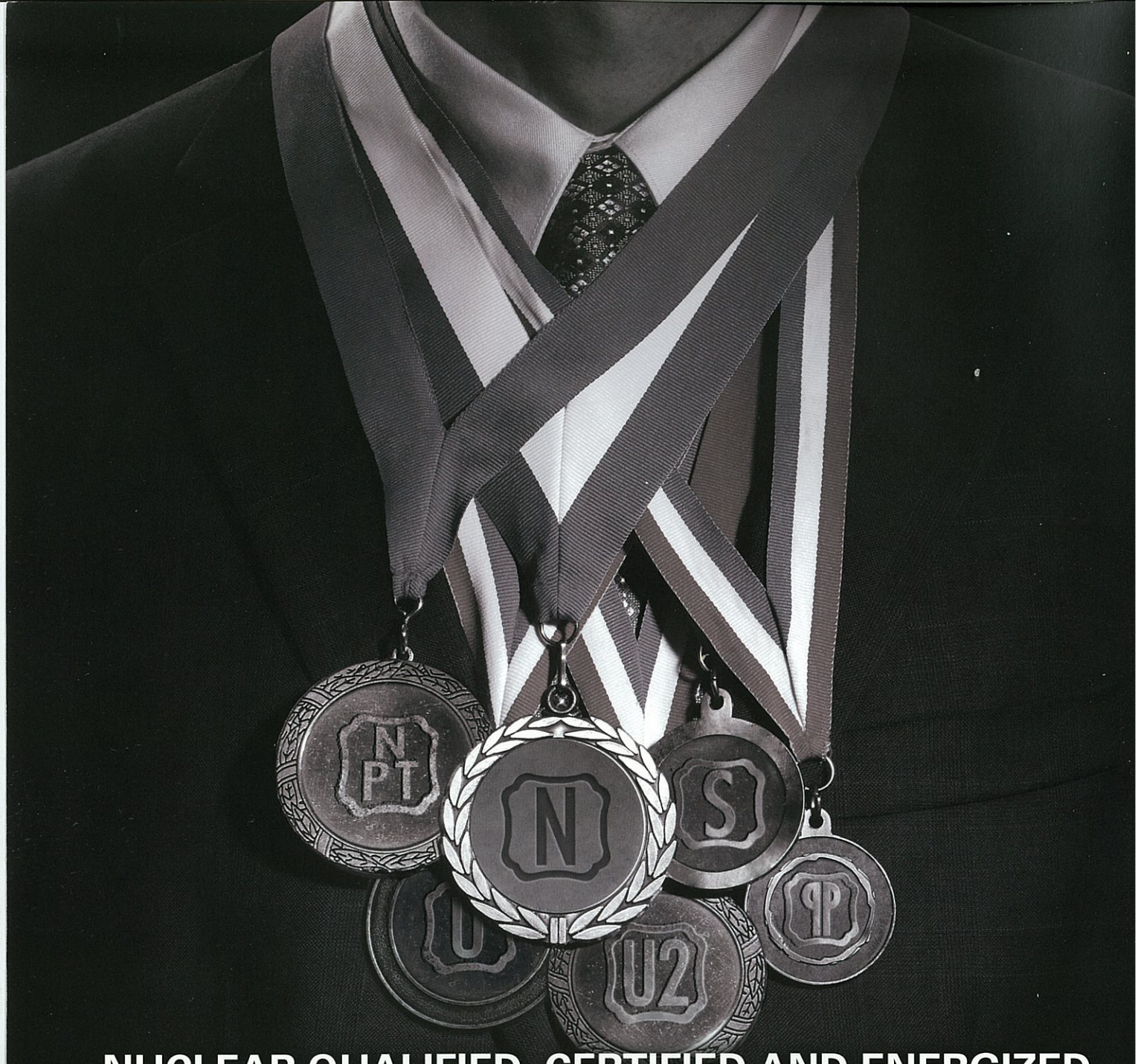
CANADIAN NUCLEAR SOCIETY

Bulletin

DE LA SOCIÉTÉ NUCLÉAIRE CANADIENNE

MARCH 2013 MARS VOL. 34, NO.1

- CNA Conference and Trade Show
- International CANDU Technology Transfer
- Canada, the Provinces and the Global Nuclear Revival
- A Happy Medium: Extreme Value Statistics



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2013 Federal Budget

Honourable Jim Flaherty, Federal Finance Minister, has released the 2013 federal budget.

There is good news in the 2013 budget for nuclear: The Canada Job Grant and the Promoting Education in High-Demand Fields program. The former is aimed at skills development to help the manufacturing sector and Canadian suppliers of nuclear components will benefit by a better skilled workforce. The world is experiencing growth in nuclear expansion and new builds and many of these projects will require precision nuclear grade quality manufactured parts and components, not limited to CANDU. All reactors use valves, instruments, pipes and tubes, and uranium fuel rods.

The Promoting Education in High-Demand Fields program is aimed at helping students attain higher education in skilled trades and science and engineering fields including mathematics and higher technologies. This too will benefit engineering service providers that solve the problems of complex technologies including development of simulators, environmental qualification of systems and components and safety and licensing. Again this is not limited to CANDU; all nuclear reactors need simulators, engineering and safety analysis, and all reactor types require a safety case to support an operating license.

With life extension and refurbishment projects underway or planned for Canada's ageing nuclear fleet there has long been concern regarding the retention and transfer of knowledge from those who are nearing retirement. The Federal program will better enable students to enter the nuclear workforce to share the knowledge and experience that has grown over the last 60 years, so that it is available for the next 60 years and beyond to support nuclear investment and return value.

Skilled trades-people and engineers are highly paid for their skills and knowledge. This will provide a steady stream of revenue for governments and local communities through Federal and Provincial tax revenue and retail sales revenue as workers buy goods and services in their communities.

The Organization of Canadian Nuclear Industries (OCI) has strongly endorsed the budget, with some of its members expecting to compete in the UK nuclear program. The University of Ontario Institute of Technology (UOIT) also welcomes the 2013 budget as it will help fund research and innovation in many high technology areas including automotive and nuclear.

Interestingly, however, the Canadian Association of University Teachers (CAUT) has condemned the budget because it "short changes post-secondary education, further diminishes Canada's research capacity, and undermines training opportunities".

According to James L. Turk, executive director of CAUT, "the [budget allocation of] $37 million for Canada's three academic research granting councils only restores half of what was cut last year and comes with strings that seriously limit its usefulness for advancing knowledge. The budget specifies that 80 per cent of the restored money for the Natural Sciences and Engineering Research Council must be spent on collaborations between community colleges and private industry that focus on company needs. Overall, the $37-million is described as being for 'research partnerships with industry.' This means there will be no new money for the basic research on which all scientific advancement depends."

Mr. Turk may have a good point - there is a need for pure fundamental research. However, it has to be paid for and it is the business and industry organizations that will drive the economy and produce the needed funds.

In This Issue

The CNA Conference and Trade show in February was again a successful event with over 700 attendees, reported in this edition. We are also grateful for a good paper on International CANDU Technology and Knowledge Transfer Experience submitted by Dr. Sardar Alikhan, AECL (retired) who worked on CANDU projects around the world.

We have a very interesting paper on "The Happy Medium" submitted by Dr. Fred Hoppe and Mr. Keith Weaver explaining Extreme Value Statistics and application to reactor trip set-points. Using the now popular "Goldilocks" metaphor, the problem is described in a level of detail that is not too complex, and not too simplistic, but just right.

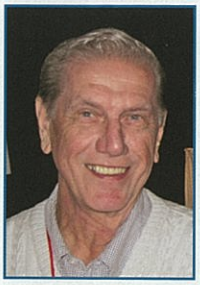
CNS member Duane Bratt has provided an excerpt from his recent book "Canada, the Provinces, and the global Nuclear Revival - Advocacy Coalitions in Action. The book is also reviewed in this edition of the Bulletin.

On the second anniversary of Fukushima Dr. Jerry Cutler has provided his commentary on the beneficial effects of low level radiation, and Don Jones discusses the need for nuclear flexibility (as to response to grid demands) while comparing the AP-1000 and the EC6.

As usual we have a selection of General and CNS News, and to end things off in a bang, we have Jeremy Whitlock's whit on bomb-grade logic in Endpoint.

It seems we are still complaining about cold weather, and we will undoubtedly soon be complaining about hot weather. It's great to be a Canadian, eh!

From The Publisher



Society activities

The first two and a half months of 2013 have been an interesting time for our Canadian nuclear program and for our Society. Within the Society there has been considerable activity on several issues. The most noteworthy ones being tackled by the Society's executive and governing Council are outlined in an article in the CNS News section. However, the members of those groups are just a small fraction of the 1200 members of the Society.

With the Council's decision to be involved in hearings of the Canadian Nuclear Safety Commission and possibly in other forums, perhaps more members will consider becoming involved, such as in public debates in their neighbourhoods. If you would like to take part in the public debate signal your interest to the president, communication director or chair of your local branch.

Future of AECL / CRL

Perhaps most significant news related to our nuclear program was the federal government's announcement about the future of Atomic Energy of Canada Limited. Interestingly, that was first made by the Minister of Natural Resources Canada (NRCan), Joe Oliver, to whom AECL reports, at the major gathering of the nuclear industry, the Annual Conference of the Canadian Nuclear Association. *(See the report on that conference and the official media release in this issue.)*

About a year ago NRCan issued an invitation for Expressions of Interest regarding the future of AECL, or, strictly speaking, Chalk River Laboratories. As noted in a previous issue of the *Bulletin*, the Society decided to respond to that invitation, not on the form of management, but on the importance of having a research reactor. Reportedly, the CNS submission was the only one that focussed on that critical need.

The Minister announced that the government was now seeking applications for the management of AECL / CRL. In the official announcement it was stated that, *"The Government is seeking to implement a Government-owned, Contractor-operated (GoCo) model, as is done in other jurisdictions, such as the United States and the United Kingdom."*

Minister Oliver commented that the government would give priority to, and presumably paying for, dealing with radioactive wastes from the past, in two categories; "legacy" (from early CRL activities) and "historic" from pre WW 2 activities (such as the radium refinery in Port Hope). Beyond that he said much of the work at CRL would be on a cost recovery basis.

On that last point it is interesting that, during th CNA Conference, two leaders of large US nuclea laboratories were asked what percentage of their tota funds came from their federal government and eacl said, about 90%. They added that it came from man different departments and agencies. About two year ago, at a US event, the head of the Idaho Nuclea Laboratory commented that about a third of thei budget came from Homeland Security (despite the fac it had little to do with nuclear technology).

If AECL-CRL is to follow the US model let us hop that other parts of the federal government, such a Health Canada and Environment Canada, will recog nize the capabilities of CRL and have some of thei research conducted there.

Darlington

Another development, definitely positive even if it i just a step, was the approval by the Canadian Nuclea Safety Commission of the environmental assessment fo the planned refurbishment of the Darlington station.

Significant contracts have already been issued b Ontario Power Generation for the planning of the hug program and construction of tools and facilities for th conduct of the task.

There remains the licensing of the actual work and probably more critical, approval of the large expendi ture by the Ontario government.

Speaking out

One of the most encouraging moves for me has beer that of Bruce Power which, very recently, has been run ning interesting advertisements on main television Since the CNA has, for the past few years, concen trated on the "social media", those of us not into tha activity have heard very little positive in the genera media about the benefits of nuclear technology.

Over the past few years the only group doing tha was the Power Workers Union. Ironically, the bes spokesperson for clarifying nuclear issues and correct ing false statements has been the president of the reg ulatory body, Michael Binder of the Canadian Nuclea Safety Commission. At the CNA Conference he urge others to join the fray.

Some members will argue that the Society is a col lection of individuals and therefore can not speak fo all. That is undoubtedly true but with a proper process the Society should be able to make statements base on facts to counter the many misleading accusation made in the media and at public hearings.

Fred Boya

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~ Cover Photo ~

Rabbit Lake: Located in northern Saskatchewan, Rabbit Lake is the longest producing uranium operation in Saskatchewan.

Photo courtesy of Cameco

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

CNS provides Canadians interested in nuclear energy with a forum for technical discussion. For membership information, contact the CNS office, a member of the Council, or local branch executive. Membership fee for new members is $82.40 per calendar year, $48.41 for retirees, free to qualified students.

La SNC procure aux Canadiens intéressés à l'énergie nucléaire un forum où ils peuvent participer à des discussions de nature technique. Pour tous renseignements concernant les inscriptions, veuillez bien entrer en contact avec le bureau de la SNC, les membres du Conseil ou les responsables locaux. Les frais d'adhésion par année de calendrier pour nouveaux membres sont 82.40$, et 48.41$ pour retraités.

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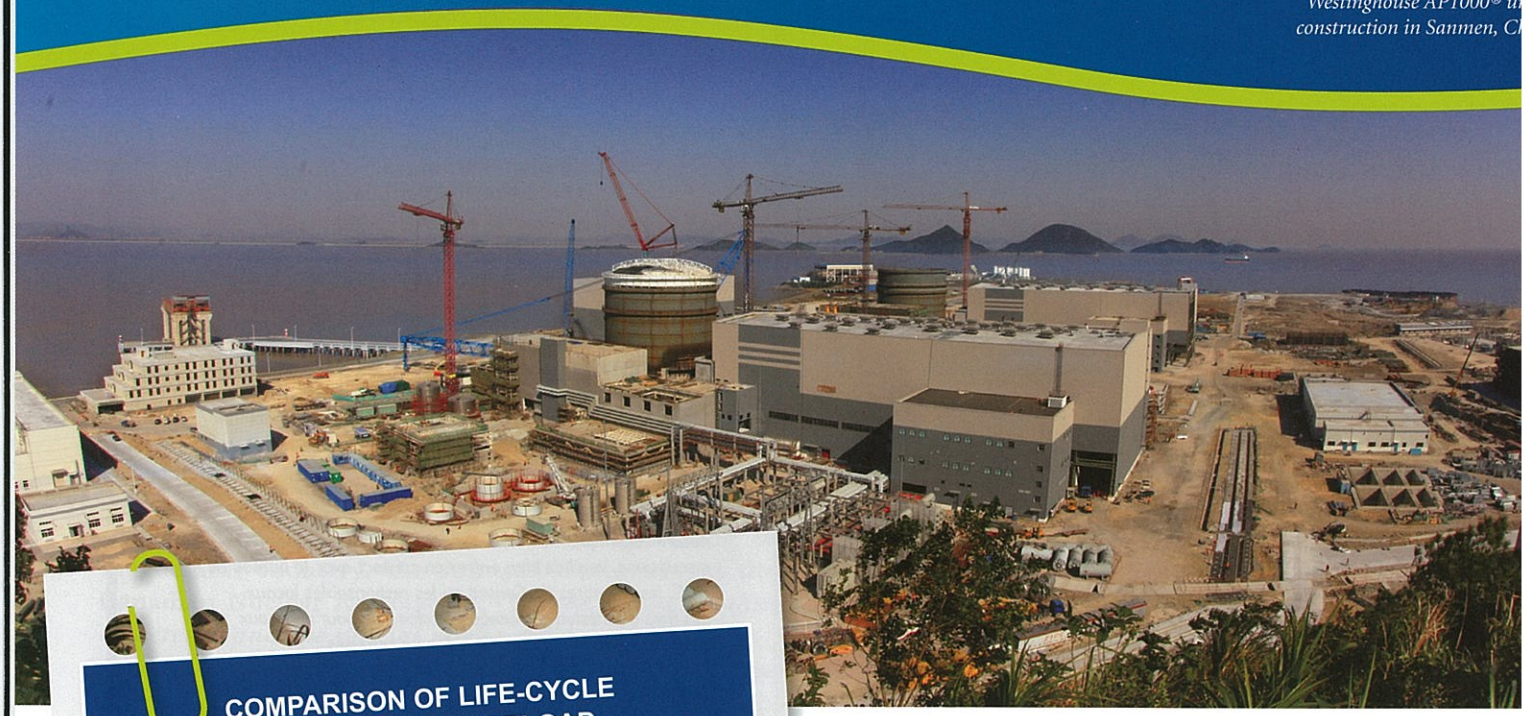

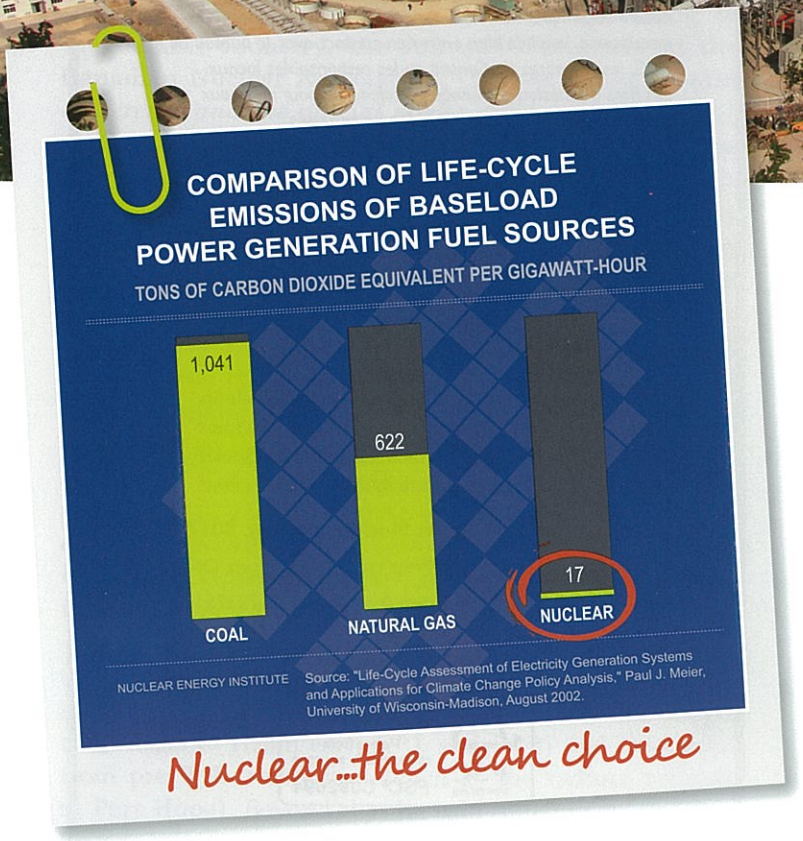

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CNA 2013 Conference & Tradeshow

Minister Unveils Plans for AECL at CNA Event

by FRED BOYD

Over 700 delegates, vendors and others gathered at the Westin Hotel in Ottawa, February 27 to March 1 for the 2013 Conference and Trade Show of the Canadian Nuclear Association. They were treated with two days of presentations related to the Canadian nuclear program, over 40 exhibits from most of the companies and organizations involved in that program, and excellent receptions and meals. In addition they heard the first announcement of the restructuring of Atomic Energy of Canada Limited from the federal Minister of Natural Resources Canada, **Joe Oliver.**

The minister, whose responsibilities include Atomic Energy of Canada Limited, emphasized that nuclear was a key part of the country's energy mix. The government's priority, he said, is on long-term issues such as medical isotopes. He reported that the government had granted a further $25 million to three organizations to continue their development of non-reactor methods of producing molybdenum 99 or technetium 99m. These are TRIUMF in British Columbia; University of Alberta; and Prairie Isotope Production Enterprise in Manitoba.

The government, through AECL, is giving priority to dealing with the liability of historic and legacy radioactive wastes.

Then he announced the decision to invite proposals for the management of AECL's Chalk River Laboratory, with a target of two years for a decision. The three priorities for CRL are: the liability waste; ensure capability to support the Canadian Nuclear Safety Commission; and industry access to the laboratory's expertise. On the last item he emphasized that such access would be on the basis of full cost recovery.

Although the Minister did not take questions from the audience he did hold a media "scrum" during which he commented that although NRU would cease isotope production in 2016 he expected it to continue operation beyond that date for research on a cost-recovery basis.

Preceding the actual conference, there were two workshops on the first day – one on Regulatory Affairs, the other on Communications – along with a Career Development Seminar primarily for students who had been sponsored to attend...

The conference proper began with an excellent welcome reception on the first evening, when **Heather Kreb**, acting President and CEO, welcomed the attendees.

At the breakfast on the following day, **Grant Isaac**, senior vice-president, Cameco Corporation and CNA Chairman, also extended a welcome, then invited everyone to the conference room where he introduced Joe Oliver,

The first speaker following Minister Oliver was **Jean Llewellyn**, CEO of the National Skills Academy for Nuclear in the UK. The academy will pursue a spectrum of levels from apprenticeships to Ph.D. and will issue certificates of "nuclear professionalism". A major objective is to redevelop the UK nuclear supply chain.

After a break two senior industry representatives, **Albert Sweetnam**, Executive V.P, Nuclear Projects at Ontario Power Generation; and **Gaetan Thomas**, President and CEO, New Brunswick Power, shared their experience about nuclear refurbishment projects. Thomas emphasized the challenge of contracting; the need for good internal communication; the challenges of decision-making and the need for realistic schedules.

Sweetnam spoke primarily about the planning for the refurbishment of the Darlington station. There are four units, he noted, but there are complex inter-connections which must be taken into account. OPG is now in the planning phase. The first refurbishment will begin in 2017. Noting that the Darlington refurbishment will be a 15 year project, potential contractors will have to show that they have a long-term staffing plan.

During the extended discussion period Thomas noted the challenge of evaluating the cost risk. He stated that, despite the delays, the refurbishment will result in a generation cost of less than 10 cents per kilowatt-hour.

Both speakers emphasized the need to use "social media" to maintain the support of the public and noted the on-going challenge of educating the media.

After the full, served, lunch, **Tim Stone**, Expert Chair, UK Office for Nuclear Development and a Senior Advisor to the UK Department of Energy and

Climate Change, spoke on the challenge of aligning national energy and industrial strategies. He noted that the UK government has issued a Directive to phase out all coal-fired electricity generation by 2016 and to have renewables provide 15 per cent by 2020. A 2008 "White Paper" called for nuclear to be part of the generation mix. The Office for Nuclear Development is mandated to enable nuclear to make the fullest possible contribution without any subsidies. Acknowledging that the problems have not been thought through, he noted that there are many constraints and the time is short to achieve that objective. Currently the UK has the lowest electricity price in Europe.

He offered a long list of challenges for the nuclear program, including: planning, licensing, political risks, legal challenges and financing. On the particular problem of disposal of the plutonium at the Sellafield site he mentioned that CANDU and the GE Prism reactors were being considered for consuming it.

The afternoon session began with a panel discussing *"Nuclear Innovation – Driving the Future"*. Panelists were **Todd Allen**, Deputy Laboratory Director, Idaho National Laboratory; **Terry Michalske**, Executive V.P. and Director, Savannah River National Laboratory, both in the USA, and **Bill Kupferschmidt**, Executive V.P. AECL.

L. to R. Todd Allen, Bill Kupferschmidt, Terry Michalske.

Each offered some opening comments before responding to a series of questions posed by the moderator.

Regarding the announcement by Minister Oliver about the change of management of AECL, Kupferschmidt commented that AECL already has a five-year plan. He suggested that the three laboratories represented should work together on common technical issues.

Allen stated that Idaho is one of the largest nuclear laboratories focussing on national issues. They have extensive alliances with researchers around the US. He added that much of its existing infrastructure could not be duplicated under the present political and economic circumstances.

