

21st CNA/CNS Annual Student Conference

March 15 and 16, 1996
Ottawa, Ontario

Conference Program

Friday, March 15, 1996

10:30 A.M. Invited talk: *CANDU Program* by Dr. J. Cuttler
12:00 P.M. Conference Registration
1:15 P.M. Opening of Conference and welcoming address
1:30 P.M. Session 1
3:15 P.M. Coffee break
3:30 P.M. Sessions 2a and 2b
6:00 P.M. Reception / Conference Banquet

Saturday, March 16, 1996

8:30 A.M. Session 3
10:00 A.M. Coffee break
10:15 A.M. Session 4
12:00 P.M. Luncheon
1:00 P.M. Session 5
3:00 P.M. Coffee break
3:30 P.M. Awards presentation and closing of the conference

Technical Sessions

Friday, March 15, 1996

Session 1: Nuclear Safety **1:30 P.M.** **CBY-C003**
Chairperson: Dr. J.R. Riznic, AECS

- *Historical Safety of Nuclear Submarines in Russia*, S. Marshall, McMaster University
- *Consequences of a Nuclear Submarine Reactor Accident*, R. Hugron, Royal Military College of Canada
- *Partition Coefficients of Iodoalkanes*, K.H. Lin, University of Toronto
- *Assessment of the Cosmic Radiation Field at Jet Altitudes*, P. Tume, Royal Military College of Canada

Session 2a: Iodine Chemistry **3:30 P.M.** **CBY-C003**
Chairperson: Dr. D.R. Wiles, Carleton University

- *The Destruction of Iodate in γ -Irradiated Solutions*, C. Gallagher, University of Toronto
- *The Effect of Chemical Reaction on the Mass Transfer of Iodine*, J.R. Ling, University of Toronto
- *The Retention of Iodine in Stainless Steel Sampling Lines*, T. Nugraha, University of Toronto
- *The Effect of pH on Iodine Volatilization Rates*, E.J. Panyan, University of Toronto
- *Extraction of Iodine from Environmental Samples*, M.D. Ho, University of Toronto

Session 2b: Nuclear Materials **3:30 P.M.** **CBY-B012**
Chairperson: Dr. P. Frise, Carleton University

- *Passivation of Stainless Steels in Simulated Reactor coolants*, D.F. Basque, University of New Brunswick
- *Location of Alloying Elements in Oxide Films on Zirconium Alloys*, H.I. Sheikh, University of Toronto
- *Experimental Technique for Testing CANDU Fuel Channel Components at High Strain-Rates*, D. Radford, Carleton University
- *Electrical Non-Destructive Testing of Zr-2.5 Nb Specimens*, K.J. Jones, Carleton University
- *Fate of Heavy Metals and Trace Elements in Residential Composting*, P. Tan, University of Toronto

Saturday, March 16, 1996

Session 3: Simulation **8:30 A.M.** **CBY-C003**
Chairperson: Dr. W. Garland, McMaster University

- *Implementation of the Xenon-135 Effect in the 3D DONJON Code*, C. Ovanes, Ecole Polytechnique de Montréal
- *Simulation of the Shutdown System Number One in the 3-D Reactor Code DONJON*, M. Dragomirescu Ovanes, Ecole Polytechnique de Montréal
- *LEU-Fuelled SLOWPOKE-2 Modelling with MCNP4A*, J.R.M. Pierre, Royal Military College of Canada
- *Modélisation de Collisions d'Ions Lourds à l'Aide de Simulations Monte-Carlo*, L. Gingras, Université Laval

Session 4: Thermalhydraulics **10:15 A.M.** **CBY-C003**
Chairperson: Dr. S. Tavoularis, University of Ottawa

- *Effect of the Position of an Orifice with respect to an Elbow in CCF*, S. Bédard, Ecole Polytechnique de Montréal
- *Studies of Subcooling Effect on CHF in Pool Boiling*, X.D. Cui, University of Ottawa
- *Experimental Investigation of Critical Heat Flux in Dumb-Bell Shaped Tubes*, G. Chen, University of Ottawa
- *Two Dimensional Modeling of a Magnetohydrodynamic Flow in the Cooling Channels of a Nuclear Fusion Reactor*, A. Kwan and D. Novog, McMaster University

Session 5: Radiation Chemistry **1:00 P.M.** **CBY-C003**
Radiation Instrumentation and Dosimetry
Chairperson: Dr. J. Lafortune, SAIC-Ottawa.

