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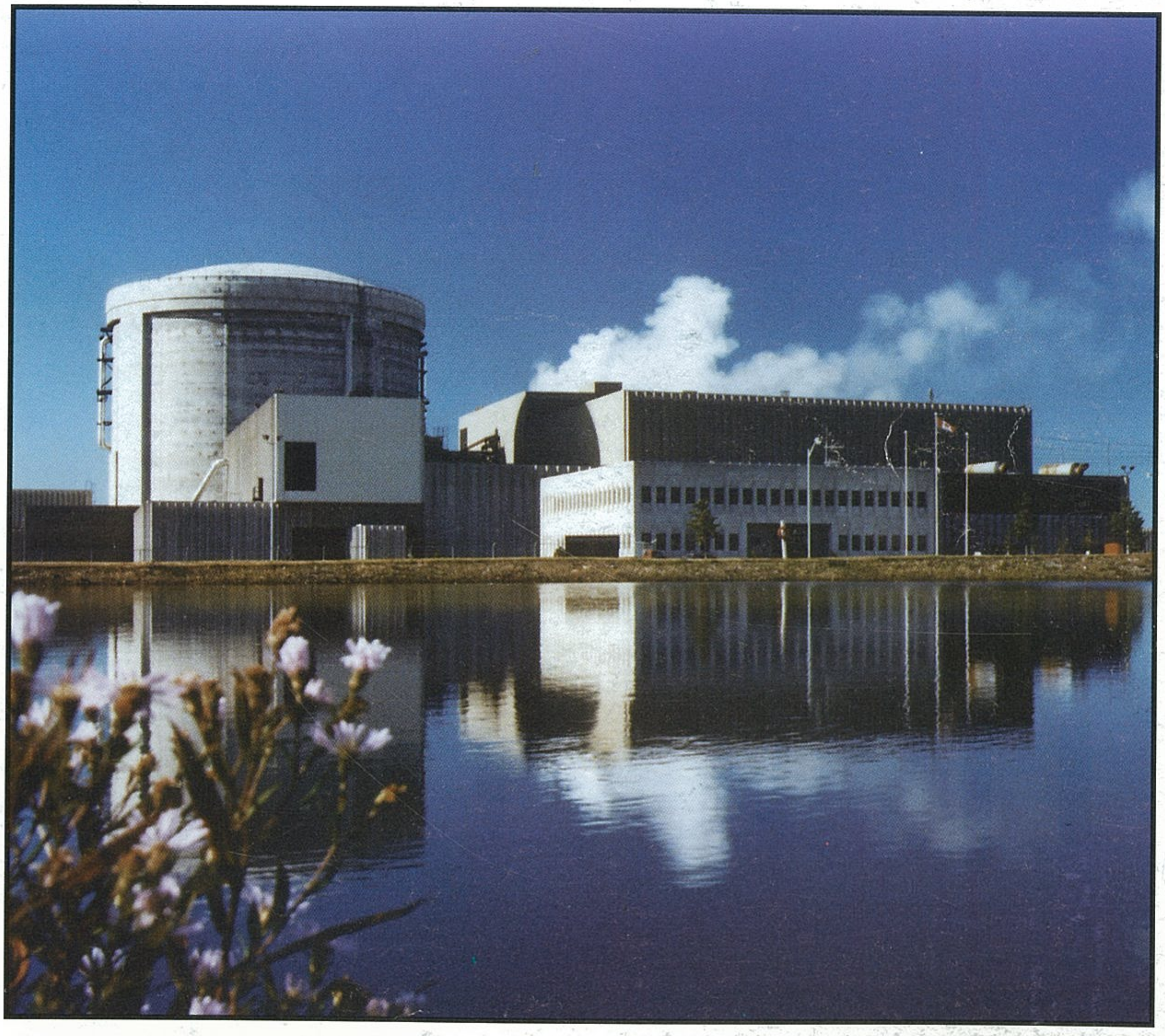

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Cover Illustration

The photograph on the cover is a scenic view of the Point Lepreau Generating Station in New Brunswick where the demonstration irradiation tests of the new CANFLEX is underway.

(Photo courtesy of AECL)

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

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EDITORIAL

Communication ?

It was difficult to overcome the perception of irony with the theme of the recent CNA / CNS Annual Conference in Montreal, *Communicating the Nuclear Advantage.*

Many of the theme talks were essentially self-congratulatory messages delivered to an audience that had heard much of it before. Except for the session on *Communication: the Story of Waste,* there was little said on how actually to communicate with the general public on nuclear issues and what was imparted came mostly from speakers from other countries. (Did anyone from here listen to their experiences?)

Even the mechanics of the conference discouraged open communication. Throughout all of the plenary sessions there was no allowance for questions from the floor or even for discussion between the speakers. Further, for most of the presentations there were no written copies. So much for the practice of "communications".

The two luncheon speakers did provide some insight on public perceptions and the workings of the media but their messages appeared to be as ephemeral as the food.

We are bombarded daily with mis-information, false claims, veiled warnings, about the evils of nuclear energy and radiation. The extreme reaction to the proposed MOX program and the associated shipment of, to date, minuscule amounts of plutonium, is one example. The very vocal opposition has even resulted in a special panel of federal Ministers being appointed just for this issue.

At the time of writing there is a large gathering in Ottawa billed as a "World Conference on Breast Cancer". This is not a scientific conference but a "grass roots" movement which has been the platform for the presentation of questionable (but well publicized) "studies" on, among other things, the increased incidence of breast cancer around nuclear power plants due to strontium 90.

In the face of this persistent anti-nuclear propaganda the Canadian nuclear industry has essentially abandoned all communication programs aimed at the general public or media and is concentrating on "lobbying". Given the governmental role in the nuclear program, through policies, regulation, and financial support for research, such action is necessary, but it is **not** sufficient. In today's political climate it is very evident that our political leaders will not act if they do not see public support. To obtain that support it is essential that not only must all nuclear activities be conducted with upmost safety but there is an ongoing program to truly communicate with the public, the media and especially the educators.

Is anyone in the Canadian nuclear community really interested in communicating the nuclear advantage ?

Fred Boyd

IN THIS ISSUE

The past few months have been active ones for the Canadian nuclear community and we have tried to reflect that in this issue of the CNS Bulletin.

In **Letters,** Richard Osborne responds to the letter by Theodore Rockwell in the last issue on the topic of the "linear no-threshold" (LNT) hypothesis for radiation protection. Two excerpts from recent Canadian papers on that issue are presented further on under the title **More on LNT.**

Continuing our series on organizations associated with the Canadian nuclear program there is brief look at the larger of our two fuel manufacturers in **Zircatec - for CANDU fuel and components.** As a technical accompaniment there a paper on, **CANFLEX Demonstration Irradiation at Point Lepreau.** This is the first of two papers drawn from the technical sessions of the 1999 CNS Annual Conference which are included in this issue.

An overview of the joint **CNA / CNS Annual Conferences** which were held in Montreal in June is followed by an account of the **1999 Awards** presented by the Canadian Nuclear Association and the Canadian Nuclear Society. Then there is the text of the plenary presentation which attracted the most interest, **Role of Nuclear in OPG Competitiveness,** by Ronald Osborne, the recently appointed president of Ontario Power Generation Inc.

To keep readers up to date on the regulatory scene we have a recent paper by Dr. Agnes Bishop, president of the Atomic Energy Control Board, on **Nuclear Regulation - Today and Tomorrow.**

A brief review article of programs here and abroad on **Meeting the Y2K Challenge** is followed by the second technical paper from the CNS conference on **The Y2K Program for Scientific Analysis Computer Programs at AECL.**

Some more history is provided in Gordon Brooks' review of **"Early Evolution of CANDU PSA".** In the context of CANDU analysis, that paper is followed by a short report on a very positive action over the past couple of years in Common Safety Analysis Codes.

There is an expanded section on **General News** which includes updates on the **Canadian Light Source** and the **Canadian Neutron Facility** as well as reports on several activities, including the **International Symposium on Ionizing Radiation** hosted by the AECB in May.

And, of course, there is considerable **CNS News,** including reports on the **Annual General Meeting** held May 31 in Montreal, an updated calendar and a revised list of Council members.

We hope that you find something of interest in this somewhat eclectic package and, as always, welcome your comments and contributions.

Osborne replies to Rockwell on LNT - current approach "prudent".

The Editor:

In his Letter to the Editor, *Radiation Protection: Living with a Threshold,* (CNS Bulletin, Vol 20, No 1, January-March 1999) Dr Rockwell stated that he was astonished by my statement in the previous issue that "...radiation measurements, dosimetry and environmental modelling would become much more complicated with a departure from an assumption of linearity of dose and response for protection purposes... ".

The statement is simply a reflection that, if a non-linear relationship between accumulated dose and attributed risk to health is the basis for protection, then one has to know where one is along the accumulated dose scale (in whatever is deemed to be the relevant period) in order to know what, if any, the incremental risk is at that value. Currently one only has to keep track of accumulated doses from exposures at work or estimate doses to the public from particular sources for protection or compliance purposes. A given increment in dose is associated with the same risk, irrespective of past accumulations of dose.

Under a non-linear protection model, the risk attributed to a given incremental dose would not be fixed. All exposures would have to be tracked, not just those associated with the regulated nuclear industry if one were to take advantage of the non-linearity and demonstrate compliance.

Any such system would be more complicated except for a model in which a threshold is specified in terms of a dose averaged over a short time minutes or possibly a few hours; essentially a dose rate threshold model. Then protection would be more analogous to protection against many chemicals for which air concentration, say, is the parameter of concern. But this is not the model Dr Rockwell is advocating; his is one based on a threshold annual dose.

The issues that Dr Rockwell actually goes on to discuss in his letter arise more from misapplication of the present system, than from the protection model itself. They are real issues and do result in disproportionate allocations of resources to reduce what should be regarded as trivial doses. That any effects from small increments in dose are certainly small often seems to be lost from view.

As Norman Gentner and I pointed out in our paper at the Pacific Basin Nuclear Congress last year (1), we do not know for any particular small increment in dose, what the actual influence on health will be - only its bounds. In any population the effects on individuals of small additions in the day-to-day radiation doses will be varied, both in time for a given individual and between individuals, depending inter alia on the individuals' genetic make-up and the spatial and temporal distributions of cellular doses. This uncertainty continues to present a challenge. There is no single quantitative generic model, nor do we have a detailed accounting of any individual's complete personal dose history, nor of their genetic make up, nor of their individual cellular responsiveness to radiation at any particular time. Given this multitude of factors, we concluded that the only practical and equitable approach in radiation management is to associate with increments of radiation dose from man-made sources (or any other) a probability of advancing an individual towards a deleterious effect on health.

The reasonable assumption for a hypothetical individual is that the bigger the dose, the proportionately bigger the likelihood of an advance towards an effect. Such an approach protects the hypothetical average individual, accepting that we do not know the characteristics of each individual and their particular response to a given pattern of dose in time, only the estimated bounds of response from epidemiology.

I believe that this is still the prudent approach.

R.V.Osborne

1. Linear versus Non-Linear: A Perspective from Health Physics and Radiobiology, N.E. Gentner and R.V. Osborne, Proc. 11th Pacific Basin Nuclear Conference, Banff, Canada, 1998 May 3-7: CD-ROM, CNA/CNS (1998)

Ed. Note: *See the summary of a paper by Ron Mitchel, Low Dose Effects: Testing the Assumptions, and the abstract of one by Jerry Cuttler, Resolving the Controversy over Beneficial effects of Ionizing Radiation, elsewhere in this issue of the CNS Bulletin.*

Zircatec
- manufacturer of CANDU fuel and components

by Fred Boyd

Ed. Note: *For our on-going series on organizations involved in the Canadian nuclear program we present the following short report on Zircatec Precision Industries Inc., manufacturer of fuel and components for CANDU reactors. Our thanks to Martyn Wash and Don Newington of Zircatec for their assistance.*

Preamble

Natural uranium fuel and heavy water are the basic defining characteristics of the reactors in CANDU nuclear power plants. The fuel is also the only significant consumable.

The total operating cost of a CANDU nuclear power plant is quite low. A major factor in achieving this low cost of electricity production is the low fuelling cost. That, in turn, is largely due to the very efficient fuel manufacturing and the high quality. Only a minuscule fraction of a one percent of the hundreds of thousands of CANDU fuel bundles produced over the years have failed in service.

A view of Zircatec's Port Hope plant.

The current standard design of a CANDU fuel bundle has nominal dimensions of 50 cm. long, 10 cm. diameter, with 37 elements of equal diameter, 50 cm. This design is the culmination of much research and development, beginning with the 7 element smaller diameter, fuel used in the demonstration NPD and the prototype Douglas Point reactors. A new design, given the acronym CANFLEX, has 43 elements of two different diameters, with the larger ones in the centre to compensate for the depression of the neutron flux due to self shielding. A number of CANFLEX bundles has recently been tested in the Point Lepreau nuclear generating station.

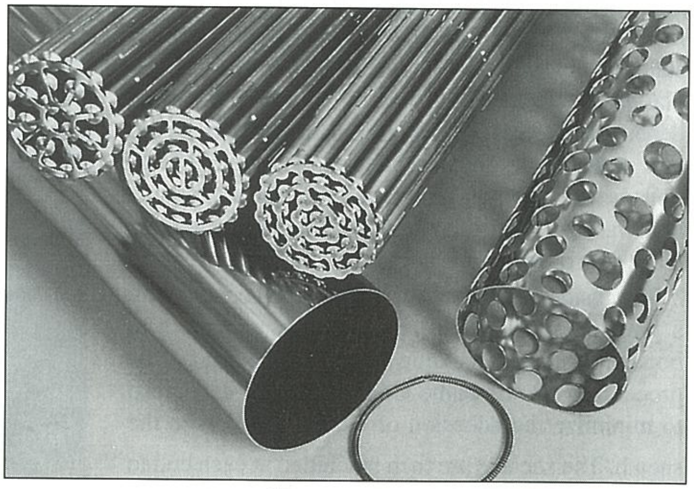
The largest manufacturer of CANDU fuel is a modest sized company located in the town of Port Hope, Ontario, about 75 km. east of Toronto (and fairly close to the Darlington nuclear generating station), **Zircatec Precision Industries Inc.**

Although the Port Hope plant celebrated its 40th anniversary two years ago, Zircatec has owned and operated it only since 1988. Over its 42 years the Port Hope plant has produced over 700,000 CANDU bundles which have been used in 28 reactors world-wide.

Zircatec has a second plant in Cobourg, a few kilometres east of Port Hope, where it manufactures various zirconium based components for CANDU rectors.

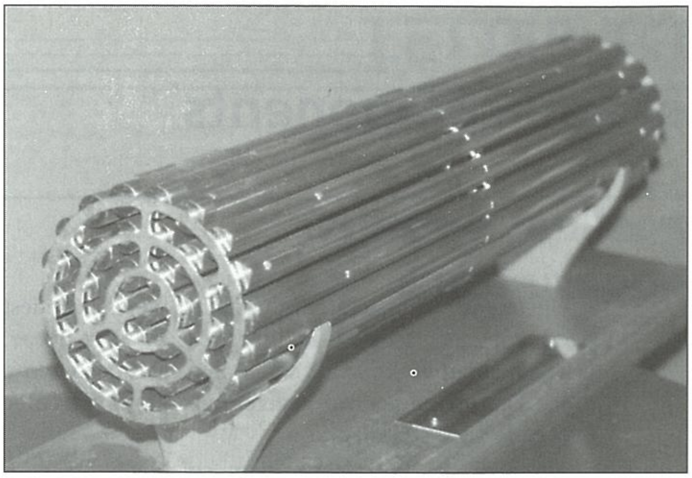
History

The Port Hope plant now owned and operated by Zircatec was built in the mid 1950s by AMF Atomics, an American subsidiary, to build fuel elements for the NRX and NRU research reactors of Atomic Energy of Canada Limited which had previously been fabricated at the Chalk River Laboratory. That fuel was aluminium clad uranium alloy metal rods and flats. The plant also supplied similar fuel for the CIR reactor in India, Pulstar in the USA, MZFR in Germany and SGHWR in the UK.



CANDU fuel elements and components.

In 1964 the business was purchased by Canadian Westinghouse Company Limited who operated the plants until 1988. During that period the Port Hope plant



A display model of a CANDU fuel bundle.

ceased to make fuel for the research reactors to concentrate on CANDU fuel. In 1988 Contour Holdings purchased what had then become the Nuclear Products Division of Westinghouse Canada and formed Zircatec Precision Industries Inc.

Until the early 1970s the zircaloy tubing used for the fuel sheaths was purchased as finished tubes from supplies in the USA and cut to a finished length at the Port Hope plant. In 1973 the tube cutting and ultrasonic inspection operations were moved to a building in Cobourg.

Fuel Manufacturing

All of the manufacturing of the fuel takes place in the Port Hope plant. For the "meat" of the fuel, UO_2 powder is obtained from Cameco's refinery (also in Port Hope). It is pressed into pellets, sintered, and ground ready for insertion into the sheaths.

The tubing for the fuel sheaths comes from the Cobourg plant in a finished condition. Bearing pads, which go onto the outside elements, and spacer pads, to keep the elements apart, are stamped from zircaloy 4 wire. They are cleaned, grit blasted and coated with beryllium using a vapour deposition process. The bearing pads and spacers are tack welded onto the sheathing at the required locations before being brazed using induction heating in a high vacuum. The zirconium-beryllium brazing technique was developed at the Port Hope plant.

The inside of the fuel sheaths are then coated with a graphite slurry, dried and baked in a vacuum to bond the graphite coating to the inside wall. This process, given the name CANLUB, was developed to minimize the adhesion of the UO_2 pellets to the sheath. The sheaths are then machined at each end to the specified length. A stack of sintered pellets is loaded into each tube and end caps, machined from zircaloy-4 bar, are welded onto the tube ends using a resistance welding process. These are the two most critical operations.

Each tube is filled with helium at the end cap welding operation to purge the air and moisture and to facilitate leak testing after final assembly.

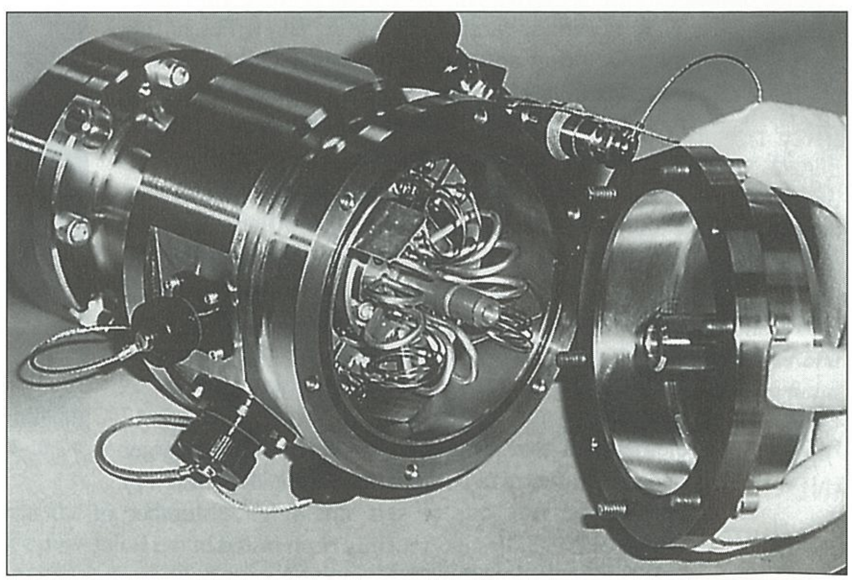
The elements are assembled into a bundle using a fixture that locates each element in its correct position. Zircaloy endplates are resistance welded onto each element. Finally, each element is inspected, tested and weighed before packing for shipment to a utility.

The Cobourg plant produces all of the seamless zircaloy tubing used for the fuel sheathing. The starting material is tube reduced extrusions with an outside diameter of 2.5 " (63.5 mm) and a wall thickness of 0.430" (10.9 mm). These extrusions are reduced to finished size using a "pilgering" process which reduces both the diameter and wall thickness at a controlled rate. The reduction is done in stages. After each step the material is annealed at 750_C to promote re-crystallization and remove the cold working. After the last pilger step the metal is heat treated at approximately 500_C to remove some of the stresses and leave the tubing with both ductility and strength. Both the re-crystallization anneals and the final stress relief anneal are done in a high vacuum to prevent oxidation of the material.

Zircatec is the only manufacturer to date of the new CANFLEX fuel. Since this involves elements of differing diameters it has added another degree of complexity to the manufacturing process. The initial batch of CANFLEX fuel (for the test in the Point Lepreau nuclear generating station) was essentially custom built. The team at Zircatec are developing new machinery to enable the quantity production of CANFLEX when it has met all regulatory and operational requirements.

Each fuel bundle is numbered and a complete history of its manufacture is maintained. In the few cases of defective fuel it has been possible to resurrect all of the pertinent information regarding the manufacture of each bundle including the source of materials.

Ed. Note: *Most of Zircatec's machinery has been custom designed and built. As a consequence company officals were reluctant to have detailed photographs taken of the plant.*



Flux Detector Assembly

Reactor components

One of the business decisions made by Zircatec when it was formed was to purchase some surplus equipment from Bristol Aerospace. Bristol had been a manufacturer of reactor components but, as it represented only a small portion of their overall business, decided to withdraw. Shortly after purchasing the equipment in 1989 Zircatec was awarded a contract by Ontario Hydro to manufacture 165 replacement flux detector assemblies and one by AECL for liquid zone control assemblies. Since these were designated "pressure retaining" components Zircatec had to develop a new Quality Assurance program and pass inspection to be issued a certificate of registration.

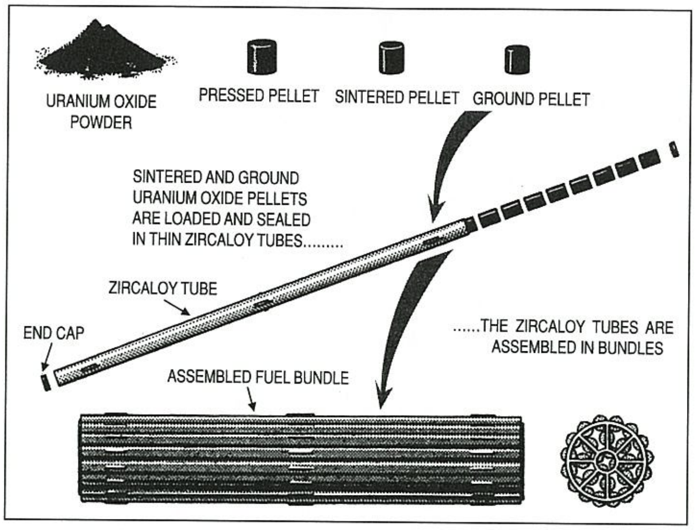
Subsequently Zircatec has been awarded contracts for the supply of a number of different reactor components for the Wolsong 2, 3, and 4 units in Korea and the Qinshan 1 and 2 unites in China. These have included:

- *liquid poison injection nozzles,* for the rapid injection of neutron-absorbing gadolinium nitrate solution into the moderator as part of the CANDU Shutdown System
- *liquid zone control assemblies,* which provide 14 compartments in which light water levels are varied to control reactivity during normal operation
- *flux detector assemblies,* for the measurement of the neutron flux
- *fuel channel annulus spacers,* otherwise know as "garter springs", which maintain separation between the calandria and pressure tubes
- *adjuster units,* consisting of stainless steel tubing with a central shim rod and used to flatten the flux during normal operation.

Quality assurance

The quality assurance program at Zircatec's fuel manufacturing facility meets all of the requirements of the Canadian standard CSA Z 299.1 even though its customers only demand Z 299.2. It also complies with the requirements of the international standard ISO 9001 and the 10CFR50 Appendix B regulations of the United States Nuclear Regulatory Commission.

For the manufacture of components that form part of the pressure boundary, Zircatec's quality assurance program meets the requirements of the CSA N285.0 standard and Section III of the ASME Boiler and Pressure Vessel Code.



Schematic of CANDU fuel manufacture.

As a handler of nuclear materials, Zircatec is licensed by the Atomic Energy Control Board. Its licence includes the production of fuel with enriched uranium.

Conclusion

The manufacturing process for CANDU fuel at Zircatec is one that combines specialized machinery and highly skilled operators. Many of the operations require the involvement or close supervision of a person. That this is successful is at least partly due to the fact that most of the 250 employees have been at the plant for years, many from long before it became Zircatec. Engineers at the plant are justifiably proud of the specialized machinery they have designed and built over the years.

With that ability and dedication Zircatec plays a key role in the success of the CANDU program. Through its production of very high quality fuel at an economical price it enables the very low fuelling cost which has been one of the features of CANDU nuclear power plants.

CANFLEX Demonstration Irradiation at Point Lepreau

by R. A. Gibb, R. W. Sancton, D. C. Taylor, R. G. Steed[1], P. J. Reid[2], J. Bullerwell[3]

***Ed. Note:** This paper was first presented at the CNS annualconference in Montreal, June 1999.*

Introduction

The Point Lepreau Generating Station (PLGS) is considering changing fuel type from the current, 37-element design to the 43-element CANFLEX design. As part of the preparation for this potential conversion, the station is performing a Demonstration Irradiation (DI) of 24 CANFLEX fuel bundles. Conversion to this new fuel type is being considered as part of PLGS' strategy to combat the effect of plant ageing. "Plant ageing" is used to denote a variety of phenomena, such as pressure tube creep and boiler tube fouling, which have the effect of reducing operating margins, particularly on the Regional Overpower Trip system. Since channels containing CANFLEX fuel have enhanced Critical Channel Powers when compared to channels containing 37-element fuel, conversion to CANFLEX could be used to regain operating margins which would otherwise be lost.

The CANFLEX bundle is the latest design in the evolution of CANDU fuel. Its 43-element fuel-bundle assembly and its patented critical-heat-flux enhancement buttons offer higher operating and safety margins, while maintaining full compatibility with operating CANDU reactors. The greater element subdivision and the use of two element diameters lower the peak linear element rating of a CANFLEX bundle compared to the standard 37-element CANDU bundle at the same bundle power. The higher operating and safety margins also offer the potential of reactor power up-rating, which would further increase the economic competitiveness of the CANDU reactor.

CANFLEX development was begun in 1986 by AECL. In 1991, the development effort became a joint effort by Atomic Energy of Canada Ltd. (AECL) and Korea Atomic Research Institute. It has undergone extensive design analysis, performance and qualification testing, as well as an independent review within the Canadian nuclear industry. The design phase is now complete and field commissioning has commenced. The first step of field commissioning is the DI at PLGS. It will establish fuel handling and irradiation experience of the CANFLEX bundle in a power reactor, and will confirm the production processes of fuel fabrication for this new bundle design. Upon successful completion of the DI, the CANFLEX bundle should be a product which is ready for full-scale use in existing and future CANDU reactors.

This paper discusses the planning and approval process for the DI at PLGS, including how safety considerations were addressed. It also provides the information gathered as part of the DI. PLGS is gathering data on bundle powers and burnups, channel flows, flux detector responses and various other process parameters which could be affected by the presence of CANFLEX fuel.

Planning for the DI addressed 3 main issues:

1. Planning of the operational aspects
2. Planning the internal approval process for the DI
3. Planning the licensing approach

Planning of Operational Aspects

In planning for the DI, PLGS has applied a "standard list" of operational considerations for special irradiations; this list was developed by drawing on experience gained while performing various special irradiations in the past (see Reference [1]). This list includes the following operational considerations:

1. Core-tracking of the special fuel
2. Effect of the fuel on bundle power and channel power uncertainty allowances
3. Effect of the fuel on bulk power limits
4. Critical channel power of channels containing the special fuel
5. Effect on ROP trip set points because of factors such as ripple and error allowances
6. Effect on reactivity calculations and coefficients
7. Defect threshold of the special fuel
8. Effect on iodine control procedures
9. Decay power levels of the special fuel
10. Plutonium content of the special fuel
11. Response to various operational contingencies

In addressing these considerations, the goal was to ensure that any changes from normal operating practice and their ramifications were thoroughly understood. Station staff involved in all significant aspects of the special irradiation were consulted to ensure that all

1 NB Power
2 ALARA Research, Inc.
3 Centre for Nuclear Energy Research

potential issues were considered. Central to the assessment was determining whether any station documentation or practices (i.e. operating, core tracking or monitoring procedures) needed to be revised. Information from this assessment was used when planning for the special irradiation to ensure that necessary resources were available and that the staff involved were appropriately informed as to any special activities which were required. In addition, various operational contingencies were considered, including the following:

1. the possibility of a significant reduction in channel flow
2. the possibility of a CANFLEX fuel getting stuck in the cross flow during fuelling
3. the possibility of a CANFLEX fuel bundle defect
4. the inability to fuel a channel containing CANFLEX fuel because of slow RTD response

In each case, appropriate operational responses were outlined, in accordance with the results of the CANFLEX design testing and assessment, as well as in accordance with PLGS' own operational practices with 37-element fuel. In most cases, the operational responses that PLGS would undertake for the considered contingencies for 37-element fuel were found to be equally effective for the CANFLEX DI.

