

TABLE OF CONTENTS

PLENARY SESSION 1: INTERNATIONAL EXPERIENCE AND PROGRAMS

PHWR Advanced Fuel R&D for the 21st Century in Korea H.C. Suk (KAERI, Korea).....	1
--	---

SESSION 2A: CANFLEX[®] Fuel Design and Development

CANFLEX-NU Fuel Licensing Status and Issues in Korea G.S. Auh, J.S. Park, S.W. Woo and Y.H. Ryu (KINS, Korea).....	11
Critical Heat Flux and Pressure Drop for a CANFLEX Bundle String Inside an Axially Non-Uniform Flow Channel L.K. Leung, D.C. Groeneveld, G.R. Dimmick, D.E. Bullock, and W.W. Inch (AECL, Canada).....	18
Static Strength Analysis of CANFLEX Fuel Bundle for CANDU-6 Reactor M.S. Cho, K.S. Sim, H.C. Suk and S.K. Chang (KAERI, Korea)	30

SESSION 2B: FUEL MANAGEMENT

Validation of WIMS-AECL with ENDF/B-V Against Phase B Reactor Physics Tests at Wolsong Units 2 and 3 I.S. Hong, C.H. Kim (Seoul National University, Korea), B.J. Min, H.C. Suk (KAERI, Korea) and B.G. Kim (Korea Power Engineering Co. Inc.).....	40
Analysis of Xenon Spatial Oscillation in a CANDU 6 Reactor with DUPIC Fuel C.J. Jeong and H.B. Choi (KAERI, Korea).....	52
Advanced CANDU Reactors Fuel Analysis Through Optimal Fuel Management at Approach to Refuelling Equilibrium C.P. Tingle and H.W. Bonin (RMC, Canada).....	61

SESSION 2C: FUEL HANDLING

New Fuel Bundle Packaging

J.W. Spencley (GEC, Canada) and D.J. Semple (OPG, Canada).....72

High Polymer-Based Composites for Spent Nuclear Fuel Disposal Containers

H.W. Bonin and V.T. Bui (RMC, Canada)82

Corrosion Resistance of (Th,U)O₂ Fuel in Water

S. Sunder (AECL, Canada) 96

SESSION 3A: FUEL PERFORMANCE ASSESSMENT

Assessment of the Core Flow Pattern and Pressure Tube Creep at Cernavoda Unit #1

N. Mazalu (CNE-PROD, Romania) 106

Post-Irradiation Examination of Two Gentilly-2 Bundles to Investigate the Effect of Pressure Tube Diametral Creep on Fuel Performance

Z. He and M.R. Floyd (AECL, Canada).....117

Measurement of the Composition of Noble-Metal Particles in High-Burnup CANDU Fuel by Wavelength Dispersive X-Ray Microanalysis

W.H. Hocking and F.J. Szostak (AECL, Canada).....127

Microacoustic Techniques to Assess the Local Characteristics of Irradiated Fuel Materials

B. Cros, (LAIN, Universite Montpellier, France), D. Baron (EDF, Etudes et Recherches France) and V. Roque (LAIN, Universite Montpellier, France)143

SESSION 3B: FUEL SAFETY - PART I

Source Term Analysis for a Nuclear Submarine Accident

B.J. Lewis and J.J. Hugron (RMC, Canada)153

Power Coefficient Calculation of a CANDU Reactor

H.B. Choi and J.W. Park (KAERI, Korea).....169

Verification and Uncertainty Analysis of Fuel Codes Using Distributed Computing

D. Evens (OPG, Canada) and R. Rock (Sententia Research Inc., Canada).....178

Verification of Fuel Performance Simulation Codes: Application of Distributed Computing	
Y. Liu (OPG, Canada) and C.J. Westbye (Geodesic Consulting Inc., Canada).....	187

SESSION 3C: MANUFACTURING AND QUALITY ASSURANCE - PART I

Five Years of Successful CANDU-6 Fuel Manufacturing in Romania	
A.C. Galeriu, A. Pascu, G. Andrei and A. Bailescu (FCN, Romania).....	197
Trends in Joining Technology Development for PHWR Fuel Assemblies in India	
P.B. Desai and P.G. Kulkarni (Bhabha Atomic Research Centre, India).....	205

