite personnel, taking specific construction activities into account
4. the risks associated with construction activities
5. evacuation times and response times of any emergency vehicles or response capability

For construction sites at existing nuclear facilities, the licensee shall perform a risk and threat assessment to identify any increased risks to the site. Preventive measures shall be taken to manage risks to the existing facility, by construction activities such as dredging, quarrying and blasting, and the creation of connections between the site and the facility.

Sites without an existing nuclear facility nearby shall be able to support their emergency response needs independently. If an existing nuclear facility is in close proximity, mutual aid agreements may be put in place to support emergency response. As construction proceeds the licensee shall ensure that emergency measures in place are commensurate with onsite hazards.

Onsite emergency response units shall be qualified and fully complemented (personnel and equipment) to ensure an expedient and effective response. These response units shall be able to deliver fire and first aid response, spill recovery and hazardous material response, and search and rescue response in case of structure collapse or cave-in.

#### **6.4 Effect on and from existing facilities**

A construction site may already have onsite operating facilities; these may have interdependent safety or support systems. Other critical facilities, such as spent fuel pools or dry cask storage, may also be present. Research reactor sites may already have associated laboratories, isotope production facilities and hot cells.

An assessment of safety and security during construction shall be performed. It shall consider all hazards from, or to, nearby site facilities and any interdependence of their safety systems. The consequences of potential contamination (nuclear and hazardous substances) from a construction site to operating units, as well as from operating site to construction site, shall be assessed and its contamination monitored if necessary. All other potential risks shall also be assessed (for example, excavation, accidental fall of cranes, collapse of items, use of explosives, etc.). Such consideration shall also include an impact assessment of cumulative environmental discharges for all facilities on a site.

The responsibilities of the relevant licensee(s) and the construction organization for safety and security shall be agreed upon before the start of construction activities at the site. Close communication and cooperation between the parties shall be established. All steps shall be taken to ensure that the existing facility can be operated safely and securely during construction activities.

For adjacent installations or those with common buildings or services, the following boundaries shall be identified: controlled areas; physical; system; security access boundaries; and clean zones. When using the resources of existing nuclear installations (such as water, electric power, fire protection, emergency medical services, and security), clear interfaces shall be defined so as not to jeopardize operating installations. Emergency plans shall take full account of the presence of other parties in the area. Procedures shall be implemented to ensure the licensee of an existing facility or facilities endorses a change of status for those common buildings or services before the construction organization puts such plans in place.

#### **6.5 Fire protection**

Fire protection controls shall be available until final systems for plant fire detection, protection and suppression are installed and operational. Details of these controls shall be included in the emergency planning arrangements.

#### **6.6 Environmental measures**

Environmental monitoring and protection controls shall be in place to ensure adequate mitigation of potential environmental effects related to construction activities. CNSC regulatory document REGDOC-2.9.1, *Environmental Protection* (draft), [6] provides specific requirements for environmental protection.

## **6.7 Aging management**

REGDOC-2.6.3, *Fitness for Service: Aging Management*, (draft) [7] provides requirements for aging management. Programs (for example, those for chemical control, inspection, examination and testing, baseline data collection, and material surveillance) shall be established and implemented to ensure that manufacturing, construction and installation processes do not adversely affect aging performance of SSCs.

## **7. Construction Program**

### **7.1 Planning, scheduling and work sequence**

Planning, scheduling and work sequencing shall identify and include provisions for:

1. items with long lead times (long-lead items)
2. onsite manufacturing, modular assembly and testing activities
3. hold and witness points by various parties, such as the licensee, architects/engineers, authorized inspection agencies and the CNSC

Construction sequencing shall ensure initial construction work (such as embedded components in walls or ground) will not be adversely affected by later construction activities. Consideration shall be given to the form of cast-in components and plant fixtures so that post-drilling of concrete is kept to a minimum.

### **7.2 Work and environmental conditions**

Construction work and environmental conditions shall be monitored to protect safety significant mechanical, electrical and control equipment, and structures from damage and contamination.

