CANADIAN NUCLEAR SOCIETY

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DE LA SOCIÉTÉ NUCLÉAIRE CANADIENNE

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Cover Illustration

The photograph on the cover is a relatively recent aerial view of Cameco Corporation's Uranium Conversion Facility at Port Hope, Ontario.

(Photo courtesy of Cameco Corporation)

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The Canadian Nuclear Society
380 University Avenue, Suite 200
Toronto, Ontario, Canada, M5G 1V2
Telephone (416) 977-7620
Fax (416) 977-8131
e-mail: cns-snc@on.aibn.com

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Editor / Rédacteur
Fred Boyd
Tel./Fax (613) 592-2256
e-mail: fboyd96@aol.com

Associate Editor / Rédacteur associé
Ric Fluke
Tel. (416) 592-4110
Fax (416) 592-4930

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EDITORIAL

First of all, our apologies for the lateness of this issue of the *CNS Bulletin,* which was caused by a number of factors. However, that delay does allow us to reflect on two events that took place in mid November, the ANS / ENS Meeting in Washington and the 5th CNS International Conference on CANDU Maintenance held in Toronto.

The former was notable in the large numbers of attendees and the optimistic tone. Although no new nuclear plants are expected to be built in the USA or western Europe in the near future the US speakers in particular were buoyed by the significant improvement in operation of US nuclear plants and the resulting large number of applications for licence extension. There appears to be a feeling that the better performance of nuclear plants which brings increased competitiveness against fossil fuelled plants, along with the growing public acknowledgement of the threat of global warming, is gradually winning public acceptance of nuclear power. If Canadian plants can improve their performance perhaps the same swing in public opinion, which was never as negative as in the USA, could occur here.

Although the Maintenance Conference was very well organized and quite successful it is a puzzle to us why the utilities, to whom the meeting was primarily addressed, sent so few participants. This question is especially relevant given the remarks of OPG's President Ron Osborne and other senior executives on the high importance of maintenance. The papers presented were generally of a very high standard and offered many insightful thoughts on all aspects of maintenance. Several participants commented to us that what they gained from attendance was well worth the day or two off the job, regardless of how pressing. Perhaps the views of the President never filtered down to those actually doing the maintenance job.

For the near future the major event will be the hearing by the Canadian Nuclear Safety Commission into the re-start of Pickering A which is scheduled to take place in mid December. Much hangs on the outcome of that hearing. If the Commission accepts the urging of local municipalities and anti-nuclear groups to demand a full environmental panel review it is highly likely, in our view, that OPG will reconsider the project. The likely long delay would change the economics. If that happens, the nuclear industry would receive another setback and we would all end up with the resulting greenhouse gases from the alternative generation.

Fred Boyd

IN THIS ISSUE

This issue of the *CNS Bulletin* is different that what we had originally planned, as result of some of the same factors that caused its delay in publication. Several articles and papers that we were pursuing did not materialize for one reason or another. Nevertheless, we hope that you will find that the papers and articles included are interesting and informative.

To begin we have two letters which you may find controversial. Your response to these (or to any other item) is always welcomed.

As part of our on-going series of articles on organizations in the Canadian nuclear program we have a short note on the **Port Hope Conversion Facility** of Cameco Corporation. That is followed by a report on a **Conversation with Gene Preston** we were privileged to have in late October.

The article **Does the Future have a Constituency?** is the text of speech by Donald Johnston, secretary-general of the OECD, in which he expresses his personal conclusion that nuclear power is necessary to meet the challenge of reducing the emission of Greenhouse Gases. Related to that topic is the paper by Duane Pendergast and others on **Greenhouse Gas Reductions and Canada's Nuclear Industry** which describes the extensive effort undertaken to develop a Canadian approach to meeting the targets set in the Kyoto protocol.

On meeting another challenge, that of mis-information, we reprint the reply by Phillippe Duport to the presentation of Rosalie Bertell to a Senate Committee in **The Effect of Low doses of Ionizing Radiation.** A related article comes later in this issue, a report by Jerry Cuttler on a special meeting devoted to **Health Benefits of Low Dose Radiation.**

In between are two technical papers that we feel might be of interest to a wider audience, one on **A Web site for Scientific Codes,** and the other on **Streamlined Reliability Centred Maintenance.**

There follows our usual short section on **General News** in which we offer tidbits that you may not have picked up elsewhere.

The section on **CNS News** contains a number of items, including a brief report on the very recent **5th International Conference on CANDU Maintenance.** Please note the other reports on activities of the *Canadian Nuclear Society.*

There is a **Book Review** by Don Wiles along with some information on publications that may be of interest and then **Endpoint** with Jeremy Whitlock's particular view on our nuclear scene.

The **Calendar** has been updated and shows a large number of interesting events over the coming year or so.

As always we invite your comments, input, suggestions, so that the *CNS Bulletin* can serve you better.

LETTERS

On the Lease of the Bruce Nuclear Stations

VERITATEM DIES APERIT

The President of Ontario Power Generation was recently quoted as saying the lease of the Bruce Nuclear Stations to British Energy PLC was "good news". He went on to say, "I also think it's important to have another large nuclear energy player in Canada to address regulatory issues, communicate with stakeholders, do research and development, and so on. It will be useful to have an Ontario-based competitor with whom to compare our capabilities. Competition will make us better." Decontrol? Competition? There is something decidedly odd about all this.

For the past five years, Ontario Hydro/OPG has been going in exactly the opposite direction with the nuclear power program. Large numbers of highly-paid Americans were brought in to implement reform guided by programs with acronyms like IAP, IIAP, IPP and seemingly many others, all containing the letter I for INTEGRATED. Using a discredited management system called Requisite Management, a massive command and control system was put in place in head office which required the creation of many new Vice President and other Executive positions. All service functions, including engineering, procurement, human resources, finance, licensing and safety, were rigorously centralized. This was considered necessary to reverse the evils of decentralization which had been earlier implemented in the nuclear program to compensate for short-falls in budgets and resources and which also recognized the major differences in the age, condition and design between the nuclear units at the three nuclear sites of Pickering, Bruce and Darlington.

My what a difference five years makes. If the lease of the Bruce Nuclear Stations to British Energy isn't decentralization, one would be hard put to find what else it could be called. Bruce Energy will have its own services in engineering, procurement, human resources, financing, licensing and safety, and is to be in competition with the other Ontario nuclear stations. All of that massive expensive integration seems to have been rendered unnecessary and wasted.

Five years ago, a big obstacle to reform of Ontario's nuclear program was the entrenched attitude of the employee union, the Power Workers Union. Management was told by the union executive that "they were dreaming in Technicolor if they thought there would ever be separate Collective Agreements for workers at the three nuclear sites." Today, not only are separate collective agreements in place but it has been announced that the employee unions are to have a minority equity ownership in the decentralized Bruce nuclear stations. Some of those union executives have been recently appointed to senior management positions in OPG. Such breathtaking reversals have no doubt left the union membership somewhat confused.

Five years ago, many of the bright, competent leadership in the Ontario nuclear program were terminated, demoted, or otherwise sidelined. Today, one is delighted to observe, some of them are back in influential positions where they can once again make a contribution. But, in between, they were treated shabbily. One particularly remembers the present Chairman's public rant against a "nuclear priesthood".

The Board of Directors of Ontario Hydro/OPG did get one thing right five years ago. For the new American managers they finally opened the purse-strings and started providing large increases in both operating and capital funding. In fact they were given virtually a blank cheque. This must have been particularly galling for previous senior managers of the former Ontario Hydro who operated and maintained twenty nuclear units and a heavy water plant for about half the budget that the Americans were given to operate just twelve nuclear units. The stations at Pickering A and Bruce A, and the Bruce Heavy Water Plant, were shutdown in 1996 in a decision that was cavalier and ill-advised. In 1994, the Ontario nuclear stations produced 92 Terawatt-hours constituting 67% of all electricity consumed in Ontario, the air pollution in the province had never been lower, and this was done at an annual cost of about $820 million. In 1999, the Ontario nuclear stations produced about 60 Terawatt-hours constituting less than 50% of all electricity consumed, the air pollution had increased significantly because a lot of electricity had to be produced from coal, and this was done at an annual cost of about $1490 million. Regular reports have been issued by OPG indicating that great progress is being made in improving the nuclear program. If this is progress, it certainly isn't evident in the amount or cost of electricity produced.

The big question is, what exactly did the citizens of Ontario get for the approximately $1.6 billion expended over the past five years on the nuclear recovery program? The big improvement claimed is that the CANDU plants are now much safer, better documented, and more effective as judged by a "Nuclear Performance Index" that was developed by the World Association of Nuclear Operators – WANO. But have maintenance backlogs been reduced, have operations really been improved? This does not seem to have yet been confirmed by the much-vaunted Peer Reviews and it is questionable whether this is a view held by the Canadian regulator. Were the stations quite safe five years ago? They most certainly were, as testified by all concerned at the Legislative Committee Hearings.

One might be inclined to conclude that the lease of the Bruce nuclear stations to British Energy is an indication that things were not going too well in the nuclear recovery program.. One might also interpret that statement by the OPG President about the desirability of having a new nuclear energy player in Ontario as meaning that OPG has just run out of new ideas and isn't sure what to do next. However, this will be seen as an uncharitable conclusion because everyone knows that the Bruce nuclear stations were leased in order to meet the "decontrol objectives" of the Ontario Government.

Both OPG and the new British operator of Bruce Nuclear must develop a better plan for Ontario's nuclear stations than the one that has been followed for the past five years.

That plan should be based on the fundamental economic advantages of the CANDU in Ontario that have always been there and should include the restart of four units at Pickering A and two units at Bruce A. That plan should not be modeled on the US nuclear industry because the great performance turn-around

trumpeted by INPO turns out to be not so great after all. The US nuclear industry is mired in procedures and locked into the past. In spite of improved capacity factors and a lot of debt having been paid down, most US utilities can no longer afford to operate and maintain nuclear plants and they are unloading them at fire-sale prices or shutting them down completely which has caused major losses in shareholder value and considerable hardship for investors holding the utility stock.

At every stage in the development and construction of the Ontario nuclear stations between 1960 and 1993, new technologies and new ideas were incorporated in a continuous orderly manner to modernize the stations and improve both safety and performance. It might be a good idea to start doing that again.

Don Anderson

Don Anderson is a former vice-president of Ontario Hydro.

Evolving Safety Analysis Technology

I enjoyed the excellent paper by John Luxat in the August Bulletin.[1] As he pointed out, recent changes in the electricity market are pushing the nuclear option to be more competitive, and this is driving an evolution/revolution in safety analysis. Among the areas being examined are the specific assumptions and their conservatisms to accommodate uncertainties in supporting knowledge. To help me understand these, I looked for an explanation of requirements established more than two decades ago, and found the 1981 paper by Domaratzki et al[2] very useful.

In addition to cost reduction, the new market requires a reduction of fear and misunderstanding. One cause is terminology. Even when there are no consequences to people, we call failures in reactor systems *accidents.*

A particularly challenging area of analysis is a potential large-break LOCA event. Because there were no LOCAs in CANDUs by 1981, the frequency of large-pipe failures was taken to be less than one in a 1000 reactor-years, based on a 1964 survey of high pressure piping systems in non-nuclear plants. "With 25 operating CANDU reactors, the average interval (between large LOCAs) would be at least 40 years."[2] It would be appropriate to reassess this frequency, based on: our use of ASME-code material; our practice of high-quality design, construction and operation; and the excellent operating experience of ~450 nuclear plants during four decades.

The defined consequences of LOCA accidents are the radiation doses which would be received by individuals at the plant boundary and those living in the vicinity. We assume no protective action is taken and we use the LNT model to calculate the number of the number of fatal cancers.

At some point, we might consider revising our assumptions to fit more realistic consequences of a nuclear accident. The actual consequences of the Chernobyl disaster,[3, 4] where the intensity of the damage and lack of containment allowed a much larger release than postulated for any western reactor accident, are as follows:

- ~40% of reactor core and most of its radioactivity released to the surroundings
- population evacuated soon after the event
- average whole-body dose 1.5 cGy (rad)
- ~1800 cases of operable thyroid cancer, in children, with 3 fatalities
- no excess leukemia or other cancers observed during the following 14 years
- severe psychological stress due to fear and relocation
- severe world reaction based on fear of contamination - social, political
- severe economic stress to the nation

Evidence has been accumulating for a century that the net health effect of low doses of radiation seems to be beneficial,[5] recognizing that children are more sensitive to significant doses.[6] We seem to be ignoring this information. In a rational world, we would be addressing only risks that involve the reasonable likelihood of acute exposures greater than 10 cGy (10 rad) or continuous exposure rates greater than the range of natural background radiation levels. The real consequences of a severe accident are fatalities of plant workers, and a very strong reaction from the public and the media due to the fear of cancer (and genetic effects) leading to severe economic consequences.

This raises the question of how many more decades we will continue to use LNT ideology, and help perpetuate the fear that has been exploited for more than a century[7] to keep nuclear technology under a cloud of cancer. Use of a scientific model for the health effects would give nuclear energy a more positive image.

Jerry Cuttler

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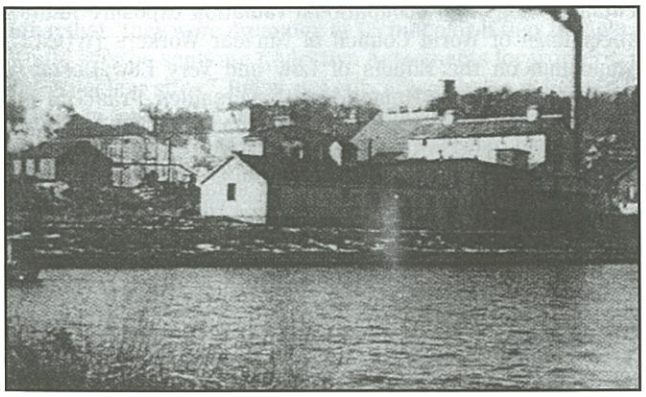
Cameco's Port Hope Conversion Plant

Ed. Note: *Over the past couple of years we have been running articles about organizations involved in the Canadian nuclear program, with emphasis on those that tend to be less visible for one reason or another. For this issue we visit the oldest "nuclear" site in the country where a key component of the nuclear fuel business, here and abroad, is located; the uranium conversion facility of Cameco Corporation at Port Hope, Ontario. Our thanks go out to Bob Steane, Tim Kennedy, Aare Puhm, and David Chester for their hospitality and assistance.*

Background

Although most of the existing buildings are relatively new, the complex on the shore of Lake Ontario in Port Hope (about 70 km east of Toronto) has ben there since the early 1930s. What is now the uranium conversion plant of Cameco Corporation, the world's largest uranium producer, began as a refinery for radium using ore from Port Radium in the Northwest Territories.

In the 1920s the use of radiation for medical purposes was well established and a favorite source of radiation was radium, the element first identified and separated by Madame Curie at the end of the previous century. Exploration for sources of radium took place the world over. In 1930 Gilbert Labine, a Canadian prospector and managing director of a mining company, Eldorado Gold Mines Ltd., discovered a rich deposit of pitchblende on the eastern shores of Great Bear Lake in the Northwest Territories. Despite the depression radium sold for up to $100,000 per gram (in dollars of the day), justifying the expense of mining in the Arctic and shipping the ore to Port Hope, Ontario where Labine began to build a small refinery in 1932. The refinery process was to extract radium, with the much larger quantity of uranium being largely discarded. (Some of that was the source of the contaminated earth that has been the focus of clean-up activities in Port Hope for the past decade or two.).



Original Port Hope plant, 1932.

The onset of World War II in 1939 disrupted the international trade of radium and increased the cost of mining, causing Eldorado to shut down its mining operation. However, shortly thereafter, others, interested in uranium not radium, came into the picture. By the spring of 1941 President's Advisory Committee on Uranium in the USA (a forerunner of the Manhattan Project) was looking for uranium and contracted with Eldorado for 16,000 pounds (7,270 kg.) of refined uranium oxide. Further sales were entered into by the company whose name was changed to Eldorado Mining and Refining Limited, the mine was re-opened and the Port Hope refinery operated at full capacity producing uranium instead of its original product, radium.

In 1944 the government took over the company and transformed it into a crown corporation, Eldorado Mining and Refining (1944) Limited. Given the interest in nuclear energy after World War II the Canadian government continued its ownership of the company, subsequently changing its name to Eldorado Nuclear Limited. In 1988 Eldorado Nuclear was merged with the Saskatchewan crown company Saskatchewan Mining Development Corporation to form Cameco. Three years later, in 1991, the two governments privatized the new company and completed an initial public offering. Shares are now traded on the Toronto, and New York stock exchanges.

Cameco today

Cameco is now the world's largest uranium producer. The company has a controlling interest in the McArthur Lake and Cigar Lake mines, which have the world's largest high-grade deposits, and owns

the largest uranium mills at Key Lake and Rabbit Lake, all in northern Saskatchewan. The company also has uranium mining operations in the USA and a gold mine in Kyrgyzstan in central Asia

At the mill the uranium ore is ground, leached purified, filtered and dried to create an uranium concentrate powder, uranium oxide U_3O_8, commonly called "yellow-cake". This material, which contains 70 to 82 % uranium is shipped to the refinery in Blind River, northern Ontario.

Cameco's Blind River refinery also receives uranium concentrate from other countries. Using processes such as, digestion, solvent extraction, denitration, the uranium concentrate is transformed into nuclear grade uranium trioxide, UO_3 . The UO_3 is then shipped to Port Hope in specially designed tote bins which hold 9.5 tonnes each to be converted into uranium hexaflouride, UF_6, which is used in enrichment plants, or ceramic grade uranium dioxide, UO_2, for CANDU fuel. About 80% of Port Hope's production is to UF_6.

A UF_6 cylinder is placed on a trailer at the Port Hope conversion facility in preparation for the journey to an enrichment facility.

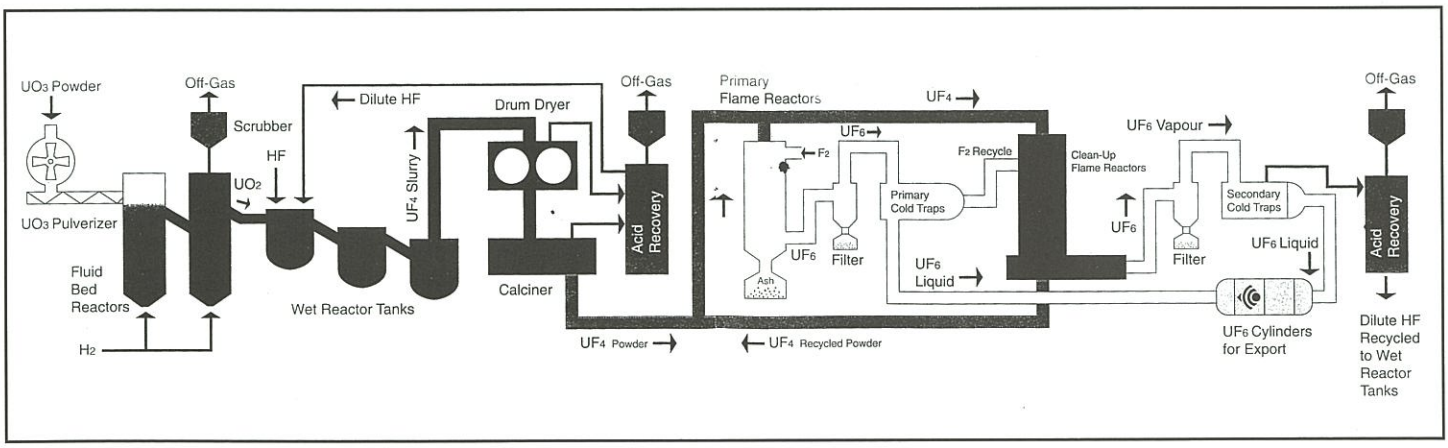
Port Hope Operations

Following the early operations noted above, in 1955 the Port Hope facility converted its refinery process to produce nuclear grade uranium trioxide, UO_3. In 1958 facilities were added to produce natural uranium metal and ceramic oxide powder. Production of UO_2 for CANDU was begun in 1962. The production of UF6 was begun in 1970. With the construction of the Blind River refinery the Port Hope one was shut down in 1983. There are now about 270 employees at the Port Hope facility, including engineering and development groups and a sizable quality assurance department.

The feed for the production of both UF_6 and UO_2 is UO_3 shipped from the Blind River refinery in specially designed tote bins that hold 9.5 tonnes each. About 80 percent of the UO_3 is converted into UF_6 which is the feed material for most uranium enrichment plants.

Given the past (early) history at the site, the operators of Cameco's Port Hope facility are extremely conscientious about the environmental impact of the plant. Considerable effort goes into conservation and recycling. The latter include in-plant recycling of hydrofluoric acid and the sale of ammonium nitrate byproduct for use as a commercial fertilizer. The waste management program monitors and cleans all scrap material before releasing to authorized recycling agencies. In 2000 the Port Hope plant obtained certification under the ISO 14001 standard.

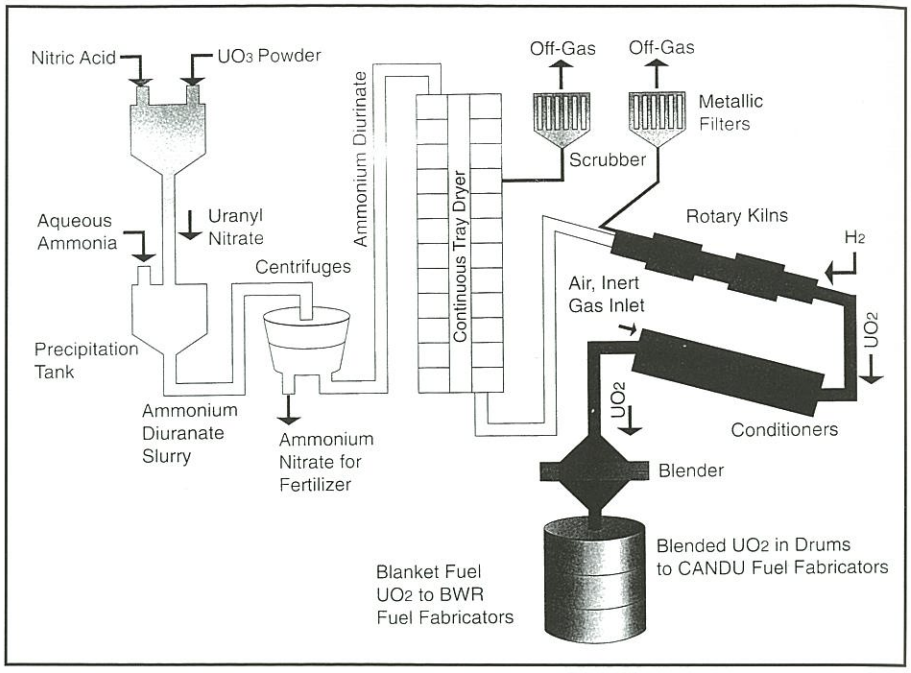
The current UF6 plant began operation in 1984. It operates 23 hours a day 11 months of the year



Production of UF_6 (Fig. 1)

In the first step of the UF_6 process the UO_3 from Blind River is pulverized and fed into a fluidized bed reactor which uses hydrogen to reduce it to UO_2. The UO_2.powder is fed to reactors where dilute aqueous hydrofluoric acid and hydrogen fluoride, HF, are added to convert the UO_2 to uranium tetraflouride, UF_4. The resulting UF_4 slurry is then pumped to drum dryers which remove most of the water. Dried UF_4 is passed into calciners operating at 4500 C to remove any trace o water.

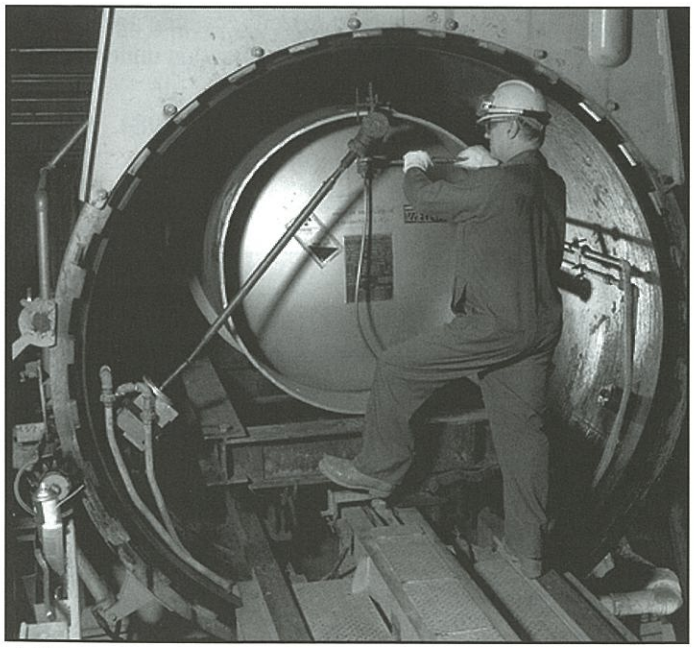
The calcined UF_4 is then reacted with fluorine gas in co-current top to bottom flow vertical reactors known as "flame reactors" to produce uranium hexaflouride (UF_6) gas. In the initial stage UF_4 and excess fluorine (to ensure good conversion) enter into the top of the reactors. The resulting UF_6 is then condensed in coldtraps. Off gas from the trap which contains residual fluorine is fed into a second reactor where it is contacted with an excess of UF_4 to consume all of the remaining fluorine.



Production of UO_2 (Fig. 2)

The Port Hope facility produces its own fluoride gas using electrolytic cells containing molten potassium biflouride and hydrogen fluoride (HF). Cameco's Port Hope plant is the only uranium conversion facility which uses a wet process to make UF_4 from UO_2 thereby reducing the consumption of hydrogen fluoride as an environmentally sound operation.

The UF_6 gas is passed through filters to remove any entrained solid particles before entering final cold traps which freeze the gaseous UF_6 into a white crystalline solid



A UF_6 cylinder is placed in an autoclave for testing.

Once a cold trap is filed to a specified weight it is isolated and heated to liquefy the UF_6. Under its own vapour pressure at a temperature of 75 - 85 0 C the liquid UF_6 is drained into specially designed, heavy-walled, 10 or 14 tonne steel shipping cylinders. After filling the cylinders are left o cool and the UF_6 again solidifies. The UF_6 cylinders are then transported by truck and/or boat to enrichment plants in the USA, Japan or Europe.

The UO_2. for CANDU fuel is produced by a different process to achieve the characteristics needed to make the desired ceramic grade for the manufacture of CANDU pellets. The current plant began operation in 1980.

UO_3 from Blind River is first dissolved in nitric acid to produce uranyl nitrate, which is then precipitated with aqueous ammonia to yield a solid ammonium diuranate (ADU). The wet ADU is dried and reduced with hydrogen in gas-fired rotary kilns to produce ceramic grade UO_2. Since the UO_2 produced by this process is in the form of fine particles which react readily with oxygen it is conditioned before being exposed to air. The conditioned ceramic grade UO_2 is a fine, greenish- black powder. The powder is packaged in 205 litre drums for shipping to manufacturers of CANDU fuel in Canada and abroad.

For a visitor, a striking feature of the plant is the very high level of "housekeeping", despite the massive amount of material being processed.

Cameco's Port Hope facility has a licensed production capacity of 12,500 tonnes per year of UF_6 and 2,800 tonnes per year of UO_2. It is a key component of the Canadian nuclear power program and a major entity in the international nuclear fuel business.

A Conversation with Gene Preston

by Fred Boyd

In late October 2000 we were privileged to have an extended conversation with Gene Preston, Executive Vice-President and Chief Nuclear Officer at Ontario Power Generation. The following is a report on that conversation.

Gene Preston

Ahead of the appointed hour we are led into a relatively large office on the 19th floor of Ontario Power Generation's head office on University Avenue in Toronto where we are greeted warmly by the man leading the drive to raise the performance of OPG's nuclear plants to world standard. Despite having just come from a dental appointment, Gene Preston, Chief Nuclear Officer at OPG, greets us in a very friendly manner. His youthful appearance belies his 53 years and his affable manner shines through his enormous responsibility for turning around the performance of OPG's nuclear plants. The openness with which he responds to our questions displays confidence, in himself and in all of OPG's nuclear staff.