Channel selection criteria for the CANFLEX DI were derived based on a list of objectives, which are as follows in order of priority:

1. some fuel should be exposed to as high a power as possible within the allowable operating envelope
2. some fuel should be exposed to as wide a power variation as possible within the allowable operating envelope
3. at least one channel should have a normal dwell with a full CANFLEX fuel string
4. some fuel should experience normal fuelling-induced power ramps
5. at least one selected channel shall be in the region of the core in which fuelling is done with the ram extension and one in the region in which it is not required.
6. some fuel should experience the highest burnup which is possible within the allowable operating envelope
7. some fuel should experience the longest time in reactor which is possible within the allowable operating envelope
8. some fuel should be in an instrumented channel

Some of these criteria are mutually exclusive (i.e. numbers 1 and 8). Therefore, more than one channel had to be selected for the irradiation. Two channels were sufficient to meet all of the requirements, and that was the selected approach. Therefore, there was a set of selection criteria for each channel. The approach was to define one channel that met the highest possible number of objectives; the second channel was defined to meet the balance of them. If any criteria could be met by both channels, this was done.

Objectives number 1 to 6 can be met by a set of criteria for a single channel. The second channel can then fulfil objectives number 4, 5, 7 & 8. The resulting criteria are:

1. One high-power channel (expectation of a bundle power ≥750 kW) close to the point corresponding to the mid-level of a Liquid Zone Controller (LZC). The channel will receive 2 regular 8-bundle shifts of CANFLEX bundles with a target exit burnup of >160 MW·h/kgU on one CANFLEX bundle.
2. One low-power flow-instrumented channel will be set up, and it will receive one 8-bundle shift of CANFLEX bundles with a target total in-reactor time of about 16 months on the CANFLEX bundles removed in the second shift.

The above criteria were later modified due to the impact of constraints imposed on the channel selection process by the Atomic Energy Control Board (AECB), as will be discussed in the following sections.

Approval & Licensing for the Demonstration Irradiation

Internal approval of the demonstration was based on the application of the standardised approach to special irradiations at PLGS, which is outlined in Reference [1]. This approach attempts to ensure that all important design, operational, financial and safety considerations are included in the decision to proceed. Application of this standard approach (Reference [2]) showed the following:

1. The DI is an important step which must be completed if PLGS is toadopt this new fuel design.
2. The design basis of the CANFLEX fuel type is comprehensive and is compatible with interfacing systems.
3. The presence of two fuel channels with CANFLEX fuel will not significantly degrade the margin of safety demonstrated in the PLGS Safety Report.
4. All potential operational considerations were addressed in the plan for the DI.
5. The fuel manufacturing and QA was in accord with PLGS requirements.
6. The plan for the DI was well developed.

Based on the above, internal approval of the CANFLEX DI was granted by NB Power, which then led the utility to seek regulatory approval of the DI, as required by the terms of the PLGS Reactor Operating License, which allows NB Power to irradiate only fuel of approved design.

Figure 1: Channel RTD Data from CANFLEX Channels for Fuellings During DI

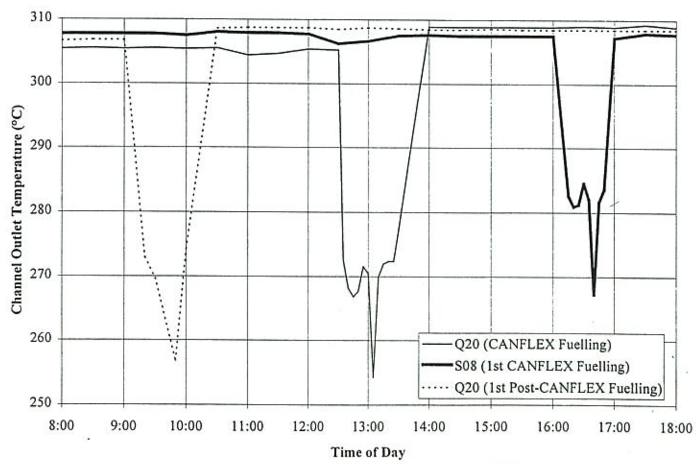
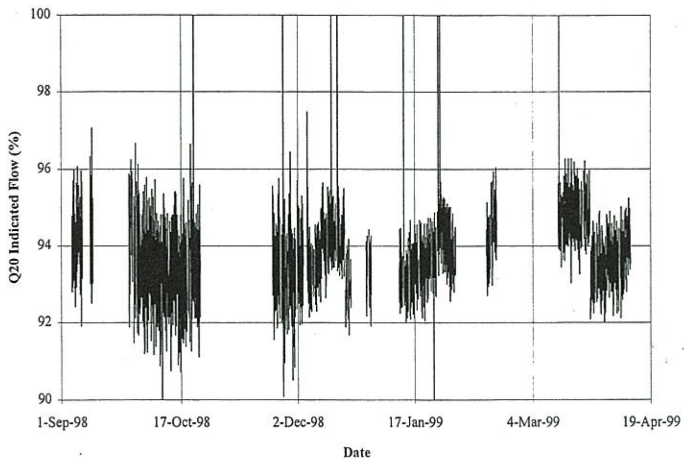


Figure 2: Channel Q20 Indicated Flow During DI (Raw Data)



The safety case for the DI was based on a complete review of every accident scenario in the Safety Report. Based on an evaluation which identified those accident scenarios most likely to be affected by the presence of up to two fuel channels with CANFLEX fuel in them, detailed safety analysis was performed for nine postulated accidents:

1. Large Break LOCA
2. LOCA/LOECC
3. Small Break LOCA
4. Pressure Tube Rupture
5. Channel Flow Blockage
6. Feeder Break
7. End Fitting Failure
8. Loss of Forced Cooling / Loss of Reactivity Control
9. Fuelling Machine Off-Reactor LOCA

The analyses showed that the presence of two channels of CANFLEX fuel did not significantly degrade existing margins of safety. For the remainder of the accident scenarios considered, a qualitative assessment was performed based on the CANFLEX design's general characteristics and the results of the nine explicit assessments outlined here. See Reference [2] for more details.

Upon review of NB Power's submission, the AECB granted approval to PLGS to use CANFLEX fuel in the limited manner proposed as for the DI. However, the AECB imposed some additional constraints on the channel selection process. Chief among them was a requirement that "The high power channel shall be one which was inspected in the Fall 1997 outage." Because of the location of these channels, it was not possible to fulfil the criterion that the high power channel be close to the mid-level of a LZC. In addition, there were several requirements which were intended to ensure that the CANFLEX fuel be irradiated in channels with large margins with respect to fuel channel dryout for various scenarios and with respect to bundle and channel power. The AECB also required that the two channels be in different heat transport loops and be "separated so that any effect CANFLEX may have on the response of vanadium detectors will not cause an additional error in the flux mapped value by attributing a higher amplitude to a higher harmonic mode."

In addition to the additional constraints upon channel selection, the AECB imposed two requirements on reactor operation during the DI. Firstly, PLGS was required to perform inspection of the pressure tube of one of the DI channels during the CIGAR inspection program planned for the outage of 1999 or 2003. Secondly, the AECB required that the eight CANFLEX bundles in the SDS1 flow instrumented channel not be pushed beyond position eight until information was forwarded to the AECB regarding the uncertainty in the two-phase pressure drop of CANFLEX.

As can be seen above, the approval and licensing process applied to the DI was robust and resulted in a high degree of assurance that it is performed in a manner which ensures that it fulfils its purpose and has a high degree of safety.

Data Gathering During the Demonstration Irradiation

Reference [2] outlines the information to be gathered during the DI:

1. The date of each CANFLEX fuelling and the channel being fuelled in each fuelling
2. Bundle power-burnup histories as calculated by RFSP for each CANFLEX bundle
3. Reactor power history for the duration of the DI
4. Channel flow indication for the instrumented channel containing CANFLEX fuel for the duration of the DI and for one week thereafter
5. All channel flow measurements for the channels containing CANFLEX fuel from the fuelling flow verification and the quarterly flow verifications
6. DN signal history for the channels containing CANFLEX fuel for the duration of the DI
7. All measurements of PHTS crud levels, pH, dissolved deuterium and dissolved oxygen for the duration of the DI
8. All fuel handling logs for the fuelling visits to CANFLEX-fuelled channels for the duration of the DI
9. Events or unusual alignments affecting the PHTS
10. Any fuel handling events affecting CANFLEX bundles
11. The results of the visual in-bay inspections

Table 1: CANFLEX Bundles Fuelled in September 1998

(a) Channel Q20W

Position	Bundle Serial #
1	FLX024Z
2	FLX023Z
3	FLX025Z
4	FLX019Z
5	FLX022Z
6	FLX021Z
7	FLX026Z
8	FLX020Z

(b) Channel S08W

Position	Bundle Serial #
1	FLX007Z
2	FLX008Z
3	FLX018Z
4	FLX017Z
5	FLX016Z
6	FLX015Z
7	FLX013Z
8	FLX014Z

Table 2: Fuelling Machine ?P (kPa) for CANFLEX and Previous 37-Element Fuellings

(a) Channel Q20W

Date	ΔP1	ΔP2	ΔP1 - ΔP2
03/09/98	352	355	3
11/0977	374	381	7
02/07/96	343	357	14
05/03/95	372	374	2
20/06/94	344	354	10
26/10/93	-359	-363	-4
25/02/93	367	355	-12
29/06/92	387	387	0
29/08/91	369	371	2

(b) Channel S08W

Date	ΔP1	ΔP2	ΔP1 - ?P2
06/09/98	610	613	3
11/03/98	563	581	18
19/01/97	0	0	0
31/10/96	703	701	-2
03/04/96	616	630	14
03/02/95	618	605	-13
11/08/94	585	578	-7
31/01/94	583	587	4
03/08/93	-622	-636	-14

The low power, instrumented channel selected for the DI was channel Q20. It was fuelled with CANFLEX on September 3 1998. On March 26 1999, 8 bundles were discharged from Q20, including 4 CANFLEX bundles. 4 more CANFLEX bundles remain in the channel. The high power channel selected for the DI was channel S08. It was fuelled on September 6 1998 and it is anticipated that it will be fuelled again with eight CANFLEX fuel bundles after the 1999 maintenance outage. The serial numbers of the CANFLEX bundles fuelled in September are shown in Table 1.

A selection of the data which have been collected with respect to the CANFLEX irradiation in these two channels are presented here. Note that no detailed data analysis has been performed - this data has been gathered in order to create an archive which can be "mined," if necessary, to assess more details of the fuel's performance. The data are presented in this paper to indicate what sort of information is available.

Table 2 shows the measured channel pressure drop before and after fuelling for a series of fuellings which includes the September 1998 fuellings of Q20 and S08. The table shows that the change in pressure drop due to fuelling with CANFLEX is not drastically different than has been observed for 37-element fuellings.

Table 3 shows the ROP detector response for these two channels for both the 37-element fuelling immediately before the beginning of the DI and for the CANFLEX fuellings. While there are differences between the individual detector responses in the two fuellings, so many factors contribute to ROP detector response that a detailed assessment would be required to assess the components of the response due to CANFLEX fuel.

Figure 2 shows the channel outlet temperatures as indicated by the RTDs for the CANFLEX channels for each fuelling thus far in the DI.

Figure 3 shows the indications of instrumented channel flow in channel Q20 for the duration of the DI. As expected, the flow is not discernibly different than what would be expected for a channel full of 37-element fuel.

Figure 4 shows the bundle power history for the highest power CANFLEX bundle as reported by RFSP. This is bundle 6 of channel S08. Note that this bundle power is the power which the bundle would achieve if the reactor were operating at full power. For most of the DI, PLGS has operated a few percent below 100% full power (at ~97% full power). The peak bundle power reported by RFSP was 784.8 kW. Bundle 7 of this channel has a very similar power history. The data show that CANFLEX fuel has achieved high bundle powers during the DI.

Figure 5 and Figure 6 show a photograph taken by R. G. Steed during visual in-bay inspection of the CANFLEX fuel bundles discharged from channel Q20. Apart from some minor deformation to both end plates of all four bundles, fuel bundles examined to date appear entirely healthy. This deformation is evident at

Channel S08

1D	0.46	0.21	1E	3.16	1.93	1F	0.96	1.55	1G	0.60	0.71	1H	0.36	0.23	1J	0.29	0.83
2D	1.59	1.78	2E	6.58	3.11	2F	2.30	0.98	2G	0.34	0.24	2H	0.91	1.07	2J	0.64	0.57
3D	2.13	0.35	3E	0.51	0.19	3F	0.21	0.32	3G	2.06	1.03	3H	0.31	1.10	3J	2.39	0.97
4D	2.93	2.09	4E	1.17	0.31	4F	1.27	0.84	4G	1.32	1.41	4H	0.75	1.08	4J	0.39	0.23
5D	2.28	2.17	5E	1.73	1.32	5F	0.26	0.34	5G	0.55	0.24	5H	2.96	1.82	5J	0.91	1.12
6D	0.67	0.41	6E	0.47	0.37	6F	0.99	0.51	6G	0.90	0.88	6H	0.42	0.32	6J	0.28	0.16
7D	2.28	1.18	7E	1.01	0.21	7F	4.58	2.52	7G	0.90	0.73	7H	1.60	2.34	7J	0.61	0.82
8D	1.63	1.60	8E	0.62	0.45	8F	0.97	0.90	8G	0.69	0.57	8H	1.92	1.09	8J	1.90	1.89
9D	0.9	0.90	9E	5.95	2.02	9F	4.95	2.74									
10D	0.69	0.49	10E	0.36	0.29	10F	0.20	0.45									
11D	0.91	0.78	11E	0.41	0.49	11F	1.88	1.09									
12D	0.29	0.37															

Table 3: ROP Response (%) for Most Recent 37-Element and First CANFLEX Fuelling

Channel Q20

1D	0.68	0.80	1E	2.03	1.79	1F	1.27	1.71	1G	0.62	0.57	1H	0.80	0.56	1J	1.02	1.15
2D	1.52	1.54	2E	0.83	1.01	2F	0.63	1.17	2G	0.62	0.61	2H	1.09	2.19	2J	1.32	1.16
3D	0.97	2.24	3E	0.39	0.86	3F	1.16	1.20	3G	2.01	1.97	3H	1.00	1.28	3J	1.31	0.91
4D	0.28	0.59	4E	0.48	0.83	4F	1.04	0.83	4G	1.49	1.08	4H	1.04	0.71	4J	0.99	0.80
5D	0.42	0.90	5E	1.59	0.83	5F	3.39	3.36	5G	1.89	1.70	5H	2.48	0.18	5J	1.59	0.36
6D	0.72	1.30	6E	0.58	0.72	6F	0.91	1.20	6G	1.52	0.48	6H	3.09	3.04	6J	1.70	1.51
7D	1.98	1.58	7E	0.52	0.65	7F	0.75	0.58	7G	0.67	0.45	7H	1.07	0.90	7J	1.61	0.82
8D	0.97	1.33	8E	0.33	0.36	8F	1.60	1.95	8G	0.92	0.55	8H	1.32	2.10	8J	1.05	0.65
9D	0.79	1.10	9E	0.70	0.41	9F	0.78	1.24									
10D	0.90	0.87	10E	0.48	0.63	10F	0.36	0.40									
11D	0.90	0.78	11E	0.66	0.47	11F	1.99	1.56									
12D	0.90	1.09															

both ends of a single element or pair of elements, and consists of shallow grooves or gouges in the circumferential surface of the end plate. The cause of this deformation has not yet been determined, but it may have been caused by either the "equi-air" hoist used in loading the bundles into the new fuel loading trough, or by an irradiated bundle lifting tool in the spent fuel reception bay. This bundle lifting tool holds a bundle by its end plates, rather than by supporting the bundle under its belly, as does a so-called "J-tool". This deformation is shown in Figures 6 and following, also taken by R. G. Steed. This deformation was not seen on a 37-element bundle discharged with the CANFLEX bundles, or on a new, unirradiated CANFLEX bundle.

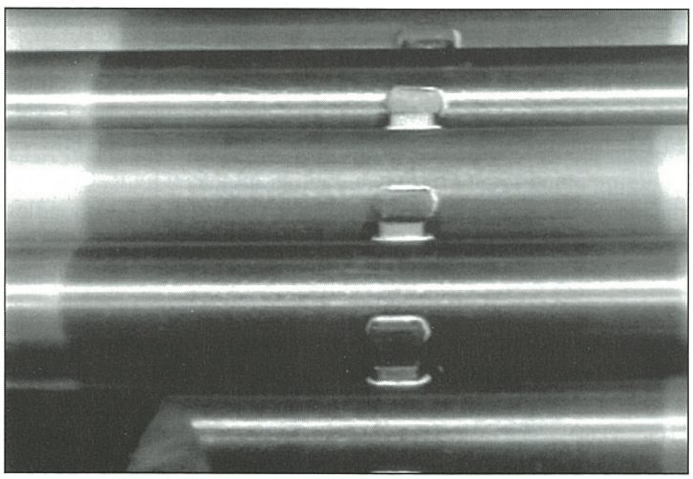


Figure 4: Photo of Bundle FLX025Z

R.G. Steed photo

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1. P. J. Reid, R. G. Steed, R. A. Gibb, R. W. Sancton, "A Standard Approach to Special Fuel Irradiations at Point Lepreau Generating Station", Proceedings of the 19th Annual Conference of the Canadian Nuclear Society, October 18-21 1998, ISSN 0227-1907
2. W. W. R. Inch, P. D. Thompson, H. C. Suk, "CANFLEX: From Development Concept to a Proven Fuel", presented at the Korean Atomic Information Forum, 1998

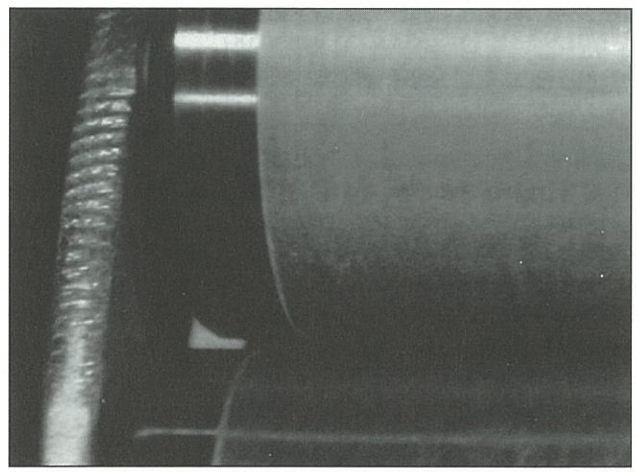
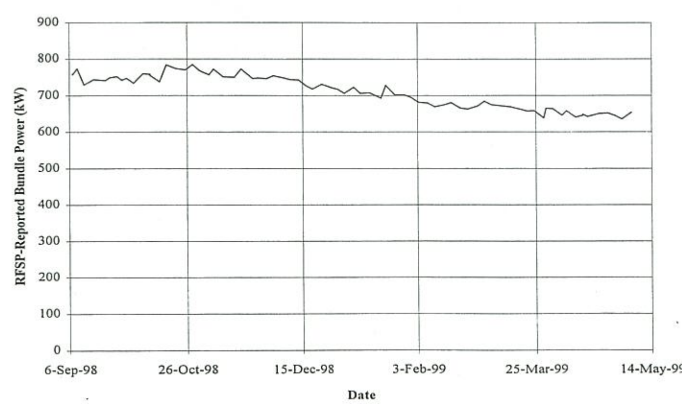


Figure 5: Bundle FLX019Z, Showing Deformation

R.G. Steed photo



CNA / CNS Annual Conferences

Jean McCloskey

"Communicating the Nuclear Advantage" was the theme of the combined annual conferences of the Canadian Nuclear Association and the Canadian Nuclear Society which were held in Montreal, May 31 to June 2, with over 250 attendees.

All of the speakers at the opening plenary session, May 31, touched on the challenge of communicating the many achievements and benefits of nuclear science and technology to the general public.

Speaking on behalf of her Minister, Ralph Goodale, who was unable to attend because of an urgent Cabinet meeting, **Jean McCloskey,** deputy minister, Natural Resources Canada, gave the opening address. "Most Canadians do not know of the achievements and that is your challenge", she warned the audience. "Communicating is not easy and their are many different audiences, but it must be done", she asserted. In particular, she said, the nuclear community must build trust with the general public.

The competitiveness of nuclear power in an economically deregulated electricity market, was the focus of the presentation by **Ronald Osborne,** president and CEO of Ontario Power Generation Inc. *(Most of his talk is reprinted in this issue of the* CNS Bulletin.) In an aside from his prepared text he expressed concern about the ageing personnel in the nuclear program and the need to attract students to nuclear programs in university.

For nuclear to remain competitive in deregulated markets nuclear power costs must decline, stated **Allen Kilpatrick,** president and CEO of Atomic Energy of Canada Limited. This can be done, he said, by increasing fuel efficiency, using modular construction techniques and employing longer lasting materials to extend reactor life expectancy to up to 60 years.. He noted that the United Nations projected that world population will grow by more than two billion over the next 25 years, mostly in the developing world. This will prompt an explosion in the demand for electricity "It has been projected that new electrical generating capacity in the next 25 years will equal what has been constructed in the world over the entire previous century," Kilpatrick said. "The environmental advantages of nuclear power are undeniable. If all the electricity generated today by nuclear were generated instead by coal, two billion tons of global warming emissions and 150,000 tons of heavy metals such as arsenic, lead and mercury, all toxic, would, each year, permanently be in our air, water and land."

The stylized face on the CNA logo reminded him of the millions of people who have benefited from nuclear medicine, commented **John Morrison,** president and CEO of MDS Nordion. "We are proud to be the world's number one supplier [of medial radioisotopes] and it is a responsibility we take very seriously", he said. He suggested that new advances in nuclear medicine might help to develop positive public attitude towards nuclear reactors. "Forty per cent of the world's medical supplies are now sterilized by cobalt 60 from a nuclear reactor," Morrison added. "It's impossible to think of our medical treatment today if it were not for the nuclear industry."

There is a continuing role for government in the energy field, asserted **Michael Cleland,** assistant deputy minister, Energy Sector, NRCan. The objectives of the Kyoto protocol (for greenhouse gases) must be considered along with market forces. A re-emergence of nuclear in the energy spectrum of western nations was likely, he suggested.

The **CNA Awards** were presented at the luncheon of the first day.(See separate article.)

The afternoon CNA session featured a number of speakers providing updates on various aspects of the domestic nuclear program.

Ghislain Ouellet, executive vice-president, Hydro Québec, spoke on that utility's role through the Gentilly 2 generating station and **Rod White,** vice-president, NB Power, gave an update on nuclear energy in New Brunswick.

A further perspective on Ontario's competitive electricity market was provided by **John Fox,** executive vice-president, OPG while **Ken Nash,** vice-president, Waste Management, OPG, offered an overview of the spent fuel management issue. He commented that the Dry Storage at the Pickering NGS would be expanded.

David Torgerson, vice-president, Research and Product Development, AECL, reported that a formal submission to the federal government had been made for the *Canadian Neutron Facility* and **Dennis Skopik,** director Saskatchewan Accelerator Laboratory, provided an update on the *Canadian Light Source,* which received approval the previous month. *(See reports on* *both of these projects in the "General News" section of this issue of the* CNS Bulletin.)

The CNA sessions on the second day were devoted to the "International Scene" in the morning and "Canada's International Nuclear Business" in the afternoon

Murray Stewart, president and CEO of the CNA, said that if climate change emissions are to be reduced nuclear power must be accepted internationally as an accredited technology. Anti-nuclear groups, he reported, are trying to block this by arguing that nuclear power is not "sustainable development" as defined the in Kyoto Protocol. The arguments of anti-nuclear groups defy logic, Stewart asserted.

Karen Strauss

Views of the European and UK scenes were provided by **Jean-Pierre Rougeau,** president Foratom, and **Douglas McRoberts,** director, Public Relations, British Energy while **Y. T. Park,** senior executive vice-president, KEPCO, provided a current summary of Korea's Nuclear Power Program

Nuclear power is being rediscovered in her country, said **Angelina Howard,** a senior vice president with the Nuclear Energy Institute in the USA. Nuclear power currently has 61 per cent public support in the US, Howard contended, largely due to public concern toward global warming and air pollution. The public doesn't realize how important nuclear power is until these plants are taken off line and air pollution increases when fossil fuel is used to replace nuclear power.

In the absence of **Dr. Li Yulun,** vice-president of the China National Nuclear Corporation, who was unable to attend at the last moment, **David Bock** of AECL presented his paper on the nuclear program in China. With 73 per cent of electricity being generated by coal, nuclear power is now considered the only real option to deal with air pollution. In 1997, China's global warming emissions were three billion tons, and 18 million tons of soot dust were expelled into the environment. Currently, only 1.2 per cent of China's electricity is provided by nuclear. Dr. Li's paper said that since China has only limited uranium resources, when new nuclear plants are sought from foreign suppliers, designs with high fuel efficiency will be favoured to cushion the cost of importing uranium.

George Assie, vice president of marketing for the world's largest uranium suppler, Cameco, informed delegates of his industry's analysis of the impact of the future planned use of nuclear fuel mixed with plutonium from dismantled American and Russian nuclear warheads as part of disarmament efforts. Some 23,000 nuclear warheads in Russia alone will be destroyed by this process, which will take 20 or more years. The amount of Russian uranium fuel mixed with three per cent plutonium would alone be enough to supply the western world's uranium requirements for two and a half years, he said.

Ann Medina

At the second day luncheon the **CNS Awards** were presented. *(See separate article.)* In addition **Dr. Karen Strauss,** a consultant on environmental and health issues, gave an interesting talk on "Public Perceptions of Radiation" and emphasized the need for clear and unbiased communciation.

Opening the afternoon CNA session, **Gary Kugler,** vice president of commercial operations for AECL, reported that the construction of the two CANDU reactors at Qinshan in China is on time and on budget. A fourth CANDU reactor in Korea will go into service later this year.

In an update regarding possible future export sales of Canada's CANDU reactor technology, **Bill Hancox,** vice-president of Sales and Marketing at AECL, told delegates that the results of recent elections in Turkey should maintain that country's interest in purchasing nuclear reactors from one of the various vendors, including AECL, who have bid for the contract.. AECL also has near term sales prospects in Australia and Korea, medium term prospects in China and long term prospects in several emerging Asian economies, including Indonesia and Thailand.

Further details of his company's activities were provided by **Grant Malkoske,** vice-president, Engineering and Technology, MDS Nordion. **John Tosney,** president, Cigar Lake Mining Corporation, spoke about progress at his company's project, the highest grade uranium deposit in the world. **Ron field,** vice-president, Canatom NPM Inc., offered his perspective on the evolution of nuclear engineering and procurement in Canada while **Paul Konderman,** president, Babcock & Wilcox Canada, described how his company had used CANDU work to expand into other markets.

Another joint CNA/CNS plenary session on the third day focussed on the communications challenge associated with nuclear waste.

Deep underground disposal represents the only feasible route to assuring the permanent isolation of these long lived materials from the human environment, said **Jacques de la Ferté** of the OECD Nuclear Energy Agency. However, he added, there has been slippage by many European countries in implementing the concept due to the perception that the public doesn't have confidence in it. Another complicating factor, he suggested, is that the process of government decision making in many countries has changed to become more transparent to allow public involvement. This means government decision making is taking into account public concerns even if these concerns are based on inaccurate information from anti-nuclear groups. While it is important that the public has a say, de la Ferté said, there is a concern that a minority, narrow, anti-nuclear view against used nuclear fuel disposal may be regarded by politicians, and the public as the majority view.

"There is not a used nuclear fuel problem," asserted **Angelina Howard,** of the Nuclear Energy Institute, in her second presentation to the conference, "what exists is a public communications challenge." Howard said the public must better informed that a solution to used nuclear fuel disposal has been found because some sectors of the (American) public believe anti-nuclear groups who claim that there is no solution.

At the closing luncheon, respected Canadian journalist, **Ann Medina,** told delegates to expect that advocacy journalism, an emerging trend in her industry, will make it more difficult for the nuclear industry to get its messages out to the public. Medina cited the example of David Suzuki, who hosts a popular science show on Canadian television, as an example of advocacy journalism. "When he reports on science, he reports only the views that he himself believes in," she said. "He does not allow an opposing viewpoint. This isn't journalism as it should be." (Suzuki is known to have a personal bias against nuclear power.) Nevertheless, Medina cautioned that the nuclear industry should make sure its message is not one-sided and should be prepared to balance its positive message with information on the negative issues, such as used nuclear fuel. The clean air benefits of nuclear power is an important message on which the public needs to be educated, she added.

