CANADIAN NUCLEAR SOCIETY

bulletin

DE LA SOCIÉTÉ NUCLÉAIRE CANADIENNE

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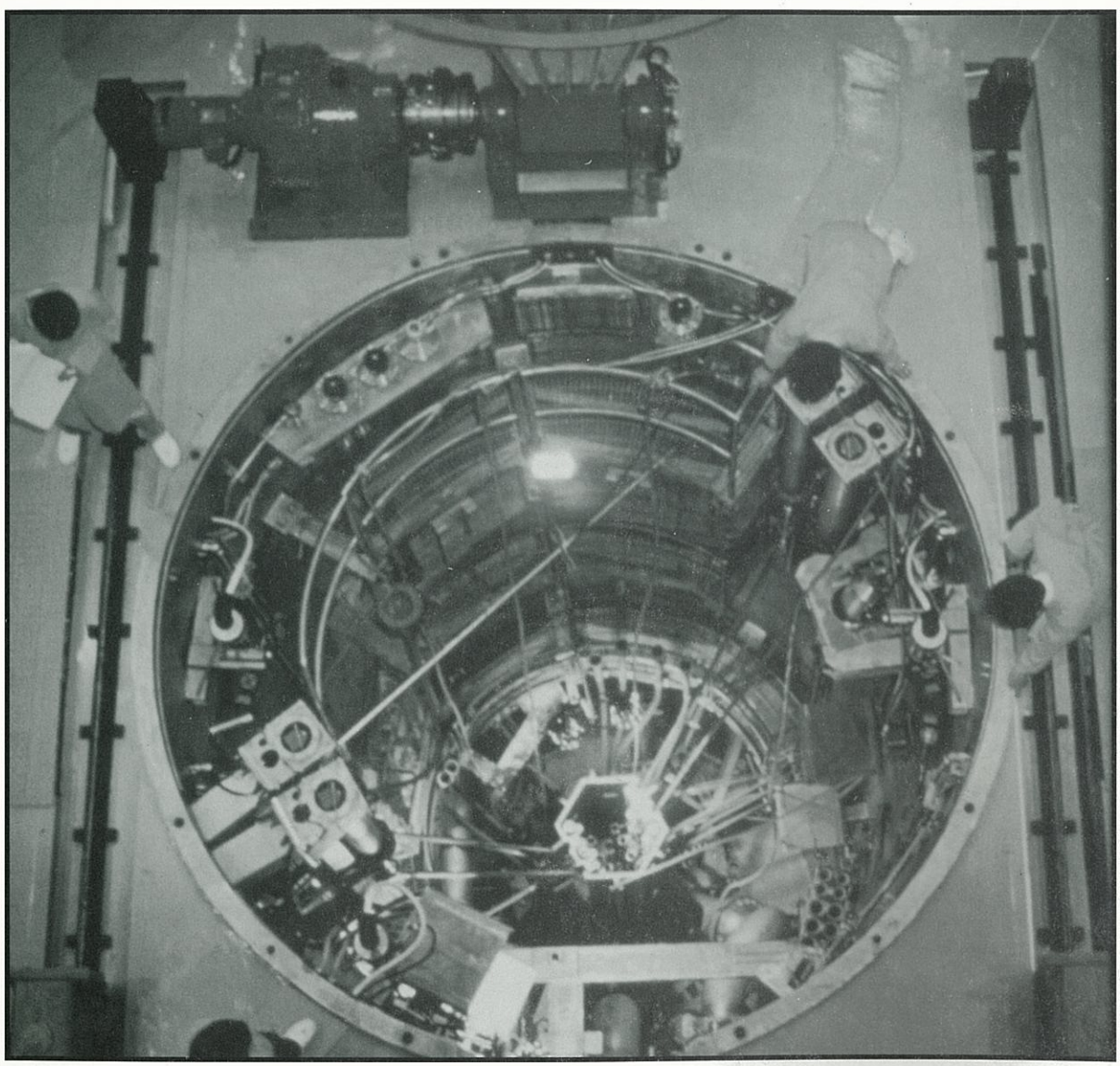

- CNA/CNS Annual Conference
- CANDU Fuel Handling Conference
- COG Safety and Licensing Seminar
- Nordion's MAPLE Reactors

Contents

Cover Illustration

The cover photograph shows a top view of the core of the HANARO reactor which is basically a MAPLE design.

(Photo courtesy of AECL)

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Le Bulletin SNC *est l'organe d'information de la Société Nucléaire Canadienne.*

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.
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La SNC procure aux Canadiens intéressés à l'énergie nucléaire un forum où ilf peuvent participer à des discussions de nature technique. Pour tous renseignements concerant les inscriptions, veuillez bein entrer en contact avec le bureau de la SNC, les membres du Counseil ou les responsables locaux. La cotisation annuelle est de 60.00$, 35.00$ pour les retaités, et 20.00$ pour les étudiants.

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EDITORIAL

INTERESTING TIMES

The past few months have been active ones for those in the Canadian nuclear industry - not only in the many meetings reported in this issue of the CNS Bulletin but especially in the progress that has been made on a number of fronts.

The agreement finally reached between Nordion and AECL (and the Government of Canada) brings a sigh of relief to many of us who feared for the future of Canada's leading role in medical radioisotopes. It is essential now that the construction of the two planned MAPLE isotope producing reactors at Chalk River proceeds without delay. While the operators of NRU have done a marvellous job in keeping that ageing reactor going they cannot be expected to create miracles and the production of Molybdenum 99, the most extensively used medical radioisotope, must, because of its short half-life, be continuous . Unless AECB regulatory hurdles and environmental assessment challenges are overcome quickly the project could be seriously delayed. Let us hope that all involved realize the magnitude of the stakes involved.

Another positive note in the period was the announcement of the "Project Award Agreement" for the construction of two CANDU units in China. As was pointed out by several at the CNA/CNS Annual Conference, the near-term future of the Canadian nuclear power industry depends on exports. The Chinese are expert bargainers and despite this milestone agreement the final steps to an actual contract will not be easy.

The fact that several of the Pickering units have returned to operation is somewhat reassuring but the extended delay in restoring the entire station to its once leading position remains disturbing. In looking at Ontario Hydro Nuclear in a broad context, an observer wonders at a corporation, after cutting its staff drastically (and essentially destroying its "corporate memory") now advertising for staff. The vision of the corporation's management sometimes appears myopic.

Another observation that is unsettling is to see the many licensing issues, as reviewed at the COG seminar, continuing on for years. The combination of the incessant desire of AECB staff to ask more and more detailed questions and the reluctance of researchers to close off their studies leads to huge expenditures and waste of talent and resources that could be applied more usefully on forward developments. Perhaps some incisive "cost-benefit" analysis would be in order.

These continue to be "interesting" times for the Canadian nuclear community.

IN THIS ISSUE

This issue of the CNS Bulletin presents reports on, and papers from, several meetings and gatherings over the late spring, early summer period.

But, first, we have another flurry of "Letters to the Editor", all prompted by previous CNS president Jerry Cuttler's crusade against the linear, no-threshold, hypothesis for radiation effect. As further background to that dispute we include (among all those reports from the various meetings) the authors' summary from a report issued by the AECB's Advisory Committee on Radiological Protection, on "Biological Effects of Low Doses of Radiation at Low Dose Rate".

The reports on gatherings begins, not chronologically, with the very successful CNA/CNS Annual Conference, which was held in Fredericton in June. Accompanying a summary report (and a number of photographs) are two papers, one by Reid Morden, AECL president, on "Shaping Canada's Nuclear Future", and the other by AECB's Jim Harvie, on "Cost Benefit Considerations in Regulatory Decision Making". An extensive report on the CNS Technical Program, compiled by CNS program co-chair Graham MacDonald, is included as a "Special Supplement".

Another CNS Conference reviewed is the "International Conference on CANDU Fuel Handling Systems", which was held in Toronto in May. A paper from that conference on "Pursuit of Excellence in F/H Operator Performance" identifies the importance of the human operator in the complex fuel handling systems.

Again this year we have the pleasure of reporting on the annual COG Safety and Licensing Seminar which reviews the work under the sponsorship of the Candu Owners Group to resolve the various safety and licensing issues associated with CANDU plants. One review paper is included, by Ric Fluke (who just happens to also be associate editor of the CNS Bulletin) on "Containment R & D Programs".

The last such report is on the very pleasant gathering organized to commemorate the U of T SLOWPOKE 25th ANNIVERSARY. That event brought together a number of veterans of the Canadian nuclear scene to recall the start-up of the first university SLOWPOKE and to discuss its many uses over the years and into the future.

In addition to all of those meeting reports there are articles on the Nordion-AECL agreement which will lead to the building of two MAPLE reactors at Chalk River and a brief description of the MAPLE -1 REACTOR. Also, there is a short report on new "Darlington Bleed Condenser Relief Valves".

After all that there is some Miscellaneous news, our usual section on CNS News, an updated Calendar, Keith Weaver's Crossword, which was missed from the last issue, and the back page, "The Darker Side".

We hope that you will find something interesting in all of this. Again we thank all of our contributors with a special acknowledgement to several at AECL and Nordion who provided information and background on their agreement and on the MAPLE reactor. Your comments are always welcomed.

More on the effects of low doses and "radiophobia"

Ed. Note: *CNS past-president Jerry Cuttler's crusade against what he calls "radiophobia" and the broad question of the effects of low doses of ionizing radiation continue to evoke response. This issue we have three letters directed at Cuttler and two further missiles from him.*

Criticism of UNSCEAR grossly unfair

Ed. Note: *Dr. R.V. Osborne is Director, Health and Environmental Sciences Division, at Atomic Energy of Canada Limited, Chalk River Laboratories. A summary of ACRP-18 is published in this issue of the CNS Bulletin*

The Editor

In the last issue of the Bulletin, Dr. Cuttler castigates the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) for producing reports on the biological effects of ionizing radiation that he describes as "nonsense that must be stopped". This is grossly unfair to the high scientific credibility of the UNSCEAR reports. To argue that the efforts of the authors of the UNSCEAR reports are somehow deficient because they have not provided readers with a validated all-encompassing model of radiation carcinogenesis free from all uncertainty is silly, to say the least. What UNSCEAR has done, however, is to provide an overview of the carcinogenic process (especially in relation to radiation) taken as far as can credibly be supported by present data.

The reality is that biological systems are not simple, engineered devices that have a behaviour that can be precisely predicted with the aid of a few computer codes. The complexity is immense and the impact of radiation doses, even small ones, can be equally complex. It is a mistake to think that a simple model can be valid in all circumstances, be it linear non-threshold, linear-quadratic, linearity after a threshold, or whatever. There are many factors that come into play. There is a clear difference in the manner and extent to which cancers in different tissues are caused by radiation; for example, between cancers that are normally rare and those that are more frequent in a population. The response of a cell or tissue or its ability to repair radiation damage may depend on what has recently happened to it or its neighbours – for example a previous radiation exposure – or what it happens to be doing metabolically at the time. Hence when and at what rate a radiation dose is received are factors that determine response, as are the type of radiation and the nature of the microscopic pattern of absorption of the energy. Furthermore, people have inherited differences in the response of their bodies to radiation, the significance of which we are just realizing.

The question for radiation protection is how to give practical all-encompassing guidance that best takes into account this wide range in responsiveness of individuals to radiation and how and when they encounter radiation.

Clearly, one has to make simplifying assumptions in designing a protection program. What has been done is to make the best estimate of the rate of increase of deleterious effect on health with radiation dose in the lowest dose and dose rate region where effects have been significantly observed. This is followed by an estimate of how much smaller the rate of increase could prudently be expected to be at doses and dose rates of interest for protection. The estimation is on the basis of studies of the literature (and yes, ICRP and UNSCEAR do read the literature, including the gray literature) and taking into account the experimental evidence on the variety of molecular, cellular, organ and whole body responses. Finally, in the case of the ICRP, to recommend above what level of radiation dose further increases in dose should be considered unacceptable – the so-called dose limit. As we continue to sort out some of the complexity, we shall be able to become more confident in these extrapolations and, conceivably, be able to identify circumstances where we can adjust our estimates.

The approach described is equivalent to taking a linear, non-threshold model for the relationship between deleterious effect and increments in dose in the range of interest and estimating the slope – which is the nominal risk coefficient.

Neither ICRP nor UNSCEAR are in the business of predicting the number of cancer deaths from low levels of radiation in any given instance, to any given individuals. The risk coefficient generated for the purpose noted above is not valid for that.

Rather than flail away at UNSCEAR and the perceived limitations of the linear non-threshold model in fitting all observations, it would be better to emphasize that already we can put very low bounds on the magnitude of effects from low levels of radiation. That one has to work in terms of bounds is important. There are many epidemiological studies of health and radiation dose that show no significant association at low doses or at low dose rates. It is wrong, though, to conclude that there are zero effects. All one can do is take into account the statistical and other uncertainties in such studies to deduce the bounds within which the magnitude of any effect – positive or negative – is likely to be. The authors of UNSCEAR and ICRP reports are aware of this; many advocates of a threshold below which effects are zero seem not to be.

There is certainly an exaggerated perception of the hazards of low doses of radiation that does not help public acceptance of nuclear facilities. But trying to alter that perception by claiming the presence of a threshold for all people in all circumstances is mistaken and counterproductive. It would be more credible and persuasive to focus on the high

level of radiation safety already achieved and not try to destroy the credibility of the very agencies that provide the basis for the confidence that we do indeed achieve that level of safety.

For a broad and Canadian viewpoint on these issues, I recommend that Bulletin readers look at the recent report from the Advisory Committee on Radiological Protection, ACRP-18.

Richard Osborne

Cuttler's reply

Ed Note: *Following is the response by Jerry Cuttler to the above letter from Richard Osborne.*

The Editor

Scientific credibility is earned by conformance to the 6 steps of the scientific method, outlined in another letter in this Bulletin. Is there really any other method to distinguish between science and pseudoscience? The French Academy of Sciences does not think so.

Consider the recent paper, in the supposedly reputable scientific journal **Nature**[1], that reported that infants in Greece who were exposed while in the womb to Chernobyl radiation may have 2.6 times the risk of developing leukemia. This received wide media coverage. I wonder whether the subsequent criticisms of this scientific paper received the same media coverage.

Would we also expect these scientists to publish in **Nature** a prediction of the number of excess fatal cancers that may result from consuming ordinary milk (due to radiation from potassium)? If they did, it might create a public scare, and the dairy industry would likely haul them into court.

Industries produce chemicals, all of which are harmful in large enough doses, but scientists generally do not study the effects of single molecules of these chemicals on single cells to predict the likelihood of fatal cancers. It is difficult to understand why nuclear science and technology, not only tolerates, but actually encourages such a practice. After a century of amazing scientific progress, what masochism causes it to retain low-level dose-response models that cannot stand up to the tests of the scientific method? Of course the picture is complex, but if a real adverse effect cannot be detected with statistical certainty, we have no basis to model it or make predictions. Our integrity demands that such models be discarded.

We used to have sensible standards for radiation protection. Continuing to lower them provides no benefit; it only makes nuclear technology more and more complex and expensive, and decreases its competitive advantage over inferior, less healthy options.

ICRP and UNSCEAR may not be in the "business" of predicting cancer deaths, but regulatory agencies/authorities do this, using ICRP/UNSCEAR models. Who are the media and the public to believe? ACRP-18 is helpful, but it will not stop the damaging publicity from the "scientists" who will not follow its recommendations. On page iii, it acknowledges there is no direct proof that exposure of adults to 10-20 mSv per year... causes any harmful effects, but it refers to "hypothetical" health effects. So I still have difficulty assuring people that nuclear technology is quite safe. Many will still believe that radiation is a carcinogen and will want no part of it. How to reverse the damage?

Jerry Cuttler

References:

1 Petridou E. et al. "Infant leukemia after *in utero* exposure to radiation from Chernobyl", **Nature** 382, Page 352-3 (1996). A contribution from Harvard Center for Cancer Prevention, Athens University Medical School, and various hospitals in Greece.

Stridency not the way

The Editor

The letter to the editor (Vol. 17, No. 2) by Keith Weaver was a model of rationality and restraint. The letter by Jerry Cuttler on the opposite page to it was not. This was a double irony. Weaver was taking issue with an earlier article by Cuttler on "radiophobia". And Cuttler's letter reinforced Weaver's criticisms by repeating the stridency of his article. Accusing UNSCEAR of "unsubstantiated assumptions" and making wanton assertions like "this nonsense must be stopped" is hardly the way to comfort or convince those who are scared of radiation. It is also an unwarranted indictment of the Canadian radiation experts associated with UNSCEAR.

Having spent a long time as a professional educator and communicator, I agree with Weaver that crusades to "educate" do not work. When they are promulgated by patronizing technocrats with a tone that suggests they have all the answers and everyone else is too stupid to understand, they not only fail but they exacerbate the issue and increase the concern.

Elitist pontificating has been every bit as harmful to the nuclear industry as radiophobia. It would be unfortunate if the CNS were to become the Condescending Nuclear Society. That its ex-president should appear to be on a "radiation is good for you" rampage does not add to the credibility of a learned society, regardless of the validity or lack thereof of the linear hypothesis. It has made some of us who have supported the CNS from its beginnings have second thoughts about sustaining our membership.

It's encouraging that people like Keith Weaver, who knows both nuclear technology and communication, bring the voice of reason to the debate. The damage inflicted by those who know neither is bad enough without its being exacerbated by the CNS.

John A. Macpherson

The Hiroshima Complex

The Editor

Jerry Cuttler's swan-song as CNS president reiterated his warning that radiophobia – the public misconception that any amount of radiation is carcinogenic – threatens to put you people out of business is worth repeating as Jerry invariably does.

He relates irrational public fears of nuclear radiation to (1) misapplication of linear, no-threshold reasoning and (2) "negative ideas that inspire fearful images" i.e. nuclear weapons, proliferation, Hiroshima, Chernobyl, etc."

I don't know much about linear, no-threshold misapprehensions but in reporting on nuclear stuff for a livelihood since 1951, I have given some thought to the lethal imagery the public has fashioned for nuclear technology. Jerry Cuttler calls it radiophobia. I call it the Hiroshima Complex – the awe, fear, incomprehension and guilt with which the Western world reacted to dropping the Bomb.

As I wrote in Fallout from Chernobyl in 1987: "In the wake of the Bomb the word 'Hiroshima' triggered the picture of a violent thundercloud roaring upward till stratospheric winds rounded its top to mushroom shape. Such word images fade quickly. Details disappear; shapes are blurred. The picture becomes an abstraction. Just days after the man-made apocalypse the Hiroshima cloud dimmed in our collective psyche. It lost its convulsive motion, the awesome darkness within its stem, its furious outreach was capped. In awe, fear and incomprehension we repressed the reality of the Bomb. All we retained in consciousness was the vague mushroom shape. In guilt we reduced that to a mere symbolic configuration. Nuclear warfare was reduced to a pictograph. Then in the early 1950's the Bomb tests began and the tocsin of frenzied ions gave sound to repressed images."

Chernobyl, of course, updated the imagery. But very specific vested interests have kept the lethal nuclear image alive and foremost. They include: (1) professional fearmongers – the pseudo-environmentalists who scare the public into constipation then ask a donation to say a novena on their behalf; (2) competitive sources of energy, notably the natural gas industry in Canada (read the Macdonald Report on privatizing Ontario Hydro); (3) opportunist politicians who recognize there are more votes at election time in shaking genitalia with fear than in shaking hands.

Ray Silver

Reply to criticism of radiophobia article

The Editor

The letter by Keith Weaver in the recent issue of the CNS Bulletin (Vol. 17, No. 2) is welcome feedback that I really got his attention. Comments I've received from many other people indicate there was no lack of clarity or focus. Sometimes it is necessary to state things rather bluntly to stir people out of their complacency, although I wish I had more time and better writing skill to match Mr. Weaver's elegant style.

I certainly do have a personal agenda and do not hide it. Fear of being viewed as advocates for the many benefits to be derived from the atom should not make us overly timid in taking a positive stand on radiation issues, for example, on nuclear power or waste disposal.[1]

The issue of radiophobia is not complex and confusing. Simply stated, scientists should use the scientific method to validate their hypotheses before going public with scare mongering. René Descartes published the forerunner of this method in 1637. It involves six basic requirements:[2]

- Obtain sufficient, relevant date to support the formulation of a hypothesis.
- Repeat the experiments by same group and by other groups of scientists.
- Address all data available and ignore none (no bias).
- The hypothesis must follow in a logical and consistent manner from the data.
- Authors of the model must be honest, avoid self-deception and seek good peer review.
- Subject the hypothesis to tests which are designed to disprove it.

Strict application of this method would have avoided the embarrassing circus in both media and scientific circles about the discovery of "cold fusion".

Fear of (low-level) radiation came about after World War II when scientists, concerned about atmospheric nuclear weapons testing, extended the linear dose-response model below the range of the data. "Regrettably, political or ideological considerations were not absent in the choice and refinement of the low dose-risk assessment model... and sometimes took precedence over strictly scientific considerations."[3]

Can we persuade the authorities to change to using a scientific approach after they accepted the validity of their current methodology for so many years? Can we convince the public that low-level radiation is quite safe, when the authorities keep publishing reports predicting the number of excess fatal cancers from exposures to trivial doses?

The call to action is occurring also in other countries that are experiencing the paralyzing effect of this fear. I wish I knew how to go about it, but I believe the first step is to get people with a stake in Canadian nuclear technology to recognize the problem and be concerned enough to want to do something about it. Mr. Weaver believes very few people out there care about this technology. I know that many are afraid of it. If the authorities changed their attitudes, it should be possible to change public attitudes about low-level radiation. I welcome suggestions and initiatives of others. We must find a way.

Jerry Cuttler

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3. Kathren RL. "Pathway to a paradigm: the linear nonthreshold dose-response model in historical context: The American Academy of Health Physics 1995 Radiology Centennial Hartman Oration", special submission, Health Physics, 70; 5, 621, 1996 May (Page 626)

CNA / CNS Annual Conference

Over 350 delegates (including at least 30 from outside Canada) enjoyed the very well-organized annual CNA / CNS Conference in Fredericton, New Brunswick from June 9 to 12, 1996.

The conference team, almost all from New Brunswick, produced an event that ran on time, provided excellent content, and more than satisfied everyone with meals and fellowship. Undoubtedly the social highlight was the entertainment and lobster feast on the Tuesday evening, even though most participants had been so well fed at the breakfasts and lunches provided that they could tackle only one of the huge, delicious, crustaceans offered. The organizers had obtained more than 20 sponsors who underwrote the breakfasts, lunches, coffee breaks, as well as the Sunday evening welcoming reception and the Tuesday evening theatre fun night and lobster feast.

Following the format of the past several years, the Monday morning was a joint CNA / CNS plenary session. Thereafter, the CNA and CNS ran separate programs. The CNS technical program included over 90 papers presented in 19 sessions, typically with four running in parallel.

A separate report on the CNS program is presented as a supplement in this issue of the *CNS Bulletin.*

Two "keynote " addresses began the plenary session; one by **Raymond Sero** of Westinghouse (USA), the other by **Reid Morden,** president of Atomic Energy of Canada Limited. The balance of the plenary session was devoted to four presentations on the theme "International CANDU Opportunities" by; **Allen Kilpatrick,** vice-president, marketing, AECL; **Maeng-Kyu Kim,** of KEPCO; **John Sommerville** for the Cernavoda NPP; and **Dr. Yulan Li** of the China Nuclear Corporation, who spoke in the slot scheduled for David Bock, AECL's V.P. China.

Excerpts from Reid Morden's address, which was enhanced by a computer-generated video presentation, are reprinted elsewhere in this issue of the *CNS Bulletin.*

Raymond Sero focused on deregulation and global competition. "Nuclear, large coal, and hydro are the only types [of generation] that can produce [electrical] power at costs close to one cent a kilowatt-hour", he claimed, and then warned that nuclear must reduce costs to remain competitive. Capacity factors of 90% for nuclear plants are feasible, he asserted, but added, "We must move to a new level of performance, and it will not be easy". Despite competition nuclear plants must share operational experience through "benchmarking", he said, (Benchmarking at Point Lepreau was the subject of a paper later in the CNA program.)

In the session on international opportunities, **Allen Kilpatrick** again emphasized the need to reduce costs and to focus on the needs and wants of customers. Since nuclear plants are so capital intensive financing will be a critical factor in export sales, he commented, and noted that the loan to China [for the proposed two CANDU units] will be the largest Canadian export loan ever. The financing challenge will force new approaches such as the B.O.O.T. (build, own, operate, transfer) concept.

Dr. Yulan Li outlined the Chinese nuclear power program which includes the 300 MW plant of their own design, and two PWRs now operating and eight plants under construction or planned - two 600 MW PWR; two 900 PWR; two 1,000 MW VVER; two 700 MW CANDU. He said the PWR would be their basic design. China plans to build 40,000 to 50,000 MW of nuclear power plants by the year 2020.

Maeng-Kyu Kim commented, proudly, that the eleven Korean operating nuclear plants (10 PWR, 1 CANDU) had an average capacity factor of over 87% in 1995. Six PWR and three CANDU are under construction. Korea intends to add over 17,000 MW of nuclear generation by 2010.

John Sommerville, formerly at Point Lepreau and now plant manager of the Cernavoda nuclear power plant in Romania provided an update on that plant which is planned to have five CANDU units. Unit 1 achieved criticality in April 1996 and is now in the power commissioning stage. He reviewed some of the history of the project that had begun over 17 years ago. In 1991, under the new regime in Romania, a consortium of AECL and Ansaldo (of Italy) took on the task of finishing the partially completed unit 1. They inherited a number of problems, he noted, including: equipment unreliability, construction deficiencies, design faults, material and supply problems, staffing and regulation. These, he noted, had all been overcome to achieve the start-up of unit 1. The consortium is to operate the unit for 18 months. At this time the operation team is composed of "expatriates" with each having a Romanian deputy destined to take over.

The other CNA sessions dealt with the following topics:

- Challenges in the Nuclear Industry
- Public Acceptance - Gaining Support
- Strategies for Success in the Nuclear Business
- Nuclear Power and the Environment
- Initiatives in Nuclear Regulation
- Other Opportunities

There were just two papers in the first. **Dave Clark** of the Uranium Exchange Company spoke on the changing uranium market with reference to three megatrends over the years - western industry consolidation, introduction of eastern [former USSR] supplies, integration of commercial and military markets. **Stan Frost** of CAMECO provided an excellent review of the development of uranium tailings management over the past five decades and described the newest system of placing tailings in a special regime within the water table.

Two of the three papers on public acceptance, one by Don Falconer of Ontario Hydro Nuclear and the other by Penny Metza of the CNA discussed the current industry initiatives while the third, by two NB teachers, **Susan Petrovich** and **Debbie McLoggan,** together with **Ross Munro** of Point Lepreau, described the special educational partnership developed in New Brunswick.