Q. Pickering A is very much in the news. The Canadian Nuclear Safety Commission is considering the Environmental Assessment Screening Report. Do you expect that the CNSC will accept that report at its December meeting ?

A. First of all, I feel that OPG, the regulator, and the public are all better off because of the process. In the past we [former Ontario Hydro] have not been as vigilant on environmental matters as we should have been. Since 1997 the [environmental] spotlight has been on Pickering and particularly, on Pickering A. It was in 1997 that copper from the condensers was found in Lake Ontario. That problem, which came from admiralty brass tubing, was a major factor in the decision to shutdown Pickering A that year.

As part of the environmental review undertaken for licence renewal in 1998 we made a concerted effort to determine other potential environmental problem areas. One that was identified was a landfill from the construction days which contained debris and even old oil barrels. That was also the year that tritium was found in the ground water. It was evident that we needed to be much more proactive about the environment.

Over 160 issues were raised from the 1998 review. Then the Atomic Energy Control Board (now CNSC) decided that the project [to re-start Pickering A] required an Environmental Assessment Screening Report. We agreed with the regulator and jointly drew up a schedule which included considerable time for public input. During the process we gave frequent presentations to the local municipalities and offered funding for their independent review. As it has turned out both Ajax and Pickering have decided to ask for a full Environmental Panel review, joining the City of Toronto and the Region of Durham who had already taken that position.

I believe that we have met all procedural requirements as well as addressing all the technical, substantial issues. I am confident that the regulator [CNSC] will conclude that the Screening Report meets the full intent of the law and that nothing further is to be gained by extending the process. Of course the Commission will provide full opportunity for all to be heard. And, we expect that such a decision will be followed by a judicial challenge, similar to the case of the Bruce waste management site last year.

Q. Assuming the CNSC does accept the Screening Report what is your schedule for the re-start of Pickering A?

A. Based on a ruling being given in December, we plan to have the first unit on line by the end of 2001. We would gear up in January, make an application in June and hope to have approval by August. That would permit start-up in September or October and steam shortly thereafter. We are currently doing work on Pickering A but being careful not to prejudice the environmental review.

A factor in this schedule is that we have determined that we do not need to replace the steam generators. We have looked closely at those in unit 4 and found them to be in good condition. Nevertheless, we will do a 100 % inspection and a cleaning. However, many of the various heat exchanges will be replaced.

It may be noted that the OPG Board is keeping a close

eye on the Pickering A project. This is the first major project as a commercial company and the Board is adamant that it will not "run away" in cost. Budgets are being approved for each step of the program.

Q. What major plans are there for the Darlington and Pickering B plants ?

A. Darlington is the closest to our long-term model. Outages have been reduced dramatically in length. Last year outages totalled only 100 unit-days. The plan is to have, each year, just one major unit outage of less than 50 days and one minor unit outage of 30 days. This has already been accomplished this year. That implies four years between major outages for each unit, which can be achieved thanks to CANDU technology.

Pickering B has more problems. The steam generators need lancing and chemical cleaning and the fuel channels of all four units need to be "SLARed" [to reposition the spacers]. This has resulted in projected schedules of 300 unit-days of outage in 2001, 275 in 2002 and over 200 in 2003. However, the SLAR process should go much faster than for other units. We have invested in two "Universal Delivery Machines" which are expected to make the SLAR operation two to three times faster. The first such UDM will be tried at Bruce this winter.

There are other major modifications needed at Pickering B. To overcome the problem of zebra mussels clogging the condenser debris filters will be installed. As motors need replacing more efficient ones will be installed. And the air conditioning units will be modified to use an environmentally friendly refrigerant.

Q. What support is OPG providing Bruce Power in connection with the Bruce units ?

A. We are still providing substantial technical support, especially in fuel channel inspection which is a very specialized process. We expect to provide some analytical service since Bruce Power has decided to have only a core group that can be "intelligent buyers". However, Bruce Power has used, and probably will continue to use, other organizations such as AECL and Canatom.

Interestingly, we are purchasing services from Bruce Power. A couple of years ago [as Ontario Hydro] we built one large laundry facility for all of our plants and located it at Bruce. Since it does not make sense to build another we intend to buy our laundry services from Bruce Power.

Q. Has the redeployment of staff from Bruce been completed?

A. Yes, the Bruce transfers are essentially complete.

Q. OPG is still advertising for staff. How critical is that for the Pickering A re-start ?

A. We have enough trained and experienced people for the first unit of Pickering A but need additional support for the following units. Also, OPG has a continuing need to replace retiring staff. The average age last year was 48. (Subsequently, the Bulletin was informed that the average age has now decreased to 45.) We expect to continue hiring [new staff] until 2002. A "Workforce Planning Model" has been developed that examines the situation by skills. The immediate need is for operator trainees since the training program takes several years. Additional engineers are needed now to work on such tasks as "design bases", and configuration management. Another area of current shortage is control technicians.

Q. Many of us believe that a replacement for the NRU reactor at Chalk River, such as the proposed Canadian Neutron Facility, is essential for an on-going Canadian nuclear power program. What is the view of OPG ?

A. We do not see a real need for the CNF specifically for OPG in the near term as we continue to operate the existing plants. Much of our work is associated with material ageing and that is done in "hot cells". On the other hand, such a facility is essential if you are going to have an industry based on the next generation CANDU .

Q. Does OPG intend to make use of the new CANDU Owners Group (COG) ?

A. We are definitely involved with COG. Our expenditures [with COG] increased this year and we expect they will increase again next year and then probably level off. Now that there are four players [with Bruce Power] COG offers a perfect opportunity for all parties to share in common problems.

Q. Now, concerning Gene Preston as a person ?

A. I and my wife live in Aurora. We like the small town atmosphere but also want to be close to the "big" city since we both grew up in cities. I commute every day and beat the traffic in the morning since I am in the office by 6:15 (a.m.). However, I have not found a time to avoid it going home, even if I work late.

We have two sons (in their thirties) living in Michigan, which is just a four hour drive away. As you noted earlier, I have three "classic" cars, a '57 Chevrolet, a '74 Mercedes, and a '81 Delorean. The Delorean is special but, unfortunately, there is a problem with the head liner and I have not yet found the right material to repair it.

(And, at that point, Gene Preston was alerted that the next of his many meetings was imminent.)

Does the Future have a constituency?

The need for nuclear power

by Donald Johnston

Ed. Note: *Donald J. Johnston, Secretary-General of the Organisation for Economic Cooperation and Development (OECD) and a former Canadian federal cabinet minister, gave the opening plenary address to the joint meeting of the American Nuclear Society and the European Nuclear Society in Washington, D.C., 13 November 2000. An abbreviated version of his talk was printed in the Globe and Mail, 17 November 2000, and a shorter abstract was included in the Canadian Nuclear Association's electronic newsletter of November 16.. We felt that readers of the CNS Bulletin would appreciate his full address.*

I accepted your kind invitation to address you here in Washington, as Secretary-General of the OECD, because I consider nuclear energy in a sustainable development perspective to be one of the most important issues of our time.

I wish to make it clear at the outset that I am speaking in my personal capacity, and not as a spokesperson for the Members of the OECD. You are aware that there are serious divisions of opinion within the OECD membership with respect to the future of nuclear energy and with two notable exceptions, Japan and Korea, there do not seem to be any plans for expanding nuclear energy capacity through the construction of new reactors.

I also want to underline that I am by no means advocating any particular energy mix in these remarks. I am simply advocating a hard look at reality, and raising questions to which I have sought answers. In fact, one of those questions is the title of these remarks, namely, "Does the future have a constituency?"

I would like to think that it does, and that those who espouse "sustainable development", in particular political leaders, are firmly committed to acting for that constituency. That, after all, is what sustainable development is about. Yet, I worry that reality and the necessity of urgent action may be lost in political rhetoric.

Let me remind you of the definition of sustainable development found in the 1987 Report of the World Commission on Environment and Development, chaired by Gro Harlem Brundtland, and entitled "Our Common Future". It is widely referred to as the Brundtland Report.

The definition is that *"sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".*

I find this definition to be as suitable as any because, taken in its broader se nse, it combines environmental, social and economic considerations. However, I do not intend today to put it in its broadest context, but rather to look at it in terms of the requirement which is stated in that report: *"...at a minimum, sustainable development must not endanger the natural systems that support life on earth: the atmosphere, the waters, the soils and the living beings".*

The erosion of any of these elements, and certainly the absence of any of these elements, make any consideration of the social and economic objectives of sustainable development irrelevant. (At the request of Ministers, the OECD will deliver next May a major report on sustainable development. The report will have a very broad overall reach, encompassing economic, social and environmental considerations, but will focus on the health of the biosphere.)

Today, I will address only one element of sustainable development, namely, atmosphere and climate change, and why the current trend in the volume of green house gas emissions, concomitant global warming, combined with population growth outside the OECD area, are putting the world on a fast track to catastrophic global consequences for future generations. I will then examine the role of nuclear energy as part of the solution.

Before returning to specifics, let me say a word about the OECD itself and why it is uniquely equipped to deal with the issue of sustainable development. The OECD is [now] composed of thirty of the world's most advanced industrialised economies. It has its origins in the administration of the Marshall Plan by its predecessor, the Organisation for European Economic Co-operation. The OEEC played a key role in the rebuilding of post-war Europe. The unique intergovernmental working procedures developed in the OEEC convinced the member governments to continue these activities under a successor organisation, the OECD. In essence, committees of government officials, treating nearly all areas of public policy, meet to share best practice, to analyse problems of common concern and to negotiate guidelines and codes of conduct for multilateral co-operation.

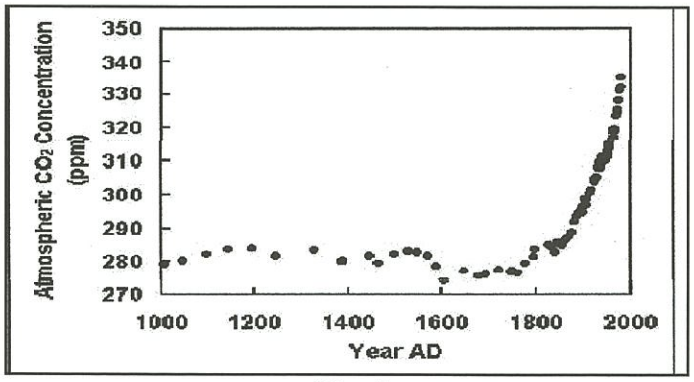
The OECD is not truly an institution. It might be called a permanent intergovernmental conference with the Secretariat, which I direct, supporting the activities of some 140 committees and working groups. The membership has now become global, though not universal, and programmes and activities are conducted with approximately 70 other non-member countries.

The OECD has expertise or access to expertise in every area of public policy and, hence, is well placed to address multi-disciplinary issues, such as sustainable development. But I will now turn to the important energy questions that must be addressed as part of the sustainable development agenda, especially with respect to the atmosphere and climate change flowing from the greenhouse effect.

How we would like to report to Member countries of the OECD that there are sources of safe, clean energy available to sustain economic growth; to bring up to OECD living standards the four-fifths of humanity which endure various forms of poverty and disease, 1.2 billion of whom live on less than one dollar a day; and to leave a world for future generations with full protection and perhaps enhancement of the air, the water, the soils and living organisms. One day we may be able to make such a declaration. But currently the world finds itself on an unsustainable energy path that will produce a very different world for future generations.

One of the most important sets of indicators showing the dangerous direction in which we are headed is the concentration of greenhouse gases in the atmosphere, and the contribution that human activities are making to those concentrations. The gases that contribute to the greenhouse effect include carbon dioxide (CO_2) and a large number of other, often more complex and less common gases. CO_2 is not the most powerful of the greenhouse gases, but it is the most abundant — accounting for the bulk of the human-induced warming effects. And because of its pathways through nature it is the gas for which historical concentrations are the easiest to reconstruct.

Atmospheric carbon dioxide concentration



(Fig. 1)

Fig. 1 shows average atmospheric concentrations of CO_2 since the Middle Ages. Note that for most of the intervening period concentrations have ranged between 270 and 290 parts per million. Since about the middle of the 19th century, however, they have shot up dramatically, and are now close to 360 parts per million — almost 30% higher than pre-industrial levels.

Emissions of CO_2 from the burning of fossil fuels are mainly to blame. These emissions increased by a factor of seven during the 20th century and continue to rise at an accelerating rate.

Surface temperatures of the Northern Hemisphere over the last millennium

Average temperatures have also risen over the last millennium. Fig. 2 shows annual changes in the Northern Hemisphere as a whole. There have been variations, reflecting the relative influence of natural phenomena such as solar intensity and volcanic activity. Viewed over a period of centuries, however, the general trend seems to have been downward until near the end of the 19th century.

Climate Change

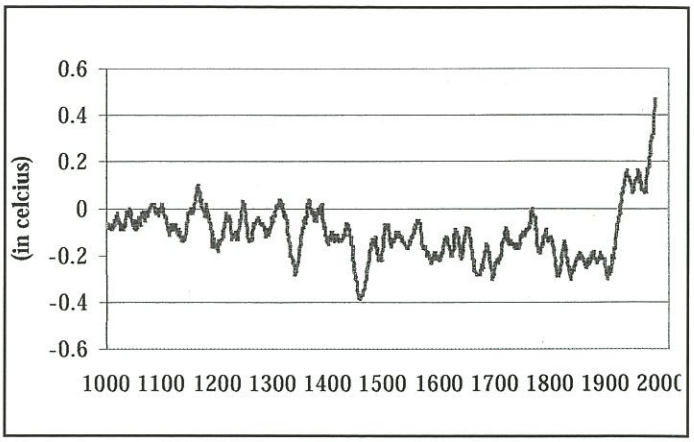


Fig. 2

Surface temperatures of the Northern Hemisphere over the last millennium.

Beginning around the year 1900, temperatures started rising steeply. The rate of increase has accelerated over the last 25 years, such that current average temperatures are believed to be close to 0.8°C — 1.4°F — above the trend. Some parts of the planet have warmed more than others. Notable is the Antarctic Peninsula, where average temperatures have risen by 2.5°C over the last 25 years.

These temperature increases might not sound like much, but on a global scale they represent a tremendous cumulative warming. The latest draft report by the Intergovernmental Panel on Climate Change (IPCC) concludes that global temperatures could rise as much as an incredible 6.1°C over this century. The report projects that my country, Canada, as well as other regions of North America, will experience temperature increases in the range of 40% above the global mean taking into account the projected increases.

We are engaged, in short, in a perilous experiment with nature that is unprecedented in the history of humankind.

Does it matter? If the climatic events we have witnessed following modest temperature increases are an indication, the potential effects of radical climate change are indeed frightening! We already see frequent extreme events –violent storms, periods of extreme heat and intense cold, with concomitant flooding and drought and loss of life. There seem to be unusual weather patterns all over the globe with seri-

ous results for the environment and human welfare.

Global warming will no doubt have catastrophic effects on ecosystems and biodiversity. It will certainly have an impact on our economies and on human health. Rising sea levels will render uninhabitable the world's low lying sea coasts. We will have to contend with the broad spread of tropical diseases. There is even serious concern that the Gulf Stream, and the larger "conveyor belt" of ocean currents could come to an abrupt halt, plunging Europe into a new ice age... even while the rest of the world experiences warmer temperatures. If current warming trends continue, serious consequences of this kind could begin within the remaining lifetime of our children, in addition to the weather aberrations we are already experiencing!

Can we do something to turn around the situation? Yes, of course we — that is, the developed, industrialised countries of the world — can. After all, our populations have stabilised, and we are probably rich enough and smart enough to develop clean, safe energy technologies that can deliver our current level of material welfare while cutting emissions— if we rise to the challenge.

But there is a major obstacle to success: poverty and population growth in the rest of the world.

UN projections of world population to 2150 (medium scenario)

Fig. 3 shows the United Nations' latest central population projections out to the year 2150. Note the differences in population growth rates between the developed and the developing worlds. In total the UN projects a 50% increase in global population by the middle of the century. Virtually all of that growth will occur outside the OECD area.

Population Growth

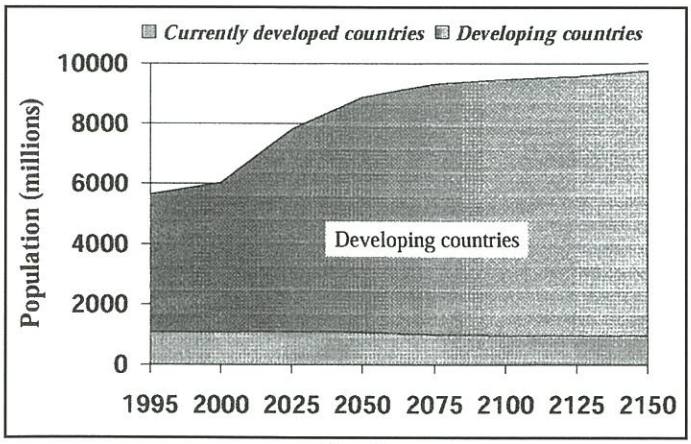


Fig. 3
UN projections of world population to 2150 (medium scenario).

We hear a lot about globalisation these days. We should not forget that globalisation is paving the way for the emergence of a world wide middle income class of 4 to 5 billion people. This will be one of the major benefits of globalisation: a middle income class with the same aspirations for comfortable homes, imported foods, foreign travel and all the other accoutrements of our modern civilisation that depend on one vital input: energy.

If the rest of the world were to have the current energy standard of living of the OECD area, energy production would have to increase by a factor of 30: a factor of 5 to account for the size of the population in the developing world relative to that in OECD; and another factor of 6 to account for high OECD per capita of energy use.

Energy use projections

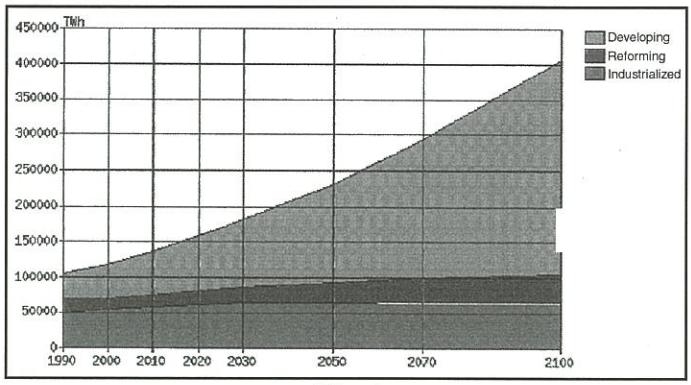


Fig. 4
Total primary energy consumption by region (IIASA reference projection scenario B in teraWatt-hours).

The reference scenario for primary energy consumption by region (Fig. 4) as projected out to the year 2100 by the International Institute for Applied Systems Analysis (IIASA) predicts an increase by a factor of 4, almost all of it occurring in the developing world.

How is that demand for energy going to be met?

Let us look at fossil fuels — the fuels largely responsible for anthropogenic emissions of greenhouse gases. Many experts expect that production of petroleum-based oils will peak some time before mid-century and start to decline thereafter. Coal, which will remain abundant, can easily fill the gap. For geological reasons, natural gas is more abundant than oil and can be expected to increase in absolute terms and then stabilise. Under this "business-as-usual" scenario, IIASA predicts that the use of fossil fuels will double over the next century.

Given the strong links between fossil-fuel combustion and growth in atmospheric CO2 concentrations that we have seen already, can we actually envisage continuing to burn fossil-fuels at current or expanding levels over the next century? The consequences for global warming and climate change would be intolerable.

What about clean renewable sources of energy like solar or wind or harnessing the ocean currents? There is certainly room to further develop wind power and solar panels and perhaps ocean currents and tidal power, but as contributors to basic energy needs they are likely to remain minuscule.

We are engaged in a perilous experiment with nature.

Having examined the best evidence available to me, I have concluded that if we are to hand on to future generations a planet that will meet their needs as we have met ours, it can only be done by incorporating the nuclear energy option. Perhaps I am wrong. Perhaps I will be presented with other evidence that would refute the conclusions I have reached, but I have yet to see such evidence. Nuclear power can be abundant, even unlimited; it produces no greenhouse gases of any consequence.

Let me put to you an apparent paradox: in my youth, despite the horrors of Hiroshima and Nagasaki at the end of World War II, President Eisenhower's initiative of "atoms for peace" was broadly embraced as the way of the future.

At that time, nuclear energy was seen as a godsend for both the developed and the developing world. Fossil fuels were understood to have a finite life, which of course they still do, although it has been modestly extended beyond estimates of that day. But fossil fuels were not seen at the time as harbouring the potential for irreversible damage to the biosphere which we now believe to be the case.

Today, the atmosphere is being choked by greenhouse gas emissions, global temperatures are rising dramatically, and the global population has more than doubled since 1955, most living in poverty in the developing world. Yet we seem to be denying ourselves the nuclear option which was seen over four decades ago as the way forward!

What happened to change public and, hence political, attitudes towards nuclear energy? It seems to be pretty obvious that the incidents of Three Mile Island a little over 21 years ago, and more recently Chernobyl, have had a major negative impact on the evolution of the nuclear industry. The tendency of the nuclear industry to secrecy, probably inherited from national defence orientations of nuclear research, made things worse. As I noted, no new nuclear facilities are currently planned within the OECD countries except in Japan and Korea. In fact others, following Germany's lead, may opt to phase it out.

Recently I had the privilege of being visited by two Nobel Prize winning physicists, Burton Richter and Carlo Rubbia. I discussed the future of nuclear energy with each of them. I also read a speech that Burton Richter was about to deliver in Italy. I will quote generously from it. He said:

> "It is our responsibility, both on ethical grounds and on grounds of self interest, to develop technologies that will allow the rest of the world to increase their standard of living without at the same time destroying the environment of the planet. I want to turn aside for a moment and express certain bewilderment that I think almost all scientists feel at the opposition to nuclear power by the green movement."

Today, with you, this will be the crux of my argument. I agree with Richter that we (or you, scientists) have a responsibility to develop the technologies that will allow us to escape from our energy conundrum. But I also think that you, as well as other knowledgeable, concerned leaders, cannot let bewilderment suffice. We must ensure that the nuclear option is the subject of informed public debate.

Let me now briefly look at some considerations concerning nuclear energy that are likely known to scientists — but probably not to the general public. I will draw on Dr. Richter — since I myself am not an expert on nuclear energy nor likely to become one.

In his speech he offered a table (Table 1) that shows radiation exposures from a number of sources. Speaking about levels of radiation exposure, he points out:

> "Natural radioactivity is the largest. Of that total, about a sixth comes from natural radioactivity in the body itself. The natural radioactivity in our bodies gave a dose about a factor of two larger than the Chernobyl accident gave in Austria in the year of the accident. Nuclear power plants and coal fired power plants give about the same average dose for the same power."

(Table 1)

RADIATION EXPOSURES

Source	**Radiation Dose (Millirem/year)**
Natural Radioactivity	240
Natural in Body	(75kg)* 40
Medical (average)	60
Nuclear Plant (1GW electric)	0.004
Coal Plant (1GW electric)	0.003
Chernobyl Accident (Austria ~ 1988)	24
Chernobyl Accident (Austria 1996)	7

* Included in the Natural Total

Source: Science and Society: Lessons for the 21st Century October 3 , 2000

Dr. Richter also cites an article by a German group entitled "Health Risks of Energy Systems" which presents extensive data and from which Richter concludes...

> " In years of life lost per terawatt hour of plant operation, the only thing better than nuclear power is windpower.
>
> There is concern about the disposition of radioactive waste. I think virtually all scientists would say that this is not a problem. It can be disposed of geologically in many ways. Not all

> countries have the proper geological formations to do such disposal, but international burial sites could be developed to handle the radioactive waste of the entire world without any difficulty. The worst scenarios dreamed up by the opponents of nuclear power for radiation release from long term storage give negligible years of life lost compared to the continued use of our conventional sources of energy.
>
> It is difficult to understand the opposition to nuclear power. No energy source is free from risk and a proper analysis has to balance risks and benefits. On such a balance, nuclear power comes out better than most".

Here I end my citation of Dr. Richter.

Risks are an inherent part of decision-making in public policy. But the risks must be identified, the risks must be assessed, there must be an application of a cost benefit analysis to the risks and, of course, the risks must be managed. So when we look at nuclear, it is not a question of saying there is a risk. There are obviously risks, but compared to what alternatives? Are we to abandon nuclear on the strength of a few accidents?

Dams are frequently located upstream from population centres: between 1918 and 1958, 33 major dam failures with much loss of life. Between 1959 and 1965, 9 major dams failed. Did we stop building dams as a result? Did we abandon coal because of the high risks associated with coal mining? No. We worked at making technologies more reliable and safety measures stricter.

But much of the public seems either unaware or unconvinced of the facts. I would go even farther. The nuclear question, like genetically modified food (another issue we are grappling with at the OECD), finds itself in a period where the public is increasingly sceptical of science and of the capacity of governments to create and apply adequate regulatory frameworks for their safety and security.

In a recent editorial on mad cow disease, The Economist wrote:

> "The political and cultural legacy of BSE is enormous. Because of it, public trust in science and government's ability to regulate it has plummeted."

Perhaps understandably, the public tends to lump all controversial issues involving science into the same basket of suspicion and doubt. Failures to deal adequately with concerns in one area, such as mad cow disease, cascade quickly into others, with the result that facts and sound scientific analysis are often lost in a flood of misperceptions and fears. It is not surprising that politicians give way to these fears, or simply refuse to deal with an issue. I would say the latter attitude — refusal to deal with the issue — characterises the nuclear debate in many countries.

I conclude that those of us who do believe that the future has a constituency must prove it by urgent action. We must have a public education campaign to lay out facts and dispel myths and fears about nuclear energy. Ideally, this campaign should be lead by political and civic leaders who have no vested interests in any particular energy option. If they abdicate this responsibility, you in the nuclear field must take it up, eventually to be joined by a broader group of respected spokespersons who wish to be part of that constituency for future generations.

Public trust in science has plummeted

This campaign should be based on an honest assessment of the risks and benefits of nuclear, and solutions to solve problems. I take our recent NEA Study *"Nuclear Energy and Sustainable Development"* as a very positive step in this direction. Fears and questions about nuclear energy abound: the safety issue, including radiation from operating plants; the relationship between nuclear reactors and the proliferation of nuclear weapons; and the dangers of nuclear waste. The latter is probably the major fear because of its longevity and the concerns for geological stability over many thousands of years.

Carlo Rubbia discussed this issue with me. He raised the Accelerator Driven Systems, and the prospect of reducing radioactive waste to harmless ash while co-generating electrical power. As you might expect, I was unable to comment on the science, but I was struck by the importance of moving ahead as quickly as possible with technological innovations in the nuclear field. Proof of further progress on safety and cost will be necessary to bring public opinion and hence political support behind the importance of nuclear energy once again.

I would also like to see the OECD membership use our Global Science Forum in order to mobilise significant resources and scientific expertise behind accelerated energy research in all areas, including fusion and Generation IV. Non-OECD countries such as Russia, China, India and others should equally participate.

The future of energy is not the future of any one part of the globe, it is the future of the fragile planet earth, the pale blue dot travelling alone through dark uninhabited space. As Burton Richter reminds us.

> "Our solar system appears to be empty of life except for us. We live in a closed system which will survive whatever we do to it, but it may not survive in a condition that is hospitable to human life."

So let us together from each corner of the global village join forces to ensure that it does survive in a condition hospitable to human life. That must be our promise to future generations.

Greenhouse Gas Reduction and Canada's Nuclear Industry

Jim Bowman[1], T. Gorman[2], Duane Pendergast[3], Murray Stewart[4]

Ed. Note: *With the CoP 6 meeting going on at the time of going to press we felt this paper, originally presented at the 21st CNS annual Conference in June 2000, would provide a perspective to that meeting and the on-going Kyoto Protocol debate . The authors have stated that it is still relevant.*

Abstract

The Kyoto Protocol of the United Nations Framework Convention on Climate change, dated December 10, 1997 committed Canada to reduce greenhouse gases to 6% below 1990 levels by 2008-2012. Subsequently the federal government initiated a broad review of the implications of such a reduction across all sectors of the Canadian economy to identify options for eventual implementation. The Canadian nuclear industry participated in this review. This paper examines the status of this review to date and identifies options, which may significantly influence the use of nuclear energy domestically and internationally.