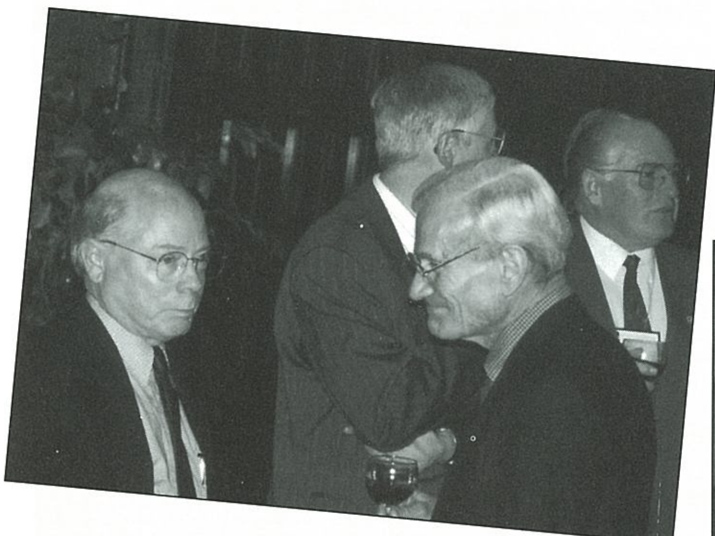
Over the Monday afternoon and Tuesday, the Canadian Nuclear Society ran parallel sessions of technical papers in the following categories:

- chemistry, radiation and environment
- thermalhydraulics
- reactor physics
- operations and maintenance
- instrumentation and control
- control operations
- safety and licensing
- regulatory and waste management

The full CNS technical program was printed in the previous issue of the *CNS Bulletin* (Vol. 20, No. 1). The proceedings, on a CD, are available from the CNS office.

On the Tuesday evening, in place of a traditional banquet, delegates were transported to the Casino de Montréal for a dinner show entitled *Sinatra, The Voice, The Actor and The Man.* After the show many stayed on to try their luck at the slot machines and gaming tables.

This may have been the last joint CNA / CNS annual conference since the CNA has decided to cancel the year 2000 joint conference that was to have been held in New Brunswick.



1999 Awards

The 1999 CNA awards go to: David Torgerson, Reid Morden, Michel Rhéaume, while CNS names Ben Rouben as a Fellow and recognizes Jeremy Whitlock for communication and education.

CNA Awards

At the luncheon on the first day, May 31, of the 1999 CNA/CNS Annual Conference in Montreal, the Canadian Nuclear Association presented its annual awards. Dick Williams, formerly of Natural Resources Canada, the chairman of the CNA Awards Committee, presided at the ceremony.

(The following is extracted or paraphrased from the citations read out by Dick Williams.)

The CNA has three awards: the *W.B. Lewis Medal;* the *Ian McRae Award;* and the *Outstanding Contribution Award.* There is only one recipient each year for the Lewis Medal and for the Ian McRae Award. Although more than one Outstanding Contribution Award can be presented this year there was only one.

David Torgerson (L) receives the W.B. Lewis Medal from CNA chairman Tom Gorman during the CNA/CNS Conference in Montreal, May 31, 1999.

W.B. Lewis Medal

The W.B. Lewis Medal was established in 1973, in honour of the late Dr. W.B. Lewis. The Medal recognizes Canadian scientists or engineers who have demonstrated a level of technical competence and accomplishment in the field of nuclear science and engineering, as exemplified by Dr. Lewis during his involvement in the Canadian nuclear energy program from 1946 to 1973.

The W.B. Lewis Medal for 1999 was presented to **Dr. David Torgerson,** Vice-President of the Research and Product Development Unit, Atomic Energy of Canada Limited.

David joined AECL's Whiteshell Laboratories in 1976 and over the period to 1987 was responsible for the establishment of AECL's R&D program on the chemistry of iodine as it applied to reactor accidents, and directed the program on nuclear reactor safety.

He served as a consultant to the U.S. Nuclear Regulatory Commissionl during the development of their first severe accident analysis code suite. David acted as Chair of the AECL Chernobyl Task Group which was formed to assess the impact of the Chernobyl accident on CANDU safety, and he led an NEA task team on the same topic.

In 1988, David was appointed Vice-President of AECL's Waste Management Program Responsibility Center, which was responsible for the Canadian Nuclear Fuel Waste Program, as well as programs in low and intermediate-level waste management, and the environmental and health-related R&D within AECL Research.

From 1991 to 1995, he was Vice-President of Reactor Development at AECL Research. In 1995 he was appointed to his present position where he is responsible for CANDU R&D, Product Engineering, Cost Engineering, and the Office of the Chief Engineer.

On the international scene, David has been the Canadian representative on the NEA's Committee on the Safety of Nuclear Installations (CSNI) and Chairman of the CSNI Task Force on Source Terms. He has also been a leading member of the CSNI's, Principal Working Group IV on reactor safety issues. In 1997, he was designated as Chair of the International Working Group on Advanced Technologies for Heavy Water Reactors of the International Atomic Energy Agency .

Last year, David chaired the very successful Pacific Basin Nuclear Conference, held in Banff.

David Torgerson's long career in nuclear science and technology has been truly exceptional, both in the quality and diversity of his many achievements. He is a model for succeeding generations of nuclear scientists and engineers, in the true spirit of the legacy of the late Dr. W. B Lewis.

Ian McRae Award

The Ian McRae Award was established in 1973 in honour of the late Ian McRae, the first President of the CNA. This Award recognizes individuals for their outstanding contributions to the general advancement of nuclear energy in Canada, through such fields of activity as management, administration, public service, medicine, communication and the arts.

The Ian McRae Award for 1999 went to **Reid Morden,** former President and Chief Executive Officer of Atomic Energy of Canada Limited.

Reid was appointed President and CEO of AECL in August, 1994, following a long and distinguished career in government. Prior to his tenure at AECL, he served as the Director of the Canadian Security and Intelligence Service, and as the Deputy Minister of Foreign Affairs. He retired from AECL in 1998.

Reid's tenure at AECL was marked by significant organizational change, an increased focus on international marketing and sales, and the resolution of several important domestic issues.

Significantly, in 1996, Reid lead the successful negotiations for the sale of two CANDU 6 reactors to the China National Nuclear Corporation at its Qinshan site in China. This sale is one of largest export sales in the history of Canada.

CNA Chairman, Tom Gorman (R) presents the Ian McRae Award to Reid Morden at the CNA awards luncheon on May 31 during the 1999 CNA/CNS Annual Conference in Montreal.

During Reid's term at AECL, a competitive process in Turkey resulted in AECL, together with Canadian and international partners, submitting a bid for two CANDU 6 reactors. Hopefully, this important initiative will lead to the opening of yet another new and important market for Canada.

Domestically, Reid lead the negotiations on behalf of AECL with MDS Nordion, which culminated in a contract to construct and operate two Maple type reactors for Nordion at Chalk River, to be dedicated to the production of medical radioisotopes. The contract model for this project is unique, calling for Nordion to own the facility, while AECL operates it under contract to Nordion.

Reid Morden's term as President of AECL was marked by both domestic and international success for the industry, and his leadership has positioned Canada for further successes in the years to come. Clearly, he has made an outstanding contribution to the general advancement of nuclear energy in Canada.

Outstanding Achievement Award

The CNA Outstanding Contribution Award was established in 1989 to recognize individuals, organizations or parts of organizations which have made significant and obvious contributions to the nuclear industry over a long period of time and / or who have made specific outstanding individual contributions that have had a significantly positive impact on the Canadian nuclear industry.

The 1999 Outstanding Contribution Award was presented to **Michel Rhéaume,** Manager of Safety and Licensing at Hydro-Québec's Centrale nucléaire Gentilly 2.

Michel has distinguished himself most particularly in the field of training. As lecturer in basic and health sciences at the University of Québec, at Trois-Rivières from 1978 to 1998, several hundred students have learned for the first time about the safe use of radioactive isotopes in medical, environmental and research work.

Michel was a founding member in 1979 of the Canadian Radiation Protection Association, and served as its President from 1995 to 1997. From 1988 to 1993, Michel was a member of the Advisory Committee on Radiological Protection of the Atomic Energy Control Board.

As a Canadian representative, he was involved in the development of the IAEA/NEA's International Nuclear Event Scale (INES), in addition to participating in several other far reaching international committees.

Michel has acted on numerous occasions as the official spokesperson for Hydro-Québec. He was called upon to

Michel Rhéaume (L) holds the CNA Outstanding Achievement Award plaque he was presented by CNA chairman Tom Gorman at the CNA/CNS Annual Conference in Montreal, May 31, 1999.

explain the Three Mile Island incident and the Chernobyl accident, and to reassure the population as to the safe operation of the Gentilly 2 nuclear power plant.

In 1994 he prepared the submissions for, and defended the proposed "Gentilly 2 Spent Fuel Dry Storage Project" at the Federal-Provincial public hearings. The environmental panel went beyond the scope of the hearings to allow a public debate on the question "should Gentilly 2 operations be stopped or continued". The results of these public hearings were extremely positive and Hydro-Québec was allowed to proceed with its project with only a minor impact on G-2 operations.

Based on Michel Rhéaume's significant contributions to the public acceptance of nuclear technology, through his skills and knowledge in the field of health physics, over a period of 25 years, he is clearly a worthy recipient of the CNA's Outstanding Contribution Award.

Ben Rouben (R) holds the plaque recording his appointment as a Fellow of the CNS, presented to him by 1998-1999 CNS president, Paul Thompson, at the CNS Awards Luncheon, June 1, during the 1999 CNA/CNS Annual Conference in Montreal.

CNS Awards

The Canadian Nuclear Society presented its awards at the luncheon on the second day, June 1, of the CNA/CNS Annual Conference in Montreal.

Although the Society has established several awards, only two were granted for 1999. The citations were read by Hugues Bonin, chairman of the CNS Honours and Awards Committee.

The CNS established the designation *"Fellow of the Canadian Nuclear Society"* in 1993 to honour members who have:

- made major and sustained contributions to the sciences and/or professions that relate to the advancement of nuclear technology in Canada;
- demonstrated maturity of judgement and breadth of experience, as well as outstanding technical capability; and,
- provided service to the Society

In the tradition of honorary membership categories of learned societies, CNS Fellows are entitled to add the letters "F.C.N.S." to letters denoting degrees and professional certifications following their names.

For 1999, the CNS named one member to this special category, **Dr. Benjamin Rouben,** manager of the Reactor Core Physics Branch, Atomic Energy of Canada Limited, Sheridan Park, and a former president of the CNS.

Since joining Atomic Energy of Canada Limited in 1975 Ben has contributed extensively to the development of techniques for the analysis of the physics of CANDU reactors. In recognition of his abilities he was appointed to his present position in 1993.

He has been active with the Canadian Nuclear Society since the early 1980s, first with the Toronto Branch and then with the national CNS Council where he served in many capacities. In 1995 he was elected 2nd vice-president, progressing to 1st vice-president and then president for the year 1997-1998.

He is also a member of the American Nuclear Society and sits on its International Committee.

The *CNS Education and Communication Award* was created by the Society just two years ago, in 1997. It is intended to recognize significant achievements in improving the understanding of nuclear science and technologies among educators, students and the public.

CNS outgoing President Paul Thompson (L) presents the CNS Education and Communication Award to Jeremy Whitlock at the CNS Awards luncheon, June 1 during the 1999 CNA/CNS Annual Conference in Montreal.

The 1999 Education and Communciation Award was presented to **Dr. Jeremy Whitlock** of the Chalk River Laboratories of Atomic Energy of Canada Limited.

Over and above his demanding work as a research physicist, Jeremy has been tireless in promoting and communicating the benefits of nuclear science and technology. He has been an active letter writer to the media and to politicians on nuclear issues and has been successful in having most of his letters published.

Within the CNS he has been a member of the Education and Communication Committee for several years and co-chairman over the past two. Among other activities, that Committee organizes the Teachers' Courses and oversees the distribution of Society funds to Branches for local educational or communication projects.

Role of Nuclear in OPG Competitiveness

by Ron Osborne

***Ed. Note:** Following is most of the prepared text for the talk by Ronald W. Osborne, president and CEO of Ontario Power Generation Inc., to the opening plenary session of the joint Annual Conference of the Canadian Nuclear Association and Canadian Nuclear Society in Montreal, May 31, 1999*

In keeping with the theme of your conference, I want to speak about nuclear's role in Ontario Power Generation's competitiveness.

I cannot overstate the importance of nuclear power to our competitiveness. Nuclear represents a major portion of our generation mix. As we head into a competitive electricity marketplace, nuclear will be one of the bedrocks upon which we build a successful company.

Ontario Power Generation's goal is to become one of most commercially successful power generation companies on the continent. This includes, but goes beyond, financial success. We also want to be a company known for top safety performance, for being publicly open, and for a commitment to protecting the environment. I want our nuclear operations to be a major part of our good reputation.

Soon we will be operating in a competitive market, which is much different than operating in a monopoly. The rules are different and consequences can be swift and severe.

Introduction to OPG

Ontario Power Generation is but two months old [April 1, 1999]. We are the successor company that has inherited the power generation assets formerly held by Ontario Hydro. We are now commercially driven, about to compete in the Ontario marketplace that will open to competition next year. We will also compete in U.S. electricity markets.

Our facilities currently supply about 85% of the power used by Ontario, although that percentage will decrease over time as competition takes hold.

OPG is one of the five largest electricity generators on the continent, along with Hydro-Quebec. We have an in-service generating capacity of 26,000 megawatts, including almost 9,000 megawatts of nuclear. We also have 5,000 megawatts of nuclear capacity that we have laid up so that we can concentrate all available resources on improving performance at our 12 newer nuclear units.

Last year, even with laid up nuclear capacity, nuclear power made up 48% of our total generation. Nuclear is capable of supplying about two-thirds of the province's electricity demand, as it has done in the past, if all units were in service and running at expected capacity levels.

I said up front that we are committed to top performance from our operations. Recently, we won the National Energy Efficiency Award of the federal Department of Natural Resources for achieving top energy efficiency improvements at our facilities, beating out 20 other companies vying for the award. Savings to date equate to $70 million worth of electricity per year. These savings also have an environmental benefit – they reduce our emissions of carbon, sulphur and nitrogen by 1.9 million tonnes each year. Our nuclear facilities were major contributors to this achievement.

Nuclear competitiveness

OPG is one of the lowest-cost generators in our future market area, which is the northeastern part of North America. The electricity generators to the south of us are dominated by higher-cost fossil fuelled plants.

We are blessed with 7000 megawatts of very low cost hydroelectric capacity. But nuclear power also has low production costs, when it performs well. That's why we must return our nuclear units back to top quartile performance.

Another significant market advantage of our new company is our low air emissions for every megawatt we generate. Both our hydroelectric and our nuclear stations play a very important role in the low emissions profile of our generation mix. Our emissions performance will help differentiate us from our competition to the south, much of which is coal fired.

Let me give you some numbers. Much of our future competition will come from generators in the U.S. midwest, with relatively low-cost generating stations situated at coal mines.

U.S. data on nitrogen oxide and sulphur dioxide emissions for 1996 – the most recent data available - shows that our generating system is much cleaner than those of midwest generators. Nitrogen oxide is a primary component of urban smog; sulphur dioxide and nitrogen oxide combine to produce acid rain.

Nitrogen oxide emission rates from the U.S. midwest were 6.23 pounds per megawatt-hour in 1996. In comparison, our system-wide nitrogen oxide emission rate last year, even with increased fossil station usage resulting from the lay-up of Pickering A and Bruce A, was 1.51 pounds per megawatt hour. This was only 25% as much as from U.S. systems.

Nuclear power has low production costs, when it performs well

The U.S. midwest sulphur dioxide emission rate was 15.39 pounds per megawatt-hour; ours was 2.51, only a sixth of that from the U.S. utilities.

As for carbon dioxide, which is one of the major greenhouse gases, there is no data available for the midwest region as a whole, but data from individual midwest generating companies shows that their system-wide emissions of carbon dioxide tend to be in the range of 1500-2000 pounds per megawatt hour. Our system-wide rate is about 500 pounds per megawatt hour.

At OPG, we have worked hard to keep our system-wide emission rates low, investing well over $1 billion over the past decade in improved controls to reduce emissions. This has not only contributed to a system-wide emissions advantage, but also to lower emission rates when we compare our fossil station fleet to the fossil stations of our future midwestern competitors.

Nuclear is also a major factor in our low system-wide emission, since it does not emit carbon, nitrogen or sulphur. This makes our nuclear stations increasingly important to our competitive position.

OPG's strategy

Our strategy for the next 10 years is to become a market-driven North American supplier, based in Ontario but with an increasing focus on U.S. markets.

Our strategy reflects both **choice** and **necessity.** We have long looked at U.S. markets as a huge opportunity, given the competitive advantages we have. As recently as 1994, our exports to the U.S. totalled $350 million. If you go back to the early 1980s, our exports were getting close to half a billion dollars. There is no reason why these sales levels cannot be achieved again, and greatly surpassed.

We [are] very interested in partnerships with private companies

Like Ontario Power Generation, Hydro-Quebec has major cost and environmental advantages flowing from its wealth of hydroelectric power. There is plenty of room for both companies to export their surplus capacity to the U.S. market, especially in light of the environmental issues that many U.S. generators will face.

But our strategy is also driven by necessity. The Ontario government, acting on advice from its multi-stakeholder Market Design Committee, has decided that Ontario Power Generation will greatly reduce its control over electricity generation in Ontario.

Within 10 years of the new market opening, we will reduce our control over generation in two phases, so that we will eventually control no more than 35% of all Ontario generating resources. The first phase of decontrol must be achieved within the next five years, with our decontrol of 4,000 megawatts of non-baseload, price-setting generation – either all fossil, or fossil with up to 1,000 megawatts of hydro-electric.

When our decontrol plan is fully implemented, we expect to have control over about 15,000 megawatts in Ontario, given that total available capacity to the province will likely be around 45,000 megawatts ten years from now.

The two-phased decontrol plan is designed to allow us to reduce our presence in Ontario in an orderly fashion, as markets open up in the U.S. It allows the province to open its market to competitors in parallel with the opening of their jurisdictions. It also gives us more flexibility as to how we will decontrol our assets, without resorting to fire sale agreements.

The decontrol agreement is obviously a powerful inducement for us to expand into the U.S. It will also help competition flourish in Ontario.

We remain very interested in exploring partnerships with private sector companies as we look to decontrol assets in Ontario and move into U.S. markets. This includes partnerships in our nuclear business.

The Ontario electricity market will open to competition next year Recommendations have been made to strengthen interconnections. Hydro-Quebec is interested in increasing the amount of power it can sell into Ontario. Independent power producers have announced plans for new plants. And several U.S. utilities have set up shop in the province, awaiting the market's opening.

Our focus on nuclear performance has taken on more urgency as we approach competition. As I said earlier, there is a huge difference between a competitive market and a monopoly.

Monopoly Vs. Competition

I've worked in both environments. Here is how I see the differences.

As a monopoly, Ontario Hydro set rates based on cost recovery. Hydro appeared before the Ontario Energy Board, but wasn't bound to follow its advice. Hydro had an obligation to serve, and its personality was cautious. To run short of power was a greater sin than to over-invest in new capacity.

Consequently, financial discipline was hard to enforce. Customers were captive; there wasn't much incentive to be customer focused. Some capital decisions were influenced by political and economic development factors. There were no built in incentives through competition to spend R&D to create new products or services.

This will all change under competition. Ontario Power Generation will be governed by commercial influences. The market will set prices. The regulator will set and monitor the market rules to which we must conform. Customers will rule the market through their buying decisions.

There is much room for improvement on the people side of our nuclear business.

We are now in a transition period to competition. But once the new market opens, no company will have the role once held by Ontario Hydro of determining how the future needs of the marketplace will be met. It will be this market that will determine supply and demand.

There will be no guarantee of cost recovery. Financial decisions must be made based on potential returns for our shareholder. R&D will have to be more creative – if we don't create new products and services through our R&D expenditures, you can bet our competition will.

In a competitive market, mistakes aren't forgiven, customers are demanding, and competitors are relentless.

Our nuclear business must succeed in this environment. First, we must complete our nuclear recovery program, returning our nuclear units to the top performance that they once enjoyed.

Nuclear Recovery at OPG

We are now well into our nuclear Integrated Improvement Plan, and it is beginning to show progress.

We are charting our progress in monthly public report cards. Over the past 15 months to the end of the first quarter of this year, our overall performance index has climbed from 58.0 to 69.2, a 19% improvement. This composite index includes nine performance indicators used by the World Association of Nuclear Operators. The index shows we are going in the right direction, although we still lag U.S. nuclear industry performance, which is sitting at about 84 on the index.

Another indicator of progress is increased production from our operating nuclear units. Total production last year was over 59 terawatt hours – a 2 terawatt hour or 6% improvement on our business plan released in February 1998. For the first quarter of 1999, production is running 7% ahead of plan.

OPG's Darlington NGS

Our nuclear units are gradually moving from the back end of fourth quartile performance, when measured against U.S. reactors, towards the third quartile. However, our improvement compared to U.S. reactors has been modest, mainly because they keep raising the bar through continued performance improvements of their own. While this doesn't show off our progress as we would like, it is a good indicator of the success of our nuclear industry.

Another improvement measure is outage performance. This is one of our largest priorities, since outages directly affect our bottom line.

Previously, outages could last a month or more longer than planned. Over the past year, however, we have improved our outage performance even though we are in the middle of an aggressive program to catch up on necessary maintenance. We have met most of our return to service commitments to the electricity system, and kept the average outage days per unit below target and much better than historical performance.

Our regulatory performance is also better than in the past. We are now in full compliance with every commitment made to our regulator, the AECB. We are determined to maintain that status.

In March, the AECB renewed our license for the Pickering Generating Station for two years, the maximum amount granted in the past. We interpret this as a vote of confidence in the way we are addressing the improvements at the station, particularly since previous Pickering licenses were for six, nine and then 12 month periods.

On a related matter, our plan remains to return Pickering A to service over the period from late 2000 to 2002-3. This is subject to approvals of our Board and the AECB.

Employee Relationships

Each of these indicators demonstrates that we are starting to improve our nuclear business. One huge challenge that we are only beginning to tackle, however, is improving relations on the shop floor at our stations.

Recently we commissioned a report, jointly with the AECB, that exhaustively examined the state of people relationships at our nuclear facilities – specifically, management/management relations and management/labour relations. The overall conclusion was that existing employee relations pose no threat to safety of the stations. The stations are operating safely.

That said, however, there is much room for improvement on the people side of our nuclear business.

We are not yet marching in the same direction. We are not communicating well on the shop floor. We don't have a common understanding of what we will be up against as a competitive company. We don't have a common vision of what we must do to succeed.

This is a top priority. High performance can only be sustained within a workplace where everyone understands what is at stake, where there is a basic understanding of the market and the business, where communication from all directions is encouraged and where employees are empowered to contribute their views and ideas.

Nuclear, when well operated, can win in a competitive market.

It's obviously easier to fix machines than to change people relationships. But this is what we must do to become competitive.

We will have the support of our union leadership in tackling this problem. For example, John Murphy, President of the Power Workers Union, said this recently to the Toronto Board of Trade:

> "As we prepare for competition, we have come to realize that there is very little gap between where we are as workers and where management is, in terms of our survival interests. We've concluded that there is only one way that we can move forward and be successful in the competitive environment and that is to build constructive, progressive, positive, cooperative labour management relations."

Nuclear Resurgence Worldwide

Looking outside Ontario, there seems to be an outbreak of optimism in the nuclear industry worldwide, based on what I've been reading lately. Nuclear's environmental advantages underpin much of the optimism. But there is also a growing realization that competition is having a very healthy effect on the nuclear power industry.

Many jurisdictions are ahead of us in the competition learning curve. In the U.K., for example, competition was introduced in the late 1980s. Competition has demanded that they produce competitively-priced nuclear electricity, while at the same time improving their safety performance. Downtime has been cut by half or more, and financial and safety performance has greatly improved.

At U.S. nuclear stations, both safety and production performance have increased. Last year, according to the U.S. Energy Information Agency, nuclear power generation was up 10%, compared with a total electricity generation increase of 3%. The rise is due to higher capacity factors. Of the 66 nuclear stations in the U.S., almost half had capacity factors of 88% or higher. Over the entire U.S. nuclear industry, the capacity factor was 6% higher than in 1997.

This helps explain why some nuclear operators want to grow their business by acquiring additional nuclear assets. They see that nuclear, when well operated, can win in a competitive market.

It also explains why nuclear generators around the world are increasingly talking about extending the lives of their reactors, perhaps to 60 years. Life extensions are expected to be far cheaper than building new plant, no matter what the fuel source. Also, we must ask if we can afford the increase in air emissions that would almost certainly occur if we retired nuclear units around the world beginning next decade. Nuclear power generates 17% of the world's power. If replaced by coal, that would add almost 2 billion tons of carbon dioxide to current greenhouse gas emissions.

Future Nuclear Industry Challenges

I agree with the theme of your conference - nuclear does have many competitive advantages. I believe that nuclear has a bright future, globally and within Ontario.

In order to realize this bright future, however, there are still some issues that the nuclear industry must resolve, in cooperation with stakeholders and government agencies. To fully describe the importance of these issues to our industry would take another speech – but it is clear, for example, that a safe, socially-acceptable and economic solution to the issue of the long-term management of nuclear waste must be found. We also need to address some of the financial issues around the segregated fund for nuclear waste disposal and decommissioning; clarify environmental aspects of the Nuclear Safety Act once it is proclaimed; and work with all interested parties to ensure that any changes to the Nuclear Liability Act are consistent with a competitive nuclear industry.

These are very important matters for our industry to resolve. Given the many advantages of nuclear that we are discussing today, I think it is imperative that we successfully address these issues, to the benefit of our electricity customers and for a healthy environment.

Conclusion

I am heartened by the resurgence of the nuclear industry. Its environmental advantages are being recognized. Its safety and cost performance worldwide is improving steadily, pushed along by competition and oversight bodies such as regulators and the World Association of Nuclear Operators.

At Ontario Power Generation, we are working steadily to realize performance improvements as we continue to make progress on our recovery program and prepare ourselves for a competitive future.

Our future competitiveness depends on strong nuclear performance. With its potential cost and environmental advantages, nuclear is an extremely important part of our generation mix.

We will make it a foundation for our new company.

Canadian Nuclear Regulation - Today and Tomorrow

by Agnes J. Bishop

Ed. Note: *Following is a slightly edited version of a talk given by Dr. Agnes Bishop, president of the Atomic Energy Control Board, to an international symposium, held in Japan in late May 1999, to commemorate the 20th anniversary of the Japanese Nuclear Safety Commission. We are reprinting these notes, with Dr. Bishop's permission, as they provide an excellent overview of the current nuclear regulatory system in Canada and Dr. Bishop's expectations for the future Canadian Nuclear Safety Commission.*

Introduction

It is an honour and a pleasure to be in Tokyo to participate in this symposium marking the 20th anniversary of the Nuclear Safety Commission of Japan. On behalf of the Atomic Energy Control Board, I wish to congratulate the Commission for its 20 years of national and international leadership on nuclear issues.

I have been asked to speak today about the current and future policy of the Atomic Energy Control Board, or AECB, and the need for international standards for nuclear safety. These are both timely topics for Canada. We are now in the process of moving to a new legislative framework for regulating nuclear activities in Canada, a regime that will stress not only the protection of workers, the public and national security but also the environment.

I will also update you on Canada's ongoing efforts to develop a safe and publicly acceptable means of disposing of nuclear fuel waste, as well as some initiatives that are now under way within the AECB to make us a more effective, open and responsive nuclear regulator in the years ahead.

In addition, Canada is entering a period of deregulation of electricity markets, which raises some potential safety issues for nuclear power operations.

On the international front, only a month ago we presented Canada's national report to the First Peer Review meeting of the Convention on Nuclear Safety. We also recognize that the challenges facing the regulation of the nuclear industry in Canada are challenges common to other nations. Therefore, we strongly support the increasing trend of national regulators working together to improve nuclear regulatory activities and safety in the operations of the nuclear industries.

Regulatory Environment

Dr. Agnes Bishop

Let me begin by examining the current regulatory environment in Canada, where the constitutional division of powers means that provincial governments have jurisdiction over the production and distribution of energy, but the federal government is responsible for regulating nuclear operations.

Fifty years ago, when the nuclear industry was in its infancy, the Government of Canada recognized the need for an effective regulatory framework to govern the peaceful development, application and use of nuclear energy. In 1946, it passed the Atomic Energy Control Act, which created the Atomic Energy Control Board as Canada's national nuclear regulator.

Today, the AECB administers a comprehensive licensing system that covers all aspects of nuclear facilities, prescribed substances and equipment. With few exceptions, if you want to acquire, use or dispose of radioactive materials in Canada, you require a licence from the AECB and your operations will be regulated and inspected. We also have a mandate to control the import and export of prescribed nuclear substances, equipment and technology, and to help fulfill Canada's domestic and international obligations under the Treaty on the Non-Proliferation of Nuclear Weapons.

Finally, the AECB contributes to the work of international agencies and organizations interested in improving the regulatory control of nuclear materials and facilities. In addition, we have bilateral cooperation agreements with several individual nations.

When the Atomic Energy Control Act was drafted, just over 50 years ago, the chief concerns of the day were related to national security and the safekeeping of information and nuclear materials. But circumstances changed dramatically over the next five decades. With the tremendous growth in the size and scope of Canada's nuclear industry, and the widespread use of nuclear energy throughout the industrialized world, the focus shifted from security to the protection of health and safety and finally to the environmental consequences of nuclear activities.

