CANADIAN NUCLEAR SOCIETY

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DE LA SOCIÉTÉ NUCLÉAIRE CANADIENNE

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- A special edition focussing on waste management, decommissioning and restoration.

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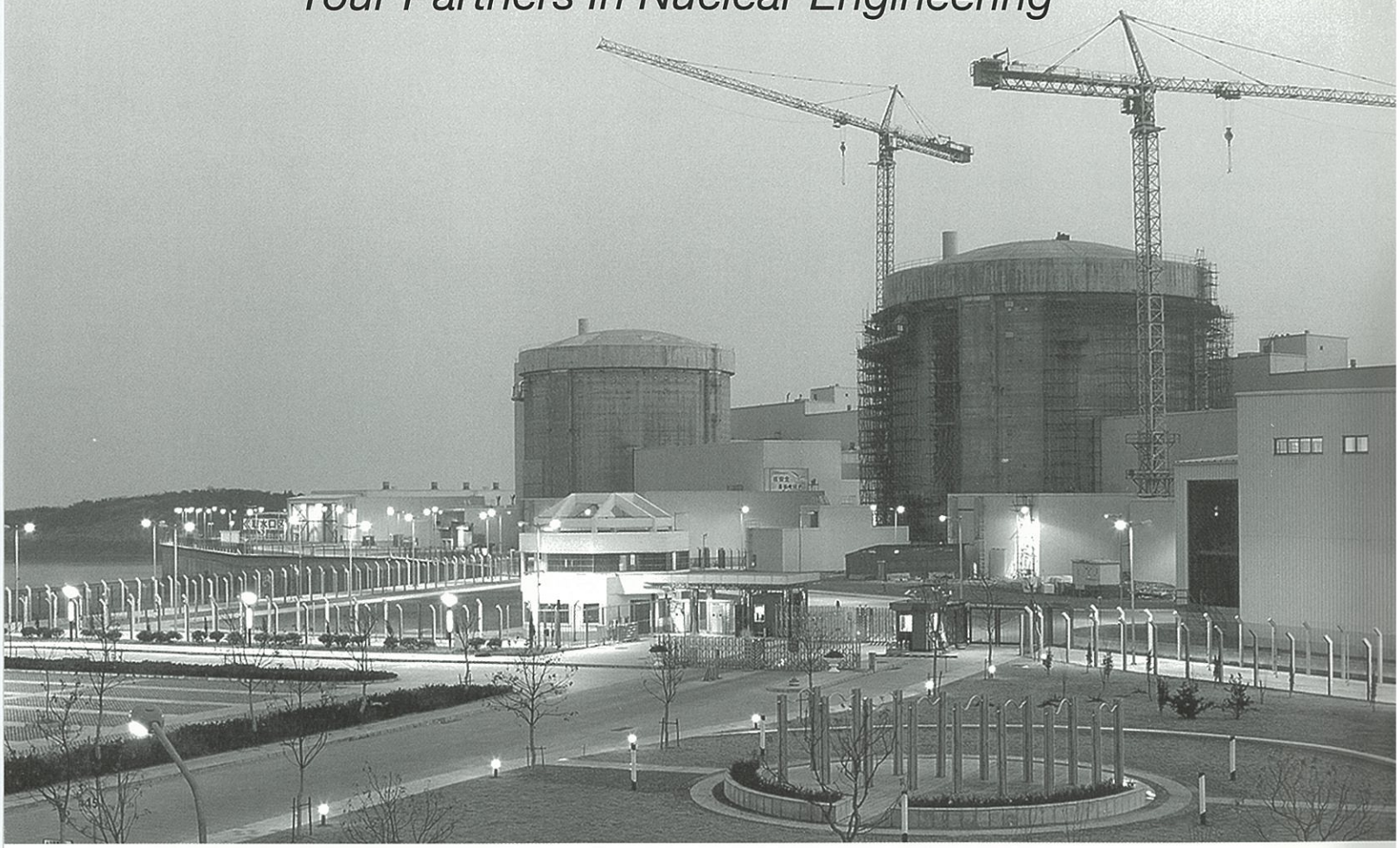

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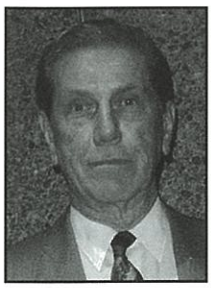
EDITORIAL

We must all speak out



Although this issue is focussed on waste management and related topics drawn from the CNS Waste Management Conference in May, these comments are being written immediately after the Annual Conference in June.

In keeping with CNS tradition both conferences were very well organized and run. Both were well attended, drawing similar numbers but from different constituencies. But there was a perceptual difference in mood. For those involved with waste management and associated issues there is now recognition of the need to actually do something. Decisions are being made to deal with the "legacy" waste at Chalk River and the contamination from early practices in Port Hope and other locations. And the Nuclear Waste Management Organization has actually come forward with a rational approach for long-term management of spent fuel.

At the Annual Conference delegates were met the first day with a front-page article in the Globe and Mail about China proceeding with PWR plants, a story from some months ago. To compound that, delegates heard of continued delays on critical decisions needed from governments for the refurbishment of Point Lepreau and Gentilly 2 and the procrastination by the Province of Ontario on an agreement necessary to support the extensive rehabilitation of Bruce 1 and 2 (despite the accepted need for more clean generation in the province). The frustration of both speakers and their audience was palpable.

It is generally accepted that at both the provincial and federal levels we have governments that constantly look for public opinion. Unfortunately, as studies and polls have shown, public attitudes are ephemeral, depending on the "news" people have just read or seen. And nuclear has been out of the news, except for some negative articles such as noted above, for some time. Further, as indicated by the federal government's Kyoto plan (which does not even mention nuclear) and reports coming from Ontario, the bureaucracy appears to have been captured by those with an anti-nuclear bias.

All real studies show that where hydro is not available nuclear is the only alternative to coal for the generation of base load electricity. This story must be conveyed to the public and politicians. The CNA plans a new public information program but all members of the nuclear community need to be speaking out, writing letters, and doing whatever else they can to carry the message, nuclear is needed.

IN THIS ISSUE

This issue is devoted almost entirely to "waste management" and associated topics and draws heavily on the recent CNS conference on *Waste Management, Decommissioning and Environmental Restoration for Canada's Nuclear Activities.*

We begin with a report on that very successful conference, titled simply **CNS Waste Management Conference.** That is followed by an article by Elizabeth Dowdeswell, president of the Nuclear Waste Management Organization, titled **Choosing a Way Forward,** which is an introduction to NWMO's draft study report with the organization's proposed recommendation to government. That paper was formally released about a week after the conference but Ms. Dowdeswell gave delegates a preview of it.

Then follows five papers chosen (with difficulty) from the 150 presented at the conference to provide some indication of the broad scope of topics discussed. They are:

- **Overview of AECL's Waste Management Operations at the Chalk River Laboratory**
- **Tailings Management Best Practice: A Case Study of the McClean Lake Jeb Tailings Management Facility**
- **Regulatory Review of Safety Assessments for Decommissioning Projects - an International Project**
- **Comparison of Risks from Deep Geological Disposal and Extended Storage Approaches to the Long-Term Management of Used Fuel**
- **Environmental Assessment of the Dismantling of 12 Russian Nuclear Submarines**

There is a short paper from the authors of a report to the Ontario government on its plans for dealing with a nuclear accident, entitled **Emergency Response to a Nuclear Power Reactor Accident.**

A personal reflection on attending a conference in Korea is given in the short note **ICAPP 2005.**

The section on **General News** includes our usual eclectic selection of items from various sources. That is accompanied with an **Obituary** for one of the founders of the Canadian Nuclear Society, **Phil Ross-Ross.**

CNS News provides information on happenings in the society and there is a page of **Publications** that may be of interest, followed by Jeremy Whitlock's special view on things in **Endpoint.**

Finally, the **Calendar** of events has been updated.

Please also note the advertisements. As well as providing some income to partially offset the cost of the Bulletin we believe they add interest and information.

Contents

~ Cover Photo ~

The almost idyllic scene in the photo on the cover is the present condition of what was the original open pit of the Cluff mine in northern Saskatchewan giving evidence of the restoration done by Canada's uranium mining companies.

Courtesy of Cogema Resources

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CNS provides Canadians interested in nuclear energy with a forum for technical discussion. For membership information, contact the CNS office, a member of the Council, or local branch executive. Membership fee for new members is $75 annually, $44.00 for retirees, free to qualified students.

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CNS Waste Management Conference

- large attendance reflects timeliness of event

What do you do when you hold a party and almost twice the expected number show up ? The organizers of the recent CNS Waste Management Conference handled this challenge expertly. They did know somewhat in advance that the number of attendees would exceed their planned target of 200 but, when late registrations swelled the number to close to 350, many last minute adjustments were necessary. However, except for standing room only at the opening plenary, 10 to a table at the first luncheon and some "togetherness" at the coffee breaks, it is likely few if any of those attending sensed any problem. It was just a great event.

Despite, or possibly because of, the scope implied by its unwieldy title, the recent Canadian Nuclear Society conference on: **Waste Management, Decommissioning and Environmental Restoration for Canada's Nuclear Activities,** attracted close to 350 delegates to the Crown Plaza Hotel in Ottawa, May 8 - 11, 2005. That number included representatives of eight countries and the International Atomic Energy Agency, even with the stated emphasis on Canadian activities.

The evening before the actual conference early registrants enjoyed a pleasant reception on the hotel's top floor, which provides an excellent view of the Ottawa River and the new War Museum. Those who arrived in the early afternoon could observe the opening ceremonies at that attractive building.

The conference proper began on the Monday morning with a plenary session featuring senior level speakers from the major organizations involved with the subject matter. Since the Ottawa political situation made it difficult for the Minister of Natural Resources, John Efford, to attend his opening address was given by **George Anderson,** deputy minister of NRCan.

Then followed **Tom Wallace,** deputy-general of the Electricity Branch at NRCan, (which includes the Nuclear Division and the Uranium and Radioactive Waste Division) who gave the presentation that was originally planned to be given by George Anderson. The talk was titled *"Radioactive Waste Management: Following Recent Progress, Some Challenges Ahead"*. The challenges, he stated, are: reducing uncertainties; creating effective decision-making processes; and, building and maintaining public confidence.

On uncertainties, he said that Canada has acquired a sound international reputation for science and technology in nuclear energy, including radioactive waste management.

Decision making in democratic countries is often difficult, he commented, but hard choices must be made. An important impending one will be the government's response to the report from the Nuclear Waste Management Organization (NWMO) later this year. The challenge will be: (1) to demonstrate a thorough understanding of all issues, and (2) to make transparent the reasoning.

Public confidence implies trust in the proponents and the government. He cited the proposed plan for a low and intermediate repository at the Bruce site as an example of winning confidence.

Wallace went on to review the several examples of "historic waste"; at Port Hope; at early uranium mine sites; and at the Chalk River Laboratories of Atomic Energy of Canada Limited (AECL). Work is proceeding or plans are being developed for each of these, he stated.

Finally, he mentioned Canada's significant role in the development of the international *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management,* and added that the Canadian report to the 2003 Review Meeting was very well received by the other parties to the Treaty.

Next, **Linda Keen,** president of the Canadian Nuclear Safety Commission (CNSC), spoke about *Regulatory Developments and Issues.* She began by noting that Canada's international obligations regarding safeguards and security apply to waste management. After commenting that there are serious concerns around the world about this issue she said she would not be addressing those issues.

Then she turned to expected issues over the next decade, beginning with a reference to the recent decision of the CNSC to issue a Waste Facility Operating Licence for the decommissioned Beaverlodge uranium mine in northern Saskatchewan. The question had arisen, "What should have been done differently, 30, 40, or 50 years ago?" "Over the next few years we will see serious decisions on large waste management and decommissioning projects that will place heavy demands on regulatory planning and oversight", she said.

Referring to the upcoming review meeting of the Joint Convention she noted the need for "integrated planning" and commented that industry must take the initiative. In closing, she emphasized that the Joint Convention provides an opportunity to benchmark ourselves against our international peers and demonstrate that Canada is "best in the class".

David Torgerson, senior vice-president, technology, at Atomic Energy of Canada Limited, spoke on *Successes and Challenges in Waste Management, Decommissioning and Environmental Restoration at AECL.*

He began by reviewing AECL's role in Canada's nuclear history, starting with its predecessor, the Montreal Laboratories set up in 1942. That led to a 60 year legacy

of facilities and waste. AECL, he noted, has received and managed all of the radioactive waste from hospitals and universities over the years. He went on to describe some of the facilities at AECL's Chalk River Laboratory and the new projects underway. *(See the paper by Norm MacDonald reprinted in this issue of the* CNS Bulletin.)

A major remediation project, Torgerson noted, is the Fuel Packaging and Storage project designed to retrieve and store "problematic legacy fuel" now in tile holes. Another activity is the Liquid Waste Transfer and Storage Project to put all of the liquid waste on site into one facility.

He went on to mention quickly: the decommissioning of the Whiteshell Laboratory and of a former Ontario Hydro laboratory in Toronto; the development of the MACSTOR dry storage for CANDU spent fuel; the work at the Underground Research Laboratory to prove out geologic disposal concepts; and the restorations underway at Port Hope, Ontario and Fort McMurray, Alberta. The latter was a trans-shipping point for early radium bearing ore from the Northwest Territories. Torgerson closed by emphasizing that AECL was dealing responsibly with the 60 years of "legacy" waste it has inherited.

After a short break, **Ken Nash,** vice president, Nuclear Waste Management, at Ontario Power Generation, spoke about relevant developments at OPG under the title *Making Progress in Nuclear Waste Management.*

He began by noting that Ontario Hydro (OPG's predecessor) had adopted, in 1995, a policy on responsibility for waste management. There followed the report from the Seaborn environmental panel and the successive Nuclear Fuel Waste Act. Since then OPG has increased its interim storage capacity; has demonstrated dry storage; has developed long-term plans for low and intermediate waste; and advanced the technical basis for a spent fuel repository.

On the financial side it has been estimated that the long-term cost for dealing with the spent fuel from current reactors in Canada will be about $22 billion ($8 billion present value). A segregated fund has been established which now has $6 billion with $450 million being added each year.

For the future, Nash said, we need to continue the safe operation of our current nuclear facilities; there needs to be government and regulatory leadership; research must continue, and all must be done with openness and transparency.

The last paper of the opening plenary session was by **Bob Pollock,** vice president, Cogema Resources. In his unavoidable absence the paper was given by Gerry Acott.

The presentation began with an overview of the uranium resources of northern Saskatchewan and then turned to the challenging mining methods that had been developed at the McArthur River Mine. Cogema has developed an extensive program for environmental protection that include the concept of temporary use of the land and extensive management of tailings and other wastes. As an example of restoration he showed photographs of Elliott Lake in northern Ontario where there is now a thriving retirement community and attractive environment.

Uranium mining in Canada has a long history, he said, and an excellent future. Waste management is being handled as an integral part of production. Canadian mining facilities are "state-of-the-art'. Several sites have been successfully decommissioned and restored. The Canadian uranium mining industry, he said, has achieved a high level of environmental protection in the past and will continue in the future, he said in closing.

The second (and last) plenary session was held on the Tuesday morning and focussed on *Long-Term Management of Used Fuel.*

The first speaker was **Hans Riotte,** division head, radiation protection and radioactive waste management at the OECD Nuclear Energy Agency who presented an *International Review of High-Level Waste Long-Term Management Plans.* With reference to the NEA's Waste Management Advisory Committee he outlined the development underway in several OECD countries for the disposal of high level radioactive waste. All are pursuing deep geologic methods, the differences being primarily in the nature of the geology. These have included Yucca Mountain in the USA, the French program in eastern France, those in Belgium and Switzerland and the depository under construction in Finland.

Next, **Gordon MacKerron,** chair of the Committee on Radioactive Waste Management in the UK, reviewed the planning underway in that country, which is still in a preliminary status.

The final speaker was **Elizabeth Dowdeswell,** president of the Nuclear Waste Management Organization, who gave a "sneak preview" of the draft report her organization released a week later. After much discussion and strong action to involve people across the country NWMO is proposing a phased program, called an Adaptive Phased Management Approach.

It consists of two components: a technical method; and a management system. A deep underground repository is seen as the end point, but the management system is phased and adaptive. A typical path might consist of phases. The first would last approximately 30 years. It would be a period of preparation and include the construction of a centralized facility. At the same time an underground research laboratory would be built and a research and development program pursued. *(See the paper* Choosing a Way Forward *in this issue of the* CNS Bulletin.).

Interspersed with the 150 technical papers presented there were three panel sessions: one on waste Classification; one on Waste Clearance and one on Social and Ethical Issues. The first resulted in a proposal be a representative of the Canadian Standards Association to pursue a standard for communication, reporting and planning. The second panel led to a much better understanding of what future regulations may look like and what the implications of the requirements could be.

A partial list of the technical sessions gives an insight into the broad scope of the conference.

- Low and Intermediate Level Waste Management
- Nuclear Facility Decommissioning

- Used Fuel Disposal
- Uranium Mine Waste Management
- Environmental Restoration
- Liquid Waste Management
- Regulatory Issues
- Financial Planning and Liability Management

There was a modest exhibit area with displays from several organizations involved in the radioactive waste program.

Continental breakfasts and lunches were provided each of the three days and a conference banquet was held on the Tuesday evening with guest speaker, Murray Elston, president of the Canadian Nuclear Association. With an easy style and a touch of humour Elston emphasized the need to develop the trust of the public. "We need to reach out", he said, and pointed to the proactive approach of the NWMO. It is critical to move forward on the waste issue, he stated, and offered congratulations to the conference organizers for being "ahead of the wave".

The conference was organized by a large committee chaired by Michael Stephens of AECL, Chalk River Laboratories, while the technical program was co-chaired by Mike Garamazeghy and Frank King, both of Ontario Power Generation. Sponsorship was provided by a number of organizations: AECL; Areva; Bruce Power; CNA; Duratek; Golder Associates; Hydro QuÈbec; Mississauga Metals & Alloys; MDS Nordion; Monserco; OPG; SNC-Lavalin Nuclear; SGN.

A CD with the technical papers is available from the CNS office.

Participants who turned in comment sheets suggested that the CNS should consider holding another conference with a similar scope in two to four years.

Scenes from CNS Waste Management Conference

Michael Stephens

Choosing a Way Forward:
- NWMO's Draft Study Report

by Elizabeth Dowdeswell

Ed. Note: *At the CNS conference on Waste Management, Decommissioning and Environmental Restoration for Canada's Nuclear Activities, held in Ottawa, May 8 - 11, 2005, Elizabeth Dowdeswell, president of the Nuclear Waste Management Organization gave a preview of the NWMO's Draft Study Report which was formally issued the following week. Following is the text of Ms. Dowdeswell's introduction to that report.*

Introduction

Canada's Nuclear Waste Management Organization is now in the final phase of its study. We have released the third of our milestone documents - a working draft of our study report and recommendation.

It has been a very short two-and-a-half years since nuclear energy corporations established our organization and the process of developing a Canadian strategy for managing used nuclear fuel was re-initiated.

It has been a journey of discovery. Through our research and assessment we have learned much about technological innovation and best practices here and around the world. There is reason to be confident that all of the concepts we were asked to study are indeed technically credible. Our interaction with a variety of specialists has allowed us to conclude that we are capable of designing and implementing a method that would be safe.

It has also been a journey of discovery about the society in which we live. It is no secret that any discussion about anything to do with "nuclear" elicits strong and often polarizing reaction. However, as we tried to better understand Canadian values and deeply held beliefs, we found some common ground. Canadians do not want to leave this problem for future generations to solve. They are prepared to accept responsibility today. And that is the starting point for finding a way forward.

First Principles

Our conclusions and recommendation have evolved through synthesizing the views and aspirations of people and examining with rigour technical and engineering information. There is a vast amount of accumulated knowledge.

Our thinking was shaped by four "first principles".

First, there is a pre-eminent requirement to ensure safety and security - to protect people and the environment from highly radioactive material, now and into the future. We must also ensure that our security systems and safeguards are compliant with Canada's nuclear non-proliferation policy and international agreements.

We know that we do not live in a risk-free world, but we must continue to build confidence and make a compelling case that the management of used nuclear fuel will meet or exceed rigorous safety and security goals over exceedingly long periods of time.

Secondly, we were guided by a mission statement that sought a sustainable approach - considering together social acceptability, technical soundness, environmental responsibility and economic feasibility. We were concerned about fairness in the distribution of costs, benefits and responsibilities within and across generations.

Thirdly, we were forever mindful of the unique time dimension of this public policy issue. After all, we are contemplating designing and licensing a system for periods longer than recorded history.

And our knowledge is not complete. We do not know what technologies may be available to succeeding generations. Nor do we know what use, if any, they may have for the used fuel we have generated. We do not know what the capacity of future generations will be to take an active role in managing this waste. And, although we can predict with some confidence, we do not know with certainty how the technologies we put in place today will perform over this very long period of time.

So, what does responsible action today look like when the potential risk to society spans so long a period?

And, fourthly - citizen engagement. We tried as openly and honestly as we could to collaborate - to engage citizens in a dialogue to define the questions and discuss the possibilities. Over the course of the study, thousands have helped in the search for societal direction and common ground.

We have benefited from the insights of more than 400 practitioners and specialists in scientific and technical disciplines, including ethical experts. Canadians expect that the best scientific and technical knowledge will be brought to bear in identifying and understanding the source and nature of risk and the ways in which safety can be assured.

However, confidence in a proposed approach will also be affected by societal notions of what constitutes risk and safety and ultimately whether the proposal resonates with what really matters to Canadians. To better understand the societal

requirements, we have undertaken a diversity of activities, both formal and informal, in person and electronically, with Aboriginal peoples and individual Canadians. We have tried to be responsive to a variety of views and perspectives.

Sustained engagement with people and communities, whether they welcome, oppose, or seek modifications to our observations and conclusions, has been and will continue to be, vital.

The Analysis

Now - to the analysis.

As required in the Nuclear Fuel Waste Act, we have undertaken a comparison of the benefits, risks and costs of 3 technical methods: deep geological disposal in the Canadian Shield; centralized storage, above or below ground; and storage at nuclear reactor sites.

The framework for this comparison emerged from our dialogue with citizens. It included objectives of fairness, health, safety, security, community well-being, environmental integrity, economic viability, and adaptability.

Of course, there is no magic formula that quantifies these objectives and transforms them into a predictable solution. How does one assess fairness? Ultimately it is a judgment based on both qualitative and quantitative input.

As we reported in our second discussion document, our analyses suggested that:

- All three of the technical methods could be designed to be safe in the near term.
- Taken individually, no single management approach specified in the Act perfectly addressed all of the values and objectives which citizens said are important, particularly when they are analyzed over both the near term (the next 175 years) and the much longer term;
- Each of the three approaches had distinct advantages and limitations.

We believe that the storage options do well in the near term, but they raise questions of fairness and of risks and uncertainties over the longer-term. Existing nuclear reactor sites were not chosen for their suitability as permanent storage locations. Furthermore, communities hosting the reactors today have an expectation that used fuel will eventually be removed.

Storage options also rely on ongoing and active management to ensure safe performance for tens of thousands of years. We expect that these institutions and our capacity for active management will be strong over the foreseeable future, but that it would be prudent not to rely on that over the very long term.

Deep Geological Disposal in the Canadian Shield is judged to perform well in the very long term because of the combination of engineered and natural barriers to isolate the used fuel.

But the approach is not seen to be easily adaptable or responsive to changing knowledge or societal circumstances. There is also uncertainty in the minds of citizens about how the system will perform over the very long term both technically and institutionally. We can't obtain advance proof of actual performance over thousands of years. The perception that has been created that this approach means "out of sight, out of mind" is firmly held by many.

A Fourth Option

It became obvious to us that a fourth approach which combined the significant advantages of the three concepts we studied but was supported by a phased, collaborative decision-making process, might better meet the objectives identified by Canadians.

We call it Adaptive Phased Management. It consists of two components: a technical method; and a management system.

Simply put, the technical method is centralized containment and isolation of used nuclear fuel deep underground in suitable rock formations. These might be the crystalline rock of Canadian Shield. Or, they could be found in Ordovician sedimentary rock.

But while we envisage a deep underground repository as the end point, it is really the second component of the approach - the management system - that we believe is most responsive to citizens - and to the times.

The key characteristic of the management system is that it is phased and adaptive. It is a commitment to continuous learning today to assist decision making tomorrow. We are advocating realistic, manageable phases - each marked by explicit decision points and continuing participation of interested Canadians.

For example, a typical path might consist of 3 phases:

Phase One would last approximately 30 years. It would be a period of preparation. The goals would be to site a centralized facility; build an underground research laboratory and continue a research and development program.

A key feature of our proposal is the option of including shallow underground interim storage at the central site -- before placement in a deep repository. So during this first phase a decision on whether or not to construct a shallow underground facility would be taken.

Phase Two would likely last another 30 years. Its purpose would be to confirm the suitability of the site and the technology for a deep repository, and to complete the final design and safety analysis needed for licensing the repository and its associated facilities.

Furthermore, if the decision had been taken to provide shallow underground storage, the facility would be constructed and fuel transported from the nuclear reactor sites.

Phase Three is expected to begin in about 60 years and could extend for several hundred years. That is when used fuel would be placed in the deep repository, still accessible, and monitored until the society of the day - possibly 300 years hence - decides to close it.

So while we identify the end point, we are not and cannot be prescriptive about how and when we reach that point. The actual choices belong to the societies which will be affected.

Adaptive Phased Management is a system that allows confidence to be developed and assured - in the technologies, the management method and supporting systems before moving to the next phase. It is a thoughtful and deliberative plan - not only for participative democratic reasons but because we genuinely expect to learn. New learning and technological innovation are continually incorporated.

At each stage, options are evaluated and decisions are made on whether and how to modify the management plan before proceeding to the next phase. Each decision point requires integration of the results of monitoring, continuous learning, and research and development

A second characteristic is that throughout implementation the used fuel will remain **monitored and retrievable.**

And thirdly, the approach is characterized by significant attention to **implementation.** Any management approach, with its institutions and systems, no matter how well conceived will fail if it is not also well executed - if it is not responsive to societal needs and concerns. The following are examples of the implementation issues we deal with.

- Institutions & Governance : Canada has an extensive system of governance to oversee the long-term management of used nuclear fuel, involving many players and in particular the CNSC. After a decision is made by the Government of Canada, the NWMO will become the implementing agency will ensure that the approach meets or exceeds all regulatory standards and requirements.
- Financial Matters: The approach will be fully funded according to a financial formula in which costs are shared across waste owners - Ontario Power Generation, New Brunswick Power Nuclear, Hydro-Quebec and AECL.
- Siting: When it comes to siting, we intend to seek a willing host community, where all technical and scientific criteria are met, and the social, economic and cultural aspirations of people are respected. We propose criteria for the process.
- Furthermore, we are proposing that site selection focus on Ontario, QuÈbec, New Brunswick and Saskatchewan, - the four provinces which are directly involved in the nuclear fuel cycle. We also recognize that communities in other regions and provinces may express an interest.
- The role of citizens: Finally, in a fundamental way our proposal advances a collaborative process in which citizens continue to play a legitimate role in making decisions, while at the same time creating conditions for productive movement forward.

This is just a sketch of the issues considered, but there are many others including the fostering of positive community development and mitigation of any disruptive impacts and the maintenance of intellectual capability.

Summary

Our vision is that Canada will take responsibility for the long-term management of its nuclear fuel waste. Our recommendation proposes a path to achieve that goal through a risk management approach of deliberate stages and periodic decision points.

