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Editorial

Bells, Whistles and Black Boxes

One important theme to emerge from the recent containment design conference was that of human intervention in very severe reactor accidents. Not enough consideration of this had been taken in accident analyses, it was argued by one speaker. As a corollory to this it was later argued that there existed a danger we could be placing too much reliance on more and more hardware, perhaps forgetting that the *management* of a system was as important to its safety as the design of the system itself.

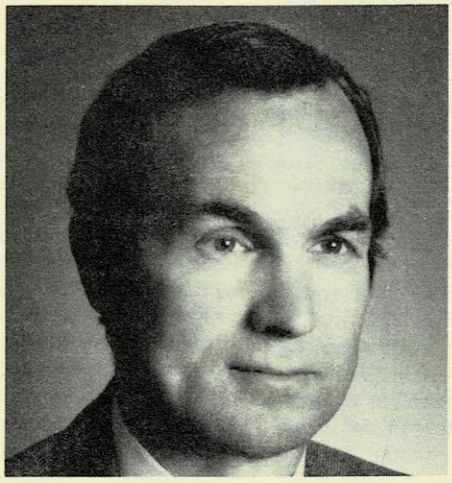
It seems a little paradoxical that in an age when, we are told by social observers, there is a growing distrust of and disenchantment with technology, a public response (as expressed by the news media and politicians) to any questions about the desirability and/or safety of any technology is a demand that more and more bits of ironmongery be bolted on to the system under discussion.

A politically easy response is to go ahead and bolt the bits on. But this is not necessarily the right one. Micro-processor controlled power disc brakes on baby carriages may offer improved stopping capability, but do they add very much (if anything) to the overall safety and reliability of the system? The White Knight in Lewis Carroll's *Through the Looking Glass* had burdened himself and his horse with innumerable devices — but they didn't do anything for his horsemanship.

Few people would question the statement that the Boeing-747 is a very safe aeroplane. But a Boeing-747 being piloted by an orangutan would hardly be regarded as a safe situation. Gadgets such as stall-warning alarms or auto-pilots are there to assist rather than replace the experienced pilot. If they don't do this, they shouldn't be there.

Striving for the perfect system by adding more and more black boxes can ultimately cause that system to sink under the weight of these auxilliary accretions with a consequent reduction in reliability and safety. The responsibility for safe operation of any machine rests principally on the shoulders of its operator — not a black box. The nuclear plant "operator" is not one individual but a large group working together in a safety management system. Items which improve this system should be accepted. Those which don't shouldn't.

Society for the Preservation of Canada's Nuclear Heritage



Peter Stevens-Guille Elected CNS President

Peter D. Stevens-Guille was elected President of the Canadian Nuclear Society at the annual meeting in Saskatoon in June. He is the fourth CNS President and is former Vice-President and Secretary/Treasurer. Peter Sevens-Guille is the Systems Integration Engineer in the Design & Development Division of Ontario Hydro. His interests and responsibilities include safety system design, nuclear codes and standards and quality assurance.

After receiving his BSc. in Mechanical Engineering from the University of Cape Town, Peter came to Canada and "graduated" from the Chalk River Nuclear Laboratories during a ten year period encompassing the start up of NPD to the commercial operation of Pickering. During that period, he also graduated with an MASc. from the University of Waterloo. He then returned to University of Cape Town as Senior Lecturer in Mechanical Engineering for a three year period prior to joining Ontario Hydro.

Peter is active in nuclear affairs. He has authored 20 technical papers and holds a patent. He is Secretary of the CSA Committee on Pressure Retaining Components for CANDU Nuclear Power Plants and is a member of the Power Division and the International Committee of the American Nuclear Society. He is also Treasurer of the Mississauga Branch of Amnesty International.

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Perspective

The Low-Level Radioactive Waste Management Office

The following article by Brad Franklin, Information Officer with the Low-Level Radioactive Waste Management Office, first appeared in the Nuclear Canada Yearbook 1984.

The formation of the Low-Level Radioactive Waste Management Office was announced on October 26, 1982, by the Honourable Jean Chrétien, federal Minister of Energy, Mines and Resources. The office is attached to the Research Company of Atomic Energy of Canada Ltd. in Ottawa and began operation on November first of that year.

The broad mandate of the office is to ensure that the ultimate responsibilities of the federal government for low-level radioactive waste management are discharged in a timely and economic manner. In essence, this means that the producer of the waste pays all costs associated with the disposal of those wastes in a proper manner while the government is responsible for ensuring that facilities for waste collection and disposal are available for this purpose. Low-level wastes, in this context, are defined by exclusion in that they are not high-level (fuel) wastes and the mandate of the office does not include responsibility for uranium mine tailings.

Historic Wastes

Historic wastes are defined as waste materials which were produced in the past and for which the owners or original producers can no longer reasonably be held responsible. They tend to be large in volume but low in activity and typically involve areas of contaminated soil. Examples of historic wastes may be found in Saskatchewan and Port Hope, Ontario.

In Port Hope, waste disposal practices dating back some forty years resulted in contamination around a large number of buildings and in several ravines and open areas. In the 1970s, a remedial program initiated by the Federal/Provincial Task Force on Radioactivity resolved the problem of contamination around the buildings but in the other areas contamination remains and it has been estimated that its removal would involve the relocation of some 200 thousand tonnes of soil. In addition, the bottom of the Town's harbour is also contaminated.

During the past year, the office conducted a sampling program within the Town and subjected the material obtained to extensive testing. This was designed to characterize the wastes and investigate the potential for concentrating the contamination in a smaller volume by chemical or physical processing. It was found that the nature of the contaminated material is very diverse, ranging from barium sulphate precipitation sludges to ash from incineration activities. No method of enrichment common to all of the wastes could be found. To date, several options for disposal of the wastes have been considered but none has yet been found which meets social acceptance.

In the Malvern subdivision of Scarborough, low-level contamination exists in the yards of about forty homes built in an area where the land had formerly been the site of a radium recovery operation. Again, the existence of the material can be traced back about forty years but it came to public attention in 1980 and last year the federal and Ontario governments reached a memorandum of understanding regarding its removal. As a disposal site for this material does not yet exist, Ontario has designated a site for its storage and will pay the additional costs associated with removing the wastes to storage while a disposal location is found. The federal government will pay those costs which would have been incurred in taking the soil to disposal and has named this office as its agent to carry out the project. The storage site is in the north-eastern part of Scarborough and preparations took place during the winter to make it ready for the anticipated movement of the contaminated soil there in the late spring or early summer. The material will be stored above ground in a heavy-duty plastic envelope covered by clean fill. The storage facility is expected to be in operation for between five and ten years until such time as a permanent disposal site becomes available.

Recently Mr. Chrétien directed the office to undertake the cleanup of two contaminated industrial properties in Surrey, British Columbia. One of these sites is the location of a former niobium smelting operation. The slag from this operation contains about one percent thorium and has been used extensively as a fill material on the property. The other site is being used as storage for drums containing the same material.

It is anticipated that B.C. and Ottawa will reach an agreement similar to that between the federal and Ontario governments. In the case of the Surrey wastes, however, it is hoped that the material can be taken directly to a disposal site. This should also take place this summer.

Continuous Arisings

Another category of low-level wastes which the office must consider are those which continuously arise from the operations of utilities, institutions and industry. Utilities such as Ontario Hydro and the New Brunswick Electric Power Commission which operate nuclear power reactors produce low-level wastes, known as reactor wastes, on an ongoing basis and have established storage facilities to deal with them. Some industries use radioactive materials either for their radioactive properties or, in some cases, because of other properties to which the fact of their radioactivity is incidental to their use. Similarly, hospitals and laboratories make use of radioactive materials in both the diagnosis and treatment of disease and for scientific purposes. Such uses result in the production of low-level wastes which require special handling and, in many cases, storage.

In order to allow the use of radioactive materials to continue and their benefits to be realized in many fields, the Chalk River Nuclear Laboratories has, for many years, provided a long-term storage for the waste products. Still, the need remains for permanent disposal of these by-products in one or more sites in Canada.

To ascertain the country's requirements for a disposal service, it has been necessary to keep a precise inventory of the ongoing production of the wastes to produce accurate information on their volume, characterization and locations. From this information, it will be possible to develop a proposal covering what types of disposal operations are needed and where they should be. This will form the basis of a disposal strategy for Canada which the office hopes to submit to the federal government for its consideration in 1985.

Remedial Actions

In addition to its work on both the historic and continuously arising wastes, the office has been dealing with the legacy of remedial actions on properties, initiated by the Federal/Provincial Task Force. Many of

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CNS provides Canadians interested in nuclear energy with a forum for technical discussion. For membership information, contact the CNS office, a member of the Council, or local branch executive. Membership fee is $30.00 annually, ($5.00 to students).

La SNC procure aux Canadiens intéressés à l'énergie nucléaire un forum où ils peuvent participer à des discussions de nature technique. Pour tous renseignements concernant les inscriptions, veuillez bien entrer en contact avec le bureau de la SNC, les membres du Conseil ou les responsables locaux. La cotisation annuelle est de $30.00 ($5.00 pour les étudiants).

