



Commission canadienne
de sûreté nucléaire

Canadian Nuclear
Safety Commission

Activities Related to International Generic Ageing Lessons Learned Database



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Canada



Outline



- **Canadian Nuclear Power Plants**
- **Materials Degradation / Ageing Issues**
- **Refurbishment Projects for Life Extension**
- **Meeting the Challenges**
 - Canadian Regulatory Approach
 - National and International Cooperation
- **Discussion**



Canadian Nuclear Power Plants



CNSC Licenses 22 CANDU Reactors

➤ Oldest

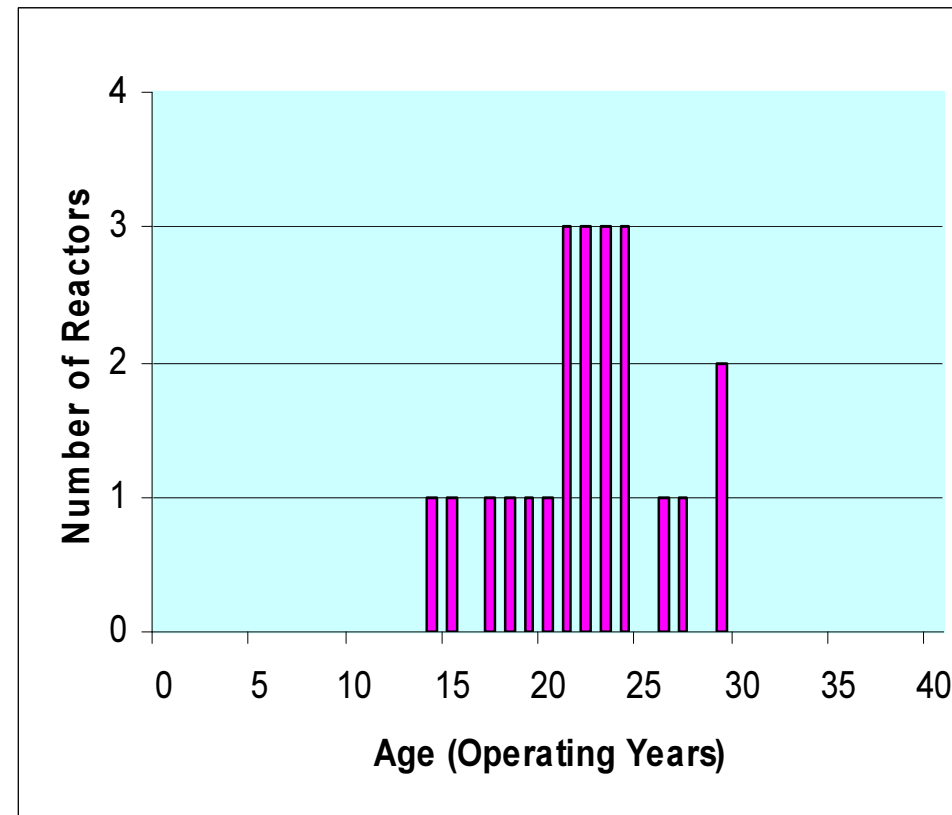
Pickering A (1971)

➤ Most Recent

Darlington (1993)

➤ Original Design Life

30 or 40 years





Materials Degradation / Ageing Issues



- **Canadian CANDU's have excellent reliability**
 - Though, as plants aged, materials degradation issues have caused a reduction of the availability at some plants
- **Some Issues are Common to LW Reactors**
 - e.g. Steam Generators, Cables, Containment
 - International experience, R&D
- **Some Issues Specific to CANDU components**
 - e.g. Pressure tubes, Feeders
 - Canadian, CANDU owners experience, R&D