- It commits this generation of Canadians to take the first steps now to manage the used nuclear fuel we have created;
- It will meet rigorous safety and security standards through its design and process;
- It allows sequential decision-making, embracing the precautionary approach and providing the flexibility to adapt to experience and societal change;
- It provides genuine choice by taking a financially conservative approach, and providing for capacity to be transferred from one generation to the next;
- It promotes continuous learning, allowing for improvements in operations and design that would enhance performance and reduce uncertainties;
- It provides a viable, safe and secure long-term storage capability, with the potential for retrievability of waste, which can be exercised until future generations have confidence to close the facility; and
- It is rooted in values and ethics, and engages citizens allowing for societal judgments as to whether there is sufficient certainty to proceed with each following step.

Next Steps - The Dialogue Continues

There is no single formula or lens through which to approach this public policy challenge. It demands the wisdom of Aboriginal Elders, the expertise of natural and social scientists and engineers, and the informed interest of citizens. Certainly all of the issues have not been resolved and the dialogue must continue.

Our report will be circulated to review and test our ideas. We want to know if our recommended management approach is appropriate for Canada - and, what are the conditions necessary to successfully implement it? Your insights, comments and questions will be welcomed. Specific opportunities for dialogue will be identified on our website.

Concluding Thoughts

We believe that our approach is both responsive and responsible, providing a strong foundation for managing with care the risks and uncertainties over very long time frames.

We are resolute in our belief that the knowledge we have today is more than adequate to start down this path, yet humble enough to acknowledge that the future will unfold in ways that may redirect the path to our end goal.

We are convinced that it is now time to act decisively.

The full NWMO Draft Study Report is available on the NWMO website <www.nwmo.ca> or by calling NWMO at 1-866-249-6966.

Overview of Atomic Energy of Canada Limited's Waste Management Operations at the Chalk River Laboratories

By N. MacDonald[1]

Ed. Note: *This paper was presented at the Canadian Nuclear Society's conference on Waste Management, Decommissioning and Environmental Restoration For Canada's Nuclear Activities: Current Practices and Future Needs, held in Ottawa, Ontario May 8-11, 2005.*

Abstract

AECL is a global nuclear technology and engineering company, well known for the CANDU reactor as well as other nuclear products and services.

AECL's Chalk River Laboratories (CRL) site has been in operation since 1952, and operates a variety of nuclear facilities to benefit the nuclear industry.

In the production of products and services, waste is produced. All solid and liquid active and/or hazardous and routine waste are handled by Waste Management Operations.

This overview looks at the past, present and future of Waste Management facilities and services at Chalk River.

1 OVERVIEW OF AECL

Atomic Energy of Canada Limited (AECL) is a global nuclear technology and engineering company that designs and develops the CANDU nuclear power reactor as well as other advanced energy products and services. Approximately 3,500 highly-skilled people worldwide are employed at various AECL sites.

AECL's Chalk River Laboratories (CRL) site is located approximately 200 km northwest of

Ottawa, Ontario on the shore of the beautiful and historic Ottawa River. The CRL site operates a variety of nuclear facilities (reactors, hot cells, analytical labs) to the benefit of the nuclear industry.

All these facilities and processes produce nuclear, hazardous, mixed and routine landfill waste that requires the services of Waste Management Operations (WMO). In addition to supplying the needs of Chalk River, WMO also receives solid commercial waste from hospitals, universities, and nuclear businesses across Canada other than the power utilities. WMO also offers a disposal service for mixed liquid wastes to all Canadian active waste producers (including the power utilities).

The overview of Chalk River provides a look at our facilities past, present and future and programs that can provide a service not only to CRL facilities, but also to the Canadian nuclear industry.

2 OVERVIEW OF WASTE MANAGEMENT OPERATIONS (WMO)

AECL's Waste Management Operations (WMO) is mandated to provide waste management services to our customers in a cost-effective, safe and environmentally responsible manner. WMO provides waste management services of solid and liquid radioactive wastes as well as conventional and hazardous wastes, required by CRL and non-AECL waste generators.

The operation focus is to prevent, reduce, and mitigate the impact of radioactive waste on the health and safety of employees and the public, and the environment by:

- reducing the quantity of radioactive and hazardous wastes;
- improving waste transfer practices;
- improving waste processing practices;
- improving waste storage practices;
- providing long-term storage until waste disposal facilities;
- enhancing performance monitoring;
- increasing the level of understanding about the nature and condition of ongoing and stored waste; and
- enhancing and formalizing initiatives to address conventional (non-radiological), hazardous wastes and mixed waste.

WMO is broken down into four main areas:

- Liquid Radioactive Waste Management Facility;
- Solid Radioactive Waste Management Facility;

1 Facility Authority Waste Management Operations, Atomic Energy of Canada Limited, Chalk River, Ontario

Moving Forward

L-3 MAPPS

On February 3rd, 2005, L-3 Communications Corporation acquired CAE's Power Systems and Simulation business. As L-3 Communications MAPPS Inc., we continue operating out of our headquarters in Montreal, Canada.

Our parent company has changed, but we are the same group of people that you have entrusted to deliver high-end power plant simulation and plant computer systems technology for more than 30 years. Continuing as L-3 MAPPS with the same management team, know-how and technology, we remain at the forefront of our business areas and will continue to invest in and to further develop our product offerings to address our customers' challenging needs – now and in the future.

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Full-scale Power Plant Simulators • Power Plant Simulator Upgrades • Plant Computer Systems

- Waste Segregation and Hazardous Waste Programs; and
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3 WASTE MANAGEMENT OPERATIONS

3.1 Liquid Radioactive Waste Management

The Waste Treatment Centre (WTC) was built at Chalk River Laboratories (CRL) in 1980 to separate radionuclides from low-level liquid waste produced on-site. The original equipment commissioned at the WTC included an incinerator, ultrafiltration, reverse osmosis, thin-film evaporators and microfiltration.

The current equipment is a 100 l/min liquid waste evaporator (LWE) to concentrate the (volume) low level liquid waste produced by the reactors, research and test areas as well as the decontamination process. Thin-film evaporators further concentrate the LWE waste and solidify the concentrate in emulsified bitumen contained in galvanized steel drums.

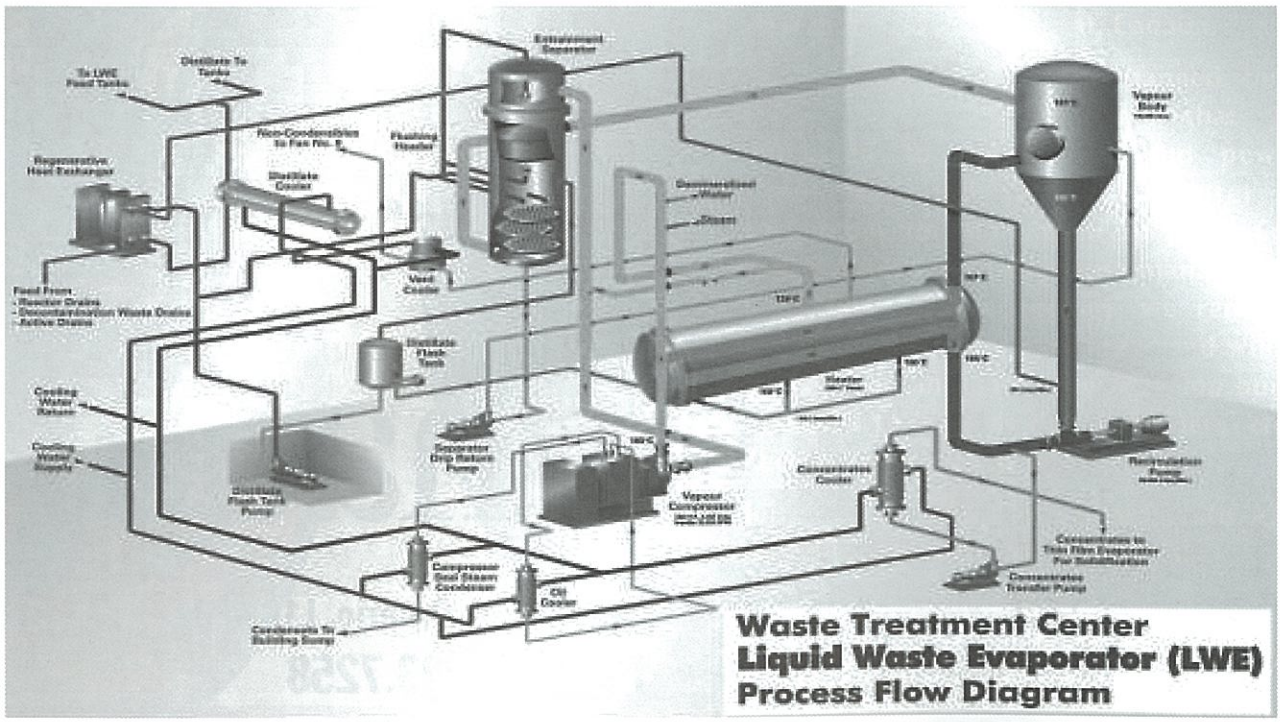
The distillate water from the evaporators is sent to holding tanks where it is acceptance tested for release. If the distillate passes testing, the water is discharged to the process sewer, which discharges to the Ottawa River. The immobilized bitumen waste is transported to a waste management area for dry-storage management.

A number of projects have been initiated to provide new and/or improved operations for the WTC:

- Site active liquid wastes are collected via Active drain lines. These lines have recently been upgraded to a double wall containment lines with leak detection.
- A new tank facility is in operation providing double containment for storage of operational waste streams.
- The reverse osmosis/ micro filtration plant has been upgraded to provide back-up processing for prolonged outage of the LWE.
- Twenty-one legacy waste tanks will be transferred and consolidated into a new double containment holding facility.
- Improvements to resin bed removal systems for bulk and selective isotope removal are in progress.

3.2 Solid Radioactive Waste Management

The WMAs are licensed to operate, construct, monitor, and maintain storage space for historic and operational solid wastes. Approximately 1400 m3 of waste (in final form) ranging from very slightly contaminated material to used reactor fuel must be stored, each year, in one of four different Waste Management Areas (WMA) Facility at the CRL site. Initiatives such as baling and high-force compaction are two techniques currently used to reduce the volume of solid wastes to minimize the use of storage space.



3.2.1 Sand Trench

Waste Management Area C (WMA C), an unlined sand trench facility used for storing Low-Level Radioactive Waste (LLRW) has been in operation since 1963 at Chalk River Laboratories (CRL). In the 1990s, it was recognized that this facility was approaching its capacity and the Modular Above-Ground Storage (MAGS) facility was built to provide improved new storage capacity for LLRW.

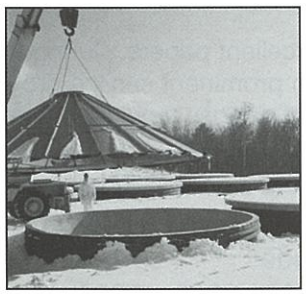
3.2.2 Modular Above Ground Storage (MAGS)

The MAGS system for processing and storing LLRW came into operation in November 2002. The MAGS system signifies a substantial change in the way low-level wastes are handled and stored at CRL. The LLRW waste generally contains items such as lightly contaminated clothing, paper towels, glassware, used equipment and building materials produced at CRL or received from Canadian hospitals, universities and other waste generators such as MDS Nordion. These materials, previously stored in unlined sand trenches, are now stored, in a dry, monitored and easily retrievable state in steel containers in MAGS storage buildings.

The principal environmental benefits derived by the MAGS project are reduction in overall volume of LLRW wastes being stored at CRL (due to compaction of loose wastes), and a significant reduction in the quantity of waste (up to 95%) stored in unlined sand trenches.

The MAGS storage buildings are prefabricated metal buildings with reinforced concrete floors containing drainage and ventilation systems. Each building has a capacity for two years' worth of low-level radioactive waste at CRL. Solid Wastes are packaged either in steel containers or in 45-gallon drums for storage.

3.2.3 Bunkers



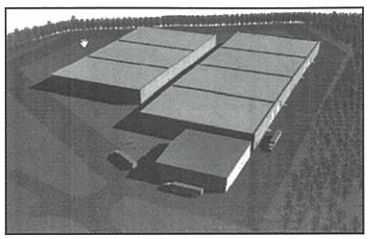
Bunkers are located in Waste Management Area "B". Waste Management area B was put into service in 1953. The early bunkers were of a rectangular design, which were in use between 1959 and 1978. The rectangular bunkers walls are 6 inches thick and the base is 8 inches thick. The rectangular design was replaced by a more robust less maintenance intensive cylindrical design which is still in use today. The entire structure is reinforced concrete. The floors and walls are 6 and 10 inches thick respectively. The floor is sloped to a center pump pit and a liquid detection tube runs from the sump pit to ground level to allow for detection of any in-leakage.

While in use, the bunkers are covered with a metal weather shield. On closure, the bunker is covered with a flat 6 inch reinforced concrete roof.

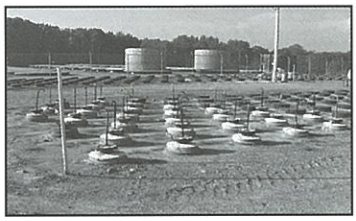
Bunkers are near surface low/intermediate level storage structures. Typical waste packages are soft materials (mop heads, tyveks), IX columns, filters and bitumen drums from the solidification process at the WTC.

3.2.4 Future Project: Shielded Modular Above Ground Storage (SMAGS)

The Shielded Modular Above Ground Storage (SMAGS) structures are based on the same principle as the MAGS, with the metal wall replaced by a 10-inch concrete wall. The SMAGS structures will house the MAGS type waste and some higher activity wastes from the bunkers. The SMAGS provides better use of available land. A project is currently underway to begin construction the first on these structures in 2006.



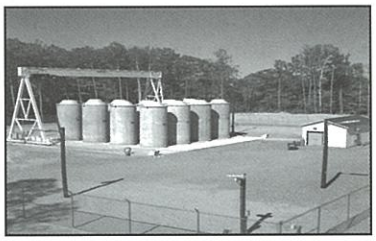
3.2.5 Tile Holes



Tile holes are concrete, steel-lined containers intended for high-level waste. Tile holes are 3.6 to 4.9 m deep and from 15 cm to 90 cm wide. The excavated tile hole construction area is backfilled with sand.

Tile holes are used to store radioactive materials that require more shielding and heat dissipation than materials stored in bunkers. All wastes transferred to tile holes is done through shielded flasks. Tile holes are continually monitored to ensure integrity and containment. Waste consists primarily of used reactor components and fuel.

3.2.6 Canisters



In 1988, 12 cylindrical canisters were built for the storage of fuel from NPD. Eleven are fuel and one is kept as a spare. The Canisters are:

- made of reinforced concrete with an internal liner of 34-inch carbon steel pipe,
- 6.2 m high and 2.6 m outside diameter,
- supported on reinforced concrete foundations placed directly on bedrock, and
- designed for deadweight, thermal, wind and seismic loads.

All canister transfers are performed with shielded flasks with an overhead crane.

Canadian Nuclear Society
Société Nucléaire Canadienne

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The Canadian Nuclear Society Announces the 7th International Conference and Exhibition on CANDU Maintenance November 20 – 22, 2005 at the Holiday Inn on King Hotel, Toronto, Ontario Conference Theme: Maintain the Fleet ~ Maximize Performance Honorary Chairman: John Coleby, OPG Senior VP Pickering "A"

The Canadian Nuclear Society has proudly supported CANDU science and technology for over 25 years. Heavy water moderated pressure-tube reactors are present in seven countries. The industry currently has 37 operating commercial units. In addition, there are 7 new units under construction and 3 in restart/refurbishment programs. It is a dynamic industry filled with countless challenges and successes. Change is the norm and keeping pace with research, operating experience and technological advances can be difficult. The strength of the CANDU industry is through the cooperation, mutual assistance and the exchange of information amongst its generators and service providers. This is especially true when trying to understand and resolve destiny issues as well as the rehabilitation activities necessary to extend plant life. Effective and efficient repair, replacement and refurbishment campaigns are essential and critical to the viability of all CANDU's. In this regard, the Canadian Nuclear Society offers a unique opportunity for individuals to find out the latest news on evolving inspection and maintenance techniques, strategies and trends at its 7th International Conference and Exhibition on CANDU Maintenance.

The International Conference and Exhibition on CANDU Maintenance continues to be a successful event. In recent years, the conference has attracted over 300 attendees; approximately 10% are from nations other than Canada. Corporate Sponsors include AECL, OPG, GE Canada, B&W, Bruce Power, RCM Technologies, ES Fox, Canatom, Framatome, Hydro Québec, NB Power, Nuclear Logistics and North American Power Partners.

The conference format includes a Sunday evening cocktail reception, two full course lunches and a very popular reception and dinner banquet on Monday evening. The banquet is capped off with an entertaining guest speaker from outside the nuclear industry and it tends to be one of the more memorable events. Keynote speakers for the opening Plenary Session and lunches are some of the most inspiring and renowned figures in the industry. The actual presentations are given in a number of different technical sessions devoted to Steam Generators, Feeders, Fuel Channels, Inspection Programs and Aging Life Management themes to name a few.

The 2003 CANDU Maintenance Conference featured over 60 excellent papers. During the breaks, individuals are able to visit a number of interesting and innovative exhibits from prominent service providers. Exhibitors for the 2005 conference include AECL, B&W, Intech International, Zetec, GE Canada, Nova Machine Products, Shultz Electric, Enertech, Ian Martin, Farris Engineering, Reality Measurements, Canspec, OPG Inspection & Maintenance Services, RCM Technologies, Larslap USA, Nuclear Logistics, Kinectrics and Justram Equipment.

Primary contacts on the 2005 Organizing Committee include:

- Chairman: Brent Murchie ~ Bruce Power (519-361-2673 x 2290 brent.murchie@brucepower.com).
- Technical Program: Marc Paiment ~ OPG Pickering (905-839-1151 x 2108 marc.paiment@opg.com)
- Exhibits and Sponsorships: Mike Schneider ~ Invaritare Data Centre (905-689-7300 mschneider@invaritare.com

Additional details can be found at the Canadian Nuclear Society Website www.cns-snc.ca

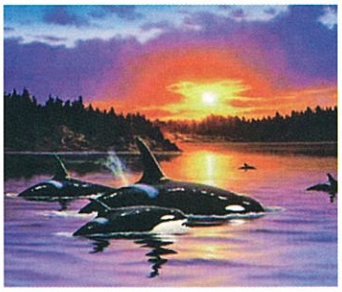
EIC Climate Change Technology Conference

Engineering Opportunities and Challenges in the 21st Century,

Don't ignore it – Deal with it!

Second call to authors and presentors.

Our first call, which resulted in close to 100 submissions, confirmed the value and interest to proceed with this first of its kind Conference. It has enabled a preliminary program to be developed, with gaps still to be filled from this second call.



Our Vision:

The need to deal in a practical manner with climate change, to adapt to and mitigate against its negative effects, implies the application of engineering and engineers. We are calling on the engineering community to embrace the opportunities and challenges of this phenomenon.

Our Main Conferences Tracks:

- **Policy, Strategy, and Regulations**
- **Measurement, Monitoring and Standards**
- **Engineering for Mitigation (reduction & removal GHG)**
- **GHG Markets and Risk Management**
- **Engineering for Adaptation (design for climate change)**

There will also be sessions on **Modeling and Analysis** and **GHG Education Programs & Strategies.**

Papers and Presentations:

Abstracts are invited for both papers and presentations. We wish to encourage industry participation in the form of presentations.

Important Dates:

Notification of Acceptance - First Call	May 31, 2005
Submission Deadline - Second Call	September 30, 2005
Notification of Acceptance – 2nd Call	November 30, 2005
Authors submit Manuscript for CD ROM	January 31, 2006
Panelists submit presentation for CD-ROM	February 15, 2006
Presentation at Conference	May 10, 11 or 12, 2006

Canister storage will be used for storage of calcined waste form isotope production and is being considered as an alternative for future high-level storage within one of our new storage projects.

3.3 Waste Segregation and Hazardous Waste Programs

3.3.1 Waste Segregation Program

The primary objective of this activity is to prevent non-radioactive waste from going into radioactive waste management areas, and ensuring that waste going off-site or to non-radioactive facilities at the CRL are not radioactively contaminated. Using the "3R" approach – reduce, reuse, recycle – WMO is ensuring the on-going availability of both CRL landfills and municipal landfills.

3.3.2 Hazardous Waste Chemical Program

The Hazardous Chemical Waste Program (HCWP) manages (segregates, collects, routes, tracks, stores, monitors and dispositions) all AECL CRL hazardous chemical waste and mixed waste (waste that has a chemical hazard and a radiological hazard). The key program principle, and one that is constantly emphasized, is that the foundation of good waste management is early segregation. To be most effective this must begin at the source - with the waste generator. The HCWP is constantly training and educating waste generators on the importance of waste segregation. A second and equally important program principle is that waste history is crucial in determining waste classifications and segregation requirements.

When waste is deemed to be non-radioactive (by history, segregation and field monitoring), it passes through an enhanced verification monitoring process to confirm a non-active status. If confirmed non-active, the waste is processed for off-site disposal by a Ministry of the Environment (MOE) certified hazardous waste disposal company. If the waste fails verification and deemed to be active, it is stored in one of the hazardous active storage facilities to be dispositioned at a later date.

Waste initially classified as active is analyzed to confirm its activity. There are a couple of options for the disposition of liquid radioactive wastes (aqueous or organic). Aqueous wastes are processed through the CRL Waste Treatment Centre and organic liquids are transported to a company in the United States.

3.4 Technical Unit

The Technical Unit is a highly experienced engineering team in facility operations. They allow the WMO facilities to remain focussed on the routine operation and maintenance by:

- providing technical solutions to non-routine problems;
- taking on significant projects; and
- acting as the client or operations representative with major-project teams who require a strong technical interface with the facility.

The Tech Unit provides a strong presence on major projects to ensure the operability and maintainability of the final deliverable and ease the commissioning and transition into operation.

The unit is built-up from experience gained in the routine operation of the supported facilities. The group affords experienced operating engineers the chance to grow by interacting more broadly with other AECL support groups such as project management, design, safety and licensing, environmental protection, maintenance and planning.

4 FUTURE OPERATIONS

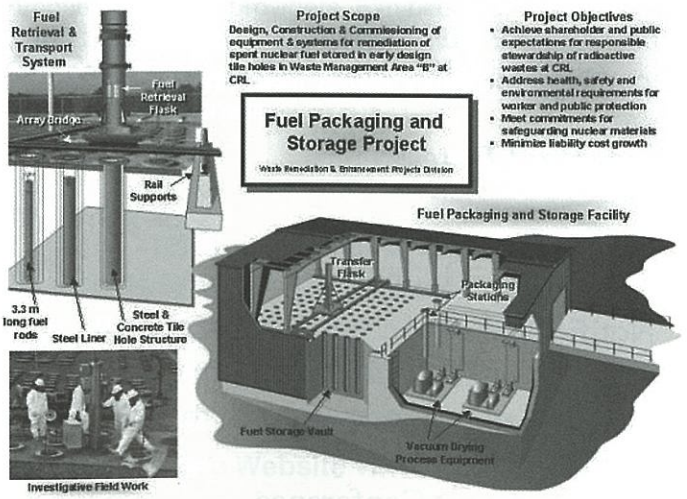
Waste Management Operations is dedicated to continuous improvement. As such, we are investigating and moving away from existing "traditional" waste storage structures. A few of the projects currently underway are:

- Major Projects:
- Tile Hole Replacement,
- Stored Liquid wastes,
- WTC upgrades,
- Active Drains / Holding Tank Facility,
- Shielded Low Level Waste Storage,
- New high level waste storage,
- Security Improvements

5 SUMMARY

CRL has been in the Waste Management business since 1946. This was a general overview of Chalk River waste programs and facilities, providing a glimpse at our past, present and future.

Waste Management Operations is committed to the continual improvement and enhancements of waste management practices. Interactions with customers help us ascertain future waste needs and ensure waste storage/ program options are available when needed. We actively pursue opportunities that will reduce or eliminate nuclear liability. Our priority is the protection and safety of our employees, the public and the environment.



Tailings Management Best Practice:
A Case Study Of The McClean Lake Jeb Tailings Management Facility

Michael A. J. Tremblay and J. Rowson[1]

Ed. Note: *The following paper was presented at the Canadian Nuclear Society's conference on* ***Waste Management, Decommissioning and Environment Restoration For Canada's Nuclear Activities: Current Practices and Future Needs,*** *held in Ottawa, Ontario, May 8-11, 2005*

ABSTRACT

COGEMA Resources Inc. (which is part of the Areva Group) is a Canadian company with its head office in Saskatoon, Saskatchewan. It owns and operates mining and milling facilities in Northern Saskatchewan, which produce uranium concentrate. McClean Lake Operation commenced production in 1999 and its tailings management facility represents the state of the art for tailings management in the uranium industry in Canada.

Tailings disposal has the potential to cause effects in the surrounding receiving environment primarily through migration of soluble constituents from the facility to surface water receptors. In-pit disposal of mill tailings has become the standard in the uranium mining industry in Northern Saskatchewan. This method of tailings management demonstrates advances in terms of worker radiation protection and containment of soluble constituents both during operations and into the long term.

Sub-aqueous deposition of tailings protects personnel from exposure to radiation and airborne emissions and prevents freezing of tailings, which can hinder consolidation. The continuous inflow of groundwater to the facility is achieved during operations, through control of water levels within the facility. This ensures hydrodynamic containment, which prevents migration of soluble radionuclides and heavy metals into the surrounding aquifer during operations.

The environmental performance of the decommissioned facility depends upon the rate of release of contaminants to the receiving environment. The rate of constituent loading to the receiving environment will ultimately be governed by the concentrations of soluble constituents within the tailings mass, the mechanisms for release from the tailings to the surrounding groundwater system, and transport of constituents within the groundwater pathway to the receiving environment. The tailings preparation process was designed to convert arsenic into a stable form to reduce soluble concentrations within the tailings mass. The design of the TMF itself relies on the high permeability sandstone unit to provide a preferential flow path for groundwater around the low permeability tailings mass. This provides a passive means of minimizing the long-term release of constituents from the decommissioned facility to the environment.

A comprehensive tailings optimization and validation program was developed to reduce uncertainties related to the performance of the tailings management facility associated with the chemical and physical properties of tailings. This paper will describe the JEB tailings management facility and provide a summary of the findings of this research program.

I. INTRODUCTION

Canada's most recent and modern uranium milling facility is located at the McClean Lake Operation in northeastern Saskatchewan, Canada, see Figure 1. The McClean Lake Operation is jointly owned by COGEMA Resources Inc. (70%), Denison Mines Ltd. (22.5%) and OURD (7.5%) with COGEMA Resources Inc. as the operator. COGEMA Resources Inc. is a subsidiary of COGEMA S.A. of France, which in turn is part of AREVA. AREVA's aim on the nuclear and electricity distribution side is to provide a comprehensive scope of services in every aspect of the nuclear fuel cycle, nuclear power reactor supply and services, and electricity transmission and distribution. COGEMA Resources Inc. forms part of the Mining Business Unit.

