



Strength through Co-operation

Perspectives of Nuclear Energy in Canada following the Fukushima Event

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Outline of Presentation



- Early response to the Fukushima Dai-ichi event in Canada
- Early Lessons Learned from the Dai-ichi event
- Canadian regulatory ongoing activities in response to Fukushima
- How Canadian Utilities are responding to the events
- Concluding Remarks



Fukushima Dai-ichi Event



- March 11, 2011:
 - Magnitude 9.0 earthquake occurred 130 Km east of city of Sendai on eastern coast of Japan;
 - Massive tsunami wave precipitated by the quake, struck major part of Japan's east coast, caused widespread destruction
- Destruction of infrastructure included the Fukushima Dai-ichi nuclear power plant:
 - Damage resulted in apparent core melting, hydrogen explosions and radiation releases
 - Damage caused primarily from loss of cooling to the reactors and spent fuel pools due to loss of cooling systems and equipment in the tsunami



Nuclear Power in Canada



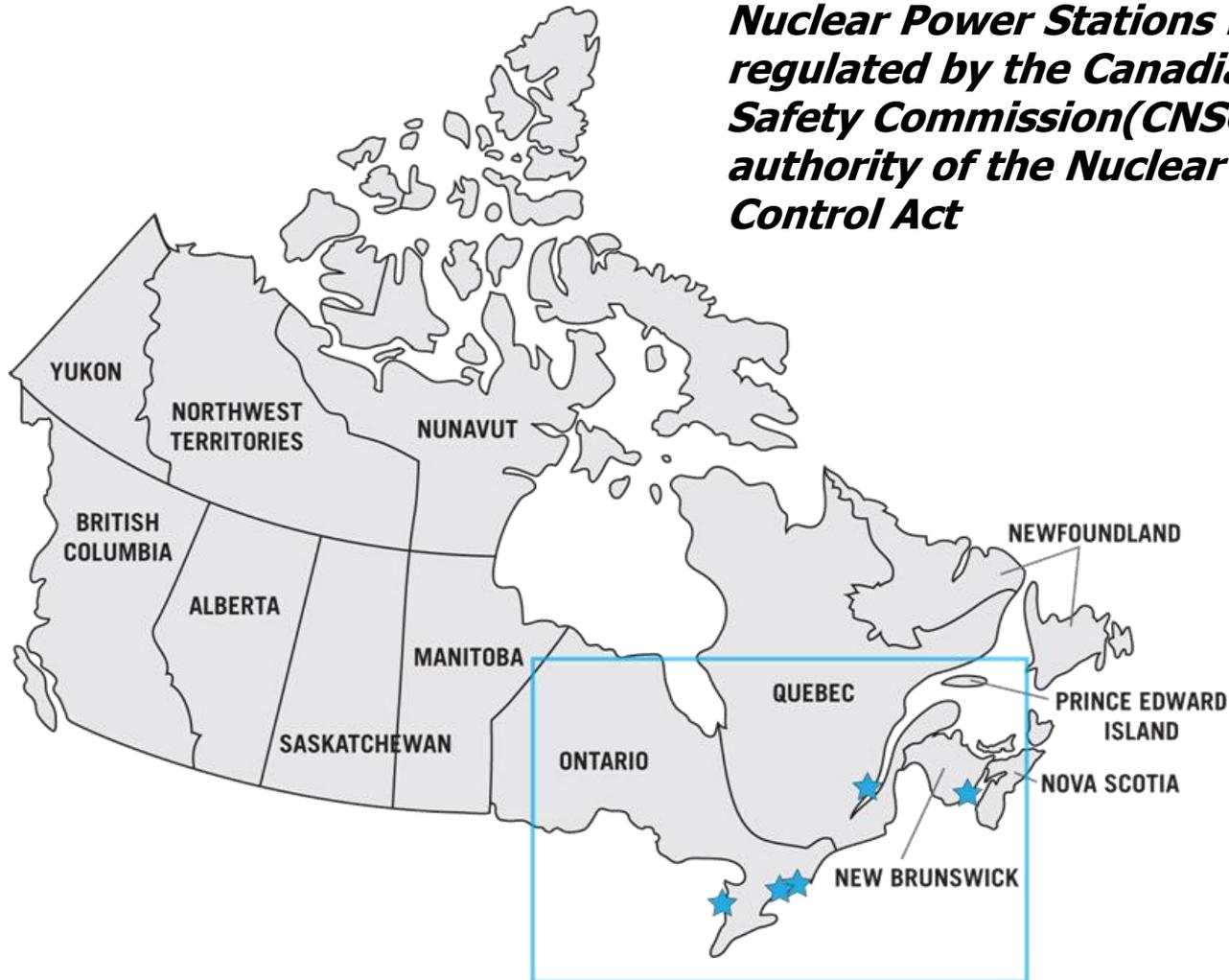
- Canadian utilities which operate nuclear power stations:
 - *Ontario Power Generation* (OPG) in the province of Ontario;
 - Pickering and Darlington Stations
 - *Bruce Power* (BP) in Ontario
 - Bruce Power stations A and B
 - *Hydro Québec* in the province of Québec
 - Gentilly 2 station
 - *New Brunswick Power* in the province of New Brunswick
 - Point LePreau station
- 20 CANDU units designed by Atomic Energy of Canada: vary in output from 500MWe to 900MWe