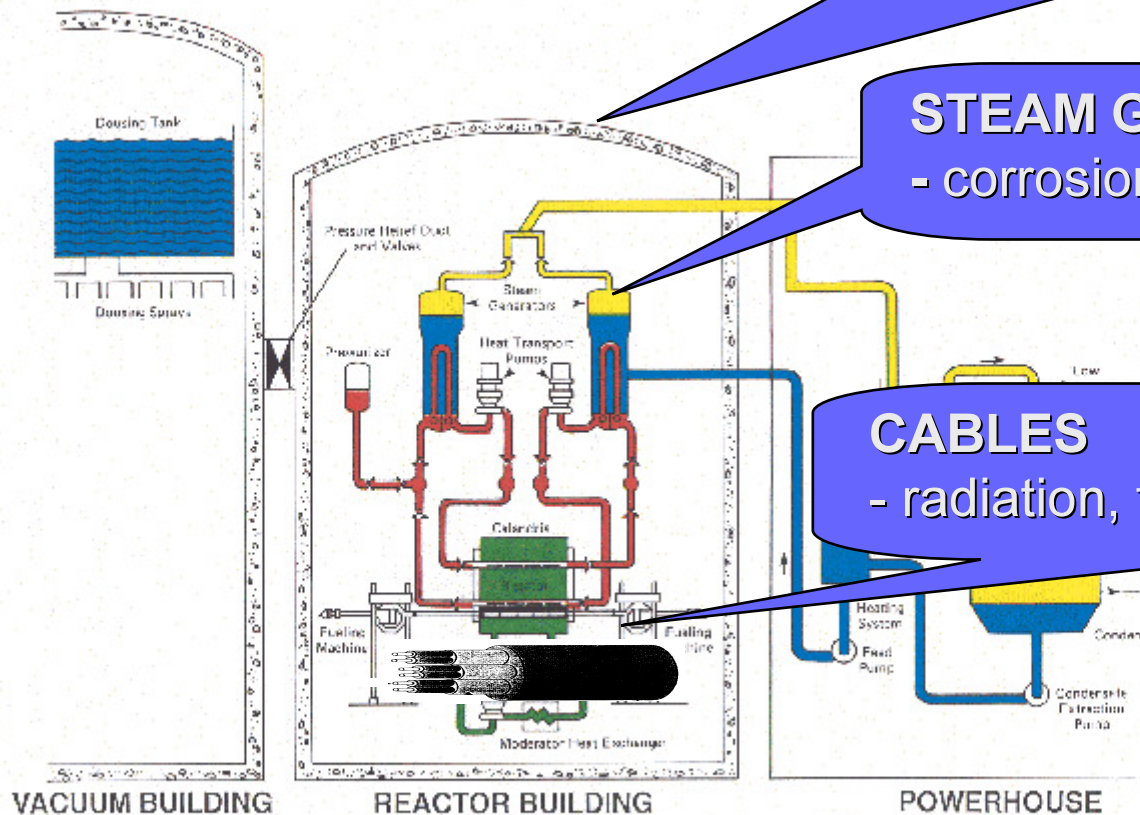
Examples of CANDU Ageing Issues Similar to other reactor types