Mill operation at McClean Lake commenced in late June of 1999 and has been operating at or above design production levels since January 2000. In the current configuration, the mill is processing the McClean Lake ore bodies at a current production rate of 6,000,000 lbs U3O8 per year. Planning calls for the future processing of ore from the Midwest and Cigar Lake mine sites. The operating life of the

1 COGEMA Resources Inc., Saskatoon, Saskatchewan

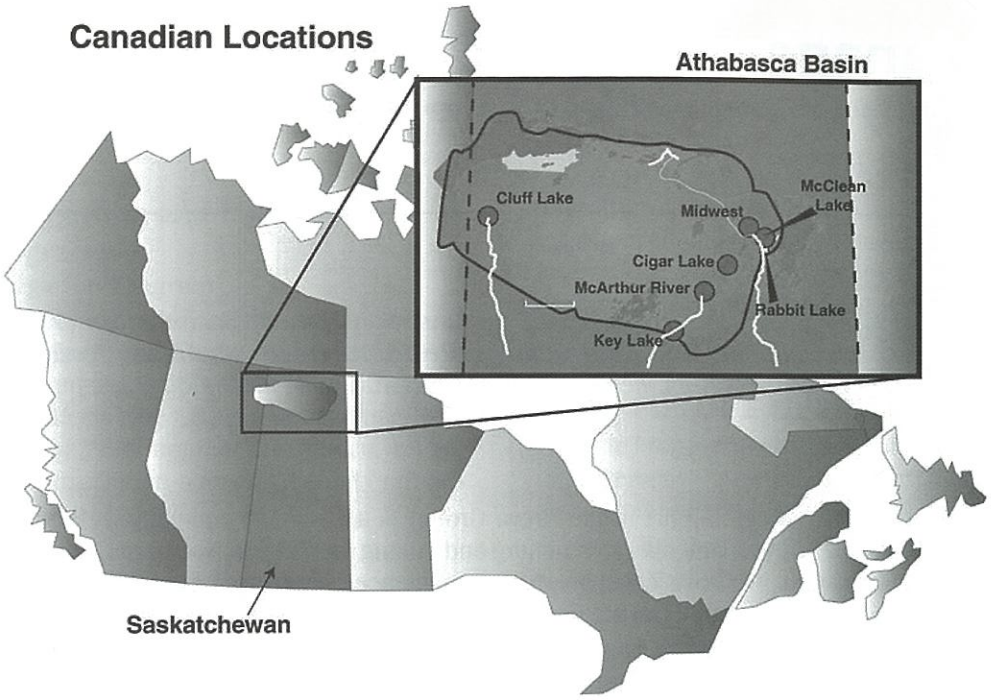


Figure 1: Uranium production locations in the Athabasca Basin of northern Saskatchewan.

milling facility is expected to be approximately 40 years.

The nearby depleted JEB open pit mine has been converted into the JEB Tailings Management Facility (TMF). The TMF has the capacity to receive approximately 1.8 million m3 of tailings from the mill over its operating life. This is adequate for all the ores from the McClean Lake, Midwest and Cigar Lake projects. Adjacent to the TMF are two small lakes, Figure 2, locally known as Fox Lake and Pat Lake. Hydrogeologic evaluations had indicated potential for long term (10,000 years) effects to the water quality of these receiving water bodies due to the presence of the placed tailings in the TMF. Chemical constituents of concern include arsenic and nickel, which originated in the pore water of the placed tailings. As a result, COGEMA Resources has developed the tailings preparation process in the mill and optimized the design and operation of the TMF to mitigate any potential environmental effects. It is now expected that none of the water quality parameters in Fox Lake or Pat Lake will exceed the Saskatchewan Surface Water Quality Objectives over the long term (10,000 years).

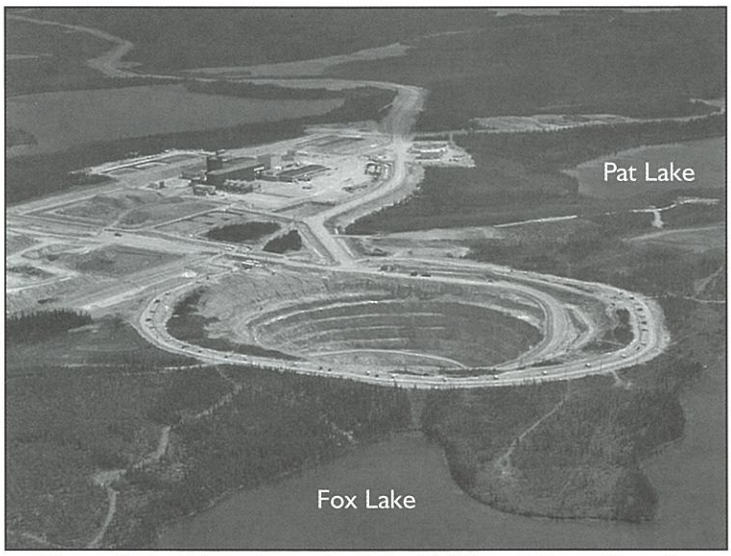


Figure 2: Aerial photograph of the McClean Lake milling site showing Fox Lake in the foreground followed by the TMF and the ore processing plant.

II. TMF DESIGN

The JEB TMF has been designed to minimize the migration of soluble constituents from the facility to the receiving environment both during the operating and post-decommissioning periods. During operations, the condition of hydrodynamic containment is maintained, whereby a constant inflow of groundwater to the facility prevents migration of soluble radionuclides and heavy metals into the surrounding aquifer. The design of the decommissioned facility relies on control of source concentrations within the tailings pore water and an hydraulic conductivity contrast between the tailings mass and the surrounding host rock such that groundwater preferentially flows around the tailings. This results in the relatively slow process of molecular diffusion being the dominant mechanism for contaminant release from the facility, which is minimized by relatively low source concentrations.

II.A. Post Operational Requirements

The key to the long-term performance of JEB TMF is the hydraulic isolation of the tailings materials within the decommissioned facility from the surrounding aquifer.

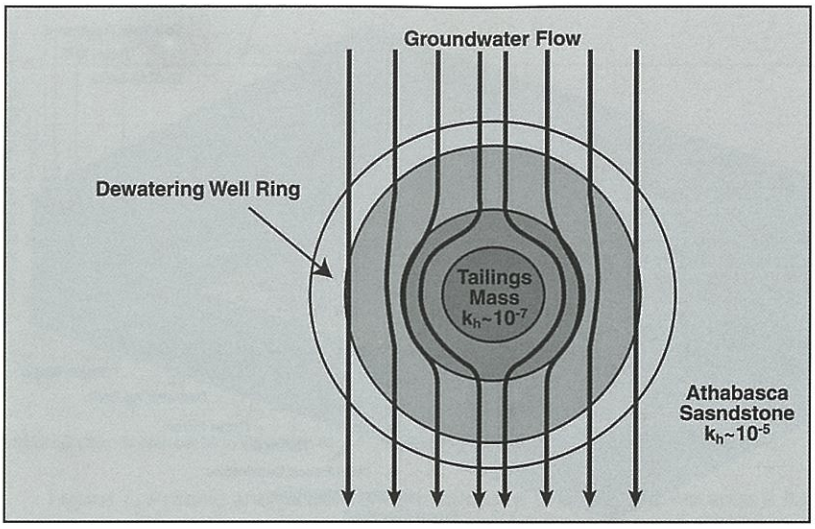


Figure 3: Plan view depicting the principle physical containment control. Ground water flows through the sandstone and around the relatively impermeable tailings mass.

Physical containment controls and geochemical controls provide the principal means of controlling the long-term release of potential contaminants to the groundwater flow system.

The control of flow through the tailings is dependent on site specific factors related to the physical characteristics of the tailings compared with those of the local Athabasca sandstone. The tailings as produced during mill operations contain a significant amount of fine-grained materials. Consolidation of these materials produces a tailings mass of low hydraulic conductivity, approximately two orders of magnitude less than the surrounding sandstone. Under these conditions for the long term, the consolidated tailings represent a lowpermeability plug and groundwater preferentially flows around the tailings mass through the surrounding host rock. Solute release from the tailings pore water, Figure 3, is then dominated by a slow diffusion process driven by the solute concentration gradient between the pore water of the tailings mass and the ground water of the surrounding host rock.

The second control on contaminant release is the tailings solids chemistry, which is designed to keep the concentrations of constituents of concern in the tailings pore water at such low levels that releases by the diffusion process over the long term are environmentally acceptable. The elements of arsenic and nickel are of primary concern. Environmental objectives for these two elements require their concentration not to exceed 5 mg/L over the long term. To facilitate this environmental requirement, an internal operational objective of 1 mg/L has been implemented.

II.B. Operational Period

COGEMA Resources has introduced new technology to the tailings preparation circuit in the mill for the long term control of arsenic and nickel in the tailings pore water. The process is shown in Figure 4. A more detailed description of the process has been published elsewhere Ref. [1].

All the process wastes are mixed and transferred to the neutralization process. Prior to neutralization the soluble arsenic concentration in the total waste stream is first measured and the iron (III) to arsenic molar ratio is then adjusted to approximately 3 by the controlled addition of ferric sulphate. This critical step provides the means to specifically and consistently precipitate arsenic with iron in a form that is suitable for long term disposal. Barium chloride is also utilized to promote the removal of radium. Slaked lime is added to the first and second slurry tailings neutralization tanks. The pH is raised to approximately 4 in the first tank and then adjusted to approximately 8 before discharge from the second tank. Total retention time for the neutralization process is approximately 3 hours with 1.5 hours reaction time at pH 4 and 1.5 hours at pH 8.

The neutralized slurry is then pumped to a tailings thickener where flocculent is added to promote settling. Tailings are thickened to 30% to 35% solids by weight prior to discharge to the TMF.

The depleted JEB open pit mine was modified to suit the requirements for the TMF. The top perimeter of the TMF is approximately circular with a diameter of about 420 meters. The natural groundwater level is at or near the surface. The facility was excavated through approximately 10 m of glacial till overburden, 75 m of sandstone, and into the granitic basement rock to a total depth of approximately 118 m below grade. To ensure hydraulic containment of tailings pore water during the operating period (40 -50 years) a ring of dewatering wells have been installed around the edge of the pit, Figure 5. The submersible pumps in these wells are located at a fixed elevation slightly above the desired pond

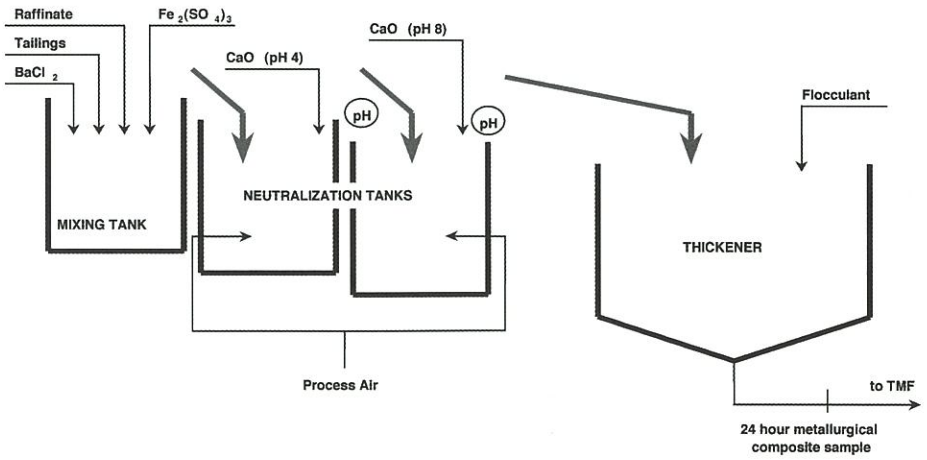


Figure 4: Flowsheet for the tailings preparation circuit.

level. These wells act as the primary control on the TMF pond water level and to intercept clean ground water before it enters the TMF. To monitor ground water levels four observational wells (external) are installed within the ring. In addition, four internal monitoring wells are installed between the de-watering well ring and the pit. A base drain and graded filter package constructed of sand and crushed rock at the base of the TMF allows collection of tailings pore water to prevent the release of solutes to the surrounding aquifer and enhance tailings consolidation by dissipating excess pore water pressure within the tailings mass. Water is removed from the base drain and pumped to surface for treatment through a dewatering drift and raise system. Hydrodynamic containment of TMF waters is ensured by maintaining the following water level hierarchy: exterior well > interior well > pond level > base drain level.

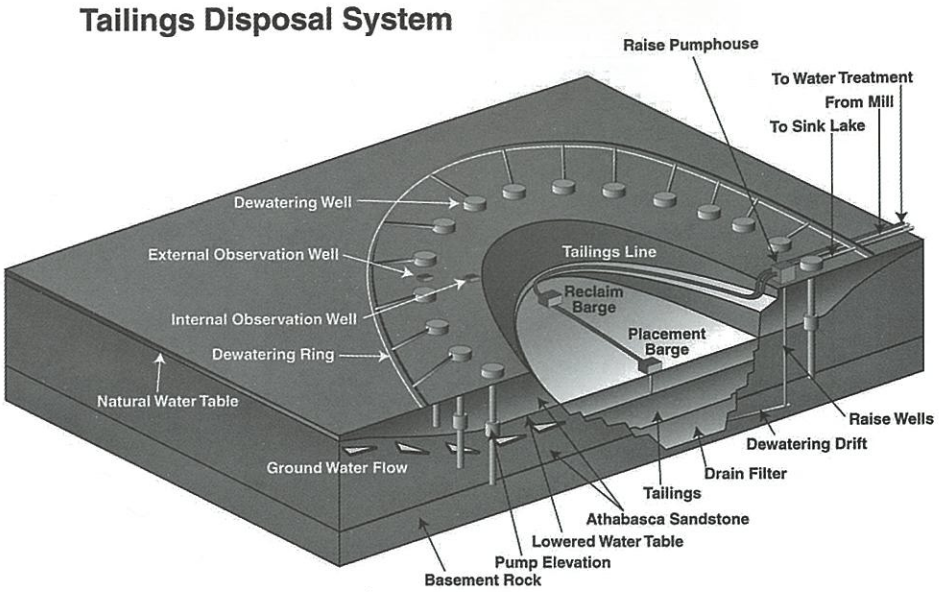


Figure 5: Design and Operational Features of the JEB Tailings Management Facility (TMF)

The tailings lines from the mill run down the TMF ramp and onto a floating walkway leading to the placement barge. The discharge pipe is suspended below the barge and the tailings are placed onto the surface of previously placed tailings using a shallow injection tremie method. This placement methodology minimizes particle size segregation and insures that relatively permeable pathways do not develop within the tailings mass. The reclaim water barge is used to precisely control the pond level by returning the mill tailings pumping water back to the mill.

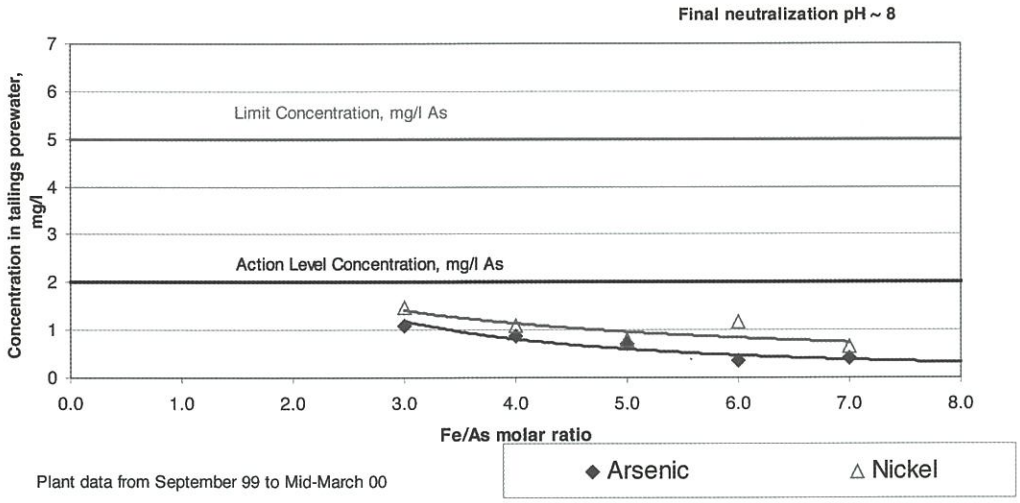


Figure 6: Arsenic and nickel concentrations in tailings pore water as a function of molar Fe/As ratio at a fixed pH of 8. Each point is the average of daily readings over a 7 months operating period.

III. TMF PERFORMANCE TO-DATE

III.A. Mill Tailings Preparation Circuit

During the first year of operation, the focus was to ensure that the tailings produced by the preparation process and discharged to the TMF met the arsenic and nickel pore water concentrations required for long term environmental protection. Figures 6 and 7 are summaries of daily results for nearly 7 months of operation of the tailings preparation process. The process has proven to be easily controllable, despite the fact that acidic waste solutions as high as 2,000 mg/L As have been processed. As can be seen from Figure 6 the addition of ferric sulphate solution to achieve an iron (III) to arsenic molar ratio of approximately 3 has successfully reduced As and Ni concentrations in the final tailings pore water to approximately 1 mg/L feeding the TMF. Similarly, the sensitivity of the process to terminal pH at a fixed Fe/As molar ratio is shown in Figure 7. This figure illustrates that soluble As and Ni pore water concentration objectives can be met within a reasonably broad pH window.

III.B. Tailings Aging Test Work

A considerable amount of laboratory aging of mill tailings has been carried out to assess the long-term stability of

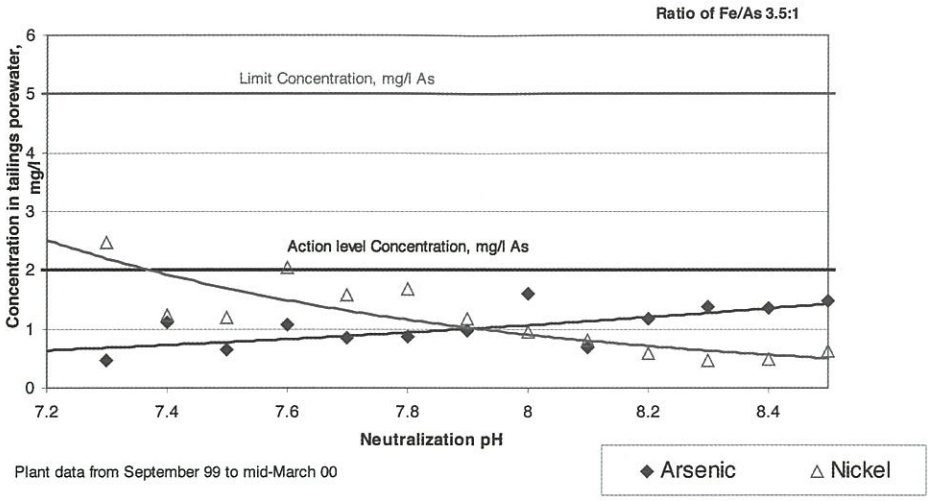


Figure 7: Arsenic and nickel concentrations in tailings pore water as a function of terminal neutralization pH at a fixed molar Fe/As ratio of 3.5.

the arsenic bearing minerals produced. During the design stage, a rapid aging technique was developed (SEPA aging tests) to determine soluble arsenic concentration equilibrium endpoints. Following mill startup aging tests were conducted over a ten-month period (TOVP aging tests) on production tailings to observe aging behavior with respect to soluble arsenic concentrations.

The results of aging tests have shown that arsenic pore water concentrations can be expected to remain at or below 1 mg/L over the long term. Mineral saturation index modeling further indicates that arsenic concentrations in tailings pore water are controlled by saturation with a poorly crystalline scorodite mineral complex. Aging test work shows a transient rise and fall of soluble arsenic concentrations during the early stages of aging.

Annual sampling of tailings from within the JEB TMF was conducted to track the aging characteristics of tailings for comparison with laboratory test work. Tailings core samples were collected from all ages of tailings within the TMF and pore water samples were extracted for analytical testing. The aging profile of soluble arsenic in tailings pore water within the TMF was consistent with laboratory aging tests, demonstrating a similar rise and fall, with equilibrium concentrations at or below 1 mg/L. Figure 8 provides a comparison of the results of all aging tests conducted to date.

III.C. Tailings Geotechnical Properties

Five annual sampling campaigns to investigate the geotechnical properties of placed tailings within the JEB TMF have been undertaken. These investigations have focussed on tailings density and hydraulic conductivity. The densities achieved by tailings as they consolidate are important from the perspective of storage within the TMF. The hydraulic conductivity of placed tailings is important for limiting the flow of groundwater through the tailings of the decommissioned facility.

Results to date indicate that tailings are consolidating at a greater rate than initially predicted. After four years of operation, the height of tailings within the facility is several metres below predicted levels, in spite of greater than predicted volumes of tailings produced. This indicates that the available storage volume within the TMF will be adequate for all future planned tailings production. Tailings core samples from throughout the TMF were collected for grain size analyses and hydraulic conductivity testing. Grain size analyses results indicate that the tailings near the central deposition point are coarser in nature than whole tailings due to segregation during placement. Figure 9 presents average grain size distributions for whole tailings and the coarse and fines zones within the TMF. The coarse zone was found on average to contain approximately 20% fines (<75um), compared with 55% fines for whole tailings. The coarse zone was found to extend approximately 40 m radially outward from the deposition point, which corresponds to approximately 20% of the area of the tailings surface (Figure 10).

Figure 11 presents the results of hydraulic conductivity testing and shows the effect of fines content (<75 um) on the consolidated hydraulic conductivity of tailings samples.

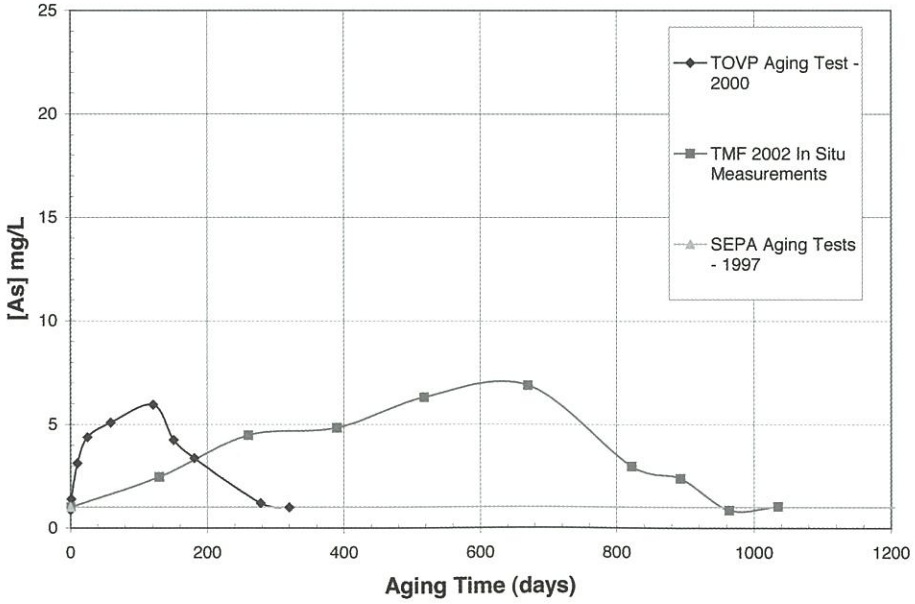


Figure 8: Summary Comparison of Laboratory and Observed Aging Behaviour.

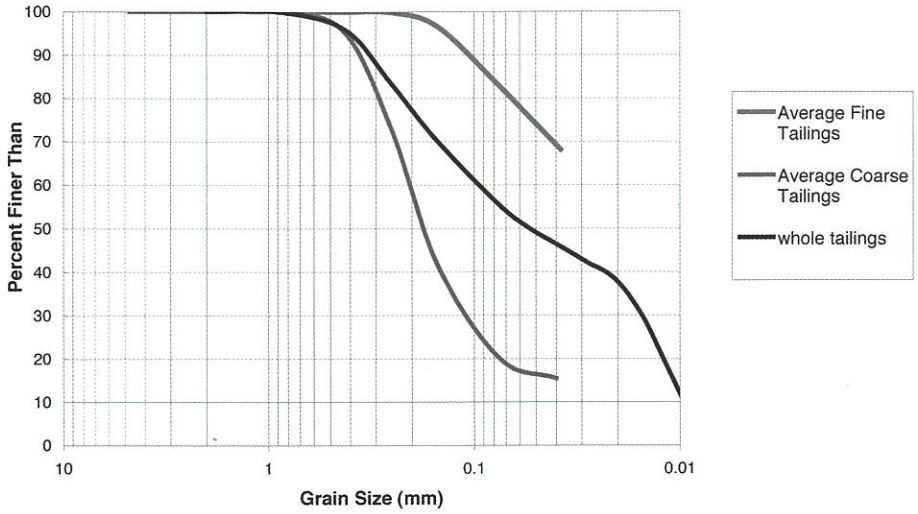


Figure 9: Grain Size Analysis – Average Coarse and Fine Zones.

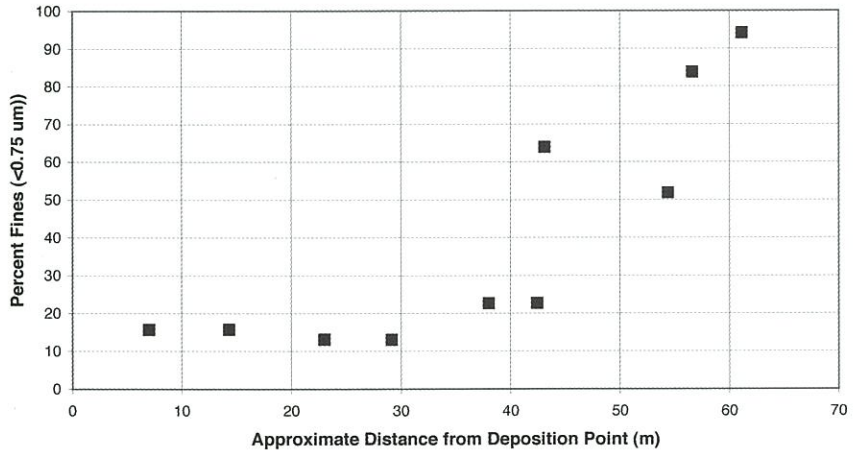


Figure 10: Percent Fines versus Distance from Deposition Point.

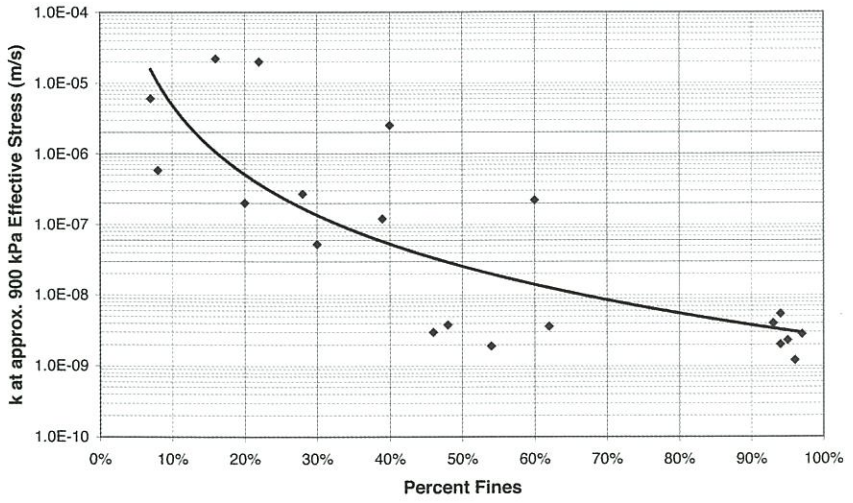


Figure 11: Hydraulic Conductivity versus Percent Fines.

The results indicate that the coarse zone may be expected to achieve a hydraulic conductivity of approximately 1x10-7 m/s , while the surrounding fines are expected to reach hydraulic conductivities in the range of 1x10-9 to 1x10-8 m/s. Overall, the tailings mass is expected to exhibit a bulk hydraulic conductivity sufficiently low to ensure a contrast of at least two orders of magnitude less than that of the surrounding host rock. Typically, sandstone host rock exhibits hydraulic conductivities on the order of 1x10-5 m/s.