Nuclear Power Stations in Canada



Nuclear Power Stations in Canada are regulated by the Canadian Nuclear Safety Commission (CNSC) under the authority of the Nuclear Safety and Control Act



Early Canadian Response to Event



- Canadian Nuclear Safety Commission (CNSC) immediately activated the Emergency Operations Centre
- Public Safety Canada's Government Operations Centre co-ordinated broader Canadian Government response to the crisis
- CNSC in regular contact with network of nuclear regulators and sent experts to support the IAEA Fukushima support team



Early Lessons Learned



- Beyond Design Basis Accidents do happen
- To avoid surprises we need to*:
 - Recognize the threat
 - Make its mitigation a priority in the organization
 - Mobilize the resources to mitigate the threat

*"Predicable Surprises: The Disasters you should have seen coming", Michael Watkins & Max Bazerman, Harvard Business Review, March 2003



Regulatory activities in Response to Event



- March 17-22, 2011 the CNSC issued directive letters to its nuclear power plant operators asking for responses to specific questions on abilities to address beyond design basis accidents
- Similar action was taken by the World Association of Nuclear Operators issued an SOER to its members



CNSC March 2011 Briefing



The CNSC early Canadian perspective on event (March 30, 2011) was:

- The scale of earthquake and resulting tsunami was not credible for Canadian nuclear power plant(NPP) sites
- Reactor designs are to consider all natural events appropriate to site
- Combined events must be considered as design basis events



CNSC Fukushima Task Force



- March 30, 2011-CNSC established the Fukushima Task Force (FTF) to review the capability of nuclear power plants to withstand conditions similar to those that resulted in the Fukushima Dai-ichi event and make recommendations for regulatory reforms;
 - examined the response of NPPs to external events of higher magnitude than have previously been considered;
 - examined the licensees' capability to respond to such events
 - Focused on the :
 - need to "anticipate the unexpected": events such as earthquakes, tornadoes or hurricanes that may cause a prolonged loss of electrical power, resulting in operators not being able to continue cooling the reactors; and
 - need for an integrated response capability
 - Fukushima Task Force report, assessing the industry responses was issued to public on October 28, 2011;
 - Fukushima Task Force report documented key lessons learned



Canadian Industry Response to Directive



- Formed Canadian Industry Integration Team (CIIT) to respond to regulatory directive;
 - Team facilitated by CANDU Owners Group (COG)
 - Participation on team by:
 - Domestic and International CANDU operators,
 - AECL and Candu Energy Inc. as designer/vendor
 - Provide a forum for exchange of reviews, generic issues and responses to WANO SOERs
 - AECL/Candu Energy task team assembled to assess issues
 - Reports submitted to CNSC in July 2011



Canadian Industry Response to Directive



- Responses to WANO & CNSC documented:
 - The basis for continued safe operation
 - Status update for work completed and plans for medium and long term to address remaining issues
 - Committed to ongoing assessments and safety improvements
 - Committed to improve defences against beyond design basis events



Canadian Industry Response to Directive



- Work to address Fukushima lessons learned grouped into 3 main categories:
 1. Capability of station design and procedures to mitigate black out conditions, internal and external flooding and potential risk to equipment functionality required to deal with fire and flooding during seismic events;
 2. Assessment of BDBA's
 3. Assessment of Emergency Preparedness plans, procedures and equipment