The "Strategies for Success" session included: **Ron Field,** general manager of OHN, speaking on "OHN - Challenges of the Future"; a paper on "Benchmarking at Point Lepreau" by **Bill Pilkington,** station manager; and a view from the UK by George Ayres of BNFL on "The Approach to Continued Operation of Calder Hall and Chapelcross to 50 Years". Also in that session **Bryan Plug** of SAP Canada spoke on "Challenging Today's Nuclear Industry to be Competitive" ; **Hans Wenger**, plant manager of the Beznau N.P.P., explained "The Cost Effectiveness of Beznau and Other Swiss Nuclear Stations"; and **Robert Dulin,** of Duke Engineering and Services, reviewed "Transforming the Duke Power Work Control Process".

Three papers were presented on "Nuclear Power and the Environment": "Streamlining the Federal Environmental Assessment Panel Process" by **John Lowe** of NR Canada; "New Directions in Nuclear Waste Disposal", by **Peter Stevens-Guille,** of Ontario Hydro; and "Two Economic, Energetic, and Environmental Assessments of the French Nuclear Program", by Marc Vielle of CEA.

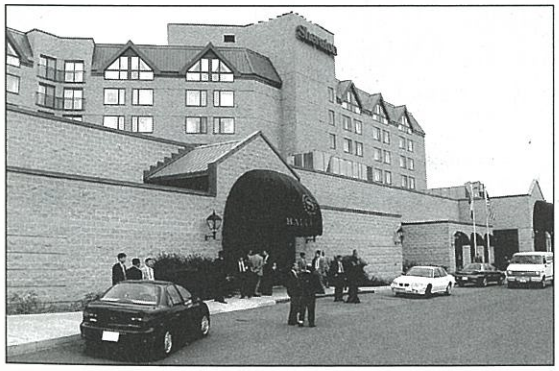
The session on "Initiatives in Nuclear Regulation was chaired by **Dr. Agnes Bishop** of the AECB. **James Martin,** of Treasury Board, spoke on "The Canadian Government Perspective on Cost Effective Regulation". **Gary Miller,** of Virginia Power, described "Virginia Power's Regulatory Reduction Program" in which issues are prioritized with the cooperation of the NRC. Jim Harvie, of the AECB, was quite critical of industry in his talk on AECB efforts to examine "Cost Benefit Considerations in Regulatory Decision Making". (His paper is reprinted elsewhere in this issue of the *CNS Bulletin.*)

Finally, in the session on "Other Opportunities" there were four papers on diverse topics: "The Canadian Initiative to Bring ITER to Canada", by **Bob James** of CFFTP; "comparative Assessment of Nuclear Power and Other Energy Sources" by **Leonard Bennett** of the OECD-NEA; "Advancing CANDU Experience to the World Steam Generator Market", by **Eric Dahlin** of Babcock & Wilcox International; and "Plutonium Disposition from the Russian Perspective", by **Sergei Kislyak** of the Russian Ministry of foreign Affairs.

Interspersed with the CNA and CNS sessions were the two Annual General Meetings, both held at the same time, late Monday afternoon, and three luncheons. **Paul Kefalas** of ABB Canada was the guest speaker at the Monday luncheon. The Tuesday lunch was devoted to CNA awards. On Wednesday the CNS awards were presented as well as a talk by **Frank Steward** of the new Centre for Nuclear Energy Research at UNB. (A full account of both CNA and CNS awards is presented elsewhere in this issue of the *CNS Bulletin*).

On the Monday there was also a "teachers workshop" organized by **Kathleen Duguay** of NB Power with the assistance of **Aslom Lone** chairman of the CNS Education and Communications Committee.

Copies of the proceedings of the CNA and CNS programs are available from the respective organizations.



Scenes from CNA/CNS Annual Conference 1996

Shaping Canada's Nuclear Future

by Reid Morden

Ed. Note: *Reid Morden, President and CEO of Atomic Energy of Canada Limited, was one of the two "keynote" speakers at the opening plenary session of the annual CNA/CNS Conference held in Fredericton, NB, in June 1996. Following are his remarks, edited for length only.*

The theme of my remarks is "Shaping Canada's Nuclear Future" – and my case is straightforward. We all know that the demand for nuclear power in Canada is likely to remain relatively static for some time. All the indicators point in that direction.

Many of these indicators simply mirror the national malaise. An uncertainty as to where we are going. An uncertainty that we will arrive. I think we spend far too much time in this kind of introspective vein. So, I've tried to put together an accounting of why the nuclear industry – and the Canadian nuclear industry in particular – can look to a dynamic future.

To start, let's ask the question which arises from our domestic situation.

Does this relatively static Canadian domestic market mean a static Canadian nuclear industry? My answer: it needn't; it shouldn't – and, more importantly, it can't.

Our industry has always depended on constant innovation and improvement – continued sharpening of what we do, and the way we do it.

The only way to keep at the cutting edge of technology is to subject it to the test of the marketplace. If the marketplace is static in Canada for some time – it is certainly not static elsewhere. It is growing – particularly in the industrializing world. If we are to survive successfully in Canada – positioned to take advantage of the next phase of domestic nuclear growth – we must succeed in that foreign market. Canada's nuclear future will be shaped abroad.

Having said that, AECL will continue to pay full attention to the Nuclear Services needs of the operating CANDU stations. We all know that it is their continuing excellent performance that keeps CANDU at the international forefront – and provides the reality behind all our marketing efforts.

Let me outline the facts that will influence the future of nuclear power.

The population of the developed world is today about 1.2 billion people – a figure that is projected to remain roughly constant over the next half century. However, over the same period, the population elsewhere – currently 4.5 billion – is projected to grow to about 8.6 billion.

Reid Morden

That population growth will be paralleled by considerable economic growth. It is projected that in order to keep pace both with economic and population growth, world energy supplies will have to double over the next 50 years.

The demand for electricity will be particularly acute. Today, throughout the non-Western world, that demand is growing at a rate faster than either gross national product or primary energy consumption.

The Asia-Pacific region will be very much at the forefront.

Strong annual economic growth means that this area will probably add between 650 and 750 gigawatts of capacity over the next 15 years. That is equivalent to double today's total installed global nuclear power capacity.

The obvious question is, where will that additional energy supply come from?

Clearly, coal, oil and gas, will remain the first choice. For many countries, they are accessible. They can be easily integrated into growing economies. And up-front costs are generally lower than the alternatives.

The use of hydro-electric power will continue to grow. But the potential is limited by considerations of availability.

On renewable sources – solar, wind, biomass etc. – their overall contribution will almost certainly continue to be small.

Which brings me to nuclear energy. In my view, nuclear power will play an increasing role. The logic is clear.

First, the priority of sustainable development is, as pressing in the Asia-Pacific region as anywhere else. Unprecedented economic growth is making that region the world's largest consumer of coal and other fossil fuels. The negative environmental consequences of that trend are becoming ever more evident.

Second, for many countries, energy supply is not

found in the same place as energy demand. For reasons related to the cost of transportation and infrastructure, nuclear power is a competitive choice.

For example, in China, 80 per cent of its coal is found in the North and 70 per cent of hydro electric resources in the South West. Only about 15 per cent of China's energy resources are located in the more developed East, North East and South. The result: fully 50 per cent of rail and one-third of water transport capacity have been used for the transport of coal. No wonder China has made the choice to have nuclear power.

Another factor in favour of nuclear energy is the desire to minimize reliance on foreign sources. This relates to concerns over price volatility and security of supply. In addition, oil imports can negatively effect trade balances. Nuclear power can lessen those concerns.

Finally, there is a growing realization that the development of a nuclear power capability is qualitatively different, in industrial terms, from the development of other energy sources. As a result of technology transfer, infrastructure development, the acquisition of expertise ranging from construction to engineering to high technology capabilities – developing countries are recognizing that nuclear power is in a class of its own.

In effect, as countries throughout the Asia-Pacific region are demonstrating, the development of nuclear power is not simply about the development of an energy source. It is about the development of an entire industrial sector.

Critics of nuclear power would have people believe that the decision to embrace that option is irresponsible – that nuclear power is experimental, that it is unsafe and that it is uncompetitive.

Let me address those perceptions.

Certainly, it would be wrong to expect any government to embrace a technology that was untried, untested.

But we are a very long way from that situation today.

We have now entered the second half of the nuclear century.

In 30 countries, well over 400 nuclear power units are in operation. This represents a cumulative world experience of 7,200 reactor years. Nuclear generation of electricity in 1994 represented 2,130 terawatt hours, greater than all the electricity generated in the world in 1958.

The technology is mature. The experience is there.

Let me turn to the issue of safety. Perhaps there is no other public policy issue on which perceptions have been influenced more by exceptions that the rule. For example, Chernobyl should never have happened. It was a terrible tragedy. But what stands out – or should standout – is the incontrovertible fact that there are about 450 other reactors around the world providing energy safely – most of which have been operating for many years.

As an example, the CANDU reactor is based on a design that has been in operation here in Canada for 30 years – without one single incident to tarnish a track record that is second to none for safety and security.

Since the early 1980's, CANDU-6 reactors have been operating successfully around the world – and are today in operation on four continents. There are more CANDU units under construction internationally than any other reactor design.

The case for reliable and safe nuclear power is no longer theoretical. It is a matter of historical record.

What about the question of competitive cost? In many countries with nuclear power, electricity generated by nuclear stations is cheaper than that which comes from coal, oil or natural gas. If this were not so, the economies of France, Germany, Belgium, Korea and Japan – all of which generate more than 35 per cent of their electricity from nuclear power – would be less than competitive, which is clearly not the case. Here in Canada, except at the source of natural gas, the cost of nuclear power has proven to be 35 per cent lower than that derived from fossil fuels. OECD studies show nuclear in a competitive light with respect to coal and gas in a number of countries, for a number of scenarios.

The competitive advantage of nuclear power is, therefore, a matter of fact.

A further issue is environmental risk. Those who would have developing countries reject nuclear power out of hand are advocating energy sources that would further damage the environment – with implications for global warming, for acid rain and for increased toxic air pollutants.

About 17 per cent of the world's electrical energy comes from nuclear power. If that energy were instead derived from coal – even from plants that had the best equipment available for removing pollutants – the consequences would be sobering. It would mean that every year more than 1.5 billion additional tons of carbon dioxide, 2 million extra tons of sodium dioxide, 1 million extra tons of nitrogen oxide and about 150 thousand more tons of poisonous heavy metals would be released into the atmosphere.

It would distort the discussion if I were to ignore two matters that are of considerable concern as they relate to nuclear power.

The first is the question of financing. Although nuclear power is competitive in the long run, it clearly involves large up-front costs that exceed those of the alternatives. Clearly, far-sighted and innovative financing arrangements are, and will be, required.

The second issue is the safe disposal and storage of nuclear waste. This is a legitimate concern. It is also a concern that is being addressed. In Canada alone, we have invested almost $500 million to identify a solution that will work. This issue will be solved – affordably, reliably, safely.

Thus far, I have spoken about the advantages of nuclear power versus non-nuclear alternatives. Let me now describe the CANDU advantage – among the nuclear power alternatives.

These advantages are unique to the CANDU. No one else does what we do.

On the question of safety, CANDU has a higher level of protection against fuel melting in major accidents than other designs – and we lead the world in automated, redundant reactor control.

CANDU is 30 per cent more efficient in uranium utilization than Light Water Reactors. Japan's Advisory Committee on Energy declared that CANDU is, "the most efficient of all existing reactors in using uranium resources". In addition to its neutron economy, CANDU technology is unique in that it can generate electricity – at full capacity – and be refuelled at the same time.

But perhaps one of the most central advantages of CANDU flows from its fuel cycle flexibility.

CANDU uses natural uranium. That means several things. One, less costly fuel. Two, indigenous sources of supply in many countries. Three, no need to purchase costly reprocessing or enrichment services. Four, no reliance on a very small number of foreign suppliers – enhancing self-sufficiency and energy independence. Five, easy production of fuel assemblies locally. And six, removal of any concern that might exist over diversion.

There is another major advantage – the CANDU reactor's ability to use alternative fuels. CANDU can use a wide variety of advanced fuels – including recovered uranium, mixed oxide fuel, thorium, and slightly enriched uranium. Most importantly, CANDU can reuse the spent fuel from existing Light Water Reactors.

For those countries who already have Light Water Reactors, CANDU can make the overall nuclear power system even more efficient – improving fuel utilization, reducing the quantity of spent fuel, lowering fuelling costs, and enhancing nuclear self-sufficiency.

Let me make one final point, not on the issue of nuclear reactors but of relationships – of nuclear partnership.

Neither Canada nor AECL approaches the issue of reactor acquisition as if it were some ordinary retail proposition. For each reactor project AECL assembles the best global team available – the CANDU Alliance. Members of the Alliance include the utilities, engineering consulting and manufacturing companies and universities that contribute to the success of the CANDU industry worldwide.

Customers are key members of the CANDU Alliance. As a matter of policy, we believe it is essential to be with our customers for the long-term. This extends from the very beginning of the process of identifying energy requirements right through to reactor decommissioning, 40 years later – perhaps 60, given the possibility of constant upgrading.

And we believe that relationship should not be static – that it should grow.

Our customers realize CANDU is a means to generate an entire industry, to develop their own expertise and value-added capacity. There is also the possibility of developing partnerships with us to explore third-party opportunities.

What makes this possible is both our attitude – and the attributes of CANDU technology itself. Unlike Light Water Reactors, components of the CANDU reactor can be more readily fabricated locally – even the largest components. They are also modular – allowing replacement as technology improves – introducing the possibility of further local contribution.

In Korea, where we have a 20 year relationship, the first CANDU built there – Wolsong-1 – had 20 per cent local content. Today, as the construction of Wolsong-3 and 4 proceeds, local content will reach a level of some 80 per cent. Technology transfer, team work, trust, experience make that possible. This is not something we simply tolerate. It is something we nurture from Day One.

Let me conclude by saying that the real energy challenge facing industrializing societies today is not to satisfy one need, but to satisfy several needs together. The need for cost-effective electricity. The need for safety and reliability. The need for sustainable development and self-sufficiency. The need for energy solutions which not only satisfy electricity needs – but themselves create industrial opportunity, sophisticated value-added growth. And, the need for international and regional partnerships premised on mutual benefit and trust. Nuclear power can respond to those various needs uniquely.

Whether or not Canada will be a leader in participating in the next phase of growth is the question. I believe we can. We have the technology, the track record, the best mix of benefits on which to build new nuclear partnerships.

But those partnerships abroad will only succeed if we continue to hone our partnerships here at home. We are all in this together. None of us will be able to do it alone.

With very tight budgets and a very competitive marketplace – never has there been such a premium on the reality, not the rhetoric, of partnership. We have become what we are by building such a partnership. We will remain what we are only by sustaining it – in fact, building it still further.

Canada's nuclear future will be shaped by Canada's nuclear alliance – the CANDU Alliance – working together at home and abroad.

Cost-benefit and regulatory decision making

Ed. Note: *Following is the submitted text of the paper by Jim Harvie, Director General, Reactor Regulation, at the Atomic Energy Control Board, for CNA Annual Conference in Fredericton, in June 1996. In his presentation he was much more direct and colourful in his comments than in the written version. Some of his verbal remarks are inserted into the formal paper to add some "colour" to the topic.*

INTRODUCTION

The Atomic Energy Control Board is investigating the feasibility of developing methods for factoring cost-benefit considerations into its regulatory decision-making. This initiative results, in part, from the federal government policy requiring cost-benefit considerations to be taken into account in regulatory processes, and from the recommendations of an Advisory Panel on Regulatory Review in 1993, submitted to the Minister of Natural Resources Canada. One of these recommendations stated:

"that mechanisms be developed to examine cost-benefit issues and work towards some consensus of opinion among stakeholders: a task force on the subject could be an appropriate starting point"

INITIAL ACTIVITIES

The AECB initially engaged a consulting company, Price-Waterhouse, to carry out some preliminary work, and an exploratory meeting was held with representatives of licensees and other interested parties on March 29th, 1994. Subsequent efforts to set up the recommended task force of stakeholders were not successful, since the nuclear industry insisted on conditions for its participation which the AECB could not accept.

Industry [representatives] demanded that the group be chaired by someone from Treasury Board, that the public were not to be considered stakeholders and that the group's decision was not to be subject to ratification by the Board. When I suggested a more balanced group .. the industry response was essentially, "Get lost Harvie, do it our way or forget it."

Since all parties maintained a strong interest in the subject, another project was initiated under the AECB Regulatory Research and Support Program to investigate further the feasibility of including cost-benefit considerations in the regulatory decision making process, and in particular to obtain information on the use of such considerations by other regulatory agencies, both in Canada and in other countries. The results of this project have been reported in the AECB report INFO-0566, which was also prepared by Price-Waterhouse.

Jim Harvie

That report showed that there were lots of good intentions [among other regulators] but nobody was subjecting their process to formal constraints on the basis of cost-benefit.

FORMATION OF WORKING GROUP

It was decided to invite a group of experts, from both within and outside the industry, to attempt to draw up proposals for factoring cost-benefit considerations into regulatory decision-making. While these experts clearly could not dissociate themselves entirely from the companies where they were employed, the intent was to invite people with expertise to offer rather than people who would represent specific interests. The main objective of the group was to prepare a report containing proposals which would be the basis for AECB consultation with stakeholders and other interested parties on the subject.

I want to give credit to Victor Snell [of AECL] who said, OK, lets discuss how to do it.

This approach was not without its critics. On the one hand, some nuclear industry interests whose representatives were not invited to participate were displeased, criticized the process, and attempted to link the initiative to other unrelated issues. Equally, Energy Probe, in a letter to the President of the AECB, was critical that the group appeared to be "dominated by a small group of like-minded people, and apparently excludes local citizens groups representing the public at risk and environmental public

interest groups." It suggested that the process "has been unduly influenced, behind closed doors, by the regulated industry and its friends."

COG [representatives] tried to get cost-benefit enshrined legally in the [new]Act. When it was pointed out that this could be a double-edged sword which might cut off important parts of their anatomy, the proposal was withdrawn.

Despite these criticisms and external influences, it was decided to proceed and attempt to produce a workable set of technical proposals which could be distributed to, and commented on, by all stakeholders in the process and other interested parties to obtain feedback prior to implementation. This would of course include the entire industry regulated by the Atomic Energy Control Board, workers in the industry and their unions and professional societies, as well as groups representing public interests and individual members of the public.

SUBSEQUENT PROGRESS

At the initial meetings of the group it proved to be necessary to clarify the types of decisions that are made by the AECB in the regulatory process. These range from formal legal decisions on regulations or licences, to the myriad of detailed decisions taken by AECB staff members on the adequacy of licensee actions or submissions. It became clear that for some of these decisions cost-benefit considerations could have a role in the decision-making process, while for others such considerations would play little or no role.

It also became clear, from discussions inside and outside the group, that there was a wide variation in expectations on application of cost-benefit considerations in the regulatory process. While some appeared to envisage all decisions made by AECB staff to be subject to a formal cost-benefit analysis before being implemented, others perceived this to be unworkable, given the large number of routine day-to-day decisions, and envisaged cost-benefit to be one of several tools available in certain situations to contribute to the decision-making process.

Notwithstanding these difficulties, the group was able to function in a constructive fashion, and agreement has been reached on a relatively brief proposed policy statement, and a guide to address where and how this policy could be applied to being developed.

We want an approach which can contribute to this complex process. There are some [in the industry] who would like a policy that would require an AECB staff member to do a cost benefit analysis before going to the washroom. One the other hand an [anti-nuclear]critic said cost-benefit should not play any role, that the criterion should be "zero release", which presumably means we can't go to the washroom at all !

The group expects to complete its work by the fall of 1996, and produce documented proposals for a policy and guide. These would form the basis of an AECB Consultative Document which will be circulated to all stakeholders and interested parties. Following the process of consultation, recommendations will be made to the Board on establishing an AECB policy and publishing an AECB guide on the subject.

PROPOSED POLICY

A proposed wording for the basic policy on the subject is as follows:

"When regulatory decisions are made with respect to nuclear activities, the costs and benefits shall be given appropriate consideration."

This simple statement of principle affirms the role of cost-benefit considerations, without putting inappropriate constraints on the decision-making powers of the AECB.

Two areas were identified where there would be mandatory consideration and documentation of cost-benefit considerations.

1) All proposed new regulations must be subjected to a Regulatory Impact Analysis, in accordance with the policy of the government. This analysis includes examination of the costs and benefits associated with the regulations.

2) Similarly, any new Regulatory Policy Statement issued by the Board would be subjected to a cost-benefit analysis, to the extent practicable. Since such policy statements are issued relatively infrequently, such an analysis should not put an unacceptable burden on the process.

Costs and benefits would not be considered in decisions related to enforcement of the legal requirements of the Atomic Energy Control Act (or its successor), or of Regulations issued in accordance with the act (except perhaps on methods of enforcement). For example, the Physical Security Regulations, issued pursuant to the Act, are legally binding requirements, and the AECB does not have discretion in their enforcement. Similarly, decisions related to enforcement of Regulatory Policy Statements, such as those specifying requirements for special safety systems (AECB Regulatory Documents R-7, R-8, and R-9), would not normally be subjected to cost-benefit analysis.

The general principle stated above would govern all decisions taken by the AECB, and affected parties could of course submit their views on costs and benefits for consideration with respect to any regulatory decision. However, for the bast majority of decisions, it is not envisaged that a formal cost-benefit analysis would be undertaken, since this would make the process much too cumbersome for all parties.

Nevertheless, the group concluded that, in cases

where an affected party believed that cost-benefit aspects should be an important factor in a decision, there should be a process by which a more formal analysis could be requested and, if agreed to by the Board, carried out. In such cases, it is envisaged that the AECB would appoint a staff member or an external consultant to review the study and produce a statement on the validity of the predicted costs and safety benefits associated with the decision.

COSTS AND BENEFITS

It was concluded that the costs associated with a decision should include the financial costs borne by all parties, including licensees, the AECB, and the public, as well as health and safety costs, including doses to licensee staff or the public resulting from implementation of the decision. However, only costs which would be incurred by a reasonably competent, efficient organization would be considered, since it would be inappropriate to have a decision on a safety improvement influenced by unnecessarily high costs caused by inefficiency.

Similarly, the safety benefits would include reduction of doses to licensee staff or the public, as well as reduction of risk to workers, the public, or the environment due to operational upsets or accidents.

It is recognized that some costs are difficult to assess. For example, while the health and safety costs of small releases of tritium to a lake may be trivial, there may be costs related to public anxiety, or benefits related to avoidance of such anxiety, that are impossible to evaluate. This is one reason why cost-benefit analysis must be considered as only one tool in the decision-making process.

It is of course necessary to use a relationship between financial costs and benefits in terms of reductions in dose, risk, or negative social or environmental impact. While this is a controversial subject, it must be addressed it a meaningful policy is to be developed.

The group discussed employment as both a benefit and a cost. A decision causing an increase in employment can be perceived as a contributor to job creation and hence as a benefit to society. Conversely, arguments were made regarding the calculated loss of life expectancy associated with each person-hour spent in construction and maintenance activities, resulting in a theoretical safety cost of each person-hour at work. Since these aspects involve judgements about the value to society of employment, and are related to considerations of the safety of people who are not at work, it was concluded that these should not be included in the process, unless work of an unusually hazardous nature is involved.

APPLICATION

A fundamental consideration is that any AECB policy on cost-benefit considerations cannot constrain in any way the decision-making authority of the Board. While it is accepted that costs and benefits should be given appropriate consideration, the Atomic Energy Control Board must retain the authority to establish acceptable standards for safety in the nuclear industry, and to insist that such standards be satisfied. If the costs of meeting reasonable safety standards are too high, the industry is not viable.

The weight given to cost-benefit considerations would clearly depend on the extent to which the costs and benefits associated with a decision can be predicted, and on the level of confidence in the predictions. The level of confidence in risk estimates is dependent on the extent to which predicted frequencies of occurrence of events are based on actual experience or reasonable extrapolations therefrom, and on the extent to which predicted consequences are based on experience or realistic experimental simulations.

For events with very low expected frequencies, it is difficult to obtain a high level of confidence in risk estimates, since experience shows that the real frequencies are often dominated by factors that have not be recognized. However, even with considerable uncertainty in the estimates, cost-benefit considerations may be relevant if the conclusions of the analysis point clearly in one direction.

Some decisions lend themselves better to cost-benefit considerations than others. In the former category would be decisions related to safety improvements for events with a significant and measurable frequency of occurrence. On the other hand, it is difficult to see how cost-benefit could be a factor in decisions on approval of personnel for licensed positions in operating stations. Some decisions, such as setting of dose limits in accordance with international standards, might well be taken regardless of the cost-benefit implications. Equally, urgent decisions to correct serious safety problems would not be delayed by cost-benefit analyses.

A further example would be a decision to require that a probabilistic safety analysis be done for a new plant design. While the costs of doing the analysis are predictable, the benefits could range from zero for a well-designed plant, to the identification of important shortcomings in safety which require correction. It is impossible to know the outcome, and hence the benefits, at the time that the decision to require the analysis is taken.

CONCLUSION

The proposed policy and guide on cost-benefit considerations in regulatory decision-making should furnish a useful tool which would, along with other relevant tools, form part of a sound regulatory decision-making process. Following release of an AECB Consultative Document and appropriate input from stakeholders and other interested parties, it is intended that recommendations be made to the Board on implementation of an AECB policy in this area.

Awards Recognize Contributions

Among the important events at the annual CNA/CNS conferences are the presentations by the Canadian Nuclear Society and the Canadian Nuclear Association of awards to individuals and groups for their achievements and contributions to the Canadian nuclear program. This year at Fredericton the CNS awarded two CNS Fellowships and two Team Achievement Awards while the CNA presented its W.B. Lewis Medal, Ian McRae Award, three Outstanding Contribution Awards to individuals and one to a team.

CNS Awards

Before naming the recipients of the CNS 1996 awards, Hugues Bonin, chairman of the CNS Honours and Awards Committee noted that his committee depended on nominations from members. The CNS Innovative Achievement Award was not being given this year because the committee had not received appropriate nominations.

Bonin added that the CNS also sponsors the **R.R. Jervis Award** for full-time graduate students at a Canadian university pursuing research in radiochemistry or its application. That award is administered at the University of Toronto and the winner for 1996 was **Sophie Wong**, a master's student at U of T, for her thesis on "Analysis of Arsenic and Uranium in Environmental Samples from a Low Level Radioactive Waste Disposal Facility".

For 1996 the CNS Honours and Awards Committee decided to present **J.S. Hewitt Team Achievement Awards** to two groups.

Charles Kittmer (R) receives the J.S. Hewitt Team Achievement Award on behalf of himself and his colleagues, Roger Joynes and Larry Green, from CNS president Jerry Cuttler at the CNA/CNS Annual Conference in Fredericton, June 12, 1996.

The first was to the team of **Charles A. Kittmer, Roger J. Joynes** and **Dr. Laurence (Larry) W. Green**, all with AECL's Chalk River Laboratories. Their citation read:

For the dedicated pursuit of project support, the creative conceptualization of design and innovative application of fundamental understanding and experiment to verify and qualify the technique of micro-sampling of pressure tubes as a valid in-service inspection method and successfully, proving and implementing the technique in-reactor.

