



CNSC Fukushima Task Force

Nuclear Power Plant Safety Review Criteria

E-doc 3743877

July 2011



Executive Summary

In response to the March 11, 2011 accident at the Fukushima Daiichi Nuclear Power Plant (NPP), the CNSC convened a Task Force to evaluate the lessons learned and the operational, technical and regulatory implications for Canadian NPPs, and to develop a strategy for prioritization and implementation of corrective measures.

This document describes the scope and criteria of the Task Force review.

- Under section 12 (2) of the *General Nuclear Safety and Control Regulations*, the CNSC requested all Canadian NPP licensees to submit detailed information regarding their facilities. The Task Force will review this information as part of its mandate.
- The review will ensure that external hazards, including multi-unit events, accounted for in the reactor safety cases, are both sufficient and appropriate; in particular the review will verify that events of the correct magnitudes have been considered.
- The review will evaluate NPP behaviour in response to beyond design basis accidents, including severe accidents, with a focus on bounding events, for example loss of electrical power that can lead to a prolonged loss of fuel cooling in the reactor core and in irradiated fuel storage. Event timing and the duration of backup services (such as fuel supplies, batteries and water) will be investigated.
- Measures to mitigate the consequences of beyond design basis and severe accidents will be reviewed. The status of Severe Accident Management Guidelines will be assessed. Availability of mitigating measures will be reviewed, including additional supplies of backup power and cooling, hydrogen mitigation, filtered venting of containment.
- The adequacy of on-site and off-site emergency measures will be reviewed - including roles and responsibilities of decision makers at the operator, municipal, provincial and federal levels - and recommendations will be made for further improvements, as appropriate, recognizing provincial and municipal jurisdictions in off-site emergency response.
- The CNSC regulatory framework and processes for operating reactors and new builds will be reviewed to identify areas where revisions may be needed.

The Task Force will report on its progress to the Commission in a public forum and prepare a report detailing its conclusions and recommendations. The following is a list of major milestones and deliverables related to the work of the Task Force.

- Updates to CNSC Commission Members:
 - Present an update to the Commission August 10, 2011
 - Present an update and IAEA findings to the Commission December 15, 2011
- Task Force Reports:
 - Nuclear Power Plant Safety Review Criteria June 17, 2011
 - Draft Report September 7, 2011
 - Final Report September 30, 2011
- Project Oversight:
 - External Advisory Committee report to be determined
 - IAEA Assessment of Canada's response to Fukushima November 28, 2011

Table of Contents

1.	Background.....	1
1.1.	Regulatory Request	1
1.2.	Closure Criteria and Schedule	2
2.	Safety Review of Nuclear Power Plants.....	3
2.1.	External Hazards	3
2.2.	Design Basis Events	3
2.3.	Beyond Design Basis Events.....	3
2.4.	Severe Accident Management.....	4
2.5.	Emergency Response	5
3.	CNSC Regulatory Framework and Processes	5
3.1.	Act and Regulations	5
3.2.	Regulatory Documents	6
3.3.	Licensing and Compliance	6
4.	Status of National Emergency Measures.....	6
5.	International Initiatives.....	6
6.	References	7

1. Background

On March 11, 2011, an earthquake measuring 9.0 on the Richter scale, followed by a devastating tsunami, combined to cause one of the worst nuclear accidents in recent years at the Fukushima Daiichi nuclear power plant. Initially rated at level 4 on the International Nuclear Event Scale, Japan subsequently increased the level to 7, the highest on the scale. A final assessment of the severity and causes of the incident will only come after the conclusion of full investigations.

The review criteria detailed in this document apply to nuclear power plants only. Other Class I nuclear facilities will be dealt with through normal licensing and compliance processes. However, lessons learned through the analysis of the events in Japan following the March 11 earthquake and tsunami will be applied to other major Canadian nuclear facilities as applicable.

The Canadian Nuclear Safety Commission (CNSC) licences and maintains oversight over all uses of nuclear energy and substances in Canada and is committed to ensuring that the Canadian nuclear industry remains among the safest in the world.