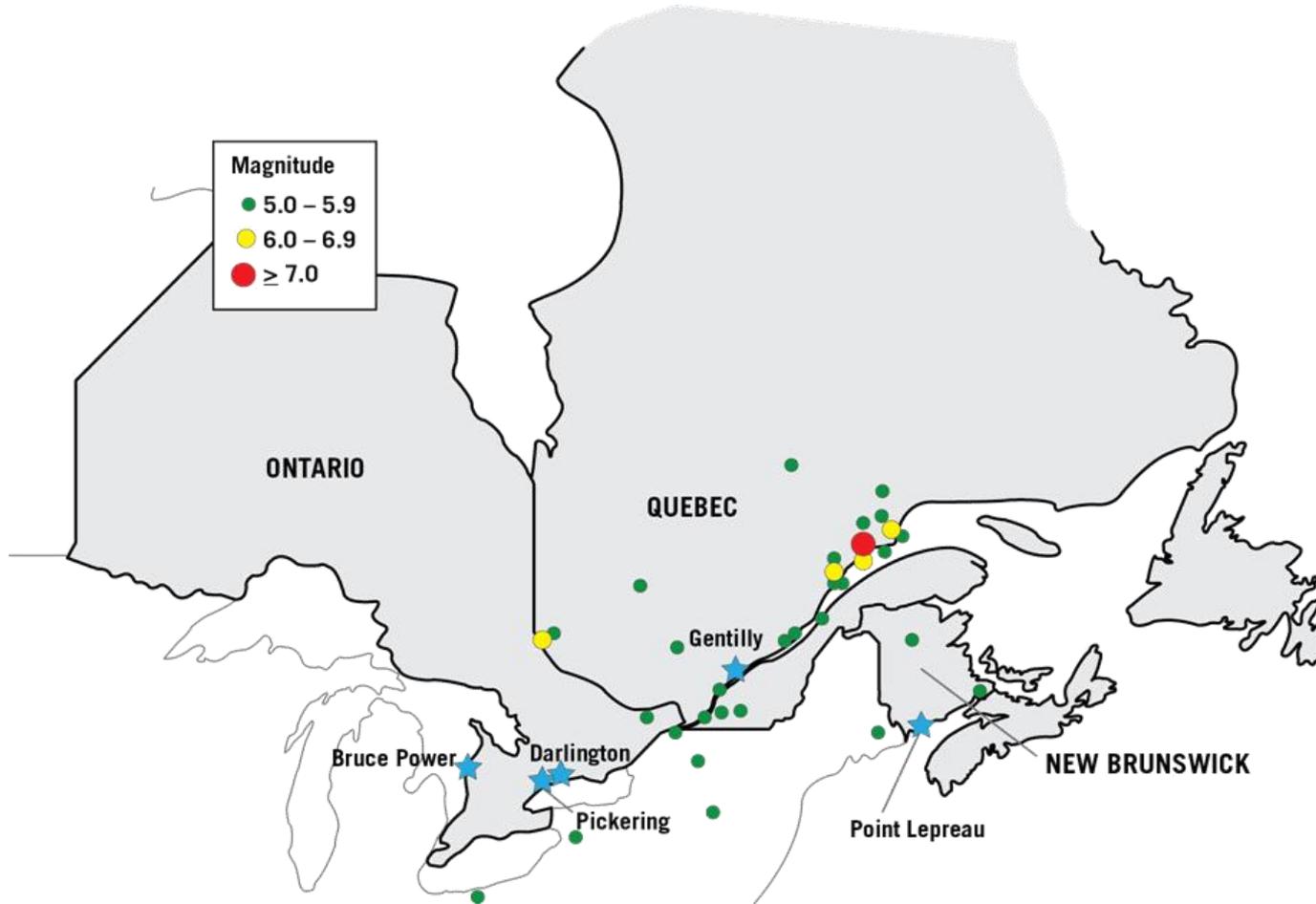
CNSC review of Industry Response to Directive



