



Safe Long-Term Operation of Nuclear Power Plants

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Presentation Outline

Part 1:

Introduction to Canadian Nuclear Safety Commission

Part 2:

Regulatory requirements for long-term operation of nuclear power plants

Part 3:

Canada's response to nuclear events in Japan

- regulatory response
- industry response

Canadian Nuclear Safety Commission



Established May 2000, under the
Nuclear Safety and Control Act

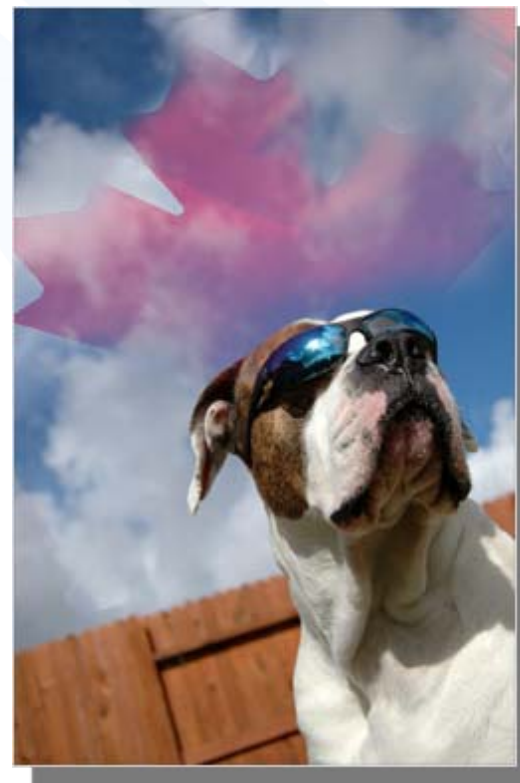
Replaced the AECB of the 1946
Atomic Energy Control Act



*Canada's independent nuclear regulator
65 years of experience*

Our Mission Is Clear

Protect the **health, safety** and **security** of persons and the **environment**; and implement Canada's **international commitments** on the peaceful use of nuclear energy



Canada's nuclear watchdog

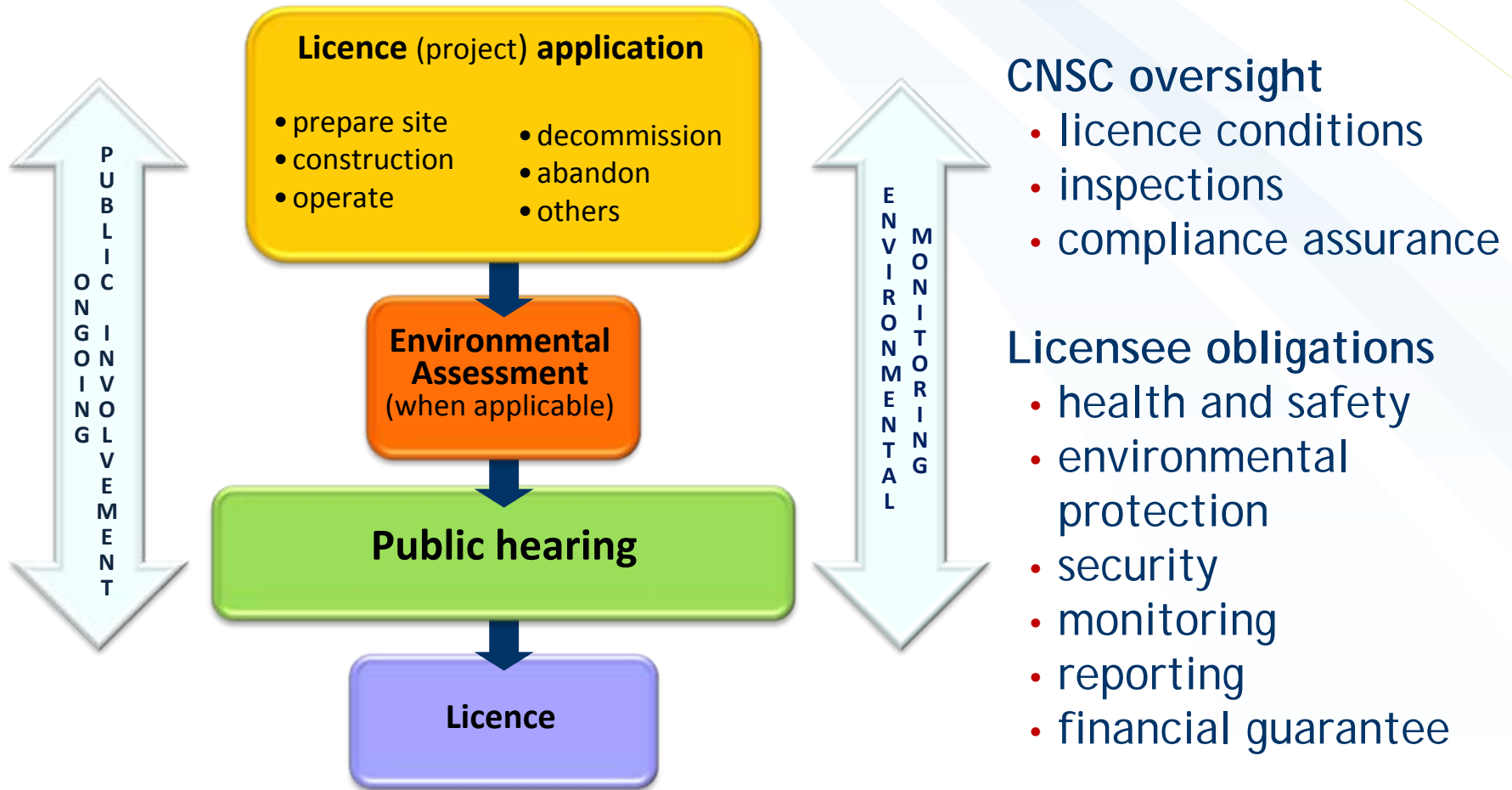
The CNSC Regulates All Nuclear-Related Facilities and Activities in Canada...