This paper provides a review of options established by the three key Issue Tables in the context of implications to the nuclear industry. Several of the other Issue Tables have also identified options, which have major future implications for the use of nuclear energy. For example the Transportation Table has addressed the possible production and use of hydrogen fuel as an energy carrier. Biological and geological sinks are emerging technologies which will likely lead to increased energy demand. Development of the necessary infrastructure to support these new technologies could lead to a substantial need for increased production of electricity from greenhouse gas free sources in Canada in coming decades.

In conclusion, international concern with climate changes re-focuses attention to human application of nature's energy sources. The studies implemented by the Climate Change Secretariat have resulted in a comprehensive evaluation of opportunities for Canada to contribute to reduction of greenhouse gas emissions in Canada and abroad. The ability of Canada's nuclear industry to provide greenhouse gas free energy in the large quantities needed by modern society is recognized.

Introduction

The Kyoto Protocol of the United Nations Framework Convention on Climate change, dated December 10, 1997 committed Canada to reduce greenhouse gases to 6% below 1990 levels by 2008-2012. The federal government initiated a broad review of the implications of such a reduction across all sectors of the Canadian economy to identify options for eventual implementation. The Canadian nuclear industry participated in this review.

The federal government enlisted, through a Climate Change Secretariat, some 450 experts from government, business and industry, the academic community, environmental groups and non-government organizations. These experts participated in the work of 16 Issue Tables (Tables) examining and analyzing the impacts, costs and benefits of options to address climate change. The Tables began their work in July 1998 and have prepared some 22 options reports. Most of these are available at the Climate Change Secretariat's public Web site (www.nccp.ca). The options in the reports are currently under review to determine actions needed to address climate change and their level of priority. The outcome of the review will form the basis of Canada's national implementation strategy for consideration by joint Ministers (federal, provincial and territorial) of Energy and the Environment over a series of meetings in 2000-01.

The Canadian Nuclear Association (CNA) supported four experts to participate in the work of three Tables and the Integrative Group. The Tables supported were: Electricity, Kyoto Mechanisms and Technology. These Tables were deemed to be of prime importance to the nuclear industry.

The Electricity Table reviewed emissions from

1 Babcock & Wilcox Canada
2 Canadian Nuclear Association
3 Computare
4 Stewart Advantage Consultants Inc.

domestic electricity production and recommended options for consideration to reduce GHG emissions.

The Kyoto Mechanism's Table is of particular importance to the export of reactor systems and uranium as cost benefits to nuclear may result from any actions taken to constrain greenhouse gas emissions.

The mandate of the Technology Table enveloped all sectors and focused on the identification of options to develop Canadian technology that could play a role in reduction of GHG emissions. A prime goal was to encourage early development of promising Canadian technology in order to take advantage of the international market expected to develop as actions are taken to implement the Kyoto Protocol.

The Integrative Group is composed of the co-chairs and selected representatives of the Issue Tables and has undertaken review of all of the Issue Table Options Reports. It is assisting the National Air Issues Coordinating Committee with the preparation of the national implementation strategy for consideration by Ministers of Energy and Environment.

Table Mode of Operation

The final reports of the Tables represent a major investment by Canadian governments and industry to review the status of climate change and greenhouse gas emissions in Canada. On average the tables were made up of 30 individuals representing a broad range of expertise and stakeholders. Membership was carefully established to ensure that regional, government, industry and non-governmental interests were represented in a balanced way. The work of the Tables t began in the spring of 1998 with options reports essentially completed and circulated within the Tables by the end of 1999. Meetings were held at appropriate locations across Canada on approximately a monthly basis. Most Tables also engaged specialized consultants to collect and analyze information needed to understand the climate change implications of the sectors represented.

Tables were asked to focus on the time period established by the Kyoto Protocol which committed developed nations to reduce greenhouse gases to a specified level relative to 1990 levels by 2008 to 2012. Canada's commitment was to a level of emissions 6% below 1990 levels. The Tables first task was to prepare a Foundation paper, which established the anticipated scope of work and detailed mandate of each Table. The next order of business was to review and establish the status of emissions from the sector and to project expected emissions to ~2010, assuming that business would proceed as usual without the additional constraints imposed by the Kyoto Protocol. The final step involved review and identification of potential measures, which could be implemented to reduce emissions. To varying degrees, Tables evaluated the effectiveness of measures and packages of measures. The final Options Reports of the Tables recommend options for consideration by ministers. The Table's work was completed at the end of March 2000.

The Tables considered their sectors in isolation from the remainder of the Canadian - and International - economies. *(The electricity table, for example, did not take into account major changes such as a possible shift of transportation to electricity as the main source of energy.)* Two additional "Groups" were formed early to consider the work of the Tables in an integrative mode. The Integrative Group, initially formed from the co-chairs of the Tables, and later supplemented with selected members of the Tables, remains involved in reviewing the work of the Tables with the goal of establishing understanding and appreciation of overlapping and complimentary aspects of the Tables. The Analysis and Modelling Group is undertaking economic modeling of the Canadian economy based on input from the Tables.

Some of the Tables (the Technology Table and the Kyoto Mechanisms Table are examples) deviated from the above mode of operation as their topic was of significance to many sectors of the economy. The Technology Table reviewed greenhouse gas reduction technology with the twin goals of identifying technology that could be developed to reduce greenhouse emissions in Canada and marketed to other countries. The perspective was to propose measures that would begin enhancing the Canadian innovation system so that technology that could be deployed well beyond the Kyoto commitment date would be well established by that time. The Kyoto Mechanisms Table examined the potential of economic instruments, or measures intended to manage the economic cost that may be imposed on greenhouse gas emissions. These **"flexibility"** mechanisms potentially involve all other economic sectors.

Generally the Tables paid little attention to possible variations in primary energy source in terms of greenhouse gas emission intensity. The Electricity and Technology Tables did include explicit discussion of nuclear energy. Several other Tables included measures that could encourage the use of more electricity, thus potentially expanding the scope for utilization of nuclear energy.

The following sections summarize analyses and measures proposed across Tables in the context of potential impact on the nuclear industry.

The Electricity Table

Electricity production in Canada is a relatively small producer of GHG as approximately 75 to 80% of Canada's electricity is derived from nuclear energy and waterpower. The goal of the Electricity Table, to reduce emissions within the sector to meet the Kyoto Protocol, thus has only a modest effect on the overall Canadian GHG emissions reduction needed to meet the Kyoto goal.

The Table undertook its work in three phases. The first

established terms of reference and prepared the Foundation Report. The second involved data gathering and analysis. Finally Table members examined the results of analytical work and developed measures that could contribute to Canada's emission reduction target to and beyond the Kyoto period.

The Foundation Paper established the current state of the sector. The Electricity Table used a Natural Resources Canada report, Energy Outlook 2020[5], as the reference for its "Base Case" as a known starting point. The report represents NRCan's best estimate of future electricity demand in Canada assuming that additional measures to reduce greenhouse gas emissions are not introduced. During the course of the work the NRCan report was updated[6].

The assumptions used to prepare Energy Outlook 2020 also imposed constraints on nuclear energy which remained throughout the modeling process. These included:

- A minimum ten (10) year lead time for project implementation
- No new nuclear plants initiated until 2010
- Bruce A and Pickering A out of service until their scheduled return to service dates

This resulted in no new actual nuclear generation being introduced up to 2020.

The "business as usual" projections of Energy Outlook 2020 do not show a large increase in demand or installed capacity. As a result the Table focussed on the cost of changing the mix of generation to reduce emissions to 6% below 1990 levels.

In the second phase some additional analyses were undertaken to examine the least cost changes in the electricity mix to reduce emissions from generation. A computer model known as MARKAL was chosen to undertake the analysis. The model has the ability to model international influence on the Canadian electricity production.

The nuclear and fossil generation pricing information was extracted from the most recent information publicly available. Information which was considered proprietary was either carefully guarded by the process or not made available to the model. As a result technology costs are not methodically documented on a comparative basis in the Options Report.

The model was run to 2040 in five (5) year intervals. The main analysis centered on the information and results up to 2020. The model is capable of determining the following based on the least cost option:

- Electricity generation required
- Capacity required with adequate reserves
- Transmission line requirements
- Inter-provincial electricity trading
- Retirement of capacity

The model outputs for each scenario included the following for Canada and each province:

- Price per ton of CO_2 avoided
- Installed capacity required for each technology each year
- Actual expected electricity generated
- Cost of electricity

The sensitivity model runs indicated that demand and gas pricing had significant effect on the output of the model:

The modeling of nuclear electricity posed some difficulty in view of uncertainty with respect to the restart of Pickering A and Bruce A. It was assumed, for the base case, that both would be refurbished as planned by OPG. New nuclear plants were not allowed in the base case modeling. The second variation resulted in increased electricity production from hydraulic and gas powered sources while simultaneously decreasing generation from coal. The net increase in annual emissions with failure to restart Bruce A was thus calculated to be only 6 Mt. The potential contribution from restarting Bruce A is thus underestimated by a large factor as each unit of Bruce is capable of avoiding about 6 Mt relative to coal powered generation. Perhaps a revision of the modeling to credit export of more electricity to the US, where most electricity is from coal, would result in better utilization of North American resources?

The constraints and economic conditions imposed on the modeling were such that nuclear energy production was projected to change very little during and beyond the Kyoto commitment period.

Finally, in the third phase of it's work, the Table considered measures in two phases that could be implemented in a staged manner. The first phase measures were identified as "preparatory" and are intended to encourage, over the next one or two years, the availability of least cost technology for deployment in the commitment period. The Table identified GHG emission pricing as the most efficient means to reach a given constraint in emissions from the sector.

The Table recommended only emission pricing as an effective means to constrain GHG emissions up to the Kyoto period and beyond. A minority of the Table felt that a large-scale binding portfolio standard (mandated percentage of generation from non-emitting technology) could also play a role. The Options Report mentions "carbon tax" only twice and then in the context of pointing out that the proposed measure should not be considered a carbon tax. The concept of "energy tax" is not mentioned in the report at all.

The membership of the electricity table included representatives of environmental non-government organizations. These members expressed reservations with respect to nuclear electricity in spite of demonstrated near zero GHG emissions. The Options Report clearly states that **"representatives of environmental groups believe the use of nuclear power as a response to climate change poses an unacceptable risk to human health an safety and**

5 Canada's Energy Outlook: 1996 - 2020, Natural Resources Canada

6 Canada's Emissions Outlook: An Update, Natural Resources Canada

the long term contamination of ecological systems. Consequently they recommend that government not pursue that option".

Some of the environmentalists have similar reservations, although not in bold type, with respect to large hydroelectric developments. These opinions are implicitly identified as a minority position.

In summary, the analysis undertaken by the Electricity Table is not surprising with respect to the scant expectations for increased nuclear capacity up to 2020. The business as usual growth rates for electricity, combined with large existing nuclear capacity and low anticipated gas prices lead to the use of natural gas for the small growth in system capacity anticipated. Clearly, once the large nuclear plants are retired, beyond the timeframe on which the bulk of the analysis of the Options Paper were based, there will be a significant requirement for replacement non-GHG emitting technology. The possibility of increased need for GHG free energy to fuel other sectors has not been included in the analysis undertaken by the Electricity Table. Should GHG restraints become a reality across all economic sectors the need for electricity from GHG free sources is likely to expand still more.

The Technology Table

The imposition of constraints on GHG emissions will result in substantial changes to the technology underlying energy production and use. Energy use pervades almost all aspects of the worlds economy from communications to agriculture and forestry. Technology development will be a fundamental part of Canada's National Implementation strategy. The Technology Table was established with the dual mandate to identify measures to advance the development, demonstration and deployment of innovative GHG reduction technology while enhancing national and international market opportunities for Canadian companies.

The Table went through a multi stage process to accomplish this end. The first stage of the process involved parallel and independent reviews of technology needs, availability, and measures to promote development. The next stage of the process included identification of existing Canadian technology responsive to needs and arranging available technology into groupings deemed "promising illustrative technologies". The final stage consolidated measures into a set of options aimed at enhancing Canada's ability to encourage invention, development and demonstration of technologies needed to reduce GHG emissions and bring them to readiness for commercial deployment as constraints on GHG emissions begin to be imposed.

Nuclear fission is included in the promising technologies. *(Nuclear fusion was discussed and was deemed of little promise with respect to the Kyoto and beyond (to ~ 2020) commitment period.)* The promising technologies are each discussed in the framework of "innovation" terminology . The capability of nuclear energy as a means of reducing GHG emissions is established and Canada's nuclear "innovation" capability is established by reference to AECL and utility facilities, expertise and accomplishments in Canada and abroad. Barriers to commercial opportunities are identified and measures to enhance innovation in the nuclear industry are suggested. Suggested measures include improvement of the nuclear knowledge infrastructure through R&D to improve reactor performance and efficiency and support of demonstration projects to prove the use of nuclear energy for heating purposes (i.e. oil sands extraction). Additional funding support for development of nuclear fission, ramping up to $30 million/year is suggested. This is in addition to the current federal funding of approximately $100 million/year. Perhaps more significant to the future of nuclear fission in Canada is technology development recommended for the so called cross-cutting/enabling technologies. These include the development of fuel cells and other electrotechnologies which will ultimately increase the demand for GHG free energy in a GHG constrained world.

The Table developed "bottom up" and "top down" (Appendix A) estimates of the funding levels deemed needed to encourage development of the promising illustrative technologies, and to implement improvements to Canada's innovation system, respectively. There was a fairly close correspondence between the two estimates. The funding recommendation sums to about $1 to 11/2 billion focused on enhancing development of GHG reduction technology.

The Technology Table Options Report provides a notional estimate of increased funding needs for promising illustrative technologies. About $15 to $30 M/yr increased development funding is deemed necessary for nuclear fission. However, funding needed for technologies which could increase the demand for GHG free electricity is estimated to be about $200 M/yr. These technologies include fuel cells ($60 M/yr), transport ($30 M/yr), hydrogen ($20 M/yr), enabling technologies ($50 M/yr) and electrotechnologies (35 M/yr). These technologies will do little to decrease GHG emissions if GHG free primary energy is not made available for their implementation.

The Kyoto Mechanisms Table

The Kyoto Mechanisms Table was one of the first Tables to get underway. The impetus for this came from a need for early input to Canada's negotiators on International teams which are establishing the framework under which mechanisms for valuing and trading credits for reduced greenhouse gas emissions. The mandate of the Table was to provide advice to Ministers, government officials and interested stakeholders on Canada's strategic interests, and in particular, positions Canada should take on the elaboration of international market based mechanisms. These "Kyoto" mechanisms include: **Joint Implementation** (JI), the **Clean Development**

Mechanism (CDM) and **Emissions Trading** (ET).

The Kyoto Mechanisms Table Options Report provides an extensive review and explanation of the CDM, JI and ET concepts. Their recommendations to government are derived from the principles of environmental effectiveness, economic efficiency, flexibility, sustainable development, clarity and simplicity, the engagement of developing countries and balance with respect to impact on Canada's international competitiveness. The recommendations of the Options Report are generally consistent with the goals of the nuclear industry.

The Table supports the concepts of CDM and JI as means to reduce emissions economically. The nuclear industry sees these mechanisms as a way for Canada and/or the nuclear industry to receive economic credit for nuclear power projects outside Canada. Constraint of emissions and Emissions Trading (of credits), if implemented will ultimately attach an additional cost to competitors with high greenhouse gas emissions.

The Table supports the concept of **"fungibility"**, whereby emissions credits associated with the three mechanisms and different types of projects are fully interchangeable. This is of course consistent with the nuclear industry position that a tonne of GHG avoided by a nuclear power plant is as important to the atmosphere as a tonne avoided by reducing combustion product releases from fossil fuel.

The issue of **"supplementarity"** is important to the nuclear industry. This term is used to describe the concept that the total credits achievable by use of the Kyoto mechanisms should be supplemental to, and limited by, a correlation with GHG reductions achievable within the country. The Table could not reach a consensus on this. On one hand, industries such as the nuclear industry could be severely restrained in the credits that could be accumulated. Others note that, although increases in global emissions might be avoided through application of ET and CDM, full flexibility to apply these mechanisms is counter to actual GHG emissions reduction in the developed countries.

"Additionality" is another concept of developing definition. Credits for CDM projects may be linked to the idea that GHG creditworthy projects are only those which have been undertaken to reduce GHG emissions. Thus, it might be argued that a nuclear plant, viable on the basis of economic factors might be built without any credits. On this basis it would not warrant credits. The Table noted this is a critical issue on which Canada should take leadership in attempting to arrive at a more concrete definition.

Another concept of importance to the nuclear industry is the concept of **"baselines"**. Should a nuclear plant be built as a CDM project, the alternative must be established in terms of GHG emissions. Alternatives to nuclear power plants could conceivably range from solar to coal power installations. The credits to the nuclear plant would need to be relative to the baseline case, presumably requiring a full life cycle assessment of the alternatives.

The Table supports the concept that the Mechanisms should contribute to the achievement of sustainable development. The Kyoto protocol requires that CDM projects contribute to sustainable development. This is another concept lacking a universally understood and accepted definition.

The Kyoto Mechanisms Table's Options Report makes it clear that the Mechanisms are far from clearly and unambiguously defined. Much work remains to be done nationally and internationally to establish working Mechanisms. The Options Report provides a good primer for lay persons coupled with critical feedback to governments from other Canadian stakeholders.

Sector Tables and Nuclear Energy

Our participation in the deliberations of the Technology Table, combined with an appreciation of the Sector Tables analyses and recommendations, through participation in the Integrative Group, has led us to additional observations relating to energy use and the importance of biological processes to future greenhouse gas reduction.

The options put forth by the Technology Table and the Sector Tables tend to emphasize the importance of energy efficiency as the way to future reduction of greenhouse gases. This is a natural consequence of the great additional emphasis placed on energy efficiency over the last twenty or thirty years.

Many of the technologies proposed to reduce greenhouse gas emissions will actually be retrograde with respect to energy efficiency. Carbon management technology via biological sinks and geological sequestration will likely require even more energy input with respect to end use application. The preparation of hydrogen for use as a transportation fuel will introduce inefficiencies of energy use to meet the primary end goal of reduced GHG intensity per unit of end use.

Overall studies of the annual carbon cycle indicate that biological systems are responsible for at least an order of magnitude more carbon cycling through the atmosphere than human use of fossil fuel. Humans are already responsible for managing - or mis-managing - a major part of this. There is a lot of technology involved with the biological systems: irrigation systems, fertilizer production, tillage practice, genetic manipulation, etc.

The reports from the Forestry, Sinks and Agriculture Tables, taken together, confirm the potentially major importance of biological sinks. The Sinks table has estimated that sinks in Canadian forestry and agriculture could total about 100 Mt/yr. The reports of the tables indicate there is still a lack of knowledge of the potential for management of GHG emissions via forestry and agricultural practice. It seems that the development of policy, science and technological solutions for greenhouse gas management through application of life science knowledge is far behind the thinking process related to reduction of fossil fuel use. This is understandable, as the GHG life cycle assessment of life is far more complex than the simple

reduction of combustion processes applied to problems associated with fossil fuels.

However, it is likely that management of the biosphere to control emissions will require the use of or redirection of energy sources. Nuclear energy stands ready to provide the energy needed to implement the technology which will be developed to make the best possible use of Canada's and international biological sink possibilities.

Conclusions

The deliberations of the Issue Tables constitute a massive and useful statement of Canadian greenhouse gas emissions relative to the commitments of the Kyoto Protocol. Our participation in the Tables has been interesting and illuminating, as we have learned many do not have quantitative appreciation of the significance of nuclear energy in this regard. We have been given an opportunity to clarify the role nuclear could play while gaining more insight to the view of nuclear from other perspectives. We believe that the case for nuclear energy as a GHG free energy source has been made in the relevant Options Reports of the Issue Tables. The Kyoto Mechanisms Option Report provided recommendations for the consideration of Ministers that strive to be free of bias to any particular industry or energy source. The groundwork is in place to establish the case for nuclear fission as a major factor in Canada's program to comply with the commitment made at Kyoto.

Appendix A - Summary of Options and Funding Profiles (From Technology Table Options Report - Table 6, Page 63)

Options	Objective	Funding					Sources
		Year 1	Year 2	Year 3	Year 4	Year 5	
1. National Climate Change Discovery Competition	To develop new concepts and ideas that could lead to new greenhouse gas mitigation technologies	$25M	$25M	$25M	$25M	$25M	federal
2. Enhanced Support for Basic Knowledge Generation	To enhance the knowledge base for opportunities that could have a long-term impact on greenhouse gas mitigation technologies	$5M	$5M	$5M	$5M	$5M	federal
3. Climate Change Technology Development Fund	To assist in developing technologies from comcept to point of demonstration	$20M	$40M	$80M	$150M	$200M	federal: up to 50% provincial: 25% industry: 25%
4. Climate Change Technology Demonstration	To alleviate some portion of the financial risks involved in early domestic commercialization of greenhouse gas mitigation technologies	$60M	$90M	$150M	$240M	$300M	provincial and industry: 70% federal: 30%
5. International Marketing	To create the climate for enhanced interantional marketing of climate change technologies and thus achieve the second part of the Technology Table's mandate	$400K	Dependent on strategy				federal (for year 1)
6. Reducing Risk and Facilitating Accreditation	To undertake comparative analysis of the recognition of risk in the technology innovation process granted by other countries	$200K					federal and provincial
7. Technology Nodes and Roadmaps	To develop improved strategic understanding of technological opportunities for greenhouse gas mitigation technologies in and across industrial sectors, and between technology suppliers and technology users	$5M	$5M	$5M	$5M	$5M	federal: 60% provincial: 40%
8. Communication Forum	To ensure that decision-makers responsible for the investment of the limited resources available for technology development have the benefit of adequate knowledge and information for informed and sound decisions	$300K	$300K	$300K	$300K	$300K	federal and provincial
Totals		$115.9M	$165.3M +	$265.3M +	$425.3M +	$535.3M +	

The Effects of Low Doses of Ionizing Radiation

Comments on Dr. Rosalie Bertell's presentation before the Senate Standing Committee on Energy, Environment and Natural Resources, September 21, 2000.

by Philippe Duport[1]

Ed. Note: *the Standing Committee on Energy, environment and Natural Resources of the federal Senate has been holding hearings into nuclear safety since early 2000. In the spring it heard from the Atomic Energy Control Board (now Canadian Nuclear Safety Commission), Atomic Energy of Canada Limited, Ontario Power Generation, Power Workers Union, and others. On September 21, Dr. Rosalie Bertell, a long-standing nuclear critic, presented the Committee with a litany of mis-information on the effects of radiation. Fortunately, Dr. Phillipe Duport, Director of the International Centre for Low Dose Radiation Research, part of the Institute of the Environment at the University of Ottawa decided to submit a rebuttal. Following is the text of Dr. Duport's submission, slightly edited.*

Summary

The calculation of a number of radiation-induced cancer cases presented by Dr. Bertell is based on hypotheses for which scientifically strong counter-arguments exist.

Verifiable examples that contradict the hypotheses upon which Dr. Bertell based her presentation are given. They show that

- Ionizing radiation is, and has always been an integral part of the environment in which life has evolved and in which we live today.
- Large populations live in areas where the natural levels of radiation exceed three times the Canadian regulatory limit for radiation workers, without evidence of increased risk of cancer or malformations in newborns.
- Beneficial effects of radiation have been observed and that some living organisms, including mammals, do better with a little more, rather a little less, radiation.
- There is no simple relationship between radiation dose and risk of cancer.

However, it is known that too much radiation is dangerous. Therefore, the hypothesis of a simple linear relationship between radiation dose and cancer risk was adopted as a *prudent default option* for protection purposes. Its authors have never condoned its use to calculate the number of cancer cases that would result from an infinitesimal dose of radiation received by an infinitely large number of individuals. Such a calculation merely results in a *hypothetical* number of cancer cases, without defensible scientific merit.

Nevertheless, evidence of both beneficial and detrimental effects of low radiation doses brings a complex but crucial public health issue: What is the real cost-effectiveness, in terms of public health and returns on investment, of systematic efforts to reduce radiation doses comparable to natural levels?

Note: The information presented in this document is drawn from an ongoing internationally funded research project untitled: "Global study of the biological effects of low doses of ionizing radiation", conducted at the International Centre for Low Dose Radiation Research, Institute of the Environment, University of Ottawa.

I Introduction

For historical, sociological and cultural reasons, there are wide differences in different countries or populations, in the perception of nuclear-related matters and radiological risks. In Canada, nuclear and radiation issues frequently evoke suspicion or fear rather than rational examination. To fully understand the rational and irrational reasons that are behind this fear, but this is beyond the scope of these comments.

The field of radiation and health is vast and complex. A great number of learned books and tens of specialized scientific periodicals have been devoted to it. Therefore, the following comments are necessarily sketchy but, if deemed useful, I would be honoured to give a presentation before the Committee.

Before addressing the various points made by Dr. Bertell, a few examples are given to put low dose radiation into perspective with radiation occurring naturally in the environment and in the human body

1 Dr. Duport is Director, International Centre for Low Dose Radiation Research, Institute of the Environment, University of Ottawa

2 Radiation in the natural environment

A few examples will illustrate the ubiquity of radiation around us.

2.1 Cosmic radiation

The Earth bathes in cosmic radiation coming from space. Reactions between cosmic rays and components of the atmosphere continuously produce radioactive atoms that become part of our natural environment. Cosmic radiation increases with altitude, so that people receive more radiation when living in elevated areas or travelling by air.

2.2 Earth crust radiation

The Earth crust contains some seventy chemical elements that are naturally radioactive. They irradiate us from the outside and from inside the body. The bulk of radioactive materials contained in rocks and soil are from uranium and thorium. They emit gamma radiation and release a radioactive gas (radon), which is present everywhere in varying quantities.

There are heavily populated areas in the world where natural levels of radiation exceed several times the maximum Canadian dose limits for radiation workers[2]. *If such levels were observed in Canadian a nuclear facility, their operator would be required to drastically reduce radiation exposures and, failing this, a shutdown of the facility.* (More details on areas with high radiation levels in Section 3.2.4, page 7.)

2.3 Plutonium vs. natural naturally occurring polonium

In the recent past, the media and some people have expressed concerns about the transportation of several samples of nuclear fuel containing plutonium 239 (mixed uranium-plutonium oxides, called MOX). The samples in question contained about 100 grams of plutonium each. It is useful to put this quantity into perspective with the quantity of one of the radioactive materials produced by Nature, polonium 210.

Typically, the first top metre of a 15 by 25-metre house lot contains, on average, three kilograms of uranium and ten kilograms of thorium. One of the elements borne from the decay of uranium is a gas called radon. Radon escapes continuously to the air from the surface of the earth. In average, every square metre of land releases about 10 thousand atoms of radon every second, that is, a source of 10,000 Becquerels[3]. Radon, which is also radioactive, decays into a series of radioactive atoms, one of them being polonium 210. Rain, fog, snow, and dust bring polonium 210 back to the ground, where it accumulates. Since the source of radon never stops, the quantity, and the activity (quantity) of polonium on the ground remains constant at about 10,000 Becquerels per square metre.

The International Commission on Radiological Protection calculates that polonium-210 is five to ten times more harmful than plutonium 239. Therefore, in terms of theoretical risk of cancer due to radioactivity, 10,000 Becquerels of polonium 210 are equivalent 50,000 to 100,000 Becquerels of plutonium 239. If one converts the quantity of polonium 210 on the ground into a mass of plutonium that presents the same *theoretical* danger to health, there is the equivalent of 0.044 mg of plutonium per square metre of land. This does not look like much, but for the Province of Quebec alone – an area of 1.5 million square kilometres - this is equivalent to some 60 tons of plutonium 239, to be compared a few hundred grams of plutonium contained in MOX samples. One may object that this in an unfair comparison because the very dispersion of radioactive materials reduces its risk, but this is exactly the point: the risk may be zero when exposures are low enough.