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these properties are in mining areas where elevated levels of radon are naturally present in the soil gases. In these cases, the work has consisted of radon-proofing of the basements and the installation of sub-floor ventilation systems. In areas where contamination from mine or mill wastes had been artificially introduced around buildings, the contamination was removed in addition to these other measures. Some commercial buildings which had become contaminated as the result of operations involving the use of radium also required some structural work.

While work had been completed on most properties prior to our involvement, some additional clean-up was required. During the first year of its operation, the office had the services of two former members of the Task Force who were attached to ensure continuity in completing this function. With very few exceptions, this task is now complete.

Project Management

The office functions as a project planning and management operation with the bulk of its work being performed on contract. It is directed by Don Cameron, a chemical metallurgist with 20 years experience in nuclear research and development. He was formerly Head of the Fuel Waste Technology Branch at AECL's Whiteshell Nuclear Research Establishment in Manitoba where he was involved with research into the disposal of high-level radioactive wastes.

The area of continually arising wastes comes under Ron Hodge, a Senior Project Manager with 27 years experience in engineering, experimental and analytical research and branch and project management.

Two additional staff members are currently being recruited to assist with the historic waste problems and with completion of the remedial action programs. In due course it is anticipated that a geotechnical engineer will be added to the staff.

Brad Franklin

The RMC SLOWPOKE-2

The following article describing the proposed SLOWPOKE-2, to be operated at the Royal Military College for the Department of National Defence is contributed by nuclear engineering staff of RMC.

The Minister of National Defence, the Honourable Jean-Jacques Blais, announced on March 14 the proposed acquisition of a SLOWPOKE-2 critical nuclear reactor for research, training and education for the department. The facility will be located at the Royal Military College of Canada in Kingston, Ontario, in the Department of Chemistry and Chemical Engineering, and should be operational by mid-1985.

SLOWPOKE is an acronym for Safe Low Power Critical Experiment and reflects the inherently safe operating characteristics of this small pool-type research reactor. The prototype, SLOWPOKE-1, was developed at the Chalk River Nuclear Laboratories of the Atomic Energy of Canada Ltd. Research Company in the early 1970's to provide an economical and intense source of thermal neutrons. The SLOWPOKE-2, with its similar safe operating behaviour yet more irradiation sites, is marketed by the AECL Radiochemical Co. There are presently six facilities in Canada and one in Jamaica which together have operated safely and reliably for over 50 reactor-years.

At RMC, the DND SLOWPOKE-2 will be located in a 2.6m wide, 6.1m deep pool in the Sawyer Science and Engineering building. On the second floor, above the pool and control room, several laboratories are located where users may complete their analysis of samples.

The SLOWPOKE-2 is especially useful for neutron activation analysis, an extremely sensitive analytical technique for determining the chemical and isotopic composition of materials down to the part per billion level. Its intense neutron flux is used to activate some of the atoms in a small sample of the material to be investigated so that they emit radiation. The sample is then analyzed by gamma spectroscopy so that the trace amounts of elements in it are determined qualitatively and quantitatively. This analysis is usually nondestructive (so that a valuable sample is retained intact) and most elements, if present, can be determined (so that the technique is complete and fast). The application of this technique to routine analysis or investigative research of materials where knowledge of their composition is required is widespread.

As a simple, small and safe reactor, the SLOWPOKE-2 is valuable for demonstrating the principles of reactor kinetics and operation. The effects of temperature, fission product poisons and control rod position and the measurement of the neutron flux can easily be observed. As well, its capability to produce short-lived radioisotopes in quantity means that topics in health physics and radiation safety can also be practically demonstrated. Access to the SLOWPOKE-2 means a better understanding of the workings and effects of larger, more complicated systems such as the proposed SLOWPOKE-3 and the CANDU reactors.

The SLOWPOKE-2, as an intense neutron source, is a worthwhile candidate for installation of a neutron beam tube for neutron radiography and large simple irradiations. Work is presently underway to develop an appropriate beam tube and the DND SLOWPOKE is being acquired with a short thermal column in order to subsequently accommodate the beam tube. Neutron radiography is a complementary nondestructive testing technique to X- and gamma radiography. Elements of low mass number, even hidden behind heavy elements (which would attenuate X- and gamma rays), are detectable. The technique is applicable to components in modern equipment that are made of polymeric or composite material, that are held together by adhesives or bonding agents, or that are light alloys subject to water entrapment and corrosion.

The operation of the DND SLOWPOKE-2 facility will be similar to the existing university facilities format in that they are viewed much like the university computer or library. Routine users and researchers have access and do not have to understand everything about the reactor or the analysis equipment, but only the analytical techniques used. An initial introduction, explanation of the required procedures and some equipment are provided, after which most workers perform their own analysis or studies. This approach allows those from almost any background to obtain results or information that will assist them in their own area of analysis or study. The design of the SLOWPOKE-2 combined with this approach to its operation has allowed it to function successfully and to be accepted for widespread application. The DND SLOWPOKE-2 will thus be available for all DND groups, other government departments, nearby educational institutions, and other local groups.

RMC Nuclear Engineering Staff

Le réacteur SLOWPOKE-2 du RMC

L'article qui suite, décrivant le réacteur SLOWPOKE-2 devant être mis en service au Royal Military College pour le Ministère de la Défence Nationale est contribué par les professeurs de génie nucléaire du RMC.

Le ministre de la défense nationale, l'Honorable Jean-Jacques Blais, annonçait le 14 mars 1984, l'acquisition d'un réacteur nucléaire critique SLOWPOKE-2 à des fins de recherche et de formation au sein du Ministère. Le réacteur sera installé au Royal Military College of Canada, à Kingston, Ontario, dans les laboratoires du Département de Chimie et de Génie Chimique, et sera en mesure de diverger au milieu de 1985.

Le nom SLOWPOKE est un acronyme pour "Safe Low Power Critical Experiment" (Expérience critique sûre à faible puissance), décrivant ce petit réacteur de type piscine caractérisé par une sûreté de fonctionnement inhérente. Le développement du réacteur prototype, SLOWPOKE-1, s'est effectué aux Laboratoires Nucléaires de Chalk River au début de la dernière décennie, par les chercheurs de l'Energie Atomique du Canada Limitée, afin de produire une source intense et peu coûteuse de neutrons thermiques. Doté d'un plus grand nombre de sites d'irradiation tout en conservant les mêmes propriétés de sûreté

inhérente, le réacteur SLOWPOKE-2 fait présentement l'objet d'une mise en marché de la Compagnie de Radiochimie de l'E.A.C.L. A l'heure présente, il y a six réacteurs SLOWPOKE-2 en usage au Canada, et un autre en Jamaïque, qui ont accumulé plus de 50 années-réacteurs d'opération sûre et fiable.

Au Royal Military College, le SLOWPOKE-2 de la Défense sera installé dans une piscine cylindrique de 6.1 m de profondeur et de 2.6 m de diamètre, au rez-de-chaussée du complexe Sawyer de Science et de Génie. A l'étage au-dessus du réacteur et de la salle de contrôle seront situés plusieurs laboratoires où les chercheurs pourront effectuer l'analyse de leurs échantillons irradiés.

Le réacteur SLOWPOKE-2 est surtout utilisé en analyse par activation neutronique, une technique d'analyse extrêmement sensible pour la détermination de la composition chimique et isotopique des matériaux, jusqu'au niveau de la partie par milliard. Le flux intense de neutrons produit par le réacteur est utilisé pour activer certains des atomes des petits échantillons étudiés, qui par la suite se désactivent en émettant des radiations très spécifiques. Les échantillons sont ensuite analysés par spectroscopie gamma, de telle sorte que des quantités infimes de ces éléments peuvent être mesurées tant qualitativement que quantitativement. Ce type d'analyse est d'ordinaire non-destructif, ce qui permet de conserver intacts des spécimens de valeur, et la grande majorité des éléments en présence peut être détectée et mesurée sans ambiguïté, rendant cette technique complète et rapide. Les applications de cette technique en analyse routinière et en recherche requérant une bonne connaissance de la composition des matériaux sont fort nombreuses et variées.

Par sa simplicité et ses qualités en matière de sûreté, le SLOWPOKE-2 représente un atout important pour démontrer les principes de la cinétique et du contrôle des réacteurs. On peut aisément y observer les effets de la température, de l'empoisonnement par les fragments de fission, et de la position de la barre de contrôle, et la mesure de la distribution du flux neutronique peut être effectuée aisément. De plus, le réacteur peut être utilisé pour la production de radioisotopes de courte demi-vie, rendant possible la démonstration d'expériences en radioprotection. L'enseignement à l'aide du SLOWPOKE-2 permet une meilleure compréhension des principes de fonctionnement de réacteurs nucléaires plus évolués et plus complexes, tels que les réacteurs CANDU et le SLOWPOKE-3 présentement à l'étude.