- *Radiation Processing of Nitrocellulose*, M.L. Bickerton and D. Murphy, Royal Military College of Canada
- *Radiation Effects on Epoxy resins*, H.C. Harris, Royal Military College of Canada
- *A Radiochemical Study of the Interaction of Zinc and Cadmium with fly ash under leaching conditions*, J.D. Rodgers, University of Toronto
- *Analysis of Arsenic and Uranium in Environmental samples from a Low Level Radioactive Waste Management Facility*, S. Wang, University of Toronto
- *Calibration of the Eberline ASP-1 Portable Hand Held Survey Meter*, B. Corse, M.E.J. Ham and D.J. Sims, Royal Military College of Canada
- *Design of a Combined Dose Calculation and Gamma Ray Spectroscopy System for Nuclear Emergency Response*, R.C.J.M. McCallum, C.J. Spearin and D.S. Whitehurst, Royal Military College of Canada

Acknowledgments

We would like to acknowledge the generous support of our Sponsors. Their Financial support is instrumental to the success of this Conference.

We would like to express our gratitude to all the judges and the sessions chairpersons. A special thanks goes to Mr. Jon H.F. Jennekens for agreeing to be the guest speaker at the Conference Banquet. Many thanks to Dr. Jerry M. Cuttler for accepting to be our invited speaker for the talk of Friday morning. Our sincere appreciation goes to Mrs. I. Kalos, of AECL Chalk River Laboratories, for her cooperation in arranging the Technical Tour.

We would like to thank the Ottawa-Carleton Institute for Mechanical and Aerospace Engineering, and Dr. E. Plett, Director, for hosting the conference. We would also like to thank the Deans of Engineering, Dr. M. Bibby, Carleton University and Dr. G. Patry, University of Ottawa, for their support and encouragement. We wish to extend our thanks to the Chairmen and the staff of both the Department of Mechanical Engineering, University of Ottawa and the Department of Mechanical and Aerospace Engineering, Carleton University.

The help and support of the executive members of the Ottawa Branch of the Canadian Nuclear Society is greatly appreciated.

The Conference Co-chairs
M.S. Guellouz and M.L. Lamari

Best Communications Awards Judges' Committee

Dr. J.T. Rogers (Chair), Carleton University

Dr. J.C. Cuttler, AECL

Dr. T. Rummery, Former President, AECL Research

Dr. F. McDonnell, AECL

Mr. F. Boyd, Former AECB

Conference Co-Chairs

Mohamed Limayem Lamari, Mechanical and Aerospace Eng., Carleton University

Mohamed Sadok Guellouz, Mechanical Eng., University of Ottawa

CONFERENCE REPORT

1. Conference Main Events

On Friday and Saturday March 15 and 16, 1996, some seventy students, professors and nuclear industry professionals, from across Canada, were gathered in Colonel By Hall, the engineering building of the University of Ottawa, to participate in the 21st Canadian Nuclear Association and Canadian Nuclear Society (CNA/CNS) Annual Student Conference. University Students from undergraduate, masters and doctorate programs had the opportunity to present their research work in the fields of nuclear science and engineering. Twenty-seven out of the twenty-nine papers submitted were presented. All contributed papers have been compiled and published in a bound conference proceedings, made available to attendees at the time of the conference.

This year's conference, hosted by the Ottawa-Carleton Institute for Mechanical and Aerospace Engineering, was co-chaired by Mohamed Sadok Guellouz, University of Ottawa, and Mohamed Limayem Lamari, Carleton University.

In addition to the technical presentation sessions, the Conference featured a full-day Technical Tour of AECL's Chalk River Laboratories (on Thursday), an Invited Talk and a Banquet.

Nineteen students took part of the technical tour, arranged by Ima Kalos and her team of the Chalk River visitor's centre. The tour was well organized and very informative, according to the participants.