Radioactivity in the human body

Two of the natural constituents of living organisms are radioactive potassium (potassium 40) **and** carbon (carbon 14). The human body contains about 55 Becquerels per kilogram of each. Therefore, more than 300 millions radioactive disintegrations of potassium 40, and the same number from carbon 14 occur every day in the human body. Radiation from external sources (uranium and thorium decay series in the ground, cosmic rays, X ray medical examinations, ...) is added to our internal sources of radiation. Continuous exposure to radiation has always been part of life. In fact, the natural radioactivity has decreased since the formation of Earth. The dose of radiation received by cells when life began some 4 billions years ago was about seven times greater than it is now.

3 Discussion of Dr. Bertell's assumptions and arguments.

Dr. Bertell represents one of the many opinions in this matter. Her arguments are based on hypotheses that have not been clearly substantiated by factual observation (experiments on mammals or human epidemiology), and for which robust experimental and observational counter-examples exist.

It is impossible to summarize in a few pages the huge volume of knowledge (and the remaining questions) on the effects of radiation on living organisms. I will use only a few verifiable examples to show that the relationships

2 Outdoors annual gamma doses in some populated beaches in Kerala reach 76 mSv per year, with 50% of the doses higher than 2.6 mSv per year, compared to an average of 0.23 mSv per year in Canada (UNSCEAR 1993).

3 A quantity of radioactive material in which one atom splits every second is a source of 1 Becquerel.

between low doses of radiation and risk of cancer are not obvious and not always in the same direction. Should the Members of the Standing Committee on Energy, Environment and Natural Resources wish more detailed information or clarification, I would be pleased to expand on any aspect of this submission.

3.1 Assumption #1:

The risk of radiation-induced cancer increases linearly with dose, without thresholds below which there is no risk (the linear no-threshold hypothesis, LNT).

At this time, science cannot determine, with certainty, whether radiation doses comparable to those delivered by Mother Nature are harmful or not. Due to limitations inherent to the science of epidemiology, it is generally impossible to detect a small increase of cancer incidence in human populations, in which about a quarter of all the deaths are due to cancer. Therefore, epidemiological studies in human populations exposed to radiation do not provide conclusive evidence of radiation harm, one way or another. For example, in the survivors of the Hiroshima – Nagasaki atomic bombs, it is possible that the risk of cancer is linear with dose, without a safe threshold (with a possible exception for leukemia), but unavoidable statistical uncertainties also make it possible to describe the relationship between dose and cancer risk with non-linear relationships. This precludes any firm conclusion in this issue. Furthermore, Hiroshima – Nagasaki populations were victims of the atomic bombs after years of war deprivation and were subject to immense distress in the aftermath of the bombing. The influence of psychological and physical stress on cancer incidence is well known[4].

Conversely, in the late 1950's, a population of over 70,000 US shipyard workers was split between those who built conventional ships and those who built nuclear vessels. An epidemiological study of these workers indicates that the "nuclear" workers had a significantly lower incidence of cancer than their "non-nuclear" counterparts. In this population, the **exposed and non-exposed populations** were quite comparable in every respect[5]. Therefore, differences in cancer rates in the two groups of workers cannot be attributed to differences in socio-economic status, lifestyle or other confounding factors.

Animal experiments indicate that the risk of cancer may be increased or decreased in mammals exposed to low doses of radiation. Factors such as the rate at which the dose is delivered, species and strain (genetic factors) may influence the magnitude of the risk in either direction.

A number of steps are necessary for a healthy cell to become cancerous, and a number of outcomes are possible before a cell becomes malignant. The steps towards malignancy and the possible intermediate outcomes after a cell has been injured are described in the figures below[6].

The mechanisms that defend living organisms against internal or external aggression are complex. Every single event following the energy deposition is countered by defense mechanisms that are the result of four billion years of evolution and selection, and there is no indication that the efficacy of defense mechanisms depends on dose. In fact, experimental evidence indicates that the progression towards malignancy is not a simple linear function of dose[7].

Indeed, cellular alterations involving multiple steps (e.g. functional changes from the loss of two or more tumor suppressor genes) may show highly non-linear responses, with apparent thresholds. Moreover, low-level radiation and its possible health effects should not be considered in isolation, but rather in the context of inherent DNA instability and of combined effects with other agents[8].

3.2 Hypothesis #2:

Any amount of radiation is harmful.

Five examples, taken from different areas of radiobiology research contradict that hypothesis:

3.2.1 Effects of deprivation of radiation

Research on radiation effects on health has almost always been aimed at detecting and measuring harmful effects. However, some researchers tried to see what happens when living organisms are deprived of radiation. The results are surprising. Bacteria colonies receiving less than natural levels of radiation dwindle while those exposed to about three times natural levels thrive[9].

3.2.2 Low-dose radiation, life expectancy and cancer risk

Various strains of mice exposed to very low doses of gamma radiation live longer and have fewer cancers than non-irradiated mice. The survival time of 50% of the exposed mice was 673 days, compared with 549 days for

4 For example: Psychosocial Stress and Cancer. C.L. Cooper, Publisher: Wiley, John & Sons, Inc. (1985)

5 Matanoski, G.M. Health effects of low-level radiation in shipyard workers. DOE Report DE-AC02-79EV10095, June 1991

6 R.E.J. Mitchell and D.R. Boreham, Radiation Protection in the World of Modern Radiobiology: Time for A New Approach, Proceedings of the 10th Conference of the International Radiation Protection association, Hiroshima, 2000.

7 See reference 5, page 5.

8 Burkart, W. et al. Damage patterns as a function of radiation quality and other factors. Proceedings of the Symposium "Carcinogenic risks due to ionizing radiation", Compte Rendus de l'Académie des Sciences (France), Série III, Tome, 322, N. 2-3, pp. 81-101, 1997.

9 Planel, H. et al. Influence on cell proliferation of background radiation or exposure to very low, chronic gamma radiation. Health Physics Vol. 2 No. 5, pp. 571-578, 1987.

the control group. Furthermore, exposed mice had fewer cancers than their non-exposed counterpart[10].

3.2.3 Radiation and genomic instability

The instability of the genome is one of the reasons for a cell to progress from normal to cancer. Genomic instability can be induced by chemical reactions and radiation. Genomic instability is variable between individuals. Recent work on the response of the genome to irradiation indicates that genetic instability induced by low-dose radiation seems to be a step-wise phenomenon, that is, an "all or nothing response". This is indicative of threshold-limited responses to irradiation[11].

3.2.4 Cancer rate and life expectancy in high natural radiation areas

Coastal areas of the Kerala state (South India) are an example of places with very high natural radiation levels, up to 70 milliSieverts[12] per year outdoors (the regulatory limit for radiation workers in Canada is 20 milliSieverts per year and the dose limit for members of the public is 1 milliSievert). Several hundred thousand persons live in this area, which has been inhabited from time immemorial. There is no indication of elevated incidence of cancer and malformations in newborns in these populations[13]. In fact, the incidence of cancer in this part of the world is about 74 per 100,000, compared to about 100 per 100,000 in Canada, with a remarkable life expectancy of 74 years for women and 69 for men, in a country with a very low Gross Domestic Product per capita of about $(Canadian)2,200. Similar observations are made in other high background radiation areas in China, Japan, Germany, etc.

3.2.5 Use of low radiation doses in cancer treatment

Clinical research in the treatment of some forms of leukemia indicates that repeated administration of relatively low doses of radiation enhances immune defense mechanisms and improves the chance of survival of the patients[14]. In these treatments, radiation is typically delivered in 15 fractions, to a total dose of 1.5 Sieverts. Although these doses are much above the annual dose received from natural sources, they are well below usual therapeutic **doses used to kill cancerous tissues.** It is their documented stimulation of the immune system that helps the patients to fight cancer.

4 Hypothesis #3:

Repair mechanisms are not triggered by low doses of radiation.

The LNT hypothesis ultimately predicts that any dose, no matter how small, increases the risk of cancer. Irradiated and non-irradiated cell cultures were used to directly test that prediction. The test consisted in counting cells that became malignant after irradiation. The results are depicted in Table 1.

Table 1: The influence of low doses delivered at low dose rate (2.4 mGy/min) on the risk of spontaneous malignant transformation.

These data show that at an average of one radiation hit per cell (the number of radiation hits per year in human cells at natural radiation levels) the risk of spontaneous malignant transformation was reduced below the rate of spontaneous transformation in the absence of radiation exposure. The data also show that higher doses, up to 100 times greater, delivered at a low dose rate, produced the same 3-4 fold reduction in spontaneous malignant transformation risk[15]. (Note: A dose of 1 mGy is about three times the average gamma radiation dose in Canada).

Treatment	Transformation Frequency (x 10-3)
Control	1.8
1.0 mGy	0.62
10 mGy	0.39
100 mGy	0.49

5 Hypothesis #4:

Radiation-induced DNA damage is the cause of cancer

Scientists agree that cancer arise from cells that have

10 Catatero et al. Effects of a continuous gamma irradiation at very low doses on the life span of mice. Gerontology, Vol. 44, pp 272-276, 1998.

11 Mothersill, C. and Seymour, C. Genomic instability after low dose irradiation: Relationship to cell stress and implications for radiation protection; and Masse, R. Synthesis and conclsions, Proceedings of the World Council of Nuclear Workers Conference "The effects of low and very low doses of ionizing radiation on human health, Versailles 1999, published by Excerpta Medica, International Congress Series 1203, 2000.

12 The Sievert is a measure of the risk of radiation-induced cancer in man.

13 Nair, K.S. et al. Population study in the high natural background radiation area in Kerala, India, Radiation research Vol. 152, pp.S145-148, 1999.

14 For example Sakamoto et al., Fundamental and clinical studies on cancer control with total or upper half body irradiation. J. Jpn. Soc. ther. Radiol. Oncology, Vol 9, pp. 161-175, 1997; and Richard P.M. et al., Place of low-dose total body irradiation in the treatment of localized follicular non-Hodgkin's lymphoma: Results of a pilot study. Int. J. Radiation Oncology Biol. Phys. Vol. 40 N. 2, pp. 387-390, 1998.

15 Azzam, E.I. et al. Low-dose ionizing radiation decreases the frequency of neoplastic transformations to a level below the spontaneous rate in C3H10t½ cells. Radiation Research Vol. 146, pp. 369-373, 1996.

mutated, survived, multiplied and transmitted their malignant mutation. However, the DNA in human cells is subject to intense aggression from highly reactive chemicals produced by the natural metabolism of oxygen (OH radicals). It is estimated that OH radicals damage the DNA in every cell in the human body at least 10,000 times per day. In comparison, natural radiation levels are the cause of about one DNA break per cell per year. Therefore, natural radiation accounts for an infinitesimal fraction of the damage sustained, and repaired in living cells[16].

6 ICRP membership and credentials

Dr. Bertell mentions, correctly, that the ICRP is a self-appointed, self-perpetuating body. However, the members of the ICRP are not without credentials. Medical doctors, radiobiologists, occupational and public health physicians, epidemiologists, geneticists, physicists, etc... are members of the Main Commission or present in specialized committees. (Dr. Duport submitted a list of members of the ICRP and its main committees.)

7 Conclusion

The calculation of a number of cancer cases presented by Dr. Bertell is based on a number of hypotheses not clearly demonstrated and for which scientifically strong counter-arguments exist.

The few examples above illustrate that, even though radiation protection regulations and practices are based on the hypothesis that the risk of radiation-induced cancer is linear with dose, this hypothesis is a *prudent default option*[17]. Its authors have never condoned its use to calculate the number of cancer cases that would result from an infinitesimal dose of radiation received by an infinitely large number of individuals. Such a calculation merely results in a hypothetical number of cancer cases, without defensible scientific merit.

These examples also show that ionizing radiation is an integral part of the environment in which life has evolved and in which we live today. We know that too much radiation is dangerous. We also know that there is no simple relationship between radiation dose and risk of cancer. Many biochemical and biological events take place in a cell whose DNA has been altered by whatever aggression, most of them with no simple linear relationship with preceding or consecutive steps.

There is also experimental evidence that some living organisms – including mammals - do better with a little more, rather than a little less, radiation. In most instances, however, unavoidable statistical uncertainties make it impossible to determine whether small deviations from natural levels of radiation, in either direction, have a negative or positive effect on the incidence of cancer. The fact remains that beneficial effects of radiation have been observed. We do not know for sure whether a systematic reduction of radiation doses comparable to, or smaller than, natural levels does more good than harm in a large, genetically diverse population.

This brings a complex but crucial public health issue: What is the real cost-effectiveness, in terms of public health and returns on investment, of systematic efforts to reduce radiation doses comparable to natural levels?

16 For example, see footnote no. 6 and Bishop, JM et al. Molecular biology of the cell. Alberts B. et al., Eds., Garland Publ., 1989.

17 Kellerer A. and Nekolla E.A. The LNT-controversy and the concept of "controllable dose". Health Physics Vol. 79(4), pp. 412-418, 2000.

A Web Site for Scientific Codes:

Building Bridges between Owners and Users

by Cheryl Gaver[1]

Ed. Note: *The following paper was originally presented at the 21st Annual Conference of the Canadian Nuclear Society held in Toronto, Ontario, June 2000. It has been slightly edited for length.*

Abstract

Web technology is a tool that is gaining in popularity. Properly used, it is a powerful tool that has tremendous potential for providing better communication. It can also be effective as a training tool, an information-sharing tool, and as a means of simplifying work load, and facilitating compliance with Company procedures.

The issue is one of communication. The challenge facing many large or geographically-distributed companies is how to communicate information to their staff and to their customers. Procedures overseeing quality-assurance programs and commitment to ensuring the quality of products need to be communicated to customers. Equally important is customer feedback. This information from users becomes the kernel for future product development.

The issue is even more important when speaking of scientific analysis computer programs (SciCodes). Regular ongoing communication between Primary Holders and End Users is essential in the development and use of SciCodes. Without this communication, quality assurance is at risk. Quality assurance processes are an integral part in developing any SciCode. End Users also have a role to play. Primary Holders keep End Users informed of improvements or new releases. End Users must ensure they act on this information. Equally important, End Users must communicate problems or suggestions to the Primary Holder to remedy or incorporate in new releases. In other words, quality assurance processes become most effective when both Primary Holder and End Users are involved. This requires communication.

This paper looks at some of the ways AECL is using Web technology with respect to its SciCodes. It briefly describes the background, vision, requirements, capabilities, and future direction of some of the SciCode Web pages currently existing or under development at AECL.

Introduction

Picture yourself as a new user of a Scientific Analysis Computer Program (SciCode). You have been told which program to use, whom to contact for information about the program, and have been given a thick reference manual. You need to know some basic, general information about the program's capabilities but cannot find it. Your contact is away for the week, so you do the best you can. If only there were one central spot where you could pull up general information on the program, including its development history, check its capabilities, or find out about upcoming training sessions with a simple click of the button. If only there were one central spot where you could retrieve major documentation, see who is developing or qualifying the program, read about its limitations or any problems with the SciCode that have been reported. If only there were one starting point that could give you what you needed about the SciCode, give you opportunity to offer suggestions for future development, and perhaps even direct you to the executable itself so that you could actually run the program!

This paper describes how we, at Atomic Energy of Canada Limited (AECL), are implementing Web technology with respect to SciCodes. It briefly describes the background, vision, requirements, capabilities and future direction of some of the SciCode Web sites currently existing or under development at AECL.

Background

AECL has had a Web site for one of its major SciCodes, Canadian Algorithm for Thermalhydraulic Network Analysis (CATHENA), for a number of years. It was developed to support internal customers, but is also used to support non-AECL CATHENA users around the globe, and has become the model for subsequent SciCode Web sites.

Until recently, however, CATHENA was the sole AECL SciCode Web site. Our recent experience on Y2K demonstrated that something comparable to the CATHENA site was desirable for other major SciCodes at AECL.

As part of the Y2K initiative, the SciCode team was responsible for co-ordinating activities relating to over 400 different SciCodes and multiple versions of these programs. Procedures were implemented, evaluations and remedial actions were completed, and external customers were kept abreast of Y2K activities. One of the daunting challenges that confronted the Y2K team was how to manage communication between the code developers (Primary Holders-Owner Branches) and the code users

1 Atomic Energy of Canada Limited, Mississauga, Ontario

(Projects and various groups actually using the program.). Traditional methods of communication such as memos, general notices, and even e-mails could too easily be buried or, once issued, be lost. The Y2K team wanted to give people a convenient means of accessing current information. To address this concern, we published Y2K updates on the Y2K SciCode Web site, and distributed the link to the site by e-mail.

As the Y2K project ended and the Y2K team assessed what lessons were learned, we recognized the need for better ongoing communication between SciCode owners and users, and realized that Web technology, properly used, could be the solution.

We noticed that the Y2K SciCode project had sometimes run into difficulties where users had incomplete or erroneous background information about programs they were using. In some cases the individual identified as "Primary Holder" for the SciCode had long since been transferred or had even retired. In other cases, "Owner Branches" no longer existed under the name provided by the project; Company reorganization had often resulted in renaming the branches. Similarly, Primary Holders knew which groups were using their programs, but were often unaware of specific individuals. These were not an issue for major SciCodes, which are used throughout the life of a project, but were at times discovered to exist for less important and less frequently-used programs.

AECL has a well-developed system of software quality controls and configuration management, and is fully committed to ensuring the quality of its SciCodes. What was missing was a way to ensure that users within and external to AECL were kept abreast of developments, modifications, and changes to our SciCodes. In other words, the Y2K SciCode team identified a communication gap between owners and users, and developed a way to bridge that gap.

Vision

People and companies often have misconceptions about the use of Web technology. They may feel that money and developing sites that are visually appealing will somehow accomplish whatever they are trying to accomplish. What they fail to realize is that Web technology is a tool and not a solution in itself. Web sites that communicate very little, are time-consuming to load. If they are difficult to navigate, they are ultimately useless.

To be effective, Web sites require planning with respect to content and organizational layout. What is to be communicated? How will it be communicated? How will the site be organized to facilitate the intended communication? The purpose of any single Web site needs to be clarified from the very beginning.

We acknowledged the potential that Web technology offered: potential for communication, marketing, code documentation, code execution, code development, management, and training. We also acknowledged several constraints: the limited resources, the number of different SciCodes used by AECL, and the desire to publish well-defined sites without undue delay.

Given the need that had been defined, and recognizing the potential offered by Web technology, and the constraints under which we would be working, we clarified our vision of what we were trying to do.

What was the problem we were trying to address?

A communication gap existed between owners and users of many SciCodes at AECL. It needed to be bridged better than it had been.

What did we think we could accomplish with a Web site?

We believed that a Web site would provide the means of posting current, easily accessible information for users.

These answers became the basis for our mission statement:

The primary purpose of the new Web site is to provide required information for people who need it when they need it, and in a form that they can easily retrieve and use.

In addition, secondary purposes were also identified:

- a repository of SciCode documentation (including feedback from users and requests for changes);
- training on how to use the SciCode;
- marketing the SciCode to potential clients.

These purposes were considered in planning the layout of the site. Anything relating to the primary purpose would be incorporated into the site from the very beginning. Anything relating to the secondary purposes would be planned for in the organization of the site, but would not be included in the initial phase.

What were we not trying to accomplish?

- We were not creating our own document management group, or developing our own methods of providing configuration management of the program.
- We were not by-passing AECL's procedures for ensuring quality and integrity of its products, or for protecting its intellectual property.
- We were not developing Web pages for all of AECL's SciCodes at this point; rather we were focusing on SciCodes that were Industry-Standard Tools (IST) or were deemed critical to AECL's business.

As we began to develop our Web site, we realized that much of we wanted to include was dynamic information, or information that was frequently updated. This information had to be current. The best way to ensure this was to create a database that would be regularly updated. Visitors to the site would access current information through Web-based queries of the database. Once we realized how much the information needed to be dynamic, we realized how much we needed to create an interactive Web site. Gradually, we discovered the potential that such a site could offer: it would be the means by which we would cap-

ture information *from* users as well as provide information *to* users. Ontario Power Generation (OPG) showed us a Web-based document they had developed for one of our SciCodes, Reactor Fuelling Simulation Program (RFSP). This gave us new ideas as to how we could transform our site from being a means of bi-lateral communication to also becoming an information repository with the need for information management.

What criteria would be used to evaluate the success or failure of the Web site?

This was difficult to define quantitatively. How does one assess *improved communication* in measurable terms?

To maintain communication, we rely on a continuous series of events—such as e-mails, telephone calls, conversations, memos, meetings, etc., that may be missed or delayed. Web sites allow visitors to access information at their convenience. Improved communication could therefore be defined and measured as the reduction in the number of telephone calls and e-mails, combined with the increased use of various Web forms, such as feedback and nonconformance forms.

To date, we continue to focus on bridging the communication gap between code developers and code users. We continue to use the CATHENA Web site as the model for our Web sites and communicate regularly with the CATHENA group to co-ordinate our activities. We are working to develop interactive sites that facilitate communication, compliance with software quality assurance (SQA) requirements, and enhance code development.

Requirements

In ascertaining the requirements for the Web site, we had considerable experience with various online systems. As a result of this experience, we were able to define the major requirements for the RFSP Web site in terms of: use, security, quality control, and content.

Use

After considering our user's needs, administrative needs, and future directions we already envisaged, we determined that the site had to be -

- easy to navigate and intuitive for occasional users;
- easy to administer: maintain, manage, and update; reliable and dependable;
- flexible, adaptable to changing requirements;
- portable to other programs if required;
- always available and always current, without compromising data integrity.

The primary requirement was *keep it simple.*

Security

Security issues were assessed in terms of -

- risk from unauthorized access, potential loss of proprietary information to unauthorized individuals;
- risk from accidental loss, such as the potential to overwrite or accidentally change data;
- risk from network problems, disk crashes, etc.;

Permissions, separate directories for different types of information, and reliance on AECL's network backups were considered sufficient to meet the security requirements. AECL's firewall and monitoring procedures as well as the professionalism of AECL staff reduce the risk of unauthorized access or loss of proprietary information to unauthorized individuals. File and directory permissions ensure that documents are not overwritten or changed. Reliance on AECL's official repositories and regular network backups ensure that no document is lost, even if the site itself is lost because of network problems, etc.

RFSP, similarly to CATHENA and several other SciCodes, is an industry-standard program hosted by AECL. The RFSP information posted on the Web site should be available to partners who work outside of AECL. However, this requirement raises other security issues. Until a permanent solution is found, copies of the RFSP Web site will be created and distributed to authorized external users via CD-ROM.

Quality Control

Quality control was evaluated at several levels:

- the Web site itself
- the ongoing maintenance of the site

Three major decisions regarding quality control were reached:

The Web site would be released in stages:

- to a limited number of individuals for review and clarification of requirements and content;
- to the SciCode development and qualification teams and selected users for testing;
- to all of AECL;
- to external customers.

Formal documentation would be required at every stage. Formal review and sign-off, including formal disposition of review comments, would be required prior to authorized release of the site.

The Web site would not replace AECL's official repository for documents.

Full-scale information management of the site itself or automated quality controls regarding data entry would not be implemented. Documents could be stored in "native format" (i.e., left in MS Word, EXCEL, etc.) so as to facilitate re-usability.

Changes to the site would be implemented in a systematic way.

Changes to the Web site will be suggested by reviewers

and users. Corrections would be made as soon as errors were reported; changes, however, would be documented and implemented in new releases of the site.

Content

To determine what information should be on the site, we returned to our original illustration of a new user. We asked what information would such a user need to become "comfortable" running a SciCode.

Information was categorized in terms of sensitivity and access privileges:

- General information should be available to everyone. This includes non-proprietary information, such as upcoming seminars or conferences, as well as more detailed information that has already been published in journals or presented at conferences;
- Restricted information should be available to authorized or registered users. This includes support information about test data, program limits, change requests as well as official documentation, and detailed information about the SciCode itself;
- Administrative information required to maintain the site. This includes user password lists, source documents and databases, forms, scripts, and a document storage area and should not be available to authorized or unauthorized users.

In addition, the possibility of an area for development information that could be accessed only by the SciCode development and qualification teams was also envisaged, to be considered at a future time.

Information was also categorized in terms of whether it was static or dynamic.

- Static information was put directly into HTML;
- Dynamic information—information that would be frequently updated—was put into MS ACCESS databases where it could be queried or updated through Web interfaces.

To make the Web site more "user friendly", we decided to create a generic interface that did not require knowledge of special programs or applications either by visitors to the site or by the administrators, who may be unfamiliar with MS ACCESS.

Capabilities

The **primary purpose** of the Web site was defined as "improved communication". We evaluated the requirements for the Web site against this purpose and ascertained that the Web site, as envisaged, would provide important and useful information to users should they visit it. We then focused on what was necessary to encourage communication from users.

An Interactive Environment

Picture yourself as the Primary Holder responsible not only for developing the SciCode program, but also for managing it. The administrative requirements are daunting. Not only are you responsible for configuration management of the program and relevant documentation; you are also responsible for maintaining a current list of authorized users, and for recording, tracking and reporting all changes to the program since the last authorized release. If only there were a way to deal with the administrative requirements easily, quicky, and without having to copy or recreate data.

A few years ago, when AECL initiated a new phase in its SQA program, procedures were revised so as to comply with the newly-released CSA N286.7-99 Standard (Reference [1]). New requirements were identified and new processes were developed. We were challenged to investigate whether it was possible to use the Web site as a way to facilitate compliance with CSA Standard.

Complying with SQA Standards

We reviewed CSA N286.7-99 and AECL SQA procedures and defined ways through which the SciCode Web sites could facilitate compliance with their requirements. Note, the SciCode Web sites do not actually meet compliance with these standards or procedures. Rather, they provide a way to simplify various processes which are designed to meet SQA requirements, and offer an interface between the Primary Holders / End Users and whatever configuration management / information-management system exists.

Some of the ways in which we facilitate compliance:

Version and Data pages. These pages identify the official version of a SciCode and direct users to the location of the authorized executable of the program. The Version pages document the relationship between configuration versions and identify the modified computer program components, description of changes, dates of new releases, and reference to documents containing more detailed information where appropriate. The Data pages direct users to the authorized executable, and to verification data. Users are able to verify the execution of a SciCode following transfer of the program to a new location or prior to using the SciCode from a new computer platform;

Events and Feedback pages. The Events page informs users of upcoming training sessions while the Feedback page allows users to request training in specific areas or components of the SciCode;

Restricted pages. These pages are accessed through a locally-controlled password system. Using them, the Primary Holder is able to create and maintain a current list of authorized users;

Bulletin page. This page allows the Primary Holder to inform Users about new developments in the computer program;

Limits page. This page allows the Primary Holder to inform about limits to the program, i.e., parameters or boundaries beyond which the applicability of the program has not been established;

Nonconformance pages. These pages allow Users to inform the Primary Holder of errors or deficiencies in the

SciCode or related documentation, and to view the status of activity relating to the nonconformances they have previously identified. The Primary Holder is able to link this information to the Change Control pages;

Documentation pages. Important documentation, such as the User's Manual and various papers or presentations, is available to the Development Team and Users through the Documentation sections of the Web Sites;

Change control pages. The Primary Holder uses these pages to enter and retrieve information necessary relating to the purpose, design, and execution of changes to a SciCode.

The SciCode Web sites began with a mission statement to improve regular ongoing communication between the Primary Holder and End Users. By making the SciCode Web sites interactive and keeping them current, AECL has developed a medium to meet these additional requirements easily, with administrative simplicity.

Work Simplification

Administrative simplicity was one issue that emerged in our discussions. Before the implementation of the CSA N286.7-99 Standard, changes to some of our SciCodes were automatically tracked through the revision control system (RCS) software (Reference [2]), and problems with the program documented through a centralized system which is used for the majority of SciCodes. The revised software standards, however, require information in addition to what is available through RCS. This additional information is currently collected manually. For a code under development, with up to several hundred changes per year, the additional labour can extend over several months.

It was decided to eliminate the centralized system, so that all problems would be tracked at the individual SciCode level.

Problems and change requests can be easily handled through the RFSP Web site. The Primary Holder can access the database through special queries and forms in the administrative area, update the information as required, and print out the information from the database onto any number of AECL forms, or export it into MS Word and incorporate it into reports. The data generated automatically in RCS can be used to verify that the content of the database is accurate and complete.