- ✿ uranium mines and mills
- ✿ uranium fuel fabricators and processing
- ✿ nuclear power plants
- ✿ waste management facilities
- ✿ nuclear substance processing
- ✿ industrial and medical applications
- ✿ nuclear research and education
- ✿ export/import control

...from cradle to grave



CNSC Licensing Process



CNSC Staff Located Across Canada



HQ in Ottawa
5 site offices at power reactors
1 site office at Chalk River
4 regional offices

Staff: ~ 850
Resources: \$140 m (70% cost recovered)
Licensees: 2,050
Licenses: 3,300



The CNSC Ensures Nuclear Safety...



The CNSC has cast its organizational priorities under the heading “core + four”:

- ✦ **core**: licensing and compliance activities, regulatory framework
- ✦ **commitment** to ongoing improvement
- ✦ **clarity** of regulatory requirement
- ✦ **capacity** for action
- ✦ **communications**



... and aims to be the best nuclear regulator in the world

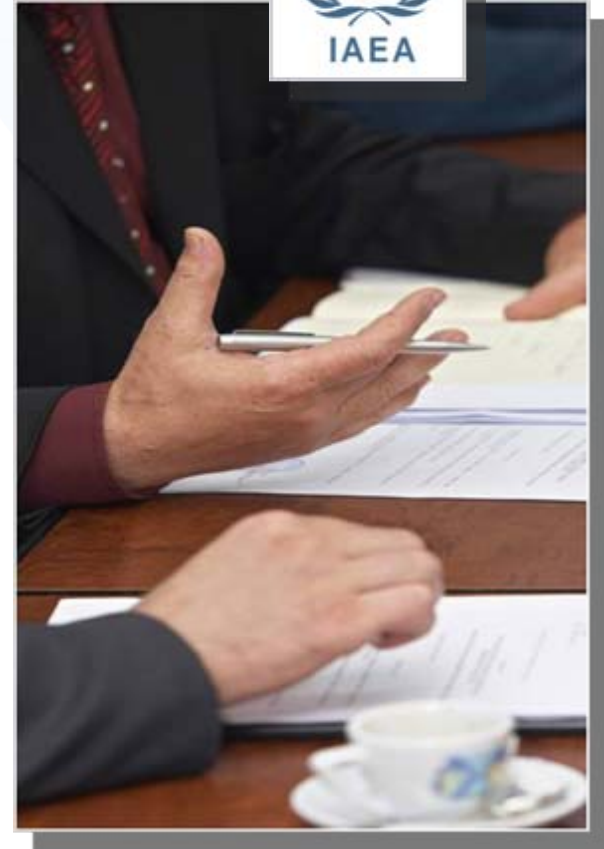
Integrated Regulatory Review Service



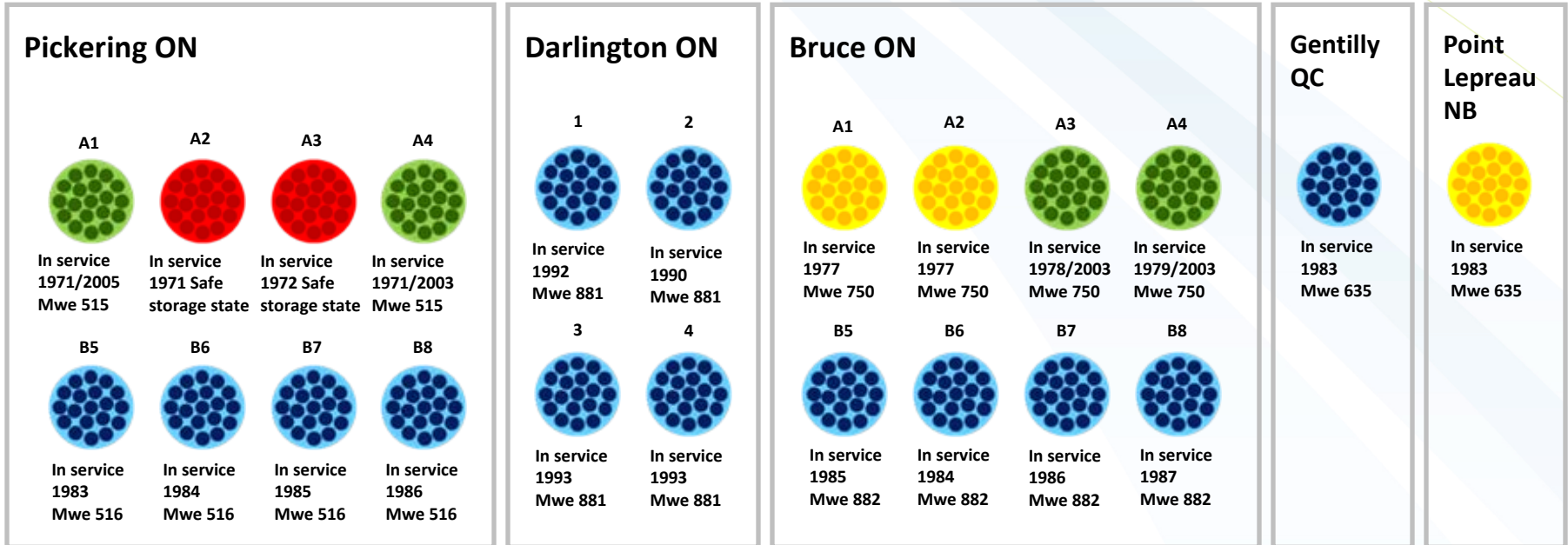
• IAEA-sponsored third-party endorsement of our framework

• Findings and recommendations:

- robust nuclear regulatory framework
- effective protection of health, safety and security of Canadians and environment
- improvement needed in strategic planning and research



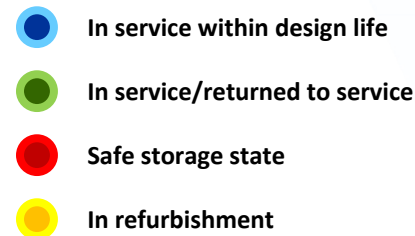
Canada's Nuclear Energy Profile



Typical share of nuclear energy in total electricity generation



Operable status (Average age – 25 Years)