Comme source intense de neutrons, le réacteur nucléaire SLOWPOKE-2, est un candidat tout désigné à l'installation d'un tube à faisceau neutronique pour des fins de radiographie neutronique et d'irradiation de spécimens volumineux. Le travail de conception d'un tel tube est présentement en cours, et une colonne thermique permettant l'installation de ce tube figure dans les plans du réacteur du Royal Military College. La radiographie neutronique est une technique d'essai non-destructif complémentaire à la gammagraphie et à la radiographie aux rayons X. Elle permet de détecter des éléments légers, même si ceux-ci sont cachés derrière des éléments lourds qui atténueraient les rayons X et gamma. Cette technique trouve son champ d'application idéal dans l'examen de composantes d'équipement moderne faites de polymères ou de matériaux composites dont la cohésion est assurée par des adhésifs synthétiques, ou encore faites d'alliages légers sujets à la rétention de l'eau et à la corrosion.

Le mode d'opération du réacteur nucléaire de la Défense sera semblable à celui des réacteurs des universités, en ce sens que l'installation SLOWPOKE sera considérée au même titre qu'un centre de calcul ou une bibliothèque universitaires. Les utilisateurs habituels et les chercheurs n'auront pas besoin d'avoir une connaissance poussée du réacteur lui-même, mais seulement des techniques d'analyse qu'ils emploieront. Lors d'une sceance d'introduction, on leur expliquera les détails de la procédure d'utilisation du réacteur et de certains équipements, après quoi ils seront déjà en mesure d'effecteur eux-mêmes leurs propres analyses. Cette approche permet aux chercheurs, sans égard à leur formation spécifique, d'obtenir les résultats expérimentaux nécessaires à la poursuite de leurs projets de recherche. De concert avec ce mode d'utilisation, la conception du réacteur SLOWPOKE a permis son utilisation spectaculaire dans une variété étonnante de domaines de recherche. Le réacteur SLOWPOKE-2 de la Défense sera donc à la disposition de tous les groupes du Ministère de la Défense, et les autres agences gouvernementales, les institutions d'enseignement locales, ainsi que certains autres groupes locaux, pourront y avoir accès.

Les professeurs de Génie Nucléaire du Royal Military College
(Traduit par Hugues W. Bonin, Ph.D.)

FYI

CANDU Pressure Tubes — The Implications of G-16 (D. Mosey)

The sudden failure of pressure tube G-16 in Pickering Unit 2 in August 1983, and subsequent investigations of pressure tubes in the first two Pickering units have been reported in previous editions of the *Bulletin*. Predictably enough the failure, coupled with the decision to begin large scale fuel channel replacement at once at Pickering 1 and 2 (announced last March), prompted much speculation about the service life of all CANDU units. Clearly a requirement for complete retubing after only 12 years operation for all reactors would require radical reassessment of the commercial viability of the system. However enough evidence has accumulated to suggest that Zr.2.5wt%Nb tubes (used in all CANDU reactors built after Pickering 2) are not likely to be susceptible to the kind of failure mechanism exhibited by G-16.

As a first step in establishing this conclusion, it's necessary to recapitulate the postulated failure mechanism in G-16:

- The outlet (eastern) garter spring was about 3 feet west of its design location, probably since reactor construction.
- The pressure tube sagged into contact with its surrounding calandria tube — the time of contact being between 1973 and 1976 (2-5 years after reactor start-up in 1971).
- The outside surface of the pressure tube was cooled where it touched the calandria tube, the calandria tube being surrounded by cool moderator water.
- The deuterium isotope of hydrogen built up in the pressure tube from the inside (ingress from the heavy-water coolant) and the outside (ingress from the insulating annulus gas).
- The deuterium migrated to the cooler contact areas to precipitate as zirconium hyride, forming the hydride blisters.
- A 4 inch crack formed through four of the hydride blisters. Though this crack did not penetrate the tube wall, the thin ductile web on the inside surface later failed and the crack extended to its final 78 inch length.

The major argument in favour of this hypothesis is the relationship between the pressure tube's hydride blisters and the marks on the inside surface of the calandria tube. Careful analyses of the marks and blisters have been able to relate their relative positions to the history of relative movement between calandria tube and pressure tube. Additionally, the outside surface of the G-16 calandria tube had marks (coincident with the inside marks) suggesting local boiling of the moderator water — an expected consequence of pressure tube — calandria tube contact.

It must be remembered that the G-16 failure resulted from the combination of at least two negative factors: high deuterium concentration in the metal, and local cooling from contact with the calandria tube. The high deuterium concentration combined with normal pressure stresses in the Zircaloy-2 was sufficient to precipitate zirconium hydride platelets in the radial-axial plane at operating temperatures, considerably reducing the fracture toughness of the material. Local cooling of the outer surface of the pressure tube led to precipitation of solid zirconium hydride in the form of large blisters. Since volume expansion occurs on conversion of zirconium metal to hydride, it is postulated that stress levels around the blister areas were considerably increased, thereby initiating the major crack. Contact between a pressure tube with only low deuterium levels and

the surrounding calandria tube is not expected to lead to fast fracture of the tube because, (a) there would be insufficient deuterium present in the vicinity of the contact area to produce large local blisters, (b) no reoriented hydrides would be present at the operating temperature.

As has been mentioned previously, CANDU reactors built after Pickering Unit 2 use a different material of construction for their pressure tubes — a zirconium-niobium alloy (Zr2.5wt%Nb). This material is somewhat stronger than Zircaloy-2, hence the tubes can have slightly thinner walls (0.16 inch vs. 0.2 inch) with a consequent improvement in reactor neutron economy and hence, fuel economy. Another feature of this alloy is that its deuterium uptake rate is very much lower than that of Zircaloy-2. Zirconium-niobium tubes removed from Bruce Unit 2 in 1982 showed very little deuterium absorption. Further support for this view of zirconium-niobium came recently (last March) when two pressure tubes were removed from the 22-year-old NPD demonstration reactor at Rolphton, Ontario. One tube was a Zircaloy-2 unit, resident in the reactor since start-up in 1962. The other was zirconium-niobium, installed in 1967. The Zircaloy-2 tube had, as predicted, hydrogen concentrations comparable to those found in the Pickering tubes. The zirconium-niobium tube had low concentrations — 15ppm. Both tubes were in sound condition and both garter springs were in the correct position and in good condition.

On April 20 Unit 3 at Pickering was shut down for scheduled annual maintenance. In the course of this work pressure tube J-09 was removed, and sent to the Chalk River Nuclear Laboratories on May 4. Visual inspection of the tube revealed indications of pressure tube — calandria tube contact, but initial results of the laboratory examination, show deuterium uptake levels to be low (in the range of 3.3-5ppm along the tube length).

Unit 3 has been in operation since 1972 and has accumulated 84,000 effective full-power hours of operation. These preliminary laboratory results, together with the evidence accumulated from other zirconium-niobium tubes, provide good grounds for confidence in the long-term performance of zirconium-niobium pressure tubes in the rigorous environment of a commercial power reactor.

Design and operating analyses have confirmed that a sudden pressure tube failure in a CANDU reactor, such as that which occurred on August 1, 1983, presents no public safety or worker safety concerns. The actual public safety and worker safety consequences on August 1 were zero.

Pressure tubes in Ontario Hydro CANDU reactors constructed after Pickering Unit 2 are of a material which, even given the disadvantageous situation of pressure tube — calandria tube contact, will neither absorb enough hydrogen nor develop large enough hydride inclusions to cause fast fracture.

Joint Studies Agreement Signed (University of Toronto)

The University of Toronto and the Korea Advanced Institute of Science and Technology (KAIST) have signed an agreement to cooperate in the field of nuclear engineering.

U of T President David Strangeway and Hak Ze Chon, President of KAIST announced May 10 that the two institutions will conduct joint study and research related to the peaceful use of nuclear energy. Areas of joint study will include reactor safety and control, thermalhydraulics, reactor systems design and operation and fuel and waste management technology.

The agreement provides for exchanges of faculty members, graduate students and research staff.

Bruce Unit 6 Critical (Staff)

Unit 6 at Ontario Hydro's Bruce B Nuclear Generating Station achieved its first self-sustaining nuclear chain reaction at 00:04, Tuesday, May 29. Reactor power level was maintained at about 0.1 percent of full power for days while reactor physics measurements were carried out. First steam to the turbine was supplied in early June, and first electricity is scheduled later in the month. The in-service date for the unit is January 1, 1985.

Dan Meneley Goes East (Staff)

One of North America's most respected nuclear scientists, Dr. Dan Meneley has been appointed to the newly-established Chair of Nuclear Engineering at the University of New Brunswick. Currently the Manager of Ontario Hydro's Nuclear Group, and an Adjunct Professor of Engineering Physics at McMaster University, Dr. Meneley will take up his new appointment August 1. He will be teaching undergraduate and graduate students and directing a research unit.

Sources at Ontario Hydro indicate that Dr. Meneley will be sorely missed — "It's a hell of a hole for someone to fill" one Hydro official told the *Bulletin*, "Meneley's a hard act to follow".