Environmental limits such as temperature, pressure, humidity, dust, dirt, airborne salt, wind, and electromagnetic conditions during construction work shall be specified. Environmental conditions shall be periodically monitored to confirm they are within allowable limits.

### **7.3 Housekeeping, cleanliness and foreign material control**

Housekeeping, cleanliness and foreign material exclusion measures shall be established for the site area, the facility, and the materials and components being incorporated into the plant to preserve the quality of the SSCs being assembled, constructed or installed.

Foreign material exclusion measures shall include provision for preventing the introduction of outside materials, debris, tools, and components into the systems and components, and areas where they pose a health and safety hazard or environmental impact.

Specific requirements and cleaning methods shall be implemented for systems such as hydraulic and instrumentation control systems and lubrication lines, as well as for those where interior surfaces are generally not accessible for visual inspection.

Waste materials and remaining consumables used or generated onsite during construction shall be removed after work is complete.

## **7.4 Chemical control**

Fluid and gas piping systems, and associated components shall be cleaned, flushed and conditioned according to applicable chemistry requirements. Chemistry staff, facilities and procedures shall be available to support system flushing and hydrostatic testing to ensure chemistry requirements are met.

### **Guidance**

To ensure the required internal cleanliness requirements are met, chemistry control should include provisions for:

1. system sampling
2. demineralized water production
3. storage capacities
4. laboratory facilities
5. system blowdown
6. recycling

Consideration should be given to suitability of facilities, equipment and procedures for their transfer to commissioning or operations.

## **8. Structures, Systems and Components**

### **8.1 Manufacture and assembly**

Procurement documents issued at all tiers of the supply chain shall include provisions for the following:

1. scope of work
2. technical requirements
3. management system or quality assurance program requirements
4. right of access to facilities and records for surveillance, witness points or audit by the purchaser, licensee and CNSC
5. documentation submission requirements
6. manufacturing history records
7. non-conformance reporting
8. spare and replacement parts

Each manufacturer's management system or quality assurance program shall include the identification and control of processes that cannot be fully verified by subsequent inspection and testing, or where processing non-conformances may become apparent only after the item is in use or operation.

Special equipment – such as tooling, inspection gauges and computers – that is required to aid the manufacturing or assembling process shall be qualified or validated. Personnel using the equipment shall be trained and made aware of any limitations of its use.

Components shall be inspected and tested according to the requirements of the procurement specifications. The traceability of individual components important to safety, or the identification of batches of such components, as appropriate, shall be highlighted in the inspection and test plan

or quality plan. Augmented monitoring and inspections, if needed, shall verify that new manufacturing techniques and new types of equipment meet relevant design requirements.

### **Guidance**

To achieve the required quality and safety in manufacture and assembly, the following should be considered:

1. the manufacturing implications of the design
2. the procurement of critical path components with long lead times
3. the amount of sub-contracted operations such as forming, heat treating, partial machining or fabrication of sub-assemblies
4. the need for clean conditions and other environmental controls to meet requirements and to achieve required quality; these controls may include dust-free or inert atmospheres, humidity controls, temperature controls, and control of the chemical composition of water
5. the assembly of components
6. the requirements for handling, storing, packaging and delivery
7. the application of new techniques in manufacturing, assembling, inspection and testing
8. the need for inspections and tests specified by the designers, the licensee and the CNSC, and those deemed necessary by the manufacturer to control quality and to ensure the process has been followed
9. the need for special attention to processes that are complex or sensitive, or that require extensive set-up, special equipment or special training
10. the compatibility of cleaning methods and materials with the components being cleaned
11. the use of commercial-grade items and services that are proposed to be a part of any safety function
12. the importance of prevention of counterfeit, fraudulent and suspect items (CFSI) entering the supply chain, including the use of standardized CFSI prevention language in procurement documents

## **8.2 Long-lead items**

The procurement of long-lead items is entirely at the licensee's risk. Submissions for procurement of items for which the licensee seeks CNSC acceptance, prior to the application for a licence to construct, will be reviewed on a case-by-case basis.

