

**32nd Annual Conference of the
Canadian Nuclear Society & 35th
CNS/Can Student Conference 2011**

**Niagara Falls, Ontario, Canada
5-8 June 2011**

Volume 1 of 2

ISBN: 978-1-61839-414-9

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2011) by the Canadian Nuclear Society
All rights reserved.

Printed by Curran Associates, Inc. (2012)

For permission requests, please contact the Canadian Nuclear Society
at the address below.

Canadian Nuclear Society
480 University Avenue, Suite 200
Toronto, Ontario, Canada M5G 1V2

Phone: (416) 977-7620

Fax: (416) 977-8131

cns-snc@on.aibn.com

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

VOLUME 1

“Computation of Actinide Pourbaix Diagrams at 298 K and 550 K (U,Np,Pu,Am,Cm – H₂O)”	1
<i>M. H. Piro, G. M. F. Bruni, B. J. Lewis, W. T. Thompson, F. C. Iglesias</i>	
Maintaining Excellence - Planning a New Multi-purpose Research Reactor for Canada	20
<i>Jeremy Whitlock</i>	
Tight Fitting Garter Springs - MODAR	23
<i>Dennis Kazimer, Bruce Power</i>	
Lower Churchill Project - Canadian Nuclear Society	30
<i>N/A</i>	
Robotic Removal of High-Activity Debris from a Nuclear Primary Heat Transfer System	35
<i>Anthony Hamilton, Steve J. Burany, Samuel B. Peralta, Lindsay Greenland</i>	
Implementation and Sustainability of a Full Scope Nuclear Power Generator Pressure Boundary QA Program	41
<i>John Charles Krane</i>	
ASME Division 4 Fusion Energy Devices	49
<i>W. K. Sowder, Richard W. Barnes</i>	
Safety Margins in Deterministic Safety Analysis	54
<i>A. Viktorov</i>	
Teaching about Energy Use at the University Level as a Way to Discuss Nuclear Power	68
<i>J. M. K. C. Donev</i>	
Generation Risk Assessment of Main Output Transformers	72
<i>M. Jyrkama, M. Pandey</i>	
Software Development Processes and Analysis Software: A Mismatch and a Novel Framework	84
<i>Diane Kelly, John Harauz</i>	
Multi-Group Fusion Reactivities for Maxwellian and Non-Maxwellian Ion Velocity Distributions	95
<i>Rudrodip Majumdar, M. S. Kalra</i>	
Reliability Analysis of Digital Instrumentation and Control Systems	107
<i>Arun Veeramany, Mahesh D. Pandey</i>	
Future Plans for Performance Analysis and Maintenance/Inspection Optimization of Shutoff Rods Based on the Case Study of Bruce Power Unit-3 Shutoff Rod 5 Inspection	120
<i>E. Nasimi, H. A. Gabbar</i>	
Waste Not, Want Not: Used Nuclear Fuel Waste as Fuel for a Thousand Years	132
<i>Peter Ottensmeyer</i>	
Ultrasonic Detection of Cracks in Pressure Tubes	144
<i>Alex Karpelson</i>	
9th International Conference on CANDU® Maintenance - Paper A - A CMC Conference-Focus Heads-Up	152
<i>Jacques Plourde</i>	
The Potential Production of Molybdenum 99 in CANDU Reactors	154
<i>A. C. Morreale, D. R. Novog, J. C. Luxat</i>	
Research and Production Corporation Radly Activities within Canadian Nuclear Market	170
<i>I. Bakhmach, O. Siora, V. Kharchenko, V. Sklyar, A. Andrashov</i>	
Entropy Generation Minimization for a Packed Bed Reactor in Nuclear Hydrogen Production	180
<i>K. Pope, G. F. Naterer</i>	
Estimation of Nusselt Number and the First Wall Heat Extraction Capability in Self-Cooled Liquid Metal Blankets	190
<i>Amit K. Srivastava, Abdul B. Ahmad, M. S. Kalra</i>	
Short, Medium and Long Term Consequences of Inadequate Defect Fuel Management	202
<i>John G. Roberts, Rod Nashiem, Maureen McQueen, Guoping Ma</i>	
9th International Conference on CANDU® Maintenance - Paper B - The Outage/ Operating Cycle Continuum	212
<i>Jacques Plourde</i>	
9th International Conference on CANDU® Maintenance - Paper C - The Configuration Management Challenge	214
<i>James Smith, Simon Weston</i>	

