CANADIAN NUCLEAR SOCIETY

bulletin

DE LA SOCIÉTÉ NUCLÉAIRE CANADIENNE

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Cover Illustration

The cover photograph shows the Bruce B nuclear power station, recently leased by Bruce Power.

(Photo courtesy of Atomic Energy of Canada Limited)

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EDITORIAL

Cautious Optimism

This is being written just after the announcement by US president George W. Bush of that country's National Energy Policy and just before the CNS Annual Conference. The former is often referred to as the Cheney report after US vice-president Richard Cheney who headed the group that prepared the 170 page document on the energy scene in the USA.

Nuclear organizations in the USA hailed the report for its endorsement of nuclear power as an important and needed component in the energy mix. Shortly after the president's talk, the Nuclear Energy Institute, the major "lobby" organization for nuclear energy in the USA, held a meeting in Washington, D.C. which vice-president Cheney and several high ranking members of Congress attended. The mood, reportedly, was ecstatic, with talk of a real renaissance of the nuclear program in the USA. Some of that mood has crossed the border and there have even been articles and editorials in our major print media favourable to nuclear power.

For much of this turn around in public and political opinion we must thank California. The electricity shortages there have made headlines around the world. The fact that the basic problem was caused by stupidity on the part of politicians and regulators has not been entirely ignored but has been replaced by the realization that practical sources of electricity are needed to meet growing demand. That coupled with the growing realization that fossil-fuelled plants emit carbon dioxide, the main "greenhouse gas", and, of more immediate concern, also emit other noxious oxides which are the major contributors to smog and acid rain, has led many to be much more acceptive of nuclear power.

This demonstrates a fact that many have noted over the years. There has to be a perceived need. For years nuclear advocates have argued that nuclear power presents a very small risk and felt frustrated that the public did not concur. What the nuclear proponents forgot was that few people will accept any risk if there is no perceived benefit. The situation in California (and to a lesser degree in Alberta) may be due to bad planning and irrational policies but it has brought out the need for adequate, reliable sources of electricity and the realization that nuclear is a rational choice.

It may be too much to expect the general public to love nuclear energy (there are still nagging concerns about accidents and waste) but if people recognize the need they appear to be ready to accept nuclear, and that is probably enough.

IN THIS ISSUE

First, our apologies for the lateness of this issue of the *CNS Bulletin*. Our excuse is a combination of computer problems and unavoidable personal commitments. The former (computer problems) is also to blame for the absence of some normal items, such as Branch News, which got lost in the shuffle.

With that aside, this issue begins with a critical comment on the proposed *Nuclear Waste Act* by John Beare a former director general at the Atomic Energy Control Board. Then our package of papers and articles opens with another note in our series on companies and groups associated with the Canadian nuclear program, **OCI - a look at the Organization of CANDU Industries.** Following is a paper intended for the previous issue but inadvertently omitted, **Radiological Consequences of Chernobyl** and then a paper on a related theme, **Why Are We So Afraid of Radiation?**

A reprint is presented of the summary of an OECD-NEA document on **Nuclear Energy and Sustainable Development**, a topic of current interest. Then we offer the first of what we hope will be an on-going feature - a photo story - this time on the **Decommissioning of the U of T SLOWPOKE.**

For those who like some more technical material there is first a paper on the **Possible Refurbishment of Point Lepreau**, followed by one on **ChemAND - a System for Control of Chemistry of CANDU Reactors.**

There are a number of diverse items in **General News**, including a short report on the **Nuclear Industry Winter Seminar**, the annual one-day review of nuclear activities in Canada.

Sadly, reflecting the age of our nuclear program (and the ageing of many of its people) there are a number of **Obituaries**, most notably for John Foster and George Howey.

There is, as noted in our apology, only a brief section on **CNS News.** This will be corrected for the net issue which will report on the Annual Conference being held as this issue goes to press.

Finally, but certainly not least, there is Jeremy Whitlock's particular look at the current scene in **Endpoint.**

We hope that you find something of interest in this mixture and invite your comments, and, of course, your contributions.

Comment

Bill C-27: unnecessary, intrusive, illogical and counter-productive

By John Beare

Ed. Note. *See the General News section for an article on Bill C-27, an Act respecting the long-term management of nuclear fuel waste, which was introduced in the House of Commons on April 25, 2001. John Beare is a former Director-General at the Atomic Energy Control Board (now, Canadian Nuclear Safety Commission).*

In April the federal government introduced Bill C-27, an Act respecting the long-term management of nuclear fuel waste. The purpose of the proposed legislation is:

> *"to provide a framework to enable the Governor in Council to make, from the proposals of the waste management organization, a decision on the management of nuclear fuel waste that is based on a comprehensive, integrated and economically sound approach for Canada."*

The basic question is why legislation such as proposed in Bill C-27 is needed. The announcements accompanying the legislation make it clear that health, safety, security and environmental issues for nuclear fuel wastes are covered under the Nuclear Safety and Control Act (NSCA), which include provision for financial guarantees for waste management. There are already provisions for public consultations under the NSCA and also under the Canadian Environmental Assessment Act (CEAA) which would apply to any future decisions regarding the management of nuclear fuel wastes. Why is it that the federal government proposes to intervene and make decisions for what are basically economic objectives? In economic terms, what is different about nuclear fuel waste compared to other types of waste that would justify intervention by the federal government? In these days of privatization and private enterprise Bill C-27 is an anachronism: government intervention into and take-over of what is fundamentally a well-ordered and regulated activity.

It appears the federal government is trying to expedite a solution to the nuclear fuel waste issue in order to remove one of the major impediments to the use of nuclear energy to produce electricity. If the government were concerned about the efficient management of long-lived radioactive wastes in general it would have included uranium mine tailings and other long-lived radioactive wastes within the scope of Bill C-27. Failure to include such wastes is, therefore, evidence that the government is catering only to public opinion rather than a genuine concern about the management of long-lived radioactive wastes. If one were to argue that other long-lived radioactive wastes are being adequately managed, then the same argument can be made for nuclear fuel wastes. In short the singling out of nuclear fuel wastes for special attention in a government Bill is illogical. There is probably a bigger contingent liability in the management of old uranium mine tailings and other "historical" wastes than there is from nuclear fuel waste. However, these other wastes currently do not loom large in the public resistance to nuclear power.

Nevertheless, removing the nuclear fuel waste issue as an impediment to the viability of nuclear power would be a worthwhile objective if it could be achieved. Alas, if Bill C-27 becomes enacted the reverse may well be the result. On the face of it the output of activities authorized under Bill C-27 seem simple enough: a study by the waste management organization created by the Act and a decision by the Governor in Council to select one of the approaches outlined in the study. Control over the implementation of the selected option would be through the control of withdrawals from the trust fund required by Bill C-27 to be established. From the amounts involved (a total initial deposit of $550,000,000 and total yearly deposits of $110,000,000) it seems that the proponents of Bill C-27 have deep geological disposal in mind. The lion's share of the money for the trust fund would be from Ontario Power Generation Inc. The government's contribution in the form of deposits from Atomic Energy of Canada Limited (AECL) is minuscule. If the Governor in Council selects indefinite storage as the management option the size of the trust fund seems exorbitant.

Bill C-27 provides for public consultations but it might also be that the Governor in Council's decision on an approach could also trigger an environmental review under the Canadian Environmental Assessment Act (CEAA). It could not be argued that the review done of AECL's disposal concept would suffice since that review was only of a concept. It doesn't necessarily follow that the approach selected by the Governor in Council would be based on that concept. Even if it was based on geological disposal intervenors could mount many arguments that no actual implementation was involved in the concept review so another public review under the CEAA should be done.

The review of AECL's concept was planned to take about two years but took ten. There is every prospect that a review of the Governor in Council's decision could take even longer since, under Bill C-27, there is much more provision for political involvement leading up to the Governor in Council's decision than was involved in AECL's concept study. If the Governor in Council were to opt for indefinite storage as the waste management option then nothing will have been accomplished with respect to resolving the underlying issue for nuclear power. If the Governor in Council were to opt for a disposal option there would still be the matter of selecting one or more disposal sites. In due course a licensing decision by the Canadian Nuclear Safety Commission on a proposed site or sites would trigger yet another review under the CEAA. There is little doubt that yet another public review by a panel would be required since an actual site or sites would be involved. Therefore, the net effect of introducing a decision-making process by Governor in Council could be to introduce another ten years or so in arriving at a solution to the nuclear fuel waste issue. Anti-nuclear intervenors would have a field day decade.

The government's ability to arrive at any decision on long-lived radioactive waste, let alone nuclear fuel waste, should be seen in the context of its inability to make a decision on a site for the Port Hope and other low-level long-lived radioactive waste. In 1986 the government stepped in and took responsibility from, then, Eldorado Nuclear to find a site for those wastes. Fifteen years later that initiative can be said to have failed. Political expediency triumphed over health and safety objectives. If the government failed to arrive at a successful conclusion in trying to manage low-level waste what confidence can one have in it deciding on high-level nuclear fuel waste? If the government selected an approach for nuclear fuel waste based on a single waste storage or disposal site in one province think of the resistance in that province to taking waste from other provinces, plus all the arguments involving the transport of nuclear fuel waste. There is a high risk that political expediency would once more result in a decision to maintain the status quo and do nothing. This should be the outcome most feared by nuclear proponents but might be welcomed even by boards of directors of utilities interested only in short-term issues. Furthermore, the launching of yet another study on nuclear fuel waste may provide the Canadian Nuclear Safety Commission (CNSC) with a reason to continue to evade practising what it preaches instead of making a regulation requiring licensees to establish a program aimed at eventual disposal of nuclear fuel wastes.

There is no provision in Bill C-27 which requires the approach selected by the Governor in Council to be consistent with the health and safety objectives of the CNSC. It was the policy of the Atomic Energy Control Board (Regulatory Document R-104, 1987 June), and I trust still is the policy of the CNSC, that the ultimate objective for the management of long-lived radioactive waste is disposal without the intention or need for ever retrieving the wastes. This policy is based on considerations of health, safety, security and the environment. With respect to disposal of nuclear fuel waste the AECB did not take any regulatory action on its policy pending the outcome of AECL's concept assessment. Thus, if the Governor in Council selects an approach to waste management that is inconsistent with the policy of the CNSC there could be a conflict. There is a provision (subsection 19(1) in the NSCA) for the Governor in Council to issue directives to the CNSC but such directives must relate to the CNSC's objectives of protecting health, safety, security and the environment. A directive relating to the purposes of Bill C-27 would be illegal.

There is no question that government involvement in the management of nuclear fuel waste will be important, particularly in the establishment of a disposal site or sites and providing post-closure guarantees. It is possible that provincial governments will be more important in this respect than the federal government since provincial governments are involved in other post-close-out operations such as in mining operations. If the federal government wanted to make a useful contribution it could find, qualify and make available a waste disposal site that could be developed by the owners of nuclear fuel waste. I doubt the federal government has the stomach for such an involvement and its record in establishing waste sites so far is pretty poor. Instead, through Bill C-27, it seeks to control the strings and let others do the dirty work. Alternatively, or as well, the government could issue a policy directive to the CNSC to require licensees to establish and implement a program for the management and disposal of nuclear fuel waste for reasons of health and safety. Such a directive would conform to the NSCA and would put and end to the CNSC's dithering.

In summary, the apparent underlying objective of Bill C-27 is laudable. However, Bill C-27 is unnecessary legislation and, if passed will probably be counter-productive. The purposes of Bill C-27 would be better achieved by leaving the onus on the nuclear industry for the long-term management and eventual disposal of nuclear fuel wastes in accordance with regulations and guidelines under the Canadian Nuclear Safety and Control Act and other existing legislation along the lines described in my previous letter on this subject (Vol. 20, No. 4). Direct participation by the federal government in making waste management decisions will lead to more, not less, delay in achieving the ultimate objective of nuclear fuel waste management, that is, the safe disposal of such wastes. The record of the federal government's ability to supervise the management of other long-lived radioactive wastes suggests that it would probably be incapable of arriving at a practical solution for nuclear fuel wastes. If passed Bill C-27 could put the government in conflict with its nuclear regulator, the Canadian Nuclear Safety Commission. The requirements for the establishment of a trust fund and stipulation of the amounts to be deposited are premature and might tie up funds, which could better, be used to expedite the management and eventual disposal of nuclear fuel wastes.

The best that the federal government can do with Bill C-27 is to let it die on the Order Paper.

OCI - a look at the Organization of CANDU Industries

Ed. Note: *As a further contribution to our series on organizations involved in the Canadian nuclear program we offer the following short note on one of the lesser known but influential groups - the Organization of CANDU Industries. Our thanks go to Jack Howett who provided the information.*

The origins of the Organization of CANDU Industries (OCI) go back to the 1970s. At that time the Canadian nuclear power program was bursting ahead, with Pickering A in operation, Bruce A under construction and advanced discussions for Point Lepreau and Gentilly 2. Both the latter would be single unit plants using the CANDU 6 design then nearing completion by Atomic Energy of Canada Limited (AECL). In addition AECL was exploring export opportunities for the CANDU 6.

Some of the larger manufacturers of components for the domestic nuclear plants were also involved in export of other, non-nuclear equipment and were interested in being involved in the export of CANDU. Feeling that, with their export experience, they could help AECL in its overseas marketing efforts seven of these companies formed an ad hoc group called "Canadian Nuclear Equipment Suppliers", composed of presidents or vice-presidents of the companies involved.

Other, smaller companies involved in the domestic nuclear power program pressed to be included. Consequently, in June 1979, the original group incorporated as a non-profit organization under the name "Organization of CANDU Industries".

The objectives of the new corporation, as set out in its charter, were, and are:

- to be widely representative of the Canadian private sector engaged in the supply of goods and services for CANDU nuclear steam plant offered in export markets;
- to participate in the development, promotion and export marketing of CANDU nuclear steam plant and related services.

The By Laws defined two classes of members: those engaged in the manufacture of equipment and those engaged in engineering, construction and management. A further criterion was that a member must be a body incorporated under the laws of Canada or part of a partnership whose principal place of business is located in Canada.

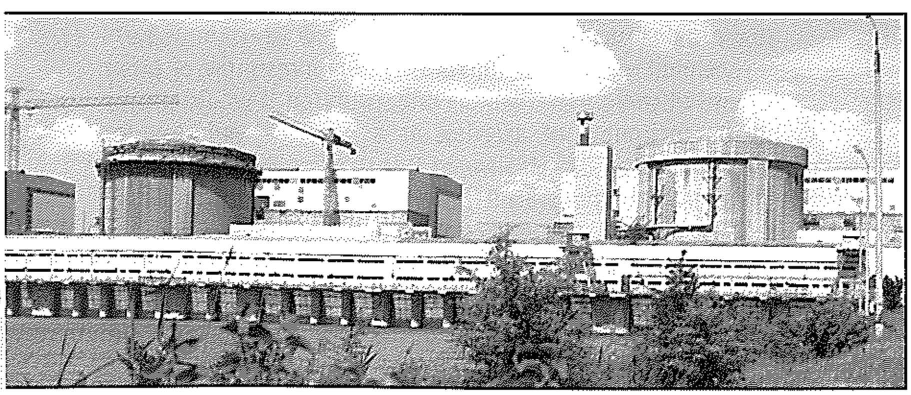
Within weeks of incorporation 37 companies applied for membership and, meeting the established criteria, were accepted. Over the two decades since then the membership has varied between 35 and 50, reflecting the economic situation and export prospects.

The first meeting of the Board of Directors of the new organization was held on June 26, 1979 under the chairmanship of W. E. (Bill) Brown of Canadian General Electric (GE Canada). One of its first actions was to establish, together with AECL, a Joint Export Marketing Committee made up five representatives from AECL, five from OCI member companies and four from utilities and government.

The Joint Export Marketing Committee proposed, and the directors agreed, that OCI members would offer to accompany AECL representatives on missions to prospective customer countries. Over the past two decades many such visits have taken place, both with AECL and separately. Sales seminars have been conducted in many prospective countries and OCI members have visited overseas plants to survey the capability and quality assurance standards of those interested in local manufacture. Among the countries visited are: Argentina, Armenia, China, Egypt, Hungary, Korea, Romania, and Yugoslavia.

OCI has also coordinated visits to Canada by representatives from prospective countries which included seminars and tours of member's facilities.

Because the initial deal with Romania for the Cernavoda project was underway at the time of the formation of OCI there was great attention to that country. The general manager and representatives of major member companies made many visits to that country over the earlier years of that project. A particularly difficult issue was the insistence by Romania for counter-trade, i.e., the acceptance of Romanian products in part payment for Canadian CANDU components. Eventually some member companies did accept counter-trade.



The Cernavoda station in Romania with the one completefd unit Cernavoda 1 on right.

Members of the Board of OCI pose for a photograph in early 2001. There have been some changes since then.
Back row, left to right: Ken Wigley, Jeff Daw, Ron Filed, Dorine Duquet, Glen Crawford, Rae Watson, Peter Clark, Don Park.
Front row, left to right: Jack Howett, Martyn Walsh, Joseph Yeremian.

Current members of the Board of Directors include: Martyn Wash (Zircatec Precision Industries Inc.), chairman; Glen Crawford (Numet Engineering Ltd); Jeff Daw (Patriot Forge; Dorine Duquet Brent Packaging and Logistics Ltd.); Ron Field (Canatom NPM Inc.); Don Parks (Sulzer Pumps Canada Inc.); Rae Watson (IST Canada Inc.); Joseph Yeremian (Thermodyne Engineering Ltd.). Jack Howett is the part-time General Manager of OCI, as he has been since 1987. *(See accompanying photo.)*

OCI Member Companies

- Alfa Laval Inc.
- ANRIC Enterprises
- Aptec - NRC
- Atlantic Nuclear Services Ltd.
- Atlas Ideal Metals
- B.C. Instruments
- Brent Packaging & Logistics Ltd.
- CAE Electronics Ltd.
- Canatom NPM Inc.
- Dresser Canada Inc.
- E. S. Fox Ltd.
- Ezeflow Inc.
- Flowserve Corporation
- GE Canada
- Haxim Canada Inc.
- Henry Controls Inc.
- Honeywell Ltd.
- Hooper Welding Enterprises Limited
- IDS / Scintrex Power & Control
- IST Canada Inc.
- Kanata Electronic Services Ltd.
- Laker Energy Products Ltd.
- Lakeside Process controls Ltd.
- Marsh Instrumentation Inc.
- MEC (Mu-Sigma engineering Consultants)
- Numet Engineering Ltd.
- Pall (Canada) Ltd.
- Patriot Forge
- Rotork Controls (Canada) Ltd.
- Schenker of Canada Ltd.
- Stern Laboratories Inc.
- Sulzer Pumps (Canada) Inc
- Summit Controls Ltd.
- Taylor Forge of Canada Corp.
- Thermodyne Engineering Ltd.
- Topax Export Packaging Systems
- Troga Pipe
- 3L Filters Limited
- 3M Canada
- Velan Inc.
- Zircatec Precision Industries Inc.

Now that there appears to a renewed interest in nuclear power in North America and abroad, OCI is ready to work with AECL in marketing CANDU overseas. It also welcomes new members, believing there is strength in numbers when dealing with governments or other large agencies.

Mr. OCI

Almost since its beginning there is one person that personifies the Organization of CANDU Industries - **Jack Howett.**

Jack joined the Board of OCI in 1983 when he was a vice-president of Vickers Canada. Four years later, in 1987, when he retired from Vickers, the group at OCI appointed him as part-time General Manager, a role he has continued to fill until today.

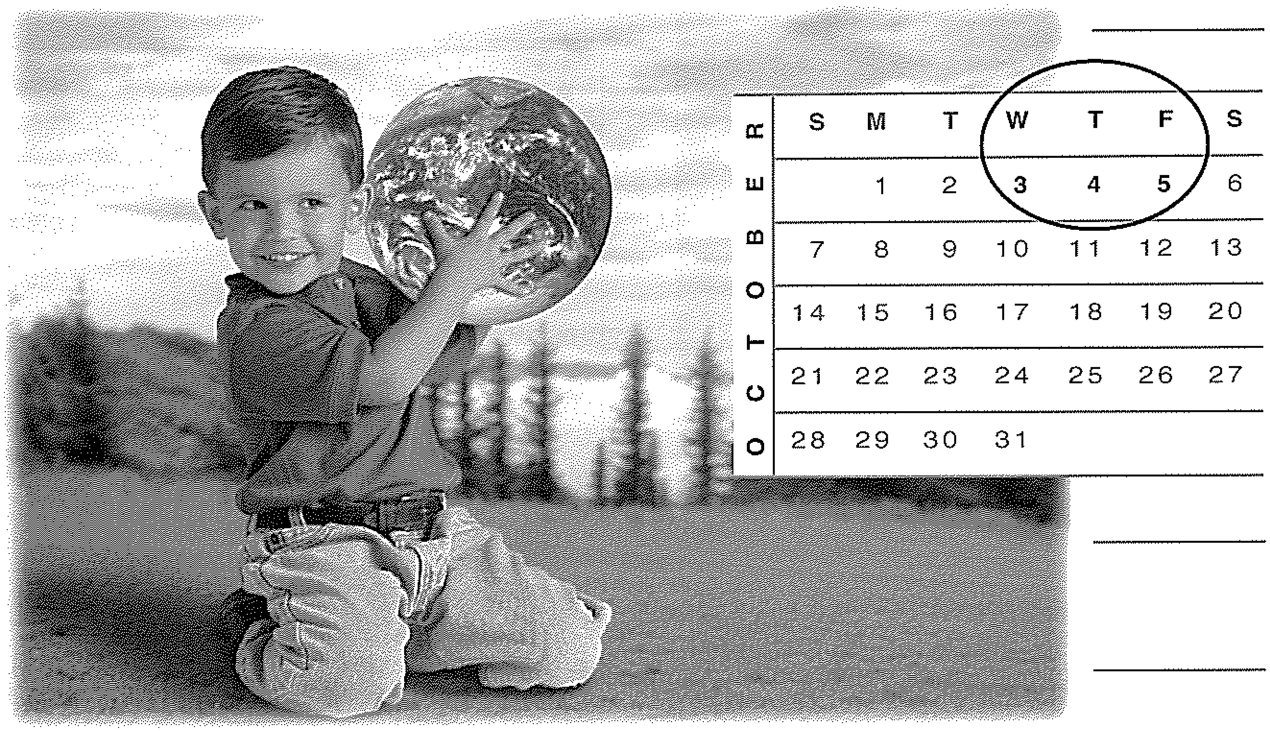
Born in the UK (in an undisclosed year) Jack served in the Royal Engineers for over six years, throughout all of World War II, primarily in bomb and mine disposal. Surviving that occupation he joined the large engineering firm of Vickers Armstrong Ltd.

He spent two years in the Far East as Vickers' representative and then was transferred to Canada in 1957 to set up a subsidiary, Vickers Armstrong Tractors Canada Ltd. That enterprise was closed in 1962 when the parent company decided to abandon tractor manufacturing and Jack was transferred to Canadian Vickers Ltd. Over the next decade and a half he held several managerial posts becoming Vice-President sales and a director in 1978. Vickers Canada was one of the seven companies that formed the original Canadian Nuclear Equipment Suppliers group, the forerunner of OCI.

Jack was very heavily involved with the negotiations with Romania on the Cernovoda project. He reports that he visited Romania 31 times and met with the then president of Romania, Ceaucescu, three times. While still with Vickers Canada he signed the first nuclear industrial contract associated with the Cernovoda project, for two calandrias. Related to this activity, he became chairman of the Canada / Romania Trade Council from 1984 to 1987. In that role he took part in many discussions on counter-trade.

Over his years with OCI Jack has travelled widely, on sales missions to many other countries including: Argentina, China, Czechoslovakia, Korea, Hungary, Mexico, Yugoslavia, and is ready to go on further trips. At the time of writing he was planning the huge trip from his home in London, Ontario to Toronto for the CNS Annual Conference.

Mark Your Calendar Today!