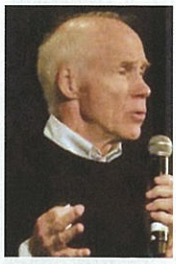
Noting that he was basically a material scientis Michalske commented that the AECL announceme had some parallel aspects to the situation at Savanna River. It had been very inward looking before becor ing a national laboratory in 2004. The continuir challenge is to achieve a broader vision and to learn work with, and for, many different government depa ments. He added that he felt that the AECL announc ment was a positive step.

To a question from the audience, both US represe tatives stated that about 90 per cent of their fundir came from the federal government, but from ma different departments and agencies.

After a break, the focus turned to the uraniu sector, beginning with an overview by **Jean-Franco Béland**, Executive V.P., AREVA Resources Canada In He noted the rich deposits in northern Saskatchewa and commented that when Cigar Lake gets into oper tion later this year Canada's portion of world produ tion will rise above the current 18 percent. He not that 42 per cent of AREVA's mining employees a first natives and that portion will rise. On the bro picture he observed than when he came to Canada concluded that the "anti-nuclear" movement is n going away so nuclear supporters need to speak out.

A complementary perspective on the uranium minir sector was offered by **Jean Paul Gladu**, President ar CEO, Canadian Council for Aboriginal Business, wh began by noting his organization was begun 28 yea ago by Murray Koffler. Some of the driving facto included recognition that most of the first natic communities were resource based and there had bee some positive Supreme Court decisions. He mentione an innovative program called Progressive Aborigin Relations which has led to meaningful relationshi with industry.

That evening there was another reception, this tir sponsored by the exhibitors and held in the exhib tion area.



Friday was a half day program whic started again with a breakfast accor panied by a motivational speaker, **Jo MacInnis**, a medical doctor who h become a deep sea explorer. He h led, or participated in, more than fif major undersea expeditions, inclu ing one to the Titanic.

After acknowledging the complexi of the nuclear program he proceeded to describe t challenges of deep sea diving. Leadership is critica he said, and must include empathy, emotional inte ligence and endurance. He showed a number of slid and a video from a series of dives near Australia invol ing a one man submersible vessel that could withstan great diving depths. One dive went five miles dee His recent book, titled *Deep Leadership*, expands o

the thoughts and experiences he recounted in his talk.

The formal part of the conference continued with two speakers focussing on safety issues of nuclear power.

First was **Tom Mitchell**, President and CEO, Ontario Power Generation, who focussed on the nuclear utilities response to the Fukushima event of March 2011. He observed that a broad public response was that it must not happen again. The public, he offered, will no longer accept the argument that an event is "not likely". Rather, it demands that if it "can happen" it must be prevented. This broad view is not limited to nuclear, he suggested, noting such developments as air bags in cars, and the recent problems with the new Boeing airliner. A major challenge, he said, is how can those in the nuclear program regain public confidence?

He mentioned the recent appointment of Ken Ellis, of Bruce Power, to a senior position at the World Association of Nuclear Operators (WANO), and the excellent public relations efforts of Don McKinnon of the Power Workers Union who was recently awarded the Order of Ontario.

Next, **Michael Binder**, President, Canadian Nuclear Safety Commission, began by listing the major items on the "CNSC plate". These include: Gentilly 2 shutdown; Darlington refurbishment and proposed new build; deep geological repository; legal challenges; and the proposed Mastoush uranium mine in Quebec.

He then listed a number of "on-going" projects, such as: Pickering renewal; Port Hope clean-up; Cigar Lake and other uranium projects; future of AECL; Fukushima action plan; and, over 3,000 licences.

The CNSC is in the process of modernizing its regulatory framework, he noted, with everything to be put on line, and asked for feed-back from the nuclear community.

After noting that neither US president Obama nor new Ontario Premier Wynne, mentioned nuclear in their recent speeches, he commented, "Uncertainty is the new normal". There is a possibility the CNSC may have to down-size, he added.

He closed by asking "who tells our story?" and commented, we are good at speaking to ourselves.

The final session of the conference involved a panel of four community representatives presenting their views on the need to be involved with nearby nuclear projects and the Director of Corporate Social Responsibility of Cameco Corporation, **Sean Willy**.

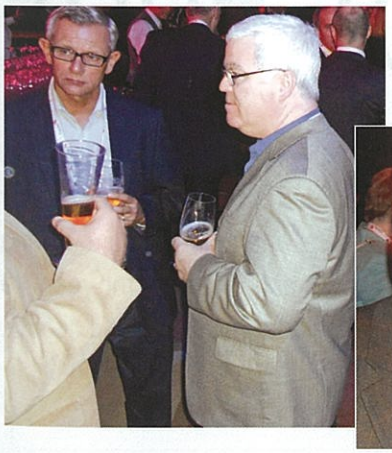
The community representatives were: **Adrian Foster**, Mayor, City of Clarington (the location of the Darlington station); **Linda Thompson**, Mayor, City of Port Hope (site of Cameco Fuel); **Larry Kraemer,** Mayor, Municipality of Kincardine (largest community near the Bruce Power site); and **David Thompson**, Mayor of the Municipality of Deep River (the residential town of the Chalk River Laboratory).

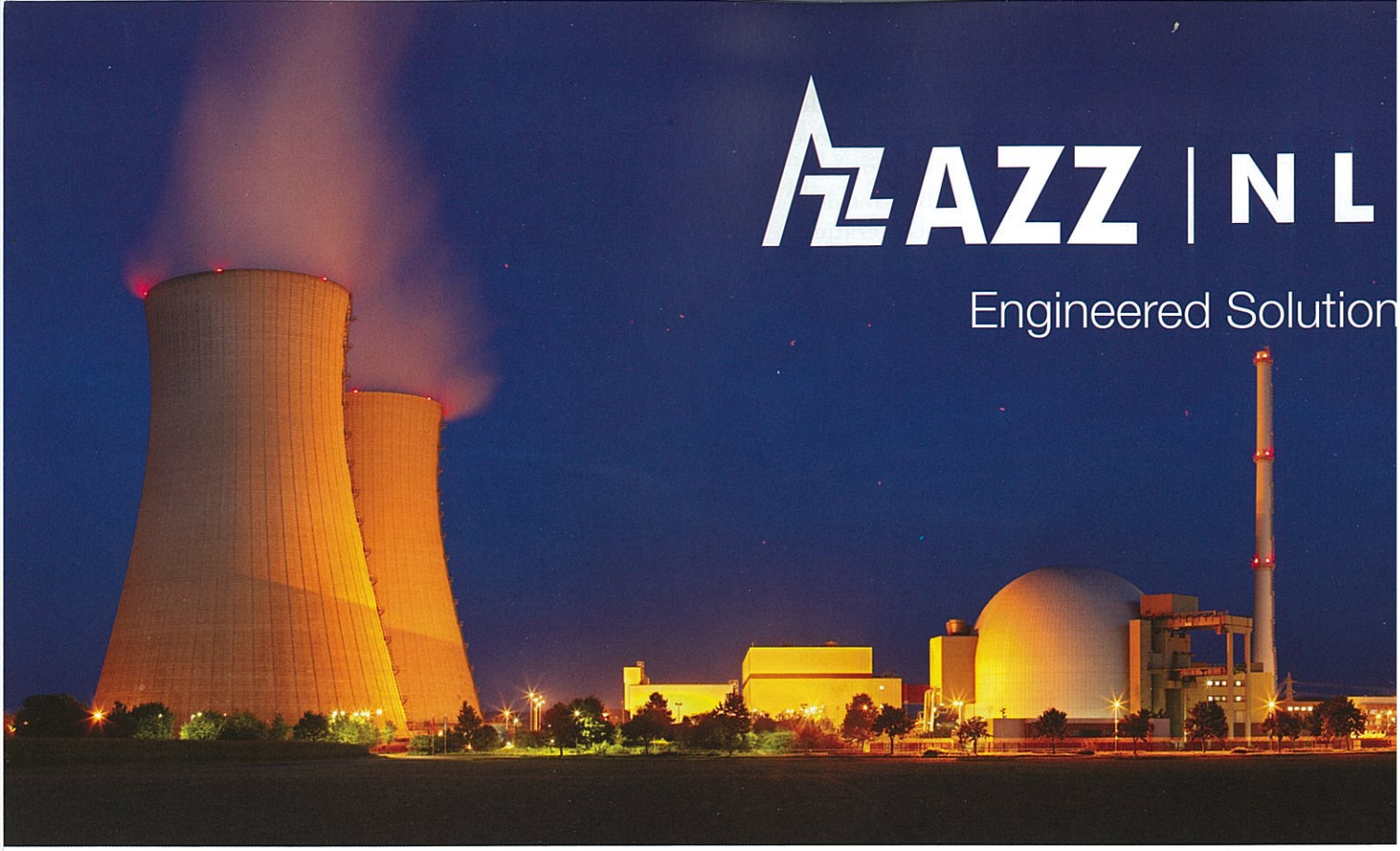
They discussed the importance of community outreach and education to inform and engage their citizens regarding the nuclear facilities nearby.

Following a buffet lunch Heather Kreb offered her thanks to all participants and invited them to return for next year's conference.

The event was supported by a long list of sponsors: Cameco; TetraTech; OPG; Aecon Nuclear; AMEC; Energy Solutions; CNSC; Westinghouse; Bruce Power; AECL; Power Workers' Union; Candu Energy; Black & McDonald; IME; Kinectrics; Workface Efficiency; B & W Canada; Areva; E.S. Fox; Fluor; SNC Lavalin Nuclear; CH2M hill; L3 MAPPS; Alberici Constructors; Worley Parsons; Babcock.

Scenes from the Conference





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Canada, the Provinces, and the Global Nuclear Revival: Advocacy Coalitions in Action

DUANE BRATT, Mount Royal University, Calgary, Alberta

[Ed. Note: Following is a brief excerpt from the book of the same title, used with permission from McGill-Queens University Press. This book is reviewed on page 53.]

The Table below summarizes the level of nuclear activity in four Canadian provinces in the first decade of the twenty-first century: Ontario, New Brunswick, Saskatchewan, and Alberta. This activity is measured in four ways. Two of the measurements identify material manifestations through restarts, refurbishments, and new reactor build projects. The other two identify virtual manifestations in the form of major studies by government, industry, and anti-nuclear groups, and the degree of public support through public consultations and public opinion polls.

There are a number of similarities across the four provinces. First, all the actors in the nuclear sector have been seriously investigating maintaining, expanding, or introducing nuclear power in their respective provinces. Second, in provinces with existing nuclear

TABLE
Comparing the Nuclear Revival across the Provinces

		Ontario	New Brunswick	Saskatchewan	Alberta
Major Studies	**Government**	IPSP, Pickering A, OPG Review	Pt Lepreau Refurb, New Reactor Feasibility	UDP	NPEP
	Industry	Bruce Power (Refurb of Bruce A), OPG (Refurb of Pickering B)	Team CANDU New Reactor Feasibility	Bruce Power New Reactor Feasibility	None
	Anti-Nuclear Groups	Several	Few	Several	Several
Refurbishments		Pickering A1 & A4 (restart), Bruce A3 & A4 (restart), Bruce A1 & A2 (refurb)	Pt Lepreau	n/a	n/a
New Builds		Two reactors at Darlington (initially suspended, restarted)	Two cancelled proposals for another reactor at Point Lepreau	One power reactor (delayed), One multiuse research reactor (proposed)	Two reactors (proposal cancelled)
Public Support	**Consultations**	Localized	Localized	Comprehensive	Limited
	Polls Pre-Fukushima	60-65% Support	45-55% Support	50-55% Support	50-55% Support
	Polls Post-Fukushima	50-55% Support	45-50% Support	45-50% Support	45-50% Support

fleets, the reactors are being restarted and/or refurbished to maintain electricity generation from nuclear power – no phasing out is occurring. Third, despite significant preparation in all four provinces (especially in Ontario), construction has not started on any new nuclear reactor project.

The announced delays in new builds, whether temporary or permanent, have resulted almost exclusively from the issue of cost. While critics have brought forward a number of arguments relating to radiation, nuclear safety, water usage, etc., it appears that governments across the country have, on balance, accepted the that nuclear energy has more strengths than weaknesses with the exception of the issue of cost. In New Brunswick, the Point Lepreau 2 project was based on a merchant model, whereby the private sector (in this case Team CANDU and Areva) would be solely responsible for financing (including assuming the risk of any cost overruns), building, and owning the nuclear power plant. It would then have to find customers in Canada and the U.S. for its electricity. However, the project has been stalled owing to a lack of financing credit and the inability to obtain a long-term purchasing agreement with NB Power. This scenario was repeated in the other three provinces. The government of Ontario initially suspended the bid process for two new reactors at the Darlington site because of a price that was "billions" too high. When they restarted the new build project, the preferred reactor design shifted from the larger and more expensive ACR-1000 to the smaller and less expensive EC6. The Saskatchewan government also referenced the cost of nuclear power when it decided to wait until after 2020 to consider a nuclear power project. Finally, in Alberta, Bruce Power crunched the numbers to see if there is a business case for building nuclear reactors in the province and realized that because of the drop in natural gas prices the business case was not there.

Problems related to access to capital resulting from the global economic recession has been a primary cause of the cost problem. However, there are additional factors beyond access to capital. The global recession, in Ontario especially, has led to a drop in electricity demand. There are real questions in Ontario about whether the province's vital manufacturing sector, in particular automobiles manufacturing, will rebound or whether this drop in electricity demand will be permanent. Finally, there are fears within government about the potential of cost overruns with nuclear power, as in the case of Darlington. The experience with the restarts and refurbishments which have been marred by significant delays and cost overruns that, combined, have totalled several billion dollars has heightened those fears.

There were also differences across the four provinces. First, Saskatchewan and Alberta used comprehensive consultation processes to gauge pub support for nuclear power. Consultations occur in different parts of the provinces, and the topic v broad, especially in Saskatchewan. In contrast, N Brunswick and Ontario used only localized and limi consultations. NB Power limited its public enga ment to the Point Lepreau refurbishment project a limited its geographic scope to the greater Saint Jo area. In Ontario, where public hearings into the n build project at Darlington were held by the Jo Review Panel, anyone could make a submission, a the hearings were webcast, but the panellists stayed Clarington, Ontario, near the Darlington reactor si

Second, while three of the provinces focused exc sively on electricity generation, Saskatchewan exa ined many different aspects of the nuclear sect In particular, the UDP panel was commissioned the government to consider opportunities in u nium mining, uranium upgrading, nuclear resear and development, and nuclear waste disposal. As result, the Saskatchewan government has pursued nuclear agenda that goes beyond electricity generati and includes the creation of an Institute for Nucl Studies at the University of Saskatchewan.

The similarities and differences in how each pr ince has responded to the global nuclear revival can explained through the history of the nuclear sector each province and the nature of the electricity marl (public, private, or mixed).

The existence of a previous nuclear history is a k variable that separates the provinces: Ontario has be the heart of the nuclear sector since the beginnir New Brunswick has had a presence in the nucl sector since the early 1970s, Saskatchewan traces uranium industry back to the late 1940s, and Albe has very little nuclear history at all. These differenc manifested themselves in many ways. First, Onta and New Brunswick had to consider maintaining th existing nuclear fleets through restarting/refurbi ment and expanding their fleet through building n reactors, but Saskatchewan and Alberta only had consider new builds. The subsequent technologi problems and cost overruns with the restarts/ref bishments were contributing factors in the decisio to delay pursuing new build projects in both Onta and New Brunswick.

Second, nuclear history has had a distinct impa on public support. In general, Ontario and N Brunswick have been the strongest supporters nuclear power in the country, for a number of reaso Thousands of jobs would be directly at risk if nucl power was phased out in those provinces, which c ates a pro-nuclear lobby that influences the gove ment's decisions on maintaining and even expandi the nuclear sector. In addition, people are famil with the technology. For example, hundreds of th

sands of Ontarians drive by the Pickering reactor on Highway 401 every day and rarely question its safety. This weakens a major constraint against the development of nuclear power.

Third, because there were no existing nuclear power plants in the province, the provincial governments in Saskatchewan and Alberta commissioned comprehensive expert panels to investigate nuclear power. In addition, both provinces conducted public consultations on the introduction of nuclear power. However, because Saskatchewan had debated nuclear power in the past, there was a coordinated anti-nuclear movement there that was able to mobilize opposition during the public hearings. In Alberta, the anti-nuclear groups were newer and weaker and have not been able, except in Peace River, to even put the issue of nuclear power on the province's political radar screen.

Electricity generation and distribution is in provincial jurisdiction, and how each electricity market operates is a key explanatory variable for comparing a province's response to the global nuclear revival. In the first period of nuclear expansion in the 1970s, the electricity market, both globally and nationally, was heavily regulated, and publicly owned utilities were the standard. Now, many developed countries, including Canada, have deregulated or partially deregulated their electricity system, which means that the provincially owned public utilities can no longer manipulate electricity prices as part of an overall economic development strategy. Private sector firms (and their shareholders) must now base investment decisions on the projected rate of return based on a levelized energy cost analysis. This is the same process regardless of whether the source is nuclear, coal, natural gas, hydroelectric, wind, or solar.

Alberta has a completely privatized electricity generation system, although some degree of governmental regulation remains through the Alberta Utilities Commission. Alberta has no provincial Crown corporation with a monopoly over the electricity grid. In that same vein, Alberta's Department of Energy can recommend to the government whether to allow nuclear power (which they did in December 2009), but they do not have to consider whether they would have a financial stake in the business. It is up to a private electricity generator to find customers to sell their electricity to. A company, such as TransAlta or Enmax, could put all its electricity on the grid, it could sell it directly to one customer, or it could decide on some combination of the two strategies. For Bruce Power, which seeks to move beyond being a reactor operator (as they are in Ontario) to being an owner/operator (as they once intended to in Alberta), there are advantages and disadvantages in the privatized Alberta market. On the one hand, the Alberta political and economic culture respects the fact that Bruce Power is a private sector firm willing to undertake the risk of building a nuclear power plant for the opportunity of great financial reward if the project succeeds. On the other hand, it would have been easier for Bruce Power to negotiate with only one customer, such as an Alberta utility that monopolized the electricity grid.

Since the restructuring of Ontario Hydro, Ontario has partially deregulated its system and now has what could be described as a quasi-private electricity market. OPG and the other successor companies remain solely owned by the government of Ontario, but OPG is expected to operate on sound business principles as if it were privately owned. This is one of the reasons why OPG initially conducted a competitive bid process for its new build project: it owed it to its shareholders (the people of Ontario) to get the best technology at the lowest price. This is also why the reactor vendors were required to be solely responsible for any price escalations. After the procurement process, the only compliant bid came from AECL, but it was rejected because, notwithstanding the economic development aspects of its proposal, it was deemed to be too expensive. Now that the new build has been restarted, it appears that Ontario will be working exclusively with CANDU Energy to acquire two EC6s. Ontario's partially deregulated electricity market also explains why Bruce Power was able, on its own, to consider investing in new reactor projects.

The situation in Saskatchewan and New Brunswick is different because both provinces have retained pure public ownership of electricity. While private sector companies (Team CANDU, Areva, or Bruce Power) would be involved, all decisions regarding electricity would ultimately flow through the provincial Crown corporations of SaskPower and NB Power. When SaskPower told the government that it wanted to wait until 2020 to consider nuclear power, that is exactly what the government did.

Both Saskatchewan and New Brunswick also continue to adhere to the old model of using electricity generation for regional development. Nuclear power was seen by both governments as a key component of their province's industrial strategy. Premier Graham's vision was to turn New Brunswick into an "energy hub" with multiple energy projects (LNG terminals, an expanded transmission system, oil refineries, etc.) based on the province's central geographic location. The refurbishment of Point Lepreau and the pursuit of a second reactor were integral parts of this "energy hub" strategy. Premier Wall created the UDP to pursue his plan of leveraging Saskatchewan's substantial uranium mining resources to move up the value-added and high-technology chain to uranium upgrading, medical isotopes, nuclear research and development, and nuclear power.

Part of the regional development strategy was also

designed to acquire federal funds for nuclear projects. Point Lepreau was first built in the 1970s with a significant contribution from the federal government. Therefore, the New Brunswick government was surprised when it was rebuffed by the Paul Martin government in its request for about $800 million to support the refurbishment of Point Lepreau. More recently, the New Brunswick government has asked Ottawa to cover the cost overruns associated with the refurbishment. In the case of Saskatchewan, its proposal for a new multi-use research reactor is based on a cost-sharing arrangement that would have the federal government contributing up to 75 percent of the construction costs and 60 percent of the operating costs.

In the years that come, we may look back on this period of activity in Canada, especially from 2005 to 2011, as the critical preparation stage that was necessary before the country fully embarked on a revi of nuclear power. It was during this period that t political, economic, and technological case for nucl power was made, that is, that the arguments of t pro-nuclear coalitions persuaded the policy brok and the wider public to maintain and expand nucl power across Canada. By 2030, we could very w be observing new nuclear power plants operating Ontario, New Brunswick, Saskatchewan, and Alber An alternative scenario would be to look back and s that Canada chose not to participate in the glo nuclear revival, to see that despite the energetic acti ty of the pro-nuclear coalition, governments across t country decided that while they would maintain t existing fleet of reactors (largely because of the su costs), they would pass on expanding nuclear powe

The Happy Medium: A Useful Property of Solutions from EVS Methodology

by FRED M. HOPPE[1] and KEITH WEAVER[2]

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Introduction

EVS methodology is a statistical approach developed to deal with problems in which there is a need to select defensible licensing values for selected variables, while taking account of a potentially complex set of error terms arising from different sources. The name EVS arises from "extreme value statistics", since the maxima and minima of random variables arise naturally for the problems of interest.

Two problems to which the approach has been applied are compliance with regulatory limits on maximum channel powers, and the selection of trip set points for the Neutron Overpower Protection (NOP) system. In the first of these problems, the limiting channel power is specified by the regulator (i.e. it is known with 100% certainty), whereas in the second problem no value for the trip setpoint can be known with certainty apart from the trivial case which would force a reactor to be shut down permanently.

One can freely admit that the use of EVS to define a trip setpoint involves some complex statistics and requires getting one's head around concepts that can be unfamiliar. It was partly for this reason that the EVS methodology has been subjected to extensive review by external examiners. At an early stage, one of us was engaged [1] to conduct a thorough study on the methodology as it had been formulated in the 1990s [2]. In 2008, a panel drawn from the US and Canadian nuclear industry [3] was requested to examine the methodology, at the request of the CNSC and COG. In 2010, a further review, carried out by one of the members of this panel, was commissioned by OPG and Bruce Power. Although each of these groups found items that needed clarification or upgrading, all the reviews concluded that the methodology was mathematically and statistically sound.

Despite all this, it is clear that both regulators and licensees must have a good sense that the methodology and its predictions are appropriate and acceptable. To arrive at this sense in a rigorous way would require an understanding at a mathematical and statistical depth that is considerable, and could pose practical problems. The need for licensees and regulator to have a sufficient comfort level is fully understood and accepted. How should one go about achieving this?

The Need to Understand

Designers and operators of NOP systems develop a finely tuned sense of the characteristics, capabilities and responses of this system, based on their understanding of the equipment itself. Analysts and regulators could be in a somewhat different position, if their "knowledge" of the system is based too much on model predictions. This is especially the case when these predictive models change, and the differences between the old and new models are considerable. "Experience" gained by exposure to the old model can be misleading if it is used as a basis for "judging" predictions from the new ones. This relates to the potentially very slippery question of intuition. Intuition based on the understanding of equipment characteristics and the underlying physics of a situation is expected to be sound. However, "intuition" that is based on experience with a model that is inappropriate, or derived in a way that is not clear, may be very problematic.