SESSION 4A: ADVANCED FUEL CYCLES

A Study on the Core Characteristics for a CANDU 6 Reactor Fuelled with Recovered-Uranium CANFLEX Bundles	
B.J. Min, C.J. Jeong and H.C. Suk (KAERI, Korea)	215
The Use of Stainless Steel in CANDU Fuel with Recovered Uranium	
B.J. Min and H.C. Suk (KAERI, Korea).....	226
A Reactor Physics Study of the Economic Penalty Associated with LVRF and Increased Pressure Tube Thickness	
D. Rozon and W. Shen (Ecole Polytechnique de Montreal, Canada)	235
Proliferation Hardening of Thorium Fusion Breeders with CANDU Spent Fuel	
S. Sahin (Gazi Universitesi, Turkey), H. Yapici, H.M. Sahin (Nigde Universitesi, Turkey) and V. Ozceyhan (Erciyes, Turkey).....	251

SESSION 4B: FUEL SAFETY - PART II
--

Status of SOPHAEROS Fission-Product Transport Code Validation	
S. Gingras, R.S. Dickson and L.W. Dickson (AECL, Canada).....	261
Release of Fission Products from CANDU Fuel in Air, Steam and Argon Atmospheres at 1500-1900°C: The HCE3 Experiment	
R.D. Barrand, R.S. Dickson, R.S. Liu and D.D. Semeniuk (AECL, Canada)	271

Post-Irradiation Examination Results from the BTF-105A LOCA/LOECC Test P.J. Valliant, J.D. Irish and S.T. Craig (AECL, Canada)	281
Preliminary Fission-Product and Post-Irradiation Examination Results from BTF-105B LOCA/LOECC Test J.D. Irish, S.T. Craig and P.J. Valliant (AECL, Canada)	291
The Development of 3-D Tomography Method Based on Gamma-Scanning of Irradiated Fuel Rods R. Dobrin (RENEL) and T. Craciunescu (Horia Hulubei Lab., Romania)	301

SESSION 4C: MANUFACTURING AND QUALITY ASSURANCE - PART II

All papers to be published in Volume 2.

SESSION 4D: HISTORY OF CANDU FUEL
--

Looking Back at Fuel Thirty Nine to Forty Years Ago R. Page (AECL Retired).....	306
CANDU Fuel: Design/Manufacturing Interaction N.A. Graham (Consultant, ZPI, Canada)	325
Oxidation and Hydriding of Zircaloy Fuel Cladding - The Inside (and Outside) Story B. Cox (University of Toronto, Canada).....	338

SESSION 5A: FUEL PERFORMANCE

Load-Following Performance and Assessment of CANDU Fuel M. Tayal, M.R. Floyd, D. Rattan, Z. Xu, A.M. Manzer, J.H. Lau (AECL, Canada) and E. Kohn (OPG, Canada)	348
Fuel Performance at Cernavoda Unit #1 D. Stanila (CNE-PROD, Romania).....	365
Gentilly 2 NGS Recent Fuel Experience N. Macici (HQ, Canada).....	374

Performance of Two CANDU-6 Fuel Bundles Containing Elements with Pellet Density and Clearance Variances	
M.R. Floyd, Z. He (AECL, Canada), E. Kohn (OPG, Canada) and J. Montin (AECL, Canada).....	384

SESSION 5B: FISSION GAS RELEASE MODELLING

SOURCE IST 2.0: Development and Beta Testing	
D.H. Barber, F.C. Iglesias, Y. Hoang (OPG, Canada), L.W. Dickson, R.S. Dickson (AECL, Canada) , M.J. Richards (HQ, Canada) and R.A. Gibb (NBP, Canada).....	393
An Overview of Defective Fuel Analysis in CANDU and Light Water Reactors	
B.J. Lewis (RMC, Canada)	403
Oxygen Potential in the Gap of Defective CANDU Fuel Rods During Severe Accident Conditions	
B.J. Lewis and C. Cole (RMC, Canada)	428