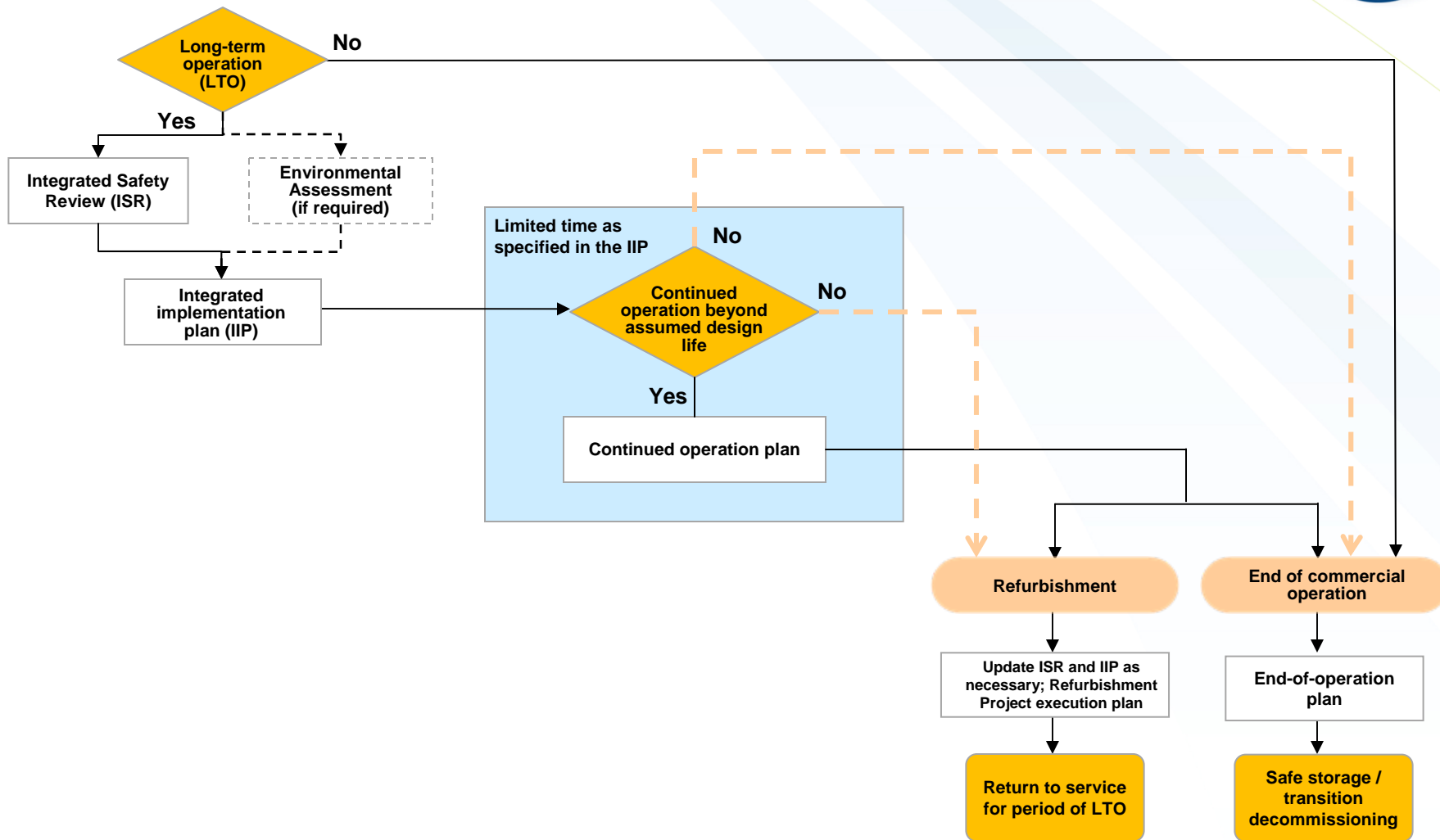


Evolution of Regulatory Approach: Long-Term Operation of Nuclear Power Plants

The approach to life extension of nuclear power plants (NPPs) in Canada is based on the application of a Periodic Safety Review (PSR)

- ✦ 2000 to 2007: IAEA documents used to guide the reviews
- ✦ 2008: Regulatory Document issued:
RD-360 "Life Extension of Nuclear Power Plants"
 - Environmental Assessment (EA)
 - Integrated Safety Review (ISR) to establish scope of work required for life extension of a nuclear power plant
- ✦ RD-360, Revision 1, under development
 - Broader scope: "continued operation", "end of life"
 - Lessons learned from ongoing refurbishment projects

Life Management of Nuclear Power Plants Approaching End of Assumed Design Life



Regulatory Trigger:

...as NPP Approaches End of Assumed Design Life



Letter of intent with plans & timelines for either:

❖ **continued operation:**

- operating for a limited period beyond the assumed design life

❖ **refurbishment (life extension):**

- extending design life for a period comparable to the original by undertaking refurbishment project