One particular feature of the EVS predictions involves a characteristic referred to as "convexity". Convexity of a function refers to its curvature when plotted as a graph. A function is convex if it opens upwards, for instance like a quadratic having a positive coefficient for the quadratic term. If one reflects a convex function in the x-axis, then it becomes a concave function. Mathematically, convexity is described by requiring that any secant between two points on the curve lie above the curve connecting the points, and can be phrased in terms of the non-negativity of the second derivative. Seen from the point of view of the "old model" predictions, one might conclude that this convexity feature in EVS is counter-intuitive and possibly wrong. Without having other ways to view this situation, discussions of the convexity feature can degenerate to a "he said, she said" level, and this is not only not useful, but is a step backwards. What is needed is as many ways as possible to help understand what the EVS method is saying. The purpose of this article is educational, to explain a metaphor recently introduced to capture this feature of EVS and also to provide a rigorous yet reasonably non-technical and self-contained explanation in the context of the first problem mentioned at the outset.

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A Metaphor for Understanding

One way we have attempted to provide insight into this convexity feature is to characterize it in terms of a "Goldilocks" metaphor [4]. This is intended to evoke the picture of something that is not too big, not too small, but just right. We are under no illusions that this metaphor will clear away all uncertainties, but we consider it another tool that can help produce better understanding.

But it will function in this way only if it is given serious consideration. It would be the easiest thing in the world to dismiss the whole approach out of hand as being a ridiculous application of an irrelevant children's fairy tale. So in the remainder of this note, we want to provide some support for this metaphor as being relevant, legitimate, and based on precedent in use, and then detail its initial appearance in EVS.

The metaphor comes from the well-known story of Goldilocks and the Three Bears. A version of the story was documented in 1837 by the English poet Robert Southey, but had been in circulation before then. The details are not particularly important, but we might as well get a few of them straight. A Harvard academic, Maria Tatar, who specializes in the history and significance of children's stories and nursery rhymes (she has written a book called "Annotated Classic Fairy Tales", and spoke on the topic in a talk she gave in Toronto last October), notes that the story has been modified over the years. For instance, the name "Goldilocks" was not introduced until 1918. Tatar notes further that these stories should be viewed as more than just ridiculous phantasies, seen from within a "modern" cocoon of disillusionment and mechanism, that they encapsulate serious life commentaries from earlier ages, and served within the cultural contexts of those ages as sources of entertainment, enlightenment, and understanding.

The value of the Goldilocks metaphor, in any application, lies in its ability to focus attention on what one might call "the happy medium". This is the only reason we apply it here. The currency and acceptance of this metaphor in serious work seems to be well beyond doubt, and some examples given below support this statement. Despite all this, it has been of particular concern to us that we have come across some dismissive comments about the use of this metaphor, and so the main objective of the present article is to try to correct, through education, any misapprehensions that might be behind such comments.

Examples of the Use of the Goldilocks Metaphor

Does our modern age of science and technology have any real need of a Goldilocks metaphor? Judging from the number of occurrences of it across many disciplines, the answer would be "apparently yes". He are a few.

- The prolific academic physicist, Paul Davies, h written a book entitled "The Goldilocks Enign Why Is The Universe Just Right For Life?"
- From biological and ecological work, comes article in the journal "Freshwater Biology" (Vol. Issue 3, March 2012) entitled "The Goldilocks effe intermittent streams sustain more plant spec than those with perennial or ephemeral flow".
- The journal "Autophagy" (August 2011) contai an item with the title "Oncogene-induced autopha and the Goldilocks principle".
- Researchers in the Department of Chemistry at Nor Carolina State University have produced an arti entitled "Goldilocks Effect in Magnetic Bistabili Remote Substituent Modulation and Lattice Cont of Photo-induced Valence Tautomerism and Lig induced Thermal Hysteresis", published in 2010 the Journal of the American Chemical Society.
- The National Science Teacher's Association in t US offers a teaching module entitled "The Goldiloc Principle: A Model of Atmospheric Gases", based an EPA report and intended to help students und stand the connections between the greenhouse effe and changes in the planet's atmosphere.
- Brian Skyrms, a professor of Logic and Philosop at the University of California has written a bo "Signals: Evolution, Learning & Information Oxford University Press, 2010, which is an expansi of his 2006 Presidential address of the Philosop of Science Association in which he refers to t Goldilocks property with respect to reinforceme learning in the context of an urn model [5].
- The National Aeronautics and Space Administrati refers to the Goldilocks Zone to refer to locatio both on Earth and also in space where life may exi the same nomenclature was used in a CBC progra Quirks and Quarks which aired on October 20, 20 with an interview with the lead author of a rece paper in Nature by a European team of astronome announcing the discovery of an Earth-like planet trillion kilometers away.

Many other instances could be cited, but we do aim at a comprehensive list, and these exampl should serve adequately to make the point that t term "Goldilocks" has gained international standi as having legitimate *explanatory* potential in serio technical discussions. Individuals who feel uncomfo able at use of this metaphor, or dismiss it as an e ment of serious discussion, would appear to be out date and out of touch with existing literature.

Still, looking at things in a more general way, sor people might feel that the term "Goldilocks" is isolated metaphor in a class on its own, that its u

here is a "reach", and that therefore the rationale for its use is somehow contrived or weak. Anyone feeling that way should think again, as can be seen from the further examples below, indicating that the Goldilocks metaphor is in good company.

- The entire theme of Roger Penrose's book "The Emperor's New Mind" is based on Hans Christian Andersen's tale "The Emperor's New Clothes". Penrose refers to Andersen's tale explicitly at both the beginning and the end of that intriguing book.
- "The Sorcerer's Apprentice" refers to a poem by Goethe (Der Zauberlehrling), to a delightful piece of orchestral music by Paul Dukas, but also to a network protocol flaw that appeared in early versions of TFTP.
- Aesop's tale of "The Ant and the Grasshopper" has been used many times to highlight provident and extravagant behaviours, but a very recent use is in the New York Times of February 28, 2013, where it is applied to characterize problems in the pricing of electricity in New England.
- The noted Harvard professor and lawyer Alan Dershowitz used an allusion to Shakespeare's famous "to be or not to be" soliloquy to describe pithily, as a "Hamlet" decision, the mixed outcome in former U.S. presidential candidate John Edwards' trial in May 2012.

So the use of a range of metaphors of this sort is alive and well and living among us (probably also in Argentina).

A Specific Example

The first use of the Goldilocks metaphor in a nuclear context was at the SUNCOP workshop in Petten, The Netherlands in 2010 [4]. The context was the methodology adopted by Ontario Power Generation to show channel power license compliance [2]. What is described below is an expanded and more gentle version of part of the SUNCOP presentation.

A typical CANDU reactor consists of 380 or 480 fuel channels, depending on location, each containing 13 bundles of 37-element uranium dioxide fuel. Because of burnup, fuelling, and the reactor regulating system, the power in channel i is a random variable Q_i. The regulatory agency has specified an upper limit L, specific to each reactor such that Q_i must be less than L. Typically L is in the range 6-7 megawatts full power, for instance at Darlington L = 7.2 megawatts. Since it is impossible to guarantee with certainty for all i that $Q_i < L$ (equivalently max $Q_i < L$) it is instead required that max $Q_i < L$ with high assurance.

Direct measurements of Q_i are not available for most of the channels (the exceptions being the fully instrumented channels, known as FINCH, of which there are either 22 or 44 in a reactor). However, there is a Fortran code called SORO developed by Ontario Hydro and which is run by station staff one or more times per week. SORO solves a steady state two-group system of equations to calculate the instantaneous bundle and channel powers and it is these that are used to check compliance.

If the SORO channel power is denoted by S_i then we may write $S_i = Q_i + \varepsilon_i$ where ε_i represents the epistemic error (actually, the error model is multiplicative and is converted to a simpler additive model through the device of logarithms). The term epistemic is used to describe an error resulting from imperfect knowledge, generally code or measurement [6]. In contrast, aleatory error represents the random variation resulting from varying conditions or raw material; stock market fluctuations, Brownian motion, or changes in the true channel powers Q_i over time are all examples of aleatory variation. It may be difficult to differentiate between the two error types and distinctions are sometimes made arbitrarily for convenience. Nonetheless both are treated using the same rules of probability.

The compliance problem is formulated as a statistical test of significance (also called hypothesis test) to decide between two competing hypotheses (scenarios): H_0: max $Q_i \geq L$ versus H_A: max $Q_i < L$ on the basis of max S_i which inherits a corresponding epistemic error relative to max Q_i so we may write max S_i = max Q_i + η. H_0 represents non-compliance with the license limit while H_A represents compliance. The code value max S_i is the best estimate for max Q_i and an intuitively appealing decision rule is to claim compliance as long as max $S_i < c$ for some constant c to be determined.

Whatever the choice for c, clearly max $S_i < c$ arises in one of two ways. Either max $Q_i < c$ and the epistemic error η does not raise the computed max S_i above c, or max $Q_i \geq c$ and the epistemic error is so negative that max $S_i < c$, making it appear as if the license limit has not been exceeded, which would represent an unsafe situation. Similarly max $S_i \geq c$ may arise in one of two ways depending on whether max $Q_i < c$ or max $Q_i \geq c$, the former case leading to an incorrect conclusion that the license limit has been exceeded.

We see, therefore, that there are two types of risks, which we will call consumer's risk and producer's risk. This terminology draws strength by analogy with quality control in manufacturing processes, where, based on data, a decision must be made whether a product is acceptable, that is meets some standards. In this nuclear setting, we may view the product as the production of power and quality as the channel power, which is desired to be as high as possible without violating the license limit, which is the standard for judging.

In selecting a decision rule, a consumer (the general public) would wish to avoid the possibility of a conclusion that max $Q_i < L$ when, in fact, max $Q_i \geq L$, that is the license limit is exceeded. This is achieved by

choosing a "small" value for c. If c is too large then the consumer's risk, namely the chance of concluding that the license limit has not been exceeded when in fact it has, is too high. However, such a c is good for the manufacturer because he can continue to operate the reactor without penalty. If c is too small, then the manufacturer's risk is large because it will appear that the license limit has been exceeded when it has not.

How should c be selected? In the reactor context, c is determined by limiting the consumer's risk (measured by a probability) to be no greater than some prescribed amount α. The channel compliance problem now becomes a statistical one (there is no avoiding the use of mathematics and statistics): Choose c so that $P[\max S_i < c \mid H_0] \leq \alpha$ where the notation means that the consumer's risk is no greater than α (typically $0.01 < \alpha < 0.05$) no matter what the channel power profile $\{Q_1, Q_2, \ldots, Q_{480}\}$ ("Aye, there's the rub.")

Determining the optimal value of c is a tall order. Intuitively, if the epistemic error e_i is normal with mean zero and standard deviation σ, one might choose $c = L - k\sigma$ where k is a constant, say $k = 2$. In words, each SORO computed channel power S_i must then be at least two standard deviation units below L in order to assure compliance. In fact, this was one of the early ways compliance was judged for CANDU reactors in Canada.

While intuitively appealing, such a rule turns out to be too stringent because it can be shown that it guards against a very unusual channel power profile in which one channel power is close to L while all other channels are far away (essentially zero) [7]. This is called a peaked channel power profile. This is obviously not a tenable situation because fuelling and the regulating system strive to maintain a profile that is flat, in which more than one channel can be a contender (also called participant) for achieving the SORO maximum channel power.

Instead of looking at each S_i individually, it is necessary to examine the distribution of max S_i. This observation was first made in a pioneering work by Charles Olive and Paul Sermer [2]. For any specified consumer's risk, the value of c depends on the channel power profile. It is convenient to write max $S_i < c$ in the equivalent form max $S_i <$ max $Q_i + h_\alpha$ in terms of the epistemic error in max S_i since the right hand side of the inequality has a parallel structure to the intuitive but incorrect decision rule where max $S_i < L - k\sigma$.

Figure 1 shows the results of a simplified version of this compliance problem for 10 channels (units are scaled), with L normalized to equal one and $\alpha = 0.02$. The graphs plot the second percentile $h_{0.02}$ as a function of the standard deviation σ of the epistemic error peaked, flat, and moderate (in-between) channel power profiles.

Although max Q_i is unknown, the limiting case to consider, from the perspective of consumer's risk is max $Q_i = L$ because larger values of max Q_i will easier to detect if they occur. Recalling that sm values of c are required for controlling the consume risk, this is equivalent to requiring small values of $h_$ It is clear from the plots that only in the moder case is there a value of $h_{0.02}$ that simultaneously wo for all σ and this occurs at the minimum of the fu tion plotted. As a result, it is also not necessary know or estimate σ in order to carry out the chan power license compliance test. The license com ance is then phrased as checking whether max $S_i <$ $h_{0.02}$. Observe that $h_{0.02}$ is negative.

The behaviour of the top curve can be explained an intuitive level. When the channel power pro is peaked, (equivalently, when the epistemic erro small relative to the spacings between the Q_i) then maximum SORO channel power will always occur one channel, say S_1 and therefore max S_i – max $S_1 - Q_1$ meaning $h_{0.02} = z_{0.02}\sigma$ where $z_{0.02}$ is the lo 2 percentile of a standard normal (and is negative, fact equal to −2.0537). This accounts for the negat slope in the top plot of Figure 1.

At the other extreme when the epistemic erro large relative to the spacings between the Q_i, the ch nel powers behave as if they are all roughly the sa in which case max S_i can be approximated by a Gum distribution (named after an engineer) and P[ma $< c$] is given approximately by $\exp(-\exp(-a(c/\sigma - b$ where $a = \sqrt{(2\ln(10))}$ and $b = \sqrt{(2\ln(10))} - (\ln(\ln(1$ $+ \ln(4\pi))/\sqrt{(2\ln(10))}$. This results in $h_{0.02} = -0.001$ 0.7263σ, giving a positive slope.

These theoretical slopes are for perfectly pea and perfectly flat channel power profiles, respectiv They differ slightly from the corresponding plots Figure 1 which are derived from more realistic prof that are approximately peaked or flat. Nonethel the linearity structure is apparent and the argume above highlight why there is a difference betw peaked and flat percentiles, in particular in the s of the slope.

Finally, concerning the middle plot, when the e temic error is small, then the differences between channel powers are magnified and the largest dominates, giving peaked behaviour. So the gr starts with a negative slope. When the episte error is large, then all differences between the ch nel powers are relatively negligible and flat behavi ensues, resulting in a positive slope. The transit region gives the convex behaviour as the char power profile changes from peaked to flat, relativ the epistemic error.

It turns out that for actual reactors, the cha power profile is found to be of the moderate vari The channel power profile is not too flat and not peaked! This is the Goldilocks Effect and was a thus named in [4].

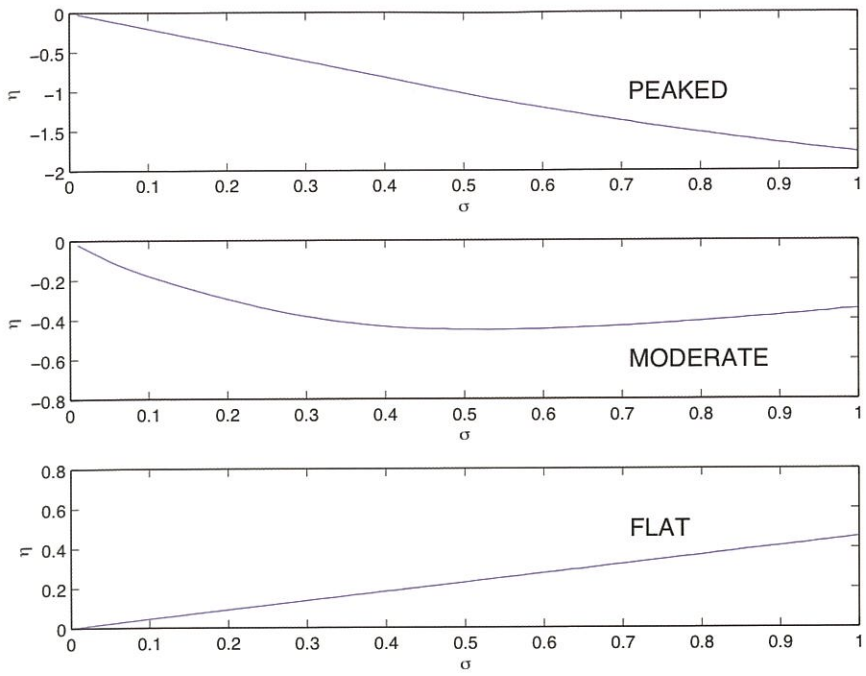

Figure 1. Simplified Compliance Problem (10 Channels) Showing a "Happy Medium" for a Moderately Peaked System.

Moreover, the estimated σ based on comparisons of SORO and FINCH channel powers lies in the vicinity of the actual minimum, meaning the decision rule is conservative but not overly conservative, yet still improves margin over the use of $L - k\sigma$. Thus, in the middle plot, this minimum occurs at approximately $\sigma = 0.5$ so using $k = 2$, we get $L - k\sigma = L - 1$, in contrast to $L + h_{0.02} = L - 0.4$, explicitly showing the increased margin obtained by EVS.

Concluding Comments

In this very short note, we have tried perhaps to do too many things, but our main objectives were these:

(a) to give a more detailed discussion, than has been presented to date, of the Goldilocks metaphor and how it has been used to help characterize a valuable feature of the EVS methodology;

(b) to state clearly that we have used this metaphor as an aid to thought only, that its value has been demonstrated by many and varied uses elsewhere in solid technical literature, and that its adaptation in the nuclear context is entirely relevant;

(c) to demonstrate how the use of the Goldilocks metaphor can help in understanding an important feature of the EVS methodology, that being its ability to find those areas that are neither too extreme low nor too extreme high, but just right - the happy medium.

Acknowledgment

Fred Hoppe and Keith Weaver prepared this note as individuals, and we are expressing our personal views. We have had the great advantage and satisfaction of working on EVS and its applications over many years with fantastic colleagues within AMEC NSS, but they have had no role in preparing this document, and neither they nor AMEC NSS has been consulted on its contents, for which the two named authors take complete responsibility.

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Personal Reflections of International CANDU Technology and Knowledge Transfer Experience

by DR. SARDAR ALIKHAN[1]

[Ed. Note: The following paper was submitted to the Bulletin by Dr. Sardar Alikhan.]

Abstract

Starting with its first nuclear power demonstration unit (22 MWe NPD-2) in 1962, Canada has built a large fleet of CANDU units both at home and abroad. This presentation covers my personal reflections of the Canadian experience on CANDU exports to Pakistan, India, Argentina, Romania, and China. It covers highlights of typical transfer of technology and knowledge to the clients in order to efficiently manage the projects from its initial planning and design phase to final commissioning and operation. It also provides guidance on important elements to develop national capability to implement a nuclear power program, with special focus on in-house expertise to operate the plants safely, reliably and economically (Note 1).

1. Status of CANDU Plants Worldwide

Canada first put its CANDU design and development expertise to test with a 22 MWe demonstration unit (NPD-2) in 1962, followed by a prototype 220 MWe Unit at Douglas Point which was placed in service in 1968. Building on this initial experience, Canada proceeded to build a large fleet of CANDU plants starting in 1971, completing its last domestic unit back in 1993 and its last off-shore unit in 2007. This paper presents my reflections of how Canada transferred nuclear power technology and knowledge on the international projects depending on the specific requirements of each contract.

2. Off-Shore Technology Transfer Perspective

2.1 Pakistan: KANUPP was a turnkey contract signed between Pakistan Atomic Energy Commission (PAEC) and Canadian General Electric (CGE) in 1965. PAEC personnel were fully integrated into the CGE organization to perform hands-on commissioning. The plant was declared in service in 1972. CGE provided only limited design information that was necessary to operate, maintain and licence the plant with no supporting design calculations or analysis codes/models. Equipment information was limited to vendor manuals with no detailed drawings. CGE arranged classroom and hands-on training for PAEC team of operating and maintenance staff at the then Ontario Hydro NPD-2 Training Centre, in addition to training a few engineers in selected design disciplines at their office in Peterborough. I was one of those trainee design engineers who benefitted immensely from the knowledge transfer from my lifelong friend and mentor Alex C. Hoyle which prepared me to take on a supervisory role in commissioning the plant and later on as Head of the Technical Unit.

Since no technology transfer was included, operation of the plant relied heavily on continuing technical support from Canada. Following the 1974 Indian nuclear device test, this "umbilical chord" got severed off and KANUPP had to quickly learn to survive on its own, largely through reverse engineering. Even a new fuel fabrication plant which was ready for shipment became a victim of this embargo. PAEC finally got off the mark to set up its own design and development group at KANUPP to manage its transition to achieve self-reliance; a decision that, in my opinion, should have been taken much earlier when the plant was committed. It took almost three decades before Pakistan was able to build another reactor unit at the Chashma Site in cooperation with China, a copy of the prototype 325 MWe PWR design built at Qinshan-1. Two such units have so far been built at Chashma in 2000 and 2011 on a turnkey basis with two more under construction. To the best of my knowledge, although Pakistan has well established knowledge base and skilled manpower, no visible progress has yet been made to achieve self-reliance to design, manufacture or build nuclear power plants indigenously.

2.2 India: India kick-started its journey in nuclear power by first building a two-unit plant at Kota, Rajasthan in cooperation with AECL by acquiring a complete design package of the prototype Douglas Point 220 MWe CANDU plant. Indian staff received training in Canada in design, construction, commissioning and operation. RAPS-1 was completed in 1973 with AECL technical assistance which came to a full stop follow-

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Note 1: This paper was first presented at the Turkey-2023, International Nuclear Technology Transfer Congress, Istanbul, September 21-22, 2012, organized by TASAM (Turkish Asian Center for Strategic Studies)

Domestic	International
Pickering A: 4-540 MWe, 1971-1973 (U2&3 laid up in 1997)	**KANUPP:** 1-137 MWe, 1972, refurbished 2006
Bruce A: 4-805 MWe,1977-1973, U1 and U2 laid up since mid-1990s, both refurbished 2012)	**RAPS:** 2-220 MWe, 1973 & 1983 and 18 more CANDU derived units in-service
Pickering B: 4-540 MWe,1983-1986	**Embalse-1:** 1-648 MWe, 1983
Point Lepreau: 1-680 MWe, 1983, refurbished 2012	**Wolsong:** 4-730 MWe, 1983-1999, U1 refurbished 2012
Gentilly-2: 1-675 MWe, 1983	**Cernavoda:** 2-705 MWe, 1996 & 2007
Bruce B: 4-845 MWe, 1985-1987	**Qinshan:** 2-700 MWe, 2002-2003
Darlington A: 4-934 MWe, 1990-1993	

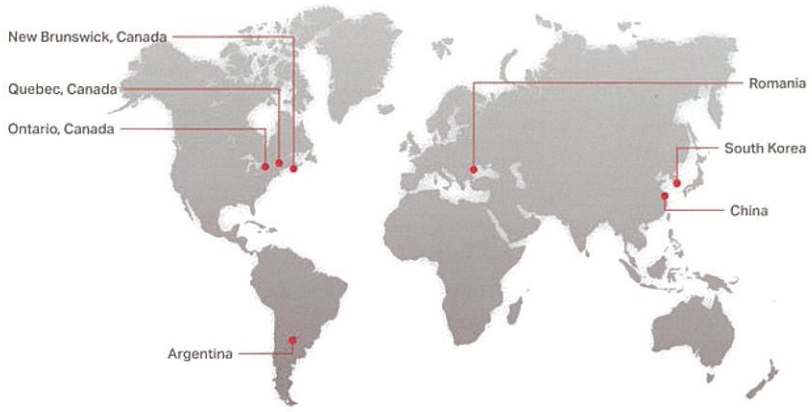


Figure 1: CANDU Plants World-Wide

ing India's 1974 nuclear device test. Given the knowledge and experience gained in building RAPS-1, India was well-placed to build RAPS-2 on its own. In parallel, India developed its own CANDU-based design to successfully build a fleet of 18-220 MWe and 2-500 MWe PHWR reactor units. In addition, 2-700 MWe PHWR units, 2-1000 MWe VVER PWR units, and 1-500 MWe PFBR unit are currently under construction.