Nuclear Safety and Control Act

In the very near future, we will have new legislation and regulations to support us in fulfilling this modern mandate.

In March 1997, the Parliament of Canada approved the Nuclear Safety and Control Act, which will replace the Atomic Energy Control Act and provide for more explicit regulation of nuclear energy in Canada. We are now in the process of finalizing new regulations to support the Act. Consultations with industry stakeholders, federal and provincial governments and the public have been a key part of this process and are essential to ensure a smooth transition to the new regulatory framework. Once the regulations have been approved, which we expect to occur later this year, the new legislation will come into effect.

> *The new [Nuclear Safety and Control] Act explicitly includes the protection of the environment as a responsibility of the new commission*

The Nuclear Safety and Control Act will provide the legislative foundation for effective regulation of nuclear facilities in Canada as we move to the new millennium. It has been eagerly welcomed by the Atomic Energy Control Board, precisely for the opportunity it gives us to reinforce the nuclear regulatory system.

The Nuclear Safety and Control Act will give the AECB a new name. We will become the Canadian Nuclear Safety Commission, which more accurately describes our role.

The Commission will have a clearer mandate than does the existing organization to establish and enforce national standards in the areas of public and worker health and safety. It also establishes a firm legislative basis for implementing Canadian policy with respect to security issues, particularly the non-proliferation of nuclear weapons. Of significance is the fact that the new Act explicitly includes the protection of the environment as a responsibility of the new commission.

A number of important changes will also be made to the structure, powers and authority of the regulatory agency.

For example, compliance inspectors will be given stronger powers, and the penalties for infractions will be increased significantly — from the current $10,000 to $1 million Canadian. The new Act also provides additional regulatory tools as well as providing a solid legislative backing for present regulatory activity.

It is essential to ensure that the transition from the old to the new regime is as smooth as possible. At any one time, we administer some 4,000 licences across Canada — everything from uranium mines to medical applications to nuclear power reactors and waste management facilities.

All of the transitional work is being done while we continue to carry out our licensing and compliance activities under the existing Act. Let me just say that this is a very busy and challenging time for Board staff.

To simplify the transition for both operators and the Commission, these licences will be progressively revised to meet the new requirements after the new Act and regulations come into force. As well, we have implemented a comprehensive training program to ensure that our staff are able to interpret and apply the new Act consistently and effectively. We are also developing new regulatory documents that further explain our requirements for specific aspects of nuclear operations.

One of the goals of the new Act is to improve the openness and transparency of the nuclear regulatory process in Canada. Toward this end, the Act provides for public hearings, reviews and appeals.

Since the late 1980's, the AECB has been steadily increasing our transparency and improving our communication and consultation with the public. When a proposed licensing action could affect a community, we advise local officials, interest groups and individuals in the community. Notices are published in local newspapers and we hold public meetings in communities near major nuclear facilities so that citizens have the opportunity to get involved.

The AECB's Board meetings are open to the public and the media. Members of the public are also invited to contribute to our decision-making processes by making submissions or presentations to the Board. As I mentioned earlier, we have also encouraged and welcomed public participation in the development of the new regulations and regulatory documents.

Other legislative requirements in Canada also encourage public involvement in decision-making processes related to the nuclear sector, particularly when major projects or issues are involved.

Opportunity for intervention by the public and other interested parties in addition to the licensees is an important and routine part of our licensing process. I believe their participation has improved and continues to improve our regulatory regimes and the safety of our nuclear facilities.

Canadian Environmental Assessment Act

As an agency of Canada's federal government, the AECB and its successor, the Canadian Nuclear Safety Commission, must comply with the Canadian Environmental Assessment Act. This legislation was introduced only four years ago, and requires federal departments and agencies to undertake an environmental assessment if they intend to carry out a development project themselves, provide funding or land for such a project, or issue licences or permits that will allow a project to go forward.

An environmental assessment can be a very effective forum for engaging non-governmental organizations, communities and individuals in the decision-making process. For example, it can provide opportunities for participation by groups and individuals who may not otherwise have the chance to present their viewpoints. Public participation inevitably strengthens both the quality and the credibility of an assessment.

The AECB considers the recommendations of assessment panels as part of our licence decision-making process, and we co-operate fully with the Canadian Environmental Assessment Agency in regulating all stages in the development, construction and operation of nuclear facilities. As indicated earlier our new Act specifically makes the protection of the environment part of our legislated mandate.

One of the most extensive environmental assessments undertaken to date in Canada was related to the long-term management of nuclear fuel waste. This is a controversial issue in Canada, as it is in many other countries, and it is not likely to be resolved quickly.

Beginning in October 1989 and continuing until last year, a panel appointed by the Government of Canada studied the safety and acceptability of a disposal concept put forward by Atomic Energy of Canada Limited, which markets the CANDU power reactor and other nuclear technology.

The AECB [and the CNSC] must comply with the Canadian Environmental Assessment Act.

The proposal is for the fuel waste to be sealed in a container designed to last at least 500 years, which would then be buried in disposal rooms deep in the rock of the Canadian shield, 500 to 1000 metres below the surface. Each container of waste would be surrounded by a buffer, and each room would be sealed with backfill and other vault seals.

As the nuclear regulator, the Atomic Energy Control Board participated extensively in the review process. We developed criteria and regulatory requirements that would ensure a high level of protection to the public, now and in the future, and assessed the proposal against these criteria. We reported our findings to the panel, which also heard from more than 500 speakers and received more than 500 written submissions.

The panel submitted its report to the government in early 1998, having arrived at two basic conclusions:

- that the proposed concept was overall technically acceptable.
- that the concept in its current form does not have broad public support and does not have the required level of public acceptability to be adopted as Canada's approach for managing nuclear fuel wastes.

The Government of Canada has responded by stating very strongly that there will be no technical concessions on the issues of safety and transparency. It has also accepted the panel's recommendation that a special organization be created to manage and coordinate all activities dealing with nuclear fuel waste in the long term. The government's position is that this organization should be established and funded by the producers and owners of nuclear fuel waste, and be subject to federal regulatory control, policy direction and public review.

Many experts accept that deep geological disposal is technically feasible and that the disposal concept ensures the protection of present and future generations. There is, of course, debate as to whether the waste should or should not be retrievable. Furthermore, if the concept was adopted as policy, further technical work would be required for site specific issues.

In Canada, however, it has become clear that broad public acceptance of a long-term radioactive waste policy will not be easily achieved. It can also be predicted that even if there was acceptance of such a policy, further major debates would be initiated over selection of site(s) and the transportation routes of high level nuclear waste material.

It would appear that Canada will be utilizing its present above ground dry storage methods for high level nuclear waste and spent fuel for several more decades.

Whatever approach is eventually accepted and implemented, it will be the responsibility of the Canadian Nuclear Safety Commission to regulate the facility or facilities so that there will be no undue risk to workers, members of the general public, national security or the environment.

Deregulation of Electricity Markets

Another issue that is in the forefront in Canada today is the deregulation of electricity markets – in other words, the transition to open competition among producers, distributors and marketers of electricity. In Canada, with minor exceptions, electrical power has been produced and marketed under monopoly conditions by publicly owned utilities.

The first province to initiate market de-regulation of electrical power was Ontario through its Energy Competition Act of 1998. The large utility previously known as Ontario Hydro has now been divided into three separate components. A new company known as Ontario Power Generation Inc. will be responsible for the generation of electricity. A second company will be responsible for the transmission of electricity to its customers. As well, an Independent Market Operator has been established to dispatch power based on least-cost bids and to arrange financial settlements between buyers and sellers.

This is of significant interest to the AECB since approximately 60% of the electricity generated by the new Ontario Power Generation Inc. comes from nuclear reactors.

These new companies are still crown corporations but will likely be opened to privatization in the future.

It is not the mandate of the AECB to dictate to a provincial government how it should organize its electric utility industry. It is our mandate, however, to ensure that structural changes in the electricity sector take into account the specific safety needs of nuclear power stations.

Regardless of deregulation, we have made it clear that the operators of nuclear power plants in Ontario are still required to comply with the licensing conditions set out by the AECB and, in the years ahead, by the Canadian Nuclear Safety Commission. As the regulator, we will continue to require that no undue hazard is posed by the rules for operation of the grid or by the relationship between the owners and operators of nuclear plants.

One of our main concerns is that the increased competition created by commercial deregulation may lead to decreased resources for safety issues in nuclear power plant operations, or that the need to meet power supply commitments could lead to less conservative safety decisions. In other words, that the drive to remain fiscally competitive in a deregulated market will overshadow the fundamental need for safety in nuclear installations. We will continue to monitor the situation in Ontario closely to ensure that this is not the case. We will also apply the same scrutiny to any future deregulation initiatives in other parts of Canada.

Future Policy Directions

Looking even further into the future, I would like to quickly update you on three initiatives under way by the Atomic Energy

Control Board that provide some indication of our policy direction in the new millennium.

First, within the framework provided by our new Act and regulations, we are in the process of developing a comprehensive environmental protection program that will be implemented by the Canadian Nuclear Safety Commission. This program will encompass a range of activities, including regulations and mechanisms for public consultation and participation in decision-making processes.

Protection of the environment is now an integral part of our mandate.

The nuclear industry has been aggressively regulated in terms of measures required for the protection of humans from the hazards of ionizing radiation. In fact, I think it would be accurate to say it is more stringently regulated in this regard than most other industries dealing with hazardous substances.

I also believe it would be fair to say that the vast majority of people within the nuclear industry still believe there is sufficient scientific data to accept the concept that if you protect humans you will be protecting other species within the environment. Whether this concept is accurate or not, it is becoming increasingly clear that the societies of many nations are demanding that environmental programs be developed at nuclear facilities that demonstrate the environment is indeed being adequately protected.

These demands and expectations for the protection of the environment for the environment's sake will be increasing and represent a significant challenge for both nuclear regulators and operators.

Our new Act and regulations in Canada reflect this shift in thinking. For the first time, the Canadian regulator will have a clear mandate to establish and enforce national standards in the area of environmental protection. Thus protection of the environment, per se, is now an integral part of our mandate.

This won't be an easy process. It will require some fundamental changes in nuclear regulatory philosophy and it will also require nuclear operators and regulators to acquire new expertise and skill sets.

I made reference earlier to the aggressive approaches to the protection of humans from ionizing radiation. I want to also point out that this approach continues and a large amount of research continues in this regard, particularly at the micro-molecular level. Therefore our knowledge of the effect of radiation on humans continues to progress.

However, the same cannot be said for the environmental effects of ionizing radiation particularly in combination with other stressors existing at nuclear facilities over both the short and long-term. There is a paucity of information on the additive or synergetic effects of ionizing radiation with other toxic substances.

This is certainly an area where nuclear nations can learn from one another. This month [May 1999], the AECB, with the support of Sweden and Australia, hosted the second International Symposium on Ionizing Radiation in Ottawa. The symposium brought together experts from industry, government, academia, and non-governmental organizations to examine some of the challenges nuclear regulators and operators face in developing environmental protection programs. I believe the symposium was a success and will aid the development of a framework for environment protection programs that will be adequate, practical and implementable.

The second initiative I want to tell you about is the development of an internal quality assurance system that will describe the AECB's core management and operational processes. Internal quality assurance is an important part of the AECB's strategic direction on improving management. The system will set out comprehensive management policies and procedures that define for staff how the organization is to conduct its operations. These policies and procedures will provide the necessary direction, information, tools, support and environment for staff to do their work efficiently and effectively.

Over the coming months, we will be formalizing policies for core activities such as developing regulations and standards, licensing nuclear operators, conducting inspections, enforcing regulatory requirements and licence conditions, responding to emergencies and communicating with the public.

We believe this system will result in a more systematic approach to the AECB's regulatory activities. It will help develop consistency, cohesiveness and transparency in our work, and will provide a vehicle for fostering the required cultural change and preserving our corporate memory.

As regulators we demand our licensees to have quality assurance programs in place. We should not ask for less of ourselves. The term quality assurance is not always received positively and therefore its perhaps better to refer to it as managing for quality.

The third initiative I referred to is the development of a corporate compliance strategy for the new Canadian Nuclear Safety Commission.

There is a recognized need for Canada's nuclear regulator to perform compliance activities in a more transparent, systematic and consistent way. Ensuring compliance has always been part of our business, but often our activities have not been properly documented or have varied significantly from activity to activity.

We are now in the process of developing a policy document that will articulate our corporate philosophy on compliance. We will also develop a corporate compliance program to ensure consistent application of the policy across the organization. Each of our business areas will then develop their own compliance programs tailored to their specific types of operations. The project should be completed by the end of the year 2000, with the implementation of these compliance programs in all areas of activity.

International Cooperation

I would like to turn now to the issue of international co-operation and the need for nuclear nations to work together not only on the development of international standards but on a variety of issues relating to the safe development and operation of peaceful uses of nuclear energy.

I believe it is becoming increasingly clear that international co-operation among nuclear nations is not an option, it is an imperative. Nuclear safety is of great importance to both those countries with nuclear power and those without nuclear power. The consequences of severe nuclear accidents do not stop at the geographical boundaries of the country in which they occur. In addition, events which occur in one country can influence the public acceptance or rejection of nuclear power in other countries. The Chernobyl accident forcefully reminded us of this.

There is a need to perform compliance activities in a more transparent, systematic and consistent way.

It is critical for nuclear regulators to share information, knowledge and appropriate technology with each other. I will even go so far as to say that anything less would be irresponsible. Over the years, we have witnessed ever-increasing co-operation between national regulators, both bilaterally and through multilateral organizations like the Nuclear Energy Agency and the International Atomic Energy Agency. In very recent years we have also seen the development of smaller international regulatory groups such as the International Nuclear Regulators Association (INRA) as well as others which provide a forum in which matters of specific mutual interest can be discussed candidly. These organizations fulfill a need which cannot be easily achieved in the much larger international agencies.

An excellent example of international co-operation is the Convention on Nuclear Safety, which came into force in October 1996. It was Canada's privilege to chair the committee of experts established by the International Atomic Energy Agency in September 1991 to develop the Convention, and I was pleased to be the first to formally sign the agreement, on behalf of Canada. I believe there are now 65 signatories, including 50 countries that have ratified the Convention and are Contracting Parties.

The objectives of the Convention are three-fold:

- to achieve and maintain a high level of nuclear safety worldwide by enhancing national measures and international co-operation;
- to establish and maintain effective defences against potential radiological hazards in nuclear installations in order to protect individuals, society and the environment from ionizing radiation;
- to prevent accidents with radiological consequences and to mitigate such consequences should they occur.

A key element of the Convention is its unique "Peer Review" process, which is intended to foster a frank and constructive discussion of nuclear safety issues so that participating countries can support each other in meeting these three objectives. This process is designed to ensure that all countries can benefit from the practices and performance of other nuclear nations, in order to raise the level of nuclear safety throughout the world.

The first Peer Review meeting was held last month in Vienna. Along with other Contracting Parties, the Canadian delegation presented a national report on the measures we have taken to meet the obligations set out in the Convention. This report provided a candid and comprehensive account of nuclear safety at Canadian nuclear power plants.

Canada will continue to play a role in encouraging all countries with nuclear power plants to commit to the Convention and its obligations. Canada will also be strongly supporting the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Other examples of very recent international cooperation is the sharing of information on the Y2K issue, international emergency exercises, and the development of international standards and guides.

International safety standards are important tools for developing and sustaining of nuclear safety. They identify the basic requirements for the safe operation of nuclear facilities and form the framework on which individual countries develop their own standards. At a minimum, national nuclear programs should meet these international standards. However, both regulators and industry should not be discouraged from exceeding these minimum standards.

Over time, I believe we will see a move toward international harmonization of standards. However, if international harmonization is to be successful international standards must go beyond the minimum requirements for safety.

Another issue that I believe is a concern in many nuclear nations including Canada is the question of succession. From where will the next generation of nuclear specialists come? In Canada, we have noted a distinct lack of interest among young people in the whole area of nuclear technology and most of our university programs in nuclear engineering have closed. How do we ensure that there is a new generation of appropriately qualified personnel for both the industry and the regulators? From the regulators point of view we are already discussing the necessity of international exchange of personnel for training purposes but the succession problem is not yet solved.

Conclusion

The final areal of concern which I believe requires increased cooperation amongst nations is the provision of adequate research programs to sustain safety of nuclear operations.

Funding for research has gradually ended at universities, regulatory agencies and within the industry itself. However, regulators must require the industry to provide sufficient research to support its operations and regulators should also be capable of some independent research activities.

As university programs become more and more dependent on support from industry for survival of their research programs, can the regulator look upon them as truly independent organizations to perform research activities on behalf of the regulator?

The basic concern exists not only in countries such as Canada with limited organizations capable of research, but also by countries with larger resources as they too are starting to see their research capability shrinking. This issue is being discussed by regulators in international fora and I have no doubt that increased international cooperation and sharing of resources amongst regulators in regards to research will have to occur.

Thank you again. I look forward to continuing to work with your Commission, both bilaterally and through international fora, in support of the promotion of nuclear safety.

Meeting the Y2K Challenge

Ed. Note: The following has been extracted from or based on various information releases by nuclear organizations in Canada and abroad.

Even though most people are probably tired of hearing of the "Y2K problem", the issue is real and could affect the safety, or at least the effectiveness, of nuclear activities, from nuclear power to nuclear medicine.

For the few unaware of the problem, the following is how the Atomic Energy Control Board describes the scope of Year 2000 technical issues as they relate to nuclear activities.

The year 2000 (Y2K) issues pertain to the potential for date-related problems that may be experienced by computers, by process systems controlled wholly or in part by computers, by devices or instruments with embedded chips and by software applications. An example of a date- related problem is the potential misreading of "00" as the year 1900 rather than 2000.

The Y2K issues are not only related to the passage of the year 1999 at midnight, December 31, 1999. There is a whole range of issues that may cause problems in computer systems or applications to accurately process date/time data (including but not limited to calculating, comparing, and sequencing from, into, and between the 20th and 21st centuries, and leap-year calculations). Further, the Y2K issues are not only related to computers but to all devices that contain firmware, embedded chips or depend upon data or services transmitted externally that may themselves be computer-controlled.

AECB Activities

AECB has required all licensees to disclose, by June 30, 1999, any Year 2000 circumstance that they have not resolved and which could potentially place the plant or facility in a condition not previously analysed. They must also inform the AECB of any work-around required to overcome such circumstances. This deadline was chosen to make the rest of the year available for licensee staff to become familiar with any changes and new procedures, as well as to allow time to resolve any remaining problems.

The AECB is using the following criteria in its review of the Y2K readiness of its licensees:

1. Planning: The licensee has a plan in place, there is a qualified team with a clear mandate and sufficient funding. A schedule exists confirming a commitment to complete by June 30, 1999, all actions needed to demonstrate Y2K readiness.
2. Inventory: Identifying "suspect" pieces of equipment evidence that a systematic process has been followed to make a complete list (e.g. from system drawings specifications and information flow analysis).
3. Identifying a "short" list: A triage process exists that determines whether the equipment is (a) safety relevant and (b) subject to Y2K problems.
4. Assessment: For equipment subject to Y2K problems, an assessment process is in place that determines either the nature of the problems or that no problem exists. (It is not always obvious that software will have Y2K problems. The fact that the equipment does not need to be date dependent does not mean that it does not contain date dependent codes or circuitry which could still cause problems.)
5. Corrective Work: Processes exist for specifying, designing, producing new codes or replacements, inspecting and testing digital equipment that needs to be corrected.
6. Verification: A review process exists (e.g. analysis, functional testing, random testing or some combination) to verify that the replaced products meet their safety requirements and will not create unspecified, unsafe conditions or results.
7. Contingency Plans: Plans exist to adequately compensate for unforeseen failures, including equipment, that may not be critical in the short term but where long-term failure could reduce safety margins (e.g. long-term unavailability of a wiring data-based program, communications).

Nuclear power plants

AECB has given particular attention to the regulatory review of Y2K issues at nuclear power reactors . The first AECB regulatory actions with respect to nuclear facilities were placed on the licensees of nuclear power reactors in March and April of 1997. At that time, the AECB placed actions on Ontario Hydro, Hydro Quebec and New Brunswick Power to review their respective situations to the extent necessary to confirm that Year 2000 problems cannot affect safe operation of their nuclear stations. All three licensees responded that Year 2000 programs were already underway. These letters were followed up with information exchanges between

AECB staff and licensee staff on the status of particular issues.

All CANDU plants have Special Safety Systems (i.e. reactor shutdown systems, emergency core cooling systems) which can bring the plants to a safe state. For Bruce A, Bruce B, Pickering A, Pickering B, Gentilly 2 and Point Lepreau, these are primarily hardwired, analogue systems. The exception is Darlington where the two safety shutdown systems are operated by minicomputers programmed in Fortran, Pascal and Assembler, and emergency core cooling and containment systems are operated by programmable logic computers called OH180's. These computerized systems do not require calendar dates for their safety functions and are not expected to be affected by the Y2K issue.

"Complete by June 30, 1999, all actions needed to demonstrate Y2K readiness" AECB

Although it was not expected would be major safety-related problems with the Special Safety Systems, licensees were required to perform a review. This review was completed on October 1, 1998, and confirmed that there were no Y2K significant issues.

However, there are other important computer-based systems that could be affected by the Y2K issues; for example, an uncommanded movement of a fuelling machine that could provoke a failure of a pressure tube and resulting loss of coolant into the containment. Examples of systems that may be subjected to Y2K issues are:

- Station Control Computers (DCCs)
- Fuelling Machine Computers
- Vendor Supplied Programmable Logic Devices for control of ventilation, standby generators, turbine speed governors, etc.
- Hardware devices with embedded software

Power reactor licensees completed all reviews and corrective actions by December 31, 1998, for other control systems such as the reactor regulating system and the fuelling system whose failure could challenge safety. All reviews, corrective actions or acceptable work-arounds were to be in place by June 30, 1999 for those other systems, components and software toolsets whose failure is not expected to directly affect the safety systems in carrying out their safety functions, but which nevertheless could impede the safe operation of the plant.

Other facilities

In addition to nuclear power reactors, the AECB licenses a variety of other nuclear facilities, including research reactors, research establishments, accelerators, uranium mines, mills, refineries and fuel fabrication facilities, and waste management facilities. Individual regulatory review strategies appropriate to each class of nuclear facility were implemented. In each case, the fundamental review criteria described earlier were applied to the review of the facilities' Y2K programs. The final deadline for assessment and resolution of all potential safety-related Y2K problems was June 30, 1999, in all cases.

The most complex nuclear facilities other than the power reactors are the two research laboratories of Atomic Energy of Canada Limited. As in the case of the nuclear power utilities, the Y2K issues in these facilities were dealt with as part of the owners' broad corporate Y2K program. AECL submitted detailed information on this program to the AECB in September 1998, and the information is currently under review against the AECB's review criteria.

Research reactor operators other than AECL all responded to the initial AECB request for Y2K information in a similar fashion, pointing out that there are no automated control systems in these reactors which could be subject to Y2K problems. In order to ensure that systems responsible for safety-related functions such as security, dosimetry, monitoring, fire alarms and data logging will also be addressed, follow-up requests for detailed information on such systems were sent to all of these licensees, with a deadline for responses in mid-November 1998. AECB staff is reviewing submissions and will require further action, as necessary.

A similar request for detailed information was also sent to research accelerator licensees in spring 1998, and responses were received from all of them. Some problems were identified with various safety-related equipment such as access control, monitoring and database systems. In each of these cases, a solution was also identified by the licensee. The licensee-proposed solutions typically involved actions such as a requirement for the equipment supplier to provide a Y2K-compliant upgrade, or complete replacement of the system with newer equipment. These licensee programs are under continuing review by AECB staff.

Radioactive Materials and Devices

In September 1998, the AECB sent out an Information Bulletin to the other AECB licensees, in particular the more than 3,700 users of radioisotopes, to alert them to the Y2K issue, and inform them of their responsibility to see that public, worker and environmental health and safety, as well as regulatory compliance, are not compromised due to year 2000-related problems.

In keeping with the graded approach to verifying licensee Y2K-readiness, the Information Bulletin also notified licensees that the AECB would require some of them to formally submit evidence of, or information on, their year 2000 readiness, depending on the attendant risks of their licensed activities.

A triage of licensed activities was carried out to determine which licensees require a level of scrutiny akin to that exercised on nuclear facilities. Licensees that fall within this group include those engaged in the following licensed activities:

medical accelerators
teletherapy
brachytherapy
consolidated licences
manufacturing of sealed sources
irradiation (pool type)
gauging device development and testing
device manufacturing
fixed gauges
research (maximum sealed source size of more than 50 MBq)
neutron activation

Of this group, those licensees (numbering 441) engaged in activities posing higher potential hazards were required individually to declare, by October 31, 1998, whether or not there were any potential Y2K problems related to their licensed activities. Licensees identified either by themselves or by the AECB as being subject to such risks were required to report to the AECB on their Y2K programs by March 31, 1999, and to have implemented their plans and resolved any Y2K problems by June 30, 1999.

"Y2K issues have been addressed in a consistent and comprehensive manner", NEA

Canadian Industry

AECL

At the Canadian industry level, Bob Gadsby, vice-president, Year 2000 Program, at Atomic Energy of Canada Limited, announced at the end of June 1999 that he is ready to assure compliance of AECL's systems and products through the transition to the year 2000.

AECL began examining the Y2K issue in 1996 and a formal program was launched in 1998, establishing inventories of systems and products. Inventoried items requiring remediation were identified. By the end of December 1998, AECL had completed all of its activities to meet the requirements of the AECB for the highest priority systems and facilities. As of March 1999, the monthly report from the Treasury Board Secretariat's Year 2000 Project Office showed AECL as 86 per cent complete on its government-wide mission critical functions. All "safety systems", and "safety related control systems" are compliant; as are "systems indirectly related to safety", and "business" items. Work is on schedule to complete all the other high priority systems by the end of June. Key lower priority systems will be completed by September 30, 1999.

Since Y2K is a worldwide problem and there are some concerns about whether all organizations will be Y2K ready, AECL has developed alternative, back-up, plans. Risk assessments have been performed and continue to be monitored. In addition, mitigation planning efforts are well underway

(An accompanying paper, "The Y2K Program for Scientific Analysis computer Programs at AECL" describes in some detail the work undertaken at AECL to ensure that all of its safety analysis programs are Y2K compliant.)

Utilities

Ontario Power Generation Inc. announced July 1, 1999 that it had met or exceeded the June 30 target of the North American Electricity Reliability Council and the requirements of the Atomic Energy Control Board. The NERC target was to complete remediation and testing and achieve "Y2K ready status" of all mission-critical facilities, and to assess operating risks associated with Y2K and prepare contingency plans.

In addition, OPG has substantially achieved its own, more aggressive, June 30 target for "operational readiness". This means that, with no material deficiencies:

– all of the corporation's Y2K impacted systems have been fixed, tested, and put back into operation

– all scheduled large scale integration and interoperability tests at hydroelectric, fossil, and nuclear generating stations have been successfully completed, and

– Year 2000 operational risks have been assessed and contingency plans developed.

Both New Brunswick Power and Hydro Quebec have met all of the AECB deadlines.

USA

According to the Nuclear Energy Institute (NEI)., the United States Nuclear Regulatory Commission (USNRC) has approved only 68 of the 103 reactors operating in the US as being fully prepared for the year 2000. However, the modifications required at the remaining facilities will not affect plant safety and should be completed by the end of the year.

International

Both the International Atomic Energy Agency and the Nuclear Energy Agency of the OECD have programs to effect international cooperation and information exchange on the Y2K issue.

In February 1999 the AECB hosted, in Ottawa, an international workshop sponsored by the NEA on *"The Impact of the Year 2000 on the Nuclear Industry"*

Over 80 participants from some 20 countries, including several from Eastern Europe, provided input to the discussions. The meeting, which included nuclear regulators and operators, government officials and software specialists, was viewed as an important step toward supporting the continued safe and reliable operation of nuclear facilities world-wide.

After reviewing the status of Y2K programs, consensus was reached among the participants that Y2K issues have been addressed in a consistent and comprehensive manner for several years, and that installations are expected to be Y2K compliant by mid-year 1999.

The situation has been made easier by the fact that the methodologies being used (e.g. inventory of components, assessment and analysis, test and verification, etc.) are fairly common among all countries. However, it was agreed that nuclear operators and regulators must continue to be vigilant to ensure confidence in Y2K readiness. In particular, experts identified the need to move contingency planning to the forefront of the Y2K strategies being implemented in the various countries. The major focus is on external risks to the electrical grid, communication systems and other related concerns.

It was announced during the meeting that, at the initiative of the U.S. Nuclear Regulatory Commission (U.S. NRC), the NEA Committee on Nuclear Regulatory Activities (CNRA) will organize an international exercise to assist in world-wide contingency planning. This exercise would provide a unique opportunity to co-ordinate planning, communication and response systems relevant to nuclear power plants.

The IAEA is serving as a clearinghouse and contact point at the request of its Member States on the Year 2000 problem as it concerns nuclear and related technologies and computer services.