❖ **end of commercial operation:**

- ceasing commercial operation/planning for safe storage and decommissioning:
 - without entering long-term operation
 - following a period of continued operation

Long-Term Operation for NPPs: General Considerations



The following will need to be carried out:

- ✿ Environmental Assessment (EA), where required, and
- ✿ Integrated Safety Review (ISR) to establish the scope of work required for long-term operation

Based on EA and ISR results, licensees will complete:

- ✿ Integrated Implementation Plan (IIP) for all necessary plant refurbishment, safety upgrades and other compensatory measures

Process Overview: Environmental Assessment



An Environmental Assessment (EA) must be completed:

- ✦ long-term operation will not likely cause significant adverse environmental effects

EAs carried out by licensees:

- ✦ nominally two years to complete

EA results are incorporated into operating licence as part of EA follow-up program

Process Overview: Integrated Safety Review



- ❖ The Integrated Safety Review (ISR) is a one-time comprehensive self-assessment carried out by the licensee.
- ❖ The ISR enables determination of reasonable and practical modifications that should be made to enhance safety to a level approaching that of modern plants, allowing for long-term operation.

Process Overview: Integrated Safety Review (cont'd)



ISR's specific objectives are to determine:

- ✿ extent to which plant conforms to modern standards and practices
- ✿ if licensing basis will remain valid over proposed extended operating life
- ✿ adequacy of the management arrangements in place to maintain safety for long-term operation
- ✿ improvements to be implemented to resolve identified safety issues

Process Overview: Integrated Implementation Plan



- ❖ licensee incorporates results of EA and ISR to develop Integrated Implementation Plan (IIP), which specifies:
 - period of long-term operation
 - scope and stages of project (continued operation or refurbishment)
 - commitments/proposed modifications credited in ISR and EA
- ❖ licensee may proceed with long-term operation upon CNSC acceptance of the IIP
- ❖ operating licence amended to include appropriate licence conditions to be met

Review and Assessment Framework



Four sets of documentation are prepared by the licensee in the ISR process:

- ✿ ISR basis document
- ✿ Safety factors reports
- ✿ Final ISR report, including results of a global assessment to evaluate the global risk
- ✿ Integrated Implementation Plan (IIP)

Post-ISR: Continued Operation



If decision is to continue operation:

Continued operations plan

- ✿ confirm safety/design analysis assumptions for extended period of operation
- ✿ resolve action items to support continued operation
- ✿ implement corrective actions/safety improvements identified in the IIP until decision to:
 - refurbish, or
 - end commercial operation

Post-ISR: Refurbishment Projects



If decision is to refurbish:

Project execution:

- ✿ project execution plan
- ✿ programs and processes
- ✿ project monitoring

Return to service (after refurbishment):

- ✿ completion of assurance documentation
- ✿ commissioning phases
- ✿ hold points
- ✿ return to normal operation

Post-ISR: Refurbishment Projects

Project Execution Plan



The licensee prepares a **project execution plan**:

- ✿ what needs to be done to maintain and improve safety
- ✿ acceptable programs and processes to execute and control refurbishment projects

The CNSC assesses:

- ✿ licensee's programs supporting refurbishment projects
- ✿ licensee's submissions (safety analyses, design packages, condition assessments, etc.)

Post-ISR: Refurbishment Projects Return-to-Service/Commissioning



Return to service based on:

- ✦ licensee's ability to demonstrate new and existing plant systems, structures, and components conform to defined physical, functional, performance, safety, and control requirements

The process of returning to service includes progressing to *regulatory hold points*:

- ✦ aligned with *commissioning phases of the facility*
- ✦ *Commission approval needed prior to removing hold points* (can be delegated to CNSC staff)

Post-ISR: Refurbishment Projects

Regulatory Oversight



Regulatory oversight activities to ensure:

- ❖ all safety improvements/modifications for systems, structures and components (SSC) installed, tested, verified available for service
- ❖ commissioning activities completed to demonstrate SSC meet the design requirements
- ❖ all activities completed to demonstrate safe and reliable operation of SSC

Summary: Refurbishment Projects



Refurbishing NPPs is required to make improvements when:

- ✿ a shortcoming is identified (plant aging, new knowledge)
- ✿ costs are moderate compared to the benefits:
 - significant efforts should be made to address generic safety issues
- ✿ reactor safety is below that expected of a newer plant operating in the proposed period

Summary: Refurbishment Projects (continued)



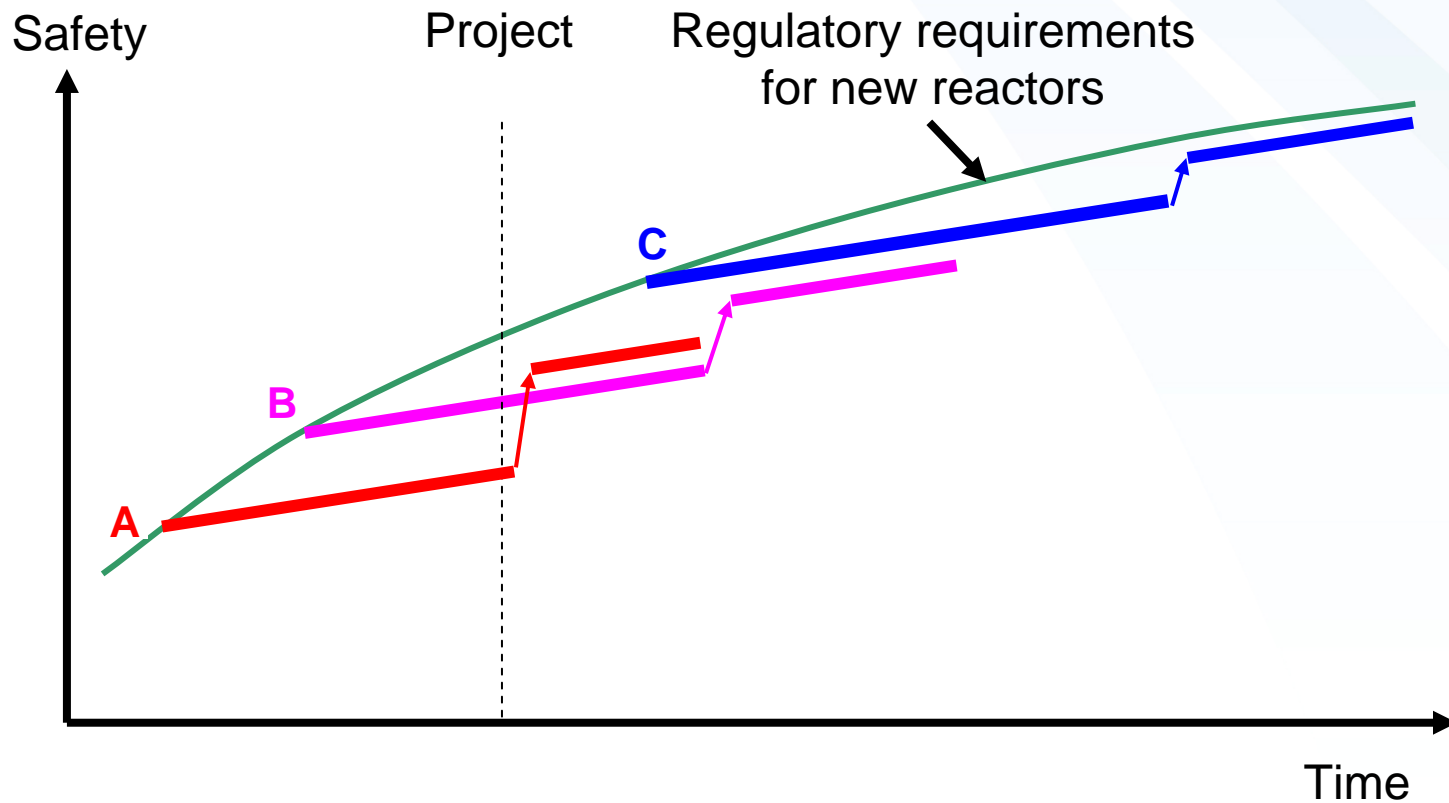
Refurbishment projects involve replacement, maintenance, and/or modifications to major SSC:

- licensees address modern high-level standards and practices:
 - “state-of-the-art” knowledge is considered
- operating licences amended for:
 - regulatory oversight of refurbishment activities
 - updating licensing basis (including design basis)

Summary: Refurbishment Projects (cont'd)



