



# **PRA Applications in Canada**

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# **PRA Applications in Canada**

- **Introduction**
- **History**
- **Scope and Targets**
- **Canadian PRA Regulatory Requirements**



# **Introduction**

- **PRA has been used as a design audit tool since 1978**
- **AECL will use PRA as an input to design decisions and later confirm these decisions in the PRA**
- **Scope and targets of the ACR PRA is presented**



# History of PRA Applications

- **NRX Accident - December 12, 1952**
- **WASH 1400- Reactor Safety Study 1975 (PWR and BWR)**
- **Safety Design Matrices (SDMs) 1978-1983 by AECL**
- **Reactor Safety Study Methodology Application Program (RSSMAP)**
- **Interim Reliability Evaluation Program (IREP)**
- **USNRC NUREG 1150 - Update of WASH 1400 with additional 2 PWRs and 1 BWR - late 1980s**
- **Individual Plant Evaluation (IPE) - Level 1 internal event PRAs required for all US operating NPPs - early 1990s**
- **Individual Plant Evaluation for External Events (IPEEE) - external event PRAs required for all US operating NPPs - late 1990s**



# **CANDU PRA Status**

## **Work Done in Canada**

- **SDMs 1978-1983: Gentilly 2, Pt. Lepreau, Wolsong 1, Pickering B, Bruce B**
- **CANDU 600 Probabilistic Safety Study - March 1988**
- **Darlington Probabilistic Safety Evaluation - December 1987**
- **Wolsong 2/3/4 PRA - March 1995**
- **Pickering A Risk Assessment (PARA) - December 1995**
- **Darlington A Risk Assessment**
- **Pickering B Risk Assessment**
- **Bruce B Risk Assessment - 1999**
- **KEPRI- Wolsong 2/3/4 Level 2 PRA - August 1997**
- **Qinshan CANDU Unit 1 and 2 PRA - May 2001**
- **Generic PSA**
- **Pickering A Return to Service - Use insights from PARA**
- **PRA for Pt. Lepreau and Gentilly-2 Refurbishment is ongoing**