The net result is that it is now possible to enter the information once, retrieve it, add to it, or update it as needed, and export it into whatever format is required, instead of having several different programs in different locations tracking the same kind of information.

A second benefit to having the entire change-control process for RFSP managed at the local level is that all the information is in one location, accessed through one reference point - the RFSP Web site.

Documentation

We intend to make important documents available online: particularly the User's Manual for each SciCode. Web technology, with its hypertext capability, provides readers with the ability to navigate easily, even intuitively, through these documents. Instead of hunting through a thick hard-copy manual for specific information, users are able to search electronically and to navigate from the table of contents to specific sections of interest to them. The OPG RFSP Web document provides an in-depth software program description that allows users to search for information on specific modules, pull up relational charts that depict all subroutines and variables within any given module, view flow charts that capture the calculational process for the specific module or subroutine, and check the data dictionary for specifics on each variable in the program. It is an impressive Web document that transforms what we even consider documents to be or how we think they should be viewed. Through its intense use of hypertext links and scripts, this document appears almost intuitive to the user.

Marketing

The SciCode Web sites have other potential as well. One area is marketing. When dealing with potential customers, we need to demonstrate how our product works. SciCodes are one of our products.

The SciCode Web site simplifies the whole process. Marketing people have something concrete to demonstrate and have access to general information about the SciCode itself. For example, potential customers can be given copies of the public Web site - or in time, be directed to the SciCode's URL (Uniform Resource Locator, the standard way to give the address of any resource on the Internet that is part of the World Wide Web (WWW)). They can then navigate through the Web site at their convenience, investigate the SciCodes they are most interested in, and have their basic questions easily answered.

Future Directions

As people begin to use the existing Web sites, new ideas and uses for the sites are suggested. Where possible, we incorporate them into existing Web sites. Where it is not possible, we note them for the future.

The following are some of the directions and potentials we see for the SciCode Web sites.

Web Sites for Industry-Standard Tools

Approximately 20 SciCodes have been identified as Industry Standard Tools. We would like to create similar Web sites for all IST programs, and work is already well under way on several of them. A unified approach for SciCode Web sites is also required. The Code Centre is currently defining its mandate with respect to the SciCode Web sites, determining what level of administrative support and technical assistance is required in the creation of the sites, and investigating the possibility of hosting the pages on its own server.

Formal Information Management

Web technology is designed for information sharing. We would like to incorporate formal information management into the SciCode sites. One advantage would be better control of the documents available to users. A second advantage is based on the recognition that SciCode sites must be available to users outside of AECL. The information that needs to be shared must first be "disentangled" from the rest of the AECL information network. By building individual information management structures for each SciCode, it becomes easier to transfer documentation about individual programs to whoever is authorized for it.

Training

An important aspect of SQA is to ensure that the users of our SciCodes are trained in their use. Considerable training documentation on SciCodes does exist and is being collected and integrated into the online documentation of the different SciCodes. We would like to create a truly interactive training program for the major SciCodes, but acknowledge this is a longer-term goal.

Code Development and Creation of Documentation

Although SciCode development and the creation of Web-based documents are not generally included in people's views of a Web site's potential, they offer the potential of including users in the different phases of developing a SciCode and its documentation.

The SciCode Web site has been designed to encourage communication. We should expect improved communication will result in suggestions for improvements, simplifying processes, modifying a comment line, rewriting a paragraph or section in a manual.

If the SciCode Web sites really do facilitate and improve communication we should expect more involvement in the development of any SciCode, by the users themselves.

Development Area and "Chat" Area

Within the structure of the SciCode Web site shared areas have been created to allow users to access different information and documentation. It is possible to create similar shared areas that are still connected to the Web site in some way for the code development teams. These areas may serve as information-sharing repositories or even "chat" rooms. When the Web site becomes available to non-AECL members, it will be possible to create shared areas for all members of the code development team, and thus become the communication hub of code development.

Ongoing Issues

Of course, issues exist that must be resolved.

Administrative issues: We need to determine which documents are to be made available to which groups and what level of review and signoff is required. We need to provide for ongoing maintenance of individual sites in order to ensure that information is always current. We need to deal with information management, ensuring that whatever AECL documentation is stored on the SciCode Web site, is also found in AECL's official information management system, and that security issues surrounding non-AECL documentation have been addressed.

Technical issues: The most important and immediate issue deals with making Web sites for the IST SciCodes available online to external customers without compromising AECL security or intellectual property. This must be resolved through negotiations with the AECL Code Management Panel, IT and external customers.

Publicity: We already had configuration management, information or documentation management and quality-assurance programs at AECL. We believe we now have the capability for easily providing regular ongoing communication between Primary Holders-Owner Branches and End Users through the SciCode Web sites. The next step is to make the users aware of their existence. We will succeed only insofar as we achieve our original mission statement:

The primary purpose of the SciCode Web site is to provide required information for people who need it when they need it, and in a form that they can easily retrieve and use.

Conclusions

Picture yourself as a new user of a SciCode. You have been directed to a Web site where you are able to familiarize yourself with the SciCode's functionality and general capabilities. You register with the Primary Holder through the Web and gain access to the secure support area. You now have access to a basic interactive training course, as well as to introductory documents on the SciCode. You are walked through the User's Manual, directed to the location of the official executable of the program, and have access to test data so that you can begin using the program and verifying your results. You can check the parameters of the program, find out some of the frequently asked questions regarding the SciCode, have the opportunity to submit your questions based on what you have learned so far, and schedule yourself for training in a specific part of the program.

Picture yourself as the Primary Holder. You are able to check and update the various database tables on a regular basis, add new documents, maintain a list of authorized users, and provide training geared to their specific requirements, questions, and suggestions. You are able also to extract information from the databases in a variety of formats, link to AECL's official repository, even run the code from the Web Site. You have a working environment where you and external customers can share ideas, and where you are actually able to access external documents relating to your SciCode.

We, at AECL, have created a SciCode Web site that provides easy two-way communication between the Primary Holder- Owner Branches and End Users, including poten-

tial customers. This Web site facilitates compliance with SQA procedures, simplifies and streamlines various work processes, and improves comprehension of the various components and modules within a given SciCode, provides access to training and relevant documentation, and points to where the program executable actually exists. All this can be done from one URL.

Acknowledgements

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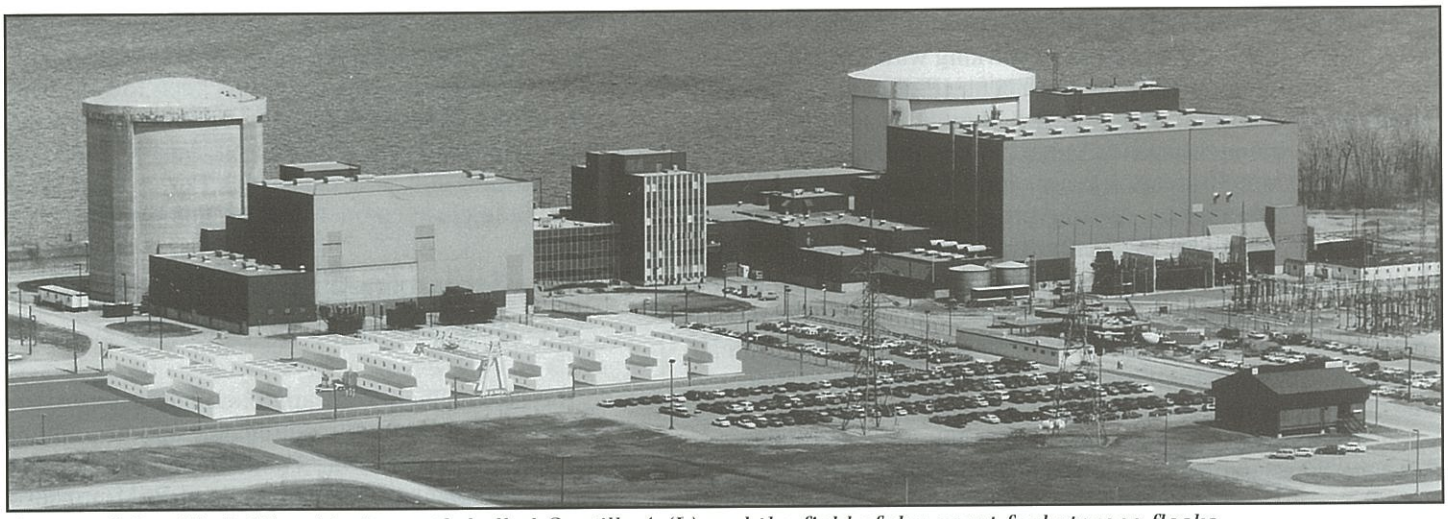

A view of Gentilly-2 (R), with the moth-balled Gentilly-1 (L) and the field of dry spent fuel storage flasks.

Streamlined Reliability Centred Maintenance: - Application to Candu 6 stations

R. A. Richard, M. N. S. Holmes, J. H. Nickerson[1], A. L. DeLong[2]

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Abstract

Over the past five years, Atomic Energy of Canada Ltd. (AECL) has been working with CANDU utilities on Plant Life Management (PLiM) programs that will see existing CANDU plants through their design life and beyond. As part of this initiative, AECL and New Brunswick Power have partnered to develop a Systematic Approach to Maintenance program applied to selected critical plant systems.

This paper will describe how streamlined Reliability Centred Maintenance (RCM) techniques have been applied on systems at the Point Lepreau Generating Station to provide a sound documented basis for maintenance strategies. These strategies have emphasized a hierarchy of condition based maintenance, time based maintenance and, where appropriate, corrective maintenance.

The major steps in the process are described. The clear benefits of focusing maintenance in areas where it is needed and effective from the context of impact on system function requirements are described. The basis of the maintenance program is fully documented at the individual task level. The results of the program are also used to define maintenance strategies for future CANDU power plants.

1.0 Introduction

Commercial power generation versions of CANDU reactors were put in service more than 25 years ago, and the first series of CANDU 6 plants (which entered service in the early 1980's) have now reached the middle of the their 30 year design life. Over the past five years Atomic Energy of Canada Limited (AECL) has been working with utilities on the CANDU Plant Life Management (PLiM) programs that will see the existing CANDU plants through their design life and beyond. As part of this initiative New Brunswick Power have partnered to develop a Systematic Approach to Maintenance program As a result a comprehensive and integrated CANDU Plant Life Management Program has been developed.

As part of this initiative, a Systematic Approach to Maintenance is being developed on selected critical plant systems. Strategies of condition based maintenance, preventive maintenance, or, where appropriate, corrective maintenance are defined based on the results of Streamlined Reliability Centred Maintenance (RCM) analysis. The most significant progress in this area has been the application of this strategy to optimize maintenance at the Point Lepreau Generating Station. Atomic Energy of Canada Ltd. and New Brunswick Power have been working in close co-operation on this project.

2.0 Streamlined Reliability Centred Maintenance Methodology

The streamlined RCM approach has been extensively used to perform maintenance optimization in the nuclear industry in Canada, Europe and the USA. The application of streamlined RCM provides the tools and performance indicators to measure maintenance effectiveness and efficiency. It also provides a documented basis for each recommended maintenance task performed on every component in the analyzed system. It provides a scientific basis for changes to maintenance program that require regulatory approval. AECL utilizes SRCM WorkstationTM Version 4.0 software developed by ERIN Engineering and Research Inc. of the USA.

The streamlined RCM process is applied to nuclear power plants assets in close consultation with plant engineering and maintenance staff. This ensures that plant experience and expertise are fully exploited to ensure validity of the streamlined RCM results. This also allows plant personnel to understand and "buy-into" the process. This is vital as plant personnel will ultimately be responsible for implementation and future program improvements.

Following is a description of a typical Systematic Approach to Maintenance study as outlined in Figure 1.

1 Atomic Energy of Canada Limited, Mississauga, Ontario

2 New Brunswick Power Corporation, Point Lepreau Generating Station

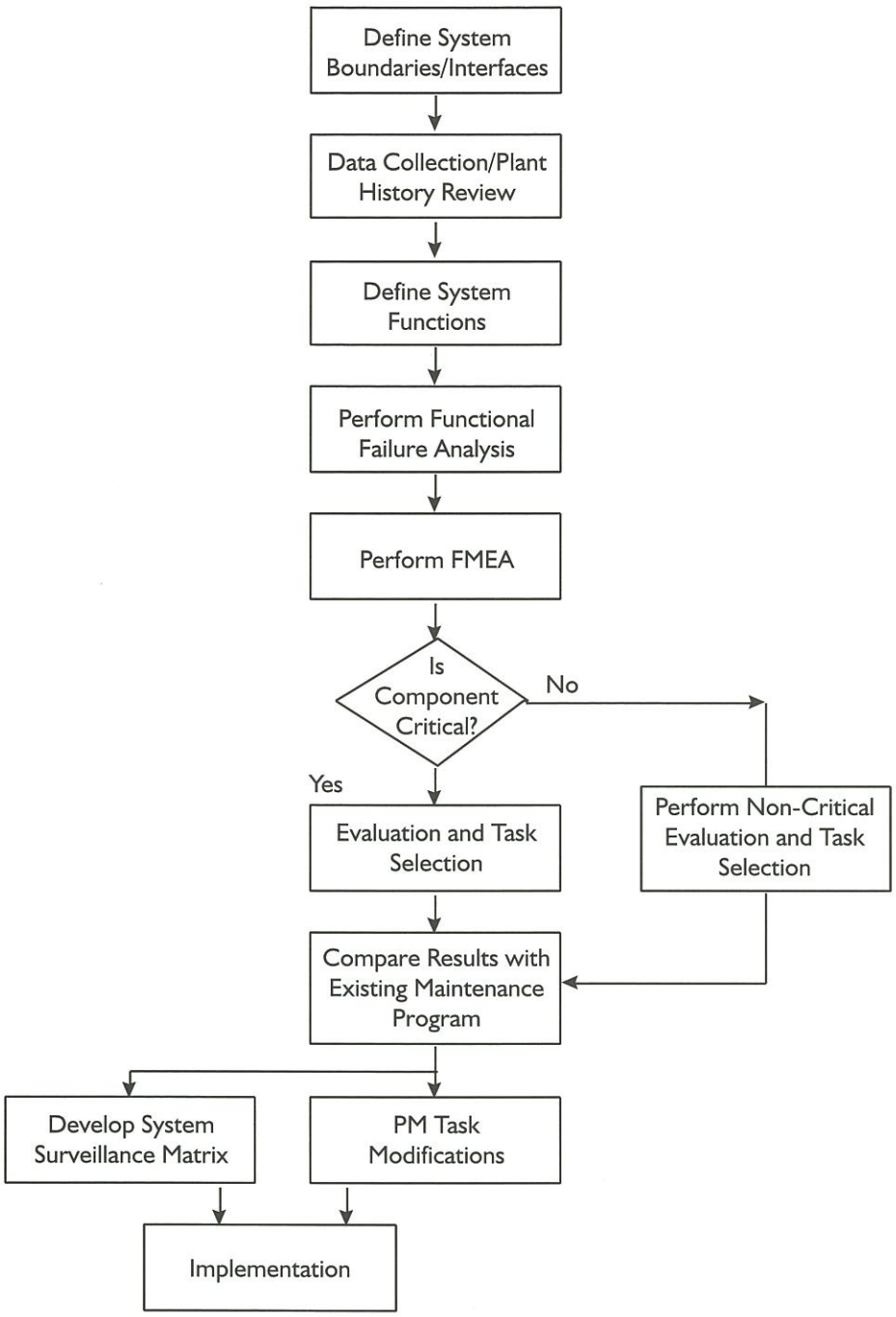


Figure 1 - The Systematic Approach to Maintenance (SAM) Process.

2.1 System Definition/Boundaries: Since streamlined RCM is applied to individual CANDU systems, the first step in the process is to define the systems to be analyzed including a definition of system boundaries with respect to interfacing systems. The system boundary must be a logical demarcation that includes equipment and components having similar functions, while clearly separating it from all interfacing systems. This is used to prevent duplication and ensure comprehensive coverage of interfacing systems without gaps.

2.2.Plant History Review: This step involves review of the following items to develop a list of issues to be resolved with the designated plant staff:

- Current system surveillance monitoring
- Current maintenance practices
- System operations and maintenance history
- Modification to system design/configuration
- Vendor recommendations

This review is performed to identify problematic components, areas where maintenance strategies are effectively mitigating failure causes, and areas where maintenance strategies are attempting to correct design or operational deficiencies.

2.3 Identify System Functions: Perhaps the most important step in the process is to identify the system functions and the required standard of performance. Both primary and secondary functions are defined. The primary functions of a system refer to the specific roles intended of the system in the overall safe operating context of the generating station. Secondary functions are those which are generally intrinsic to the system required to ensure that the primary functions are met, i.e. environmental protection, conventional safety, start-up, control, monitoring and shutdown.

2.4 Functional Failure Analysis: Once the system functions are identified, the analyst then identifies how each function can fail. A functional failure represents the inability of the system/subsystems to perform a function to the desired standard of performance.

2.5 Failure Modes and Effects Analysis: For each functional failure, a qualitative failure modes and effects analysis (FMEA) is performed. This analysis identifies the most plausible failure modes of the components involved and determines the effects of each failure mode. This assessment is largely based on engineering judgement, system maintenance history and industry experience. The analysis is "streamlined" to avoid unnecessary expenditure of resources to analyse the system at too low a level.

2.6 Criticality Analysis and Task Selection: Based on a systematic assessment of each failure effect, the importance (criticality) of the component is determined. In general, if

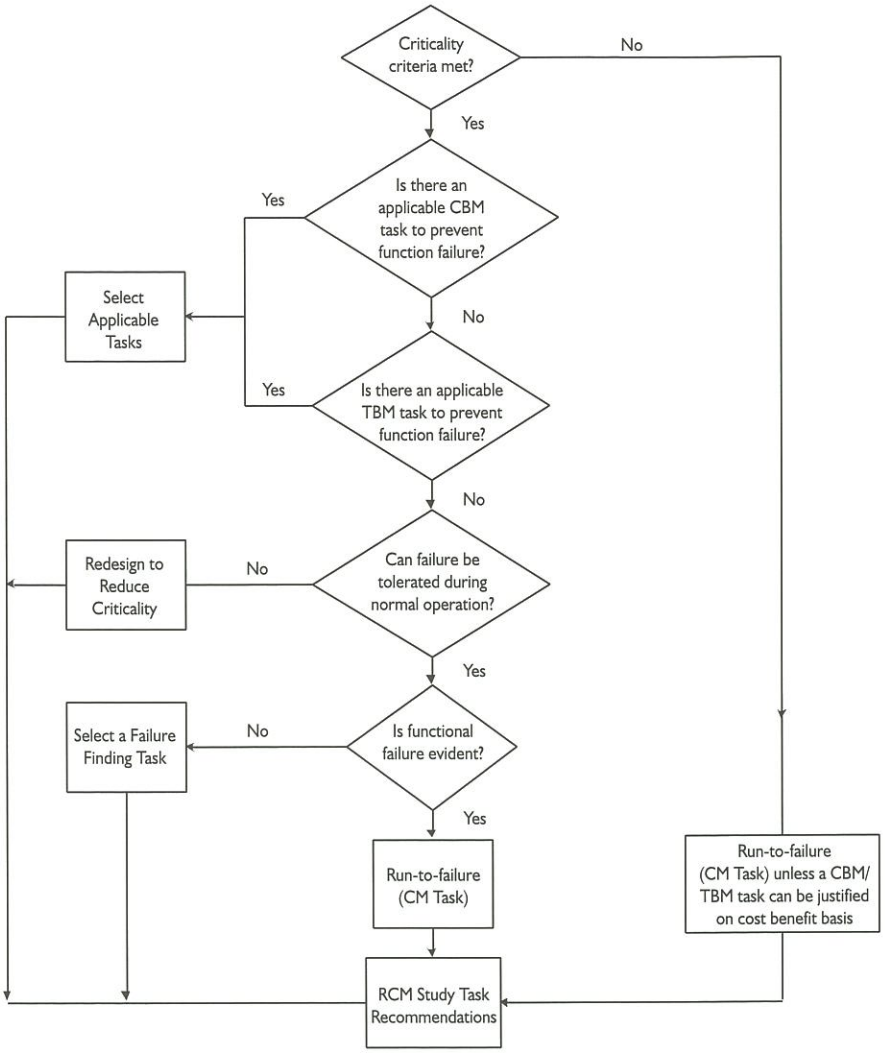


Figure 2: Maintenance Strategy Selection.

the effect of failure on system function cannot be tolerated, then the subject component is deemed "critical". Where practical and effective, condition based maintenance (CBM) strategies are defined. Otherwise time-based failure finding or preventive maintenance tasks are defined.

Components whose failure effects on the system can be tolerated are deemed "non-critical". For such components, the decision to apply applicable preventive maintenance tasks is based on a cost-benefit assessment. If the cause of failure can be addressed through a simple and cost effective PM task, then the PM task is applied. Otherwise, it is acceptable to apply corrective maintenance for non-critical components as and when they fail.

Figure 2 outlines the maintenance strategy decision process. The process can also determine candidates for redesign where unacceptable failures cannot be effectively prevented with a maintenance task.

At this stage of the analysis, the team reviews the criticality analysis based on FMEA tables and recommended CBM and PM tasks from the streamlined RCM work, with designated plant staff. Any outstanding issues are resolved through mutual discussion.

2.7.PM Task Comparison and PM Program Modification: The results of the streamlined RCM analysis are compared with the existing preventative maintenance system (PMS) to identify needed changes.

Recommendations may involve adding tasks not yet performed. Current maintenance tasks are retained if effective, modified where they can be made more effective, or deleted if they are redundant or ineffective. A documented basis is provided for all changes.

The resultant maintenance tasks are grouped into task packages based on suggested work group responsibility and frequencies for ease of work definition and program implementation.

2.8 System Surveillance Matrix: A system surveillance matrix, which summarises the monitoring and trending tasks to be performed by the system engineer, is also developed. The surveillance matrix is defined by identifying degradation indicators for each system functional failure mode. System parameters which can be trended to give an indication of the degradation are identified. Parameter acceptance bands with appropriate actions are prescribed. The system surveillance matrices include both direct (process parameter) and indirect (maintenance backlog) indicators.

2.9 Implementation: Station personnel are involved in the streamlined RCM process at various stages. This is done to ensure that basis for the maintenance tasks are sensible and defensible. It also exposes the plant staff to the optimized maintenance strategies and allows for buy-in from the key personnel responsible for final implementation. All the recommendations also require formal approval from the managers with overall responsibility for the plant assets.

At the end of the streamlined RCM study the following items are available to ease implementation:

- maintenance tasks and schedules sorted by responsible work groups
- system surveillance matrices
- clearly documented basis for each maintenance task
- a list of one-off changes such as procedure or design changes.

It is imperative to implement the recommendations as soon as practicable while personnel involved in the program can still easily recall specific decisions made. The sooner the results are implemented, the sooner the plant derives the full benefits of the analysis.

Changes in plant operation or design could impact on the effectiveness of the maintenance strategies defined. Also, quick implementation will ease the establishment of a living program for continuous improvement.

Living Program: As with any maintenance optimization strategy, streamlined RCM uses knowledge of past and present maintenance experience and industry knowledge. With time, knowledge of degradation mechanisms and maintenance technologies improve. Also changing operational demands or practices may present a change in system function or required standard of performance.

The streamlined RCM analysis and maintenance task basis must be reviewed periodically to ensure they remain valid and improved knowledge is captured and exploited. The basis for the maintenance program will be preserved, even in the event of staff turnover, allowing for legacy maintenance strategies to be compared fairly against emerging technologies and maintenance trends.

3.0 Streamlined RCM Studies for Point Lepreau Generating Station

To date nine (9) streamlined RCM studies have been performed on systems at New Brunswick Power's Point Lepreau Generating Station.

- Auxiliary Feedwater System
- Airlocks and Containment Sealing Door
- Dousing System
- Containment Isolation System
- Reactor Building Cooling System
- Class III Standby Diesel Generator System
- EPS Diesel Generator System
- Main Feedwater System
- Condensate System

The following streamlined RCM studies are presently underway:

- Shutdown Cooling System
- Moderator and Auxiliary Systems
- Emergency Core Cooling System
- Instrument Air System

Up to four (4) more system streamlined RCM studies are planned for Point Lepreau G.S. in the near future, and it is planned to complete the balance of the systems over the next two years.

4.0 Sample Study - Point Lepreau G.S. Airlocks

This section summarizes the results of the streamlined RCM based maintenance optimization program to develop and document an applicable, efficient and cost-effective preventive maintenance program for the Equipment Airlock (EAL), Personnel Airlock (PAL) and Containment Sealing Door (CSD) Systems.

The conclusions and recommendations of this study were:

- The testing frequency of Equipment Airlock door penetration shaft seals should be changed from once every 4 weeks to once every 13 weeks. This would be consistent with an identical test being performed on the Personnel Airlock with good results.
- The replacement of the new inflatable door seals should be based on the number of cycles derived from qualification testing. This will require necessary measurement of door operation cycles and setting up the control process.
- Consideration should be given to replace the existing seal air pressure switches with a more appropriate range. This design change should reduce the current frequency of adjustments to maintain proper set point.
- Delete the bi-monthly bubble leak test of the pressure safety valves, and reduce the frequency of the popping-up setpoint test from current once per year to once every 6 years to be more consistent with the ASME recommendations for nuclear Class 2 safety valves.
- Only the Airlock door relays associated with providing the interlock contact pairs should be checked formally to ensure containment integrity. The operation of other relays associated with door operation and testing can be adequately tested during normal operation or testing and necessary corrective maintenance applied in a timely manner.
- Because of the less stringent service conditions for the spent fuel discharge bay containment sealing door (being used only 1-2 times a month), the frequency of its inter-seal leak test should be reduced from once every 4 weeks to once every 13 weeks. Also the frequency of its instrument air leak test should be reduced to once every 52 weeks, consistent with current practice on the Airlocks.

It can be seen from the above recommendations that the maintenance optimization analysis resulted in a significant reduction in the frequency and number of required maintenance operations, leading to an overall cost reduction, while focusing on the maintenance that is critical to the system. For example, it is expected that the recommended program will result in fewer door seal replacements, hence less maintenance effort and also making the airlock itself more available in support of other maintenance activities.

From this analysis work, it was concluded that the methodology was sound. The recommended changes will ensure that the system performance does not deteriorate as the plant enters the second half of its design life. Needless equipment down time for redundant maintenance will also be minimized.

5.0 Application to Future CANDU Plants

The experience gained performing streamlined RCM studies for existing CANDU stations serves as a solid foun-

dation for defining maintenance strategies for future CANDU nuclear power plants. All the benefits of the streamlined RCM studies are assessed and documented for future plants in CANDU Maintenance Manuals.

Maintenance schedules are specified with condition based maintenance emphasized where practical and effective. System surveillance matrices are also defined. As with the streamlined RCM studies for existing CANDU plants, the basis of all recommendations is provided.

This effort will enable AECL to provide effective guidance to new CANDU utilities on how to effectively maintain their valuable investments. Reactor vendor guidance on maintenance strategies is expected to become strategically more important in future power reactor sale negotiations.