The second was to the past and present staff of the **Point Lepreau nuclear generating station**. The award was accepted by Al Gallant of the Point Lepreau staff.

The citation read:

For an outstanding lifetime plant performance from start-up in September 1982 to this day, a remarkable achievement made possible by an exemplary coordination of knowledge, talents and teamwork, and for demonstrating so perfectly not only the superiority of the Canadian Candu Reactor design, but that electrical power can be generated in vast amounts from the nuclear fission in a safe, economical, efficient and environmentally friendly manner.

The two new **CNS Fellows** named were **Dr. James Terence (Terry) Rogers**, professor emeritus at Carleton University and **Dr. William (Bill) Midvidy**, of Ontario Hydro Nuclear. Unfortunately, Terry Rogers was not able to be present to accept his Fellowship in person.

The citation for Terry Rogers read:

For his exemplary career and lifetime contribution to Nuclear Reactor Thermohydraulics and safety and his dedicated passion towards teaching and research within academic institutes, and for his extensive involvement in learned societies and notably the Canadian Nuclear Society where he maintained an active role within the Ottawa Branch and through the organization of several CNA/CNS student conferences as well as many other seminars and symposia.

CNS President Jerry Cuttler (L) presents the J.S. Hewitt Team Achievement Award to Al Gallant representing the staff of the Point Lepreau Generating Station, at the CNA/CNS Annual Conference in Fredericton, June 12, 1996.

The citation for Bill Midvidy read:

For his enthusiastic and energetic contribution to serving the Canadian Nuclear Industry through grass roots research, model development, analysis and management of research programmes aimed at making the CANDU the best Nuclear Reactor in the world, and for his tireless dedication to the Canadian Nuclear Society for which he gave countless hours into making the C.N.S. the mature society of today.

CNA Awards

The CNA **W. B. Lewis Medal** is awarded for major contributions and achievements related to the Canadian nuclear program in scientific and technical areas. The 1996 winner was **Dr. Donald G. Hurst.**

The citation read:

Don Hurst has played an important role in the development of nuclear energy in Canada over half a century, beginning in 1944 at the Montreal Laboratory, where the Canadian nuclear program started, until his retirement in 1995 from an Ontario Hydro advisory panel on the safety of CANDU reactors. He has made highly significant contributions in many fields, from basic science, through reactor control and safety circuits, reactor physics and power reactor design, to reactor safety and licencing. He has served in many capacities, as a researcher, as a manager of R&D, as president of the AECB, and as advisor to organizations such as the IAEA and Ontario Hydro.

At the Montreal Laboratory, Don was involved in the planning of the control and safety circuits of the NRX Reactor. Later at Chalk River, he introduced the concept of "pseudo fission products", a concept that led to highly effective simplifications in making design estimates of fission product effects on reactor reactivity and attainable fuel burnup. Don designed and built the first neutron spectrometer at Chalk River, and he enthusiastically encouraged a new recruit, Bertram Brockhouse, to pursue the completely new field of neutron inelastic scattering research. Dr. Brockhouse's techniques in neutron scattering were recognized world-wide, culminating in the award of the 1994 Nobel Prize for Physics.

In 1970, Don resigned from AECL to succeed George Laurence as President of the Atomic Energy Control Board. His leadership helped ensure the successful licencing of several projects. For example, the first CANDU unit of full commercial power was licenced for operation at Pickering A, and licencing activities for Bruce A and B, Gentilly 1, Pickering B and Point Lepreau were initiated. In 1974, the Director General of the IAEA appointed Don to chair a senior level advisory committee to oversee the Agency's Nuclear Safety Standards Program. The results of the NUSS program were a resounding success; 59 safety codes and guides governing all aspects of the regulatory organization of nuclear power were published under Don's direction.

Don received an Outstanding Contribution Award from the Canadian Nuclear Association in 1990, and the Tommy Thompson Award of the American Nuclear Society in 1994. He is a fellow of the Royal Society of Canada.

In summary, Don's long career in nuclear science and the nuclear industry has followed W.B. Lewis's example in fine style.

The CNA **Ian McRae Award** is for major contributions and achievements in areas other than scientific. The 1996 winner was Donald E. Anderson.

His citation read:

Don Anderson has been selected for the 1996 Ian McRae Award in recognition of his 32 years of outstanding contributions to the nuclear industry in Canada. He has played a leading role in the design, construction and operation of Ontario Hydro's nuclear generating stations.

Early in Don's career, he headed the design team at Sheridan Park working on the Bruce A regulating and

CNS president (95-96) (L) presents a certificate to Bill Midvidy condirming his being named a "Fellow of the Canadian Nuclear Society" at the CNA/CNS Annual Conference in Fredericton, June 12, 1996.

shutdown systems. Innovative design features introduced by that team included setback/stepback control action, and the poison injection system. Subsequently, his operating and design experience was used on the conceptual designs for Bruce B and Darlington.

In 1980, Don was named Project Manager, Bruce Nuclear Power Development, responsible for the design and construction of Bruce B. His outstanding leadership qualities forged effective relationships among engineering, construction and operations. This team dealt successfully with two large problems, loose garter springs, and loose steam generator shroud bolts, to minimize the delay in starting up Bruce Unit 6. While at Bruce, Don championed the development of the Bruce Energy Centre, a unique facility utilizing nuclear generated steam for process heat, Ontario's first large scale cogeneration project.

Murray Stewart, CNA president, (L), presents the W.B. Lewis Medal and certificate to Don Hurst at the CNA/CNS Annual Conference in Fredericton, July 11, 1996.

Don was founding Director of Ontario Hydro's New Business Ventures. His most notable successes included the establishment of the cobalt radiation service in co-operation with the AECL Radiochemical Company, and the creation of Ontario Hydro's international fuel channel inspection team.

In 1991, Don became Vice President, Design and Construction Branch. In response to the moratorium on new nuclear construction, Don reorganized the branch to improve support for operating plants. Under his leadership, the technical problems plaguing Darlington were solved and the four units placed in service. He established a commercial approach to the service business, establishing accountable units to serve each nuclear site. This approach became the model for the complete reorganization of Ontario Hydro in 1993.

In 1993, Don became General Manager of Ontario Hydro Nuclear, responsible for all aspects of the nuclear program. Don established a business culture based on mutual trust and respect, leadership, teamwork and staff involvement. Despite the recommendation of a corporate task force to close the Bruce Heavy Water Plant, Don convinced senior management to retain the plant as a viable business supporting AECL's international CANDU marketing program. Despite the turmoil of reorganization, Don led Ontario Hydro Nuclear to a record year in 1994, generating a total of 91.1 Terrawatt/hours, and contributing $992 million to debt reduction.

The CNA presented CNA **Outstanding Achievement Awards** to three persons and one team. The three individuals recognized were: Donald S. Lawson, John D. Murphy and Dr. Howard K. Rae.

The citation for **Donald S. Lawson** read:

As leader of the commercial arm of AECL, Don Lawson has ensured that CANDU and the Canadian nuclear industry have faced and been successful in the needs of the global marketplace and in coping successfully with international competition. Through his perseverance and apparent immunity to either fatigue or jet lag, Don provided the leadership and dedication required to open CANDU to global marketing opportunities. As a result of his unswerving commitment, Wolsong 2, 3 and 4 in Korea, and the recently commissioned Cernavoda 1 in Romania became reality, and AECL can aspire to the completion of 10 reactor sale in 10 years.

In his 16 years with AECL, 10 of them as President of AECL CANDU, Don made great contributions to CANDU engineering, design, development and project engineering. He took CANDU to mean just that (CAN DO), and he was not deterred by AECL and the disparate elements of the Canadian nuclear industry taking on the highly co-ordinated international giants of the industry from France, Germany and the United States. Without his dedication to winning a solid place for CANDU in international markets, the Canadian nuclear industry would not be contemplating further international successes and would be at the mercy of a languishing domestic marketplace.

Although very much known for his efforts to establish international opportunities for CANDU, Don never overlooked the engineering side of the industry. With a commercial orientation unfamiliar thus far at AECL, he led numerous strategically important initiatives in creating new engineering tools and improving CANDU technology, as well as new CANDU designs to meet changing market needs.

The commercial success of CANDU has created and maintained thousands of good jobs in the Canadian nuclear industry. These jobs were created thanks to hundreds of AECL purchase orders for equipment and services from over 150 small, medium and large companies throughout Canada, many of whom are represented in this room today. These jobs were created during Canada's most painful recession since the 1930s, when Canadian families needed and greatly appreciated the well-paid, highly skilled jobs which flow from CANDU reactor exports and the contracts for building and servicing them.

In 1993, Don led AECL into becoming a truly global competitor. AECL is still on that path, and it is for his foresight, personal dedication and commitment to CANDU and its success in the world that we are pleased to recognize today his outstanding contribution to the Canadian nuclear industry.

The citation for **John D. Murphy** read:

John Murphy has been very active in promoting and improving the Canadian nuclear industry since beginning his employment at Ontario Hydro's Pickering Nuclear Generating Station in 1980. His efforts have been directed in two areas: to improve the regulatory and safety aspects of the industry; and to support its continued growth and evolution.

John has actively pursued the first area through his activities as a union leader with the Power Workers Union. He led the team that negotiated lower worker exposure limits through collective bargaining with Ontario Hydro, leading to improved safety standards and greater acceptance of nuclear electricity production.

John has also represented the nuclear industry on numerous labour committees, including the Ontario Federation of Labour Energy and Environment Committee, and the Canadian Labour Congress Radiation Committee. He has worked diligently to increase the knowledge and support for the nuclear industry through the introduction of resolutions debated and passed at provincial and national labour conventions. John was also instrumental in revising a potentially damaging Ontario NDP policy statement on nuclear energy in 1990. His dedication and involvement was recognized in 1992, when he was chosen as the Canadian labour representative at the International Labour Organization conference in Geneva to discuss international nuclear safety.

John has headed numerous delegations to the Atomic Energy Control Board on regulatory and nuclear safety issues. He has served on both the CNA and the CAIRS Boards of Directors during the 1980s and 1990s.

John is active on the ITER Siting Board. He has accepted responsibility for being a spokesperson for the nuclear industry within the labour movement, and, more recently, on national television when he took the pro-nuclear position in a debate over AECL funding. John is also working for the future of our industry through submissions to the FEARO panel on behalf of the Power Workers Union in support of the concept for waste disposal proposed by AECL.

The citation for **Dr. Howard K. Rae** read:

Howard Rae's career with AECL extended from technical work on reactor chemistry and radio-isotope process development to management of a wide range of programs. The best remembered legacy from his lifetime career with AECL is his technical and managerial leadership to assure the supply of heavy water for CANDU reactors.

In the late 1960's, three large scale heavy water production plants using the Girdler-sulphide process were committed in Canada. The introduction of this technology was expected to be straightforward, since Canada had access to all previous American experience with the process. It was discovered, however, that American plants had been much over-designed, and many assumptions made for the new Canadian plants proved to be untenable. Before the mid-1970s, Howard assembled and directed a team of over 50 specialists to solve the problems of the Canadian G-S plants, and he co-ordinated the remedial activities of AECL, Ontario Hydro, and Canadian General Electric.

CNA president Murray Stewart presents the Ian McRae Award to Don Anderson at the CNA/CNS Annual Conference in Fredericton, June 11, 1996.

Problems included the sieve trays which provide the central element of the process of contact between water and hydrogen sulphide. These trays were found to be highly prone to loading up with water and then dumping it. Even when running properly, their efficiency was very low. Components were being corroded by the hydrogen sulphide, the seals on blowers were failing, and the heat exchangers and sieve trays were fouling.

Resolving the fouling and corrosion problems and improving performance took almost 250 person-years of work under Howard's leadership. The G-S plants became reliable, and the acquired knowledge was the basis for advanced designs of subsequent plants. This project took CANDU from teetering on the brink of death from thirst for lack of D20 to almost drowning in an excess of production.

This was a large effort to rescue the G-S production method, but it amounted to less than 3 per cent of the value of the heavy water produced.

Howard's technical and managerial contribution also laid the foundations for development of advanced heavy water processes. The amino-methane-hydrogen process was successfully developed in the late 1970s, and processes based on hydrogen-water exchange were advanced substantially.

Howard's career with AECL extended over four decades. His work included reactor chemistry, uranium isotope separation, radio-isotope process development, and irradiated fuel reprocessing. He was Manager of Chemical Engineering Branch, Director of Fuels and Materials Division, Director of Applied Research and Development, and Vice-President for Radiation Applications and Isotopes.

In 1978, he was honoured with the Canadian Society for Chemical Engineering's premier technical distinction, the R.S. Jane Memorial Lecture Award,

and he was that society's president in 1984-85.

For his unparalleled role in technological development and management of heavy water, Howard is a highly worthy recipient of the CNA's Outstanding Contribution Award today.

The CNA also awarded an Outstanding Achievement Award to a team; all the members of the **NRX Reactor Team** that kept that historic and world-leading facility operating for over four decades. The presentation was made to Mike Wright, current General manager of nuclear operations at the Chalk River Laboratories and Jim Arnott, chief steward of the Chalk River Nuclear Process Operators.

The citation read:

The 1996 CNA Group Outstanding Contribution Award is given in recognition of the achievements of a large team that made a world-acclaimed contribution to nuclear energy. This team designed, operated, maintained and supported the NRX Reactor at Chalk River during its 45-year life between 1947 and 1992.

As a facility for fuels and materials testing, basic research and radio-isotope production, NRX was without parallel or peer. As a symbol of the new technological frontier, it gave Canada world class status in nuclear science and technology, an excellent return on its investment that enabled the pioneering work that led to the design of the CANDU system.

CNA president Murray Stewart (L) presents Howard Rae with a CNA Outstanding Contribution Award at the CNA/CNS Annual Conference in Fredericton, June 11, 1996.

CNS vice-president Aslom Lone (R) makes a point to AECB president Dr. Agnes Bishop and former AECB Secretary – General John McManus during the CNA/CNS Annual Conference in Fredericton, June 1996.

1st International Conference on CANDU Fuel Handling Systems

by W J Knowles.

Ed. Note: *The following report on this successful first conference on CANDU fuel handling was prepared by Bill Knowles of GE Canada who was the Technical Program Chair. A paper on the operator's role in fuel handling is included in this issue of the CNS Bulletin and a pre-print of another paper on Pickering Dry Storage was in the last issue.*

This conference, organized by the Design and Materials Division of the Canadian Nuclear Society, was held at the Plaza II hotel on the 13th and 14th May 1996 where a total of twenty three papers were presented in four sessions. Over 80 delegates representing organizations in Design and Research organizations as well as industry and utilities, attended.

The theme of the conference was "Fuel Handling Systems: The Heart and Soul of CANDU - Implementation ,Operating Experience and Future Designs." The analogy here being that the Fuel Handling System is the mechanism that pumps the life blood, fuel, through the body of the reactor to sustain its vitality.

The papers presented could be placed in several categories such as:

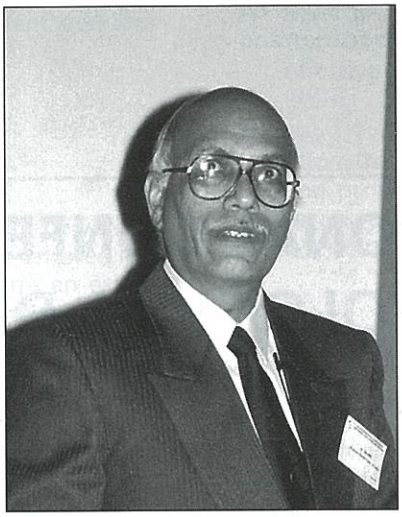
Traditional aspects including future equipment designs, structural analysis and instrumentation and control.

The effect of new fuel cycles and new fuel bundle design on fuel handling systems.

Operational considerations - commissioning, training, in service repair and maintenance.

Dry Storage.

Reactor inspection and remedial work carried out by the fuel handling system.



Dr. A. Ghare of the Nuclear Power Corporation of India speaks to the CNS International Conference on CANDU Fuel Handling Systems, May 14, 1996.

It is always stimulating to see concepts for new systems when designers are given the opportunity to design for a new station. This happens very rarely in the nuclear industry so it was interesting to note the different approaches taken for the next generation AECL CANDU 9 Reactor and the Indian Nuclear Power Corporations PHWR 500.

Papers by D. Ullrich and J. Slavik on the CANDU 9 F/M carriage and Z. Keszthelyi and D. Morikawa on the CANDU 9 Fuel Transfer system allowed comparison with the Indian work in two papers presented by A. Ghare, one on the Evolution and innovations of the 500 Mwe PHWR and the other the Design of fuelling machine carriage to meet seismic qualification requirements. Notable is the similarity of both using a magazine concept for transferring irradiated fuel, although the Indian concept also uses the same facility for transferring new fuel. The fuelling machine support at the reactor diverges in the two concepts with the AECL design going from a bridge support in the CANDU 6 to a carriage design as in Douglas Point; where as the reverse is the case in the Indian design going from the 220 MWe to the 500 MWe.

Two papers on I & C aspects looked at the upgrading of obsolete computer equipment. V. Leung and B. Crouse_s paper described the replacement of the PDP 11/70 computers with modern equipment from Quickware specifically designed to run the 11/70 code. Other up grades were also discussed. The paper from W. Ernst and D. Raymont addressed the use of configurable hardware as replacements for protective and control computers. These were likened to having the advantages of hard-wired logic and the flexibility of software control.

The effects of future fuel designs and cycles were presented. In a paper from P. Alavi et al, testing the compatibility of the new 43 element CANFLEX fuel bundle with the CANDU 6 F/M bundle separators was reported, while that from D. Koivisto et al noted the increased bundle through put required for some potential fuel cycles. Reference was made to the potential for the destruction of plutonium from nuclear weapons in CANDU fuel.

Operational aspects were covered by a presentation from Romania by C. Tiron on the commissioning and training at Cernavoda, while B. Keelan looked at creating and maintaining high operator standards at Darlington by training using the "Circle of Excellence" concept. On going design and development to address a typical 'Problem' maintenance job was outlined by D. Koivisto in his paper describing a remotely deployable bung to isolate the Pickering fuel transfer conveyor for maintenance. Another

Parva Alavi

very important aspect of maintenance is decontamination. R Pan described various techniques with particular relevance to fuel handling equipment.

The final part of the "On Station" fuel cycle was addressed by S Jonjev on the implementation of Dry Storage in concrete shielded casks at Pickering. The initial experience in transferring irradiated fuel from the bay into the casks and sealing them was described. This paper was followed by one from E Young on the conceptual design of a similar cask for Bruce. The main difference being that it would accommodate fuel in trays rather than modules and the casks would be for "on station" only allowing less stringent design criteria to be used. Jonjev's paper has been published in the Spring 96 edition of the Bulletin.

The major focus on reactor remedial work was on the use of the revised fuel handling processes and equipment in overcoming the reactivity power pulse concerns that were limiting the Bruce A reactors power output. Papers by M. Gray and P. Henry reviewed the changes required to allow the direction of fuelling to be reversed from fuelling against flow to fuelling with flow. This was Bruce A's chosen power pulse solution. An overview paper by R Day not only reviewed all the major options considered for the power pulse problem resolution at Bruce A and other stations but Provided an excellent explanation of the of the whole power pulse problem.

Steve Jonjev

The conference was considered very successful and there is every expectation of holding other fuel handling conferences in the future.

Copies of the conference Proceedings are available from the Canadian Nuclear Society.

INTERNATIONAL CONFERENCE ON DEEP GEOLOGICAL DISPOSAL OF RADIOLOGICAL WASTE

WINNIPEG, MANITOBA

16 - 19 SEPTEMBER 1996

This conference will bring together several hundred experts from many countries developing geological disposal technologies. Sessions will cover the technical, social and economic aspects of deep geological disposal of all levels of radioactive waste.

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Fuel Handling – Pursuit of Excellence in Operator Performance [1]

Bryan Keelan and Brad Curle[2]

Ed. Note: *The following paper was one of a very few papers at the CNS International Conference on CANDU Fuel Handling Systems, held in Toronto in May 1996, that dealt with the role of the operators, in contrast to design features.*

Foreword:

Performance of any F/H system is heavily dependent on the performance of the system operators. Sadly, this topic often receives little attention until incidents occur.

Darlington has taken a proactive approach designed to reach and maintain excellent operator performance.

F/H System at DNGD

The Fuel Handling system at DNGD can be viewed as a special purpose robotic manipulator encased in a pressure vessel. The pressure vessel forms an extension of a reactor Primary Heat Transport System during fueling operations. Fuel Handling routinely passes fuel through containment boundaries, and handles irradiated fuel bundles, each one of which can contain active elements several orders of magnitudes greater than allowable releases to the public.

The fuel handling system at Darlington has three trolley systems and two Fueling Facility Auxiliary Areas (FFAA's). The three trolley systems run in a common ducts under the four units to visit either a unit that needs fueling, or to an FFAA to load new fuel or discharge irradiated fuel.

A trolley consists of two half trolleys, and its associated FFAA. Each trolley half has a fueling machine, and a set of auxiliaries that provide D20 and air at appropriate pressures and temperatures as is required during the fueling process.

Control System

The operational computers scan and operate about 5000 I/O points and operate 4 work stations per trolley half. The main workstations have a CRT and two keyboards for operator interaction.

The computer controls the system in real time. Operators insert high level commands called 'jobs' which define for example, the number of bundles to be pushed in a reactor channel.

Operator Interaction with F/H

The man machine interface puts the operator in the loop in three ways:

1) Command – The control system requires operators to initiate fueling runs. Following initiation, operators monitor the system to have a clear view of the status and to be able to act appropriately in an event.
2) Monitor – Sensor display data tell the operator the status of the system, and allows him to take effective action to maintain control during an event.
3) Log – The system logs all auto and manual operation. Operators manually log fueling operations and problems. This provides an opportunity to review operator and machine performance at a later date if required.

Field Work

The Fuel Handling system requires extensive field support. New Fuel Bundles must be loaded into the New Fuel (NF) mechanism, and their serial numbers must be entered into the bundle tracking system. When fuel comes out of the reactor, storage modules must be loaded onto the Irradiated Fuel Discharge Mechanism (IFDM), and must be moved for final storage when full.

Any special work requires the loading of special equipment or components. Discrepancies between the expected and actual components in the FM can have drastic consequences at the unit.

Previous Training Systems

Operators were trained by using several levels of

[1] Paper presented at 1st International Conference on CANDU Fuel Handling, Toronto, May 1996.

[2] Bryan Keelan and Brad Curle are at the Darlington Nuclear Generating Division of Ontario Hydro.

Training Manuals (TM's) to operate the machine via operating manuals. The TM's explained and justified the principles that operators must follow in the Operating Manuals (OM's), and deviate only with appropriate authorization. Although good in theory, often there was missing or conflicting information. Often the TM's did not reflect the OM information, and were not kept up to date. Many situations were not covered in either document.

The training manuals were poorly written, making information transfer even more difficult.

As a result, much of the training was done via 'oral tradition' or individual beliefs held by senior operators as to status of systems. Often based on faulty information or misunderstanding, these legends developed a life of their own independent of the station documentation. This process was a major impediment in the pursuit of operator excellence.

Many standards and expectations were implied. Not formally documented, individual interpretations led to haphazard interpretation and execution.

Requirements for Operators

The goal of any operator performance program can be stated simply:

Ensure the system is operated safely and correctly, and correct responses are made to fault conditions.

Excellence in operator performance is achieved when this standard is defined, and always met.

Taking these very general statements and converting them to usable daily directions is where the circle of excellence comes in. The circle generates standards and expectations which cover both the philosophy and direct operation of the job, as no set of written instructions can cover all issues.

Circle of Excellence

The unified approach to operator excellence is best described in the model described in Figure 1.

The circle model conveys several important concepts:

The movement is continuous and self renewing. As individuals enter into the circle, their actions and experiences are a building block for the next step.

The circle is an iterative process, adaptable to the real world, where 'perfection' is a moving and changing definition.

The circle has mechanisms for defining a direction, determining how far off from that direction you are going, and it has tools to get you back on track. Since the redefinition phase repeats, the circle analogy allows for changes in direction as the work environment changes.

Initial Selection

Initial selection of candidates is based on corporate hiring practices, which provides assurance of a reasonable level of capability. Movement in Fuel Handling is mostly on a volunteer basis, which is the first step in having a positive motivation towards job excellence.

Initial Training

Initial training (level IV) at DNGS starts with a common stream for all operators. Courses cover the full range of station systems and both radiological and conventional safety.

Fuel Handling Specific Training

Following completion of generalist operator training, candidates may wish to enter into the F/H department. This set of training is performed in the following order:

Field Training: Operators are trained in all the field equipment, with a combination of classroom and on the job training. Expectations are that they will obtain a clear understanding of all F/H field equipment by the time they are fully qualified.

Main Panel Operator (MPO): The MPO level of training begins where the field studies stop. Candidates are introduced to the control panels and control systems. Training concentrates on explaining the 'why' as much as the 'what' of control system operation. Candidates are examined to ensure they have an in depth knowledge of fuel handling from a panel perspective. Mastery of this package allows candidates to be co-pilots.

Co-piloting

Co-piloting is the transition phase where individuals combine knowledge based training with actual operational experience. They are allowed to perform OM procedures under the direct supervision of a qualified panel operator. This allows them to gain experience in a limited risk situation.

After the specified period of co-piloting, a final interview concentrates on Operating Principals and Procedures (OP&P's), and the Recommended Operating Practices (ROP's). These emphasize the operating philosophy as much as the logic. Operators at this level have the additional responsibility of dealing more with interfacing work groups, i.e. maintenance, Authorized Nuclear Operators (ANO's) who operate the reactor units.

Experience

Experience is the grist of the mill in the pursuit of excellence. Operators, like most of us, learn a great deal through properly structured experience, in both the co-pilot and operational phases. Experience generates the problems which measure the successes and failures of the process. Properly recorded, experience helps point the direction to excellence.

Standards and Expectations:

Standards and Expectations are key to the pursuit of operator excellence. Individuals will not strive for excellence is they do not know what excellence is.

Standards are measurable goals against which performance of specific actions are measured. Expectations are the requirement that certain actions be performed or attitudes be upheld.

The standards and expectations documents are the base of the pursuit of excellence.

– Standards and expectations define the current definitions of excellence, or the manner in which it may be approached.

– By comparing standards and expectations against a new goal, or challenge, it measures the amount of change required to move to the new direction.

– Standards and expectations define the requirements of tools to get to the level of required excellence.

Expectations come from the stakeholders in the performance process, customers, and the group themselves. They include technical and maintenance groups, the operations coordinator, and the operators.

Generation of Expectations

A major thrust at DNGD in the last year has been to formalize standards and expectations.

DNGD has taken the tack that there must be 'buy in' for expectations to be adopted generally and upheld. The first stage is for management to provide the expectation that the F/H system will be operated with a high degree of professionalism. 'Performance Objectives and Criteria' provide a starting point. The next step is to have operators accept that having published expectations is a valuable tool to achieving the first, agreed upon expectation.