When the licensee/applicant proceeds with procurement of long-lead items, the submissions shall include the following information:

1. item description and quantity
2. codes and standards
3. safety classification
4. code classification
5. code-effective date
6. technical performance requirements
7. quality assurance requirements
8. documentation requirements and timing of submissions

Any differences between the original purchasing requirements, the licence-to-construct design basis and the as-built items shall be evaluated and reconciled.



## **8.2.1 Transportation of components to the construction site**

### **Guidance**

Transportation routes should be planned with consideration given to:

1. type of transport and lifting equipment for large, heavy or awkwardly shaped components
2. assessments of roads, rail and waterways, and bridges, docks and wharfs, to ensure transport is possible without posing hazards or causing damage to the components, or harm to persons or anything on the routes

## **8.3 Onsite construction activities**

### **8.3.1 Receipt of components**

An initial check shall be carried out when components are received at the construction site to ensure they are as ordered and have not been obviously damaged during transport.

Before the component is accepted and used, an inspection shall be carried out to confirm that:

1. components are configured correctly
2. identification and marking are correct
3. manufacturing and assembly documentation, including approved deviations, is available where required
4. inspection records and/or certificates are traceable to the inspected item for confirmation of acceptance
5. source verification release notes – for both components and documentation – are available where required
6. protective covers and seals are intact
7. coatings and preservatives have not been damaged
8. no physical damage has been sustained
9. cleanliness meets applicable codes and standards and design requirements
10. inert gas blankets and the condition of desiccants, where relevant, have not been compromised
11. non-conformance identified by receipt inspections, or detected during manufacturing but to be corrected onsite, are recorded

Components shall be controlled to prevent inadvertent installation or use.

### **8.3.2 Handling**

Equipment such as special cartons, containers, protective devices, cranes, hoists, manipulators and transport vehicles shall be qualified. Equipment for handling components shall be used and maintained in accordance with national regulations and standards. Operators and handlers of such equipment shall be trained and qualified in their use.

### **8.3.3 Control of components and consumables**

Components (including spare and replacement parts) and consumables shall be controlled at all locations, including offsite manufacturing facilities, to prevent their misuse, damage, deterioration or loss of identification.

Components shall be clearly identifiable by using appropriate marks. Marks shall be as specified by the designer or manufacturer.

#### **8.3.4 Storage**

Storage shall be provided as specified by the designers and manufacturers to protect components prior to their installation and use.

#### **Guidance**

When establishing storage areas, the following should be taken into account:

1. cleanliness and housekeeping practices
2. requirements for fire protection
3. protective requirements related to coatings, preservatives, covers and sleeves
4. prevention of physical damage
5. environmental controls: airborne matter, static electricity, temperature and humidity
6. preventive maintenance
7. security against theft, vandalism and unauthorized removal
8. shelf life due to physical and chemical characteristics
9. identification of components

#### **8.3.5 Care of installed structures, systems and components**

Installed SSCs shall be protected from personnel traffic, temporary structures, weather, and adjacent construction activities (such as sandblasting, acid cleaning, welding, jack hammering, chipping, burning, and stress relieving) that would adversely affect the quality of the SSCs or any test results.

Temporary use of SSCs that are to become part of the completed facility shall be authorized by the responsible organization. Such temporary use shall not subject the SSCs to conditions for which they were not designed.

#### **Guidance**

Such protection may be provided through good cleanliness and housekeeping practices, temporary packaging, erection of barriers, protective covers, and walkways as required.

#### **8.3.6 Maintenance**

During the entire construction phase, SSCs shall be subject to an appropriate preventive or corrective maintenance plan to maintain their functionality as required by the design. This shall be continued until operational maintenance programs are initiated. RD/GD-210, *Maintenance Programs for Nuclear Power Plants*, [8] provides information on maintenance programs.

#### **8.3.7 Onsite manufacturing, installation and testing**

Items important to safety of nuclear facilities shall be manufactured, constructed, installed, tested and inspected in accordance with established processes that ensure the achievement of the design specifications and the required level of safety.