IV. PREDICTED LONG-TERM PERFORMANCE

Solute transport simulations, based on a groundwater flow model of the local JEB area, were performed to predict the long-term effects of tailings disposal within the JEB TMF to the surrounding surface water receptors. Based on the flow model output, and the predicted source concentrations of soluble contaminants within the tailings, the mass flux out of the decommissioned TMF and transfer to each receptor were calculated. Figure 12 presents the predicted long-term concentrations of solutes within Fox Lake and Pat Lake resulting from tailings disposal within the TMF along with water quality guidelines. Predicted concentrations of solutes are expected to be well within applicable guidelines into the long term and in most cases are only marginally elevated above background concentrations.

V. CONCLUSION

The JEB TMF at the McClean Lake Operation has been designed to minimize potential effects of tailings disposal both during operations and into the long term. Hydrodynamic containment prevents the migration of solutes out of the TMF during operations. Through engineered tailings geochemistry and proper tailings placement, migration of solutes from the decommissioned facility may be minimized. The long term effects associated with tailings disposal within the JEB TMF are predicted to be insignificant.

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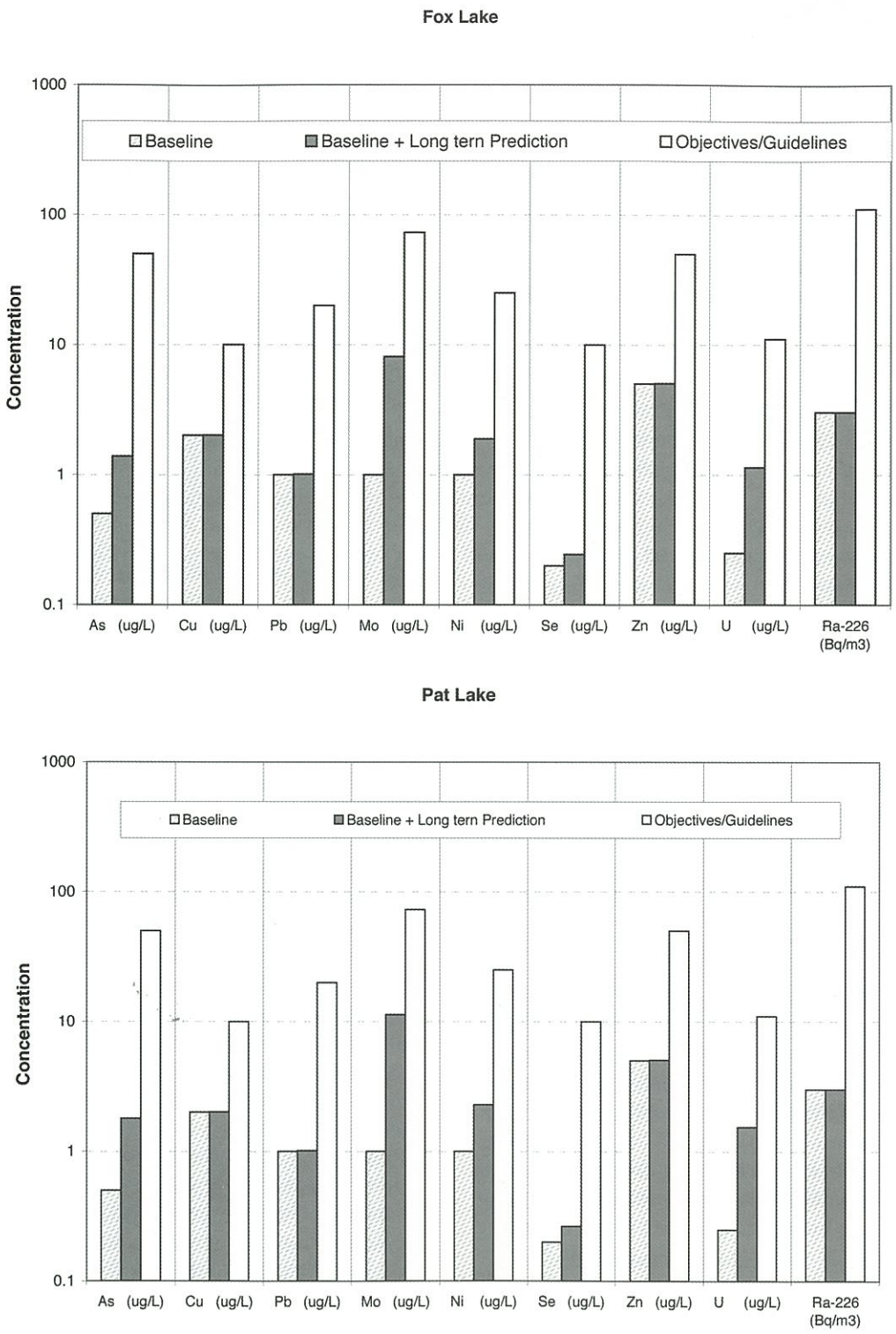

Figure 12: Predicted Effects for Fox Lake and Pat Lake Water Quality.

Regulatory Review Of Safety Assessments For Decommissioning Projects - An International Project

R. Ferch[1] & B. Batandjieva[2]

Ed. Note: *The following paper was presented at the Canadian Nuclear Society's conference on* ***Waste Management, Decommissioning and Environmental Restoration for Canada's Nuclear Activities: Current Practice and Future Needs,*** *held in Ottawa, Ontario,May 8-11, 2005*

ABSTRACT

Decommissioning is being planned or has already taken place for a broad range of nuclear facilities worldwide, including nuclear power plants, research reactors, nuclear fuel cycle facilities, research laboratories and industrial facilities, and it is expected that the number of facilities permanently ceasing operations will increase in the next few decades. Ensuring safety during decommissioning is a regulatory equirement, and adequate planning, evaluation and demonstration of safety for decommissioning activities are necessary to meet this requirement.

It has been recognized that it would be desirable for a harmonized approach to be developed taking into account international experience and lessons learned. In view of this, a new international project was initiated by the International Atomic Energy Agency on evaluation and demonstration of safety of decommissioning of nuclear facilities (DeSa). It aims at drawing on international experience in order to develop a harmonized approach for evaluating the safety of decommissioning activities and reviewing safety assessments for these activities for all types of nuclear facilities (e.g. nuclear power plants, research reactors, nuclear fuel cycle facilities, research laboratories, industrial plants). The DeSa project commenced last year and this paper will describe the outcomes and progress of the project to date.

I. Introduction

There is a broad range of nuclear facilities around the world, including nuclear power plants, research reactors, nuclear fuel cycle facilities, research laboratories and industrial facilities, where decommissioning is planned in the near future. In particular, there will be an increasing number of research and nuclear power reactors closing down in the next few decades, and the associated decommissioning activities will require adequate planning, evaluation and demonstration of safety [1, 2, 3, 4, 5]. A systematic approach to the demonstration of compliance with safety requirements and the criteria for decommissioning and release of material, buildings and sites from regulatory control is required.

The safety of decommissioning has been emphasized at various international fora, such as the International Atomic Energy (IAEA) Conference on Safe Decommissioning for Nuclear Activities in Berlin (14-18 October 2002) [6] and the OECD/NEA International Seminars on Decommissioning in Taragona, Spain (2-4 September 2003) [7] and Rome, Italy (6-10 September 2004). In its June 2004 meeting the IAEA Board of Governors approved an Agency Action Plan on Decommissioning of Nuclear Facilities [8] which encourages the IAEA to develop an internationally agreed approach to safety assessment of decommissioning and also to develop information for regulators and operators on the preparation and contents of the detailed safety assessment which should be developed in association with the decommissioning plan for each facility being decommissioned.

The first review meeting of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [9, 10] also highlighted the importance of safety of decommissioning. The evaluation and demonstration of safety is one of the set of requirements presented in the IAEA Safety Standards on decommissioning, including Safety Requirements [1, 2] and Safety Guides [3, 4, 5] published by the Agency over the last few years. Supporting reports addressing record keeping [11], dismantling techniques [12], and on the standard content of safety related decommissioning documents [13] have also been developed that provide specific information about technical subjects.

International projects to develop similar recommendations for demonstration of safety of near surface disposal facilities have been carried out in recent years by the Agency, such as the ISAM (Improvement of Safety Assessment Methodologies for Near Surface Disposal Facilities) [14] and ASAM (Application of Safety Assessment Methodologies for Near Surface Disposal Facilities) [15] projects.

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In light of these developments, a new International Project on Evaluation and Demonstration of Safety of Decommissioning of Nuclear Facilities (DeSa) has been undertaken by the IAEA to develop an equivalent level of detailed information in the field of decommissioning, taking into account international experience and lessons learned in this field. In addition to information on the preparation of safety assessments by the proponents of decommissioning projects, the DeSa project also aims to provide parallel information for performing reviews of these safety assessments. Such reviews may be carried out by the proponent, by a third party, and/or by the regulatory body. In Canada, regulations under the Nuclear Safety and Control Act [16, 17, 18, 19] require that decommissioning plans be submitted in support of applications for licenses to construct, operate and decommission nuclear facilities. Guidance to support these regulations has been published as Regulatory Guide G-219 [20], which describes the CNSC's expectations for the contents of decommissioning plans. The regulator requires this information in order:

a) to support decisions to grant authorizations for the construction or operation of facilities;
b) to support decisions to grant authorizations for decommissioning nuclear facilities;
c) to identify the limits and conditions that need to be applied to decommissioning activities to ensure safety; and
d) to provide a basis for assessment of the conduct of activities during decommissioning.

Forming a judgment about the safety of a decommissioning project involves assessment of the risks to health and safety of workers and members of the public arising both from the conduct of decommissioning and from the presence of radioactive and hazardous materials within the facility being decommissioned. The safety assessment and other information provided by the facility operator in support of an application for authorization must address these issues. The regulatory authority must satisfy itself that safety principles have been applied, and good engineering practice has been used in developing proposals for decommissioning and that effective procedural controls have been developed and will be applied during the decommissioning process. The safety assessment and all supporting arguments must provide a high level of confidence that the decommissioning will be carried out safely and that the end-state of the project will meet all regulatory requirements.

II. DeSa Project

The DeSa project aims to develop a harmonized methodology for evaluation and demonstration of safety during decommissioning and to develop safety assessments for selected nuclear facilities by applying this methodology. It also has the objective to assist operators and technical support specialists in planning and undertaking decommissioning activities for all types of nuclear facilities. It will also be of use to regulators, and approaches to regulatory review of decommissioning safety will be also addressed. More specifically, the project aims to [21]:

a. define the elements of the safety assessment;
b. investigate the practical applicability of the methodology and performance of safety assessments for the decommissioning of various types of facilities through selected "real- life" test cases;
c. investigate approaches for review of safety assessments for decommissioning activities and development of a regulatory approach for reviewing safety assessments for decommissioning activities and as a basis for regulatory decision making; and
d. provide a forum for exchange of experience in evaluation and demonstration of safety during decommissioning of various types of nuclear facilities.

The DeSa project addresses the evaluation of the impacts on workers and the public from normal anticipated decommissioning activities and from potential accidents which might occur during these activities. Attention will be given to the application of the methodology at the different stages of planning and implementation of decommissioning strategy on different types of civilian nuclear facilities up to final release of the site from regulatory control. It will consider the three main decommissioning options, i.e. immediate dismantling, deferred dismantling and entombment. All types of nuclear facilities (e.g. nuclear power plants, research reactors, nuclear fuel cycle facilities, research laboratories, industrial plants, mines and mills) will be covered. It will also address the waste arising from decommissioning activities up to the point of disposal/intermediate storage, free release or transport away from the site.

The DeSa project is being undertaken in three phases as follows (see Fig. 1) [21]:

- Phase 1 – development of safety assessment methodology, safety assessment content and review procedures;
- Phase 2 – application of the methodology to test cases; and
- Phase 3 – evaluation of the lessons learned and development of information and recommendations.

The project commenced on 1 November 2004. Phase 1 is focusing on several areas – formulation of a consensus on a safety assessment methodology; initiation of review and development of a review procedure, and application of the graded approach in development and review of safety assessment. At present there are five working groups established by the project participants who contribute to the fulfilment of these tasks (see Fig. 1): Assessment Framework Working Group, led by Mr. Adriaan Joubert (National Nuclear Regulatory Body, South Africa); Hazard Analysis Working Group led by Mr. Kurt Lauridsen (Danish Decommissioning, Denmark); Analysis of the Results and

Confidence Building Working Group led by Mr. Jean-Guy Nokhamzon (CEA, France); Graded Approach Working Group led by Mr. Stefan Thierfeld (Brenk Systemplanung GmbH, Germany); and Regulatory Review Working Group led by Mr. Richard Ferch (CNSC, Canada). The consistency and coordination of the project is maintained through the DeSa coordinating group established at the meeting, consisting of the working group leaders, the Chairman of the project, Mr. Ken Percival (UKAEA, United Kingdom), and the IAEA scientific secretary, Ms. Borislava Batandjieva.

The outputs of this project are intended to assist regulators, safety assessors, operators and independent reviewers of decommissioning projects worldwide in:

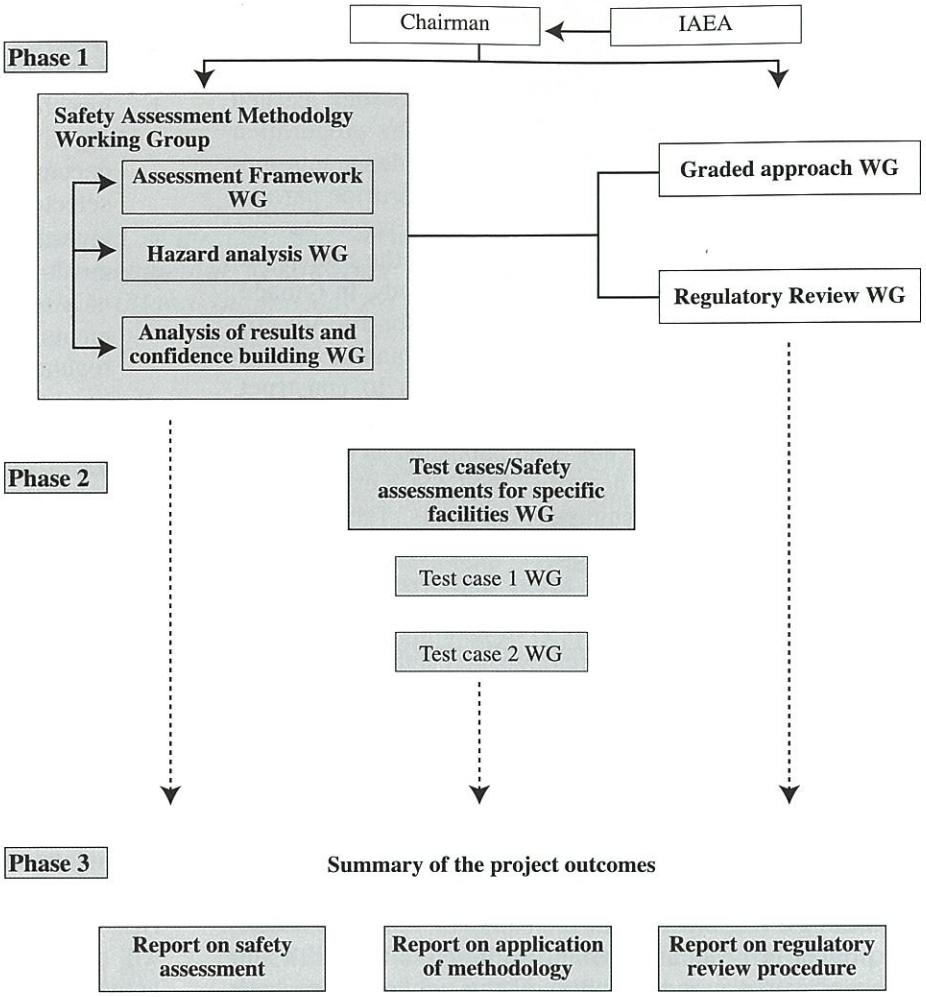
a) decision making on the adequacy and acceptability of safety assessments;
b) decisions on approval of proposed decommissioning options; and
c) identifying and resolving safety is sues arising during decommissioning.

III. Safety Assessment Approach

A documented assessment of safety of decommissioning activities is generally a requirement of the regulatory body. This is sometimes referred to as a safety analysis report, but for the purpose of this paper it will be referred to as a safety assessment. The safety assessment can have a number of purposes [22]:

— to provide a documented demonstration that the proposed decommissioning operations can be carried out safely and meet regulatory requirements for protection of the workers and members of the public;
— to provide a basis against which the safety of the proposed activities can be assessed, independently of the decommissioning project team, by the regulatory body and/or internally to the operator organisation;
— to document safety assessment results that can be used by the regulatory body and/or operator, as appropriate, to give formal approval to the proposed decommissioning operations;
— to provide a systematic evaluation of consequences of planned operations and to test their robustness in normal and accidental conditions;
— to support the justification for the selection of a decommissioning option;
— to identify the limits and conditions that will be applied to decommissioning activities to identify a safe envelope and ensure the requisite safety standards are met and maintained.

Figure 1: Organization of DeSa Project



In summary the safety assessment is necessary to be carried out in a systematic, transparent and logical manner that could provide sufficient level of confidence in the approach and assessment result to be presented to the national regulatory body, other competent authorities (e.g. responsible for environment or health aspects) and other stakeholders. The ongoing work of the DeSa project suggests the following main steps of the safety assessment for decommissioning of nuclear facilities (see Fig. 2) [22]:

a) establishment of assessment framework;
b) description of the facilities and decommissioning activities;
c) hazard identification and screening;
d) hazard analysis;
e) evaluation of results and identification of controls;
d) establishment of limits, conditions and control specification.

It should be noted that as compared with safety assessments for operating nuclear facilities, there is a relatively strong emphasis in the DeSa project on occupational safety

and on hazard assessment assessment and analysis, reflecting the high importance of workplace hazard control during decommissioning.

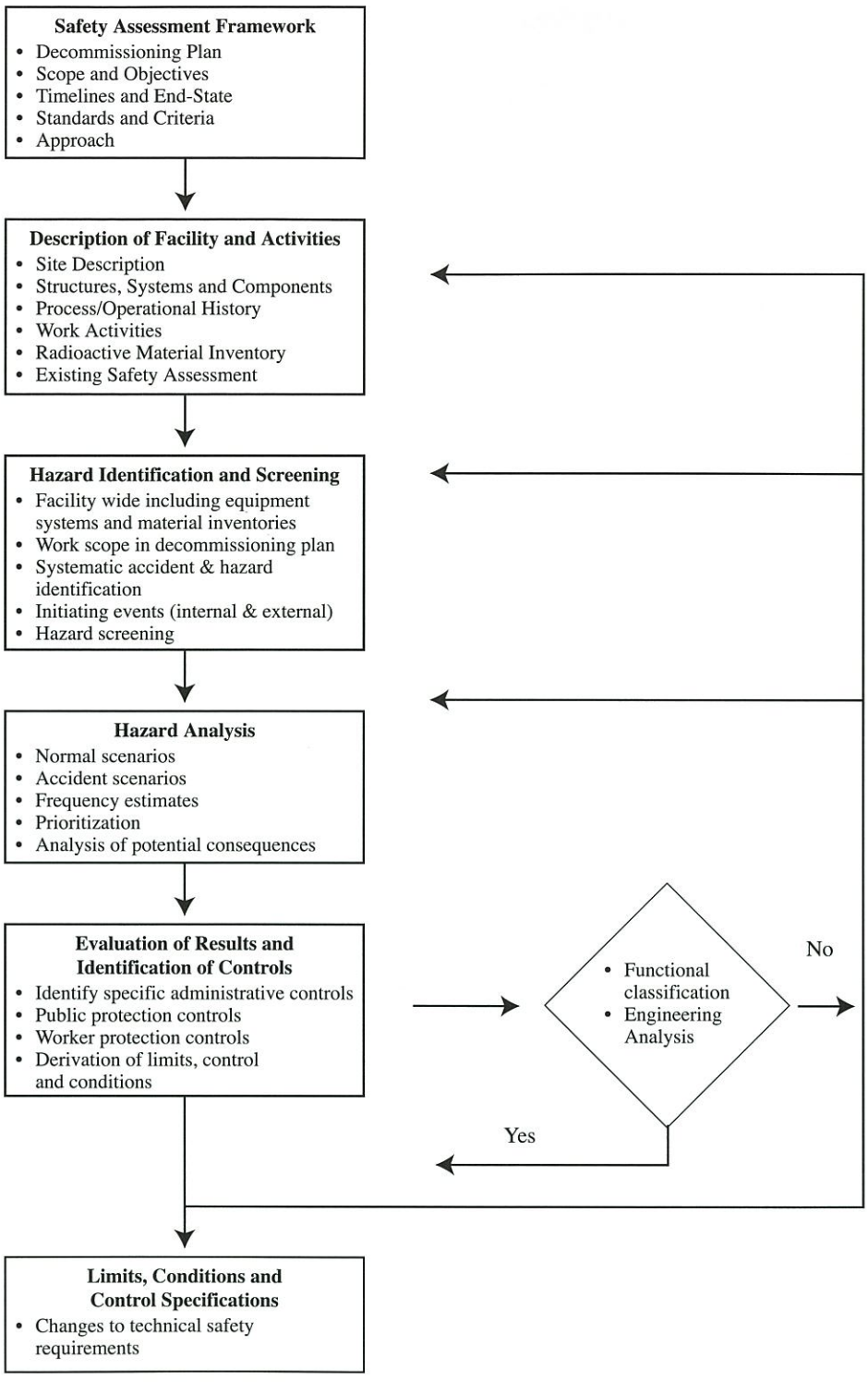
IV. Approach For Regulatory Review Of Safety Assessment

As part of the DeSa project the Regulatory Review working group attended by over thirty experts aims:

a) to identify strategies and mechanisms to review decommissioning safety assessments and safety cases for decommissioning projects;
b) to develop procedures for regulatory review of decommissioning safety assessments of nuclear facilities;
c) to test and illustrate these procedures on test cases; and
d) to document the review procedure and the findings from the practical application of this regulatory review procedure within the overall DeSa project.

The work of this DeSa working group aims also to assist in definition of screening and evaluation criteria to provide answers to the following questions:

— Is there an unanalyzed hazard, change, or increase in uncertainty in analyzed hazards or a change in hazardous substance type, form, or quantity, as a result of the proposed activity, or a discovery that could affect (directly or indirectly) the health and safety of workers at or around the job site?
— Are prescribed safety controls (including personal protective equipment) adequate to protect workers, as established by approved hazard baseline documentation, and have the safety controls been reviewed and approved?



The main challenges of the development of recommendations in the field of regulatory review of safety assessment for decommissioning of nuclear facilities could be summarised as follows:

— review of safety assessment as part of the review of the decommissioning plan;
— evaluation and justification of the graded approach in the development and review of safety assessments;
— review and acceptability of sufficient engineered barriers and application of defence in depth principle;
— review and adequacy of consideration of radiological and non-radiolo gical hazards and their evolution with time; and
— link between safety assessment results and proposed limits, controls and conditions.

IV. Application To The Canadian Situation

Existing Canadian regulatory guidance on decommissioning [20] focuses on the preparation of decommis-

sioning plans. This guidance deals with not only Detailed Decommissioning Plans submitted in support of applications for decommissioning licences, but also Preliminary Decommissioning Plans prepared during the construction and operation phases of the facility life cycle. A safety assessment for the decommissioning work is an important component of a Detailed Decommissioning Plan.

As the number of projects entering decommissioning increases, and as their size and complexity also increases, the importance of these safety assessments will also increase. It is anticipated that the role of the regulator in reviewing these assessments and in assessing compliance with the decommissioning plans, programs and procedures will also increase. This will lead to increased needs for regulatory guidance, criteria and review procedures.

In keeping with current CNSC policy regarding the use, where possible, of international experience and international consensus documents in developing the CNSC's own regulatory documents, it is anticipated that the outputs from the DeSa project will contribute directly to future CNSC regulatory documentation on the subject of decommissioning.

V Conclusion

The new IAEA project creates an opportunity for review of the experience of over thirty Member States and also development of consensus and recommendations on the development and review of safety assessment for decommissioning of nuclear facilities. Within Canada, it is expected that the reports produced during this project will contribute to the Canadian Nuclear Safety Commission's review processes for future decommissioning safety assessments.

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Comparison of Risks from Deep Geological Disposal and Extended Storage Approaches for the Long Term Management of Used Fuel

by Nava C. Garisto and Morley W. Davis[1]

Ed. Note: *The following paper was presented at the Canadian Nuclear Society's conference on Waste Management, Decommissioning and Environmental Restoration for Canada's Nuclear Activities: Current Practices and Future Needs. held in Ottawa, Ontario, May 8-11, 2005. It is based on a study conducted for the Nuclear Waste Management Organization.*

ABSTRACT

The Nuclear Waste Management Organization has a mandate from the Government of Canada to consult with the public and to recommend an approach for managing Canada's used nuclear fuel. Three main fuel management methods are being explored and evaluated: disposal in a Deep Geological Repository; reactor-site extended storage; and centralized extended storage, either above ground or below ground. In this study, the management methods were reviewed to estimate potential risks at each stage of their development. The risk assessment presented is based on a combination of operating experience at the nuclear sites in Ontario (Pickering, Darlington, Bruce) as well as Canadian and international assessments.

I. Introduction

The Nuclear Waste Management Organization (NWMO) has a mandate from the

Government of Canada to consult with the public and to recommend an approach for managing Canada's used nuclear fuel. Three main approaches are being explored and evaluated by the NWMO. These are:

- Disposal in a Deep Geological Repository (DGR);
- Extended storage at nuclear reactor sites (RES);
- Centralized extended storage (CES), either above ground or below ground.

Conceptual designs were developed for the used nuclear fuel management options studied by the NWMO (CTECH 2002, 2003a, 2003b; COGEMA Logistics 2003). All these designs meet regulatory safety and environmental requirements. Regulatory compliance does not imply that these concepts can be implemented under zero-risk conditions. Like any major industrial project, a nuclear used fuel facility may affect the health of project workers and of members of the public living near the site or along affected transportation routes. It is not surprising therefore, that a small risk to human health or the environment would be expected from any of the management options mentioned above. This is the case even though all the relevant regulations are met and particular care is taken to reduce the risk to as low as practically possible.

This paper provides a brief summary of potential risk to the public, risk to workers and risk to the environment for the three approaches listed above (Garisto, 2004). The possible effects associated with the various management options are not limited to those resulting from exposure to radiation, nor to those experienced by individuals working at, or living near, the facility. Equally, they may not be limited to the period during which the facility is built, filled and sealed, but may arise many centuries in the future.

Potential radiological and non-radiological effects are considered in this paper. Furthermore, both routine operating conditions and hypothetical accident scenarios are considered. Where emissions are thought to occur, the resulting exposure doses are compared to existing limits, guidelines and background values for perspective. Where there are gaps in current knowledge, *these gaps are noted,* so they can be addressed in a future analysis, during the step-wise implementation of the approach. Such an analysis will close gaps in the analysis, update the calculations, quantify the risk associated with this option and document the results for communication with the public.

II. Objectives

The objective of this study is to provide answers to the following questions, based on currently available information:

(i) What can we expect, under normal and off-normal conditions for the three options?
- Are there any potential, significant public health impacts expected?

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- Are there any potential, significant worker health impacts expected?
- Are there any potential, significant ecological impacts expected?

(ii) What are the main gaps in the responses to the above questions?