Occupational Exposure Levels Questioned Again (AIF)

On April 19 the Industrial Commission of the state of Colorado awarded $40,000 to the widow of a Rocky Flats weapons facility worker. The man, who died shortly after his retirement in 1974, is reported to have died of cancer of the colon and to have received less than the current exposure limits.

Prominent in the hearing was the evidence of Drs. Karl Morgan and Alice Stewart, both familiar names in the radiation debate. In Associated Press reports Morgan is quoted as saying that "they are operating at a level we set a quarter of a century ago. We did the best we could with the information available at the time. Since then studies have shown that radiation-induced cancer is much greater than we thought it was".

Atomic Industrial Forum data show that the risk of fatal injury from radiation in the nuclear industry is less than the risk of fatal injury in most other industrial enterprises and Nuclear Regulatory Commission data show that about 25 percent of the population develops cancer.

SLOWPOKE-3 To Be Built (Chalk Talk)

Construction of a 2MW demonstration reactor has been approved in principle by AECL senior management. The $4.5 million development program will demonstrate the production of hot water that could be used to heat several buildings at an AECL site and will also demonstrate electricity production using a small closed-cycle turbine. The pool-type reactor, named SLOWPOKE-3, is scheduled to start up in 1986.

Team coordinator Al Bancroft and his colleagues assessed the markets for a SLOWPOKE-3 for heat production in the 2-20 MWt range, as well as two other new electricity-producing reactors: the Super SLOWPOKE (0.2-2 MWe) and Small High Temperature Reactor (SHTR, 5 MWe). In all, five concepts were reviewed since three versions of SHTR were considered: a scaled-down presurized heavy water reactor, a scaled-down WR-1, and a scaled-up SLOWPOKE using an organic coolant.

The ultimate goal is to establish a profitable small reactor business that could eventually include a number of small reactors for heat, electricity, research and marine propulsion.

Canadian Nuclear Society Annual Report 1983-84

The 1984 annual general meeting of the Canadian Nuclear Society was held recently in Saskatoon in conjunction with the highly successful International Nuclear Conference reported elsewhere in this issue of the *Bulletin*. This meeting marked the fourth anniversary of the transition of the CNS from a *pro tem* organization to one with a duly elected council, whose leadership with the support of a small but dedicated membership, has fostered the vigourous development of the CNS.

The present-day CNS, in the tradition of the great learned societies descendant from the Renaissance, well serves the vital interests both of its members and of society at large. In a conspicuous demonstration of fulfilled objectives, the CNS in but a few years has become a facilitator of technical communications of significance on the local, national and international scales. In parallel with the experience of the earlier scientific societies, the collective knowledge and counsel of the CNS is increasingly realized within the governing and sustaining institutions of contemporary society.

As retiring President, it is my pleasant duty to comment on the state of the society and to report to the membership on the specific accomplishments which have furthered CNS objectives during the year culminating with the recent annual general meeting. This is also a time to acknowledge the personal contributions of the many officers, committee members, and CNS member volunteers who made it all possible. The report complements a similar accounting offered at the annual general meeting, which included the "changing of the guard" following the annual elections reported elsewhere (see photo below and CNS Council list, page 12). First of all, it is propitious that I acknowledge those who have lightened my current reporting task, namely the editors (David Mosey, Hugues Bonin, David McArthur) and other contributors who within the pages of the *CNS Bulletin* have provided excellent coverage of the many facets of CNS activities throughout the year. They have kept us informed and amused with various articles of interest, including those of increased technical content facilitated through the Technical Divisions. The six issues of the *Bulletin*, produced bi-monthly under the general direction of the Communications Committee, ensure an informed membership which is essential to the vitality of the organization.

An additional activity of the Communications Committee (under the Chairmanship of George Bereznai) has been to establish a scheme whereby the proceedings of CNS conferences are systematically marketed to the world's scientific and technical libraries through subscription or standing order. This activity will create immediate monetary return on current inventory and later a regular source of income for the CNS. To assist in maintaining editorial and production standards, an instruction manual for the convenience of conference organizers was developed.

To supplement the previous CNS consideration of introducing a "Nuclear Journal of Canada," an independent consultant was commissioned to examine feasibility. The consultant's report is now in hand and council's decision on the matter may be anticipated later in 1984. Public education continues as an area demanding careful attention by both the Communications Committee and the council. Steps have been taken to prepare the society for participation in continuing education programs, public hearings and panels.

Constitutional changes took place during 1983-84 in response to the evolution and maturation of the Technical Divisions. Beginning in the summer of 1984, each of the four technical divisions will be represented on the council by its Chairperson, rather than through the Technical Divisions Committee which now becomes obsolete. This step attests to the strength of the Technical Divisions on which much of the success of the CNS has depended, as well as to the skill and dedication of the succession of Chairman of the Technical Divisions Committee and its precursors (Wladimir Paskievici, Joe Howieson, and Irwin Itzkovitch) who fostered their development. The four current division names and assignments of subject areas effectively embraces the current interests of the CNS, but marginally augmenting the number of divisions to serve special areas of interest may occur in the near future. The advent of the journal would considerably expand the role of the Technical Divisions.

Following the long-term schedule of CNS-sponsored international conferences organized in turn by the different Technical Divisions, the International Conference on Numerical Methods in Nuclear Engineering, Montreal, September 6-9, 1983 (under the Nuclear Science and Engineering Division, with Riccardo Bonalumi as Division and Conference Chairman and John Griffiths as Program Chairman), drew outstanding contributions from a large cross section of countries and institutions. The ANS was co-sponsor. The International Conference on Containment Design (under the auspices of the Design and Materials Division chaired by Nabila Yousef) with Bill Morison as Conference Chairman, and Nabila Yousef as Program Chairperson, hosted wide international participation in Toronto, June 17-20, 1984, on a subject of intense current interest. To follow in Toronto on September 23-27, 1984, will be the International Conference on Robotics and Remote Handling in the Nuclear Industry (under the Mining, Manufacturing and Operations Division, chaired by Joe Howieson) with Bill Durant and Hugh Irvine as Conference and Program Chairmen, respectively. The next major conference which is to be organized by the Waste Management and Environmental Affairs Division (chaired by Eva Rosinger) will be the 1985 International Conference on Radioactive Waste Management, September 26-27, 1985, Winnipeg, under the Chairmanship of Eva Rosinger.

Other CNS sponsored events during the year included the Simulation Symposium on Reactor Dynamics and Plant Control (Nuclear Science and Engineering Division) held in St. John on April 9-10, 1984, with Neil Craik as Symposium Chairman, and

CNS Council 1984-85

Seated, left to right: Joe Howieson (Vice-President), Peter Sevens-Guille (President), John Hewitt (Immediate Past President). Standing, left to right, Gerry Lynch, Riccardo Bonalumi, Nabila Yousef, Fred Boyd, Phil Ross-Ross (Past President and CNS International Delegate), Eva Rosinger, Jim Weller. Not present: Richard Bolton, John Boulton (Secretary-Treasurer) Jan-G. Charuk, Ernie Card.

the Seminar on ASME III and its Relation to Canadian Requirements held in Toronto, October 4-5, 1983 (Design and Materials Division) and organized by John Martin.

In addition to its valuable coordinating role with respect to the above-mentioned events, the CNS Program Commitee with Nabila Yousef as Chairperson manages CNS involvement in a number of important conferences of which the CNS is a co-sponsor. Those events benefiting from specific contributions by the named individuals on behalf of the CNS are: 4th Pacific Basin Nuclear Conference, Vancouver, September 11-15, 1983 (Phil Ross-Ross, John Hewitt, Jim Weller); Workshop on Analytical Chemistry Related to Canada's Nuclear Industry, Hecla Island, Manitoba, October 24-26, 1983, (Phil Campbell); Topical Meeting on Financial and Economic Bases for Nuclear Power, Washington, D.C., April 8-11, 1984 (Rudi Sligl); Topical Meeting on Fission Product Behaviour and Source Term Research, Snowbird, Utah, July 15-19, 1984 (A. Muzumdar); International Topical Meeting on Fuel Reprocessing and Waste Management, Jackson Hole, Wyoming, August 26-29, 1984 (Eva Rosinger); International Meeting on Thermal Nuclear Reactor Safety, Karlsruhe, September 9-13, 1984 (Bill Penn, Dan Meneley); 3rd International Conference on Technology Transfer, Madrid, October 1985 (Nabila Yousef, Tom Carter, John Hewitt, John Boulton).

Of special interest this year was the CNA Student Conference on Nuclear Science and Engineering held at McMaster University on March 16-17, 1984 and co-sponsored by the CNS. The organizing group at McMaster included Eva Hampton and John Marczak who are also regular participants in the activities of the Toronto CNS Branch.