Climate Change 2: Canadian Technology Development
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- Jay Ingram, co-host and producer of *Discovery Channel's* science and nature news magazine

Visit our website at http://www.cns-snc.ca to register online.

The radiological consequences of the Chernobyl accident - the UNSCEAR report

Preamble: *April 26 this year was the 15th anniversary of the 1986 accident at the Chernobyl nuclear power plant in the Ukraine. In its report to the General Assembly in late 2000 the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) included a section on the radiological consequences of that accident.*

The UNSCEAR 2000 report, titled Sources and Effects of Ionizing Radiation, contains some 1220 pages encompassing a 20-page summary and ten technical annexes. It was prepared over several years by 146 committee members of 21 national delegations plus 15 scientific staff and consultants. Two of the topics are of particular interest, those on natural radiation and on The Chernobyl Accident. Following are excerpts from the summary of the annex on Chernobyl.

(This report was intended for the previous issue of the CNS Bulletin but was inadvertently missed in the final layout.)

UNSCEAR 2000

The Chernobyl Accident

The Committee has given special attention to the accident at the Chernobyl nuclear reactor that occurred on 26 April 1986. It was the most serious accident ever to have occurred in the nuclear power industry. The reactor was destroyed in the accident, considerable amounts of radioactive materials were released to the environment, and many workers were exposed to high doses of radiation that had serious, even fatal, health consequences (see below). Among the residents of the local regions of Belarus, the Russian Federation, and Ukraine, over a thousand cases of thyroid cancer (about 1,800) have been reported in children. Notwithstanding problems associated with screening, these cancers were most likely caused by radiation exposures received at the time of the accident. Many other health problems have been noted in the populations that are less likely to be related to radiation exposures.

Soon after the accident, the deposition of dispersed radionuclides and the exposures that resulted were measured and evaluated throughout the affected region. The Committee made use of these data to evaluate the average individual and population doses for the various regions and countries and for the northern hemisphere as a whole. The results were presented in the UNSCEAR 1988 Report, Annex D, "Exposures from the Chernobyl Accident".

Evaluating the exposures received by the people who were evacuated or who still reside in the areas most affected by the accident has required much time and effort. The initial measurements must be supplemented by information on such things as the location and diet of the people in each settlement. The accumulation of data on late health effects has also required further time. Only now, some 15 years after the accident, can an initial assessment of the local exposures and effects of the accident be made.

Release of Radionuclides

The accident at the Chernobyl reactor happened during an experimental test of the electrical control system as the reactor was being shut down for routine maintenance. The operators, in violation of safety regulations, had switched off important control systems and allowed the reactor to reach unstable, low-power conditions. A sudden power surge caused a steam explosion that ruptured the reactor vessel. This allowed further violent fuel-steam interactions that destroyed the reactor core and severely damaged the reactor building.

It is noteworthy that an earlier accident in 1979 at the Three Mile Island reactor in the United States also resulted in serious damage to the reactor core but without a steam explosion. In that case, however, the containment building surrounding the reactor prevented the release of all but trace amounts of radioactive gases. The Chernobyl reactor lacked the containment feature. Following the explosions, an intense graphite fire burned for 10 days. Under these conditions, large releases of radioactive materials took place.

The radioactive gases and particles released in the accident were carried by the wind initially in the westerly and northerly directions. On subsequent days, the winds came from all directions. The deposition of radionuclides was governed primarily by precipitation occurring during the passage of the radioactive cloud. This led to a complex and variable exposure pattern throughout the affected region.

Exposure of Individuals

The radionuclides released from the reactor that caused exposure of individuals were mainly iodine-131, caesium-134, and caesium-137. Iodine-131 has a short radioactive half-life (eight days), but it can be transferred to humans relatively rapidly from the air and through milk and leafy vegetables. Iodine becomes localized in the thyroid gland. For reasons related to the intake of these foods by infants and children, as well as the size of their thyroid glands and their metabolism, the radiation doses are usually higher for this age group than for adults.

The isotopes of caesium have relatively longer half-lives (caesium-134 has a half-life of 2 years while the half-life of caesium-137 is 30 years). These radionuclides cause longer-term exposures through the ingestion pathway and through external exposure from their deposition on the ground. Many other radionuclides were associated with the accident, and these have been considered as well in the exposure assessments.

Average doses to those persons most affected by the accident were about 100 mSv for 240,000 recovery operation workers, 30 mSv for 116,000 evacuated persons and 10 mSv during the first decade after the accident to those who continued to reside in contaminated areas. Maximum values of the dose may be an order of magnitude higher. Outside Belarus, the Russian Federation, and Ukraine, other parts of European countries were affected by the accident. Doses there were at most 1 mSv in the first year after the accident with progressively decreasing doses in subsequent years. The dose over a lifetime was estimated to be 2-5 times the first-year dose. **These doses are comparable to an annual dose from natural background radiation and are, therefore, of little radiological significance.** *(Our emphasis.)*

The exposures were much higher for those involved in mitigating the accident and those who resided nearby. These exposures are reviewed in great detail in this assessment of the Committee.

Health Effects

The Chernobyl accident caused many severe radiation effects almost immediately. Of 600 workers present on the site during the early morning of 26 April 1986, 134 received high doses (0.7 to 13.4 Gy) and suffered from radiation sickness. Of these, 28 died in the first three months and another two soon afterwards. In addition, during 1986 and 1987, about 200,000 recovery operation workers received doses between 0.01 and 0.5 Gy. This cohort is at potential risk of late consequences such as cancer and other diseases and their health will be followed closely.

The Chernobyl accident also resulted in widespread radioactive contamination in areas of Belarus, the Russian Federation, and Ukraine inhabited by several million people. In addition to causing radiation exposure, the accident caused long-term changes in the lives of the people living in the contaminated districts, since the measures intended to limit radiation doses included resettlement, changes in food supplies, and restrictions on the activities of individuals and families. Later on, these changes were accompanied by the major economic, social, and political changes that took place when the former Soviet Union was dismantled.

For the last 14 years, attention has been focused on investigating the association between exposure caused by radionuclides released in the Chernobyl accident and late effects, particularly thyroid cancer in children. A majority of the studies completed to date are of the descriptive type, in which average population exposures are correlated with the average rates of cancer incidence in specific time periods. As long as individual dosimetry is not available, it is difficult to determine whether the effects are radiation-related, and it is also impossible to make reliable quantitative estimates of risk. The reconstruction of individual doses is a key element for future research on radiation-associated cancers related to the Chernobyl accident.

The number of thyroid cancers (about 1,800) in individuals exposed in childhood, particularly in the severely contaminated areas of the three affected countries, is considerably greater than expected based on previous knowledge. The high incidence and the short induction period are unusual. Other factors may be influencing the risk. If the current trend continues, additional thyroid cancers can be expected to occur, especially in those who were exposed at young ages.

Apart from the increase in thyroid cancer after childhood exposure, **no increases in overall cancer incidence or mortality have been observed that could be attributed to ionizing radiation.** *(Our emphasis.)* The risk of leukaemia, one of the main concerns (leukaemia is the first cancer to appear after radiation exposure owing to its short latency time of 2-10 years), does not appear to be elevated, even among the recovery operation workers. Neither is there any proof of other non-malignant disorders that are related to ionizing radiation. However, there were widespread psychological reactions to the accident. These are due to fear of the radiation, not due to the radiation doses.

There is a tendency to attribute increases in the rates of all cancers over time to the Chernobyl accident, but it should be noted that increases were also observed before the accident in the affected areas. Moreover, a general increase in mortality has been reported in recent years in most areas of the former USSR, and this must be taken into account when interpreting the results of the Chernobyl-related studies.

The present understanding of the late effects of protracted exposure to ionizing radiation is limited, since the dose-response assessments rely heavily on studies of exposure to high doses and animal experiments; extrapolations are needed, which always involves uncertainty. The Chernobyl accident might shed light on the late effects of protracted exposure, but given the low doses received by the majority of exposed individuals, any increase in cancer incidence or mortality will be difficult to detect in epidemiological studies. One future challenge will be to develop individual dose estimates including estimates of uncertainty and determine the effects of doses accumulated over a long period of time.

Previous articles on Chernobyl in the *CNS Bulletin:*

Vol. 12, No. 2,	Summer 1991 "Chernobyl revisited"
Vol. 17, No. 2	Spring 1996 "More on Chernobyl"
Vol. 20, No. 4	January 2000 "Chernobyl-4 - Post accident radiation monitoring in the exclusion zone"

Why Are We So Afraid of Nuclear Radiation?

by Jerry M. Cuttler

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Abstract

The origin of the LNT model of radiation carcinogenesis is outlined. The A-bomb survivor cancer mortality data is shown to not support this model at all. The nature of cancer and the role of the body's natural defense mechanisms are discussed. A simple biological model of the effect of radiation is shown to be more credible and consistent with the observed beneficial health effects at low doses and adverse effects at high doses. Important therapeutic applications of low dose irradiations are mentioned. Reference is made to the UNSCEAR 2000 Report on sources and effects of ionizing radiation, its comparison of natural and human-made sources and its review of the health effects of the Chernobyl accident. The evidence indicates public fear of low-dose and low-level radiation is unwarranted and blocks efforts to supply reliable, environmentally friendly nuclear energy and important medical therapies. ICRP resolution of the contradictions is urgently needed.

Introduction

A negative impression of nuclear technology has developed over the past century,[1] especially since the 1979 TMI accident. Many of the negative images relate to perceptions of adverse health effects, specifically the possibility of inducing cancer and genetic damage, from any exposure to ionizing radiation. The irony is that we are continuously exposed to radiation from natural sources. Do exposures from human-made sources really increase significantly the normal incidence of cancers and birth defects? What about the beneficial health effects from low doses we've been hearing about? The answers to these questions are rather important because humanity faces severe environmental, energy and medical issues, which greatly impact our quality of life. Nuclear technologies can provide realistic remedies, but fear about exposures to any human-made radiation greatly constrains their application. We make arguments about relative risks, but people make their own judgments about the acceptability of various risks, regardless of our comparisons. It would be possible to gradually change public notions about nuclear technology if, instead of trivial risks, a different, more positive picture of radiation's significant beneficial health effects could be communicated. The problem is strong resistance from influential scientists in recognizing the real benefits and discounting insignificant risks. This has led to a raging controversy over the past decade and pressures from many scientific organizations to change regulatory policy. The facts are quite clear. When the controversy will be resolved is unclear.

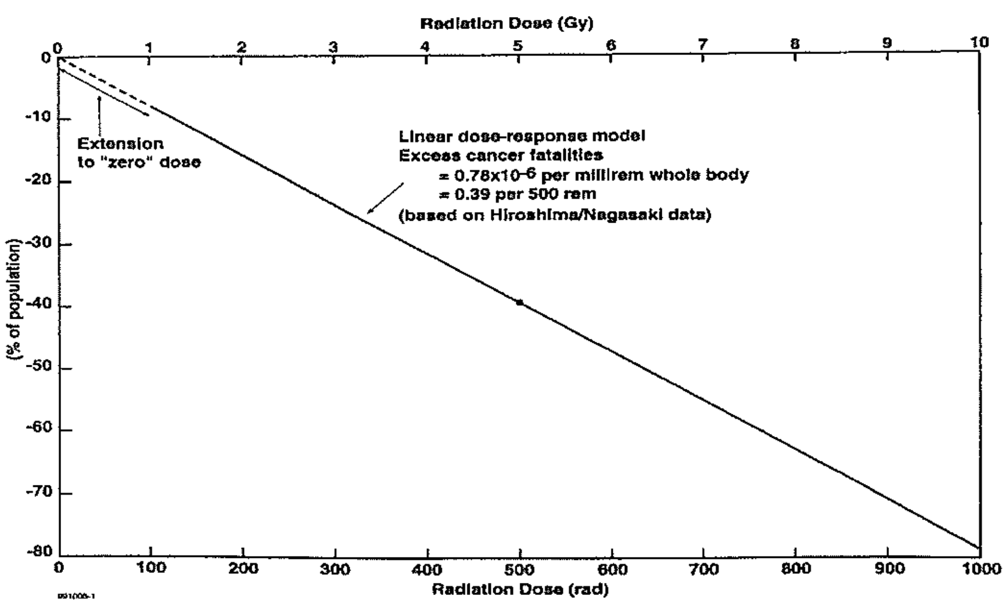

Figure 1. The linear dose-response model for radiation-induced cancer, Cuttler[22]

Radiation Carcinogenesis and The LNT Model

As we know, Röntgen discovered X-rays in 1895, and Becquerel discovered radioactivity in 1896. Since then, a tremendous amount of research has been carried out on the effects and after effects of ionizing radiations, and many very important applications have been found. Harmful health effects following large exposures were identified, almost immediately, and radiological protection advice was issued and updated, as more accurate information became available. The early recommendations were concerned with avoiding burns and late effects from intense short-term radiation. This involved defining a safe limit for exposures (e.g., ~0.2 R/d in 1934 and 0.3 R/wk in 1951) based on a threshold concept. By 1955, this threshold concept was rejected by the International Commission on Radiological Protection (ICRP) in favour of the concept of cancer and genetic risks, kept small compared with other hazards in life. "Since no radiation level higher than natural background can be regarded as absolutely 'safe', the problem is to choose a practical level that, in the light of present knowledge, involves negligible risk."[2] This change in philosophy was brought about by new biological information - epidemiological evidence of excess cancer malignancies among radiologists and indications of *excess* leukemia cases in the survivors of the atomic bombings at Hiroshima and Nagasaki - "stochastic effects", whose probability of occurrence, not the severity, was assumed to be proportional to the size of the dose.[2]

This is the origin of the linear no-threshold (LNT) model of radiation carcinogenesis. It derives from the hypothesis that a single impact of ionizing radiation on a cell causes an alteration, which could develop into a mutation, which could eventually become the first cancer cell in a tumor, which could cause death. The likelihood of this transformation, from a normal cell to organism death, is assumed to be proportional to dose. Statistically significant data on excess cancer deaths following exposures to high doses are fitted by a straight line, which is then extended to zero dose through the entire lower dose region where there was no statistically significant human data. The LNT model for an acute (short-term) exposure is shown in Figure 1. This model is generally used to calculate the excess number of cancer fatalities following exposure to a low dose from a (human-made) source of radiation. A risk reduction factor, in the range from 2 to 10, may be applied to the integrated dose of a chronic (long-term) exposure at a low dose rate. The increase in the average dose (above background) received by the population due to the source is evaluated, and this average dose is multiplied by the slope of the LNT line to predict the increase in the normal fraction of these people (~28% in Canada) who will die from cancer (instead of a different cause). The incremental exposure received by a person due to a source is multiplied by this factor to determine his/her increased risk of dying from cancer.

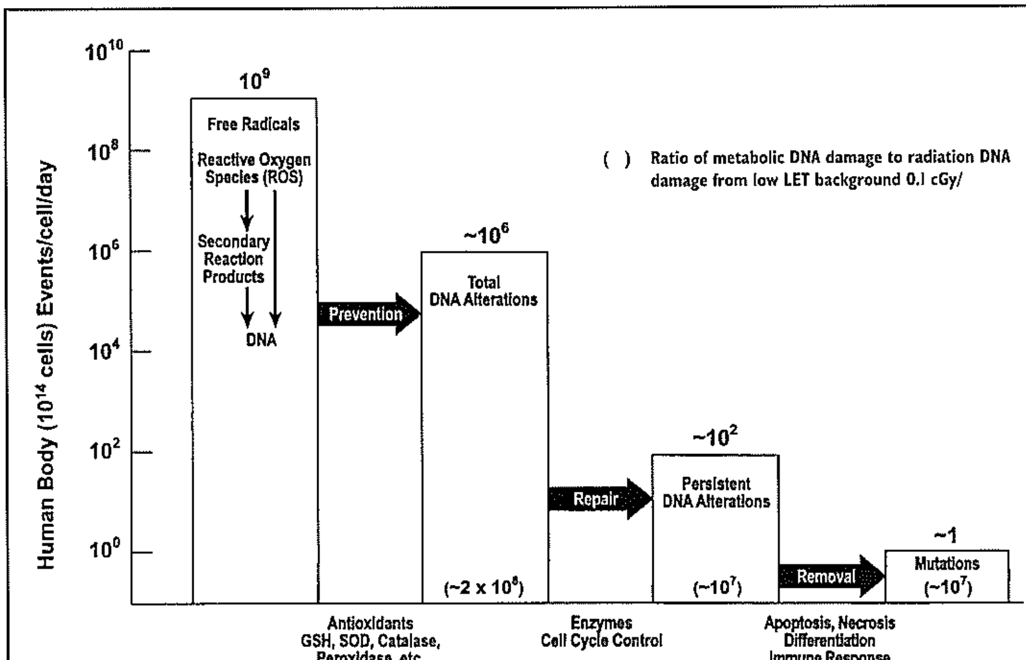

Figure 2. Biological model of our DNA damage-control system, 0.1 cGy/ year normal radiation, Pollycove and Feinendegen[11]

Non-Linear Effects and Non-Scientific Influencres

It is fascinating to review the early investigations that were carried out to determine what radiation does to living things. Thousands of these studies revealed a variety of beneficial health effects following exposures to low doses. Many people actually began to consume small amounts of a radium solution, sold in bottles as an elixir, until the practice was stopped after several well-publicized cases of radium poisoning due to over consumption. Epidemiology on the famous radium dial painters by RD Evans identified a maximum body burden of radium (0.1 μCi), including a 10-100 safety factor, and a threshold (lifetime) skeletal dose (~1000 cGy) below which no long-term excess cancers or other adverse effects appeared.[3,4] Why was the very large amount scientific information on beneficial effects and on thresholds for adverse effects ignored when the LNT model was formulated, and afterwards when more research was carried out?

To understand the answer, we have to consider the social and political environment when the new radiation protection recommendations were formulated. Scientists were agonizing over their roles in the development and actual use of A-bombs in war. The creation of large stockpiles of more powerful nuclear weapons in several countries raised enormous moral issues and fears about their potential use. Scientists realized they could not put "the genie back in the bottle", so they began to campaign against further A-bomb development, testing and production, and for nuclear disarmament. Concerns began to be expressed about potential, long-term adverse health effects following exposures to very small amounts of radioactive fallout; the information about beneficial health effects and thresholds, up until then, was not rigorously scientific. Over the past 50 years, many research programs were carried out to study the incidence of adverse biological effects, measured at high doses and extrapolated linearly to zero dose; many observations during the past 30 years of beneficial health effects were either ignored or suppressed.[5]

Table 1. A-bomb survivors: observed and expected deaths from solid cancers, 1950-90, Pierce et al[8]

Dose (Sv)	Dose (rem)	Number of Subjects	Observed Deaths (1)	Expected Background (2)	Excess Deaths (1) – (2)	Standard Deviation* $\sqrt{(1)+(2)}$
0	0	36,459	3013	3055	- 42	78
0.005 – 0.1	0.5 – 10	32,849	2795	2710	85	74
0.1 – 0.2	10 – 20	5,467	504	486	18	31
0.2 – 0.5	20 – 50	6,308	632	555	77	34
0.5 – 1.0	50 – 100	3,202	336	263	73	24
1.0 – 2.0	100 – 200	1,608	215	131	84	19
> 2.0	> 200	679	83	44	39	11
	Totals:	86,572	7578	7244	334	

* a rough assessment of the statistical uncertainities

A-Bomb Survivors

The principal scientific evidence that supports the LNT model is the 1950-2020 Life Span Study (LSS) of cancer mortality among the Hiroshima-Nagasaki survivors. The two A-bombs dropped in August 1945 killed between 150,000 and 200,000 of a total population of 429,000 people.[6, 7] The LSS cohort of 86,572 people contains roughly half of the survivors who were within 2.5 km of the bombs.[8]

Based on the many concerns expressed over the past fifty years about the risk of fatal cancers from nuclear radiation, how many of the A-bomb survivors would we expect to have died from cancer, in excess of the normal incidence of cancer? Several people I asked recently indicated they would expect 20 to 50% of the survivors! So, let us examine the recent data in Table 1.[8] It is very surprising to note only 344 *excess* deaths, forty years after the event, among this very large cohort! Now 36,459 people were far enough away to have received no significant radiation exposure, so we might consider the fraction 334 ÷ 50,113 = ~0.7%, or 334 ÷ 7578 = 4.4% as the attributable risk. But the authors of this LSS prefer the ratio [334 - (-42)]/(7578-3013) = 8%. Of this cohort, 56% were alive in 1991, and 38,092 had died. So we could conclude that ~1% of them died from radiation-induced cancer.

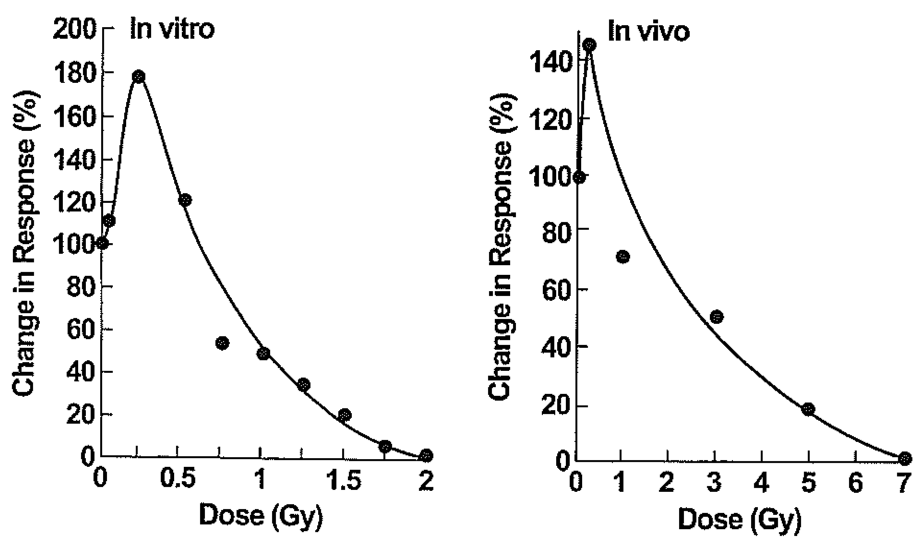

Figure 3. Stimulation of immune system with radiation, Makinodan and James[20]

Survivors under 20 years of age at the

time of bombing constitute 40% of the population, but a much smaller fraction of the deaths because cancers generally occur late in life. The final results will depend strongly on what happens to these survivors as they enter their cancer-prone years after age 50. Those over 50 at the time of bombing did not live long enough to show evidence of radiation-induced cancer, because of the ~20 year latency period. Leukemia was the first malignancy to appear. By 1985 almost all the radiation-induced leukemias to be observed were recorded; the number of *excess* deaths determined is 87. Ralph Lapp states there were ~300,000 survivors in 1950 when the LSS was undertaken. He estimates that in 2020, about 800 will have died from A-bomb radiation, or ~0.3% of the H-N population. Since one of every four survivors (or 75,000) will die of cancer, one in a hundred of these deaths will be caused by the A-bomb radiation.[6]

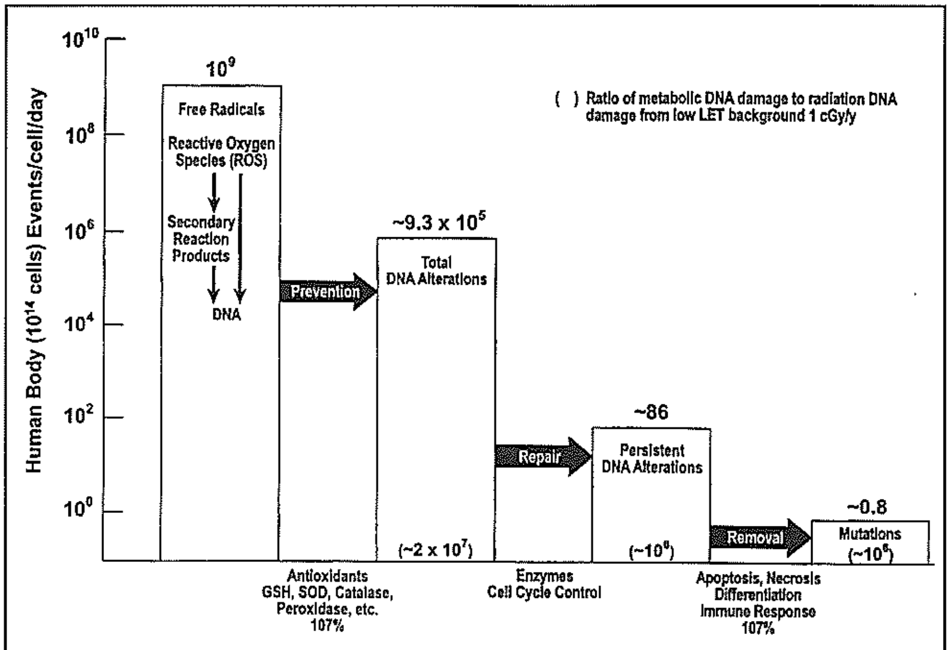

Figure 4. Potential effect of 1 cGy/year background radiation on rate of DNA mutation, Pollycove and Feinendegen[11]

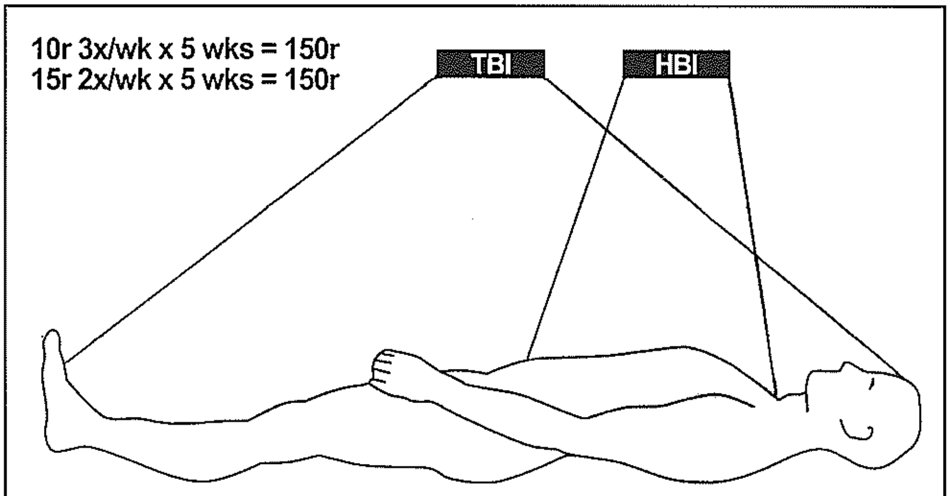

Figure 5. Low dose irradiation (LDI) therapy, Pollycove and Feinendegen[11]

A rough assessment of the statistical uncertainties (standard deviations) of the excess deaths in Table 1 indicates that they are quite large below doses of 0.5 Sv (50 rem). And there is controversy over the LSS rejection of the T65D dosimetry in favour of DS86 dosimetry, which underestimates the neutron contribution and leads to a much higher risk estimate. This suggests there are no significant excess deaths below 1 Sv (100 rem). There is no mention of important confounding factors for cancer incidence, such as the widespread, severe malnutrition, the pollution caused by the A-bomb blasts/fires; the psychological stress from burns, sickness and loss of family members, friends, homes; the loss of medical care, etc. The LNT model is not supported by *any* statistically significant evidence.[9] It should also be noted that there was no detectable increase in the incidence of mutations in the children or grandchildren of the A-bomb survivors.

