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Editorial

Arms and Diversions

The issue of the relationship between civilian nuclear energy programs and nuclear weapons programs is a recurring theme in criticism of nuclear power development. In Canada over the last few months this issue has been given particular emphasis with respect to plans by Ontario Hydro to market tritium and, in conjunction with the Canadian Fusion Fuels Technology Project, stake out some of the high ground in the area of tritium technology particularly as applied to fusion energy systems.

A fund raising letter on behalf of Energy Probe (a Toronto-based group) signed by University of Toronto Chancellor George Ignatieff, suggested that Canadian tritium sales would help fuel the nuclear arms race since tritium is a vital ingredient in nuclear weapons. Predictably enough this aroused a certain amount of concern among individuals and organizations in the nuclear business, and a certain amount of response.

However it is important to avoid the tendancy to bring the discussion to the point of argument over the constructional details of nuclear weapons, whether or not they use tritium and whether or not tritium in the form in which it might be exported from Canada is particularly useful for nuclear weapons manufacture. Canada does not have a nuclear weapons development and production program. But there are numerous individuals in the nuclear business who, in previous employment, have gained some knowledge of nuclear weapons design. These people are (or should be) constrained from public discussion of design details by such security instruments as the British Official Secrets Act.

Since it is not likely that any government will publish in the open literature design or performance details of its latest weaponry (nuclear or otherwise) it is probably safe to say that such information on nuclear weapons as is published in the open literature is either out of date or inaccurate.

It is also reasonable to infer that, assuming tritium is an essential ingredient in nuclear weapons, any state producing nuclear weapons would be most unlikely to place reliance for supply of a vital strategic material on an offshore source when it is possible to manufacture that material domestically.

Few people would disagree with the proposition that a world without nuclear weapons would be a more reassuring place in which to live. And nationally, Canada is committed to extremely rigorous safeguards to prevent its commercial nuclear technology being misapplied to weapons development. In the final analysis the decision that Canada should or should not export tritium is a national policy decision and one that the national government has the responsibility to make, and to justify.

Perspective

Ethics and the Nuclear Industry: The Face in the Mirror

The following is an address by S.G. Horton, Executive Vice-President, Engineering Services, with Ontario Hydro, originally presented to the CNA/CNS Student Conference on Nuclear Science and Engineering on March 29, 1985, in Toronto.

Ethics is one of the keys for the nuclear industry today, and it will become even more important in the future. The nuclear industry and the people associated with it will have to pay a lot of attention to social issues and the ethics behind them if the industry is to survive and be healthy.

It has been suggested that one reason for the industry's problems today is that in the past it didn't pay enough attention to people's concerns about radiation, waste disposal and overall safety.

It has also been suggested that this is because scientists and engineers refuse to recognize any intrinsic ethical content in their work.

Both of these charges need to be challenged and clarified.

But before I go any further, let me say that my comments are about the civilian nuclear industry, not about nuclear weapons. Nuclear arms are a whole different subject and one that I am not going to get into.

With that established, let me say I do not believe the nuclear industry failed to address the concerns of society — certainly not in Canada. Far from it, though we may have failed to communicate effectively, and maybe thought we understood what was concerning people without listening long enough to be sure, or perhaps we assumed that people were listening when they were not.

When we begin discussing ethics, it's all too easy to wander down any of several hundred avenues — all concerned with ethics, and all equally valid for discussion. So I want to limit my approach to the questions that have been raised in the following way.

First, I agree with the premise that many scientists and engineers are not sufficiently

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concerned with the ethics of their work — but I suspect this is less of a concern inside large corporations — such as those comprising the nuclear industry — than it is among scientists and technicians working on their own. That may surprise you.

Second, I suggest that the nuclear industry is, generally speaking, a pretty good example of how large corporations and even whole industries *do* include ethical considerations in their planning.

Third, there is a cause and effect relationship between society's values, and the ethical behaviour of corporations; to a great extent, we get the level of corporate citizenship that we deserve, and I believe that the trend today is a positive one.

I called this paper "Ethics and the Nuclear Industry: The Face in the Mirror" because corporate behaviour generally reflects society's values. But it's like any mirror image. We don't really want the reflection to be exact; rather, we want it to be a little better than the original — and, as a rule, that just doesn't happen.

But even if the results are not everything we might want, social pressure on corporations does tend to translate into greater ethical concern on their part, and also on the part of scientists who work for them. So we find that scientists working within a definite structure are under more pressure to adhere to community ethical standards than those working in a less structured environment.

Incidentally, when I say corporate structure, I am also referring to people working in universities, research establishments — any environment in which there is a strong element of peer review.

Coming under the day-to-day scrutiny of one's peers, through any process of review, formal or informal, is a powerful deterrent to unethical behaviour.

Any *formal* process of ethical review will require a high degree of realism, combined with a genuine desire to arrive at a solution through cooperation and understanding. Such a happy combination is, unfortunately, largely a recent phenomenon. History is littered with examples of approaches to avoid.

Probably the most famous example of the conflict between science for science's sake, and the will of society, is the case of Galileo versus the Roman Catholic Church.

The controversy was clear: Galileo believed the sun was the centre of the solar system, and that the planets, including Earth, revolved around it. The Church held that the earth was the centre of the universe, and that the sun revolved around *it*.

Obviously, Galileo's teachings were at odds with community beliefs. As such, they were not tolerated.

In 1633, Galileo was tried by the Inquisition, forced to recant, sent to prison for a time, and finally released to spend the rest of his life in seclusion.

In the years that followed, Galileo was proven right. The church has long since stopped insisting that the sun revolves around the earth. And it can be argued that civilization suffered a great loss because Galileo's major work was curtailed in the name of the prevailing morality.

This example is 350 years old and as a controversy it may seem silly and unjust. But as historical precedent, it remains very relevant. The story of Galileo's conflict with the Church is still cited as a powerful argument in favour of the pursuit of science for the sake of pure knowledge, to be kept separate and immune to the changing pressures of religious and secular society.

For modern society, the example of Galileo holds lessons for those who would regulate science, but also for scientists themselves. The church may have been wrong to condemn him based on scientific fact, but it is also now recognized that Galileo, at that point, did not have complete scientific proof for his theory. Obtaining the final evidence fell to his successors. Both Galileo and his persecutors acted in haste — something we would do well to avoid.

For society, addressing ethical questions today, the case of Galileo is a good example of how *not* to seek solutions in ethical conflicts.

It was a situation in which those with power exercised it, with little or no cooperation and understanding, no recognition of their own biases or attempt to transcend them, and no realization of their responsibility to history, beyond their own beliefs.

But before you conclude that individual technologists should always be protected from interference by society, let me tell you about a story that appeared in the *New York Times* a few weeks ago. The headline reads "The Latest Frontier Of The Programmers Is All In Your Mind." It's about a young computer software specialist who is selling a program that supposedly allows computer owners to alter their own minds through subliminal messages and computer-induced hypnosis.

In his own case, he had his computer flash the message "Hunger is pleasure" on the computer screen for five minutes every day. He claimed that after four days be began losing his appetite and that he lost 10 pounds in a week.

Harmless, maybe — or even beneficial in some cases. But now, several software firms are offering similar programs for sale. Computer hackers today are a very ingenious bunch — and let's be honest, they tend to be short on scruples and long on mischief. The potential for abusing these programs is enormous.

The programmers themselves see the danger — Quote: "It's like a knife," the programmer said nervously..."It can be used, or abused."

Granted, in relative terms, the issue of subliminal messages is old, and pretty well discredited. It first made headlines in 1956 — almost 20 years ago. In those days, only a very few people had the power to flash subliminal messages, and so it was brought under control quickly and easily. Today, however, anyone with access to a computer and the price of the program — less than $100 — can be on his way to mind manipulation.

Clearly, this is an instance where the programmers themselves should seriously question the ethics of what they are doing.

Perhaps some are. But remember, we are dealing with a segment of technology where respect for even the law itself is notorious by its absence. This being the case, we can hardly expect to find much concern with ethics, which is a relatively grey area, particularly from the freelancers operating outside a strong professional base, and without meaningful corporate sanctions.

But perhaps this is not all their fault. The evidence suggests that society itself does not yet view computer crime with any great alarm — particularly when the victims are large, faceless corporations, and not individual people.

For instance, 2 or 3 months ago I saw an article about computer crime in the *Toronto Star*. It seems there was a journalist who did a feature story on computer hackers. They didn't like what he wrote about them, and they decided to get even using their computers. The journalist was a bit of a computer nut himself, so he found the harassment amusing, at first. He stopped laughing when they broke into his personal credit data and tried to spend a thousand dollars of his money. "It was fun," he said, "Until they got into my wallet."

Until computer criminals start to get into a lot *more* wallets — wallets belonging to people like you and me, rather than big corporations — then society will continue

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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. La cotisation annuelle est de $30.00 ($5.00 pour les étudiants).

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to view computer crime with a degree of tolerance and fascination that does nothing to discourage unethical behaviour.

As long as society secretly cheers for computer criminals, how can we expect the hackers to worry about the ethics of their conduct? The journalist I mentioned saw nothing particularly wrong until he faced a personal financial loss.Only *then* did it get serious. As a society, we will have to start taking it all seriously long before it gets to that stage if we expect the independent computer programmers and researchers to adhere to a code of ethics.

These examples — Galileo, and the freelance computer industry — are of people working largely on their own, not bound by constraints of either corporate discipline, or the discipline instilled by groups of their professional peers. They are also examples of *societies* unwilling to be morally serious about important issues.

Compare this, however, to the scientific labouring in the laboratories of business and industry, universities, and so on. There are dozens of ethical concerns facing any corporation doing business today, anywhere in the world.

A company with a branch in South Africa balances jobs that it provides for disenfranchised blacks, against being perceived as supporting apartheid. An electric power utility burning coal weighs the good to society from the electricity it provides against the environmental and health costs that are involved. An explosives manufacturer is concerned that its product be used for peaceful purposes, not terrorism. These are all ethical issues.