1.1. Regulatory Request

Section 12(2) of the *General Nuclear Safety and Control Regulations*, places an obligation on licensees to respond to a request from the Commission, or a person who is authorized by the Commission to “conduct a test, analysis, inventory or inspection in respect of the licensed activity or to review or to modify a design, to modify equipment, to modify procedures, or to install a new system or new equipment”. Under this section, the CNSC sent a written request to all Class 1 nuclear facilities on 2011-03-17 requesting that licensees:

Review initial lessons learned from the earthquake in Japan and re-examine the safety cases of nuclear power plants, in particular the underlying defence-in-depth concept, with focus on:

- *external hazards such as seismic, flooding, fire and extreme weather events;*
- *measures for the prevention and mitigation of severe accidents;*
- *emergency preparedness; and*

Report on implementation plans for short-term and long-term measures to address any significant gaps.

Meanwhile, the CNSC convened a Task Force, [1], with the objective to evaluate operational, technical and regulatory implications of the Japan 2011 nuclear event on Canadian Nuclear Power Plants, as well as to review licensees’ responses to the 12(2) letter; specifically, provisions taken by licensees in the design basis (initiating events) and beyond the design basis (available design margins, diversity, redundancy, barrier integrity, physical separation) for Nuclear Power Plants.

The purpose of this document is to describe in more detail the scope of the Task Force review of:

- industry responses to the CNSC’s 12(2) letter (section 2), including evaluation of short-term responses and proposals for longer-term follow-up work;
- potential changes to the CNSC regulatory framework and processes relevant to existing NPPs and potential new builds (section 3); and

- the status of emergency measures, including municipal, provincial and federal jurisdictions (section 4).

1.2. Closure Criteria and Schedule

The Task Force will determine whether licensees have addressed CNSC's request for information as committed in the initial response to the 12(2) letter:

- review initial lessons learned from the earthquake in Japan and re-examine the safety cases of nuclear power plants, in particular the underlying defence-in-depth concept, with focus on:
 - external hazards such as seismic, flooding, fire and extreme weather events;
 - measures for the prevention and mitigation of severe accidents;
 - emergency preparedness; and
- report on implementation plans for short-term and long-term measures to address any significant gaps.

The licensees' reports and implementation plans should:

- provide a plan and schedule for the completion of short-term and long-term measures;
- identify measures that have already been put in place; and
- identify any previously planned activities that have been accelerated as part of the lessons learned.

The reports and implementation plans submitted by NPP licensees must consider all the items described in section 2. The CNSC will consider the extent to which the NPP conforms to regulatory requirements and expectations and will use a risk informed approach, such as Risk Informed Decision Making [2] in judging the acceptability of proposals. Plant modifications may be included in the scope of the long-term actions. Any actions arising from the Task Force review will be tracked as station-specific action items using established communication protocols.

The following is a list of major milestones and deliverables related to the work of the CNSC Task Force:

MILESTONE/DELIVERABLE	
Description	Completion Date 2011
Complete Terms of Reference for CNSC Task Force	April 12
Identify Task Force (project) Team Members	April 19
Complete Project Charter (Scope Milestones & Assumptions)	June 10
Updates to CNSC Commission Members	
Present an update to the Commission	June 8
Present an update to the Commission	August 10
CNSC Task Force Reports	
Nuclear Power Plant Safety Review Criteria	June 17
CNSC Final Draft Report	September 7
Senior Management Review & Approval	September 23
Issuance of Final Report	September 30
Project Oversight	
External Advisory Committee interim report	October 1
IAEA assessment of Canada's response to Fukushima	November 28
Present IAEA findings to the Commission	December 15

2. Safety Review of Nuclear Power Plants

The CNSC has licensed Canadian NPPs on the basis of comprehensive safety reports and supplementary analyses which demonstrate that the facility design meets regulatory requirements and expectations, and appropriate safety management systems, plans and programs for safe and secure operation are established. Any new analyses, such as those supporting modifications or new research findings, are incorporated into the safety reports to include lessons learned from the Fukushima event, as appropriate. This information is updated every three years and submitted for regulatory review.

The safety reports include the evaluation of the underlying defence-in-depth concept for the effective implementation of safety functions in the facility design. There are five levels to defence-in-depth:

- prevention of abnormal operation and failures;
- control of abnormal operation and detection of failures;
- control of accidents within the design basis;
- control of severe plant conditions, including prevention of accident progression and mitigation of the consequences of severe accidents; and
- mitigation of radiological consequences of significant releases of radioactive materials

The defence-in-depth concept is supported by emphasis on the inherent safety characteristics of the reactor, and insights from deterministic and probabilistic safety analyses to evaluate and optimize the overall plant design. In principle, an application of the defence-in-depth concept assures the prevention and control of incidents and accidents at several engineering and procedural levels in order to ensure the effectiveness of the protection of physical barriers.

