



Fukushima's Lasting Impacts on the Global Nuclear Industry

The Canadian Regulator's View

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Lecture to the Canadian Nuclear Society
New Brunswick Branch
August 30, 2017



Progression of the Accident

14:46, March 11, 2011

Great East Japan Earthquake

Loss of offsite power; all operating reactors automatically shut down





Timeline of Events

Mar 11, 15:27–15:37

Tsunami waves overwhelmed the tsunami barriers of the Fukushima Daiichi nuclear power plant (NPP) site, flooding primary and backup power systems and equipment, as well as the ultimate heat sink systems and structures of all six units on the site.



Fukushima Daiichi nuclear complex, March 11, 2011 (Photo: AP/Tokyo Electric Power Co.)



Compounding offsite power loss that occurred due to the earthquake damage to the transmission system resulted in the loss of onsite power sources (and/or onsite power distribution systems).





Mar 11, 15:42

Station blackout declared. Units 1 – 5 of the Fukushima Daiichi NPP experienced extended station blackout (SBO) events, which exceeded 9 days in units 1 and 2, and 14 days in units 3 and 4.

Mar 12–15, 2011

The nuclear units were unable to cope with the extended loss of electrical power and plant heat removal, and the reactors of units 1, 2 and 3 suffered damage as the fuel overheated and melted. The reactor pressure vessels that enclose the reactor cores were eventually breached in those units, and radioactive material escaped from the reactors.



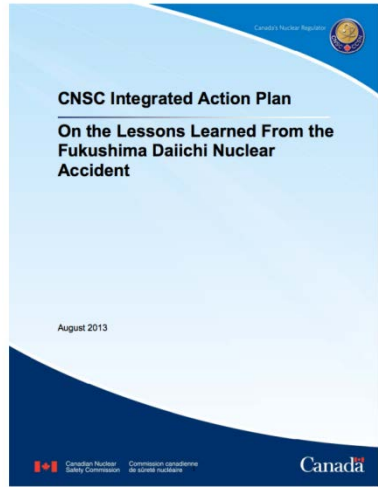
The radioactive material confined in the primary containment vessels (PCVs) was further released directly to the environment, either in a controlled manner, i.e. by venting of the reactors' PCVs, or in an uncontrolled manner upon damage and failure of the confinement structures.



Fukushima Daiichi nuclear complex, Unit 4, March 24, 2011. (Photo: TEPCO)



Chronology



Apr. 2011

CNSC Task Force convened

Jul. 2011

Safety review criteria – Canadian “stress test” issued

Oct. 2011

CNSC Task Force Report – Issued for public comment

Dec. 2011

IRRS mission conducted

Mar. 2012

CNSC Staff Action Plan – Issued for public comment

Apr. 2012

External Advisory Committee Report issued

Jun. 2012

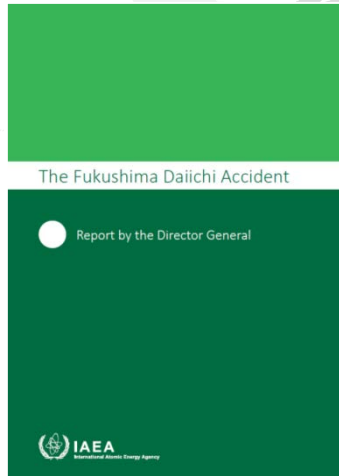
CNSC Action Plan – Approved by CNSC Commission

Dec. 2013

Short-term actions completed



Chronology



Dec 2014

Mid-term actions completed

Dec 2015

Closure of CNSC Action Plan
IAEA DG's Report on
Fukushima Daiichi Accident

Reassessment of external hazard of higher magnitudes and consequences



Post-Fukushima

Safety Enhancements



Post-Fukushima Safety Enhancements

- Reassessment of hazards
- Portable emergency equipment
- Enhanced control of hydrogen
- Emergency filtered venting
- Pre-distribution of potassium iodide pills
- Real-time radiation monitoring
- Exercise-Exercise-Exercise
- Stronger regulations
- Communications and public disclosure
- International involvement



CNSC Action Plan



McMaster University
Emergency preparedness exercise



International collaboration



CNSC Online Extreme Events Simulation,
communications and public education

Shift in regulatory focus from accident prevention to accident prevention and mitigation



