

CANDU Owners Group Inc.



"Strength Through Co-operation"

COG R&D Program Overview

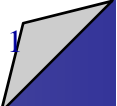
Presented to CNC IAPWS Workshop

I Hey
Program Manager

May 2009

PROTECTED INFORMATION

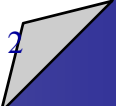
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CANDU Owner's Group (COG)

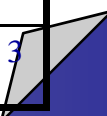
- COG is a private not for profit corporation funded voluntarily by its Members:
 - ◆ Five Canadian and six offshore Members
 - ◆ Programs on collaborative research, information exchange, joint projects and regulatory affairs
 - ◆ Mission is to provide programs for cooperation, mutual assistance and exchange of information for the successful support, development, operation, maintenance, and economics of CANDU technology





CANDU Reactors in the World

COG Members	Operational Units	Units under Construction	Other
Canada-Bruce Power	6		2 – Under Refurbishment
Canada-Hydro Quebec	1		
Canada-New Brunswick			1 – Under Refurbishment
Canada-OPG	10		2 – Laid-up
Argentina	1		
Romania	2		2 – Construction Planned
South Korea	4		
China	2		
India	16	4	
Pakistan	1		
Canada-AECL	NRU research reactor		
TOTAL	44	4	7





R&D Program Overview

■ The Program is managed under five areas:

- ◆ Chemistry, Materials and Components
- ◆ Fuel Channels
- ◆ Safety & Licensing
- ◆ Health, Safety and Environment
- ◆ Industry Standard Toolset



R&D Program Overview

■ ***Chemistry, Materials & Components***

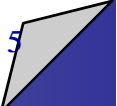
- ◆ addresses a diverse range of CANDU reactor operating and maintenance issues that impact the economics and reliability of a station and may shorten its operating life

■ ***Fuel Channels***

- ◆ addresses the need to improve confidence in the fitness-for-service of CANDU pressure tubes
- ◆ develops industry standards for pressure tube integrity

■ ***Safety and Licensing***

- ◆ addresses issues relating to the safety design basis and safe operating envelope of existing facilities
- ◆ focuses on the resolution of outstanding generic safety and licensing issues





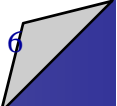
R&D Program Overview

■ ***Health, Safety and Environment***

- ◆ Addresses issues related to radiation monitoring and dosimetry, including the establishment of the risks of radiation exposure
- ◆ Addresses regulatory aspects of ecological impact, emission reduction and techniques for monitoring emissions and the environment

■ ***Industry Standard Toolset***

- ◆ Provides ongoing updating, maintenance and validation of standard use computer codes used for plant licensing

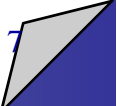




R&D Program Overview

COG R&D Funding Distribution (M\$)

Chemistry, Materials & Components	9.4
Fuel Channels	12.0
Safety & Licensing	8.4
Health, Safety & Environment	4.2
Industry Tool Set	4.8
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Total including COG costs	41