The fact that operators provide many of their own performance standards is a measure of the buy-in they already have. Operators (as with other work families) recognize any tool that helps them achieve excellence is in their own self interest. No one wants to initiate or worsen a caper.

The generation of 2nd level expectations was done in a cooperative environment to maximize buy-in.

Expectations were fleshed out by field staff, and given concrete form that was meaningful in the work environment. As an example, a housekeeping standard by itself is open to interpretation, as two people may have two different views of acceptability. A concrete interpretation of that general standard came from a field operator: "all fuel pallets must be stacked in the north end of the fuel area".

Vigilance

The lessons learned by experience are only retrieved through vigilance. The skill, or expectation is hard to cultivate, and easy to loose. Issues such as a positive attitude for incident reporting, perceived positive effects of previous reports, must be addressed to have an effect vigilance program. A vigilance program is often made more effective by the use of a reporting system:

Fuel Handling Incident Report (FHIR) and Technical Section Input

To aid in the process of vigilance, Darlington NGD has incorporated a FHIR data base, with the Significant Event Report (SER) database. FHIRs have a format similar to SER's, but with circulation limited to the F/H family. F/H personnel enter depersonalized reports of incidents that may affect F/H, but are not classified as SER's. FHIR's are reviewed by operating maintenance and technical section and action items are generated. Regularly, the action items are reviewed for completion and are closed out when complete.

FHIRs perform several functions: 1) they may indicate short coming in the OM's or TM's, 2) they may indicate a good response to an incident that should be communicated to the operator group; 3) they may illustrate a new hazard that is not clearly understood; 4) they may document an ongoing problem that needs attention from another work group.

Follow-up actions of FHIR's often involve the Technical Support Unit, and/or design. FHIRs help those groups focus on issues important to the operator group.

Internal Peer Capability

Another important player in directing the pursuit of excellence is an Internal Peer capability. On an ongoing basis, this process asks people, "Are we going in the right direction and are we near where we want to be?" Examples of internal peer tools are questionnaires and specially trained people who compare standards and expectations documents with day to day operating experience.

Training and Operating Documentation Updates

The results of FHIR's, and Internal Peer Audits must be used to ensure training and operating documents reflect the pursuit. Documentation that is out of date brings the whole system into disrepute, the reduces the by-in for the rest of the process. Updating of the documentation demonstrates to the operator family that their needs are important, and that the job is important, besides the obvious attributes of having correct procedures and information.

Motivational Tools

There are various tools available to shape the performance of the operator family. Many have been tried and found wanting. The secret of successful use is a combination of how the tool itself is formed, along with its use.

Tools for the pursuit of excellence are often straight forward. If a standard requires that a certain action be performed safely, a tool will be an authorized procedure to perform that function. Operating manuals, training manuals are tools to reach a standard of system knowledge.

Job expectation guides both inform and measure against the current definition of excellence, as embodied in the document.

The model of the pursuit of excellence in itself is a tool, used to visualize the process.

A second key tool of motivation is respect. Members of the F/H family must respect each other, and the contributions they bring to the table. Each job group must realize the important contribution the others make to the overall goal of F/H.

Respect (buy-in)

Respect must infiltrate every element of the model for it to be effective:

Operators must respect the aims of the program, the tools that are provided, and the trainers, and standard providers.

The standard givers and trainers must provide tools the operators can respect, and must respect the operators ideas and opinions. Respect and disrespect are shown in many different ways. One of the most important aspects in this model, is appreciating and considering other peoples points of view, and not discarding them simply based on the source. It is important to recognize that each group in this circle brings different talents to the table, and there is no one group that has monopoly on them all.

Job Performance Measures

Job Performance Measures (JPM's) provide an important tool to measure quality of the physical actions of an operator. The JPM instructs the operator to perform a certain sequence of operations, using the real equipment. This allows the operator to form a kinetic (body image) memory of the action, increasing the chance of correct operation in the time of need.

Refresher Training

Refresher training provides a means of the operators meeting expectations on an ongoing basis. Refresher training reinforces components of the job expectations that are not normally performed as a part of day to day duties.

Key aspects of refresher training are:

Selection of Training Topics

The FHIR data base helps in the selection of training topics. New hazards, challenges, or changes covered since the last session are easily detected and covered. Topics will be relevant as they have already happened.

Refresh rate

The refresh rate is affected by the complexity of the covered material and the rate of use in the field, and the projected use of the information.

As an example, refresh training on maintenance equipment used during outages should be provided, and provided just before use during the outage.

Procedures seldom used, i.e. power transfer procedures, should have a higher refresh rate than a procedure that is used every fuelling push.

Fitting in Shift Cycle

Since the customers for the training are usually on shift, multiple editions of the training should be considered.

Problem Reporting and Feedback

Trainers must be responsive to course feedback. While it will not be possible to please everyone, feedback can provide important considerations for course design.

1996 CNS Technical Sessions

Chaired by
Paul Thompson – NB Power
Graham MacDonald – ANSL

This year's CNS technical sessions were a huge success (or so we are told... we try not to believe our own press releases). There were 19 sessions spread over two mornings and three afternoons, with over 90 high quality papers presented. The sessions covered practically every aspect of current interest in the nuclear industry, with the crown for the strongest crowd turnout arguably going to the plant operations and maintenance sessions. The sessions were chaired by industry's finest, and their experience and influence was both felt and appreciated at the conference.

Organizing the technical sessions was both challenging and rewarding, and the work didn't stop until last call on the Wednesday afternoon of the conference. Juggling the different needs and wants of the conference and organizing it into a comprehensive program took a lot of long days and nights, but the work definitely paid off.

Perhaps one of the most interesting and pleasant surprises of the conference was the strong turnout for the Wednesday afternoon sessions. Typically, the afternoon sessions on the last day of a conference have suffered from poor attendance as people leave the conference to catch their flights or for various other reasons. This time around, some of the marquee papers were presented at the end of the conference, and consequently, people stuck around to see them.

We are looking forward to next year's conference in Toronto, and from us in New Brunswick who have "been there and done that", we wish the new organizing committee the best of luck in 1997.

CNS Session A.1: Design & General Information Chaired by Glenn Archinoff, ALARA Research

The session consisted of 5 papers on diverse topics, but the common theme running through all papers was the ongoing challenges which face the industry. These challenges are applicable to both operating stations and to new designs. The first paper, "Overcoming the Fear of Radiation: The Key to the Golden Age of Nuclear Technology" was written and presented by J.M. Cuttler of AECL. Jerry is also President of the CNS. Dr. Cuttler outlined the irrational fear of radiation held by many people, and provided us with substantial evidence with which to refute the claims that any dose due to radiation from nuclear power is too much. Overcoming this fear is a challenge faced by utilities which operate nuclear power plants, and by vendors seeking new markets for nuclear power. Because the fear is based on emotions, it is particularly difficult to overcome. Nevertheless, it must be if we are to have a flourishing nuclear power industry. The second paper was titled "Increasing Operational Effectiveness and Reducing Licensing Risk of Design Changes to Nuclear Power Plants", written by M.P. Feher and E.C. Davey of AECL-CRL, and M. Tullet and C. McIntyre of Ontario Hydro - Pickering. The paper was presented by Mark Feher. This paper used the Critical Safety Parameter Monitoring system at Pickering as an example of how design changes involving human-factors engineering could be successfully implemented and licensed. At the start of the project, there was great concern about controlling the licensing process, as costs could mount if the process got out of hand. Mark described the steps taken to ensure that the AECB were kept informed throughout the project, and concluded that licensing risks can be controlled if handled properly. The third paper was titled "Staff Training Program of CANDU Projects in Saskatoon", and was written and presented by J. Huterer of AECL in Saskatoon. Joe described the challenges which faced AECL as they started up their Saskatoon office. There were many inexperienced staff, and staff in new roles. A comprehensive technical and business training program was mounted and executed, including a full complement of audits. Following implementation of the program, an AECB audit had no significant findings. The fourth paper was titled "The Evolution of CANDU 6 Design" written by J.M. Hopwood, P.J. Allen and A.R. McKenzie of AECL, and presented by Jerry Hopwood. The paper described how the CANDU 6 design has evolved by taking into account operating experience from the existing stations in Canada and abroad, developments in the nuclear power industry in general, and safety improvements made possible as a result of ongoing experimental programs. The challenge facing the designers is to deliver a plant that results in cheaper power than CANDU 6's competitors, yet still achieves the outstanding performance for which CANDU is renowned. The final paper was titled "Preparing for the Future: The Implications of the Information Revolution for the Canadian Nuclear Industry", by M.O. Luke of AECL-WL. Mike described business trends spurred by the information revolution and talked about the changes needed by the industry to cope with and prosper from the information revolution. Although all of the papers were on different topics, the common thread was that there are still many interesting challenges facing the industry. Some have been overcome, and we can learn from these successes, but there is still lots of hard work to do.

CNS Session A.2: Waste Management & the Environment Chaired by Judd Tamm, AECL-Whiteshell

This session represented a rekindling of Society efforts to expand technical presentations on nuclear waste management and environmental issues at CNS conferences. The first two papers dealt with the importance of consulting the public when performing environmental assessments of nuclear projects. Dr. David Malcolm, Director of the Aurora Research Institute, Inuvik, shared his experiences working with aboriginals in northern Saskatchewan, as they participated in the federal environmental assessment reviews of uranium mining projects and the nuclear fuel waste disposal concept. His advice was that aboriginal groups should be personally consulted, before draft environmental assessment documents are

written; to allow a mutually acceptable position to be reached prior to decision being made by project managers. Bob Pollock, Director of the Low Level Radioactive Waste Management Office, Ottawa, shared his Office's many examples of successful public consultation efforts during environmental assessments of low-level radioactive cleanup activities from Fort McMurray, Alberta to Port Hope, Ontario. Ongoing cleanup work north of Fort McMurray has the Office staff consulting with the affected aboriginal groups prior to any environmental assessment documents being produced. The third paper, by Prof. Greg Naterer, Dept. of Mechanical Engineering, University of New Brunswick, presented a one-dimensional analysis of energy and species transport during solidification as might be applied to represent solidification of castings in used nuclear fuel containers. The model is able to capture recalescence or local momentary heating effects which may affect final casting properties. The model was compared to experimental results of solidification of aqueous ammonium chloride solutions in a rectangular enclosure.

CNS Session A.3: Instrumentation & Control I Chaired by John Pauksens, AECL-CANDU

This session consisted of four papers regarding recent developments in CANDU Control Center design. Two of these papers deal directly with key aspects of the CANDU 9 control centre design, namely, the control room mockup, which is being as a tool for developing and verifying the CANDU 9 control room design, and the distributed control system (DCS) , which will be used to implement real time plant data acquisition and plant control functions in the CANDU 9. The other two papers have a more generic flavor and deal with the "Advanced Control Centre Information System (ACCIS)" which is presently under development at AECL, and Plant Historical Data Systems (HDS systems) , which have recently been under investigation as part of the CANDU Owner's Group (COG) R&D programme in instrumentation and control. Both the ACCIS system and the work on HDS are aimed not only at new plant designs such as CANDU 9 , but also at retrofit applications in existing plants. All four papers have a common thread in that they all deal with the introduction of new computer technology, with considerable cost-related and functional benefits, into CANDU Control Centers. The following is a brief summary of the papers: CANDU 9 Control Center Mockup, presented by Anthony Webster (AECL-Saskatoon). A control centre mockup facility is being used on the CANDU 9 project as a tool for developing, evaluating and validating the human system interface design, for integrating the distributed control system (DCS) the Plant display system (PDS) and other control centre equipment, and for evaluating and verifying "critical" main control room operator actions. The facility is in the dual form of a 3D CADD model and a model full scale control room, and includes a safety system console, a main operating console, a fuel handling operator's console, main control room panels, a computerized annunciation system, and a central plant overview mimic. The 3D CADDS model allows conceptual designs and layouts to be evaluated before implementation in the physical mockup, thereby providing a cost effective method for procurement and installation of the mockup equipment and an auditable trail of the evolution of the control centre design from the original reference design to the final new product. Distributed Control System for CANDU 9 Nuclear Power Plant, presented by J.E. Harber (AECL-Saskatoon). The computer-based portion of the CANDU 9 plant monitoring and control systems consists of two interconnected computer systems, the Distributed Control System (DCS) and the Plant Display System (PDS) . The DCS system performs data acquisition and device- and group-level control functions, while PDS is used to implement higher level user interface functions. The CANDU 9 DCS design is based on the use of ABB Procontrol P13/42 programmable controller and data highway products. To ensure good immunity of DCS from common mode faults, a functional partitioning scheme, fail-safe features, and redundancy are used to good advantage. Detailed development and review of DCS application software will be done with a function block language for process control. Significant portions of the DCS partitions will be prototyped in the CANDU 9 control system mockup, facility, and will be tested and proven with the help of the CANDU 9 PC-based plant simulator. At the present time DCS system design requirements and the software development process have been approved and issued for use, and concepts for the DCS system hardware design are being developed and tested on a prototype system in the CANDU 9 control centre mockup. Advanced Control Centre Information System (ACCIS) presented by W. Fieguth, (AECL-Sheridan Park). The ACCIS System, which is currently under development at AECL, integrates commercial, off the shelf computer and software components into a standard configuration which will be used for implementing plant display systems both for new CANDU's, such as CANDU 9, and for retrofit applications. Where suitable off-the-shelf components are not available, some custom design will be undertaken. The design goals for the ACCIS project are configurability and scaleability for diverse applications, portability between hardware platforms, consistent speed of response, robustness (i.e. graceful degradation in response to component failures), and on-line maintainability. Typical functions of the system in a full scale application such as CANDU 9 include fuel handling supervisory control, unit supervisory control, safety system monitoring, fuel handling technical support, unit technical support, and safety system technical support. The technical support functions include storage and retrieval of plant historical data and annunciation messages, and analysis tools for these data. The system concepts for ACCIS have their roots in the CANDU DCC system design which has served CANDU well for many years; however, the ACCIS system embodies substantial advances in the deployment of current off-the-shelf software and hardware technology in a durable and cost-effective computer system configuration for the future. Canadian CANDU Plant Historical Data Systems: A Review and a Look to the Future, presented by M. Deverno (AECL- Fredericton). As part of several CANDU Owner's group (COG) projects, AECL has conducted a review of current approaches and investigated solutions for the future, for the collection, management, and subsequent use of plant process data. The systems for doing this are commonly referred to as "Historical Data Systems" or HDS systems, and are emerging as a critical information technology for supporting all aspects of plant operation and maintenance. The primary focus in these HDS systems is typically on activities outside the control room. Some HDS functionality has, by now, been implemented by the operating utilities at all of the domestic CANDU plants. However, the existing systems have, to varying degrees, a number of limitations, including limited data sources, limited storage capabilities, data transmission bottlenecks, limited accessibility across the entire plant, lack of user friendly data extraction and analysis tools, and limited integration with data from work management and other business systems. The

paper describes a model for plant-wide historical data systems for the future, which overcomes these and other limitations. The proposed new HDS system model has excellent prospects for reducing OM& A costs and improving plant capability and capacity factors through the improved utilization of plant historical data.

CNS Session A.4: Safety Analysis I Chaired by Graham MacDonald, ANSL

This session was originally slated to be chaired by John Luxat of Ontario Hydro RSOAD, but John was unable to attend due to a case of laryngitis. The session covered a very broad spectrum of safety analysis topics and enjoyed a large audience. The presentations were started off by Ed Moeck, director of fuel and thermalhydraulics at AECL, who presented a paper which discussed the use of a systematic and standardized methodology for the validation of safety analysis codes against experimental and operational data. Sergio Russomanno, AECL's station services director at Darlington, presented a paper on a statistical approach for calculating instrument loop errors in special safety systems. At this time, the presentations were momentarily interrupted by a power failure at the Sheraton, but the session continued after a short break and the resetting of an electrical breaker. Krish Krishnan, senior engineer at the Bruce-A nuclear safety department, gave an interesting PowerPoint presentation on the probabilistic risk of loss of shutdown heat sinks at Bruce-A, and how these risks can be quickly assessed with the use of a fault tree model. Michel Demers, from the Gentilly-2 reliability group, presented a paper on a reliability study for emergency core cooling loop isolation valves, which demonstrated that valve failures are more attributable to the demanded usage than the service time, and presented a case for the reduction of valve test frequencies. After a short break, Ken Locke, from the Bruce-A nuclear safety department, presented a paper on the effect that a LOCA induced flow reversal would have on the fuel bundles, and looked specifically at the fuel bundle impact velocities that would be generated by such an event. The final paper of the session was presented by Wen Tong, a senior consultant of EQE international, based out of Irvine, California. His paper delt with the seismic fragility and qualification of multi-storied buildings at CANDU plants. Unfortunately, Wen's very interesting presentation had to be cut short due to the fact that the conference room had also been booked for the CNS annual general meeting.

CNS Session B.1: Reactor Physics Chaired by Al Wight, AECL-Saskatoon

The reactor physics session got under way with the paper "On-Line Power Monitoring in CANDU using PMFD" by John Pitre of AECL-CANDU. The PMFD program has shown to be an accurate and computer friendly method of monitoring channel and bundle powers on-line. The next two papers were presented by Jack Walsworth of Atlantic Nuclear Services, and they were titled "In-Reactor Test to Assess Alternate Scheme for Adjuster Rod Banking of the CANDU-6 Reactor" and "Performance of the Regional Overpower Protection Trip System during Reactor Shutdown and Restart Conditions" respectively. The first paper delt with the problems of the partial withdraw of in-core adjuster absorbers, and explained how this problem could be remedied by breaking up the control of the last bank of adjusters into individual rods. Jack's second paper delt with the re-assessment of the operating limits, tolerances and calibration procedures of the Regional Overpower Protection Trip (ROPT) at PLGS using data from a reactor trip and recovery. Jim Donnelly of AECL-CANDU presented a paper on "Modeling of CANDU Reactivity Devices with WIMS-AECL/MULTICELL and Superhomogenization", which represents a new method for analyzing reactivity devices, and which shows good agreement with more detailed Monte Carlo and collision-probability 3-D calculations for adjusters and ZCU's. "LEU-Fueled Slowpoke-2 Modeling with MCNP4A" by Hughes Bonin of the Royal Military College of Canada, discussed the modeling of the RMC Slowpoke reactor using the Monte Carlo N-Particle Transport code system and how this compared to excess reactivity measurements. Hyundae Kim from the Korean Institute for Advanced Engineering (IAE) finished off the session with "A Multi-Point Kinetics Model Applied to Three-Dimensional Neutronic Transient Analysis" which discussed the modeling of neutronic transient problems and comparing them to standardized benchmarks.

CNS Session B.2: Instrumentation & Control II Chaired by Werner Fieguth, AECL-CANDU

Unlike the other I&C session, which was fairly narrowly focused on the CANDU control room, this session provided considerable variety, from upgrades to aging CANDU digital control computer systems through statistical process control and wavelet transform techniques to improve process monitoring and signal noise reduction, to a novel high temperature ultrasonic flow measurement device. Five papers were delivered in this session - a very brief summary of each follows. Hardware Replacements and Software Tools for Digital Control Computers, presented by R.A.P. Walker (AECL-CANDU). This paper describes the results of efforts of AECL's DCC service support group to replace a number of obsolete components and to provide friendlier software related to maintenance and use of digital control computers in CANDU. The DCC computers are 1970s vintage technology, and although they have served and continue to serve admirably, some of the associated system components are obsolete. These include the paper tape reader/punch, the moving arm disk, the contact scanner and the Ramtek display. Functionally equivalent components using more modern technology have been designed and built, which are smaller, simpler, more reliable and easier to maintain. Minimal or no software changes in the DCCs are required to use the new replacement hardware. A complementary development by the same group is a suite of desk top tools to enhance productivity of DCC software maintenance staff. These include a Varian cross-assembler and cross-linker, a fixed head disk manager, a DCC file access system, and a DCC emulator. These tools allow maintainers to conduct most of their work using modern, fast IBM compatible PCs, up to and including the testing of DCC software using the DCC emulator. Further enhancements and developments are planned to help extend the life of CANDU control computer systems. Development of DCC Software Dynamic Test Facility, presented by A.M. MacDonald (AECL-CANDU). This paper describes a test facility for future dynamic testing of DCC software used in the control computers of

CANDU power stations. The test facility consists of a network of three IBM PC compatible computers and suitable software. One computer is a DCC emulator (referred to in the previous paper) which directly runs the binary image of the actual DCC software. The second computer is a CANDU plant simulator, which accepts DCC control signals and returns realistic transient plant process signals. The third computer is a test computer, which runs AECL's Test Language Interpreter; it can automate testing functions, generating test scenarios from test scripts which manipulate the I/O values 'seen' by the DCC emulator. The test computer can log test results and provide summaries for test reports. This test facility is much more powerful and convenient than traditional DCC software test methods. With modern Pentium CPUs, real-time emulator and simulator performance can be achieved. Together with the cross-development tools, this facility will in future allow software production and testing ahead of actual hardware delivery. Comparison of Multivariate and Univariate Statistical Process Control and Monitoring Methods, presented by R.P. Leger (McMaster). This paper presents research into possible advantages of using a multivariate approach to monitoring a process such as a nuclear power plant, over traditional univariate statistical process control schemes which look at each plant variable individually. The multivariate approach uses principal component analysis (PCA) to derive a much smaller set of variables which are linear combinations of the basic process measurements. The linear combinations are selected based on signal correlations in normal plant operating data. The two approaches are compared in their ability to detect upsets in a simple test system. Fault detection times are about the same in the two approaches, but the multivariate method is thought to give significant advantages in data presentation to the operator because of the reduced dimension of the problem. It is thought that the new method may prove useful in fault diagnosis, because the multivariate analysis provides useful information about the most important contributors to the detected fault. Further work is suggested to explore the fault diagnosis possibilities more fully. Use of Wavelet Transforms for Signal Denoising of Nuclear Power Plants, presented by W. Thompson (Atlantic Nuclear Services). This paper describes the theoretical background of wavelet transforms and how they can be used to filter noisy signals. It then describes a software package developed by ANS which applies this technique in a user friendly fashion to plant process signal records to help in process analysis and diagnosis. The wavelet approach is said to be superior to traditional filtering techniques where data samples over only a finite period exist and where the process signal may have strong transients which need to be preserved, i.e. not filtered out along with the noise. The process was successfully applied during Lepreau's recent start-up following its extended outage, specifically to filter noisy temperature signals in order to estimate channel flows from the time delays in temperature rises between the inlet header and the channel outlet feeders. Reactor Coolant Flow Measurements at Point Lepreau, presented by R. Jeppeson (Canatom). This paper describes the CROSSFLOW cross-correlation flow meters recently customized by AMAG for use in measuring Point Lepreau heat transport flows, both in the large pump suction lines and in much smaller individual fuel channel feeder pipes. Novel aspects of this new meter are its ability to operate reliably and for long periods at high temperatures (300°C) and radiation levels (>100R/hr), its compact size which is compatible with use on feeders in the crowded feeder cabinet, and its ability to function with unmodified feeders (no surface machining). Such an instrument was successfully developed, tested and installed in Lepreau on two pump suction pipes and four feeders. They have been used at all power and temperature levels, and continue to operate correctly and accurately after five months of full power operation. Further development will concentrate on improving measurement accuracy to a target level of 1%. Current measurement error (95% confidence) is about 3%.

CNS Session B.3: Thermalhydraulics I Chaired by Parviz Gulshani, AECL-CANDU

The session started at 9:30 a.m. due to withdrawal of the first two papers. The session was well attended. Four papers were presented. The first paper, by R. Girard on "Simulations of a hypothetical stuck open LRV at PLGS" using CATHENA with the PLGS plant controller program LEPCON, discussed the importance of thermodynamic non-equilibrium on degasser-condenser valve performance and the importance of the initial pressurizer water level on the simulation results. One of the questions that followed the presentation was on the effect of non-condensables. The second paper, by M. Cormier, R. Girard, and A. Galia on "Commissioning of CATHENA/LEPCON to simulate plant transients at PLGS" discussed the results of simulations of actual plant power transients. These simulations provided a code verification. The discussion following the presentation was on the effect of measurement (such as power) uncertainties, comparison with the Wolsong I D20 spill, etc. The third paper, by L. Shoukas, G. Martin, S.F. Ho, Z. Saddiqui, and B. Phillips on "Use of operational data for the validation of thermalhdyraulic models", presented an interesting comparison of SOPHT and mini-SOPHT simulations of the station operational transients with operational data. The paper demonstrated a validation process for the codes and use of the codes as performance monitoring tools. Following the presentation, the effects of correction for the static head and type of two-phase multiplier used were discussed. The fourth paper, by M.P. LeBlanc , G.F. Naterer, and R. Girard on "1-D numerical model of CANDU fuel channels using the SIMPLEC method", demonstrated a simple, robust method of solving homogeneuous flow conservation equations. The results of this method agreed closely with those of ASSERT-PV.

CNS Session B.4: Safety Analysis II Chaired by Marc Petrilli, Hydro Québec

The session was started by Walter Thompson of Atlantic Nuclear Services Reducing with his paper "Uncertainties in Moderator Sub-Cooling Assessments - Activities Underway at PLGS" which details the steps taken to reduce the moderator temperature at PLGS and thus increase the subcooling margin in the event of pressure tube/calandria tube contact. John Mackinnon of Onatrio Hydro - RSOAD presented "MOD-TURC_CLAS Analysis of Moderator Poison/Coolant Mixing in the Calandria due to a Pressure Tube/Calandria Tube Guillotine Rupture during an Overpoisoned Guaranteed Shutdown State" which covered the study of mixing characteristics and spatial and temporal evolution of poison concentration fields during an in-core LOCA. Mohd Sajid Quraishi presented the next two containment oriented papers titled "A Model for Turbine Hall Pressure Relief Panel" and "Prediction of Fan Assisted Flow in a Duct/Pipe Network", respectively.

The first paper discussed his dynamic modeling of the pressure relief panels that had been installed on the PLGS turbine hall, and the second paper covers the work done to formulate an algebraic model for pipe/duct network systems that can replace the empirical methods that are presently used. The next paper was presented by Patrick Spitz of IPSN (France) titled "Modeling of Condensation or Evaporation Transients in the PITEAS and PHEBUS FP Containment Vessels", and it delt with checking the validity of various correlations and models in condensation transients by comparing against test data acquired in the PITEAS facility. The last paper of the session was presented by Keith Scott of Atlantic Nuclear Services, titled "Using Microgravity Conditions to Measure Aerosol Physics Parameters for Containment Analysis" which discussed the use of parabolic flight trajectories that are used to generate a microgravity environment in which aerosol aggregation can be studied, and then analysed using fractal geometric methods.