Unless required for operations, onsite manufacturing and installation facilities shall be designed, assembled, maintained, utilized and removed as required by regulations, standards, specifications, procedures or contracts.

Onsite manufacturing shall be located in facilities so as not to affect adjacent SSCs or activities. Where such facilities require the need for specialty construction equipment such as very heavy lift (VHL) cranes and automated rebar assembly machines, their set-up, use and disassembly shall be controlled as required by manufacturers and statutory requirements. Operators and handlers of such equipment shall be trained and qualified in their use.

Onsite manufacturing may include:

1. concrete production in a concrete batch plant
2. rebar assembly
3. pipe spool fabrication
4. modular assembly, such as:
  - a. mechanical modules: structural equipment on a common structural frame, along with interconnecting piping, valves, instruments and wiring
  - b. structural modules: liner, wall, floor, heat sink floor, turbine pedestal form, stairs, platform, structural steel, and space frame modules; some structural modules may include leave-in-place formwork for concrete
  - c. piping modules: pipe, valves, valve tree, pumps and associated instrumentation and wiring on a common structural frames
  - d. electrical modules: electrical modules on a common structural frame

Rules and procedures shall be established for onsite testing facilities to ensure that industry codes and standards are met. Testing facilities include those for:

1. concrete mix, and core extraction and testing
2. process instrumentation and set point calibration
3. pressure relief valve setting
4. pressure gauge calibration

Operators and handlers of testing equipment shall be trained and qualified in their use.

#### **8.4 Completion assurance and readiness review**

Completion assurance, commissioning and operational readiness reviews shall be established to ensure construction commitments have been met and the facility is ready for fuel load, subsequent commissioning and commercial operation.

For completion assurance, the licensee and construction organization shall develop and agree to a process to verify the completion of construction activities and transfer of completed work. The process and acceptance criteria shall be documented such that they can be independently assessed. The results of the tests (coverage, contents, results and timing) shall be analyzed against the specified acceptance criteria. Testing and verification of components important to safety shall be performed by a qualified independent party to confirm the components have been constructed to the specified requirements and comply with the acceptance criteria, including those detailed in licensing documentation.

## **9. Transfer of Responsibility**

### **9.1 Transfers during construction**

Rules and procedures shall be established to control and coordinate the handover of completed work and associated facility configuration information from one party to another (for example, from civil to mechanical, piping and electrical) to maintain completed work integrity. Access control for SSCs and working areas shall also be established and implemented for the transfer. Transfer requirements and responsibilities shall be documented.

When SSC and areas are to be transferred between parties within the construction organization or contractors, both parties shall jointly check the transferred SSC and area, and the facility configuration information, at the location in question. Configuration of the components and working areas, addressing any identified deficiencies, shall be agreed upon by both parties.

After transfer, further work or corrective actions by the previous party shall only be done with appropriate authorization by the party to whom the work has been transferred and the licensee.

### **9.2 Transfers to operations/commissioning**

Rules and procedures established to control and coordinate the handover from construction to operations/commissioning shall include the following activities:

1. review of the facility configuration information relating to SSCs, and areas by the transferring party and the receiving party for completeness and accuracy
2. performance of tests to ensure the SSCs have been manufactured, constructed and installed according to design specifications
3. identification and assessment of any remaining non-conformances or incomplete components, to ensure there is no safety implication during commissioning activities
4. development of inaugural or baseline inspection data for systems or components for comparative purposes for in-service inspection
5. agreement upon, planning and scheduling of any outstanding work
6. identification of termination points of the boundaries of transferred or transferred parts of SSCs in transfer documentation with associated required configuration
7. inspection of transferred components and associated records and documents
8. assessment of compatibility of information and communication technology systems when transferring electronic documents and records
9. documentation of the transfer of responsibilities
10. establishment and transfer of approved as-built plans together with adequate and precise plant configuration details
11. marking and tagging of all SSCs transferred

Transfer requirements and responsibilities shall be documented. The level of technical detail in transfer documentation shall be sufficient to allow the recipient to identify parts and order replacements for maintenance. All relevant information shall be copied to the parties who will be responsible for aging management.

