Welcome and Overview

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Reactor Safety Division

Presentation to U.S. Nuclear Regulatory Commission

Chalk River Laboratories

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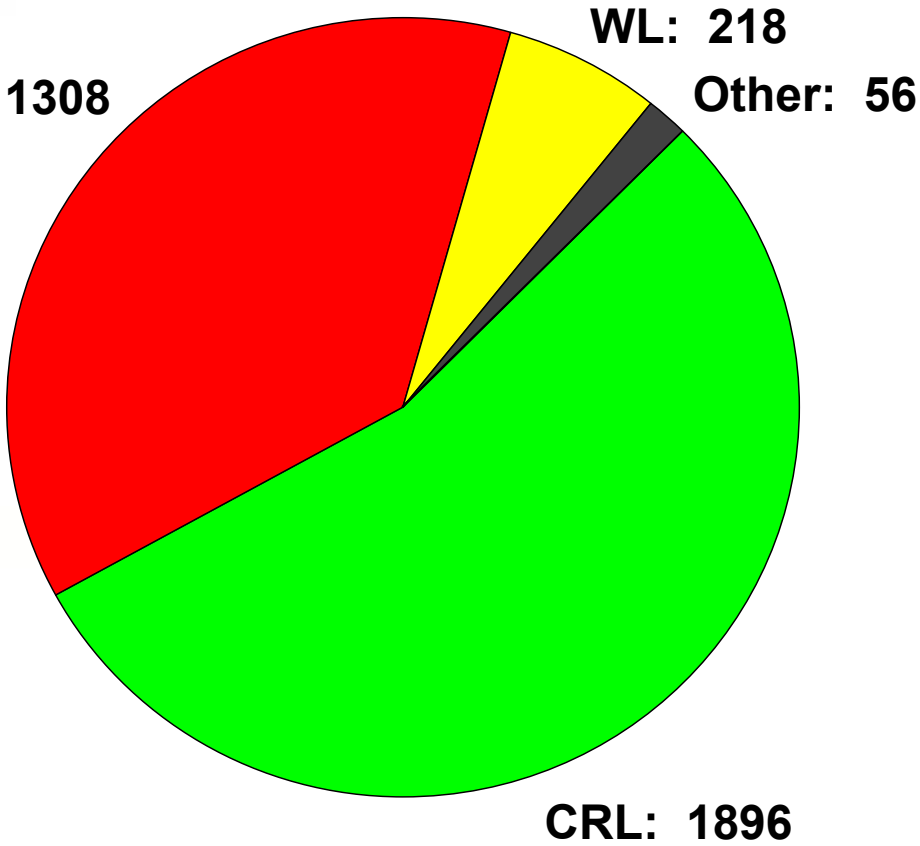
AECL TECHNOLOGIES INC.

AECL's Staff Distribution (March 2004)



- Ontario: Mississauga, Chalk River, Ottawa
- Quebec: Montreal
- New Brunswick: Fredericton
- Manitoba: Pinawa
- Alberta: Calgary
- Argentina
- China
- Romania
- South Korea

Total Staff: 3478

Chalk River Laboratories

How We Began

- Canada's nuclear program born at Chalk River Laboratories
- First sustained fission reaction outside USA achieved 1945 in "ZEEP" (Zero Energy Experimental Pile)
- From those early days came larger and more powerful research reactors: 1947 NRX, 1957 NRU
- NRX and NRU key facilities in development of CANDU design and medical isotope production
- NRU produces ~60% of world radioisotope supply for medical and industrial applications
- NRU continues to be critical to AECL for CANDU fuel and materials testing, and to NRC for neutron scattering
- AECL incorporated 1952, 50 years of successful operation

Activities/Responsibilities at CRL

- Nuclear Platform R&D
  - Maintain safety, design & licensing basis (CNSC Stakeholder)
  - Support operating nuclear facilities (COG)
  - Public policy support – e.g., MOX, Safeguards
  - International technical representation (IAEA, NEA, etc.) & collab.
- Manage CRL nuclear facilities and infrastructure
- Manage legacy liability on behalf of Government of Canada
  - Decommissioning and waste management
- AECL Business Development R&D
  - New products & services development
  - Next Generation CANDU development (ACR®)
- Commercial Activities
  - Research reactor fuel fabrication
  - Isotope production/isotope facility operations (MDS Nordion)
  - Commercial R&D activities
- Neutron Scattering for Materials Science (NRC)

Reactor Safety Division

- ~ 120 staff in 4 branches at CRL and WL
  - Experimental Thermalhydraulics and Combustion (WL)
  - Fuel and Fuel Channel Safety
  - Thermalhydraulics
  - Facilities Safety and Licensing