III. Stages In The Development Of Used Fuel Waste Management Systems And Associated Potential Risks

This section provides an overview of stages in the development of Used Fuel Waste Management systems and asso-

Table 1: Overview of Stages in the Development of Deep Geological Disposal and Potential Risks

Stage	Non-radiological Effects		Radiological Effects	
	On site worker	Off site resident	On site worker	Off site resident
Siting				
Construction				
Operation				
Transportation				
Extended Monitoring Decommissioning and Closure				
Post Closure				
Inadvertent Human Intrusion				

Table 2: Overview of Stages in the Development of Storage at Reactor Sites and Potential Risks

Stage	Non-radiological Effects		Radiological Effects	
	On site worker	Off site resident	On site worker	Off site resident
Site Preparation and Construction				
Operation				
Transportation				
Extended Monitoring				
Facility Repat				
Repackaging				
Replacement of Modules and Baskets				
Extended Long Term Monitoring				
Inadvertent Human Intrusion				

Table 3: Overview of Stages in the Development of Centralized Storage and Potential Risks

Stage	Non-radiological Effects		Radiological Effects	
	On site worker	Off site resident	On site worker	Off site resident
Site Preparation and Construction				
Operation				
Transportation				
Extended Monitoring				
Facility Repat				
Repackaging				
Replacement of Modules and Baskets				
Extended Long Term Monitoring				
Inadvertent Human Intrusion				

	No significant effect; very small risk of injury
	The potential effect of loss of institutional controls and inadvertent human intrusion was not assessed. The potential effect of fuel bundle disintegration not assessed.
	Potential exposure in the hypothetical and unlike event of institutional collapse in the near-term and society memory loss of the site. No potential impact from DGR is expected if such a societal collapse occurs in the long term even in the case of human intrusion (because of gradual radioactive decay).
	Theoretical potential lost time accident
	Theoretical potential fatality

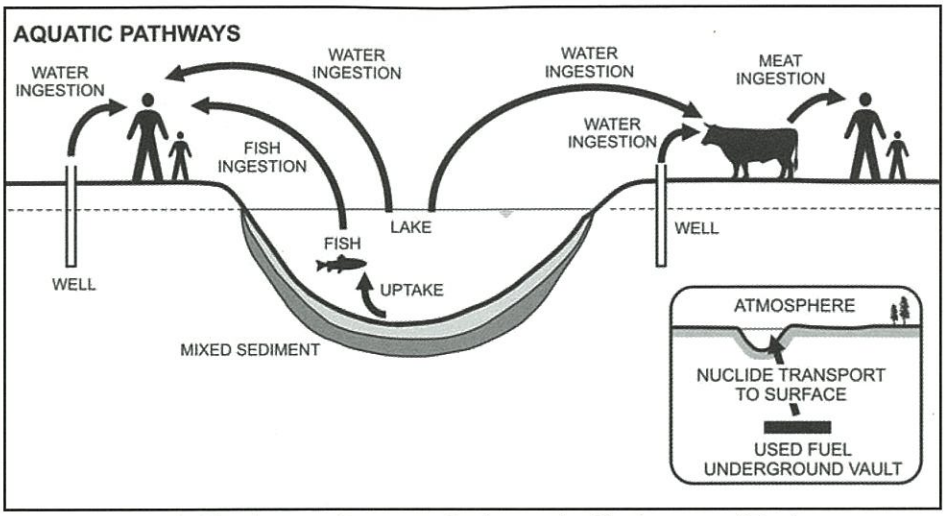


Figure1: Key Aquatic Exposure Pathways for Underground Facilities

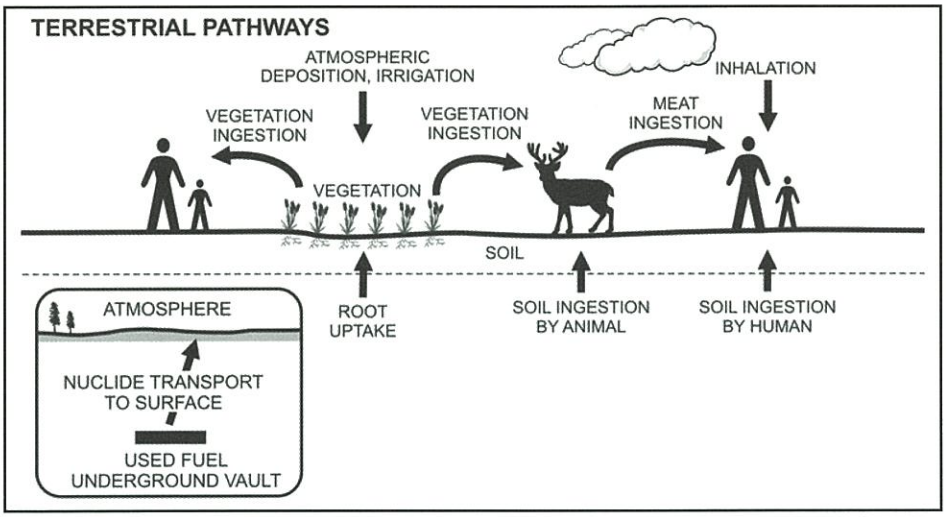


Figure 2: Key Terrestrial Exposure Pathways for Underground Facilities

ciated risks. It addresses radiologieal and non-radiological aspects of Used Fuel Waste Management. Further details on radiological aspects are provided in Section IV.

Extensive studies have been conducted on radiological aspects of used nuclear fuel management (see Section IV in this paper). There has been less emphasis in past assessments on exposure to non-radioactive contaminants, because they were perceived to be less hazardous than radioactive contaminants. Recent assessments of sites with mixed contaminants developed comprehensive systematic approaches for considering both radioactive and non-radioactive contaminants (e.g., Garisto, 2002). Based on available screening-level information (e.g., Environmental Assessments on the Extension of Storage Sites for Dry Used Fuel Storage), there are no major issues associated with chemical emissions from dry used fuel storage facilities. Similarly for a DGR, based on Goodwin and Mehta (1994) and Gierszewski et al. (2004), it is likely that no exposure to chemical contaminants will occur until containers fail, engineered barriers fail and chemicals gradually disperse into the receiving environment through groundwater transport. An updated analysis of the risk from chemical contaminants will be required as part of the implementation of the approach selected by the federal Government for the long-term management of nuclear fuel waste.

The risk comparison by stage is provided in a detailed report (Garisto, 2004). Examples of the results are illustrated in Tables 1-3.

IV. A Comparison Of Potential Radioactive Exposure

Where emissions are thought to occur, the resulting exposure doses are compared to existing limits, guidelines and background values for perspective. Where there are gaps in current knowledge, these are noted, so that they can be addressed in a future analysis during the implementation of the monitoring program.

Radiological dose rates were estimated for the various stages in the implementation of each of the three types of facilities and for the public, workers and non-human biota (e.g., mammals, birds, fish) in each case.

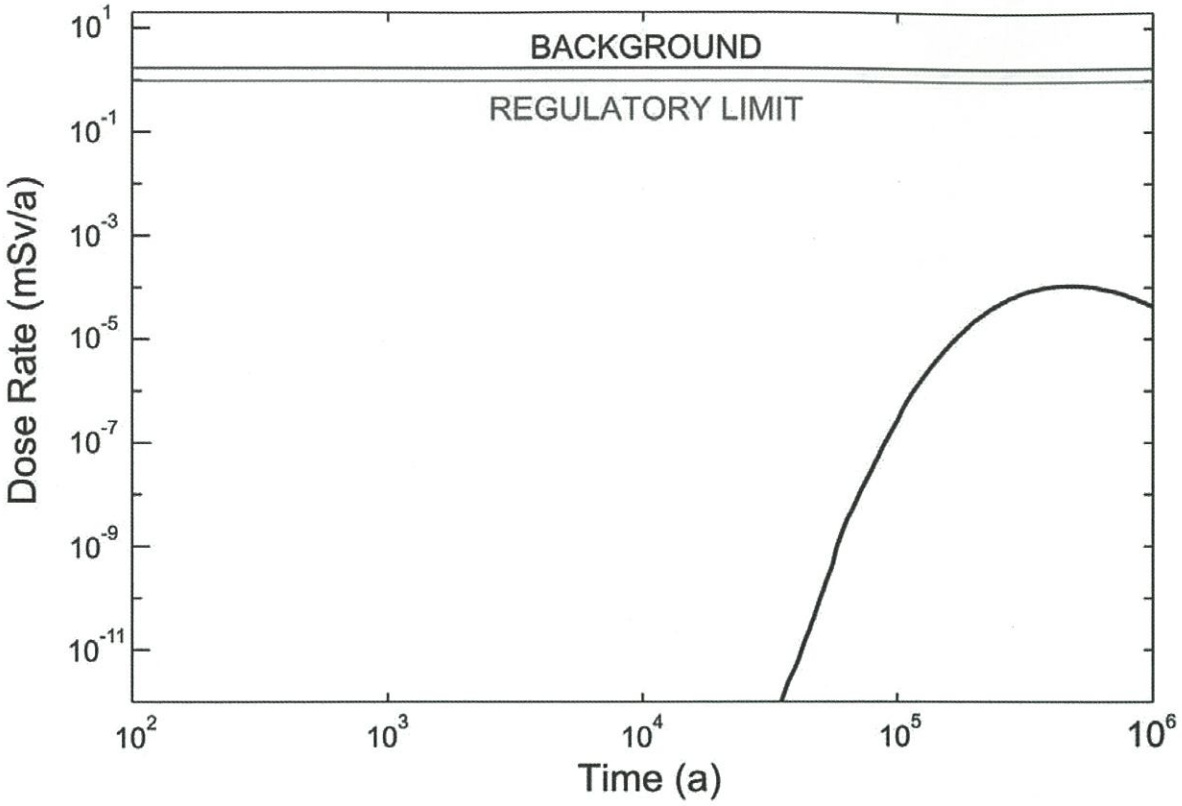
The dose estimates were made using a comprehensive pathways analysis (see Figure 1, 2 for pathways being considered). The dose estimate results for a deep geological repository and reactor-site extended storage are shown in Figures 3-7, respectively. Other routine and nonroutine scenarios are provided in Garisto, 2004.

V. Conclusions

The main conclusions from the risk-analysis are:

- Under current routine conditions, and based on available information, no significant impacts on human health or the environment, from any of the proposed management approaches are expected.
- Conventional industrial and/or transportation accidents may occur in the implementation of these methods, as with any large industrial project. Such risks can be mitigated by the implementation of safety programs including worker education, strict implementation of safety procedures, and monitoring of this implementation. Some small differences between the options can be expected regarding risk from conventional accidents. For example, transportation risk is smaller for storage at reactor site than at a centralized facility.

Figure 3: Dose Rate as a Function of Time for the post-Closure Stage of a Deep Geological Repository

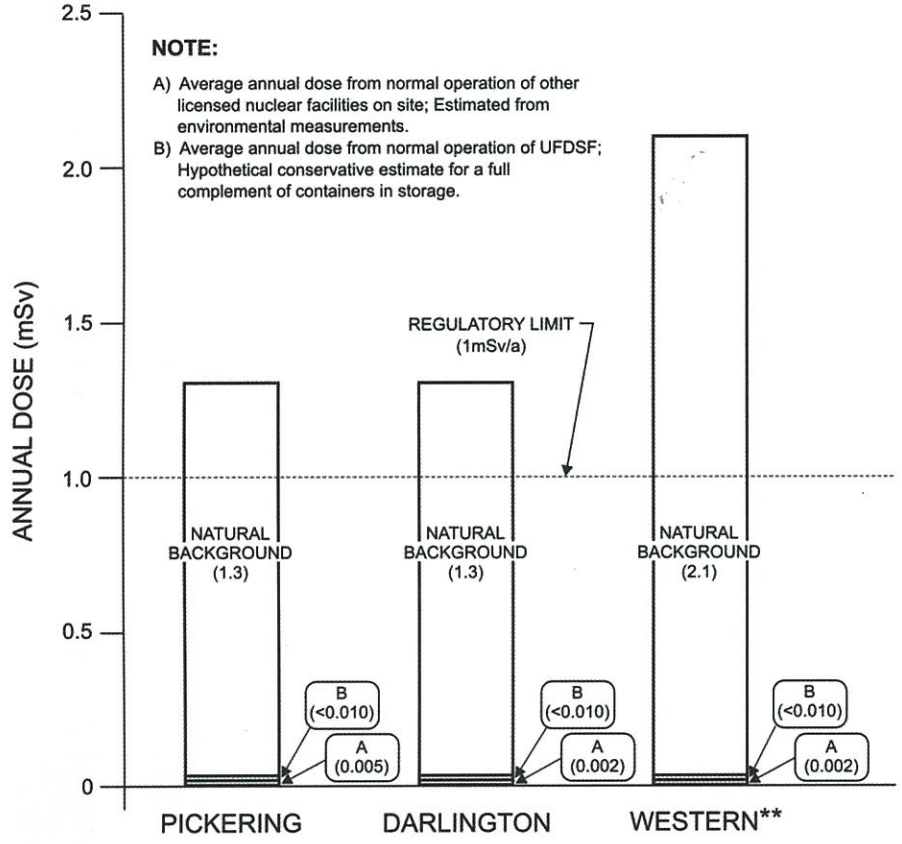


SOURCE: Adapted from Garisto et al, 2004

- Overall, except for negligible changes in radiological dose after container failure, the total risk from a Deep Geological Repository decreases with time due to radioactive decay and the inherent passive nature of this disposal method.
- Dose from inadvertent human intrusion was estimated for Deep Geological Disposal and shown to diminish with time. The probability of exposure was estimated to be less than onein- a-million per year for the first 1000 years after disposal. Site accessibility is expected to be higher for surface storage facility, especially in the event of institutional collapse. However, no analogous assessment is available for long-term storage facilities.
- Over the long term, there may be a requirement to relocate the used fuel for the reactor-site extended storage and perhaps centralized extended storage (e.g., for above-ground facilities). This may be due to potential rise in surface water levels caused by climate-change factors such as global warming. Monitoring of climate conditions may be used to warn of the need for used-fuel facility relocation. Also, the impact of a far-future glaciation scenario has not been addressed in existing documentation on reactor-site extended storage and centralized extended storage. The consideration of such a scenario may result in such facilities having to be relocated, prior to glaciation, to avoid glaciation related impacts.

  The risks associated with the extension of storage time at either reactor sites or a centralized location to very long times has not been studied quantitatively in detail. Such an assessment requires for example, an understanding of risks associated with potential loss of integrity of the fuel bundles (i.e., the cladding and potentially the fuel). However, a specific monitoring program can be developed to focus on this aspect of the performance of storage systems, to determine potential risk and decide on mitigation measures.
- Although radioactivity is often perceived as being a high risk factor associated with used fuel management, the estimated exposure doses for the various options are generally low in comparison to established national and international benchmarks.
- Current information on risks associated with the various approaches supports the safety of these systems under current conditions. Security risks such as acts of terrorism have not been evaluated in the present study.
- Several gaps in the risk estimates and its documentation were noted. However, none of these are considered to affect the overall conclusions from this study. They include a need:
  1. to update the documentation of risk assessments to ensure that they consider the current reference design concepts and alternatives studied by the NWMO;

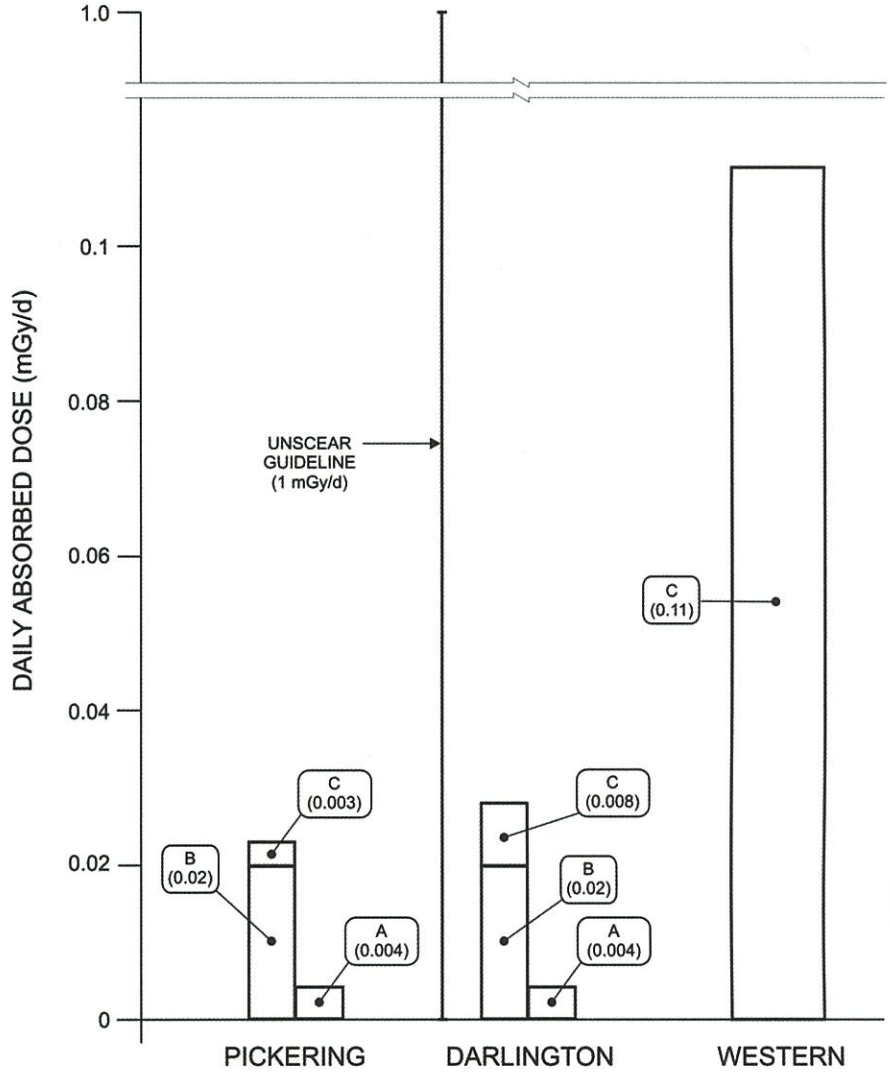
Figure 4: Annual Dose to a Member of the Public for Reactor-Site Extended Storage: Operating Conditions in Existing Facilities



* The operating experience from existing facilities has confirmed that the current dose rate to the public at the property boundary is less than 1% of the regulatory limit.

** Western refers to the Western Management Facility at the Bruce Site

Figure 5: Daily Dose to Non-Human Biota (Operational – Normal)



NOTE:

A) Low end of range of daily dose from natural background.
B) High end of range of daily dose from natural background.
C) Average daily dose from normal operation at Used Fuel Dry Storage Facility (UFDSF).

2. to complete the documentation of risk assessment from chemical emissions;
3. to directly address potential specific human receptors (e.g., a specific documentation of potential risk to Aboriginals would enhance the transparency of the assessment, although most diets assumed in the current assessment encompass those of Aboriginal receptors);
4. to complete and update the assessment of ecological risk to non-human biota (e.g., mammals, birds, fish).
5. to re-evaluate the risk from transportation and if necessary, to develop mitigation measures to improve transportation safety.

In our opinion, these gaps will need to be addressed as part of the implementation of the approach selected by the federal Government for long-term management of nuclear fuel waste.

Acknowledgements

This study was supported in part by the Canadian Nuclear Waste Management Organization. We would like to acknowledge useful technical discussions with H. Román, T. Kempe, M. Jensen, F. Garisto, P. Gierszewski and A. Khan.

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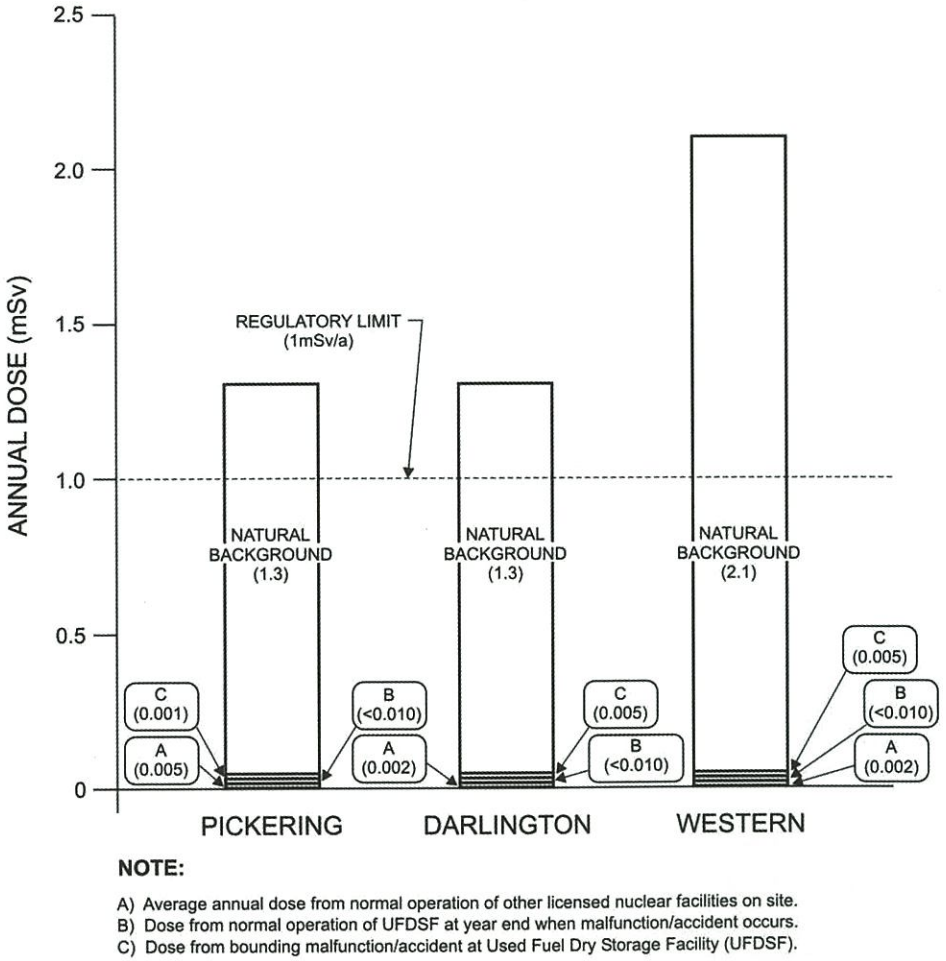

Figure 6: Dose to a Member of the Public During a Hypothetical Year in Which a Bounding Malfunction/Accident Occurs at UFDSF

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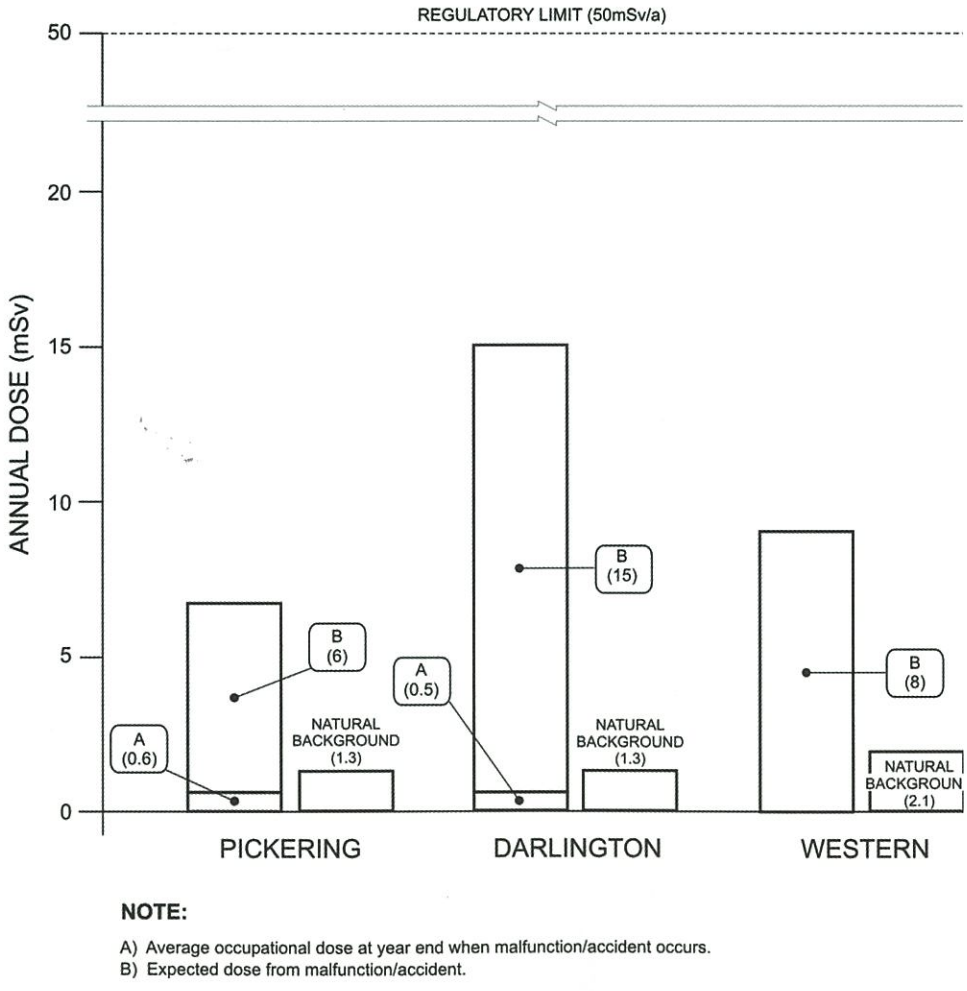

Figure 7: Nuclear Energy Worker (NEW) Dose During a Hypothetical Year in Which a Bounding Malfunction/Accident Occurs at UFDSF

Environmental assessment of the dismantling of 12 Russian nuclear submarines

by: Duncan Moffett & Peter Craig[1], Mark Gerchikov[2], Michael J. Washer[3], Konstantin Kulikov[4]

Ed. Note: *The following paper was presented at the Canadian Nuclear Society's conference on Waste Management, Decommissioning and Environmental Restoration, held in Ottawa, Ontario, May 8 - 11, 2005. It deals with an international project quite different from most of those discussed.*

Abstract

The project to dismantle 12 out-of-service nuclear submarines ("the dismantling project") consists of all operations and activities that are required for the defuelling and recycling of 12 Russian nuclear submarines at Zvezdochka shipyard in Severodvinsk, northwest Russia. The dismantling began in late 2004 and will continue over the next four years. The dismantling project will secure the highly enriched spent nuclear fuel (SNF) currently onboard the 12 submarines by re-incorporating it into the Russian nuclear fuel cycle, thereby combating the proliferation of weapons and materials of mass destruction.

The assessment was conducted over a two month period in 2004, including a study team visit to the dismantling site. A systemic multi-step screening approach was used to focus a team visit to the site and allow production of a thorough Screening Report on an accelerated schedule. Potential effects were methodically assessed and opportunities for environmental performance improvement identified. Methods and procedures for conducting EAs on Canadian nuclear projects were applied in this challenging international project.

The assessment concluded that the project is not likely to result in any significant adverse effects on the environment, taking into account identified mitigation measures. A follow-up program is planned to confirm the validity of this conclusion.

Background

The Project to Dismantle 12 Out-of-service Nuclear Submarines ("the dismantling project") consists of all operations and activities that are required for the defuelling and recycling of 12 Russian Victor class nuclear submarines at Zvezdochka shipyard in Severodvinsk, Russia, with Canadian financial assistance. Figure 1, below, shows the location of the shipyard. Figure 2 includes a figure of a Victor class submarine.

The dismantling project will safely secure the highly-enriched spent nuclear fuel (SNF) currently onboard the 12 submarines by re-incorporating it into the Russian nuclear fuel cycle, thereby combating the proliferation of weapons and materials of mass destruction. In addition, the project will enhance the Arctic environment through the removal of a threat of radioactive and chemical pollution from deteriorating submarines stored afloat.

The dismantling project is a component of Canada's contribution to the broader Global Partnership Initiative against weapons and materials of mass destruction. Canada now joins other international partners, including the United States, Norway, Japan and the United Kingdom in the securing of SNF and the broad international initiative to rid the world's oceans of old, retired nuclear submarines.

