

## TABLE OF CONTENTS

### **PLENARY SESSION 1: International Experience and Programs**

<b>Manufacturing, Quality Assurance &amp; Performance of PHWR Fuel in India</b> C. Ganguly (NFC, India).....	3
<b>Current Status and Future Prospect of CANDU Fuel Research &amp; Development in Korea</b> H.C. Suk (KAERI, Korea).....	13

### **SESSION 2A: CANFLEX® Fuel Design & Development**

<b>Dryout Power of a Canflex Bundle String With Raised Bearing Pads</b> L.K.H. Leung (AECL, Canada), J.S. Jun (KAERI, Korea), G.R. Dimmick, D.E. Bullock, W.W.R. Inch (AECL, Canada) and H.C. Suk (KAERI, Korea).....	27
<b>A Refuelling Strategy of CANFLEX-RU Fuel in CANDU Reactors</b> S.Y. Kim, C.J. Jeong, B.J. Min and H.C. Suk (KAERI, Korea).....	41
<b>Mechanical Fretting Endurance Test of CANFLEX Fuel Bundle</b> S.K. Chang and H.C. Suk (KAERI, Korea).....	51
<b>Status of the Demonstration Irradiation Program of the New Fuel Bundle CANFLEX-NU in Korea</b> H.C. Suk, M.S. Cho, J.S. Jun (KAERI, Korea), S.H. Lee and Y.B. Kim (Korea Electric Power Research Institute).....	63

### **SESSION 2B: Fuel Management**

<b>Development of CANDU-PHWR Neutronics Code SCAN</b> I.S. Hong, C.H. Kim (Seoul National University), B.J. Min and H.C. Suk (KAERI, Korea).....	77
<b>Application of Direct Search Technique to Optimal Refueling Channel Selection for CANDU Reactors</b> C.J. Jeong, H. Choi, H.C. Suk (KAERI, Korea) and N.Z. Cho (KAIST, Korea).....	87
<b>New Selection Criteria for Channel Refueling of a CANDU-6 Reactor: Introduction to "Floppy Rules"</b> D. Brissette (HQ, Canada).....	95

**Mathematical Modeling Of CANDU-PHWR -**  
Fatma A. Gaber and R.A. Aly (Atomic Energy Authority, Egypt)..... 113

**Validation of MCNP-4B Code Against Measurement Data of Wolsong Nuclear Power Plant 2**  
G. Roh, H. Choi and C-J. Jeong (KAERI, Korea)..... 123

### **SESSION 2C: Manufacturing & Quality Assurance – Part I**

**Comparative Study of Turbo and Spray Drying Techniques in the Production of Nuclear Grade Uranium Dioxide**  
C. Radhakrishna, M. Ravindran, J.P.N. Srivastav, P.B. Ojha, M. Anuradha, T.K. Sinha and A.P. Kulkarni (NFC, India)..... 133

**Optimising Welding and Assembling Processes for Manufacturing PHWR Fuel Element and Bundle**  
D.S. Setty, U.K. Arora, A.R. Rao, G.V.S.H. Rao and R.N. Jayaraj (NFC, India)..... 143

**New Development in PHWR Fuel Assembly Fabrication**  
P.K. Banerjee, V.S. Sastry, G.N. Ganesh, A. Singh and C. Ganguly (NFC, India)..... 151

### **SESSION 3A: Fuel Performance Assessment**

**Microchemical Studies of Irradiated Fuel by Imaging-XPS**  
W.H. Hocking and K.G.Irving (AECL, Canada)..... 163

**Mechanical Characterization of Irradiated Fuel Materials with Local Ultrasonic Methods**  
D. Laux, G. Despaux (LAIN, France), D. Baron (EDF, France) and J. Spino (ITU, Germany)..... 177

**Two-phase Pressure-drops for CANDU Fuel Bundles in Uncrept and Crept Channels**  
S.C. Sutradhar (AECL, Canada)..... 191

### **SESSION 3B: Fuel Safety**

All papers to be published in Volume 2.