Regulatory expectations for safety upgrades



End of Commercial Operation: End-of-Operation Plan



Sustainable operations plan:

- ✳ demonstrates maintaining safe operation under normal and accident conditions up to final shutdown

Safe state of storage plan:

- ✳ describes strategy for safe transition to safe storage
- ✳ ensures monitoring/surveillance until dismantlement and decommissioning

Canada's Response to Events in Japan

Regulatory Response



Issued a request pursuant to the *Nuclear Safety and Control Act* to all major nuclear facilities to:

- ✳ review initial lessons learned
- ✳ re-examine safety cases, with focus on:
 - external hazards
 - measures to prevent or mitigate severe accidents
 - emergency preparedness
- ✳ implement immediate actions
- ✳ implement long-term measures

Canada's Response to Events in Japan

Regulatory Response: Immediate Actions



- ❖ CNSC site staff carried out focused inspection on:
 - seismic qualification
 - fire
 - flooding
 - backup power
 - hydrogen igniters and passive recombiners
- ❖ Ongoing inspection against external hazards

Canada's Response to Events in Japan

Regulatory Response: Immediate Actions



- ❖ inspections of spent fuel bays:
 - components and equipment
 - heat sinks
 - alarms
- ❖ availability of on-site and off-site resources

Canada's Response to Events in Japan

Regulatory Response: Long-Term Measures



- verification of defence-in-depth strategy and measures to:
 - minimize frequency of abnormal operation and failures
 - control abnormal operation and detect failures
 - limit the progression of accident to within the design basis
 - control severe plant conditions (Severe Accident Management Guidelines)
 - mitigate radiological consequences (emergency management)

Canada's Response to Events in Japan

Industry Response



- ❖ public engagement and employee involvement
- ❖ established working group under CANDU Owners Group to exchange information and define response strategies
- ❖ verifying station capability to mitigate:
 - conditions during beyond design basis events
 - station blackout conditions
 - internal and external flooding events
 - other events concurrent with a seismic event

Canada's Response to Events in Japan

Industry Response



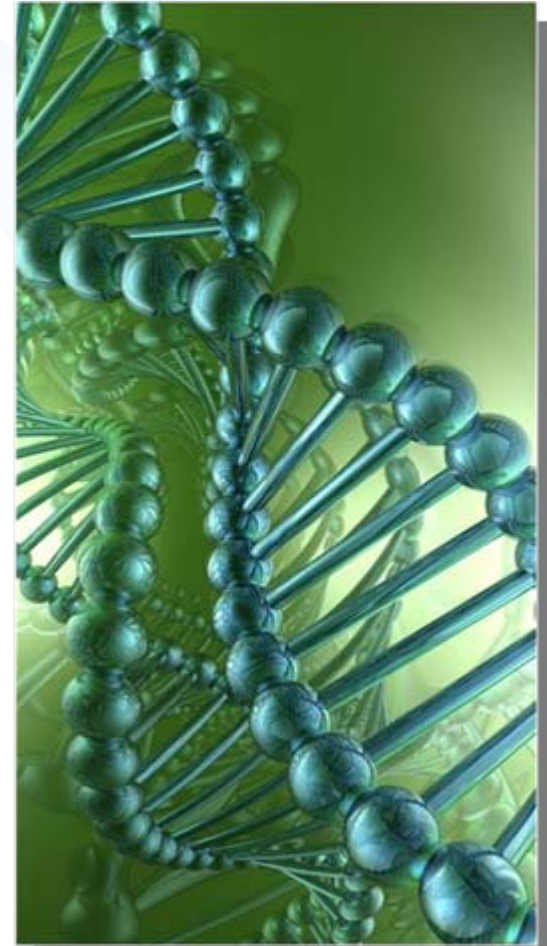
- ❖ timely response by industry to CNSC directive:
 - all licensees responded by April 1, 2011 on short-term actions
- ❖ enhanced environmental monitoring and reporting
- ❖ AECL product development program review:
 - review lessons learned from all reviews and findings
 - incorporate improvements into new build design

*While We Strive to Be More
Effective and Efficient...*



...We will never
compromise safety...

...It's in our DNA!



For More Information on the CNSC



Annual Report 2009-10

Visit our Web site
nuclearsafety.gc.ca



Canadian Nuclear
Safety Commission

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de sûreté nucléaire



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