6.0 Conclusions

The application of the streamlined RCM methodology helps to achieve enhanced system reliability and availability, making optimum use of available maintenance resources and provide a documented basis for system maintenance. This approach has been utilized in various industries world-wide and is now being successfully applied to CANDU power plants with the following benefits:

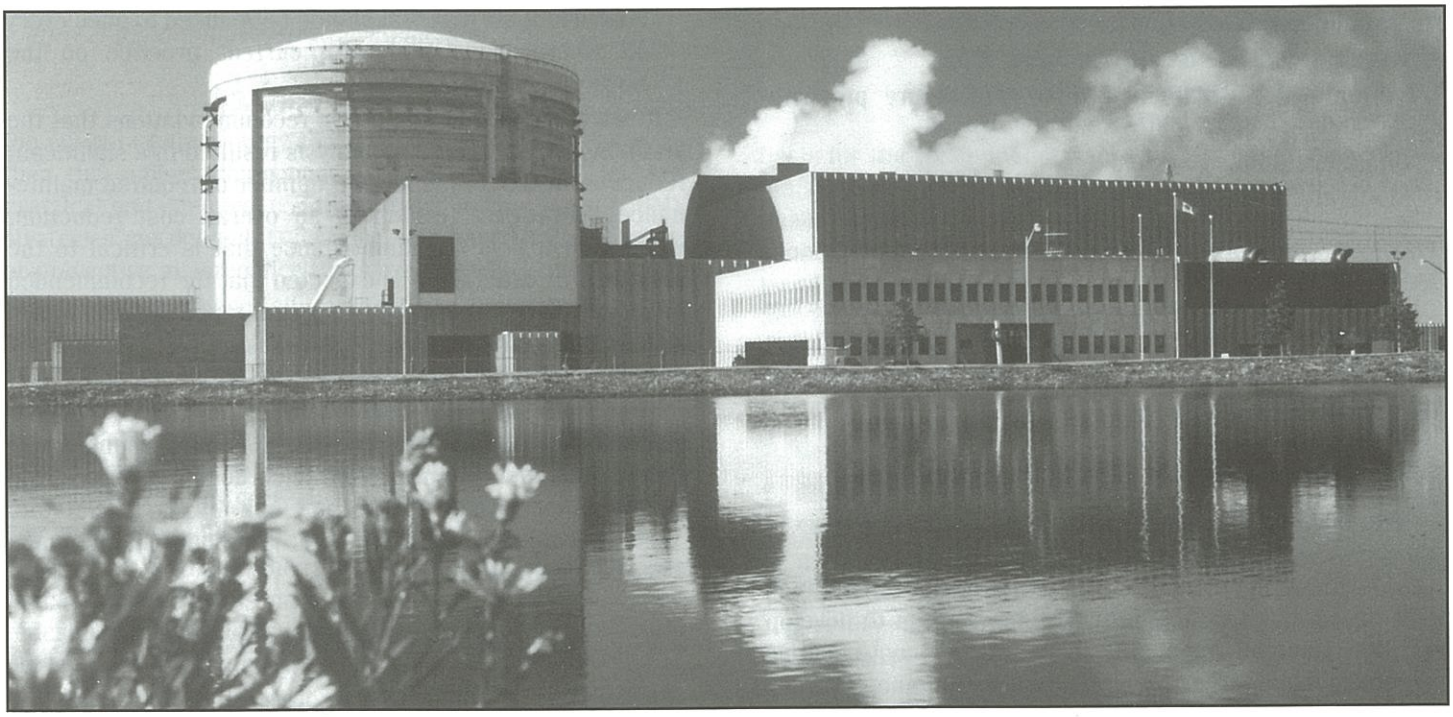
- High capacity plants at reduced cost by focusing maintenance tasks on critical components and only performing preventive maintenance on non-critical components when it is cost effective to do so.
- Better understanding of equipment performance in the current operating context.
- Rationale to demonstrate that maintenance programs are built on a properly analyzed foundation.
- Provides documented basis for gaining regulatory approval of changes.
- Feedback on skills required to maintain the asset.
- Means to optimize the spare parts program.
- Significant cultural change with respect to avoiding or reducing the consequences of failure rather than focusing on eliminating all equipment failures within a system.
- Well documented basis of each maintenance task which will be preserved for future plant personnel responsible for systems and equipment maintenance.
- Results of system studies form a solid foundation from which to define maintenance strategies for future CANDU plants.

Two less tangible benefits of the process are that participants gain a better understanding of how the plants assets work and that they also tend to function better as a team.

References:

(1) J. H. Nickerson, J. R. Hopkins, K. R. Hedges "CANDU Plant Life Management Programs", presented at 1999 SIEN Conference, Bucharest, Romania

(2) J. Moubray, "Reliability-Centered Maintenance, Second Edition", Industrial Press Inc. 1997



Point Lepreau Generating Station

Health benefits of low-dose radiation: the science and medical applications

by Jerry Cuttler

Ed. Note: *Jerry Cuttler, a former president of the CNS, has been an active participant in the dispute over the linear no-threshold (LNT) hypothesis used as a the basis for radiation protection and an advocate for the beneficial effects of low doses of ionizing radiation. Recently retired from AECL he has his own company and can be reached at <jerrycuttler@home.com>*

A symposium on *Health benefits of low-dose radiation: the science and medical applications* was held in Washington, November 15, near the ANS/ENS Winter Meeting. It was sponsored by Radiation, Science and Health (RSH), an international non-profit organization, and the Center for Nuclear Technology and Society at Worcester Polytechnic Institute (WPI), MA. The purpose was to inform nuclear scientists/engineers and physicians about current knowledge on the beneficial health effects of low doses of radiation and discuss some of the activities underway to change radiation protection policies. Some of the activities underway to challenge the scientific basis for radiation protection policies were also discussed. The symposium featured a variety of speakers from Canada, USA, Japan, Germany and the UK. Although invited speakers from Poland and China were unable to attend their papers are included with all of the other papers on the RSH/WPI Website: < http://cnts.wpi.edu/RSH/ > .

Ron Mitchel of AECL/Health Canada started the event with a one-hour tutorial titled, "The biological imperative: low-dose radiation stimulation." Current practices for the management of ionizing radiation exposure, either for the purposes of radiation protection or for medical therapy, rely on long held assumptions that all exposures create risk in the exposed cells, and that the effects are linearly proportional to dose, without a threshold. A wealth of experimental evidence indicates that these basic assumptions break down at low doses and dose rates. Until recently, that evidence tended to be dismissed as phenomenology, and was not considered to be a serious challenge to the established assumptions. However, recent advances in molecular and cellular biology have placed such observations on a secure scientific footing. Mitchel's presentation reviewed the biology of low dose/low dose rate ionizing radiation exposure and provided examples of the consequences in cells and in animals. It was an elaboration of the popular paper, co-authored with Doug Boreham, that was presented at Plenary Session 1 of the IRPA-10 Conference in Hiroshima, Japan, May 10, 2000, titled, *"Radiation protection in the world of modern radiobiology: time for a new approach."*

Myron Pollycove MD of NRC/UCSF then gave a polished presentation of his paper, with Ludwig Feinendegen MD, titled, *"Cellular and organism dose-response: biopositive (health benefit) effects"*, in which he explained how the genes in every cell continuously undergo an immense amount of metabolic damage by reactive oxygen species (ROS) which is prevented, repaired and removed by a complex anti-mutagenic system. Recent studies document low dose radiation stimulation of many cellular functions, including antioxidant prevention, enzymatic repair, and immunologic and apoptotic removal of DNA damage. A ten, or even a hundredfold increase in background radiation stimulates this homoeostatic system. Enhanced prevention of gene mutations by the spatial and temporal differences of ionizing radiation ROS and metabolic ROS is associated with radiation hormesis: decreased mortality and decreased cancer mortality observed in populations exposed to low dose radiation. Therapeutic stimulation of the immune system by low dose body irradiation prevents and removes cancer metastases in mice, rats, and humans. This paper, which quantifies the effects, was based on the keynote lectures Pollycove presented at the *International Conference on Radiation and its Role in Diagnoses and Treatment,* in Tehran in October.

Then followed short presentations by physicians, biologists and others, who reported on their activities and commented on other presentations. Don Luckey, author of two books and many papers on radiation hormesis, outlined the results of many studies on nuclear workers and repeated his often-stated contention that ionizing radiation is essential for life and that more radiation would enhance our health. He related the reductions in cancer in exposed workers to the reductions in premature cancers that supplemental radiation would achieve

Sadao Hattori summarized the remarkable achievements of recent Japanese research on the biological effects of low doses. Their program has been reorganized under new, dynamic leadership. New data were presented on suppression of tumor induction in mice by chronic low dose-rate gamma irradiation, suppressive effect of low-dose irradiation on diabetes and the suppressive effect on lipid peroxide in the mouse brain (of interest for Parkinson's disease).

Ed Bauser talked about the low-dose irradiation (LDI) therapy he has been receiving at the Johns Hopkins Medical Institute (reported in CNS Bulletin 21, 2, pp 45-46, Aug 2000). The therapy delivered last April to Ed's spleen

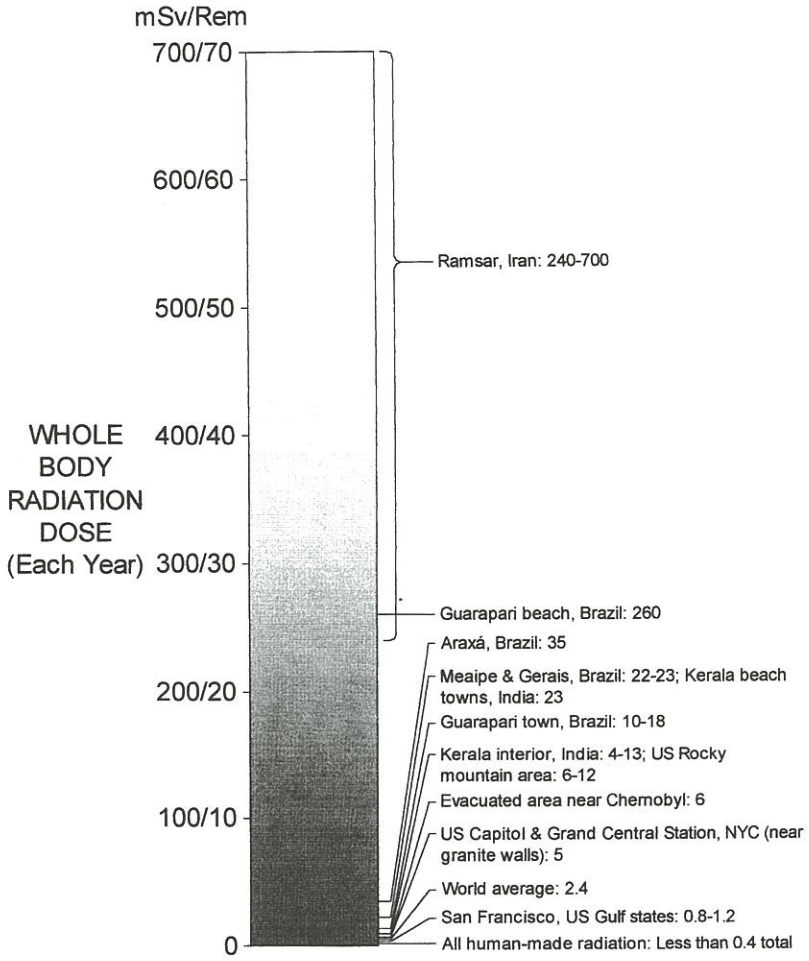


Figure 1. Natural Background Radiation

(a part of his immune system) stabilized his IgM level, and his blood viscosity readings (which are the real cause of symptoms) were lowered. He had just completed five weeks (Oct 18 – Nov 13) of his second booster[1] at JHMI. He was feeling very good as he distributed copies of his blood analysis chart. Based on his delayed response to the splenic irradiation, further improvement in his condition is expected to start in about two months time.

I gave a presentation titled, *"Challenges in providing low-dose irradiation therapy"*, in which I described the difficulties I have encountered over the past year in communicating information on beneficial health effects of low doses to Canadian radiation oncologists and urging them to try this form of therapy on cancer patients. Fourteen barriers were identified. I also reported on the proposal, approved October 6 by the European Organization for Research and Treatment of Cancer, for a randomized clinical trial of low-dose total body irradiation and involved field (local high-dose) radiotherapy in patients with localized non-Hodgkin's lymphoma. The objectives include confirming the immediate efficacy of LD TBI and testing whether the addition of LD TBI to a patient receiving IF-RT will increase survival. Dr. Richaud of Bergonie Institute sent me the proposal for review, and I fed back comments from Dr. Sakamoto and Dr. Pollycove. Copies of the proposal were provided to several cancer treatment centres in Ontario for their input.

Ed Calabrese was the luncheon speaker. He related his early research work in toxicology and pharmacology, and how he encountered, repeatedly, evidence of hormesis. Ed described the formation of the Biological Effects of Low Level Exposures (BELLE) organization. Support from the chemical industry led him to carry out (with Linda Baldwin) an extensive survey of the literature to identify evidence of chemical hormesis. They subsequently supplemented this survey, for the NRC, to cover radiation hormesis. Ed also described political and funding difficulties he encountered.

Klaus Becker's topic was *"Radon health benefits: populations, animal studies, medical studies."* He pointed out that there is **no** difference in biological response between natural and artificial radiation. Regulations should be consistent for both, but we "swim in a sea of contradictions and uncertainties." In the September conference in Munich, ~310 scientists from forty countries discussed the science and the politics in the present double standards. Natural radiation is, by far, more significant than human-made radiation (see Figure 1). Many people go to radon spas in Germany, Austria and the Czech Republic for medically supervised treatment of chronic illnesses at. Costs are covered by many European medical insurance plans. There are many other such facilities world wide, including the very popular Misasa radon springs in Japan.

Patricia Lewis, owner of the Free Enterprise Radon Health Mine in Montana, spoke briefly about the many guests over the past 50 years and the remarkable cures achieved, immediately or several months after the ten days of therapy. She referred to the study carried out recently by U of Nevada anthropologist Barbra Erickson on the hundreds of people who visit each year from all over the USA and Canada.

John Cameron discussed the $10 million DOE nuclear shipyard worker study carried out in the 1980s by Matanoski of Johns Hopkins University. The data indicate clearly that the moderate radiation doses received by the 28,000 most exposed workers were beneficial to their health when compared to 33,000 unexposed age-matched and job-matched shipyard workers. The nuclear workers had a significantly lower cancer death rate and a much lower death rate from all

1 To the ribcage area, left of the spinal column, to minimize bone marrow exposure

causes (24% lower) compared to the unexposed controls. The death rate of the nuclear workers was 16 standard deviations lower! The important findings of this study, completed in early 1988, have never been published in a scientific journal or made known to the public. The DOE ignores this study; it is planning to pay the nuclear workers compensation for the damage to their health!

Jim Muckerheide, president of RSH, and Ted Rockwell, vice president, discussed the ethics of many scientists, regulators and administrators in suppressing and ignoring the scientific data that contradicts current policy. They contend "it's time to tell the truth about the health benefits of low-dose radiation." They have been organizing sessions at ANS conferences since 1994 on beneficial health effects of low doses and participating in many conferences to communicate the large amount of scientific information on this subject. They have challenged DOE's false reports on radiation health effects in workers to the DOE Inspector General, Information on these matters can be found at RSH Website: < http://cnts.wpi.edu/RSH >

Kipp Coddington, of Covington and Burling, a prestigious Washington law firm, explained the RSH legal actions currently underway. This was followed by a short presentation by Roger Shaw, a certified health physicist, attached to McCarter & English, Attorneys at Law, who are representing a nuclear utilities group organized to defend against workers lawsuits alleging radiation exposure as a cause of cancers based on the unscientific regulatory policies.

A dinner at the National Press Club followed the symposium. I was seated beside the managing editor of a popular science and technology magazine, and we got onto the topic of LDI therapy for cancer patients. She mentioned that the wife of a close friend is ill with ovarian cancer. I pointed out that Dr. Sakamoto's first LDI patient had prior surgery for ovarian cancer. Her friend has since contacted Dr. Welsh at JHMI to arrange LDI therapy for his wife, who is too weak after surgery (and a respiratory infection) to undergo standard chemotherapy. Her doctors are willing to consider it. Stay tuned.

Call for Papers

Conference on Climate Change: Canadian Technologies Development

Toronto, Ontario
3 - 5 October 2001

This conference is the second of a series, following the succesful Climate change and Energy Options Symposium held in Ottawa in November 1999. Thsi conference, organized by the Canadian Nuclear Society in association with a number of other organizations, is to provide a forum for discussion of Canadian greenhouse gas avoidance and mitigation technologies.

Papers are invited on any related topic.

Deadline for receipt of abstracts is: 28 February 2001

Contact: Dr. Duane Pendergast
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tel. 403-328-1805
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GENERAL news

Refurbishment of Point Lepreau

New Brunswick Power has released an update on its provisional plans to refurbish the Point Lepreau nuclear generating station.

In February 2000, the NB Power Board of Directors approved Phase 1 of a project to produce a business case including a detailed scope and estimate for the possible refurbishment of the Point Lepreau Generating Station.

Although Point Lepreau Generating Station has a lifetime capacity factor of about 83% since start up in early 1983, the pressure tubes and feeders are nearing the point in time in which they will reach their fitness for service criteria.

The Preliminary plan for refurbishment projects an 18-24 month outage starting as early as January of 2006. If the station is refurbished, then it would be run for another 25 to 30 years.

The decision on whether or not to refurbish PLGS has not been made and is not expected until 2002. The results of the first phase of the project will be used to prepare a detailed business case that will be presented to the NB Power Board of Directors in early 2002. At that time a decision will be made as to whether to refurbish the unit, or obtain other means of replacing the energy produced by PLGS.

If the business case is approved, all-380 pressure tubes & calandria tubes, along with their related end fittings and feeders would be replaced. This material would be stored in new storage vaults to be constructed at the existing on-site Waste Management Facility. Replacement of other station components will be performed as required, as determined from the results of a comprehensive Plant Condition Assessment that is currently in progress.

Regular monitoring of fuel channel performance up to the time of refurbishment has been and will continue to be provided by an inspection and maintenance program backed up by a specialized team providing support to utilities operating CANDU reactors.

If a decision to proceed with refurbishment is reached then the project will continue in three phases:

Phase 1: Complete definition of work

Phase 2: Prepare for refurbishment outage

Phase 3: Conduct refurbishment outage

Atomic Energy of Canada Limited has been selected as project manager for Phase 1 and has put together an integrated project team of NB Power and AECL staff with support from other consultants. John Barclay (AECL) is the Project Manager and Stu Groom is the NB Power Owner's Representative.

To deal with the interaction of the refurbishment project with the operating station a Site Interface Committee has been formed with members from NB Power and AECL. The purpose of the Site Interface Committee, which will meet approximately every six weeks, is to provide a formal mechanism for information exchange between the site and the project. This is to ensure that site management is aware of the various activities that are going on in the project and have an opportunity to provide input.

The status of the project as of November 2000 is as follows.

- Plant condition assessment procedures are complete and the assessment of the plant equipment is underway. Station staff will be asked to participate in this process from November 2000 to February 2001.
- In conjunction with this, the age management assessment of major equipment including fuel channel, steam generators, containment and major piping has been completed. The assessment of the turbine generator is in early progress.
- Work is progressing at AECL on developing the fast retube process. The study plan for dealing with the radioactive wastes is expected to be generated as part of the retube process.
- The guiding principles for a licensing framework for the project were submitted to the CNSC and discussed at a high level meeting with them in September 2000. A document outlining the principles and process to be used in benefit-cost analyses was also submitted to the CNSC.
- A submission outlining the proposed scope of the screening level Environmental Assessment was also made to the CNSC.
- The strategy for the preparation of the business case to support refurbishment has been developed and is under review.
- Meetings have been held locally and throughout the province to obtain the current view of the public on matters relating to energy, NB Power, nuclear power and PLGS refurbishment and aid us in focusing our community relations program.

President-elect for CNSC appointed

The Canadian Nuclear Safety commission has a new President-elect. In October, Ralph Goodale, Minister of Natural Resources Canada, announced the appointment of Linda J. Keen as a full time member of the Commission effective November 1, 2000 and as President-elect of the Canadian Nuclear Safety Commission. Ms. Keen will take up her role as President and CEO on January 1,2001. The current President of the CNSC, Dr Agnes Bishop, who had her term extended, will retire December 31, 2000.

Ms. Keen was the Assistant Deputy Minister of the Minerals and Metals Sector of Natural Resources Canada from July 1997 to June 2000. She has spent the last three months with Human Resources Development Canada as Assistant Deputy Minister of Employment Programs.

While at NRCan, Ms. Keen led the development of the federal government's science, technologies, policies and programs for the mining, minerals and explosives industries. In addition, she was responsible for coordinating NRCan's regulatory policies.

Ms. Keen has had management and international experience in international marketing, international development and trade policy for the federal government and two provincial governments. Prior to her appointment at NRCan, Ms. Keen held management positions of increasing responsibility with Agriculture and Agri-Food Canada and Industry Canada since joining the public service in 1986.

She is a native of Alberta and holds a Bachelor of Science (Chemistry) and a Masters of Science (Food and Nutrition Sciences) from the University of Alberta.

CNSC approvals

Over the past few months the Canadian Nuclear Safety Commission has made a number of licensing decisions.

In October the Commission approved the renewal of the Operating Licence for the Point Lepreau nuclear generating station for a two year term and of the Operating Licence for the Gentilly-2 nuclear generating station for a term of two years and two months. The reason for the odd period is to bring the licensing of similar plants onto the same schedule.

Also in October the Commission approved a two year renewal of the Operating Licences of the Whiteshell Laboratories and the Chalk River Laboratories of Atomic energy of Canada Limited . The processing facility of MDS Nordion in Kanata, Ontario was renewed for a term of five years.

In November the CNSC approved the renewal of the Operating Licence of the Darlington nuclear generating station for a period of two years and two months.

IST to develop special dosimeter

Imaging & Sensing Technology Canada has announced that its parent company has obtained an exclusive worldwide licence to further develop and commercialize a real time neutron and gamma dosimeter, originally developed by the U.S. Department of Energy's Idaho National Engineering and Environmental Laboratory (INEEL). The dosimeter is capable of measuring low neutron dose in high gamma fields. Neutron and gamma measurements are made and displayed simultaneously. Commercial, pocket-size versions will be available mid-2001.

OPG shifts responsibility for IIP

The Integrated Improvement Program has been the flagship of the drive of Ontario Power Generation to revive the performance of its nuclear plants. Since its inception in early 1998 - as a response to the findings of the Integrated Independent Performance Assessment (IIPA) in 1997 by the team of consultants from the USA under Carl Andognini - the IIP has been directed and managed centrally. Now OPG has decided to pass the responsibility and accountability to the sites. The transfer will officially take place on 1 January 2001.

In a presentation to the Canadian Nuclear Safety Commission in November, OPG's Executive Vice-President and Chief Nuclear Officer, Gene Preston, noted that site maintenance and improvement work was competing with IIP programs for resources. CNSC staff had pointed out the same observation.

Earlier in 2000 a pilot project, termed Core 6 Integration, was carried out on improvements to the Bruce B emergency coolant injection system. In that pilot project routine work and the "Core 6" project were pursued in parallel. The results of that test were sufficiently encouraging that OPG management decided to take the challenge of moving the IIP projects to the sites and integrating them with the ongoing maintenance programs.

ANS / ENS Meeting

The American Nuclear Society and the European Nuclear Society held their bi-annual joint meeting in Washington, D.C., November 12 to 16, 2000 with a theme of *Nuclear Science and Technology: Supporting Sustainable Development.* The large attendance, approximately 1200, attested to the renewed interest in nuclear energy in the USA.

Donald Johnston, secretary general of the OECD and a former Canadian cabinet minister, gave the opening keynote address. *(The text of Johnston's presentation is printed elsewhere in this issue of the* CNS Bulletin.) He stated his personal opinion that nuclear power is necessary to reduce the emission of greenhouse gases.

Richard Meserve, chairman of the US Nuclear Regulatory Commission commented that the USNRC sees a renewed interest in nuclear power and expects that a majority of the existing plants [in the USA] will be applying for licence extensions. He also commented on the "desperate" need for a workable solution to the problem of radioactive waste. Meserve, and other speakers, noted the ageing of the nuclear workforce, a theme that was also raised at the CNS Annual Conference last June.

Korea to decide on nuclear program

It has been reported that Korea will decide by the end of 2000 whether or not to continue with its dual-reactor nuclear power development strategy using both PWRs and PHWRs. The utility, Korea Electric Power Company (KEPCO), and the Ministry of Commerce, Industry and Energy are reportedly nearing the completion of a long-awaited evaluation which is focussed mainly on the relative economic competitiveness of the two types of plants.

IEA predicts large rise in CO2 emissions

Carbon dioxide emissions will rise by 60% between 1997 and 2020, according to the International Energy Agency's newly released World Energy Outlook, with developing countries accounting for over 67% of the increase and emissions from power generation increasing by 75%. World energy use is forecast to grow by 2% per year from now until 2020. Fossil fuels will continue to provide 90% of the world's primary energy, and while nuclear's output is forecast to remain constant its share of total energy supply will decline as older reactors retire. Renewables will 'increase rapidly' from 2% to 3% of total demand.

David Anderson, the Canadian Minister of the Environment was scheduled to speak but was apparently deterred by the campaign for the Canadian federal election.

Despite the renewed interest in nuclear power shown at the meeting several speakers commented that without some form of incentive it is unlikely that private electricity utilities will invest in a new nuclear plant in the present competitive electricity market.

Kaiga 1 commercial, Rajasthan 4 connected

The Nuclear Power Company of India Ltd. has announced that its Kaiga 1 unit is now in commercial operation and its Rajasthan 4 unit was connected to the grid on November 17, just 14 days after going critical. Both units use pressurized heavy water reactors based on the Douglas Point prototype plant built at what is now the Bruce site in the 1960s. The Rajasthan units have a rating of 220 MW(e) while the Kaiga units are slightly uprated to 235 MW(e). The Kaiga plants also feature double containment, with an inner dome of pre-stressed concrete and an outer one of reinforced concrete.

Appointments

Reid Morden, former president of Atomic Energy of Canada Limited, has been appointed chairman of KPMG Corporate Intelligence Inc..

KPMG Corporate Intelligence Inc. is a subsidiary of KPMG LLP, the Canadian member firm of KPMG International. It provides confidential domestic and foreign intelligence on individuals, companies, industries, and countries to support business decision-making.

Wayne Boyd has been appointed president and CEO of Canatom NPM, succeeding René Godin who is retiring after a 42 year career, 34 of which were with SNC Lavalin. Canatom NPM is the major project management company for CANDU projects. It is owned by SNC Lavalin (38%, AGRA Inc. (38%) and BFC Construction Corporation (24%). Boyd was previously vice-president of mining and metallurgy at SNC Lavalin

René Godin became president of Canatom in 1989 and took over the same role with Canatom NPM when the two companies were merged in 1998. During his career he was resident engineer for the Glace Bay Heavy Water Plant and for Gentilly 2; construction manager for Wolsong 1, resident director at the AECL office in Romania and vice-president of the SNC Group.

Pickering A hearing

Whether or not Ontario Power Generation proceeds with its project to return the four unit Pickering A station to service may well be determined by the outcome of the hearings being held by the Canadian Nuclear Safety Commission on the Environmental Assessment Screening Report that was submitted in August. The CNSC held its first day of hearing on the matter on October 5 in Ottawa. The second, and final, hearing day will be held in Pickering on December 14 (with the possibility of it being carried over until the next day).

The CNSC staff have recommended that the Commission accept the Screening Report conclusion that the project will not cause significant adverse environmental effects. However, the four municipalities around the Pickering station, Pickering, Ajax, Durham and the City of Toronto, have all asked that there be a full panel environmental review and a number of anti-nuclear groups have made the same request. Given the duration of other environmental panels the prospect could cause OPG to reconsider the large investment involved in the many modifications planned for the return to service.

New nuclear unit proposed in Finland

The TVO utility in Finland has submitted an application in principle for the construction of a new nuclear plant to the Finnish Council of State. Under Finnish law, the licensing process for a new nuclear plant takes several years and is a multi-phased process. TVO has indicated that the planned plant could be either a BWR or a PWR, with an output of 1000 to 1600 MW(e). It will be built at an existing nuclear power plant site and will be Finland's fifth nuclear unit. The estimated cost of the new plant is FM10-15 billion (US$1.4-2.2 billion), depending on the size of the plant, and it will be financed by TVO. The application follows a study earlier this year that showed that a new nuclear plant would be the least-cost option for new generating capacity. TVO also stated that it was making the submission because of the need for additional electricity, and because nuclear power, together with renewable energy resources, would help Finland to meet its commitments under the Kyoto protocol to reduce greenhouse gas emissions in 2008-2012 to the 1990 level.