CONTAINMENT STRUCTURE
- creep, corrosion, stress relaxation

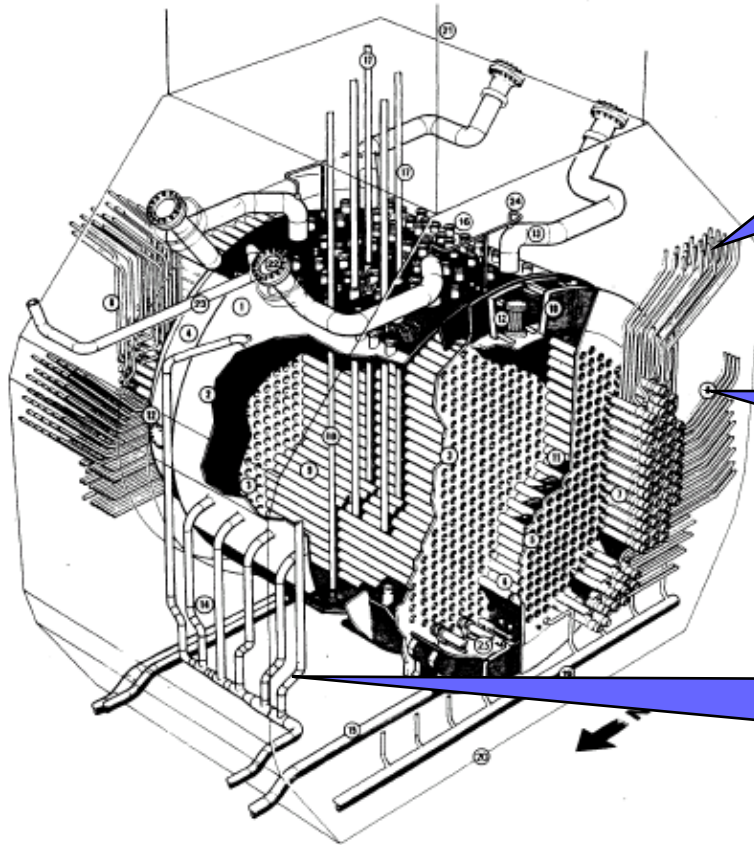
STEAM GENERATORS
- corrosion, erosion, wear

CABLES
- radiation, temperature embrittlement





Examples of CANDU Specific Ageing Issues



FEEDERS

- Flow Accelerated Corrosion (FAC)
- Stress Corrosion Cracking (SCC)

FUEL CHANNELS (PT/CT)

- Creep, DHC, property changes

REACTOR ASSEMBLY

- Corrosion, erosion, fatigue, creep, embrittlement

- | | |
|---------------------------------------|--|
| 1. CALANDRIA | 15. MODERATOR OUTLETS |
| 2. CALANDRIA MAIN SHELL | 16. NOZZLES FOR VERTICAL REACTIVITY CONTROL UNITS AND VIEWING PORT |
| 3. CALANDRIA SIDE TUBESHEET | 17. THIMBLES FOR VERTICAL CONTROL UNITS |
| 4. CALANDRIA SUB-SHELL | 18. GUIDE TUBES FOR VERTICAL REACTIVITY CONTROL UNITS |
| 5. FUELLING MACHINE-SIDE TUBESHEET | 19. END SHIELD COOLING PIPING |
| 6. LATTICE TUBES | 20. SHIELD TANK |
| 7. END FITTINGS | 21. SHIELD TANK EXTENSION |
| 8. FEEDERS | 22. RUPTURE DISC ASSEMBLY |
| 9. CALANDRIA TUBES | 23. MODERATOR OVERFLOW |
| 10. SHIELD TANK SOLID SHIELDING | 24. PRESSURE BALANCE LINES |
| 11. STEEL BALL SHIELDING (END SHIELD) | 25. INLET AND OUTLET STRAINERS |
| 12. MANHOLE | |
| 13. EMERGENCY DISCHARGE PIPES | |
| 14. MODERATOR INLETS | |



Regulatory Controls

– Licence Conditions



- All power reactor operating licences include ageing management related conditions:
 - Periodic Inspection and surveillance programs
 - Equipment Environmental Qualification Programs
 - Maintenance Programs
 - Equipment reliability programs
 - Notification and reporting



Regulatory Controls

- CNSC Regulatory Documents



- S-98** Reliability Programs for NPP
- S-99** Reporting Requirements for NPP
- S-210** Maintenance Programs for NPP
- S-294** Probabilistic Safety Analysis for NPP
- RD-310** Safety Analysis for NPP
- RD-337** Design of New NPP
- RD-360** Life Extension of NPP