The Fifth Annual CNS Conference was held June 3-6, 1984, in Saskatoon under the Chairmanship of Irwin Itzkovitch. This year's conference, while being held in conjunction with the CNA Annual International Conference as in previous years, departed from the usual format of the separate CNS day in favour of CNS technical sessions operating in parallel with the sessions organized by the CNA and the Uranium Institute, the third co-sponsor of the main event. This experimental format well accommodated the special circumstances of locale, sponsorship, and the orientation of the conference theme towards uranium recovery. The CNS Annual Conference continues as our focal event of the year, attracting a wide cross-section of the membership and depending for its success on the technical divisions, the nearest branch, the various committees of council and the appointed Conference Chairman.

In addition to its role in coordinating CNS involvement in technical meetings, the Program Committee maintains and publishes regularly a list of upcoming events of interest to CNS members and others. Also, much progress has been made in the consolidation of documentation to effectively guide the organizers of CNS events.

The CNS maintains a high level of cooperation with related organizations at home and abroad. During the year, formal representation of the CNS was established on a number of committees of the Canadian Nuclear Association. These include the Technical Committee, the International Affairs Committee and the CNA Council, supplementing the CNS President's ex-officio position on the CNA Board of Directors and the CNS Annual Conference Chairman's participation on the CNA Annual Conference organizing committee. Last September, a formal CNS-ANS agreement to cooperate was signed in Vancouver, and the ensuing collaboration with the American Nuclear Society has already enhanced the opportunities of the CNS in a number of areas. A similar agreement was negotiated during the year with the Chinese Nuclear Society and a formal signing followed by specific joint activity is expected in late 1984. The CNS (through our International Delegate, Phil Ross-Ross), continues to play important roles in the affairs of the recently-formed International Nuclear Societies Group, including our hosting of the meeting of INSG held at the time of the Fourth Pacific Basin Nuclear Conference in Vancouver. The INSG concept for an International Commission on Nuclear Safety (see *CNS Bulletin*, Nov.-Dec. 1983) has been vigorously deliberated on in various fora, including the Zangger Committee of the INSG, and we acknowledge the contributions of Dan Meneley and Gary Vivian on behalf of CNS to this process.

The five existing CNS branches under the names, Chalk River, Manitoba, Ottawa, Quebec, and Toronto, sponsored a number of local technical functions during the year (see branch reports in various *Bulletin* issues), provided support for major program events held in their respective areas, and assisted with membership drives initiated by the Membership Committee. A new committee of council, the Branch Activities Committee, was established under the chairmanship of Ernie Card and created guidelines for branches in relation to the CNS as a whole. The branches are currently going through a period of reassignment of executive responsibilities, the original executives having served for a number of years. In collaboration with the Membership Committee, steps have been taken to establish new branches to serve members in the localities of Blind River, Bruce, New Brunswick and Vienna.

Recognizing in advance that the present downturn in the nuclear industry, and in the economy in general, would produce a secondary depression in CNS membership, the CNS Council supported Gerry Lynch and the Membership Committee in a vigorous campaign to obtain new members and reinstate lapsed memberships. The task has been a difficult one and the membership has been maintained at approximately 500. I extend a plea to all existing members to do their part to further strengthen our membership. My supporting message of one year ago as incoming President is even more relevant today, i.e., that the combination of social awareness and technical expertise, characteristic of the CNS membership, presents the CNS with both the capability and the obligation to become a social force assuring meaningful utilization of the products of our endeavours for the benefit of present and future societies. Our quest is arduous, but the company is good!

The financial status of the CNS council remains good, despite a disappointing return on membership fees. The annual operating budget is about $34,000 and our reserves amount to about $50,000 as the result of all conferences being financially successful, some exceedingly so! We are thus in a good position to undertake new, but sound, ventures. The CNS Council held seven (full-day) meetings during the year at various locations including Chalk River, Montreal, Ottawa, Saskatoon, and Toronto. The work of the council was faciliated by frequent meetings of an informal executive group consisting of the elected officers Tony Colenbrander, John Hewitt and Peter Stevens-Guille. Now that the council has been widened to include the Technical Division Chairman and the International Delegate, along with the (generally) elected members, a more formally constituted executive group is likely. An exceptional contribution has been made to the work of the CNS by Tony Colenbrander, who having served for four years as first Membership Chairman and then as Secretary-Treasurer, is retiring from council this year. Unfortunately, space does not permit me to acknowledge the contributions made to the work of the society by the dozens of members serving on the standing, branch, technical and conference committees; they can be assured that their efforts, and the consideration and support of their employers, are known and appreciated. Finally, the excellent support provided to the many active members of the CNS by the staff of the CNA/CNS headquarters is gratefully acknowledged.

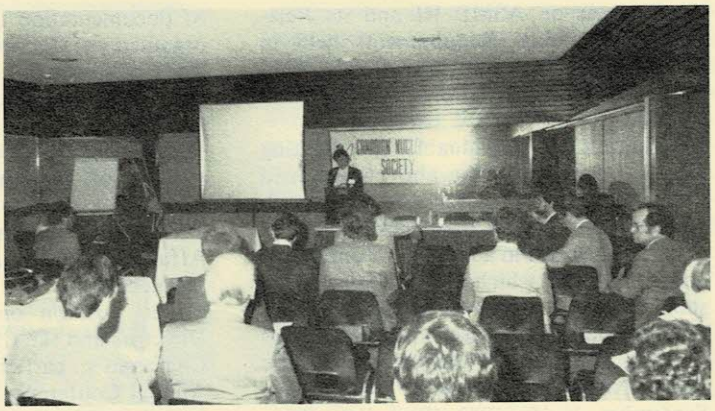
John S. Hewitt,
CNS President, 1983-84.

Annual reports of the CNS Committees are available on request to CNS members from the CNS office.

Saskatoon Conference Report

Saskatoon hosted the International Nuclear Conference June 3-6, with the theme "Electricity and Uranium — A Brighter Future." The conference was sponsored by the Canadian Nuclear Society, the Canadian Nuclear Association and the

Eva Rosinger chairs the CNS session "Tailings and Reactor Waste Management" at the CNS 5th Annual Conference, held in Saskatoon Centennial Auditorium, June 1984.



Gerry Lynch (facing front), CNS Membership Chairman in charge of the CNS membership display (in its latest arrangement) at the International Nuclear Conference in Saskatoon.

England-based Uranium Institute, each sponsor with its own parallel sessions, which included the 5th Annual Conference of the CNS and the 24th Annual International Conference of the CNA.

The conference as a whole attracted 58 speakers from 13 countries and well over 400 delegates to the Saskatoon Centennial Auditorium. In addition to the papers presented the program included visits to uranium mines in Northern Saskatchewan as well as a rodeo and barbecue on a prairie ranch.

Energy ministers from two provinces gave luncheon addresses: Ontario Energy Minister Philip Andrewes and Paul Schoenhals, Saskatchewan Minister of Energy and Mines.

CNS sessions dealt with the technical aspects of the Canadian nuclear program, with reactor modelling and analysis, new nuclear technologies, and tailings and reactor waste management. Individual topics covered included CANDU loss of coolant (LOCA) research, recycle of light water reactor (LWR) uranium in CANDU reactors, decommissioning of Beaverlodge uranium operations and a Gentilly-1 reactor dismantling proposal. Full proceedings of these CNS papers will be published soon.

Chairman of the "Modelling and Analysis" session was Riccardo Bonalumi and Co-Chairman was John Waddington; Chairman of the "Nuclear Technologies" session was Nabila Yousef and Co-Chairman was John Webb; and Chairman of the "Tailings and Reactor Waste Management" session was Eva Rosinger, Co-Chairman was Joe Howieson.

Uranium Institute and CNA session titles were "Electricity in Demand," "Nuclear Power: A Leading Competitor," "Nuclear Electricity in Canada," "International Nuclear Policy Overviews," "CANDU in International Markets," "Nuclear Power Supply: The Future Perspective," "International Uranium Production" and "Issues in the Nuclear Fuel Cycle." Speakers included Bernard Cohen of the University of Pittsburgh dealing with "Risks in Perspective."

Peter Stevens-Guille, of Ontario Hydro, formerly CNS Vice-President, succeeded John Hewitt, U of T, as CNS President, and Joe Howieson of EMR Canada becomes CNS Vice-President. The new CNA Chairman for 1984-85 is Hal Dickout, Vice-President and General Manager, Power Systems Dept. with Canadian General Electric Co. Ltd. He succeeds Roy Lloyd, Chairman of Saskatchewan Mining Development Corp., who was a sponsoring Co-Chairman of the INC with A.J. Grey, Chairman of the Uranium Institute and of Pancontinental Mining Ltd.

CNA award winners for 1984 were Larry Woodhead, winner of the Ian McRae Award, and Dr. Franc Joubin, winner of the W.B. Lewis Medal. Woodhead is head of Ontario Hydro's new Technical and Training Services Division and former station manager of NPD and Pickering A N.G.S., and Joubin is the geologist who discovered the huge uranium deposits of the Algoma/Blind River area of Ontario.