Information on the full range of the Agency's Y2K activities now is accessible over its WorldAtom Internet services, in a special series of "Nuclear Forum" pages, at < www.iaea.org/worldatom/program/y2k >

The IAEA's Y2K Web site is designed as a one-stop directory for information about Y2K activities carried out in the Agency, its Member States, and international organizations within and outside the UN system. It covers four broad categories: documents and reports; information about IAEA activities related to nuclear safety, radioactive waste management, medical facilities, safeguards, and internal computer systems; current news and viewpoints of experts; and links to other Y2K Internet information resources, including sites in more than 20 Member States. A number of IAEA documents are electronically available over the site. They include the Agency's Y2K Action Plan, a technical guidance document on nuclear safety for achieving Y2K readiness; and technical documents on safety measures with respect to radioactive waste management facilities and at medical facilities that use radiation generators and radioactive materials.

The Y2K Program for Scientific-Analysis Computer Programs at AECL

by Jad Popovic, Cheryl Gaver and Dawn Chapman[1]

***Ed. Note:** The following paper was originally presented at the 20th CNS Annual Conference in Montreal, June 1999.*

Abstract

The evaluation of scientific-analysis computer programs for year-2000 compliance is part of AECL's year-2000 (Y2K) initiative, which addresses both the infrastructure systems at AECL and AECL's products and services. This paper describes the Y2K-compliance program for scientific-analysis computer codes. This program involves the integrated evaluation of the computer hardware, middleware, and third-party software in addition to the scientific codes developed in-house. The project involves several steps: the assessment of the scientific computer programs for Y2K compliance, performing any required corrective actions, porting the programs to Y2K-compliant platforms, and verification of the programs after porting. Some programs or program versions, deemed no longer required in the year 2000 and beyond, will be retired and archived.

Introduction

Scientific-analysis computer programs (or "scientific codes") are extensively in CANDU design and safety-analysis work. Examples include computer programs in:

- Reactor physics
- Fuel analysis
- Reactor-transient analysis
- Heat transfer
- Thermalhydraulics
- Reactor chemistry

These programs model or simulate different aspects of nuclear-plant behaviour. Usually, they make only rather simple use of calendar dates (e.g., date-stamping of runs for date management purposes). However, in view of the large number of disciplines and administrative units in AECL, large numbers of codes and distinct code versions have had to be examined.

As noted, since the use of dates in scientific-analysis computer programs is not generally extensive, the compliance of the computer platforms on which the codes execute is often the greater concern. (By computer platform we mean the computer hardware, operating systems, libraries and compilers.) The platforms also must be checked and made Y2K compliant to ensure that the scientific codes will continue to run correctly beyond 1999. Various network-connected computer platforms (primarily HP and SGI UNIX workstations, VMS mini-computers, IBM RISC machines and Windows 95 and NT PCs) are used at AECL, and most of them in fact require operating-system upgrades or vendor-supplied patches to achieve Y2K compliance. Thus, the AECL Y2K-compliance program for scientific-analysis codes involves the integrated evaluation of computer hardware, middleware, and third-party software in addition to the scientific codes developed in-house.

Once Y2K-compliant computer platforms have been procured, the identified scientific codes must be ported to these platforms in advance of the year 2000, and their correct operation on these platforms must be verified. Software quality assurance (SQA) standards for scientific codes used in nuclear-system design or nuclear safety analysis require systematic verification that a change of platform does not corrupt the functionality or numerical results of a code.

Y2K Program for Scientific Codes

At AECL, the Y2K program for scientific codes has proved to be a substantial effort, involving evaluation and verification of over 600 scientific-analysis program versions. The program involved scientific-code assessment and porting on many different computer platforms at the various AECL sites.

The primary focus of AECLís Y2K program for scientific codes has been on codes that are in active use for design and service support.

Y2K Project Area Leaders are responsible for leading the planning and execution of the detailed Y2K analysis and compliance work and for preparing and identifying applicable Y2K project guidelines and procedures.

The detailed work consisted of Y2K-compliance analysis, formulation of proposed remedial measures, testing, contingency planning and implementation of corrective actions where required. This work was mostly assigned to the code holders, also referred to as ìprimary holdersî from the scientific-code ìproduct ownerî branches, typically referred to as ìperforming branchesî. These code specialists performed the detailed work on their respec-

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tive products under the Y2K Program - Engineering Systems and Products Project work authorizations.

Y2K Program for Information Technology (IT) Infrastructure

The Y2K IT Infrastructure Program includes computer systems, software, and equipment with embedded digital processors used in the following applications:

Business support systems deploying Oracle and other database and programming environments, used in support of business functions such as Finance, Human Resources, Facilities Management, Nuclear Inventory Management, etc. This category included applications purchased commercially or developed by or for AECL.

Intel-based computers and Windows- or DOS-based operating systems and applications that make up the general purpose computing environment within AECL. It includes desktop, notebook and server class computers, Windows 95, NT and DOS operating systems and applications that run within this environment such as MS-Office, MS-Exchange, Adobe Acrobat, etc.

UNIX-based workstations and server hardware, operating systems and commercial applications. This group covers all versions of UNIX in use at AECL and commonly used tools such as compilers, editors, database systems and selected applications.

VMS-based workstations and server hardware, operating systems and commercial applications. This category covers all versions of VMS in use within AECL, common tools such as compilers, database systems and selected commercial applications.

Network and computer centre equipment not thought of as a computer or workstation, such as a router, a PBX, a tape backup system, etc. It also covers devices such as printers, scanners, fax machines. These typically use microcomputer chips, but in an embedded fashion.

Of these project areas, only the PC (Wintel), UNIX and VMS projects have an effect on the Y2K Program for Scientific Codes.

Y2K Project Leaders are responsible for leading the planning and execution of the detailed work in each of these project areas, and for preparing and identifying applicable project guidelines and procedures.

The detailed technical work associated with Y2K compliance assessment and correction has been assigned to qualified staff familiar with those computer systems and software. The detailed work consists of Y2K-compliance assessment, corrective action planning and scheduling, testing, and implementation of corrective actions where required (corrective actions being upgrade, replace or eliminate). The staff for the detailed work in the IT Infrastructure part of the Y2K program is typically drawn from the Information Technology Branch.

Major Steps of the Y2K Compliance Process for Scientific Codes

The major steps of AECLís Y2K compliance process for scientific codes are the following:

Inventory of scientific codes
Prioritization
Project planning and organization
Assessment of codes for use of dates
Assessment and/or correction of codes for Y2K compliance
Assessment of computer platforms for Y2K compliance
Program porting to Y2K-compliant platforms
Testing and verification
Implementation (bringing into production)

The details/activities associated with the above steps are outlined in the following subsections. It should be noted that some of these steps may not be within AECLís scope of Y2K responsibility for all products. For example, implementation of corrective actions for products installed in clientsí facilities and under their full technical control may be part of the clientsí scope, or under third-party vendorsí scope, as in the case of products supplied by third parties.

Inventory of scientific codes

Ensuring that a full and accurate inventory of scientific codes was captured, and correct ìproduct ownerî and ìproduct userî branches were identified, proved a significant challenge.. An integrated, Company-wide inventory had not been maintained routinely prior to the Y2K project. The existence of three major sites (Mississauga, Chalk River, and Whiteshell), the duplication of some scientific-analysis programs at the various locations, and the existence of different program versions on various computer platforms used by various branches at different sites created a logistical challenge. The situation was complicated by the fact that each product typically had not only a designated ìprimary holderî who looked after the product overall, but also users of different versions of the product, based in different ìproduct-userî branches across the Company. For the Y2K project, all the information on scientific codes has been captured in a single, consolidated database. Supporting information was provided to accurately describe operating systems, compilers, libraries, third-party suppliers, etc. Branch managers were contacted for inventory completion sign-offs.

The scientific-code inventory currently lists over 600 products. There are 24 ìproduct ownerî branches, with about 120 primary holders, supporting 10 ìproduct userî branches. The inventory is being kept up-to-date and is revised as required to capture details of reorganizations, staff changes, and development of new products. Details of Y2K compliance of products is also entered in the database as it becomes available.

Prioritization

Once the inventory listing was completed and signed off by owner branches and projects, the products were assigned priority categories based on the assessment of their need for current and future business. For purposes of planning, four levels of priority were identified:

Urgent priority was assigned to programs essential for licensing purposes.

High priority and **medium priority** were assigned to codes used by projects and customers based on the urgency of schedule commitments.

Low priority was assigned to codes identified as seldom used, obsolete, or replaceable. These codes are prime candidates for retirement.

Note that, while some of the scientific-analysis codes are safety-related, none were classified as critical from the viewpoint of reactor operation because the codes are used off-line, and faultsówhether from year-2000 problems or resulting from other causesódo not have the same immediacy of consequence as do faults in the on-line special safety systems or reactor control systems.

Project planning and organization

Based on the information received during the inventory phase, a more detailed work plan and schedule were developed to implement the actual Y2K evaluation and remediation of scientific codes. Three main phases were identified: assessment, corrective action, and porting. Each of these phases is described in more detail below.

Assessment: In this phase, the use of dates in the program was inspected, leading to the assessment of the coding as Y2K compliant or not Y2K compliant. In addition, the platform on which the code is executed and the middleware in use with the code were also assessed for Y2K compliance.

Corrective Action: In this phase, the coding was repaired if it had been declared as not Y2K compliant.

Porting: Regardless of the codingís Y2K compliance, this phase was required if the original platform and/or compilers were not compliant. In this case, the code was moved to a compliant platform and/or recompiled with compliant middleware. It was then verified that the code executed properly on the new system, that it was producing the same results, and that it could correctly handle dates in 2000 and beyond.

Assessment of codes for use of dates

Y2K-specific procedures were developed to define the process for assessing scientific codes. These procedures formed part of the comprehensive Y2K engineering program at AECL.

If the program is to be used in 2000 and beyond, it has to be assessed for use of dates. The definition of year-2000 conformity that was used in this work was that of the British Standards Institute, which was adopted by AECLís Y2K program and used in other parts of the program as well.

For scientific codes, the manner in which dates are used in the code input, algorithm and output needed assessment, and the number of digits used for the year (2 or 4) needed to be documented.

No detailed assessment was needed for those programs that were identified by their owner branches as unessential for AECL business beyond 1999. However, another set of actions was identified for these programs: *intent to retire, notification, archiving.* The manager of the ìowner branchî was requested to file an ìIntent to Retireî statement for the code in question. End users of the program/program version, usually other analysts or projects, are notified either by ìcode ownerî branches or by the Y2K scientific-code team about the intent to retire, and their agreement or opinion on this intent is solicited. In the fall of 1999, the Y2K team will review these programs, ensuring that they have been archived in compliance with Company SQA procedures, and removed from the Companyís network computers.

Y2K-compliance code analysis/conversion

For codes that will remain in active use beyond 1999, the aim of the project is to ensure full Y2K compliance, i.e., conversion of dates to a 4-digit year. The repair of non-Y2K-compliant coding is performed in the corrective-action phase.

Assessment of computer platforms for Y2K compliance

Platform compliance information was gathered by communicating with hardware and software vendors through e-mail, telephone and fax, and through Web-site searches. Documentation was solicited from these vendors on the compliance status of each product. In addition, letters were sent to each vendor by the Y2K Client and Supplier Interface team, requesting documentation of proof of compliance. The vendor was also asked to document recommendations on the best upgrade path to a compliant stage, such as upgrading to version HP-UX 10.20 for HP UNIX workstations. Vendor information continues to be monitored in case of changes to compliance statements.

Use of particular standard operating system versions (see Table 1) was recommended for each platform, to reduce variation that would result in increased time spent porting and testing programs. For each major platform, we purchased or reallocated current systems for use as Y2K test systems, and upgraded each to the-Y2K-compliant operating system and software version.

The test systems were subjected to Y2K date tests, and verification reports were written. The capability to change dates in test systems was provided to enable users to test programs with dates in 2000 and beyond. Userís manuals were provided, defining the test-system configurations and user tips for tests.

Program porting to Y2K-compliant platforms

Porting and verification of the scientific codes proceeded as Y2K-compliant computer platforms became available. In addition to checking date functionality, SQA requirements for scientific codes used in nuclear-system design or safety analysis imposed the systematic verification of program performance, to ensure that the change of platform did not corrupt the functionality or numerical results of a code.

Y2K-specific procedures were developed to define the process for porting scientific codes. These procedures formed part of the comprehensive Y2K program at AECL.

Testing and verification

The primary holder of each program was responsible for writing a verification report or reports documenting assessment and porting activities. These reports were then subjected to branch technical review and acceptance by the Y2K Scientific-Analysis Computer Program team.

For platforms, test criteria and procedures were produced, based on the Year 2000 Test Procedures Manual from Chrysler Corporation and from the systemís vendor (e.g., HP, Digital), in order to test the compliance status of our major operating systems (i.e., HP-UX, SGI IRIX, IBM AIX and OpenVMS). Because of the specialized nature of scientific software, we relied on information from the vendors, except for those software items considered business-critical, such as compilers and backup software, for which we prepared basic Y2K test procedures.

Implementation (bringing into production)

Once the Y2K assessment work began, it was soon confirmed, as expected, that the use of dates in scientific codes is not generally as extensive as in other business applications. Coding assessments therefore proceeded fairly smoothly. Usually, scientific codes use dates only for date-stamping of runs for data management purposes. However, in rare cases, calendar dates may play a significant role in the calculations performed by the code. Identifying and correcting Y2K non-compliance for scientific codes was relatively straightforward in simple cases; however, every code had to be considered separately. In view of the large number of disciplines and administrative units in AECL, large numbers of codes and distinct code versions have had to be examined for Y2K compliance.

Even when the corrective action for scientific codes required a simple fix of dates, ìpatchingî of the computer platforms to make

Table 1

Platform	OS	Recommended Y2K Compliant Standard Operating Versions **indicates patches/enhancements req'd.*	Y2K Version Status	Test Systems Available
Apollo	Domain/OS	Obsolete	**Replaced by HP-UX**	NO
Digital	dUNIX	**4.0D**	OS available	NO
Digital	ULTRIX	4.3+, 4.3A+, 4.4+, 4.5+	Y2K kit available	NO
HP	HP-UX	**10.20+**	OS and patches available	Yes - **y2keng1 available now**
IBM	AIX	**4.3.1+**	OS and patches available	Yes - **y2kibm1 available now**
Intergraph	CLIX	Obsolete	**Replaced by Windows NT**	NO
SGI	IRIX	**6.5, 5.3+**	OS and patches available	Yes - **cu84 available now**
Sun	SunOS	4.1.3 U1 ver B+, 4.1.4+	Patches available	NO
Sun	Solaris	**2.6+**	OS and patches available	NO
Digital	OpenVMS	**5.5-2+, 6.2+, 7.1+**	Y2K kits available	Yes - **cm22 (Alpha) & wp71 (VAX)**
Intel	DOS	**6.22+**	No fixes available	NO
Intel	Windows	Windows 3.11+*, **Windows 95+*, NT 4.0+***	Fixes available	Yes - upon request

* Operating systems are listed by Microsoft as Compliant with minor issues.

- DOS 6.22 recognizes dates beyond the year 2000 but there is an issue with the MS-DOS DATE command and MSBACKUP command.
- Windows95 recognizes dates beyond 2000 but there is an issue with the command.com and the winfile.exe. Both versions (OSR1 & OSR2) require these files to be updated.
- NT4.0 recognizes dates beyond 2000 but there are issues with IE3.02, User Manager and Find Files.

Standard Platforms at AECL for Year 2000

them Y2K compliant (or providing new, Y2K-compliant platforms) and porting programs to these platforms required significant effort.

AECL has a number of different, network-connected computer platforms (primarily HP and SGI UNIX workstations and servers, VMS minicomputers, IBM RISC machines, and Windows í95 and NT PCs). It was discovered that **all** UNIX and VMS systems in use at AECL were non-compliant, and that over one third of the 3200 PCs required BIOS changes. In addition, compilers also had to be checked for Y2K compliance. The major issue for the Y2K team, therefore, was to ensure that compliant test and production platforms were available for code testing so that work could proceed on schedule. (Production platforms were provided later.)

Once these operating systems and software versions were in use in the Scientific-Analysis program verification exercises, they were ìfrozenî; i.e., the system configuration could not be changed, no new library patches could be added, and FORTRAN and C compilers could not be further upgraded since this may have required revalidation of the porting. For the Company-standard UNIX platform, HP-UX, additional systems were purchased to be used as Y2K-compliant production systems, in order to alleviate upgrade scheduling problems. The schedule was derived for upgrades of all users systems, and achievement of Y2K compliance of the scientific codes is scheduled for September 1999.

Benefits of Y2K Program for Scientific Codes

Besides providing a set of Y2K-compliant programs on Y2K-compliant platforms, the Y2K program provided other benefits. Maintaining an up-to-date inventory of scientific codes, communicating and co-ordinating with ìownerî and ìuserî branches were important activities on the project, because of the large number of branches, projects, program holders and users.

Up-to-date inventory: Providing a ìliveî inventory of scientific programs and versions and documentation was among the most important benefits of this project; this exercise provided the opportunity to identify those codes/platforms that are important for AECLís business and those codes/platforms that are no longer required.

"Housecleaning": The Y2K exercise provided a good opportunity to retire old or obsolete programs, no longer needed for business in the future. It was also an incentive to consolidate program versions, generally keeping only one or a very few versions of any given code. The inventory of scientific codes is now leaner, cleaner, and more meaningful.

"Cutting Across Silos": The size and diversity of AECL, and the number of different sites, sometimes result in less than ideal level of interaction between branches. The Y2K exercise created an opportunity for branches to cut across communication "silos" and develop a more comprehensive picture of the many facets of AECL.

Communication was necessary with other Y2K teams to ensure smooth work interfaces and effective communication between program owners, primary holders, and users. With three sites, and over 120 primary holders involved, communication has been crucial, and will have benefits in the future.

Co-ordination between all parties – i.e., owner branches and other Company units (projects), primary holders and end users, the Information Technology System Y2K team and third-party suppliers – has provided an opportunity for collaboration and work towards a common goal.

Summary and Conclusions

In summary, the Y2K project provided the impetus for a consolidation of AECL's scientific-code products. The project will provide Y2K-compliant programs on compliant platforms for uninterrupted scientific work in 2000 and beyond. A clearer picture has emerged of the extent of the intellectual property available in-house and of its value. In addition, an opportunity was provided for code holders and developers to renew their familiarity with their software, middleware and hardware, and with the overriding requirements of software quality assurance.

Acknowledgements

The authors would like to acknowledge the assistance provided by Traci Fraser, AECL's Y2K Project Leader for the Intel-based systems.

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Early Evolution of CANDU PSA

by Gordon Brooks

When the International Atomic Energy Agency and Atomic Energy of Canada Limited held the first symposium on probabilistic safety analysis (PSA) for CANDU nuclear power reactors, the organizers turned to Gordon Brooks, one time Chief Engineer and now Engineer Emeritus at AECL, to provide a historical background. Following is his paper for the opening session of the First International Symposium on CANDU Probabilistic Safety Analysis *held in Toronto, in May 1999. A short report on that Symposium is presented in the General News of this issue of the CNS Bulletin.*

Introduction

In this presentation, I will outline a number of the key evolutionary steps taken in Canada during the early years of the CANDU program which started us along the road towards today's CANDU PSA technology. I will also outline a number of the evolutionary steps in CANDU design which play an important role in the CANDU PSA safety story as we know it today. The information I will be presenting will be largely anecdotal, drawn from my own personal memory bank and from discussions with a number of people who played key roles in this early evolution. I hope this will be a useful historical backdrop for the presentations and discussion which will follow during this symposium.

The Early CANDU's – NPD and Douglas Point

The Canadian nuclear power program had its official launching in the early 1950's with the establishment of a study team at AECL's Chalk River laboratory. Membership in this team was drawn from Canadian utilities, engineering firms and manufacturers. AECL staff provided expertise in specialized areas such as reactor physics and metallurgy.

One of the many questions which faced this team was that of an appropriate safety objective for Canadian nuclear power plants. No real precedents existed, except in the field of general industrial safety, nor were there any existing nuclear-related regulatory requirements, except those relating to nuclear worker radiation exposure, to provide guidance to the study team.

In discussions with John Foster, a leading member of this team, he recalled that after some deliberation, the team adopted a societal risk target of two orders of magnitude lower than the level generally achieved by industries in Canada such as petrochemical plants, oil refineries, thermal power plants, etc. Two considerations led to this rather demanding target. Firstly was the recognition that nuclear power plants would represent a new, and relatively unknown, technology and that, therefore, not all risks could be well identified in advance. Secondly was the recognition that serious accidents involving the public could well "kill" the fledgling industry before it became fully established, particularly given the general public's fear of "things atomic" arising from nuclear weapons.

The study group recognized that it would be difficult, in fact, to establish quantitatively that their conceptual design would meet this target but believed that it would, nevertheless, be useful to have such a target even if, in some respects, it could only be addressed qualitatively on the basis of engineering judgment.

In addition to this target, the study group had very much in mind the lessons learned from the accident suffered by the NRX research reactor at Chalk River in December, 1952.

Briefly, this accident involved a loss of reactor regulation, combined with malfunction of the safety shutdown system. The severity of the accident was increased by the state of the reactor core at the time. For experimental purposes, a group of fuel rods had their coolant flow substantially reduced from normal full-power levels. When the reactor power increased beyond the intended level through failure of the regulating system, the light water coolant in these fuel rods boiled bringing in additional positive reactivity. A major power overshoot resulted - the power rose to a peak of about 75 MWt as compared to the rated full power of 20 MWt. This caused severe damage to a large number of the uranium metal fuel rods, their aluminum cladding and flow tubes, and the surrounding aluminum calandria tubes.

It is likely, based on post-accident analysis, that the transient was terminated by the injection of light water coolant into the moderator from the damaged fuel rods and calandria tubes although some uncertainty exists because the assistant superintendent of the reactor happened to enter the control room at the time and manually initiated a dump of the heavy water moderator.

A number of important operational and maintenance lessons were learned from this accident since both operational and maintenance errors played an important role - as is typically the case with real accidents. One poor operational practice was permitting a reactor physicist, who was not qualified as a reactor operator, to operate the controls of the reactor. When the problem first developed, he did not recognize that the moderator should be dumped. From a maintenance standpoint, the control/shutoff rods (the rods fulfilled both functions) were known to be troublesome and, in fact, a maintainer was trying to rectify problems with the rods during the test and through a miscommunication with the control room, inadvertently caused one of the rods to be withdrawn beyond its proper position leading to the loss of regulation. A cross-linked problem then resulted in the rods not being injected into the core properly following the trip signal.

From a design standpoint, the key lessons learned were:

1. Reactor regulating and safety shutdown systems must be isolated from each other and be independent to the degree that no possible regulating system malfunction can impair operation of the safety shutdown system.
2. The safety shutdown system and its components must be testable at regular intervals under all reactor operational states to ensure and demonstrate the continuing achievement of the requisite system reliability.

You will recognize that these "lessons learned" are directly relevant to ensuring the necessary high quality in operations and maintenance, the necessary avoidance of design features which can lead to "cross-link" failures between systems, and the necessary confidence in safety system reliability predictions, all of which underlie credible probabilistic safety assessments.

Returning to the study team at Chalk River, the work of the team was carried out in two phases, the first leading to the detailed design of the small 20 MWe NPD reactor built near Chalk River which went into operation in 1962, and the second which led to the detailed design of the larger 200 MWe Douglas Point reactor built on what is now the Bruce Nuclear Power Development site which went into operation in 1967.

Originally, the design for NPD was based on the use of a pressure vessel. Work on this design started in 1955 and was undertaken by a design team located at the Canadian General Electric facility in Peterborough. The team comprised engineers and scientists drawn from AECL, Chalk River, members of the first study team noted earlier, and CGE staff.

By early 1957, while work had been sufficiently advanced for an order to be placed for the pressure vessel in the U.K. (even this relatively small pressure vessel could not be constructed in Canada) and for site excavation work to begin, a number of problems had arisen. This led to an "agonizing reappraisal" of the project. One of these problems was that the design had not incorporated a containment system, the need for which was becoming increasingly apparent as safety analysis work proceeded. To incorporate a containment system, the design would have required extensive alteration. At the same time, ongoing work by the second phase study team at Chalk River of a commercial-scale pressure tube reactor was looking very promising. It was recognized that the use of pressure tubes would avoid the problem of procuring large pressure vessels which would be required for future commercial-scale plants. The design group at Peterborough was therefore directed to develop a conceptual design for a pressure tube version of NPD which would incorporate a containment system. By late in 1957, this new concept was formally adopted and named, at the time, NPD-2.

In 1958, as work was progressing on NPD-2, AECL and Ontario Hydro decided to further pursue the conceptual design of the larger (200 MWe) pressure tube reactor. The Chalk River study team was moved to Hydro's Manby Service Center in Toronto to carry out this work. The team was augmented by engineers and scientists from AECL, Ontario Hydro, and Canadian manufacturers and consulting companies. By 1960 their work was sufficiently advanced to allow commitment of detailed design and construction. The reactor was called CANDU and a site was provided by Ontario Hydro at Douglas Point on Lake Huron. As work proceeded, the name CANDU was dropped and the plant was formally called Douglas Point. CANDU was then adopted as the generic name for reactors of this type.

In those early days, the licensing body, the Atomic Energy Control Board, had not yet established detailed safety design and analysis criteria. The Board, which previously had been primarily concerned with the control of "prescribed substances" such as uranium and heavy water and the safeguarding of Canada's nuclear technology from a non-proliferation standpoint, established an expert advisory committee, the Reactor Safety Advisory Committee (RSAC). The role of this committee was to review the safety of the proposed new nuclear power plants and to advise the Board, as to whether the plant siting, design, construction and planned operation appeared to offer an appropriate level of safety in terms of societal risk. The Board hired a small number of experienced engineers and scientists to provide support and assistance to the Committee. Membership in the Committee was drawn from AECL and provincial and federal departments of health and labour [and academia, ed.].

The basic "modus operandi" followed in the licensing process for these early reactors was one of the designers proposing and the Committee disposing. The approach adopted by the designers involved, firstly, the identification of a broad spectrum of possible accidents which could lead to fuel damage and the release of fission products to the containment. The possible magnitude of such releases was then estimated together with the possible releases to the environment with the containment assumed to perform both as designed and in possible impaired states. The probability of each such combination of events was then estimated. In the case of Douglas Point, this estimation of probability was termed the "Risk Index". The spectrum of identified possible accidents included:

- Fuel failures and possible consequential damage to pressure tubes
- Reactivity transients from various reactor operating states and overpower accidents
- Pressure tube failures
- Loss of coolant accidents, both large and intermediate in size
- Minor piping failures
- Failures of end fittings and closure plugs
- Secondary system failures including pipe ruptures, loss of feedwater, steam drum failures, and boiler heat exchanger shell failures
- Loss of primary coolant flow accidents
- Failure of primary pressurizing system
- Failure of steam turbine

- Failure of primary system check valves
- Failure of moderator circulation
- Failure of standby cooling pumps
- Loss of booster rod cooling accidents
- Loss of electrical power accidents
- Fuel handling system accidents

In developing probability estimates for these accidents, the designers utilized equipment reliability data available from Ontario Hydro through experience with both fossil and hydraulic plants. The quality of this data was generally good for electrical power and conventional instrumentation systems and for conventional process equipment such as pumps and valves. Chalk River research reactor experience was utilized as the data base for neutronic instrumentation reliability predictions. In some cases involving unconventional equipment, the designers acknowledged that "the numbers used have little more than the strength of reasonable guesses". Where practical, the design incorporated features such as "two out of three" voting logic for important instrumentation systems which permitted the claimed reliability to be demonstrated through regular testing during plant operation.

Pickering-A

For the first large commercial CANDU station, Pickering-A, the AECB published what was called the "Siting Guide" which codified the approach the Board intended to follow in the licensing of this station. This represented the birth of the Canadian "single/dual failure" approach to safety design and analysis. The Siting Guide was authored by Dr. George Laurence in his capacity as Chairman of the Reactor Safety Advisory Committee and Fred Boyd, a senior member of the AECB staff.

The Siting Guide approach categorized all plant systems needed for the production of electricity as "process systems" and categorized those systems provided solely for safety purposes as "special safety systems". These included the reactor emergency shutdown system, the emergency core cooling system, and the containment system. A basic principle was that the special safety systems must be totally independent of the process systems and must be independent of each other. A further principle was that the special safety systems must, to the maximum degree practical, be testable during reactor operation to demonstrate that their requisite reliability was maintained at all times.

With this basic approach to system classification, accident analysis was carried out in two phases. The first phase, termed single failure analysis, called for a comprehensive set of process system failures to be analyzed assuming availability of the special safety systems. These analyses were required to demonstrate that the predicted radioactive releases to the public, both collectively and to individuals most at risk would be below prescribed limits. In effect these analyses were a test of the effectiveness of the special safety systems. In the second phase of the accident analysis, the set of assumed process system failures were to be re-analyzed assuming that each of the special safety systems in turn was unavailable. These analyses, termed dual failure analyses, were required to demonstrate that the predicted doses to the public would be below a second, and higher, set of prescribed limits.