Nature of Cancer

Since fear of cancer is the issue, let us briefly examine the nature of cancer.[10] Cancer is a single disease and it is a hundred diseases. The unifying aspect of cancer is uncontrolled growth - the appearance of disorganized tissues that expand without limit, compromising the function of organs and threatening the life of the organism. Each cell type, each tissue, may spawn a distinct type of tumor with its own specific growth rate, prognosis, and treatability.

Virtually all malignant tumors are now thought to be monoclonal in origin, that is, the starting point for a tumor is a single abnormal cell, rather than a large cohort of normal cells being recruited by some agent into becoming cancer cells. Human tumors often become apparent only after they have grown to a size of 10-100 billion cells, in a person of 10 to 100 trillion cells (cell weight is ~10^{-9} g). Cancer is generally a disease of old people because it usually takes a long time to accumulate the multiple mutations required to accelerate cell growth and disable growth suppression. To become a fatal tumor, a normal cell must undergo many changes - a long, complex series of successive changes in its behaviour. Several decades must pass

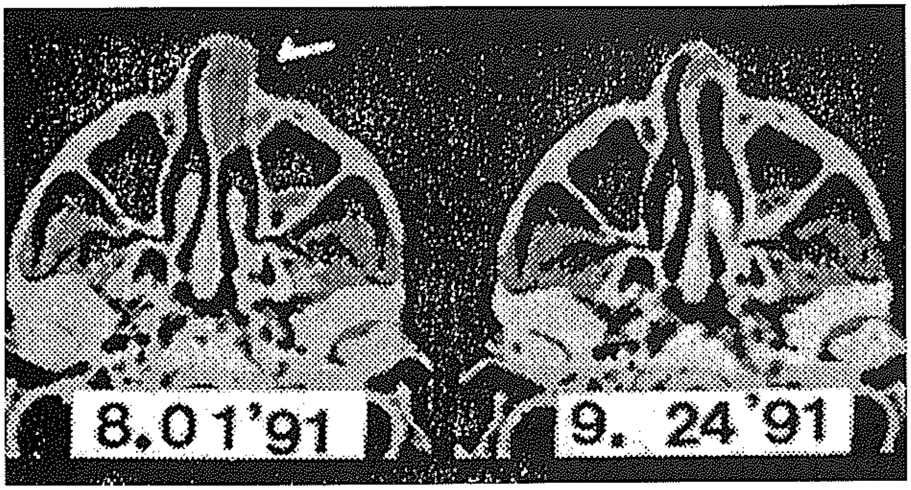

Figure 6. Suppression of cancer in upper nasal cavity by half-body LDI therapy, Takai et al[21]

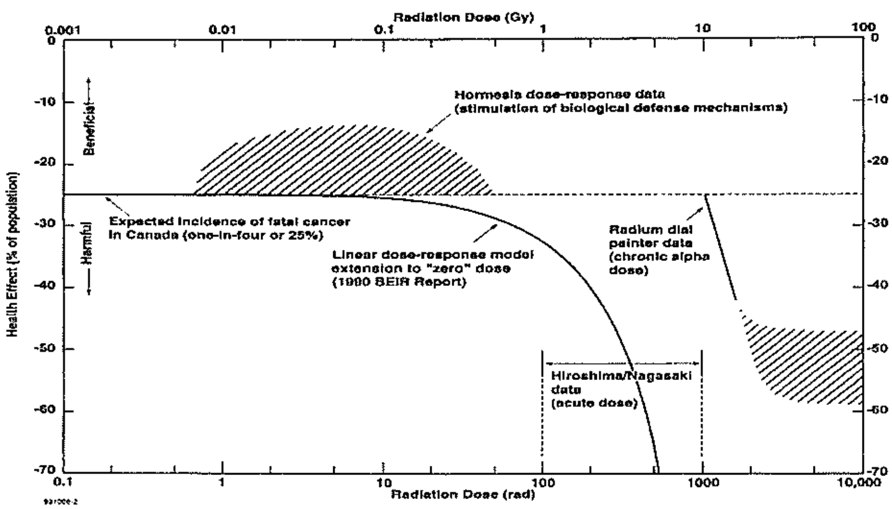

Figure 7. The linear model with radiation dose on a logarithmic scale, Cuttler[22]

from the initiation of the tumor to its ultimate detection in the clinic.

The most disquieting fact about carcinomas is that they do not respect territorial boundaries. They grow locally, and eventually progressing further, shed small clumps of progeny cells able to start new colonies - so-called metastases - in other organs. These progeny cells travel through blood or lymph to lodge at distant sites. Cancer cells evolve into a large number of diverse cells with new traits that allow them to grow more rapidly, compete more effectively with normal cells and evade defences. Tumor cell populations sooner or later exceed the ability of the host to nourish them. Often, long before that, tumors will compromise the functioning of a vital organ, leading to illness and then death. The incidence of cancer increases exponentially with age, compatible with multistep, time-dependent tumor progression. For example, in the USA, the annual death rate from colon cancer rises from 14 to 83 to 400 per million, as people age from 40 to 60 to 80 years, a factor of ~6 and ~30. The risk increases approximately as the fifth power of elapsed time (ref. 10, p 157).

What causes formation of abnormal cells or acceleration of the process leading to cancer? Many factors and carcinogens have been identified: genetics, diet, chemicals, biological agents, ionizing radiation, etc. More are discovered every week; the list appears endless and growing. But recent research has revealed an immensely high rate of cell damage caused by normal metabolic activity due to attack by reactive oxygen species.[11]

Stimulation of Defences

Living organisms have many defences, both within and outside the cell, to prevent, repair, remove cell damage.[11] These defences can limit cell proliferation by signaling growth factor rationing and growth suppressor genes, and by other means. In addition to removing cells with persistent DNA damage, the immune system also plays an important role fighting certain types of cancers, especially if it becomes stimulated.[11, 12, 13] Severe psychological stress, leading to depression and despair, adversely affects the defences creating hormonal imbalance and suppressing immune activity, allowing faster cancer progression.[14] As organisms age and mutations accumulate, their defense mechanisms become weaker and less effective in preventing new cancers and controlling the many cancers that have already started. For a long, healthy life, it is very important to maintain and enhance the performance of our natural defences.

It was mentioned earlier that a large number of investigations were carried out over the past century into the effects of radiation on many different biological organisms, including plants. Many of these studies revealed significant beneficial health effects after exposures to low doses. There is overwhelming evidence of this phenomenon,[15, 16, 17, 18, 19, 20] and a model of the effect of ionizing radiation on living organisms has been provided by Pollycove and Feinendegen.[11] Recent studies show that low doses of radiation stimulate many cellular functions, including oxidation damage prevention, enzymatic repair, and immunologic and apoptotic removal of DNA damage (Figure 2).

Acute, large doses (>50 cGy) impair these functions, causing adverse health effects. But chronic low doses, such as a ten or even hundredfold increase in background radiation, stimulate prevention and repair of DNA damage and the immune system (Figure 3) that decreases gene mutation rate (Figure 4), leading to the beneficial effects of decreased mortality and decreased cancer mortality. Therapeutic stimulation of these defences by low dose body irradiation (Figure 5) prevents and removes cancer metastases in mice, rats and humans (Figure 6).[21] The cell damage caused by the low dose radiation is insignificant compared to the metabolic oxidative DNA damage prevented, repaired and removed by the stimulated defences, leading to overall beneficial effects (Figure 7).[22]

Many medical studies have been carried out to determine the cancer risk following diagnostic and therapeutic treatments involving radiation with very surprising results. The Canadian breast cancer study, published in 1989, compares breast cancer mortality against dose, following fluoroscopic examinations for tuberculosis, between 1930 and 1952.[23] The plotted data from nine provinces (Figure 8) show a surprising decrease in risk at low doses (34% and 16% at the dose points of ~15 and ~25 cGy).[24] A recent study of hyperthyroidism treatment with radioiodine (average total dose of ~300 MBq, ~50,000 cGy to the thyroid and ~28 cGy whole body) revealed a significantly lower cancer incidence and a lower cancer mortality.[25]

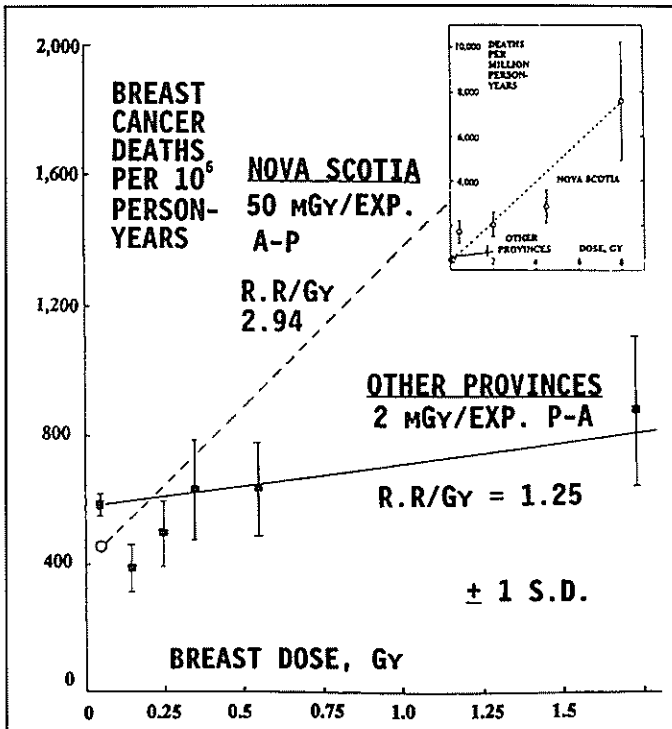

Figure 8. Canadian breast cancer study following fluoroscopy examinations for tuberculosis, Webster[24]

Japanese scientists, in fourteen universities and two research institutes, have been researching beneficial effects of low radiation doses for ~20 years and found remarkable bio-positive effects,[10] which could be grouped as:

- rejuvenation of cells (increase of SOD and cell membrane permeability)
- moderation of psychological stress through stimulation of key enzymes
- suppression and therapy of adult diseases, such as diabetes and hypertension
- suppression of cancer through enhancement of the immune systems
- suppression of cancer and radio-adaptive response by activation of DNA repair and cell killing.

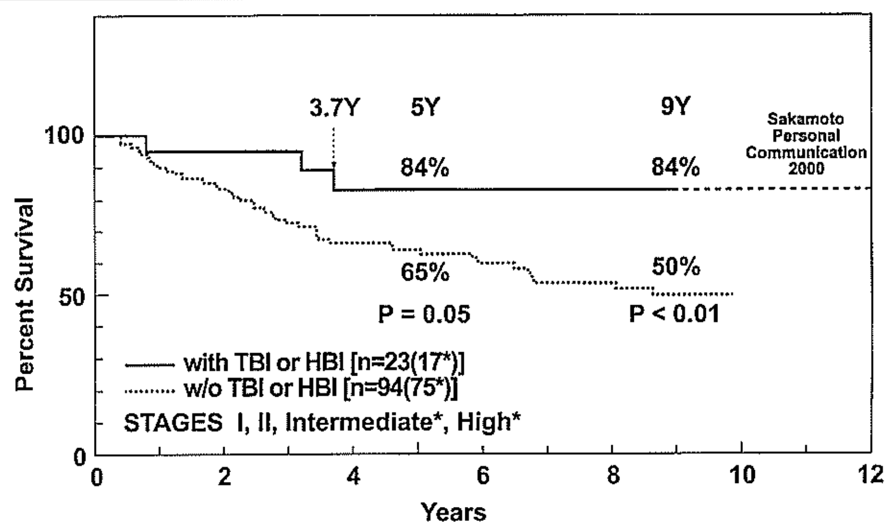

Figure 9. Survival of non-Hodgkin's lymphoma patients with and without LDI therapy. (Both groups received chemotherapy and localized high-dose radiation), Sakamoto et al[26]

Therapeutic Applications of Low Dose Irradiation

One of these Japanese scientists, K. Sakamoto, provided total-body low-dose irradiation (LDI) therapy (6 MV X-rays) in conjunction with local high-dose palliative radiation treatment to a patient with advanced ovarian cancer, following surgery. The LDI therapy, 15 fractionated doses of 10 cGy over a five-week period, achieved total elimination of the cancer metastases. This led to a program of LDI therapy for ~150 non-Hodgkin's lymphoma (NHL) patients, including many intermediate and high-grade cases. This LDI therapy was given to patients who had previously received localized high-dose radiation and chemotherapy, and did not get better. LDI enhanced their immune systems and other defences, thereby achieving many cures, which have lasted more than ten years. Figure 9 shows

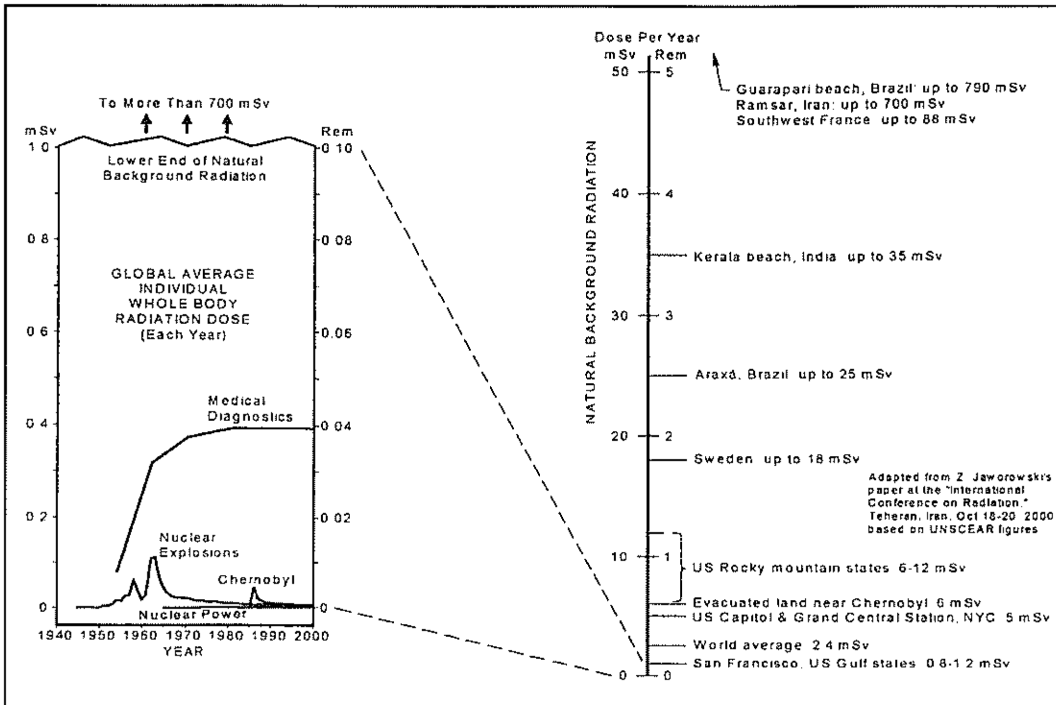

Figure 10. Comparing average annual dose: natural vs human-made radiation, Rockwell[39]

that the recurrence-free survival rate of NHL patients was increased by this therapy from ~50% to ~84%.[26] Nevertheless, this controversial program ended recently when Dr. Sakamoto retired.

Similar effectiveness of LDI therapy for NHL had been noted at the Harvard Medical School in the 1970s and more recently in France.[27] This success has led to the recent approval of a proposal for a clinical trial of LDI therapy in Europe.[28] A comprehensive review of this application indicates that significant therapeutic benefits can be expected.[29] Nevertheless, oncologists seem to be very reluctant to use or even consider this controversial therapy, as can be noted from the current experiences of an American patient who has been requesting LDI therapy for a rare lymphoma (blood cancer). Only one oncologist, at the Johns Hopkins Medical Institute, has been willing to provide this therapy. The improvement observed following this treatment has been comparable to that achieved with chemotherapy, but with no symptomatic adverse side effects.[30]

The Chernobyl Accident and The UNSCEAR 2000 Report

April 26 was the 15th anniversary of the tragic Chernobyl accident, which was followed by an immediate and very strong reaction of fear and outrage throughout the world. Many people expected the radioactivity released to cause millions of cancer deaths and abnormal babies, but the reality is totally different.

We know this from the 1220-page UNSCEAR 2000 Report: *Sources and Effects of Ionizing Radiation* that was released last June[31] and tabled in September at the UN General Assembly. It took the 146 committee members and staff, from 21 countries, six years to collect and study the facts in 5400 documents and prepare the 20-page summary[32] and ten annexes of technical details. This report is the most credible information on this subject, and was written by an independent, non-nuclear organization.

This report compares the radiation dose that an average person receives from all types of natural and human-made sources. It estimates the health effects, including those caused by the Chernobyl accident. The average natural radiation dose is 2.4 mSv (0.24 rem) per year, but the report presents data (see Figure 10) indicating that ambient radiation levels are many tens and hundreds times higher in some geographical regions where many people live. No adverse health effects related to radiation were ever observed among people exposed to such high natural doses. Human-made sources expose the average person annually to much less radiation - 0.4 mSv (0.04 rem) medical diagnostics, 0.1 mSv (0.01 rem) A-bomb tests in the 1960s, 0.05 mSv (5 millirem) Chernobyl accident and less than 0.01 mSv (1 millirem) nuclear electricity. Since radiation from natural or human-made sources affect living cells in the same way, we should not expect the health effects to be any different for the same dose from either source, both being short-term or long-term.

Of the 134 Chernobyl employees who developed symptoms of acute radiation disease, 28 died from radiation sickness and two died from fire and falling objects - the others recovered. Many emergency workers came to the station to remove radioactive debris, to allow the staff to continue operating the other three reactors. No increases above the natural incidences of cancers or leukemias were observed among these 381,000 clean-up workers. The authorities moved 116,000 people from their homes in 1986, and 220,000 more afterward, to avert a lifetime (70-year) dose more than 350 mSv (double the world natural average), even though many people live very healthy lives in areas that are much more radioactive.

Careful health screening of all the people in the Chernobyl area began in 1986. Nothing like this existed before. So far, this has identified a total of about 1800 thyroid cancers. Before the accident, the incidence of thyroid cancers noticed in children was ~0.2 per 100,000 in Belarus and

Ukraine; no data are available from Russia. The maximum incidence rates registered in 1987-1998: Belarus 17.9, Ukraine 4.9 and Russia 26.6 per 100,000 children. Does it mean these cancers were caused by the accident? Normally, it takes ten or more years for cancers to develop, if radiation is the cause, but half of these cases were found sooner (in Russia in the second year after the accident: 9.1 cases per 100,000). Also, the number of these cancers is lower in areas of higher dose! Could they be occult (small, stable) thyroid cancers? These happen naturally, and rarely cause medical problems.[33] Typically, there are many thousands of such thyroid cancers in a population of 100,000. The number varies according to geographic location and depends on many different factors. In the USA there are 13,000 per 100,000 people (24,000 per 100,000 in Hawaii). Is it valid to imply an increase in thyroid cancer incidence after the accident, when there was no equivalent screening before the accident?

In a report[34] of the US National Council on Radiation Protection on thyroid cancer, we have the remarkable statement, "available human data on low dose I-131 exposures have not shown I-131 to be carcinogenic in the human thyroid." The National Cancer Institute carried out a 14-year study of thyroid cancers found all over the United States, in the thirty-year period after the hundred A-bomb tests in Nevada, in the 1950s and early 1960s. The 1997 report[35, 36] compared the number in each area with the amount of radiation, and did not find any evidence to associate thyroid cancer to this radiation. So, it seems that the 1800 "excess" thyroid cancers, in the Chernobyl screening, were not caused by radiation.

The UNSCEAR report concludes that no increases in cancer incidence or mortality have been observed that could be attributed to ionizing radiation; the risk of leukemia does not appear to be elevated, even for the clean-up workers, and there is no evidence of other non-malignant disorders that are related to radiation. There were many psychological reactions, but these were caused by fear of the radiation, not the actual radiation. There is no need for anyone to live in fear of serious health consequences from the Chernobyl accident. For the most part people were exposed to radiation levels comparable to, or a few times higher than, the average natural background level.

Conclusions

Policies and myths that were created half a century ago by the ICRP have convinced many people that radiation is harmful in any amount. The authorities and many scientists continue to ignore statistically significant contradictory evidence of no adverse effects from high levels of natural radiation in many regions and the evidence of significant overall beneficial health effects to medical cohorts (including cancer patients) and nuclear workers who received low doses of radiation. The ethics of this behaviour is being questioned and debated.[37, 38]

This makes it very difficult for many scientists to respond in a credible manner to public fears and concerns about radiation, by presenting the scientific evidence of the actual beneficial effects that have been observed on humans and other living things. It is therefore not surprising that the very important UNSCEAR 2000 Report received very little publicity. So the myths about cancer and abnormal babies will continue, as scientists continue to carry out more and more politically correct research on the response of cells and mice to radiation.