Obituary

Douglas James Gordon, head of Ontario Hydro from 1970 to 1980, died in North York, on November 28, 2000. Gordon joined Ontario Hydro in 1945 after two years in the Canadian navy. He held several posts of increasing responsibility and was named General Manager (then the senior position) in 1970. In 1974 Ontario Hydro was transformed from a Commission to a provincial crown corporation and Gordon was named its first president.

During his period at the helm of Ontario Hydro the organization went through tremendous growth. Under the leadership of Harold Smith, whom Gordon named Chief Engineer, Ontario Hydro built the Pickering A and Bruce A plants and committed the Pickering B and Bruce B plants.

Douglas Gordon was born in Brockville, Ontario in 1920. He graduated from Queen's University in 1943.

G-2 refurbishment studied

Hydro-Québec staff will begin a "Pre-Project" for the refurbishment of Gentilly 2 in January 2001. This is the culmination of a number of "plant life management" studies that have been conducted since 1993.

The "Pre-Project work will include all of the studies needed to determine the viability of the proposed refurbishment as well as all government approvals. The latter includes not only approval from the Canadian Nuclear Safety Commission but also from the Minister of Energy of Quebec. An environmental assessment will be required, at least a screening report but there could be a need for public hearings.

The schedule is to produce all the technical, economical and environmental studies by mid 2003. These will go to Hydro-Québec's Board of Directors for a formal approval to seek governmental approvals. It is hoped that these approvals could be obtained by the end of 2004. On that basis detailed engineering and the procurement (the project) could begin in January 2005 for a refurbishment to be carried out over 2008 - 2009.

The "Pre-Project" work, which is estimated to require more than 100 person-years effort, will include:

- determining the scope of work for refurbishment
- determining the cost and schedule
- clarifying with CNSC on licensing requirements
- conducting the environmental impact studies

A basic objective of the "Pre-Project" is to achieve reasonable assurance that G-2 would be technically and economically viable until 2033 if the refurbishment took place.

US President names Fermi Award winners

The three winners of the **Enrico Fermi Award** were named by US President Clinton on November 9, 2000. The award is given for a lifetime of achievement in the field of nuclear energy (broadly defined to include the science and technology of nuclear, atomic, molecular, and particle interactions, and their effects).

Sheldon Datz, a physicist and senior corporate fellow at Oak Ridge National Laboratory, was recognized for his pioneering research in atomic and chemical physics. Datz began his career in 1951 as a research chemist at ORNL. In his early career, he and a colleague developed a technique to study chemical reactions using crossed molecular beams. This work is credited with establishing the foundation for the field of chemical dynamics. Later in his career, his interests shifted to the physics of atomic and molecular collisions in gases and solids. He initiated experiments at CERN, near Geneva, Switzerland, on atomic collisions at ultrarelativistic energies, thereby uncovering some unanticipated new phenomena.

Sidney Drell, a physicist and professor emeritus at the Stanford Linear Accelerator Center (SLAC), Stanford University, was honored for his contributions to arms control and national security and to the field of particle physics. Since 1960, Drell has led efforts to provide essential technical advice to the government on national security issues, including the safety, reliability, and performance of nuclear weapons and their long-term stewardship. In high-energy physics research, Drell carried out important theoretical work on the use of electromagnetic interactions as an experimental probe into the structure of protons and other strongly interacting particles.

Herbert York, a nuclear physicist and emeritus director of the University of California's Institute on Global Conflict and Cooperation (IGCC), received the award for his efforts for nuclear deterrence and arms control agreements. For more than four decades, York has led efforts to design and deploy a secure and stable nuclear deterrent posture capable of maintaining peace. He became involved with nuclear weapons at Oak Ridge, Tennessee., where he worked on the electromagnetic separation of uranium-235. He later oversaw the expansion of the Radiation Laboratory at the University of California, Berkeley into the Lawrence Livermore Laboratory, and in 1952 became its first director. York was science advisor to President Eisenhower and cofounder and first chief scientist of the Advanced Research Projects Agency. He served as ambassador and chief negotiator for the Comprehensive Test Ban negotiations under President Carter.

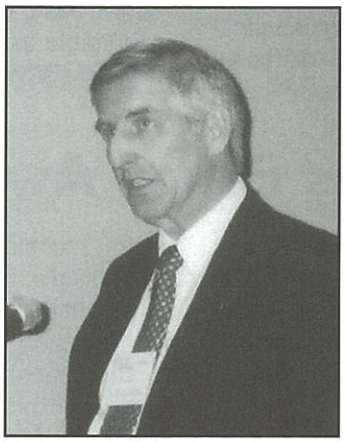
Nuclear and GHG

In a recent publication, Climate change and Nuclear Power, the International Atomic Energy Agency provides some interesting data on the amount of "greenhouse gases" (GHG) that can be avoided through the use of nuclear for electricity generation. "Substituting a single nuclear power plant for a coal fired plant (assuming each has a capacity of 1,000 MW(e) and an 80% load factor) would avoid stack emissions of 1.3 - 2.2 million tonnes of carbon annually." "Substituting nuclear power for natural gas [for the same assumption] would avoid 0.6 - 1.0 megatonnes of carbon per year" "The International Energy Agency business as usual scenario projects that 3,000 GW(e) on new generating capacity will be needed by 2020 and an additional 600 GW(e) of existing ageing capacity will have to be replaced."

5th CNS International Conference on CANDU Maintenance

Maintenance Conference - interesting and informative

Ed. Note: *Because of the inadvertent delay of this issue it had not gone to press when the* 5th CNS International Conference on CANDU Maintenance *took place in Toronto, 19 -21 November 2000. That unexpected timing permitted us to provide the following short report on the Conference. A further report and reprints of some of the presentations will be included in the next issue of the CNS Bulletin.*



Rod White

With the drive to improve the performance and extend the life of our ageing nuclear power plants the theme of the **5th International Conference on CANDU Maintenance,** *Competitive Edge Through Efficient Maintenance,* was very topical. The 225 or so participants who gathered in Toronto from the 19th to 21st of November shared ideas and experience on how to ensure CANDU nuclear plants operate at a world class level.

Rex Murphy

The meeting was structured with an opening plenary session the first half of the first morning, followed by sets of three or four parallel technical sessions. The Conference was closed with a fascinating unannounced address by Charles Packer, until recently vice-president Darlington site, OPG. Leavening the technical content were a number of "social" events including an opening reception on the Sunday evening, two lunches and a conference dinner, along with generous coffee breaks held in the exhibition area. The latter included 15 booths of providers of services and equipment for maintenance of CANDU units.

Ron Osborne, president and CEO of Ontario Power Generation, gave the opening address, emphasizing the importance of maintenance. "We must ensure that we achieve, at least, the design life of our plants", he stated. He noted the improvement in performance of OPG's stations but observed that they were still not in the top quartile of North American plants because the level of that goal kept rising. The investment of British Energy in the Bruce stations showed their faith in the CANDU design, he said. Reflecting on the recent municipal elections in Ontario he commented that despite an active campaign in the Pickering area by anti-nuclear groups the re-start of the Pickering A station was a "non-issue". He reported that some 300 volunteers from OPG went door to door to provide factual information but found little interest.

The three plenary papers gave perspectives from the USA, Canada and France.

Hank Drumhiller, from INPO and WANO, stated that nuclear plants in the USA were now competitive with coal and better than oil or gas. Performance has continued to improve and utilities are now aiming at an "error free year". There is increased emphasis on preventative rather than corrective maintenance. Noting the ageing workforce, US nuclear utilities are now looking seriously at replacement and training.

Pierre Charlebois, chief nuclear engineer at OP, stated that OPG's safety rating was now at the top level but acknowledged more needs to be done to improve performance. He spoke of re- emphasizing maintenance to preserve OPG's nuclear assets.

Jean-Pierre Hutin, vice-president, Electricité de France, began by noting that EdF has 58 units of 900 to 1450 MW which supply 80 percent of France's electricity. In addition, EdF exports between 15 and 20 percent of its production, earning considering income. Even though many of the plants operate in a load following mode the overall capacity factor is over 80 percent. EdF uses a modified reliability centred maintenance (RCM) approach and does inservice inspection on a risk basis. Because the nuclear plants make up such a large share of the generation the

major criterion for outages is to meet the specified schedule rather than minimize the duration.

(It is hope to have the text of each of these three interesting plenary talks for the next issue of the CNS Bulletin.)

The technical sessions included 62 papers presented in six groupings each having three or four parallel sessions. The papers were classified under the following headings:

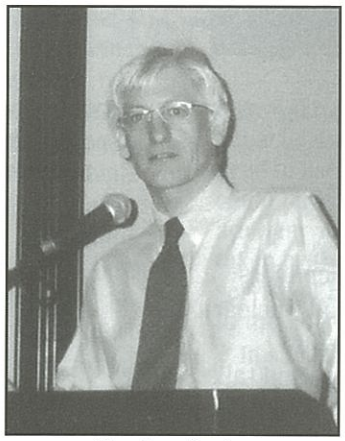
- Fuel channel inspection and maintenance
- Improving human performance
- Preventative maintenance techniques
- Use of analysis techniques to facilitate maintenance
- Maintenance programs
- Plant upgrades
- Steam generator maintenance
- Heat transport systems
- Use of robotics
- Ageing effects
- Monitoring and surveillance techniques
- Valve maintenance
- Maintenance management
- Environmental qualification experience
- Plant life management
- Steam generator inspection techniques
- Facilitating maintenance
- Spare parts engineering

Most of the papers are included in the printed Proceedings of the Conference which are available from the CNS office.

The luncheon speaker the first day was **Paul Konderman,** president of Babcock & Wilcox Canada, who spoke proudly of the success his company has achieved in supplying replacement steam generators for nuclear plants in the USA. In the two year period, 1998, 1999, Babcock & Wilcox Canada won 100 percent of US nuclear steam generator replacement. Of the 226 steam generators in all CANDU plants, B & W Canada supplied 222 (all but those in Wolsong 1). None have yet had to be replaced, he noted, but excepted Bruce A.

On the second day, **Rod White,** vice-president New Brunswick Power, spoke about the plans for a major refurbishment of Point Lepreau. An initial study has been completed and they are now into a detailed plan scheduled to be finished in 2002. Atomic Energy of Canada Limited has agreed to be a partner. He concluded that they will need: a sound business case; public acceptance; and demonstrated performance in the interim. The cost of the refurbishment is currently estimated to be between $500 and $700 million.

Rex Murphy, host of CBC radio's Cross Country Checkup and a participant on many other radio and TV programs,



Charles Parker

was the guest speaker at the Conference dinner. Murphy reviewed the Canadian political scene in style ranging from sharp humour to biting criticism.

In the unannounced wrap-up talk, **Charles Packer,** recently retired as vice-president of the Darlington site, provided a philosophical and erudite commentary on life and work which he title "Living Stones". With quotations from the New Testament, Homer and Tennyson he spoke of how he chose "Cherrystone" for the name of his new management consulting company. "Living Stones know that life is journey not destination", was one of several attributes he described and concluded by stating, "Living Stones are able to bring things of value and of beauty out of difficult times."

This successful Conference was organized by a committee which included: Ron Osborne as honorary chair; Larry Nichol, conference chair; Martin Reid, Bob Tapping and Greg Shikaaze for the technical program; Ken Belfall treasurer; Ronnie Faulkner and Anne Williams as exhibit coordinators; Denise Rouben registrar; Tim McLaughlin publications; Ed Price for plenary session (and general advisor); and committee members Karel Mika, Asman Usmani, Ehab Bhikit, Chris Guiry, Henri Bordeleau, Keith Stratton, Ricardo Tibaldi, Romeo Urjan.

Larry Nichol, conference chairman, and Ed Price, advisor and plenary session chair, relax at the beginning of the 5th CNS International Conference on CANDU Maintenance held in Toronto, 19-21 November 2000.

BRANCH ACTIVITIES

Ed. Note; *At the time of writing only a few of the CNS Branches had reported on their fall activities.*

CHALK RIVER

The CNS Chalk River Branch held two public seminars:

- 2000 Sep. 26 – Bill Clarke (President, Canadian Nuclear Association) gave a talk on current CNA activities
- 2000 Nov. 9 – Branch Annual General Meeting, and talk by David Cox (Manager, Fuel Development, AECL) - "In the Aftermath of the MOX Shipments".

In its support of educational activities the Branch has purchased a Geiger Counter for the Englehart High School in Englehart, Ont.

GOLDEN HORSESHOE

A nuclear careers night is planned for November 14 where students and potential employers can make contact.

OTTAWA

Bill Clarke, Chairman of the CNA gave a presentation entitled "The CNA Viewpoint: Opportunities and Challenges in the Canadian Nuclear Industry", to the Ottawa branch of the CNS, October 26, 2000.

NEW BRUNSWICK

The New Brunswick Branch of the CNS held a noontime session at the Point Lepreau Generating Station STOIC Theatre on Thursday October 26, 2000 entitled *"NB Power, the Environment and Point Lepreau"*. The lecture was delivered by Charles Hickman , Manager of Environmental Assessment, NB Power and Claire Flood, from NB Power's Environmental Assessment Group.

This lecture described NB Power's approach to the environmental impact of its operations from both a historical and a forward-looking perspective. Topics covered included Canadian environmental firsts, such as the Tobique Dam fish ladder, and the first utility scrubber on a fossil generator. Current corporate activities were also addressed, describing some of the links between NB Power and other utilities and trade organizations. The Point Lepreau situation on environmental compliance was discussed and its applicability to the upcoming decision on refurbishment.

SHERIDAN PARK

The Sheridan Park planned a talk by Michel Ross of Hydro Quebec on nuclear plant ageing..

TORONTO

The revitalized Toronto Branch has held two seminars this fall:

- October 17 - Dr. Peter Barnard, chairman and CEO of ITER Canada on *The International Thermonuclear Experimental Reactor (ITER) - Past, Present and Future.*
- November 2 - Marcello Olivierio, OPG on Environmental Spills Risk Assessment.

OBITUARY

Norm Graham, another Canadian nuclear pioneer, passed away on November 9 2000.

Born into a farming family near Barrie, Ontario, he was a graduate of the University of Toronto with a Masters degree in Analytical Chemistry. He joined Westinghouse Canada in 1951 and worked on a variety of projects at the Hamilton Labs before beginning an attachment at Chalk River in 1956/1957. Norm was assigned to the Corrosion Science group of the Chemistry and Materials Division, working on fuel development for NPD-1 and NPD-2. Upon his return to Hamilton, he continued working on the many fuel design parameters associated with prototype manufacture (welding/brazing) of early CANDU fuel (NPD and Douglas Point).

In 1979 he moved to the Port Hope fuel manufacturing facility where he continued to work on development work associated with fuel/pressure tube crevice corrosion, stress corrosion cracking, fretting corrosion and delayed hydride cracking of Zirconium, uranium dioxide, CANLUB coatings and steam generator materials.

After his retirement, he continued to work as a consultant including the transfer of fuel manufacturing technology in support of overseas sales of CANDU technology. Norm was also an active member in many professional and technical societies such as ASTM, CNS, the National Association of Corrosion Engineers and the Chemical Institute of Canada.

All his colleagues in our industry recognized Norm as a superb source of knowledge and inspiration in the Canadian nuclear fuel program. He is also remembered for his warmth, humor and unassuming manner; a true friend and gentleman.

by Martyn Walsh

CNS comments on Pickering A

Ed, Note: *Feeling there was insufficient time to prepare a full brief on the Pickering A return to service issue, the CNS Council empowered the President to submit the following letter.*

Dr. Agnes Bishop
President
Canadian Nuclear Safety Commission

Dear Dr. Bishop

Environmental Assessment Regarding the Return to Service of Pickering A

The Canadian Nuclear Society wishes to provide the following written comments to the Commission, to assist in its review of the above topic at its meeting on December 14, 2000.

The Canadian Nuclear Society (CNS) is a federally incorporated not-for-profit corporation of individuals involved in nuclear science and technology in Canada. The CNS promotes the exchange of information on all aspects of nuclear-related topics, including nuclear power generation, uranium mining and refining, medical and industrial uses of radionuclides, management of nuclear wastes, and related research and development activities. The following comments have been prepared on behalf of the Canadian Nuclear Society by the undersigned individuals who have not been, and are not now, involved in any activities related to the restart of Pickering A, or the preparation of the Environmental Assessment which is currently under review by the Commission.

We have examined the Environmental Assessment Screening Report in sufficient detail to conclude that we support the conclusions arrived at by Commission staff in their CMD 00-H29. The conclusions which are contained Section 8 of that document are repeated at the end of this letter.

When the CNSC (formerly the AECB) decided that an Environmental Screening Report must be prepared for this project (in order to follow legal requirements defined by the two Acts which govern the CNSC actions on this topic), an important objective was to determine whether the restart of Pickering A would have any significant adverse environmental impacts. We agree with the conclusion of the CNSC staff (see Point 3 below) "that the project, taking into account the appropriate mitigation measures, is not likely to cause significant adverse environmental effects."

Regarding Point 5 below, the Canadian Nuclear Society would like to record its opinion that there is insufficient objective evidence of public concern about this project to warrant referring it to a mediator or review panel. Although the CNSC has received written submissions which include expressions of concern from some vocal groups about the environmental effects of restarting Pickering A, the lack of input from people outside these groups suggests that the majority of the population either (a) do not agree with those concerns, or (b) are unconcerned with this topic and therefore have no opinion, or (c) are in favour of restarting Pickering A.

The preparation and review of the Environmental Screening Report has already delayed the restart of Pickering A. Such delays in fact cause much more significant environmental impacts than the operation of Pickering-A, as a result of the need to use coal-fired power stations to replace the power that could have been generated by Pickering A. It follows that we are very much concerned about any action which might be taken by the Commission that could further delay the return to service of Pickering A, because it would be counter-productive to the health of our environment.

In summary, we strongly support the conclusion recorded by the CNSC staff in Point 7 below.

K.L. Smith, PEng.
President

Dr. D.P. Jackson
1st Vice President

Addendum to CNS Letter

The following text is copied from Section 8 of CMD 00-H29. The numbering of the seven points has been added for convenience in referring to them in the above letter.

8.CNSC Staff Conclusions and Recommendations

"1. The CNSC must consider and make a decision on the following issues before taking a course of action under Section 20(1) of the Canadian Environmental Assessment Act:
- the likelihood and significance of effects to be caused by the project [the restart of Pickering A], taking into consideration appropriate mitigation measures;
- the degree of uncertainty associated with the assessment of effects; and
- the degree of public concern about the project.

"2. CNSC staff conclude that the Screening report meets all the requirements of the Canadian Environmental Assessment Act (CEAA) and of the scope of the assessment.

"3. Based on the findings in the Screening Report, CNSC staff conclude that the project, taking into account the appropriate mitigation measures, is not likely to cause significant adverse environmental effects.

"4. CNSC staff also believe that the Environmental Assessment has been able to identify the likelihood and significance of the adverse effects with reasonable certainty.

"5. Furthermore, CNSC staff conclude that public concerns expressed to date about the project do not warrant a reference to the Minister of Environment for referral to a mediator or review panel.

"6. CNSC staff recommend that the Commission accept the conclusions of the Screening Report; that is, that the project, taking into account the appropriate mitigation measures, will not cause significant adverse environmental effects.

"7. CNSC staff further recommend that the Commission determine a course of action consistent with Paragraph 20(1)(a) of the CEAA; that is, to proceed to an assessment of the licence application under the Nuclear Safety and Control Act."

CNS Fellows and Award Winners

Fellows of the Canadian Nuclear Society

George Howey	1992
John Hewitt	1992
Phil Ross-Ross	1992
John Foster	1993
Terry Rummery	1993
Ken Talbot	1993
Alan Wyatt	1993
Fred Boyd	1994
Stan Hatcher	1994
Daniel Rozon	1994
Michel Ross	1995
Bob Jervis	1995
Dave Torgerson	1995
Bill Midvidy	1996
Terry Rogers	1996
Paul Fehrenbach	1997
Edward Price	1997
Richard Bolton	1998
Hugues Bonin	1998
Dan Meneley	1998
Benjamin Rouben	1999
Jerry Cuttler	2000

CNS Innovative Achievement Award

Bill Morison	1991
Wing Tao	1991
Andrew Stirling	1992
Dé C. Groeneveld	1993
Tom Holden	1994
Ray Metcalfe	1998
Ralph Hart	2000

John S. Hewitt Team Achievement Award

Don McLean, Bill Morgan and Mitch Ohta

- for the development and demonstration of dry spent fuel storage

1995

Charles Kittmer, Roger Joynes and Larry Green

- for the development and demonstration of micro-sampling of pressure tubes

1996

Staff of Point Lepreau G.S.

- for excellence in nuclear power plant operation and exceptional sustained plant performance

1996

The Members of the Nuclear Fuel Waste Management Team at Atomic Energy of Canada Limited and Ontario Hydro

- for Development of the Concept, and Preparation of the Environmental Impact Statement for Disposal of Canada's Used Nuclear Fuel

1997

Charles Y. F. Chang, John Skears, and Tung Toong

- outstanding contribution to thermal hydraulic process design and safety analyses for CANDU reactors, particularly, the development of the SOPHT computer code

1998

Team from SAIC Canada, Defence Research Establishment, Ottawa and Suffield, Bubble Technologies Industries

- for the creative conceptualization and innovative application of a thermal-neutron-activation-based system for detecting non-metallic land mines, allowing the effective detection and removal of these deadly devices.

2000

All of the organizations involved with the Wolsong 2,3, and 4 units

-for outstanding teamwork in completing the Wolsong 2, 3, & 4 Project on schedule

CNS Education / Communication Award

Aslam Lone	1997
Morgan J. Brown	1998
Ronald G. V. Hancock	1998
Jeremy Whitlock	1999
Murray Stewart	2000

Canadian Nuclear Society

Honours and Awards - Call for 2001 Nominations

DEADLINE FOR ALL NOMINATIONS: 2001 April 13

Fellows of the Canadian Nuclear Society

CNS members who have been designated "Fellows of the Canadian Nuclear Society" belong to a membership category established by the Society in 1993 to denote outstanding merit. The criteria for admission to this membership category include "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, service to the Society, and current CNS membership of at least five years standing, are also requirements for admission.

The newly admitted fellows are presented with special membership certificates on a suitable occasion at the time of the annual conference of the CNS. 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. The maximum number of CNS Fellows at any one time is limited to not more than five per cent of the total membership.

All CNS branches and technical divisions are encouraged to forward confidential nominations statements, signed by three members, to the Chairperson of the CNS Honours and Awards Committee. Alternatively, any three CNS members, not necessarily of the same branch or division, may together forward a nomination. The nomination statement should include a focused rationale for the nomination, supported by information on the candidate's:

(i) formal education or equivalent,
(ii) work history, professional achievements, publications, patents,
(iii) experience, demonstrated maturity of judgement and contribution to nuclear science and technology, and
(iv) past services to the CNS.

The Honours and Awards Committee will consider the above criteria with weights of 20%, 20%, 25% and 35%, respectively.

CNS Innovative Achievement Award

The Innovative Achievement Award was established by the CNS in 1991. Recipients of the award are specially recognized for

> *"Significant innovative achievement, implementation of new concepts, or outstanding contribution in the nuclear field in Canada."*

The award trophy, on which all recipients' names are inscribed, is in the form of an original sculpture showing three figures supporting the Society's logo. Each recipient retains a miniature replica of one figure from the sculpture, as well as a commemorative certificate presented at the annual conference of the CNS.

Members of the Society are strongly encouraged to nominate individuals who have made key contributions to the Nuclear Science and Technology. Such contributions should have been to the conceptual design, development or implementation phase of the concept, or to a combination of these phases.

Nominations letters should be signed by three persons and accompanied by:

(i) a short biography,
(ii) a description of the particular innovative or outstanding achievement for which the award would be made, and
(iii) a well focused rationale supporting the nomination.

CNS John S. Hewitt Team Achievement Award

The John S. Hewitt Team Achievement Award was established by the CNS in 1994. This awards aims at recognizing the recipients for

> *"Outstanding team achievements in the introduction or implementation of new concepts or the attainment of difficult goals in the nuclear field in Canada."*

The award is in the form of one or more engraved plaques or certificates presented to the members of the team at the annual conference of the CNS.

Members of the Society are strongly encouraged to nominate teams of generally not more than five persons who have made key contributions to the introduction or the implementation of new concepts or the attainment of difficult goals in the nuclear fields in Canada. Such contributions should have been to the conceptual, design, development or implementation phase leading to the achievement, or to a combination of these phases.

Nomination letters should be signed by three persons and accompanied by:

(i) a short biography of each team member,
(ii) a description of the particular achievement for which an award would be made, and
(iii) a well focused rationale supporting the nomination.

CNS Education /Communication Award

The Education / Communication Award was established by the CNS in 1997. This awards aims at recognizing the recipients for

> *"Significant achievements in improving the understanding of nuclear science and technologies among educators, students and the public"*

The award is in the form of a certificate, presented to each person being recognized, at the annual conference of the CNS.

All CNS branches and technical divisions are encouraged to forward confidential nominations statements, signed by three members, to the Chairperson of the CNS Honours and Awards Committee. The nomination statement should include a focused rationale for the nomination, supported by information on the candidate's:

(i) biography of the nominee,
(ii) description of the achievement(s) with specific references, examples, etc.

Please send your nominations in confidence, before 1999 March 15 to :

The Chair, Honours and Awards Committee
Canadian Nuclear Society
144 Front Street West, Suite 475
Toronto, Ontario M5J 2L7

News of Members

Dr. Brent Lewis, a professor at the Royal Military College and a long-time member of the CNS, was presented with the Literary Award of the Materials Science and Technology Division of the American Nuclear Society (ANS) for 1997 at the ANS Honours and Awards banquet Nov 15, 2000 in Washington D.C. during the ANS / ENS Meeting. Dr. Lewis received the award on behalf of himself and his co-authors for the paper *"Iodine Spiking Model for Pressurized Water Reactors,"* by B.J. Lewis, F.C.Iglesias, A.K. Postma and D.A. Steininger, which was published in the Journal of Nuclear Materials 244 (1997) 153-167. The Literary Award recognizes authors that have contributed the best full-length materials-oriented paper or review article in the field of materials science and technology contributing to the development of nuclear energy.

Dr. Esam Hussein and Dr. Pratondo Busono of the Department of Mechanical Engineering, University of New Brunswick, were awarded the Sylvia Fedoruk Prize in Medical Physics for 2000, for their paper *"Algorithms for density and composition-discrimination imaging for fourth-generation CT systems"*, published in Physics in Medicine and Biology, volume 44, pages 1455-1477. This award is presented for the best paper on a subject falling within the field of medical physics, relating to work carried out wholly or primarily within a Canadian institution and published during the past calendar year.

The Sylvia Fedoruk Prize in Medical Physics was established in 1986 by the Saskatchewan Cancer Agency to honor Dr. Fedoruk for her 35 years of dedicated and distinguished service to Saskatchewan's cancer program as a Medical Physicist. Dr. Fedoruk was elected Chancellor of the University of Saskatchewan in 1986 and Lieutenant Governor of Saskatchewan in 1995. She was also a member of the Atomic Energy Control Board in the mid 1980s.

Free

A new service for members

The Canadian Nuclear Society is pleased to offer a free new service for its members. Any CNS member in good standing who is seeking a job is welcome to send his/her curriculum vitae (C.V.) to the CNS office at < **cns-snc@on.aibn.com** >. The C.V. will be posted on the "CNS Member C.V's" web page, linked from the main CNS web page at < **www.cns-snc.ca** >.

When you send your C.V. file to the CNS office, you must use HTML, pdf or MS Word format. You should also include, **separately**, your qualification description (e.g. mechanical engineer, health physicist, geotechnologist, etc.) and contact information (phone numbers, e-mail and postal addresses). The CNS will not edit or format your C.V. file.

The C.V. file will be posted on the web page with a number, your qualification description and the posting date.

Your name and contact information will not be posted, and is inaccessible from the web site. Any potential employer will have to contact the CNS office. The CNS office will pass the potential employer's message to you, and it will then be up to you to respond. The CNS can only establish initial contact between CNS members and potential employers - the CNS cannot act as a go-between for further correspondence.