It will be seen that this approach was rather more deterministic in nature than the earlier probabilistic approach used for NPD and Douglas Point. This reflected Dr. Laurence's view that probability predictions of the type developed for these earlier plants were questionable because of uncertainties associated with component reliability data, assumptions regarding operator reliability, and difficulties in ensuring that all possible common-mode and cross-linked failures were identified.

To a substantial degree the design of the 500 MWe Pickering units was based on a scale-up of the design of Douglas Point. One major innovation was adopted, however, that being the negative pressure containment system. This innovation was in response to RSAC concerns regarding the siting of the Pickering station immediately adjacent to the eastern edge of metropolitan Toronto. This containment system employs a large vacuum building coupled by ducts to each reactor building of the multi-unit station. Following a large loss-0f-coolant accident (LOCA), the rise in reactor building pressure opens an array of parallel self-acting valves located in the duct adjacent to the vacuum building. The opening of these valves rapidly reduces the pressure in the affected reactor building to sub-atmospheric. As a result, any leakage in the containment boundary would result in air in-leakage rather than in the release of fission products to the environment.

A further innovation relative to Douglas Point was the addition of a number of gravity-operated shutoff rods to augment the moderator dump fast reactor shutdown system. Accident analysis showed that this was necessary because of the larger reactor core size which meant that moderator dump (with practical dump port configurations) could not provide a sufficiently fast initial negative reactivity "bite" under certain accident conditions. This combined shutdown system incorporated a rather ingenious feature called the "dump arrest" system. This allowed for a more rapid reactor restart by interrupting the dumping of the moderator provided the measured rundown in reactor power matched a predetermined profile. As a result, moderator pump-up times for restart were considerably shortened.

Bruce-A & CANDU-6

For the next Canadian plants, Bruce-A and the CANDU-6 units, the use of the Siting Guide was retained with a few relatively minor changes introduced by Dr. Don Hurst, who had replaced Dr. Laurence as Chairman of the RSAC, and Mr. Fred Boyd.

A major change affecting accident analysis was introduced for these plants. This was the incorporation a second emergency reactor shutdown system. With the agreement of the RSAC, the introduction of this second shutdown system altered the structure of the single/dual failure accident matrix by elimination of the need to analyze dual accidents involving failure of the previous single reactor emergency shutdown system, i.e., credit would be given for assumed operation of at least one of the two emergency shutdown systems (the least effective of the two). To earn this credit, it was essential that the design of the two systems should be diverse to avoid possible common mode faults, and physically separated to avoid possible cross-linked failures.

The design chosen for the second shutdown system utilized liquid poison injection into the moderator through horizontallyoriented perforated tubes, thereby providing both diversity (as compared to the shutoff rods used for the first shutdown system) and a maximum of physical separation. From an accident analysis standpoint, this change obviated the need for what was termed "core disassembly" analysis (accidents involving failure to terminate positive reactivity transients prior to serious core disruption) which the RSAC had considered somewhat speculative in the case of Pickering-A. Based on this initially identified purpose for the addition of the second shutdown system, the Bruce-A and CANDU-6 designers proposed that the second shutdown system be actuated only by neutronic trip parameters. After considerable debate, the RSAC insisted that if the second shutdown system was to be credited for any accidents, it must be actuated by not only neutronic trip parameters but also by process system parameters in the same comprehensive manner as the first shutdown system.

For both the Bruce-A and CANDU-6 reactors, the moderator dump system employed in all of the earlier reactors was abandoned. At the time, this move was primarily a cost-saving measure. Moderator dump had originally been adopted because of concerns with shutoff rod reliability resulting from the NRX accident. The development of highly reliable shutoff rods for the NRU research reactor and for Pickering-A finally laid this "bogeyman" to rest in the Canadian program. At the time, the elimination of moderator dump was not fully recognized as being desirable in terms of providing a back-up heat sink in the case of a LOCA and failure of emergency core cooling (ECC), its later importance in the CANDU PSA safety story shows that it was a fortunate move.

As the design of these reactors proceeded, some AECB staff members, led by Mr. Declan Whelan, the Board staff officer for Bruce-A, identified the following concerns regarding the safety analysis program then underway:

- The analyses demonstrated only the short-term effectiveness of the safety systems. There was no demonstration of how the plant could be stabilized and recovered in the longer term following the accident.
- The analyses targeted only serious process failures, i.e., failures which would lead to fuel failures in the short term in the absence of safety system action. The approach did not require the formal examination of other failures, such as loss of service water, which could constitute a longer term threat to fuel integrity.
- The approach did not formally examine some combinations of failures which could constitute a longer-term threat such as failure of Class IV electrical power combined with failure of Class III electrical power.

After considerable discussion between Board staff and designers, an approach was evolved to deal with these concerns. This was termed the "safety design matrix (SDM)" approach.

The first part of this matrix was made up by the "classical" single and dual failure analyses which in themselves formed a matrix. These represented, in effect, the short-term analyses having a time duration of 15 minutes, this duration being that within which operator action was not credited.

The matrix was then extended to a long-term assessment of the actions required to stabilize the plant such as providing alternate heat sinks, ensuring containment, restoring electrical power supplies, etc. These assessments were in the form of reliability assessments. Probabilities were assigned for the failure of an operator to take a required action or for equipment to fail to perform its required function. The assessment was continued for all branches for which the predicted frequency is greater than once in ten million years. The requirement was to show that all branches have acceptable consequences, i.e., that apart from a LOCA, there is no additional release of radioactive material. In addition to the foregoing, this technique was applied to non-classical failures such as loss of service water, instrument air, etc., and to combinations of failures such as the combined loss of both Class IV and Class III electrical power.

The foregoing safety design matrix approach was employed on a trial basis for the Bruce-A and early CANDU-6 reactors and was judged by both designers and AECB staff to be very effective. It was subsequently adopted by the AECB as a formal licensing requirement. It proved to be very effective in identifying design weaknesses during the design program and led to worthwhile design improvements, particularly with respect to what became known as safety support systems, i.e., those systems needed to support the special safety systems in the longer term following an accident. Examples of design improvements which arose, at least partially, from the SDM analyses include the Secondary Control Center, the Emergency Power System, and the Emergency Water system, all of which were qualified for both design basis earthquakes and tornadoes. The SDM analyses also proved valuable in identifying in detail necessary operator actions under accident conditions. Out of this identification, a set of procedures was developed which came to be called Emergency Operating Procedures (EOPs).

As a matter of historical interest, the incorporation of design changes arising from the SDM programs was far from a "painless" process since the detailed design and construction of the Bruce-A and early CANDU-6 reactors was well advanced by the time the SDM process was introduced. In order to control these late changes with a practical minimum of disruption, a formal Change Control Board process was introduced. Each change identified as desirable by the SDM working teams was submitted to the Board for review and approval prior to being implemented. While this process was reasonably successful, significant project delays and cost increases were unavoidable because of the advanced stage of design and construction. The lesson learned for the future was that such analyses must be undertaken in parallel with the design process as the design evolves in order to minimize program disruptions and cost increases.

Concluding Remarks

I will leave the story of the evolution of CANDU probabilistic safety assessment at this point. Other papers will pick up the story of the evolution of CANDU PSA technology where I have left-off. (It is intended to re-print those in subsequent issues of the CNS Bulletin. Ed.)

In conclusion, I would like to thank the organizers of this symposium for inviting me to make this presentation this morning and to wish you all well for an interesting and beneficial symposium.

More on LNT

Ed. Note: As a further contribution to the on-going debate over the "Linear No-Threshold" hypothesis (LNT) we offer the following summary of an invited paper presented by Dr. Ron Mitchel of the Biology Dvision at AECL-CRL at the Annual Meeting of the American Nuclear Society in Bosoton, June 1999.That is followed by the abstract of a paper presented by former CNS president Jerry Cuttler to a conference on low doses held in Paris, also in June 1999.

Low Dose Effects: Testing the Assumptions

by Ron Mitchel[1]

Current radiation risk estimates and all radiation-protection standards and practices are based on the so-called "Linear No-Threshold (LNT)" hypothesis. The LNT model assumes that risk is linearly proportional to dose, without a threshold, and thus includes a number of assumptions about the dose-effect relationship: (a) every dose, no matter how low, carries with it some risk; (b) risk per unit dose is constant; (c) risk is additive; (d) risk can only increase with dose; and (e) biological variables are insignificant compared to dose. The radiation protection community has historically accepted the LNT model as the basis for a conservative approach to radiation protection practice. There is, however, no actual data to support these assumptions at doses which are relevant to occupational and public exposures. Our work is investigating the biological responses of cells and animals to low doses and low dose rates of low LET radiation, and comparing the results to the predictions of the LNT hypothesis.

The biological risk of most concern from exposure to ionizing radiation is the risk of cancer. Since cancer ultimately arises from a series of genetic changes in a single cell, it is therefore necessary to understand the effects of radiation on single cells. If we consider the potential biological outcomes of a radiation exposure to a cell, there are three general possibilities (Figure 1).

When DNA damage is created as a result of one or more tracks of radiation through a cell, the cell will attempt to repair that damage. If the cellular repair is successful and the DNA is restored to its original state, i.e., an error-free repair, then the cell is also restored to normal. In this case, there is no resulting consequence to the cell and hence no resulting risk. A second possibility is that the cell recognizes that it cannot properly repair the DNA damage, and as a consequence activates its genetically encoded programmed cell death process, called apoptosis. Again, in this case, no risk of carcinogenesis results since dead cells do not produce cancer. The third possible outcome of the DNA damage is repair which avoids cell death but which is error-prone and creates a mutation. While the vast majority of mutations do not create the potential for cancer, there are some that do and it is these mutations that represent the risk. Of the three possible outcomes, therefore, only one creates a risk of carcinogenesis.

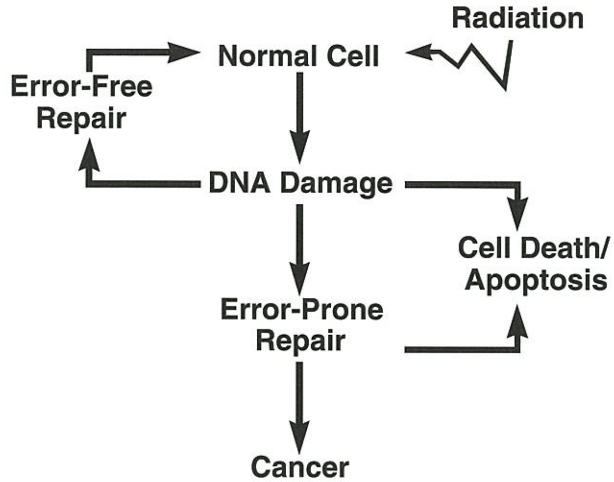


Figure 1. Potential outcomes of a radiation exposure in a normal cell

It is useful to remember that the LNT model predicts that risk is influenced only by dose, and hence predicts that the relative proportions of the biological possibilities must be constant. If they were not constant, then risk would vary with their relative proportions, i.e., not only as a function of dose. Our experiments show, however, that this is precisely the situation that occurs when cells are exposed to low doses. They respond by altering the relative probabilities of the three possible outcomes described above.

The lowest dose a cell can receive is one charged particle track. Our experiments show that human and rodent cells, exposed to an average of about one track per cell (1 mGy of 60Co-g radiation), or many tracks per cell, respond by increasing, and then selectively applying, their ability to repair broken chromosomes resulting from a second exposure. The net result for the cell was that increasing the dose, by pre-exposing the cells, reduced the risk of genetic damage (Figure 2).

1 Atomic Energy of Canada Limited, Chalk River

Figure 2. Influence of radiation on spontaneous cancer formation in rodent cells

DOSE (mGy)	FREQUENCY (X 10^{-4})
0 (CONTROL)	18.0
1.0	6.2
10	3.9
100	4.9

An average of one track per cell was just as effective at protecting the cells as many tracks per cell. On the other hand, cells unable to adequately repair their genome were sensitized to die by apoptosis, eliminating the possibility that they could transform into cancer cells. These "adaptive responses" of cells protected them against the risk of being transformed into cancer cells by a subsequent radiation exposure, and it also provided a 3-4 fold protection against their own inherent, spontaneous risk of transforming into cancer cells in the absence of further exposure. Very recent, preliminary results indicate a so-called "bystander effect" for this protection. It appears that induction of the protective effect does not require a cell to actually receive a track, but that the cell will also respond to intercellular communication signals from other cells which have experienced an energy depositing event.

In vivo experiments in mice support the concept that low doses reduce rather than increase risk. Pre-exposure of the skin of mice to ß radiation reduced by about five fold the frequency of skin tumors in mice whose skin was subsequently exposed to a chemical carcinogen, indicating a protective effect on early, tumor initiation events in cells. Another *in vivo* mouse experiment has shown that a low, whole body dose of g radiation substantially extended the latent period for myeloid leukemia induced in the mice by a subsequent large radiation dose, indicating a protective effect of low doses against the late, secondary processes of carcinogenesis (Figure 3).

Figure 3. Life shortening in irradiated mice that developed myeloid leukemia

TREATMENT	AVERAGE LIFESPAN (days)	LIFE LOST (days)
control	727	0
1.0 Gy	486	241
0.1 Gy, 24h, 1.0 Gy	578	149

These experiments indicate that at low dose, none of the assumptions of the LNT hypothesis were supported by the data, either in cells or in animals. If these results from human and rodent cells, and from animals, are applicable to humans, the data further indicate that the use of the LNT hypothesis for radiation protection purposes is not conservative, but may actually increase the overall risk of cancer.

Resolving the Controversy over Beneficial Effects of Ionizing Radiation

by Jerry Cuttler

Ed. Note: Following are the abstract and conclusions of a paper presented by Dr. Jerry Cuttler to the Conference on the Effects of Low and Very Low Doses of Ionizing Radiation on Health, organized by the World council of Nuclear Workers and held in Versailles, France in June 1999. For the full paper contact him at e-mail address: < cuttlerj@aecl.ca >

Abstract

In spite of the extensive research carried out during the past century, intense controversy continues over the health effects of low-level radiation. This controversy is largely due to political, social and economic issues among scientists and analysts in a variety of disciplines. These issues cloud objectivity and strengthen paradigms. Over the past ten years, in 14 universities and two research institutes, Japanese scientists have conducted exceptional research which clearly demonstrates beneficial effects of low-level radiation and cancer cures following therapy with low doses of radiation. Assessment, replication and extension of this work in North America could lead to greater appreciation of its significance. Cancer patients would demand such treatments, leading to universal acceptance of these biopositive effects and reducing public fear of nuclear technology.

Conclusions

The current pace of the evolution towards science-based regulation of nuclear technology may be two slow to prevent the phase-out of nuclear technology, being driven by political and anti-nuclear environmental movements. The nuclear workers are very important and credible participants in the resolution of this controversy, by virtue of the direct impact of radiation on their health and the public fear of radiation on their jobs. The recent massive public demonstrations of 35,000 nuclear works in Bonn and 4,000 in Prague have shown that the workers can exert considerable influence in the public forum. Could they not also urge the scientists and regulators to use more scientific methods to quantify the actual benefits and risks of radiation at low and high doses?

But the real key to resolving the controversy are patients with cancer and other life-threatening diseases who could be cured by low dose radiation treatments (with negligible side-effects), if they were available. These people have an immediate life-or-death interest in the resolution of this controversy.

If western scientists would only urge the replication of the Japanese medical treatments in their local hospitals, the effectiveness of these low-dose treatments could be confirmed. If terminal patients were aware of these remedies, they would demand the treatments. This would soon lead to universal acknowledgement of the reality of radiation hormesis, and end the fear of low-level radiation and all things nuclear.

Common Safety Analysis Codes

by J. Luxat[1], V.G. Snell[2], M.-A. Petrilli[3] and P.D. Thompson[4]

***Ed. Note.** For years, especially in the context of COG meetings, there has been discussion about the need to harmonize the many codes that had been developed for reactor safety analysis, especially those whose objective were similar. Over the past few years significant progress has been made in this direction as outlined in the following short paper, a summary of a presentation at the 20th CNS Annual Conference in Montreal, June 1999.*

The safety analysis of CANDU reactors requires large and sophisticated computer codes. In the early days of CANDU, these were developed by the designer. As utilities, particularly Ontario Hydro, took over more of the project execution of their reactors, and had to maintain the safety analysis of the operating units, they developed customized versions of these codes, or new codes completely. The net result was that two complete code suites were being developed and maintained.

Although the codes in these suites had been validated against experiment as they were developedand used, the methods were not formal and were therefore difficult to audit for completeness. TheCanadian nuclear industry therefore began a programme of formal validation and verification in themid 1990s, the objectives of which were to demonstrate a very low likelihood of significant errorsor unquantifiable uncertainties in the codes, and to provide a documentation base which woulddemonstrate to a regulator that the job was done properly. In addition AECL wished todemonstrate to its foreign customers that the CANDU codes had undergone a thorough and formal validation.

It was quickly apparent that the formal validation/verification was costly; and that substantialsavings in both manpower and expenses were there for the taking if the efforts could be combined.AECL and the utilities therefore began a systematic evaluation of all safety analysis codes, with aview to selecting a reference code *and* code version to be validated, verified, and used by the entireindustry. This code would then be called an "Industry Standard Tool", or IST. Other less quantifiable advantages of adopting ISTs were: best use of scarce specialized expertise both in the industry and at the regulator; consistent positions internationally and domestically; synergy among code developers at utilities and AECL; and ease of sharing work among organizations.

The bases of code selection were however to be technical and business-oriented. An industry-wide Steering Committee was set up to determine policy, and make final decisions on the technical and business cases in each discipline; and expert Working Groups were tasked with detailed evaluation. The process was as follows:

- candidate disciplines for selection of an IST were identified by the Steering Committee, the Working Groups, or individuals
- the Steering Committee decided if the opportunity was worth pursuing, and if so, struck a special Working Group to review the discipline in detail
- the Working Group determined the technical requirements across the industry; assessed candidate codes against these requirements; estimated the amount of work required; developed a preliminary business case showing the net savings to be achieved by adopting a single IST versus proceeding separately; and made a recommendation on the code.
- the Steering Committee endorsed the recommendation
- the Working Group then developed a detailed implementation plan and schedule (Programme Execution Plan, or PEP) which listed the work required to implement the IST, the schedule, and the sources of manpower, broken down by task and organization. Approval of this PEP by the Steering Committee finalized and formalized the plan.

The result was successful in almost all areas, except for system thermohydraulics, where the investment required either to converge on a common tool, or for one party to switch tools, was so large as to make the business case marginal.

1 Ontario Hydro
2 AECL
3 Hydro Québec
4 New Brunswick Power

Once an IST had been adopted, the PEP was executed by the participants. Most PEPs are now in place and are beginning to be executed.

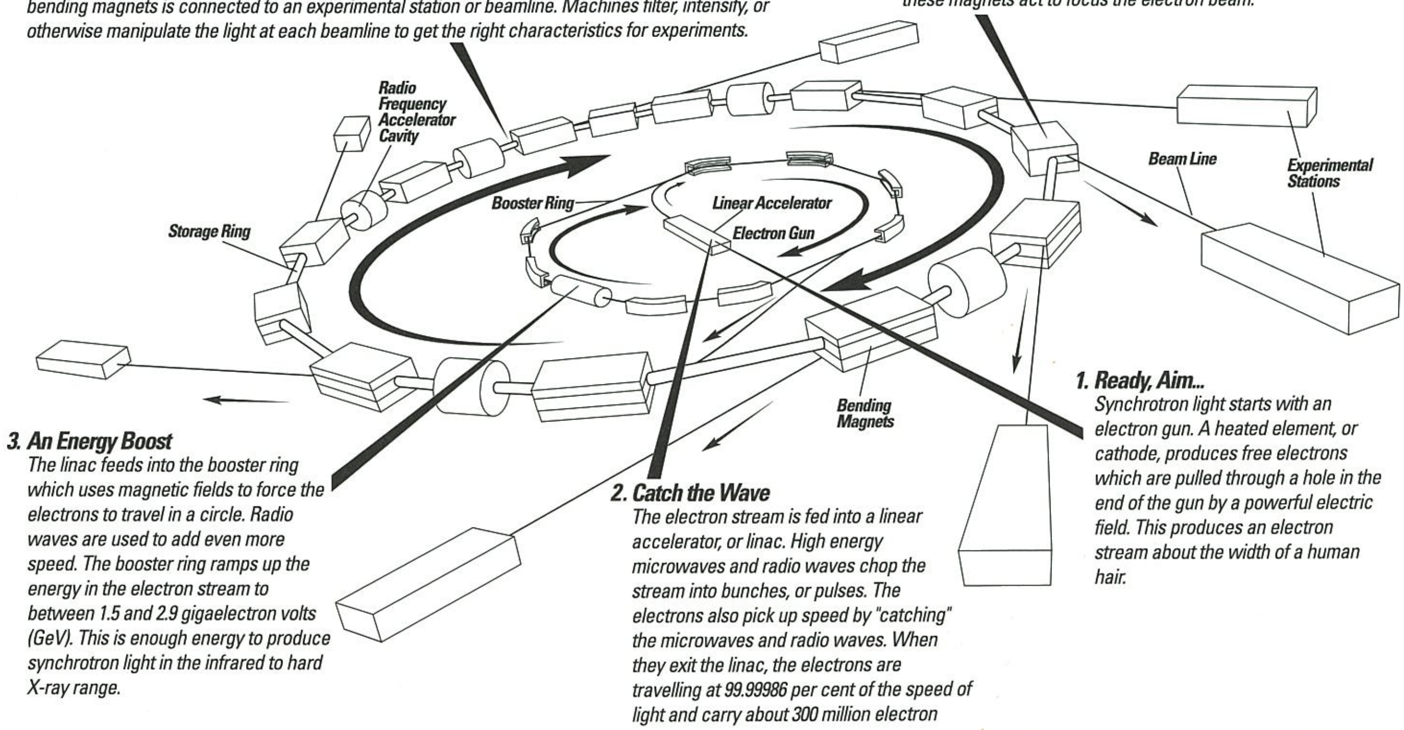
For each IST, a "host" organization is nominated, charged with controlling and maintaining the authorized IST version, determining user requirements through User groups, and co-ordinating development, verification, and validation. The actual work on each code is not restricted to the host, but is done by each organization in accordance with the PEP. The QA requirements are set by the host, but must meet those of participating organizations, with the host treated as a third-party code supplier.

To date the following tools have been adopted as ISTs:

Discipline	IST Computer Code
Lattice Physics	WIMS-IST
Core Physics	RFSP-IST
Containment Themohydraulics	GOTHIC-IST
Moderator Circulation	MODTURC-CLAS-IST
Fuel Initial Conditions	ELESTRES-IST
Fuel Transient Behaviour	ELOCA-IST
Moderator Behaviour for In-Core Break	TUBRUPT-IST
Fission Products from Fuel	SOURCE-IST
Fission Products in Containment	SMART-IST
Severe Core Damage	MAAP-CANDU-IST

Further IST candidates are under discussion and development.

Schematic of CLS Synchrotron



GENERAL **news**

UK Royal Society supports nuclear

Joint report with Royal Academy of Engineering states, "It is vital to keep the nuclear option open".

***Ed. Note:** Following is the "Foreword" and "Key points" from the summary of a report recently released by The Royal Society of the UK, entitled, Nuclear Energy - the Future Climate. The report was prepared by a joint working group of The Royal Society and The Royal Academy of Engineering.*

The Royal Society was founded in 1660 and is the independent scientific academy of the UK dedicated to promoting excellence in science.

Foreword

A secure supply of energy is fundamental for modern society. One might therefore expect energy policy to be the constant subject of intense public debate. The fact that, at least in the UK, it is not, may mean that on the whole our energy policy works. We do not worry particularly about the lights going out.

But energy policy is both a long-term and a global issue. Society requires an energy supply that can meet growing demand and that is reliable, economically affordable and sustainable in terms of its global and local environmental impact. These are major challenges, and there is nothing inevitable about future success. Energy does need to be centre stage in policy-makers' minds.

The Royal Society and The Royal Academy of Engineering therefore set up a joint working group to examine one aspect of energy policy where there is a powerful temptation to procrastinate: the role of nuclear energy in generating electricity. This has been given extra prominence by the Kyoto commitments on emissions of greenhouse gases in general and carbon dioxide in particular. Our aim has been to survey the full range of current and potential technologies for generating electricity and, against that background, to form a view on the future role for nuclear.

The CO_2 issue is real and increasingly urgent; the many emerging forms of renewable energy do merit substantial levels of R&D investment and could well become key parts of the UK strategy for sustainable energy supply; initiatives to promote efficiency and conservation do have a part to play. But, in the light of this study, the Royal Society and The Royal Academy are convinced that it is vital to keep the nuclear option open. We view with great unease current policies that appear unperturbed by the prospect of all nuclear capacity disappearing from the UK by the middle of the next century.

In order to make our analysis and conclusions accessible to a wide readership, we have produced a full report © 80 pages; and a summary version, both of which are obtainable from the Royal Society. We look forward to a serious debate about its practical recommendations on how to develop secure energy supplies in ways that are sustainable in the long term.

Key points

- There is a strong case for acting to mitigate the threat of drastic climate change associated with unrestrained increases in emissions of greenhouse gases, particularly CO_2. Just waiting to see what happens to the atmosphere if we persist with business as usual in electricity generation is not a sane option.
- We must consider exploiting all possible approaches, including using less electricity, using technologies based on renewable sources, and finding ways to prevent CO_2 reaching the atmosphere, as well as exploring the nuclear option. It is not appropriate to dismiss an energy source on the grounds that it could supply 'only' a few percent of need.
- It is vital to keep the nuclear option open. We cannot be confident that the combination of efficiency, conservation and renewables will be enough to meet the needs of environmental protection while providing a secure supply of electricity at an acceptable cost. It is essential to win back public confidence in this option.
- We therefore endorse the 1998 recommendation of the House of Commons Trade and Industry Committee that: 'a formal presumption be made now, for the purposes of long-term planning, that new nuclear plant may be required in the course of the next two decades.' We would further urge that the timetable for such considerations should allow a decision to be taken early enough to enable nuclear to play its full, long-term role in national energy policy. This is likely to mean early in the next administration if a damaging decline in the role of nuclear is to be avoided.

- The planned levy on the use of energy is deeply flawed. Since the objective is to reduce CO_2 emissions, the levy would be much more effective if it was based directly on net CO_2 emitted rather than, as proposed, on the amount of energy supplied.
- There is a need for major investment in research and development in all energy sectors. Because of the long-term and international nature of such work, we propose the formation of an international body funded by contributions from individual nations on the basis of GDP or total national energy consumption. The body would be a funding agency supporting research, development and demonstrators elsewhere, not a research centre itself. Its budget might reasonably build up to the order of $25 billion pa, roughly 1% of the total global energy budget.

The full summary is available on The Royal Society`s Website: www.royalsoc.ac.uk.

International Nuclear Forum

Policy Statement on Climate Change

Ed. Note: *In connection with a large international gathering in Bonn, Germany, in June 1999, the International Nuclear Forum issued the following statement. The INF is an informal group of the world's leading nuclear industry association interested in climate change policy. The CNA is an active member.*

World demand for electricity will continue to grow as population grows and countries develop and expand their industrial base. All methods of electricity generation have some impact on the environment. Our global challenge is to minimize this impact while satisfying the electricity needs of the world. Nuclear energy plays an important role in fulfilling this objective because it protects the environment, provides much needed energy and makes sustainable development possible.

Particularly, nuclear electricity generation avoids the emission of greenhouse gases and thus plays a key role in limiting potential climate change.

Parties to the UN Framework Convention on Climate Change should acknowledge nuclear power as an acceptable energy and environmental policy option that successfully avoids greenhouse gas emissions. Continued, effective use of nuclear energy to address potential climate change requires several policy elements be included in, or implemented in concert with, any effort to manage risks from global warming. These should include:

- Recognition of the contribution from operating nuclear energy facilities as an integral part of current and future greenhouse gas abatement strategy.
- Accreditation of current and future emission avoidance from non-emitting and low-emitting technologies, including nuclear energy facilities, in the design and implementation of all the Kyoto Mechanisms.
- Distribution of emission allowances in global electricity sectors based on electricity generated to ensure an emissions trading system that is non- discriminatory of non-and low-emitting technologies.
- Equal application of full life-cycle analysis, to all energy generation technologies, in order to account for greenhouse gas emissions from every stage of energy generation.

Nuclear energy is already avoiding global carbon emissions and contributing to the attainment of voluntary reduction commitments. Therefore nuclear energy should be entitled to credits in the same manner as reduction technologies such as sinks or carbon sequestration. In the event that binding emission limits are established, avoidance actions eligible for emissions trading should include (but not be limited to):

- emissions avoided through plant upgrade or modernization that increases electricity output at existing nuclear plants over the 1990 baseline year;
- emissions avoided by refurbishment or regulatory action that extends the operating life of a nuclear plant beyond the current business-as-usual case;
  and
- emissions avoided through the addition of a new nuclear plant unit.