From the very beginning, India has had the benefit of well-defined policy objectives along with the enabling infrastructure to maintain its dedicated focus over the last six decades to achieve self-reliance to design,

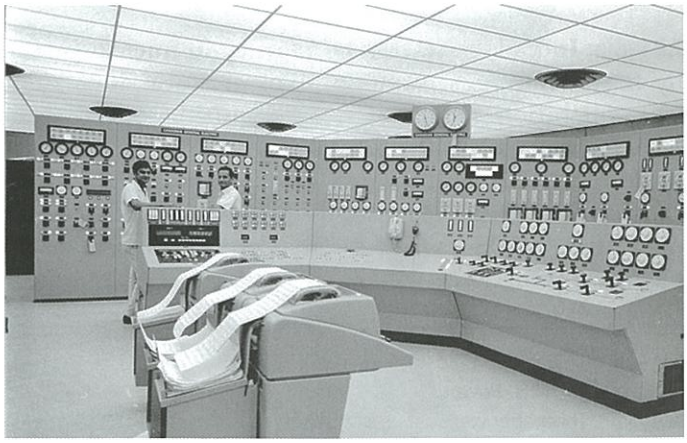


Figure 2: KANUPP Control Room 1972, the author on left with one of the Control Room Operators.

manufacture and build CANDU plants. a developing country, Indian experience r resents a good case study for technology a knowledge transfer to meet specific natio objectives.

2.3 Argentina: Embalse-1 was one of the f original CANDU 6 plants (along with Pc Lepreau, Gentilly-2 and Wolsong-1) that w committed in the mid 1970's. It was a turn project with AECL as the prime contrac who provided the NSP design and compone with Italimpianti providing the balance plant. The transfer of knowledge was limi to training of Embalse staff to perform c missioning and operation of the plant un the overall supervision of AECL. Curre work is in progress to complete Atucha-2 in 201 Siemens designed PHWR on which construction started back in 1981.

2.4 South Korea: Wolsong-1, another CANDU 6 unit, built as a turnkey project with AECL as the prime c tractor. For Wolsong-2, 3 and 4, Korea acquired technology transfer package and managed the pro with AECL technical support. In spite of the wo class performance of the Wolsong CANDU units a the experience gained to build them, South Korea 2000, decided to forgo its CANDU option in fav of the PWR technology that was indigenously de oped based on technology transferred earlier fr Combustion Engineering (later Westinghouse). So Korea has built a total of 19 PWR units with five un construction and four exported to UAE. Curre South Korea has 23 reactor units in operation wh provide one third of its electricity and plans to bu 17 more units to increase nuclear share to 59%. So Korea therefore represents a good case study for te nology transfer and its adaptation to meet natio objectives in a highly focussed and systematic man

2.5 Romania: In 1978, Romania signed a tech ogy transfer agreement under which AECL licen its design for the first CANDU unit at Cernav which was later extended to five units. Under o all Romanian management, AECL provided des

Figure 3: Mr. Ionel Bucur accepting turnover of Unit 1 from Dr. Sardar Alikhan, June 30, 1997.

and procurement services for Unit 1 and ANSALDO/ General Electric provided design and supply of the BOP including the turbine generator. In addition AECL and ANSALDO/General Electric provided technical assistance for construction and commissioning.

In hindsight, it was too ambitious a program for the then Romanian management and resources to deliver. By December 1989 with the demise of the communist regime, Unit 1 was only about 45% completed, with other units progressively less. At that time, the Romanian Regulatory Authority (CNCAN) managed to exercise its authority to suspend licences of all the Romanian contractors and manufacturers for failing to meet the required quality standards. Furthermore, Romania commissioned an IAEA pre-OSART Mission to perform an independent assessment of the project. Its findings supported and confirmed CNCAN observations and made several recommendations on how to move forward. The end result was that Romania signed a contract with AECL-ANSALDO Consortium (AAC) to manage the project on their behalf, using an integrated management approach that included the owner's staff, with the primary objective to refurbish and complete all remaining work on Unit 1 and to preserve the work already done on Units 2-5.

My own journey at Cernavoda started in 1992 as AAC Production Manager with particular focus on developing the Romanian team to take over full operating responsibility from AAC at turnover. Following completion of training in Canada (Point Lepreau), the Romanian team was fully integrated into the AECL-ANSALDO Consortium (AAC) commissioning and operations organization for hands-on experience. Special attention was given to appoint a Romanian deputy for each of the expatriate manager, supervisor or expert level position. The integrated team planned the commissioning work, executed it, assessed the results and produced the necessary documentation to demonstrate compliance with the specified acceptance criteria for each of pre-defined commissioning control points up to and including operation at full power. The unit was declared in-service in December 1996 after which I was appointed as the Plant Manager when my dear friend and mentor John D. Sommerville who decided to rest and relax after enjoying his share of excitement at Cernavoda. To confirm that our Romanian colleagues were indeed ready to take full operating control of the plant, I spearheaded a team to perform an in-depth assessment of the overall capabilities of all the functional groups with the objective of identifying any gaps and a plan to fill them in a timely manner. On June 30, 1997, it was my heartfelt joy, pride and relief to formally turnover Unit#1 to my Romanian Deputy and Plant Manager, Mr. Ionel Bucur. Six years later, a similar management contract was signed between RENEL and AAC to complete the remaining work on Unit 2 which was successfully completed in 2007. Currently, project feasibility work is in progress to complete CANDU Units 3 and 4, with no plan to complete Unit 5 for the time being.

2.6 China: The Third Qinshan Nuclear Power Company (TQNPC/CNNC) built the two-unit CANDU 6 Plant with AECL as the main contractor at the Qinshan Site in Zhejiang Province. The contract became effective on February 12, 1997 with a scheduled completion period of 72 months for Unit 1 and 81 months for Unit 2. In fact, Unit 1 was declared in-service on December 31, 2002, 43 days ahead of schedule and Unit 2 on November 12, 2003, 112 days ahead of schedule, with an overall specific cost/kW reduction of about 10% (Figure 4). Other than fuel manufacturing technology which was arranged through a separate contract, no technology transfer was included. Even though it was a complex contractual arrangement, a key success factor was how all the parties adapted to the Contract and their working experiences.

TQNPC prepared the site and facilities, managed the BOP construction, executed commissioning and operation, managed licensing and provided first fuel and heavy water load.

AECL managed the overall project, designed and supplied NSP, managed NSP construction, and provides guidance and direction to TQNPC for commissioning.

Bechtel/Hitachi Consortium, through a sub-contract with AECL, designed and supplied BOP, turbine generator, and technical assistance to TQNPC for BOP construction management.

Chinese Construction Contractors performed all construction work.

With AECL technical assistance, TQNPC has since

Figure 4a: The Chinese moved a mountain to make room for the Qinshan CANDU plant, 1997.

Figure 4b: Completed Qinshan 2x700 MWe CAND Project, 2003.

successfully manufactured and tested the use of PWR recycled uranium (RU) in the CANDU core and plans to have full core implementation by the end of 2013. In addition, Candu Energy has signed an expanded agreement (August 2012) with China National Nuclear Corporation's subsidiary companies, TQNPC, China North Nuclear Fuel Corporation (CNNFC), Nuclear Power Institute of China (NPIC), to continue cooperation in the development of PWR RU/Thorium as alternative fuel for new CANDU reactors. The success of this program would potentially pave the way for the CANDU option to complement PWR technology, a very exciting prospect indeed!

Looking into the future, in addition to the fifteen reactor units already operating on four sites, China is ambitiously marching forward with the following four options in parallel:

- CPR-1000: Fifteen units under construction with fifteen more planned, based AREVA's 3-loop PWR design which China has acquired and adapted to suit local conditions;
- AP-1000: First four of the Westinghouse AP-1000 units are under construction, two at Sanmen, Zhejiang and two at Haiyang, Shandong, with at least eight more planned at four sites. Through a technology transfer agreement with Westinghouse, the State Nuclear Power Technology Company (SNPTC) in Beijing is developing local capability build future AP-1000 units.
- EPR-1500: First two of the AREVA EPR units are under construction at Taishan, Guangdong and at least two more are planned. A joint venture between the China Guangdong Nuclear Power Company (CGNPC) and AREVA has been established to develop local capability to engineer and procure EPR and CPR-1000 initially for China with potential for export.
- VVER-1000: First two of the Russian VVER-1 units have already been built at Tianwan, Jiang with two more planned at the same site.

Suffice to say that there is lot to learn from Chi experience in transferring technology and its ada tion to meet national program objectives.

3. Specific CANDU Technology and Knowledge Transfer Tool and Methodology

3.1 Transfer of Major Project Delivery Tools (Figure 5)

a) Plant Design System (PDS): AECL used PDS- produce "Released for Construction" drawings process, control and electrical design which integrated with other AECL electronic man ment systems to control and manage mate and documentation. The Use of three-dimensi PDS-3 in the design phase led to dramatic re tions in interferences among different de elements such as piping, cable trays, struct and equipment, making vast improvement manual methods used before.

b) CANDU Material Management System (CMM CMMS identifies and tracks equipment and m rial from design through to construction and o ation of the plant. Material management st from the moment a designer identifies a de element in PDS or IntEC, right through to curement, storage and issue of materials du the lifetime of the plant. The PDS demand ge ates the engineering quotation request which out for tender to become a purchase order. CM is also used to create bar coded bills of mate supplier information, delivery schedule, shipm

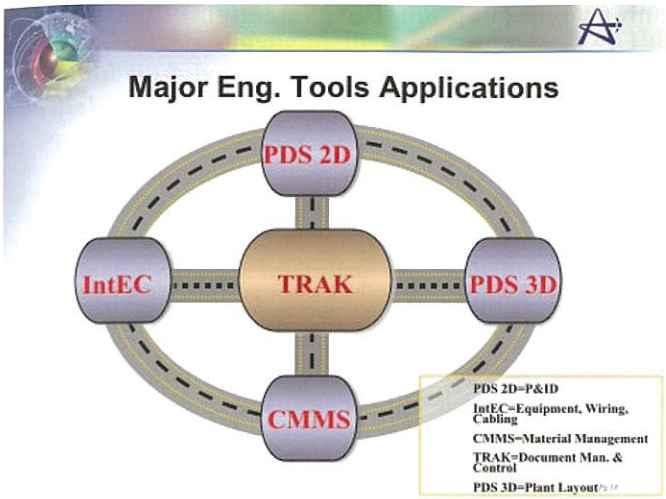


Figure 5: Major Project Delivery Management Tools.

information. Issuing of materials to contractors using the same bar coding and online linkage to CMMS gave good material tracking and control.

c) Integrated Electrical and Control (IntEC) Database: IntEC provides wiring, cabling, connection and equipment information and includes live design office data and as-pulled site data for all the wiring, cabling and connections. Design information in PDS-2 and IntEC was integrated with other AECL electronic management systems to control and manage materials and documentation.

d) Asset Information Management (AIM) and TRAK: AIM is a documentation file manager that provides on-line access and an archive for all project participants. TRAK manages all project documentation (including drawings, documents, correspondence and other records) in electronic format on line, which has improved quality and efficiency and reduced costs. TRAK accesses information from AIM to facilitate the scheduling, issue, distribution and shipping of Project deliverables and maintains the project document baseline. The AIM/TRAK system for managing project documentation provides all participants with a common and real time view of all design and construction documents.

e) Project Schedule Management Tool (Figure 6. The heart of the Qinshan planning and scheduling management was a detailed 8500activity Level 2 Co-ordination and Control (C&C) schedule, which set the work requirements for all major project activities, including engineering deliverables, procurement deliverables, construction completion and turnovers, and commissioning. These Level 2 C&C schedules were produced within 6 months of contract effective date (CED). The Level 3 schedules were developed by the engineering and supply organizations within the first 12 months of the Project. The construction and commissioning Level 3 schedules were developed throughout the first two years. The individual subcontractors produced their own Level 2 and 3 schedules to comply with the overall Level 2 C&C schedule. The Level 2 C&C schedule was formally revised three times over the life of the Project to reflect actual progress and incorporate improved sequences for construction and commissioning.

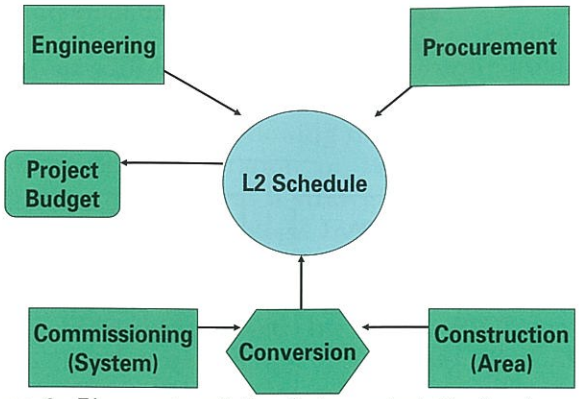


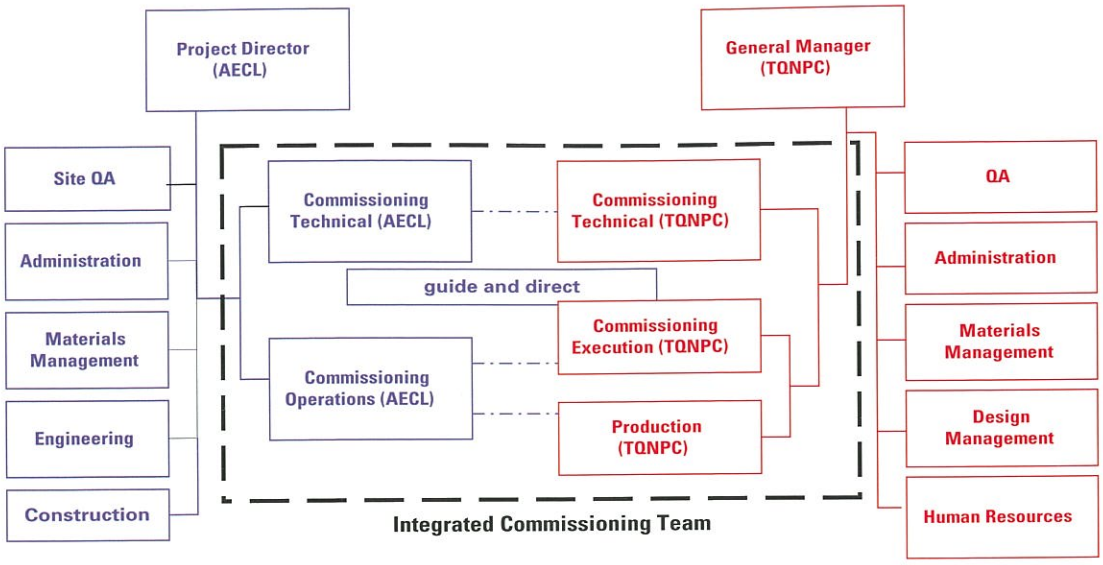
Figure 6: Elements of the Integrated Project Schedule.

3.2 Transfer of Knowledge through Integrated Commissioning Team (Qinshan)

The Commissioning Team was an integrated organization of the owner TQNPC and AECL with support from Bechtel and Hitachi (Figure 7). The process of integration was started early in the project implementation phase. Major steps included developing the organization structure to meet contractual requirements, assisting TQNPC to select and hire staff, defining job related training requirements, assessing knowledge gaps (safety, technical, skills and supervisory/management), providing initial classroom training, providing training at a sister operating CANDU plant (Gentilly-2), followed by on-the job training during commissioning, and finally a formal assessment to authorize staff to perform position specific job function. In parallel, AECL and TQNPC senior staff developed the overall Management System Manual along with supporting business process and procedures to conduct every commissioning and operations function. In spite of several initial delays in turnovers from construction, the Commissioning team worked around these issues to achieve commercial operation of both units ahead of schedule primarily due to:

- Excellent cooperation, teamwork, dedication and motivation among team members;
- Focus on troubleshooting commissioning issues, with senior management of all the project participants giving number one priority to expedite resolution;
- Good planning, coordination and control of all work activities;

Figure 7: Integrated Commissioning Team-Senior Level Functional Organization.



Senior Commissioning Management Team shown below (from left to right)

1. *Mr. Gu Jun, then TQNPC Commissioning Manager, later moved to Sanmen (2-AP1000) Project as its General Manager, now General Manager of The State Nuclear Power Technology Company*
2. *Dr. Sardar Alikhan, then AECL Commissioning Operations Manager, now retired*
3. *Mr. Jiang Guoyuan, thenTQNPC Operations Manager, now General Manager, 4-1000 MWE VVER Tianwan*
4. *Mr. Jeff Thomson, then AECL Commissioning Technical Manager (AECL), now Engineering Director (Candu Energy)*

- Well-documented management system that was reinforced through ongoing surveillance and audits;
- Early involvement of commissioning staff in the turnover process which identified potential issues;
- Learning from an effective experience feedback program during commissioning;
- Highly energetic, motivated Chinese staff willing to learn and work hard as long it takes to complete the work as planned and take ownership to solve p lems discovered.

4. Guidance to Develop Nationa Nuclear Power Program for a Developing Country

The road to develop self-reliance should neve paved with good intentions alone. Instead it shoul built on a sound policy and supporting administra framework to plan and execute all the activities ne sary to achieve the policy objectives. The following elements should be developed depending on the st of the overall program in a coordinated and syst atic manner. Several IAEA Safety publications pro valuable guidance on various topics of interest.

a) National Policy: Develop a national policy long term objectives for nuclear power prog as part of the overall mix of other available en resources. This task should be done with due i from all the stakeholders, including political, t nical, commercial and economical interests, approved at the highest national level for it to vive any short term political or economics imp tives. In addition, a high level national overs body should be established to review, recomm and adjust technology option(s) to deliver approved policy objectives.

b) Framework for Safety: Establish appropriate ernmental, legal and regulatory framework wi which responsibilities of various organization safety of the public, facilities and the environ are clearly defined and co-ordinated. A regula body with clearly defined legal authority and mitted resources should be established to f

its statutory obligations for safety. Ensure that it is effectively independent from other entities that could unduly influence its safety related decision making.

c) Technology Transfer Framework: Establish necessary commercial, technical and industrial framework to acquire the required technology option(s). This should include comprehensive technology transfer package including engineering and design, equipment supply, and construction techniques.

d) Project Management Capability: Develop project management capability to manage all aspects of projects delivery, including contracts management, engineering, procurement, construction and commissioning.

e) Engineering and Design Capability: Develop all-inclusive design organization responsible for all plant design including capability to perform safety analysis/assessments to support licensing, and to function as the resident design authority.

f) Commissioning and Operations Preparedness: Within each owner's organization, develop a comprehensive commissioning and operations preparedness capability to interface with the responsible engineering and construction organizations, manage transfer of as-constructed systems, perform defined checks and tests to demonstrate specified design capability, and transfer fully tested plant to the operating organization.

g) Supply Chain Framework: Develop a local supply chain capability for materials, equipment and services to the specified quality standards. This would require an in-depth understanding of the local industrial capability, identifying any gaps, and organizing appropriate measures to fill any gaps.

h) Human Resources Availability: Develop programs to acquire and train necessary human resources to meet the program requirements. Establish necessary academic and skills development organizations and facilities to train and authorize staff to operate and maintain the nuclear plants in a safe and efficient manner.

5. Concluding Remarks

a) CANDU Plants: Historically, CANDU plants have performed well world-wide with relatively high average lifetime capacity factor for all 27 operating units (excluding India and Pakistan) of 81.4% till December 2011, taking into account refurbishment outages, with Wolsong units taking the lead in lifetime performance of 91.6%. In 2011, three CANDU units (Wolsong-2, Darlington-4 and Cernavoda-1) were among the top 20 units world-wide.

b) CANDU Technology: For lovers of CANDU technology like myself, it has not flourished as well as we expected, except in India where home-grown CANDU's remains the technology of choice consistent with meeting long term governing national policy objectives. In Pakistan, CANDU option suffered a fatal blow following the Canadian embargo on nuclear cooperation in 1974. South Koreans decided against it as a strategic move to focus on its own PWR technology. In Romania it is alive to complete what was started over three decades ago. Argentina may build more CANDU's but nothing had been decided yet. In China, PWR remains the premier technology option although CANDU option may find a niche to complement it if recycling PWR fuel becomes a national priority. Even in Canada, CANDU faces a rather tough challenge from other competing technology options for the next major project (Darlington B).

c) Technology Transfer: India, Korea and China represent good models to study and adapt, as appropriate, to develop potential options to meet national policy objectives.

d) Knowledge Transfer: One of the most efficient and effective way for plant staff to acquire technical knowledge and skills is through participation in hands-on commissioning. An integrated team approach should be adopted where possible to achieve close working environment for efficient and effective transfer of knowledge and expertise on-the-job.

e) Developing National Policy and Objectives: For a long term sustainable nuclear power program, it is vital to develop a viable national policy along with a clear set of long term objectives with input from all the stakeholders and duly promulgated at the highest national level to ensure that it remains immune from short term political or economic changes. In addition, necessary enabling infrastructure should be established to achieve the policy objectives in a well-coordinated and systematic manner. An independent review and assessment body should be established to perform program oversight and make recommendations for adjustments as necessary.

Acknowledgements

Some of the information presented here is available on applicable websites and from various topical presentations made by me and my former colleagues in the AECL Qinshan CANDU Project management team. Specific acknowledgements are due to Dr. Kenneth Petrunik (ex-AECL Project Director), Dr. Simon Pang (ex-AECL Deputy Project Director), Mr. Larry Powers (ex-AECL Planning and Coordination Manager), and Mr. Jeff Thomson (ex-AECL-Commissioning Technical Manager).

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Commentary on Fukushima and Beneficial Effects of Low Radiation

by JERRY M. CUTTLER[1]

Fukushima

Two years after the Fukushima Dai-ichi NPP was damaged by the March 11, 2011 earthquake and tsunami, approximately 70,000 of the 160,000 people who evacuated have not been allowed to return to their homes. Recently, a number of reports were issued on health effects, mechanisms of low radiation effects, lessons learned, and a health risk assessment based on preliminary dose estimation.