The Invited Talk, entitled "CANDU Program", was delivered, on Friday morning prior to the opening of the conference, by Dr. Jerry Cuttler, manager at AECL and President of the CNS, to an audience of local graduate and undergraduate students and conference participants. The Talk, designed to provide an overview on the Canadian nuclear program, attracted a large audience and exposed new students to the nuclear technology.

The Conference Banquet was held on the evening of Friday, March 15, in conjunction with the annual dinner of the Ottawa branch of the CNS. The guest speaker for the banquet was Mr Jon H.F. Jennekens, former president of the AECB, former deputy director general and head of the safeguards department at IAEA and currently chairman of Ontario Hydro's technical advisory panel on nuclear safety and member of the Canadian siting board for ITER.

In the coffee-break area, i.e. the lobby in front of the main conference auditorium, three information booths were set. The first displayed literature, gathered by the conference organisers, from the CNS, the CNA, AECL, Nordion and Hydro-Québec. The other two, consisted of booths laid by the Atomic Energy Control board and the organisers of next year's conference in Fredericton, New Brunswick.

1.1 Technical Sessions: Chairpersons' Reports

During the two days of the Conference, attendees listened to high calibre presentations covering a large spectrum of topics in nuclear science and engineering. These are summarized below, based on reports submitted by the session chairs.

Session 1: Nuclear Safety

Chairperson: Dr. J.R. Rizni_, AECB

Four papers were presented in this session. Sean Marshall, graduate student of McMaster University presented a paper on *Historical Safety of Nuclear Submarines in Russia*. An attempt was made to examine the performance records of submarine reactors in general, and those of the Russian reactors specifically, to determine whether or not they are suited to serve as electrical power plants. In conclusion, Sean suggested that the conversion of existing nuclear submarine reactors to serve as civilian power stations does not appear to be a safe alternative source of power.

The second paper, by Captain Roger Hugron, graduate student at the Royal Military College of Canada, dealt with the *Consequences of a Nuclear Submarine Reactor Accident*. In his research, Roger analyzed a hypothetical large break LOCA aboard a nuclear powered vessel and its possible consequences, in terms of individual doses of fission products released to the environment. Preliminary results show that even if there is a large quantity of activity in the fuel at the time of a specific accident, little activity will be released to the atmosphere because of a combination of engineered safety barriers and physical hold-up processes.

Ka Hing Lin, graduate student at the University of Toronto presented results of a research on the *Partition Coefficients of Iodoalkanes*. The partition coefficients have been used extensively in the environment chemistry to describe the interfacial distribution of chemicals. Ka Hing developed a novel experimental procedure for dynamic measurements. Data on the partition coefficients of several iodoalkanes were presented and compared to the results of other authors. These indicated that the proposed method gives an accurate measurement of the partition coefficients, but additional work is necessary in refining the methodology.

Pamela Tume, Doctoral student at the Royal Military College of Canada, presented a paper on the *Assessment of the Cosmic Radiation Field at Jet Altitudes*. The study involved a survey of military pilots during normal flight duties, to determine their annual total dose equivalent. The latter was found to be below the current limit for the public and may exceed the ICRP-60 recommended limits.

Session 2a: Iodine Chemistry

Chairperson: Dr. D.R. Wiles, Carleton University

Iodine occupies a unique position among the radionuclides produced in nuclear reactors, not only because it is more mobile than most other elements but also because it furnishes perhaps the most hazardous radionuclides both in the short term (¹³¹I) and in the very long term (¹²⁹I). As a consequence, it is particularly important that we come to understand its behaviour and its control in the environment. A series of five research papers, all from the University of Toronto, deal with several aspects of the properties and behaviour of iodine compounds.

The first paper in this series, *The Destruction of Iodate in Gamma-Irradiated Solutions*, by Christine Gallagher, dealt with the radiation chemistry of iodate ions under simulated reactor conditions. Two papers, *The Effect of Chemical Reaction of the Mass Transfer of Iodine*, by Juliette Ling and *The Effect of pH on Iodine Volatilization Rates*, by E.J.Panyan, dealt with mass transfer processes, as influenced by chemical reactions. Two further papers, *The Retention of Iodine in Stainless Steel Sampling Lines*, by Tutun Nugraha and *Extraction of Iodine from Environmental Samples*, by Mark Ho treated aspects of the chemical analysis and monitoring of iodine activity.