Regulatory Framework

Foreign Affairs Canada (FAC) is responsible for the project through the provision of funds. FAC will carry out the Canadian commitments flowing from the Russian nuclear submarine dismantling initiative. The Zvezdochka shipyard, which has successfully dismantled ten nuclear submarines with foreign financial assistance, will carry out dismantling with Canadian oversight and in accordance with a comprehensive environmental management plan.

Because the project is not described in the Canadian Environmental Assessment Act (CEAA) Exclusion List Regulations, FAC determined that a screening must be conducted for the project and that a Screening Report must be prepared, pursuant to paragraph 14 of the CEAA Projects Outside Canada Environmental Assessment Regulations. As the responsible agency for the environmental assessment (EA) under CEAA, FAC determined the scope of the project and the scope of the assessment, in accordance with the CEAA and best current practice. FAC employed qualified special-

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2 Nuclear Safety Solutions Ltd., Toronto, Ontario, M5G 1X6
3 Foreign Affairs Canada, Ottawa, Ontario, K1A 0G2
4 NIPTB Onega, Severodvinsk, Russia

Figure 1: Location of the Zvezdochka Shipyard

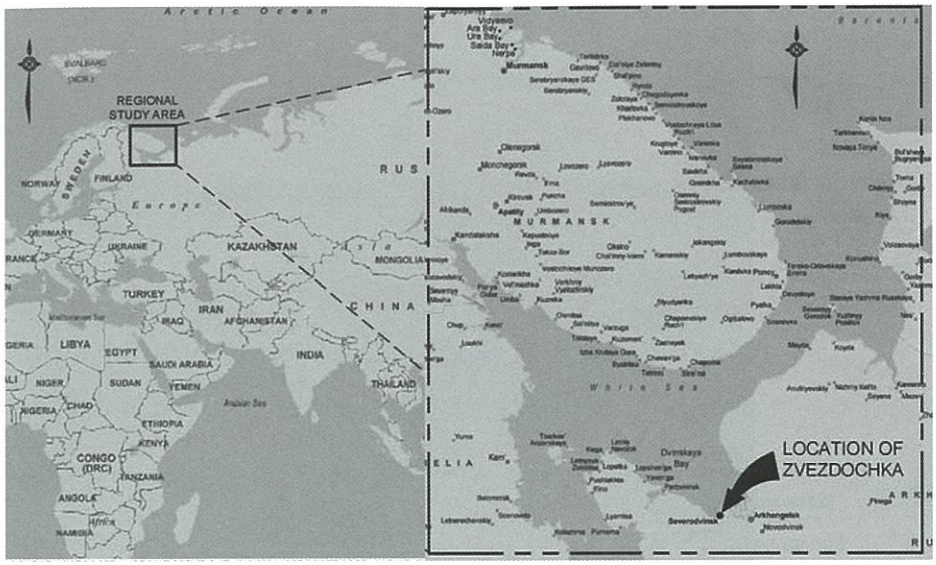
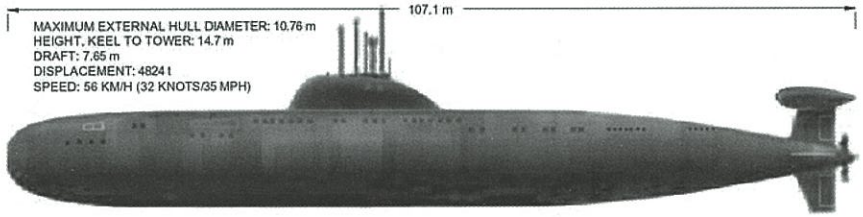


Figure 2: Victor Class Submarine

Armament (removed when withdrawn from service)
Missiles: SLCM - SS-N-21 Sampson fired from 21 in (533 mm) tubes A/S - SS-N-15 fired from 21 in (533 mm) tubes SS-N-16 A/B fired from 25.6 in (650 mm) tubes, payload Type 45 torpedo
Torpedos: 2 - 21 in (533 mm) & 4 - 25.6 in (650 mm) tubes. Type 53 and Type 65



ists to conduct the assessment, supervised the assessment, conducted stakeholder and public consultation throughout the assessment, and reviewed the results of the assessment.

Environmental Assessment Process

In accordance with the scope of the assessment, the process to conduct and document the EA involves the following major steps:

- Describing the physical works and activities that constitute the project and identifying those that have a potential to interface with the environment;
- Assessing the likely environmental effects of the project, identifying mitigation measures and residual effects, and determining the significance of residual effects; and
- Conducting public and stakeholder consultation in Canada and developing a plan for follow-up to verify the conclusion of the EA.

The assessment is conducted for normal operations and for malfunctions and accidents with a reasonable probability of occurring.

Project Works and Activities

The dismantling project encompasses a chain of activities beginning with the preparation of a submarine for transport to Zvezdochka and ending with the salvage of uncontaminated materials, shipment of SNF for reprocessing at

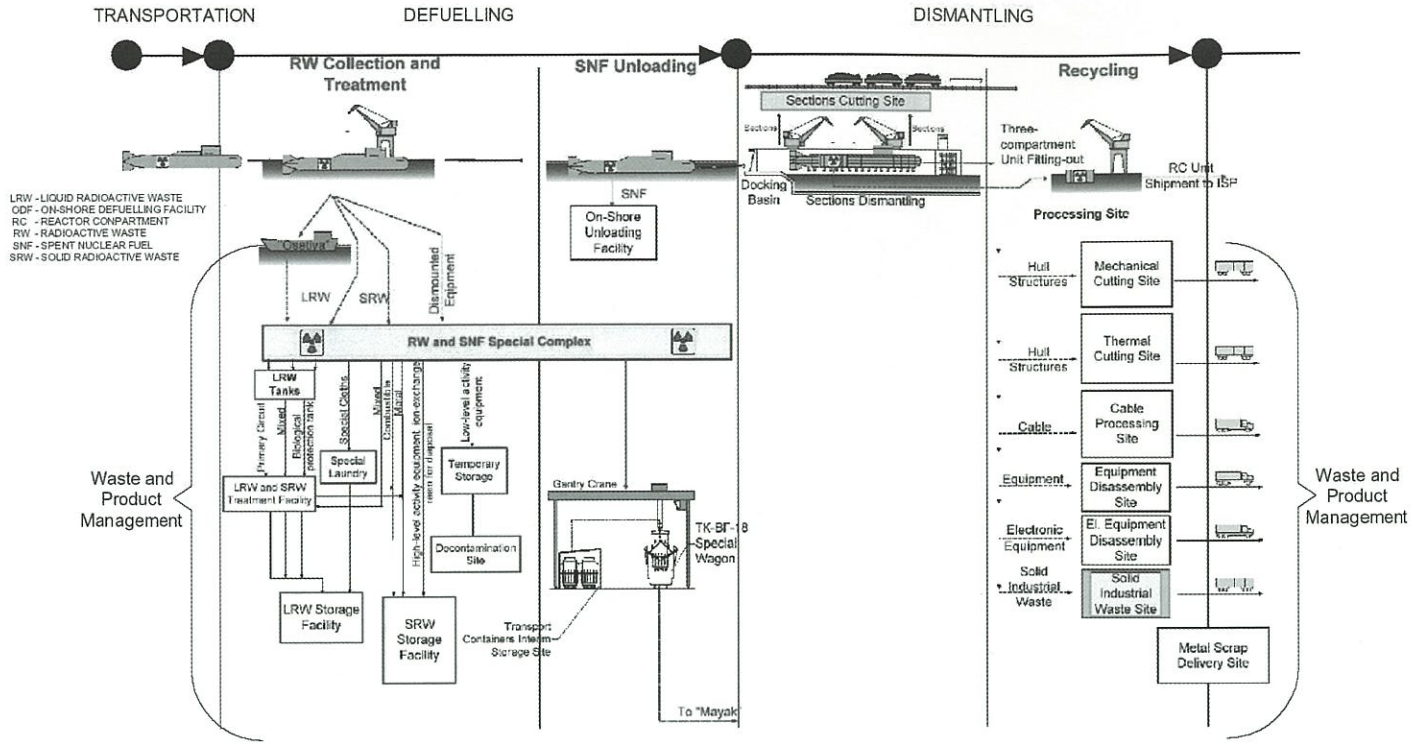


Figure 3: Schematic of Major Aspects of the Project

the Mayak Chemical Combine ("Mayak"), and receipt of a reactor compartment at Saida Bay for long-term, secure management. Figure 3 presents the major aspects of the project schematically.

For the purposes of the EA, 13 project works and activities for the project are identified for the assessment of effects:

- Preparation for Transit, which includes crew training, draining and depressurizing systems in preparation for transport and the inspection and modification of a submarine to ensure buoyancy during towing;
- Transportation of Submarine, which includes towing of a submarine from its point of origin to Zvezdochka;
- Arrival and Acceptance, which includes mooring of a submarine at Zvezdochka;
- Preparations for Reactor Defuelling, which includes removal of flammable materials and some radioactive waste from a submarine and metal work in preparation for bringing crane-borne defuelling tools to the reactor;
- Reactor Defuelling, which includes opening reactor lid, removing SNF from the reactor and transferring the fuel to specially-designed transport containers;
- Management of Spent Fuel, which includes loading special rail cars with filled transport containers to transport SNF by rail to the reprocessing facility at Mayak in the Southern Urals;
- Preparation for Submarine Dismantlement, which includes moving the defuelled submarine to either the docking basin (and its slipways) or to a floating dock, final cleanout of the submarine and preparation for major cutting and disassembly;
- Construction of Three-Compartment Unit, which includes cutting out the reactor compartment and one compartment to either side to create a seaworthy package containing the remaining radioactive components of the submarine;
- Dismantlement of Fore & Aft Compartments, which includes processing the submarine components remaining after formation of the three-compartment unit;
- Preparation of Reactor Compartment for Transportation, which includes outfitting the three-compartment unit for towing;
- Transportation of Reactor Compartment, which includes towing the threecompartment unit from Zvezdochka to Saida Bay, near Murmansk, for long-term management;
- Management of Radioactive Wastes, which includes the processing of radioactive wastes by existing facilities at Zvezdochka; and
- Management of Non-Radioactive Wastes & Products, which includes the processing of non-radioactive wastes and saleable products by existing facilities at Zvezdochka.

In addition, the Screening Report describes two accident categories:

- Conventional Accidents, which includes representative accidents with a reasonable probability of occurrence which do not result in a release of radioactivity (sinking, fire, spill of hazardous liquid); and
- Nuclear Accidents, which includes representative acci-

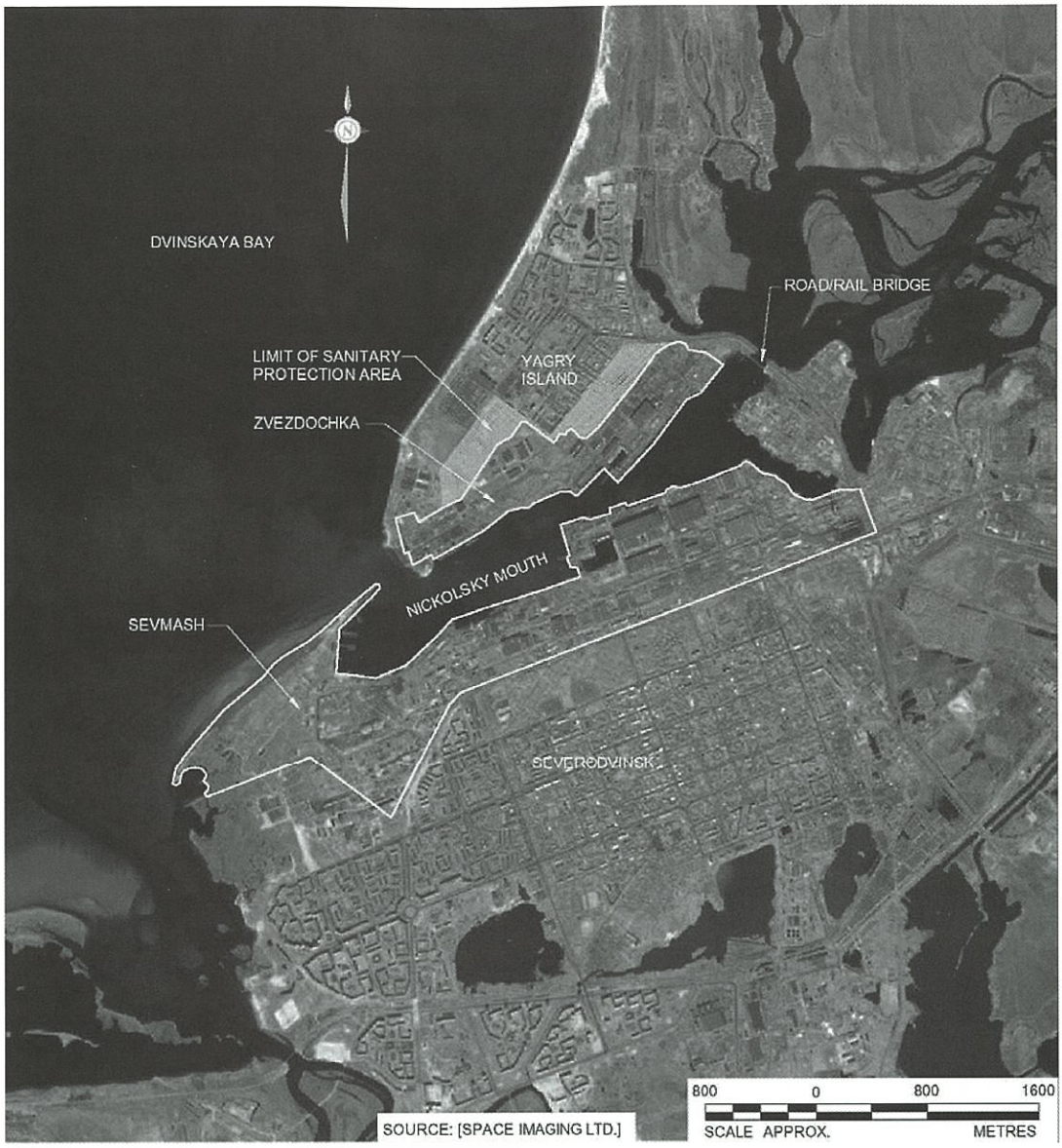


Figure 4: Local Study Area

dents with a reasonable probability of occurrence which do result in a release of radioactivity.

Existing Environment

The existing environment is described by focusing on areas where there are known or likely effects of the project. The spatial boundaries of EA study encompass the city of Severodvinsk, Kola Peninsula and adjacent areas of the Barents Sea and White Sea (see Figure 1) and the existing environment is described for this area. The existing environment is described in detail for the local study area, shown on Figure 4, and includes a description of the conditions with respect to the six environmental components defined for the EA study, as follows:

- Radiation (represents environmental radiation and radioactivity, including radionuclide emissions and doses to humans and biota). This includes five sub-components: radioactivity in air, radioactivity in water, dose to workers, dose to members of the public, and dose to biota.
- Atmospheric Environment (represents air quality with respect to non-radiological parameters, including noise, and considers meteorological and climatic conditions). This includes two subcomponents: air quality and noise.
- Surface Water Resources (represents surface water quality and conditions). This includes one subcomponent: water quality.
- Aquatic and Terrestrial Ecology (represents aquatic and terrestrial biota and habitat). This includes two subcomponents: aquatic habitat and biota, and terrestrial habitat and biota.
- Geology and Hydrogeology (represents soil and groundwater quality with respect to non-radioactive parameters,

and considers geological and hydrogeological conditions). This includes two subcomponents: soil quality and groundwater quality.

- Socio-Economic, Health and Cultural Considerations (represents populations, economic base, services, communities, occupational and public health, land use, cultural and heritage resources, and traditional use of lands and resources by Aboriginal persons). This includes four subcomponents: occupational health, economic base, residents and communities and cultural and heritage resources.

Assessment of Project-Related Effects under Normal Conditions

An initial screening of each of the project works and activities is carried out individually for the six environmental components and their subcomponents. A total of 208 possibilities for project interfaces with the environment are evaluated.

The results of the initial screening are summarized on a matrix that identifies 155 potential interactions between the project and the environment. A second screening step evaluates each of the identified potential interactions to determine which of them are likely to result in a measurable change in the environment, compared with existing conditions. A total of 65 interactions between the project works and activities and the environment resulting in possible measurable change are identified for detailed assessment. These include radiation doses to workers and releases to the atmospheric environment as well as a number of effects from the identified representative malfunctions and accidents.

The likely effects associated with each of these 65 measurable changes are considered and mitigation measures to eliminate, reduce or control any adverse effects are identified.

The detailed assessment identifies no residual adverse effects once mitigation is applied. Fifteen positive effects are identified, including sustaining high-skill employment at Zvezdochka and reducing real and perceived risks related to the out-of-service submarines.

Assessment of the Effects of Potential Malfunctions and Accidents

Twenty-four possible conventional accident scenarios and sixteen nuclear accident scenarios are screened to identify conservative, representative accident types for detailed assessment with respect to each of the six environmental components.

Detailed assessments of nuclear and conventional accidents are carried out for:

- Submarine sinkings;
- Fires; and
- Large spills.

Changes in the environment are determined to be local and temporary. Detailed analysis shows that, taking into account mitigation measures, representative accidents, both nuclear and nonnuclear, are unlikely to lead to residual adverse effects.

Uncontrolled criticality in SNF is shown to have a probability of less than one in a million per decommissioned submarine because of multiple safeguards against its occurrence and a dearth of possibilities for initiation.

Assessment of the Effects of the Environment on the Project

Just as the project has an effect on the environment, the environment may have effects on the project. The project comprises sea transport of seaworthy vessels along well-established sea routes and dismantling at an existing, experienced facility. Many mitigating factors are included in the project that address natural hazards. The project is subject to an environment management plan, a towing plan, and safety analyses as well as an extensive framework of Russian and international regulations.

Screening and assessment of the possible interactions between the project and ice, extreme weather, tsunami, storm surge, biota and earthquake show that the environment is unlikely to have an adverse effect on the project when mitigation measures are considered.

Assessment of Cumulative Effects

Other projects and activities with the potential to create similar effects as the dismantling project in the same effective area and timeframe are identified. Overall shipyard environmental performance is considered.

As no significant residual adverse effects are anticipated from the project, no residual adverse cumulative effects are predicted. Monitoring of environmental media is expected to continue as part of research and regulatory oversight in the region. It is anticipated that cumulative effects would detected through monitoring of environmental media, allowing modification of the project and/or remediation.

Public and Stakeholder Consultation

Throughout the EA, FAC carried out a focussed consultation program using multiple means to solicit input and engagement from stakeholders.

An initial press release and backgrounder was issued to the media, including wire services, on August 4th 2004. FAC maintains a website for the dismantling project, at http://www.dfaitmaeci. gc.ca/foreign_policy/global_partnership/submarine-en.asp (English) and http://www.dfaitmaeci. gc.ca/foreign_policy/global_partnership/submarine-fr.asp (French).

On August 23, 2004, FAC also distributed an initial notification letter (Foreign Affairs Canada Document 4025-03/SOW3) to potentially interested stakeholders, ensuring that they were aware of the EA. The letter also confirmed FAC's commitment to disseminating copies of the Final EA Screening Report.

Follow-up Program

A follow-up program is identified to assist in determining if the direct and cumulative effects of the project are as predicted in the EA. Follow-up will also confirm whether identi-

fied mitigation measures are effective and, thus, determine if new mitigation strategies are required.

As a condition of Canadian financial assistance for dismantling, FAC is requiring that a comprehensive environmental management plan be implemented at Zvezdochka. The plan will conform to accepted international norms and standards (ISO 14001).

EA follow-up requirements will be incorporated into a formal Environmental Management Plan. FAC will verify implementation through required shipyard reporting and periodic inspections by FAC personnel and contractors. Canadian financial assistance for dismantling, i.e., the dismantling project, is contingent on continuous demonstration of Zvezdochka's adherence to sound environmental practices and continuous improvement as documented in the Environmental Management Plan.

A preliminary list of required follow-up activities is identified and includes the following:

Conclusion

Taking into account the findings of the assessment, including identified mitigation measures, it is FAC's conclusion that the project is not likely to result in any significant adverse effects on the environment. A planned follow-up program will confirm the validity of this conclusion. The lack of likely significant adverse effects is complemented by three key benefits from project implementation:

1. Transfer of highly-enriched SNF from a floating submarine to Russian fuel cycle facilities ashore, which ensures appropriate safeguards.
2. Removal of environmental risks associated with open-ended long-term storage of nuclear powered vessels afloat.
3. Provision of employment at Zvezdochka shipyard in Severodvinsk and in the locations in Murmansk region where the submarine will be prepared for towing.

With the completion of the EA, FAC proceeded with the implementation of the decommissioning project. Decommissioning of the first submarine was begun in late 2004 and is scheduled for completion by mid-2005.

Acknowledgements

The assessment would not have been possible without provision of the necessary information, hospitality and technical advice by managers and experts from GMP Zvezdochka.

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Focus	Follow-Up Activity
Workers/Public	Set up a system to automatically collate and analyse worker dose data and reduce the radiation exposure of workers by introducing the ALARA principle and removing the link between worker exposure and benefits
	Review training, emergency preparedness, emergency response plans, and worker medical monitoring data
	Verify appropriate workplace ventilation and PPE use
	Dissemination of risk analyses and project information to the public (to the degree allowed by security and commercial interests)
Air/Water	Identify the source of the tritium leak on site and implementation of measures to stop the leakage
	Confirm the implementation of best practices for handling volatiles at Zvezdochka and improvements in surface conditions in cutting areas
	Maximize mechanical cutting, as opposed to thermal cutting, in order to limit air emissions
	Verify air emissions control performance for ventilation systems and that there are negligible onventional contaminants in high pressure gas systems requiring venting
	Periodic review of air quality data to optimize monitoring efforts and target any necessary corrective actions, and discharged effluent and stormwater data to optimize monitoring efforts and target any necessary corrective actions
	Confirm that tug engines for towing activities are in good operating condition, to limit emissions
	Confirm the Russian commitment to expeditious recovery of sunken submarine if monitoring data warrants
Wastes	Review of procedures for collating waste inventory data
	Verify that there are plans for the long-term management and disposal of solid radioactive wastes and that appropriate waste management facilities and practices are used at facilities where submarines are prepared for transport (note that this information is available for Zvezdochka)
	Confirm planned improvements in containment and isolation of waste storage areas

Emergency Response to a Nuclear Power Reactor Accident

W.R.Bruce[1], L.W.Shemilt[2] and A.T.Stewart[3]

Ed. Note: *Although the report to which this article refers was submitted back in 1996 it has only recently become publicly available. The author's offered this note to the CNS Bulletin because they feel that their main arguments remain valid.*

Forward

The Province of Ontario recently reviewed its plans for an emergency response to a possible nuclear power reactor accident that might contaminate some of the surrounding countryside with radioactivity. The Province requested some comments from a small Panel (the present authors) that was formed for this purpose by the Royal Society of Canada and the Canadian Academy of Engineering.

This note is a summary of our findings[1]. It presents, first, a short account of the probabilistic risk assessment of accidents and the probability and severity of accidents for which response training should be undertaken; and second, the mitigation of possible harmful effects of escaped radiation and the radiation level at which action should be taken.

Probability and Severity

In the unlikely event of a serious nuclear accident in one of Ontario's power reactors, there may need to be an emergency response to protect people living nearby from injury by radiation. The emergency team needs to practise by imagining an accident scenario and planning in detail its response to the accident.

From the probabilistic risk assessment studies available for the power reactors of Ontario we suggested that accidents that result from a credible series of events that could occur with a probability of at least one in ten million reactor years, be the basis for response training. Accidents of this probability of occurrence can expose an individual at the 1 km boundary of the power station, to a dose of about 200 mSv in 24 hours, and at 6 km about 20 mSv. (To place these radiation doses in context; we all receive an average of about 30 mSv a year from natural and medical sources. A dose of 200-300 mSv in a day can cause nausea and vomiting. An exposure of 5000 mSv will cause serious illness from which about 50% will die.)

Training for a realistic accident will develop the skills needed to cope with the unexpected. While our recommendation was based on what was considered to be the best current probabilistic safety evaluation analysis, such methodologies continue to be developed and improved. We also observed the continuing enhancement of reactor operation conditions and design of safety features in recent years, a factor that is likely to continue.

Mitigation of possible harmful effects

In an accident the Emergency Planning Authority must exercise good judgment to prevent undue concerns - even panic - in the public when advising any action to mitigate the possible harm of radiation. For example: if some radioactive gases or particles are released to the air, the resultant radiation downwind must be monitored. If the radiation from the gas plume is high enough to cause immediate injury, evacuation is necessary. If however the radiation field is low such that even several days exposure does not accumulate a serious dose, then evacuation may not be wise.

Any emergency measures taken must create more good than harm. Since the radiation from the plume itself may change - increase or even cease - difficult decisions must be made. The purpose of this letter is to point out that wise and quick judgment may be hampered by the response rules themselves. We illustrate this by quoting sections of the response criteria currently recommended both internationally and for Ontario. They are rather complex and we will argue, unnecessarily so.

The current intervention criteria of the International Atomic Energy Agency[2] in Vienna are shown in Table 1.

Application

1. The PALS for exposure control measures are expressed in terms of, and shall be related to, the highest projected dose likely to be received by the most exposed individual in the relevant critical group (see Glossary in Annex X, page 187, for definitions of these terms).

Notes

1. The effective dose PALs above were adopted by the province in 1984 upon the recommendation of Working Group #3. The latest authoritative international guidance on the subject confirms their continuing valid-

1 Division of Epidemiology and Statistics, Ontario Cancer Institute / University Health Network, and Department of Nutritional Sciences, University of Toronto

2 Department of Chemical Engineering, McMaster University

3 Department of Physics, Queen's University

ity. (Cf. *International Basic Safety Standards for Protection Against Ionizing Radiation..... International Atomic Energy Agency. Safety Series No 115-I. Vienna, 1994).*

2. The intervention levels recommended in the International Basis Standards (IBSS) are in terms of avertabledose, whereas the Ontario PALs are in the form of projected dose. This difference is essentially academic since the PALs are used most often in decisions on protective measures taken prior to any radiation exposure, and hence are being compared to avertable dose. In most cases where radiation exposure is already occurring, it would be neither possible nor desirable to base protective action decisions on calculations involving PALs; instead, they would be based on preplanned responses and conservative estimates. (See Operational Response Strategy, section 6.5, page 64).
3. It is necessary to express PALs in terms of projected dose in order to conform to the Plan principle that protective measures should avert (or at least reduce) risk resulting from radiation exposure. Thus, expressed as projected doses, PALs in essence represent levels of risk from potential exposure which justifies the initiation of various protective measures. The risk commences when radiation exposure begins, and not when the emergency management organization starts to use PALs to assess the need for protective measures. If this assessment occurs in some circumstances after radiation exposure has commenced, the use of PALs in the prescribed manner will fulfill the principle adopted in this Plan.
4. The PALs for exposure control measures are prescribed as a range for each protective measure because the decision on applying a protective measure is based not only on technical factors but also on operational and public policy considerations. To enable these considerations to be applied, it is appropriate to provide decision makers with technical advice ranging between when a measure should be considered for application (on purely technical grounds) and when it becomes necessary on the same grounds. This span also allows for the fact that there are inherent uncertainties the results of technical assessments.
5. The factor of 10 used to obtain the thyroid dose equivalent to the effective dose is based on the assumption that non-fatal or curable cancers of the thyroid carry the same socioeconomic impact as fatal thyroid cancers. This assumption is a valid one in the context of public safety and the low dose (or risk) levels used in the PALs.

Table 1 Intervention levels recommended by the International Atomic Energy Agency for emergency protective measures.