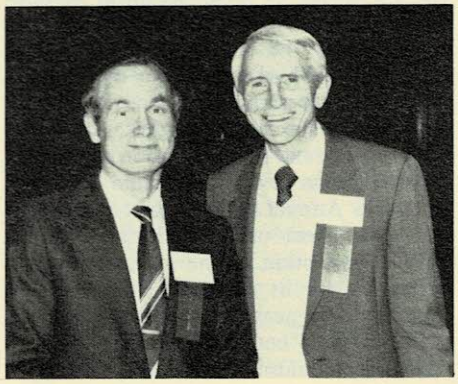
The CNS Conference Chairman was Dr. I. Itzkovitch of Eldorado Resources Ltd. Cassette audiotapes of the CNA, CNS or Uranium Institute sessions as well as most individual presentations are available from Say It Again Recording Services, 750 Delaronde Crescent, Saskatoon, Saskatchewan, S7J 3X9. Copies of most CNA and Uranium Institute papers are available at cost from the CNA/CNS office.

Staff

Containment Design Conference Report

Over 100 delegates from 9 countries attended the CNS conference on containment design at Toronto's Westin Hotel, June 18-20. As noted in the introduction to the conference program, containment design, and the question of a containment system's ability to accommodate very severe accidents, transcend reactor types and international boundaries. This was borne out in the three plenary sessions when, comparing the perspectives from Europe, the US and Canada, it was clear that there was a remarkable degree of agreement across international and technical boundaries. Not unexpectedly, there was a certain amount of disagreement (or debate) *within* those boundaries between the designers and operators on the one hand, and the regulatory bodies on the other.

Opening the session on the US perspective, Anthony Buhl, Vice-President, Technology for Energy Corporation, outlined some of the conclusions reached in the course of the IDCOR (Industry Degraded Core Rulemaking) program. A general observation, Dr. Buhl noted, was that containment was highly tolerant, analyses suggesting that ultimate containment strength appeared to be 2 to 4 times design. Prompt containment failure was extremely unlikely, Dr.



Peter Stevens-Guille (left) new CNS President, with Joseph Hendrie, new President of American Nuclear Society and former Chairman of US Nuclear Regulatory Commission, at CNS Containment Design Conference, Toronto, June 1984.

Buhl said, pointing out that steam explosions of sufficient energy to fail containment were simply not realizable. This implies, in even the most severe accidents, a long time before containment failure pressures would be reached, giving scope for operator intervention. Dr. Buhl emphasized that findings thus far indicated a considerably more important role for operators in dealing with severe accidents than has hitherto been allowed for. As for melt-through of the containment base-mat, Dr. Buhl noted that this was simply not a significant possibility — "the China Syndrome is a myth" he said.

In summary, Dr. Buhl indicated that there existed few sequences of events leading to containment failure, and these were of low probability. Known physical phenomena precluded early containment failure, giving time for operator action, fission product reduction and emergency measures. Urging that more attention be paid to the evaluation of operator intervention during severe accidents, Dr. Buhl concluded by pointing out that regulatory stability was a requirement for a future for the nuclear power option.

Speaking for the US Nuclear Regulatory Commission, Dr. Frederick Bernthal opened his presentation by pointing out that despite what he called "unprecedented demands for reliability and public accountability" the nuclear program in the US had been a stupendous success. By 1990, he noted, 130 nuclear plants in the US would be supplying 20 per cent of that country's electricity demand.

Dr. Bernthal did allow that institutions in the US — including the regulatory authority — had not always worked the way they should, but was quick to point out that the NRC should not be perceived as a "bottleneck." There were, he said, 30 new plants due to come on-line in the next 6 years. Some of these would have construction times of 7 years or less, and some over twice that time. Some would cost $1500/kW(e) installed, and some $4000/kW(e). Yet all these plants were being regulated by one body. These dramatic differences could have a number of causes, he suggested, such as varying degrees of management competence. The higher costs did not demonstrate the death of the nuclear industry in America, but rather the fact that "time is money."

Dr. Bernthal reminded his audience that the NRC did not exist to see that "those plants are built right," but rather that "they are not built wrong." Excellence was the responsibility of the industry, he said — adequacy that of the regulatory body. He added that the legislation upon which the NRC was based called for the imposition of "the minimum amount of regulation to protect public health and safety."

Following up on some of Dr. Buhl's points, Dr. Bernthal noted that the NRC was preparing a new policy statement on severe accidents and preparing a new study on source terms. Draft safety goals are on trial until the end of 1985, he said, by which time it could well be that the NRC would "require not a great deal more containment regulation, but a great deal less."

The session on the European approach to containment design and regulation was chaired by the UK Atomic Energy Authority's Anthony Edwards. As Mr. Edwards pointed out, with regard to the British situation, he was in the position of having to construct bricks with virtually no straw, in view of the fact that the Sizewell enquiry was still in progress — and what was more, such bricks as he could produce would have to be considered as unofficial. However he did outline the approach to regulation in Britain, and related this to containment-specific analyses related to the pressurized water reactor — the system currently under consideration at the Sizewell enquiry.

In Britain, Mr. Edwards noted, the Nuclear Installations Inspectorate has issued "guidelines" on nuclear design, the main objective of which is to ensure that nuclear plants do not produce "any significant hazard." "Large" releases of radioactivity from any installation must have a frequency of 10^{-6} per reactor year, though the expression "large" has not been defined. The Central Electricity Generating Board (CEGB) has adopted the standard US approach, Mr. Edwards said, of evaluating the design basis accident (large break LOCA for example) in its Preconstruction Safety Report, prepared to support the application for a construction licence. The Nuclear Installations Inspectorate, however, had felt there was need for some assurance that the design basis accident did not sit "on the edge of cliff," in that very large (catastrophic) releases might take place as the result of an event just beyond the DBA. This concern had prompted the CEGB to ask Westinghouse to carry out a further study of the probabilities of beyond DBA and containment failure and the results of this study, Mr. Edwards said, indicated a frequency of core melt of 1.2×10^{-6} per reactor year, with containment failure taking place in 4-5 per cent of these cases.

Mr. Edwards emphasized that more than three-quarters of these failures would be in the form of *containment by-pass*, such as lift-valves failing to reseat. Also a National Radiological Protection Board study, using source terms from the Westinghouse study, as well as UK data, estimated that 95-98 per cent of public risk arises from containment by-pass, Mr. Edwards said.

Mr. Edwards noted that studies thus far had considered only internal events and the Nuclear Installations Inspectorate had requested that some attention be paid to external events such as earthquakes or aircraft impact. This latter event has particular relevance to the Sizewell site, Mr. Edwards said, pointing out that there were two military air corridors one to the north and one to the south of the Sizewell site, there was a military low-flying area just off the east coast, and two RAF aerodromes within 20 miles of the site. He noted this point was emphasized during the Sizewell proceedings when, at not infrequent intervals, conversatons were drowned out by the passage overhead of low-flying RAF jets!

Mr. Edwards concluded by noting that while other European countries had expressed the view that beyond DBA analysis had been pursued as far as was reasonable, in the UK it was felt that containment bypass seemed so important that "we may be forced to look at it again," and that external events might also require some attention.

The perspective from West Germany was provided by Dr. H. Hennies from the Nuclear Research Centre, Karlsruhe. Dr. Hennies noted that West Germany's nuclear power program, based around the pressurized water reactor, called for a future installed nuclear capacity of 24GW (compared with a present level of 12GW) providing 40-50 per cent of the country's electrical energy. The PWRs were standard 1300MW KWU units (the "konvoie koncept"). The units use double containment — with the reactor enclosed by a 56m diameter by 38mm thick steel shell which in turn is enclosed by an outer concrete structure of 1.8m wall thickness. The DBA assumed the "classic" double-ended guillotine pipe break and a release to containment of 10 percent noble gases, 0.1 percent alkali metals and .0001 percent solids.

Containment design pressure was 92 psi (6.3 bar), Dr. Hennies said, however the maximum calculated pressure to which the containment could be subjected was about 82 psi (5.57 bar). This should be contrasted, Dr. Hennies emphasized, with the "best estimate" for pressures reached of 61 psi. This conclusion had been reached through experimental work on scale models in 1969 — it was clear, he noted, that "computer codes used in general licensing practice contain highly conservative assumptions and have resulted in an extraordinarily high safety margin in containment dimensioning."

Over the long term, Dr. Hennies pointed out, the main contributor to hydrogen generation would be radiolytic production. Local high hydrogen concentrations would be dissipated by forced mixing using circulating blowers, and hydrogen would be removed using recombiners.

Dr. Hennies was at pains to point out that while he agreed with previous speakers that the China Syndrome (known in West Germany as the New Zealand Syndrome) was a myth, it must be remembered that a degraded core situation was "almost an uncontrollable situation" and that if "you assume you reach this (degraded core) you also have to assume complete melt." With this in mind, Dr. Hennies noted, melt erosion of concrete would eventually lead to contact between melt and sump water, resulting in containment pressure increase — design pressure could be reached after 5 days, he suggested, leading to a most probable containment failure at the large material access hatch. This 5 day delay was an

important consideration, he noted, not just for instituting any necessary emergency procedures, but also for aerosol decomposition. Again, here Dr. Hennies echoed earlier comments about the over-conservatism of some source terms calculations — an earlier German risk study, he noted, assumed containment failure after 27 hours leading to the release of $6x10^3$ Ci of Cs-137 and 10^6 Ci of I-131. This should be contrasted with the latest calculations (assuming a 300 cm^2 (46 in^2) hole in containment) of 8 Ci Cs-137 and 10^4 Ci I-131.