These papers all presented preliminary results of work in progress, and it may be expected that each of them will provide information and understanding important to the control of these fission products.

Session 2b: Nuclear Materials

Chairperson: Dr. P. Frise, Carleton University

Five papers were presented in this session beginning with a discussion of *Passivation of Stainless Steels in Simulated Reactor Coolants* by Daniel F. Basque of the University of New Brunswick. He examined the rate of corrosion of two grades of stainless steel in the presence of magnesium and zinc additives and found that both additives helped to reduce the rate of oxide formation but that the magnesium was about twice as effective, at least with the AISI 316L stainless grade.

The second paper was by Haroon I. Sheikh of the University of Toronto and was entitled: *Location of Alloying Elements in Oxide Films on Zirconium Alloys*. Mr. Sheikh used several advanced microscopic techniques such as TEM, EDX and X-ray mapping to locate the particles of iron, chromium and nickel in the oxide film on Zircalloy-2 samples.

Darren D. Radford presented the third paper in the session. Mr. Radford's paper, entitled: *Experimental Technique for Testing CANDU Fuel Channel Components at high Rates of Strain* was a description of the tensile split-Hopkinson bar method of loading a specimen at a very high strain rate. The original apparatus was built at

Carleton University and another has been built at AECLs Whiteshell labs to carry out this work on irradiated specimens of fuel channel material.

The fourth paper was presented by Kim Jones, also of Carleton University in Ottawa. Mrs. Jones' work on non-destructive testing of fuel channel materials was presented in her paper: *Electrical Non-Destructive Testing of Zr-2.5Nb Specimens*. She described the Direct Current Potential Drop (DCPD) method of crack measurement and presented some results of her test program including some tests at high temperatures to simulate actual reactor operating conditions.

The final paper in the session was given by Mr. Phillip Tan of the University of Toronto and was entitled: *Fate of Heavy Metals and Trace Elements in Residential Composters*. This was a very interesting and timely study of how backyard composting concentrates the heavy metals that are used in vegetable fertilizers into the soil which comes out of the composter unit. The study showed that the soil is fairly high in these undesirable substances. It was noted that the environmental community did not want this study done since they felt that it might decrease the appeal of composting to the average citizen.

Phillip's very fine effort was recognized by an Honourable Mention in the Awards Ceremony.

Session 3: Simulation

chairperson: Dr. W.J. Garland, McMaster University.

The simulation session consisted of two papers on enhancements to the 3D Reactor Code, DONJON, under development at Ecole Polytechnique de Montréal, and two probabilistic studies using the Monte Carlo code, MCNP.

Catalin Ovanes, Master's candidate at Ecole Polytechnique, presented on Xenon-135 modelling in DONJON. Steady state has been implemented and transient modelling is underway.

Michaela Ovanes, Master's candidate at Ecole Polytechnique, discussed SDS1 implementation in DONJON. Again, steady state is complete and work is proceeding on the transient mode.

Martin Pierre, Master's candidate at the Royal Military College, reported on a rather detailed modelling of LEU SLOWPOKE-2 using MCNP 4A. In particular, the temperature reactivity coefficient was studied, giving much better agreement to experimental data than previously achieved with deterministic codes.

Luc Gingras, an undergraduate student at Université Laval, discussed the MCNP simulation of collisions of heavy ions.

All papers were of high calibre, the question periods were vigorous.

Session 4: Thermalhydraulics

Chairperson: Dr. S. Tavoularis, University of Ottawa.

The Thermalhydraulics session included three papers. The first two were experimental studies, while the third one was a numerical investigation.

Serge Bédard, of Ecole Polytechnique de Montréal, presented experimental results on counter-current flow, of air and water, and flooding in a test section containing a vertical run and a horizontal run in which an orifice was placed. The study examined the influence of the position, with respect to the elbow between the vertical and horizontal runs, of various sizes orifices on the flooding limit and the partial liquid delivery.