These myths block efforts to supply reliable, environmentally friendly nuclear energy, which is needed by humanity. It also blocks the widespread use of LDI therapy to cure or control cancer and other diseases. Hopefully the current concerns about energy supplies and health care will cause people to pay attention to the scientific results, discount the myths, and take action to reap great societal benefits.

Acknowledgements

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Nuclear Energy and Sustainable Development

***Ed. Note:** Reprinted below (with permission) is the Executive Summary of a recent report issued by the Nuclear Energy Agency of the Organisation for Economic Cooperation and Development under the title of "Nuclear Energy in a Sustainable Development Perspective". The full report can be seen at the NEA Web site < www.nea/fr > or can be obtained in paper format from the NEA Publications Office, 12 boulevard des Iles, 92130 Issy-les-Moulineaux, France, e-mail: neapub@nea.fr .The summary has been edited slightly for length.*

Effective Summary

This document is a contribution from the Nuclear Energy Agency (NEA) to the OECD Project on Sustainable Development. It provides information on nuclear energy relevant for policy making within a sustainable development framework. In this context, the specific characteristics of nuclear energy are reviewed from the economic, environmental and social viewpoints of sustainable development.

The intent of the document is not to arrive at judgements as to whether or not nuclear energy can be considered a sustainable technology in particular situations or countries, as this will depend on a wide range of factors, many of them specific to local situations. Furthermore, the document does not prejudge the policies of individual Member countries towards nuclear energy.

The intent is to identify the main impacts of nuclear energy in a sustainable development perspective, to outline some of the factors that should be considered in assessing the contribution that nuclear energy can make to sustainable development goals, and to underline the challenges that must be overcome in order to make the contribution of nuclear energy positive. The data and analyses represent the co-operative efforts of the NEA Secretariat supported by the relevant NEA Standing Technical Committees and other experts. It should be noted that some of the information contained in this report may not lead to the same conclusions in all Member countries.

The concept of sustainable development was elaborated in the late 1980s and defined by the Brundtland Report as

> "a development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

In a broad sense, sustainable development incorporates equity within and across countries as well as across generations, and integrates economic growth, environmental protection and social welfare. A key challenge of sustainable development policies is to address those three dimensions in a balanced way, taking advantage of their interactions and making relevant trade-offs whenever needed.

A central goal of sustainable development is to maintain or increase the overall assets (natural, man-made and human or social assets) available to future generations. The development of nuclear energy broadens the natural resource base useable for energy production, and increases human and man-made capital. The framework of regulatory, institutional and technical measures already in place in OECD countries aim at ensuring that the use of nuclear energy does not reduce irreplaceable natural assets significantly. Maintaining this framework is essential to address social and environmental concerns. To the extent that these concerns are addressed successfully, the nuclear industry, and the scientific knowledge and institutional infrastructure that support it, can represent an asset for present and future generations.

Technology is critical to support economic development but needs careful control and monitoring to be consistent with the social and environmental goals of sustainable development. In the energy field, services are needed to support economic development and increase social welfare but energy production and use, by any source or technology, has the potential for negative impacts on human health and the environment. Environmental and social burdens have to be minimised in order to achieve sustainable development goals.

Economic competitiveness is a prerequisite for a technology to contribute to sustainable development. Assessments of competitiveness, ideally, should be based upon comparisons of full costs to society including social and environmental costs. Most existing nuclear power plants are competitive by current standards, including those of deregulated electricity markets, since their marginal costs of production are low compared with fossil-fuelled alternatives. This competitive position is robust from a sustainable development perspective since most health and environmental costs of nuclear energy are already internalised. For example, electricity consumers are paying for nuclear safety and insurance against nuclear accidents, decommissioning of nuclear facilities, and radioactive waste disposal.

New nuclear units will have to compete within a broad range of alternatives, including fossil fuels, renewables and demand management, on the basis of full generation costs - i.e. capital, operation, maintenance and fuel costs. The large capital costs of nuclear power plants create financial risks, especially in deregulated markets, and make its competitiveness very sensitive to the discount rate applied when selecting investments. Ongoing R&D efforts to lower capital costs of nuclear power plants should be pursued to achieve significant results. Low discount rates are more favourable to capital-intensive projects such as nuclear energy facilities and reflect a preference for the future that may be considered to be in line with the goal of sustainable development. The future competitiveness of nuclear energy will be affected by values placed in each country on environmental resources, such as global climate and local air quality, and social objectives, such as diversity and security of energy supply. However, technology choices in the energy sector will be based largely on market competition and the value of different energy sources for sustainable development will need to be recognised by adequate policy measures.

Nuclear energy has an ample resource base. Current reserves are large enough to support nuclear fuel production for decades. Since the cost of nuclear fuel is a small proportion of the cost of nuclear electricity, higher fuel prices could make much greater resources available without materially affecting the competitive position of nuclear power. Furthermore, the resource base for nuclear energy can be extended through recycling of fissile materials and implementation of advanced fuel cycles that convert fertile uranium and thorium into fissile materials. In broadening the base of natural resource capital, nuclear energy is consistent with the objectives of sustainable development related to the creation and effective use of natural assets and their preservation for future generations.

Finding effective policies to respond to climate change is one of the challenges to sustainable development. Nuclear energy is essentially carbon-free and contributes to reducing anthropogenic emissions of greenhouse gases that induce global warming as well as local atmospheric pollution. Although there are a number of technical options and policy measures available to alleviate or mitigate the risks of global climate change, stabilising carbon dioxide concentration in the atmosphere is likely to require comprehensive policies taking advantage of a range of technologies and economic and regulatory measures. Including the nuclear energy option in the basket of tools aiming at addressing climate change issues is consistent with the precautionary principle and sustainable development objectives.

The record in OECD countries after several decades of commercial use of nuclear energy suggests that, in normal operation under independent and effective regulation, nuclear power plants and fuel cycle facilities have relatively small health and environmental impacts. Radiation protection regimes based upon the "as low as reasonably achievable (ALARA)" principle have been generally effective in limiting the impacts of radiation, to workers in nuclear facilities and to the public, to levels below regulatory limits, which are set conservatively.

Radioactive releases from nuclear facilities are very small in routine operation and a significant threat to worker and public health may occur only under accident conditions. Severe accident is a major concern that is addressed by nuclear safety regulations and measures. Nuclear safety objectives, based upon the precautionary principle, have been strengthened progressively and the lessons learnt from the two severe accidents that have occurred with nuclear reactors - Three Mile Island in 1979 and Chernobyl in 1986 - have led to significant improvements. The potential hazards from nuclear accidents and the probability of such accidents can be further reduced by technological modifications, manpower qualification and training, accident management measures and enhanced regulatory effectiveness.

Radioactive waste from the nuclear energy sector represents small volumes that can be isolated from the biosphere at acceptable costs but raise significant public concern. Repositories for the disposal of short-lived radioactive waste are in operation in many countries. For long-lived radioactive waste, the nuclear industry has always had the goal of containing them safely over the very long periods of time during which they may present a hazard. This ambitious goal, which is consistent with the objective of sustainable development, is seen by experts as technically and economically achievable. For several decades, adequate safe interim storage is in place. For the long term, several options may be considered but geological disposal has been recognised as a strategy responsive to fundamental ethical and environmental considerations in several OECD countries. The implementation of repositories, in ways discussed with and accepted by the public, will be a major step towards meeting sustainable development goals.

The risk of nuclear weapon proliferation is a major concern raised in connection with peaceful applications of nuclear energy although the international non-proliferation and safeguards regime has proven to be highly effective so far. Moreover, since proliferation of nuclear weapons is driven primarily by political incentives and concerns, the goals of non-proliferation must be achieved primarily through political means. It should be noted that most countries who choose to acquire nuclear weapons did so through dedicated, often clandestine, military facilities rather than through diversion from civilian nuclear power programmes, that are mostly under international safeguards. Nonetheless, diversion from civilian programmes is one possible route to the acquisition of fissile material, a crucial technical step towards weapons. Accordingly, the non-proliferation regime must be extended to ensure a very high likelihood of detecting, and hence deterring, any such diversion. This is particularly important as nuclear power programmes spread to new regions and countries.

Nuclear energy is based upon major scientific developments of the 20th century that add to the stock of man-made, human and social capital available to future generations. Because much of the cost of nuclear facilities is embodied in science and technology, rather than resources, nuclear energy is amenable to continuous improvement in performance and safety through R&D and through developments in information, technology and effective training. The scientific and technical knowledge, industrial experience and regulatory framework and institutions that ensure quality in design, operation and regulation of nuclear activities constitute a valuable human and social capital. In countries where nuclear energy is used, it provides opportunities for highly qualified employment and enhances diversity and security of energy supply.

Addressing public concerns is essential to meet the social objectives of sustainable development. For this purpose and in the light of the widespread public concern about nuclear risks, it is necessary to include the public in a democratic decision-making processes through which it gains confidence that its concerns are being heard and addressed. The implementation of nuclear energy projects requires a participation of the public at the national and local level, and the exchange of a broad range of information and perceptions covering scientific, technical, economic and social aspects. It is important to allow the public to put social, ethical and political issues related to nuclear energy into perspective with the issues raised by alternatives, including the different liabilities passed to future generations such as long-lived radioactive waste, climate change or resource exhaustion. It is the responsibility of governments to create the conditions for decision-making processes to be consistent with inter-generation equity and the social objectives and environmental protection goals of sustainable development.

National policy decisions result from trade-offs within each dimension of sustainable development and between those dimensions. Trade-offs are based upon factual data but reflect specific socio-economic and political conditions of each country. The overall energy context, environmental sensibility, historical and cultural evolution and political approaches are different from country to country and will affect trade-offs and decisions.

Decommissioning the U of T SLOWPOKE - a photo story.

Ed. Note: *In January 2001 the Canadian Nuclear Safety Commission granted the University of Toronto a Licence to Abandon the SLOWPOKE 2 reactor that had been at the university for 27 years. The permission to abandon came after a one day CNSC hearing at which university officials and their contractors presented a detailed account of the decommissioning process. The following report is based on that presentation. Our thanks go to Jack Richman, president of Merlin Simex Corporation, which was the primary contractor, for permission to reprint some of the many photographs used in their presentation to the CNSC.*

Prologue

Back in 1997, the Governing Council of the University of Toronto decided, on the advice of a special advisory committee, that the SLOWPOKE 2 should be decommissioned. One of the factors was the need for a new core which the university deemed it could not afford. Research associated with the facility was terminated at the end of 1998 and the reactor was shut down in 1999.

To commemorate the end of 27 years of operation and research with SLOWPOKE 2 (there had been an earlier one) a "wake" was held on December 9, 1998 that drew many senior and retired members of the Canadian nuclear community. (See Vol. 20, No. 1 Jan - Mar 1999 issue of the CNS bulletin for an account of that event.)

Background

SLOWPOKE is a small, inherently safe, reactor with a maximum power of 20 kilowatts, intended as a neutron source for activation analysis and other experiments. It has a small core using highly enriched uranium that is barely critical with large beryllium reflectors top and bottom. A single cadmium rod serves as the control device.

The core consists of about 300 thin, aluminium clad rods containing the highly enriched uranium metal housed in an aluminium cage. The fuel cage is housed in a reactor vessel, which is submerged in a circular pool about 2 metres diameter and 6.7 metres deep.

SLOWPOKE was conceived by John Hilborn at the Chalk River Laboratories of Atomic Energy of Canada Limited in the late 1960s. A demonstration unit was built at AECL's Commercial Products (now MDS Nordion) in suburban Ottawa. In 1971 the first SLOWPOKE outside of AECL's premises was installed at the University of Toronto. That reactor was replaced with SLOWPOKE 2 in 1976. There are six SLOWPOKE reactors in universities across Canada and one at the University of the West Indies in Kingston, Jamaica.

Decommissioning Process

In 1998 the university proposed to the Atomic Energy Control Board that, as a first step in decommissioning, the reactor be defuelled under the existing Operating Licence and be shipped to the US Department of Energy at Savannah River, South Carolina. That operation was completed during June 2000.

The decommissioning work was divided into three phases.

Phase 1. (pre-decommissioning) This work, which was completed under the Operating Licence, included: removal, packaging and shipping of the fuel. The beryllium reflectors, the five inner radiation tubes, irradiation controller and sample receiver were removed from the reactor vessel for later packaging and shipping.

Phase 2. (dismantling) The reactor was dismantled, reactor components packaged and removed from the facility and the facility cleaned. The pool water was discharged to the sanitary sewer system and the pool concrete sampled for activated elements. No activity above IAEA release criteria were detected. The beryllium reflector, five irradiation tubes, the irradiation controller and sample receivers were shipped to the University of West Indies in Kingston, Jamaica. Other radioactive and non-radioactive reactor parts were shipped to AECL's Chalk River Laboratories. All other non-radioactive material was disposed of as industrial waste.

Phase 3. (final release survey) This phase comprised the survey work done to ensure that the site was safe to return to unrestricted use.

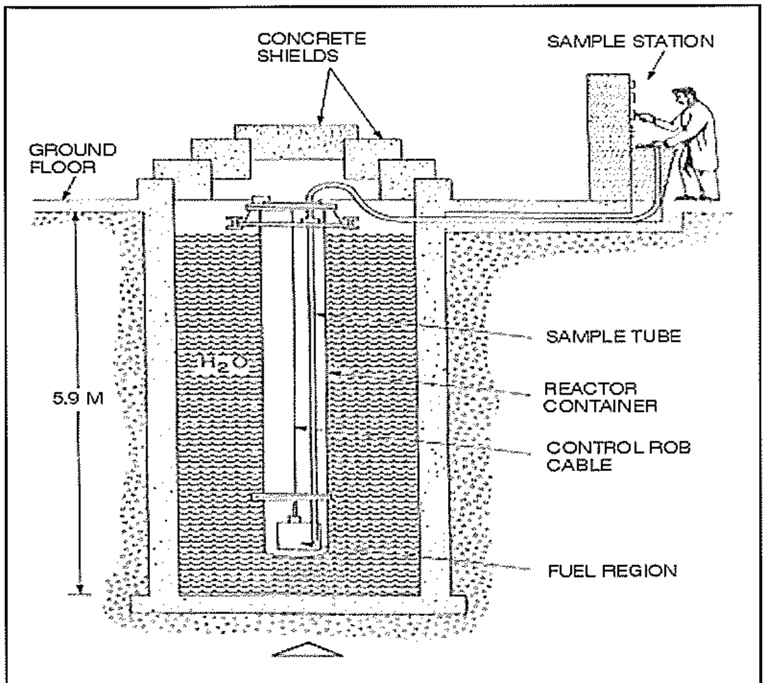
The dismantling and cleaning took place during October to December 2000.

The University held three open meetings in October and November 2000 to inform staff and nearby residents of the project. A fourth meeting was held in late January 2001 after the CNSC had granted permission to abandon the reactor.

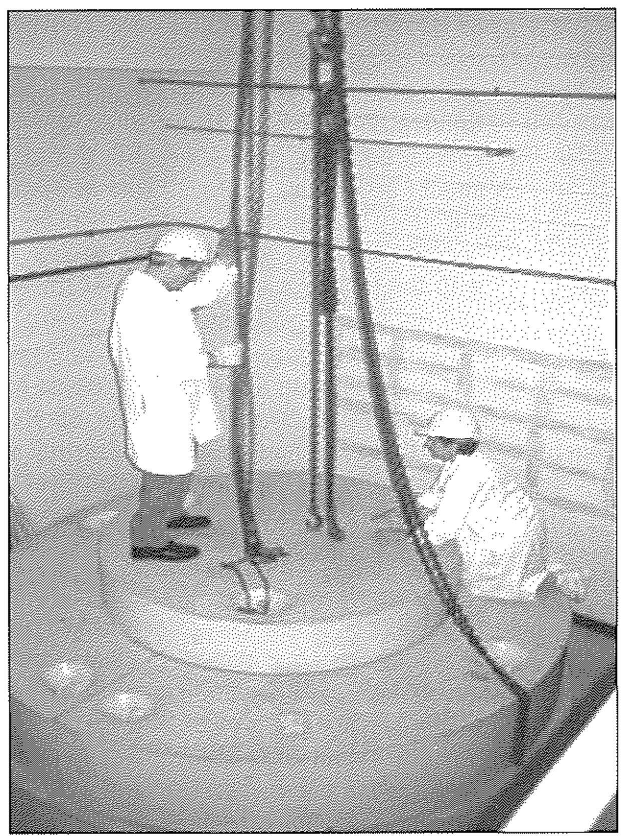
A particular part of the survey work of Phase 3 concerned some university staff. The slightly radioactive beryllium reflectors had been placed in a certified shipping container but the gamma radiation, unexpectedly, exceeded that for unrestricted shipment. Therefore the container sat for two weeks until lead shielding could be added. During that time a barrier was set up around the immediate area. Although surveys showed that no worker or member of the public could have received a radiation dose in excess of background the union expressed concern and intervened at the CNSC hearing.

At the CNSC hearing Commission staff stated that the only outstanding item was acknowledgement by the International Atomic Energy Agency that there were no safeguards issues remaining. That occurred later in January.

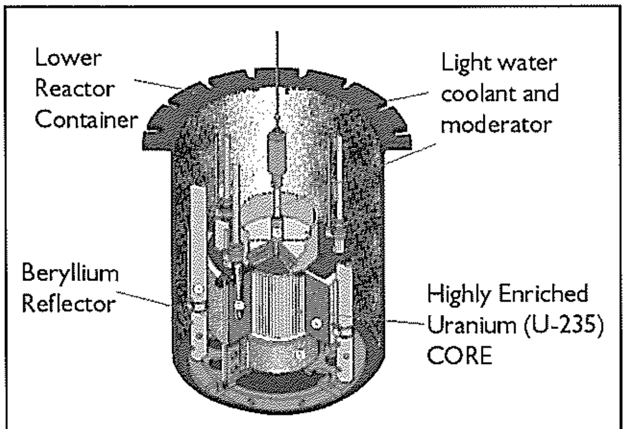
The accompanying photographs depict various stages in the decommissioning process.



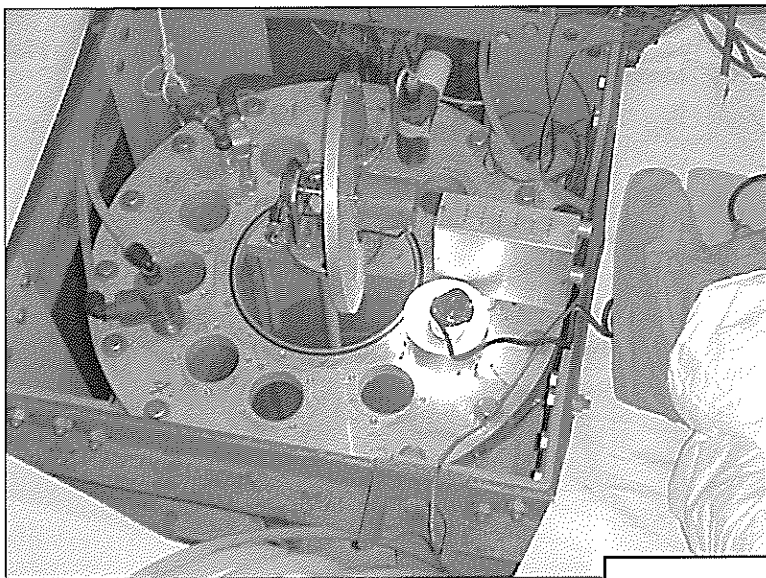
Cross Section of Reactor Pool



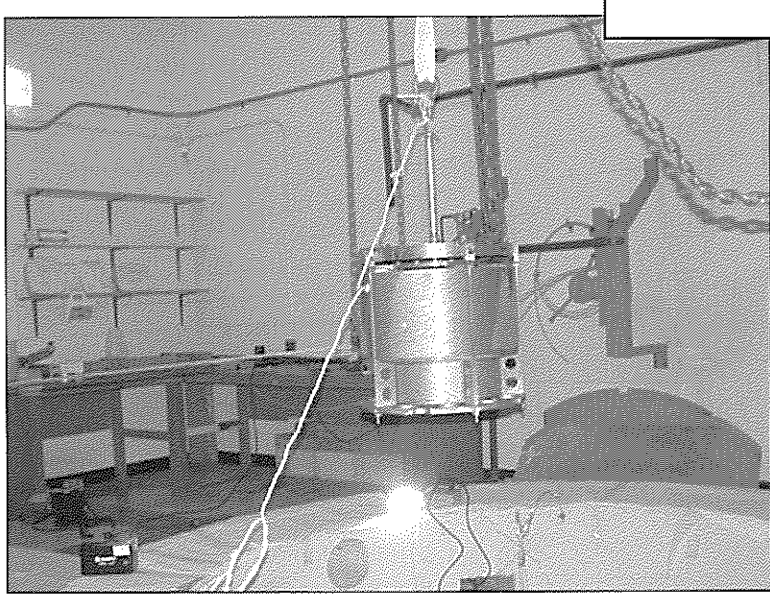
Preparing to remove reactor cover.

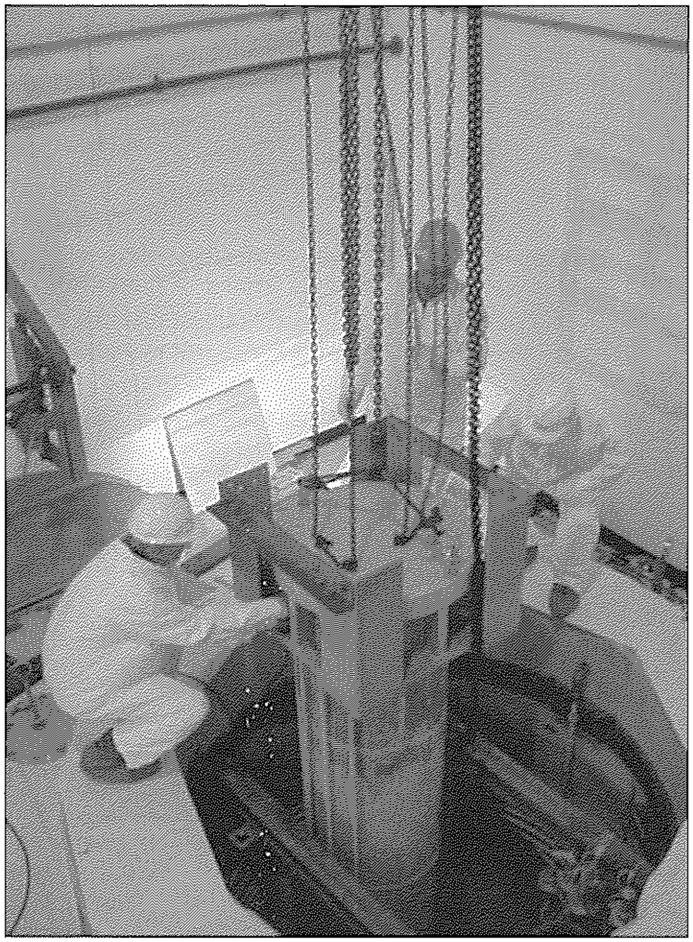


Reactor Assembly

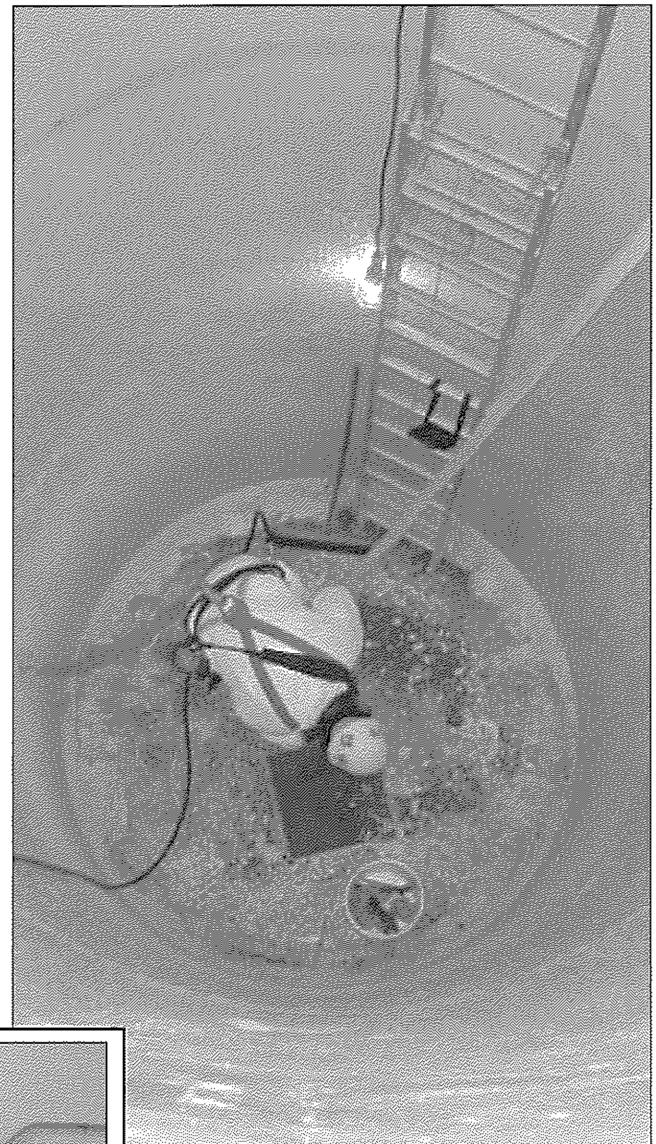

The top of the reactor vessel.