SESSION 6A: FUEL DESIGNS AND DEVELOPMENT

Technical Aspects and Benefits of the use of RU in CANDU Reactors	
H.C. Suk, J.H. Park, B.J. Min, K.S. Sim (KAERI, Korea), W.W. Inch (AECL, Canada) and T.G. Rice (BNFL, UK).....	444
Irradiation Plan of DUPIC Fuel at HANARO	
K.K. Bae, K. Kang, M.S. Yang and H.S. Park (KAERI, Korea)	460

SESSION 6B: FUEL PERFORMANCE MODELLING

A Comparative Study of Uranium and Thorium Based Fuel Pins using Code FAIR-TFC	
B.K. Dutta (Bhabha Atomic Research Centre, India)	470
Assessment of Fuel Manufacturing Safe Operating Envelope	
R.A. Gibb (NBP, Canada) and T.J. Chapman (ALARA Research Inc., Canada).....	479
Analysis of Thermomechanical Behaviors of a Fuel Element using Three Dimensional Isoparametric Finite Elements	
S.D. Yu, and S. Xu (Ryerson Polytechnic University, Canada).....	492

Validations and Applications of the FEAST Code

Z. Xu, M. Tayal, J.H. Lau, D. Evinou (AECL, Canada) and J.S. Jun (KAERI, Korea).....504

TABLE OF CONTENTS

SESSION SUMMARIES	1
-------------------------	---

PLENARY SESSION 1: INTERNATIONAL EXPERIENCE AND PROGRAMS

PHWR Fuel Experience in India C. Ganguly (NFC, India).....	19
The Experience in the Cernavoda Unit 1 Operation - A Stimulating Argument for Future Nuclear Power Development in Romania I. Rotaru (S.N. Nuclearelectrica S.A, Romania), I. Bucur (CNE, Romania), A.C. Galeriu (FCN, Romania) and O. Budan (S.N. Nuclearelectrica S.A, Romania).....	33
Nuclear Fuel Cycle Activities in Argentina P. Adelfang (CNEA, Argentina)	40
Experience in CANDU Fuel for KANUPP and Establishment of Supporting Facilities for Self Reliance M. Shabbir (PAEC, Pakistan)	52
Canadian CANDU Fuel Development Program and Recent Operating Experience J.H. Lau, W.W. Inch, D.S. Cox (AECL, Canada), R.G. Steed (NBP, Canada), E. Kohn (OPG, Canada) and N.N. Macici (HQ, Canada)	66

DINNER PRESENTATION

CANDU: Fuel for the Next Millennium P.G. Boczar (AECL, Canada).....	78
---	----

LUNCHEON PRESENTATION

Resolving the Controversy over Beneficial Effects of Ionizing Radiation J.M. Cuttler (AECL, Canada).....	80
--	----

SESSION 2A: CANFLEX® FUEL DESIGN AND DEVELOPMENT

- CANFLEX Demonstration Irradiation at Point Lepreau: A Status Update**
R.A. Gibb, R.W. Sancton, R.G. Steed (NBP, Canada), P.J. Reid (ALARA, Canada)
and J. Bullerwell (CNER, Canada)91
- Full Scale Water CHF Testing of the CANFLEX Bundle**
G.R. Dimmick, W.W. Inch (AECL, Canada), J.S. Jun, H.C. Suk (KAERI, Korea),
and G.I. Hadaller, R. Fortman and R. Hayes (STERN Lab., Canada) 103
- An Update on the Design Verification of CANFLEX Fuel Bundle**
P.K. Chan, P. Alavi, G.G. Chassie, J.H. Lau, P.L. Purdy, D. Rattan, R. Sejnoha,
M. Tayal, B. Wong and Z. Xu (AECL, Canada)114
- Comparative Strength Assessment Between 43 and 37-element Fuel Bundles**
G.G. Chassie, C. Manu and M. Tayal (AECL, Canada)124

SESSION 2B: FUEL MANAGEMENT

- Fuel Re-ordering in the Bruce A Reactor Cores**
E. Kohn, J. Novak, H. Bromfield and R. Day (OPG, Canada).....137

SESSION 2C: FUEL HANDLING

All papers were published in Volume 1.