Geng Chen, of the University of Ottawa, reported preliminary test results of an on-going experimental study of Critical Heat Flux (CHF) in a dumb-bell shaped tube. This geometry, which consists of two subchannels interconnected via a narrow gap, is used to investigate the effect of gap size on CHF.

The third paper, entitled *Two-Dimensional Modeling of a Magnetohydrodynamic Flow in the Cooling Channels of a Nuclear Fusion Reactor* was presented by Alex Kwan of McMaster University. It discussed the effect of a magnetic field on the flow of a liquid metal and the heat transfer.

Session 5: Radiation Chemistry / Radiation Instrumentation and Dosimetry

Chairperson: Dr. J.F. Lafortune, SAIC-Canada

Five papers were presented. In *Radiation Processing of Nitrocellulose*, Michelle Bickerton and Dan Murphy, Royal Military College, discussed the potential of irradiating nitrocellulose polymers as a method of reducing the hydrogen content of explosive grade nitrocellulose. They found that exposure to thermal neutrons is effective in lowering hydrogen content.

Hilary Harris, Royal Military College, presented a paper titled *Radiation Effects on Epoxy Resins*, where she discussed the effects of various types of radiations on the strength of epoxy adhesive resins. Her experiments show a definite impact of irradiation, dose rate and time of exposure with respect to curing on the strength of epoxy adhesives.

In *Radiochemical Study of the Interaction of Zinc and Cadmium with Fly Ash under Leaching Conditions*, James Rodgers, University of Toronto, used neutron activation analysis to study the leaching dynamics of metals in incinerator ash, in order to examine the potential environmental impact of incinerating waste prior to landfilling. The results of his experiments show that a high pH is a dominating factor in the ability of municipal solid waste to bind metals.

Sophia Wang, University of Toronto, then presented a paper on the *Analysis of Arsenic and Uranium in Environmental Samples from a Low Level Radioactive Waste Management Facility*. Using epithermal neutron activation analysis, she was able to produce a reliable mapping of the distribution of contamination in samples of vegetation, soil and water at the Port Granby Waste Management Facility.

The final paper on the *Calibration of the Eberline ASP-1 Portable Hand Held Survey Meter* described the work done by Brian Corse, Marnie Ham and David Sims, Royal Military College, to design, test and utilize a calibration rig and facility for a radiation detection instrument to be widely used by the Canadian Forces. The calibration technique developed uses a 120 Ci Cs-137 source and respects all AECB requirements for calibration and safety.

1.2 Best Communications Awards

A five-member judging committee, chaired by Dr. J.T. Rogers (Carleton University) and composed of Dr. J.C. Cuttler (AECL and President of the CNS), Dr. T. Rummery (former President, AECL Research), Dr. F. McDonnell (AECL) and Mr. F. Boyd (former AECB) reviewed all presentations. They had a difficult task selecting the Award winning papers. At the closing of the Conference, Awards were presented for the Best Communications in each student category, i.e. Bachelor, Master's and Doctorate. The First prize in each category consisted of a cheque and CorelDRAW™6 software package, while the second prize included a cheque and a CD-ROM. The *Honourable Mention* prize was a CD-ROM. All awarded softwares were a courtesy of Corel Corporation.

The results of the Best Communication competition were as follow:

1 Doctorate Category:

1st Prize: Pamela Tume, Royal Military College of Canada.

1 Masters Category:

1st Prize: J.R. Martin Pierre, Royal Military College of Canada.

2nd Prize: Serge Bédard, Ecole Polytechnique de Montréal.

1 Undergraduate Category:

1st Prize: Mark D. Ho, University of Toronto.

2nd Prize: Luc Gingras, Université Laval.

1 Honorable Mention:

Phillip Tan, undergraduate, University of Toronto.

2. Conference Sponsorship

The following organizations were the sponsors of the 21st CNA/CNS Annual Student Conference:

- Canadian Nuclear Association
- Canadian Nuclear Society
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- Graduate Students' Association des Étudiant.e.s Diplômé.e.s (University of Ottawa).