Shielded shipping containers.

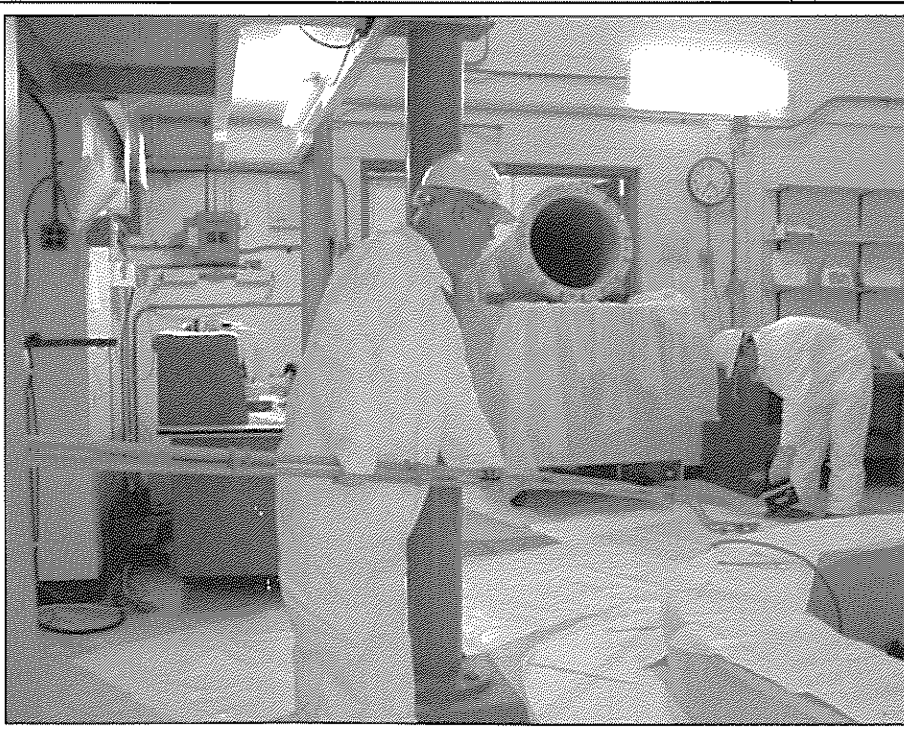

Removal of beryllium assembly.



Removing the reactor vessel.



Final cleaning of pool.



Packing the irradiation tubes.

Possible Refurbishment of Point Lepreau

by R.M. White, S.H. Groom, P.D. Thompson[1]; J.M. Barclay, P.J. Allen[2]

***Ed. Note:** The following paper was first presented at the 22nd Annual Conference of the Canadian Nuclear Society held in Toronto, Ontario, June 2001.*

ABSTRACT

In February 2000, the NB Power Board of Directors approved Phase one of a project to produce a business case including a detailed scope and estimate associated with the possible refurbishment of the Point Lepreau Generating Station (PLGS).

The Preliminary plan for refurbishment projects an 18-month outage starting as early as the spring of 2006. If the station were to be 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 the summer of 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 January of 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. The station currently produces about a third of the power generated within the province.

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. The condition assessments build on work done under the Plant Life Management Program.

Point Lepreau Generating Station has operated well since start of commercial operation in early 1983. With a lifetime capacity factor of about 84% (up to the end of 2000), it has proven to be an economic and environmentally sound electricity provider. The station has also had a significant positive economic impact in Southern New Brunswick, employing over 600 people. However the Pressure Tubes and Feeders are nearing the point in time in which they will exceed their fitness for service criteria. Although tubes can be replaced on an individual basis, this can lead to prolonged outages ultimately making the unit uneconomic to operate.

This paper provides an overview of the various activities that are currently underway to provide the detailed information in support of the refurbishment decision.

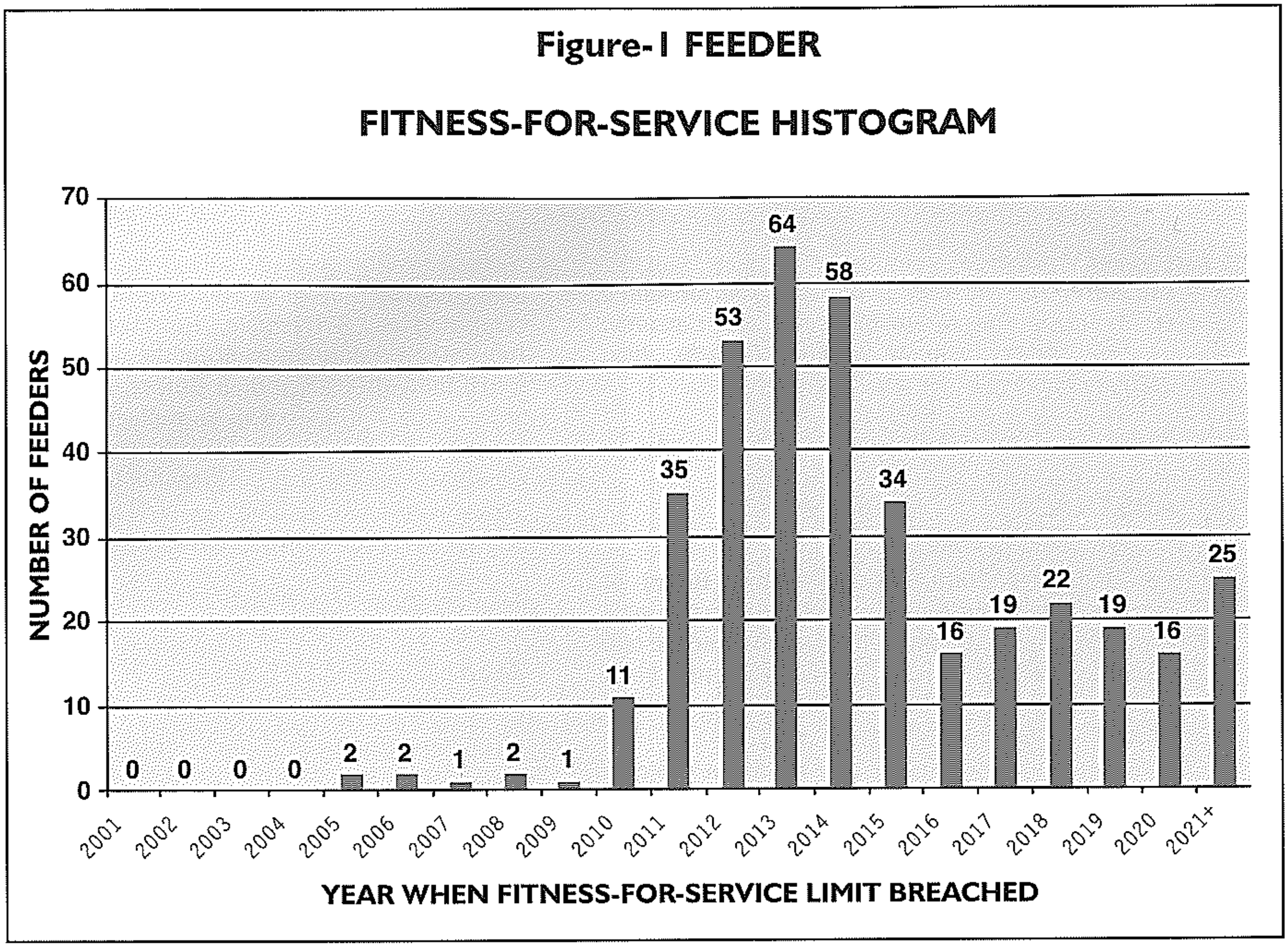
Refurbishment Drivers

The most significant issues that are leading for a need to refurbish the reactor are associated with the Fuel Channels and Feeders.

The Pressure Tubes are exposed to high neutron fields as well as fast flowing hot pressurized heavy water coolant. Due to these harsh conditions they undergo a variety of metallurgical changes which eventually lead them to reach their service limits. Replacement technology is well proven. Several individual tubes have been replaced in various CANDU 6 reactors around the world, including two tubes at Point Lepreau (K05 and R16). Large-scale replacement has also been conducted successfully by Ontario Hydro at the 4 unit Pickering A station in the 1980's. Although tubes can be replaced on an individual basis, the length of individual outages will grow to the point where it is no longer economic to operate as more and more channels reach their fitness for service limits. Based on an assessment of remaining Pressure Tube life, it was determined that PLGS should be in a position to retube the reactor as early as the spring of 2006. 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 all utilities operating CANDU reactors.

Like the Pressure Tubes, the Calandria Tubes are also exposed to a harsh operating environment. Because of the sag of the tubes, replacement of the

1 NB Power, Point Lepreau Generating Station
2 Atomic Energy of Canada Limited



Calandria tubes is required to restore the nominal Fuel Channel lattice.

In 1996 it was recognized that the Outlet Feeders at PLGS and other CANDU reactors were experiencing accelerated flow assisted corrosion at a location immediately downstream of the channel outlet. An extensive program was put in place to understand the degradation mechanism, root cause and contributing factors, the rate of wall thinning and the remaining life of each individual Feeder. Figure-1 presents a histogram of when the various Feeders will reach their fitness for service limits. The figure indicates that 5 feeders will need to be replaced before 2006, and that the number steadily grows in the following years. Sections of four individual Outlet Feeder pipes have already been replaced at PLGS. Although these were replaced for reasons other than flow assisted corrosion, it is a good demonstration of Feeder replacement technology. As with Fuel Channels, individual replacement is practical only for the leading edge of the population distribution.

Pre-project history

To set the stage for refurbishment, in 1993 agreement was reached between NB Power, Hydro Quebec and AECL on establishing a joint Plant Life Management Program (Reference 1). Initial studies concentrated on critical systems, structures and components that would be too costly to replace. Studies were carried out for the Calandria and Reactor Structures, concrete Reactor Building structure and the Steam Generators, with other systems following thereafter. This program ensured that the right care and attention was being provided to ensure the longevity of the critical components, and that the information required to determine that they could operate out for a least another 25 years after refurbishment was identified and acted upon.

In the mid 1990's discussions were also initiated between NB Power and AECL pertaining to a fixed priced contract to retube the reactor. AECL was proposing a "fast retube" approach that they were developing. This was based on the lessons learned from the large-scale Fuel Channel replacement that took place at the Pickering A units, and also on the various single channel replacements. As these discussions progressed it became obvious to NB Power that a new type of working relationship with AECL was required. Past work with AECL had been performed on a straightforward fee for service approach. While this method has its advantages, it had limitations in the degree of corporate buy-in and accountability on the part of the service provider. Hence discussions also began to take place on establishing a risk-sharing relationship.

The prospect for refurbishing the unit was given an important boost in 1998 as a result of the Hagler Bailly assessment that looked into the continued operation of the unit. This study, which was commissioned by the President of NB Power, examined the technical and economic issues associated with the continued operation of the station at a time when the confidence in station operation was shaken (References 2 and 3). The study clearly indicated the strong economic benefit of continued operation of the station. It also showed that depending on the price of natural gas, that refurbishment of the station would likely be more competitive. In order to protect the option of refurbishment, the report recommended that a project be established with priority to produce the detailed case for refurbishing the unit.

In keeping with the recommendations of the Hagler Bailly report, organizational responsibility was established (Mr. S.H. Groom of NB Power), preliminary planning was conducted, and in February of 2000, a preliminary business case was presented to the NB Power board of directors. This case looked at replacing all the Fuel Channels and a good portion of all the connecting Feeders, and operating the unit for at least another 25 years. Wastes generated from the retube campaign would be stored in a new facility to be constructed on the existing on-site Solid Radioactive Waste Management site. Other changes to the station would be based on a comprehensive condition assessment and the conduct of a comprehensive safety review.

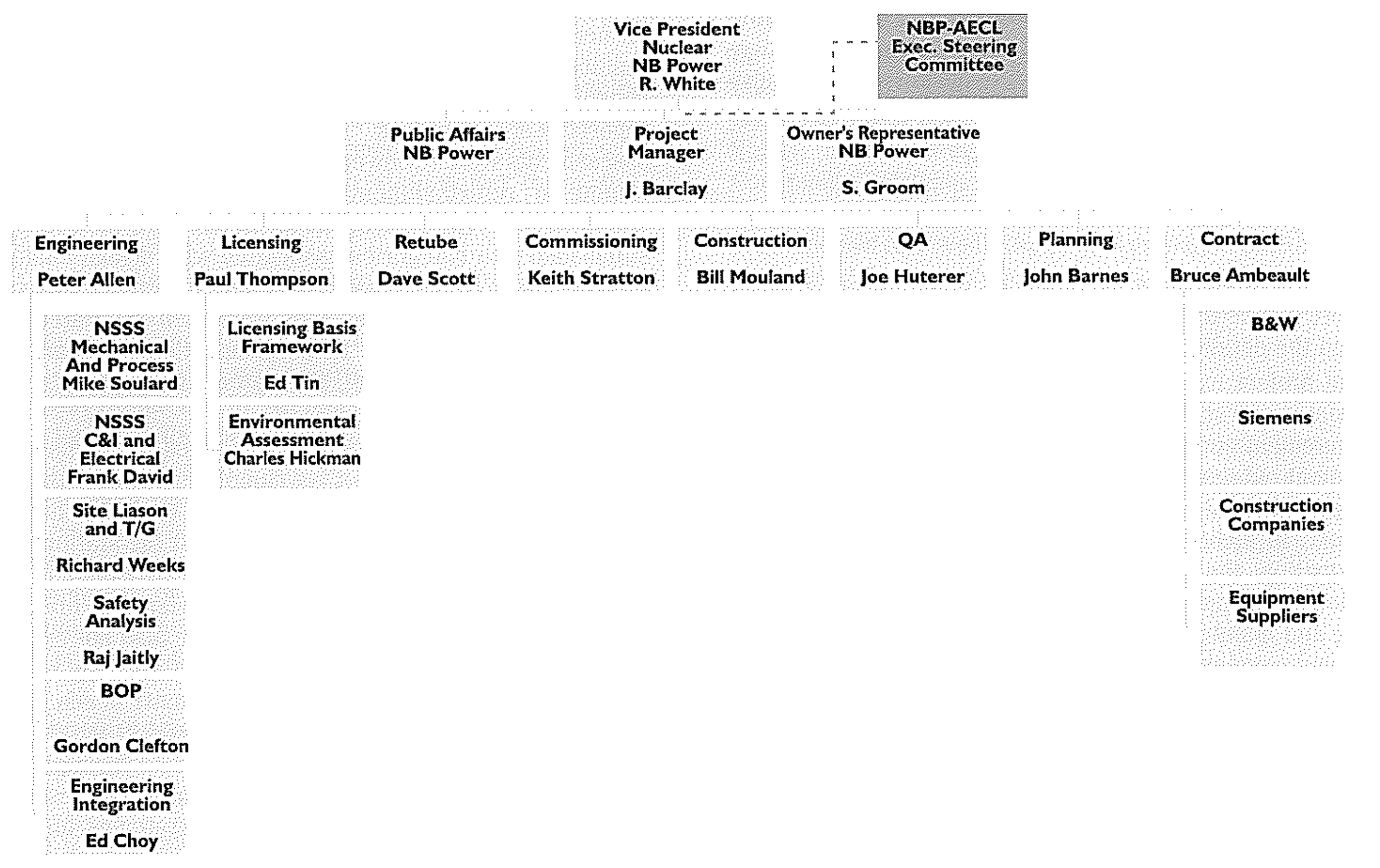
In the presentation to the NB Power board of directors, it was recommended that the project be divided into 3 phases. The first phase would define the project activities and costs in detail. The second phase would encompass detailed engineering, procurement and site preparation. The third phase would be the outage itself.

Based on the information provided, the NB Power board of directors gave approval to proceed with the first phase of the project.

Getting Started

From mid February 2000 until the end of June 2000, Mr. Stu Groom headed up the project. During this time detailed work plans were produced, the phase 1 project execution plan was developed, and the project infrastructure was created. The Safety & Licensing team and the Environmental Assessment team were established and began work. The

Figure 2 **Project Organization - Phase I**



task of acquiring manpower for the project was also initiated. This was a challenging task as the reliance on PLGS staff had to be kept to a minimum in order to allow them to concentrate on issues pertaining to operating the unit, however it was important to have a strong operating perspective on the project. This lead to the establishment of a joint project team made up of representatives from NB Power, Atomic Energy of Canada Ltd. (AECL) and other smaller consulting groups. This joint project team combined the strengths from the various organizations.

Project Organization

The current organization chart for the project is shown in Figure-2. The project reports to Mr. Rod White who is the Vice President - Nuclear for NB Power. Reporting to Mr. White is the Project Manager (Mr. John Barclay of AECL) and the owner's representative (Mr. Stu Groom of NB Power). Reporting to the Project Manager is the Engineering Manager (Mr. Peter Allen of AECL), the Licensing and Environmental Assessment Manager (Mr. P.D. Thompson of NB Power), the Retube Manager (Mr. D.A. Scott of AECL), the Construction Manager (Mr. W. Mouland of NB Power), the Commissioning Manager (Mr. K. Stratton of NB Power), the Quality Assurance Manager (Mr. J. Huterer of AECL), the Planning and Scheduling Manager (Mr. J. Barnes of AECL), and the Contracts Manager (Mr. B. Ambeault of AECL).

Progress on the project is monitored by a joint executive steering committee that is made up of senior executives from both NB Power and AECL. A senior three person advisory team that reports directly to the President of NB Power also provides oversight.

Key Products for Phase I

The key products to be produced under phase 1 of the project will be the project execution plan for phases 2 and 3, and the detailed business case.

The project execution plan will include detailed scope, estimates and schedules for phase 2 (detailed Engineering, Procurement and Site Preparation) and phase 3 (the refurbishment outage itself). This information will be input into the overall business case that is being prepared by NB Power. In addition to the specific refurbishment project information, the overall business case will include information on the need for generation capacity, long term operating and maintenance costs for PLGS, and the identification and comparison against alternative development scenarios. The business case will also discuss the plan for PLGS in the event that the station will not be refurbished.

The following portions of the paper summarize the various activities that are underway in the project.

Retube / Discussion with Contractors / Commissioning

Considerable effort by AECL has gone into the development of "fast retube" technology for the replacement of fuel channels and feeders. In addition to improvements on previous methods to reduce the time for channel replacement and radiation exposure to plant staff, innovative concepts have been developed to take care of the waste products. The pressure tubes and calandria tubes will be flattened automatically as they are removed and will be cut up into small pieces to reduce the overall volume and simplify the radiation shielding and handling requirements. An overview of the retube process is presented in Appendix-I.

To support the retube activity, a number of temporary facilities will need to be constructed. Work has been initiated to determine what structures are best to support the outage. In addition discussions with various local contractors, trades organizations and unions are under way to support both retube and the outage in general.

Preliminary work is also underway to define the commissioning principles and tasks that will be required at the end of the outage so that the overall schedule of the project can be refined.

Engineering

A comprehensive and systematic review of all plant systems important to safety and power production was performed to determine which components might need to be replaced from either an age degradation or obsolescence consideration. A total of 163 Condition Assessment reports were produced. Recommendations from these assessments were reviewed to determine whether they pertained to refurbishment or ongoing Operations and Maintenance. The refurbishment items were then further subdivided into categories associated with design change, refurbishment (replace with equivalent or repair), analysis and inspection. Work packages were then generated and the design changes sent to a Change Control Board for review. An overview of this process is provided in Reference 4.

The determination of the exact changes to be made as part of refurbishment is not yet complete, however the following list provides an indication of the types of changes that may be necessary. It is expected that the station control computers and the Programmable Digital Comparators will need to be replaced due to issues related to obsolescence. The windings of the generator are also not expected to last the required time and hence a strategy on the generator (either rewinding or replacement) needs to be developed. The rectifiers and inverters used in the Class I & II Power Systems will also likely need to be replaced. Inspection of the Calandria Vault and Calandria Vessel is also being recommended. Inspection strategies for systems that are normally inaccessible to work on such as the

Moderator, RCW and RSW systems are also going to be developed. An inspection strategy will also need to be developed for various heat exchangers. It should be noted however that neither the Steam Generators nor the Containment structure require extensive work since these have been determined to be in good condition.

In addition to the Condition Assessment Process, work is also underway to assess the environmental qualification of equipment for another 25 to 30 years.

Safety & Licensing

An important element in the preliminary business case was the fact that the reactor would need to operate for at least another 25 years after refurbishment. As the plant was nominally designed for 30 years of operation, it was necessary to develop a strategy to deal with the issue of Life Extension and to discuss this aspect with the CNSC.

The Safety & Licensing program was developed by a group of experienced industry experts and consists of work related to life extension and outage support. The portion of the program to address life extension comprises a number of categories of activities. The first is associated with looking into improving safety margins for a number of specific longstanding issues. The second area deals with various processes to identify potential issues that should be dispositioned. This includes looking at Safety related changes made on the newer CANDU-6 plants, as well as comparing PLGS against the current set of codes and standards. In all the cases, a benefit cost analysis will be performed to determine whether or not a change is warranted. Another area of the S&L program involves identifying additional analysis that should be performed to complement work that has been undergoing at the station over the past 18 years. This includes both probabilistic as well as deterministic analyses.

The activities mentioned above constitute a form of safety review. However in discussions with the CNSC, it became clear that the review should be extended to be comparable to the Periodic Safety Review recommended by the IAEA (Reference 5). In response, the project identified a methodology for performing an Integrated Safety Review. This review integrates the various activities being performed under the Refurbishment project, as well as initiatives underway at the station and compares it to the safety factors and elements identified in the IAEA Safety Guide.

A summary of the various Safety & Licensing activities pertaining to both life extension and the actual outage itself is provided in Appendix II.

Environmental Assessment and Community Relations

AECL has produced a conceptual design for the facility to store the Fuel Channel and Feeder components that will be removed from the reactor. The facility will be located at the on-site radioactive waste storage area. As the construction of this facility will require a change to the waste site Licence, an environmental assessment at the screening level will be required.

To inform the public about the possibility of refurbishing Point Lepreau, public information sessions have been held in Saint John, Dipper Harbour, St. George, Moncton and various communities around Saint John. Meetings with key stakeholders are also underway and will continue for the next several months. A 1-800-information phone line has also been established so that the public is provided with an easy opportunity to ask questions.