CNS Session C.1: In-Core Instrumentation Chaired by Tantawy Attia, Ontario Hydro - RSOAD

The session started on time and finished on time with 2 minutes break after the third paper. Five papers were presented in this session. The session was well attended and the number of attendees varied between 12 to 27. All papers were well presented and stimulated useful discussions. Three to 5 questions were asked for each paper. David McAllindon, of I&C Branch of Chalk River Laboratories, presented 2 papers; "Comparison of Measured and Predicted Sensitivities of In-Core Flux Detectors" and "Noise Analysis Based Validation of the Dynamic of In-core Flux detectors". In the first paper, David described the work and the results of a series of measurements that have been performed on in-core detectors in the NRU research reactor at Chalk River. This is the first measurement of the effect of long irradiation time on the SIR Pt-clad, Inconel and Vanadium detectors. For the Pt-clad and Inconel detectors the perdition is about 30 % higher than measurements. Further work is needed to explain the source of this discrepancy. For the Vanadium detectors the agreement is reasonable. In the second paper, David described the Ontario Hydro noise analysis program. He described how noise analysis can be used to assess the dynamic of the in-core detectors, detect and confirm failed detectors by comparing two detectors in the same location, and detection of vibrations in assemblies and fuel channels. Tim Qian (pronounced as "Chen"), of the I&C Branch of Chalk River Laboratories, presented 2 papers; "Degradation and life expectancy tests for BF3 Detectors" and Tests of Arc-Welding-Related EMI Effects on Startup Instrumentation". In his first paper, Tim described the tests that were conducted to explain the recent decrease in the life expectancy of the BF3 detectors in CANDU stations. Four models were tested on 4 types of detectors from different manufacturers. Two types fully recovered from long irradiation times. In the second paper, he described the tests to characterize the arc-welding-related EMI (ElectoMagnetic Interference) effects on the startup instrumentation. The tests were carried out for different kinds of arc-welding. Some recommendation were given to reduce the effects of electromagnetic interference on the SUI in order to minimize the spurious trips. John Kemp of IST Canada Inc. presented one paper; "Practical Test Set-Up and Method for Determining the Response Characteristics of a Log Rate Over 6 Decades". John described the setup that was used, discussed his results. He concluded that this test is more informative than the common single measurement of the derivative time constant component values. and may be performed in-situ without decommissioning the amplifier of the trip circuit. As it can be seen, the papers described methods to characterize various effects on in-core instrumentation and the use of their signals not only to control and trip the reactors but also as a diagnostic tool.

CNS Session C.2: High Temperature Fuel & Fuel Channels I Chaired by Brock Sanderson, AECL-Whiteshell

The six-papers in the session focused on recent developments in modeling of the high-temperature behaviour of fuel and fuel channels under postulated loss-of-coolant accidents. Three of the papers presented a common theme using the best-estimate code FACTAR for fuel and fuel channel analysis. Applications covered by the three papers ranged from its use in analyzing fuel string axial expansion to high-temperature oxidation of fuel and fuel channel components. All indications are that the code will evolve into an excellent analysis tool for Safety Analysts. Recent developments in coupling the multi-purpose code CATHENA with the detailed fuel code ELOCA were presented in a paper from AECL. The work demonstrated the importance of modeling the thermal coupling between the fuel and its cladding when analyzing various large break LOCAs that experience rapid heat-up rates. This concept was further reinforced by the paper on recent developments with the ELESIM fuel code, improving its ability to model UO2 pellet deformation and fission-gas release (both of which are sensitive to fuel temperatures). The final paper in the session looked at using the classical modal expansion technique to model fuel channel temperatures during postulated loss-of-coolant accident scenarios. Results from the modal technique were compared against results using the well-established HOTSPOT-II code with good results. The principle advantage of the new simplified approach was in the significantly reduced computation times, making it useful for incorporation into real-time CANDU simulators for reactor operator training at the Institute for Advanced Engineering in Korea. All six papers in the session were informative and sparked lively discussion within the small but enthusiastic audience.

CNS Session C.3: Plant Operations I Chaired by Kamal Verma, NBP-PLGS

The session was started by Vlad Hera of Ontario Hydro-Darlington who presented a paper on "SEBIM Pilot Operated Tandems: A New Solution for Darlington NGS Bleed Condenser Relief Valves" which discusses the events of bleed condenser relief valve instability which lead OH to install pilot operated tandem valves at Darlington Unit 2. The paper presented by Evan Kennedy of AECL "Hand-held Electronic Procedure Environment" discusses the COG project in which a system was developed to allow operations staff to access any station procedure or instruction using a PC-compatible hand

held computer. Tom Price from NB Power-PLGS presented a paper titled "PLGS-1995 SLAR Program" which discusses the full scope of the SLAR project (resources, manpower, schedule targets, etc...) as well as details on the objectives and technical difficulties that faced the SLAR team. "Heat Sink Considerations During SLAR defuelling activities of the 1995 Maintenance Outage at the Point Lepreau G.S." by Robert Richard of Atlantic Nuclear Services covers issues that arose on flow interruptions during SLARing at PLGS, and assess the effect of varying parameters which could effect channel heat-up. David Dennier of AECL-CANDU presented "Element Bow Profiles from New and Irradiated CANDU Fuel Bundles", looks at the causes and effects of fuel element bowing, and compares experimental measurements from both in- and out-of-reactor tests. "The Advanced Carrier Bundle to Irradiate Materials Samples in CANDU Power Reactors" which was presented by Parva Alavi at AECL-CANDU discussed the uses of the Advanced Carrier Bundle in testing pressure tube materials at a high neutron flux in the cores of operating power reactors, and how this improved testing method will lead to the development of better material properties in the future..

CNS Session C.4: Thermalhydraulics II Chaired by René Girard, NBP-PLGS

Bill Liu of Onatrio Hydro-RSOAD began the session with his paper "Development Status of the Code TUF", in which he introduces and discusses the development and application of the code for modeling thermalhydraulic conditions. "A Numerical Investigation of Coolant Thermal Mixing within 28-Element CANDU Fuel Bundles using ASSERT-PV" was presented by Marilyn Lightstone from the University of Toronto, and it discusses the various physical mechanisms that contribute to coolant mixing that are applied in the ASSERT-PV code, as well as the development of a preliminary model suitable for use in the fuel and fuel channel code FACTAR. The session was concluded by Marc Leblanc from the University of New Brunswick, and his paper "Numerical Model of CANDU Fuel Channels Using the SIMPLEC Method" discusses the coupling of channel and sub-channel flow codes in order to arrive at an integrated solution.

CNS Session D.1: Safety, Analyses and Environmental Qualification Chaired by Iaian Lee, AECB

This well attended session combined three papers on safety analysis topics with two on environmental qualification. The papers on environmental qualification concentrated on the practical aspects of ensuring equipment can withstand post accident environmental conditions. The first paper; "Equipment Qualification Testing - A Practical Approach", by G. Davies, R. McDougall and M. Poirier of Mu-Sigma Engineering Consultants, described their experience with EQ testing for such items as cable connectors, LAC motors and valve actuators. The second paper on environmental qualification was by D. Stonkus of DJS Associates and M. Poirier of Mu Sigma Engineering Consultants and presented by S. Benson of NB Power and M. Poirier. It described the use of a cable indenter to monitor cable conditions and ageing effects at Point Lepreau. The balance of the session was filled with three papers on safety analysis topics. The first examined the reactivity effects of fuel string relocation on the large LOCA power pulse for the KANUPP reactor. It was prepared by I. Ahmed of KANUPP, H. Chow and M. Younis of AECL, and N. Lee of Ontario Hydro and presented by H. Chow. This was followed by a paper on the verification of the Point Lepreau version of the SMOKIN computer code by R. Robinson which was presented by W. Thompson of Atlantic Nuclear Services Ltd. The final paper, prepared by Y. Kim, N. Wahba, P. Petherick and S. Lie of Ontario Hydro and presented by Y. Kim, was on the timing of core damage states for CANDU severe accident sequences.

CNS Session D.2: Plant Operations II Chaired by Roger McKenzie, McKenzie Nuclear Consulting

The sessions began with a joint presentation by Paul Lafreniere of HQ-G2 and Bill Schneider of Babcock and Wilcox titled "Gentilly-2 and Point Lepreau Divider Plate Replacement", which discusses the technical and project management aspects of the boiler divider plate replacement program. The next two papers were presented by Kamal Verma of NB Power-PLGS. "Steam Generators Secondary Side Chemical Cleaning at Point Lepreau using the Siemen's High Temperature Process" and "Steam Generator Primary Side Tube Cleaning at Point Lepreau using the Siemen's Mechanical Cleaning Process" covers technical aspects of the boiler cleaning program that was carried out while PLGS was shut down for the SLAR project. Stu Groom of NB Power-PLGS presented "Consequences of Foreign Materials being left in the PHTS at Point Lepreau" which is an in depth investigation into the root causes, consequences and remedial action taken after the incident in which a wood maintenance cover was shredded in a primary pump and debris spread through the core. "Channel Coolant Flow Verification Support for the December 1995 Startup at the Point Lepreau Generating Station using NUCIRC MOD 1.911 and Pre-outage Channel Flow Models" by Wolfgang Hartmann of AECL-CANDU covered the flow verification program that was carried out during the PLGS run-up from the debris incident, in which ultrasonic channel flows were compared against historic and predicted values. "Assessment of the Integrity of KANUPP Fuel Channels" by Brian Cheadle of AECL-Chalk River covered the review and investigation into an event in 1983 in which a KANUPP fuel channel was found to be leaking from it's rolled joint.

CNS Session D.3: High Temperature Fuel & Fuel Channels II Chaired by Vince Langman, OH-RSOAD

Six papers were presented in this session. The session started and finished on time. The session was well attended and the number of attendance varied between 20 to 25. All papers were well presented and stimulated useful discussions and comments. On average, there were about five questions for each paper. The first paper, "Total Emissivity of CANDU Fuel Sheath at High Temperatures", presented by Mani Mathew, described the experiments conducted to determine the total emissivity of Zircaloy-4 in both unoxidized and oxidized environments for temperatures ranging from 1423 K to 1973 K. The results presented showed the total emissivities for unoxi-

dized and oxidized fuel sheath remain constant at 0.2 and 0.82, respectively. The second paper, "Fuel Channel Thermal-Chemical Experiment CS28-3", presented by Pat Mills, described the third 28-element fuel channel thermal-chemical experiment. The results showed the fuel element simulators sheath temperature reached 1700oC before the electric power was turned off. Analysis of the experimental results indicated the exothermic zirconium-steam reaction within the channel was locally self-sustaining as fuel element simulator temperatures increased to 1950oC and about 57 moles of hydrogen were produced in the experiment. The third (The Analysis of Bearing-Pad to Pressure-Tube Contact Heat Transfer Experiments) and fourth papers (Simulation and Analysis of Bearing Pad to Pressure Tube Contact Heat Transfer Under Large Break LOCA Conditions), presented by T. Nitheanandan and Mohamed Bayoumi, respectively, described the simulation and analysis of the Bearing Pad/Pressure Tube Interaction experiments. The objective of both papers is to derive the contact conductance between bearing pad and pressure tube under simulated LLOCA conditions. This parameter is required in safety analysis to demonstrate fuel channel integrity. Although the simulation methods and tools used by each author are significantly different, the simulation results were very similar. The fifth paper, "Experimental Investigation of Thermal Behaviour of Concentric Tubes During Severe Accident", presented by Bob Hammersley, described two experiments conducted to provide data and technical basis for investigating selected aspects of postulated severe accidents in a pressure tube/calandria tube configuration. The first objective of the experiments was to asses the potential for failure of unflawed pair of concentric tubes when prototypic wall stress is produced while high temperature debris is resident within the inner tube and subcooled water is present outside the outer tube. The second objective was to asses the dynamic and energetic interaction given the rupture of the concentric tubes and the discharge of the molten debris under steam pressure into the surrounding subcooled water pool. The results showed the unflawed inner tube melted at a location where the contact with the outer tube was not tight and the discharge of molten debris into subcooled water results in an energetic interaction that is ineffective in converting the debris thermal energy into mechanical energy. The concentric tubes used in these two experiments were made of stainless steel. The sixth paper, "Effect of Neutron Irradiation on Mechanical Properties of Heat Treated Zr-2.5Nb Pressure Tube in Prototype Advanced Thermal Reactor FUGEN", presented by Y. Abe, described separate effect experiments designed to examine the effect of neutron irradiation on mechanical properties of heat treated pressure tubes. The results showed tensile strength of pressure tube increases initially and reach saturation around 1000 MPa and 800 MPa at room temperature and at 573 K, respectively. The fracture toughness of the modified HT Zr-2.5Nb pressure tube is improved at both unirradiated and irradiated conditions. The fracture toughness is very sensitive to the orientation relationship between hydrided pellets and crack extension axis. The radially reoriented hydride specimens degrades in fraction toughness. In conclusion, the papers presented in this session addressed different and diverse aspects of fuel channel integrity ranging from measuring and deducing parameters required for safety analysis to examining the effect on mechanical properties of pressure tube in irradiating/hydriding environment. The integrated behaviour of fuel channel under conditions of LLOCA/severe accidents was also addressed.

CNS Session E.1: Design & Radiation Biology Chaired by Frank Doyle • AECL-CANDU

Five interesting and informative papers were presented in this session dealing with design and biological aspects of radiation. The first presentation by Mr. N. Spinks, "A Passive Emergency Heat Sink for Water Cooled Reactors with Particular Application to CANDU Reactors" discussed the advantages of passive heat removal concepts for advanced CANDU and PWR (AP600), compared to existing, designs. The second presentation by Dr. M. G. Lipsett, "Using Range Vision for Telerobotic Control in Hazardous Environments" described the equipment and interfaces used to undertake work in a hazardous environment from a remote workstation. The final three papers covered risk, protection, and measurement of the effects of radiation. Dr. D.R. Boreham's presentation on "Factors that Affect Radiation Risk" addressed genetic risk of cancer, influencing factors such as prior conditioning by sublethal radiation or hyperthermia treatments, and relationship to health risks in the nuclear industry. Dr. C. L. Greenstock's presentation on "Antioxidants and biological Radiation Protection" addressed the effects of biological and lifestyle factors on sensitivity to radiation. One of the observations from this research is that decreasing oxidant levels occur with increasing age and correlates with increasing radiosensitivity with age. Ms. K.L. Gale's presentation on "RBE of Tritium in Human Cells using Cyrogenetic Endpoints" addressed the results of measurements of relative biological effectiveness (RBE) for tritium beta rays compared to gamma and X rays. The results of the experimental investigation support an RBE of one for tritium, compared to other radiation forms, and is consistent with recent ICRP recommendations. All papers were well presented followed by questions and discussion from the audience.

CNS Session E.2: Thermalhydraulics III Chaired by Bill Garland, McMaster University

Given that this session took place at the end of the conference and that only two of the four papers on the program were given, attendance was good and discussion was vigorous. John Handbury spoke on "Shutdown Cooling Temperature Perturbation Test for Analysis of Potential Flow Blockages". The shutdown cooling system was temperature pulsed and the transit time delays through the core at Pt. Lepreau was used to identify potentially blocked reactor channels. The method was quite successful and contributed to quick rehabilitation of Pt. Lepreau. Parvis Gulshani presented on the "Assessment of Fuel Cooling Under Natural Circulation Conditions in Intact Loop for LOCA Scenarios in Gentilly 2". Once again, Parvis advances the state of the art in the understanding of thermosyphoning in CANDU reactors. Experimental results from RD-14M, intuition, insight and analysis were combined to bring some understanding to the complex, interrelated phenomena involved in thermosyphoning in partially voided parallel channels. Both papers were well received and the session was declared successful, albeit short.

CNS Session E.3: Research Facilities, Fundamental Research & Fusion Chaired by Derek Lister • UNB

The first paper, by Albert Lee (of AECL Whiteshell) and co-authors expanded on the subject that was presented at the previous CNS conference when the concept and argument for the irradiation research facility to replace the NRU reactor were introduced. This year's paper "Progress in Developing the Concept for the Irradiation Research Facility" began with a brief description of the proposed facility, which is based on the MAPLE-type reactor with a heavy water reflector in a light-water-filled pool and has horizontal test sections to take CANDU fuel bundles, vertical irradiation sites and horizontal beam tubes. Dr. Lee continued by emphasizing the effort that is currently being put in the pre-project program, which is meant to develop the IRF concept to the point that uncertainties in feasibility and licensability are minimized at the initial stages. The second paper was "Measurement of Tritium on Surfaces" by N.P. Kherani and W.T. Shmayda of Ontario Hydro. Dr. Kherani first reviewed the methods that are currently used to detect contamination of surfaces, in particular, wipe testing or smearing was described as the most commonly used because of it's simplicity. Wipe testing, however, is subject to many uncertainties and will not give reproducible, quantitative results. The more complicated direct-reading instruments such as windowless vacuum scintilators and windowless proportional gas flow counters are delicate and difficult to apply and have not been widely accepted. An alternative instrument is proposed by the authors. It depends upon the principle of ionization of the air (or prevailing gas) in contact with the contaminated surface by the outward electron flux. The instrument is compact and portable, and shows promise for monitoring other (-emitters than tritium. The third and final paper of the session was presented by Prof. A.M. Hassan (Egyptian Atomic Energy Authority), who was one of E.A. Eissa's Co-authors of "Multielemental Neutron Activation Analysis of some Egyptian Cement Samples". The elemental analysis of the three types of cement was undertaken in order to evaluate contaminants that could spoil the products, pose occupational health risks or pollute the environment. Neutron activation analysis is well suited to such multi-elemental products, so the ET-RR-1 reactor was used for a set of irradiations for short times (1min.) at an average thermal neutron flux of 1.65 x 1011 n.cm-2.s-1 and a set for long times (48h) at 4.0 x 1012 n.cm-2.s-1. Dosimetry was performed with simultaneous irradiations of gold foil, and aluminum sample holders were corrected for by irradiations of aluminum foil. Gamma spectra of irradiated samples were recorded with a high-purity germanium co-axial detector of 200 cm3 active volume. Chlorine was an unexpected major constituent of all samples, suggesting an ore treatment by chlorine-containing compounds. Calcium was measured at about half the manufacturers' stated levels, while iron was consistently higher. Aluminum varied widely among the three cement types. No significant level of hazardous elements were measured.

CNS Session E.4: Plant Operations III Chaired by Keith Scott, ANSL

The following three papers were presented: Detection of Gaseous Heavy Water Leakage Points in CANDU-6 PWHRs by T.-K. Park of KAERI, Header/Feeder Cleaning and Maintenance by Chuck Holmes of Babcock & Wilcox, and Assessment of Heat Sink Capabilities without Forced Circulation at Very Low Decay Powers by Dave Edgar of Systec. T.-K. Park presented an interesting paper on heavy water management and occupational doses. He emphasized the need for a detailed system analysis to identify potential leak locations so that monitoring systems can be installed for early detection of leaks. With this strategy, occupational doses will be minimized. The papers by Chuck Holmes and Dave Edgar were complimentary presentations on the work done to clear the wood fragments from the heat transport system at Point Lepreau. Chuck Holmes described the team effort required to design and implement inspection and retrieval tools while working against the clock. Dave Edgar described the analytical basis for establishing heat sinks capabilities during the heat transport system cleaning work. His included data collection during the outage to support the assessment and the understanding of heat removal mechanisms. The session was well attended and presentations well received.

Paul Thompson and Graham MacDonald, co-chairmen of the Canadian Nuclear Society's Technical Program at the CNA/CNS Annual Conference in Fredericton, June 1996.

COG Safety and Licensing Seminar

The annual seminar on Safety and Licensing programs of the CANDU Owners Group appears to become more popular each year. This year's event, held in Toronto, May 27 to 29, drew almost 200 registrants, although the actual attendance at sessions was somewhat less.

For the second time, staff of the Atomic Energy Control Board were invited and turned out in moderate force, constituting about one tenth of the attendance.

COG Safety and Licensing program manager, **Dr. Jatin Nathwani** opened the meeting with an overview of the program and its future and was followed by **John Waddington,** Director General of Assessment and Analysis at the AECB, giving the regulator's perspective.

Nathwani noted that the overall COG research and development budget for 1996 / 97 was $107 million compared to $174 million in 1995 / 96. Of the $67 million decrease, $35 million is accounted by the transfer of the disposal work to another envelope. The Safety and Licensing budget drops from $37 million to $30 million in 1996 / 97.

On the COG / AECB agreement, announced at last year's seminar, Nathwani commented that it had gone "fairly well". A joint meeting between the COG Safety and Licensing Technical Committee and AECB staff had been held in June 1995 and would be repeated this year.Internationally, COG hopes to work with groups in other countries working on similar problems and, to that end, COG representatives would attend an inaugural "collaborative" meeting hosted by the International Atomic Energy Agency in Vienna in June.

In 1996 / 97 the Strategic Plan will continue to evolve, Nathwani said, with the focus this year on "two Cs" - closure and cost.

John Waddington titled his address, "Are We Winning", which he left as a somewhat rhetorical question despite giving three areas where, in his judgement, "closure", or solution of a problem, had not been, and was not being, achieved.

His three examples were: (1) power pulse with large LOCA; (2) hydrogen in containment; (3) single channel blockage. Although some progress had been achieved many questions remained unanswered, Waddington asserted.

Among several remaining uncertainties associated with the first issue (power pulse with large LOCA) Waddington stated that pressure tube ballooning and pressure tube integrity were most worrisome. On the hydrogen issue, he noted that the GOTHIC code had not yet been fully validated and questions remained about distribution and mixing. There had not been, he said, much progress on understanding molten fuel / water reactions which are a critical part of the single channel blockage problem.

John Waddington

Waddington concluded that there were significant uncertainties in several key areas of CANDU reactor safety. "These issues must be resolved soon, either by research or by making the problems tractable", he warned the audience.

Following on these opening overview addresses were five presentations by representatives of the three nuclear utilities and of Atomic Energy of Canada Limited. Two of the speakers gave further overviews from the perspective of their organizations while the two from Ontario Hydro reviewed two major technical activities.

Len Simpson, of AECL - CRL, outlined AECL's funding process and the implications of the company's restructuring on the safety and licensing research and development. AECL is facing a drop in government funding of $72 million by 1998 which will result in a reduction of $6 million in safety and licensing R and D. The cuts are forcing the company to concentrate on its core business, which, he said, are CANDU 6 and 9 and MAPLE. He noted, also, that cuts had led to efforts to integrate the AECL *CATHENA* and the *OH TUF* thermalhydraulic codes. *(Ed. Note: finally !)*

Marc Antoine Petrilli provided the perspective of Hydro Quebec which is also facing budget pressures. He assured the audience that HQ intends to run Gentilly 2 to the end of its useful life since it plays a strategic role in grid stability. Consequently, considerable effort is going into life management studies. The COG programs help their decision making, he said.

Nino Oliva, of Ontario Hydro, substituted for John Luxat in giving a broad look at the industry's work toward generic code validation in a paper titled, "Phenomenology Based Validation Matrices". (That work is fully described in a paper given at the 1996 CNA/CNS Annual Conference in Fredericton, *Generic Validation of Computer Codes*, and reprinted in the last issue, Vol. 17, No. 2, of the *CNS Bulletin*.)

Jatin Nathwani

Vijay Raina, also of Ontario Hydro, spoke on "Risk Assessment - OH Experience". The risk models being developed will aid future decision making, he said. Referencing the Darlington Probabilistic Safety Evaluation and the Pickering "A" Risk Assessment, which predicted probabilities of severe core damage of 4 x 10-6 and 2 x 10-4 respectively, he commented that these values could change significantly depending on how the plants were operated.

The final plenary speaker, **Paul Thompson,** of New Brunswick Power, gave what he described as a "multi-media" presentation (using slides and videos) of the boiler cover incident at the Point Lepreau station of last winter, including the use of the "Rover" robot.

During the question and answer session with all of the plenary speakers the major topic was "closure", i.e., how to reach a joint decision that an issue was sufficiently understood and controlled that no further R and D work was needed. The AECB's John Waddington left everyone with another rhetoric question, "What amount of uncertainty is acceptable?" He added that COG should put special effort into problems unique to CANDU, such as positive reactivity feedback. Len Simpson added that, in the context of the OECD-NEA, Canada is not doing enough. Victor Snell, of AECL, countered with a reminder of the basic constraint of available resources. "If everything we are doing is essential, how can we do more?", he asked.

In the first of the technical sessions, Rick Jones of AECL-CRL, spoke on the programs to address the problem John Waddington had emphasized - void reactivity effects. Existing codes diverge markedly with higher burnup, he noted. Since it is too expensive to conduct experiments in CANDU power reactors a program is underway using a "substitution" method in the ZED-2 reactor at Chalk River with representative fuel. He commented that an American consultant had recommended to the AECB that a larger reactivity uncertainty allowance, of 3 to 3 1/2 mk, should be used in safety analyses.

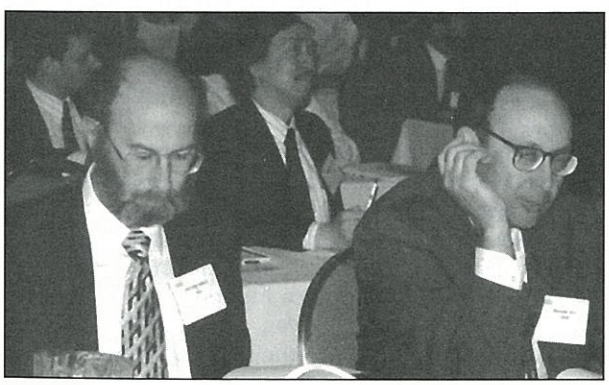
The ten review sessions each began with an overview of a COG safety and licensing program, generally by the chairman of the Working Party, followed by one or more presentations on specific topics. The sessions and their chairmen were:

- Reactor Physics	(WP 25)	M. Gold
- Moderator Circulation	(WP 23)	W. Midvidy
- Containment	(WP 6)	R. Fluke
- Fuel Channel CPR	(WP 7)	D. Groeneveld
- Codes and Modelling	(WP 12)	K. Krishnan
- Safety Thermalhydraulics	(WP 5)	D. Richards
- Fuel Technology	(WP 9)	D. Cox
- Fuel High Temperature transient Behaviour	(WP 8)	L. Dickson
- Fuel channel Temperature Transients	(WP 4)	M. Bayoumi
- P.T. Failure Consequence	(WP 14)	R. Shewfelt

A set of abstracts of the technical papers was distributed to all registrants and can be obtained from COG.

At the excellent banquet hosted by COG, Doug Hinks, of AECL, gave an interesting and informative summary of overseas CANDU sales initiatives.

As highlighted in the plenary discussion session, and raised again several times during the seminar, many, if not most, of the topics covered by the COG Safety and Licensing program have been on the agenda for years. Further, it was observed that most of the issues arise from licensing considerations and not necessarily safety. With the shrinking of budgets, there was a general consensus that all parties involved, and especially the AECB, will have to agree on criteria for "closure" of topics or, to paraphrase John Waddington, come up with designs that avoid the problem.



Victor Snell of AECL and Aly Aly of the AECB listen intently during the plenary session of the COG Safety and Licensing Seminar in Toronto, May 1996

Containment R & D Overview

Ed. Note: *The following is based on the presentation by Ric Fluke, outgoing chairman of the Containment Working Party, at the COG Safety and Licensing Seminar held in Toronto, May 1996. It was one of the best summaries presented at the seminar.*

Introduction

As part of the CANDU Owners Group Safety and Licensing Program, the Containment Working Party is managing $5 million annually for research to address containment safety concerns and bring issues to closure. This Working Party, known as "WP #6", is a diverse group of experts including research scientists, safety analysts and code developers, from AECL, Ontario Hydro, Hydro-Québec and New Brunswick Power. This summary report reviews the safety concerns, the goals of WP#6, and presents some highlights and key acievements over the last year.