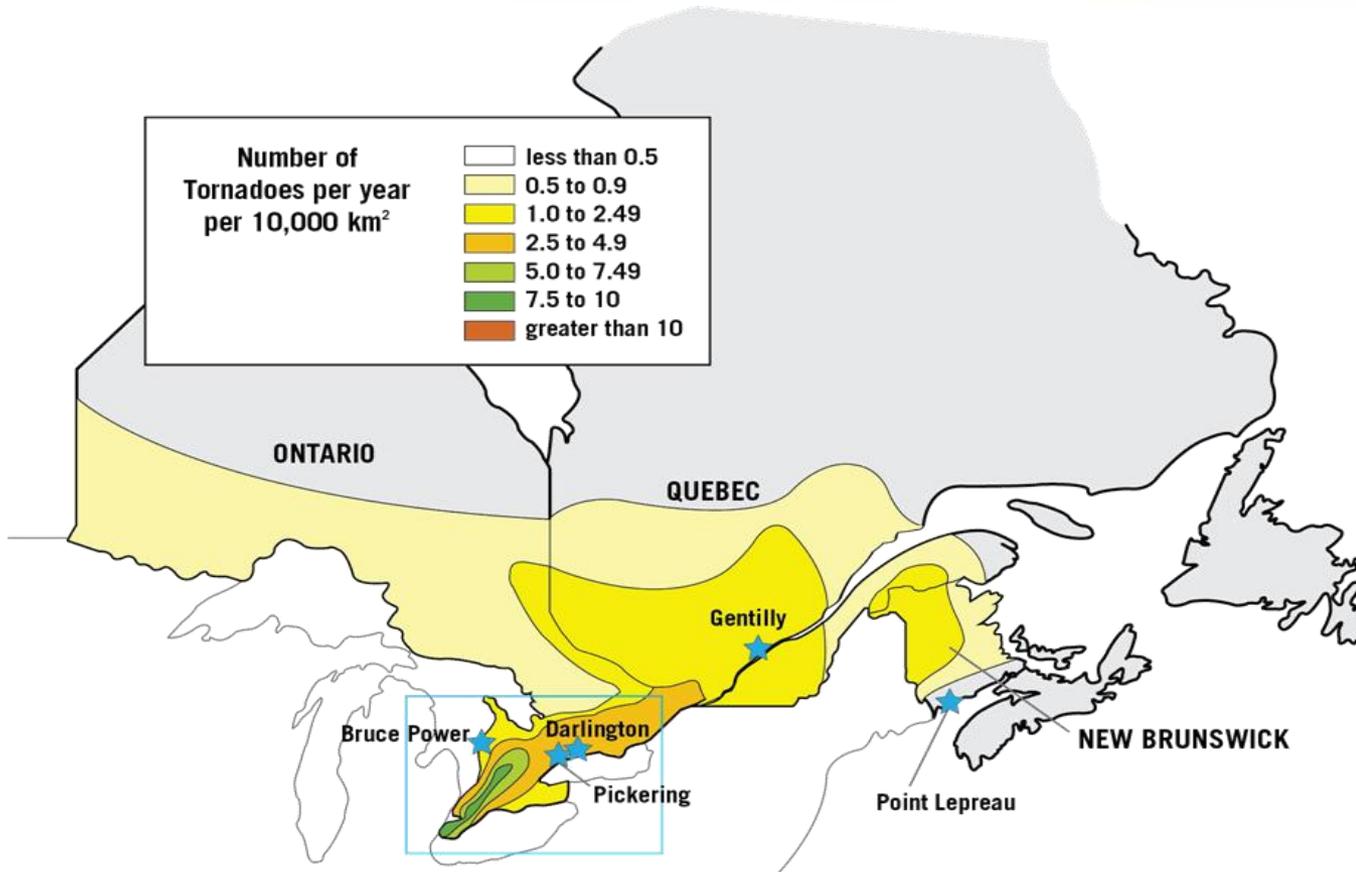
- Fukushima Task Force report, assessing the industry responses was issued to public on October 28, 2011;
- Fukushima Task Force report documented key conclusions:
 - NPPs are safe; risk posed to the health and safety of Canadians or to the environment is small.
 - verified that all Canadian NPPs are located far from tectonic plate boundaries and that the threat of a major earthquake at a Canadian NPP is negligible.
 - improvements recommended in:
 - Capability to withstand extreme external events such as earthquake, fire tornadoes, flooding and combinations thereof
 - Adequacy of Canadian emergency response capability
 - Adequacy of Canadian regulatory framework, processes and regulatory requirements