PLGS has a significant socio-economic impact in Southern New Brunswick as it employs more than 600 full time staff and a large number of contractors during maintenance outages. PLGS also plays an important environmental role as it does not release any emissions of carbon dioxide, sulphur dioxide and nitrogen oxide. As a specific example, last year alone with a capacity factor of 71%, the station avoided approximately three million tonnes of carbon dioxide, 52 thousand tonnes of sulphur dioxide, and 11 thousand tonnes of nitrogen oxide. Although these issues are not direct factors in the business case, they are none-the-less important issues in the eyes of the public.

Summary

Effort has been underway since February of 2000 to define the detailed scope and estimate of the project to refurbish the Point Lepreau Generating Station. To date considerable effort has taken place in the areas of Retube, Engineering, Safety & Licensing, Environmental Assessment and Community Relations. Within the next six months the exact scope of the outage and the commissioning program will be produced and reviewed. The project execution plan and business case will be prepared such that the review by the NB Power board of directors and the Public Utility board can commence at the beginning of 2002.

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2. R.M. White, J.J. McCarthy, W.S. Pilkington and P.D. Thompson, "Improving Performance in a Competitive Environment", paper presented at the 19th Annual Conference of the Canadian Nuclear Society, Toronto, October 1998.

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Ewing, J.J. McCarthy and P.D. Thompson, "Improving Performance at Point Lepreau", paper presented at the 21st Annual Conference of the Canadian Nuclear Society - Toronto Ont. June 2000.

4. P.J. Allen, MR. Soulard, F. David, G. Clefton and R. Weeks, "Point Lepreau Refurbishment: Plant Condition Assessment", paper presented at the 22nd Annual Conference of the Canadian Nuclear Society, Toronto, June 2001.

5. IAEA Safety Series Document 50-SG-012 PSR Review Guide,1994.

APPENDIX-I

High level outline of steps in the Retube Process

The following provides an overview of the key steps in the tentative refurbishment outage:

- Reactor shutdown
- Defuel reactor
- Drain Heat Transport System and Moderator Systems
- Remove Closure and Shield Plugs and replace with temporary Shield Plugs
- Disconnect feeder at Graylock connection
- Cut and remove feeders, cut feeders into sections and transport to waste facility
- Cut Pressure Tubes close to the inboard end of the end fitting
- Remove positioning assembly, cut bellows weld and remove end fitting into flasks - leaving temporary Shield Plug in Pressure Tube
- Transport End Fittings to waste site
- Remove Pressure Tubes, cut them into pieces, flask them and transport them to waste site
- Remove alternate Calandria tubes and replace them
- Remove remaining Calandria tubes and replace them
- Install Pressure Tube/End Fitting Assemblies
- Install remaining End Fittings
- Weld the Bellows
- Install the Positioning Assemblies
- Pressure test the Annulus Gas system
- Install new Feeders
- Install new Shield and Closure Plugs and replace insulation panels
- Refill Moderator and commission Moderator and establish GSS conditions
- Load Fuel
- Refill Heat Transport System
- Pressure test and commission Heat Transport System
- Complete remaining commissioning activities and remove GSS
- Run-up to full power

APPENDIX II

Key Activities in the Safety & Licensing scope

A: Life Extension

A1: Design Related:

A1.1 Specific studies associated with safety margin improvements:

- Determination of upgrades to Shut down Systems to improve trip coverage
- Determination of changes to address End Fitting ejection
- Determination of changes to reduce the predicted future unavailability of ECC
- Determination of changes to improve moderator sub-cooling margin
- Review of changes to improve two phase thermosyphoning

A1.2 Studies to determine whether or not additional safety improvements should be made

- Review of PLGS against Safety related design changes for Wolsung/Quinshan
- Review of PLGS against generic CANDU 6 PSA for potential changes
- Review of PLGS design against current codes & standards
- Review of ability of PLGS Safety Systems, Standby Safety Support, and Safety Related systems to meet their unavailability targets
- Review of fuel string gap allowance for LOCA's

A1.3 Economic changes

- Changes to improve CCP/ROP margins

A2 Review of Safety Analysis

- Produce Level 2 PSA work plan
- Review Safety Analysis to determine what analysis needs to be updated (includes review against C6 Rev 1)

A3 Integrated Safety Review

B Work to support the Outage

- Review of OP&P to identify clauses to be changed to reflect defuelled core
- Provide CNSC with overview of commissioning and run-up plan
- Get up-front agreement with CNSC on acceptance criteria for start-up and run-up

C Other support activities:

- Establish Benefit-Cost Analysis Process
- Establish risk baseline for PLGS
- Establish post accident management strategy
- Review of Steam line relocation

ChemAND™ - A System Health Monitor for Plant Chemistry

C.W. Turner, G.R. Mitchell, G. Tosello, P.V. Balakrishnan, G. McKay, M. Thompson[1], Y. Dundar, M. Bergeron, R. Laporte[2]

Ed. Note: *The following paper is an updated version of one originally presented at the 5th CNS International Conference on CANDU Maintenance held in Toronto, Ontario, November 2000*

ABSTRACT

Effective management of plant systems throughout their lifetime requires much more than data acquisition and display-it requires that the plant's system health be continually monitored and managed. AECL has developed a System Health Monitor called ChemAND for CANDU® plant chemistry. ChemAND, a **Chem**istry **AN**alysis and **D**iagnostic system, monitors key chemistry parameters in the heat transport system, moderator-cover gas, annulus gas, and the steam cycle during full-power operation. These parameters can be used as inputs to models that calculate the effect of current plant operating conditions on the present and future health of the system.

Chemistry data from each of the systems are extracted on a regular basis from the plant's Historical Data Server and are sorted according to function, e.g., indicators for condenser in-leakage, air in-leakage, heavy water leakage into the annulus gas, fuel failure, etc. Each parameter is conveniently displayed and is trended along with its alarm limits. ChemAND currently includes two analytical models developed for the balance-of-plant. The first model, ChemSolv, calculates crevice chemistry conditions in the steam generator (SG) from either the SG blowdown chemistry conditions or from a simulated condenser leak. This information can be used by plant staff to evaluate the susceptibility of the SG tubes to crevice corrosion. ChemSolv also calculates chemistry conditions throughout the steam-cycle system, as determined by the transport of volatile species such as ammonia, hydrazine, morpholine, and oxygen. The second model, SLUDGE, calculates the deposit loading and distribution in the SG as a function of time, based on concentrations of corrosion product in the final feedwater for both normal and start-up conditions. Operations personnel can use this information to predict where to inspect and when to clean.

1. Introduction

Nuclear power plant operators worldwide have shown considerable interest in improving the monitoring and diagnostics of plant chemistry to improve capacity factors and extend plant life. WANO (World Association of Nuclear Operations) and INPO (Institute of Nuclear Plant Operators), for example, provide comparative data to enable operators to evaluate their plant's performance against industry norms. Improved monitoring and diagnostics of plant chemistry will help the plant chemist to identify chemistry problems, evaluate them, and take appropriate action to remedy situations that could lead to degradation of key plant components.

This need for improvement is especially true in the steam cycle where all impurities introduced by condenser leaks, the water-treatment plants, air in-leakage, or poor control of chemistry enter the Steam Generator (SG). Here, they can cause aggressive chemistry conditions to develop and ultimately cause corrosion failure of the SG tubes. Thus, a System Health Monitor (SHM)[1] for plant chemistry must provide both data acquisition and display, and easy access to diagnostic, analytical, and predictive models to help the plant operators assess the effect of operating chemistry on corrosion and fouling, and improve operational control of the systems.

2. How ChemAND Works

ChemAND (**Chem**istry **AN**alysis and **D**iagnostic system) is a SHM for plant chemistry currently under development by AECL that provides additional capability to the plant chemist and system responsible engineer (SRE) in the areas of automated monitoring, alarming, diagnostics, prediction, and on-line execution of analysis codes. ChemAND is an integral part of the "smart" CANDU reactor that will be used with on-line, in-situ probes to optimise chemistry control for the entire plant. The product has been undergoing field trial at

1 Atomic Energy of Canada Limited, Chalk River Laboratories

2 Hydro Quebec, Central Nucleaire Gentilly-2

Gentilly-2 since early 1999, and a commercial version is now available.

ChemAND has three main components:

- **Chemistry surveillance and reporting**
- **Alarming on chemistry out-of-spec, and**
- **Models for prediction and analysis.**

ChemAND provides enhanced 'situational awareness' to the plant chemist or SRE by **monitoring and trending chemistry parameters** from eight key systems:

- Steam Cycle (balance-of-plant, BOP),
- Heat Transport System (HTS),
- Annulus Gas,
- Moderator-Cover Gas,
- Endshield Cooler,
- Liquid Zone System,
- Emergency Core Cooling, and
- Gadolinium Storage Tanks.

Monitoring of chemistry from other plant systems can easily be added as the need arises.

The parameters from each system are acquired from the plant's Historical Data Server (HDS)[2], and are sorted and displayed according to their function, e.g., 'monitor for condenser leak', 'monitor for air in-leakage', or 'monitor for corrosion-product transport'. On-line chemistry parameters are integrated with laboratory analysis results ('grab samples') to provide a complete picture of plant chemistry conditions. Note that chemistry-related data can be easily correlated with other operational data stored in the HDS.

Using ChemAND the SRE can trend current values, look at previous data, and compare values to design or commissioning data. ChemAND also provides a static library of information that the plant chemist needs to have readily available. Thus, for each parameter that is measured, there are links to tables showing the reason for monitoring that specific parameter, its control limits and its 'tag name' in the HDS. Additional information, such as links to the rationale for setting chemistry control limits and the standards for sampling and analysis, can be added in the future.

In each station, performance limits are established for each chemistry parameter. ChemAND supports two levels of high and low alarms. ChemAND **alarms when chemistry parameters drift out-of-spec,** flags the parameter(s) and provides the chemist with information to track down the source of the problem and rectify the situation by:

- displaying an alarm panel, akin to the 'window tiles' used in control rooms, that changes colour when a parameter is 'out-of-spec' and identifies the affected plant system,
- providing easy navigation from the alarm bar to trends of parameters in alarm for a given system, and
- using 'function-based' displays to help the chemist diagnose the cause of the problem.

Chemistry parameters both in and out of spec are tracked continuously, facilitating the **calculation and reporting of both performance and safety-related indices** on an on-going basis. This feature greatly enhances the accountability of plant chemistry systems, and facilitates chemistry reporting to both management and regulatory authorities.

The foregoing may be described as a 'present' and 'past' view of plant operation. The plant chemist and SRE must, however, also manage the plant's future. ChemAND uses **models for the analysis and prediction** of the effect of current chemistry conditions on the degradation of plant systems and components. Two models are currently resident in ChemAND: SLUDGE and ChemSolv.

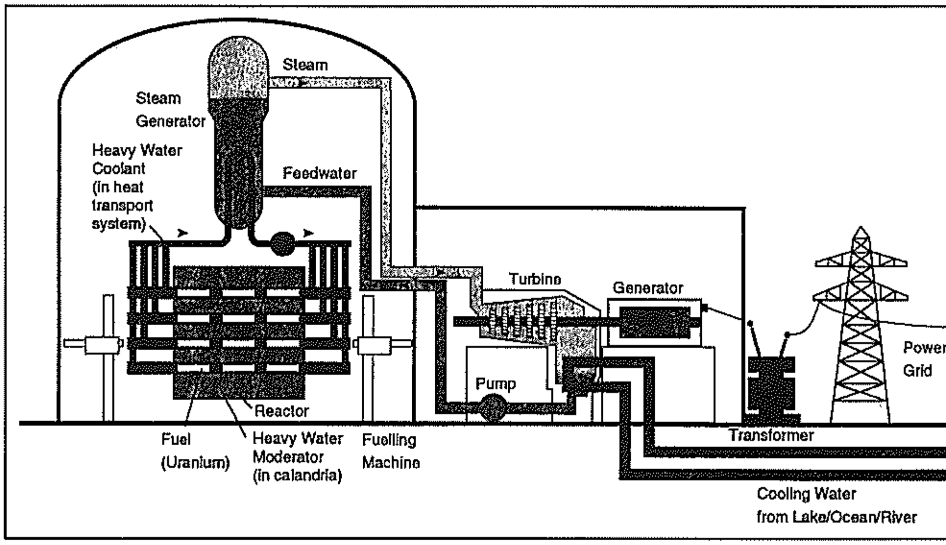


Figure 1. Major Systems in a CANDU Power Plant.

SLUDGE is a fouling model that tracks deposit build-up and distribution in the SG from corrosion-product transport data for both normal operation and start-up conditions, i.e., when a significant amount of corrosion product is transported to the SG in a 'crud burst'. Future increments to deposit build-up can be run as scenarios from ChemAND as a function of feedwater chemistry and plant operating conditions, e.g., blow-down rate[1].

A second model, ChemSolv, is a chemistry model that can be used to calculate the effect of a condenser leak or impurity ingress from the water treatment plant on SG crevice chemistry. Crevice chemistry is calculated at four strategic locations in the SG; two on the hot leg and two on the

1 During operation, water is continuously removed from the SG at a small fraction of the steaming rate to limit the build-up of impurities. This action is called blow-down.

cold leg. ChemSolv also tracks the transport of volatile species, e.g., oxygen, amine, hydrazine, and volatile decomposition products, throughout the steam-cycle.

All models that have been incorporated into ChemAND can be run using either user-defined input parameters or parameters read from the station's HDS. This capability allows the user to compare the results from several scenarios. For example, one could compare the effect of changing the blowdown rate on crevice chemistry and deposit build-up in the SG, or assess the effect of a change in water treatment program on SG chemistry conditions. Output files from the models can be saved or plotted as 'what-if' scenarios as a plant lifetime management tool.

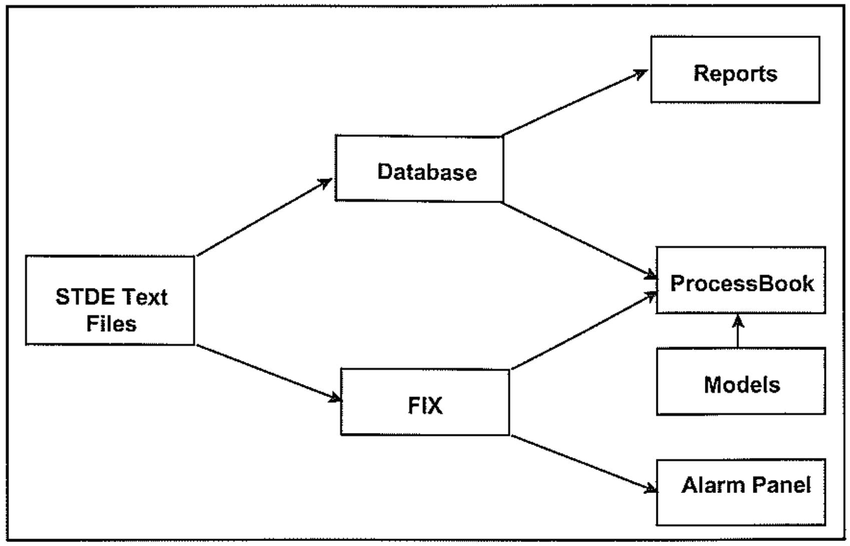


Figure 2. Data Flow within ChemAND

3. ChemAND Requirements and Links To Other Software

ChemAND is a client-server application developed for the Microsoft® Windows NT/95 operating system. It uses two commercial software packages: ProcessBook® from OSI Software for displaying plant information stored in a data historian; and FIX® from Intellution, which provides the automated monitoring, alarming and scheduling capabilities using its point database. Both software packages have a rich development environment for customisation to suit the user's needs. FIX and ProcessBook are able to read data from PI servers as well as from ODBC-compliant databases. Thus, ChemAND can receive plant data in a variety of electronic formats, e.g., ASCII text file, Microsoft® Access database, Microsoft® Excel spreadsheet, etc.

If ChemAND has electronic access to historical plant data (on the plant's own HDS), much greater functionality can be achieved. For example, current chemistry behaviour can be compared to past events and new analysis results compared with previous analyses to validate grab sample data. If no data historian exists, AECL can build one under separate contract and populate the database with the plant's historical data.

At Gentilly-2, plant personnel have developed an indigenous HDS called the STDE (Système de Traitment de Données d' Exploitation). Installation of ChemAND at Gentilly-2 for the field trial required some on-site work to set up the data extractions from STDE and to make the appropriate changes to file formats. STDE generates text files containing rows of time-stamped data collected from on-line sensors and laboratory samples (grab samples). The data are converted into a suitable format for importing into a Microsoft Access database, which is then read by ProcessBook and FIX. The scheme is shown in Figure 2.

Most of the user interface and display navigation takes place using ProcessBook. ProcessBook displays the historical trends. Any additional display information, e.g., alarms, alarm limits, engineering units, and engineering range, is retrieved from the FIX point database. The point database, which defines sampled parameters, is custom-installed at each plant. Users can easily modify graph scales, alarm limits, and units.

ChemAND is fully compatible with Microsoft® Office products, such as Word, Excel and Power Point. This feature enables the user to easily cut and paste graphs and tables from ChemAND for reports and presentations. Operators can easily e-mail a snapshot of current plant conditions to other interested parties. Alternatively, ChemAND can be installed on a server with read-only access so that it is available to a number of plant users.

4.3. ChemAND USE

ChemAND is designed from the users' point of view, mindful of conditions and operating constraints in operating plants. Our goals are to:

- enhance accessibility to chemistry information,
- facilitate the sharing of that information, and,
- promote the use of information in the timely response to events and in the management of equipment health and lifetime.

Upon opening ChemAND, the user sees the dialog screen shown in Figure 3. ChemAND contains a number of 'workbooks' (*.piw files), each one corresponding one of the systems monitored. Opening a particular workbook, for example "Monitor Steam Cycle (BOP) Chemistry" opens the Steam Cycle (BOP) page shown in Figure 4. From this page, one can navigate to the static, trending, and modelling portions of ChemAND associated with the Steam Cycle. Workbooks for other systems are organized in a similar fashion.

5.4. ChemAND STATIC FEATURES

Several 'static' features are illustrated in Figure 4. The

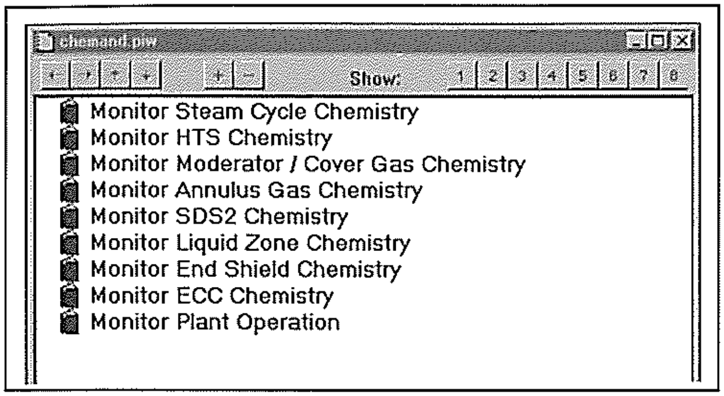


Figure 3 ChemAND Main Dialog Screen.

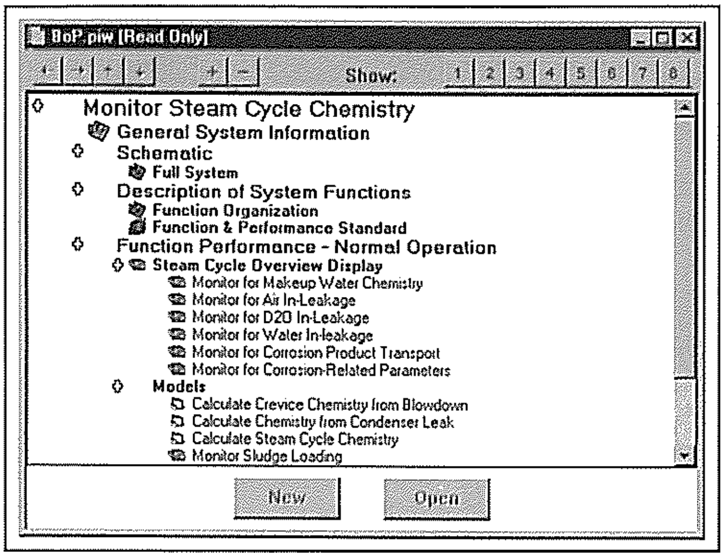


Figure 4. Steam Cycle Workbook.

upper lines point to a schematic of the system, as well as information on the functional decomposition of the steam cycle (BOP)[3].

Opening the 'Function and Performance Standards' sheet in Figure 4 opens an MS Word document containing data on particular chemistry parameters, e.g., their 'tagnames' in the database, sampling frequency, sampling and analysis procedures, and operating limits. This information is a synopsis of the plant's chemistry operating manual. It must be recognized that, more often than not, problems will occur outside of normal working hours when plant chemists and other specialists may not be readily available. It was felt that the inclusion of this synopsis from the plant chemistry operating manual could help operations personnel determine the short-term response to a chemistry excursion. For example, a decision could be made whether to tolerate a small condenser leak until morning or isolate it immediately using personnel called in for the occasion.