Dr. Hennies said that there was great confidence that the West German containment system could absorb very severe hypothetical core melt accidents with minimal offsite radiological effects. Following completion of current work, he noted, no further experiments were planned and further work was deemed unnecessary.

Outlining the Canadian regulatory perspective on containment design, the Atomic Energy Control Board's Zygmond Domaratzki noted that regulatory requirements in Canada had evolved over the years, but stemmed from the basic single and dual failure criteria. Until about 10 years ago, Mr. Domaratzki reminded the conference, the assumption had been that a single process system failure such as a large break LOCA would not be accompanied by any significant fuel sheath failures. However later reviews, completed in 1975, indicated that most LOCAs would cause extensive fuel failures, hence containment design was reviewed. It was noted that in the event of a dual failure (LOCA plus containment impairment) reference dose limits could be exceeded, so a wide variety of containment impairments (such as airlock open, dampers open etc) have been analysed. Additionally, work has gone on to reduce the probability of containment impairment (by, for example, installing alarms on air lock door seals) and improve post-LOCA operation through such measures as shielding and installation of filtered air discharge systems.

A great deal of emphasis in Canada, Mr. Domaratzki noted, was placed on *demonstration*, as far as practical, that containment systems meet minimum requirements, and he cited the requirement that containment proof testing be done very late in any project and the testability/checkability of vacuum containment system as features of this approach. The question of testing and demonstration, Mr. Domaratzki noted, was one area where opinions differed between the Control Board and its licensees — there was not, he pointed out, an agreed answer to the question "how comprehensive can a test be and yet still be practicable?"

While the performance of containment systems in Canada this far gave good grounds for confidence — the availability record for 1983 was particularly good — Mr. Domaratzki identified several problem areas — especially in the field of testing. A major uncertainty, he noted, was the absence in Canada of a comprehensive program for doing in-service leak tests. Identifying three categories of leak tests — on-power leak tests of major penetrations, on-power leak tests of the entire envelope and periodic leak tests at design pressure — Mr. Domaratzki noted that only the first had been implemented so far, and in some cases even this was token. Ontario Hydro had demonstrated the feasibility of on-power leak tests but such tests were not being done at the 600MW CANDU units. Only two units, Douglas Point and Gentilly-1, had ever been tested at design pressure, Mr. Domaratzki pointed out, and neither of these units had passed. "Tests at design pressure are not an encouraging picture in this country," he said, adding that tests at lower than design pressure had not been extensive. Admitting that there was an understandable reluctance on the part of operators of large multi-unit stations to incur the high costs implied by full-scale tests to design pressure, Mr. Domaratzki suggested that these were costs "which should have been allowed for at the outset."

Mr. Domaratzki also expressed concern about the inflow of instrument air to containment following a LOCA. This works against the negative pressure containment principle, Mr. Domaratzki argued, and would in time require containment venting to preclude later uncontrolled releases — though this would take some days at the Pickering and Bruce installations. "I don't think it appropriate to design a very good containment system, then build in something that works against it," Mr. Domaratzki said, adding that the board was in touch with Pickering and Bruce and it was expected that the situation would be remedied.

Mr. Domaratzki concluded by suggesting that requirements for in-service leak testing could be included in future licenses, and that he hoped these would demonstrate that containments were as good as they were expected to be, "we need to make sure that we have the continued efforts of designers and operators who are committed to the concept of defence in depth."

The CANDU-600 single unit containment system was described by John Webb from AECL Engineering Company. He pointed out that the containment design pressure of 18 psig was about twice the predicted overpressure resulting from a LOCA and added that experiments on models had shown cracks first appearing in the concrete at 2.5 times design pressure, followed by failure (if indeed pressure rise was not terminated by leakage through the cracks) at 77 psig. Leak tests revealed a leak rate of 0.3 percent building volume/day — above the 0.1 percent target, but below the 0.5 percent rate assumed in safety analyses.

Optimum use of dousing water was obtained by arranging the dousing water valves to close when internal pressure dropped to 1 psig (they open at 2 psig). Since the consequences of a spurious douse were severe in economic terms, Mr. Webb noted, the valves were arranged to close on air failure, although the consequences of a spurious douse had been analysed, the results of this analysis confirming that even under such disadvantageous conditions the reactor could be shut down safely. Availability of a filtered air discharge system, together with the ability to isolate the instrument air system (a point raised in the previous presentation) provided greater flexibility to cope with extremely severe accidents, Mr. Webb said, reminding his audience that core melt "is not a consideration in CANDU."

Hydrogen igniters were not used in the 600 units, Mr. Webb pointed out, since the building volume would preclude hydrogen concentrations of 4 percent or greater, save in the reactor vault where concentrations of about 6 percent might be expected. However the air circulation provided by the building air coolers, it was anticipated, would keep concentrations below the level at which deflagration or detonation would occur. "We don't think we need anything," Mr. Webb said, "but we are keeping the subject under review."

Responding to questions, Mr. Webb emphasized that main stream isolation valves were not called for in the CANDU design, citing in support of this contention the "clean" condition of the PHT water, the very sensitive leakage detection system used (because of the cost of D_2O) would catch steam generator tube leaks at a very early stage, the relatively low PHT system pressure which would mean that the make-up system could accommodate tube failure and the excellent record of steam generator performance in all commercial CANDU units. Mr. Webb pointed out that in the unlikely event of a large steam generator tube failure, it would be rapidly detected and would not impede the orderly shut down of the reactor and transfer to the shut-down cooling system.

In his presentation on the multi-unit negative pressure containment system, unique to the CANDU units operated by Ontario Hydro, Dan Meneley paid particular attention to the problem of repressurization of containment by instrument air inflow. This, he pointed out, was a long process — up to 10 days — a period which gives the operators plenty of time to take action. "It's very difficult to persuade an operator to give up control of his unit," Dr. Meneley said, adding that "we should give an operator as much control as possible." It was the philosophy behind this comment which informed much of Dr. Meneley's presentation — having dealt with the physical details of the negative pressure containment system, Dr. Meneley was at pains to emphasize the fact that an engineered system does not exist in isolation — it is after all designed, operated and regulated by human beings, and surely attention should be paid to this fact. The system must be managed properly, Dr. Meneley said, adding that human errors were by no means confined to the field — many are made at a desk.

Dr. Meneley re-emphasized that safety did not depend on the number or degree of elaboration of gadgets added to an

already elaborate system — indeed if one were not careful one could find oneself in the position of having too many gadgets for safety. In the lively panel discussion period following, the question of instrument air inflow and consequent containment re-pressurization leading to containment venting via the filtered air discharge system was again raised, with Mr. Domaratzki making the point that he felt there was room for improvement in the instrument air situation at Pickering and Bruce. Dr. Meneley agreed that containment venting might produce perceptual problems — "it's a difficult political situation," he said, adding that from a scientific public safety viewpoint the actual consequences of venting were "trivial."

David Mosey

CNS Simulation Symposium Report

The 10th Annual Symposium on Simulation of Reactor Dynamics and Plant Control was held on April 9-10, 1984 at the Delta Hotel, Saint John, New Brunswick.

This symposium was sponsored by the Nuclear Science and Engineering Division (NSED) of the Canadian Nuclear Society and covered many aspects of CANDU nuclear power plant modelling and simulation.

This was the first meeting of the CNS to be held in New Brunswick. The location of the meeting recognized the importance to the Canadian nuclear industry of the Point Lepreau-1 600 MW Nuclear Generating Station owned and operated by the New Brunswick Electric Power Commission, and which has been in successful operation for over a year. New Brunswick is also the location of Maritime Nuclear, a joint undertaking by AECL and NB Power, investigating the commercial feasibility and pre-planning of a possible additional CANDU 600 unit at Lepreau.

Thirty-seven papers of a high standard of technical content were given. There were over 70 attendees, with groups of representatives from AECL, Ontario Hydro, Hydro Quebec, the Group d'Analyse Nucleaire (GAN) de l'Ecole Polytechnique de Montreal, and from the NB Power Nuclear Operations Group.

The program also included a visit to the Lepreau-1 CANDU 600MW Nuclear Generating Station.

The guest speaker at dinner was A.J. O'Connor, General Manager of the New Brunswick Electric Power Commission, who gave an excellent talk illustrated by slides on "Nuclear Power in New Brunswick — Progress and Opportunities."

The organizers of the symposium were:

General Chairman and Local Organizer: Neil Craik, Canatom Inc., attached to Maritime Nuclear, Fredericton; Technical Program Chairman: Pierre Mercier, Hydro Quebec; Technical Program Co-Chairman: Augustin Brais, Groupe d'Analyse Nucleaire — Ecole Polytechnique de Montréal; Chairman NSED: Riccardo Bonalumi, University of Toronto; Publicity: Diane Waechter, CNA/CNS Office, Toronto.