Regional Seismic Event history near Canadian nuclear utilities



Regional Tornado Activity near Canadian Nuclear Power stations



CNSC Fukushima Task Force Recommendations



Within approx. 12 months:

- Complete Cost-Benefit Assessment for containment venting options
- Develop strategy for assessing hydrogen risk
- Complete Cost-Benefit Assessment for moderator and shield tank make-up
- Develop industry strategy for instrument survivability under severe accident conditions
- Develop a plan for a Regional Emergency Response Support Centre
- Complete the multi-unit modeling options assessments
- Complete fuel bay assessing accidents
- Complete Cost Benefit Assessment to improve margins for overpressure protection



CNSC Fukushima Task Force Recommendations



Within approx. 24 months:

- Implement Severe Accident Management Guidelines exercise
- Establish a Mutual Assistance Agreement
- Take action to satisfy provincial authorities with respect to dose projection and radiation monitoring

Within approx. 48 months:

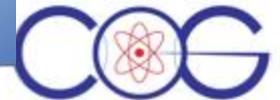
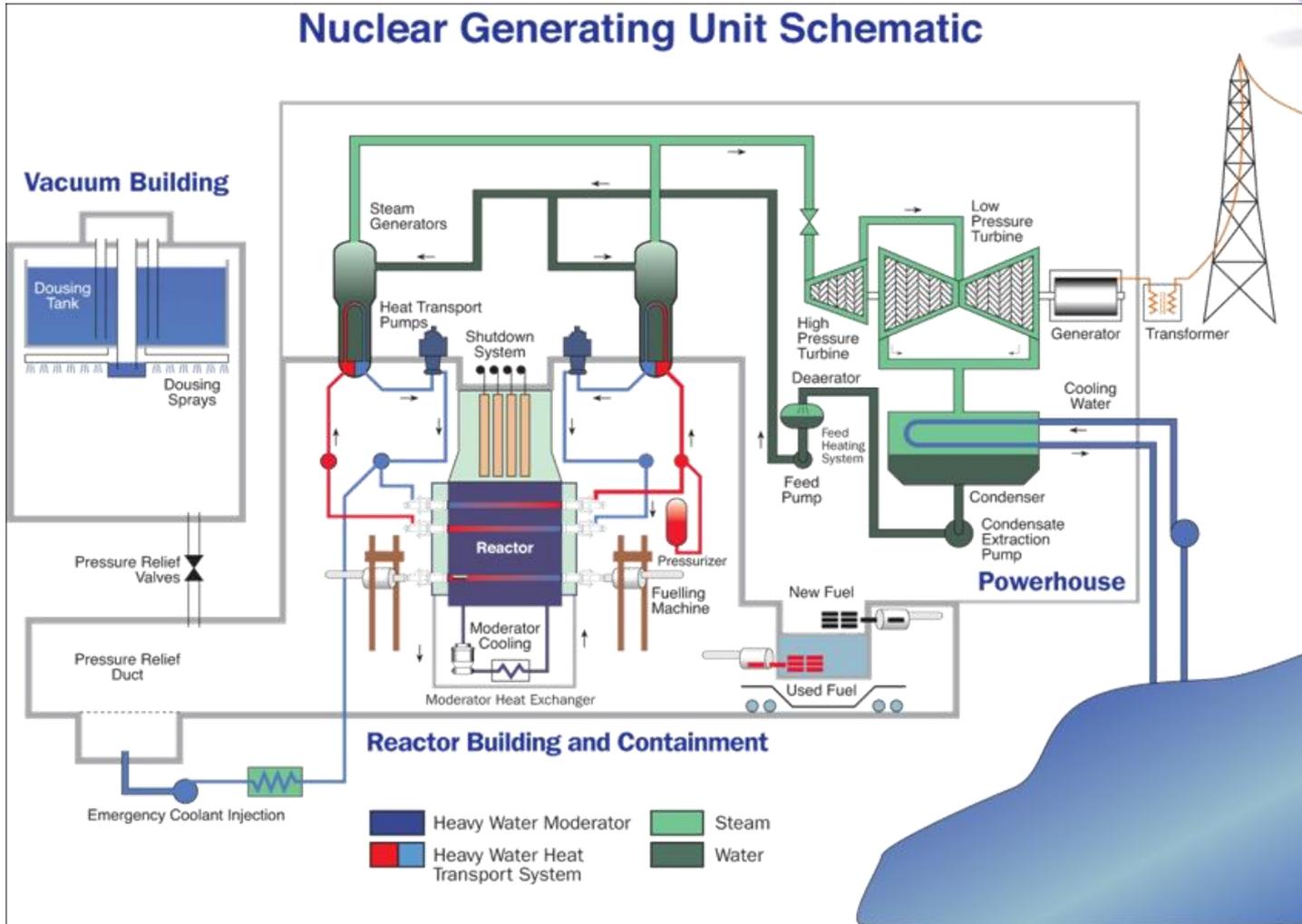
- Complete installation of PARs
- Complete implementation of make-up to Steam Generators, Heat Transport System and fuel bays
- Establish back-up power and back-up communications for emergency response centres