### **SESSION 3C: Manufacturing & Quality Assurance – Part II**

#### **Optimization of Powder/Pellet Fabrication for DUPIC Fuel**

J. H. KIM, K. H. KANG, B. G.KIM, JAE. W. LEE, J. W. LEE and M. S. YANG..... 205

#### **The Precise X-Ray Inspection for DUPIC Fuel Elements Welded by Nd:YAG Laser**

W.K. Kim, S.S. Kim, J.W. Lee and M.S. Yang (KAERI, Korea)..... 217

#### **DUPIC Fuel Fabrication in Shielded Facilities in Korea**

J.W. Lee, W.K. Kim, S.S. Kim, M.S. Yang and H.S. Park (KAERI, Korea)..... 227

### **SESSION 4A: Fuel Designs & Development**

#### **Analysis of the Thermal Behavior of DUPIC Fuel**

H.S. Park, K.C. Song and M.S. Yang (KAERI, Korea)..... 237

#### **Romanian Program for SEU/RU Fuel Manufacturing at Nuclear Site Pitesti**

D. Ohai (Institute for Nuclear Research, Romania) and G. Andrei (Nuclear Fuel Plant, Romania)..... 249

#### **Exporting Technology for CANDU Fuel Manufacturing to the People's Republic of China - A Stimulating Experience for the Romanian Nuclear Fuel Plant**

V. Bailescu, G. Burcea, V. Turcanu and C. Stanciu (S.N. NUCLEARELECTRICA S.A. – FCN, Romania)..... 261

### **SESSION 4B: Advanced Fuel Cycles**

#### **A Dark Side Of The Fuel Cycle: Some Military Uses Of Depleted Uranium And Potential Consequences**

W.S. Andrews, B.J. Lewis, L.G.I. Bennett and E. Ough (RMC, Canada)..... 269

### **SESSION 4C: Fuel Handling**

All papers to be published in Volume 2.

## **SESSION 5A: Fuel Performance – Part I**

<b>Gentilly 2 NGS Recent fuel Experience</b> N. Macici (HQ, Canada).....	287
---	-----

## **SESSION 5B: Fuel Performance Modelling - Part I**

<b>FISM: A New Optimized Fuel Modeling Computer Code</b> M.Y. Khalil (Alexandria University, Egypt), W.A. Omar and K.A. Yasso (Nuclear Power Plants Authority, Egypt).....	299
--	-----

## **SESSION 5C: Fission Gas Release Modelling**

<b>Fuel Oxidation and Thermal Conductivity Model for Operating Defective Fuel Rods</b> B.J. Lewis, B. Szpunar (RMC, Canada) and F.C. Iglesias (OPG, Canada).....	311
<b>Multi-Component Gas Transport in CANDU Fuel Rods During Severe Accidents</b> B. Szpunar, B.J. Lewis, V.I. Arimescu (RMC, Canada), R.S. Dickson, L.W. Dickson (AECL, Canada) and M.I. Baskes (LANL, USA).....	329

## **SESSION 6A: Fuel Performance – Part II**

<b>Knudsen Cell-Mass Spectroscopic Studies on the Relationship between Molybdenum Oxidation and Iodine Volatility in CANDU Fuel</b> S. Sunder and R. F. O'Connor (AECL, Canada).....	355
---	-----



## TABLE OF CONTENTS

### **PLENARY SESSION 1: International Experience and Programs**

#### **Canadian CANDU Fuel Development Programs and Recent Fuel Operating Experience**

D.S. Cox, J.H.K. Lau, W.W.R. Inch (AECL, Canada), R.G. Steed (NBP, Canada), E. Kohn (OPG, Canada), N.N. Macici (HQ, Canada) and R. Chun (BP, Canada)..... 1-1