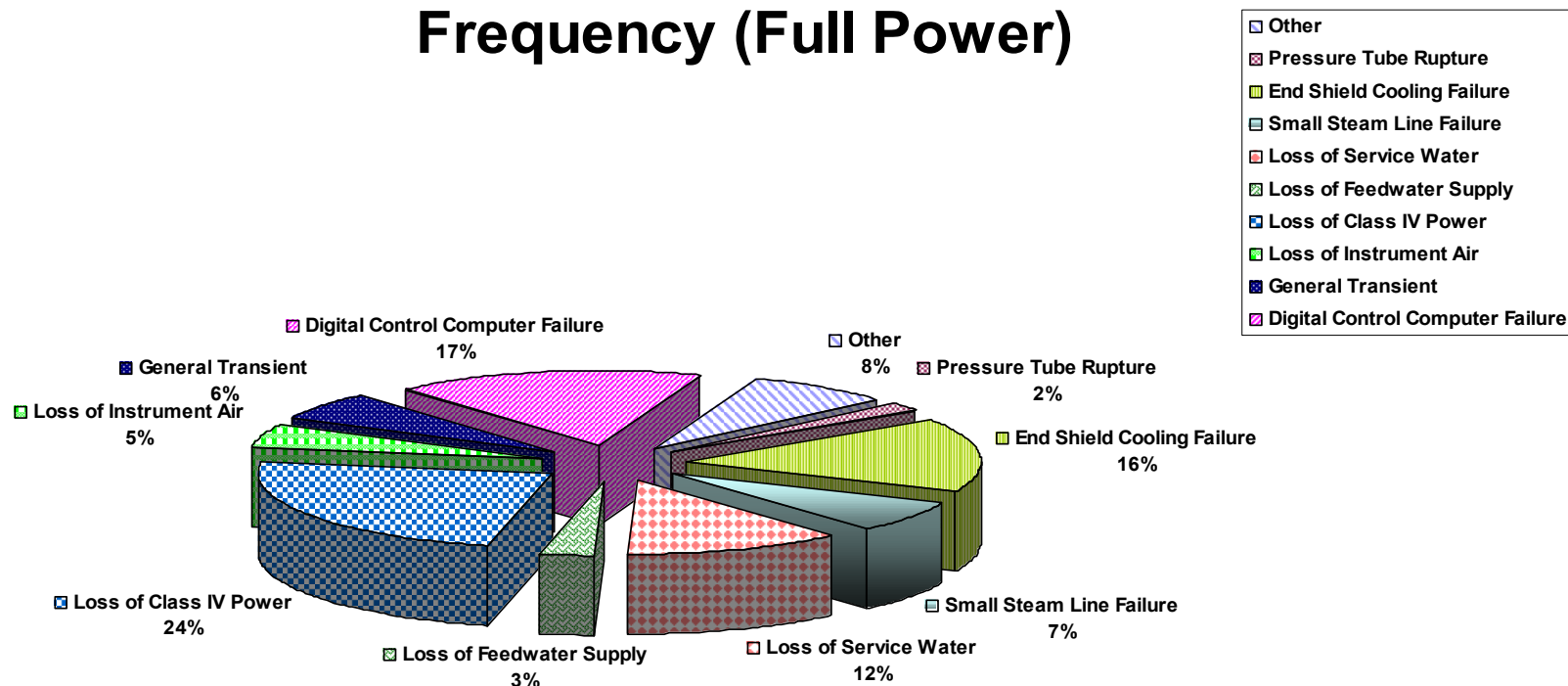


# PRA Scope Performed By AECL

Plant	Level of PRA	Commentary
SDMs-Gentilly-2, Pt.Lepreau Wolsung 1,Bruce B, & Pickering B	Partial Level 1	Internal Events, “No heat sink “ frequencies not summed.
CANDU 6 Probabilistic Safety Study	Full Level 1 PRA and Level 2 PRA	Internal Events. Using SDM input “no heat sink” sequences summed. Level 2 PRA used WASH-1400 methodology.
Wolsong 2/3/4	Full Level 1 PRA	Internal Events (Full Power and Shutdown ). Detailed Accident Sequence Quantification (ASQ) using CAFTA code.
Qinshan CANDU 1/2	Full Level 1 PRA	Internal Events (Full Power and Shutdown). Detailed Accident Sequence Quantification using CAFTA code.
Generic CANDU 6 and CANDU 9 PRA	Level 1 & Level 2 PRA Methodology and Reference Analysis	Internal, External and Shutdown Events to demonstrate methods and tools
ACR	Full Level 1 and Level 2 PRA	Internal (full power and shutdown state) and External Events



## Wolsong 2/3/4 Summed Severe Core Damage Frequency (Full Power)



Summation =  $6.1\text{E-}06/\text{Year}$



# **PRA Targets**

- **ACR summed severe core damage frequency will be less than  $1\text{E-}05/\text{yr}$**
- **ACR summed large release frequency target will be less than  $1\text{E-}06/\text{yr}$**
- **Seismic margin target of the plant HCLPF is 0.5g based on a 0.3g Design Basis Earthquake**





# **Canadian PRA Regulatory Requirements**

- **CNSC – R7, R8, and R9 - Special Safety Systems Reliability Requirements**
- **CNSC – S98 - Requirements for Reliability Analysis of Safety Related Systems in Nuclear Reactor**
- **CNSC – R99 - Reporting Requirements for Operating Nuclear Power Facilities**
- **CNSC – P-151 Draft 1 Regulatory Policy on the Use of a Balanced Approach for Regulatory Decision Making**
- **CNSC – G-152 Regulatory Guide on Guidance on the Balanced Use of Deterministic and Probabilistic Criteria in the Decision - Making**