Implementation of emission restrictions should be flexible, without limits on the nature and scope of acceptable projects, so as not to interfere with an individual country's development and energy choices. Maintaining and expanding nuclear energy generation can avoid emission increases which result from developed and developing country industrial growth. Nuclear energy projects meet the test of sustainable development as defined in Clause 12 of the Kyoto Protocol because they are real, quantifiable, verifiable, and additional. Therefore, the development of nuclear energy, as Joint Implementation or Clean Development Mechanism projects, should receive credit for early action.

Strategies and measures to avoid man-made emissions of greenhouse gases must strive for efficient use of all energy sources, including electricity. In addition, strategies and measures should encourage fuel switching and take advantage of available low emitting primary energy sources, as provided by nuclear generation.

The global nuclear energy industry, through its participation in this International Nuclear Forum, will continue to work with all UNFCCC Parties, observers, and the public to protect the environment and make sustained development possible.

Formal proposal for CNF

In May the National Research Council of Canada (NRC) and Atomic Energy of Canada Limited (AECL) jointly submitted a proposal to the Ministers of Industry (John Manley) and of Natural Resources Canada (Ralph Goodale) to build the Canadian Neutron Facility for Materials Research (CNF).

(Following is a slight paraphrase of the summary of the proposal.)

The CNF is intended to support next-generation neutron-based materials research and innovation in Canada for the 21st century.

The CNF will provide:

i) advanced materials research capability to meet the needs of Canadian universities and industry;
- needed to ensure Canadian competitiveness on many fronts in the global arena, and,

ii) an essential testing facility to advance the CANDU power reactor design.
- to ensure the Canadian nuclear industry (which injects $6 billion annual into the Canadian economy) remains competitive and that CANDU is available to Canada in the future, when the need for new, environmentally-sound electricity generation arises, as dictated by the Kyoto Protocol on Climate Change.

The proposal is brought forward with full regard for academic, research and industrial stakeholders.

Construction and operation of the CNF will substantially stimulate local and national economies. Ninety per cent (90%), about $350 million, of the CNF can be provided by Canadian firms.

All industrialized, and some newly industrialized countries, have access to neutron beams from research reactors. However, because of the growing international awareness of the critical importance of neutrons for advanced materials development, the global demand is now exceeding supply. Australia, China, Egypt, Germany, Holland, Japan and Thailand have identified the requirement for advanced materials research facilities in the 21st century and are already constructing, or planning to construct new research reactors.

All nuclear vendor countries have access to government-supported research reactors to augment their commercial programs.

Several generations of Canadian materials researchers will be trained at this facility, providing a continuous, strong knowledge-base in Canada.

A CNF Project, planned to begin in 1999, would have a projected reactor start-up in 2005. The total estimated cost for the reactor and program facilities is $388 million. The CNF reactor is estimated at $208 million; CANDU development facilities are estimated at $90 million, while the neutron beam facilities are $90 million.

Operating costs for the CNF are estimated at $14.2 million annually, about half those of the current NRU research reactor. Operating costs for the CANDU programs will be about $30 million annually. The operating costs for the CNF Neutron Beam Laboratory are projected to be $8 million annually when the operation is mature in 2006/07. Operating funds will be contributed by the CNF owner/operator, the CANDU Program, and by the Beam Laboratory operator, respectively.

AECL and NRC will produce a detailed CNF Decommissioning Plan for the AECB. From MAPLE 1 and MAPLE 2 planning experience, a CNF decommissioning provision with a present value estimated in the range of $60 - 80 million (1998 $) would cover future facility decommissioning including fuel disposal, and will be detailed in the formal licensing submission.

With a strategic investment in the CNF, the federal government can lay the foundation for a revitalized materials research infrastructure to support innovation, knowledge and productivity for Canada.

Officials at NRCan informed the CNS Bulletin that the proposal is being reviewed in terms of both its technical dimensions and its business case. Since many stakeholders will be consulted they suggest that it will be several months before a recommendation is made to Ministers.

New Appointment at NRCan

Natural Resources Canada has created a new position of Associate Assistant Deputy Minister for the Energy Sector and appointed Richard Cameron to the post.

In that role Mr. Cameron will focus on: nuclear, uranium, radioactive waste, electricity issues, and some oil and gas issues.

Before joining NRCan, he was with the Treasury Board. Previously he was in the Privy Council Office and spent a period in the Department of the Prime Minister of Australia under an executive interchange program.

Construction begins on Canadian Light Source

Site preparation work for the Canadian Light Source (CLS) synchrotron project at the University of Saskatchewan began in July. Tenders for the first construction work were issued on June 12, 1999. The first contract includes site stripping, relocation and installation of underground utility services, installation of a parking lot, fencing of the site, and demolition of a cooling tower.

A decision in the spring by the Canada Foundation for Innovation (CFI) to contribute $56.4 million towards the Canadian Light Source (CLS) synchrotron project at the University of Saskatchewan gave the green light to the $173.5 million national facility.

The CLS represents an unprecedented level of collaboration among governments, universities and industry in Canada. The project marks the first federal-provincial-civic partnership with a university to build a major research project in Canada. Eighteen universities, in addition to the U of S, have endorsed the project.

The CLS will be built around the existing Saskatchewan Accelerator Laboratory (SAL) on the U of S campus. The state-of-the-art facility is expected to begin operation in 2003.

The CLS will be owned and operated by the U of S for the various stakeholders. With an advisory board having representation from various funding partners, the management structure will emphasize the facility's unique national character and its focus on serving users. The National Research Council (NRC) will work with the U of S in managing the CLS as a national facility.

Total value of the CLS project is $173.5 million — a $140.9-million cash portion and $32.6 million in 'in-kind' contributions which includes the SAL and three University of Western Ontario beamlines (scientific work stations) which are to be moved from a facility in Madison, Wisconsin.

The Canada Foundation for Innovation, funded by the Government of Canada, is providing 40 per cent of the $140.9 million in capital costs; other federal departments are contributing another 20 per cent, or $28.3 million. The Government of Saskatchewan will contribute $25 million, the U of S $7.3 million, the City of Saskatoon $2.4 million, SaskPower Corp. $2 million and the Universities of Alberta and Western Ontario $300,000 each. As well, $19 million will flow from other provinces, universities and industry to build beamlines.

The Government of Canada is committed to providing a significant portion of the $13.9 million (or about 55 per cent) in annual operating costs (1998 dollars) through agencies such as the Natural Sciences and Engineering Research Council (NSERC), the NRC, and the Medical Research Council. Remaining operating costs will be covered by user fees, the U of S and other sources as required.

CLS - a third generation synchrotron

The Canadian Light Source is described as a "third generation synchrotron". Synchrotrons use a combination of magnetic fields and radio frequency to accelerate electrons to very high speeds and energies. Basically they comprise of: an electron gun such as in a cathode ray tube; a linear accelerator, a booster ring which uses magnetic fields to force the electrons to travel in a circle; a storage ring; bending magnets; and focussing magnets.

The first synchrotrons were built to study sub-atomic physics. The light produced, when the bending magnets deflect the electron beam, was an annoyance to those researchers because it meant the electron beam lost energy every time they went through a bending magnet. However the remarkable qualities of this light were soon recognized.

Synchrotron light proved so useful that new facilities were built specifically to produce it. These machines were called "second generation".

"Third generation" synchrotrons added insertion devices, called *wigglers* and *undulators,* to produce even more light. Undulators and wigglers bend the path of the charged particles many times over a short distance to produce a wider spectrum of extremely intense light.

Synchrotron light is used for research in a number of disciplines, from physics and geology to biology and chemistry but approximately 70 per cent of synchrotron light research world wide is devoted to materials science.

Radiation Safety Institute of Canada

Radiation Safety Institute of Canada is the new name for the organization formerly known as the Canadian Institute for Radiation Safety or CAIRS.

The announcement was made at the annual meting of the Canadian Radiation Protection Association (CRPA) in Saskatoon in May, 1999 by Fergal Nolan, the president of the Institute, who said that the name change is to help make the Institute more visible and more accessible.

The Institute, whose head office is in Toronto and laboratories in Saskatoon, provides a range of radiation safety services. It was the first radiation dosimetry service certified by the Atomic Energy Control Board and the only government certified radon progeny and dust dosimetry services in North America.

NB Committee proposes deregulation

The Select Committee on Energy of the New Brunswick Legislative Assembly released its report on the deregulation of the electricity sector in New Brunswick in May 1999.

The report recommends a managed transition to a new electricity market to provide the opportunity to fully evaluate the impact of any proposed changes. The transition would be composed of four major elements:

- The gradual introduction of wholesale competition into domestic electric generation markets and development of a wholesale power exchange;
- Incentives for improving economic efficiency in regulated transmission and distribution functions;
- Improved and consistent regulatory oversight, and
- Assurance that all citizens will continue to have access to safe, reliable, affordable and uniformly priced electricity supplies.

The Committee recommends immediate formation of a stakeholder group that will develop detailed recommendations and policies and monitor industry restructuring efforts elsewhere to ensure that New Brunswick continues on an appropriate restructuring path. Once the stakeholder group has developed detailed guidelines a five-year transition period would begin towards a competitive wholesale generation market in the province.

The committee recommends that NB Power undergo a structural separation into three distinct Crown Corporations: NB Generation, NB Transmission and NB Distribution. Each corporation will address the needs of different aspects of the electric market and each should be required to operate as efficiently as possible. NB Generation would continue to own all of NB Power's existing generating assets including the Point Lepreau Generating Station.

The Provincial Government has indicated that it will take the Committee's report under consideration as it examines future energy policy options.

The Committee's complete report can be accessed on the Web, at < http://www.gov.nb.ca/legis/reports/energ-99/index.htm >.

AECB presidents term extended

Dr. Agnes Bishop's term as President and chief executive officer of the Atomic Energy Control Board has been extended until December 31, 2000.

Dr. Bishop was first appointed a member of the AECB in April 1989, and named President, for a five-year term, on September 1, 1994.

Before her appointment as President of the AECB, Dr. Bishop was Professor and Head of the Department of Paediatrics, Faculty of Medicine at the University of Manitoba, and Head of the Department of Paediatrics and Child Health at the Children's Hospital of Winnipeg, Health Sciences Centre.

During her tenure as AECB President, Dr. Bishop has overseen an extensive review of AECB's internal management practices. She was very much involved in the efforts to have the Nuclear Safety and Control Act passed in 1997 and has been guiding the AECB through the development of regulations for the new Act. She has also been active in support of Canada's international efforts related to non-proliferation and nuclear safety. It is expected that the Nuclear Safety and Control Act will be put into effect later this year.

COG "prospectus"

As noted in the last issue of the CNS Bulletin, the CANDU Owners Group (COG) has now been registered as a not-for-profit corporation under federal law and has moved to its own offices at 480 University Avenue in Toronto. (The unincorporated COG operated out of space in the former Ontario Hydro offices.)

Now COG Ltd. has issued a glossy brochure outlining the benefits of membership. The brochure presents the officers of the new company and describes the several program it conducts.

The managing group are:

- President — John Sommerville
- Treasurer — Rod McIvor
- Program Manager, Station Support — Henry Chan
- Program Manager, R & D — Glen Wolgemuth (Safety & Licensing; Chemistry, materials & components)
- Program Manager, R & D — Malcolm Harvie (Fuel channels; Health and Safety)

The programs described (which appear similar to those run by the previous COG organization) include:

- Information exchange
- Inter-station assistance
- Inventory management
- Joint projects
- Research and Development
- Safety and licensing
- Health and Safety
- Fuel Channels
- Chemistry, materials and components.

Further information can be obtained from any of the above at: tel. 416-595-1888; fax 416-595-1022; e-mail: < cog@candu.org >

Bruce dry storage passes environmental review

The federal Minister of the Environment, Christine Stewart, has informed the Atomic Energy Control Board that the proposed Bruce Nuclear Power Development Used Fuel Dry Storage Project has been determined as not likely to cause significant adverse environmental effects. The project has, therefore, been referred the back to the AECB for appropriate action.

AECB staff will now proceed with a licensing review of the proposal and recommendations on licensing will be made to the Board following this review which is anticipated to be completed by the fall of 1999.

Ontario Hydro proposed the construction and operation of a dry storage facility for used nuclear fuel produced at the Bruce A and Bruce B Nuclear Generating Stations. As required under the Canadian Environmental Assessment Act, the AECB, as the federal authority for the project, ensured that an environmental assessment was conducted for the project, and that a Comprehensive Study Report was prepared and submitted to the Canadian Environmental Assessment Agency. The report was made available for public comment.

The mitigation and follow-up programs identified in the report would be implemented through the AECB's licencing process.

A copy of the comprehensive report may be obtained by contacting:

Bernard Richard, Atomic Energy Control Board

Telephone: (613) 996-9997 or 1-800-668-5284,

Fax: (613) 995-5086

E-mail: richard.b@atomcon.gc.ca

2nd International Symposium on Ionizing Radiation

The *2nd International Symposium on Ionizing Radiation* was held in Ottawa, May 10 - 14, 1999. It was sponsored by the Atomic Energy Control Board , The Supervising Scientists Group of Australia and the Swedish Radiation Protection Institute as a follow-up to the first such symposium in Stockholm, Sweden in 1996.

As suggested by the sub-title of the Symposium, *"Environmental Protection Approaches for Nuclear Facilities"*, the emphasis was on the environmental effects of releases from nuclear facilities.

The 4-day symposium had three main themes, with each of the first three days being devoted to one of them:

- regulation and risk management
- involving the public
- multiple stressors

On the fourth day the 100 or so delegates gathered in three workshops on the each of the main themes. On the last morning there were reports back from each of the workshops followed by a closing address by AECB president Dr. Agnes Bishop.

In his opening address to the Symposium, John Waddington, director general, Environmental and Human Performance, at the AECB, set the philosophy of the meeting by stating, "It is no longer acceptable to assume that if humans are protected so will other species". Protecting the environment, he said, is an end in itself. And, he added, we must look at the combined or synergistic effects of all types of contaminants, not just radiation.

In closing the Symposium, Dr. Bishop echoed these points and noted that the soon to be implemented Nuclear Safety and Control Act specifically includes "environment" in its regulatory ambit. She commented that the AECB is developing a regulatory framework for protecting the environment for when the new Act is put into force later this year and the AECB is transformed into the Canadian Nuclear Safety Commission.

For more information on the symposium contact the principal organizer, Dr. Patsy Thompson, at the AECB; tel. 613-947-3352; e-mail: < thompson.p@atomcon.gc.ca >

AECB renews McMaster reactor licence

At its June 17, 1999 meeting the Atomic Energy Control Board approved the renewal of the Operating Licence for McMaster University research reactor, in Hamilton, Ontario, for a three-year period.

Cogema mill and tailings

At the same meeting the Board approved an amendment for Cogema Resources Incorporated's mining facility Operating Licence for the McClean Lake Project, in northern Saskatchewan. This amendment will authorize the operation of the JEB mill and the JEB Tailings Management Facility and allow the McClean Lake Project to begin producing yellowcake from currently stockpiled ore. A document explaining the reasons for the decision is available on the AECB Web site (accessible through the CNS Web page < www.cns-snc.ca >).

Medical Accelerators

The Board also approved, for a four-period, the issuance of a particle accelerator Operating Licence for the "Centre hospitalier régional de Trois-Rivières" and the construction of two particle accelerators by Cancer Care Ontario at the Toronto-Sunnybrook Regional Cancer Centre.

IAEA holds PSA workshop in Canada

The International Atomic Energy Agency in cooperation with Atomic Energy of Canada Limited held a Workshop on "Probabilistic *Safety Assessment for Pressurized Heavy Water Reactors"* in Toronto from May 3-6, 1999

The Workshop had two main objectives.

The first objective was to compile and review the experience gained from performing PSAs for PHWRs. In particular it was planned to determine the availability of PHWR-specific component failure data and initiating event frequencies, to compare results of accident sequence analyses, and to discuss modelling aspects specific to PHWRs, such as definition of core damage states. Based on the results of the technical analysis, the second objective of the Workshop was to prepare, driven by the needs of the PHWR user community, a step by step programme of co-operation, which might include the exchange of PHWR specific data bases, and deterministic studies supporting accident sequence modelling information, on practices in Level 1 to 3 PSAs (including treatment of external events), and information on severe accident analyses.

The format was a plenary session for the first day. The invited speaker led off with a history of probabilistic techniques as applied to PHWRs. Then PHWR owners, designers and regulators presented the status of PSA in their respective countries.

During the following two days, two Working Groups discussed issues in more depth. Group #1 covered Databases and Data Analysis; and Group #2 covered Accident Sequence Analysis Methodologies.

The final plenary session discussed and revised the recommendations from the Working Groups and prepared a consolidated list of proposed activities.

It was concluded that the exchange of information and development of common methodologies and assumptions would be helped if there were a "reference PHWR PSA" made available. This could be used as a basis for comparison of data, assumptions, initiating events, methodologies, etc.

AECL offered to make available, within the next 2 years, the generic CANDU 6 PSA for participant peer review and as a basis for comparisons.

A further workshop will be convened in about two years to review the results of the tasks described above. AECL's Victor Snell will co-ordinate.this with the IAEA.

First Safety Convention Review Meeting

With participation of 45 of the 50 parties to the Convention on Nuclear Safety, the first review meeting was held at the headquarters of the International Atomic Energy Agency in Vienna, in April 1999.

The Convention calls for "peer review" meetings to be held every three years. Each of the parties prepared a comprehensive report on their nuclear safety organizations and practice. At the review meeting each national report was reviewed and discussed in depth.

In a concluding summary report the contracting parties involved stated that the review process had demonstrated strong commitment to the safety objectives of the Convention.

The full summary report is available on the IAEA's Website: www.iaea.org.

CNS news

Annual General Meeting

The 1999 Annual General Meeting of the Canadian Nuclear Society was held in Montreal, May 31, during the 20th Annual Conference of the Society. This was the second AGM of the Society since incorporation.

Over 50 members were present, including six Branch chairmen, making it one of the best attended AGMs in the history of the Society.

The meeting followed the standard format: minutes of the 1998 meeting, reports from the (outgoing) president, treasurer, and committee chairpersons. The report from 1998 - 1999 president, Paul Thompson, was prepared early and enclosed with the last issue of the *CNS Bulletin.* Andrew Lee's treasurer's report along with the auditors report and audited financial statements are reprinted elsewhere in this issue.

On a motion by the treasurer, a new auditor was appointed for the period 1999 2000, David W. Rogers.

In his report for the Program Committee, chairman Krish Krishnan reminded members of the many successful events held by the Society over the previous twelve months.

- Teachers' course on the Science of Nuclear Energy and Radiation
- CANDU Reactor Lattice Physics course
- CANDU Reactor Safety course
- CNS Annual Conference (held in fall 1998, for the first time independent of the CNA)
- CNA/CNS Winter Seminar
- 24th CNA/CNS Student Conference
- 20th CNS Annual Conference (in conjunction with the 39th Annual conference of the CNA)

He noted that there appeared to be a growing demand for specialized courses which, with its broad base of members, the Society was in a good position to present.

In the coming 1999 - 2000 season three courses and a specialists workshop are planned along with a number of symposia.

- Teachers' course on the Science of Nuclear Energy and Radiation
- Quality Assurance course
- CANDU Shutdown Systems course
- Specialists meeting and workshop on Hard Facing Alloys in Water Reactor Environments
- 6th International CANDU Fuel Conference
- Climate Change and Energy Ooptions Symposium
- CNA/CNS Student conference
- CNS Annual Conference

Election of new Council

Ben Rouben, chair of the Nominating Committee, referred to the proposed slate of candidates for the CNS Council which had been distributed with the notice of meeting (and printed in the last issue of the *CNS Bulletin*). Unfortunately, one candidate died (Peter Laughton). On a call from the chair, Victor Snell was nominated. There being no further nominations the slate was declared elected by acclamation. *(See below)*

CNS - SNC Executive and Council for 1999 - 2000

Executive:

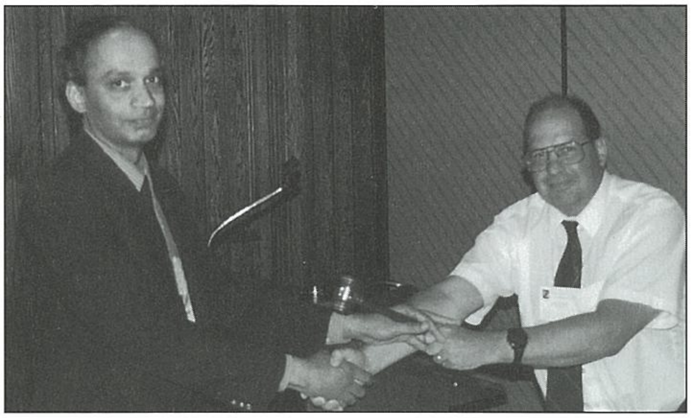
President	V.S. Krishnan (Krish) AECL
1st Vice-President	K.L. Smith (Ken) UNECAN
2nd Vice-President	D. Jackson (Dave) McMaster University
Treasurer	S.Y. Lee (Andrew) Ontario Power Generation
Secretary	J.E. Wilson (Ian) Retired.
Past President	P.D. Thompson (Paul) New Brunswick Power

Members-at Large

P. Gulshani (Parviz)	AECL
G. Harvel (Glenn)	AECL
D.A. Jenkins (Dave)	AECL
K. Mohan (Kris)	AECL
A. Pant (Aniket)	Zircatec Precision Industries
J. Popovic (Jad)	AECL
E. Price (Ed)	AECL
M. Rhéaume (Michel)	Hydro-Québec
B. Rouben (Ben)	AECL
A.W.L. Segel (Duke)	Retired
V. Snell (Victor)	AECL
J. Tamm (Judy)	AECL

At this point, outgoing president Paul Thompson handed the "CNS gavel" to incoming president Krish Krishnan. In turn Dr. Krishnan presented a plaque to Paul Thompson in recognition of this considerable efforts on behalf of the Society despite his injuries from a very serious car accident December 1998. The new president gave a short presentation on his view of the coming year for the CNS. *(See elsewhere in this section of the Bulletin.)*

The only "other business" was a complaint by a member about the high fee for the Annual Conference which, he said, prevented many members, especially from academia, from attending. The new president promised to explore this issue. *(Ed. Note: The fees for the joint CNA/CNS annual conferences have always been set by the CNA who were the primary organizers. It likely that the CNS will be holding a separate conference in the year 2000.)*



Retiring CNS president Paul Thompson (R) hands the "CNS gavel" to 1999-2000 president Krish Kirshnan at the CNS Annual General Meeting in Montreal, May 31, 1999.

Incoming President's Message

I feel deeply honoured and privileged to be elected to serve your Society as its President and to take it into the next millennium. I assure you I'll do my best, with your support, to carry out my duties in the excellent tradition set by my predecessors.

Let me take a few minutes to talk about some of the challenges that face us.

The objective of our Society is to promote nuclear science and technology. We live in an era where communication is most important. The theme of this [1999] Annual Conference, *"Communicating the Nuclear Advantage"*, is a recognition of this aspect. As you know, it does not matter what we think and how feel about nuclear science and technology. The general public must feel about it the same way we do. The various Divisions, Branches and Committees established within the CNS are designed to achieve this objective of communicating nuclear science and technology to the Canadian public. We must therefore continue to work more closely with the general public, schools, universities, media and other institutions. In this regard, although we are now an independent organization, we will need the continued cooperation, support and encouragement of the Canadian Nuclear Association.

Secondly, we need to strengthen and expand our membership base. All of us associated with the nuclear industry have a stake in its future. Therefore, ideally, every one of us working in the nuclear industry should belong to the CNS. I would ask that you encourage your colleagues to join the Society. Another important point I would like to make is that the International Nuclear Societies Council recently acknowledged that the future of the nuclear industry belongs to the younger generation. We therefore need a greater representation of the younger generation in our Society. We need to work with them, listen to their views and ideas, and let them take a more active role in running the Society. The recent trend in increased recruiting of new graduates by the nuclear industry is a good sign. Let us encourage new entrants to the industry including the younger generation to join the CNS.

Thirdly, please get involved in organizing conferences, courses, seminars, or any other forum that you can think of to promote nuclear science and technology. You have just heard annual reports from the many CNS Divisions, Branches and Committees. I would encourage you to get involved in one or more of their activities that cater to your particular interests. These events are a major source of revenue for the CNS and the Council will help you in organizing them. Also please let the Council know of any other ideas that you may have.

Note the following important events over the next few months.

- 6th International Fuel Conference, September 26-28, Niagara Falls
- Climate Change and Energy Options Symposium, November 17-19, Ottawa.
- Specialists Meeting and Workshop on Hard Facing Alloys in Water Reactor Environments, October 4-6, Quebec City

The events calendar on the CNS website lists all other events of interest and is updated regularly.

Finally, as you are aware, the CNS is a volunteer organization. Volunteering takes a lot of personal time. I therefore appreciate your time in promoting the CNS cause. I also want to thank your various employer organizations for their support to you. I am counting on their continued support of the CNS.

In closing, I request you to continue to give strong support to the CNS. Remember this is "your" Society. I and the incoming Council eagerly look forward to working for and with you. As a team I am confident we will overcome the challenges that face us and will achieve the objectives of our Society.

V.S. (Krish) Krishnan

Meet the new CNS president

Krish Krishnan

The president of the Canadian Nuclear Society for this last year of the millennium is an analyst turned manager with Atomic Energy of Canada Limited's Sheridan Park office, Dr. V.S. (Krish) Krishnan

Krish, as he is known to all of of his colleagues, was born in India where he received his undergraduate degree in Chemical Engineering at the University of Madras in 1969. He pursued graduate studies in Chemical Engineering at the University of Rochester, New York, where he obtained his Master's and PhD degrees in 1971 and 1973 respectively. After working for 5 years in the chemical processing industry, most of them with Imperial Chemical Industries in India, he returned to Rochester for post-doctoral research work in Chemical Engineering. In 1979 he moved to Canada to take up a senior post-doctoral fellowship in the Department of Engineering Physics, McMaster University.

In 1980 Krish joined the Thermalhydraulics Research Branch at AECL's (Whiteshell Laboratories. He was made the Manager of the branch in 1988. In 1990 he was transferred to AECL's Sheridan Park office where, until recently, he was the Manager of the Safety & Licensing Technical Resources functional branch. Presently Krish is the AECL Account Manager for OPG General Services.

Krish has authored or co-authored over 50 technical reports and publications. He has represented AECL at many national and international conferences and other events. While at the Whiteshell Laboratories he was an Adjunct Professor in the Department of Mechanical engineering at the University of Manitoba. For the past 10 years he has been an Adjunct Professor in the Department of Engineering Physics, McMaster University where, with other faculty members, he does joint teaching and supervising student research on nuclear related topics.

Krish has been an active member of the Canadian Nuclear Society since 1985 and has served on the Council in various capacities, most recently as 2nd , then 1st vice-presdient before assuming his present postion as President.

Krish and his wife Veni live in Mississauga. Their daughter and son will soon be starting their law and engineering studies at the Universities of Victoria and Pennsylvania, respectively.

CNS joins PAGSE

At its last meeting, May 30, the 1998-99 CNS Council decided to join the Partnership Group for Science and Engineering (PAGSE) on a one-year trial basis.

PAGSE is a cooperative association of more than 20 national organizations in science and engineering. It was formed in 1995 at the invitation of the Academy of Science of the Royal Society of Canada to foster common interests and address issues concerning research and the applications of science in Canada. Through its many member organizations, PAGSE is able to hold events and undertake studies that can be used to communicate with and influence governments, non-government organizations and the public.

CNS Council concluded that it would be beneficial to join Canada's other learned societies in PAGSE. This could ensure the recognition of nuclear science as an essential part of the national research and development activity.

The cost to the CNS is $1,000 per year.

1998-99 CNS president Paul Thompson is seen at the 1999 CNA/CNS Annual Conference in Montreal still bearing the injuries from his severe accident in December 1998.

BRANCH ACTIVITIES

Like many organizations in Canada, almost all of the local Branches of the Canadian Nuclear Society suspend their activities for the summer months. Consequently, there are few reports.

Ottawa Branch

The small executive of the Ottawa Branch gathered in mid-July, primarily to say farewell to **Sadok Guellouz,** who has been chairman for the past two years. Sadok has been lured away by AECL and is moving to Sheridan Park at the beginning of September. The new chairman of the Branch will be **Bob Dixon,** who can be reached at: tel. 613-834-1149 E-mail:< dixonrs@ftn.net >

Quebec Branch

The Quebec Branch has a new chairman: **Guy Marleau.** Dr. Marleau is a professor at École Polytechnique in Montreal. He can be reached at: tel. 514-340-4202, e-mail: < marleau@meca.polymtl.ca >.

Saskatchewan Branch

The Saskatchewan Branch also has a new chairman; **Ralph Cheesman.** Dr. Cheesman is an Adjunct Professor at the University of Regina, Regina. His address is 4705 Pasqua Street, Regina, SK S4S 6N7. Tel 306-586-6485 Fax 306-522-1393. He can be contacted by e-mail at: < keewatin@sk.sympatico.ca >.