Administrative support was received from the New Brunswick Electric Power Commission and Maritime Nuclear.

Altogether, it was a very successful symposium which augers well for the establishment of a significant branch of the CNS in New Brunswick.

Neil Craik

Interfaith Program for Public Awareness of Nuclear Issues (IPPANI)

A series of week-long hearings will be held in Toronto on: Canada's Domestic Nuclear Issues (Oct. 29 - Nov. 2); Canada's International Nuclear Trade (Nov. 12-16); and Canada's Involvement in Nuclear Arms (Nov. 26-30). The purpose is to "identify those ethical and moral issues pertaining to Canada's nuclear policies with which we must struggle, both as religious faith groups and as citizens of Canada." The above agenda and quote is from an invitation the CNS has just received from IPPANI, which represents the Anglican, Baha'i, Jewish, Roman Catholic and United Church faiths. Concerned CNS members may express their views to the panel to be appointed by IPPANI, to counterbalance those opposing nuclear science and technology who have been invited. Contact: IPPANI, 85 St. Clair Ave. E., Toronto, Ontario, M4T 1L8, or call Judy Langstaff, (416) 884-6759. The CNS is likely to submit a brief to the first two hearing weeks. If you are interested in contributing, contact Fred Boyd, (613) 996-2843.

Peter Stevens-Guille
CNS President

CNS Branch Programs

Toronto Branch

On May 30, Dr. McCready, an Associate Professor in the Department of Biology at Dalhousie University, Halifax, spoke to the Toronto Branch on "Microorganisms: Friend or Foe of the Mining Industry?" He dealt with optimization of bacterial leaching of uranium as well as other applications of microorganisms, such as in the desulphurization of coal.

The Toronto Branch nominating committee has received a nomination for each of the three named positions:

Chairman	R. Abel, AECL
Deputy Chairman	T. Lassau, ORF
Secretary-Treasurer	A. Habayeb, Ontario Hydro Research

However, the positions of members-at-large are still undecided. I wish to extend a personal invitation to all Toronto Branch members who wish to see the activities of the Toronto Branch continue as in the past (or those who wish to see the direction completely change!) to telephone me concerning these undecided positions as soon as possible at 823-9040 x3560.

A. Guthrie
Past Chairman

Conferences & Meetings

International Meeting on Fuel Reprocessing and Waste Management

Sponsored by Canadian Nuclear Society and American Nuclear Society et al., to be held **August 26-29, 1984** in Jackson Hole, Wyoming. For information contact: **Eva Rosinger, Whiteshell Nuclear Research Establishment, Pinawa, Manitoba, R0E 1L0.**

5th International Meeting on Thermal Nuclear Reactor Safety

To be held **September 9-13, 1984,** in Karlsruhe, West Germany, sponsored by the European Nuclear Society, the American Nuclear Society, the Canadian Nuclear Society and the Japan Atomic Energy Society. For information contact: **H. Rininsland, Kernforschungszentrum Karlsruhe, Postfach 36-40, D-7500 Karlsruhe 1, FRG;** or **Bill Penn, Ontario Hydro, 700 University Ave., Toronto, Ontario, M5G 1X6.**

Conference on Structural Engineering in Operating Nuclear Facilities

Sponsored by American Society of Civil Engineers et al., to be held **September 10-12, 1984,** in Raleigh, North Carolina. For information contact: **North Carolina State University, Division of Continuing Education, P.O.B. 5125, Raleigh NC 27650.**

Tritium Safe Handling Course

Sponsored by Canadian Fusion Fuels Technology Project, to be held **September 17-21, 1984** in Toronto and Chalk River, Ontario. For information contact: **CFFTP, 2700 Lakeshore Rd. W., Mississauga, Ontario, L5J 1K3.**

International Conference on Robotics and Remote Handling in the Nuclear Industry

Sponsored by Canadian Nuclear Society, co-sponsored by: Canadian Society for Mechanical Engineering and the American Nuclear Society. To be held at the King Edward Hotel, Toronto, Ontario, **September 23-27, 1984.** For information contact: **H.S. Irvine, Ontario Hydro, 700 University Avenue, Toronto, Ontario, Canada M5G 1X6.**

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Jan-G. Charuk (514) 934-4811

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Jim Weller (416) 977-6152

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Quebec	**Contact/Responsable**	(514) 934-4811 x334
Ottawa	Frank McDonnell	(613) 237-3270
Toronto	Ruby Abel	(416) 823-9040
Manitoba	Ernie Card	(204) 956-0980

CNS 1985 Annual Conference Chairman / *Président de la conférence annuelle de la SNC (1985)*
Peter French (613) 996-9947

International Conference on Occupational Radiation Safety in Mining

Sponsored jointly by CNA, EMR Canada and AECB; co-sponsored by CNS et al. To be held **October 14-18, 1984** in Toronto, Ontario. For information contact: **R.D. Gillespie, Program Chairman, Radiation in Mining Conference, c/o MacLaren Engineers Inc., 33 Yonge Street, Toronto, Ontario, Canada, M5E 1E7.**

Annual Reliability and Maintainability Symposium

Sponsored by ASME et al., to be held **January 22-24, 1985**, in Philadelphia, Pennsylvania. For information contact: **H.C. Jones, Westinghouse Electric Corp., MS 3608, P.O. Box 1521, Baltimore, MD 21203.**

International ANS/ENS Topical Meeting on Probabilistic Safety Methods and Applications — Call for Papers

Sponsored by the American Nuclear Society, co-sponsored by the Canadian Nuclear Society et al., to he held **February 24-28, 1985**, in San Francisco, California.

The theme of the meeting will be the application of probabilistic methods to enhance the design and operation of facilities related to nuclear power. Papers describing new methodological developments and applications are encouraged.

Papers and sessions will include the following topics:

- Applications: Utility operation, regulatory response, technical specifications, Plant design and design modifications, Decisions by regulatory authorities, Economic risk, Experience to date: what has been learned?
- Safety Assurance Methods: Establishing safety reliability performance targets, Programs to demonstrate and maintain safety performance.
- Systems Analysis Methodology including dependent events, human interactions, sensitivity/uncertainty, external hazards and effects, benchmark exercises, data bases, computer aids for systems analysis, standardization.
- Consequence Analysis Methodology including physical processes, radionuclide source terms, atmospheric dispersion and health effects, emergency response planning, standardization.

Summaries and abstracts are due **September 4, 1984**, papers are due **December 14, 1984.** For further information contact: **Ian B. Wall, Electric Power Research Institute, 3412 Hillview Ave., P.O. Box 10412, Palo Alto, California 94303.**

Second National Topical Meeting on Tritium Technology in Fission, Fusion and Isotopic Applications — Call for Papers

Sponsored by American Nuclear Society and co-sponsored by Canadian Nuclear Society, to be held **April 30 - May 2, 1985** in Dayton Ohio.

Papers are solicited emphasizing experience or experiments related to the fuel cycle, tritium generation and experiments related to the fuel cycle, tritium generation and management, and source terms in fission and fusion reactors; environmental studies, release modeling, HT/HTO conversion and dose assessments; materials interactions, hydrides absorption/desorption; monitoring and measurement techniques; containment and control, lab/plant design, waste management, transportation, systems and equipment, accountability; research and development, labeling, physical and chemical properties, health effects. Deadline for summaries: **October 1, 1984.** Final paper deadline: **March 15, 1985.** For further information contact: **Program Chairman Michael L. Rogers, Monsanto Research Corporation, P.O. Box 32, Miamisburg, Ohio 45342.**

25th Annual International Conference of the CNA and 6th Annual Conference of the CNS:

Co-sponsored by Canadian Nuclear Society and Canadian Nuclear Association, to be held **June 2-5, 1985** in Ottawa, Ontario. For information contact: CNS.

The Unfashionable Side

Neutron Registry Proposed

A federal government department has recently proposed a compulsory neutron registry as part of a move to increase control of nuclear matters. As originally conceived by a committee of the Association of Solar Laboratories for Ephemeral Energy Production (ASLEEP), the proposed code of neutron registration would require any provincial electrical utility which runs a commercial nuclear reactor to register all neutrons produced during power operation. Operators at the plant would monitor flux detectors from the control room and fill out the appropriate forms, one form per neutron, in quintuplicate. The forms would record neutron location, direction, speed, energy, temperature, cost, lifetime expected, and would assign an identification number which would uniquely identify the neutron for further reference. Some modification to flux detectors would probably be required. While the initial reaction of representatives of provincial utilities was one of disbelief, one federal official contacted expressed alarm at the existence of unregulated neutrons, indicating that his department was also taking a hard look at quarks, neutrinos, pi mesons, etc. with the goal of requiring the registration of these as well. When informed of these developments, an industry spokesman was heard to grumble "Hell, the sky's full of them (neutrons). I wonder if these clowns really know what they're doing."

Chuck Wood