Protect Fuel



Point Lepreau connections to emergency water supply, freshwater pumphouse



Backup power generator and connections - PLNGS has 4 in total



Severe accident sampling and monitoring system

Licenses met CNSC requirements



Prevent Severe Core Damage



Hose trailer for emergency water make-up



Point Lepreau, calandria vault make-up



Emergency water supply pump to further strengthen emergency preparedness

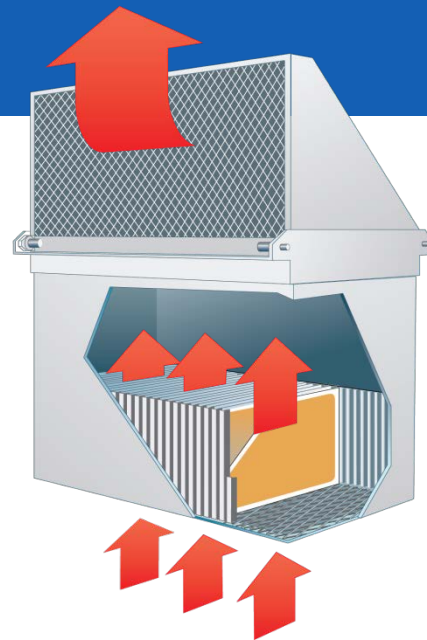
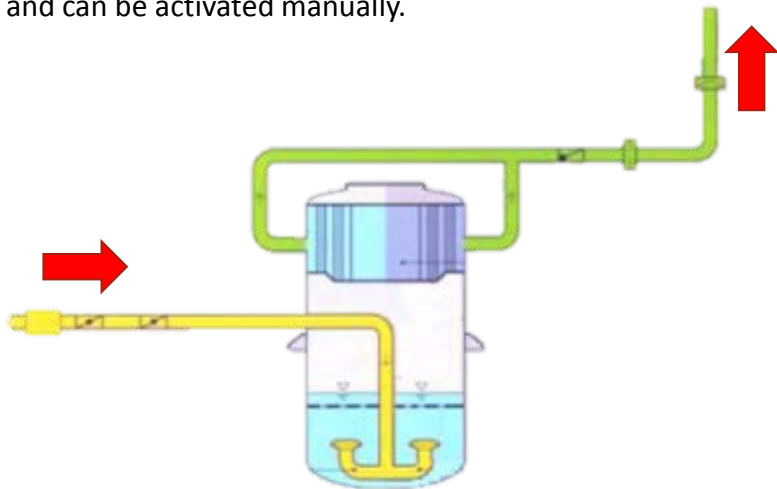
Licenses met CNSC requirements



Reactor Defence in Depth Protect Containment

Emergency containment filtered ventilation

The system is designed to provide additional filtering in case of a severe accident. It does not require power to function, and can be activated manually.



Hydrogen control and mitigation

Passive autocatalytic recombiners (PARs) are designed to remove hydrogen in non-flammable atmospheres. Self-starting, they do not require power to function.



Protect Containment



Point Lepreau emergency filtered vent stack



Containment emergency filter venting system



Hydrogen control and mitigation with licensees have enhanced hydrogen control through installation of PARs.

Reactor defence in depth



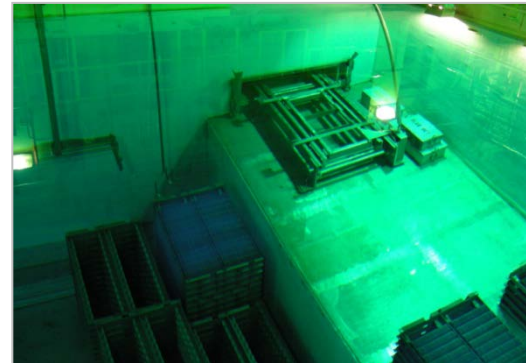
Protect Spent Fuel Pools



Point Lepreau EME drills



Point Lepreau, crew fuel storage tank farm drill



Piping to spent fuel pool maintains pool water levels above the top of spent fuel to control overheating and shielding against radiation.

Licenses met CNSC requirements



Enhancing Emergency Preparedness (Onsite)



Control room operator reviews emergency operating procedures.



CNSC inspector oversees Point Lepreau emergency preparedness exercise.