9th International Conference on CANDU® Maintenance - Paper D - Service-Provider and Utility Task-Leadership Integration	216
<i>Sean Bagshaw, Doug Van Tassel</i>	
9th International Conference on CANDU® Maintenance - Paper E - Plant Operating Chemistry - Best Learned in Reverse	218
<i>Bill Schneider</i>	
Research Study on Typical Feature of the Media Coverage on Nuclear Accidents in the National Newspapers in Japan	221
<i>T. Tsuchida, H. Kimura</i>	
GRA Model Development at Bruce Power	233
<i>R. Parmar, K. Ngo, I. Cruchley</i>	
Determination of Large Early Release Frequency Used in PSA.....	242
<i>Kyungmin Kang, Moosung Jae</i>	
Implementation of CNSC Regulatory Guide G-323 at Pickering Nuclear Generating Station.....	251
<i>A. Louie Shoukas, B. Angela Vieira, C. Jessica Phyland</i>	
Physics Aspects of Reload and Approach-to-Critical of the NRU Reactor After Vessel Repair.....	263
<i>T. C. Leung, M. D. Atfield, X. Wang, S. Nguyen, P. Pfeiffer, J. Budgell</i>	
AREVA Fatigue Concept: FAMOS for CANDU and its Accompanying Fatigue Assessment Methods, Great Value for Availability and LTO in NPPs	273
<i>C. Poeckl, B. Heinz</i>	
Empirical Observations on the Aging of Flux Detectors at Darlington.....	285
<i>C. Banica, R. Slovak</i>	
A Direct Coupling between RFSP and CATHENA Using PVM.....	296
<i>E. L. Pelletier, E. Varin</i>	
Hitachi DCS Emulator Design to Support NPP Simulator Implementation	307
<i>Y. Nakashima, K. Ishii, D. Chiba</i>	
Minor Design Changes for Controlling Reactor Inlet Header Temperatures in CANDU Reactors.....	319
<i>E. Yang, J. Sherin, V. Chugh</i>	
A Predictive Code for International Space Station Radiation Mission Planning	328
<i>S. El-Jaby, B. Lewis, L. Tomi</i>	
A Novel Neutron-Gamma Dosimeter	340
<i>T. Wood, B. J. Lewis, E. C. Corcoran, K. McDermott</i>	
Simulation and Design of a Neutron Detector Based on Boron-Loaded Linear Alkyl Benzene (LAB) Liquid Scintillator.....	352
<i>G. Bentoumi, X. Dai, A. Ho, G. Jonkmans, L. Li, G. Marleau, B. Sur</i>	
Qinshan CANDU® 6 Main Heat Transport System High Accuracy Performance Tracking in Support of Regional Overpower Protection	362
<i>W. J. Hartmann, C. Zeng, J. Feng, X. Mou</i>	
Detailed Finite Element Analysis of Darlington NGS Feeder Pipes with Locally Thinned Regions Below Pressure Minimum Thickness	382
<i>Irfan Haq, Mike Stojakovic, Ming Li</i>	
Inattentional Blindness: Present Knowledge, Recent Research and Implications for the Nuclear Industry	402
<i>Jeff Budau</i>	
Detector System for Radiation Imaging Using Inverse Collimation.....	411
<i>A. Das, B. Sur, S. Yue, G. Jonkmans</i>	
Remote detection of radioactive materials via Coherent Anti-Stokes Raman Scattering.....	420
<i>A. Chalyk</i>	
An Examination of the Time-Dependent Background Counts of the Delayed Neutron Counting System at the Royal Military College of Canada	426
<i>M. T. Sellers, E. C. Corcoran, D. G. Kelly</i>	
Simulation of Adjuster Withdrawal in Darlington Unit 4.....	437
<i>Jakub Szymandera, Omar Shaikh, Derek Hennig, Steve Goodchild, Constantin Banica</i>	
Risk-Informed Prediction of Feeder End of Life	457
<i>M. Jyrkama, M. Pandey</i>	
Minimum Staff Complement: Safety in Numbers	468
<i>Suzanne Dolecki, Helen McRobbie</i>	
Alternative Energy Technologies: Integrated Energy Systems.....	478
<i>Bill Smith</i>	
Comparison of Calculated and Measured Fine-Structure Reaction Rate Data from CANFLEX-RU in ZED-2	487
<i>M. B. Zeller, J. E. Ltfeld</i>	