SESSION 3A: FUEL PERFORMANCE ASSESSMENT

- Hydrogen Gas in CANDU Fuel Elements**
R. Sejnoha (AECL, Canada) 154

SESSION 3B: FUEL SAFETY - PART I

- Upgrading Potential of a CANDU 6 Reactor with CANFLEX Fuel - A Safety Analysis Perspective**
A. Grace and Z. Bilanovic (AECL, Canada).....162

SESSION 3C: MANUFACTURING AND QUALITY ASSURANCE - PART I
--

**Implementation of CANFLEX Bundle Manufacture - From "Bench Scale"
to Production**

A.Pant (ZPI, Canada)172

**Performance of Indigenous Resistance Welding Equipment for PHWR Fuel
Fabrication in NFC**

G.V. Hemantha Rao, R.N. Jayaraj, M.S. Prakash, U.C. Gupta and C. Ganguly
(NFC, India)184

**Approaching Six Sigma Quality in Nuclear Fuel Fabrication - An Indian
Perspective**

B. Laxminarayana, B.K. Kumar, N. Saratchandran and C. Ganguly (NFC, India).....192

SESSION 4A: ADVANCED FUEL CYCLES
--

New Fuel for Advanced Heavy Water Reactors

C. Notari (Atomic Energy Commission of Argentina, Argentina)201

**SEU Fuel In Atucha-1 NPP, A Valuable Experience for a CANDU-6 Core
Enrichment**

L. Alvarez, J. Casario, (CNEA, Argentina) and J. Fink, R. Perez, M. Higa,
(NASA, Argentina)206

SESSION 4B: FUEL SAFETY - PART II

All papers were published in Volume 1.

SESSION 4C: MANUFACTURING AND QUALITY ASSURANCE - PART II

**Refining Practices in India to Produce Consistent Uranium Oxide Powder for
PHWR Fuel Pellets**

S.M. Rao, P.B. Ojha, C. Radhakrishna, U.C. Gupta and C. Ganguly (NFC, India).....215

Effect of Loading Pattern on High Temperature Sintering of UO₂ Pellets K.P. Chakraborty, R.N. Jayaraj, N.P. Katiyar, J.V. Raj Kumar, V.K. Gopalakrishnan, S.M. Rao, and C. Ganguly (NFC, India).....	224
--	-----

Novel Method for Recycle of Sintered UO₂ Rejected Pellets A.L. Kumar Reddy, E. Venkatesham, C. Radhakrishna, S.M. Rao, U.C. Gupta and C. Ganguly (NFC, India).....	235
--	-----

SESSION 4D: HISTORY OF CANDU FUEL

All papers were published in Volume 1.

SESSION 5A: FUEL PERFORMANCE

Fuel Element Sheath Strains at High Powers and Burnups: Rationalizing the Reference Bundle Overpower Envelope E. Kohn (OPG, Canada) and M.J. Notley (M.J. Notley & Associates Inc, Canada)....	241
--	-----

SESSION 5B: FISSION GAS RELEASE MODELLING

Modelling of Intra-Granular Diffusion, Production and Removal in SOURCE 2.0 P.J. Reid (ALARA, Canada), B.J. Lewis (RMC, Canada) and F.C. Iglesias, D.H. Barber (OPG, Canada)	249
---	-----

SESSION 6A: FUEL DESIGNS AND DEVELOPMENT

CARA Fuel Bundle: A New Concept for HWR Present Situation P.C. Florido, R.O. Cirimello, J.E. Bergallo, A.C. Marino, D.F. Delmastro, D.O. Brasnarof, J.H. Gonzalez, L.A. Juanico (CNEA, Argentina).....	258
---	-----

Investigations of Fuel-Bundle Motion and Fretting-Wear in the Chalk River Single-Channel Test Rig V.P. Janzen, N.L. Fisher, B.A. Smith, C.E. Taylor, J.L. Gerardi, S.J. Palleck (AECL, Canada) and J.S. Ryu, H.T. Chae and Y.G. Cho (KAERI, Korea).....	268
--	-----

SESSION 6B: FUEL PERFORMANCE MODELLING

Probabilistic Assessment for Nuclear Fuel Rods Behavior

A.C. Marino (CNEA, Argentina)	278
-------------------------------------	-----