Protective action	Generic intervention level (Dose avertable by the protective action)[a,b]
Sheltering	10 mSv[c]
Evacuation	50 mSv[d]
Iodine prophylactics	100 mSv[e]

Table 2 Ontario Nuclear Emergency Plan, 1999, (Interim Plan)

Protective Action Levels (PALS)				
Protective Measure	Lower Level		Upper Level	
	Effective Dose	Thyroid Dose	Effective Dose	Thyroid Dose
Sheltering	1 mSv	10 mSv	10 mSv	100 mSv
Evacuation	10 mSv	100 mSv	100 mSv	1 Sv
Thyroid Blocking		100 mSv		1 Sv

It can be seen that these "Protective Action Levels" are not simple to understand and apply. Our comments follow:

Concerning sheltering: For most Canadian houses the radiation from an overhead plume of radioactive material is reduced by 10%-50% inside compared to outside and thus sheltering in a house with windows closed will reduce exposure by this amount. The lower floors of a multi-storied building will provide better protection. However in any serious accident even 50% reduction of radiation is unlikely to confer safety. Thus we recommend that "sheltering" should be the automatic response to any radiation threat while awaiting evacuation; the only safe procedure.

Concerning thyroid blocking: Saturating the body with iodine by taking a 130 mg tablet of potassium iodide (KI) will certainly prevent absorbing radioactive iodine from the plume if taken just before the plume arrives. The effectiveness diminishes steadily; it is down to half as effective if taken two or three hours later. However if there is enough radioactive iodine in the plume to be a risk, then the total radioactivity in the plume is very much greater and results in the radiation risk to the whole body that is 100 times or more

a These levels are of avertable dose, i.e. the action should be taken if the dose that can be averted by the action, taking into account the loss of effectiveness due to anydelays or for other practical reason, is greater than the figure given (see para. 426).

b The levels in all cases refer to the average over suitable samples of the population, not to the most exposed individuals (see para. 429-432).

c Sheltering is not recommended for longer than 2 days. Authorities may wish to recommend sheltering for lower intervention levels for shorter periods or so as to facilitate further countermeasures, e.g. evacuation.

d Evacuation is not recommended for a period of longer than 1 week. Authorities may wish to initiate evacuation at lower intervention levels, for shorter periods and also where evacuation can be carried out quickly and easily, e.g. for small groups of people. Higher intervention levels may be appropriate in situations in which evacuation would be difficult, e.g. for large population groups or with inadequate transport.

e Avertable dose to the thyroid. For practical reasons one intervention level is recommended for all age groups.

greater than the risk to the thyroid. Thus while the thyroid gland itself can be protected, this procedure eliminates probably less than 1% of the total risk. In addition, the taking a KI tablet may confer a false sense of security that is dangerous. Again evacuation is the only safe procedure.

Conclusion

These ideas suggest that there should be only one "intervention" or "protective action" and that is evacuation when the estimated averted dose[4] is in the range[5] 10-50 mSv, or about 20 mSv if a single dose level is preferred. (It should be recalled that the averaged total annual dose to Canadians is about 30 mSv) The principal advantage of this suggestion is simplicity. Only one action to mitigate possible harm from radiation makes the emergency response action and training much easier and more straightforward.

The action of sheltering and of taking KI tablets are, by themselves, not very effective. And both may give a dangerous false sense of security. Another major advantage of a single criterion for action is that officers of the emergency response team and local police can carry a simple radiation monitor (suggested marking-mSv/day) that will enable them to make decisions in the field about evacuating or not evacuation various neighbourhoods.

1 The "Report to the Ministry of Environment and Energy concerning ....the Province of Ontario's Nuclear Emergency Plan" was submitted in 1996. The complete Report may be found at the Royal Society's website; www.rsc.ca .

2 International Atomic Energy Agency, Vienna 1994, Safety Series No. 109, p 41.

3 Province of Ontario Nuclear Emergency Plan, 1999, Part 1,Provincial Master Plan (Interim Plan) p 97-99.

4 Averted dose is defined in Table 1, footnote a.

5 The concept of a range of Action Levels is discussed in Note 4 of Table 2.

ICAPP 2005

- personal observations from a conference half a world away

by Fred Boyd

ICAPP 2005, the 2005 International Congress on Advances in Nuclear Power Plants, was held in Seoul, Korea, May 15 - 18, 2005. Following are some impressions of that meeting and its venue.

Having had a long experience working with the nuclear community in Korea I decided to attend the ICAPP 2005 meeting in Seoul as an excuse to have one more visit to that interesting country,

For reasons of economy I flew through Chicago, even though I realized transiting in the USA these days can add complications. Going out proved to be relatively smooth since I cleared customs in Ottawa. Returning was another matter. When my bag did not arrive with me in Ottawa my first reaction was to blame to airlines. Two days later, however, when the bag was finally delivered, I found inside a note from US Homeland Security informing me that it had been selected for opening and search. Some of my documents from the conference were missing. Another small indication of the paranoia that still pervades our neighbour.

ICAPP 2005 was held in a very modern (and very expensive) "five star" hotel in the new business area of Seoul on the south side of the Han River. When I first was in Korea, in 1978, that side of the river was undeveloped. Now it hosts striking new office buildings, wide avenues filled with cars, and crowds of people looking very busy. Most of the people looked young even though the government is expressing concern about the low birth rate, and very few were overweight, despite eating huge bowls of rice in the food courts.

Surprisingly, most of the cars were large, the smallest being the Hyundai Sonata, and almost all domestic. Apparently Korea builds small cars just for export, even though Korea imports all of its oil. The architecture of the buildings was particularly attractive, being imaginative but not extreme, a stark contrast to the bland buildings of my home town Ottawa.

The conference attracted about 700 delegates with about half from Korea. It was structured in the typical manner, with daily plenary sessions and numerous parallel technical sessions. AECL's Paul Fehrenbach gave the one Canadian plenary paper, on a Multi-displinary Approach for Implementation of New Plants For some reason the organizers arranged ridiculously long days, from 8 am to 7 pm. Many delegates wondered why they did not add another day as had been originally advertised. There was a modest exhibition, mostly of Korean organizations with the notable exception of AREVA advertising its new EPR design (being built in Finland) and BNFL/Westinghouse promoting their AP 1000 design, now in the USNRC design approval program.

From the displays and presentations it is apparent that the Korean nuclear program is progressing strongly. There are now 17 nuclear units operating, producing about 40 % of the nations electricity, with four more under construction, two of their OPR 1000 design at the Kori site and two of their new APR 1400 design at the Wolsong site. Both of those designs are Korean evolutions of the Combustion Engineering AP 600 design they purchased in the mid 1990s. Several further units are in the planning stage. There were indications that they would like to export these designs

All of the nuclear plants are operated by Korea Hydro and Nuclear Power (KHNP), a division of Korea Electric Power Company (KEPCO) a government owned corporation. KHNP has an excellent website, in English as well as Korean, which even includes a movie presenting the benefits of nuclear power. (Perhaps our nuclear utilities should consider this.)

Despite the ever present threat of North Korea and the pervading sadness the division of the peninsula invokes, Korea has become a vibrant, modern, efficient country. Seoul has become a very attractive, albeit quite large city, with about 10 million inhabitants. The government has directed the construction of satellite cities that now house another seven million. But there is an attractive and efficient subway system and the city has reclaimed the banks of the Han River and created pleasant parks. The countryside is remarkably free of development, partially due to the mountainous nature of much of the country but also, according to locals, the desire of most Koreans to live in the city. "Everyone must have their cell 'phone", I was told more than once.

The city and country exude a confidence based on the remarkable growth and development achieved over the past two and a half decades. In a parallel vein, in the same period the Korean nuclear program has gone from the beginnings of two units of foreign design and largely foreign manufacture to an integrated industry with the capacity to build nuclear power plants equal to any in the world.

Refurbishment of CIRUS Reactor *by R. C. Sharma and S.K. Agarwal*

Ed Note: *The following article is extracted from one in the BARC Newsletter, a publication of the Bhaba Atomic Research Centre, Mumbai, India. CIRUS is a research reactor based on the NRX design, built in the late 1950s.*

Refurbishment

During early nineties, signs of ageing started surfacing. The availability factor of the reactor started declining due to the increase in the frequency of equipment outages and the considerable effort and time requirement for bringing the equipment back into service after repairs.

Therefore, at that point of time, detailed ageing study on reactor systems, structures and components was undertaken to examine in detail the technical viability of extending life of the reactor with the aim of allowing another 10 to 15 years of intensive continued operation of CIRUS.

After detailed evaluation of the results of the study, refurbishing requirements of critical plant components were identified and a comprehensive plan was drawn up. Regulatory consent was obtained for implementation of the plan. The refurbishment outage was seen as an opportunity for safety upgrade and accordingly the action plan encompassed several safety up-grades to cope with the current standards. The procurement of necessary equipment was initiated well in time. The reactor was shut down in October, 1997 to carry out the refurbishment plan.

Achievements

Some of the main achievements of refurbishment are:

- For rectification of seepage from the central shaft of primary coolant emergency reservoir (Ball tank), the tank was emptied soon after core unloading. The concrete wall in leaky region was repaired by chipping old plaster and cementing with polymer modified mortar followed by pressure grouting at selected locations.
- Several mechanized inspections and metallurgical studies undertaken towards re-qualification of reactor vessel and tubes for many more years of operation.
- Replacement / reconditioning (as required) of the underground (4 metres below ground) carbon steel primary coolant pipe lines with provision for monitoring the leakage from the underground piping.
- Installation of split sealing clamps with remote handling techniques towards rectification of helium leak from the tongue and groove joints of cover gas system located in inaccessible area below the biological shields of the reactor.
- Installation of a new failed fuel detection system based on gamma radiation monitoring.
- Rectification of leak from the weld joint of inlet line to the upper aluminum thermal shield by installation of hollow plug using remote handling techniques.
- Physical separation of Ball tank make up pumps, a safety related equipment, to guard against common cause failures.
- Installation of more efficient iodine removal system having activated charcoal HEPA filters in place of obsolete system of alkali scrubber followed by silver coated copper wire mesh iodine filters.
- Detailed studies of the thermal safety of the Graphite reflectors was carried out and it was concluded that there was no need to undertake planned annealing of graphite reflector.

Startup

After completion of refurbishment activities and commissioning of various systems, CIRUS reactor was made critical on October 30, 2002 and rededicated to the nation by Honourable Prime Minister of India.

At this stage, some seepage was observed from a few locations on the pour joints of spherical concrete surface of Ball tank. Also, the observed critical height of moderator was found to be higher than the estimated one indicating core reactivity anomaly of the order of 12 mk. The reactor was kept shut down for repairs to rectify the seepage from Ball tank.

The Ball tank was emptied again and necessary repairs were carried out.. The Ball tank was commissioned and ensured to be free of leak or seepage.

The core reactivity anomaly, after detailed investigations, was attributed to the wetting of graphite reflector caused by water spillage from primary coolant system in upper service space. Operation of the reactor at high power was the appropriate option for raising the temperature of graphite for gradual removal of moisture.. Reactor was re-started on October 3,2003.

Operation at Power

At the first step of reactor operation on power at 4 MW setting, it was observed that the thermal power of the reactor was about 12 MW. The mismatch between neutronic and thermal power was attributed to attenuation of neutron flux by moisture present in graphite reflector and thermal column where reactor regulating system (RRS) ion chambers are located.

The mismatch was offset by appropriate combination of repositioning of the reactor regulating system ion chambers and adjustment of gain of amplifiers after careful review and safety clearances at every stage of reactor power increase.

The reactivity anomaly gradually decreased with progressive operation of reactor at power.

After significant improvement in neutron flux at the location of RRS ion chambers and reduction of reactivity anomaly to about 2 mk, the reactor power was raised to 30 MW during February 2004 after normalising the position of the RRS ion chambers.

Perspectives & Future Utilisation

A Desalination Unit of 30 tonne/day capacity has been integrated with primary coolant system of the reactor towards demonstration program for utilisation of waste heat from nuclear reactor.

The utilisation of irradiation facilities of the reactor has been commenced. The Pneumatic Carrier Facility was commissioned and being utilised well.

Use of various neutron beam ports and positions for irradiation of Cobalt /Thorium in graphite reflector annulus is kept in abeyance and awaiting future experiments and irradiations.

We look forward to another 15 years of intensive utilisation of CIRUS.

GENERAL news

NWMO issues draft proposal

In late May 2005 the Nuclear Waste Management Organization (NWMO) issued its "Draft Study Report" titled ***Choosing a Way Forward.*** This is a draft of the proposed report required by the *Nuclear Fuel Waste Act* of 2002 to be submitted to the federal government by November 2005.

NWMO's preferred approach is an Adaptive **Phased Management Approach**. This would involve the possibility of a central storage facility being built within two decades to supplement the present site storage. That would serve while the design, siting and construction of a deep geologic repository proceeded, with the expectation that it would begin receiving spent fuel in about 60 years.

The NWMO is seeking comment on its Draft Study Report by August 31, 2005.

Copies of an eight page, illustrated Executive Summary and of the full 300 page report are available through the NWMO website <www.nwmo.ca> or by telephone 1.866.249.6966 or by writing to: Nuclear Waste Management Organization, 49 Jackes Avenue, Toronto, Ontario M4T 1E2.

Keen reappointed at CNSC

Linda Keen has been reappointed as President and CEO of the Canadian Nuclear Safety Commission for a further five years.

She first assumed those roles on January 1, 2001. Prior to that appointment she was Assistant Deputy Minister of the Minerals and Metals Sector at Natural Resources Canada (NRCan) where she led the internationally renowned CANMET technology centre as well as directed the departmental Work and Innovation, International Trade and Investment Strategies. Previous to NRCan, Ms. Keen was a director general in Industry Canada, which included leading the International Trade Centres, and development of the prize-winning Export Source Web site.

A native Albertan, she holds a Bachelor of Science and a Masters of Science from the University of Alberta. She is a professional chemist, a member of Women In Science and Engineering (WISE), is the Immediate Past President of the International Nuclear Regulators Association (INRA), and is the newly elected President of the Third Review Meeting of the Convention on Nuclear Safety in 2005.

As President of the Commission, Ms. Keen presides over a quasi-judicial federal tribunal that is responsible for regulatory policy and making licensing decisions in an impartial manner and where the public is invited to participate. As CEO of the staff organization, Ms. Keen is responsible for the strategic oversight of the scientific and engineering oriented organization of more than 500 people.

Environmental Assessment for Port Hope Project

The Low-Level Radioactive Waste Management Office (LLRWMO) has submitted its Environmental Assessment Study Report for the Port Hope Long-Term Low-Level Radioactive Waste Management Project (Port Hope Project) to the federal departments that are responsible for the environmental assessment of the Project - Natural Resources Canada, Canadian Nuclear Safety Commission and Fisheries and Oceans Canada.

The Report is the LLRWMO assessment of the environmental effects of the proposed project. It is intended to meet the information requirements outlined in the document, *Scope of the Environmental Assessment for the Port Hope Long-Term Low-Level Radioactive Waste Management Project,* which was issued in July 2002 according to the requirements of the *Canadian Environmental Assessment Act (CEAA).*

The responsible authorities are now reviewing the LLRWMO's Environmental Assessment Study Report to assess its completeness and technical soundness. Federal authorities and Ontario ministries providing expert technical advice to the responsible authorities in this Government review include Transport Canada, Health Canada, Environment Canada, the Ontario ministries of Environment, Natural Resources and Culture, and the Ontario Provincial Police. Once accepted as satisfactory by the responsible authorities, the Environmental Assessment Study Report will be used as the basis for developing the Government's screening report on the Port Hope Project. The screening report will be prepared by the responsible authorities pursuant to section 18(1) of the CEAA. It will represent the Government's view of the environmental effects of the Project and will contain the findings and conclusions of the responsible authorities. The public will be

provided with an opportunity to comment on the screening report before it is finalized.

The LLRWMO's Environmental Assessment Study Report can be obtained by contacting Natural Resources Canada at phai.irph@nrcan.gc.ca.

Rod White retires from NB Power

Rod White retired from his position as Vice President, NB Power Nuclear Corporation on May 31, 2005 after 38 years of with NB Power.

Rod's extensive career at NB Power began in Generation where he assumed a number of roles before transferring to that of Maintenance Superintendent at the Point Lepreau Generating Station in 1975. After 10 years at PLGS, Rod returned to Generation where he held various positions including: Southwest Area Generation Manager, Belledune Station Manager, Northern Plant Region Regional Manager, and General Manager Generation. In 1997, Rod became Vice President, Nuclear with responsibility for management of the nuclear program with particular focus on continuous improvement and refurbishment.

Bill Pilkington will take on the role of Acting Vice President, NB Power Nuclear Corporation.

Bill joined NB Power in 1981 and has held various positions at the Point Lepreau Generating Station during his 24-year career including: Technical Specialist, Technical Supervisor, Shift Supervisor, Operations Superintendent, Production Manager and Station Manager. Most recently, Bill as Site Director has taken a lead role in ensuring the long-term safe operations and commercial viability of the Station. His proven track record makes Bill an ideal candidate to assume this responsibility pending the refurbishment decision.

L-3 MAPPS To Provide Simulator Upgrade for Daya Bay

L-3 Communications MAPPS (formerly part of CAE) will carry out a significant software upgrade on the Daya Bay nuclear power plant simulator on behalf of China's Guangdong Nuclear Power Joint Venture Company (GNPJVC). The work is targeted for completion by early 2007.

This follows a related project where L-3 MAPPS built the Ling Ao full-scale nuclear power

plant simulator for GNPJVC's sister organization Ling Ao Nuclear Power Company (LANPC).

The reference plant for the Daya Bay simulator is the Guangdong Nuclear Power Station (GNPS), made up of two Framatome-designed, three-loop Pressurized Water Reactors (PWRs) in Da Keng on the coast of Daya Bay 45 km from the city center of Shenzhen, China and about 50 km from Hong Kong.

Coined the Daya Bay Simulator "Backfit," the upgrade project involves the adaptation of the Ling Ao simulator's advanced thermal-hydraulic, reactor, balance of plant, electrical systems and instrumentation and control models to be Daya Bay-specific.

CNSC schedules hearings on MAPLE

The Canadian Nuclear Safety Commission (CNSC) will hold two public hearings on applications by Atomic Energy of Canada Limited (AECL) for the renewal of the operating licences for the MAPLE reactors and the New Processing Facility (NPF).

The two MAPLE reactors and the NPF are located at AECL's Chalk River Laboratories. While separately licensed by the CNSC, the MAPLE reactors and the NPF combine to form the proposed new medical isotope production facility. Both hearings will therefore be held on the same two-day hearing schedule.

- Hearing Day One: August 18, 2005
- Hearing Day Two: October 19, 2005

Both will be held at the CNSC Public Hearing Room, 14th floor, 280 Slater Street, Ottawa, Ontario. Agendas and information on the hearing process are available at the CNSC Web site: <www.nuclearsafety.gc.ca>.

The MAPLE and NFP facilities have been constructed. CNSC authorization for commercial operation is pending the successful completion of commissioning tests by AECL. CNSC is still reviewing the results of tests to resolve the power coefficient issue.

In related news MDS Inc., in its recent quarterly report, showed a further $6 million expenditure on the MAPLE project. It also reported that mediation proceedings with AECL (see Vol. 26, No. 1 issue of the CNS Bulletin) are scheduled to be completed in the fall of 2005 and noted that MDS Nordion continues to depend on the NRU reactor for the majority of its reactor isotopes.

AECL develops decommissioning plan for Chalk River

In May 2005, Atomic Energy of Canada Limited (AECL) presented information at a public hearing of the Canadian Nuclear Safety Commission (CNSC) related to its long-term waste management and decommissioning plan for its Chalk River Laboratories. The information included a Comprehensive Preliminary Decommissioning Plan (CPDP) and a public consultation framework.

The CNSC requires that decommissioning plans be prepared by nuclear site licence holders. AECL's Chalk River

site is unique in that decommissioning of obsolete facilities and old waste management areas is occurring following sixty years of nuclear research in Canada while refurbishment of the site proceeds to accommodate decades of future operations. The CPDP represents the culmination of a major initiative undertaken by AECL in 2003 with other government departments. The goal was to develop a conceptual technical strategy for managing nuclear legacy wastes on AECL sites that would:

- Be consistent with modern international standards and practices
- Ensure the ongoing health, safety and security of the public and employees, while protecting the environment; and
- Address regulatory requirements and expectations.

Both the CPDP and the public communications and consultation plan can be found on AECL's website <www.aecl.ca>.

CNSC proposes amendments to security regulations

Following the events of September 11, 2001, the Canadian Nuclear Safety Commission (CNSC) undertook a complete review of the *Nuclear Security Regulations,* which were enacted in May 2000 under the *Nuclear Safety and Control Act.* After discussions and consultations with affected licensees, the CNSC proposed amendments to the *Nuclear Security Regulations,* which were published in the *Canada Gazette,* Part I, on October 25, 2003. Comments received resulted in extensive changes and consequently the amendments have been published in the *Canada Gazette,* Part I, again.

The new proposed amendments were published on June 4, 2005. Interested parties must comment on the proposed amendments by **August 3, 2005.**

The proposed amended *Nuclear Security Regulations* are divided into two parts. Part 1 applies to:

- high-security sites - those facilities captured by the CNSC Order Number 01-1 (i.e. nuclear power plants, and facilities where Category I or II nuclear material is found), and
- facilities where Category III nuclear material1 is found.

Part 2 applies to the nuclear substance processing facilities, uranium refineries and nuclear fuel fabrication facilities captured by DO Order Number 01-D1.

The principal security requirements of the proposed amendments are listed below and are applied depending on whether the licensee operates a facility under Part 1 or Part 2.

- establishing a permanent, on-site armed nuclear response force at high security sites - this response force is required to be available twenty-four hours a day, seven days a week;
- enhancing security clearances for employees of nuclear facilities, as well as contractors - this includes measures such as background, police and security checks;
- taking into account the level of threat determined by the CNSC (the design basis threat analysis (DBT)) when designing physical protection systems, to protect nuclear facilities against the threat of unauthorized removal of nuclear substances or sabotage of nuclear substances and nuclear facilities;
- conducting a threat and risk assessment in order to identify the local threats to a facility and to take any credible threats into account in the design of its physical protection system;
- increasing access control for unescorted personnel that includes improved physical identification checks by using two independent systems, an access card reader and a biometric device such as a palm scanner;
- identifying and protecting those areas that, if sabotaged, could directly or indirectly lead to unacceptable radiological consequences;
- maintaining uninterrupted power supply (i.e. back-up battery power) for alarm and monitoring systems;
- testing physical protection systems and security response through regular drills and exercises and the development of contingency plans for anticipated security-related emergencies;
- taking measures to reduce the risk of forced vehicle entry (this can be achieved through the use of vehicle barriers and portals); and
- developing supervisor awareness programs to reduce security risks - this involves sensitizing supervisors to behavioural changes in facility personnel, including contractors, which may indicate an increase in risk to the security of the facility.

More detailed information about the proposed amendments can be found at http://canadagazetteducanada.gc.ca/partI/2005/20050604/pdf/g1-13923.pdf (page 38).

New president at OPG

The Board of Directors at OPG has appointed **Jim Hankinson** as President and Chief Executive Officer at Ontario Power Generation (OPG). Mr. Hankinson, who has been a Board member of OPG since December 2003, was previously President and Chief Executive Officer of New Brunswick Power Corporation from 1996 to 2002 and President and Chief Operating Officer of Canadian Pacific Limited from 1990 to 1995. His appointment became effective May 13, 2005

Jake Epp, chairman of the Board expressed, on behalf of the Board, its appreciation to Richard Dicerni for his contribution as Acting President and CEO during the past year and a half.

ElBaredi Reappointed at IAEA

The Board of Governors of the International Atomic Energy Agency has reappointed Dr. Mohamed ElBaredi as Director General for a further four years, until November 2009.

Dr. ElBaradei was born in Cairo, Egypt, on 17 June 1942. He gained a Bachelor's degree in Law in 1962 at the University of Cairo, and a Doctorate in International Law at the New York University School of Law in 1974.

Dr. ElBaredi is just the fourth Director General of the IAEA. Preceding him were: Sterling Cole 1957 - 1961; Sigvard Eklund 1961 - 1981; Hans Blix 1981 - 1987.

Obituary

Philip Arthur ROSS-ROSS

Phil Ross-Ross, one of the founders of the Canadian Nuclear Society, died at Deep River, Ontario, On April 5, 2005, after a long struggle with Alzheimer's disease.

Phil was born in Cornwall, Ontario, April 10, 1927. He attended McGill University in Montreal, obtaining a Bachelor of Mechanical Engineering in 1949 and a Masters of engineering in 1951.

After graduation he joined A. V. Roe Gas Turbines division of Orenda Engines in the test facility located at Nobel on the shores of Georgian Bay for the engine intended for the Avro Arrow fighter plane, staying there until the "black Friday" of February 20, 1959, when the then Prime Minister, John Deifenbaker, cancelled the entire project.

Along with others he moved to the Chalk River Nuclear Laboratories of Atomic Energy of Canada Limited, where he remained until his retirement in 1986. At CRNL he was a member of the Metallurgical Engineering Branch and conducted many early experiments on the possible consequences of failure of pressure tubes of the evolving CANDU nuclear power plants. He continued to work on the mechanical properties of CANDU components.

Phil was very active in professional societies, initially with the Canadian Society for Mechanical Engineering. He was elected president of CSME in 1978 - 1979. In that role he was involved with the restructuring of the Engineering Institute of Canada and the following year was awarded the EIC Robert Angus Medal.

Those looking at the creation of a professional nuclear society recognized Phil's experience and ability in organizational matters and convinced him to join in the formation work. He was elected a member of the first executive of the Canadian Nuclear Society in 1979 - 1980 and became the only person to serve two years as president, 1981 - 1982 and 1982 - 1983. He was the primary author of the original constitution and by-laws of the society and of a document "The Formative Years of the Canadian Nuclear Society", which was co-authored by George Howey, the first CNS president and John Hewitt the third.

Phil Ross-Ross is shown at the front left in this 1988 photograph of some early presidents of the Canadian Nuclear Society. Front, L - R, Phil Ross-Ross; George Howey (1980 - 81); John Hewitt (1983-84); Back, L-R, Ken Talbot (1988-89); Nabila Yousef (1986-87); Peter Stevens-Guille (1984-85)

Joe Howieson, CNS president 1985- 1986, remembers Phil as thoughtful, conciliatory, an excellent president and meeting chairman, and an amusing companion.

Phil and his wife Anne Marie were inveterate travellers. Before and especially after his retirement they visited almost all corners of the world, Europe, Asia, Africa, and South America; despite their love of their cottage on Huckleberry Island in Georgian Bay, near Nobel.

A family funeral service was held in Deep River.

CNS news

Education and Communications Committee (ECC)

World Nuclear University

The CNS is pleased to support Mark McIntyre's (Atlantic Nuclear Services Ltd.) attendance at the inaugural session of the new world Nuclear University (WNU) this summer. Upon analysis of feedback from this WNU session, the ECC will make a recommendation to the CNS Council regarding future bursaries for WNU sessions, which would be made available to all CNS members.

Canadian Museum of Science & Technology -- International Year of Physics

The ECC has received approval to provide $2000 to assist with the development of the ZEEP reactor display at the CMST in Ottawa as a contribution to IYP 2005 activities.

Previously, the ECC had set out to develop a timeline historical poster highlighting Canadian Nuclear Science and Technology. The Committee has failed to develop an acceptable result to date.

CNS Scholarship Program

Elisabeth Varin of ...cole Polytechnique led the development of the CNS Undergraduate Student Summer Project Scholarship program. Subsequently, she acted as the administrator for this first year of operation.