Tools to Quantify Safety Culture	495
<i>Bettina Avella</i>	
Simulations and Imaging Algorithm Development for a Cosmic Ray Muon Tomography System for the Detection of Special Nuclear Material in Transport Containers	503
<i>C. Jewett, V. N. P. Anghel, J. Armitage, K. Boudjemline, J. Botte, D. Bryman, J. Bueno, E. Charles, T. Cousins, R. Didsbury, L. Erhardt, A. Erlandson, G. Gallant, A. Jason, G. Jonkmans, Z. Liu, M. McCall, S. Noel, F. G. Oakham, D. Ong, T. Stocki, M. Thompson, D. Waller</i>	
Modeling of a 3-D SCWR Unit Cell	518
<i>G. Harrison, G. Marleau</i>	
End--Flux Peaking Experiment in the ZED-2 Reactor using CANFLEX-RU	527
<i>J. E. Atfield, M. B. Zeller</i>	
Developing Acoustic Magnetized Target Fusion an Overview of the Science and Development Program at General Fusion	542
<i>M. Delage, D. Blondal, D. Richardson</i>	
Non-Parametric Study on the Optimization of Thorium Content in a 54-Element Fuel Bundle for use in a CANDU-SCWR	553
<i>D. W. Hummel, D. R. Novog</i>	
Scoping Study of a Thorium Reactor Driven by PWR-Derived Plutonium	563
<i>Y. Friedlander, B. Hyland, G. Edwards, J. Luxat</i>	
On the Functional Failure and Quantification of Margins	576
<i>Dumitru Serghiuta</i>	

VOLUME 2

An Ion Trap for β-delayed Neutron Spectrum Measurement	602
<i>N.D. Scielzo, R. Yee, G. Li, R. E. Segel, P. F. Bertone, F. Buchinger, J. E. Crawford, D. Lascar, J. Van Schelt, A. F. Levand, M. Pedretti, D. Seweryniak, M. G. Sternberg, S. Gulick, K. S. Sharma</i>	
Inertial Fusion Energy - Research at the University of Alberta and a Proposed Alberta/Canada Program	607
<i>R. Fedosejevs, A. A. Offenberger, S. Singh, Y. Y. Tsui</i>	
Effects of Structural Materials on BP/CP Uncertainty Studies for RFSP-IST Modelling of Wolsong Candu 6 Reactors	615
<i>Dai-Hai Chung, Hyung-Jin Kim, Sung-Min Kim</i>	
Bearing Pad to Pressure Tube Contact Simulation	627
<i>Farshad Talebi, Azin Behdadi, John C. Luxat</i>	
A Preliminary Study on BP/CP Uncertainty Analysis of Wolsong CANDU 6 Reactors Based Upon RFSP-Ist Fine Mesh Core Model	648
<i>Hyung-Jin Kim, Dai-Hai Chung, Jong-Hyun Kim, Sung-Min Kim</i>	
System Safety Theory and Human Factors Approach to Patient Safety for Radiotherapy	659
<i>Seraphin Chally Abou</i>	
IAEA ICSP on Evaluation of System Codes for HWR SBLOCA	667
<i>J. H. Choi, M. Krause</i>	
An Advanced Engineering Test Reactor for Canada	680
<i>Daniel Meneley, Glenn Harvel</i>	
Application of DCS to New Build CANDU[®] Designs using the G-HIACS v SAFE Platform	691
<i>V. Gomez, R. Zurek, S. Masunaga, K. Ishii, P. E. Marko</i>	
Deuterium Isotope Effects on Acid Ionization and Transition Metal Hydrolysis at Reactor Conditions by Raman Spectroscopy	703
<i>M. Yacyshyn, M. Madekufamba, P. Tremaine</i>	
Electrochemical Study of H₂O₂ Decomposition on the Magnetite Bulk Electrode	715
<i>H. R. Zebardast, E. Asselina, S. Rogak</i>	
Feeder Grayloc HUB Local Allowable Thickness -A Comparison of Asme Section III and FFSG Appendix E Level 2 Evaluation	725
<i>Ming Li, Perrik Le Dreff, Ian Wilcox</i>	
An Optimization Scheme for Selecting Alternative Fuels in CANDU-6 Reactor	748
<i>E. St-Aubin, G. Marleau</i>	
Evaluation of the Mechanical Cleaning of The Primary Side of the Steam Generator for Wolsong Nuclear Power Plant-2	761
<i>Sung-Min Kim</i>	