6.5. ChemAND Trending and Alarm Features

Displays of the chemistry parameters that are monitored in each system are organised on separate sheets of the workbook, according to their function. For example, all of the chemistry parameters that are monitored to alert the operator to the onset of a condenser leak are displayed on one sheet labelled "Monitor for Water In-leakage" in the Steam Cycle (BOP) workbook (see Figure 4). Similarly, chemistry parameters that measure the quality of water from the water treatment plant are organised onto a sheet labelled "Monitor for Makeup Water Chemistry". The chemistry parameters

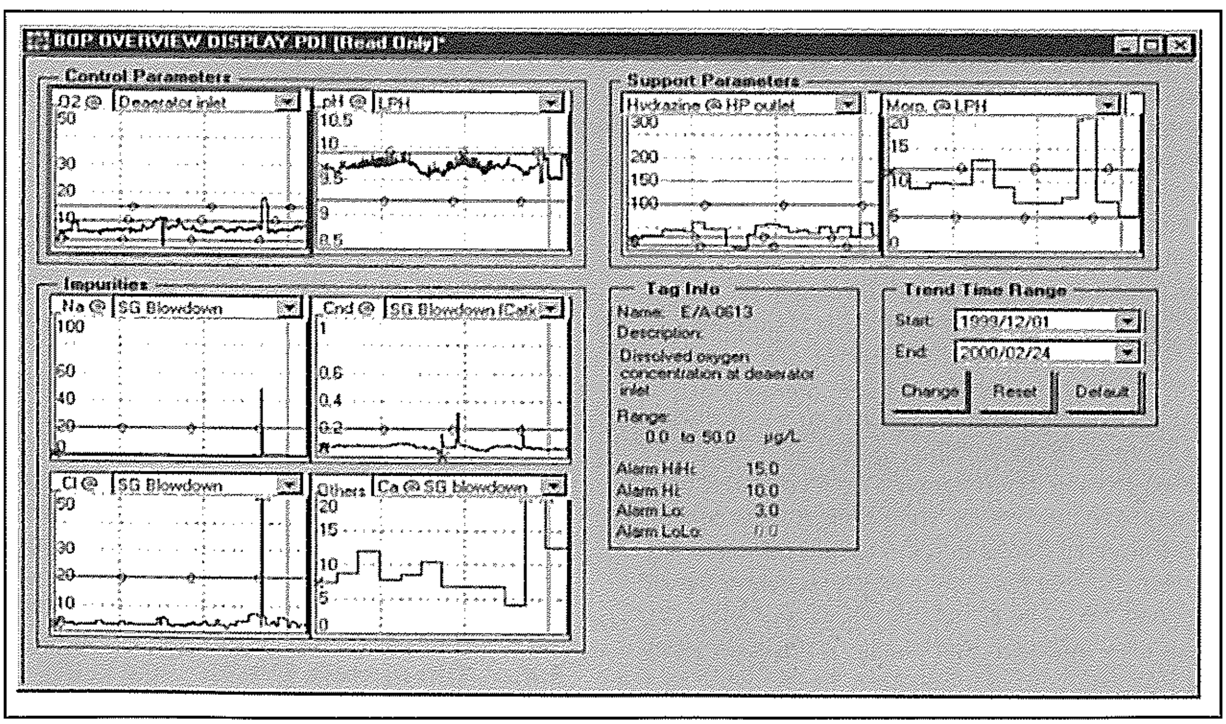


Figure 5. Steam Cycle Overview Display

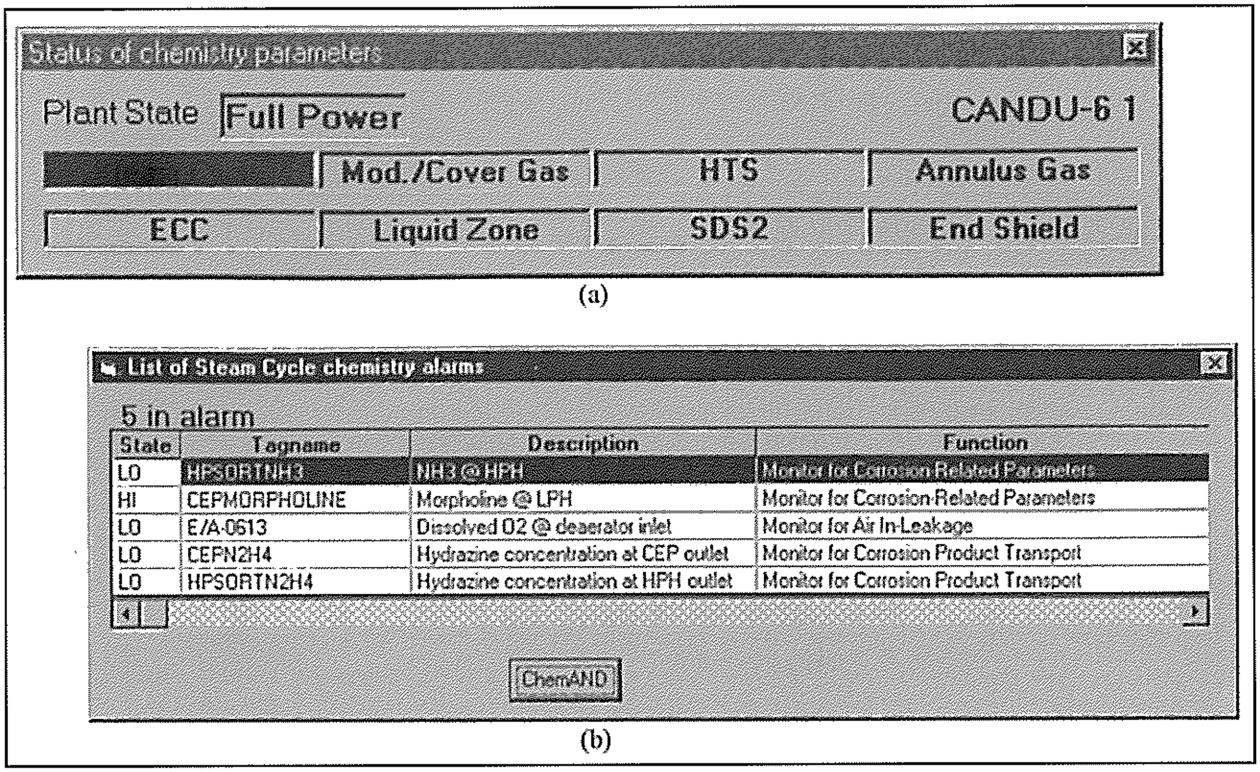


Figure 6. Alarm panel showing; a) an alarm in the steam cycle, together with the list of chemistry parameters that are out-of-spec, and b) the location of the alarm in the steam-cycle.

monitored in other systems are organised in the same way. Thus, the HTS workbook contains a sheet labelled "Monitor for Corrosion Control", and the annulus gas workbook contains a sheet labelled "Monitor for Air Ingress".

Plant operators need to monitor not only the concentrations of impurities that have leaked into the system, but also the concentrations of chemicals that are added to control the system chemistry. Displays for these parameters, together with the concentrations of key impurities that must be monitored very closely, have been collected together into an overview sheet. An example of the overview sheet created for the Steam Cycle (BOP) workbook is shown in Figure 5.

The support parameters are chemicals that are added to control system chemistry. In the steam cycle, an amine is added to adjust the pH, whereas hydrazine is normally added to scavenge oxygen. CANDU ® plants generally add morpholine to control pH in the steam cycle. Because ammonia (NH3) is a decomposition product of both morpholine and hydrazine, it will be present in the steam cycle as well. Two displays have been created for the support parameters. Figure 5 shows trends for the concentrations of hydrazine and morpholine at the high-pressure (HP) and low-pressure (LP) heater outlet, respectively. By using the drop-down list menu, the user can select trends for other support parameters at locations of interest in the steam cycle. The parameters to be controlled are pH and oxygen, and are labelled 'control parameters' in Figure 5. The user can select trends for the concentrations of 'control parameters' at locations other than those shown in Figure 5 by using the drop-down list menu. Displays for the support and control parameters, together with graphs showing the concentrations of key impurities introduced to the steam cycle from either condenser leaks or from the water treatment plant, give the plant chemist a useful overview of the chemistry throughout the steam cycle. The "trend time range" feature allows the user to define the time range of interest for the displays. This feature is available on all the display sheets in ChemAND, and provides flexibility in reporting on important chemistry trends.

For chemistry performance monitoring the first line of surveillance is ChemAND's 'alarm panel', which is illustrated in Figure 6 (a). The 'alarm panel' interrogates the database for the latest values, flags parameters that are "out-of-spec", and points to appropriate displays to diagnose the problem. Specifically, when a parameter in one of the plant systems monitored by ChemAND strays out of specification the appropriate system field in the 'alarm panel' changes to red to indicate the system that has a problem. Figure 6 (a) shows that at least one chemistry parameter in the steam-cycle (BOP) is out of specification. Clicking the red field displays a list of chemistry parameters that are out of specification in the steam cycle, as shown in Figure 6 (b). Clicking the 'ChemAND' button below the list will display the 'function-based' display containing the parameter in alarm, along with related parameters that are symptomatic of a particular problem. For example, for the alarm on low oxygen at the deaerator inlet, the appropriate 'function-based' display is 'monitor

GENERAL news

Licences and Agreement for Bruce A and B

On May 9, 2001, the Canadian Nuclear Safety Commission announced that it had issued two power reactor operating licences for the Bruce A and Bruce B Nuclear Generating Stations, to Bruce Power Inc.

The Bruce A and B nuclear generating stations are part of the Bruce Nuclear Power Development site on Lake Huron between the towns of Kincardine and Port Elgin. The site also contains two waste management facilities, a non-operational heavy water plant and the demonstration Douglas Point power reactor, none of which are affected by this licensing decision.

Bruce B consists of four 915 megawatt CANDU reactors which came into service between 1984 and 1987. Bruce A, which consists of four 904 megawatt CANDU reactors that came into service between 1977 and 1979, was shut down by OPG on October 1, 1998 as part of their Nuclear Asset Optimization Plan (NAOP). Under the current Bruce A licence, the units must remain in a guaranteed shutdown state. Bruce Power Inc. is not applying to restart the Bruce A units and any proposal to restart Bruce A would require approval of the CNSC following a public hearing.

Bruce Power Inc. is the general partner of Bruce Power Limited Partnership. Bruce Power Inc. is owned by British Energy (Canada) Limited (85%) and Cameco Corporation (15%). The limited partners of Bruce Power Limited Partnerhip are British Energy, Cameco Corporation and two Bruce employee organizations, the Power Workers' Union and the Society of Energy Professionals.

The CNSC held public hearings on February 8, 2001 in Ottawa and April 19, 2001 in Kincardine, Ontario.

The licences are valid from midnight on the day of the closing date as that term is defined in the Master Agreement dated July 11, 2000 between Ontario Power Generation Inc., Bruce Power L.P., and British Energy plc, and will expire on October 31, 2003. The licences require Bruce Power to report quarterly on the status of the letters of financial guaranty.

Subsequently, on May 14, Bruce Power and Ontario Power Generation announced the signing of the agreement whereby Bruce Power will lease the eight reactors to 2018 with an option for a further 25 years.

Bruce Power will be the first non-government owned operator of nuclear reactors in Canada.

Formal Bid For Iter in Canada

On June 7, 2001, in Moscow, Canada's Ambassador to Russia, Rod Irwin,

Officially launched Canada's bid for Iter, the $12 billion fusion energy research and development centre. The presentation to delegations from Russia, Japan, the European Union and the United States was made in the Presidential Hall of the Russian Academy of Sciences.

Ambassador Irwin said: "It is with the greatest pleasure that I now, on behalf of the Government of Canada, hereby formally announce Canada's offer of our Clarington site, located just east of Toronto on the northern shore of Lake Ontario as the location for the implementation of Iter in Canada."

Iter is an international fusion energy research and development centre, planned by a unique international collaborative effort with participation from Russia, the European Union, Japan and Canada. The goal of this centre is to develop fusion energy as a safe, clean and sustainable energy source for our planet. The Iter project will be the second largest research and development project in the world after the International Space Station. In addition to Canada, other Iter Party governments may also compete to host the project.

Dr. Peter Barnard, Chairman and CEO of Iter Canada, said, "With the support of the Government of Canada, the endorsement we have received from the Government of Ontario, and the continuing commitment of our private sector, labour, university and local community members, we believe Iter Canada is in a very strong position to win this project for our country. As host of the Iter project, Canada will become a world centre of excellence for research and development in the high tech energy field. Iter will be the largest "brain gain" in Canadian project history"

OPG Sponsors Nuclear Engineering at Five Universities

In May, Ontario Power Generation announced that it has committed $5 million towards the support of engineering programs at five Ontario universities, Queen's, Toronto, McMaster, Waterloo and Western, in support of education and research in nuclear engineering. The funds will create five Research Chairs and sponsor up to 30 students in Master level programs.

In addition, OPG has committed $750,000 to an NSERC research chair at Western in nuclear fuel waste research, and $105,000 for Master degree nuclear engineering scholarships at McMaster.

In making the grants, OPG President and CEO Ron Osborne said he hoped the network would grow to include other Canadian universities and to allow other Canadian nuclear industries to participate. The express purpose of the program is to maintain nuclear technology and provide a supply of qualified nuclear scientists and engineers to meet future nuclear industry needs.

Jeffrey becomes chairman of British Energy

Robin Jeffrey, president of Bruce Power, has been named as executive chairman of its parent company British Energy. The move was facilitated by the early completion of the leasing deal for the Bruce A and B nuclear power stations. Jeffrey will remain president of Bruce Power for the immediate future.

Changes at AECL

In late April 2001 Robert Van Adel, President & Chief Executive Officer of Atomic Energy of Canada Limited announced changes in the company's organization. The company will have two major units each with a senior vice president.

Gary Kugler is Senior Vice President, Nuclear Products and Services (NPS), responsible for business development, proposals, and products and services delivery.

David Torgerson is Senior Vice President Technology, to be "custodian" of AECL's nuclear technology and obligations. In partnership with NPS, he will develop new products to meet customer demand, provide related R&D, ensure the safety and quality of all our products and services and deliver the requisite support facilities.

Nuclear Products and Services will include Marketing and Sales, Cost Engineering, Technical Resources and certain engineering functions.

Compliance and waste management activities will move from Strategic Development to Technology and the facilities and nuclear operations functions previously performed within Human Resources and Administration will transfer to Technology.

A Risk Review Panel, a Business and Product Development Review Panel and an Operations Leadership Team to perform cross-functional and operations related activities will be created. These committees will be comprised of executives and senior experts from across the company.

In light of these changes Bill Hancox has elected to retire and Doug Hink will also be leaving us to pursue new challenges.

Operating Licence for Canadian Light Source

On May 30, 2001, the Canadian Nuclear Safety Commission announced the issuance of a Particle Accelerator Operating Licence to Canadian Light Source Incorporated, effective May 28, 2001, for a term of five years.

The facility will be operated by the licensee, Canadian Light Source Inc., but ownership of the facility is retained by the University of Saskatchewan. Construction of the $170 million facility began in June 1999. It is associated with the Saskatchewan Accelerator Laboratory on the campus of the University of Saskatchewan

The Record of Proceedings, including the Reasons for Decisions, will be available on the CNSC web site at www.nuclearsafety.gc.ca or by contacting the CNSC.

The Canadian Light Source is a "third generation synchrotron" designed to produce large amounts of light. Synchrotron light is used for research in a number of disciplines, from physics and geology to biology and chemistry but most synchrotron light research around the world is on material science.

New head of COGEMA Resources

On June 1 it was announced that Tim Gitzel will be appointed as President and Chief Executive Officer of COGEMA Resources effective September 1, 2001 Mr. Gitzel is currently senior vice-president and corporate counsel. He has been with the company since 1993 but had an earlier experience as a summer employee at the Cluff Lake mine. He will replace Arnaud de Bourayne who will be returning to France to become head of COGEMA's Enrichment Business Unit and chairman of EURODIF.

COGEMA Resources operates mining and milling facilities at Cluff Lake in northern Saskatchewan, is operator and majority owner of the McLean and Midwest uranium projects, and part owner of the Cigar Lake, McArthur River and Key Lake uranium mines.

(see also p. 48)

Winter Seminar

The annual *Nuclear Industry Winter Seminar* for 2001, held in Ottawa, March 26 and 27, drew more representatives from government than any over the past few years.

This yearly event, sponsored by the Canadian Nuclear Association and the Canadian Nuclear Society, features overview reports on various aspects of the Canadian nuclear program by senior representatives. As usual it began with a social evening, held this year in the West Block of the Parliament Buildings, with **Ralph Goodale**, Minister of Natural Resources as the guest speaker.

Goodale noted the major challenges he saw facing the nuclear industry: building public acceptance, increasing public awareness of the benefits of nuclear science and technology, and solving the waste problem.

The very full agenda on March 27 was adjusted from that planned to accommodate travel plans of some of the speakers. As a result the first set of talks were focussed on Climate Change, the Kyoto Protocol and CoP6, with presentations by **David Drake** of the Department of Foreign Affairs and International Trade, and **Douglas Russell**, president of Global Change Strategies Inc. Drake noted what he called the "cultural gap" between the representatives of the European Union and those from the USA at the 6th Conference of the Parties (CoP6). The talks were never close to agreement, he said. Consequently, the CoP6 discussions will resume in July. Canada, he said, remains committed to the Kyoto Protocol (to reduce "greenhouse gas" emissions) but insists that "sinks" and emission trading mechanisms are essential. Russell amplified on these views and, noting the argument about nuclear, contended that all technologies must be included.

After the morning break the Seminar returned to its program with a talk by **Robin Jeffries**, president of Bruce Power and chairman-designate of British Energy Plc. on "Nuclear Energy in a Deregulated Electricity Market". Noting the problems in the USA, Jeffries stated that Ontario was not California and that British Energy had considerable experience with an open market for electricity.

Peter Barnard, chairman of ITER Canada, presented an intricate electronic presentation with video clips and computer-drawn illustrations of the proposed ITER project at the site beside the Darlington nuclear power station.

The importance of international standards and consistent regulations for the transportation of nuclear materials was part of the message of **Lorne Green**, secretary general of the World Nuclear Transport Institute. His institute, he said, is able to transcend the competitive pressures between individual companies in discussions with regulators and international organizations.

Closing the morning session, **Linda Keen**, the newly appointed president of the Canadian Nuclear Safety Commission, outlined the directions she hoped to take the Commission over her three-year appointment. Although she is both CEO of the Commission staff and chair of the Commission, she intends to have a clearer distinction between the two groups. Here aim, she said, is to make the CNSC one of the best regulators in the world. She emphasized the need for a clearly articulated "safety culture" by all organizations in the nuclear industry.

Luncheon speaker, **Joe Colvin**, president of the Nuclear Energy Institute in the USA, gave a very "upbeat" picture of nuclear opportunities in that country. There is now stability in the regulatory system, improved operation of nuclear plants, decreased production costs, and growing public acceptance. He noted that the share price of nuclear plant companies had soared in recent months. As well as licence extensions, there is increased talk of new nuclear plants.

Bernard Michel, chairman of Cameco Corporation referred critically to the situation in California before outlining the uranium situation. He commented that Canadian uranium reserves have an energy equivalent to 25 billion barrels of oil. The current price for uranium is too low to attract investment in new mines, he noted, even though the price of uranium makes up only about 5% of the price of electricity from a nuclear power plant.

The results of recent opinion polls were outlined by **David Herle** of Earnscliffe Research and Communications. Only 40% of Canadians nationally support the use of nuclear energy to generate electricity, although in Ontario and Saskatchewan there was a majority in favour. **Heather Douglas** of AECL noted that the industry was considering an advertising program to increase the acceptance of nuclear power. Continued good performance by existing plants was essential, she said, if public confidence is to be improved.

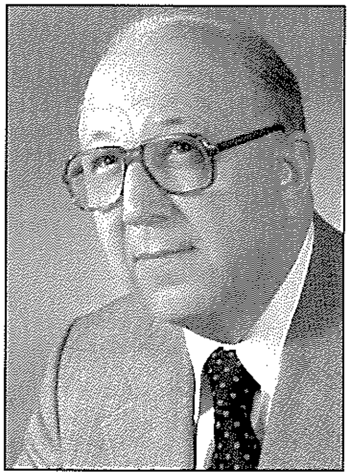
Rod White, vice president of NB Power, summarized the extensive studies underway to determine whether or not to refurbish the Point Lepreau plant. A decision will be made in early 2002.

Now that the environmental assessment for the re-start of Pickering A has been accepted, Ontario Power Generation president **Ron Osborne** said they are proceeding with a $1.3 billion program to overhaul and upgrade the station. Pickering 4 will be the first unit restarted, scheduled for early 2002.

Paul Koenderman, president of Babcock & Wilcox Canada, gave a presentation on the success his company was enjoying in replacing steam generators in US plants.

The afternoon closed with a short talk by **David Schier**, president of the Canadian Nuclear Workers Council in which he emphasized the support of his members for the renewed nuclear program.

Most of those attending appeared appreciative of the many interesting presentations but some complained of "information overload", with just too much squeezed into one day.



John S. Foster

John Stanton Foster, a major figure in the Canadian nuclear program, died March 26, 2001 at the age of 79.

John Foster was born in Nova Scotia on June 14, 1921. After graduation from Dalhousie University and the then Nova Scotia Technical College with a degree in mechanical engineering he served with the Canadian navy from 1942 to 1945. He returned to Nova Scotia Tech and obtained an electrical engineering degree in 1946.

The next eight years he worked at Montreal Engineering on thermal power plants in Canada and South America. During that time he was one of two independent consultants brought in by Atomic Energy of Canada Limited in 1953 to review the control system for the NRX reactor which had been redesigned after the 1952 accident. That led to his being chosen by Harold Smith to become a member of the nuclear power study group. That group's report was the basis for the decision to build the Nuclear Power Demonstration, Canada's first nuclear power plant.

When Canadian General Electric was awarded the contract to design and build NPD in 1955, John Foster became design manager. In 1958 AECL created the Power Projects division in Toronto and John was appointed general manager and, in 1966, with the expansion of the division, vice-president. In that role he oversaw the design of the first full scale nuclear power plant, Douglas Point, and, subsequently, Pickering A, Bruce A, Gentilly 1 and 2, Point Lepreau, Wolsong 1, Cernavoda 1, Embalse. His team was also involved in the Bruce heavy water plant and the high voltage DC transmission line in Manitoba.

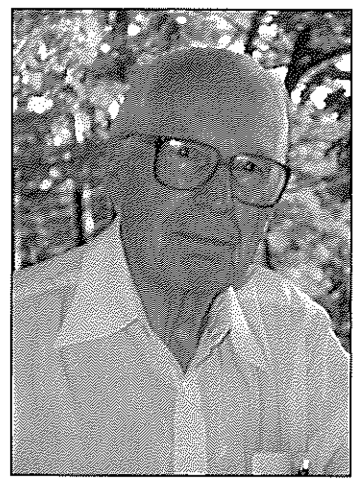
John was appointed president of AECL in 1974, serving until 1977. Thereafter he turned his attention to international matters eventually being appointed president of the World Energy Council.

In recognition of his contributions John received many honours. He was a Fellow of the Royal Society of Canada and of the Canadian Academy of Engineering. Both Carleton University and Nova Scotia Technical College granted him honorary doctors degrees. The Canadian Nuclear Society awarded him the W. B. Lewis medal, the Professional Engineers of Ontario gave him their Gold Medal and the Engineering Institute of Canada presented him with their Julian Smith Medal. The American Nuclear Society named him as a Nuclear Pioneer. He was on the Board of Directors of the Canadian Nuclear Association for many years and remained as an honorary member until his death. John was also a charter member of the Canadian Nuclear Society and an active supporter over the years.

His memorial service on April 4 was attended by a large number of the early members of the Canadian nuclear program, many of whom had worked with John. In his eulogy, Lorne McConnell, former vice-president of Ontario Hydro and long-time colleague and friend of John Foster, commented that John was a gentle gentleman, humble, honest and hardworking. Lorne added that John provided the inspiration for everyone to effectively contribute to the task at hand. In closing Lorne stated that he believed John Foster was one of the most competent Canadian engineers in the past century.

As Lorne said in closing, John will be missed.

George Howey



Another pioneer of the Canadian nuclear power program, George Howey, a member of the first operating team of NPD and a founding member of the Canadian Nuclear Society, died in Deep River, Ontario, on May 2, 2001 after an extended illness, at the age of 84.

George was born in British Columbia and obtained a B.A.Sc. from UBC in 1949 and an M.A.Sc in 1951. After graduation he worked for three years as production supervisor with Dominion Tar and Chemical Company in Toronto. Then he joined Atomic Energy of Canada Limited at the Chalk River Laboratories becoming a shift supervisor in the NRX reactor.

In 19547 he joined Ontario Hydro as one of the initial operations team to commission and then operate NPD, Canada's first nuclear power station. In 1964 he was appointed head of the nuclear training and recruitment program and oversaw the hiring and development of the large number of operations personnel engaged by Ontario Hydro over most of the next two decades until his retirement in 1982.

He was awarded the Outstanding Achievement Award by the Canadian Nuclear Association in 1992. In part the citation read:

"George Howey was responsible for training an entire generation of CANDU operators. He began by making his own contribution to the design and commissioning of the Nuclear Power Demonstration plant at Rolphton from 1957 to 1962. He then became manager of Ontario Hydro's Nuclear Training Program and established the first CANDU Nuclear Training Centre at Rolphton in 1962. The Centre provided the basic training for all of Ontario Hydro's nuclear operations staff until 1984."

"Later, George was the driving force in establishing training centres at Pickering and Bruce. He was instrumental in developing the concept of full-scope simulators."

George was one of the group that worked for the establishment of the Canadian Nuclear Society and served as its first elected president for two years, 1980 -1982. He remained a strong support of the CNS and was very active with the Chalk River Branch.

George R. Howey Memorial

The University of British Columbia has established, on behalf of George's wife Beatrice and family, a scholarship called the "George R. Howey Award in Chemical Engineering" to be presented annually to the top third-year student in chemical engineering at UBC.

Donations can be made to:

Dean Michael Isaacson
Faculty of Applied Science
University of British Columbia
Vancouver, B.C. V6T 1Z4

Details are on the CNS Web site < www.cns-snc.ca >

Charles Grinyer

It is likely that few in the Canadian nuclear program today will remember him but Charles Albert Grinyer was a vice-president of Atomic Energy of Canada Limited in 1959 -1960, then manger of the Nuclear Power Demonstration (NPD) from 1960 to 1962 and a member of the Board of Directors of AECL from 1962 to 1965.

Charles Grinyer was born in Kent, England in 1903 and died in Shelburne, Ontario on March 10, 2001 at the age of 98.

He spent most of his professional career in the aircraft field, first with Bristol Aircraft in the UK and then with the Orenda Engines division of A.V. Roe Canada Ltd, the designers and builders of the Arrow. He was appointed vice president, engineering, at Orenda in 1955 and oversaw the development of the Iroquois engine. After the Canadian government abruptly terminated the Arrow and Iroquois projects in February 1959 he considered several offers to move to the USA before joining AECL.