## **10. Configuration Control**

During manufacturing, onsite construction and testing, inevitable design changes shall be managed to ensure that consistency of design, as well as the physical facility being built, is

maintained. Change control processes shall ensure that approved changes are accurately reflected in design requirements, facility configuration information, and the physical configuration. Such changes include:

1. design changes
2. field changes
3. non-conformances
4. changes to as-built condition
5. changes to as-built test documentation
6. changes inaugural inspection records
7. computer software changes
8. changes to records of maintenance history
9. temporary modifications and alterations

The CNSC shall be notified where configuration changes have an impact on the submitted design and licensing basis information.

### **Guidance**

Design changes that could have an impact on safety should be minimized after construction starts and should be recorded according to a well-defined process, so that the safety of the as-built design is achievable.

## **11. Construction Records**

The control of construction records shall be established and shall be consistent with the schedule for accomplishing construction activities. Construction records shall furnish documentary evidence that SSCs meet specified requirements forming part of the facility configuration information. Construction records shall be identified, generated, authenticated, and maintained, and their final disposition specified as required by regulation, law, code, standard, specification, procedure or contract.

Photographic and, where appropriate, video records and computer simulations shall be compiled, particularly in areas that will eventually be inaccessible or will be subject to intense radiation. This information will facilitate the planning of work in these areas during commissioning, operation and decommissioning. These visual construction records of as-built conditions shall show identification marks and shall be catalogued with descriptive captions. This will ensure that visual records made during subsequent inspections or maintenance work can be easily compared, and will help in any work preparation.

## Glossary

**authorized inspection agency**

An organization designated by the regulatory authority as authorized to register designs and procedures, perform inspections, and perform other defined functions.

**commissioning**

A series of activities intended to demonstrate that installed systems, structures and components and equipment perform in accordance with their specifications and design intent before they are put into service.

**construction**

The process of procuring, manufacturing and assembling the components, carrying out civil work, installing and maintaining components and systems, and performing associated tests.

**construction organization**

The entity managing the procurement, manufacture and assembly of components, carrying out of civil work, installment and maintenance of components and systems, and performance of associated tests. They may be part of the licensee's organization or a contracted entity.

**construction safety case**

The information provided with the licence application for a licence to construct, including the documents to which the application makes reference, once approved by the CNSC.

**design**

In the context of a review of a reactor design, the overall planning and philosophies that go into ensuring that every aspect of the physical design will consider safety, security and safeguards under all scenarios it may encounter during its lifecycle.

**design basis**

The range of conditions and events taken into account in the design of a reactor facility, according to established criteria, such that the facility can withstand the range of conditions and facilities without exceeding authorized limits by the planned operation of safety systems.

**facility configuration information**

Recorded information that describes, specifies reports, certifies, or provides data or results regarding the design requirements or design basis, or that pertains to other information attributes associated with the facility and its structures, systems and components.

**interoperability**

The capacity to manage and communicate electronic product and project detail between collaborating firms and within individual companies' design, construction, operations, maintenance, and business process systems.

**licensee**

A person who is licensed to carry on an activity described in any of paragraphs 26(a) to (f) of the *Nuclear Safety and Control Act*.

**licensing basis**

A set of requirements and documents for a regulated facility or activity comprising:

- the regulatory requirements set out in the applicable laws and regulations

- the conditions and safety and control measures described in the facility's or activity's licence and the documents directly referenced in that licence
- the safety and control measures described in the licence application and the documents needed to support that licence application

**management system**

A set of interrelated or interacting elements (system) for establishing an organization's policies and objectives and enabling the objectives to be achieved efficiently and effectively. These elements include the structure, resources, and processes. Personnel, equipment, and organizational culture, as well as the documented policies and processes, are parts of the management system. The organization's processes have to address the totality of organization's requirements as established in, for example, IAEA safety standards and other international codes and standards.

**nuclear power plant (NPP)**

A nuclear facility consisting of any fission-reactor installation that has been constructed to generate electricity on a commercial scale. A nuclear power plant is a Class 1A nuclear facility, as defined in the *Class I Nuclear Facilities Regulations*.