Containment Safety Concerns

Of paramount concern is public safety. From a reactor containment perspective, public safety is protected by ensuring that the containment design is adequate to limit the radiation dose following a reactor accident to a safe level, well within the regulatory guidelines for public dose limits. Hence, the role of containment is to limit the off-site release of radioactive materials. WP #6 manages two areas of research relevant to radioactive materials: aerosol behaviour and iodine chemistry.

Another concern is containment integrity. The severe pressure and temperature transient associated with a hydrogen burn could pose a threat to containment integrity. Since hydrogen is generated by high temperature metal-water reactions in the core of a damaged reactor, WP #6 manages a program on hydrogen behaviour.

Finally, the performance of safety equipment designed to reduce the consequences of an accident is a concern. The development of equipment for hydrogen mitigation and control or emergency filtered venting of containment are two examples of R&D managed by WP #6.

Goal of Containment Working Party

WP #6 states its goal as follows:

"To provide information and tools to support the demonstration that the containment system is adequate to limit the consequences of a reactor accident such that off-site radiation dose to members of the public are within the regulatory limits set out in the Reactor Siting Guide."

This statement captures the essence of the goal in broad and general terms, which is aimed at public protection. This goal is made more specific by breaking it into a number of issues that relate to the three safety concerns. As such, some subgoals of WP#6 are to obtain the information and tools needed to:

- support the resolution of hydrogen issues
- assess and minimise the release aerosols
- assess and minimise the release of radioiodine
- demonstrate adequate performance of safety equipment exposed to accident conditions

Highlights of Containment Program

Components of the program on hydrogen, iodine chemistry, aerosols are maturing and several projects occupy high international visibility. Work is directed toward useful and practical applications. For example, efforts are now concentrating on developing information, expertise and tools that can be applied to reduce analytical and regulatory uncertainty. Several of the program elements have achieved noteworthy results:

- The Large-Scale Vented Combustion Test Facility was commissioned and is generating useful data.
- Work on filter carbon has now been implemented at Ontario Hydro Stations.
- An Iodine behaviour code, LIRIC, is being tested against intermediate scale integral test data from the Radioiodine Test Facility (RTF).

Solid achievements have been recorded in other work areas as well:

- The very successful RTF program of intermediate scale studies on iodine behaviour is approaching completion
- The work on iodine losses in sampling lines is being consolidated
- High quality data from tests on full size HEPA filter units is being produced

Hydrogen

Hydrogen mitigation strategies are in place in all Canadian reactors, and detailed information is need-

ed to demonstrate adequacy of these measures. For example, dilution by mixing is adopted by all Canadian reactors. Glow Plug Igniters are adopted by Multi-unit reactors and CANDU 9. Passive Autocatalytic Recombiners will be used in CANDU 9. Whatever control and mitigation measures are adopted, the key result that needs to be demonstrated is that "Damaging Burns" do not occur. Hence, the R&D is focussed on the study of Deflagration, Standing Flames, Transition from Deflagration to Detonation (DDT), and Mitigation.

The COG programme is complemented by information exchange agreements under discussion with five countries: Japan, France, Germany, USA and Russia.

Deflagration Highlights: Data from the Containment Test Facility and the new Large Scale Vented Combustion Test Facility was used to validate the GOTHIC containment code. With GOTHIC, full three-dimensional simulations produced reasonable results and showed the influence of vent flows and buoyancy on flame propagation.

Standing Flame Highlights: When hydrogen is released from a broken reactor pipe, and ignites in a containmet air environment, a "Standing Flame" can result. Tests have shown that a stable standing flame is possible, but due to the presence of steam and turbulent mixing with the surrounding air, the temperatures are lower than 1000 C.

DDT Highlights: Work continues to establish DDT criteria for accelerated flames and to define a transition limit in terms of the composition of the mixture.

Mitigation Highlights: Catalyst formulations were designed and tested for operation throughout the flammable range of a mixture of hydrogen steam and air. These formulations enable operation in high concentrations of hydrogen without the corresponding high temperatures.

Aerosols

The Large Scale Experiments at Stern Laboratories Inc. were completed successfully. The data is being used to support water aerosol behaviour models. Current work is focussed on a detailed mechanistic model. To support this, droplet sizes and velocities within flashing water jets have been measured using Phase Doppler Anemometry (PDA).

Models for turbulent deposition of aerosols have been evaluated and a new correlation for turbulent deposition was formulated which shows a better agreement with the experimental data.

There is a plan to develop and validate the SMART aerosol code by adopting the new models and ensuring that their implementation meets current Quality Assurance standards. A validation plan is being developed.

Iodine Chemistry

The Iodine "Problem" is nearing closure. The workhorse to close this issue has been the Radioiodine Test Facility and Separate Effects tests, which provided data needed to develop the LIRIC code. Testing against independent data is in progress.

The test of the Iodine closure is to:

1. Predict the gas phase iodine to within an order of magnitude
2. Know the main sinks, and conditions for their stability
3. Provide reasonable mechanistic explanations for the above two conditions

The first two conditions have been met. Code exercises have shown that LIRIC can predict gaseous iodine to within an order of magnitude, and the main sinks, water and surfaces, are well known and the conditions for their stability can be determined. The third condition is within reach.

25th Anniversary for U of T SLOWPOKE

At 2:47 p.m. on June 5 in 1971, the SLOWPOKE reactor at the University of Toronto achieved criticality. Two and a half decades later, almost to the minute, a seminar was held to celebrate the 25th anniversary of that event.

About a hundred people, many veterans of the Canadian nuclear scene, attended the seminar in the Sandford Fleming building and the reception that followed in the rooms adjacent to the SLOWPOKE reactor in the Haultain building.

After a welcome by U of T Vice-provost Derek McCammond and prior to the four presentations of the seminar, host **Brian Cox,** holder of the Chair of Nuclear Engineering at U of T and current chairman of the U of T SLOWPOKE Committee, presented special mugs to three SLOWPOKE pioneers, John Hilborn, Peter Stevens-Guille, and Ron Kay.

The first of the four speakers was **John Hilborn,** a

Brian Cox, current chair of the U of T SLOWPOKE committee, presents a special mug to John Hilborn, at the U of T SLOWPOKE 25th Anniversary, June 5th, 1996

researcher emeritus at Atomic Energy of Canada Limited's Chalk River Laboratories and considered the inventor of the SLOWPOKE design. He reviewed the work leading up to the building of the prototype SLOWPOKE at CRL and its move to the U of T in 1971. In the mid 1960s, he recalled, he came across reports from Los Alamos (one of the US laboratories associated with the Manhattan project) describing minimum critical mass reactors and saw their potential.

Subsequently, he and Bob Lyon submitted a proposal to build what would become the initial SLOWPOKE at Chalk River. The proposal was approved and a team of six completed the design and oversaw the construction of a 5 kw prototype, all in a period of a year. That was 1970. The following year it was moved to the U of T. In 1973 it was upgraded to 20 kw and then in 1976 it was replaced with a "commercial" unit, which U of T officials dubbed SLOWPOKE 2.

Hilborn credited Bob Lyon with coming up with the name SLOWPOKE, which was derived from Safe, Low Power, Critical, Experiment.

The emphasis, Hilborn said, was on passive safety, which was obtained through a strong negative temperature coefficient of reactivity combined with limited excess reactivity. To test this characteristic they inserted 6.8 mk quickly into the prototype reactor. The result was a rapid rise in power to 150 kw which quickly settled down to 40 kw. In closing Hilborn noted that the eight SLOWPOKE reactors in operation had had an excellent safety record.

Bob Jervis took the audience through the period at U of T leading up to the installation of SLOWPOKE and the early years of its use. Over the decade following his arrival at U of T in 1957 there were repeated proposals for a "full reactor to augment the subcritical facility they had. A TRIGA reactor was considered but the cost was prohibitive. Having close association with Chalk River and knowing John Hilborn they became aware of SLOWPOKE and eventually arranged for it to be installed at U of T. Once in place its use grew rapidly, primarily for activation analysis, reaching a level of 15,000 irradiations per year.

(Jervis did not mention his own extensive use of SLOWPOKE in his work on forensic analysis which gained him international attention.)

He praised the Atomic Energy Control Board of the day and its then president Don Hurst for being "broad minded" enough to recognize the inherent safety and allowing "remote surveillance", i.e., operation without an operator on site. He and Hack Chung were the first authorized operators, with Ron Hancock joining them the following year on his return from New Zealand.

Bob Jervis

From the beginning it was decided that SLOWPOKE should be available to researchers from throughout the university. This led to it being designated a university facility directed by a committee with representation for some facilities.

At the beginning, Jervis noted, there were concerns about the ability to effective research with a flu of only about 1010 n/cm2/sec compared to 1013 available at the McMaster reactor or NRX. With the upgrade of power and slightly modified design of SLOWPOKE 2 a flux of 1012 became achievable. In addition researchers adapted by focusing on larger samples and short-lived isotopes since they could analyze them as soon as they came out of the reactor.

Sophie Wong

Jervis closed by noting that SLOWPOKE had led to awards (he and John Hilborn both won the CNA's W. B. Lewis medal) and launched the careers of several people who have gone on to other locations, such as Les Bennett at RMC, Amares Chatt at Dalhousie, Sheldon Landsberger at University of Illinois, John Paciga at Point Lepreau.

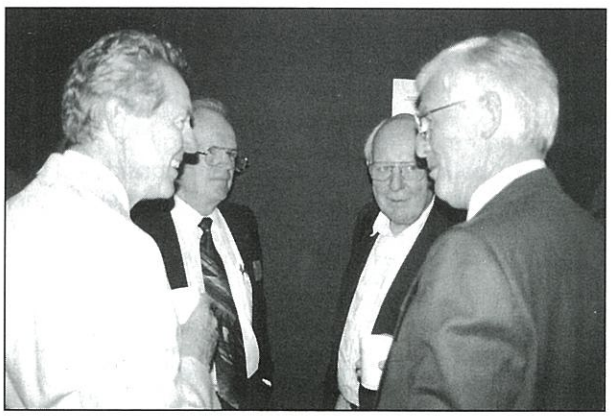
To a question after his talk Jervis stated that with new fuel the U of T SLOWPOKE could run for another 25 years.

Sophie Wong, winner of the 1996 R. E. Jervis Award for the best graduate student paper on radiochemistry, gave an interesting and informative presentation on the use of activation analysis (using SLOWPOKE) to determine the distribution of toxic elements at the Port Granby waste site.

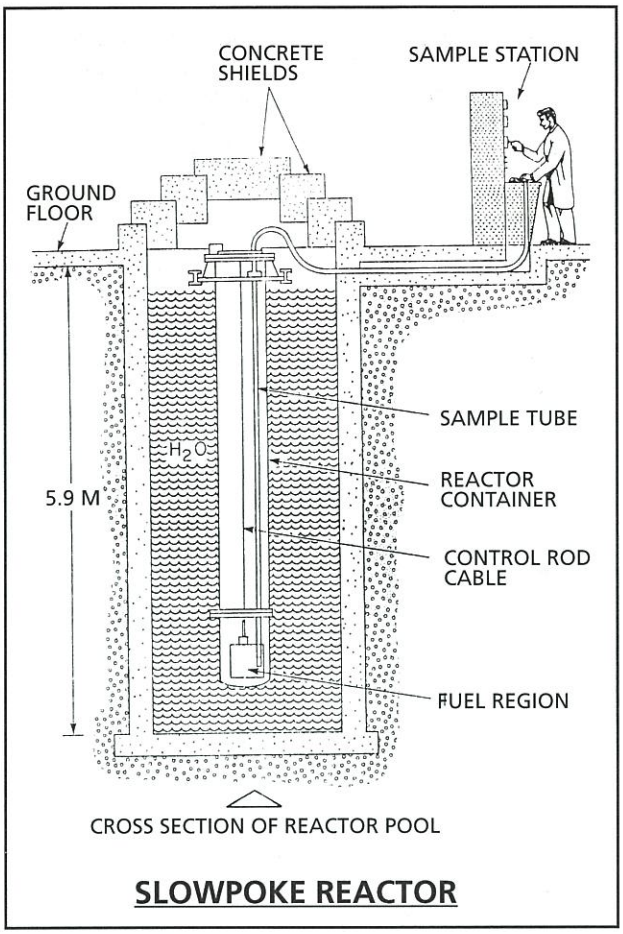
The concluding speaker, **Ron Hancock,** spoke about the use of the U of T SLOWPOKE in teaching, training and research. The past, present and future are a continuum, he observed. Over the years there have been about 100 research and teaching projects each year. The areas of application range from anthropology (analyzing samples of ancient ceramics), through environmental engineering and analysis (such as exemplified by Sophie Wong's paper), to chemistry, geology and materials. Since 1971 there have been some 800 refereed papers on work related to or using SLOWPOKE. Reflecting the broad usage SLOWPOKE has her designated as a university facility, not a departmental one, and is governed by the campus-wide SLOWPOKE Committee (currently chaired by Brian Cox) which reports to the vice-president of research.

At the close of the seminar Brian Cox invited all those in attendance to a reception in the rooms adjacent to the SLOWPOKE reactor, which, he noted, was partially sponsored by the Canadian Nuclear Society thanks to president Jerry Cuttler.

Past and present meet at the 25th Anniversary celebration for the U of T SLOWPOKE reactor. L to R: Hack Chung, original operator and researcher; Peter Stevens-Guille, commissioning engineer; Bob Jervis, original supervisor and long-time chair of SLOWPOKE committee; John Hilborn, SLOWPOKE inventor; Ron Hancock, current supervisor.



The 25th Anniversary celebration of the U of T SLOWPOKE reactor, June 5th, 1996, brought together many veterans of the Canadian nuclear program.
Here, John Hilborn (L), SLOWPOKE inventor and award winning physicist at AECL-CRL converses with Elgin Horton, Don Milley and Don Anderson, all former executives with Ontario Hydro.



SLOWPOKE REACTOR

Agreement on Isotope Production

In July an agreement was reached that should ensure Canada's predominance in the medical radioisotope business.

Nordion International and MDS Health Group Limited (Nordion's parent) entered a 20 year agreement with Atomic energy of Canada Limited and the Government of Canada which will result in the construction of two MAPLE reactors and a radioisotope processing facility at AECL's Chalk River Laboratories. Nordion will own the reactors but they will be constructed by AECL and operated on a contract basis. Construction will proceed as soon as regulatory approvals are obtained and it is hoped that the first reactor will go into service in 1999. It is understood that initial application has been made to the Atomic Energy Control Board. In addition the project must be approved by the Canadian Environmental Assessment Agency.

The project is estimated to cost $140 million. It will be partially financed by a $100 million, interest-free loan from the Government of Canada. The government will also contribute $5 million and AECL will provide $12.5 million to the overall project.

The agreement ends a dispute begun in 1993 when AECL cancelled the MAPLE X-10 project which was intended to replace the radioisotope producing capabilities of the shutdown NRX. Nordion and MDS, in turn, sued AECL for damages totally $300 million since the provision of a back-up to NRU for isotope production was part of the sale agreement when Nordion (formerly part of AECL Radiochemical company) was privatized in 1991.

The AECB approved the first stage of the MAPLE X-10 in 1989. The proposed reactors will be essentially the same as that design although a new concept for the target for the production of Molybdenum 99, the most popular radioisotope for medical diagnosis, will be used. The new reactors will be dedicated solely to the production of Mo-99 and other medical radioisotopes including Iodine 131, Xenon 125, Iodine 125.

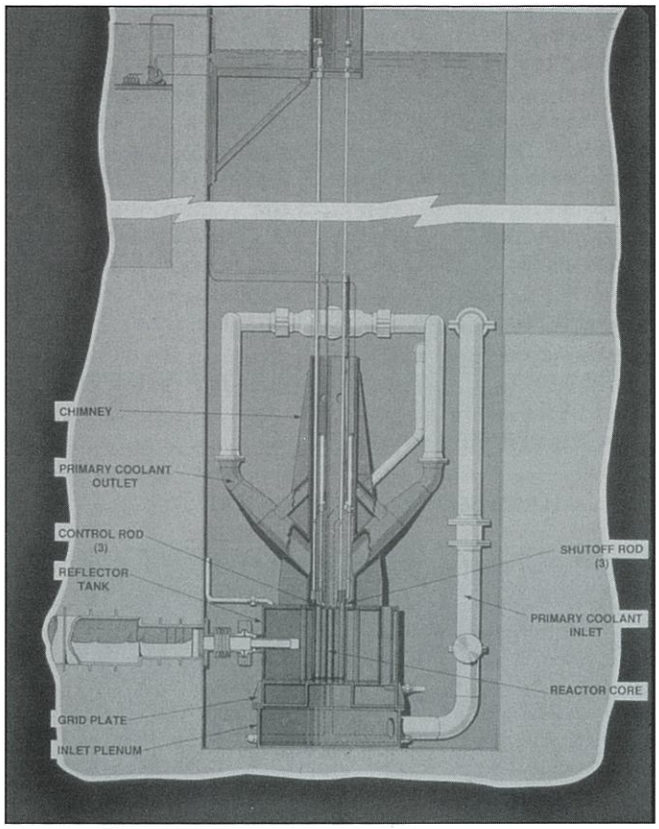
Nordion is the world's leading supplier for medical isotopes most of which is shipped to radiopharmaceutical companies for further processing.

Molybdenum 99 is the most widely used radioisotope. An estimated 50,000 patients a day benefit from diagnostic procedures using the very short half-life (6 hours) Technetium 99m which is derived from Mo-99. The half life of Mo- 99 is just 66 hours so a

constant supply and rapid delivery are essential. About 80 per cent of nuclear medicine diagnostic procedures employ Tc-99m.

The radiopharmaceutical companies prepare various sizes of Mo-99 / Tc-99m generators by loading 100 mCi to over 2 Ci of Mo-99 onto alumna in a sterilized glass column. When the hospital or clinic uses the generator the Tc-99m is eluted off the molybdenum ' alumna complex, using saline at one end and evacuated vial at the other. The vacuum pulls the saline solution through the alumna column stripping off the Tc-99m. This sterile solution is then ready to be used with a variety of compositions depending on the organ that is being imaged.

Xenon 133, a gas, is used for lung ventilation scans while Iodine 125 is used for a variety of applications such as bone densitometry studies, brachytherapy applications and radioimmunoassay. Iodine 131 is used primarily for thyroid studies and treatment.



MAPLE REACTOR

MAPLE-1 Reactor

The MAPLE-1 reactor is a light water moderated and cooled pool-type reactor with a heavy water reflector.

It has 19 core sites that include nine hexagonal 36-element fuel assemblies, six cylindrical 19-element fuel assemblies and four target assemblies for Mo-99 production. The core is surrounded by a D2O reflector with 18 irradiation sites which can accommodate 60 mm diameter isotope target assemblies and six larger diameter sites for silicon irradiation.

The fuel is an aluminum-uranium matrix coextruded with an aluminum cladding to form finned elements. The fuel meat is composed of low-enrichment (about 19.7 wt% U-235 in total uranium) U3Si particles dispersed in an aluminum matrix. This fuel was developed by AECL for use in NRU and HANARO (the Korean version of MAPLE). The performance has been excellent with up to 93 per cent burnup of initial fissile fuel at high power ratings in excess of 100 kW/m.

MAPLE-1 has two safety systems. One (SS 1) uses hydraulically-actuated pistons to poise a set of cylindrical hafnium absorbers above the core. When inserted these absorbers envelop the fuel in three symmetrically located circular flow tubes. The second safety system (SS-2) operates three electromagnetic latches on the support shafts for the hafnium absorbers used by the reactor regulating system and triplicated valves which partially drain the reflector tank. The systems have been designed so that fuel changing can proceed without the need to disable the regulating or safety systems. In keeping with Canadian practice the two least effective absorbers can shut down the reactor and maintain it in a sub-critical state.

Regulating reactivity control is provided by three hafnium absorbers in symmetrically located positions in the core.

A New Solution for Darlington's Bleed Condenser Relief Valves

by Vlad Hera

There have been a number of incidents involving failure of Primary Heat Transport liquid relief valves. These valves relieve into the bleed condenser which, in turn, can become overpressurized causing its relief valves to lift – discharging heat transport water into the reactor vault. The bleed condenser reliefs are simple spring loaded valves which tend to 'chatter' around their set point pressure, leading to undesirable consequences, such as the Pickering Unit 2 Loss of Coolant Accident in December 1994. The potential for similar problems also existed at Darlington, a fact borne out by an earlier theoretical study based on computer simulation of an "LRV Failed Open" transient.

As a consequence, early in 1995, Darlington decided to replace the big, spring loaded valves with pilot operated tandem valves, manufactured by the French company SEBIM. This type of valve is used extensively in Europe, for both nuclear and conventional applications.

The operation of the main valve is controlled by the pilot valve, which constantly compares the pressure in the protected system to the valve setpoint. If the setpoint is reached the pilot, through an intricate internal system of mini-valves, springs and other moving parts, drains the main valve head allowing it to open. There is no continuous discharge through the pilot valve, hence the operation of the relief valve is very stable. The main valve moves relatively slowly and is able to assume intermediate opening positions, if required by a low discharge flow. All these features contribute to the valve's stability in operation.

The valve itself is a "tandem" valve, meaning that there are actually two valves in series in one housing – a pressure relief protection valve and a redundant valve, both of which are normally closed. To satisfy the ASME code requirements the redundant valve opens first and shuts last. It is there only to prevent a LOCA, should the protection valve fail to reclose for any reason, or if it opens spuriously. Also, the redundant valve, being itself a pressure relief protection valve, can assume the system overpressure protection role for a limited period of time allowing normal unit shut down in the event of a failure of the main protection valve.

In February this year Darlington engineers tested the new relief valves extensively in France. The valves passed their specific design tests and proved to work as quickly and as stably as expected. Also, a computer model of this type of valve was developed and integrated with the Darlington TUF (Two Unequal Fluids) computer model. Extensive simulation of the testing done in France was used to tune up the model, then to validate it. Transient simulations were performed, using the new tool, in order to confirm original calculations used to establish the process requirements for the bleed condenser relief valves as well as to investigate the valve response under many foreseeable incident scenarios. Particular attention was given to the way this new valve may interact with the Pressure and Inventory Control and Primary Heat Transport Systems at Darlington, in order to ensure that the best combination of valve setpoints and blowdown percentages are used to protect our reactors. The model and simulations, along with the test results, were used to get the valve 'qualified'.

Previously, a number of measures – commonly known as the "short term solution" – had been taken at Darlington. These measures consisted of software and hardware changes designed to reduce drastically the probability of the bleed condenser RV's actually being challenged to protect the system.

Along with the earlier precautions the new valves will prevent, under all foreseeable circumstances, an incident that can have both unacceptable financial implications as well as a damaging effect on public confidence.

The new SEBIM valves, which involved quite a financial outlay, were fitted in Unit 1 during its spring outage and will be fitted in Unit 4 during its August outage. The other two units will follow shortly. The entire project was subject to strict deadlines and required substantial efforts from all those involved. However, despite the understandable sense of accomplishment, and the natural desire to see one's work proved correct, all those connected with the project, as well as everybody else at Darlington, will be very happy if the new valves never open in anger!

Vlad Hera is a design engineer at the Darlington nuclear power station.

Biological Effects of Low Doses of Radiation at Low Dose Rate

Ed. Note: *As part of our contribution to the on-going debate over the effect of low doses of ionizing radiation – see "Letters to the Editor" – we present the following summary (prepared by the authors) of a recent report from the Advisory Committee on Radiological Protection of the Atomic Energy Control Board, ACRP-18.*

The report was prepared by a Working Group chaired by Dave Myers, formerly of AECL-CRL, and including Art Marko, Doug Chambers, John Johnson, Pierre Duport, Ron McGregor and Neils Lind. It was reviewed by an international group of experts. ACRP-18 is available from the Atomic Energy Control Board without charge.

This summary of ACRP-18 is published with the permission of the AECB.

The purpose of this report was to examine available scientific data and models relevant to the hypothesis that induction of genetic changes and cancers by low doses of ionizing radiation at low dose rate is a stochastic process with no threshold or apparent threshold. Assessment of the effects of higher doses of radiation is based on a wealth of data from both humans and other organisms.

The best evidence to support the linear non-threshold hypothesis stems from studies on radiation-induced genetic changes in lower organisms such as bacteria, yeast and spiderwort plants (Tradescantia). At low dose rate, the yield of genetic mutations in these organisms is strictly proportional to dose down to very low doses in the region of a few mSv of sparsely ionizing radiation. Studies on specific locus mutations in the offspring of irradiated male mice represent a less sensitive endpoint but the results are compatible with the linear non-threshold hypothesis and demonstrate that the effects of radiation delivered either at low dose rates or in fractionated doses are additive.

The data on radiation-induced cancer are less clear. This may be due to the fact that the development of cancer, in contrast to genetic changes, involves several different steps. It may therefore be unwise to extrapolate directly from the data on radiation-induced genetic changes to radiation-induced cancers in some cases. Not all available data on radiation-induced cancers fit the linear non-threshold hypothesis.

In humans, epidemiological data suggest a practical threshold for induction of bone cancer by long-lived radium-226 and for induction of liver cancer by thorotrast (an insoluble form on long-lived thorium-232). The concept of a practical threshold for induction of bone cancer by long-lived radionuclides has been confirmed in experimental animals with a variety of internally deposited alpha and beta emitters. Similar evidence of a practical threshold appears for induction of lung cancer in (non-smoking) dogs by long-lived alpha emitters, in (non-smoking) rats after prolonged exposure to low levels of radon, and possibly in non-smoking humans where lung cancer incidence is relatively low. However, the data on induction of lung cancer by radon in miners who smoke cigarettes, and who already demonstrate a high incidence of lung cancer due to smoking, is compatible with the linear non-threshold hypothesis. The concept of a practical threshold implies an accumulated dose below which no excess cancers are likely to appear within the normal life span of humans or other animals (even if excess cancers might appear below this threshold dose if the animals were to live forever). This concept is most likely to apply to those types of cancers which are relatively rare in humans when the radiation dose is accumulated over a large portion of the human life span.

Other human data which do not appear to fit the linear non-threshold hypothesis include some, but certainly not all, of the results on excess cancers after exposure to medical x-rays. For example, the data suggest a marked threshold in the dose response relationship for induction of lung cancer in fluoroscopy patients both in Massachusetts and in Canada. The data on excess cancers other than leukemia induced in the Japanese bomb survivors at Hiroshima and Nagasaki are clearly compatible with the linear non-threshold dose response hypothesis, but the data on excess leukemias in the same bomb survivors are possibly compatible with a threshold in the region of 200 mSv even for brief radiation exposures at high dose rates. The reasons for these discrepancies are unknown.