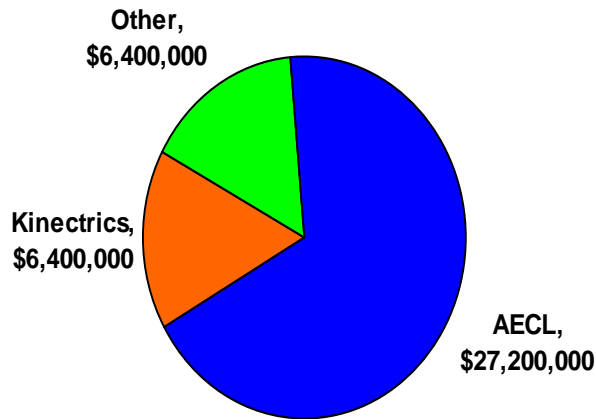




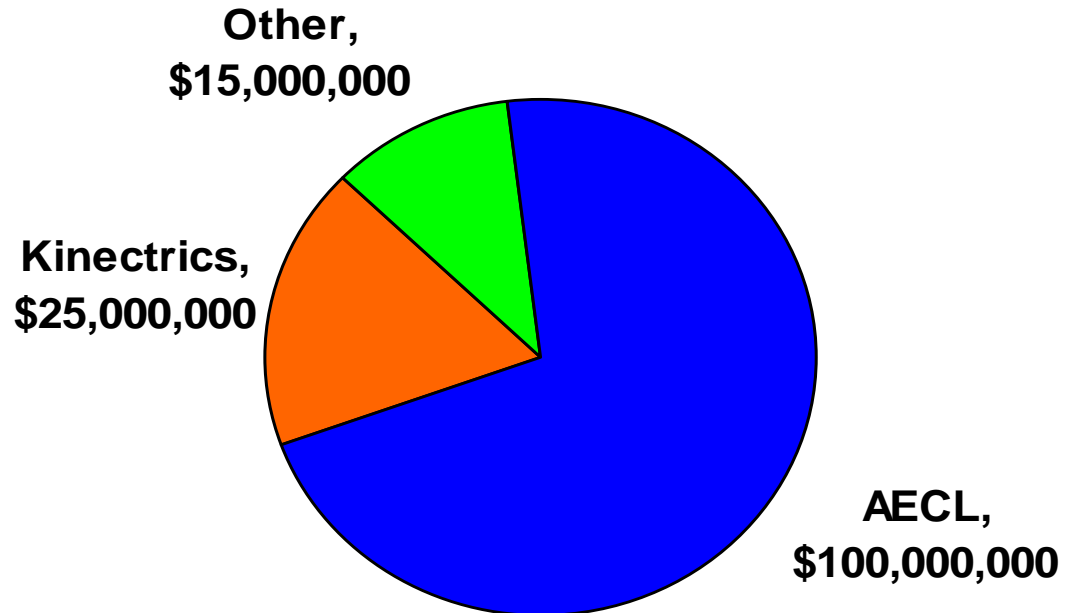
R&D Program Overview

R&D Suppliers Funding

COG Funded
40M\$



Total Funding
>140M\$

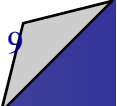




15th International Conference on IAPWS (2008)

Topics included:-

- Water & Steam Thermodynamic Properties
- Flow Accelerated Corrosion
- Piping Corrosion
- Copper Oxide Formation in Generator Stators
- Intergranular SCC in CS and SS
- Solubility of Zirconium
- H² and H²O² effect on Corrosion
- Suppression of Boiler Deposits
- Seawater Thermodynamics
- Organics Removal from BFW
- Sulphur in Magnetite





SAFETY & LICENSING R&D

- The current **S&L R&D program** includes work on high temperature water cooling issues:
 - ◆ Quench/Rewet Temperature coefficients
 - ◆ Contact Boiling Tests
 - ◆ Nucleate Boiling Correlations
 - ◆ Heat Transfer Correlations
 - ◆ Critical Heat Flux Correlations
 - ◆ High Temperature Measurement Techniques



The current CM&C R&D program includes work on

■ Piping

- ◆ Flow Accelerated Corrosion (FAC)
- ◆ Review of FAC Commercial Codes
- ◆ Thermal Stratification
- ◆ H₂ Assisted Creep/Cracking Experiments
- ◆ Trending FAC in CANDU Reactors



Chemistry, Material & Components

■ Heat Transport & Moderator Systems

- ◆ Corrosion Product Sampling
- ◆ Corrosion Product Transport
- ◆ Suppression of Radiolysis
- ◆ Resin Qualifications
- ◆ Effects of Organics



■ Boiler Water

- ◆ Solubility of Lead Compounds
- ◆ Corrosion by interactive Combination of Impurities
- ◆ Wet Lay-up and Start-up Chemistry
- ◆ Feedwater Hydrazine Optimization
- ◆ Degradation of SG Tubing in Reduced Sulphur Environments



- Advanced reactor concept using supercritical water as a coolant
- 25 MPa and core outlet temperatures of 400 to 625°C
- Volatile amine (e.g. ammonia) proposed for chemistry control, but lithium hydroxide not ruled out

- Chemistry Issues
- effect of discontinuity in water properties at critical point on solubility, reaction kinetics, etc. and impact on fouling and activity transport