2.1. External Hazards

The review will ensure that external hazards accounted for in the reactor safety cases and credible consequential events are both sufficient and appropriate. The events considered will be specific to each site and include seismic, fire, flood, extreme weather events and man-made events (such as explosion). The consequential events include external events (such as severe weather and cooling water intake blockage) and internal events (such as fire or small break loss of coolant accident caused by earthquake). The review will focus on verifying that appropriate magnitudes have been considered in the design basis and beyond design basis analyses.

2.2. Design Basis Events

Design basis accidents, including on-site irradiated fuel storage, have been extensively studied by the industry and the regulator for many years. However, if new information on external initiating events is discovered in section 2.1 above, and as additional details on the Fukushima events come to light, then relevant events will be reviewed to demonstrate adequate plant safety or to identify mitigating measures.

2.3. Beyond Design Basis Events

Beyond Design Basis Accidents (BDBA) could lead to limited core damage, or less likely to widespread physical damage to fuel and core structures accompanied by a large release of fission products referred to as severe accidents.

The review will investigate selected BDBA scenarios, including severe accidents. The focus will be on events that could lead to a sustained loss of heat sink, either through the loss of electrical supplies, loss of service water or other sequences.

The review will assess delivery of critical safety functions for credible beyond design basis events and identify sensitivity to large increase in the severity of an event caused by a small change of conditions, using judgement where appropriate (referred to as cliff-edge effects).

The review will consider the progression and timing of the event and the consequences of the failure of progressive levels of mitigation and backup. Given the differences in NPP designs and implementations of safety upgrades in the areas under review, the Task Force will consider plant-specific event details. The duration of backup services (batteries, diesel fuel, etc.) will be an important consideration, as will events with small margins, cliff-edge effects, likely failures consequential to the external event, and the impact of events on multi-unit stations. This will include identification of the barriers to fission product release into containment and the margin to failure of mitigating equipment. Preventive measures to slow or halt the progression to severe accidents will be identified.

In addition, the review will assess margins to containment failure and will identify important cliff edge effects. This will include identifying the mitigating systems to delay or halt calandria and containment failure. Multi-unit effects will also be considered in the review.

Loss of shutdown and large break Loss of Coolant Accidents (LOCA) as a result of a seismic event have been investigated in the past and are accepted as incredible. Nonetheless, the possibility of a consequential small break LOCA will be re-evaluated.

2.4. Severe Accident Management

Severe Accident Management (SAM) is one of the components of defence-in-depth used in the overall safety assurance framework. SAM provides for the management of risks posed by unlikely events leading to severe accidents in a nuclear power plant.

The review will consider the use of existing plant capabilities, complementary design features (such as Passive Autocatalytic Recombiners, Emergency Containment Filtered Venting System, Calandria Vault Make-up, etc.) and *emergency mitigating equipment*¹ in the management of a severe accident. The focus will be on delaying or halting the progression of an accident leading to eventual calandria and/or containment failure. Plant monitoring and instrumentation survivability in severe accident conditions will also be reviewed. Where additional equipment or design modifications are found to be necessary, the Task Force will review the licensees' plans and schedules for implementation.

SAM includes the development of guidance and procedures for use by plant personnel. The Task Force review will verify the status of Severe Accident Management Guidelines (SAMG) at Canadian NPPs. Where SAMG has not been fully implemented, the Task Force will review the licensees' plans and schedules for completion.

This review will also consider plans for the use of external resources, such as equipment, fuel and people in mitigating severe accidents. Formal plans for inter-utility cooperation in matters such as

¹ Emergency mitigating equipment includes portable equipment that may be delivered to site with the purpose of mitigating severe accidents.

availability of skilled personnel, provision of technical support and the sharing of equipment will also be considered.

2.5. Emergency Response

This section of the review addresses the licensees' responsibilities. Section 4 deals with the current status of emergency preparedness and response measures in Canada.

The review will assess the adequacy of the on-site emergency plan and consider the following aspects:

- adequacy of current emergency response plans and organizations to deal with beyond design basis and severe or multi-unit accidents;
- integration of severe accident management guidelines with emergency response organization, including overall command and control arrangements;
- need for alternate site locations for control room, emergency operation center, emergency management center and the robustness of these rooms against external hazards;
- confirmation of the availability of support and supplies from external resources (e.g. industry, commercial or government suppliers of equipment, fuel, resources, etc.); and
- capability of the emergency response facilities and equipment (e.g., boundary radiation monitoring) to function without external power.