#### **The Manufacture and Performance of KANUPP Fuel**

B.A. Ansari, K.G. Qasim and Hameedullah (PAEC, Pakistan)..... 1-15

### **SESSION 2A: CANFLEX® Fuel Design & Development**

#### **PLGS CANFLEX® Demonstration Irradiation: Highlights of In-Bay Inspections and Hot-Cell Examinations**

P.J. Valliant, A.M. Manzer, G.L. Montin, D.F. Sears (AECL, Canada) and R.G. Steed (NBP, Canada)..... 2A-1

#### **Impact Strength Analysis of CANFLEX Fuel During LOCA Conditions**

M.S. Cho, J.Y. Jung and H.C. Suk (KAERI, Korea)..... 2A-15

### **SESSION 2B: Fuel Management**

#### **Lattice Characteristics with WIMS-AECL and MCNP-4B Codes in a Deuterium Critical Assembly (DCA)**

B.J. Min and G. Roh (KAERI, Korea)..... 2B-1

### **SESSION 2C: Manufacturing & Quality Assurance – Part I**

#### **Technological Developments in Pelletisation of UO<sub>2</sub> Fuel for PHWRs in India**

D. Pramanik, A.K. Dube, K.P. Chakraborty, R.N. Jayaraj, P.S.A. Narayanan and C. Ganguly (NFC, India)..... 2C-1

#### **Graphite Coating of Zircaloy Cladding Tube for Production of PHWR Fuel**

A. Kanna Rao, S.K. Pathak, G.V.S. Hemantha Rao and R.N. Jayaraj (NFC, India)..... 2C-11

## **SESSION 3A: Fuel Performance Assessment**

### **Capability for Measurement of O/U Ratios in As-Discharged Defected CANDU Fuel**

R.A. Verall and J.F. Mouris (AECL, Canada)..... 3A-1

### **Mechanical Characterization of Irradiated Fuel Materials with Local Ultrasonic Methods**

D. Laux, G. Despau (LAIN, France), D. Baron (EDF, France) and J. Spino (ITU, Germany)..... 3A-13

### **A Thermodynamic Model for Noble Metal Alloy Inclusions in Nuclear Fuel Rods and Application to the Study of Loss-of-Coolant Accidents**

M.H. Kaye (Queen's University, Canada), W.T. Thompson, B.J. Lewis (RMC, Canada), S. Sunder and R. O'Connor (AECL, Canada)..... 3A-33

## **SESSION 3B: Fuel Safety**

### **High Temperature Oxidation of a Zirconium Base Alloy in Steam**

K. Park, T. Yoo, S. Kim (Kyunghee University, Korea), H.G. Kim, Y. Jeong (KAERI, Korea) and K. Kim (KEPCO, Korea)..... 3B-1

### **Validation of FACTAR 2.0 Against Small Out-of-Pile Laboratory Tests**

C.J. Westbye (OPG, Canada), R.C.K. Rock (CRC, Canada), L. Sie (University Laval, Canada) and G.R. Berzins (OPG, Canada)..... 3B-11