The dose response relationship for induction of different types of tumors in experimental animals are complex. In general, there is roughly an equal chance of observing linear and non-linear dose response relationships for induction of different types of tumors. However, life shortening due to induction of all cancers in two strains of mice followed accurately a linear non-threshold dose response relationships for lifetime gamma-ray exposures at dose rates from about 3 up to 200 mSv per day. There is some evidence that highly fractionated doses of sparsely ion-

izing radiation may actually increase the life span of animals, especially in the presence of other environmental stresses such as unusual ambient temperatures. It is highly probable that any potential increases in average life span are associated with other physiological factors necessary for the maintenance of a healthy state, not with a decrease in cancer incidence.

Adaptive responses to radiation doses as low as 5 mSv are known to occur and were reviewed in this report. However, it currently seems improbable that these adaptive responses would have any influence on the shape of the dose response relationships at low dose rates equivalent to 50 mSv per year received at a relatively uniform rate over the course of a year.

The following recommendations follow from this review:

(a) Considerable caution to make sure that health detriments are not over-estimated is required in application of the linear non-threshold hypothesis to those types of cancer which are relatively rare in humans and where the radiation dose is accumulated over a large portion of the human life span. There appears to be a practical threshold in these cases, for example, in induction of bone cancer by long-lived radium-226 (but not by short-lived radium-224) and of liver cancer by insoluble forms of thorium-232 (thorotrast).

(b) The linear non-threshold hypothesis has been very useful in regulating exposures to ionizing radiation and there does not seem to be good reason to abandon its use, particularly since those tissues where a true threshold or practical threshold seems likely (e.g. bone surfaces, with long-lived radionuclides) do not contribute greatly to the total health detriment of radiation exposure as calculated by the ICRP. The assumption of linearity may be quite appropriate for practical purposes in radiological protection even though it may not always be the best model for the relationship between dose and any particular effect.

(c) However, because of the possibility that low doses of radiation accumulated at low dose rate over a large portion of the human life span may not induce any excess cancers at all, it is recommended that health detriments should not normally be considered below the de minimis dose rate of 10 microsievert per year to individuals that was recommended by the AECB Advisory Committees in 1990.

(d) Since there is no direct proof that exposure of adults to 10-20 mSv per year for a few years causes any harmful effects on health, it is strongly recommended that any detrimental health effects calculated using the linear non-threshold hypothesis for radiation exposures of adults in this region or lower should be referred to as hypothetical health effects only.

(e) If the linear non-threshold hypothesis is adopted for calculation of collective dose for humans, it is recommended that these calculations should be categorized into three levels of concern: (i) above 200 mSv in a short period of time where measurable biological effects are probable, (ii) between 200 mSv in a short time and 10 microsievert per year where potential biological effects can be predicted but not measured, and (iii) below 10 microsievert per year where the hypothetical individual risks are considered to be negligible even if the linear non-threshold hypothesis is assumed to be correct. It is further recommended that the calculated collective doses in each of these three different categories should not be added to obtain a total collective dose, because of the very different societal implications of the three categories.

(f) Recommendations for future research

Human epidemiology cannot demonstrate whether the risk of cancer at low of very low doses is nil or not because, at these levels, the confidence interval for risk estimates include the possibility that the risk is nil. Useful information on the effects of low doses can come only from two types of experimental work, radiobiology and animal experiments. Studying the effects of radiation, at cellular and DNA levels, will continue to bring information on how radiation modifies the fate of the cell and how repair mechanisms modify the outcome of initial radiation injury. Animal experiments, like human epidemiology, cannot confirm or disprove the existence of thresholds, but they can bring crucial information when the influence of a single parameter like dose rate is varied, and when such experiments are conducted at the lowest possible dose and dose rate levels at which statistically significant results are still obtained, and from which a trend toward the effects of low doses can be derived.

Domaratzki goes to IAEA

Zygmund (Zig) Domaratzki, formerly Director General, Reactor Regulation, at the Atomic Energy Control Board, has been appointed as Deputy Director General of the new Department of Nuclear Safety at the International Atomic Energy Agency in Vienna. His appointment began August 1st and runs nominally for three years.

Chernobyl: Conference Sums Up Consequences

Ed. Note: *The following report is extracted from "IAEA Newsbriefs", a publication of the International Atomic Energy Agency.*

In April 1996, an International Conference was held in Vienna to review, one decade afterwards, the accident at the Chernobyl nuclear power station in 1986. The Conference summed up the scientific understanding of the major health and environmental consequences attributed to the Chernobyl accident that occurred in Ukraine a decade ago. More than 800 scientists and government officials in fields of nuclear energy and radiation safety attended the meeting, which was jointly sponsored by the IAEA, European Commission (EC), and World Health Organization (WHO). Participants included high-level governmental representatives from the accident's three most heavily affected countries – Belarus, Russian Federation, and Ukraine – plus delegates from more than 70 other States and inter-governmental organizations. The Conference carefully reviewed the scientific, medical, environmental, social, and political issues involved in assessing Chernobyl's impact, in the context of major changes over the past decade in countries of the former Soviet Union.

While the Conference did not expect to reach scientific consensus on all issues involved, its Joint Secretariat did issue conclusions and recommendations that place the Chernobyl consequences into perspective and can serve as the factual basis for decisions about future work and collaboration. Highlights of the findings include those related to:

Accident Initial Fatalities and Injuries. The explosion on 26 April 1986 and early release of radionuclides resulted in 30 deaths, including 28 deaths attributed to acute radiation sickness. These fatalities occurred among the 134 plant staff, firefighters, and emergency workers ("liquidators") who initially responded to the accident and who suffered from severe radiation sickness that was treated in hospitals. Since then, over the past decade, while 14 additional patients have died, only some of these might be directly attributable to radiation exposure.

Incidence of Thyroid Cancer. There has been a substantial increase in reported cases of thyroid cancer in Belarus, Ukraine, and some parts of Russia, especially in young children, generally attributed to exposure to radioiodine during the early phases of the accident in 1986. Up to the end of 1995, a total of about 800 cases (including 400 in Belarus along) have been reported in children who were under age 15 at the time of diagnosis. To date, three children have died from thyroid cancer. Over the next decades, there will most probably be an increase in the incidence of thyroid cancer among those who were children in 1986; the estimated number of cases is in the range of a few thousand but there is considerable uncertainty about this. The group at risk should be closely monitored throughout their lives, since treatment should be successful in most cases that are diagnosed early.

Long-Term Radiation Health Effects. Apart from increases in thyroid cancer, there has been no statistically significant deviation in the incidence rates of other cancers that can be attributed to radiation exposure due to the accident. Based on predictive models, it is estimated that the number of future deaths from leukaemia is of the order of 200 among the 3.7 million residents of the contaminated territories and 200 among the 200,000 front-line liquidators who worked at Chernobyl in 1986-87. Leukaemia is an early indicator of radiation health impact. The fact that it has not been seen to date provides reassurance that early predictions are not severely in error.

Other Health-Related Factors. Many changes in health have been seen in the exposed population that are not the result of radiation exposure. There are significant health disorders and symptoms, such as anxiety, depression, and various psychosomatic disorders attributable to mental stress among the population in the region. The psychological impact cannot be completely dissociated from that of the breakup of the Soviet Union, and any forecast should therefore take into account the economic, social, and political circumstances of the three countries.

Environmental Consequences. No dramatically obvious long-term impacts on populations or ecosystems have been observed. Effective countermeasures can be taken at specific sites to achieve significant reduction in the uptake of radiocaesium into food. In general, no food produced by the collective farm system exceeds established international radiation levels, although some foods produced by private farmers does.

Nuclear Safety Remedial Measures. The technical causes of the Chernobyl accident are well known and the safety levels of the 15 RBMK plants operating in Lithuania, Russia, and Ukraine have been raised to practically prevent the same type of accident from occurring again. More RBMK safety improvements are required, however, and further steps are needed to stabilize the sarcophagus built to confine the destroyed Chernobyl Unit-4. RBMK safety issues were examined at an international forum in early April in Vienna and were reported to the subsequent Chernobyl Conference (see following item.)

The technical symposium featured eight separate topical sessions on the range of social, health, and environmental subjects. Topics included clinically observed health effects; thyroid effects; longer term health effects; other health-related effects, including psychological effects, stress and anxiety; consequences for the environment; the social, economic, institutional and political impact; nuclear safety remedial measures; and the consequences in perspective, a prognosis for the future. A panel discussion further explored the public's perception of the Chernobyl accident.

Proceedings of the Conference are being published by the IAEA. ***Highlights of the Conference are available through the IAEA's World Atom Internet Services at the address http://www.iaea.or.at/this/preview/chernobyl.*** *– More information may be obtained from the IAEA Department of Nuclear Safety.*

GENERAL news

Convention on nuclear safety to enter into force

The International Atomic Energy Agency announced in late July that it had received notice of ratification from 25 countries, including 17 with at least one operating reactor, of the Convention on Nuclear Safety, the number required to have the Convention enter into force. Consequently, the IAEA has declared that the Convention will officially enter into force on 24 October 1996.

Canada is among the countries ratifying the Convention. Two major nuclear countries, Germany and the USA, have not yet notified the IAEA of their ratification.

The Convention was negotiated during several large, international, meetings convened by the IAEA over 1993 and 1994 and chaired by Canada's Zig Domaratski (formerly Director General, Reactor Regulation at the Atomic Energy Control Board and now Deputy Director General, Nuclear Safety, at the IAEA). It was opened for signature in September 1994 with Canada, represented by AECB president Dr. Agnes Bishop, being the first signatory.

The Convention commits subscribing countries to ensuring the safety of their land-based civilian nuclear power plants and requires the periodic submission of review reports. The Canadian Nuclear Society has offered to the AECB, the responsible agency in Canada, the names of experts that could assist in the reviews.

(See the Spring 1995 issue of the CNS Bulletin, Vol. 16, No. 1, for more information on the development of the convention and its contents.)

Canada provides special safeguards device to IAEA

A special Cerenkov Viewing Device (CVD) developed in Canada was presented to the International Atomic Energy Agency last spring by Dick Keefe of the Atomic Energy Control Board and Ms. A. Nilsson of Sweden.

The CVD is a hand-held device which provides safeguards inspectors with an image displaying the ultraviolet light from the Cerenkov effect caused by the radiation from spent fuel in a water bay. With an associated special 250 mm ultraviolet lens which has enhanced light-gathering capabilities, the device provides high resolution enabling more effective verification of fuel having a long cooling time or low burnup. The Cerenkov characteristics of some BWR and VVER fuel were difficult to distinguish with previous devices.

Development of the CVD was done at the Whiteshell Laboratories of Atomic Energy of Canada Limited and of the 250 mm lens at Applied Physics in Toronto under AECL's guidance.

Following field testing of the new device at nuclear power stations in Sweden and Finland the IAEA has ordered several for its safeguards inspectors.

Most of the Canadian work was funded by the Canadian Safeguards Program which is within the budget of the AECB. Sweden funded some of the development work and all of the field testing.

Obituary

Frank Foukles, a leader in the Canadian nuclear industry for over three decades, died in Oakville, August 5, at the age of 72.

Frank was born in England and served with the Royal Navy, becoming one of the youngest Lieutenant Commanders by the end of World War II. After obtaining his degree in electrical engineering he came to Canada in 1952 and joined Montreal Engineering (now Agra-Monenco).

He was seconded to AECL from 1958 to 1964 and then returned to head the Nuclear Division of MECO until the formation of CANATOM in 1969 where he subsequently became president. In 1983 he became AECL's senior representative in Korea, nominally retiring in 1986. Over the past decade he has been a part-time consultant and has served in many volunteer roles in the nuclear industry, in his church and in the community. He was chairman of the Organization of CANDU Industries, 1980-81, and of the Canadian Nuclear Association, 1982-83. The CNA awarded him the Ian McRae Award in 1983. As a member of the CNA Board he helped in the creation of the Canadian Nuclear Society and was a long-time member of the Society.

Frank's ability, dedication, high standards and sense of humour gained him respect and affection from all who had the privilege to know him. His passing is a loss to the Canadian nuclear community.

Pickering celebrates 25th anniversary

An Open House will be held at the Pickering nuclear generating station on Saturday, September 7, 1996, as the last of a series of events to commemorate the 25th anniversary of the start-up and in-service date of the first unit in 1971.

Family and friends of the Pickering staff are invited to tour the plant and enjoy a day of entertainment in the parkland adjoining the station. There will be complimentary refreshments, a helicopter display, heavy equipment displays, hot air balloon ride and more.

Pickering Unit 1 first went critical on February 21, 1971. Less than two months later, on April 4, full power was achieved, and on July 29, the unit was declared "in-service". The remaining three units of Pickering "A" went into service over the next two years. In 1973 Unit 1 had the highest capacity factor in the world at 92.9 per cent. Its lifetime capacity factor, to date, is about 63 per cent.

For information on the Open House contact David Lloyd, chair of the PND 25th Anniversary Committee, at 905-839-1151 ext. 3167.

Ontario Hydro reorganizes nuclear

Ed. Note: *As this issue of the* CNS Bulletin *was almost on the press, news was received of another shake-up of the nuclear operations at Ontario.*

On August 19, 1996, the president of Ontario Hydro, Allan Kupcis, announced a re-organization which spells the end of Ontario Hydro Nuclear as a business unit.

The three nuclear sites will now each have a site director who will report directly to the Managing Director of the Generation Business Group. Jim Burpee, formerly in the thermal area, will become site director at Bruce, while Ken Talbot and Bob Strickert will continue to be responsible for Pickering and Darlington respectively.

An American consultant, Gregory Kane, formerly with Virginia Power, has been brought in to assist Talbot "in his turn-around program at Pickering".

Ron Field, formerly general Manager of Ontario Hydro Nuclear "will assist in ensuring that the many transition issues are dealt with expeditiously".

Kupcis' statement said that the change was necessary because "our nuclear operations have failed to make significant progress in improving performance".

CNS news

BRANCH NEWS

Although summer is normally a dormant time for CNS Branches some have held meetings while others already have plans underway for the season beginning this fall.

BRUCE

The Branch Annual Meeting featuring a barbecue is planned for Tuesday, September 10, with guest speaker Ken Talbot, formerly director of Bruce "A" and now director of Pickering, talking on "Pickering Status and Future". A further meeting is scheduled for Thursday, October 10, with Jerry Cuttler of AECL-SP and past-president of the CNS, speaking on "The Chernobyl Legacy". Planning is already underway for meetings in November and December.

Branch representatives are consulting with local school boards about possible awards or prizes for students going on to post-secondary studies and interested in nuclear science.

CHALK RIVER

The Chalk River Branch will hold its Annual Meeting in October but the date was not set at time of printing.

DARLINGTON

The Darlington Branch closed out its 1995/96 year with a talk on June 18 by Reid Morden, president of AECL, on "The CANDU Business: Today's Reality, Tomorrow's Potential".

Plans are being developed for a program to begin in the early fall.

GOLDEN HORSESHOE

The main activity of the Branch, based at McMaster University, at this time is the operation of the CNS Homepage on the World Wide Web.

Look for:

http://www.science.mcmaster.ca/cns/www/cns/cns.html

MANITOBA

The Manitoba Branch is considering producing a nuclear calendar as a possible fund-raising venture.

The Grade 8 class from the Oak Lake school, who were the winners in the 2nd Annual Manitoba Schools competition run by the CNS Manitoba Branch, visited the Underground Research Laboratory on June 14. The prize was $500 towards the cost of bringing the students to the URL.

SHERIDAN PARK

Two summer seminars were held July. On July 4 Victor Snell spoke on "Up-Front Licensing of CANDU-9". An important milestone was reached at the end of June when the Atomic energy control Board issued an interim decision that there were "no fundamental barriers to licensing the CANDU-9 design in Canada". The work is important for AECL's efforts to market the CANDU-9 for the Bonggil site in Korea. A number of additional analyses will be sent to the AECB this fall and the final report from the AECB is scheduled for next January.

On July 18, Alessandro Martelli, of the National Agency for New Technology, Energy and the Environment (ENEA) of Italy, spoke on "Seismic Isolation: Benefits / Performance / Application". Seismic isolation is a new technology for reducing the seismic motion at the base of a structure which has been used successfully in different parts of the world. AECL is developing a conceptual design for a base-isolate CANDU-6.

DEADLINE

The deadline for the fall 1996 (Vol. 17, No. 4) issue of the *CNS Bulletin* will be November 8 for publication about the end of November.

CANADIAN NUCLEAR SOCIETY
bulletin
DE LA SOCIÉTÉ NUCLÉAIRE CANADIENNE

CNS Annual General Meeting

The 17th Annual General Meeting of the Canadian Nuclear Society was held in the late afternoon of Monday, June 10, 1996 at the Sheraton Inn in Fredericton, New Brunswick, at the end of the first day of the annual CNA/CNS conference. About 35 members attended.

A typical agenda was followed, with reports from the President, Treasurer and chairpersons of the major divisions, election of officers and Council members for the 1996/97 term and a short address from the incoming president.

Reprinted below are the reports from [outgoing] president, **Jerry Cuttler,** and treasurer, **Ken Smith,** and the remarks of incoming president **Hong Huynh.**

Ben Rouben, vice-president and Branch Chair, reported on the active year at most of the Society's 12 branches. (Most of the Branch activities have been reported in the *CNS Bulletin.*) He noted that he had developed an on-going information base of Branch activities which can be used by Branch executives when planning programs. Among the new initiatives he mentioned was a joint dinner held by the Darlington and Pickering branches.

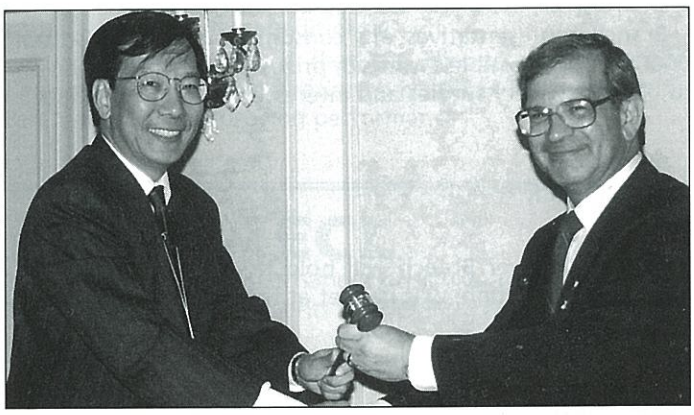
The many activities of the Education and Communication Division were referenced by chairman **Aslam Lone**, including the very successful 50th Anniversary celebration held in Chalk river and Deep River last August and September and the teachers' workshops (such as the one being held during the CNA/CNS conference).

Judy Tamm reported on the work of the Waste Management and Environmental Affairs Division, whose major activity has been organizing the major International Conference on Deep Geological Disposal being held in Winnipeg in September. On behalf of her group she presented a motion that the CNS should expand its stated list of topics [e.g. for conferences] to include " environmental concerns... and stewardship topics". This was carried unanimously.

Chairman of the Nominating Committee, **Ed Price,** presented a proposed slate of officers and Council members for the 1996/97 term. There being no further nominations from the floor those named were declared elected by acclamation. (See list elsewhere in this issue.)

Ed Price then moved a vote of thanks to Jerry Cuttler and the remainder of the outgoing executive and Council for an excellent year. This was strongly endorsed by all present.

Dr. Tatchai Sumitra, of Chulalongkorn University of Thailand and president of the Thai Nuclear Society, (L) and Dr. Jerry Cuttler, 1995-96 president of the Canadian Nuclear Society initial an agreement of cooperation between the two societies, while incoming (1996-97) CNS president, Hong Huynh looks on, during the CNA/CNS Annual Conference in Fredericton, June 1996.



Outgoing president of the Canadian Nuclear Society, Jerry Cuttler (R) hands over the gavel to 1996-97 president Hong Huynh at the CNS Annual General Meeting held in Fredericton, June 10, 1996.

Members of the 1996-97 Executive of the Canadian Nuclear Society pose after the Annual General Meeting in Fredericton, June 10, 1996.
L to R – Ken Smith, treasurer; Ben Rouben, 1st vice-president/ president-elect; Hong Huynh, president; Jerry Cuttler, past president; Aslom Lone, 2nd vice-president. Missing – Jim Platten, secretary

President's report

In my incoming speech, last year in Saskatoon I promised I would change the CNS – broaden our appeal – change our image from a very technical organization to one that is more oriented to the public. I explained that our nuclear heritage would not survive without strong public support.

What has happened? While we have changed in that direction, the internal support has been less than enthusiastic. Is this surprising? Organizations resist change, and the CNS is no different. But we did change. And our membership?... it

has grown more than 25% over the past 12 months, passing the 1000 mark!

We are appealing to everyone who has a stake, or simply an interest, in the success of our nuclear heritage. Many of the 205 new members, who joined since September, are keen to support our newly broadened objectives – to strengthen our branch programs and to reach out to students, teachers, media, governments and ordinary people, with good science in plain language. We are influencing outward and upward, with positive messages, to safeguard Canada's nuclear science and technology from attacks by the anti-nuclear groups, who exploit the public's fear of radiation.

We are networking with other scientific organizations to expose the unsubstantiated linear, no-threshold dose-response model, that is used to predict the number of "excess fatal cancers" from exposures to low-level radiation. With more than a century of experience with ionizing radiation, we know there are no factual grounds to predict any adverse effect from low-level exposures. Such invalid predictions only serve to scare the public. Concerns about this practice were communicated in a series of letters to the AECB.

Our listserver on the Internet has attracted two hundred subscribers. They correspond and debate, sharing their knowledge and views on many important issues. We continue to congratulate Fred Boyd on our Bulletin.

As you can judge for yourself, this conference, with 100 high-quality technical papers, is a smashing success, as was last year's annual conference in Saskatoon. This year, our Program Committee, led by Hong Huynh, sponsored: the Fusion Conference, the Fourth International Conference on CANDU Fuel, the Simulation Symposium, a course on the Role of Reactor Physics in CANDU Engineering, the CANDU Maintenance Conference, the Students' Conference and the First International Conference on CANDU Fuel Handling Systems. The Maintenance Conference was especially successful, illustrating the importance of the operating CANDU stations for the viability of the CANDU program.

This September the 5th International Conference on Simulation Methods in Nuclear Engineering will be held in Montreal and the International Conference on Deep Geological Disposal of Radioactive Waste will be held in Winnipeg. The CNS secured Pacific Nuclear Council agreement to host the 11th Pacific Basin Nuclear Conference in Banff, in May 1998. And the CNA has accepted our invitation to co-sponsor this major event. Preliminary organizing activities have begun.

What about anniversaries? Last August, thanks to Aslam Lone's special effort, we organized a very successful celebration of our nuclear heritage – the golden anniversary ZEEP – the first chain-reaction in Canada. Many individuals and organizations participated to make it a truly memorable occasion. At the Winter Seminar in February, we presented a plaque to Pickering, to commemorate the silver anniversary of Unit 1.

The CNS, as an intervenor, prepared a unique submission to the Environmental Assessment Panel reviewing AECL's environmental impact statement on its concept for deep geological disposal of used nuclear fuel. We also delivered our presentation to the Panel on the first day of the public hearings and responded well to the attacks of anti-nuclear activists.

The Society commented on the CNA fact sheets, "Chernobyl – 10 years later", and we contacted the media and various local and international organizations to explain the true cause of this disaster. We participated in a symposium at the University of Toronto, organized by the Faculty of Medicine, commemorating the 10th anniversary of the Chernobyl disaster, and we delivered a presentation titled, "RBMK vs CANDU – the Canadian contribution."

The media were approached to achieve accurate reporting of the Canadian nuclear scene, and stimulated favourable articles on the 50th anniversary of ZEEP, the Underground Research Laboratory, dispositioning of plutonium in CANDU, and the 1994 loss of coolant incident in Pickering.

An agreement of cooperation was signed with the Nuclear Society of Russia, and agreements with the Chinese Nuclear Society and the Romanian Nuclear Energy Association were renewed. Frequent exchange visits occurred with the American Nuclear Society, and we are discussing a symposium in China with the Chinese Nuclear Society, on CANDU reactors, this autumn.

Our Education and Communication Committee, led by Aslam Lone, has been very active on various projects, such as the celebration of ZEEP, 21st Science for Educators Seminar, educators training workshops, funding of educational activities in the local community by the 12 CNS branches, World Wide Web support and Internet training, and distribution of videos, fact sheets and science kits. The committee prepared a database of the key events in Canadian nuclear science and technology, and will make a calendar chart. It is also preparing a guide to contact people in various fields of nuclear science and technology.

These times of change present many challenges and opportunities, and hopefully our Society will continue to change – to adapt and exploit opportunities. By maintaining a positive attitude and with the magnificent volunteer support of our members, the CNS can look forward to further growth and further strides in overcoming adversity and achieving our goal of preserving, enhancing and fully utilizing our nuclear heritage.

Jerry Cuttler

An Accolade

From the perspective of an editor who has worked with several CNS presidents we want to acknowledge that Jerry Cuttler has been one of the most active presidents the Society has had. During his years on the CNS Council he has committed a large amount of his personal time to the advancement of the organization, which became intensified over the past year as President. His initiatives to increase the membership, which he began when he was Membership Chairman, became intensified as President. Over the past year he has been very pro-active in contacting politicians, school officials, and the media in an effort to communicate the benefits of nuclear science and technology.

As often happens, his actions have sometimes ruffled some feathers – most notably in his crusade against the liner, no-threshold, hypothesis for radiation effects in humans – as can be witnessed by the number of letters-to-the-editor in this and the previous issue on that topic.

For all of that, Jerry has increased the size and the visibility of the Canadian Nuclear Society and made it a stronger organization. For that he deserves much credit.

Treasurer's report

The Auditor's Report (see the last issue of the CNS Bulletin, Vol. 17, No. 2) shows that the CNS continues to maintain a strong financial position. For 1995, total revenue was $160,742, and total expenditures were $145,332, thereby providing an excess of revenue over expenditures of $15,410. As of the end of 1995, the accumulated surplus was about $238,000.

Members should be aware of the fact that their membership fees only account for about 1/4 of total revenue (about $38,000). The favourable net income for 1995 can be largely attributed to the very successful Maintenance Conference that was held last November, which provided a net revenue of about $71,200. The Conference organizing committee deserves our considerable appreciation. As a result of the positive feedback from attendees, a similar conference is being planned for 1997.

We must not ignore the positive contribution of the other smaller conferences, plus the annual conference last year in Saskatoon. The combined net revenue from these functions came to about $38,700.

For 1996, we do not expect to see a repeat the 1995 level of conference income, with the result that the 1996 budget is forecasting a deficit of about $20,000.

Membership fees have not been increased since 1990. When the GST was implemented in 1992, the fee was kept unchanged and the CNS absorbed the 7% charge. Thus, the actual fee was reduced to $51.40. For 1996 a $5.00 late payment penalty was added, but the basic fee was kept unchanged at $55.00 ($51.40 plus $3.60 GST). For 1997, I will be recommending that the fee be increased to $60.00 ($56.07 plus $3.93 GST), while retaining the $5.00 late payment fee. A further $5.00 increase would be appropriate for 1998, but this could be left to 1997/98 Council to discuss.