The review will assess the interface to guide and support off-site emergency response and consider the following:

- source term estimation including source term for multi-unit accident;
- plume dispersion and dose modelling;
- station boundary radiation monitoring and field radiation monitoring;
- containment venting decision process and authority; and
- coordination of communication between licensee and CNSC, provincial authorities and federal government, related to information exchange, decision making and public affairs/media.

The review will also assess communications plans with public, federal, provincial and municipal authorities.

3. CNSC Regulatory Framework and Processes

The review will assess the CNSC's regulatory framework and processes to make recommendations for revisions where lessons learned from Fukushima indicate potential weaknesses. The review will cover the regulatory requirements for existing NPPs and potential new builds in Canada.

3.1. Act and Regulations

The *Nuclear Safety and Control Act* and the regulations made under the NSCA will be reviewed to ensure that CNSC has the authority and legal instruments it needs to discharge its responsibilities.

3.2. Regulatory Documents

Regulatory documents will be reviewed to identify any that may require revision in the light of lessons learned from Fukushima. Any recommendations for document revision will be referred to the CNSC Regulatory Framework Steering Committee for acceptance. Document revisions will be subject to existing document control processes, including public review and, where appropriate, approval by the Commission.

Regulatory documents will be reviewed, including those in the following topic areas:

- reactor design;
- reactor siting;
- safety analysis;
- severe accident management;
- emergency preparedness; and
- radiation doses.

3.3. Licensing and Compliance

The processes for licensing and compliance monitoring at NPPs in Canada will be reviewed. Generic Power Reactor Operating Licences will be reviewed to identify any lessons learned from Fukushima that may require the addition or modification of licence conditions. The Licence Condition Handbooks will also be reviewed. Recommendations to develop additional inspections will be made if deemed necessary.

4. Status of National Emergency Measures

The management of a nuclear emergency in Canada involves overlapping municipal, provincial and federal jurisdictions. The CNSC Task Force will work with all stakeholders to compare the plans, capabilities and lessons learned reviews of individual agencies to identify any outstanding issues related to coordinated emergency management.

The review will ensure that agencies' responsibilities and communications channels have been defined and that information needs are well established. Decision making, including lead roles and responsibilities of the decision makers will be reviewed and recommendations will be made for further improvements, as appropriate. The scope of the review of emergency preparedness measures will also include catastrophic conditions resulting from natural disasters and nuclear accidents combined.

The review will also assess the protocols between USA and Canada for management of nuclear emergencies in either country and will scope expectations for actions the CNSC should undertake in the case of an emergency in one of the CANDU countries.

5. International Initiatives

In developing the review's scope, the CNSC Task Force has reviewed and considered similar initiatives being undertaken by selected international organizations to ensure that the Terms of Reference include the pertinent elements of the other task groups as well as items unique to the Canadian situation.

In particular, the Fifth Review Meeting of the contracting parties to the Convention on Nuclear Safety (CNS) has proposed an Extraordinary Meeting of the CNS to be held in August 2012 [3]. Contracting parties will present short national reports at that meeting, addressing, to the extent possible, the following topics:

1. nuclear power plant design against external events
2. offsite response to emergency situations (e.g. station blackout)
3. emergency management and preparedness following worst case accident scenarios
4. safety consideration for operation of multi-units at the same Nuclear Power Plant site
5. cooling of spent fuel storage in severe accident scenarios
6. training of Nuclear Power Plant operators for severe accident scenarios
7. radiological monitoring following a Nuclear Power Plant accident involving radiological release
8. public protection emergency actions
9. communications in emergency situations

The CNSC Task Force review will address these areas and the final Task Force report will provide the basic information needed for the Canadian National Report to the CNS.

6. References

- 1 [*Terms of Reference, CNSC Task Force on Review of Japan Nuclear Event: Implications on Canadian Nuclear Power Plants*](#), 2011-04-14, Edoc #3703741
- 2 *Risk-Informed Approach for the CNSC Power Reactor Regulatory Program*, 2010-05-07, E-Doc # 3264949
- 3 [*Summary Report of the 5th Review Meeting of the Contracting Parties to the Convention on Nuclear Safety 4-14 April 2011*](#), Vienna, Austria, 2011-04-14