### **Fission-Product Releases from CANDU Fuel at 1650°C: The HCE4 Experiment**

L.W. Dickson and R.S. Dickson (AECL, Canada)..... 3B-21

### **CANDU-Specific Models for SOPHAEROS-IST 2.0**

R.S. Dickson, R.J. Lemire and L.W. Dickson (AECL, Canada)..... 3B-31

## **SESSION 3C: Manufacturing & Quality Assurance – Part II**

### **Ultrasonic Testing of End Closure Welds for Higher Reliability of PHWR Fuel**

K. Vasudev, K.R. Subramanyam, B. Laxminarayana, M. Suryaprakash and C. Ganguly (NFC, India)..... 3C-1

### **Fabrication of Experimental MOX Fuel Pellets with Varying Microstructure**

H. Hamilton and F.C. Dimayuga (AECL, Canada)..... 3C-11

## **SESSION 4A: Fuel Designs & Development**

### **Fabrication, Irradiation Testing and Post-Irradiation Examination of DUPIC Fuel**

J.D. Sullivan, M.A. Ryz, M.R. Floyd and G.L. Montin (AECL, Canada)..... 4A-1

## **SESSION 4B: Advanced Fuel Cycles**

### **Comparative Cost-Benefit Analysis of Advanced CANDU Reactor Fuel Cycles**

C. Fawcett, H.W. Bonin and K. Creber (RMC, Canada)..... 4B-1

### **Status of the Parallex Project – Testing CANDU® MOX Fuel with Weapons-Derived Plutonium**

F.C. Dimayuga, D.S. Cox (AECL, Canada), T.W. Horning (ORNL, USA), K. Chidester (LANL, USA), Y.I. Bibilashvili and S.A. Antipov (SRIIM, Russian Federation)..... 4B-3

### **Status of the Development of CANFLEX 0.9% SEU**

W.W. Inch, P.S.W. Chan and Z. Bilanovic (AECL, Canada)..... 4B-17

## **SESSION 4C: Fuel Handling**

### **Fuel Handling Aspects of 2- and 4-Bundle Shift Schemes with the SEU in a CANDU 6 Reactor**

A.M. Manzer, D.J. Koivisto and D. Howlett (AECL, Canada)..... 4C-1

### **Advanced Polymer Based Composite Containers for the Disposal of Spent Nuclear Fuel**

I. Miedema, H.W. Bonin and V.T. Bui (RMC, Canada)..... 4C-13

## **SESSION 5A: Fuel Performance – Part I**

### **Extended-Burnup CANDU Fuel Performance**

M.R. Floyd (AECL, Canada)..... 5A-1

### **Load Following Testing by AECL in Collaboration with the Institute for Nuclear Research in Romania**

S.J. Palleck, K.S. Sim (AECL, Canada) and C. Gheorghiu (INR, Romania)..... 5A-21

### **Prediction of Power Ramp Defects – Development of a Physically Based Model and Evaluation of Existing Criteria**

M.J.F. Notley (M.J.F. Notley and Associates, Canada) and E. Kohn (OPG, Canada)..... 5A-33



## **SESSION 5B: Fuel Performance Modelling - Part I**

### **CANFLEX Mk-IV Qualification Program and Readiness for Implementation**

W.W.R. Inch and P. Alavi (AECL, Canada)..... 5B-1

### **FROM Modelling and Zircaloy-4 Oxidation Properties for CANDU Fuel**

A.G. McLean, F.C. Iglesias (BP, Canada) and C. Westbye (OPG, Canada)..... 5B-11

### **Progress in Qualifying ELESTRES-IST 1.0 Code: Verification and Interim Results of Validation**

K.S. Sim, G.G. Chassie, Z. Xu, M. Tayal (AECL, Canada) and C. Westbye (OPG, Canada)..... 5B-21

### **Performance of Two CANDU-6 Fuel Bundles Containing CANLUB and Non-CANLUB Production Elements**

J. Montin, M.R. Floyd, Z. He (AECL, Canada) and E. Kohn (OPG, Canada)..... 5B-35

## **SESSION 5C: Fission Gas Release Modelling**

### **Fuel Oxidation and Thermal Conductivity Model for Operating Defective Fuel Rods**

B.J. Lewis, B. Szpunar (RMC, Canada) and F.C. Iglesias (OPG, Canada)..... 5C-1

### **SOURCE-IST 2.0 Phenomena Modelling**

D.H. Barber (OPG, Canada), F.C. Iglesias (BP, Canada), L.W. Dickson (AECL, Canada), M.J. Richards (HQ, Canada) and P.J. Reid (NBP, Canada)..... 5C-21

### **SOURCE-IST 2.0 Validation Approach**

D.H. Barber (OPG, Canada), L.W. Dickson, R.S. Dickson and M. Audette-Stuart (AECL, Canada)..... 5C-31