K.L. Smith, CNS Treasurer – 1995/96

Hong Huynh – 96-97 CNS President

Hong M. Huynh became the 16th president of the Canadian Nuclear Society at the CNS Annual General Meeting in Fredericton, June 10, 1996. He is the first CNS president from the province of Quebec.

Hong was born in Viet Nam of Chinese ancestry and came to Canada in 1968. Here he obtained a B.Eng. degree in Chemical Engineering from Ecole Poytechnique in Montreal and then went on for a M.Eng in the same discipline from McMaster University in Hamilton in 1974.

On graduation he joined the Aluminum Company of Canada (ALCAN) where he served as a process control engineer until moving to Hydro-Quebec in 1980. He is currently safety thermalhydraulics engineer for Gentilly-2 but is based in Montreal.

While at ALCAN Hong also lectured at the University of Quebec in research methodology and operations management. He is the author or co-author of over 20 technical papers.

Hong has been very active with the CNS for several years and has been part of the organizing team for several conferences, including several national and international Simulation Conferences and the 1994 Annual Conference in Montral. He was chairman of the CNS Membership committee 1992 to 1994 and of the CNS Program committee from 1994 to 1996. He is also active with the association of former students of Lasan School in Viet Nam.

Hong Huynh

He has a wife and a son, 18, who, undoubtedly, will see less of him during the coming as he fulfils the busy schedule of a CNS president.

Remarks by incoming CNS President

Thank you all for coming and participating in our Annual General Meeting. This is a major event for the Canadian Nuclear Society.

It is a great honour and a privilege for me to serve the Canadian Nuclear Society as your president for 1996/97.

I would like to thank Jerry Cuttler, our former President, for his leadership and his efforts in conducting various activities for our society during 1995-96.

Jetons un coup d'oeil sur les objectifs de la Société Nucléaire Canadienne:

1) Faciliter les échanges d'information reliée aux sciences et aux technologies nucléaires.
2) Organiser les cours, séminaires et conferences (canadiennes et internationales) qui permettent d'élargir les domaines de connaissance et favorisent le développement personnel des membres.
3) Épauler les sections locales dans leurs activités éducatives ou dans leurs rencontres publiques.
4) Être votre porte parole dans les interventions publiques

sur tout ce qui touche le domaine nucléaire.

5) Parrainer le développement et l'utilisation des sciences et des technologies nucléaires à des fins pacifiques.

We have five technical divisions which organize impressive technical events to give our members opportunities for personnal development, broadening and exposure. From the CNS 1996 events colour calendar (available at the conference), you can see that we are doing well for objectives 1 and 2.

Many activities have been carried out in our 12 branches, such as public meetings on issues of interest, social events, technical visits, etc... Several branches were very active during last year. Some were less active. The data base for branches activities has been developed by our Branch Chair, Ben Rouben. This will help local branches to organize future activities. In general, we meet objectives 1 and 3.

Our Education & Communications Committee Chair, Aslam Lone has put much effort to help local high schools and local communities. These activities are beneficial in getting public support for the nuclear science and technology in Canada. I think that CNS achieved significant improvement in meeting objective 4. Efforts should be maintained in this area in order to dimistify the public fear of nuclear sciences and technologies.

The CNS has also participated in different environmental hearings, such as the geological disposal of used fuel, and has co-sponsored several Conferences, Courses and Meetings organized by other Societies. We should continue in these activities to fulfill objectives 4 and 5.

Nous vivons actuellement dans un contexte très difficle. La rationalisation et la restructuration entreprises dans des sociétés touchent tout le monde. Pour réduire le coût d'exploitation, l'Association Nucléaire Canadienne (ANC) a réduit le nombre du personnel de bureau en 1995 et a déménagé récemment pour louer des bureaux plus petits. Vous savez sans doute que notre Société loue les services de l'ANC. Avec la réduction substantielle du personnel à l'ANC, la détérioration dans la qualité des services à nos membres commence à se faire sentir. Il est donc primordial d'examiner les diverses solutions pour garder, sinon améliorer, les services à nos membres et la gestion de la SNC. J'ai l'intention de former un comité pour examiner ces solutions. Nous entamerons les discussions avec l'ANC sur ce sujet.

These are the areas on which I will try to focus CNS effort. With the collaboration of the incoming CNS Council members, we will continue to meet the objectives of CNS and we will try to attract the non CNS members who are involved in the nuclear science and technologies into our society.

I look forward to your support.

Hong Huynh

CNS EXECUTIVE AND COUNCIL FOR 1996/97

Executive		
President	Hong Huynh	Hydro-Québec
1st Vice-president (president-elect)	Ben Rouben	AECL-SP
2nd Vice-president	Aslom Lone	AECL-CRL
Secretary	Jim Platten	AECL-SP
Treasurer	Ken Smith	UNECAN
Past-president	Jerry Cuttler	AECL-SP
Council Members-at-large		
Emélie Lamothe	Edit-Right Technical Services	
Guy Le Clair	MPB Technologies Inc.	
Andrew Lee	Ontario Hydro - Nucl. Fin. & Bus. Ser.	
Raymond Leung	Ontario Hydro - Nuclear Tech.	
Graham Parkinson	Ontario Hydro - Pickering	
Jad Popovic	AECL-SP	
Ed Price	AECL-SP	
Judy Ryan	OntarioA Hydro - Nuclear Waste & Env.	
John Saroudis	AECL-Mtl.	
Surinder Singh	AECL-SP	

CNS PRESIDENTS OVER THE YEARS

1980-81	George Howey	1989-90	Eva Rosinger
1981-83	Phil Ross-Ross	1990-91	Hugues Bonin
1983-84	John Hewitt	1991-92	Gil Phillips
1984-85	Peter Stevens-Guille	1992-93	Bill Midvidy
1985-86	Joe Howieson	1993-94	Paul Fehrenmbach
1986-87	Nabila Yousef	1994-95	Ed Price
1987-88	Irwin Itzkovich	1995-96	Jerry Cuttler
1988-89	Ken Talbot	1996-97	Hong Huynh

AECL signs agreement with China

In July, Reid Morden, president of Atomic Energy of Canada Limited and Jiang Xinxiong, president of the Chaina National Nuclear Corporation, signed a Project Award Agreement in connection with the proposed construction of two CANDU-6 plants at the Qinshan site in southern China.

The PAA finalizes the price and commercial terms for the Qinshan CANDU project as well as the fees , financing scope and conditions from the Canadian Export Development Corporation and other export credit agencies. The agreement commits the parties to have "signed contracts" by November 12 and "effective contracts" by January 12, 1997

The project consortium will be led by AECL and the customer is the Qinshan Nuclear Power Company. Other organizations involved include Hitachi and Itochu of Japan and Bechtel of the USA.

CALENDAR

1996

September 8 - 11
5th International Conference on Simulation Methods in Nuclear Engineering
Montréal, Québec
contact: J. Saroudis
AECL Montreal
Tel: 514-871-1116
Fax: 514-934-1322

September 16 - 19
Deep Geologic Disposal of Radioactive Waste
Winnipeg, MB
contact: M.M. Ohta
WL Pinawa, Manitobe
Tel: 204-345-8625 ext. 201
Fax: 204-345-8868
e-mail: ohta@wl.aecl.ca

September 17 - 20
IAEA Specialists Meeting on Experience and Improvements in Advanced Alarm Annunciation Systems
Chalk River, ON
contact: L.R. Lupton
AECL - CRL
Tel. 613-584-8811 ext. 3433
Fax 613-584-9541
e-mail: luptonl@crl.aecl.ca

September 29 - October 2
Canadian Society for Chemical Engineering Annual Conference
Kingston, ON
contact: Dr. H.W. Bonin
RMC
Kingston, ON
Tel: 613-541-6613
Fax: 613-542-9489

September 30 - October 2
Economic Nuclear Power for the 21st Century
Paris, France
contact: TOPNUX '96
Société Frkancois D'Energie Nucléaire
Tel: 33.1.44.19.62.16
Fax: 33.1.44.19.62.22

October 7 - 9
Yugoslav Nuclear Society Conference
Belgrade, Yugoslavia
contact: Radojko Pavlovic
Belgrade
Fax: ++ 381-11-455943

October 14 - 18
International Symposium on Nuclear Energy and the Environment
Beijing, China
contact: Chinese Nuclear Society
P.O. Box 2125
100822, Beijing, China

October 16
Symposium on Radiological Impacts on Non-Human Species
Ottawa, Ontario
contact: Ms. Judy Tamm
AECL
Pinawa, Manitoba
Tel: 204-753-2311 ext. 2958
Fax: 204-753-2483

October 20 - 25
10th Pacific Basin Nuclear Conference
Kobe, Japan
contact: 10-PBNC
Atomic Energy Society of Japan
Tokyo, Japan
Fax: 81-3-3581-6128

October 27 - 31
General Conference on Nuclear Energy
Rio de Janeiro, Brazil
contact: Everton de Almeida Carvalho
Brazil Nuclear Energy Assoc.
Fax: 55-21-541-8785

November 10 - 15
ANS/ENS International Meeting
Washington, DC
contact: ANS
Le Grange Park, Illinois
Tel: 708-579-8258
Fax: 708-352-0499

continued on page 45

continued from page 44

November 17 - 22

ASME International Mechanical Engineering Congress
Atlanta, Georgia
• Symposium on Inelastic Methods for Structural Analysis and Design
contact: Robert Sammataro
Electric Boat Div.,
General Dynamics
Groton, Conn.
Tel: 860-433-3904
Fax: 860-433-3157
• Session on Exp:l Study of Multiphase Flow
contact: Dr. B.W. Yang
Columbia University
New York, NY
Tel: 212-280-4163
Fax: 292-678-5279

November ??

Reactor Safety Course
Toronto, Ontario
contact: V.S. Krishnan
AELL
Mississauga, Ontario
Tel: 905-823-9040

November ??

CANDU Seminar
Beijing, China
contact: Jerry Cuttler
AELL
Mississauga, Ontario
Tel: 905-823-9040 Ext. 2556
Fax: 905-823-9470

1997

February ??

CNA/CNS Winter Seminar
Ottawa, Ontario
contact: Ms. Sylvie Caron
CNA/CNS
Toronto, Ontario
Tel: 416-977-6152 Ext. 18
Fax: 416-979-8356

March 23 - 26

Advances in Fuel Management
Myrtle Beach, SC
contact: Dr. Paul Turinsky
North Carolina State Univ.
Rawleigh, NC
Fax: 915-515-5115
e-mail: turinsky@eos.ncsu.edu

March ??

22nd Annual CNA/CNS Student Conference
Fredericton, NB
contact: Dr. Wm. Garland
McMaster University
Hamilton, Ontario
Tel: 905-525-9140 Ext 24975

April 6 - 11

4th International Conference on Methods and Applications of Radioanalytical Chemistry
Kailua-Kona, Hawaii
contact: Sylvie Carson
CNS office
Toronto, ON
Tel: 416-977-7260 ext. 18
Fax: 416-979-8356

April 14 - 18

5th International Topical Meeting on Nuclear Thermal Hydraulics, Operations and Safety
Beijing, China
contact: Ken Talbot
Pickering NGD Ontario
Ontario Hydro
Pickering, ON
Tel: 905-839-1151

May 13 - 16

CRPA Annual Conference
Victoria, BC
contact: Sylvie Carson
CNS office
Toronto, ON
Tel: 416-977-7260 ext. 18
Fax: 416-979-8356

June 1 - 4

2nd International Topical Meeting on Advanced Reactors Safety
Orlando, Florida
contact: Dr. Rusi Taleyarkhan
Oak Ridge National Lab.
Oak Ridge, TN
Tel: 423-576-4735
Fax: 423-574-0740
e-mail:
zrt@cosmaill.ornl.gov

June 8 - 11

CNA/CNS Annual Conference
Toronto, ON
contact: Sylvie Carson
CNA/CNS
Toronto, ON
Tel: 416-977-6152 ext. 18
Fax: 416-979-8356

August 17 - 21

International Conference on Neutron Scattering
Toronto, ON
contact: Dr. W.B.L. Buyers
AECL Chalk River Lab.
Chalk River, ON
Tel: 613-584-3311
Fax 613-584-1849

September 22 - 24 — **5th International CANDU Fuel Conference**
Toronto, ON
contact: Dr. J. Lau
AECL - SP
Mississauga, ON
Tel: 905-823-9040

September 30 - October 4 — **NURETH-8, 8th International Topical meeting on Nuclear Reactor Thermal Hydraulics**
Kyoto, Japan
contact: Dr. Jerry Cuttler
AECL - Sh. Pk.
Mississauga, ON
Tel: 905-823-9060 ext. 2556
Fax: 905-855-0945

September ?? — **Nuclear Simulation Symposium**
TBA
contact: V.S. Krishnan
AECL
Mississauga, ON
Tel: 905-823-9040

October 5 - 10 — **Global '97 International Conference on Future Nuclear Systems**
Yokohama, Japan
contact: Dr. Jerry Cuttler
AECL - Sh. Pk.
Mississauga, ON
Tel: 905-823-9060 ext. 2556
Fax: 905-855-0945

October 6 - 10 — **International Conference on Mathematical Methods and Supercomputing for Nuclear Applications**
Saratoga Springs, NY
contact: Dr. M.R. Mendelson
Knolls Atomic Power Lab
Schenectady, N.Y.
Tel: 518-395-7046
Fax: 518-395-4422

November 16 - 18 — **4th CANDU Maintenance Conference**
Toronto, ON
contact: D. Iafrate
Ontario Hydro
Darlington, ON
Tel: 905-697-7496

November ?? — **International Conference on Effects of Radiation on In-Reactor Corrosion**
TBA
contact: V. Urbanic
AECL-CRL
Chalk River, Ontario
Tel: 613-584-4676

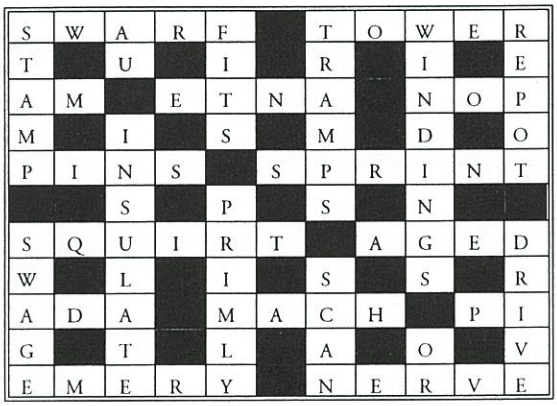
1998

May 3 — **11th Pacific Basin Nuclear Conference**
Banff, Alberta
contact: Ed Price
AECL Sheridan
Tel: 905-823-9040
Tel: 613-584-3311
Fax: 613-584-1849

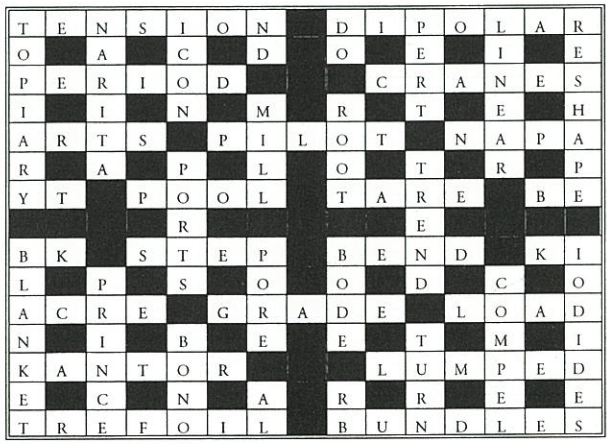
June 7 - 11 — **3rd CNS International Steam Generator and Heat Exchanger Conference**
Toronto, Ontario
contact: R. Tapping
AECL-CRL
Chalk River, Ontario
Tel: 613-584-8811
Ext. 3219

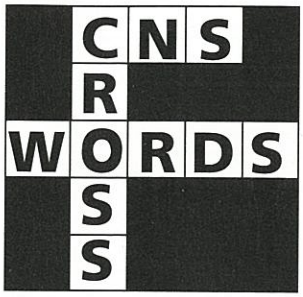
June 14 - 18 — **12th International Symposium Zirconium in the Nuclear Industry**
Toronto, Ontario
contact: G.D. Moan
AECL
Mississauga, Ontario
Tel: 905-823-9060
Ext. 3232

Easier

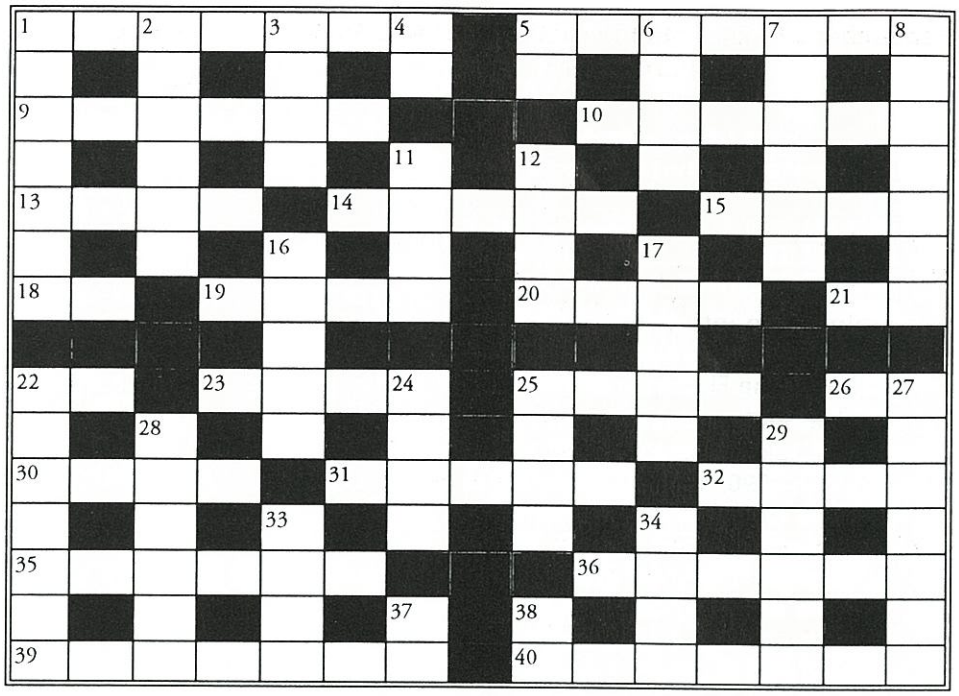


Harder





The Cross Section: No. 5



Harder

Across

1 High, in some power lines (7)
5 Two-ended, like the Earth (7)
9 Characteristic time. Full stop (5)
10 Lifting birds? (6)
13 Described as engineering, medical or fine (4)
14 Conspiracy includes me for trial operation (5)
15 Valley produces big reds (4)
18 Element 39 (abbr) (2)
19 Where 40 Across cool off (4)
20 Vehicle weight (4)
21 Command a light element to exist (2)
22 Campus element (abbr) (2)
23 Taken one at a time, as in procedures or hikes (4)
25 Divers and pipes sometimes have more than one (4)
26 Chemical to block thyroid (abbr) (2)
30 Land area of ancient city? (4)
31 Level slope gets good mark (5)
32 Do this before firing (4)
35 He displeased Kronecker infinitely (6)
36 Thrown together, like parameters (6)
39 Three-leaved warning (7)
40 Groups of pencils go through proper channels (7)

Down

1 Sculpturing shrubs and trees (7)
2 Airport in Tokyo (6)
3 I trick a symbol (4)
4 Laser gas (abbr) (2)
5 Step two for Deming (2)
6 Chart looks sprightly (4)
7 Straight, close to Li (5)
8 Concerning from, fashion it again (7)
11 Dither about dark and satanic place (4)
12 Cheer for solution (4)
16 Many a haven, sport (5)
17 Pattern for yuppies (5)
22 Vacuous extra-terrestrial covers bed? (7)
24 Close study of a hole (4)
25 German astronomer offers portents (4)
27 Salts from purple gas (7)
28 Former AECB head regal? (6)
29 Forceful Spanish benefits manager? (6)
33 Boon produces lateral thinker (4)
34 Machinists round a corner (4)
37 Italian particle stands in for light metal (abbr) (2)
38 Relative of calcium (abbr) (2)

Solutions on page 46

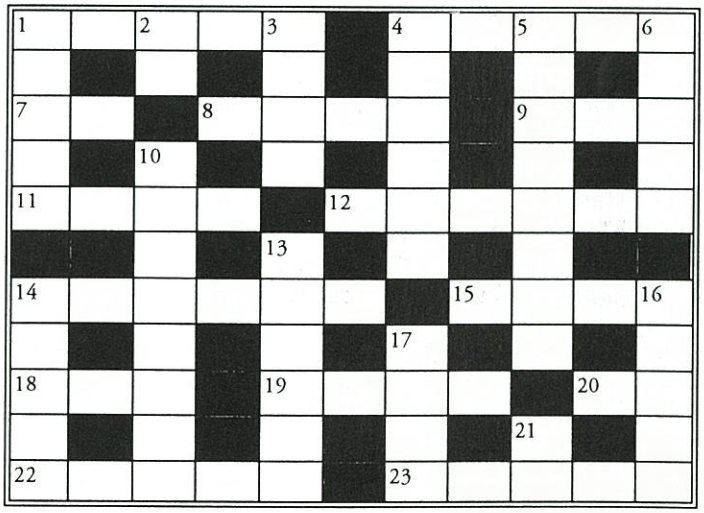
Easier

Across

1 Metal shavings (5)
4 Structure supporting e.g. weather instruments (5)
7 Element named after a country (abbr) (2)
8 Sicilian volcano (4)
9 Nominla Over-Power (abbr) (3)
11 Elements of fuel assembly (4)
12 Done by short distance runners (6)
14 Eject liquid (6)
15 Old, as in whisky (4)
18 Programming language named after a woman (3)
19 German physicist associated with sound (4)
20 Common transcendental number (2)
22 Abrasive material (5)
23 With this you will be unflinching (5)

Down

1 Done to metal and letters (5)
2 Gold (abbr) (2)
3 Along with "starts", describes irregular behaviour (4)
4 Transients (6)
5 Coils in motor (8)
6 Give plants a fresh start (5)
10 Surround with protection, as an island (8)
13 Formerly and precisely (6)
14 Operation used for metal-to-metal fitting (5)
16 Associated with rotating magnetic disks (5)
17 Survey or view quickly (4)
21 Boolean operation (2)



THE DARKER SIDE

by George Bauer

An interesting international first concluded recently. Very few people were aware that it was even taking place. It was the First International Nuclear Olympics.

The idea was certainly a novel one, and started almost as a joke. Some say that it managed to end as one. Back in 1990, a small committee in INPO picked up on the idea of a friendly competition among nuclear power stations. Where they found this notion is hard to say, because everyone knows that competitions of any sort are anything but friendly. In any event, they bashed away at this, flew around the country a bit to make the travel expenses look reasonably respectable, and then all got fired during one of the diurnal downsizing efforts. However, they had got as far as producing some headed notepaper, and this was leaked to the internet. A junior staffer in the AECB found it while conducting a search (known within the Board as a "browsing break"), and sent the item up the line with an attached note saying something like "Wouldn't it be nice to see our applicants lose at something without us being blamed?". For a long time, this document was mistaken as a draft Board technical position paper, and was even given a number: Position Paper Number 1. Eventually, however, it was a case of bishop takes pawn, check and mate.

The scene shifts to Ontario Hydro. Within that mighty organisation, keen minds trawl the internet ceaselessly, and the annotated AECB item was duly logged. Although the corporate office is often labelled the "garden furniture department", someone within that beleaguered function recognised that anything the AECB disapproves of must have intrinsic value. The small seed grew and eventually was plagiarised as part of paper to be delivered at an IAEA conference. This was enough.

Interest grew. Fed by a steady supply of out-of-work QA types, a sub-critical mass was soon reached, and an organising body began to emerge. Names, as we all know, are crucial. Without a catchy name, no project will go anywhere. Fortunately, they hit upon one early: IOTA. This stands for International Olympic Team (and Associates). The last bit was demanded by the fee-for-service crowd. Within days, things were moving.

The first meeting was in an abandoned cooling tower on the Island of Grain. On that day alone, fourteen sub-teams were struck. More sub-teams appeared in short order, and soon they had achieved their first objective. A bureaucracy had been born; it was now big enough that it needed no further contact with the outside world. The thing had become unstoppable. Soon a site was chosen. Events were accredited as standard problem events. A second site was chosen: Atlanta. (The first site had been the capital of Gondwanaland, but nobody seemed able to find it on the map.) There were two reasons for the choice of this second site. First, Ted Turner had just bought INPO, fearing a pre-emptive strike by Rupert Murdoch right under his nose. Second, he had just had a row with Jane Fonda and wanted to irritate her.

All too soon the whole thing was over, but as a first cut it was judged a success. There was a stunning line-up of events. Swimming took place in one of the spent fuel bays. The time trials required entrants to complete one lap of the pool within 14 seconds, not easy when you are covered with wax blocks. The three metre diving event was a disappointment. Nobody came back up. This was traced ultimately to a coding error: with all the spent fuel piled at the one end, the water there was only four feet deep. There was a "paper chase", since steeples were deemed too heavy. In this event, each competitors was required to run 100 metres with a standard operating manual strapped to his or her back. The 100 metre dash was two laps of a standard control room without tripping. Golf was one of the events, a condition of entry being irradiated balls. An event that attracted great attention was the four unit relay. The US was very confident of winning this but Canada took the gold easily, having lots of experience running four units in parallel. The American team put the best face on it, claiming that they hadn't lost, they had come second. In the evenings, everyone gathered poolside to watch the Cerenkov display and be entertained by the Hartree-Fock octet.

The entire competition had been beamed to the Ontario Hydro corporate office, but was interrupted irretrievably during a fiscal discussion when a whisky bottle was thrown through the monitor. Only that morning, the A/V unit had been outsourced, and nobody could remember to whom.

As is sometimes the case, there was one slightly sour note. Spain had taken the gold for number of tonnes of turbot caught on an intake screen. Alas, they were later disqualified when it was learned that the mesh was undersized.

CNS Council • Conseil de la SNC

1996-1997
Executive / *Exécutif*

President / *Président*	Hong Huynh	(514) 392-5614
1st Vice-President / *1ier Vice-Président*	Ben Rouben	(905) 823-9040
2nd Vice-President / *2ième Vice-Président*	Aslam Lone	(613) 584-3311
Secretary / *Secrétaire*	Jim Platten	(905) 823-9040
Treasurer / *Trésorier*	Ken Smith	(905) 828-8216
Past President / *Président sortant*	Jerry Cuttler	(905) 823-9040

Members-at-Large / *Membres sans portefeuille*

Jeff Lafortune . . . . . (613) 563-2122
Emélie Lamothe . . . . . (613) 584-2880
Andrew Lee . . . . . (416) 592-6843
Raymond Leung . . . . . (416) 592-8624
Guy LeClair . . . . . (514) 652-8743
Graham Parkinson . . . . . (905) 839-1151
Jad Popovic . . . . . (905) 823-9040
Ed Price . . . . . (905) 823-9040
Judy Ryan
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