**operation**

All activities performed to achieve the purpose for which a facility was constructed. For reactor facilities, this includes maintenance, refuelling, in-service inspection and other associated activities.

**structures, systems and components (SSCs)**

A general term encompassing all of the elements (items) of a facility or activity that contribute to protection and safety. Structures are passive elements: buildings, vessels, shielding, etc. A system comprises several components, assembled in such a way as to perform a specific (active) function. A component is a discrete element of a system. Examples are wires, transistors, integrated circuits, motors, relays, solenoids, pipes, fittings, pumps, tanks, and valves.

**safety analysis**

Analysis by means of appropriate analytical tools that establishes and confirms the design basis for the items important to safety, and ensures that the overall plant design is capable of meeting the acceptance criteria for each plant state.

**safety case**

An integrated collection of arguments and evidence to demonstrate the safety of a facility. A safety case will typically include a safety assessment, but could also include information (including supporting evidence and reasoning) on the robustness and reliability of the safety assessment and the assumptions made therein.

**small reactor**

A reactor with a power level less than approximately 200 megawatts thermal (MWt) that is used for research, isotope production, steam generation, electricity production or other applications.

## References

[It is expected that the draft documents listed will be published before this document. The references will be updated and revised as necessary before publication.]

1. CNSC, REGDOC-2.5.2, *Design of Reactor Facilities: Nuclear Power Plants* (draft), Ottawa.
2. CNSC, REGDOC-2.3.1, *Operating Performance: Commissioning of Reactor Facilities* (draft), Ottawa.
3. Canadian Standards Association (CSA Group), N286-12, *Management system requirements for nuclear facilities*, Mississauga, 2012.
4. CNSC, RD/GD-369, *Licence Application Guide, Licence to Construct a Nuclear Power Plant*, Ottawa, 2011.
5. CNSC, REGDOC-2.2.2, *Human Performance Management: Personnel Training* (draft), Ottawa.
6. CNSC, REGDOC-2.9.1, *Environmental Protection* (draft), Ottawa.
7. CNSC, REGDOC-2.6.3, *Fitness for Service: Aging Management*, Ottawa, 2014.
8. CNSC, RD/GD-210, *Maintenance Programs for Nuclear Power Plants*, Ottawa, 2007.



## Additional Information

### Codes, standards and guides:

The following national and international codes, standards and guides, which are the most widely accepted and used internationally, provide detailed information on how to meet the requirements of this regulatory document:

- American Concrete Institute, ACI 349, *Code requirements for Nuclear Safety Related Concrete structures*, Farmington Hills, Michigan, 2007
- American National Standards Institute (ANSI) and Nuclear Information and Records Management Association, ANSI/NIRMA CM 1.0-2007, *American National Standard for Guidelines for Configuration Management of Nuclear Facilities*, New York, 2007
- ANSI and American Nuclear Society, ANSI/ANS-56-8, *Containment System Leakage Testing Requirements*, New York, 2002
- American Society of Mechanical Engineers (ASME), *Rules for Construction of Nuclear Facility Components ASME Boiler and Pressure Vessel Code, Section III, Division I*, New York, 2010
- ASME, *Rules for Construction of Nuclear Facility Components, ASME Boiler and Pressure Vessel Code, Section III, Division 2*, New York, 2010
- ASME, *Quality Assurance Requirements for Nuclear Facility Applications, ASME NQA-1-2008 and the NQA-1a-2009 Addenda, Parts II and III*, New York, 2008 and 2009
- Canadian Nuclear Safety Commission, REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response* (draft), Ottawa
- Canadian Standards Group (CSA), N285.0, *General Requirements for Pressure-Retaining Systems and Components in CANDU Nuclear Plants*, Mississauga, 2012
- CSA, N285.4-10, *Periodic Inspection of CANDU Nuclear Power Plant Components*, Mississauga, 2010
- CSA, N285.5, *Periodic Inspection of CANDU Nuclear Power Plant Containment Components*, Mississauga, 2013
- CSA, N286, *Management System Requirements for Nuclear Facilities*, Mississauga, 2012
- CSA, N287.1, *General Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants*, Mississauga, 1993, reaffirmed 2009
- CSA, N287.4, *Construction, Fabrication, and Plant Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants*, Mississauga, 2009
- CSA, N287.5, *Examination and Testing Requirements for Concrete Containment Structures for Nuclear Power Plants*, Mississauga, 2011