AECL's Safety R&D Objectives

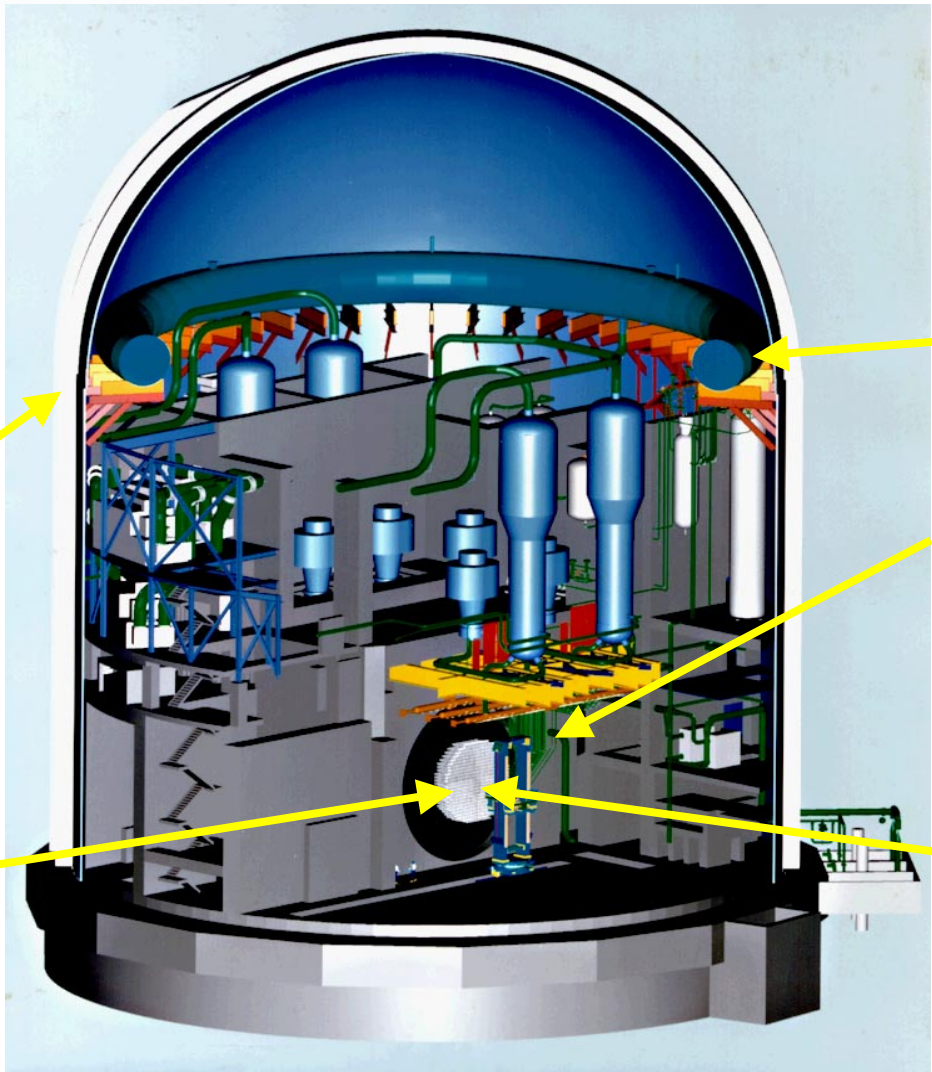
- Address generic safety issues
  - ensure safety and licensing basis
- Improve plant operations and margins
  - Improved analysis methodologies
  - Technology to improve margins (e.g. fuel improvements)
- Simpler, less costly, more reliable safety systems
  - Improved ECC (ball seal + rupture disk)
  - Passive cooling (e.g. reserve water system)
- Support safety, licensing and design basis
  - Support CANDU code suite
  - Maintain minimum core competencies
  - Address emerging issues

Safety Technology

Methodology Development

Containment Behavior

Fuel Channel Behavior



Passive Features

Thermal hydraulics

Fuel and Fission Product Behavior

Meeting Scope: Core Damage Accidents

Low frequency core damage accidents for CANDU reactors can be divided into two classes:

- *Limited Core Damage Accidents*: improbable events for which the channel core geometry is maintained
- *Severe Core Damage Accidents*: highly improbable events for which there is the possibility of core disassembly

Limited Core Damage Accidents

- Improbable events, that typically result from a combination of failures, in particular an initiating event and total failure of a safety system
  - e.g. LOCA with LOECC
- Design requirements are established to preclude core disassembly
  - e.g. LOCA + LOECC: must have adequate moderator subcooling to prevent fuel channel failures
- Accident sequences are analyzed with detailed models

Severe Core Damage Accidents

- Extremely improbable events that typically result from a combination of several events, such as an initiating event and failure of multiple safety systems
  - e.g. LOCA + LOECC, loss of moderator cooling and loss of Reserve Water Tank make-up
- While there can be loss of channel geometry, water in the calandria vessel delays core collapse
- Calandria vault, with make up from the Reserve Water Tank, prevents failure of the calandria vessel
- Targets are set for summed frequencies of severe core damage and large releases
- Accidents are analyzed with integral models

Examples of Events

- Limited Core Damage Accidents
  - Small LOCA + LOECC
  - End Fitting Failure + LOECC
  - Large LOCA + LOECC
  - Pressure Tube / Calandria Tube Failure + LOECC
  - Steam Generator Tube Rupture + LOECC
  - Stagnation Feeder Break
  - Severe Channel Flow Blockage
- Severe Core Damage Accidents
  - LOCA + LOECC, with loss of moderator cooling
  - Station Blackout (Loss of all AC Power)

Meeting Process

- Overview presentations followed by time for discussion:
  - Severe Core Damage Accidents – includes MAAP
  - Containment
  - Fuel and Fission Products
  - Molten Fuel Moderator Interaction
  - Fuel Channels
- Tours arranged mid-day for relevant facilities and labs
- Working lunches and dinners

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