Longtime chairman, Walter Keyes, will remain as an active supporter of the Branch. As one of his last reports as Branch chairman, Walter sent us the following story.

In the spring, the Saskatchewan Branch of the CNS sponsored a high school essay contest titled *"The Nuclear Advantage".* Prizes of $350 were awarded to each winning school while each winning student got $150 and a nice wrist watch. The prizes were provided by Natural Resources Canada, AECL, Northern Resources Transport and JNR Resources Inc. Support for the project was also provided by Cameco Corporation, The University of Saskatchewan, Thyssen Mining Construction, PNC Limited and Cogema Resources Inc who assisted with the cost of printing and distribution of over 16,000 copies of the Saskatchewan Edition of the Nuclear Advantage pamphlet to 490 Saskatchewan schools.

The contest received many good essays, and Ralph Cheesman, who headed the Awards Panel, reported that the Panel ended up awarding two first prizes in two instances. Winners were:

Raelyne Linton – Best Overall, *The Slowpoke Nuclear Reactor at the University of Saskatchewan,* Pangman School, Frank Fitzpatrick, Teacher

Sarah Von Tettenborn and Erica Stockdale, *Nuclear Technology in Medical Diagnostics and Treatment,* St. Angela's Academy and Churchill High School, Sister Gertrude Sopracolle and Mr. Ken Gray, Teacher

Travis Uteck, *Contributions of Saskatchewan Uranium Mining,* Glentworth Central School, Crystal Kornfeld, Teacher

Jeremy Basset and Rochelle La Brash, *The Role of Nuclear Power in Reducing Global Warming,* Bruno Central School, Gail Huber, Teacher

The following letter from one of the winners, Sarah von Tettenborn, confirms that the prizes are going to good use.

> *"Thank you for choosing my essay on Nuclear Magnetic Resonance as one of the winners in your essay contest. I apologize for the tardiness of my appreciation. Unfortunately, circumstances prevented me from writing sooner. I thought you may wish to know what the money will be used for. The money St. Angela's Academy received will be used to expand their physics department and the money I won will be put to use in my post-secondary education.*
> *Thank you."*

Sheridan Park Branch

The active Sheridan Park Branch held two meetings in May to close out the season.

On May 11, Dr. Jim Ballinger provided an interesting insight into the role of nuclear science in the health field with a talk on *Diagnostic Use of Radiotracers in Nuclear Medicine.*

On May 26, Dr. R. A. Holt, from AECL Sheridan Park, spoke on *The Technology of CANDU Pressure Tubes.*

The Branch also arranged for two classes of high school students to visit the Pickering nuclear generating station on May 28.

Earlier, the Branch participated in the Peel Region Science Fair and the Hamilton District Science Engineering Fair by offering prizes and acting as judges for both the CNS prizes and one by AECL.

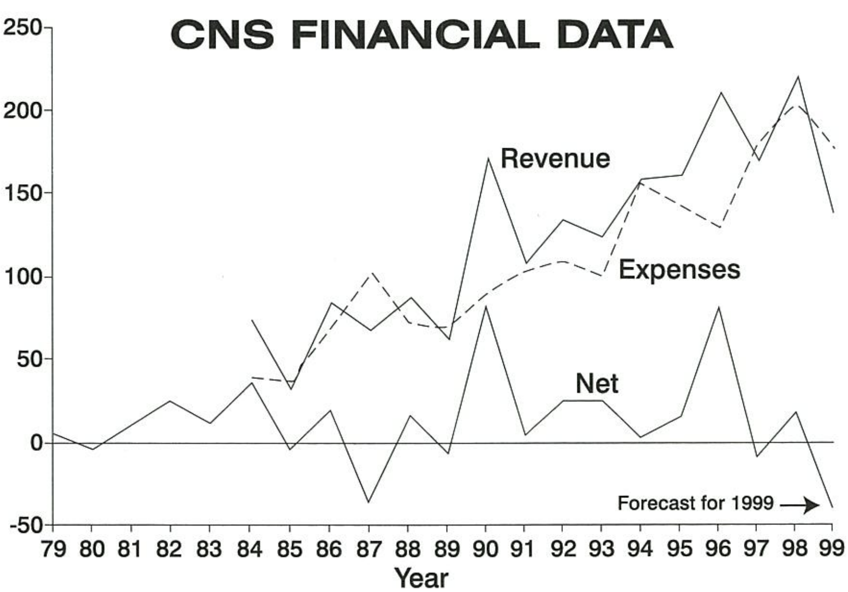
Treasurer's Report
to the 1998 Annual General Meeting

The Auditor's Report for the Canadian Nuclear Society for the year ending at December 31, 1998 is attached to this letter. This audit was done by Grant Thornton, Chartered Accountant, in accordance with generally accepted auditing standards. The Auditors concluded that the financial statements present fairly the position of the Society as at December 31, 1998.

From a financial perspective, 1998 was a successful year for the Society. The greater than expected revenue from the Pacific Basin Nuclear Conference, and the financial success of the 1998 Annual Conference, the Steam Generator and Heat Exchanger Conference, and the Lattice Physics Course led to a total revenue which was higher than in 1997. Annual expenses were also higher, but not to the same extent. This yielded an excess of revenue over expenses at the year-end. The revenue and expense data are shown on Page 2 of the Auditor's Report, and the subsidiary detail is provided on Page 10.

As a result of new Auditing requirements, and because of the incorporation of the Society in June 1998, the detail provided on Page 3 is much greater than on the equivalent page in the 1997 report. See Note 2 on Page 6.

The Balance Sheet is shown in Page 4. The Society's Assets include Cash, Receivables, Securities and the Education Fund. Because of the incorporation of the CNS, the full value of the Education is now shown as an asset of the Society. The portion of the Education Fund, the portion of which was contributed by the Canadian Nuclear Association, is shown as a liability. See Note 7 on Page 8. The other Liabilities include Payables, and membership fees received for the year 2000. The signatures of the President and Treasurer are shown on Page 4.



Page 5 shows the "Changes" of Cash Flows by the Society made in the year of 1998. The entries must be read in references to Pages 3 and 4. For Example, the "Cash, beginning of year", $277,488, is taken from the 1997 column. The "Cash, end of year", $241,049, is the sum of $230,542 (Bank Accounts), $1,793 (Nuclear Operation Division Account) and $9,614 (Branch Bank Balances) on Page 4.

Note 6 on Page 7 provides detailed information on the revenue and expense for each of the CNS sponsored Conferences.

Graphs showing the trend of CNS financial status are attached on the back of this letter.

This concludes the 1998 Treasurer's Report.

Andrew Lee, Ph.D., P.Eng.
Treasurer

Auditor's Report

To the Members of the Canadian Nuclear Society

We have audited the balance sheet of the Canadian Nuclear Society as at December 31, 1998 and the statements of revenue and expenses, changes in net assets and cash flows for the year then ended. These financial statements are the responsibility of the Society's Council. Our responsibility is to express an opinion on these financial statements based on our audit.

We conducted our audit in accordance with generally accepted auditing standards. Those standards require that we plan and perform an audit to obtain reasonable assurance whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation.

In our opinion, these financial statements present fairly, in all material respects, the financial position of the Society as at December 31, 1998 and the results of its operations and changes in its net assets and its cash flows for the year then ended in accordance with generally accepted accounting principles.

Grant Thornton, Chartered Accountants
Toronto, Canada, March 4, 1999

Canadian Nuclear Society

Statement of Revenue and Expenses

Year Ended December 31		1998		1997
Revenue				
Membership fees	$	**37,475**	$	38,645
Publications		**8,228**		7,181
Interest		**15,777**		7,088
Advertising		**2,800**		-
Trust fund contributions		**2,396**		-
		66,675		52,914
Society projects - excess of revenue over expenses				
Annual Conference (Note 6)		**21,506**		7,629
Adjustments from prior Conferences/Courses		**4,285**		2,206
1996 International Conference on Simulation Methods		-		2,593
1996 Geological Disposal Conference		-		904
1996 Symposium on Radiation Impacts		-		1,135
1997 Simulation Symposium		-		8,342
1997 CANDU Maintenance Conference		**(263)**		65,858
1997 CANDU Fuel Conference		**(269)**		14,953
1997 Reactor Safety Course		-		13,838
1998 Laftice Physics (Note 6)		**6,755**		-
1998 Steam Generator and Heat Exchanger Conference (Note 6)		**25,669**		
Pacific Basin Nuclear Conference (Note 6)		**96,482**		-
		154,165		117,458
Total revenue		**220,840**		170,372
Operating expenses				
Net expenditures by branches		**16,513**		10,013
Committees		**22,569**		17,946
Office support		**70,000**		60,000
Office services		**17,350**		17,580
Canadian Nuclear Society Bulletin		**36,869**		32,070
Other items		**26,123**		17,385
Total operating expenses		**189,424**		154,994
Excess of revenue over operating expenses		**31,416**		15,378
Expenditures from Special Projects Fund (Note 8)		**14,501**		24,382
Excess (deficiency) of revenue over expe[illegible]	$	**16,915**		(9,004)

Balance Sheet

December 31		1998		1997
Assets				
Current				
Cash				
Bank accounts	$	**230,642**	$	259,179
Memorial Trust Fund		**1,615**		
Nuclear Operations Division		**1,793**		1,793
Branch bank balances		**9,614**		16,476
Receivables		**49,197**		15,775
GST receivable		**3,187**		-
Accrued interest		-		500
Prepaids		**4,940**		-
Conference advances				24,803
Due from Canadian Nuclear Association		-		4,715
		300,888		323,241
Marketable securities (market value - $68,257; 1997 - $54,111)		**65,071**		53,427
Equipment (Note 5)		**1,931**		1,666
		367,890		378,334
CNS share of Education Fund assets (Note 7)		-		17,000
Education Fund assets (Note 7)		**60,393**		-
	$	**418,283**	$	395,334
Liabilities				
Current				
Payables and accruals	$	**22,848**	$	66,391
GST payable		-		3,526
Subsequent years membership fees received in advance		**18,884**		13,826
Due to Canadian Nuclear Association		**14,260**		-
Due to Education Fund		**28,000**		-
		83,992		83,743
Net assets				
Invested in capital assets		**1,931**		1,666
Internally Restricted				
Education Fund (Note 7)		**22,393**		17,000
Special Projects Fund (Note 8)		**18,117**		25,618
Memorial Trust Fund (Note 9)		**1,615**		-
Unrestricted		**290,235**		267,307
		334,291		311,591
	$	**418,283**	$	395,334

Notes to the Financial Statements

December 31, 1998

1. Nature of operations

The Canadian Nuclear Society ("CNS" or "the Society") was incorporated in June 1998 and is a not-for-profit, voluntary group comprised of individuals with an interest in nuclear science and technology. CNS operates through a number of branches whose activity is incorporated in these financial statements. Prior to June 1998, CNS operated as a division of the Canadian Nuclear Association ("CNA"). At incorporation, CNS assumed all assets and liabilities of the former CNA division and CNS's financial statements reflect a full year of operations with comparative figures.

The objectives of the CNS are:

- to act as a forum for the exchange of information relating to nuclear science and technology;

- to foster the development and beneficial utilization of nuclear science and technology for peaceful uses;
- to encourage education in, and knowledge about, nuclear science and technology; and
- to enhance the professional and technical capabilities of those involved in nuclear science and technology in the Canadian context.

2. Basis of presentation

The financial statements have been prepared and restated where necessary, in a manner which segregates net assets balances in accordance with the new CICA not-for-profit reporting requirements.

3. Summary of significant accounting policies

Revenue recognition

Membership fees are included in income in the fiscal year to which they relate. Interest and other income are recorded on the accrual basis. Mutual fund gains reinvested in additional units are recorded as income in the year the gains are declared and reinvested.

Marketable securities

Marketable securities are carried at cost adjusted for amortization of premiums or discounts.

Equipment

Computer equipment is recorded at cost and depreciated over its estimated useful life on a 30% declining balance basis.

Use of estimates

In preparing financial statements, management is required to make estimates and assumptions that affect the reported amounts of assets and liabilities, the disclosure of contingent assets and liabilities at the date of the financial statements and reported amounts of revenue and expenses during the period. Actual results could differ from these estimates.

4. Financial instruments

For cash and short term investments, accounts receivables, investments and accounts payable and accrued liabilities, the carrying amount of these financial instruments approximates their par value.

5. Equipment

	Cost	Accumulated Depreciation	**1998 Net Book Value**	1997 Net Book Value
Computer equipment	$ 2,860	$ 929	**$ 1,931**	$ 1,666

6. Conference gross revenue and expenses

	PBNC Conf.	Lattice Physics	Steam Generator and Heat Exchanger	Annual Conf.	Total
Gross revenues	$ 872,709	$ 17,610	$ 82,938	$ 84,716	$ 1,057,973
Expenses	679,745	10,855	57,269	63,210	811,079
Amount allocated to CNA	96,482	-	-	-	96,482
	776,227	10,855	57,269	63,210	907,561
Net revenue	**$ 96,482**	**$ 6,755**	**$ 25,669**	**$ 21,506**	**$ 150,412**

7. Education Fund

From 1988 to 1991, annual contributions amounting to $3,000 from CNS and $7,000 from CNA were allocated from income from the annual conference. In 1995, CNS made an additional contribution of $5,000. The principal remains the property of the CNA and CNS. The interest on these funds is available for education purposes to local branches of CNS. In 1998, principal responsibility for this fund is reported by CNS as CNS monitors the day-to-day activity of the fund.

	1998	1997
The total fund is composed as follows:		
Principal contributions		
Canadian Nuclear Association	**$ 28,000**	$ 28,000
Canadian Nuclear Society	**17,000**	17,000
	45,000	45,000
Accumulated interest available for education activities, beginning of year	**5,785**	7,540
Fund assets as of beginning of year	**50,786**	52,540
Interest earned during the year	**2,614**	2,995
Allocations during the year	**(3,006)**	(4,750)
Fund assets as of end of year	**$ 50,393**	$ 50,785

8. Special Projects Fund

During 1997, the Society internally designated $50,000 from its unrestricted surplus for a Special Projects Fund which is to be used for non-budgeted and unforeseen projects. During 1998, Council approved an additional transfer of $7,000 from its unrestricted surplus, as well as expenditures of $14,501 from the Fund.

Fund balance, beginning of year		$ 25,618
Transfer from unrestricted surplus in the year		7,000
Expenditures during the year:		
Support for CDN book on Nuclear energy	$ 3,501	
University of Ottawa, Centre for Low Level Research	10,000	
Russian Nuclear Society Youth Forum	1,000	(14,501)
Fund balance, end of year		$ 18,117

9. Eric Carruthers Memorial Trust Fund

During the year, the Sheridan Park Branch of CNS created a Trust in the memory of a past member. Contributions received are to be distributed as awards to students showing an interest in science.

10. Commitment

CNS has entered into an agreement with the Canadian Nuclear Association in which the Association will provide CNS with office space and administrative support. The minimum support costs for the one year term of the agreement is $75,000.

11. Uncertainty due to the Year 2000 Issue

The Year 2000 Issue arises because many computerized systems use two digits rather than four to identify a year. Date-sensitive systems may recognize the year 2000 as 1900 or some other date, resulting in errors when information using year 2000 dates is processed. In addition, similar problems may arise in some systems which use certain dates in 1999 to represent something other than a date. The effects of the Year 2000 Issue may be. experienced before, on, or after January 1, 2000, and, if not addressed, the impact on operations and financial reporting may range from minor errors to significant systems failure which could affect any entity's ability to conduct normal business operations. It is not possible to be certain that all aspects of the Year 2000 Issue affecting the Society, including those related to the efforts of members, suppliers, or other third parties, will be fully resolved.

Ed. Note: *Statement of Changes in Net Assets; Statement of Cash Flows; and Schedule of Expenses have not been reprinted.*

Upcoming CNS meetings

The Canadian Nuclear society is holding two important meetings in the fall of 1999; the *6th International Conference on CANDU Fuel;* and the *Symposium on Climate Change and Energy Options.*

6th International Conference on CANDU Fuel

The *6th International Conference on CANDU Fuel* will be held September 26 - 28, 1999 at the Sheridan Fallsview Hotel & Conference Center at Niagara Falls, Ontario.

This conference will bring together designers, engineers, manufacturers, researchers and modellers to share their knowledge and experience. The program will include sessions covering topics related to: international experience and programs, fuel performance, fuel safety, design and development of fuel, advanced fuel cycles, fuel model development, manufacturing and quality assurance, fuel management, spent fuel management, fuel for small reactors, history of CANDU fuel, and CANFLEX® fuel bundle development.

Over 70 papers will be presented from Argentina, Canada, Egypt, France, India, Korea, Romania, Turkey, and UK. . The support of IAEA to sponsor a limited number of participants from IAEA countries has also been arranged.

Sponsorship is being provided by: Zircatec Precision Industries Inc., General Electric Canada - Nuclear Products, STERN Laboratories Inc. and AECL.

Symposium on Climate Change and Energy Options

This Symposium is an innovation for the Society in that it will deal with all energy options, not just nuclear, to meet the challenge of climate change arising from the emission of "greenhouse gases".

The Symposium is designed to provide policymakers with information on energy systems which will assist their assessment of Canada's options to meet commitments to the Kyoto protocol and beyond.

The following three main themes will be explored.

Climate Change and Energy

The implications to Canada of the Kyoto Protocol and the process initiated by Canada's Climate Change Secretariat to establish options to meet Canada's commitments will be established. Canadian and world energy needs will be discussed in the context of gradually depleting fossil fuel supplies. This discussion will set the stage for subsequent technical sessions.

Reducing Greenhouse Gas Emissions

This, the main part of the Symposium, addresses the exploration of greenhouse-gas-free energy technologies to meet climate change constraints.

The availability and application of nuclear and renewable primary energy sources to various sectors of the Canadian economy will be considered.

Supporting technologies that will play a role in expanding the application of these primary energy sources will also be identified and addressed. Applications such as electricity generation, heating, desalination, production of hydrogen for transportation, extraction of oil from tar sands, food processing, industrial process heat, etc. will be included.

Enhancing The Dividend

This closing session will focus on the track record of Canadian non-fossil energy systems deployed in Canada and elsewhere. Their contribution to primary energy production in Canada and abroad will be established. Continuing actions to build on this experience and to encourage and enhance financial and environmental dividends will be described.

Additional information on both of these meetings can also be obtained at the CNS web site at: < http://www.cns-snc.ca >

New Members

We welcome the following members of the Canadian Nuclear Society who have joined since April 1999.

Amad Abdul-Razaak	Perry Lee
Marie-Josee Basque	Rene Pageau
Gordon Brooks	Michel Rhéaume
Stephen Bushby	Marc Robillard
Christopher Clment	Yang Qiang Ruan
Simon E. Day	Mehdi Sarram
Peter De Buda	Douglas Semple
Said El Hajjami	Robert Steane
Greg Evans	Herman Stremler
Steven Goodchild	Mitchell Truitt
Don Gratton	Donald Wiles
Ralph Hart	Bruce Willemgen
Paul Hynes	Ji Zhang
Jean Koclas	

News of Members

Paul Wilson, who is pursuing post-doctoral research at the Madison Fusion Technology Institute at the University of Wisconsin, is heading up the organization of a group called North American Young Generation in Nuclear (NA-YGN) which is being patterned somewhat after the Young Generation Nuclear group which has been operating in Europe for a few years. In recognition of his efforts Paul was invited to be one of the speakers at the opening plenary session of the American Nuclear Society's Winter Meeting in Boston in June.

David Torgerson was awarded the *W. B. Lewis Medal* by the Canadian Nuclear Society, the highest scientific honour in the nuclear filed in Canada. **Michel Rhéaume** received the CNA's *Outstanding Achievement Award* for his educational and public communication efforts.

The Canadian Nuclear Society named **Ben Rouben** a *Fellow* of the Society and presented **Jeremy Whitlock** with the *CNS Education and Communication Award.*

(Details of the awards are provided elsewhere in this issue of the CNS Bulletin.)

Stan Hatcher has been appointed to the Nuclear Oversight Committee of Ontario Power Generation. The NOC is composed of senior executives of OPG with a few outside members. It advises Chief Nuclear Officer Carl Andognini on all aspects of OPG's nuclear program. After an extensive career in various roles Stan was president of Atomic Energy of Canada Limited from 1990 to 1992. Internationally he was president of the Pacific Nuclear Council from 1994 to 1996 and of the American Nuclear Society in 1997 - 1998.

John Skears has been appointed vice-president, engineering Standards and Programs at Ontario Power Generation. He was previously Director, Engineering Standards and Technology. His new position integrates that role with that of the Director, Engineering Projects and Programs and includes the Configuration Management Restoration Project.

Paul Thompson, CNS past-president, reports that he is still undergoining therapy to recover the full use of his legs which were seriously injured in a car accident in December 1999 and is unlikely to be back, fully, to work for a few months.

Obituaries

Peter Laughton
First CNS Webmaster

To the dismay and astonishment of friends and colleagues, Peter Laughton took his own life on April 27, 1999 in Deep River.

Peter joined AECL's Chalk River Laboratories in 1988 after obtaining a Ph.D. in Nuclear Engineering from the Massachusetts Institute for Technology. At CRL he was involved with simualtion work and was the guardian of the WIMS-AECL reactor physics code, which is one of the company's signature-codes and soon to be a part of the Industry Standard Toolkit.

Peter graduated from Queen's Univeristy in 1982 at the top of his Engineering Physics class while winning a University Medal. While at Queen's he worked at CRL as a summer student. Following graduation he won an NSERC post-graduate scholarship, which he took to MIT to pursue a doctoral degree.

Peter's educational interests went farther than his own formal schooling. He was heavily involved in the educational aspects of the Deep River Legion and organized the Legion student bursaries for several years. He continued to be involved in the Alumni Association for almost ten years. Pete and each year arranged a send-off for local students who were about to attend Queen's.

Peter became involved with the Canadian Nuclear Soceity in the early 1990s and organized the CNS Simualtion Symposium held inPembroke in 1994. Peter became a member of CNS Council in 1997. When the CNS created an Internet Committee in the fall of that year, Pete's computer skills and experience made him the obvious choice for the chair. He organized the committee, largely created the CNS Web site and became Webmaster in the winter of 1998. At the time of his death he was working on a procedure for handling electornic voting by the CNS Council.

He leaves his wife Simone and a one-year daughterErin Renée.

As an indication of the esteem in which he was held by friends and colleagues the Deep river Communicty Church was overflowing for the memorial service held May 6.

CALENDAR

1999

Aug. 1 - 5

Symposium on Flow - Induced Vibration - 1999
Boston, Mass.
contact: Michael Pettigrew
AECL - CRL
Chalk River, ON
Tel: 613-584-8811 ext. 3792

Aug. 29 - Sept. 3

Global '99 - International Conference on Future Nuclear Systems
Jackson Hole, Wyoming
contact: Dr. Todd Allen
Argonne National Laboratory
P.O. Box 2528
Idaho Falls, Idaho
83403-2528
e-mail: todd.allen@anlw.anl.gov

Sept. 6 - 10

3rd International Conference on Isotopes
Vancouver
contact: Dr. Nigel Stevenson
TRIUMF
4004 Westbrook Mall
Vancouver, BC V6T 2A3
e-mail: nigel@triumf.ca

Sept. 12 - 16

Decomissioning, Decontamination and Reutilization
Knoxville, Tenn.
contact: John E. Gunning
e-mail: jegunnin@bechtel.com

Sept. 12 - 17

International Conference on Inertial Fusion Sciences and Applications
University Bordeaux, France
contact: IFSA '99
162, Avenue Dr. Schweitzer
33608 Pessac Cedex
France
e-mail: voirin@ixl.u-bordeaux.fr

Sept. 12 - 17

2nd Symposium on Technologically Enhanced Natural Radiation
Rio de Janeiro, Brazil
contact: Andrea Couto
CONGREX do Brasil Ltda.
e-mail: andrea@congrex.com.br

Sept. 12 - 17

6th International Conference on Facility Operations - Safeguards Interface
Jackson Hole, Wyoming, USA
contact: Steve Herring
P.O. Box 1625 MS 3860
Idaho Falls, Idaho
83415-3860 USA
web site: www-citr.ornl.gov/ans

Sept. 25 - 28

ICENES 2000: 10th International Conference on Emerging Nuclear Energy Systems
Petten, The Netherlands
contact: Dr. Harm Gruppelaar
Petten, The Netherlands
e-mail: gruppelaar@ecn.nl
website: www.ecn.nl

Sept. 26 - 29

6th International CANDU Fuel Conference
TBD
contact: Mukesh Tayal
AECL - SP
Tel: 905-823-9040 ext. 4652
e-mail: tayalm@aecl.ca

Sept. 30 - Oct. 1

Conference on the Future of Nuclear Energy in Canada
Ottawa, Ontario
contact: Jackie Carberry
Carleton University,
Ottawa
Tel.: 613-520-2752
e-mail: jackie_carberry@carleton.ca

October 3 - 8

NURETH-9 - 9th International Meeting on Nuclear Reactor Thermalhydraulics
San Francisco, California, USA
contact: Dr. S. Levy
Levy & Associates
3880 South Beacon Avenue
Suite 112
San Jose, California

Oct. 10 - 14

Topseal 99Radioactive Waste Management - Commitment to the Future Environment
Antwerp, Belgium
contact: ENS Secretariat
Berne Switzerland
Fax: 1-41-31-383-44-66

Nov. 14 - 18

ANS Winter Meeting
Long Beach, California
contact: ANS Office
La Grange Park, Illinois
Tel: 708-579-8258

Nov. 16 - 18

International Topical Meeting on Nuclear Plant Instrumentation, Control and Human-Machine Interface Technologies
(embedded in ANS Winter Meeting)
contact: Dr. R. M. Edwards
University Park, Penn., USA
Tel: 814-865-0037
Fax: 814-865-8499
e-mail: rmenu@engr.psu.edu

Nov. 17 - 19

Climate Change and Energy Options Symposium
Ottawa, Ontario
contact: Duane Pendergast
AECL - SP
Mississauga, Ontario
Tel: 905-823-9060 ext. 4582
e-mail: pendergastd@aecl.ca

Nov. 29 - Dec. 3

International Symposium on Restoration of Environments with Radioactive Residues
Arlington, Virginia, USA
contact: Ms. T. Niedermayr
IAEA, Vienna, Austria
e-mail: t.niedermayr@iaea.org

2000

March 19 - 24

6th International Conference on Tritium in Fission, Fusion and Isotopic Applications
Augusta, Georgia USA
contact: Faye M. Williams
Westinghouse Savannah River Site
773 A
Aiken, S.C. 29808 USA
Fax: 803-725-2756
Website: www.tritium2000.org

Apr. 2 - 6

8th International conference on Nuclear Engineering (ICONE - 8)
Baltimore, Maryland, USA
contact: Dr. Jovica Riznic
AECB Ottawa
Tel. 613-943-0132
e-mail: riznic.j@atomcon.gc.ca

May 7 - 11

PHSOR 2000 ANS International Topical Meeting on Advance in Reactor Physics, Mathematics and Computation into the Next Millennium
Pittsburgh, Pennsylvania, USA
contact: I.K. Abu-Shumays
Bettis Atomic Power Laboratory
e-mail: abushuma@bettis.gov

May 14 - 19

10th International congress of the International Radiation Protection Association
Hiroshima, Japan
For info. Website:
www.convention.co.jp/irpa10
e-mail: irpa10@convention.jp

July 10 - 13

Plutonium Futures - The Science
Sante Fe, New Mexico, USA
For info.
Website: www.lanl.gov/Pu2000
e-mail puconf2000@lanl,gov

Aug. 6 - 11

10th International Symposium on Thermaldynamics of Nuclear Materials
Halifax, Nova Scotia
contact: Richard Verrall
AECL - CRL
Tel. 613-584-3311
e-mail: verrallr@aecl.ca

Sept. 25 - 28

ICENES 2000: 10th International Conference on Emerging Nuclear Energy Systems
Petten, The Netherlands
contact: Dr. Harm Gruppelaar
Petten, The Netherlands
e-mail: gruppelaar@ecn.nl
website: www.ecn.nl

Oct. 15 - 19

12th Pacific Basin Nuclear Conference
Seoul, Korea
contact: Mr. Kyo-Sun Lee
KAIF
Seoul, Korea
Fax: +82-2-785-3975
e-mail: kaif@borna.dacoin.cc.kr

VISIT THE CNS WEB PAGE

The CNS now has an exciting, comprehensive, web site, with an easy-to-remember address. The site has information on Conferences and Courses, Branch seminars, and Education and Communications. It also has forms to apply for CNS membership and to order publications. It has hyperlinks to other web sites on nuclear science and technology. All CNS Branch pages are part of this web site.

La SNC possède un site web complet, et son adresse est facile à retenir. Vous y trouverez des informations sur les congrès, les cours, les conférences de chapitre, l'éducation et les communications. Le site contient aussi des formulaires d'adhésion à la SNC et de commande de publications. Il y a des hyperliens à d'autres sites sur la science et la technologie nucléaires, ainsi que toutes les pages des chapitres de la SNC.

Visit the CNS web site at:
Veuillez visiter le site web de la SNC à:

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