Five applications were received, and the winners are:

Student: Sumi Wren University of Western Ontario

Supervisors: D.W. Shoesmith and J.J. Noel, University of Western Ontario, Chemistry; and Z. Tun, NRC, Chalk River

Neutron Reflectometry Studies of Nuclear Fuel Waste Management Materials is an on-going innovative research program in combined electrochemistry/in-situ neutron reflectometry. The University of Western Ontario (London, ON) collaborates with the Neutron Program for Materials Research of the National Research Council of Canada, Chalk River, ON for this work. The technique has been developed to investigate the composition and structure of thin films at the nanometre level, and is ideal for studying passive, anodic and corrosion films on metal surfaces exposed to corrosive environments.

Student: Stephen Kooiman McMaster University

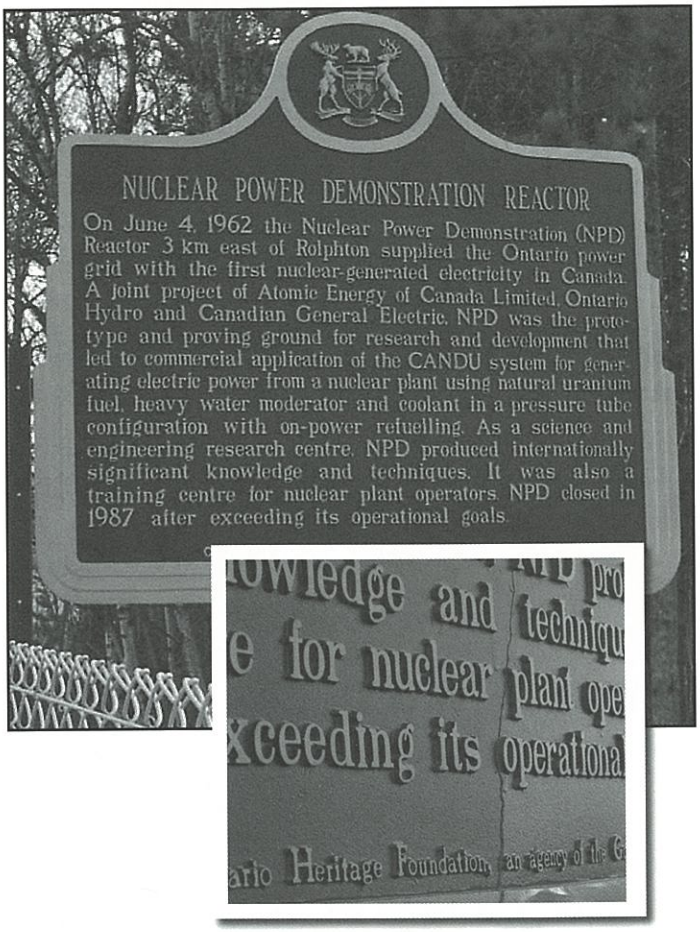
Supervisor: M.F. Lightstone, McMaster University, Mechanical Engineering

Mathematical Modelling of Inter-Subchannel Mixing in nuclear reactor fuel using computational fluid dynamics is an on-going research program. S. Kooiman's work scope will focus on performing scoping simulations to assess a number of turbulence models for prediction of large-scale flow pulsations in simplified geometries.

Nuclear Plaque Cracking Incident

At a special ceremony on Saturday, June 1, 2002, the Canadian Nuclear Society, in conjunction with the Ontario Heritage Foundation (OHF), unveiled a roadside plaque honouring a historical milestone for Canadian science and technology: the 40th anniversary of the start of electricity supply by the prototype CANDU reactor, Nuclear Power Demonstration (NPD). The CNS co-sponsored the dedication and installation of the Ontario Historical Plaque commemorating the startup and operation of NPD near Rolphton, Ontario in 1962. In the spring of 2003 the plaque and the accompanying informative sign developed by the CNS were installed at the Highway 17 roadside vantage point for viewing the Des Joachims hydraulic generating station. In the spring of 2005, the deteriorating concrete block barrier in front of the sign was replaced with a chain link fence. Subsequently, on inspection by CNS Past President Jeremy Whitlock the historical plaque was found to be slightly bent and sporting a crack, visible primarily on the English text side as shown in the accompanying photographs.

The OHF, the owner of the plaque has been contacted. While the cause has not been confirmed, the ECC executive is confident that neither political stress nor official language tensions contributed to this apparent brittle failure.



CNS members inducted into Academy of Engineering

Two members of the Canadian Nuclear Society were among the 30 new members inducted into of the **Canadian Academy of Engineering** at a ceremony in Calgary June 5, 2005, held in conjunction with the Academy's 2005 Annual General Meeting.

They are **Ken Petrunik** and **Terry Rogers.** Following are the citations associated with their membership.

Kenneth Petrunik, AECL's Senior Vice President and Chief Operating Officer, is the company's leading commercial executive; as such he is responsible for managing all aspects of the company's commercial operations, including major projects and services, and marketing and business development. He has led the construction and completion of the Canadian technology CANDU 6 Nuclear Power Plants, spending more than 15 years abroad. Via CANDU 6's on time construction and sound performance in five countries, he has helped to raise the image of Canadian technology worldwide, while creating thousands of high technology jobs in Canada.

Terry Rogers, Professor-Emeritus at Carleton University, has served the profession with great distinction, both nationally and internationally. He worked in the nuclear industry for 15 years in both Canada and the USA, making important contributions in reactor thermal-hydraulics, heat transfer and safety. He then joined Carleton University in 1970 and continued his research in these areas as well as serving as a consultant to nuclear organizations in Canada and elsewhere. He played and important role in the found-

ing of the Canadian Society for Mechanical Engineering, and was Editor of the Transactions of the CSME for 11 years. He has also served actively as a Canadian delegate to international bodies, in the fields of heat and mass transfer and reactor safety.

The Academy is an independent, self-governing organization, established to serve the nation in matters of engineering concern. Fellows of the Academy are engineers from all disciplines; they are elected by their peers on the basis of their distinguished achievements and of their contributions to the profession, to the country, and to society. The total number of active fellows in the Academy slightly exceeds 250.

The Canadian Academy of Engineering works in close cooperation with other senior academies in Canada and internationally. The Academy is also a member of the *International Council of Academies of Engineering and Technological Sciences,* which includes some 25 similar national bodies around the world.

NEWS FROM THE BRANCHES

Bruce *John Krane*

Mr. Ken Talbot, Chief Nuclear Engineer, Bruce Power addressed the Bruce Branch of the CNS on Monday May 9th and Wednesday May 18th providing an overview and lessons learned from his IAEA OSART visit of Kashiwazaki - Karewie Nuclear Power Station, Japan.

Chalk River *Morgan Brown*

The Chalk River Branch annual essay contest on the Benefits of Nuclear Science and Technology has enjoyed an increased response with 14 essays received from students representing 5 Renfrew County high schools in this its second year.

On April 7th Bob Pollock of AREVA-COGEMA Resources Inc. spoke to the branch on "Saskatchewan's Uranium Mining Industry".

Darlington *Jacques Plourde*

The UOIT Student Tour of Darlington NGS occurred on March 31. This visit by 20 students included an introduction by Public Affairs at the Information Centre, followed by a Q&A session, and then the plant tour capped by refreshments. Some comments received:

> "We were all impressed with the structure of the tour and the wealth of knowledge that was shared with us last night. Just to quote a student, it was an amazing and mystifying experience. Seeing pictures and schematics in textbooks is one thing, but to see first hand the control room, turbines, fuel storage bays (and the list goes on), adds greatly to our education experience! We look forward to working on future projects and events in connection with OPG, as well as the CNS!"

New Brunswick *Mark McIntyre*

NB Branch members are pursuing a public relations campaign to combat the environmentalists and the coal lobby in order to convince government to proceed with the refurbishment of the Point Lepreau NGS.

The Branch has 2 lectures scheduled following the Point Lepreau maintenance outage.

Stanton Friedman, internationally renowned science writer and nuclear physicist will be speaking about nuclear propulsion in space and other space issues.

Andrew Justason, General Manager of the Centre for Nuclear Energy Research will be explaining his organization's new relationship with the University of New Brunswick and industry.

Ottawa *Jim Harvie*

The Ottawa Branch was addressed on April 7th by Frank King, Director of Nuclear Waste Engineering and Technology at Ontario Power Generation. He spoke on "OPG's Plan for a Deep Geological Repository for Low and Intermediate Level Waste". The speaker at the May 9th meeting was Bob Pollock, Vice-President, Environment, Health and Safety at AREVA-COGEMA Resources Inc. of Saskatoon. Fresh from his presentation to the Chalk River Branch, Bob spoke on "Saskatchewan's Uranium Mining Industry".

Sheridan *Adriaan Buijs*

Two seminars have been held recently at Sheridan Park. On March 9 Richard SauvÈ spoke on State-of-the-Art Numerical Simulation of a Rolled Joint Manufacturing Process. On April 15 Dick Bourgeois-Doyle spoke on the life and work of George Klein.

The branch sponsored two regional science fairs:

The Bay Area Science and Engineering science fair, held at the Sheridan College in Oakville where Raj Jain from the branch judged the projects and selected two winning projects; and the Peel Region science fair, held at the Mississauga Campus of the University of Toronto where Roman Sejnoha and Adriaan Buijs judged the projects and selected two winning projects. The chairman of the Sheridan Park branch handed out the awards at the awards ceremonies of both fairs. The Peel Region science fair is smaller, and the contribution of the CNS is much appreciated there. Neither fair included projects related to nuclear power. The winning project at the Peel Region science fair was related to hydrogen as fuel, and included a photograph of the Darlington reactors.

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Canada

Toronto *Bob Hemmings*

The Toronto Branch seminar on April 13th featured Scott Berry, a Senior Communications Advisor with OPG Pickering Nuclear Public Affairs speaking on the Pickering A Return to Service Project. On May 10th Marcello M. Pavan spoke to the branch on "What TRIUMF is Doing & Has Accomplished".

Toronto is hosting the 55th Canadian Chemical Engineering Conference, Oct. 16-19, 2005, and the theme is Innovation for a Healthy Planet. There is a focus on energy, and nuclear in particular, in some sessions. Please see details on the website <www.csche2005.ca>.

John Luxat heads 2005 - 2006 Council

The Annual General Meeting of the Canadian Nuclear Society was held Monday, June 13, 2005, in Toronto, just before this issue of the CNS Bulletin was going to press. Following is the list of members of the governing Council for 2005 - 2006 elected at that meeting.

Executive

President:	J.C. (John) Luxat	McMaster University
Past President:	W.G. (Bill) Schneider	Babcock & Wilcox Canada
1st Vice-President / President-Elect	D.A. (Dan) Meneley	Retired (formerly AECL)
2nd Vice-President:	E.L. (Eric) Williams	Bruce Power
Treasurer:	J. (Jim) Harvie	Retired (formerly CNSC)
Secretary:	A. (Adriaan) Buijs	AECL

Members at Large

I. (Ibrahim) Attieh	AECL
J.M. (Jerry) Cuttler	Cuttler & Associates Inc.
C. (Charles) Gordon	Nuclear Safety Solutions (NSS)
R.L. (Bob) Hemmings	Canatom NPM
E.M. (Ed) Hinchley	Retired (formerly AECL)
D.P. (Dave) Jackson	McMaster University
V.S. (Krish) Krishnan	AECL
P. (Prabhu) Kundurpi	Retired (formerly OPG)
S.Y. (Andrew) Lee	Retired (formerly OPG)
K. (Kris) Mohan	Consultant (formerly AECL)
E.M. (Dorin) Nichita	University of Ontario Institute of Technology (UOIT)
J. (Jad) Popovic	AECL
M.R. (Michel) RhÈaume	Hydro-Québec
B. (Ben) Rouben	AECL
R. (Roman) Sejnoha	Retired (formerly AECL)
K.L. (Ken) Smith	UNECAN
R.G. (Roger) Steed	Retired (formerly NBP)
J.J. (Jeremy) Whitlock	AECL

Ex-officio Voting Member

Murray Elston	President, Canadian Nuclear Association

Special Duties Reporting to Council:

Executive Administrator:	B. (Ben) Rouben
Financial Administrator:	K.L. (Ken) Smith
Bulletin Editor:	F. (Fred) Boyd
CNS Webmaster:	M. (Morgan) Brown
CNS Office Manager:	D. (Denise) Rouben

Following the election of the 2005 - 2006 CNS Council at the CNS Annual General Meeting. June 13, 2005, retiring president Bill Schneider (L) hands the traditional gavel to incoming president John Luxat.

North American Young Generation in Nuclear - in Canada

Could your company benefit from having an organization for newer employees that is proactive about finding solutions to knowledge transfer issues, building its own personal development opportunities, and learning more about nuclear locally and globally? Would your employees benefit from a stronger sense of ownership of the nuclear industry? If so, visit the NA-YGN website at www.na-ygn.org or contact the Canadian Affairs Chair, Brent Williams at brent.williams@brucepower.com to learn how to start a NA-YGN branch at your site.

Membership is free!

North American Young Generation in Nuclear is about proactive personal development, finding ways to improve knowledge transfer, public outreach, networking, and building support for peaceful use nuclear technologies for young professionals in nuclear science and technology fields. North American Young Generation in Nuclear currently has two chapters in Canada contributing to a total of 22 in North America. With a third Canadian chapter in the process of starting up, there are over 160 members in Canada right now. These members represent a number of different industries including medical applications, energy research, power production and regulatory interests.

The membership for North American Young Generation in Nuclear (NA-YGN) consists of individuals under the age of 36 or that have less than ten years of experience in nuclear science and technology, whichever comes last.

NA-YGN is extremely active. NA-YGN hosted a professional development seminar at the CNS Conference. Our members have provided input to the Nuclear Waste Management Organization, and incurred the wrath of Energy Probe as a result of writing in support of nuclear station restarts in Ontario and New Brunswick. Previous NA-YGN Canadian Affairs Chair Mark McIntyre has been working to communicate nuclear to the public. Local Chapters have provided judges for science fairs and are involved in initiatives to promote technology careers to public and high school students. NA-YGN recently held a Professional Development Conference in partnership with the Nuclear Energy Institute preceding the Nuclear Energy Association conference in Washington DC. In 2004, NA-YGN co-hosted the International Youth Nuclear Congress (IYNC) in Toronto.

Brent Williams, the Canadian Affairs Chair of the North American Young Generation in Nuclear, can be contacted at: brent.williams@brucepower.com

NRU life extension *by Bryan White*

On May 24, 2005, in Deep River, Ontario, Atomic Energy of Canada Limited held the first of four Public Information Sessions with respect to the Continued Operation of AECL's National Research Universal (NRU) Research Reactor at the company's Chalk River Laboratories. Subsequent meetings were held in Petawawa, Pembroke and Chapeau on May 25, 26 and 30.

The meetings were advertised in local papers with a summary of the background to the 1996 commitment to the Canadian Nuclear Safety Commission (then AECB) to cease operation of NRU by December 31, 2005. The advertisements extolled the importance of continued operation of NRU to support the research and development programs of AECL and its customers, those of the National Research Council of Canada - the Canadian Neutron Beam Centre, and others. The role of NRU in the production medical isotopes, molybdenum-99 in particular that is to be supplied by the long-delayed Dedicated Isotope Facility was emphasized - as well as the fact that there is no alternative Canadian source for other isotopes produced by NRU, including high specific activity cobalt-60 that has been used in cancer therapy for over 50 years.

The advertisements and the presentation stated that the 1996 commitment was made with the expectation of imminent approval of funding for the proposed Canadian Neutron Facility - a multipurpose research reactor intended to succeed NRU at Chalk River. The CNF initiative did not advance past agreement in principle.

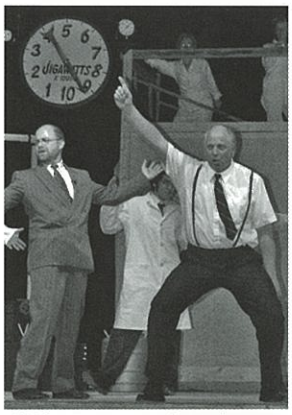
A summary report from the meetings will be provided to the CNSC prior to a one-day public hearing on the "NRU Licensability Extension Environmental Assessment Screening" that will be held at the CNSC's office in Ottawa on June 29, 2005.

There were 16 present at the meeting in Deep River: 8 representing AECL and NRC, and 8 members of the public, including Cheryl Gallant, MP. The members of the public attending the Deep River meeting were supportive.

West Wylie Story

CNS Past President Jeremy Whitlock showed another dimension of his talents when the musical play **West Wylie Story** opened on April 1, 2005.

The play, loosely based on the Broadway show West Side Story told the story in music of the beginnings of the Chalk River project, the building of the ZEEP reactor (the first outside the USA) and, particularly, the interaction of the scientists brought to the new project and the long-time residents of the area. Some of the songs were based on those from West Side Story but many were drawn from other sources.



CNS past-president Jeremy Whitlock (L) is seen as Sir John Cockcrow (think Cockcroft) with Greg Merrill (R) as C.D. Who (Howe) in the Deep River musical West Wylie Story.. In the background is ZEEP (note the Jigawatt meter)

"Badge-Draw" Winners at CNS Annual Conference

At the end of the CNS Conference on *"Waste Management, Decommissioning and Environmental Restoration for Canada's Nuclear Activities"*, in Ottawa, on May 11, 2005, 8 prizes were drawn from among badges returned by Conference attendees.

The winners:

- Parvez Butt of the Pakistan Atomic Energy Commission, Malcolm Stevenson of Jacques Whitford Ltd. and Donna Roach of AECL each won a copy of the book "Canada Enters the Nuclear Age".
- Joanne Jackson and Gregory Kuzyk of AECL each won a CNS membership good to the end of 2006.
- Heather Marshall, and Joanne Smith of Natural Resources Canada, each won a 64-Mb memory stick.
- Gregory Edwards of Perma-Fix Environmental Services won a CNS multitool.

Congratulations to all the winners!

Gagnants de prix au tirage des porte-insigne à la Conférence de la SNC sur la gestion des déchets

À la fin de la *Conférence sur la gestion des déchets, la mise hors service des installations, et la restauration environnementale dans les activités nucléaires au Canada*, à Ottawa, le 11 mai 2005, 8 prix ont été tirés au sort parmi les porte-insigne retournés par les participants à la conférence.

Voici les gagnants des prix:

- Parvez Butt de la Commission de l'énergie atomique du Pakistan, Malcolm Stevenson de Jacques Whitford Ltd. et Donna Roach de l'EACL, ont chacun gagné une copie du livre "Canada Enters the Nuclear Age".
- Joanne Jackson et Gregory Kuzyk de l'EACL ont chacun gagné une adhésion à la SNC jusqu'à la fin de décembre 2005.
- Heather Marshall, et Joanne Smith de Ressources Naturelles Canada, ont chacune gagné un bâtonnet de mémoire de 64 Mb pour ordinateur.
- Gregory Edwards de Perma-Fix Environmental Services a gagné un outil multiple de la SNC.

Félicitations à tous les gagnants!

Call for papers

Pacific Basin Nuclear Conference 2006

October 15 - 20, 2006

Sydney, Australia

The Pacific Basin Nuclear Conferences are held every two years under the aegis of the Pacific Nuclear Council of which the Canadian Nuclear Society is a member. It is the premier nuclear conference of the countries around the Pacific, many of which have active nuclear programs.

The theme for this 15th PBNC is: *A Pacific Nuclear Future: Nuclear Science and Engineering for a Sustainable Society.*

Papers are invited in any of the following broad categories:

- Nuclear Power
- Nuclear Fuel Cycle
- Safety and Regulation
- Non-Proliferation and Safeguards
- Research reactors, Accelerators and Applications
- Nuclear Medicine and Biomedical Applications
- International and Regional Cooperation
- Public Information and Education

Abstracts are due October 20, 2005

For information about the conference visit the website <www.pbnc2006.com>

Queries regarding submission of papers should be directed to e-mail: pbnc2006@tourhosts.com.au

BOOK REVIEW

Fusion - the Energy of the Universe

Garry McCrachen and Peter Stott

Elesvier Academic Press, 2005 ISBN 0-12-481851-X $44.95 (US)

This modest sized book (186 p.) provides an overview of the nature of fusion, its role in nature and of the various methods mankind has pursued to create and contain fusion. The language is semi-technical, suitable for an intelligent non-scientist, and augmented with good illustrations.

Publications available

Following are some recent publications from the International Atomic Energy Agency, wagramer Strasse 5, P.O. Box 100 A-1400 Vienna, Austria.

IAEA Safety Standards Series

Safety Guides

Protection against Internal Fires and Explosions in the Design of Nuclear Power Plants No. NS-G-1.7

Design of Emergency Power Systems for Nuclear Power Plants No. NS-G-1.8

Design of Reactor Containment Systems for Nuclear Power Plants No. NS-G-1.10

Application of the Concepts of exclusion, Exemption and Clearance No. RS-G-1.7

IAEA Proceedings

National Infrastructures for Radiation Safety

Proceedings of an International conference, Rabat, Morocco, September 2003

This 450 page volume contains all of the papers given at this conference together with a 12 page summary note "Findings and Recommendations of the Conference President". The papers dealt with operational, educational and regulatory aspects of radiation protection.

INSC Report

Nuclear Production of Hydrogen: Technologies and Perspectives for Global Deployment, ISBN 0-89448-570-9

The eight chapters of this concise (130 p) document deal with the various methods of production of hydrogen and its possible role for transportation.

It was prepared by a task group of the International Nuclear Societies Council (of which the Canadian Nuclear Society is a member). One chapter is written by Alistair Miller of AECL. It is published by and available from the American Nuclear Society. ANS Order No. 690064

NRCan Report

Inventory of Radioactive Waste in Canada

This report presents the inventory of radioactive waste in Canada as of the end of 2003. It includes nuclear fuel waste; low-level radioactive waste; and uranium mill tailings. It contains a number of illustrations, figures and charts.

This publication was prepared by the Low-Level Radioactive Waste Management Office for Natural Resources Canada. It is available from that office: e-mail: info@llrwmo.org

Overheard In A Cafe

by Jeremy Whitlock

I'd like to interview you for a magazine article.

Why me?

Because you're interesting and have a story to tell.

Couldn't find anyone else eh?

Oh I've talked to enough CEOs and VPs. But they're all so gung-ho about nuclear's future. It's sad.

You're looking for a negative story?

Don't be ridiculous, that would be bad journalism. I'm looking for the facts. The facts about nuclear's questionable past and grim future.

Hey where's your tape recorder?

I prefer my own notes. I don't trust technology. Technology is evil.

Excuse me?

Now tell me about your technology.

Nuclear? Okay, well, it all started in World War II...

Where's the science?

Come again?

The science. Where is it? I toured Chalk River yesterday. I didn't see any science.

Did you talk to any scientists?

Of course not. Scientists are shallow and narrow-minded. They don't see the big picture and what's more, they're hopeless at communicating.

Didn't do well in math eh?

The devil's in the details my friend! Now, you were saying how nuclear power was a child of war.

Did I say that?

Sure it's in my notes. Here, have another coffee. So, nuclear needs war to survive. Its fortunes rise when conflict erupts, and sink as it dies down again.

I said that?

No I did. Keep up with me chum.

But what you said is silly. Didn't you prepare for this interview?

Look, I'm the famous journalist here. Don't tell me how to do my job.

I've never heard of you.

That's because you're a scientist. You're shallow and narrow-minded.

Did a scientist jilt you at university or something?

I'm not the one being interviewed, Neuron Boy.

That's "neutron".

Whatever. Now, tell me about nuclear power's grim future.

Okay, well, it's not so grim see. With gas prices uncertain and its supply limited....

Bull! We're swimming in natural gas up in the Mackenzie Valley.

Sure but that's not going to make it past the oil sands. In any case, there's also a compelling environmental argument...

If you overlook the waste. We don't have a clue what to do about the waste.

Actually you should talk to the people out at Whiteshell. You might be surprised at how much we know about the waste.

But Whiteshell's defunct.

You really didn't prepare much for this interview did you.

Hey I've prepared enough. I know all about the industry's rampant subsidization over the years.

Oh, you've been talking to Greenpeace and Sierra Club.

I can't divulge my sources. But I assure you they're diversified.

Ah, Energy Probe too.

Have some more coffee. Okay, so you came to Chalk River ten years ago and found the science gone...

I didn't say that.

And the company on its ass.

What? I didn't say that either.

And you found yourself in an unmanageable, increasingly dangerous black hole that you couldn't escape, that none of us could escape, and you screamed "My God! What have I done!"

Are you okay? Maybe you should lie down.

I've got to get back to Toronto. What kind of a town has one coffee shop anyway?

CALENDAR

2005

July 12 - 15
Nuclear Power Asia Pacific 2005
Hong Kong
website: www.terrapinn.com/205/nps_au

Aug. 7 - 11
ANS Topical on Decommissioning, Decontamination & Reutilization
Denver, Colorado
website: http://ddrd.ans.org
email: registrar@ans.org

Aug. 7 - 12
SmiRT 18 18th International Conference on Structural Mechanics in Reactor Technology
Bejing, China
website: www.smirt-18.org.cn

Aug. 14 - 18
Int'l Conference on Environmental Degradation of Materials in Nuclear Power Systems
Salt Lake City, Utah
email: piking@babcock.com

Sept. 4 - 8
ICEM'05 10th International Conference on Environmental Remediation & Radioactive Waste Management
Glasgow, Scotland
website: www.iceconf.com

Sept. 4 - 9
4th International Conference on Inertial Fusion Sciences and Applications
Biarritz, France
website: www.celia.u-bordeaux1.fr/ifsa05

Sept. 11 - 15
PSA '05 Probabilistic Safety Analysis 2005
San Francisco, California
website: www.ans.org/meetings/psa

Sept. 18 - 21
9th Int'l Conference on CANDU Fuel
Belleville, Ontario
website: www.cns-snc.ca

Oct. 2 - 6
NURETH 11 Nuclear Reactor Thermal Hydraulics
Avignon, France
website: www.nureth11.com

Oct. 3 - 7
International Conference on Safety of Radioactive Waste Disposal
Tokyo, Japan
website: www.pub.iaea.org/MTCD Meetings/Meetings2005.asp
email: H.Schmid@iaea.org

Oct. 9 - 13
Global 2005
Tsukaba, Japan
website: www.global2005.org

Nov. 20 - 22
7th CNS Int'l. Conference on CANDU Maintenance
Toronto, Ontario
Contact: Denise Rouben, CNS
email: cns-snc@on.aibn.com

Dec. 11 - 14
European Nuclear Conference
Versailles, France
website: www.sfcn.fr/enc2005

2006

Feb. 12 - 15
ANS Topical Meetings - 9th Emergency Preparedness & Response - 11th Robotics & Remote Systems
Salt Lake City, Utah
website: www.sharingsolutions.com

May. 9 - 12
EIC Climate Change Conference 2006
Ottawa, Ontario
website: www.ccc2006.ca

May. 29 - June 2
WIN Global
Cambridge, Ontario
email: susan.brissette@brucepower.com

June 4 - 8
ANS Summer Meeting
Reno, Nevada
website: www.ans.org

June 11 - 14
17th CNS Conference & 30th CNS/CNA Student Conference
Toronto, Ontario
website: www.cns-snc.ca

Sept. 10 - 14
Physor - 2006 Physics of Reactors 2006 Advances in Nuclear Analysis and Simulation
Vancouver, British Columbia
website: www.cns-snc.ca/physor2006
email: physor2006@aecl.ca

Oct. 15 - 20
15th Pacific Basin Nuclear Conference
Sydney, Australia
website: www.pbnc2006.com
email: pbnc2006@tourhosts.com.au

2004-2005 CNS Council • Conseil de la SNC

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	Ken Smith	905-828-8216
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Dave Jackson	905-525-9140
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