Main initiative: Cool the fuel



Nuclear Generating Unit Schematic



Canadian Industry Ongoing Response



- Major theme: protect the fuel:

Terminate the event before it becomes a severe accident by establishing:

- Additional redundant and diverse water supply capability to the:
 - Boilers
 - Heat Transport System
 - Moderator System
 - Irradiate fuel bay
- Additional portable power supplies
- Expediting hydrogen control equipment installation
- Creating emergency equipment warehouses for longer term mitigation
- Expediting industry initiative to complete the pre-existing Severe Accident Management Program.
- Expanding the current initiative to multi-unit / multi-station response



Canadian Industry Ongoing Response



- In the event of a sustained loss of heat sinks following the BDBA, it is important to:
 - Maintain or restore both steam generator and heat transport inventories
 - Protect containment integrity
 - Provide and manage alternate emergency water make-up if irradiated fuel bay cooling is lost
 - Provide response aids to staff in the event of loss of bay coolant
 - Confirm bay structural integrity



Canadian Industry Ongoing Response



CANDU utilities are putting in place :

- Additional portable power and water supplies
- Hydrogen mitigation and containment venting
- Severe Accident management and emergency planning programs



CNSC External Advisory Committee



August 2011: CNSC formed the External Advisory Committee to review the CNSC response to Fukushima:

- Review CNSC's immediate response to events
- Review CNSC's interaction with Canadian Nuclear Sector and regulated industries
- Review CNSC's communications with affected stakeholders
- Assess implications from international response on the CNSC responses



CNSC External Advisory Committee Recommendations



April 2012: External Advisory Committee recommendations

- **Recommendation 1**—CNSC continue to work with regulators of other member states of the IAEA to ensure that the Integrated Regulatory Review Service (IRRS) process is mandatory, transparent and that the findings and recommendations are enforced.
- **Recommendation 2**—CNSC work with its fellow regulators in convincing World Association of Nuclear Operators' (WANO) members to share the results of their peer review process to promote nuclear safety in all nations with nuclear power plants.
- **Recommendation 3**- the CNSC work with other government departments to ensure better coordination and redefinition of departmental roles and responsibilities should a nuclear accident occur in Canada, the United States or overseas.
- **Recommendation 4**- the CNSC meet with its partner organizations and licensees to establish the extent and frequency of multi-level emergency exercises.
- **Recommendation 5**—the CNSC clarify its position on the 12(2) orders with respect to the non-NPPs.



CNSC External Advisory Committee



April 2012: External Advisory Committee recommendations continued:

- **Recommendation 6-** the CNSC examine the area of Human and Organizational Performance to achieve a more complete understanding of lessons learned from the Fukushima crisis.
- **Recommendation 7**—the CNSC clarify its plans to address tornado hazards.
- **Recommendation 8**—the CNSC develop a comprehensive communication and education strategy that includes the use of various tools including social media and expands partnerships and relationships with various science media organizations that have the ability to inform the public on nuclear safety.
- **Recommendation 9**-the CNSC should play an active role in ensuring that emergency planning exercises with the United States are conducted regularly.



Conclusions



- **One year has passed since the tragic event at Fukushima Dai-ichi**
 - **Our sympathies are with the people of Japan as they struggle to deal with the loss**
 - **Our resolve is strong to learn from the events to make nuclear plants more robust to mitigate against the effects of natural disasters**
- **There has been focused effort around the globe and in Canada to help each other gain understanding and the trust of our stakeholders**
- **The industry is one year into a multi-year undertaking to have better capability to deal with the challenges of beyond design basis events**
- **Thank you.**