The Analysis of Local Plasticity during Macro-indentation of the Nickel-based Alloy 600 Used in CANDU Steam Generator Tubing	769
<i>Robert J. Klassen, Jashanpratap S. Grewal, V. Bhakhri</i>	
High-Temperature Fracture of Candidate Gen IV Reactor Materials	778
<i>S. Xu</i>	
Severe Accident Analysis of Stagnation Feeder Break Scenarios Using MAAP4-Candu for Application to the Level 2 PSA for the Point Lepreau Station Refurbishment Project	793
<i>S. M. Petoukhov, G. M. Khawaja</i>	
Severe Accident Analysis of Shutdown State Accident Using MAAP4- CANDU to Support Level 2 PSA for the Point Lepreau Station Refurbishment Project	810
<i>S. M. Petoukhov, M. J. Brown, P. M. Mathew</i>	
Whole-Core Transport Solutions to A Stylized CANDU-6 Core Problem	828
<i>D. Zhang, F. Rahnema, D. Serghiuta</i>	
Filling the Gaps in SCWR Materials Research: Advanced Nuclear Corrosion Research Facilities in Hamilton	837
<i>J. L. Krausher, W. Zheng, J. Li, D. Guzonas, G. Botton</i>	
Physical Design and Performance Prediction of the STOR-U Spherical Tokamak	847
<i>D. Liu, C. Xiao, A. Hirose</i>	
C-NET: The Centre for Nuclear Energy Technology	858
<i>J. W. Roberts</i>	
Three-Dimensional Discrete Heterogeneous Finite Element Method and Code for Static Multi-Group Neutron Diffusion	862
<i>E. Aydogdu, E. Nichita</i>	
Effect of Coating and Surface Modification on the Corrosion Resistance of Selected Alloys in Supercritical Water	872
<i>Jian Li, W. Zheng, W. Cook, A. Toivonen, S. Penttila, D. Guzonas, O. T. Woo, P. Liu</i>	
Enhanced CANDU 6 (EC6): A Proven Mid-Sized Reactor with Fuel Cycle Capability	879
<i>Jerry Hopwood, Michael Soulard, Ian J. Hastings</i>	
Fuel Cycles in CANDU: Security of Supply and Reduced Used Fuel Management	886
<i>Jerry Hopwood, Sermet Kuran, Ian J. Hastings</i>	
Technology Spin-offs from a CANDU Development Program	892
<i>Stephen Yu</i>	
Enhanced CANDU 6[®]: Reactor Core Design and Safety Characteristics	900
<i>M. Ovanes, M. Soulard, M. Cormier</i>	
The Future of Nuclear (Science and) Technology	908
<i>Robert Walker</i>	
Zirconium Oxide Coatings on P91 and Zircaloy (Zr-2.5%Nb) Substrates for use in SCWRs	917
<i>W. Cook, J. Miles, R. Hui</i>	
Model Support for an Out-Reactor-Instrumented-Defected-Fuel-Experiment to Validate the RMC Fuel Oxidation Model	926
<i>A. D. Quastel, E. C. Corcoran, B. J. Lewis, C. Thiriet, G. Hadaller</i>	
Electrical, Control and Information Systems in the Enhanced CANDU 6[®]	939
<i>J. de Grosbois, G. Raikums, M. Soulard</i>	
9th International Conference on CANDU[®] Maintenance - Paper F - Intelligent Replication - A Way-of-Working for the Future	952
<i>Bill Schneider</i>	
65 Years of Nuclear Safety	954
<i>Michael Binder</i>	
Small Reactors for Energy Supply	967
<i>Philip Moor</i>	
Aircrew Radiation Exposure Estimates and the Effect of Solar Flare Anisotropy	979
<i>H. Al Anid, B. J. Lewis, L. G. I. Bennett, M. Takada</i>	
The Boundary Dam Story	992
<i>Michael J. Monea</i>	
Evolution of the Enhanced CANDU-6 Monitoring and Control System Design	1017
<i>P. Foster, J. Harber, S. Tikku, A. Xing</i>	
Global Nuclear Energy Developments: The nuclear Market After Fukushima	1027
<i>Jean-Francois Beland</i>	
Development of an FPGA-Based Controller for Safety Critical Application	1034
<i>A. Xing, J. de Grosbois, V. Sklyar, P. Archer, A. Awwal</i>	
Advancing Clean Energy Technology in Canada	1042
<i>Geoff Munro</i>	

Natural Gas: The Future of Shale Gas	1053
<i>Kerry Guy</i>	
Special Address: Fukushima Dai-Ichi Nuclear Power Station Update	1068
<i>D. R. Novog</i>	
Canada’s Medical Isotope Strategy	1081
<i>Shannon Quinn</i>	
Materials Research in Support of Nuclear Power Generation	1088
<i>Jennifer Jackman</i>	
Alternative Fuels for CANDU Reactors	1101
<i>Zhang Zhenhua</i>	
Molybdenum-99 Supply: A Global Issue	1116
<i>R. V. Cote</i>	
Communicating the Nuclear Message	1126
<i>Dietwald Claus</i>	
Point Lepreau Refurbishment and Energy Outlook in New Brunswick	1141
<i>Blair Kennedy</i>	
Building on Strengths Canada’s Energy Policy Framework	1150
<i>Greg Schmidt</i>	
Author Index	