McMaster (research reactor) emergency exercise

Implemented safety enhancements



Enhancing Emergency Preparedness (Offsite)



Evacuation and decontamination station



Potassium iodine (KI) pills



OPG

Protecting the public through sheltering and evacuation



Offsite Emergency Planning

Ontario

- Provincial Nuclear Emergency Response Plan (PNERP) revision in progress
- Discussion paper for 75-day public consultation ~ 1600 comments
- Minister advisory panel to review comments and make recommendations
- Expected completion December 2017 with Cabinet approval

New Brunswick (NB)

- NB Emergency Measures Organization (EMO) is updating its offsite emergency plan to align with CSA and IAEA guidance
- Offsite plan to be made public
- NB Power is reviewing offsite technical planning basis



Fukushima Lessons Learned

CNSC played key role internationally

- IAEA Action Plan on Nuclear Safety
- Enhancing international peer review process
- IAEA Fukushima Report – DG lessons learned
- Enhanced accident prevention, improved mitigation of accident consequence, public protection



**Global safety is the responsibility of all stakeholders,
government, independent regulators and industry**



Convention on Nuclear Safety: 7th Review Meeting

- Adopted in Vienna on June 17, 1994
- Aim of the Convention is to legally commit participating States operating nuclear power plants to maintaining a high level of safety
- As president of the 7th Review Meeting, I have successfully implemented and continue to support strong review processes that achieve tangible improvements in nuclear safety
- For the first time in the history of the CNS - All Contracting Parties' Country Reports have been posted on the publicly accessible IAEA website



Convention on Nuclear Safety: Vienna Declaration on Nuclear Safety

Principle 1

“New nuclear power plants are to be designed, sited, and constructed, consistent with the objective of **preventing accidents** in the commissioning and operation and, should an accident occur, **mitigating possible releases** of radionuclides causing long-term off site contamination and avoiding early radioactive releases or radioactive releases large enough to require long-term protective measures and actions”

Principle 2

“Comprehensive and systematic **safety assessments are to be carried out periodically** and regularly for existing installations throughout their lifetime in order to identify safety improvements that are oriented to meet the above objective. **Reasonably practicable or achievable safety improvements are to be implemented in a timely manner**”



Canada's Global Efforts Post-Fukushima

Risk Communications and Perceptions Workshop

- Hosted by the CNSC in November 2016
- Included eight municipal, provincial, federal and international partners
- Keynote speakers were Dr. Makiko Orita, a public health nurse, and Professor Noboru Takamura from Nagasaki University's Atomic Bomb Disease Institute





Framework for Recovery after Nuclear Emergency

Recovery planning and decision-making process is highly complex

- hazards posed by radiation exposure
- involvement and overlapping accountabilities of all levels of government
- economic, political, environmental, cultural, ethical, social and psychological aspects
- need for significant stakeholder engagement
- variation in scale and response to any given emergency



Fukushima Impacts on the Nuclear Industry

- Public perception
 - There are demands for transparency, information and engagement
- Reconsideration of energy mixes
 - Some countries are quitting or scaling back nuclear
 - Others are continuing or increasing their nuclear portfolio
- Enhancement to nuclear safety from improvement initiatives
- Small modular reactors gaining attention
- World Association of Nuclear Operators (WANO) has a role in maximizing **global nuclear safety**



Continuous Improvement From Other Events

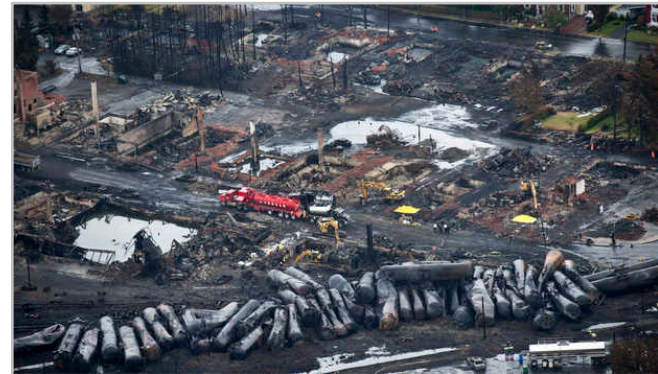
**CNSC learns lessons from all
sectors, not just nuclear**



Root Cause Findings

Lac Mégantic (July 6, 2013)

- Inadequate regulatory oversight
- Inadequate awareness / monitoring of regional activities
- Inadequate follow-up on safety-related deficiencies





Root Cause Findings

Mount Polley (August 4, 2014)

- Dam built on undetected weak layer of glacial deposits
- Updating required for design, monitoring and regulation of tailings dams in British Columbia





Conclusions for the CNSC

- Shift in regulatory focus from accident prevention to **accident prevention and mitigation**
- Continuous improvement from other events
 - Learn lessons from all sectors, not just nuclear

No room for complacency!



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