Arthur Marko

Dr. Arthur M. Marko, former director of the Health Sciences Division of Atomic Energy of Canada Limited, died in Deep River, Ontario on March 5, 2001.

Dr. Marko was born in Saskatchewan in 1925. He attended the University of Saskatchewan and then went on to obtain an M.D. from the University of Toronto in 1949 and a Ph.D. in biochemistry in 1952. He pursued post-graduate research at the National Institute for Medical Research in London, England from 1952 to 1954.

The following year he joined the staff of the University of Saskatchewan. Six years later, in 1961, he joined AECL at the Chalk River Laboratories as assistant director of the then Biology and Health Physics Division. He was appointed director of that division in 1979 and then director of the transformed group, the Health Sciences Division from 1986 to his retirement in 1989.

Art played a leading role as one of the founding members of the Canadian Radiation Protection Association and the International Radiation Protection Association. The CRPA awarded him their Achievement Award in 1989 and the Founders Award in 1991. IRPA presented him with an Outstanding Service Award in 1992. He served for several years as Canada's representative on the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEASR).

The Atomic Energy Control Board (now Canadian Nuclear Safety Commission) appointed him to their Advisory Committee on Radiological Protection in 1979, made him vice-chairman in 1989 and chairman in 1995, a position he filled until 1999.

Ray Silver

Ray Silver was not an engineer or scientist but in his role as a writer and reporter he was one of Canada's staunchest supporter of our nuclear program. Ray died in Scarborough, Ontario of a massive stroke on April 15, 2001 at the age of 81.

Ray began his journalism career as a reporter for the Windsor Star prior to World War II. During that conflict he flew with Bomber Command and was shot down over Holland. He continued his reporting with the Toronto Star, and the Globe & Mail. Later he edited The Etobicoke Press, the Canadian Atomic Newsletter, and the Journal of College of General Practice, and wrote articles for Maclean's and business publications. He also had his own PR firm for a quarter century.

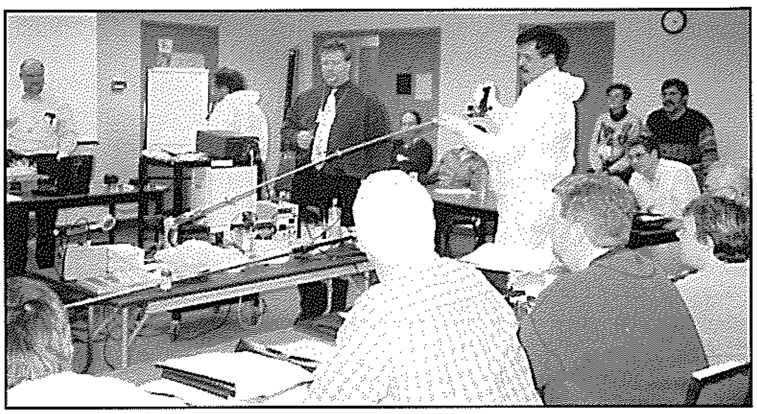
He began writing about Canadian nuclear science and technology in 1952 and was the Canadian correspondent for Nucleonics Week for over two decades. From 1978 until his retirement last August (2000) Ray was a member of the Ontario legislative press gallery for McGraw-Hill energy publications, the publishers of Nucleonics Week. He reported on the 1986 Chernobyl information sessions at the International Atomic Energy Agency for Canadian Press. Subsequently he authored a book about the consequences of that accident entitled "Fallout from Chernobyl" (1987). Later he wrote another book, this time about his wartime experiences, "The Last of the Gladiators" (1995).

Ray was presented an Outstanding Contribution Award by the Canadian Nuclear Association for his continued writing in support of the nuclear program. At his retirement in 2000 the Canadian Nuclear Society made him a lifetime member.

CNS news

A Course for High School Physics Teachers

High school physics teachers across Nova Scotia had the opportunity to attend a course entitled *"Science of Nuclear Energy and Radiation"*, February 23 - 25, 2001, at the Learning and Resources Centre in Halifax. The seminar was organized in partnership with the Nova Scotia Department of Education by Clair Ripley, Atlantic Coordinator of Education Programs for Atomic Energy of Canada Limited, and Mark McIntyre of Atlantic Nuclear Services and New Brunswick Chairman of the Canadian Nuclear Society.



Angus Duncan, a radiation survey specialist with SAIC Canada, demonstrates a handling tool as part of the lecture by Ed Waller (also of SAIC Canada) during the Course for High School Teachers held in Halifax, February, 2001.

Twenty-four teachers and administrators registered for the program which combined classroom lectures, laboratory sessions, field trips, workshops and discussions.

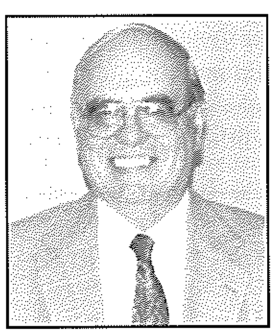
Session themes ranged from "Risk and Risk Assessment" by Health Physicist Dr. John Sutherland to "Nuclear Fuel Storage" by Jack Walsworth of Brunswick Nuclear. A highlight was Dr. Ed Waller's luncheon talk on Saturday, "A Walk in the Exclusion Zone: Thirteen Years After the Chornobyl 4 Accident.".

Dr. George Holzbecher conducted a tour of the Slowpoke Reactor at Dalhousie University on Friday and a field trip on Saturday consisted of a tour of the Nova Scotia Cancer Centre and Diagnostic Imaging Facilities at the Queen Elizabeth 11 Health Sciences Centre organized by Dr. Cupido Daniels. Dr. Daniels gave a talk on "X-Ray and MRI" followed by Dr. George Mawko's explanation of "Nuclear Medicine" and Drs. John Andrew and Jim Meng's update on "Cancer Care Nova Scotia".

On Saturday evening everyone was invited to a dinner at the Holiday Inn Select hosted by Clair Ripley and sponsored by AECL. A time of socializing was followed by dinner and an entertaining and informative talk by Dr. Douglas Boreham on the topic, "Low Doses of Radiation Versus Viagra - What's Up?"

From the President's Desk

by Ken Smith



As I write this brief report, we are rapidly approaching our **Annual Conference** for 2001. The Conference organizing committee has prepared an excellent program for the three plenary sessions, and about 90 technical papers have been received for fifteen technical sessions spread over the three days. In particular, I am most pleased with the financial support that has been received from industry, as without such support it would be difficult to organize an effective Conference. By the time you read this, the Conference will be history, so I would like to take this opportunity to thank everyone who had a role in making it a success.

The annual CNS/CNA **Student Conference** has been held every March for a number of years, but this year, for the first time, it is being held in conjunction with the Annual Conference. One of the advantages of this format is that the students will have a much better opportunity to meet with members of the industry. If this format proves to be successful, it is likely that the same approach will be adopted in future years.

Looking into the fall, planning is progressing on the **International Fuel Conference** in September, and a **2nd Climate Change Conference** in October. Looking further ahead to 2002, the arrangements for another **International Steam Generator and Heat Exchanger Conference** are well in hand. These are the major events for the next year, but other conferences, seminars, and courses will be fitted into the schedule. 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. Meanwhile, the work of the CNS Committees continues, and many of the Branches are maintaining an active program of local seminars. Some of these activities are mentioned elsewhere in this issue of the Bulletin. All of this requires considerable volunteer effort, and this contribution of time and effort is much appreciated.

Finally, for those readers of this Bulletin who may not be familiar with all of the activities of the CNS, I would like to draw your attention to the notes contained in the adjacent box entitled "What is the Canadian Nuclear Society". CNS membership is growing, but there is a lot more room to grow. Please introduce your colleagues to the CNS, and encourage them to join, as the CNS would like to be the Society for everyone with an interest or stake in Canadian nuclear science and technology.

What Is The Canadian Nuclear Society

For more than 20 years, the CNS has been **THE** organization open to all those involved in or interested in Canadian nuclear science and technology, for the benefit of humanity and the environment. The CNS is:

- fostering development and applications of nuclear technologies for peaceful uses;
- acting as a forum for exchanging/sharing information - to encourage education and to enhance the professional and technical capabilities of its members;
- serving the Canadian nuclear science community and industry and the public in the following ways:
  - organizes high quality conferences, general and specific, which provide excellent opportunities to network with colleagues and exchange technical information;
  - organizes technical courses on subjects of industry interest;
  - organizes many public seminars at its 12 branches on very interesting topics, allowing many more opportunities to learn and network;
  - sponsors or supports science fairs, scholarships, science camps and equipment for classrooms, through branch use of the CNS Education Fund;
  - sponsors or supports initiatives, such as the Teachers' Course on Nuclear Energy and Radiation, a Journalism Workshop on Scientific Reporting and AECL's Science for Educators Seminar, and the Deep River Science Academy;
  - publishes the quarterly CNS Bulletin, a combined technical journal and news magazine, which is distributed to members and selected others associated with the Canadian nuclear program;
  - presents awards to people, to recognize their significant achievements;
  - co-operates with a large number of nuclear and scientific sister societies in Canada and abroad;
  - communicates with government, the media and the public on nuclear issues;
  - maintains an Internet website that provides news and information on CNS events, posts job opportunities and members' resumes, and provides links to other informative nuclear sites.

Publications available

CNSC Draft Regulatory Standard for Operators

The Canadian Nuclear Safety Commission (CNSC) is issuing for public review and comment Draft Regulatory Standard *C-204, Certification of Persons Working at Nuclear Power Plants.*

The document describes the qualifications, the training, the examinations and the certifications that may be required of nuclear power plant personnel for positions referred to in a term or condition of their operating licence.

The draft regulatory standard references three other documents. Two of these are CNSC documents. They are entitled *Generic Station System Knowledge Objectives for Control Room Operators,* dated June 1998 and Operational Procedure PQAD-ST6(RO), Rev.2, *Simulator Based Examinations for Reactor Operators of Nuclear Power Plants* dated February 2001. Both are available from the CNSC on request.

The third document referenced in C-204 is called *Common Standard for Requalification Testing of Certified Staff at Canadian CANDU Nuclear Generating Stations.* This is a document being developed jointly by Canada's nuclear power plant licensees and it is not yet available.

The CNSC invites interested persons to assist in the further development of Draft Regulatory Standard C-204 by commenting in writing on the document's content and potential usefulness. Please respond by August 31, 2001. Direct your comments to the postal or e-mail address below, referencing file 1-8-8-204.

The CNSC will take the comments received on this document into account when developing it further. These comments will be subject to the provisions of the federal Access to Information Act.

Draft Regulatory Standard *C-204, Certification of Persons Working at Nuclear Power Plants,* can be viewed on the CNSC website (www.nuclearsafety.gc.ca). To order a printed copy of the document in English or French and to request copies of the draft CNSC documents referenced in C-204, please contact: Operations Assistant, Corporate Documents Section, Canadian Nuclear Safety Commission, P.O. Box 1046, Station B, 280 Slater Street, Ottawa, Ontario K1P 5S9 CANADA; Telephone: (613) 996-9505; Facsimile: (613) 995-5086; E-mail: reg@cnsc-ccsn.gc.ca

Publications available

CNSC Regulatory Policy

The Canadian Nuclear Safety Commission (CNSC) has released a new regulatory document, Regulatory *Policy P-211, Compliance.*

The new regulatory policy describes the basic principles and directives which will govern the establishment and conduct of the CNSC compliance program. This program is aimed at securing compliance by regulated persons with regulatory requirements made under the Nuclear Safety and Control Act. The document also describes how the CNSC will govern the implementation of the policy. It takes into account the comments received on the draft version of the policy issued for public consultation purposes in May 2000.

Regulatory Policy *P-211, Compliance,* is available in English or French on the CNSC website (www.nuclearsafety.gc.ca). A paper copy in either official language may be ordered from: Communications Division, Canadian Nuclear Safety Commission, P.O. Box 1046, Station B, 280 Slater Street, Ottawa, Ontario K1P 5S9 CANADA; Telephone: (613) 995-5894 or 1-800-668-5284 (Canada only); Facsimile: (613) 992-2915; E-mail: publications@cnsc-ccsn.gc.ca

Review too soft

The ethics of nuclear energy - and of its critics.

Don Wiles' review of *"Nuclear Wastes: Exploring the Ethical Dilemmas"* by Lois Wilson (CNS Bulletin, Vol.21, No.3, p.57, Nov. 2000) concludes that it is no "great contribution". This litotes underestimates how appalling the book is.

The book's title is grossly misleading - and the contents are more so. The word dilemma" means a choice between two unfavourable alternatives but Wilson presents only one side of the debate, and fails to admit that her default preference is unfavourable. If the book had been on "exploring" Canada, we would know of nothing west of Winnipeg. Similar twisting of the accepted meaning of words results in some of Wilson's unethical treatment of the subject.

The book's format is a chronological account of the hearings of a panel to review the concept for nuclear fuel waste management and disposal, interspersed with personal comments by the author. Wilson employs the technique of reporting only criticisms of the proposal, thereby implying her endorsement of these submissions but avoiding the responsibility for the errors in them. This may prevent Wilson having to defend individual statements but readers will have no difficulty concluding that her sympathies lie with those opposing the concept and nuclear energy in general.

Had the book been written by some unknown author it would simply be unethical for its bias. For someone in a position of respect and trust, a senator, a holder of the Order of Canada and a former moderator of the United Church of Canada, to have produced such a biased treatment in the name of ethics is contemptible. After Wilson spent eight years as a panel member, with every opportunity to educate herself on the issues at taxpayers' expense, and four years since then to draft her book, her inability or unwillingness to put forward for challenge her own convictions on the ethics of nuclear energy suggests that she is aware of the weakness of her position.

Detailed justification for my allegations can be found on my website, www.magma.ca/~jalrob/ , click on The Ethics of Nuclear Energy, then the Critique of Wilson's book.

Archie (J.A.L.) Robertson

American Booty

by Jeremy Whitlock

Alvin Weinberg may be about to go from "dreamer" status to "prophet". Over the past decade, in books, articles, speeches, and interviews, the former ORNL Director and Manhattan Project physicist has quietly foretold the coming of a Second Nuclear Era.

The First Era, so the Gospel of Weinberg goes, saw the birth and rapid commercialization of nuclear technology, decoupled almost entirely from popular culture, ending with the entombment of Chernobyl Unit 4 - and five decades of nuclear industrial paternalism along with it.

So began the Period of Adjustment that has been the last 15 years. The wilderness was wandered, the industry lost fat, and the reactors aged. Even as Global Warming entered the common vernacular, with nuclear power fingered as a cure (as early as 1983's NOVA episode on "The Climate Crisis"), nobody seriously saw a turnaround in sight.

Weinberg did not say how long this adjustment would last, but he did suggest it would end when the public embraced new passively safe reactor designs, built in droves to combat an inevitable energy crunch.

Few doubted this prophesy. Fewer, still, expected Weinberg to see the start of the Second Nuclear Era in his own lifetime. At 86, however, the prophet may be just about to enter the Promised Land with the rest of us.

The trick, it turns out, was not the Earth warming up, but Hell freezing over. Who would have thought that California, Land of Plenty, turbo-generator of the New Economy, would suffer rolling blackouts?

Nothing short of a sex scandal could have caught political attention quite as much. Toss in a Republican government itching to reconstruct national energy policy, an industry and a public both looking for solutions, and you've got the early makings of a Second Nuclear Era.

Of course the tide didn't turn overnight. The last five years have seen environmental bureaucrats around the world slowly building a consensus that nuclear power, former pariah, belongs on the table in Kyoto strategy planning.

Over the same period, hard-nosed financiers watched keenly as nuclear plants became hot commodities on the "previously-owned" market. Spot prices rose 1600 per cent, from Three Mile Island's 29 \$/KW in July 1998, to Nine Mile Point's 480 \$/KW announced in December 2000. One-third of American nuclear power plants have applied for life extensions. New designs (including that sexy newcomer, the PBMR) are about to be brought before the U.S. regulator.

Then, suddenly, the silicon heart of America skipped a beat, and Vice President Cheney got his signal to rally the charge on prime time television. Nuclear's back Jack, and dontchya look back no more.

As we know, nothing affects Canadian policy quite like American policy, and it wasn't long before Ontario Premier Mike Harris and OPG President Ron Osborne were openly talking about new CANDU reactors in Ontario. The industry did a double-take in May as Premier Harris labelled nuclear power "the number one green energy alternative", "practical, cost-effective", and "the safest, greenest electricity available", while Ron Osborne declared nuclear power to be an "inevitable source of the province's future energy supply".

Provincial energy supply is one thing; the most lucrative commodity market in the Western hemisphere is another. That's what electricity supply is evolving into, and that's certainly what British Energy has in mind as it assumes operation of the Bruce cash cows on Lake Huron.

Meanwhile, it would seem that Canada's traditional antinuclear sector has become disenfranchised in the nuclear renaissance. Content to stick with the Seventies' "No-Nukes" credo throughout the harvest years of the Eighties (when it didn't matter), and the tide-turning years of the Nineties (when it started to matter), they now find themselves somewhat out of the loop.

Part of the problem was an unspoken reliance on natural gas in many alternative energy proposals. The flagship promotions of conservation and renewable energy were shored up with nods to "clean" natural gas - and in practical terms the eggs were never anywhere but in that basket. Today the escalating cost of natural gas has left the alternative portfolio looking rather thin.

It's particularly humbling for Energy Probe, with its right-wing agenda of decentralization and privatization that should, rightfully, be basking in glorified fruition at this time. Instead, and quite ironically, nuclear power appears best-poised to succeed as Ontario prepares its plunge into a competitive electricity market.

This has the anti-nuclear front offices scrambling for words. Sierra Club sends letters to editors trashing CANDUs in comparison with American LWRs. Energy Probe flails even more awkwardly, trotting out the prototype Gentilly-1, as well as Chernobyl, and "too cheap to meter". The Toronto Star tries to spread falsehoods about leukemia and prostate cancer clusters near nuclear plants.

All good news. Realism was never a strong suit of the antinuclear establishment, and perhaps its time they regrouped. Their best strategy now would be to reach out to a broader constituency - the population of this continent finally realizing what energy shortage means, and looking for realistic answers.

At last the playing field is being levelled, and that's all we ever asked for.

2001

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

June 25 - 29

Research Reactors - Science and High Technolody
Dimitrougrad, Russia
Contact: Nuclear Society of Russia
Moscow
e-mail: agagarin@kiae.ru

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. 14 - 15

International Symposium on Nuclear Energy
Bucharest, Romania
Contact: Stefan Pall
ROMATOM
e-mail: spall@snn.rdsnet.ro
web: www.te.pubiro

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
or CNS office

Oct. 8 - 9

Power Generation and Sustainable Development
Liege, Belgium
Contact: A.I.M.
e-mail: ch.lacrosse@aim.skynet.be
web: www.conf_aim.skynet.be

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 5 - 8
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

?? (Fall)
Corrosion of Nuclear Reactor Core Components
Toronto, Ontario
Contact: CNS Office
Tel. 416-979-7620
e-mail: cns-snc@on.aibn.com

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Nuclear Fuel Waste Legislation Introduced

On April 25, 2001, the Minister of Natural Resources Canada, Ralph Goodale, introduced in the House of Commons Bill C-27, a proposed Nuclear Fuel Waste Act.

This proposed legislation follows the Canadian government's response in 1998 to the recommendations of the Environmental Assessment Panel on Nuclear Fuel Waste Management and Disposal Concept, also known as the Seaborn Panel after its chairman, Blair Seaborn.

The legislation will require nuclear utilities to form a waste management organization (WMO) as a separate legal entity. The WMO would then be required to report regularly to the Government and provide recommendations on the long-term management of nuclear fuel waste.

The nuclear utilities would also be required to establish a segregated trust fund to finance long-term fuel waste management activities. The government would retain a review and approval authority.

Officials of Ontario Power Generation, the largest nuclear utility, stated that they welcome the proposed legislation, as it will clarify the roles and responsibilities of all of the parties. OPG is expected to take the lead in the creation and operation of the required waste management organization.

More information is available from the Natural Resources Canada website: < www.nrcan.gc.ca >

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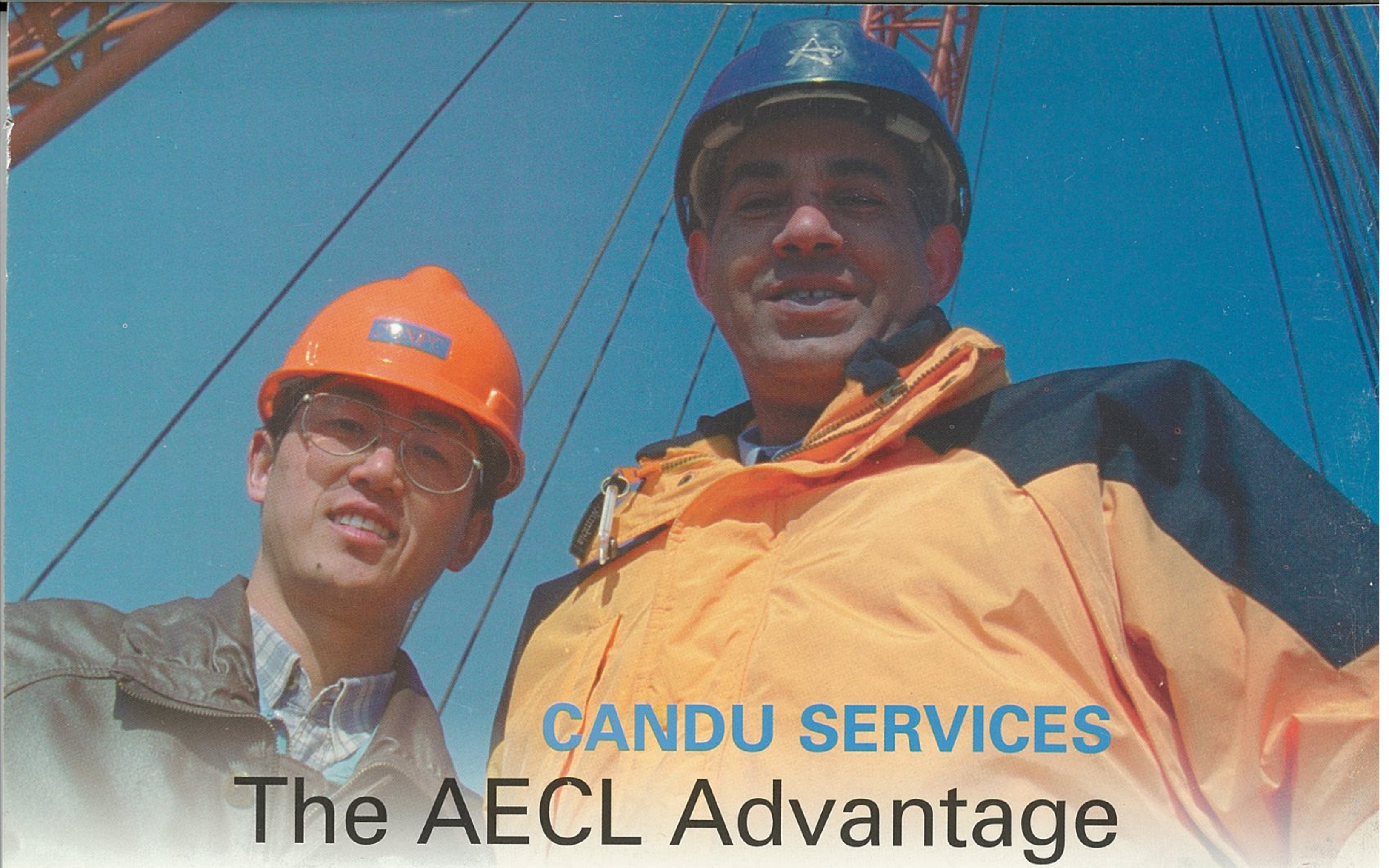
CNS WEB Page

For information on CNS activities and other links

http://www.cns-snc.ca



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