In order to maintain your anonymity, you will have to remove any name or address information from your C.V. file. You have, of course, the option of including your name and contact information in your C.V. file, if you wish. Your C.V. will be removed from the C.V. page after 3 months, unless you request it be re-posted for another 3 months. If you would like your C.V. deleted from the page before 3 months, please contact the CNS office.

Note that the CNS cannot bear any responsibility for any errors or mistakes in operating this service.

Employers: if you see a c.v. which interests you on the Members' c.v. page, pls. contact the CNS office at < **cns-snc@on.aibn.com** >.

Gratuit

Un nouveau service à membres

La SNC est heureuse d'offrir un nouveau service gratuit à ses membres. Tout membre en règle de la SNC et à la recherche d'un poste peut soumettre son curriculum vitae (C.V.) au bureau de la SNC à < **cns-snc@on.aibn.com** >. Le C.V. sera affiché à la page "C.V. des membres", disponible à partir du site web de la SNC, à < **www.cns-snc.ca** >.

Les fichiers de C.V. doivent être envoyés en format électronique - HTML, pdf ou Microsoft Word. Vous devez inclure, **séparément**, la catégorie de vos qualifications (par exemple génie mécanique, physique de la santé, géotechnologie, etc.), ainsi que vos données de contact (numéro de téléphone, adresses postale et électronique). La SNC ne peut modifier le contenu ou le format de votre fichier C.V. Le fichier C.V. sera numéroté et publié avec son numéro, la catégorie de vos qualifications, et la date initiale de parution.

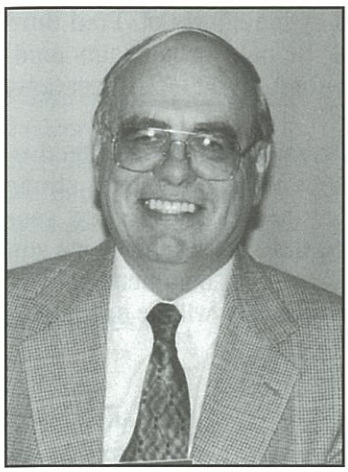
Votre nom et vos données de contact ne seront pas affichés, et seront inaccessibles à partir du site web. Tout employeur potentiel devra contacter le bureau de la SNC. Le bureau de la SNC vous relaiera le message de l'employeur potentiel, et ce sera votre responsabilité de répondre à l'employeur. La SNC ne peut que faciliter le contact initial entre le membre de la SNC et l'employeur potentiel - la SNC ne peut en aucun cas agir comme intermédiaire dans les correspondances ultérieures.

Afin de maintenir l'anonymité, vous devrez vous même omettre vos nom et données de contact de votre fichier C.V. Vous pouvez toujours naturellement, si vous le voulez, inclure ces détails dans votre fichier C.V., c'est vous qui décidez. Votre C.V. restera publié pendant 3 mois et puis sera effacé, à moins que vous ne demandiez qu'il soit republié pour 3 autres mois. Si vous voulez que votre fichier soit effacé avant 3 mois, veuillez communiquer cette requête au bureau de la SNC.

Veuillez noter que la SNC ne peut en aucun cas être tenue responsable d'erreurs dans l'exploitation de ce service.

Employeurs: si vous voyez un C.V.. qui vous intéresse, veuillez contacter le bureau de la SNC à < **cns-snc@on.aibn.com** >.

From the President's Desk



This is my first report to members since our Annual CNS Conference in June. All feedback indicated that it was a great success, and this was largely due to the excellent attendance and financial support provided by the nuclear industry, plus the hard work put in by the organizing committee. We have booked the same location in Toronto for next year's conference, which will be held on June 10-13.

The annual CNS/CNA Student Conference, which has been held every March for a number of years, was successful this past March in spite of the small turnout. However, it is apparent that the gradually reducing enrollment in nuclear courses at our Canadian universities will make it increasingly difficult to hold a viable stand-alone student conference. Therefore, we have decided that it would make more sense to organize it as an embedded part of the Annual Conference next June. One of the advantages of this format is that the students will have a much better opportunity to meet with members of the industry.

Other recent CNS events were the 21st CNS Nuclear Simulation Symposium (September 24-26), the CANDU Reactor Safety Course (November 1-3), and the CANDU Maintenance Conference (November 19-21). All of these were successful events because of the efforts of the organizing committees and the support from industry. Looking ahead, planning is progressing on the following events in 2001: a CANDU Chemistry Course in February; a Fuel Design Seminar later in the spring; the International Fuel Conference in September, and a 2nd Climate Change Conference in October. Looking further ahead to 2002, the planning for another International Steam Generator and Heat Exchanger Conference has begun, and preliminary discussions have been held regarding a possible conference on radioactive waste management. I am extremely pleased with the initiatives that have been taken by our Program Committee and the various CNS Technical Divisions, in order to set up such an active program.

Now let me turn to some of the activities that your CNS Council has been involved with in the recent past. Perhaps our most important activity during the past month was the development of a brief letter to the Canadian Nuclear Safety Commission, to put forward our support for the positive results of the Pickering A Environmental Assessment Screening Report, which had been developed to evaluate the environmental effects of returning Pickering A to service. A copy of that letter is printed elsewhere in this issue of the Bulletin. As you are probably aware, the CNS has a policy that any official position of the organization is thoroughly reviewed by numerous members before issue. Therefore, although the letter is short and direct, a considerable effort went into reaching agreement on the text. I am pleased with the final result.

Other major CNS activities are related to our interfaces with other Canadian and international organizations. Some of the recent developments are noted below:

- The CNA took the initiative to draft a Memorandum of Understanding, to define the working relationship between the CNS and the CNA, and we have been working with the CNA President, Bill Clarke, to finalize this document. I expect that this MoU will be signed in the near future.
- Early this year the CANDU Owners Group offered us some space within their office in Toronto, and (as you are aware) our CNS office has been located there since last March. Now that COG has signed a new long-term lease in the current building, we have been negotiating an agreement with COG to formalize our use of space plus some other minor services in their office. I expect that this agreement will be signed in early December.
- The CNS has been a member of the Pacific Nuclear Council since that organization was formed in 1989 by the technical societies in the Pacific Basin countries - to pursue issues of common interest. Our representative at the October 29 meeting of the PNC (which was held on the sidelines of the Pacific Basin Nuclear Conference in Seoul) was Paul Fehrenbach, who was the CNS President in 1993/94. The PNC has revised its Charter to permit membership by organizations other than just technical societies, and now includes three membership categories.
  a) Professional Associations: This now includes technical and professional societies such as the CNS, and not-for-profit trade organizations and associations such as the CNA;
  b) Institutional Membership: Colleges, universities, and other educational institutions;
  c) Commercial Organizations: Commercial, for-profit, organizations.

  The PNC Executive Committee shall be made up of representatives from the first category of membership.
- The CNS has been a member of the International Nuclear Societies Council since it was formed in the early 1990s. Its function is similar to that of the PNC, except on a world-wide scale. There are 41 member societies, of which 27 are affiliated with the European

Nuclear Society. Fred Boyd and I represented the CNS at the most recent meeting of the INSC on November 12, which was held on the sidelines of the annual winter meeting of the American Nuclear Society in Washington D.C. A review of both the INSC and the PNC activities requires more space than I can use in this report, so these two topics need to be covered in more detail in a future issue of the Bulletin.

- I was pleased to be able to represent the CNS at the ANS meeting in Washington, from November 11 to 15. This meeting was co-sponsored by the European Nuclear Society. The meeting was well attended (by about 1200 people) and the mood was quite up-beat, with various speakers talking positively about the future of nuclear power in the United States, particularly in view of the decisions by many utilities to apply to the U.S. NRC for licenses to extend the life of their existing nuclear plants.

I would like to close with three comments:

- I am encouraged by the work being done by the various Committees of your CNS Council. For example the Education Committee has prepared a budget for 2001 for a continuation of its support for various courses for teachers, journalists, and students, as in previous years. I will be soliciting a report from the Education Committee for the next issue of the Bulletin.
- I continue to be impressed by the efforts of Fred Boyd in assembling this Bulletin. He puts out a quality product with virtually no input (and no editorial overview) from your CNS Council.
- I would like to remind all members that the effectiveness of the CNS is dependent on maintaining a strong membership base. The time has come to renew your membership for 2001 (if you have not already done so), and I encourage you to talk to your "non-member" colleagues about the activities that they will be supporting by joining the CNS.

Ken Smith

Input sought for courses

In recent years, the Nuclear Science and Engineering Division (NSED) of the CNS has successfully organized a multitude of technical courses. Now it is seeking your views.

The NSED has created a Webpage linked to the CNS Website which lists all proposed NSED courses and invites visitors to fill out an online feedback form. This form will be used to establish a waiting list for each of the listed courses. Courses will be offered as soon as possible after a required minimum number of potential participants have shown an interest. The form in the Webpage also invites your suggestions for new courses.

Please visit our new page and let us know what interests you by filling in the online form. You will be notified first when the course is scheduled. To find our new webpage, go to the CNS Webpage < www.cns-snc.ca > and follow the links to "courses".

Dr. M.S. Guellouz, Chair
Nuclear Science and Engineering Division
Canadian Nuclear Society
e-mail: guellouzs@aecl.ca

CNS President Ken Smith shakes hands with Oleg M. Saraev president of the Nuclear Society of Russia after signing a renewal of the co-operation agreement between the two societies. The ceremony took place at the NSR booth at the ANS/ENS Meeting in Washington, D.C., 13 November 2000.

Canadian Nuclear Society / Société Nucléaire Canadienne

480 University Ave., Suite 200, Toronto, Ontario M5G 1V2
Telephone: 416-977-7620 FAX: 416-977-8131 e-mail: cns-snc@on.aibn.com

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[Note: Membership for remainder of 2000 is free if applying after Sept. 30]

Please check boxes for the Divisions and up to two Branches in which you would like to be a member [if choosing two Branches, please mark them 1 and 2]:

Branches

- ❑ Bruce
- ❑ Chalk River
- ❑ Darlington
- ❑ Golden Horseshoe
- ❑ Manitoba
- ❑ New Brunswick
- ❑ Ottawa
- ❑ Pickering
- ❑ Québec
- ❑ Saskatchewan
- ❑ Sheridan Park
- ❑ Toronto

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- ❑ Nuclear Operations
- ❑ Nuclear Science and Engineering
- ❑ Design & Materials
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Formulaire d'adhésion - 2001/2002

[N.B.: L'adhésion pour le restant de l'année 2000 est gratuite si la demande est faite après le 30 sept. 2000]

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- ❑ Chalk River
- ❑ Darlington
- ❑ Golden Horseshoe
- ❑ Manitoba
- ❑ New Brunswick
- ❑ Ottawa
- ❑ Pickering
- ❑ Québec
- ❑ Saskatchewan
- ❑ Sheridan Park
- ❑ Toronto

Divisions

- ❑ Exploitation nucléaire
- ❑ Science et génie nucléaires
- ❑ Conception et matériaux
- ❑ Technologies du combustible
- ❑ Environnement et gestion des déchets

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+ Escompte pour 2002 si payé avant le 31 décembre 2000:

Pour 2001 et 2002: ❑ standard 125$ ❑ retraité 71$ ❑ étudiant 39$

[Pour catégorie couple, veuillez communiquer avec le bureau de la SNC]

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Téléphone: 416-977-7620 Télécopieur: 416-977-8131 Courriel: cns-snc@on.aibn.com

Lois Wilson: Nuclear Waste: Exploring the Ethical Dilemmas

United Church Publishing House, 2000. ISBN 1-55134-116-6

reviewed by Don Wiles[1]

Dr. Wilson was a member of the Environmental Review Panel selected to assess the Environmental Impact Statement (EIS) of Atomic Energy of Canada, Ltd. dealing with AECL's proposal for the management and disposal of high-level nuclear waste from Canadian power reactors. In this connection, she was intimately familiar with the elaborate and often difficult discussions that occurred within the Panel. This book recounts her personal feelings during the course of the public hearings and the Panel's debates. One is made to feel her frustration when major social omissions are not faced by the system within which she worked. This makes very interesting, if often repetitive, reading.

Dr. Wilson clearly favours long-term monitoring, and admits to having greater confidence in societal organizations than is implied in other discussions of the EIS.

The title of the book leads one to expect a thorough exploration of the many important ethical problems that surround the whole question of nuclear waste disposal worldwide. Unfortunately, the book lives up to its title only in part. While many ethical questions are raised in passing, the most important, and almost the sole ethical issue discussed at length is one of procedure: the pervasive (one hopes inadvertent) omission of discussion with the aboriginal peoples of Canada. This is a serious omission since, by unstated implication, likely disposal sites are expected to lie within lands occupied by aboriginal communities. Dr. Wilson's exasperation with this omission is right, and most thinking people will readily agree with her.

However, one wishes that other, arguably more fundamental ethical issues had also been explored. The question of permanent or temporary disposal: does this generation have the right to make a decision precluding other decisions by later generations, or does this generation rather have the obligation to clean up the problem before imposing it on other generations? What is the origin of the numerical figure of one in a million chance of fatal cancer as representative of public acceptability? What is the significance of the time limit of 10,000 years for imposing this acceptability criterion? Is it realistic to imply that the waste disposal site must be within the Canadian Shield in Ontario, or would some other area be equally successful and perhaps more welcoming?

In short, this book is not as deeply thought provoking as its title suggests and, although the point made is indeed important, it is not likely to be a great contribution to future debates on the ethics of nuclear waste disposal.

Nuclear Reactor Theory in Canada, 1943 - 1946

Volume 36, Number 3, 2000 Progress in Nuclear Energy (Special Issue)

ISSN 0149-1970

Published by Elsevier Science Ltd., UK.

Most of this special issue is devoted to a review of the papers on nuclear reactor theory produced at the Montreal Laboratory of the National Research Council by guest editor Dr. M. M. R. Williams of Surrey, UK. At the beginning of the review he offers biographies of all of the authors, who include: Henry (Hank) Clayton, Steve Kushneriuk; George Placzek; John Stewart; George Volkoff. Although George Laurence is not included as an author the issue includes an extract from his article Early Years of Nuclear energy Research in Canada that was published by AECL in 1980. Also included are excerpts from letters which provide an insight into the personnel problems at the Montreal Laboratory.

This is an excellent reference for anyone interested in the origins of Canada's nuclear program and a fascinating read for those able to understand the mathematics and physics involved.

Fred Boyd

From the Canadian Nuclear Safety Commission

The CNSC has issued the following Regulatory Documents:

Regulatory Policy P-119 ***Policy on Human Factors***

This was issued by the AECB as a Consultative Document C-119 in November 1999 and has now been adopted as a Regulatory Policy.

It describes how the CNSC will take human factors into account during its regulatory activities.

Regulatory Policy P-242 ***Considering Cost-benefit Information***

This document was issued in draft form as C-242 in October 1999

This document describes how the CNSC will consider cost-benefit information in certain of its decision-making processes.

Regulatory Guide G-149 ***Computer Programs Used in Design and Safety Analyses of Nuclear Power Plants and Research Reactors***

A draft version of this Guide was issued in April 1998 as C-149.

This Guide provides guidance to licensees on how to develop, maintain and use computer programs used in the design and safety analyses of nuclear power plants and research reactors.

From the International Atomic Energy Agency

Energy, Electricity and Nuclear Power Estimates for the Period up to 2020 - July 2000

Reference Data Series No. 1

130 Austrian schillings

This is the 20th edition of this publication and contains the most recent (as of early 2000) estimates.

1 Don Wiles is professor emeritus at Carleton University and is currently working on a book about the chemistry of radioactive waste management

Great Expectations

by Jeremy Whitlock

Taking the Long View comes naturally to a career nuclear employee. Well-accustomed to the feints of fortune, the parries of politicians, the antics of anti-nukes, today's veteran Atomic Warrior is surprised only when events unfold in a timely and entirely logical manner. Seldom is he or she surprised.

The Long View, of course, is that nuclear power's value will continue to appreciate, here and around the world. It has to. Options are limited, particularly as true life-cycle costs sneak more and more into the bottom line. The cause célèbre of anthropogenic Climate Change, fact or fiction, is only the tip of the melting iceberg.

It is with some sense of irony, therefore, that pro-nukes receive news of their technology being a "sunset industry", as is sometimes heard. In fact it is very easy to characterize the nuclear industry this way – one need only note the number of reactor orders in the last ten years and compare with, say, snowmobiles. Factor in government R&D subsidization and you've got the makings of a great public smear campaign. It's easier than falling off a log and much more lucrative if done right.

As the manure lobs overhead, the nuclear trenches teem with oblivious activity. The immediate outlook is typically obscure: "good prospects", "potential sale", "favourable climate", "maybe next year". Most of it hinges upon glacial-speed politics and billion-dollar financing that tantalize perpetually from beyond the six-month horizon. And yet, so colossal are the benefits to humankind of one single reactor sale anywhere on the globe, that to the earnest soul it all seems worthwhile.

Paddling on the Ottawa River by canoe, the introspective nuclear scientist (with a weakness for metaphor) is reminded of this aspect of his profession. The mighty waterway flows past Chalk River Laboratories with an enormity that renders visual depth perception useless. Particularly when travelling down the middle of the mile-wide river, the illusion of zero progress can be disconcerting to the neophyte canoeist. So vast is the watercourse that you typically see your destination for five hours before arriving, all the while thinking it is only 30-minutes away. One is often given to glancing back at his meagre wake for reassurance that the canoe is actually moving.

Even so, the avid Big Water canoeist forges on, stroke begetting stroke, absorbing sounds and scenery with the perspicacity of a wine expert at his craft – certain that he will eventually arrive where he's going and be richer for the journey. Up ahead Wolsong and Cernavoda loom on the horizon; NG CANDU can barely be made out further beyond. Qinshan towers to starboard. Far off the stern Akkuyu slips forever into the mist.

This isn't the life for everyone. Certainly not the ubiquitous motorboat enthusiasts, with the roar of the engine in their ears and the smell of oil in their nostrils. These are the Nortels, the Microsofts, the JDS Uniphases.

Nor is it for thrill-seeking kayakers, careening over watery precipices and surfing in the frothy back-fill. These are the Dot-Commers and the day traders.

Then there are the hellish Personal Water Craft – screaming, self-indulgent pests that circle tirelessly in their own wake, lurching haphazardly as the whims dictate. These are the anti-nuclear forces, the living embodiment of a little knowledge being a dangerous thing. These are the armchair safety analysts who overnight become experts on the qualification of MOX transport containers. They spew their ignorant detritus into the mainstream media like a Sea-doo spews its oil slick into the Ottawa.

Occasionally an OPP patrol boat pulls alongside to confirm compliance – bailer, life-jackets, 50 feet of floatable rope, whistles. A bit over-regulated for flat-water canoeing you think. These are ... well, perhaps that one's obvious.

When the wind is in your favour the going is good. More often, it seems, a challenge is afoot and the stroke compensates. On the open water great swells can raise you momentarily and improve the forward perspective. Look, the CNF is just around the bend. No not that bend, the next one.

Rollers come in from the wake of an unseen boat. It is best to spot these at a distance and manoeuvre accordingly. The paddler inattentive to developing side disturbances can have his boat rocked a little harder than he bargained for.

A sudden gust of wind can stop you in your tracks, maybe turn you about and send you where you don't want to go. On the Big Water these often portend greater grief and the experienced paddler knows there's a time to fight, and a time to head for shore and lay low.

But it's the underlying sublime struggle – the dogged quest for unseen grails, despite apparent futility and popular misconception – that sets both Big Water canoeists and nuclear employees a breed apart. Staying in the game requires not just the Long View, but the stamina to get there.

Quitting is, after all, as easy as falling out of a canoe.

CALENDAR

2000

Dec. 11 - 13 — **Americas Nuclear Energy Symposium**
Miami, Florida
Visit Website: www.nes2000.org

Dec. 14 - 19 — **Radioisotope Production and Applications in the New Century at 2000 International Chemical Congress**
Honolulu, Hawaii
contact: Dennis Phillips
Los Alamos National Laboratory
Tel: 505-667-5425
Fax: 505-665-3403

2001

Feb. 19 - 20 — **CANDU Chemistry Course - An Introduction**
Cambridge, Ontario
Contact: Bill Schneider
Babcock & Wilcox Canada
Tel: 519-621-2130
e-mail: schneidw@pgg.mcdermott.com

April ?? — **CANDU Fuel Design Seminar**
Toronto, Ontario
Contact: Erl Kohn
Ontario Power Generation
Tel: 416-592-4603
e-mail:
erl.kohn@ontariopowergeneration.com

April 8 - 12 — **ICONE-9 9th Int. Conf. on Nuclear Engineering**
Nice, France
Visit website: www.sfen.fr/icone9

April 29 - May 3 — **9th International High Level Radioactive Waste Management Confeence**
Las Vegas, Nevada
Contact: American Nuclear Society
Tel: 708-352-6611
e-mail: meetings@ans.org

May 13 -17 — **CRPA / CRSO Annual Conference**
Halifax, Nova Scotia
Contact: Dr. George Mawko
e-mail: gmawkp@is.dal.ca

June 10 - 13 — **22nd CNS Annual Conference**
Toronto, Ontario
Contact: Denise Rouben
CNS office
Tel: 416-977-7620
e-mail: cns-snc@on.aibn.com

June 17 - 21 — **ANS Annual Meeting**
Milwaukee, Wis
Visit website: www.ans.org

Sept. 9 - 13 — **Global 2001 Conference: "Back End of the Fuel Cycle - From Research to Solutions"**
Paris, France
Contact: SFEN/global2001
e-mail: global2001@sfen.fr

Sept. 9 - 14 — **2nd International Conference on Inertial Fusion Sciences and Applications**
Kyoto, Japan
Contact: Dr. William Hogan
Lawrence Livermore National Laboratory
Livermore, California
Tel: 925-422-1344
e-mail: bill-hogan@llnl.gov

Sept. 24 - 27 — **7th International Conference on CANDU Fuel**
Kingston, Ontario
Contact: Prof. Brent Lewis
Royal Military College
Tel: 613-541-6611
e-mail: lewis-b@rmc.ca

Sept. 30 - Oct. 4 — **ICEM'01 - 8th International Conference on Radioactive Waste Managment and Environmental Remediation**
Bruges, Belgium
Contact: Donna McComb
Laser Options Inc.
Tucson, Arizona
Tel. 520-292-5652
e-mail: dmccomb@laser-options.com
Web: www.icemconf.com

Oct. 3 - 5 — **Climate Change: Canadian Technologies Development**
Toronto, Ontario
Contact: Duane Pendergast
Comutare
Tel; 403-328-1804
e-mail:
duane.pendergast@computare.org

Nov. ?? — **Management of System Ageing**
Toronto, Ontario
Contact: Robert Tapping
AECL - CRL
Tel: 613-584-8811 ext 3219
e-mail: tappingr@aecl.ca

Nov. 11 - 15

ANS Winter Meeting
Reno, Nevada
Contact: ANS
LaGrange Park, Illinois
Tel. 708-352-6611
e-mail: meetings@ans.org

Nov. 11 - 16

6th International Conference on Tritium Science and Technology
Tsukuba-shi, Ibaraki-ken, Japan
Contact: Dr. M. Nishi
Japan Atomic Energy Research Institute
Tel. +81-29-282-6390
e-mail: nishi@tpl.tokai.jaeri.go.jp

2002

March 10 - 14

4th International Conference on Isotopes
Cape Town, South Africa
Contact: 4ICI Conference Secretariat
Claremont, South Africa
Tel. +27-21-762-8600
e-mail: 4ici@globalconf.co.za
Web: www.globalconf.co.za

May 6 - 9

Steam Generator and Heat Exchanger Conference
Toronto, Ontario
Contact: Robert Tapping
Tel: 613-584-8811 ext 3219
e-mail: tappingr@aecl.ca

June 17 - 21

ANS Annual Meeting
Hollywood, Florida
Contact: ANS
LaGrange Park, Illinois
Tel. 708-352-6611
e-mail: meetings@ans.org

June ??

23rd CNS Annual Conference
Toronto, Ontario
Contact: CNS office
Toronto, Ontario
Tel. 416-977-7620
e-mail: cns-snc@on.aibn.com

July ??

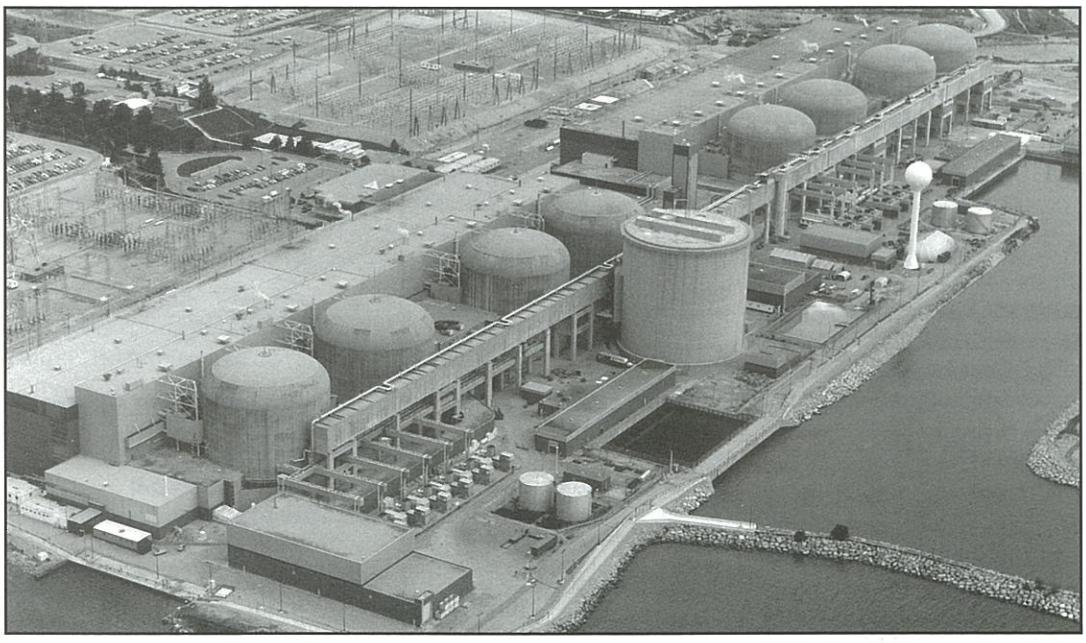
Symposium on the Isolation of Radioactive Waste
Toronto, Ontario
Contact: Judy Tamm
AECL - SP
Tel. 905-823-9060 ext. 4197
e-mail: tammj@aecl.ca

Oct. 7 - 10

PHYSOR-2002: International Conference on the New Frontiers of Nuclear Technology - Reactor Physics, Safety and High-Performance Computing
Seoul, Korea
Contact: Prof. Nam Zin Cho
KAIST
Taejon, Korea
Tel. +82-42-869-3819
e-mail: tpc@physor2002.kaist.ac.kr

Oct. 21 - 25

PBNC 2002 - 13th Pacific Basin Nuclear Conference
Shenzhen, China
Contact: PBNC 2002 Secretariat
Fax: +86-10-6852-7188
e-mail: cns@cnnc.com.cn



Pickering NGS, with the four units of Pickering A in the foreground.

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  Erk Kohn (416) 592-4603 erl.kohn@ontariopowergeneration.com
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  Sadok Guellouz (905) 823-9040 guellouzs@aecl.ca
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  Judy Tamm (905) 823-9040 tammj@aecl.ca

CNA Liaison / *Agent de liaison d'ANC*

Bill Clarke . . . . . (613) 237-4262
e-mail: clarkew@cna.ca

CNS Office / *Bureau d'ANC*

Denise Rouben . . . . . (416) 977-7620
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Manitoba	Morgan Brown	204-753-2311	brownm@aecl.ca
New Brunswick	Mark McIntyre	506-659-2220	mmcintyre@nbpower.com
Ottawa	Bob Dixon	613-834-1149	dixonrs@ftn.net
Pickering	Marc Paiment	905-839-1151	marc,paiment@ontariopowergeneration.com
Quebec	Guy Marleau	514-340-4711	marleau@meca.polymtl.ca
Saskatchewan	Ralph Cheesman	306-586-6485	keewatin@sk.sympatico.ca
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Web Site: http://www.aecl.ca

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