Regulatory Controls

- CSA International Standards



CSA N285.4	Periodic Inspection of CANDU NPP Components
CSA N285.5	Periodic Inspection of CANDU NPP Containment Components
CSA N285.8	Technical Requirements for In-Service Evaluation of Zirconium Alloy Pressure Tubes in CANDU
CSA N287.7	In-Service Examination and Testing Requirements for Concrete Containment Structures for CANDU NPP
CSA N290.13	Environmental Qualification of Equipment for CANDU NPP



Regulatory Controls

- Ageing Management Programs



- Currently all the licensees have established, or are in the process of implementing, ageing management programs for SSC's important to safety, e.g.
 - Fuel Channels
 - Feeders
 - Steam Generators
 - Containment
 - Calandria Internals



CANDU Refurbishment Projects for Life Extension



- **CANDU pressure tubes, calandria tubes, and feeders can be replaced after about 25 years to address materials degradation effects.**
 - “Refurbishment outage” provides opportunity to perform other major plant inspection, maintenance and safety upgrade activities that are not feasible during a normal maintenance outage.
 - Extends operating life for another 25 to 30 years.
 - Materials degradation effects with other SSC can become of more concern for longer term operation.



Meeting the Challenges - Ageing Reviews for Life Extension



- **CNSC Regulatory Document RD-360 – Life Extension of Nuclear Power Plants**
 - Outlines key activities to be undertaken by a licensee
 - Integrated Safety Review (ISR) - comprehensive one-time application of PSR assessment
- **ISR includes assessments directly related to management of materials degradation, e.g.**
 - Actual Condition of SSC
 - Management of Ageing



Meeting the Challenges - Enhancing the Regulatory Framework



- **CNSC recognizes current activities may need to be augmented to ensure continued plant safety as Canada's NPPs age and for Life Extension.**
 - New Regulatory Document on Ageing Management
 - Strengthen role of proactive ageing management for Existing Plants and New Builds
 - National and International R&D programs
 - Sharing / exchange of OPEX

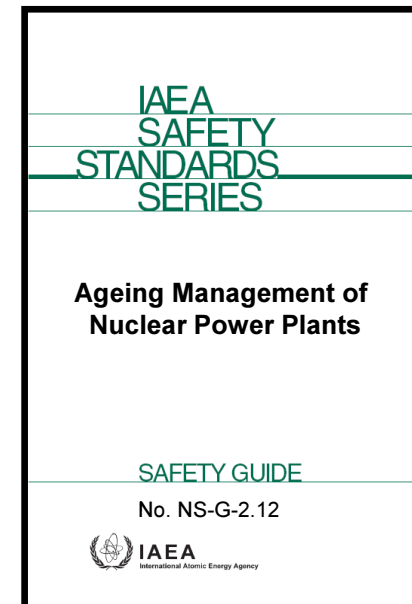


Meeting the Challenges - New RD-334 on AM



- Will represent the CNSC's adoption and adaptation, consistent with the Canadian regulatory framework, of the guidance established in new IAEA draft safety guide

IAEA NS-G-2.12 Ageing Management of Nuclear Power Plants (2009)





Meeting the Challenges - National and International Cooperation



- **CNSC actively participates in national and international initiatives related to materials degradation :**
 - **IAEA** : Ageing Management, Long Term Operation, International Generic Ageing Lessons Learned (GALL)
 - **OECD-NEA** : Environmentally Assisted Cracking (EAC), Integrity and Ageing of Components & Structures (IAGE), Stress Corrosion Cracking & Cable Aging (SCAP)
 - **R&D programs** : CNSC, CANDU Owners Group (COG).
 - **Cooperation** with nuclear regulatory agencies



Conclusion



- **The CNSC is taking an active approach to ensure the knowledge base and tools required to ensure adequate regulatory oversight of ageing issues for NPP:**
 - Strengthening the regulatory framework for life extension and proactive management of materials degradation / ageing issues;
 - Participating in R&D initiatives with industry, international organizations and standards committees;
 - Ensuring effective coordination and exchange of R&D and OPEX.



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Thank You !