UNSCEAR indicates that no health effects attributable to radiation were observed among the workers, among children or any other member of the population (UNSCEAR 2012a, Chapter IIB, Section 9(a)). Chapter III, Section 1 discusses the difficulties in attributing health effects to radiation exposure and inferring risks, meaning radiation-induced cancer and hereditary effects (so-called "stochastic" effects). *"In general, increases in the incidence of health effects in populations cannot be attributed reliably to chronic radiation exposure to radiation at levels that are typical of the global average background levels of radiation. This is because of the uncertainties associated with the assessment of risks at low doses, the current absence of radiation-specific biomarkers for health effects and the insufficient statistical power of epidemiological studies."* Section 2 points out that not addressing uncertainties properly can cause anxiety and undermine confidence among the public, decision-makers and professionals.

The UNSCEAR report on mechanisms (UNSCEAR 2012b) is a short document reviewing the biological mechanisms of action of radiation at low doses. It highlights major advances in the field for guidance on future work programs. Understanding of the mechanisms is improving, but there is a lack of consistency and coherence. UNSCEAR states there is as yet no indication of a causal relationship with radiation-related disease and no consensus on the impact of radiation exposure.

ICRP Task Group 84 compiled a considerable amount of detailed information and developed recommendations on efforts to protect people against radiation exposure during and after the accident (ICRP 2012). Eighteen issues were identified as needing actions and relevant ICRP Recommendations were scrutinized. The Task Group prepared suggestions and recommended eleven actions. The ICRP should ensure:

- proper interpretation of radiation risk coefficients
- understanding of the limitations of epidemiological studies on radiation effects
- resolution of confusion on protection quantities and units
- proper interpretation of the hazard from intake of radioactivity
- an ad hoc system to protect rescuers and volunteers
- clear recommendations for crisis management and medical care and for recovery and rehabilitation
- consistent and understandable recommendations about public protection levels (infants, children, pregnant women, fetus) and related issues (categorizing accident exposures, transit from an emergency, and rehabilitation)
- updated public monitoring policy
- definition of tolerable contamination levels for consumer products, rubble and residues
- strategies to mitigate the serious psychological consequences from radiological accidents
- information sharing on radiological protection policy after an accident is fostered with recommendations to minimize communication lapses.

Using the ICRP methodology and atomic bomb survivor risk estimates (Ozasa 2012), the World Health Organization issued a health risk assessment (WHO 2013) that estimated the lifetime risks of cancer and calculated the cumulative risks for the 15 years following the radioactivity release from the power plant. The findings in the executive summary indicate that in the two most affected locations of the Fukushima Prefecture, the preliminary estimated radiation "effective" doses for the first year ranged from 12 to 25 mSv. In the highest dose location, the estimated additional lifetime risks for the development of leukemia, breast cancer, thyroid cancer and all solid cancers over the baseline rates are likely to represent an upper bound of the risk as methodological options were consciously chosen to avoid underestimation of risks.

For leukemia, the lifetime risks are predicted to increase by up to 7% over the baseline cancer rates in males exposed as infants; for breast cancer, the estimated lifetime risks increase by up to 6% over the baseline rates in females exposed as infants; for all

1. Cuttler & Associates Inc.

solid cancers, the estimated lifetime risks increase by up to 4% over the baseline rates in females exposed as infants; and for thyroid cancer, the estimated lifetime risk increases by up to 70% over the baseline rates in females exposed as infants. Less than 1% of the NPP emergency workers received an effective dose in the range 100 – 200 mSv, while several workers received up to 700 mSv. Their lifetime cancer risks are estimated in Section 5.3 of the report and are much higher. Section 7.4 discusses the psychological consequences. Attributing a cancer risk to a low radiation exposure produces a psychosis of fear that outweighs other health consequences.

The methodology used by the WHO to estimate risk is very complex and is based on many assumptions. It is difficult to understand. The bomb survivor information (Ozasa 2012) is for a short-term exposure and is subject to many confounding factors. The linear extrapolation of high-dose (> 1 Gy) risk to calculate health effects of low radiation is very controversial; the biology is absent. In 1980, a founder of the ICRP, Lauriston Taylor stated (Taylor 1980):

"Today we know about all we need to know for adequate protection against ionizing radiation. Therefore, I find myself charged to ask: why is there a radiation problem and where does it lie?" "No one has been identifiably injured by radiation while working within the first numerical standards (0.2 r/day†) set by the NCRP and then the ICRP in 1934." "An equally mischievous use of the numbers game is that of calculating the number of people who will die as a result of having been subjected to diagnostic X-ray procedures. An example of such calculations are those based on a literal application of the linear, non-threshold, dose-effect relationship, treating the concept as a fact rather than a theory. ... These are deeply immoral uses of our scientific knowledge."

The tsunami-only refugees number 250,000. The 160,000 Fukushima refugees include about 90,000 who voluntarily evacuated and have returned home. However, 70,000 were forced to leave the mandated zones by the government's overly-restrictive and arbitrary emergency evacuation to comply with the ICRP's ALARA principle. They receive compensation payments each month from TEPCO. This was not a "conservative" precautionary measure (Cuttler 2012). Prolonged evacuation was enforced because of widespread radiation phobia (Brumfiel 2013), and the "Reconstruction Headquarters" has reported approximately 1100 disaster-related (pre-mature) deaths among the evacuees, due to psychosomatic effects (67%) and disruption of medical and social welfare facilities (18%) (Saji 2013, Table A5).

†The SI radiation level that corresponds to 0.2 r/day is ~ 1.86 mGy/day or 680 mGy/year (68 rad/year).

Beneficial Effects

Beneficial health effects were identified by mec scientists and practitioners very soon after the coveries of x-rays and radioactivity in 1895/6. T began using ionizing radiation for diagnosing b fractures and other medical conditions. They lea that large exposures were harmful; however, low e sures produced remarkable beneficial effects, suc rapid healing of wounds and cures of infections. T discovered that a low radiation dose to the entire b increased the action of protective processes in li organisms, including the overproduction of lym cytes that significantly prevented or impaired tu growth (Murphy and Morton 1915).

Many very important beneficial applications of radiation, other than curing cancer, were identifie the early 1900s and applied to thousands of patie There were no apparent increases in the incidenc "stochastic effects" (cancer or other genetic effe long after these radiation treatments. The app tions include accelerated healing of wounds (Calab 2013a) and curing of a wide variety infections, s as: gas gangrene (Calabrese and Dhawan 2012), ca nuncles and boils (Calabrese 2013b), sinus (Calab and Dhawan 2013a), and inner ear (Calabrese Dhawan 2013b). Other applications are treatmer arthritis and other inflammatory conditions (Calab and Calabrese 2013a, 2013b; Roedel et al. 2012) swollen lymph glands (Schenck 1935; Hurwitz Zuckerman 1937).

Most people and even scientists are puzzled w they are informed about the extensive evidenc radiation-induced beneficial effects that apply t many different characteristics in living things (Lu 1980, 1991). They try to disregard this informa because it contradicts what they have been care taught all of their lives, namely that exposure to n ar radiation or x-rays, in any amount, carries a ' of health effects." The implied meaning of the health effects is adverse health effects, i.e., ca and harmful genetic effects. They request a det explanation of the mechanism of this action be they will believe the evidence of positive health eff However, the detailed mechanism of action of n natural phenomena, such as gravitational attrac is not well understood, yet we accept and employ t as needed. The biological effects of radiation been carefully and extensively studied for more th century. We likely know more about these effects those of any other stressor (Taylor 1980).

An excellent explanation of the complex pro es whereby ionizing radiation induces benef effects in biological organisms has been provide Feinendegen et al (2012). The occurrence of s taneous DNA damage was discovered more tha

years ago. Its rate is at least six orders of magnitude greater than the damage rate caused by the average background level, 2.4 mGy/year (Cuttler 2012). While single-strand breaks are readily repaired, double-strand breaks (DSBs) are more serious and relevant to induction of cancer and other genetic changes. Measurements have determined that nonirradiated cells, depending on the type and age, contain on average from about 0.1 to numerous DSBs at steady state. This value corresponds well to the calculated probability of 0.1 for a DSB to occur per average cell in the human body per day from endogenous, nonradiogenic sources (Pollycove and Feinendegen 2003). In contrast, at background level, the probability of a radiogenic DSB to occur per day was calculated to be on average only about 1 in 10,000 cells. So the ratio of nonradiogenetic to radiogenetic DSBs produced per day is about 1,000, i.e., the natural damage rate is a thousand times greater than the rate due to background radiation (Feinendegen et al 2012).

The key determinant is the effect of radiation on the biological defences and protective systems, which involve the actions of more than 150 genes. They act on all the damage occurring (and its consequences), from internal causes and the effects of external agents, to restore good health. In contrast to high-dose irradiations, low-dose irradiations can up-regulate adaptive protections in cells, tissues, animals and humans. The detailed behaviours of the mechanisms are very complex, but the evidence of beneficial health effects is very clear, from cancer prevention and cures to the very important medical treatment applications mentioned earlier.

The evidence of beneficial effects from low radiation requires the definition of the range for harmful effects. This was known when the first radiation protection standard was set in the early 1930s. There have been many studies on mammals, especially since the 1940s. The recent review by Fliedner et al. (2012) on the response of the hematopoietic system‡ to low dose-rates of ionizing radiation is very important because it focuses on the damage accumulating in this rapidly turning over cell renewal bone marrow tissue, which is generally more radiosensitive than the gastrointestinal cell system or skin.

The article assesses many human exposures and animal studies. A study of dogs exposed to cobalt-60 gamma radiation during their entire lives allows the range for harmful effects to be determined. Figure 1 shows the mortality curve for each dose-rate group. At dose rates higher than 18.8 mGy/day (1.88 cGy/d), death was nearly always due hemopoietic insufficiency. In the dose-rate group 18.8 mGy/day, still some dogs died from myeloproliferative disorders (MPD), but below this dose-rate the relative number of deaths from fatal tumors increases to the level seen in the control dogs. Figure 2 shows the lifespan, at the 50% mortality level, for each dose-rate group, normalized to the lifespan of the control dogs (4300 days). Lifespan decreases below that of the controls when the radiation level exceeds about 700 mGy/year. Some dogs succumbed earlier than others, indicating individually varying radiosensitivities for tolerance or failure of the blood-forming system.

There was no group of dogs in the dose-rate range between 1100 mGy/year and background radiation level. Extending the fitted line from 1100 mGy/year to 2.4 mGy/year suggests the likelihood of a lifespan longer than the controls in this range, a beneficial effect of low radiation.

In the group of 92 dogs exposed to 3 mGy/day (1,100 mGy/year), there were no significant changes in the concentrations of the blood cells in a clinically relevant way; however, radiation effects were apparent beyond 1000 days. In this group, some dogs survived up to 5000 days within the radiation field–a full life span. The cause of death in these dogs was similar to the control dogs, dominated by fatal tumors (Fliedner et al. 2012).

Non-scientific Influences on Radiation Protection

This data brings into question the dose limits in radiation protection. Current limits are fixed numbers without much attention to dose rate. The dose rate should be built into the exposure limits. The great discrepancy between the recommended dose rate limit, 1 mGy/year for the general public, and the observed dose rate of 1,100 mGy/year, at which the hemopoietic system keeps providing stability and full function in service of the entire body without apparent radiation-induced increase in tumor incidence, questions the justification of the radiation protection recommendations (Fliedner et al. 2012).

As pointed out in an earlier article (Cuttler 2012), the 1934 radiation protection standard that was based on the "tolerance dose" concept of 0.2 r/day (680 mGy/year) was changed in the 1950s because of strong political pressure by scientists and other influential people to create a social fear of low radiation from a-bomb testing during the arms race and their potential use in war. The concept adopted was a radiation-induced probabilistic (stochastic) risk of cancer death and genetic harm that is to be kept small compared to other hazards in life. The risk is calculated using the linear-no-threshold (LNT) hypothesis of radiation carcinogenesis being promoted by Hermann Muller and other geneticists in the early 1900s. The incredible irony is the continued use of this concept, six decades

‡stem cells in the bone marrow that produce the blood cell components

later, in spite of more than a century of contradictory radiobiological evidence. The flood of assessments based on the LNT theory of cancer and genetic risks continues and many research studies based on this model are funded.

Calabrese has described "the road to linearity" in great detail (Calabrese 2009). The eugenics movement was an important factor in the widespread acceptance of the LNT dose-response model. *"Eugenics is the applied science or the biosocial movement, which advocates the use of practices aimed at improving the genetic composition of a population, usually a human population"* (National Library of Medicine 2013). The word was coined in 1883 by Francis Galton, a cousin of Charles Darwin, founder of the science of evolutionary biology. Galton wanted eugenics to develop from a science to a policy to a religion (Cavanaugh-O'Keefe 1995). Natural evolution occurs slowly and progressively; significant improvements occur over a period of centuries. However, the eugenicists wanted to expedite improvements in the human race (its gene pool) by social and political interventions. This movement became very popular throughout the world, beginning in the early 1900s and continuing through to the present. In 1970, the American Eugenics Society (I. Gottesman) defined it in this way: *"The essence of evolution is natural selection; the essence of eugenics is the replacement of 'natural' selection by conscious, premeditated, or artificial selection in the hope of speeding up the evolution of 'desirable' characteristics and the elimination of undesirable ones."*

In the 1920s, Hermann Muller, a biologist and proponent of eugenics, became interested in the genetics of fruit flies (Drosophila Melanogaster), focusing on the gene mutation rate and lethal mutations. He found a strong temperature dependence leading him to believe that spontaneous mutation was the dominant mode. In his Science article on his discovery of radiation-induced mutations (Muller 1927a), he states that the study of gene mutations is very seriously hampered by their extreme infrequency and by the generally unsuccessful attempts to modify organisms for utilitarian purposes. Following reports of germinal changes induced by radium or x-rays, he performed a series of experiments using relatively heavy doses of x-rays. Mutations were induced in a high proportion of the treated germ cells causing a rise of about 15,000 percent in the rate over that in the untreated cells. The experimental data appears in his paper at the 5th International Congress of Genetics in Berlin (Muller 1927b). Four irradiation times were used: 12, 24, 36 and 48 minutes. The x-ray tube target was at a distance of 16 cm from the flies; the voltage was 50 kV, and the current was 5 milliamperes. This suggests that a dose-rate of about 100 r per minute was used, based on information in a related article. Therefore, these radiation doses were in the ra from about 1200 to 4800 r. There should be an e proportionality between point mutations and do if the former directly result from chance hits by rays, but his data suggested a square-root relat Subsequently, Muller became an activist promo the fear of genetic damage from any exposure to x- or nuclear radiation stating that the risk was line proportional to dose without any threshold.

Many other scientists carried out similar researcl fruit flies. For example, a paper in 1930 showed the mutation frequency was linear with dose betw 285 and 4560 r (43.5 Gy) (Oliver 1930). Howeve critical study using special flies supplied by Herm Muller revealed in 1946 that there was no evidenc a significant difference between the controls and tl that were irradiated for 21 days with radium gan rays to a dose of 50 r (Caspari and Stern 1948). Mu knew about this result, weeks before he delivered Nobel Prize lecture in which he declared that the no safe level of radiation exposure–"no escape f the conclusion that there is no threshold" (Calab 2012).

Later research demonstrated that mutation quency depends not only on the total dose but also dose rate. Because repair capacity is limited, a hig dose rate results in a greater number of mutations the same dose. A study by Koana et al. (2004) c onstrated there is a threshold at 1 Gy for fruit f and another study (Koana et al. 2007) demonstr a reduction in the mutation frequency in sperm diated with a low dose rate of 0.05 Gy/minute (rad/hour). The mutation frequency was 0.79% f dose of 10 Gy and 0.07% for 0.2 Gy. The latter significantly lower than 0.33% for the controls, wl indicates that a threshold exists between 0.2 anc Gy. Ogura et al. (2009) irradiated flies at the m lower dose rate of 22.4 mGy/hour (2.2 rad/hour). shown in Figure 3, the mutation frequency at 0.5 r is much lower than in the control group, whereas mutation frequency in the 10 Gy group is significa higher. It is very clear that the LNT model, w predicts harm at low dose, is wrong. The biolog evidence shows a benefit.

Conclusion

In light of the on-going crisis of suffering and nomic hardship in Japan, the appropriate action the radiation protection establishment is to abar the concept of stochastic cancer risk, based on the dose-response model, and adopt the previous toler dose concept. It is supported by extensive biolo evidence and credible models. This change in con would dispel the psychosis of fear surrounding the of radiation in medical diagnostics and the treatr of serious diseases and illnesses. It would also imp

social acceptance of using nuclear energy for many very important peaceful applications. In view of the 1100 disaster-related deaths caused by the evacuation order, it is clear this long-term precaution to avoid a low radiation exposure was not a "conservative" emergency measure.

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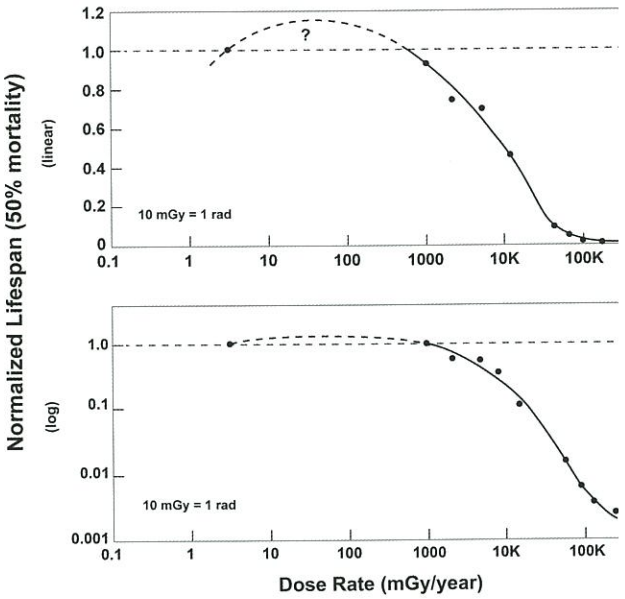

Figure 2. Lifespan versus radiation level.

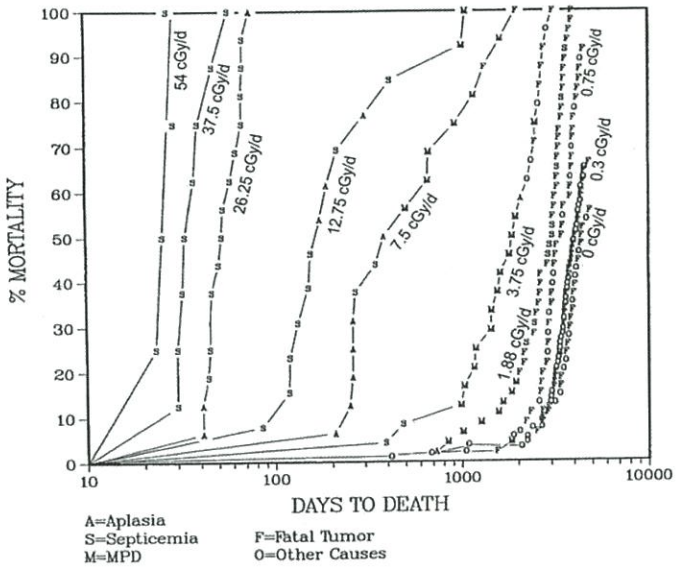

Figure 1. Mortality curves of dogs subjected to whole-body chronic gamma irradiation at different dose rates (Fliedner et al. 2012, Figure 3).

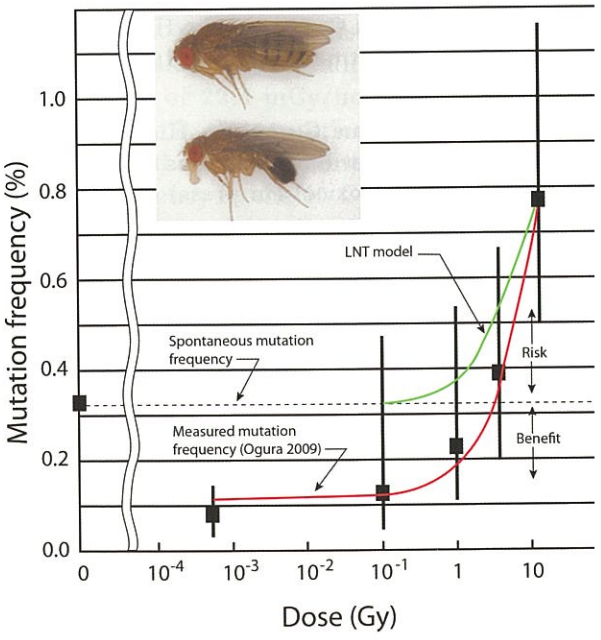

Figure 3. Fruit fly mutation frequency versus r tion dose.

Opinion

Contenders for nuclear flexibility at Ontario's Darlington B: AP1000 and EC6 - and the winner is .....

Although Ontario Power Generation (OPG) has a site preparation licence from the Canadian Nuclear Safety Commission for new nuclear build at Darlington it has yet to select a vendor. Two vendors are in the running. Westinghouse with the AP1000 and Candu Energy Inc. with the EC6 were asked by OPG to prepare cost estimates and construction schedules for two reactors. The reports must be ready by June this year and will be submitted to the government for selection and go-ahead, or not.

Although not contributing much to the annual Ontario electricity supply the intermittent wind/solar generators become a problem during periods of low demand and/or significant wind production since their output has to be accommodated on the grid. This means other generators on the grid need to have operating characteristics flexible enough to cater to several thousand MW of wind that come and go over short periods of time. With coal being removed from the mix by 2014 and with the limited flexibility of the hydro and gas-fired units there is an opportunity for the new nuclear units to provide the missing flexibility. Indeed this has been a regular requirement in the "18-Month Outlook" from the Independent Electricity System Operator (IESO), for example,

"The existing coal fleet, though running at vastly reduced levels from previous years, provides the IESO with desirable flexibility, such as quick ramping and operating reserve, under all market conditions. As Ontario's coal-fired generation is shut down over the next two years, its associated flexibility will be lost. Therefore, future capacity additions should also possess this flexibility to help facilitate the management of maintenance outages, provide effective ramp capability, supply of operating reserve and even provide regulation when necessary".

The The AP1000, at around 1117 MWe net, operates in the reactor following plant load mode and does not use steam bypass for normal at power manoeuvring. In the 15 to 100 percent load range it can ramp at +/-5 percent full power per minute subject to reactor core power distribution limits. For 90 percent of its 18 month fuel cycle it is designed to perform a 100-50-100 percent full power daily load cycle with between 2 and 10 hours spent at 50 percent power and with two hour linear load ramps. For grid frequency control (regulation) it can manoeuvre at +/-2 percent power per minute for power changes of 10 percent peak-to-peak when operating between 15 and 100 percent power, up to 35 times a day for the life of the unit. The unit can satisfy a 20 percent power increase or decrease within 10 minutes. It is capable of a 10 percent step load decrease between 100 and 25 percent full power and a 10 percent step load increase when between 15 and 90 percent power. In the event of a loss of grid connection or grid blackout steam bypass together with a reduced reactor power will supply unit house load until the connection is established or the grid is available.

The EC6, at around 700 MWe net, has a turbine steam bypass system that can accommodate 100 percent bypass. From this it can be inferred that the unit would be capable of dispatchable load following from zero to 100 percent power with the rate of manoeuvring set by the turbine and not by the reactor. This would typically be up to 10 percent of full power per minute, with relatively low temperature nuclear steam. The reactor could be manoeuvred to follow the turbine at a slower rate to reduce wear and tear transients on the reactor systems and on the fuel. Operating the reactor at reduced power will extend the calendar life of critical components. If the reactor power cannot be changed for operational reasons this will not affect unit manoeuvring in response to dispatches. Steam bypass would also provide the rapid power changes that allow automatic generation control of grid frequency (regulation) and in the event of a loss of connection to grid or grid blackout the 100 percent bypass capability would allow a quick return to full power since the reactor could remain at full power if necessary. Although any steam bypassing the turbine is a waste of energy CANDU fuel costs are very low.

The reviewers of the vendor reports should ensure that the IESO requirement is met. Output power changes by steam bypass are inherently more flexible than reactor power changes. Thus the EC6, with an output that can be varied between zero and 100 percent and is always available, would be more suitable for the wind/solar heavy Ontario grid than the AP1000, or any other LWR for that matter. When Ontario's infatuation with wind comes to an end the highly flexible CANDU nuclear units that are built (or refurbished) now will enable more and more nuclear to be part of the future grid.

Don Jones

Editor's note: For the full version of this article please see, http://thedonjonesarticles.wordpress.com/2013/01/10/contenders-for-nuclear-flexibility-at-ontarios-darlington-b-ap1000-and-ec6-and-the-winner-is/ or item 19 of http://thedonjonesarticles.wordpress.com/articles/

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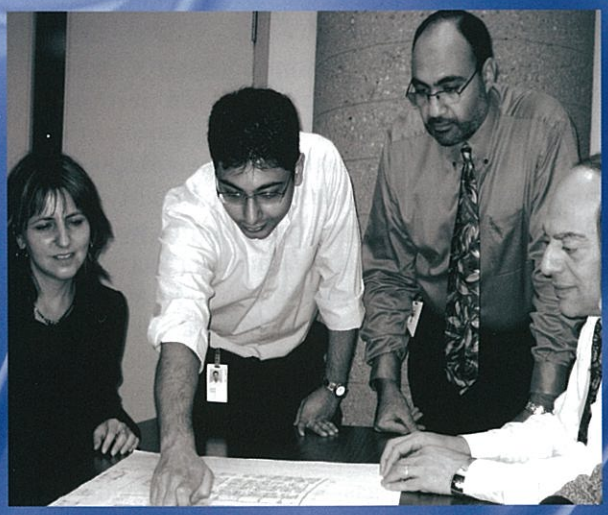
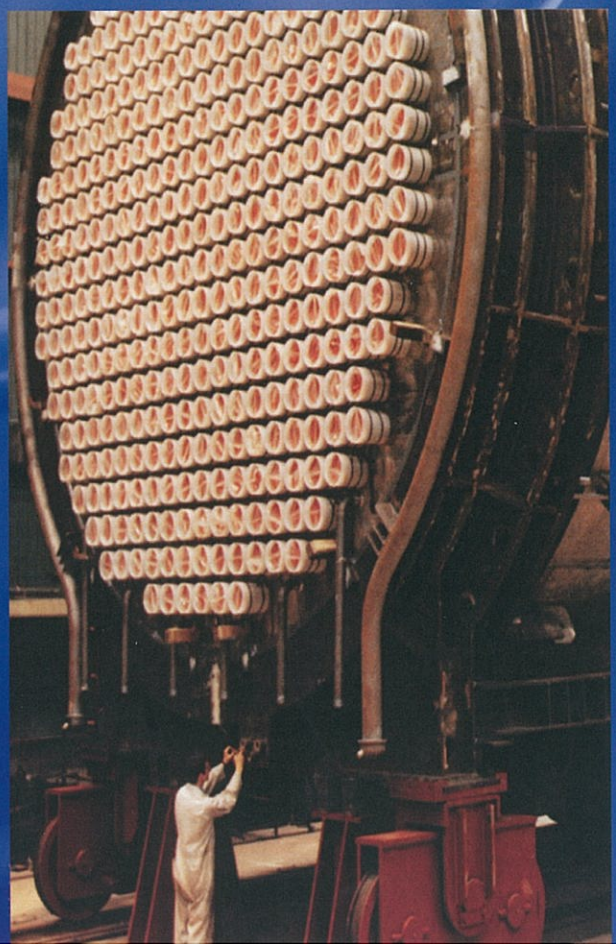
Maximizing Plant Performanc Enhancing Safety





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GENERAL news

(Compiled by Fred Boyd from open sources)

Government Announces New Direction for AECL

On February 28, 2013, during a speech to the 2013 Canadian Nuclear Association Conference and Trade Show, the federal Minister of Natural Resources, Joe Oliver, announced the government's plans to engage the private sector in the management of Atomic Energy of Canada Limited's (AECL) Nuclear Laboratories.

Following is the subsequent government media release

In the coming months, the Government of Canada will engage in a competitive procurement process to restructure the management and operation of Atomic Energy of Canada Limited's Nuclear Laboratories. In doing so, the Government is demonstrating its commitment to fairness and the responsible use of taxpayers' dollars. An information session for industry will be held to launch this process. The Government is seeking to implement a Government-owned, Contractor-operated (GoCo) model, as is done in other jurisdictions, such as the United States and the United Kingdom.

This competitive procurement process will follow government best practices in engagement, oversight, transparency and due diligence, including the use of third-party advisors. Over the coming weeks, the Government will be acquiring the services of financial and nuclear advisors as part of the process.

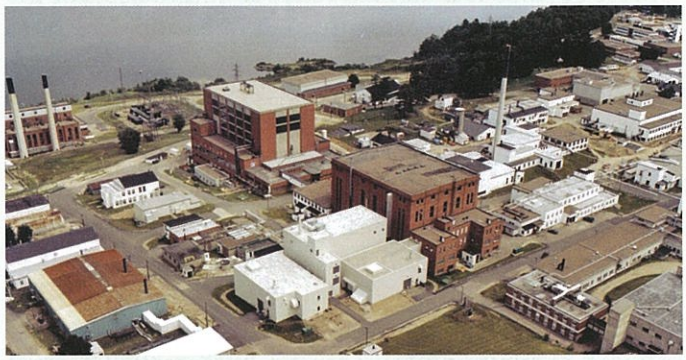
Atomic Energy of Canada Limited will conduct normal business during the process, and employees and other interested parties will be kept informed of progress. Employees can be assured that the Government is sensitive to their situation during this transition period and that it recognizes the talent and expertise that are critical to Canada's nuclear sector.

Recognizing the wealth of expertise and unique facilities at the Laboratories, the Government is taking this next major step in restructuring Atomic Energy of Canada Limited to put in place the conditions for Canada's nuclear industry to succeed in the future. This is in keeping with the conclusions of the Government of Canada's Review of Atomic Energy of Canada Limited and draws on input from the industry and other stakeholders following a Request for Expression of Interest issued last year.

The Government will focus the Laboratories on three key objectives: managing its radioactive waste and decommissioning responsibilities; performing science and technology activities to meet core federal responsibilities; and supporting Canada's nuclear industry through access to science and technology facilities and expertise on a commercial basis.

The Government is still assessing the value of investing federal tax dollars in longer-term nuclear innovation. Over the coming months, the Government will work to understand the potential business case for a forward-looking, industry-driven nuclear innovation agenda.

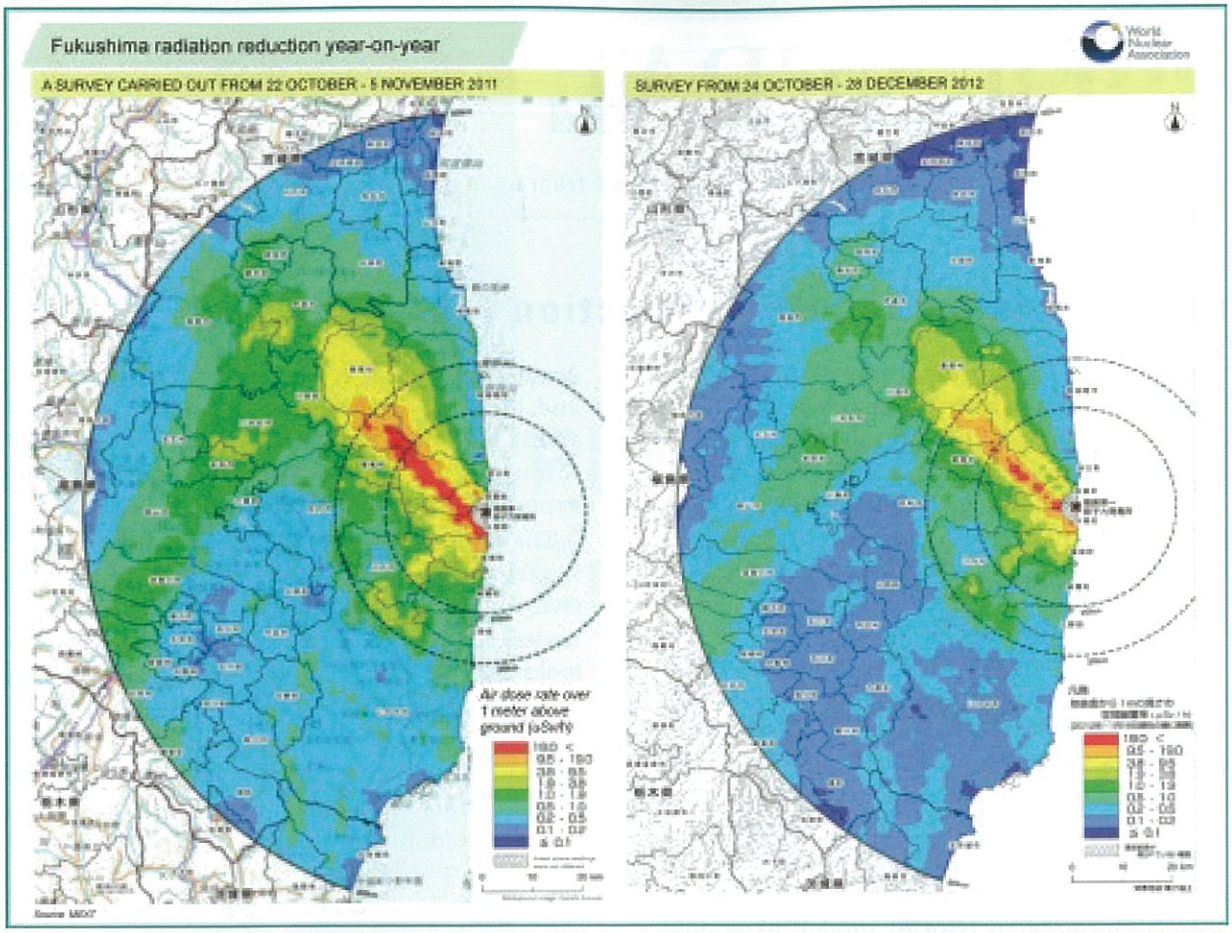
The health, safety and security of Canadians and environmental stewardship in all aspects of the nuclear industry remain a priority of the Harper Government. The Canadian Nuclear Safety Commission, Canada's independent nuclear regulator, will continue to regulate all parts of the nuclear industry in Canada, including the Nuclear Laboratories. During the restructuring process, the Government will take all steps necessary to protect national security.



Aerial view of part of the Chalk River Laboratories.

Radiation levels decline at Fukushima

The Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) released a map of radiation levels in the vicinity of the Fukushima nuclear station on 1 March 2012, based on data collected by a survey during October and December last year. Compared to the version from October and November 2011 it shows widespread recolouring, with each colour change indicating a reduction by half in surveyed radiation dose.



Most obvious is a marked reduction in the size of the red portion, which represents high radiation dose rates of over 19.0 microSieverts per hour (uSv/h) - some 166 milliSieverts per year (mSv/y). Anything above 50 mSv/y is characterised as 'difficult to return to' by Japanese authorities.

The accident at Fukushima Daiichi nuclear power plant in March 2011 released three main radioactive substances: iodine-131, caesium-134 and caesium-137.

Of these, iodine-131 is the quickest to decay, with a half-life of around eight days that means it had contributed virtually nothing to the 2011 map. Of more interest is caesium-134, with a half-life of two years that would show significant reduction in the annual timespan shown by the maps. Further noticeable reductions due to ongoing decay of caesium-134 decay are expected, with these gradually tailing off in years to come.

The long-term issue remains the caesium-137, which has a half-life of about 30 years, and will maintain raised levels of ambient radiation for a significant time. Japanese national and regional governments are tackling this through an extensive clean-up and decontamination program.

Apart from decay, natural processes have also contributed to reducing levels of contamination in the last year. Rainfall moves contamination through rive tems to the sea, where strong currents and a pow dilution effect make radioactivity virtually und able even alongside the damaged power plant i The region also suffered a Class 4 Typhoon in Jul year that will have accelerated dispersal effects.

from World Nuclear

Report confirms lower risk f Port Hope workers

A report published in the February 2013 issue *British Medical Journal Open* has confirmed tha mortality and cancer risk of workers in what is no Cameco fuel processing plant in Port Hope, On had lower mortality and cancer incidence com with the general Canadian population.

This is one of the largest cohort studies of ers exposed to radium, uranium and γray Continued follow-up and pooling with other coho workers exposed to byproducts of radium and ura processing could provide valuable insight into pational risks and suspected differences in risk uranium miners.

Following is the abstract of the report:

Mortality (1950–1999) and cancer incidence (1969–1999) of workers in the Port Hope cohort study exposed to a unique combination of radium, uranium and γ-ray doses

Lydia B Zablotska[1], Rachel S D Lane[2], Stanley E Frost[3]

Abstract

Objectives *Uranium processing workers are exposed to uranium and radium compounds from the ore dust and to γ-ray radiation, but less to radon decay products (RDP), typical of the uranium miners. We examined the risks of these exposures in a cohort of workers from Port Hope radium and uranium refinery and processing plant.*

Design *A retrospective cohort study with carefully documented exposures, which allowed separation of those with primary exposures to radium and uranium.*

Settings *Port Hope, Ontario, Canada, uranium processors with no mining experience.*

Participants *3000 male and female workers first employed (1932–1980) and followed for mortality (1950–1999) and cancer incidence (1969–1999).*

Outcome measures *Cohort mortality and incidence were compared with the general Canadian population. Poisson regression was used to evaluate the association between cumulative RDP exposures and γ-ray doses and causes of death and cancers potentially related to radium and uranium processing.*

Results *Overall, workers had lower mortality and cancer incidence compared with the general Canadian population. In analyses restricted to men (n=2645), the person-year weighted mean cumulative RDP exposure was 15.9 working level months (WLM) and the mean cumulative whole-body γ-ray dose was 134.4 millisieverts. We observed small, non-statistically significant increases in radiation risks of mortality and incidence of lung cancer due to RDP exposures (excess relative risks/100 WLM=0.21, 95% CI <–0.45 to 1.59 and 0.77, 95% CI <–0.19 to 3.39, respectively), with similar risks for those exposed to radium and uranium. All other causes of death and cancer incidence were not significantly associated with RDP exposures or γ-ray doses or a combination of both.*

Conclusions *In one of the largest cohort studies of workers exposed to radium, uranium and γ-ray doses, no significant radiation-associated risks were observed for any cancer site or cause of death. Continued follow-up and pooling with other cohorts of workers exposed to by-products of radium and uranium processing could provide valuable insight into occupational risks and suspected differences in risk with uranium miners.*

+ Author Affiliations

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Point Lepreau temporarily reducing power

On March 4, 2013, New Brunswick Power announced that the Point Lepreau Generating Station had begun reducing reactor power from the 100 percent level to address re-fuelling requirements. This reduction is necessary to allow adjustments to be made to equipment associated with re-fuelling the reactor.

Before the Station came back online in November of 2012, the reactor had been filled with new fuel. This meant that re-fuelling was not required for the first several months of high power operation. The station had reached the point in its operation that online fuelling was required on an ongoing basis to sustain operation.

Moving to lower reactor power reduces the rate of fuelling which allows the plant to operate longer with the current fuel while adjustments are made to the refueling equipment. The plant will return to high power once the problem is resolved.

Bruce Power's Ken Ellis assuming Managing Director's role at WANO

The World Association of Nuclear Operators (WANO) has appointed Ken Ellis, currently the Executive Vice President of Strategic Support and former Chief Nuclear Officer of Bruce Power, as Managing Director.

The appointment was made at the organization's board meeting in London, UK, on Jan. 29. Ken will formally replace George Felgate on April 1.

Ken has more than 31 years experience in Operations, Maintenance and Engineering at Bruce Power. He was named Executive Vice President, Strategic Support, in August 2012, after having served as Executive Vice President and Chief Nuclear Officer Bruce B since January 2010.

Previously he held several senior positions at Bruce Power, namely Bruce B Station Vice President, Chief Engineer & Vice President Engineering, Vice President Maintenance and Bruce B Operations Production Manager.

His career also included a two-year assignment in France as the Ontario Hydro Liaison Engineer to Électricité de France. Ken was licensed as a Bruce B Shift Manager in the late-1980s.

Born in Espanola, ON, he graduated from Royal Military College with a degree in Mechanical Engineering. He spent four years as an Aerospace Engineer with the Canadian Armed Forces, primarily in Search and Rescue prior to joining Ontario Hydro. Ken is a registered Professional Engineer.

About WANO:

- WANO is a non-profit member association established in 1989 by the world's nuclear power operators to exchange safety knowledge and operating experience amongst organisations operating commercial nuclear power reactors.
- WANO members operate some 440 nuclear units in more than 30 countries around the world.
- WANO works with members in pursuit of its mission: to maximise the safety and reliability of nuclear power plants worldwide by working together to assess, benchmark and improve performance through mutual support, exchange of information and emulation of best practices.

Environmental Assessment Decision on Darlington Refurbishment and Continued Operation

On March 14, 2013, the Canadian Nuclear Safety Commission (CNSC) announced its decision on the environmental assessment (EA) of Ontario Power Generation's (OPG) proposed refurbishment and continued operation of the Darlington Nuclear Generating Station (DNGS).

The Commission concluded that the proposed project is not likely to cause significant adverse environmental effects, taking into account mitigation measures identified in the EA Screening Report.

A public hearing was held December 3 – 6, 2012 in Courtice, Ontario, which drew 690 intervenors.

The Commission's decision was based on the screening-level environmental assessment of the project prepared in accordance with the *Canadian Environmental Assessment Act* (S.C. 1992, c.37). The Commission has determined that the EA process is sufficient and that the project need not be referred to a review panel.

The Commission can therefore proceed, under the *Nuclear Safety and Control Act*, with its consideration of a licence application from OPG for the proposed project.

This *Record of Proceedings, including Reasons for Decision* deals specifically with the Commission's decision regarding the EA for OPG's proposed refurbishment and continued operation of the DNGS. The *Records of Proceedings* for the Darlington Waste Management Facility licence renewal and the renewal of the nuclear power reactor operating licence for the DNGS are separate documents.

During the public hearing on the three matters ref to above, the Commission considered the EA Scre Report and submissions from OPG and the 690 in nors, as well as CNSC staff recommendations.

The *Record of Proceedings* is available upon requ the Commission Secretariat. It will be available, in official languages, on the CNSC Web site at a later Transcripts of the hearing are available on the C Web site at nuclearsafety.gc.ca, or by contacting the C

Operating licence extended

In late February the CNSc renewed the Oper Licence for Darlington for a period of 22 months, December 31, 2014.

The CNSC added a condition to the licence requ OPG to ensure that the emergency plans of the va levels of government concern are integrated and i mented in a manner satisfactory to the CNSC.

Aerial view of Darlington NGS.

Appointments to AECL Board and CNSC

On March 14, 2013, the Minister of Na resources, Joe Oliver, announced appointmen the Board of Directors of Atomic Energy of Ca Limited and a new Commissioner of the Can Nuclear Safety Commission.

The new members of the AECL Board are: **Gre Josey** and **Serge Dupont**. Their appointment until December 31, 2014.

Gregory Josey possesses considerable exec leadership and financial expertise, having s for 11 years as Chief Financial Officer in mu organizations and more than 27 years in the fi health care.

Serge Dupont, as Deputy Minister of Na Resources Canada brings in-depth knowledge o ernment operations and priorities to the Boarc

will help support and inform the restructuring process.

Appointed as a permanent member of the Canadian Nuclear Safety commission is **Dr. Alexander McEwan.**

Dr. McEwan is Chair of the Department of Oncology within the Faculty of Medicine and Dentistry at the University of Alberta. He is also Adjunct Professor of the Department of Radiology and Diagnostic Imaging within this Faculty. In addition, he is the Associate Director of Research and the Acting Director of the Department of Oncologic Imaging at the Cross Cancer Institute in Edmonton. He's been a member of the University of Alberta faculty since 1986. He has been instrumental in the development of the Positron Emission Tomography (PET) Programme at the Cross Cancer Institute.

New Chair of the Board of Directors at Cameco

Cameco has announced that Victor J. Zaleschuk will step down as chair of Cameco's board of directors following the corporation's annual general meeting on May 14, 2013.

Cameco's board has selected **A. Neil McMillan** to succeed Zaleschuk as non-executive chair of the board, provided he is re-elected at Cameco's annual general meeting. Zaleschuk will continue to serve as a director if re-elected.

McMillan has been an independent director of Cameco since 2002. He has CEO experience and diverse expertise in mining, government relations and the investment industry.

CNSC Publishes its Regulatory Framework Plan 2012-2018

The Canadian Nuclear Safety Commission (CNSC) has released its 2012-2018 Regulatory Framework Plan.

The Plan outlines the regulations and regulatory documents that the CNSC will be developing or amending in the coming years. Aligned with the CNSC's corporate priorities, the Plan also considers current developments in the nuclear environment.

The Plan has been updated to organize the CNSC's regulatory documents by regulated facilities and activities, safety and control areas, and other regulatory areas of interest. As documents are reviewed or developed according to the Plan, they will be assessed in the context of their broader section in the structure and opportunities to consolidate documents will be explored.

The 2012-2018 Plan focuses on:

- lessons learned from the Fukushima accident
- nuclear power plant site preparation and construction
- long-term operations management and aging management for nuclear power plants
- reliability and maintenance programs for nuclear power plants
- certification and training
- better defining the CNSC's expectations for security and reporting
- licence application guides for Class II nuclear facilities
- safety culture for nuclear facilities

View CNSC's Regulatory Framework Plan 2012-2018 (PDF)

For further information on the regulatory framework plan, call 613-996-5894 or 1-800-668-5284 or e-mail consultation@cnsc-ccsn.gc.ca

Further grants for non-reactor isotope production

During his talk at the Canadian Nuclear Association Conference and Trade Show, February 28, 2013, the Minister of Natural Resources, Joe Oliver, announced the signing of contribution agreements with three innovative Canadian organizations to develop new sources of supply of the key medical isotope, technetium-99m (Tc-99m). Tc-99m is the most widely used isotope for medical imaging and is used in approximately 80 percent of nuclear medicine diagnostic procedures.

Following a rigorous competitive process, the Government is funding projects led by the University of Alberta, TRIUMF in British Columbia and Prairie Isotope Production Enterprise in Manitoba. This funding will support the development and application of cyclotron and linear accelerator production technologies to improve the security of supply of medical isotopes for Canadians, reduce radioactive waste and meet nuclear non-proliferation goals.

The funding will be provided as follows:

- University of Alberta ($7 million - cyclotron) in Edmonton,
- TRIUMF ($7 million – cyclotron) in British Columbia, and
- Prairie Isotope Production Enterprise ($7.46 million – linear accelerator) in Manitoba.

For information about the specific projects, please visit the websites of the project leaders: University of Alberta, TRIUMF and Prairie Isotope Production Enterprise.

AECL reviews waste liability

On March 19, 2013 Atomic Energy of Canada Limited (AECL) announced that it is reviewing and updating its liability for nuclear decommissioning and waste management and has advised the Government that its estimate of the liability has increased by an amount of $2.4 billion.

The increase will require a corresponding adjust-

ment to the liability recorded in the Public Accounts of Canada, which was $3.6 billion as at March 31, 2012. The adjustment will be reflected in the Government's financial results for 2012-13.

In mid 2012, AECL initiated a comprehensive review of its decommissioning and waste liability and the related plan for its management through the Nuclear Legacy Liabilities Program. The last comprehensive review of this nature was completed in 2005. The review is intended to reflect best global policies and practices in nuclear decommissioning and waste management.

The liability represents the estimated future costs, in Net Present Value (NPV), of decommissioning, managing and disposing of its radioactive waste in a manner that will ensure long-term health, safety, security and environmental responsibility. All activities are in compliance with regulatory requirements established and enforced by the Canadian Nuclear Safety Commission. Confirmation of the amount of the adjustment to the liability will be subject to verification by AECL management, review and approval by its Board and audit by its external auditors, the Office of the Auditor General and KPMG.

The main reason for the liability adjustment is an increase in the indirect costs attributed to the decommissioning and waste management over the period of up to 70 years of the Program. Indirect costs include site operational and corporate support costs at AECL's Chalk River Laboratories (CRL). These costs are shared among the multiple mandates executed by AECL at its Chalk River site. Between 2005 and 2013, the mandates and related activities at the CRL have evolved significantly in response to many factors, notably: a shift **in** demand for services, the introduction of targeted programs and capital investments to address health, safety, security and environment priorities and to respond to enhanced regulatory requirements. The adjustment reflects these higher indirect costs.

Candu Energy Inc. still in competition for Turkey's Second Nuclear Power Plant

In early March 2013h 06, Candu Energy Inc issued a statement that, contrary to some media reports, it has not pulled out of a bid for the construction of the second nuclear project in Turkey at Sinop, Turkey on the Black Sea.

Candu Energy has submitted a feasibility report for the construction of four EC6 units at Sinop. The Company's spokesperson stated that they expect the Enhanced CANDU 6 option, with its medium size, localized fuel fabrication, proven and licensable design, and excellent project delivery record, to be an excellent option for nuclear power in Turkey.

Bruce Power promoting nucl

Bruce Power has begun advertising on regular telev with messages about the positive attributes of nu power. This is the first such campaign that the Can nuclear community has launched for several years.

The utility runs the same messages on the l page of its website in an automatic slide show.

In addition, their website has a sub-section *Revitalizing the Bruce Power Site.* This is a 24 presentation of photos and concise messages sho the extent of the site and the developments unde

Aerial view of the Bruce site (courtesy of Bruce Power).

Fukushima - Investigation of Torus Chamber at Unit 1, Fue Pool at Unit 3

In February 2013, the Tokyo Electric Power Co. (TEPCO) announced the results of its remote-cont investigation inside the concrete torus room housin suppression chamber of the containment vessel at U of the Fukushima Daiichi Nuclear Power Station (I

According to the investigation, the accumu water inside the torus was approximately 4.9m reaching just to the middle of the donut-shaped pression chamber. The visibility (i.e., water cl was about 60cm. As for the structures inside the t no major damage was revealed by the camera im although rust and other changes were confirmed.

Radiation was measured at 1.5mSv/h at floor on the first floor of the reactor building. Rea increased the lower that measurements were tak the torus room, with a maximum dose of 920m being registered immediately above the water su The radiation levels decreased in the water, due t shielding effect, and were measured at 90mSv/h the bottom of the water.

On the same day, TEPCO also released photos of conditions inside the spent fuel pool at Unit 3.

In order to determine the effects after a fuel handling machine mast fell onto the fuel storage rack and liner on February 6, TEPCO investigated the pool using an underwater camera from February 14 to 18, finding that the fallen mast had not deformed the fuel rack. TEPCO also said that it had generally grasped the situation of the distribution of submerged rubble and more.

Upper photo: fuel rack from above

Lower photo: close up of sediment on the fuel rack

Courtesy of Japanese Atomic Industrial Forum

NRU Planned Outage

On March 12, 2013 Atomic Energy of Canada Limited's (AECL) reported that the National Research Universal (NRU) reactor will enter a planned outage beginning on April 14, 2013 and ending May 14, 2013. The purpose of the outage is to conduct scheduled inspection and maintenance. This marks the third annual outage for the NRU. Inspection results to date continue to confirm that the NRU vessel remains fit for service.

In addition to the annual vessel inspection, work is planned during the outage to enhance the reliability and safety of the reactor. A dedicated work management outage team has been established to coordinate the activities of suppliers. NRU specialists and supporting departments will ensure the safe and successful execution of the outage.

Facility users and the isotope community have been informed well in advance of this outage and have taken steps to adjust their activities.

View of top deck of NRU.

The ongoing operations of the NRU allow AECL to continue to produce medical isotopes and provide vital research support to scientists and universities from across Canada and around the world.

Rat suspected for temporary loss of fuel pool cooling at Fukushima

On March 18, 2013, an electrical failure led to the loss of cooling systems at the fuel pools of Fukushima Daiichi units 1, 3 and 4, as well as the shared pool.

Tokyo Electric Power Company (Tepco) said that power supply facilities in the main anti-earthquake building at the plant "momentarily stopped" just before 7.00pm yesterday. This led to the failure of three switchboards which in turn caused the malfunction of the cooling systems for the used fuel pools of units 1, 3 and 4, as well as the shared fuel pool.

The power failure did not interrupt the operation of the cooling system for unit 2's used fuel pool or the water injection systems employed to cool the damaged reactor cores of units 1-3.

Tepco resumed operation of the cooling systems for the pools of units 1, 3 and 4, the following day and that for the share pool the day after.

The temperatures in the used fuel pools prior to the power loss ranged from 13.7°C to 25.2°C, Tepco noted. It estimated that it would have taken over four days for the temperature of unit 4's fuel pool to exceed 65°C, while unit 1's would have taken some 27 days to reach this temperature.

The operator of the crippled Fukushima Daiichi nuclear plant reported after the incident that it had found what it believed was the cause of the cooling system failure -: the charred body of a rat.

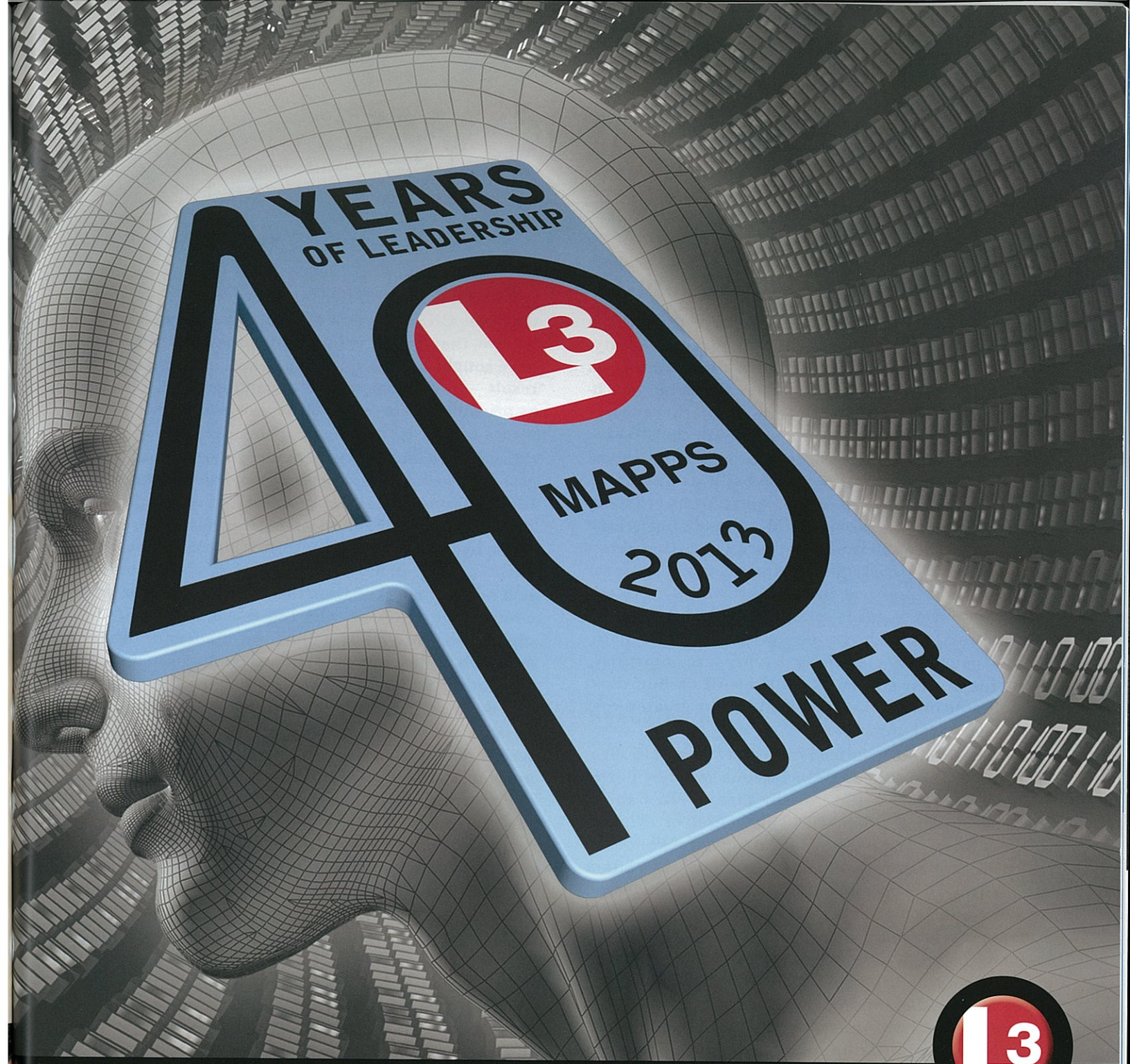
Inspection of Units 3-4 temporary M/C.

Soot found on the instrument current transformer.

Small animal found dead (Photo taken from above).

TEPCO said that when its engineers looked inside a faulty switchboard, they found burn marks and the rodent's scorched body. The company said it appeared that the rat had somehow short-circuited the switchboard, possibly by gnawing on cables.

Photos courtesy of Tokyo Electric Power Company taken on March 20, 2013.



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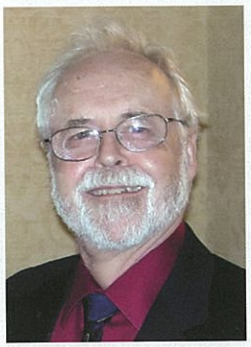


Message from the President

2013 has arrived with a return to, in Bruce County, of what I would describe as more traditional winter weather. Despite this, the reports from the arctic are that the ice continues to melt – believed to be via global warming. One gas which contributes to global warming is carbon dioxide. Much is being stated about the environmental benefits of shutting down Ontario's fossil (coal) generating plants. However it appears that political interference will lead to the OPG (tax-payer owned) plants at Lambton (coal) and Lennox (natural gas) being replaced with natural gas generated electricity by private enterprise. My point is that copious quantities of carbon dioxide will continue to be produced but at greater cost to the electrical consumer.

Nuclear reactors use fission heat to generate electricity. For safety (heat sink) reasons stand-by power must be available at the nuclear plants. In Canada stand-by power is produced using diesel or aviation turbine fuels. So strictly speaking, it cannot be stated that nuclear generated electricity is carbon dioxide free. Government regulations should demand regular reports of carbon dioxide emissions from each generating plant along with the MWe produced. Just because you cannot see carbon dioxide being emitted from natural gas fired plants does not make it "clean" as their industry would have you believe. Interestingly, little is mentioned of the contaminants extracted when purifying natural gas.

The recent announcements with respect to the Crystal River and Kewaunee plants are worrisome. It would appear that the decisions account only for the dollar and cents cost of natural gas with no consideration for the environmental cost. Perhaps placing a price on carbon would change the dynamics?

License renewals and hearings for sites/companies under CNSC jurisdiction are held regularly. I would encourage each CNS member to keep abreast of these events and consider whether it is appropriate for them to support such license renewals. I had thought that the CNS was not a lobbying organization but believe that I was using an incorrect definition. I have sought a legal opinion and will inform you of the result. In the meantime I encourage CNS members as private citizens, should they wish, to add their own voices to the debates.

Heather Kleb and her team deserve hearty congratulations for having organised a most successful and energetic CNA Annual Conference and Tradeshow. There were many interesting presentations by excellent presenters. I think that I was most surprised by the meaning of "uranium" in several languages of Canadian and Australian indigenous populations – "the rod that kills". The message to the audience is that the nuclear industry's outreach is important everywhere but crucial with our aboriginal populations.

A follow-up CEOs' Leadership Forum was held ahead of the CNA Board meeting and concluded with two significant actions. The first is that we, the nuclear families and industries, need to have one common message delivered by many voices – the message is being formulated. The second is that there will be a further CEOs' Leadership forum to occur around CNS AnnCon2013.

The recent announcement from the Hon. Joe Oliver with respect to AECL was certainly good news. I believe that the CNS can take a some credit for this (thank you Colin Hunt for spearheading the effort). There was no mention of NRU which is both bad and good. It is bad because the future is in doubt – it is good because the future is in doubt. It is now up to the nuclear industry as a whole to (again!) make the case for keeping NRU going. What has to be remembered is that the government wants to see income as opposed to expenditure. Perhaps there is some middle ground that can be explored. The message is that the CNS will need to again play its part.

Spring will soon be upon us and again we will feel more warmth from the big reactor in the sky. Please remember to take appropriate safety precautions and take good care of your family as you have fun together.

John Roberts

Council Notes

By FRED BOYD

The governing Council of the Society has been very active over the past months.

New Incorporation

One significant activity has been preparing for a change of legal status as a result of the federal government passing the Canadian Non-Profit Corporations Act (CNPA) two years ago.

The Society was originally formed in 1979 as *The Canadian Nuclear Society – The Technical Society of the Canadian Nuclear Association.* In 1998, after a few years of internal debate and negotiations with the CNA, the Society decided to incorporate as a separate legal entity. Being a national body, that meant incorporating under the federal Canadian Corporations Act (CCA). The passing of the new CNPA requires that all such national non-profit corporations re-incorporate under the new Act. That involves modifying the By Laws of the Society and applying for what is called "Continuance" under the new Act.

An ad hoc committee has reviewed the existing By Laws and consulted with a legal firm specializing in non-profit organizations. The committee's recommendations have been accepted by Council and the first step, formal acceptance of proposed modest changes to the existing By laws will be sought at the Annual General Meeting to be held during the 2013 Annual Conference in Toronto in June. Those changes need to be approved by Industry Canada, under the CCA. When that approval is received it will be necessary to hold a Special General Meeting (proposed to be held during the CANDU Fuel Conference) to obtain formal acceptance to apply for Continuance with the approved By Laws. Application for Continuance must be submitted by 2014.

PBNC 19

The CNS is the prime organizer of the 19th Pacific Basin Nuclear Conference (PBNC), which will be held in Vancouver, August 24 – 28, 2014. The PBNC is a major biannual international conference authorized by the Pacific Nuclear Council (PNC) of which the CNS is a member. PNC is a coordinating organization with membership of most of the nuclear associations and societies in countries around the Pacific Ocean. Canada hosted a very successful PBNC in 1998 in Banff. Alberta.

CNS Past President, Frank Doyle, is spear-heading the organization of PBNC 19. Bill Kupferschmidt of AECL is the technical chair.

As this is a major international event, the CNS Council has decided not to hold a CNS Annual Conference next year. However, there will be a substantial Canadian presence at PBNC 19. Any CNS member who would like to assist in the organization of this major event should contact either Frank or Bill.

Finances

Last year proved to be a devastating year for CNS finances. Although the final figures are not yet in, the Society had an operating deficit of well over $100 K.

About three quarters of the CNS income comes from conferences and courses. There were fewer events in 2012 and a major one, the Steam Generator and Controls conference, unfortunately had a much smaller attendance than expected. Forecasts for 2013 also show a projected deficit.

The Society still has a sizable balance built up over many years. But it is obvious that it can not sustain large deficits very long. Perhaps there are inventive members with ideas for extending activities of the Society which can both benefit members and produce income.

Speaking out

Over the years the Society has concentrated on its members, with courses, meetings, conferences and publications, to enhance their professional capabilities. The concept of the Society speaking out in public has been avoided.

Individual members have been encouraged to take advantage of opportunities to speak about the benefits of nuclear science and engineering but there has been general acceptance that it would be difficult to identify, let alone express, the opinion of all members in public debates

Now, however, the social and political environment is such that many members have expressed the need for the Society to be more vocal. Council has debated this issue and, at its March 8, 2013 meeting, accepted a proposed procedure for the Society to speak out on nuclear-related issues. At that meeting it was reported that the CNS had been invited to participate in Day 2 of the CNSC hearing on the renewal of the Operating Licence for the Pickering NGS.

Council approved the drafting of an intervention for that hearing to be reviewed at its next meeting April 12.

Members with comments on this policy should contact the President, Secretary or Communication Director.

News from Branches

ALBERTA – Duane Pendergast

Alberta Branch member Shaune Ward represented the Branch at the CNA Small Reactor Workshop held in Calgary in November 2012. A number of provincial officials, representatives of a number of companies in the Alberta energy field and some students from the University of Calgary attended.

On January 30, 2013 Jason Donev gave a presentation to an undergraduate club of students at the University of Calgary interested in energy issues. This club, ISEEESA, is the undergraduate student association affiliated with the Institute for Sustainable Energy and Economy at the University of Calgary.

Forty students were expected to attend. Sixty showed up, and some were turned away at the door because there wasn`t enough room. There were many questions about thorium as well as what happened in Japan re Fukushima.

Jason also spoke at the Calgary City Teachers Convention on **February 14** on "Nuclear Power in the 21st Century" including Fukishima, and the advantages of nuclear power compared to other forms of electricity generation.

At the same convention Duncan Smith, a local HS science teacher, presented a way of making a home built cloud chamber. He did an excellent job representing naturally occurring radioactive material, and perhaps should be approached about helping with more CNS outreach. The room was completely packed and the talks were very well received.

BRUCE – John Krane

The Bruce Branch presented a CNS cheque to the organizers of the Bluewater Regional District Science Fair to be held in Owen Sound in April 2013 for 2 prizes (Junior and Senior).

On February 1, the Branch also hosted a presentation at the Bruce Power Auditorium by Julia Grein, a 16 year old high school student from Hanover Ontario (JDSS) and also a participant of the Deep River Science Academy "Scientist for the Summer" program.

She spoke on "Can Hydrogen (H-1) be Used to Determine Deuterium (H-2) Absorption into CANDU Pressure Tubes? The presentation was well attended by Bruce Power technical staff and CNS members. A follow-up article is planned for the Bruce Power "The Point" publication.

The book by Theodore Gray "The Elements") was given to the presenter.

A dinner meeting/presentation on the proposed Deep Geologic Repository is planned for March/April.

CHALK RIVER – Ruxandra Dranga & Bruce Wilkin

Speakers:

January 29th - Ian Clark, professor at Ottawa University, presented a seminar titled "Bury It - a Seminar on Nuclear Waste".

This seminar was organized in collaboration with PEO Algonquin Chapter, and it presented the current research and tests performed at Ottawa University, in support of the low and intermediate level deep geological repository planned to be located in the Bruce Peninsula. Approximately 40 people attended the event, some of them CNS members, others PEO members.

March 11th - The branch held its Annual President's Dinner at which CNS President, John Roberts, spoke about his favourite subject, chemistry, in a seminar titled "Overlook Chemistry at Your (Plant's) Peril".

Education and Outreach:

Renfrew County Regional Science Fair and CNS Elementary School Poster Contest - the RCRSF will take place on April 6th. The CNS CRB will be judging the posters for the CNS Special Awards in Science and Technology, and the Poster Contest for Grades 6 to 8.

We will also have a display booth with information on nuclear science and technology, display a mock-up fuel bundle, and perform Geiger Counter demonstrations.

The Science Fair is an excellent opportunity to reach out to the various communities in the Renfrew County, which include both children and adults, and discuss with them about radiation and the benefits of nuclear technology.

DARLINGTON – Jacques Plourde

Efforts continue on the merger with the Pickering Branch. The OPG Chief Engineer, Mark Elliott, has a complete list of the OPG members of the CNS who have selected Darlington or Pickering as a 1st or 2nd Branch choice. He will set up a meeting with us (Leon Simeon and I) later this month to discuss the path forward aimed at improving OPG membership and participation in the CNS. In the meantime, we are canvassing from among our existing membership for interest in working on the new Durham Branch Executive.

A meeting was held with the UOIT Student Branch on January 10. Terry Price and his colleagues were interested in increasing OPG participation, through the Darlington and Pickering Branches, in their activities. As a stronger connection with UOIT is one

of the objectives of the new Durham Branch, we are now making sure that our Branch members receive invitations to UOIT events. The students at UOIT wish to strengthen the link with the Operating Utility in Durham Region, and our new Branch is well positioned to make that happen. This will also be a subject of discussion with Mark Elliott.

GOLDEN HORSESHOE – Kurt Stoll

On February 26, the Golden Horseshoe Branch hosted Nick Sion for a seminar titled "Radiation Hazards and Countermeasures in Space Missions."

Nick discussed the challenges of long duration space travel and educated everyone on the doses expected for a mission to Mars. He referenced an impressive number of NASA reports and collaborations with health physics professionals.

On March 5, the Branch hosted Stephen Yu, Director of Candu Products Technology, CANDU Energy Inc., who spoke about the Enhanced CANDU6 (EC6).

NEW BRUNSWICK – Mark McIntyre (Acting)

The New Brunswick branch has made contact with the Nuclear Medicine department at the Saint John Regional Hospital with the hope of determining a mutually agreeable date for a tour of the NM facility.

The hospital has several new pieces of radio-isotope equipment that will be of interest to CNS members.

OTTAWA – Mike Taylor

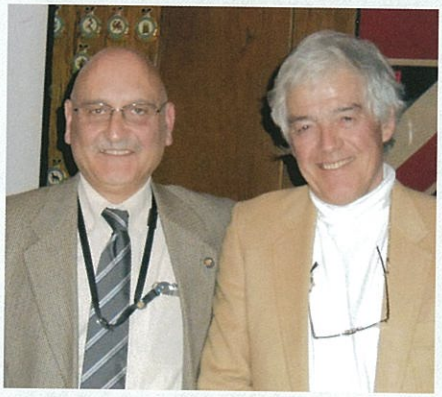
On 11 Jan 2013 CNS Ottawa had a joint meeting with the CNSC which was addressed by Mr. Paul T. Dickman, Dr. Dale E. Klein, and Dr. Michael L. Corradini of the American Nuclear Society (ANS) who discussed their report on the incident at the Fukushima power plant. They explored the role which professional societies such as the ANS can play in the dissemination of information or countering factually inaccurate claims, including those in the media, during a crisis.

The speakers also discussed appropriate safety standards during a crisis and why they believe ALARA may not be in the public's best interest when dealing with emergency situations such as the Fukushima accident.

Following a recent case of low attendance at a meeting, a sub-group of the branch executive developed a strategy document aimed at increasing future attendance. We are in the process of implementing the strategy and would be happy to share it with other branches, recognizing that each branch faces a different situation.

On Tuesday, February 19, the branch held a special dinner meeting with Ramzi Jammal, the CNSC's Executive Vice-President and Chief Regulatory Operations Officer of the Canadian Nuclear Safety Commission as the guest speaker. He titled his presentation "Fukushima-Daiichi NPP Site Visit and Decontamination Tour of the Tohoku Region". He had visited the plant in December as part of a small select international committee. He spoke both about the radiation contamination of the area then showed slides of the extensive damage to the plant and of the large amount of effort being expended to clean up the facility and surrounding area. (His PowerPoint presentation is posted on the CNSC website.

Some 35 people attended despite an extreme wintry night. They were rewarded with an excellent talk showing the low levels of remaining radioactive contamination and the Japanese government's enormous and comprehensive efforts to clean up, as well as the speaker's own photographs taken in, on, and around the damaged facility.



Ramzi Jammal and CNS Ottawa chair Mike Taylor pose after Jammal's presentation to the CNS Ottawa Branch February 19, 2013.

PICKERING – Leon Simeon

Local high schools have been contacted for names of potential recipients of CNS awards for science projects.

QUEBEC – Michel Saint-Denis

The announcement of the closure of the Gentilly 2 plant was a shock to the Québec nuclear community. Several members participated to events / information sessions.

Michel Saint-Denis, Québec Branch CNS president, participated at a public expert panel to provide information in Bécancour on October 17, 2012. A report of the event can be found on the following website (http://www.lapresse.ca/le-nouvelliste/gentilly-2/201210/18/01-4584489-gentilly-2-exploitable-pendant-cinq-ans-sans-refection.php for a report of the event).

Michel Saint-Denis participated to a college debate on nuclear energy in Jonquière, on October 30, 2012.

Other CNS members have also been very active in the media to educate the general population and to provide factual information on nuclear science.

UOIT Branch – Ray Mutiger

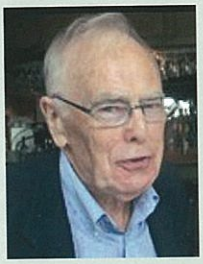
Michael Godfrey, from Westinghouse, visited UOIT on February 7th to deliver a presentation on the Westinghouse AP-1000 Reactor. The presentation overviewed the passive safety systems and a desire to enter the Canadian market.

Then, Mike Soulard from CANDU visited UOIT on February 12th to give a presentation on the Enhanced CANDU 6 Reactor. The presentation was interesting and the concepts to enhancing the CANDU design were well presented.

David Dabney and David Poole from StarCore Nuclear visited UOIT on Wednesday March 13th to speak on the topic of tristructural-isotropic (TRISO) fuel and its use in a pebble bed reactor.

Donald Larson and Dr. William Thesling from the Energy from Thorium Foundation are scheduled to visiting UOIT on Friday March 22nd to give a presentation on thorium fuel cycles and Liquid Thorium-Fluoride Reactor (LFTR). They hope to engage the industry and regulators in a discussion forum to learn more about the state of thorium research in Canada and the possible future of a thorium reactor.

Obituaries



Don Lawson

Donald Stuart (Don) Lawson, a former president of AECL CANDU, died in Oakville, Ontario on December 19, 2012 at the age of 78.

Don was born in Liverpool, UK and studied at the University of Bristol, receiving a B. Sc. in Aeronautical Engineering in1956. After two years with the UK Ministry of Supply working on a fluid mechanics research project he joined English Electric which subsequently became part of GEC, UK.

Starting as a technical engineer he was soon promoted to senior engineer, then section head, and in 1969 became Chief Engineer a position he held until 1976 when he decided to move to the USA to join the consulting firm Sanderson and Porter in New York

Two years later, in 1978, he joined Atomic Energy of Canada Limited as Vice President (Operations) of what was then AECL Engineering Company. Over the next several years he progressed to Executive Vice President, then as the unit's name changed, Executive Vice President of CANDU Operations, finally retiring in 1995 as President of AECL CANDU.

Over those years with AECL he oversaw AECL's contracts on 16 reactors and was involved in the contracts with Korea and Romania.

Don was registered as a Professional Engineer in Ontario and a Chartered Mechanical Engineer in the UK. He was a Charter member of the Canadian Nuclear Society. He was presented with the CNS Outstanding Contribution Award in 1996 and presented with a special award from the Canadian Society of Senior Engineers with which he became very active after retirement...

He was predeceased by his oldest son, David, and survived by his wife, Rosanne, sons Nicholas and Hugh and grandchildren Richard, Gamma, Ben and Chloe.

His funeral took place January 5, 2013 at St. Simons Anglican Church in Oakville.

John Lipsett

John Lipsett,78, a pioneer researcher at the Chalk River Laboratories, and his wife Eleanor, 80, departed together, after fifty-four years of marriage, on February 22, 2013, as the result of smoke inhalation from a fire in their house in Deep River, Ontario.

John joined Atomic Energy of Canada Limited in 1956 after obtaining his B.Sc. in Engineering Physics from the University of Saskatchewan. John conducted studies on failed fuel detection associated with the NRX and NRU reactors and was largely responsible for the development of the gaseous fission product (GFP) detector used on the CANDU 6 reactors. He was also the inventor of the feeder scanning system installed on the Pickering units.

In the 1960s John was involved with the creation of the Algonquin Chapter of the Association of Professional Engineers of Ontario and later with the beginning of the Chalk River Branch of the Canadian Nuclear Society. He was awarded the PEO Engineering Medal in 1984.

After retirement in 1991 he continued his involvement with PEO and served on the AECL Safety Review Committee.

John and Ellen are survived by their children: Katherine Ann; \Michael George and Frances Andrea.

Their funeral service was held at St. Barnabas Anglican Church in Deep River on March 2, 2013.

10TH International Conference on CANDU Maintenance

10TH International Conference on CANDU® Maintenance

Metro Toronto Convention Centre, Toronto, Ontario, Canada • May 25-27, 2014

Hosted by the Nuclear Operations & Maintenance Division (NOM) of the Canadian Nuclear Society

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Provides the themes for four plenary and technical streams over the 2 days, related to maintenance of CANDU® units.

Mark your calendars and watch for further details on this important industry event. Get engaged: plan to participate as a speaker, a session chair or part of the organizing team.

Note that in 2014, the CNS will not host a separate Annual Conference. Instead, events associated with that Conference have been re-distributed between CMC 2014 and PBNC 2014.

Jacques Plourde
CNS NOM Division, Sponsor

Vinod Chugh
Conference General Chair

Contact:
CNS Office
Email: cns-snc@on.aibn.com
Tel.: 416-977-7620
Fax: 416-663-3504

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- Trade Show
- Special Recognition Awards
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- CNS Annual General Meeting
- CNS Branch Affairs Meeting
- CNS Utility Engagement Joint Steering Committee Meeting

Canadian Nuclear Society
Société Nucléaire Canadienne

12th International Conference on CANDU Fuel

"CANDU Fuel: Safe, Reliable and Flexible"
"Combustible CANDU: sûr, fiable, polyvalent"

Holiday-Inn Waterfront Hotel and Conference Centre, Kingston, Ontario, 2013 September 15-18

On behalf of Conference Organizing Committee, we would like to thank those who have submitted a paper abstract to the 12th International Conference on CANDU Fuel. Under the theme of *CANDU Fuel: Safe, Reliable and Flexible,* paper abstracts have been solicited for the following categories. This conference will be held with parallel technical sessions and a plenary session.

A. ***Fuel Performance:*** PIE studies/techniques, fuel behaviour (normal operating conditions and extended burnup), and station experience.

B. ***Fuel Safety:*** Licensing issues, accident studies, fission-gas release, fuel behaviour, LOCA initiative and experimental simulation, fuel acceptance criteria, and fuel deformation and dryout.

C. ***Fuel Design & Development:*** Modifications to fuel designs and quality assurance in fuel design and development, MOX, inert matrices, DUPIC, slightly enriched uranium (SEU), recovered uranium (RU), thoria-based fuels, SCWR fuel, and economical and societal implications of fuel cycles.

D. ***Fuel Code Development:*** Predictive capability for thermal, mechanical, irradiation and fission-gas release behaviour under normal operating and accident conditions, and predicting aerosol behaviour.

E. ***Fuel Manufacturing:*** Fuel manufacturing experience, advances in manufacturing & inspection technologies, blending Recycled Uranium (RU) & Depleted Uranium (DU), and fuel manufacturing issues and improvements.

F. ***Fuel Management:*** Fuel management schemes, load following, fuel physics analysis, and specific operational problems.

G. ***Fuel Bundle Thermalhydraulics:*** CHF and CCP assessment and enhancement, reactor aging, crept pressure tube and fuel simulation and testing.

H. ***Spent Fuel Management:*** Fuel handling technology, spent fuel storage, and in-storage fuel behaviour.

I. ***Advanced Code Development:*** Development of models that support fuel performance and safety assessments.

We are now accepting nominations for a new award to recognize senior or retired individuals who have contributed greatly to the field of **Nuclear Fuel.** Please send your nomination letters to Dr. Paul K. Chan at Paul.Chan@rmc.ca by 31st May 2013. For further details on this award please visit our website at **http://www.cns-snc.ca/events/candufuel2013/**.

Full papers must be prepared and submitted to https://www.softconf.com/d/CANDU2013/ according to guidelines published on the conference website. Publication in the conference proceedings is not guaranteed if your final paper is received after 31st May 2013. For final papers to be accepted for publication, one of the authors of the paper must register for the conference and present the paper at the conference. If you are planning to submit a paper and it is pending internal (and/or customer) approval, please contact the Conference Chair (Dr. Paul Chan) directly.

This is a CNS conference that is being held in co-operation with the IAEA. The Conference Organizing Committee would like to take this opportunity to thank our sponsors. For more information and latest news, please visit the conference website.

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Join us in Toronto in June, as we boldly explore where the next generation of "enterprising" Canadians will take nuclear science and technology

34th Annual CNS Conference and 37th CNS-CNA Student Conference

NUCLEAR
THE NEXT GENERATION

CNS 2013 SNC
TORONTO

2013 June 9-12· Marriott Toronto Downtown Eaton Centre

- **Who** The CNS Annual Conference and Student Conference gathers scientists, engineers, technologists, senior management, government officials, and students from across Canada and from other countries interested in nuclear science and technology. Guests will also enjoy an engaging Guest Program.

- **Why** The central objective is to exchange views on how nuclear science and technology can best serve the needs of humanity, now and in the future.

- **Where** This year's conference returns to vibrant downtown Toronto, where decisions about the future of nuclear electricity in Ontario will be made - decisions that affect the economy of Ontario, and the well-being of Canadians.

- *2013 W.B. Lewis Lecture/Luncheon*
- *Three plenary sessions + many technical sessions*
- *Canadian Nuclear Achievement Awards luncheon*
- *Student poster session*
- *Main conference banquet*
- *North American Young Generation in Nuclear Professional Workshop*
- *Reception, breaks, exhibits, and other networking opportunities*
- *Guest program*

info:- www.cns-snc.ca

Canada, the Provinces, and the Global Nuclear Revival - Advocacy Coalitions in Action

Author: Duane Bratt, Professor and Chair of the Department of Policy Studies, Mount Royal University, Calgary, AB. [*Ed. Note: An excerpt from Duane Bratt's book is presented on page 9 of this edition.*]

Reviewed by Ric Fluke

The world is experiencing a nuclear revival driven by the need for more electricity, concern about global climate change and the need to find alternatives to greenhouse gas emitting fossil fuels. Despite the efforts of anti-nuclear coalitions the public at large is looking more favourably to nuclear power as a "green" energy source, even following the Fukushima accident. How are Canada and its provinces responding to the nuclear revival at home as well as their opportunities internationally?

Duane Bratt examines this in his book "Canada, the Provinces, and the Global Nuclear Revival - Advocacy Coalitions in Action". As a tool for his analysis and case studies he introduces the concept of the Advocacy Coalition Framework (ACF). An advocacy coalition, he explains, is "a *set of actors from a variety of public and private institutions at all levels of government who share a set of basic beliefs (policy goals plus casual and other perceptions) and who seek to manipulate the rules, budgets and personnel of governmental institutions in order to achieve these goals over time.*"

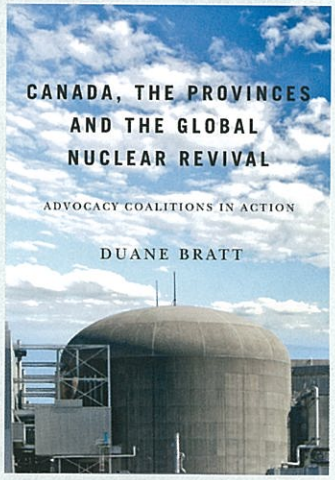
In Canada the ACF for nuclear power is comprised of three groups: the pro-nuclear advocacy coalition, the anti-nuclear advocacy coalition and the advocacy brokers. The composition of pro- and anti-nuclear advocacy coalitions has been fairly stable over decades. The advocacy brokers are the elected politicians and senior civil servants who seek to find compromise between the opposing groups.

Bratt observes that the pro-nuclear groups often base their arguments on technical and scientific grounds whereas anti-nuclear groups focus on environmental and emotional issues. This makes public communication and education difficult, as anti-nuclear coalitions instill a sense of public anxiety and fear of radiation, often linking nuclear electricity with atomic weapons whereas the scientific arguments put forth by pro-nuclear groups are often not understood by the public and are certainly not producing sensational headlines in the media. The two groups are ideologically opposed to each other, something Bratt refers to as "the devil" within a group as viewed by the other group.

With this background Bratt is able to explain the history, desires and results of nuclear projects in four provinces: New Brunswick, Ontario, Saskatchewan and Alberta. Each province has taken a different approach which Bratt identifies with the history of the province. Some years ago New Brunswick decided to refurbish its Point Lepreau reactor, build a second reactor and to establish itself as an energy "hub" including transmission, oil and gas projects. Ontario, with the largest nuclear fleet in Canada, also decided to refurbish or otherwise extend the life of its existing reactors and build more reactors. Saskatchewan, already a supplier of uranium, wants to add value by becoming a nuclear centre of excellence with uranium conversion, refining and enrichment, a research and medical isotopes reactor and nuclear power reactors. Alberta, with no nuclear history but in need of both heat and electricity to sustain its oil projects while reducing greenhouse gas emissions began to investigate nuclear power as an option.

Bratt examines each province and draws a number of hypotheses. The breakdown of relations between two pro-nuclear coalition actors, New Brunswick and AECL over the Point Lepreau refurbishment problems, has not dampened public support for new build in that province. Ontario new build began as an open bid, was cancelled due to "sticker shock" of AECL's ACR-1000 reactor, and has reopened its bid process following the sale of AECL's Reactor Division to Candu Energy Inc. Candu is offering its more modest EC-6 reactor. Saskatchewan has not ruled out a reactor but has put the decision on hold until 2020. Similarly, Alberta has not ruled out nuclear, but proponent Bruce Power has withdrawn its proposal, apparently due to a poor business case resulting from cheap and abundant shale gas.

On international opportunities Bratt believes the future is good for Canadian supplier companies based on recent changes in Canada's foreign policies but believes that CANDU will be a hard sell in the highly competitive new reactor markets.



Written in laymen's language Duane Bratt presents an in depth analysis of nuclear power in Canada and abroad including its history, public opinion results versus how the polls were structured and the make-up of the "actors" in pro- and anti-nuclear advocacy coalitions, and how effective they have been in influencing policies in the provinces. The book is readable, provocative, and a must read for both pro- and anti-nuclear groups, or any advocacy group in general, including politicians, engineers and scientists, business leaders and policy makers.

http://mqup.mcgill.ca/book.php?bookid=2916
McGill-Queen's University Press, 2012
ISBN 978-0-7735-4069-9

Calendar

2013

Feb. 27-Mar. 1 — **Canadian Nuclear Association Conference & Trade Show 2013**
Ottawa, Ontario
website: www.cna.ca

Mar. 3-7 — **6th International Symposium on Supercritical Water-Cooled Reactors (ISSCWR-6)**
Shenhen, China
Contact CNS e-mail: cns-snc@on.aibn.com

Apr. 22-26 — **7th International Conference on Naturally Occurring Radioactive Materials (NORM-VII)**
Beijing, China
Contact CNS e-mail: cns-snc@on.aibn.com

May 12-17 — **15th International Topical Meeting on Nuclear Reactor Thermal Hydraulics (NURETH 15)**
Pisa, Italy
email: dlshubring@ufl.edu

May 27-29 — **3rd Climate Change Technology Conference**
Concordia University, Montréal, Québec
(Organized by EIC including CNS)
website: www.cctc2013.ca

June 9-12 — **34th Annual Canadian Nuclear Society Conference and 37th Annual CNS/CNA Student Conference**
Toronto, Ontario
email: cns-snc@on.aibn.com
website: www.cns-snc.ca

June 16-20 — **ANS Annual Meeting**
Atlanta, George
website: www.ans.org

July 29-Aug. 2 — **ICONE-21**
Chengdu, China
Contact CNS e-mail: cns-snc@on.aibn.com

Aug. 18-23 — **22nd International Conference on Structural Mechanics in Reactor Technology SMiRT 22**
San Francisco, California
website: www.smirt22.org

Sept. 15-18 — **12th International Conference on CANDU Fuel**
Kingston, Ontario
website: www.cns-snc.ca

Oct. 27-31 — **Joint International Meeting on Supercomputing in Nuclear Applications and Monte Carlo**
Paris, France
Contact CNS e-mail: cns-snc@on.aibn.com

2014

May 25-27 — **10th International Conference on CANDU Maintenance**
Toronto, Ontario
Contact CNS e-mail: cns-snc@on.aibn.com

Aug. 24-28 — **19th Pacific Basin Nuclear Conference (PBNC 19)**
Vancouver, British Columbia
website: www.cns-snc.ca

Oct. 26-31 — **Nuclear Plant Chemistry Conference 2014**
Sapporo, Japan
e-mail: npc2014@issj.com

New IAEA Publication
Non-HEU Production Technologies for Molybdenum-99 and Technetium-99m

IAEA Nuclear Energy Series No. NF-T-5.4

Summary

Technetium-99m (99mTc) is used in approximately 85% of diagnostic imaging procedures in nuclear medicine worldwide. Interruptions in the supply of Molybdenum (99Mo), which is used to produce 99mTc, prompted governments and international agencies to step up efforts to identify both short- and long-term solutions to supply shortages. These calls for actions resulted in economic and technology studies on the 99Mo supply chain.

The present publication supports global efforts to eliminate the civilian use of highly enriched uranium in 99Mo/99Tc production and proposes several alternative/supplementary technologies.

STI/PUB/1589; 59 pp., 20 figs; 2013; ISBN978-92-0-137710-4, English, 24.00 Euro

Electronic version can be found at: http://www-pub.iaea.org/books/IAEABooks/10386/Non-HEU-Production-Technologies-for-Molybdenum-99-and-Technetium-99m

Bomb-Grade Logic

by Jeremy Whitlock

CAMBRIDGE BAY, NUNAVUT, June 2045: Anti-diesel groups are decrying a plan by the federal government to ship over two million litres of the bomb-grade liquid petroleum product to the U.S. for safe conversion and recycling.

The material has been in storage under high-security at this remote northern Canadian community for most of the last two decades, following the start-up of a suite of "micro" nuclear reactors that now provide the municipality's heating and electricity needs.

Diesel once saw widespread use in the Canadian arctic, particularly in regions without ready access to natural gas, and wherever natural gas price volatility made it increasingly less practical.

The advent of nuclear energy has now limited the use of diesel to transportation, leaving millions of litres of the fuel under close scrutiny in storage tanks.

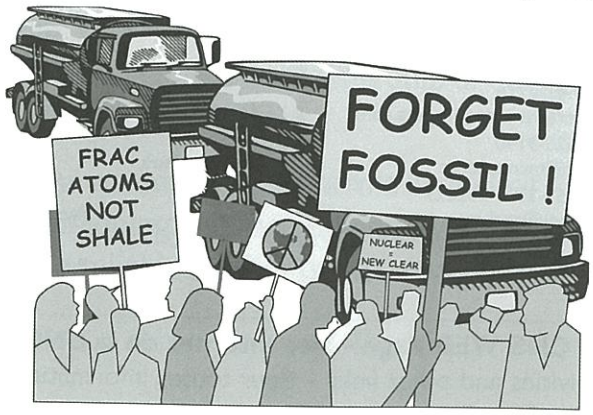
The problem, according to groups like the Canadian Coalition for Fossil Responsibility (CCFR), is that diesel oil can be directly used in weapons of mass destruction and other forms of terrorist bombs.

Moreover, it is used in over 80% of mining and construction explosives in North America, which, according to the CCFR, means that the knowledge of how to manufacture an explosive with it is widespread.

"These so-called ANFO, or fertilizer bombs, have been the weapon of choice for terrorists and insurgents around the world since the 1970's," says the literature on the CCFR website.

ANFO's notoriety stems from high-profile attacks such as the 1993 World Trade Centre and 1995 Oklahoma City bombings, as well as countless car bombs and other IEDs used in Northern Ireland, Pakistan, Iraq, Afghanistan, and other trouble spots over the years.

"In any situation where the essential technical know-how is widespread," says the CCFR, "the only limiting factor is access to materials. Since the key ingredients for ANFO weapons are diesel fuel and ammonium nitrate found in fertilizer, the attractiveness of these devices becomes understandable."



Hence the level of security accorded this surplus material in Cambridge Bay. Recently, however, U.S. Homeland Security has increasingly become concerned about stockpiles of the bomb-grade fuel around the world, and has attempted to reduce the global risk by buying it up and shipping it to U.S. soil for safekeeping.

The plan with the Cambridge Bay stockpile is to convert it from Arctic diesel to standard transportation grade for the rest of the United States, and safely distribute it to the nation's vehicle fleet.

However this will involve hundreds of truck shipments, as well as ocean freighter shipping.

"Rather than leaving this deadly material in its current secure location, where it presents a minimal risk," says a CCFR news release, "the government seeks to make a buck by selling it to the U.S., sending it thousands of miles through our waters and on our highways."

This poses an environmental risk that is even greater than the terrorist risk, according to the CCFR.

"Humankind has never mastered the art of safely handling petroleum products, either on water or land," says the CCFR.

"History is littered with the environmental catastrophes of past attempts. This lethal proposal demands nothing less than a full Environmental Assessment, so the public can have a say in whether it is safe enough."

At issue is the government decision to keep the route of the diesel shipments top secret, and to avoid a public Environmental Assessment due to security concerns.

"It's environmental hypocrisy," claims the CCFR, "This is not like shipments of nuclear fuel or waste, where we know much more about the process, and where we have never had a problem. Why can't diesel shipments be held to the same level of accountability and protection?"

"Furthermore, nuclear material hasn't been used in a bombing anywhere for a hundred years. This deadly and toxic diesel fuel is used to blow something up, somewhere in the world, on a weekly basis."

"And it sets yet another dangerous precedent – that it's OK to ship high level liquid bomb material whenever the fossil-fuel technocrats find it convenient to do so."

"It appears more and more that the Age of Diesel Power is drawing to a close, but the Age of Diesel Waste has just begun. It is essential that the public withhold approval from dangerous and unnecessary practices such as this."

2012-2013 CNS Council • Conseil de la SNC

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