At the first Canadian Nuclear Association workshop on ethics in the nuclear industry, we found that some members didn't really understand the issues. Their attitude tended to be that they were "just doing business," — and it used to be that "just doing business" was good enough.

At the time of the industrial revolution, producing goods, providing jobs, and adding to economic growth were more than enough justification; pollution, health hazards, and other negative factors were not the concern of the people who were "just doing business".

That's not the case today. Not only will the public not stand for it, the company's employees themselves won't stand for it, and that includes the scientists and engineers doing the research and designing the products and processes.

Why? Because scientists and engineers don't exist in a vacuum, anymore than the company itself does. They are members of society and they share society's concerns. As these concerns change, so do the concerns of the people doing the research.

As professionals, we have a special responsibility to consider the implications of our work within an analytical framework, and we should not be content merely to reflect society. As people with greater access to knowledge, we have a responsibility to provide leadership in these areas. In other words, we should be even tougher on ourselves than society demands.

In the last 25 years, the public has become concerned about quality of life, about water and air pollution, about depletion of natural resources, and about renewing resources for future generations. These concerns are reflected in society's demands upon business and industry.

More and more, we see large corporations taking an explicit interest in corporate ethical values. Committees are being established to deal with questions of social responsibility.

As well as company directors and senior executives, these committees often include a new breed of company employee: the "professional ethicist". These people are just now coming into their own. Business and industry are serious about dealing explicitly with ethical questions today. One piece of evidence is the fact that more and more, ethics is being pinpointed as a growth area for jobs.

Not too long ago, I read an article that predicted the job market in the 21st century. It quoted an organization called National Career and Counselling Services in Washington, saying new careers that will open up in the near future include moon geologists, lunar miners, space pharmacists, genetic counsellors, *and professional ethicists.*

These ethicists would be employed by companies to be consulted on questions raised by scientific advances like genetic engineering, organ transplants, and so on.

It is not far-fetched at all to say that in future, in structured environments like corporations and universities, consideration of the ethical dimensions of scientific work will be accepted as a matter of course. Scientists and technologists will consult ethicists on the ethics of their work routinely, just as they have consulted marketing experts and production planners for years.

This will not come about because of some miraculous, revolutionary change in the psychological makeup of scientific practitioners. Rather, it will be part of an overall restructuring of the way we all do business.

Corporations have not arrived at the corporate values they have solely out of a sense of altruism. At the risk of being cynical, I believe they have adopted these values because society has demanded it. To go back to my earlier comments about "just doing business," paying greater attention to ethical conduct and social responsibility has become, in the late years of the 20th century, a price of doing business.

What has changed is not so much the scientific community, or the business community. Society itself has changed.

Corporations are adapting for the most powerful business reason of all: to stay in business. And the greatest pressure on corporate scientists to adhere to ethical standards will come from their business-minded employers, if those employers perceive that this is what the public wants.

In individual circumstances, scientists will continue to be faced with personal ethical decisions, outside of corporate ethics.

For instance, a researcher working for a big defence contractor might question whether he believes in everything his company does. I expect most would rationalize that the end use of their product will not be determined by themselves, or even by their company, but by a democratically elected government.

In the context of what we are discussing today, however, the rationalization in this case is not what matters; what really matters is the fact that the scientist questioned the ethics of his work in the first place. Recognition of the ethical content is an important step. The subsequent decision then depends on the individual's sense of right and wrong, in the context of the beliefs of the society in which he lives.

I turn now to the nuclear industry, and the question of whether its problems have been due to a lack of attention to society's ethical concerns.

As I mentioned earlier, I don't believe this to be the case.

On the contrary, the nuclear industry and the individuals involved with it have an admirable record of concern for ethics, going back to the birth of the technology in the 1930's. The nuclear industry today might even be said to provide a good model for other industries examining the ethics of their conduct and their social responsibilities.

Concerns about nuclear energy generally include safety, the effects of radiation on current and future generations, the production of radioactive wastes, and the creation of a complex nuclear dependency.

Of course, there *are* ethical dimensions to all of these subjects — dimensions of justice, of social responsibility, and of sustainability, for example. These are legitimate concerns which have been, and will continue to be, debated at length.

The issue I want to discuss is whether the nuclear industry has ignored these ethical concerns over the years, and I contend that it has *not* ignored them. It is important to establish this, because our critics are more likely to claim that we have been negligent in leaving ethics out of our considerations than they are to be morally serious about the issues themselves.

The civilian nuclear industry was born out of an ethical concern that the energy of the atom, developed for wartime use, should be turned to serve mankind in peacetime. Surely, it is not immoral or unethical to undertake such a challenge in the first place.

Let us acknowledge our science and engineering bias: our enthusiasm to gain the benefits from such a development naturally influences our determination that we can solve any problems along the way.

But, having acknowledged a bias of optimism, it can hardly be said that the industry proceeded irresponsibly. After all, the industry was, and is, made up of people who are members of society, members of churches, people with families, concerned

for their futures, — *people who would want to do what is wise and right.*
Government agencies, too, are filled with real people, who have real concerns for making wise decisions.
And so, industry and government set up elaborate mechanisms (some might say too elaborate) to protect the public interest. Has there ever been an industry which has invested so much in a search for the facts, to isolate the problems, to separate speculation from informed judgement?
This is part of a process of ethical reasoning and analysis. Whatever the failings of regulatory processes, they were put in place specifically *to balance the biases and arrive at ethical solutions* — a determination of what is wise and right in the circumstances.
What, then, of the public debate? How is it that the nuclear industry has been losing the support of the people who initially shared its vision of a future powered by nuclear fission? It is not because we were unwilling to address the issues, for we have done so at every opportunity from local service clubs to universities to the World Council of Churches.
Let me suggest that the falling out may be part of a larger picture in which engineers and scientists have addressed the social issues as we saw them, but have failed to appreciate the most fundamental concerns and anxieties of the public, it sees them — not necessarily rational as we define rationality, not necessarily articulate, but real concerns and anxieties nevertheless.
I know of no better technique to create an atmosphere of trust, than to take the time and make the effort to listen to an opponent's viewpoint, to question it, and to understand it. In fact, if we fail to make this effort, we may well find ourselves giving crystal clear answers to the wrong questions. We will do well to take time from our persuasive arguments to listen, and to understand. That is also part of ethical reasoning.
Ontario is by far the largest user of nuclear power in Canada. We've used it since 1962, and right now, more than one-third of our electricity is generated from uranium. We have 10 reactors producing electricity; eight more are under construction, and two originals are undergoing extensive mid-life renovations.
Our nuclear plants consistently perform with the best in the world; on the basis of lifetime capacity factors, we hold down five of the top ten places; in more than one million person-years of operating effort, our safety record is spotless. There has been no occupational fatality for any reason among our operation's employees.
Our electricity prices are among the lowest in the world, and we project that they will become relatively *more* competitive over the next decade as nuclear power assumes the dominant role in our power system.
The system we have is the result of a tremendous amount of work — in planning, design, manufacturing, construction, and in operation and maintenance. It represents a huge investment in both time and money.
Inevitably, such an undertaking produces a certain amount of social disruption. It spawns a degree of opposition, both political and public. So, we have been involved in a very persistent and minute examination of the need for the system, and the form it should take.
Over the last decade and a half, there have been two royal commissions, and several legislative committees examine aspects of Ontario Hydro's nuclear program. As well, it has been scrutinized in the course of normal government proceedings. Over this period, we have devoted an enormous amount of manpower, time, and money to giving testimony, preparing briefs, answering questions and generally supporting public participation in our decision-making.
Throughout all this scrutiny, the questions concerning nuclear power — the objections to nuclear power on moral grounds — have been, and are being, examined.
The consensus has been that nuclear power in its various aspects is "acceptably safe."
"Acceptably safe" is a direct quote from a legislative committee that studied Hydro's operations seven years ago. You may think that "acceptably safe" is pretty grudging praise, but coming from a committee that included politicians opposed to nuclear power, it is still praise, and not condemnation.
As you well know, nuclear power has also been the subject of intense debate in the media. Our opponents are very vocal and, in some cases, very convincing. And we have taken part in that debate as well.
To suggest the industry has ignored the ethical concerns of society, and that its economic troubles today are a result of that, is to suggest the industry exists in a fantasy world of its own, out of the control of government, and out of touch with the public. This is simply not so!
In this respect, the nuclear industry is no different than any other industry in today's society. It has contractors that produce various plant components. Those contractors have boards of directors, who are responsible to shareholders. The shareholders are members of the public. The company's employees, from its clerks to its welders to its president, are members of society.
It's hard to imagine a nuclear physicist, working in the industry, who can remain oblivious to both corporate pressure for acceptable behaviour, and to the pressure from his neighbours in conversations about nuclear energy over this backyard fence.
These is no question, over the past decade, that Ontario Hydro has become more and more sensitive to public concerns, and acutely aware of its social responsibilities in all of its operations.
I remember an incident that occurred awhile ago when we were holding hearings about the location of transmission towers between Lennox and Oshawa. I think it was in Napanee.
There were two farms, side by side, and the tower could have gone on either one. One farm was owned by a city man who ran it as a hobby. He didn't want the tower because it spoiled his view. His neighbour, on the other hand, did want the tower because he could use the compensation we pay.
The problem was, if we put the tower on the second farm it would interfere with a beaver who had built himself a dam, and our own environmental people at Hydro were concerned about the welfare of that beaver!
Well, Hydro's environmental biologists, the hobby farmer, and the working farmer debated that issue for weeks. And it could have gone on a lot longer, except that one day the working farmer called us up and reported that the beaver had suffered a premature, but most convenient, demise.
The hobbyist breathed a sigh of relief, the working farmer got his tower, and we were spared the necessity of making a decision that would have left everybody unhappy except the beaver.
When our new chairman took office last fall, one of the first things he said was that Ontario Hydro should be, and I quote, "a reflection of the public".
That's our objective, and we are not unique among either utilities or private corporations in the nuclear industry.
I believe that we are a fair reflection — an accurate "face in the mirror" of the Ontario public's concern for safety, morality, and ethical behaviour.
I agree with the employment experts in Washington: I think that the role of the professional ethicist in corporate planning *will* grow significantly over the next 40 or 50 years.
And while we will always have individual scientists and engineers whose behaviour is questionable, I believe that they, too, are an accurate "face in the mirror". Like those computer programmers I talked about: if society does not like the reflection it sees, then society has an equal responsibility to change the original.
S.G. Horton

FYI

Darlington Debate — Report and Comment

(J. Marczak, E. Hampton)

On 1985 February 13, the University of Guelph hosted a debate entitled: "Resolved that Construction of the Darlington Nuclear Power Plant be Halted." The debate was sponsored by the University Centre and the on-campus Ontario Public Interest Research Group (OPIRG). The affirmative position was taken by Mr. Paul McKay, author of "The Electric Empire — The Inside Story of Hydro," while the negative position

TECHNICAL SUPPLEMENT

CNS Bulletin March/April 1985 Canadian Nuclear Society

OPERATING EXPERIENCE WITH ONTARIO HYDRO'S IRRADIATED FUEL BAYS

Paper Presented at the International Workshop on Irradiated Fuel Storage — Operating Experience and Development Programs, Toronto, Ontario, October 17-18, 1984

C.R. Frost

Ontario Hydro

Abstract — *The characteristics of Ontario Hydro's fuel and at-reactor irradiated fuel storage water pools (or irradiated fuel bays) are described. With on-power fuelling of reactors, each reactor of >500 MW(e) net discharges an average of 10 or more irradiated fuel bundles to bay storage every full power day. The logistics of handling such large quantities of irradiated fuel bundles present a formidable challenge. The development of high density fuel storage containers and remote handling mechanisms and the use of several irradiated fuel bays at each reactor site have all contributed to the safe handling of the large quantities of irradiated fuel. Routine operation of the irradiated fuel bays over a period of more than 20 years and some unusual events in the bay operation are described.*

It is concluded that the operation of Ontario Hydro's irradiated fuel storage bays has been relatively trouble-free despite the large quantity of fuel involved, and wet storage provides safe, reliable storage of irradiated fuel. Evidence indicates that there will be no significant change in irradiated fuel integrity over a 50 year wet storage period.

INTRODUCTION

Ontario Hydro presently operates 13 CANDU-PHW* nuclear reactors with a total capacity of more than 7000 MW(e) net. Details of these and other Ontario Hydro reactor units being commissioned or under construction are given in Table 1. The CANDU-PHW units, which are fuelled at power, use natural UO_2 fuel. With on power fuelling, a typical four unit station discharges 40 to 50 irradiated fuel (IF) bundles during a full power day. Such large quantities of irradiated fuel bundles provide station operating staff with inherent challenges in dealing with irradiated fuel handling and management.

Based on the excellent Atomic Energy of Canada Limited (AECL) experience with waterpool storage of IF, dating from 1947 (Remington et al, 1983), Ontario Hydro has used water pools (or irradiated fuel bays as they are called in Ontario Hydro) for IF storage at all its reactor sites (Table 1).

The zirconium alloy clad natural uranium dioxide CANDU fuel has proven to be ideally suited for wet storage. The fuel bundles, (Figure 1), are about 50 cm long by about 10 cm in diameter and weigh about 25 kg each. At an average reactor discharge burnup of 650 GJ/kg U (180 MWh/kgU), the fuel contains about 0.22 percent ^{235}U and 0.38 percent total plutonium (0.28 percent fissile Pu), has a decay heat output of

* CANDU = Canadian Deuterium Uranium Reactor
PHW = Pressurized Heavy Water

Table 1 Ontario Hydro's Nuclear Generating Stations*

Station	Capacity/unit (MW(e) net)	No. of Units	In-Service Date First Unit	Last Unit
NPD	22	1	1962	-
Douglas Point	206	1	1968	-
Pickering A	515	4	1971	1973
Pickering B**	516	4	1983	1985
Bruce A	740	4	1977	1979
Bruce B***	784	4	1984	1991
Darlington****	881	4	1988	1992

* All units are CANDU, with a pressurized heavy water coolant (or CANDU PHW)

** Two units are in-service, the others are being commissioned

*** One unit is in-service, the others are being commissioned

**** All units are under construction

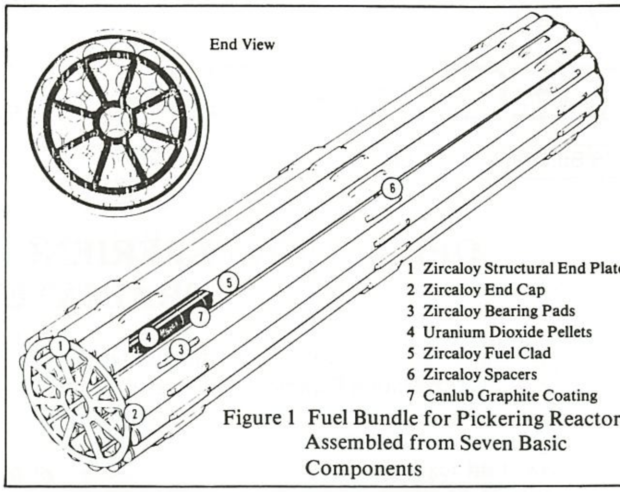


Figure 1 Fuel Bundle for Pickering Reactor Assembled from Seven Basic Components

less than 1 to 5 kW/bundle after one day's cooling, and will not go critical in light water storage regardless of storage density or age of the fuel. With these characteristics, the irradiated fuel bundles can be closely packed in simple storage containers stacked in the irradiated fuel bay (IFB) floor.

Ontario Hydro's irradiated fuel bays presently store over 300,000 bundles (Table 2). By the year 2000, this figure will increase by a factor of more than five.

This paper describes:

- The characteristics of CANDU irradiated fuel, and Ontario Hydro irradiated fuel bays (IFB's).
- The successful routine operation and performance of the IFB's, and how the logistics of handling the large numbers of fuel bundles involved have been successfully resolved.
- Some of the operating problems experienced.
- An on-going program to evaluate the long-term integrity of irradiated fuel in IFB storage.

CHARACTERISTICS OF ONTARIO HYDRO FUEL AND IRRADIATED FUEL BAYS

Fuel Characteristics

From the beginning of the Canadian nuclear program, the objective has been to develop power-reactor fuels that are reliable, inexpensive, and have low parasitic neutron absorption. To achieve this objective, the CANDU fuel design has been kept simple, as shown in Figure 1. Fabrication techniques are also simple, and, where possible, adapted from normal industrial practice. These techniques lend themselves to standardization and automation, thus minimizing the number of different fabrication processes.

Dimensions and other characteristics of Ontario Hydro's fuel are given in Table 3.

All Ontario Hydro fuel bundles fabricated since 1974 have a thin graphite layer (called Canlub) up to 20 μm thick on the inside surface of the zircaloy-4 clad. This Canlub layer, which reduces susceptibility to stress corrosion cracking on reactor power ramps, has led to a low in-reactor defect rate, (i.e. $\leqq$ 0.1 percent).

Table 2 Irradiated Fuel Quantities (In Thousand Bundles)

Nuclear Generating Station	Typical Annual IF Arisings	Bay	Inventory as of January 1, 1984
NPD	0.25	Primary	4.0
Douglas Point	1.6	Primary	19.6
Pickering A	12.5	Primary	71.4
		Auxiliary	82.4
Pickering B	14.0 (Projected)	Primary	12.7
Bruce A	23.0	Primary	12.7
		Auxiliary	113.5
Bruce B	23.5 (Projected)	Primary	0.0
		Auxiliary	0.0
Total	74.8	Total	305.5

Table 3 Characteristics of Ontario Hydro's Fuel Bundles

Reactor		NPD	Douglas Point	Pickering A	Pickering B	Bruce A	Bruce B	Darlington *
Number of Elements Per Bundle		19	19	28	28	37	37	37
ELEMENTS								
Material		ZIRC-4	ZIRC-4	ZIRC-4	ZIRC-4	ZIRC-4	ZIRC-4	ZIRC-4
Outside Diameter	mm	15.25	15.22	15.19	15.19	13.08	13.08	13.08
Min Cladding Thickness	mm	0.38	0.38	0.38	0.38	0.38	0.38	0.38
BUNDLES								
Length	mm	495.3	495.3	495.3	495.3	495.3	495.3	495.3
Maximum Diameter	mm	82.04	81.74	102.49	102.49	102.49	102.49	102.49
Avg Discharge Bundle Burnup	MWh/kgU	188	199	203	193	201	178	180

* First unit is scheduled to go in-service in 1988

ON-SITE IRRADIATED FUEL BAYS (IFB's)

General Description

Data on the type, liner material, size, fuel capacity and estimated fill date for the IFB's at Ontario Hydro's nuclear generating stations (NGS) are given in Table 4. The earliest stations, NPD* and Douglas Point*, had sufficient IFB storage capacity for the station life. The other stations (Pickering A, Pickering B, Bruce A and Bruce B) will need additional storage capacity beyond existing IFB's starting in the mid-1990's; Darlington will also need additional IF storage capacity in 1996. This paper will focus mainly on the Pickering and Bruce sites, as they alone account for over 90% of all irradiated fuel presently stored at Ontario Hydro's stations. The on-site IFBs are of two types:

1. Primary bays (PIFBs).
2. Auxiliary or secondary bays (AIFBs).

Irradiated fuel is discharged directly from Ontario Hydro's reactors to the primary irradiated fuel bays for initial storage and cooling. The primary IFBs consist of two compartments, separated by a hydraulically operated gate. The two compartments are:

1. The receiving bay to which IF is discharged from the reactor directly. In this bay the IF is stacked in storage containers (Figure 2), possibly inspected, and later transferred to the second storage compartment known as the storage bay. There are facilities for canning defected IF, if required.
2. The storage bay, where the IF is stored in stainless steel storage containers called baskets, trays or modules (Figure 2). The receiving and storage bays generally have separate cooling and purification systems.

* NPD and Douglas Point NGS are owned by AECL but operated by Ontario Hydro.

The basket is the container used to initially store irradiated fuel bundles in the Pickering A and Pickering B PIFB's. The tray is used to stack IF bundles in the Bruce A and Bruce B PIFB's (and the Bruce A AIFB). The module is a newer container designed to store the IF at about 1.5 times the storage density in the IFB compared to baskets i.e., 2189 kg U/m^3 (for the module) and 1393 kg U/m^3 (for the basket). The module not only provides for a higher storage density but has also been designed as an IF container for irradiated fuel transportation, which reduces double-handling of the bundles. Thus, all Pickering A and B IF bundles will eventually be transferred from baskets to module storage to optimize the IFB storage capacity.

The AIFBs, consisting of a single compartment, are very similar to the PIFBs in function and operation. They are designed to receive and store fuel after its initial cooling in PIFBs, and provide additional storage capacity as needed. The AIFB's also have provision for receiving IF transportation casks. Because of the reduced radioactivity of IF bundles when transferred to the AIFB's, the bundles need less water shielding. Thus in the AIFB's, the IF can be stacked closer to the water surface.

The IFB walls and floor are steel-reinforced concrete about two metres thick, and are either in-ground or above-ground structures. All inner IFB walls and floors are lined with either stainless steel or a fibre-glass-reinforced epoxy compound, to form a watertight liner.

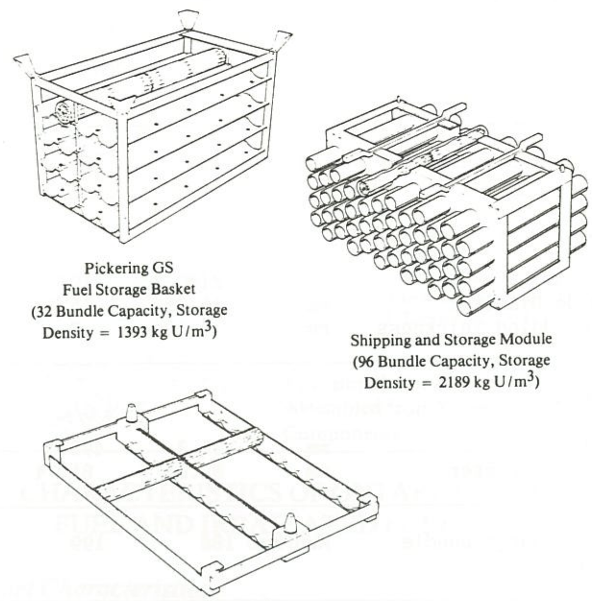
In all the bays, water is circulated through cooling and purification circuits, which are described below. Methods used to control water purity are a combination of ion exchange columns, filters and skimmers.

Ontario Hydro's IFB's use various liners and water purification systems. The choice of these components has been made on the basis of economics for the particular nuclear generating station concerned.

Cooling and Purification Systems

(a) Cooling

Cooling of bay water is achieved by tube and shell heat exchangers, with demineralized IFB water on the tube size and raw lake or river water on the shell side.



Pickering GS
Fuel Storage Basket
(32 Bundle Capacity, Storage Density = 1393 kg U/m^3)

Shipping and Storage Module
(96 Bundle Capacity, Storage Density = 2189 kg U/m^3)

Bruce GS
Irradiated Fuel Storage Tray
(20 Bundle Capacity, Storage Density = 1683 kg U/m^3)

Figure 2 Ontario Hydro Irradiated Fuel Storage Containers

Table 4 Irradiated Fuel Bays at Ontario Hydro's Nuclear Generating Stations

Station	Type	Dimensions** (m)	Capacity 000's of Bundles	In-Service Date	Bay Fill* Date	Liner Material
NPD	PIFB	4.3Wx7.3Lx5.5D	2	1962	**	All stainless steel (S/S)
Douglas Point****	PIFB(a) PIFB(b)	3.4Wx7.3Lx7.2D 7.6Wx20.9Lx7.2D	50	1966	****	All stainless steel (S/S)
Pickering A	PIFB***** AIFB	16.3Wx29.3Lx8.1D 17Wx34Lx8.1D	93 214	1972 1978	1994 1994	All epoxy All epoxy
Pickering B	PIFB	16.3Wx29.3Lx8.1D	158	1983	1995	Receiving bay - all S/S Storage bay, all epoxy
Bruce A	PIFB AIFB	10Wx41Lx6D 18Wx46Lx9D	21 352	1977 1979	1994 1994	S/S floor, epoxy walls S/S floor, epoxy walls
Bruce B	PIFB AIFB	10Wx46Lx6D 18Wx46Lx9D	36 330	1983 1987	2002 2002	S/S floor, epoxy walls S/S floor, epoxy walls
Darlington******	PIFB	(a) 9.65Wx20.6Lx5D (b) 17Wx32Lx9.2D (c) 17Wx4Lx9.2D	212	1987	1996	All S/S

* Based on combined capacity of all bays on-site.
** W = width, L = length, D = depth
*** Irradiated fuel is transported to AECL/CRNL for storage after six months cooling at NPD
**** PIFB consists of an IF receiving bay (a) and an IF storage bay (b). As unit was shut down in 1984, the PIFB will never fill.
***** Based on storage using baskets. Transfer of bundles to higher density module storage would increase the capacity and extend the bay fill date to the year 2000.
****** Darlington will have two identical PIFB's, the second (east) one will be in-service in 1991, with the fill date about 2000. Each PIFB consists of an IF receiving bay(a), an IF storage bay (b) and an IF cask handling bay (c).

Table 5 Irradiated Fuel Bay Purification System Capacity

Station	Bay	Purification Flowrate (L/s)	Purification Equipment
Pickering A	PIFB (receiving bay) PIFB (storage bay)	12.1 30.3	Ion exchange (IX) columns Ion exchange (IX) columns
Pickering A	AIFB	65	Filters, IX columns
Pickering B	PIFB (receiving bay) PIFB (storage bay)	63.7*	Filters, IX columns Filters, IX columns
Bruce A	PIFB (receiving bay) PIFB (storage bay)	75.6 37.8	IX columns IX columns
Bruce A	AIFB	37.8	IX columns
Bruce B	PIFB (receiving bay) (storage bay) AIFB	75.7 37.8 19	IX columns IX columns IX columns
Darlington	PIFB (receiving bay) PIFB (storage bay) (cask handling bay)	92 78 39	Filters, IX columns Filters, IX columns Filters, IX columns

* The purificaton system draws water from both the receiving bays and the storage bay together.

As the irradiated fuel in the AIFB's has been stored for at least three months in the PIFBs, the AIFB cooling system capacity is proportionally smaller than that needed for the PIFBs.

(b) Purification

All IFB purification systems are designed to remove suspended and dissolved solids (both of which may be radioactive). The IFB purification system components and flow capacity for Pickering A and B, Bruce A and B and Darlington are shown in Table 5.

In addition, water flows continuously through skimmers located at the water surface at intervals around the bay walls to remove any floating solids. Vacuum system type equipment is used at a frequency of once every 2 or more years to remove solids deposited on the bay floor and ledges.

The AIFB purification system capacity in general is proportionally less than that of the PIFB purification system, because any leaching of radioisotopes from clad crud and defected fuel is at a reduced rate.

Irradiated Fuel Bay Water Specificiations

(a) Chemical Specifications

Chemical control is maintained:

1. To minimize corrosion of metal surfaces, e.g. fuel clad, stainless steel bay liner, storage containers, stacking frames, and handling tools,
2. To minimize the level of radioisotopes in the water, and as a result reduce the radiation fields and radioiodine levels in the bay area, and
3. To maintain clarity of the bay water for ease of bay operation.

Table 6 IFB Chemical Control Specifications

Parameter	Specified Range (For NPD, Douglas Point, Bruce A,B)	(For Pickering A, B)
pH	5.5 to 8.0	5.9 to 9.0
Chloride	≤0.3 mg/kg*	≤1.0 mg/kg
Conductivity	≤0.2 mS/m or (2 μmho/cm)	≤1.0 mS/m (or 1.0 μmho/cm)

* No chloride specification for NPD and Douglas Point.

The water purity is maintained by using only demineralized make-up water and close chemistry control based on pH, conductivity and for the Pickering and Bruce bays, chloride concentration (specified values are quoted in Table 6).

(b) Temperature Specifications

The temperature of the bay water is maintained at ≦ 32°C.

The temperature specification has been selected to prevent excessive stresses in the bay walls which could eventually lead to cracking of the concrete. Such a bay water specification also provides comfortable working conditions (i.e. air temperature and humidity) for personnel in the IFB vicinity.

ROUTINE OPERATION

Background

The early operating experience gained at NPD and Douglas Point stations has provided a basis for the successful operation of the irradiated fuel bays at Pickering and Bruce sites. The early experience and the development of high density storage containers, interbay fuel transfers, and remote handling mechanisms have all contributed towards meeting the logistics challenge of handling large quantities of IF bundles in an economical and safe manner.

IRRADIATED FUEL HANDLING AND STORAGE

Primary Bay

The fuel arrives underwater at the receiving bay of the primary bay, in pairs by conveyor (Pickering Nuclear Generating Station-A or PNGS-A) or by a port (Bruce Nuclear Generating Station-A or BNGS-A) mounted with a discharge mechanism.

At PNGS-A, each pair of bundles is pushed via a ram into a basket. Once the basket is full, the bay gantry crane moves the basket to the storage area of the bay where it is stacked vertically on stacking frames (Figure 3) no more than six baskets high in order to maintain an effective water barrier for shielding. These stacking frames maintain a clearance of 45 cm between the bottom of the filled baskets and the floor to ensure that the flow of cooling water is uninterrupted and that the epoxy liner has adequate water shielding for radiation protection.

Baskets are loaded in a similar fashion in the PNGS-B primary bay. However, once the baskets are filled, the bundles are transferred from baskets to the higher density module containers. The modules are then placed onto a stacking frame six modules high.

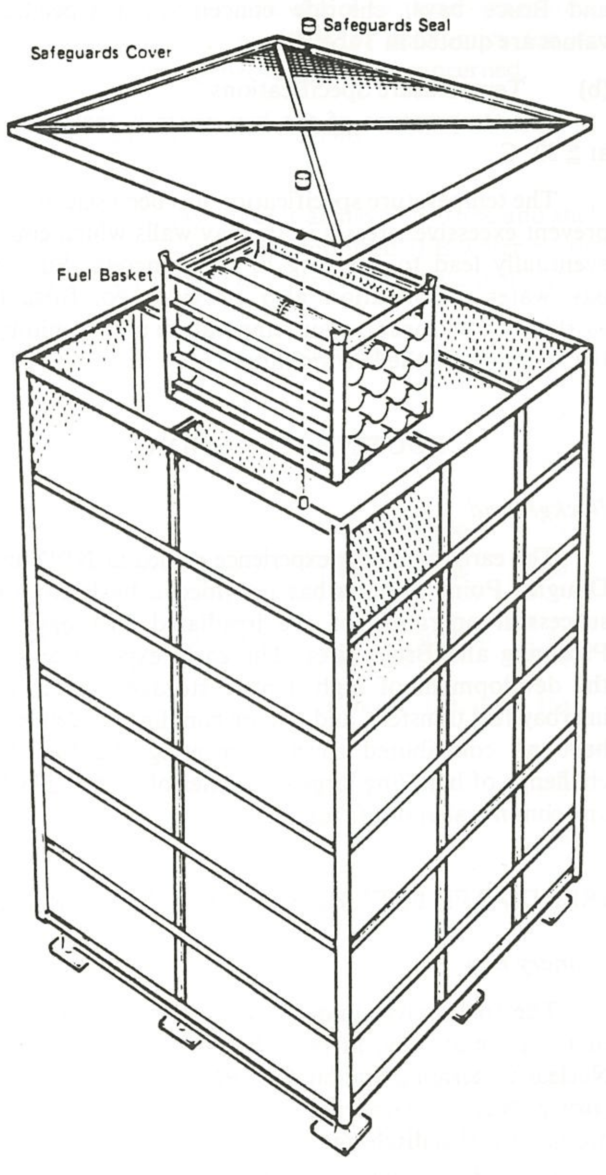


Figure 3 Pickering NGS-A Irradiated Fuel Stacking Frame

At BNGS-A, the discharge mechanism lowers each pair of bundles onto racks which are placed on an indexing mechanism located below the irradiated fuel discharge port. The crane operator transfers the bundles from the racks onto the storage trays. The full trays are then moved to the storage section of the bay where they are stacked 15 high.*

Irradiated Fuel Transfer to Auxiliary Bay

As previously stated, the auxiliary bay provides an interim storage facility to handle the irradiated fuel volume which is in excess of the capacity of the primary irradiated fuel bay. Figure 4 depicts diagrammatically the fuel handling/storage/transfer in the PNGS-A/B and BNGS-A bays.

The PNGS-A primary bay is connected to the auxiliary bay by an enclosed corridor. For each irradiated fuel transfer operation, eight baskets of at least 4-year old irradiated fuel are selected from the PNGS-A primary bay and loaded underwater into the on-site cask. The bundle age restriction ensures acceptable radiation fields from the on-site shipping cask during transfer operations. After washing down, the cask is loaded onto the transfer vehicle (Figure 5) and moved through the enclosed corridor (≈200 m distance) to the auxiliary bay. The maximum rate of travel for the transfer vehicle is 0.25 m/s. Once the cask is lowered into the auxiliary bay and unloaded, a basket-to-module transfer is carried out. The modules are then stacked seven high. PNGS-B does not have an auxiliary bay. Various options to provide additional storage space at the Pickering site are presently being evaluated.

At BNGS-A, the trays of irradiated fuel remain in the primary bay for a minimum of 3 months. Approximately every 4 months, roughly 300 trays are transferred to the auxiliary bay. Trays are transferred two at a time on a cart which travels through a water-filled tunnel connecting the two bays. The trays are then stored in stacking frames. A program is currently underway to increase the storage capacity of the auxiliary bay by approximately 3.5 station years arisings of fuel. This involves the installation of new stacking frames which allow for closer spacing coupled with higher stacks, i.e. 37 trays high compared with 32 trays high with the previous configuration.

* Because the stainless steel floor liner is more tolerant to radiation than an epoxy liner, a clearance of only 18 cm is maintained between the fuel trays and the floor at Bruce NGS.

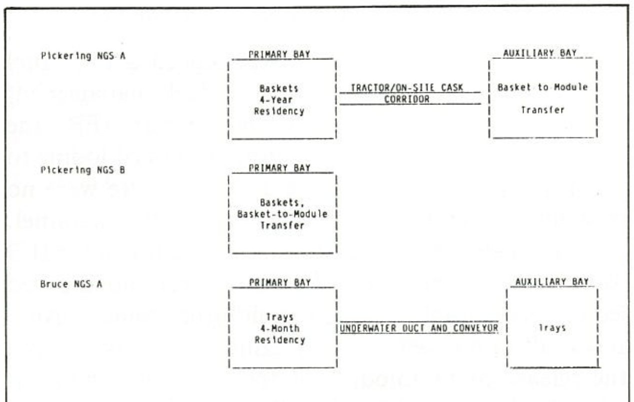


Figure 4 Fuel Handling/Storage

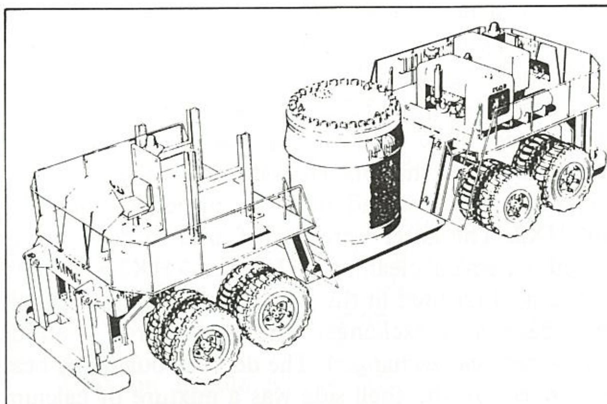


Figure 5 On-Site Flask Transfer Vehicle

Cooling and Purification

The normal operating temperature of the PNGS-A primary bay is 23 to 32° with two heat exchangers on-line. If the temperature exceeds the specified maximum value of 32°C, a third heat exchanger is valved in. Some fouling of the shell side of the Pickering and Bruce PIFB heat exchanger tubing has necessitated periodic chemical cleaning of the heat exchangers to restore their cooling capability. The frequency of cleaning is from one to five years. Details of the heat exchanger fouling problems and chemical cleaning procedures at both stations follow.

Good chemical control has been achieved in both PNGS-A and BNGS-A irradiated fuel bays. A survey covering the 1978 to 1982 period indicated that the pH, Cl^-, and conductivity levels have remained within specification most of the time, the only exception being a single conductivity measurement made in the PNGS-A PIFB which was 30% higher than specified. A high conductivity reading on the outlet of an ion exchange column indicates when the resin is spent. For the Pickering and Bruce PIFB's, this occurs about once per year.

With this close chemical control, the effect of bay water contamination on the long-term integrity of IF clad and other bay metal surfaces is considered to be insignificant.

Handling of Defected Irradiated Fuel

Since the CANLUB fuel design has been in use, (i.e. since 1974), the overall PNGS-A and BNGS-A IF defect rate has been low, i.e. <0.1% (a total of 221 bundles have defected). During early operation, the canning (i.e. the storing of a bundle in a sealed cylinder) of defected fuel was carried out. As more operating experience was gained, canning of defected fuel has become a contingency rather than a routine operation, due to the minimal release of fission products from most defected bundles.

At Bruce NGS-A, an on-power defect detection system serves to identify reactor fuel channels containing defected fuel. Once identified, fuel from such a channel is removed at the earliest possible date. Each bundle pair is pushed into the discharge mechanism and kept there while air from the mechanism cavity is purged past a gamma detector to identify the defect bundles. The suspect bundles are then transferred to a tray in the normal fashion. This tray is segregated from the rest of the irradiated fuel until the suspect bundles on it can be inspected. After inspection, all intact bundles are returned to normal storage. Defected bundles are stored in a special location in the bay and, depending upon the severity of the defect, some may be canned.

Pickering-A PIFB has IF canning facilities but with the excellent fuel performance, no IF bundles have been canned since 1974.

The plan for PNGS-B is not to send any known defected fuel to the IFB until the defected bundle has had 2 to 3 days to cool and allow fission products to decay while held temporarily in the fuel handling systems.

UNUSUAL EVENTS

Background

In light of the excellent overall performance of underwater IF storage, operational problems experienced at the IFB's have been minimal. Two unusual events which have occurred are described below.

Heat Exchanger Tube Fouling and Cleaning

(a) Pickering NGS-A

During the summer months of each year from 1975, it has been difficult to provide sufficient cooling of primary bay water to maintain the temperature in the 23°C to 32°C operating range, even with two heat exchangers, HX1 and HX2, on line. If the bay temperature exceeds 32°C on a regular basis, there is a risk of minor damage to the concrete walls. In 1979, a third heat exchanger was installed to allow inspection of HX1 and HX2. The latter were both found to be seriously fouled. Chemical cleaning of HX1 and HX2 with 10% formic acid resulted in the removal of 50 kg of deposit from each heat exchanger (the tubing area is about 365 m^2 per heat exchanger). The deposit fouling the heat exchangers on the shell side was a mixture of calcium carbonate, iron oxides and silica, with an approximate thickness of 1.5 mm. However, a post-cleaning inspection revealed that although the straight legs of the tube bundle were effectively cleaned, the U-bend region was not.

Formic acid cleaning was used again during 1981 and 1982 with similar results. Although most of the calcium carbonate was removed, silt and mud deposits still remained in the U-bend region. Laboratory tests to identify a more effective cleaning solvent resulted in a recommendation to use ammoniated citric acid solution. This method will be incorporated in the next heat exchanger cleaning operation.

(b) Bruce NGS-A

In late June 1980, the primary bay water temperature rose to approximately 37°C. With HX (heat exchanger) 2 and HX3 operating with maximum cooling water flow, HX1 was valved in to cool the PIFB back to below 32°C. Fibre optics inspection of the shell side (raw lake water) of HX3 showed the tube nest to be solidly blocked with deposits. The composition of the deposits consisted of calcium carbonate, iron oxide, and silica. HX1 was found to be similarly fouled.

In October 1980, HX3 and HX1 were chemically cleaned with inhibited 10% formic acid followed by a neutralizing solution. After cleaning, the tubes were visually inspected revealing that only a very thin deposit remained. Thus the cleaning method was successful. A total of 140 kg of calcium carbonate and 63 kg of iron compounds were removed from the two heat exchangers (the shell side tube area is about 555 m^2 per heat exchanger). The tube surface of HX2 was inspected and found to be clean.

Presently, there has been no further need to repeat the cleaning. However, a program to routinely monitor the cooling capability of the heat exchangers has been implemented.

Use of Hydrazine to Reduce Volatile Iodine Levels

During 1972, PNGS A experienced a high fuel defect rate caused by the initial fuel management scheme. Upon discharge to the primary IFB, the defected fuel released sufficient quantities of iodine to generate high airborne iodine activity. There were no incidents of high radiation exposure of personnel. Tests indicated that the addition of hyrazine to the IFB water reduced the oxidized forms of radioiodine and led to a significant reduction in airborne iodine activity. It was also observed that hydrazine effectively reduced the release of radioiodine under transient conditions when fresh defected fuel bundles were discharged into the bay.

Actual tests conducted in IFB water indicated that a decrease of airborne I-131 activity by a factor greater than seven was observed 15 minutes after hydrazine was added to the receiving bay (to give 125 mg/kg hydrazine) and to the storage bay water (to give 5 mg/kg hyrazine). It was also confirmed that hydrazine is not rapidly decomposed by atmospheric and dissolved oxygen at the temperature and chemical conditions in the bay water. It took about 48 hours for almost all the hydrazine in the bay water to be decomposed. Hydrazine also has an advantage over many other chemicals in that its main reaction with oxygen results in the formation of water and nitrogen which do not effect bay operation. To avoid eluting any ions from the IFB purification system ion exchange columns, the latter are valved out prior to hydrazine addition and not valved in until the hydrazine concentration falls to ≦1 mg/kg.

It has not been necessary to use hydrazine addition to the PNGS A PIFB since 1972 due to the excellent reliability of the irradiated fuel.

LONG-TERM IRRADIATED FUEL INTEGRITY IN WET STORAGE

Background

A key element in irradiated fuel management is to ensure the IF integrity during the various phases of its handling and management, including IFB storage. Thus, Ontario Hydro and AECL have a program (Hunt et al. 1981), initiated in 1977, to examine irradiated fuel stored in IFBs for possible deterioration.

Nineteen bundles from the Douglas Point, Pickering and NPD generating stations and the AECL Chalk River NRU prototype reactor are being examined. The oldest bundles have been in wet storage since 1962.

Seven destructive and non-destructive tests have been selected to characterize the elements initially and in subsequent re-examinations after further wet storage periods. The tests used to determine if there is any deterioration of either the uranium dioxide fuel (with defected cladding) or the Zircaloy cladding, are as follows:

1. Neutron radiography.
2. Fission gas analysis.
3. Hydrogen and deuterium analysis.
4. Ring tensile tests.
5. Visual examination.
6. Metallographic examination.
7. Torque tests.

Post-irradiation (i.e. from the time when they were first discharged from the reactor) data from such tests is available for many of the bundles for comparison with recent examination results.

The original re-examination period was every five years starting in 1978. However, since no IF deterioration was detected (Hunt et al, 1981), this period has been increased to ten years. The second set of re-examination tests is thus scheduled for 1988, and the final set for 1998. This will give results on any fuel deterioration in wet storage up to about 45 years. All seven of the tests described above will be repeated for each re-examination.

Results and Discussion

The results (Hunt et al, 1981) of the characterization tests and the first set of re-examination tests show no apparent irradiated fuel deterioration of either the uranium dioxide fuel matrix (for defected fuel) or Zircaloy cladding due to storage in IFB's for a time period up to 17 years. Based on results to date, irradiated fuel should maintain its integrity during fifty years of underwater IFB storage. With future characterization results, this predicted period may be extended.

CONCLUSIONS

Ontario Hydro has gained considerable experience in the design, construction and operation of irradiated fuel storage facilities. Water-filled bays at the reactor sites have been designed with capacitites ranging from about 700 Mg to 7,000 Mg of irradiated fuel. Auxiliary irradiated fuel bay storage facilities have also been constructed at the reactor sites. Irradiated fuel is being successfully transferred from the primary storage bays to these auxiliary bays of means of on-site flask/vehicle systems and conveyor systems.

A new irradiated fuel storage container, the module, has been designed to provide a higher density fuel bay storage. The module has also been designed as the irradiated fuel container for off-site transportation, thus minimizing fuel handling operations at the storage/transportation interface.

Routine operation over a period of more than 20 years of the Ontario Hydro-operated irradiated fuel bays has been relatively trouble-free, and the bays have provided safe, reliable interim storage of irradiated fuel bundles.

Tests on irradiated fuel after wet storage for periods up to 17 years indicate no fuel deterioration, whether it is defected (i.e. with a through-wall defect in the clad) or not. All evidence to date suggests there will be no significant change in irradiated fuel bundle integrity over a 50 year wet storage period, whether or not there are any fuel clad through-wall defects.

REFERENCES

1. Remington, J.A.; Oberth, R.C. and Hunt, C.E.L. (1983). "Twenty years experience in Canada with wet and dry storage of irradiated CANDU fuel". Paper presented at IAEA Int. Conf. on Radioactive Waste Management, Seattle, Washington (May 16-20, 1983).

2. Hunt, C.E.L.; Wood, J.C.; Surette, B.A. and Freire-Canosa, J. (1981). "Seventeen years of experience with storage of irradiated CANDU fuel under water". Paper presented at NACE Conference, Toronto, Canada.

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was defended by Dr. David Drinkwalter, Director of the Western Region of Ontario Hydro. The debate was moderated by Mr. Peter Kohl, Publisher of the Guelph Daily Mercury.

The debate centred primarily on the question of whether the electrical power from the Darlington Nuclear Generating Station, now under construction, will be required by Ontario consumers. Mr. McKay began the debate by stating that Darlington is "unaffordable, unnecessary, unsafe and bad for the economy." He suggested that with 50% over-capacity currently built into the system, a debt of over $20 billion, and a decreasing rate of demand for electricity, Ontario Hydro should instead put the $9 billion slated for Darlington into a 'Conservation Bank' to ensure that the electrical power from Darlington is never needed.

Dr. Drinkwalter corrected Mr. McKay, stating that the over-capacity on the Ontario Hydro system is only 11% (if unemployment was 5-6%, there would be no surplus), and that Darlington is needed for the 1990s, adding that the long lead times required for project completion necessitate that construction begins in the 1980s. Ontario Hydro expects growth in Ontario's electrical demand to increase by 2% per year into the 1990s, in spite of conservation efforts. The Department of Energy, Mines and Resources supports a figure of 4% per year.

Dr. Drinkwalter stated that Ontario Hydro believes nuclear power is the best option for meeting this increased demand for electricity, satisfying the dominant thrusts of Ontario's energy policy by fulfilling the requirements for a safe and economical, internally controlled, power production system. Consequently, in the 1990s Ontario Hydro expects to be 65-70% nuclear.

In response to the issue of the growing Ontario Hydro debt, Dr. Drinkwalter asserted that the utility's debt is growing only because Ontario Hydro is building for the future. Revenues meet current operating costs, and if Ontario Hydro was not expanding, the debt would be paid off in 20 years.

Although the debaters focussed on issues of growth and conservation, most of the questions from the audience dealt with environmental issues. Several members of the audience felt threatened by the dangers of nuclear power and wondered why Ontario Hydro had not, instead, invested more heavily in 'safe' wind and solar technology. While Dr. Drinkwalter proceeded to outline Ontario Hydro's alternative energy program, he neglected to detail the safety problems associated with wind and solar power, which make these forms of energy considerably more dangerous than nuclear power when the entire power production cycle is considered.

Mr. McKay expounded only very briefly on the regular anti-nuclear subject fare — accidents, wastes, radiation, etc. — and efforts by these reporters to set Mr. McKay's comments in the correct perspective were greeted by heckles from certain members of the audience, who at the end of the debate began chanting "No More Darlington."

The vote at the start of the debate indicated that 62% of the approximately 30 people in the audience supported the resolution to halt construction of Darlington. The vote at the end of the debate brought that figure up to 69%.

The debate did provide an opportunity to hear some of the anti-nuclear arguments from people opposed to nuclear power. Apart from the emotionalism, it was evident that economic issues are becoming a focal point in the nuclear debate. This could provide the opportunity for which the nuclear industry has been waiting. Armed with figures to support the economical, inflation-proof nature of nuclear power in Canada, there will be much less room for emotional anti-nuclear rhetoric in the debate.

Finally, we must continue in our efforts to educate the public about nuclear power and to put the dangers into proper perspective. When account is taken of all activities involved in the power production cycle, solar power is 60 times more dangerous than nuclear power, and wind power is twice as dangerous as solar. Yet, these facts remain unknown to the large majority of Canadians.

It is our responsibility to keep abreast of the facts and to continue our role in educating the public — not as distributors of CANDU propaganda, but as sincere citizens, knowledgeable in the technical aspects of nuclear power, with a genuine concern for the continued strength and growth of our country.

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- H. Bonin, Associate Editor, *CNS Bulletin*, c/o R.M.C., Dept. of Chem. & Chem. Eng., Kingston, Ontario, K7L 2W3.
- The *CNS Bulletin*, c/o the CNS office.
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Pour soumettre des articles originaux, de lettres, des nouvelles, des revues, des appels aux communications, etc., veuillez bien entrer en contact avec l'une des personnes suivantes:

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SLOWPOKE Operator Required (Queen's University)

Queen's University requires a Senior Operator for a SLOWPOKE-2 facility. The candidate, with on-the-job training, must be able to fulfill the operator licensing requirements of the Atomic Energy Control Board of Canada and become proficient in neutron activation analysis.

Duties will include operation and maintainance of the facility, scheduling of use, maintenance of records, supervision of research and interaction with the university and college staff and the general public. Familiarity with microcomputers for record keeping and data evaluation would be an asset.

The typical candidate would have as a minimum a B.Sc. or M.Sc. in chemistry, physics or engineering. The facility is located on the campus of the Royal Military College of Canada and the candidate must be able to satisfy the hiring requirements of both Queen's University and the Royal Military College of Canada. The initial appointment will be for one year.

Letters of application stating relevant experience and the names of 2 referees should be sent to: Professor V.H. Smith, Jr.; Head, Department of Chemistry; Queen's University; Kingston, Ontario; K7L 3N6.

In accordance with Canadian Immigration requirements, this ad is directed to Canadian citizens or landed immigrants. Candidates of either sex are equally encouraged to apply.

Carbon-14 Dust Found at Pickering (Staff)

Fine Carbon-14 dust found while retubing Pickering-1 has slowed Ontario Hydro's pressure tube replacement operations. The radioactive dust was released during removal of the tubes and resulted in some contamination of workers, however the doses have so far been found to be below regulatory limits. New monitors and new work procedures are expected to cope with the problem, however a solution is being sought on the best method to confine the dust, which is in the micron size range and easily passes through most vacuum filters. The Carbon-14 was formed by neutron activation of the nitrogen gas which insulates the exteriors of the pressure tubes.

AECL and Romania Sign Marketing Agreement (Staff)

Atomic Energy of Canada Ltd. and the Romanian Nuclear State Committee have signed an agreement for cooperation in developing markets for CANDU reactors in eastern European countries, in which any new contracts would likely be supplied by Canada and Romania. The agreement was finalized during the recent visit of Romanian President Nicolae Ceausescu to Canada.

AECL Strike Settled (Staff)

In late April, Atomic Energy of Canada Ltd. settled a partial strike by members of the Society of Professional Engineers and Associates in Mississauga, Ontario which was begun in March over wage demands and job security. About 100 nuclear engineers and scientists had been called out on the selective strike. The strike had little effect on AECL design work for the Darlington construction project and on the retubing of two units at the Pickering Nuclear Generating Station.

CAN-DECON IGA Problems Overcome (London Nuclear)

A solution has been demonstrated to avoid the intergranular attack (IGA) on highly sensitized stainless steel following exposure to CAN-DECON decontamination reagents. Maintaining the concentration of ferric ions in the decontaminating solution above about 50 ppm prevents attack on sensitized welds. The concentration of ferric ion required to be effective depends on the degree of sensitization of the steel. Material encountered in actual reactor systems is usually less highly sensitized than the laboratory samples on which most of the testing has been peformed.

A recent announcement by London Nuclear said they were temporarily limiting the application of CAN-DECON until this IGA problem had been overcome. The effectiveness of the ferric ion to inhibit IGA has been successfully demonstrated in several types of test, including the constant extension rate tensile (CERT) test that led to the original problems with CAN-DECON. Armed with these new results, London Nuclear is now lifting the self-imposed restrictions on application of the process.

CNS News

Year End Report from the CNS President

I am pleased to give you a report on the many and varied activities carried out by your Society during the Council's year from June 1984 to June 1985. Many people have given generously of their time in order to make this year's program a success. On your behalf I thank them all.

Objectives Early in the program year the Council and I sat down and in proper management style developed a set of objectives to guide us for the year. The 19 objectives covered all aspects of the operation from membership to public awareness of the nuclear program. Some specific objectives are:

- Target for 600 members in August 1985.
- Make a decision on the CNS Journal.
- Achieve international recognition for excellence of technical program.
- Start one new branch.

In this report you will find that we have met the majority of these objectives.

Conferences Two international conferences were held in the year. Bill Morison of Ontario Hydro, as Conference Chairman, and Nabila Yousef as Program Chairperson, ably assisted by many others organized the International Conference on Containment Design. Over 100 attended, many from overseas.

The Robotics in the Nuclear Industry Conference attracted some 150 and received good reviews in *Nuclear Engineering International* and *Nuclear News*. Bill Durant of the Ontario Robotics Centre was Conference Chairman and Hugh Irvine of Ontario Hydro the Program Chairman. Together these two conferences produced substantial revenue and established the society as a credible organizer of world-class events.

The successful Student Conference was held in April. It was organized by Glen Pringle, Chairman and Greg Evans, Vice Chairman who are to be complimented for their organization. This was followed by the Simulation Symposium in Kingston, organized by Hugues Bonin. This annual event continues to attract and provide a forum for analytical aspects of nuclear technology.

The CNS year culminates in the Sixth Annual Conference, June 2 to 4, in Ottawa where Peter French and his committee organized the largest CNS Annual Conference ever held.

The Program Committee under Nabila Yousef has arranged for Canadian participation in the Third International Conference on Nuclear Technology Transfer in Madrid, Spain, to be held later this year. Tom Carter, John Hewitt and Nabila Yousef have attended organizational meetings over the past year in that country as representatives from North America.

Outreach Apart from conferences organized by the society, several other events of interest occured. As previously reported, your executive participated in the IPPANI interfaith church hearings on nuclear issues, held in November. A splendid brief written by John Hewitt and Fred Boyd was presented as one of the first depositions to the first week of the hearings. This brief, coupled with a suggestion by your President that the $100,000 spent on the hearings could probably be better spent on other initiatives by the churches, set a tone for the hearings. The hearings failed to provide a media platform that the antinuclear special interest church groups and the strident "public interest" groups obviously expected. Instead it gave many of us in various nuclear fields the opportunity to reflect on the moral and ethical issues involved.

At my invitation, carried personally by Prof. Archie Harms of McMaster University, the President of the Chinese Nuclear Society and three senior members were our guests in November. During their week-long visit our two societies signed an Agreement of Cooperation. The document was signed by John Hewitt on my behalf as I was out of the country at that time. Joe Howieson, Phil Ross-Ross, our International Delegate and Jim Weller attended the ceremony at the University of Toronto together with other Councillors. The Council was host to the CNA directors and other guests on the occasion of the signing. The visit has already proved fruitful; Joe Howieson represents the society in Beijing in May when the CNA will sign a similar agreement with the Chinese Nuclear Society.

Your society continues to be active in international events. Phil Ross-Ross and I attended a regular meeting of the International Nuclear Societies Group in Washington last November. Phil is a leader within the group, and has acted as overall Chairman at their Vancouver meeting in 1983. The CNS has, and is, playing a role out of all proportion to size in international affairs thanks to leadership, our proactive stance, and the dedication of our members. This has recently brought about the appointment of Dr. Dan Meneley as a representative from Canada to the IAEA International Nuclear Safety Advisory Group.

Our relations with the ANS continue to grow; I invited Joe Hendrie, ANS President, to the 1984 Containment Design Conference, which he accepted, and he was Chairman of one of the sessions. Jon Stouky, ANS Program Chairman, sits on the Program Committee; this forms a valuable link between the two societies.

Branches Numerous events have taken place at branch meetings in Ottawa, Chalk River and Toronto. The Quebec branch is moribund due to a major shift of many members to Gentilly. Meetings in the Winnipeg branch continue to be dogged by the distance to Whiteshell, which makes an evening meeting difficult. However that branch is most active in arranging the 1986 Waste Management Conference, Chaired by Eva Rosinger. On your behalf I addressed a dinner meeting of the New Brunswick branch-in-formation in Fredericton last January. It is expected that a branch will be formed there shortly.

As part of the liason with branches, a CNS Officers Seminar was organized last September by Ernie Card, Chairman of Branch Affairs. This attracted 24 members and proved a useful meeting for all concerned.

Membership, Finances and Secretariat Gerry Lynch, Membership Chairman, resigned last fall due to personal reasons. Richard Bolton took on the post and is involved in attracting new members. John Boulton, Treasurer, is in an enviable position this year as he has the pleasant task of reporting a surplus of over $35,000. At the end of 1984 Ric Bonalumi, Secretary, suffered a tragic illness. We wish him success in his recovery. The CNS office continues to provide valuable services, and we thank Jean, Shirley and Diane for their continued help and assistance.

Communications The *CNS Bulletin* continues to flourish under the Communication Committee chaired by Fred Boyd, and by David Mosey our indefatigable editor, Hugues Bonin, associate editor and David McArthur our production editor. In the Jan./Feb. issue the first technical supplement appeared. This is a credit to the editors and the authors, George Field, John Dunn and Brian Cheadle.

After a report commissioned from Alan Wyatt, much discussion and a mini-conference in Kingston, a motion has been passed by the Council in April to proceed with detailed planning of a "Nuclear Journal of Canada." This long-planned event will likely materialize in 1986. I trust it has the support of members. I further hope you will write papers to continue to make it happen.

Outlook Many varied events are planned for the near future. There will be several meetings and one major international conference on waste management which will be held in Winnipeg. A topical meeting with the ANS is planned for 1987.

In many ways the nuclear industry in Canada is a victim of its own success. In 40 years one of the world's most successful power systems has been developed: CANDU. In that same period incredible advances have been made in nuclear medicine, extending the life span of this population by thousands of "people-years": innumerable other benefits have occured. Yet for all this, the average Canadian, when polled, is either not knowledgeable about nuclear topics, or worse, associates them with nuclear weapons. Clearly one of the most important, long-term tasks we face is to deliver a balanced message to change the public's attitude from indifference and ignorance to understanding and enlightenment.

On this philosophical note I close my year-end report to you. I have enjoyed being your President. I set out to make the year exciting and fun; I know it has been for me; I hope you can say the same.

Peter Stevens-Guille
CNS President

Conferences & Meetings

CNS 6th Annual Conference

To be held **June 2-4, 1985** in Ottawa, Ontario, in parallel with the Canadian Nuclear Association's 25th Annual International Conference. For information contact: **P.M. French, c/o Atomic Energy Control Board, P.O. Box 1046, Ottawa, ON K1P 5S9.**

7th International Conference on Zirconium in the Nuclear Industry

Sponsored by the American Society for Testing and Materials, to be held **June 24-27, 1985** in Strasbourg, France. For information contact: **R.B. Adamson, General Electric Co., Box 460, Pleasanton, CA 94566.**

11th International Conference on Numerical Simulation of Plasmas

Sponsored by Varennes Tokamak Group, to be held **June 25-27, 1985** in Montreal, Quebec. For information contact: **M. Shoucri, IREQ — Institut de recherche d'Hydro Quebec, 1800 montee Ste-Julie, Varennes, Quebec, J0L 2P0.**

International Nuclear Reactor Decommissioning Planning Conference

Sponsored by U.S. Nuclear Regulatory Commission, to be held **July 16-18, 1985** in Bethesda, Maryland. For information contact: **B.L. Baumann, UNC Nuclear Industries, P.O. Box 490, Richland, WA 99352.**

International Topical Meeting on Computer Applications for Nuclear Power Plant Operation and Control

Sponsored by ANS, cosponsored by CNS and ENS, to be held **September 8-12, 1985** in Pasco, Washington. For information contact: **Lino Magagna, Ontario Hydro, 700 University Ave., Toronto, ON M5G 1X6.**

International Topical Meeting on High-Level Nuclear Waste Disposal

Sponsored by ANS, cosponsored by CNS, to be held **September 24-26, 1985** in Pasço, Washington. For information contact: **Dr. H.C. Burkholder, Battelle Pacific Northwest Laboratory, P.O. Box 999, Richland, WA 99352.**

3rd International Conference on Nuclear Technology Transfer (INCONTT-III)

Sponsored by Spanish Nuclear Society, ENS and ANS, to be held **October 14-19, 1985** in Madrid, Spain. For information contact: **Spanish Nuclear Society, Estebanez Calderon 5, 3 E, 28020 Madrid, Spain.**

3rd Workshop on Analytical Chemistry Related to Canada's Nuclear Industry

Sponsored by CNS, CNA, Chemical Institute of Canada, AECL, et al., to be held **October 20-23, 1985** in Kimberley, Ontario. For information contact: **Dr. A. Guest, Ontario Hydro, A7 A11, 700 University Ave., Toronto, Ontario, M5G 1X6.**

International ANS/ENS Topical Meeting on Thermal Reactor Safety — Call for Papers

Sponsored by the American Nuclear Society Nuclear Reactor Safety Division and the ANS San Diego and Los Angeles sections; cosponsored by the Canadian Nuclear Society, the European Nuclear Society, the Japanese Atomic Energy Society, and the Korean Nuclear Society; to be held **February 2-6, 1986**, in San Diego, California. Papers are sought on all current topics relating to thermal reactor safety issues and to safety-related design and licensing developments, including safety research and future needs, design implications of safety research results and licensing developments, probabilistic safety, reactor design concepts with enhanced safety, external events, operational safety, and safety matters of particular interest to utilities. Deadline for submittal of four copies of 1000-word summary: **August 1, 1985.** Author notification: **September 25, 1985.** Deadline for camera-ready full-length papers: **December 6, 1985.** Summaries should be submitted to **David Okrent, University of California at Los Angeles, 5532 Boelter Hall, Los Angeles, Calif. 90024;** (213) 825-3259.

Topical Meeting on Advances in Fuel Management — Call for Papers

Sponsored by the ANS Fuel Cycle and Waste Management Division and Reactor Physics Division, Canadian Nuclear Society

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Conseil de la SNC et responsables locaux 1984-85

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- **Design & Materials / *Conception et matériaux***
  Nabila Yousef (416) 592-5983
- **Mining, Manufacturing & Operations / *Exploitation minière, fabrication, exploitation des centrales***
  Ken Talbot (416) 839-1151
- **Waste Management and Environmental Affairs / *Gestion des déchets radioactifs et environnement***
  Eva Rosinger (204) 753-2311

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Jan-G. Charuk (514) 871-1116

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CNS General Manager and CNA Liaison / *Directeur-général de la SNC et agent de liaison de l'ANC*
Jim Weller (416) 977-6152

CNS Branch Chairmen / *Responsables locaux de la SNC*

Chalk River	Ian Crocker	(613) 687-5581
Quebec	**Contact/Responsable**	(514) 871-1116 x504
Ottawa	Frank McDonnell	(613) 236-6444
Toronto	Rudi Abel	(416) 823-9040
Manitoba	Ernie Card	(204) 956-0980

CNS 1985 Annual Conference Chairman / *Président de la conférence annuelle de la SNC (1985)*
Peter French (613) 996-2810

and Electric Power Research Institute, and hosted by ANS Eastern Carolinas Section, to be held **March 2-5, 1986** in Pinehurst Hotel and Country Club, Pinehurst, N.C. Papers are being sought in the following areas as applicable to nuclear fuel management: automated and interactive design analysis tools, development and validation of design analysis methods, applications of micro and mini computers, impact of cost and schedule uncertainties and the backend of the fuel cycle on decisions, utility experience in reload design and licensing, practical constraints on decisions, cycle length and design flexibility, fuel performance optimization with on-line monitoring systems, innovative core loading strategies, physics and economics of advanced fuel and burnable poison designs, and advanced reactor systems' core designs. Deadline for submission of three copies of 900-word summary: **August 1, 1985.** Author notification: **September 1, 1985.** Full-paper deadline: **December 1, 1985.** Submit summary to **Paul J. Turinsky, Department of Nuclear Engineering, P.O. Box 7909, North Carolina State University, Raleigh, NC 27695-7909**; (919) 737-2301. CNS contact: Dr. G.M. Frescura, (416) 592-3134.

Topical Meeting on Nuclear Power Plant Maintenance — Call for Papers

Sponsored by the Idaho Section of the ANS and co-sponsored by the ANS Reactor Operations Division, Remote Systems Technology Division, Power Division, Human Factors Technical Group, Canadian Nuclear Society, European Nuclear Society, Atomic Energy Society of Japan and the Taiwan Section of ANS, to be held **March 23-27, 1986** in Little America, Salt Lake City, Utah. The purpose of the meeting is to compile a complete assessment of state-of-the-art maintenance and maintenance support technologies. Papers are invited on: maintenance success in availability trends; major maintenance projects; maintenance economics and management — including outage planning, scheduling techniques, staffing, training, and qualification; regulatory aspects of nuclear plant maintenance; use of computers in maintenance; plant system status monitoring; maintenance data storage, retrievability and analysis; computer controlled tools; diagnostic and non-destructive evaluations; inspection; human factors; and spare parts procurement and management. Deadline for 1,000-word summary (for review only): **July 26, 1985.** Author notification: **September 30, 1985.** Send four copies of summary to **Technical Program Committee Chairman, R. Jon Stouky, Westinghouse-Power Cutting Inc., One Energy Drive, P.O. Box 3000, Lake Bluff, Illinois 60044** (312) 680-8100. Please advise R.J. Stouky or Debu Majumdar, DOE-Idaho, (208) 526-1805 as soon as possible, of your intention to present a paper. For further information, call General Chairman Wayne K. Lehto, Argonne National Laboratory, P.O. Box 2528, Idaho Falls, ID 83401, (208) 526-7369, FTS 583-7369. Note: CNS members interested in this meeting should call the CNS contact: Ken Talbot, Pickering NGS, (416) 839-1151.

The Unfashionable Side

Down The Tubes

A new proposal from Dr. Dennis Molestrangler, RMS Professor of Plausible Energy Studies at Aphasia University, promises to have a profound impact on long-term planning to meet electricity demands. Dr. Molestrangler points out that in large office buildings much electrical energy is expended in running lifts which, on the way down at least, are merely duplicating an extraordinarily effective and reliable system — the law of gravity. In an energy conscious era, Dr. Molestrangler argues, such duplication is inexcusable. What is more, the potential energy available from the movement of overweight senior executives from their top storey offices to ground level could well be profitably harnessed.

The resulting concept — the Molestrangler Electromechanical Vertical Personnel Energy Conversion System (MEVPECS) — eliminates costly and inefficient lifts replacing them with a 3 ft diameter, vertically oriented coil. Users are issued with 20 lb waistcoats incorporating suitably oriented bar magnets ("magnejackets") which they don before entering the coil or tube. Their vertical movement down the tube under the influence of gravity induces an EMF in the coil under the ineluctable laws of electromagnetic induction. A simple calculation shows that a 150 lb executive (a very conservative estimate) wearing a 20 lb magnejacket will generate approximately 4.6 kW(e) during a descent of 200 ft. Dr. Molestrangler notes that careful load management will be required to ensure that the rate of descent remains tolerable.

On the basis of the above figures, Dr. Molestrangler calculates that the Toronto head office of a well-known publicly-owned electrical utility could make a significant contribution to meeting peak load requirements. A side benefit of this arrangement would be the increasing health and physical fitness of office workers constrained to climb stairs (carrying their 20 lb magnejackets) to their offices. However, during off-peak hours the MEVPEC System could be operated in reverse, wafting office workers upwards.

Development of MEVPECS is as yet at an early stage, but Dr. Molestrangler remains confident that his proposal for a "proof of principle" installation at Toronto's CN Tower will receive enthusiastic support from federal and provincial government agencies.

Ernest Worthing