- CSA, N287.6, *Pre-operational Proof and Leakage Testing Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants*, Mississauga, 2011
- CSA N288.4-10, *Environmental Monitoring*, Mississauga, 2010
- CSA, N289.4, *Testing procedures for seismic qualification of nuclear power plant structures, systems and components*, Mississauga, 2012
- CSA N290.7, *Cyber security for nuclear power plants and small reactor facilities* (draft)
- CSA N291-08, *Requirements for safety-related structures for CANDU Nuclear Power Plants*, Mississauga, 2008
- CSA, N293-12, *Fire Protection for CANDU Nuclear Power Plants*, Mississauga, 2012
- CSA, N393-13, *Fire protection for facilities that process, handle or store nuclear substances*, Mississauga, 2013
- CSA, Z1000-06, *Occupational Health and Safety*, Mississauga, 2012
- International Atomic Energy Agency, draft standard, DS441, *Construction for Nuclear Power Plants Safety Guide*, Vienna

**Safeguards agreements:**

- *Agreement Between the Government of Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons Article* <http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc164.shtml>
- *Protocol Additional to the Agreement Between Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non- Proliferation of Nuclear Weapons* <http://www.iaea.org/Publications/Documents/Infcircs/2000/infcirc164a1.pdf>

**Nuclear industry organizations:**

- Institute of Nuclear Power Operations (INPO) [www.inpo.org](http://www.inpo.org)
- World Association of Nuclear Operators (WANO) [www.wano.info](http://www.wano.info)
- Electric Power Research Institute (EPRI) [www.epri.com](http://www.epri.com)
- Nuclear Energy Institute (NEI) [www.nei.org](http://www.nei.org)
- Institute of Electrical and Electronics Engineers (IEEE) [www.ieee.org](http://www.ieee.org)
- Organisation for Economic Co-operation and Development – Nuclear Energy Agency (OECD-NEA) [www.oecd-nea.org](http://www.oecd-nea.org)
- International Atomic Energy Agency (IAEA) [www.iaea.org](http://www.iaea.org)  
Safety Series, Nuclear Energy Series, Safety Report Series, Nuclear Security Series and Technical Documents

- Project Management Institute (PMI), PMBOK® Guides and Standards [www.pmi.org](http://www.pmi.org)

**Other nuclear regulatory organizations:**

- United States Nuclear Regulatory Commission (NRC) [nrc.gov](http://nrc.gov)
- United States Department of Energy (DOE) [energy.gov](http://energy.gov)
- United Kingdom's Office for Nuclear Regulation [gov.uk/nuclear](http://gov.uk/nuclear)
- Finland's Radiation and Nuclear Safety Authority (STUK) [stuk.fi/en\\_GB/](http://stuk.fi/en_GB/)
- French Safety Authority (ASN) [french-nuclear-safety.fr](http://french-nuclear-safety.fr)

## CNSC Regulatory Document Series

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

Effective April 2013, the CNSC's catalogue of existing and planned regulatory documents has been organized under three key categories and twenty-five series, as set out below. Regulatory documents produced by the CNSC fall under one of the following series:

### 1.0 Regulated facilities and activities

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

### 2.0 Safety and control areas

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

### 3.0 Other regulatory areas

Series	3.1	Reporting requirements
	3.2	Public and Aboriginal engagement
	3.3	Financial guarantees
	3.4	Commission proceedings
	3.5	Information dissemination

**Note:** The regulatory document series may be adjusted periodically by the CNSC. Each regulatory document series listed above may contain multiple regulatory documents. For the latest list of regulatory documents, visit the CNSC's website at [nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents](http://nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents)