CANADIAN NUCLEAR SOCIETY

Bulletin

DE LA SOCIÉTÉ NUCLÉAIRE CANADIENNE

Fall / L'automne 1991 Vol. 12, No. 3

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The major article in this issue is the interesting proposal by Herb Inhaber for the siting of a waste disposal facility. Some readers may recall Dr. Inhaber's seminal paper on comparative risks of energy production when he was with the Atomic Energy Control Board in the late 1970's.

Another fascinating item is Duke Segel's account of the views of a resident of Kiev of the 1986 accident at Chernobyl, which provides us with a valuable insight into the feelings of those affected by such an event.

For those unable to hear Don Anderson's comments to the Toronto Branch on Ontario Hydro's nuclear activities our reprint should be required reading.

There is a comprehensive review of the CNS Annual Conference by co-chairman Al Wight and a brief report on the recent CNA/CNS Fusion Seminar.

A "Miscellany" section has been added. Let us know how you feel about the type of articles included.

Cover photo

The photograph on the cover is an aerial view of the Underground Research Laboratory located near AECL's Whiteshell Laboratory.

(Photo courtesy of AECL Whiteshell)

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ISSN 0714-7074

The *Bulletin of the Canadian Nuclear Society* is published by the Canadian Nuclear Society; 144 Front Street West, Suite 725; Toronto, Ontario; Canada; M5J 2L7. (Telephone (416) 977-7620; Telex 06-23741; Fax 979-8356).

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 is $55.00 annually, $30.00 to retirees, $20.00 to 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. La cotisation annuelle est de 55.00 $, 30.00 $ pour les retraités, et 20.00 $ pour les étudiants.

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Printed by Heritage Publications, Peterborough, Ont.

Nuclear Phaseout

Over the past year there has emerged in Canada a movement for the "phaseout" of nuclear power plants.

The Nuclear Phaseout campaign is an effort to widen support for the groups who have traditionally made the nuclear industry their primary target. It is a movement to get hundreds of societies, clubs, unions, parties and churches to join them in endorsing a Nuclear Phaseout.

Spearheading a Nuclear Phaseout is a Private Member's Bill in the House of Commons. While these bills seldom become law, the campaign will likely continue, and the more groups that endorse the Nuclear Phaseout, the more popular it will seem to politicians in the future.

The Nuclear Phaseout is presented by proponents as a responsible course, taking place over such a long period that it will not disrupt living standards or eliminate jobs. Proponents argue that it will be natural because we will soon conserve so much energy we will not need reactors.

The movement spreads as the fervent opponents of nuclear power (for whatever reason) promote the Phaseout in other organizations to which they belong. These broader-interest groups may not necessarily have a consuming interest in matters nuclear, but can be easily persuaded to take what is put to them as a prudent action.

Such has recently been the case in the Anglican Church of Canada, where its national Public and Social Responsibility Unit recommended to its Program Committee that the church endorse the Nuclear Phaseout. Later, a motion to endorse the phaseout may come to the church's national governing body. This could occur with almost no input from the average church member, and certainly very little from the thousands of workers in the nuclear industry who are Anglicans. Anglicans who are prominent members of the nuclear industry have made a start on talking to the church's various committees. A similar situation no doubt exists for other churches, or groups that you belong to.

By the time a motion for Nuclear Phaseout reaches the governing body of an organization there is little time to do more than hold a debate, confuse the decision maker whom, when in doubt, will likely support what is sold as a prudent course of action. Years of heated debate have shown that it is almost futile.

As one member of the Anglican Church's Program Committee said, "I think both sides are sincere, both are telling the truth, but I'm not sure both are telling all the truth."

The only way for members of the nuclear industry to be accepted as credible is to engage in a dialogue with the public. If you are an Anglican and wish to offer your experience in the nuclear industry to the dialogue, take the initiative. Call or write to national synod representatives, your bishop or your clergy and open the dialogue so that a broad and informed discussion takes place long before a Nuclear Phaseout becomes a motion at one of the policy-making levels.

If you are aware of a similar situation in other churches, unions, etc., take the same approach. But please remember, a dialogue is a two-way process; and we scientists and engineers must be prepared to listen as much as we are prepared to preach.

Andrew Stirling

Background

Although Andrew Stirling's guest editorial can stand on its own, some background will, we believe, provide readers with some further appreciation of the problem he addresses.

Last spring an article appeared in the *Anglican Journal*, the national newspaper of the Anglican Church of Canada, which argued for the church to take a stand against nuclear power and against the James Bay 2 development. That article came from the national Public Social Responsibility Unit (committee) of the church which had discussed the issues at its semi-annual meeting in January.

Several active Anglicans with involvement or background in nuclear technology decided to pursue the topic, initially by correspondence. These included Andrew Stirling (General Manager of AECL Accelerators), Jim Weller (formerly of the CNA), Eric Perryman (retired director from AECL Research) and Stan Hatcher (President of AECL). Others of us became peripherally involved.

Initially little resulted from the correspondence with the chair-person of the PSRU, Ms Lynn McDonald. However, the National Executive Council of the Anglican Church asked the PSRU to meet with representatives of the nuclear community. That meeting took place in September, with the above four attending. Dr. Ursula Franklin, professor emerita of the University of Toronto, was invited to present the anti-nuclear view.

Almost immediately after the meeting the PSRU issued a communiqué re-affirming its earlier call for the Anglican Church of Canada to endorse the campaign for nuclear phaseout.

In mid-October Stan Hatcher and Andrew Stirling met with the national Program Committee of the Anglican Church at which Ms McDonald and Dr. Hatcher each had ten minutes to present their positions. At the time of writing the conclusion of that committee is unknown.

Fred Boyd

Programme d'échange d'étudiants et de jeunes professionnels

Déscription du programme

Sous l'égide conjointe de la Société nucléaire canadienne et de la Société française d'énergie nucléaire, le programme d'échange d'étudiants et de jeunes professionels vise à rendre possible des stages de recherche pour les membres de chacune des Sociétés dans le pays de l'autre Société. Ces stages permettront aux participants d'acquérir non seulement des connaissances et des techniques du pays-hôte, mais aussi d'échanger des points de vue et du savoir-faire en science et en génie nucléaires, tout en créant des liens personnels entre les participants. Ce programme d'échange est possible grâce à une entente convenue et signée en Septembre 1989 entre la Société française d'énergie nucléaire et la Société nucléaire canadienne.

Procédure

À la réception d'une demande de stage d'un candidat, la Société nucléaire du candidat passera le dossier à l'autre Société nucléaire qui établira les contacts nécessaires avec les établissements appropriés ou avec les compagnies où un stage est possible dans le domaine d'intérêt.

Une fois que l'on aura choisi l'établissement et une équipe de recherche pour le stage, les deux Sociétés fourniront de l'aide pour satisfaire aux besoins administratifs, comme par exemple, des conseils sur la marche à suivre pour obtenir les visas et les permis de travail nécessaires. Toutes les questions sur les aspects de confidentialité et de secret industriel restent la responsabilité de l'institution-hôte et des candidats. Ni la SFEN, ni la SNC, ne pourront être tenues responsables des conséquences dans le cas où les candidats ne peuvent satisfaire aux exigences de sécurité.

Une fois les arrangements définitifs sont complétés, les Sociétés nucléaires paieront les frais de voyages raisonnables des candidats entre leur domicile et le lieu de leur stage.

Durée

Les stages dureront normalement de trois mois à une année. Des durées plus courtes ne sont pas encouragées, mais des termes plus longs sont possibles. Les démarches visant à faire accréditer le travail de recherche pour les besoins d'une Maîtrise ou d'un Doctorat sont la seule responsabilité des candidats et de leur université. La propriété des résultats et des découvertes effectuées lors des stages devra faire l'objet d'une entente écrite entre les candidats et l'institution-hôte. La SFEN et la SNC ne seront tenues responsables d'aucun manquement à ces ententes.

Demande

Les étudiants de niveau universitaire et les scientifiques et ingénieurs au début de leur carrière peuvent poser leur candidature pour un stage en soumettant, par écrit, les renseignements décrits ci-bas et en fournissant les noms de leurs superviseurs immédiats et les noms du directeur du département (dans le cas des étudiants) ou du directeur de la Division ou section (dans le cas des jeunes professionnels). Dans les deux cas, un rélevé des notes universitaires est requis avec la demande de stage.

Sélection des candidats

Les demandes seront examinées sur une base de mérite par un Comité ad-hoc de trois membres nommés par le Conseil de la SNC (pour les Canadiens). (La SFEN doit avoir déjà sa procédure de sélection pour les candidats français.) Comme les occasions et les ressources financières vont limiter le nombre de stages, le nombre de candidats choisis sera forcément faible les premières années du programme. Toutes les décisions du Comité seront sans appel, mais un candidat à qui l'on aura dû refuser un stage pourra faire une nouvelle demande l'année suivante.

Renseignements requis pour la demande de stage

- Noms et adresses au complet (domicile et au travail)
- Numéros de téléphone (et fax)
- Lieu de naissance, citoyenneté
- Diplômes
- Expérience de travail (technique)
- Domaine de recherche préféré pour le stage
- Centres de recherche préférés pour le stage
- Notes académiques
- Référence #1
- Référence #2

Dates importantes

- Date limite pour soumettre les demandes de stage: **31 janvier 1992.**
- Annonce des stages: **15 mai 1992.**

Adresses pour envoyer les applications

Société nucléaire canadienne
(Programme d'échange SNC-SFEN)
Kathy Murphy
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France

Téléphone: (1) 45.67.07.70
Télécopieur: (1) 40.65.92.29
Télex: SEE 200 565 F

There is a Solution to Siting Nuclear Wastes

Herbert Inhaber*

Abstract

The story of siting nuclear wastes in Canada and most other countries has been a tale of controversy, with little actual emplacement being accomplished. It has been widely believed that few, if any communities would accept waste and other noxious facilities. This paper presents a possible solution to the problem of developing such sites. It attempts to generate a volunteer community with retaining appropriate environmental and safety guidelines and criteria. The reverse Dutch auction may produce an exit from the seemingly endless cycle of disputes, apparent resolution and a renewal of confrontation.

Introduction

Ever since the onset of the nuclear age in 1945, radioactive wastes in large quantities have been generated. However, there has been considerable difficulty in finding permanent storage or disposal sites for these wastes. Generally speaking, the process of finding sites works smoothly administratively and scientifically until a specific town, county or province is chosen. Then considerable opposition usually arises.

The opposition can take the form of heated "public information" meetings – sometimes described as "the last of the blood sports." Petitions are circulated, elected representatives propose bills, and various lawsuits are threatened or actually filed. All of this is characteristic of what has been called NIMBY – Not In My Back Yard.

Nuclear Waste Riots

In some cases, the confrontation can lead to violence. In western New York, what may have been the first nuclear waste riot took place in April, 1990.[1] Dozens of protesters fought with police who were attempting to escort members of a low-level radioactive waste siting commission onto prospective sites. Although many were arrested, the feeling in the community was such that none of them were indicted by the grand jury.

An even larger confrontation took place in the Republic of Korea in November, 1990.[2] During the protest on Anmyon Island, a police station was burned to the ground, 73 were arrested, and 22 injured. A report said that 10,000 had taken part in the protest. The island had been considered as the site for low- and intermediate-level waste. About 3,000 riot police were on the scene, undoubtedly the largest number ever to patrol a nuclear waste site conflict.

Politically, the demonstration brought about the firing of the Korean Minister of Science and Technology, Chung Kun Mo, and the cancellation of the plans for a facility at the site.

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It has seemed to many that there is no way out of the cycle of confrontation, withdrawal of plans, followed by new plans and yet more disputes. (The Korean episode was a continuation of the 1989 plans, when a proposal for a disposal site near the Ulchin reactor was dropped after protests by local residents). Radioactive wastes have become a type of Flying Dutchman, doomed forever to roam without finding a home.

Is There a Way Out?

There may be a way out of the problem, a solution that draws on normal human behaviour. It does not require greater regulation, yet does not discard existing regulation. The overall concept is called the Facility Acceptance System (FAS). It includes a reverse Dutch auction for generating a volunteer community along with other elements based on incentives and cooperation.

The reverse Dutch auction sounds like an exotic concept, but almost everyone who has flown commercially has taken part in one. From time to time, airlines overbook, i.e., sell more seats on a flight than are available. If there is one extra seat that has been sold, then someone has to be induced to leave, and take the next flight.

A Reverse Dutch Auction on an Airplane

Airlines have a quick and equitable solution to the problem they have created. It is never labelled as a reverse Dutch auction, although technically it is one. First, passengers are asked to deplane voluntarily. This sometimes happens. This would be analagous to a siting agency asking for volunteers to accept wastes. This has been known to take place, although with such rarity that no siting agency can depend on its occurrence. Obviously, no auction has or will take place if a volunteer comes forward.

If there is no volunteer, then the auction begins. A steward will say, "Will anyone take $50 to leave? $100? A free trip to Tucson?" The offer will continue to rise until a volunteer comes forward.

To outside observers, the process may appear unremarkable. But that is only because it works smoothly and with no argument. Yet volunteers suffer a true detriment. They leave a flight they were planning to take.

Principles of the Reverse Dutch Auction

Why does the system work so effortlessly that it is hardly even noticed? First, it depends on volunteers alone. There never is any implied threat that someone will be forcibly removed from the aircraft. Second, there is a *dynamic* incentive to come forward. The system would not work if, for example, the steward offered a fixed bonus and then tried

to cajole passengers into accepting it. Third, because of the nature of the auction system, there is something lacking which is often assumed to be necessary to a siting system – negotiation. That is, the steward does not negotiate with each of the passengers to decide who shall deplane. In an auction, each person negotiates with himself, deciding if the bonus is adequate for the inconvenience produced.

The system may not appear to have any relationship to the present system for finding sites for noxious materials. The latter system is marked by acrimony and difficulty in finding sites. The former is smooth, and completed before many of the passengers even notice that one of them has volunteered to leave.

The principles of the airline system, technically called a "reverse Dutch auction," can be applied to finding waste sites.[3] At first glance, the two cases appear quite dissimilar. Communities slated for a waste facility regard the risks, real or perceived, as great. As noted above, they are sometimes willing to riot against the site. The volunteer passenger who deplanes regards his or her loss of time as of little consequence.

But this comes about primarily because of the volunteer nature of the airline deplaning system. If one of the passengers was selected by an "objective" system, he or she would probably say that the detriment of being forced to take the next flight was large. In that sense, the objections would be analogous to those voiced by targeted waste communities.

Applying the Auction to Finding Waste Sites

How can the apparently successful airline deplaning system be applied to finding sites for hazardous wastes? To do thus, some definitions are in order.

The standard, Saturday-morning, auction is known technically as an English auction. It has a rising price, and more than one bid. Since we generally want only one site at a time, this disqualifies it from consideration.

The Dutch auction, apparently first devised in Holland, runs the opposite way from the English auction. It starts at a higher level, which then drops. When a bidder makes a bid, the auction is over. The Dutch auction then has the advantage, in the present context, of only one bid.

The two auctions described above deal with *positive* objects. But wastes are never thought of in this way. Thus if wastes are to be subject to any auction process, the auction must run the *reverse* way. Thus to find a site for wastes, or have an airline passenger deplane voluntarily, we use a reverse Dutch auction.

Is the airline example a reverse Dutch auction? The bonus rises, as in this type of auction. There is only one bid, again corresponding to this variety of auction. Thus the airline example is a true reverse Dutch auction. (Readers may have noted that, in principle, one could obtain more than one volunteer with this system. For simplicity, that option will not be explored).

If the present system for finding waste sites were working well, with communities coming forward on a regular basis, there would be no need for a reverse Dutch auction or any other system. But few observers would contend that the present system functions adequately. As a result, new approaches are necessary.

Risk Analysis in an Auction System

Will the introduction of a reverse Dutch auction reduce the required level of risk and hazards analysis? It will not. As will be illustrated below, no diminution of environmental standards is required for the success of the system.

What will be different with the reverse Dutch auction is that risk analysts – and by that term I refer to all the scientists and engineers who participate in site characterization and other scientific activities – will be listened to by citizens. At present, agencies like the Atomic Energy Control Board and Atomic Energy of Canada Limited spend considerable effort on risk analysis and related fields. However, their conclusions on the size of risks are often rejected by citizens of affected communities. This appears dramatically in the public meetings referred to above, but is also reflected in polls and other surveys. One recent survey in the U.S. showed that most people thought that nuclear energy would be the energy source of the future, but very few would accept a nearby reactor.

Interest in Risk Analysis

Yet these same citizens listen carefully to other scientific advice, such as in medical areas. Can the reverse Dutch auction raise the level of interest of citizens in risk analysis, or are we condemned to the often raucous scenes at public information meetings?

The level of interest will rise along with the bonus. When the bonus is small, there will probably be little change from the disinterested or even hostile attitude of many citizens. But as the bonus increases, that attitude will gradually change in a number of communities (not all). Since citizens in those communities will be seriously considering whether they should make a bid, they will carefully investigate the true risks of the facility, not merely those which are conjectured. They will have a great incentive to do so, since if they make a bid they will have to live with those risks.

Of course, evaluation of the true risks – as far as we can estimate them – does not guarantee that citizens of a given community will make a bid. They may perform the investigation and then not decide to bid. But the level of disclosure on risk will be on a much calmer level than now.

How the System Would Work

How would a reverse Dutch auction work? The system is shown in Figures 1 and 2. There are three stages in all. The first stage takes place when the siting authority lists the environmental and safety requirements for the site, and asks for volunteers. This corresponds to the initial stage in the airline case, when the steward asks for volunteers. There are no regulations in the latter case, but the detriment – taking the next flight – is clear.

It is unlikely that a community will come forward in the initial stage. If it did, and met environmental requirements, the problem would be over. This has happened from time to time. Allegany County, the site of the radioactive waste riot mentioned above, volunteered for a new penitentiary.[4] However, siting authorities cannot count on this happening frequently.

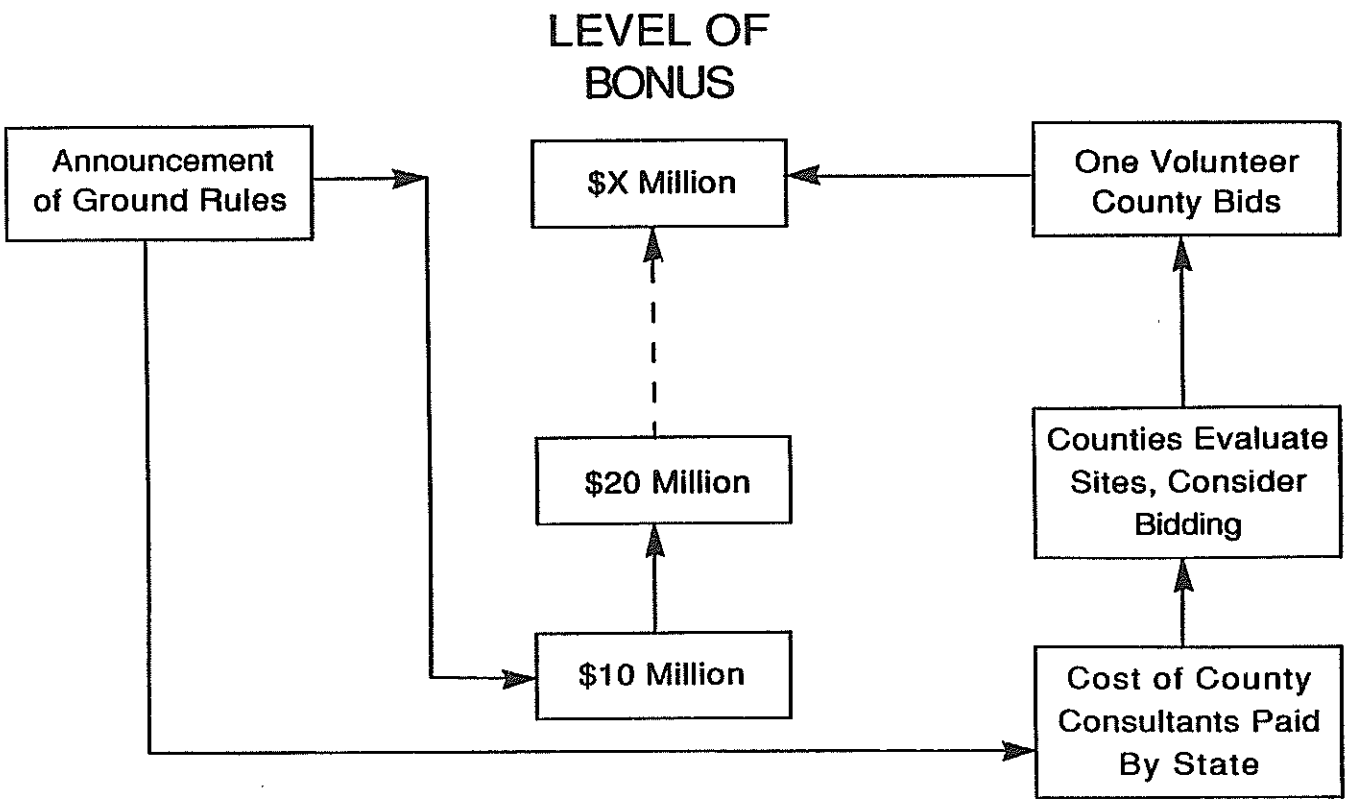


Figure 1: Pre-bid steps in the reverse Dutch auction for noxious facilities.
The process starts with an announcement of the environmental rules and criteria. After each community (identified as counties in the figure) evaluates these regulations, the auction begins. The pace is set by the siting authority. As the bonus rises, a volunteer community will bid.

The Second Stage

In the second stage, the auction begins. The bonus level, at a pace set by the siting authority. Arbitrary values are shown in Figure 1; others may be substituted. Since most communities have little technical expertise, they will have the opportunity to hire consultants at no cost to them, to evaluate specific sites on a preliminary basis. Of course, hiring consultants does not obligate them to bid.

As well, the consultants will not be hired to prove a negative, i.e., that a community is unsuitable for wastes. A community not interested in having the facility need take no specific action to bring about that result. The day of the pseudoscientific proof of unsuitability will be over.

The True Social Cost

The bonus level will continue to rise, until a community makes a bid. The level of the bonus at that stage will be the *true social cost* of the facility. This is the price that the rest of us have to pay to avoid having the site in *our* back yard. Although attempts have been made by sociologists and economists to estimate this social cost from polling and other data, the reverse Dutch auction is the only method by which it can be accurately determined.

While most analysts of the siting system have advocated that compensation be paid to host communities, there never has been an accpeted system for determining its level. The reverse Dutch auction sets the level without outside intervention, because in effect the bidding community sets it for itself.

The Third Stage

It is possible that a volunteer community proposes an inadequate site, although the ability to hire consultants should decrease the chances of this happening. This then leads to the third stage, the evaluation, shown in Figure 2. Prior to the evaluation, most of the bonus – perhaps two-thirds – is placed in a trust fund to be temporarily controlled by both the volunteer and the siting authority. This will produce confidence on the part of the citizens that the bonus really exists. Otherwise, they would be dependent on the vagaries of a legislative appropriation process.

The evaluation process is similar to that undertaken by the Atomic Energy Control Board and provincial environmental agencies. None of them ever chose a site for unwanted facilities; they merely ensured that the pre-agreed criteria were met.

The Community Receives the Bonus

Assuming that the site passes the tests, the bonus is turned over to the volunteer community, for any lawful purpose it wishes. In the past, various strings were put on proposed compensation packages – X% was to be spent on roads, Y% on schools, etc. This tended to accentuate the targeted community's feeling of helplessness, already in existence from the targeting process. In the reverse Dutch auction, the community will have complete control over its funds.

Local Control

The problem is not over at this stage. Much thought has

been devoted by theorists about how much control the local community should have over a facility once it is constructed. Generally speaking while local citizens may be appointed to advisory boards in certain cases, the host community is rarely if ever given the legal right to shut down the facility or order a major repairs or data collection.

An example of this is in the proposed repository in Yucca Mountain in Nevada. The Nuclear Waste Policy Act, as amended, makes no provision for any substantive degree of control by Nevada if the facility is built.

The Facility Acceptance System

The Facility Acceptance System (FAS), of which the reverse Dutch auction is a part, changes centralized control to a mutual process, in which there is a system of checks and balances between a host community and the site operator. First consider the reason why local control is rarely, if ever, offered by a siting authority. Under the present system, communities often feel they have been coerced into accepting a facility. As a result, siting authorities believe, with some justification, that if local control were exercised, citizens would shut down the facility under some pretext. Then all the work that had gone into the site would be lost, and the process would have to start over again.

The balance is reversed under the FAS. It begins by having a community accept a waste facility, rather than have it thrust upon them. That fact alone will make the community less willing to shut it down. They will have weighed the pros and cons of the facility beforehand, and voluntarily come to a decision to accept it.

An Existing Facility is More Acceptable

As well, the fact that a facility has been built makes most more tolerant of it. For example, there have been about a dozen referenda in the U.S. on the fate of existing nuclear power plants. With one exception, that of the Rancho Seco, California, reactor, all votes have been to keep the plants operating. This result has come about in spite of some evidence that citizens in the states holding referenda would have been hesitant about a *new* reactor being built near them.

The Community can Control Its Own Information

Citizens of a proposed waste site often do not exhibit much trust towards regulatory agencies. This is often reflected in demands for data that these agencies are either unwilling or unable to supply. When a community thinks that the data supplied to it is inadequate, it again accentuates its feelings of helplessness.

The reverse Dutch auction also changes this aspect of siting. Part of the bonus can be devoted to environmental monitoring and safety studies by the community itself. They will not have to rely on any other authority. How much should they spend? That will be up to the citizens. Some communities may trust the site operator, and spend little on their own scientists and engineers. Others may be more

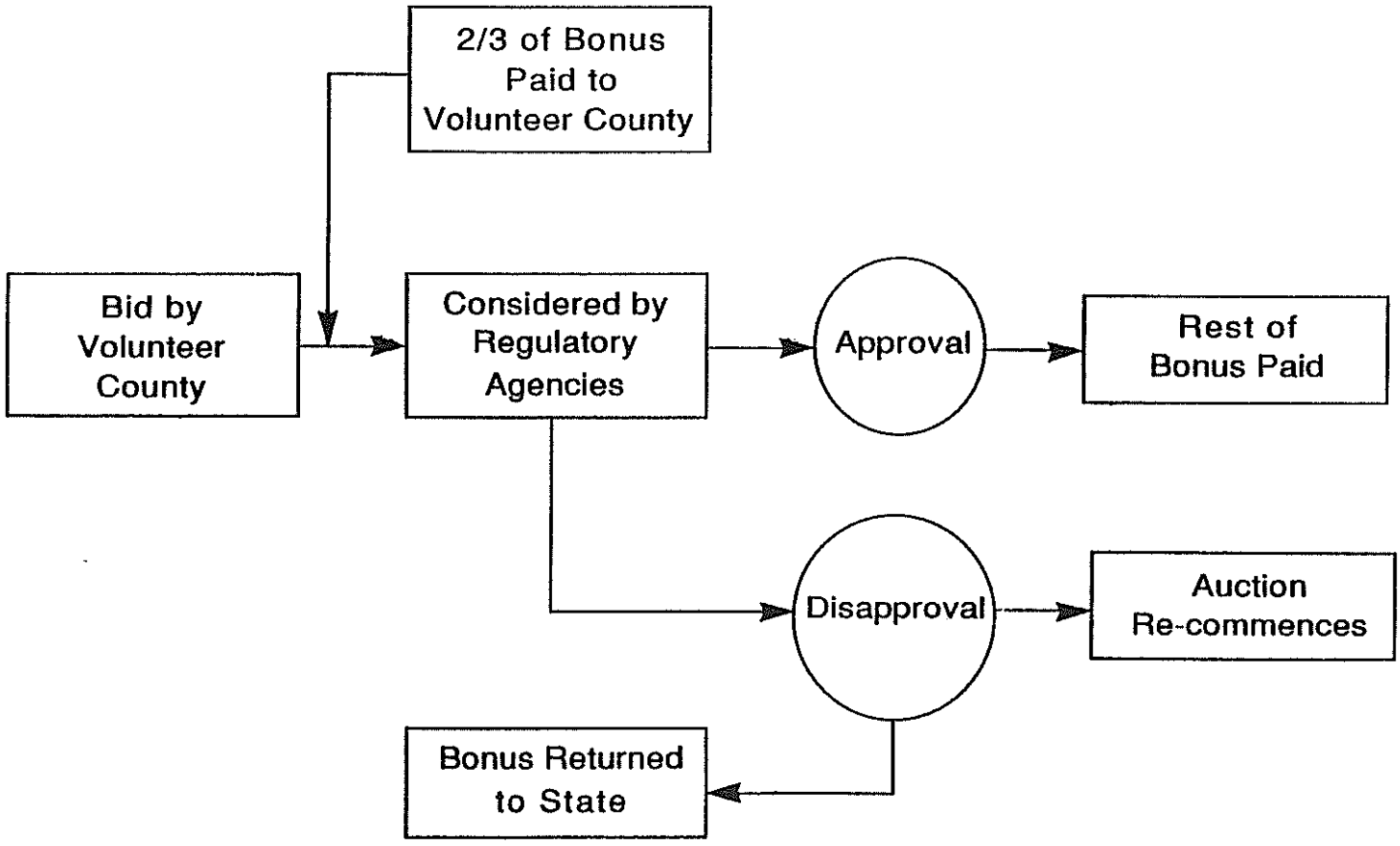


Figure 2: Post-bid steps.
After the bid is made, it must still gain environmental approval. Most of the bonus is transferred to a temporary trust fund until the decision on environmental suitability is made. If disapproval occurs, the auction begins again, at the bonus level previously achieved.

suspicious, and allocate more. The choice will be up to them.

The power of the purse-strings is the power to control. This maxim is applicable to waste siting as well as to other functions of government.

Reversing a Decision

The examples discussed above indicate that with the reverse Dutch auction, there will be considerable incentive to build a waste facility and to keep it running. However, it is not beyond the realm of possibility that, some years after the facility is completed, a candidate for office will advocate its closure. How does the reverse Dutch auction cope with that situation?

Before discussing this, consider the present system. If a community has an existing facility, there is usually little or no cost in advocating its closure. A few jobs may disappear, but waste facilities are generally not noted for an abundance of employment.

Repaying the Bonus

Under the reverse Dutch auction, the bonus must be returned by the community if the facility is closed. This policy is in accordance with ethical principles, in which money must be returned if a service – in this case, accepting wastes – is not supplied. The rule is also consistent with standard contract law.

If a community must raise the funds to repay the bonus, it, as well as candidates for office, will think carefully before taking a precipitous step. There will be a substantial cost to the community if it does not decide to advocate the closure of the facility.

After a facility is built, most differences of opinion between a community and a site operator will be intermediate in magnitude between advocacy of shut-down and nonchalance. How should these intermediate situations be handled?

The Facility Oversight Board

The FAS proposes a board, similar to public utility commissions, that would have ultimate control over the facility. These commissions, used to set electricity rates in many parts of the world, have proved a useful tool for public policy for about seven decades. They can be used as a model for administration of the waste facility.

The Facility Oversight Board (FOB) would strike a compromise between the concerns of the community and those of the site operator. It would be made up of appointees of the premier and possibly legislature, much as public utility commissions are appointed today. There would be representatives of the local community, the site operator, technical personnel, and others.

Balancing Local and Societal Needs

The FOB would meet the concerns of both the site operator and the community. The operator may be concerned that if the community has final shut-down power, it could take that step in a two-minute vote, thus wiping out the work of years. The community may think that if the site operator has the final say on the system, any valid complaints it has will be ignored.

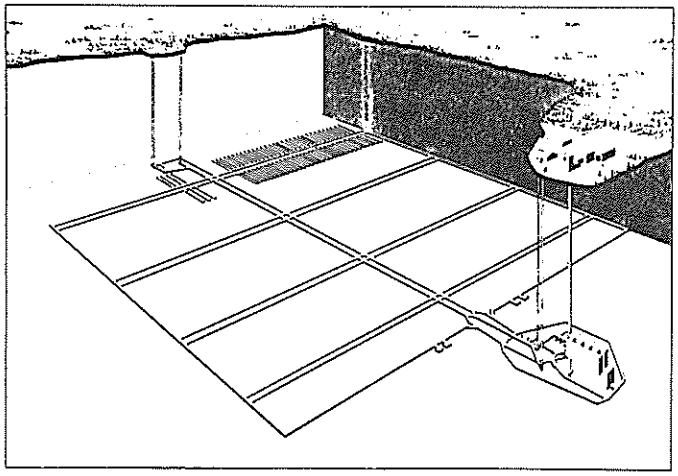
There would be a cost to the community, in addition to the loss of the bonus, if it desired a shut-down after operation began. It would have to prepare a detailed brief to the FOB, stating its reasons. This is analogous to the legal cases that must be presented to public utility commissions by utilities when they desire to raise electricity rates. The cost would be both in gathering the information and paying legal and technical fees. The funds would have to be derived from the bonus, thus reducing the money for other purposes.

A Public System

All of the activities of the FOB would be public, just as those of public utility commissions are. This would allow the general public to make a determination of the merits of any disputed cases.

Will Lawsuits Disappear?

Would the Facility Acceptance System and the reverse Dutch auction eliminate the possibility of all lawsuits? There is no conceivable waste siting system that can remove that possibility. However, the FAS would reduce legal wrangling to the bare minimum, because it will be in the interests of most parties to avoid legal confrontation. For example, the volunteer community will have made a bid to have the facility. There would be no reason for it to sue the siting authority to overturn an agreement it had signed. Contrast this with the situation in Nevada and the proposed high-level waste repository. Nevada has tried many legal avenues to prevent the facility from being built there, because the legislature, governor and its members of Congress are on record as opposed to the project.



Conceptual drawing of an underground storage vault.

Private Lawsuits

It is possible that private individuals may file lawsuits. These cannot be prevented. But if a volunteer community, siting authority and regulatory agencies agree on a facility, it is unlikely that private lawsuits aimed at overturning that agreement will prevail.

No conceivable siting system can promise no lawsuits. The FAS and the reverse Dutch auction do promise agreement between a potential community and a siting authority. If communities volunteer for a waste site, there will be much less of the delaying legal tactics often pursued by unwilling hosts.

Summary

The Facility Acceptance System, which encompasses a Facility Oversight Board as well as a reverse Dutch auction for finding a volunteer waste site, may be a solution to the problem of siting wastes. It is not a siting system in the ordinary sense, since it does not allow for coercion at any stage. It provides an incentive for a community to accept a facility, but a specific community that does not want the facility need take no action to avoid it. At the same time, environmental criteria are maintained. After the facility is built, the mechanisms prevent arbitrary shut-down unless the facility is grossly inadequate. All concerned would want cessation of operations in that case. Rather than the "stick" approach, prevalent in most siting systems, it provides a carrot. That may well be the best approach to solving what seems like an insoluble problem.

References

1. Peter Simon, "Troopers Arrest 39 at Allegany Site as N-Dump Protest Takes Ugly Turn," *Buffalo News*, May 2, 1990, p. 1.
2. "Rioting Over Alleged Radwaste Disposal Plans in Korea," *Nuclear News*, 33 (15) 19 (December 1990).
3. Herbert Inhaber, "Hands Up for Toxic Wastes," *Nature*, 347 (6294) 611-612 (October 18, 1990).
4. Peter Simon, "Curiosity Unlocks Prison's Potential," *Buffalo News*, May 2, 1990, p. B1.

Appel aux communications

Symposium de simulation SNC 1992

Sous la commandite de la Division des sciences et du génie nucléaires de la Société nucléaire canadienne et du Royal Military College of Canada, le 17ème Symposium annuel de la SNC sur la simulation de la dynamique des réacteurs et du contrôle des centrales aura lieu les **17 et 18 août 1992** au Royal Military College of Canada, Kingston, Ontario, Canada.

Le Symposium couvre tous les aspects de la modélisation nucléaire et de la simulation, et inclut d'habitude des sessions sur la simulation des systèmes, la thermohydraulique, la physique des réacteurs, l'analyse en matière de sûreté et sur d'autres aspects pertinents de la recherche et du développement. Le but premier du Symposium est de procurer aux ingénieurs et scientifiques une plate-forme pour stimuler la discussion et les échanges de points de vue dans l'industrie nucléaire. Le fait de présenter une communication à ce Symposium n'empêche pas la presentation de cette communication ailleurs et l'on encourage les communications sur des problèmes en voie de résolution et/ou sur des méthodes en cours de développement. Les communications complètes ont d'ordinaire une longueur de 10 à 20 pages, mais des communications (et des présentations) plus courtes sont fort acceptables.

La date limite pour recevoir vos résumés de 300 mots ou moins est le **31 janvier 1992**. Veuillez bien les envoyer à :

Dr Hugues W. Bonin
Département de chimie et de génie chimique
Royal Military College of Canada
Kingston, Ontario, Canada
K7K 5L0

On avertira les auteurs de l'acceptation de leurs communications en avril 1992. La date limite pour recevoir les textes complets est fixée au **2 juillet 1992**.

Pour de plus amples informations, veuillez bien téléphoner au Dr Hugues Bonin aux numéros de téléphone suivants : (613) 541-6613 ou (613) 541-6271 ; Télécopie (613) 542-9489.

Call for Papers

1992 CNS Simulation Symposium

Sponsored by the Nuclear Science and Engineering Division of the Canadian Nuclear Society and hosted by the Royal Military College of Canada, the 17th Annual CNS Symposium on Simulation of Reactor Dynamics and Plant Control will be held on **August 17 and 18, 1992** at the Royal Military College of Canada, Kingston, Ontario, Canada.

The scope of the Symposium covers all aspects of nuclear modelling and simulation, and usually includes sessions on systems simulation, thermalhydraulics, reactor physics, and related aspects of R&D and safety analysis. The main objective of the Symposium is to provide a forum for stimulating discussions and exchange of views amongst engineers and scientists working in the nuclear industry. Presenting a paper at this Symposium does not preclude presentation elsewhere and papers are encouraged on unresolved problems and/or methods under development. Full papers are usually 10 to 20 pages long but shorter papers (and short presentations) are quite acceptable.

The deadline for receipt of your abstracts of 300 words or less is **January 31, 1992**. This should be sent to:

Dr. Hugues W. Bonin
Dept. of Chemistry and Chemical Engineering
Royal Military College of Canada
Kingston, Ontario, Canada
K7K 5L0

Authors will be notified of paper acceptance by April 1992. The deadline for receipt of the final full paper will be **July 2, 1992**.

For further information call Dr. Hugues Bonin at (613) 541-6613 or (613) 541-6271, or FAX (613) 542-9489.

Conference Report

Twelfth Annual CNS Conference

Al Wight
Ontario Hydro


Dr. A.L. Wight

The Thirty-First Annual Conference of the Canadian Nuclear Association and the Twelfth Annual Conference of the Canadian Nuclear Society were held jointly June 9 to 12, 1991 at the Sheraton Cavalier Hotel, Saskatoon, Saskatchewan. Gordon Leaist of Cameco was overall Conference Organizing Committee Chairman. CNS conference Co-Chairmen were Dr. David Malcolm of D.G. Malcolm and Associates and Dr. A.L. Wight of Ontario Hydro. The Conference Theme was "Nuclear Technology – Building Our Energy Future".

The conference ran three full days, starting with a reception Sunday evening. Combined CNA/CNS plenary sessions were held Monday and Wednesday mornings. Parallel CNA/CNS sessions were held Monday afternoon and all day Tuesday. The CNA conference ended at noon on Wednesday, with the CNS parallel sessions continuing Wednesday afternoon. Monday's and Tuesday's luncheons were sponsored by the CNA, with Wednesday's luncheon being CNS sponsored. Dr. Dan Meneley of University of New Brunswick spoke on the topic "Safety is a State of Mind" at the Wednesday luncheon. Tuesday evening's entertainment was a rodeo and barbecue at the Flying Appaloosa Ranch outside of Saskatoon. Spirits were only slightly dampened by a downpour in the middle of the rodeo.

The CNS final technical program consisted of 66 papers presented in 17 parallel sessions. The technical program was a great success, in spite of some last minute cancellations. The program was well received and enjoyed by participants, as well as being useful and informative.

A total of 104 paper summaries were submitted to the Technical Program Committee. Of these 97 were accepted for presentation, and seven were rejected. Of the 97 accepted papers, 11 were withdrawn before the final program was printed, leaving 86 papers in the final program. Of these, 20 authors either withdrew their papers at the last minute, or did not attend the conference, so that 66 papers were actually presented. The last minute cancellations and no-shows forced rearrangement of the program for several sessions, and combination of two sessions with other sessions, so that only 15 sessions were actually presented. Most of the cancellations were due to travel difficulties experienced by several foreign authors.

Session 1

Session 1, entitled "Reactor Physics I", was chaired by Dr. B. Rouben of AECL-CANDU. Of the seven papers originally scheduled for this session, only two were presented. Both papers dealt with aspects of "local-parameter" methods, which compute spatially-varying nuclear properties of the core to reflect the variation of local conditions, such as fuel temperature, absolute flux level, coolant properties, etc. The session illustrated that very interesting developments are still on-going in the field of CANDU reactor physics analysis.

Session 2

Session 2, entitled "Thermal-Hydraulics", was chaired by Dr. W.I. Midvidy of Ontario Hydro. Of the five papers originally scheduled for this session, only two were presented. The first paper discussed a non-equilibrium model for the CATHENA code, and the second discussed two-phase flow experiments in the RD-14M loop.

Session 3

Session 3, entitled "Industrial Irradiation", was chaired by Mr. P. Kennedy of Kennedy Enterprises. The session started with an overview of industrial irradiation opportunities in Saskatchewan. The remaining four papers discussed radiation effects on materials, environmental advantages of radiation processing, and radiation pasteurization of animal feed. The session papers clearly indicated a potentially bright future for commercial irradiation. However, there remains the concern regarding public acceptance of irradiation activities.

Session 4

Session 4, entitled "Computer Applications", was chaired by Dr. M. Milgram of AECL-Research, CRNL. The session featured an eclectic selection of papers from various fields. The two remaining papers from Session 1 (Reactor Physics I) were combined with this session. This "mini--session" subsumed the coffee break, but no one suffered unduly. The first paper discussed a novel statistical approach to satisfy regulatory compliance limits on maximum channel power in the face of uncertainties in these values calculated by the SORO code. The next paper discussed modifications to the CANSIM code system which better simulate a close-coupling between the thermo-mechanical stresses experienced within the channel components (fuel, pressure and calandria tubes) and the gross thermalhydraulic conditions along the channel. The third paper discussed the migration of the SORO code from mainframe to SUN workstations and Local Area Networks. The closing paper discussed the coupling of thermal hydraulics and space-time neutron kinetics in a simple model which leads to limit cycle behaviour and unexpected solutions.

Session 5

Session 5, entitled "Fuel Channel Analysis", was chaired by Mrs. J.Y. Stambolich of Ontario Hydro. Five well-prepared papers were presented, all dealing with experiments and analysis of CANDU reactor channels. The first two papers dealt with validation of the CATHENA code against CHAN and experiments at Whiteshell. The next paper described tests performed at Chalk River to characterize the flow patterns in typical reactor channel. The fourth paper described tests at Stern Laboratories and a simple computer model to quantify the bundle velocities in case of a flow reversal in reactor channel. The last paper talked about an experimental program at Whiteshell Laboratories to measure the fuel channel response when molten material from an overheated fuel bundle contacts a pressure tube that is ballooned into contact with a calandria tube.

Session 6

Session 6, entitled "Reactor Physics II", was chaired by Dr. R. Jones of AECL-Research, CRNL. This session was truncated from six to only three papers by the non-arrival of delegates at the conference. The remaining three papers proved to be interesting. Two of the papers were in the mainstream of Reactor Physics in that they described comparison of calculation within reactor measurement. The other paper was concerned with the analysis of the stability of fission reactors, in particular the BWR.

Session 7

Session 7 on Small Reactors was chaired by Mr. T.J. Jamieson of Science Applications International. A continued high level of interest in small reactor development in Canada was evident in this year's session. A total of six papers were presented, two each on the MAPLE-X10, AMPS and SES-10 reactor development programs. Participation in the questions portion of each presentation was very good, particularly the interactions of the presenters on common safety and licensing issues, such as the analysis of off-design-basis events. As the three reactor programs progress towards completion, CNS members can look forward to future papers on the results of final analyses and commissioning programs.

Session 8

Session 8 on Severe Accidents was chaired by Mr. C. Blahnik of Ontario Hydro. The session consisted of four papers on various aspects of analysis of severe accidents in nuclear reactors.

Session 9

Session 9, entitled "Fuel Behaviour Under Accident Conditions" was chaired by Mr. A.D. Lane of AECL-Research, CRNL. Five papers were presented in this session, which dealt with UO_2 behaviour under accident conditions. Two of the papers dealt with modelling the release of fission-product gases from the UO_2. Two other papers described the experimental determination of the properties and release kinetics of fission products. The final paper described an experimental program to confirm the effect of zirconium-uranium interaction on the fragmentation of UO_2 pellets and delineate the conditions under which the process operates. All papers were well received, with many questions and extensive discussion.

Session 10

Session 10 on reactor components was chaired by Dr. J. Cuttler of AECL-CANDU. The first paper was on rolled joints for CANDU 3 fuel channels. The second paper explained the improvements to the CANDU shutdown rod unit for new reactors. The third paper was on methodology for calculating the temperature of uncovered in-core reactivity mechanisms. The next paper described the quality review carried out on the tooling used for retubing Pickering Unit 3. The final paper was on the Pickering Unit 3 annulus gas system pigtail blockage programme. All the papers covered nuclear technology that is necessary to help build our energy future.

Session 11

Session 11 on Safety Related Computer Software was chaired by Mr. G.H. Archinoff of Ontario Hydro. The session began with an overview paper, "Overview of World Trends in Safety-Related Computer Applications", which addressed the issues of when computer-based solutions should form part of safety critical systems, and what is the best way to use computers in such applications. The second paper was on the subject of categorizing software with respect to its nuclear safety significance. The final two papers dealt with specific elements of the software engineering process. The third paper was on software engineering standards for safety critical software. The fourth paper described how hazard analysis using fault trees is applied to software, and described the merits and disadvantages of the technique. The final paper addressed the many technical issues associated with random testing of software to obtain a reliability estimate.

Session 12

Session 12, chaired by Mr. K. Talbot of Ontario Hydro, was a collection of miscellaneous papers which did not fit into any other session. The first was on radiation and industrial safety training for reactor operations. The second paper was on the Darlington Emergency Response Projection Code. The third paper was on Ontario Hydro's transportation or radioactive material and emergency response plan. The final paper was on heavy water's role in improving the quality of life through medical applications.

Session 13

Session 13 on Nuclear Fuel Management was chaired by Mr. M.B. Gold of Ontario Hydro. This session turned out to be very depleted indeed, consisting of one paper of the six originally scheduled. The paper dealt with fuel management studies in support of a core loaded with bundles enriched to one percent U-235 content.

Session 14

Session 14, entitled "Nuclear Fuel Behaviour and Performance", was chaired by Dr. P.J. Fehrenback of AECL--Research, CRNL. Two of the four scheduled papers in this session were not presented. As a result, Sessions 13 and 14 were combined. The two papers presented described both

developments and practical applications of fuel behaviour modelling. The first paper described an application of the understanding of fuel behaviour during power increases, specifically defect criteria during power ramps, to develop a set of maximum power criteria for use by reactor operators during shim operation when some bundles are exposed to local overpower conditions. The second paper described an enhancement to the treatment of fuel sheath interaction in the transient fuel behaviour code ELOCA Mk4s.

Session 15

Session 15 on Reactor Safety was chaired by Mr. P.O. Thompson of New Brunswick Power. The first paper discussed the methodology of assessing trip coverage for events which result in flow oscillations, and presented sample results for a small LOCA. The second paper discussed comparisons of predictions from various Aerosol physics codes, such as VICTORIA, against CATHENA/PACE results using various aerosol models. The third paper discussed a comparison of different techniques for measuring water droplet size distributions for cold jets. The fourth paper examined the significance of different models and data sources in order to recommend a self-consistent approach for use in licensing related safety analysis.

Session 16

Session 16 on Reactor Engineering was chaired by Dr. J. Cuttler of AECL-CANDU. The first paper covered integrated pipe stress analysis and pipe support design for the CANDU 3. The second paper described how the standard CANDU 3 reactor and fuelling machine were qualified for a design basis earthquake having a maximum ground acceleration of 0.3 g, with a wide range of foundation conditions. The next paper was on passive safety design options for future CANDU stations, focusing on proposed concepts for passive decay heat rejection and passive containment of fission products. The next author spoke about how the CANDU 3 station layout meets the safety and licensing requirements, and how it shortens the construction schedule and reduces construction costs. The next paper described the evolution of the CANDU control centre and its design process from Douglas Point through Darlington and beyond to the new CANDU 3. The final paper provided an overview of some of the implicit and explicit requirements of Section III of the ASME code for the design of nuclear components.

Session 17

Session 17, chaired by Mr. T. Meadley of Uranium Saskatchewan, combined the topics of Nuclear Waste Management and Uranium Mining and Processing. Three very different papers were presented. The first presented a history of the radium mining and extraction industry, with an emphasis on Canada. The second discussed the engineering aspects of the design of a below ground structure for the disposal of low level radioactive waste. The third described a dry storage facility for CANDU fuel, called CANSTOR, that requires less space and cost than present storage facilities.

IAEA Proposes Safety Convention

At the General Conference of the International Atomic Energy Agency, September 20, delegates proposed that a "nuclear safety convention" be prepared for consideration by the Board of Governors next February. If accepted then the convention would be presented to member states of the IAEA for signature.

This initiative arose from the International Conference on the Safety of Nuclear Power – Strategy for the Future, which was held in Vienna, September 2-6.

That conference, which attracted 350 attendees, focussed on five basic issues:

- fundamental principles for the safe use of nuclear power
- ensuring and enhancing the safety of operating plants
- treatment of plants built to earlier standards
- next generation plants
- final disposal of radioactive waste

Gene Yaremy of the IAEA Division of Nuclear Safety, on leave from AECL CANDU, was Scientific Secretary of the Conference. John Waddington of the Atomic Energy Control Board was rapporteur for the session on treatment of earlier plants while Peter Wigfull, also of the AECB, was on the expert working group which prepared the issue paper on the same topic.

Ten Canadians attended, representing AECB, AECL, Ontario Hydro, and NBEPC.

The declaration issued at the conclusion of the safety conference is reprinted below. The full report of the conference will be available from the IAEA within a few months.

Declaration from International Conference on the Safety of Nuclear Power – Strategy for the Future

reviewing

- the fundamental principles for the safe use of nuclear power,
- the safety of operating plants,
- the treatment of nuclear power plants built to earlier safety standards,
- the next generation of nuclear power plants, and
- the final disposal of radioactive waste; and

considering the discussions held on several substantive topics related to these issues,

DECLARES that:

1. There was general agreement that safety should be primarily enforced at national levels, by conscientious application of existing safety principles, standards and good practices at each plant, and within each national regulatory body, making best use of national legal frameworks and working practices.
2. Operating organizations and National Authorities should identify operating nuclear power plants which do not meet the high safety performance levels of the vast majority of operating plants and undertake improvements with assistance from the international community.
3. The Governing Bodies of the IAEA are invited to develop a more vigorous overview process with the objective of achieving a high safety performance in all operating plants, *inter alia* by expanding and strengthening services such as ASSETs and OSARTs, and by promoting the achievement of sufficient national regulatory oversight.
4. The IAEA should initiate a process to develop a common basis on which the acceptable level of safety of all operating nuclear power plants built to earlier standards can be judged. In some cases, international cooperation and support will be necessary to ensure the completeness of safety reviews and the adequacy of implementation of measures to achieve that acceptable level of safety.
5. International organizations should enhance mechanisms to improve the quality and timely exchange of findings and conclusions of systematic analysis of operating experience, in particular relating to human and organizational performance. This could be achieved in part through regular use of the Incident Reporting System.
6. The IAEA should improve its mechanisms for timely public dissemination of authoritative information on operational safety performance experience. This could be achieved in part through a regular use of the International Nuclear Event Scale.
7. The IAEA should set up a small group of experts to establish safety criteria for the design of future reactors using a step-by-step approach which would begin with the development of safety principles and evolve, in the long term, into a comprehensive set of criteria. INSAG (International Nuclear Safety Advisory Group) documents could provide an important input to the process.
8. The IAEA should develop international safety objectives for use by participating Member States with regard to the implementation of waste management and disposal. The programmes should include consideration of the provision of advice on safeguards commensurate with the safety of the final disposal of spent nuclear fuel.
9. There is a need to consider an integrated international approach to all aspects of nuclear safety, including the disposal of radioactive wastes, which would be adopted by all Governments, and in this connection, the potential value of a step-by-step approach to a framework convention is recognized; and, therefore the Conference requests the Governing Bodies of the IAEA to organize the preparation of a proposal on the necessary elements of such a formalized international approach, examining the merits of various options and taking into account the activities and roles of relevant international and intergovernmental bodies and using the guidance and mechanisms already established in the IAEA.
10. Member States of the IAEA are reminded that appropriate budgetary resources must be made available if the objectives of these findings are to be achieved.

Special Report

Ontario Hydro's Nuclear Program

Don Anderson

Ed. Note: *Following is the slightly edited text of a talk by Don Anderson, Vice-President of Design and Construction at Ontario Hydro, to the Toronto Branch of the CNS, October 29.*

After his address Don fielded questions from the large audience for almost three-quarters of an hour, mostly dealing with further details or comments on the points raised in his talk.

I'd like to preface my remarks by stating the obvious: there hasn't been much good news for the nuclear industry from Ontario Hydro lately.

I wish I could tell you that all our problems were solved – that a new golden age of nuclear energy was about to dawn in Ontario.

The fact of the matter is that we face some very serious and troubling challenges. How well we meet these challenges will go a long way in determining the future of nuclear energy in Ontario and probably in the rest of Canada.

Ten months ago, I was given responsibility for engineering and construction of Ontario Hydro's nuclear power stations. The timing was apropos to that old Chinese curse: "May you live in interesting times."

Hydro's nuclear plants were coming off their worst year ever in terms of performance. The new government had just imposed a moratorium on additional nuclear stations. And there was a lot of criticism about the $12 billion cost of the new Darlington station.

To make matters worse, I was barely into the job when Darlington experienced serious technological problems.

Aside from that, it's been a great few months.

But not all is gloom and doom. We're addressing our problems. We're making progress. And we're showing results.

Moreover, this industry has a tradition of rising to the challenge – a tradition that dates from its very beginnings. It's no small achievement for a small country like Canada to have developed an internationally-competitive nuclear industry.

That was brought home again last December when AECL sold a second reactor to South Korea. The thousands of jobs created by that sale couldn't have come at a better time for a recession-battered Canada.

I'm also delighted that AECL has finally straightened out the situation at the Cernavoda station in Romania.

With the previous Romanian government in charge, Ontario Hydro did not feel it was in a position to provide any support whatsoever to Cernavoda. Now that AECL has taken over responsibility for the job, we will be strongly backing their efforts.

I've been to Romania, and other parts of eastern Europe. And I've seen the woeful shortages and know how absolutely essential electric energy is to that part of the world. Cernavoda could be one of Canada's greatest contributions to the success of the democracy movement in eastern Europe.

Here in Ontario, we're facing quite a different type of challenge – the challenge of maintaining and sustaining the plants we already have in operation.

The branch in Ontario Hydro that I represent is in the midst of a dramatic shift in focus. Our main purpose used to be to design and build big new plants. Now we are concentrating on rehabilitating, upgrading and maintaining the licenses of our existing workhorse units.

By 1993, when Darlington wraps up, our nuclear work will be almost entirely rehabilitation.

This rehabilitation work is both important and exciting.

Important, because the deteriorating performance of our nuclear plants over the past several years is a serious concern for Ontario Hydro.

Those plants account for about 60 per cent of our installed generation. Their continuing poor performance is hurting Hydro financially.

Improving the performance of our nuclear plants, particularly our older "A" units, is one of the most important issue facing the corporation. I can't emphasize this strongly enough.

Hindsight is always 20-20. But it's pretty evident looking back that we greatly underestimated the task of operating our plants at a high level of reliability, quality and safety over a 40 year period. The job now is to fix the problems this has created, and make sure we don't make similar mistakes in the future.

Rehabilitating a nuclear plant is a very different and complex type of business. But it is one that should interest you as scientists and engineers. This is because rehabilitation is an extremely knowledge-intensive business. More so, even than building new plants.

Let me give you an idea of what I mean. On a new nuclear station such as Darlington, the engineering component would be less than 15 per cent of the cost of the job. But in rehabilitation projects, the engineering could account 25 to 35 per cent.

Think of it like a car. The assembly line in the Ford plant in Oakville is really very simple. As the chassis moves along the line, workers are waiting to weld or bolt on just-in-time parts in a straightforward, orderly manner. A simple operation, really.

Now compare that to opening up the hood of a 1938 Rolls Royce Silver Cloud to rebuild the engine. Parts would be corroded. Some would be difficult to get at. And many replacement parts would have to be custom made since they are not being produced anymore, and there aren't any

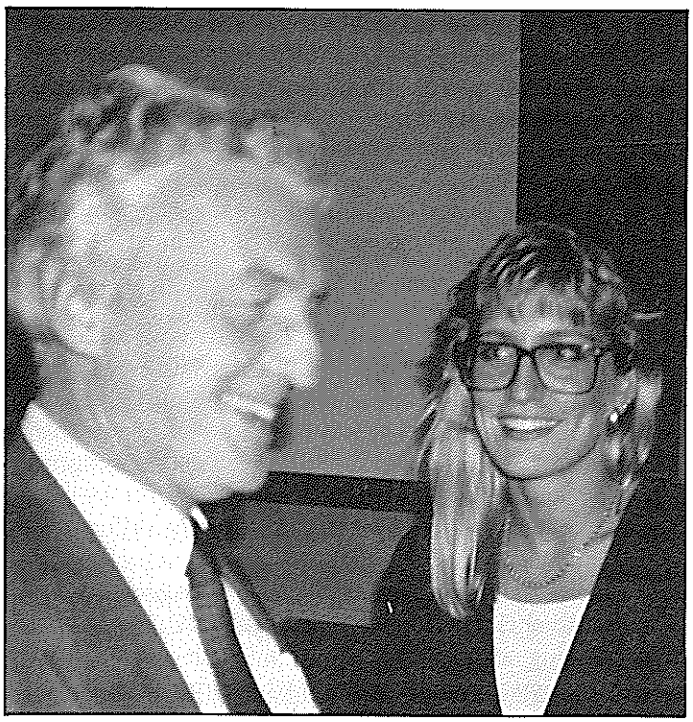
stockpiles on hand.

And finally, try to imagine working on that old Rolls if you were missing pages from the maintenance manual. Knowing the exact configuration of the facility or equipment you are working on is the key challenge of rehabilitation – be it nuclear plants, fossil plants or transmission lines.

We have pretty good documentation of all our nuclear plants. We have to in order to meet the licensing requirements of the Atomic Energy Control Board. But we've had to make many small changes, backfits, and safety enhancements to our "A" plants over the past 20 years, and this has required continuous updates to the documentation.

The result is that we have a huge continuing task ahead ensuring that our documentation stays right up to date. That's the type of job we're facing in our nuclear rehabilitation projects. The challenge is to do the work as quickly, as effectively and as economically as possible.

I'm pleased to report that we've enjoyed some success so far. The brightest spot has been the retubing program. It took us 38 months to retube the first unit at Pickering, 34 months for the second, and 24 months for the third. We're predicting 19 for the fourth. That's progress!



Don Anderson, Vice-President, Design and Construction at Ontario Hydro, shares a joke with Lisa Anzil, Vice-Chairperson of the CNS Toronto Branch at the branch meeting, October 29.

The bad news is that rehabilitation has added to the cost of nuclear energy in Ontario. The good news is that in spite of these rehabilitation costs, the "A" plants still remain a very competitive option.

Over the past six months we've done some very detailed analysis on the cost impact of current and projected work just to sustain the operation of our nuclear electric workhorses for 20 more years. This would take them to the end of their useful lives.

Even with all the extra costs taken into account, the economic analysis is very favourable. The older "A" plants are still economic by a factor of two compared with any other replacement generation, and that includes natural gas.

So, it's not all doom and gloom. The world isn't coming to an end for the nuclear industry with the completion of Darlington and the government moratorium. There's some really interesting work ahead of us.

One factor that will be key to the success of the rehabilitation efforts will be support from and partnership with others in the industry, particularly AECL.

As you probably know, the relationship between Ontario Hydro and AECL has had its ups and downs through the years. In the early days we cooperated very closely. And that synergy ensured that the development of the industry wasn't fragmented or dissipated – as was the case elsewhere, notably the United Kingdom.

By the mid-70's, however, a number of tensions combined to cause a serious rift between the two organizations. Each was driven by tremendously high commitments. AECL was loaded with work overseas, while Hydro was extremely busy expanding its nuclear capacity in Ontario.

I won't go into details of the rift. Suffice to say that the problem was recognized as serious once the industry passed through its halcyon days in the early-80's. The general consensus was that we could no longer afford the degree of overlap and duplication that existed.

Unfortunately, it's taken until recently for the two organizations to work out their differences and develop a more effective working relationship.

This began with agreement amongst Hydro, AECL, and the Ontario and federal governments to form the CANDU Owners Group. This group was responsible for nuclear research to support existing plants and to advance the technology into the future.

Just over a year ago, a new dimension was added to the equation. With its nuclear moratorium, the new government in Ontario made it very clear that Ontario Hydro should cease and desist any work related to future nuclear plants.

That meant stopping site selection work for CANDU "A" in its tracks, and it meant that the money we provided to the CANDU Owners Group should be used exclusively to support the rehabilitation of our existing plants.

This change in direction has caused some renewed tensions. AECL and the federal government are interested in the future advancement of the technology. Ontario Hydro's focus is now on its existing plants.

I think that the CANDU Owners Group was a good idea and has a role to play in optimizing the application of limited research funds. That's why we are working hard to avert a serious schism.

Admittedly, the goals and interests of the partners have changed, and some romance may have gone out of the relationship. But I think we can still make it work. Neither of us is prepared to pay the price of divorce because we need each other very badly in these tough times.

On a happier note, I am delighted by the success of another joint Ontario Hydro – AECL effort – the CANDU Engineering Authority.

This was set up with very little fanfare, very little hype, and a good dose of common sense. It's been working hard over the past 14 months to rationalize our business relationship with AECL.

Basically, we drew up a matrix outlining the specific responsibilities of each partner. The aim was to avoid duplication and overlap, and to better integrate the research and engineering components. We've also been dealing with specific technical problems. And we've been examining ways to facilitate the working relationship in the future.

More recently, the Engineering Authority has set up four quality improvement teams to examine key technical areas:

- nuclear safety and licensing
- computers for reactor safety and control
- reactor and fuel channel design
- fuel design

There are four people on each team: two from Ontario Hydro and two from AECL. They're not executives. They are managers and others who understand and are influential in the specific technical areas. They are to come back with ways the two organizations can better work together to solve problems and improve quality.

It may be that we'll set up centres of excellence, combining the expertise from both organizations. Or it may be that things are working fine as they are, so they'll be left alone.

In any event, I think the CANDU Engineering Authority is a real bit of good news for the industry. It's going to pay dividends well down the road. As the present chairman, I can assure you that I'll be dedicating my energies to making it a success.

In the meantime, there is still a black cloud hanging over Ontario Hydro's nuclear program, and the entire industry.

That cloud is Darlington. I find it disheartening that we could spend over $12 billion to build a nuclear plant of the highest quality with the most advanced technology, and discover it has a strange and even mysterious flaw.

Darlington is like a superbly muscled, finely tuned athlete with a heart defect.

Some people said we shouldn't have changed the designs from Bruce "B", which has been an excellent station, but we believe in moving forward as technology progresses. I don't think anyone could have predicted the problem that's emerged.

As some of you probably know, it's centred on the heat transport system. The configuration of the system is exactly identical to the CANDU 600's. But because the 900's are a little bigger, the pipes are a little wider in diameter and a little longer, and the pumps are a little larger.

What has occurred is that by the worst happenstance of chance, the small pressure pulses from the pumps are exactly in tune with and are being amplified by this piping configuration – just like the organ pipes in a church that produce musical notes.

This is causing the fuel to dance around unacceptably in about 10 of the 480 channels in the reactor. If this was allowed to continue, it would damage the pressure tubes, and they would have to be replaced much sooner than planned.

That's a serious problem. The fix is not simple. It's going to be expensive. And it is going to take time, possibly 12 to 16 months.

Basically, the athlete will need some heart surgery before he can run full out.

But we'll get through this. The patient will survive. The station will perform extremely well for many years, and provide reliable and affordable electricity for the people of Ontario.

In the meantime, however, the problems at Darlington are dominating the nuclear agenda. They are overshadowing our retubing successes, and they are overshadowing the very concrete steps we've taken to improve quality and maintenance.

I'd like to wrap up with one final development at Hydro that you may find of interest.

Almost two years ago, Ontario Hydro submitted to the Ontario government the most comprehensive, far reaching and detailed long term demand/supply plan ever developed by a major utility in North America.

Those two years seem more like two centuries in light of all the changes that have occurred since: the nuclear moratorium, huge increases in conservation and demand management targets, the suspension of hydroelectric studies in the Moose River basin, greater reliance on power from private, non-utility generators, and finally, a dramatic drop in the long-term forecast for electricity demand.

All these changes have prompted Hydro to take another look at future nuclear alternatives – including smaller, single unit containment stations.

This is a shift in thinking for Ontario Hydro. But given the uncertain planning horizons we now face, smaller, single unit plants are very attractive. They can be built much quicker, and so can be added closer in step with the growth in electricity demand.

Some of the arguments ascribed to these single unit plants include: they are less complex to design and build; they involve less up-front investment, and less financial risk. Moreover, when they do come on stream, the immediate impact on rates would be much lower.

Although the per unit energy cost over the life of such a plant would be higher than for a multi-unit station, it would be very competitive when compared to other alternatives. Moreover, if you build four side by side on the same site – even one at a time – the cost difference shrinks considerably.

We certainly will never build a new nuclear station unless we absolutely need it, and are given approval to go ahead. And no doubt this will depend to a great extent on public support and on clear evidence that nuclear is the best option.

We can help build that case and encourage support by getting our existing plants back up to world competitive standards. A great deal is resting on the rehabilitations and on our continuing efforts to improve quality and maintenance in our nuclear plants.

There's a lot of important, detailed work that has to be done, but this industry has overcome serious challenges in the past. And I am sure we can do so again.

AECB *Study Report*

Tritium Releases and Birth Defects

Kenneth Johnson and Jocelyn Rouleau

Ed. Note:

In 1988 a private citizen, David McArthur, distributed to the news media a report he had prepared which claimed to have found a possible connection between waterborne tritium releases from the Pickering nuclear generating station and birth defects and infant mortality in the area. The media publicity led to concerns among some parents and prospective parents in the Pickering area. As a result the Atomic Energy Control Board decided to commission a scientific study of the subject by an expert epidemiologist.

The principal author of the report was Kenneth Johnson, who is in charge of the Birth Defects Section of the Bureau of Chronic Diseases Epidemiology of Health and Welfare Canada, and who has been responsible for the national database for recording birth defects, the Canadian Congenital Anomalies Surveillance System. The work was reviewed by a panel of eight eminent experts.

For the information of readers and in the interest of accuracy, following is a reprint (through the courtesy of the AECB) of the Executive Summary of the report, which was entitled "Tritium Releases from the Pickering Nuclear Generating Station and Birth Defects and Infant Mortality in Nearby Communities, 1971-1988", and is published by the AECB as report INFO-0401.

Readers may have noted that the only report by the general media was on the 85% increase in Down Syndrome observed in Pickering, without mentioning the fact that there was little or no correlation with tritium releases or that there was another municipality in Ontario, far from any nuclear plant, with similar elevated levels.

1) Background:

A recent study by a private citizen in Toronto alleged an association between deaths from congenital anomalies in the Town of Pickering and tritium releases from the Pickering Nuclear Generating Station. An association between tritium release and neonatal infant death was also described. External review by the Ontario Ministry of Health suggested the study had serious data and analytic shortcomings. The Atomic Energy Control Board (AECB) decided it would be in the public interest to have a thorough and independent analysis of the birth defect and infant death data undertaken. Accordingly, the AECB commissioned the Laboratory Centre for Disease Control, which runs the Canadian Congenital Anomalies Surveillance System, to examine more closely the risks of selected reproductive outcomes in the area and to examine whether the risk of any of these outcomes correlated with rates of tritium release from the power plant.

2) Objectives:

The first study objective was to examine whether there were elevated rates of stillbirth, birth defects, or death in the first year of life, between 1971 and 1988, among offspring of residents of communities in close proximity to the Pickering Nuclear Generating Station (within a 25-kilometre radius). The second study objective was to investigate whether there were any statistical associations between the monthly airborne or waterborne tritium emissions from the Pickering Nuclear Generating Station and the rates of these reproductive outcomes.

It was not the objective of this study to estimate radiation exposure levels for women living in the vicinity of the plant, nor to examine the plausibility or possible biological mechanisms by which *in utero* radiation exposure might occur.

The ecological design of this epidemiologic study imposes the same limitations on interpretation inherent to all studies of this design. The study deals with exposure at the level of communities, as opposed to the individual. Accordingly, the study can only identify associations at the level of the community – associations which may not hold for individuals. Furthermore, association is only one tenet of the detailed evidence required to make a causal judgment.

3) Data Source:

The AECB provided data to the Laboratory Centre for Disease Control, supplied via Ontario Hydro's effluent monitoring programme, on monthly airborne and waterborne releases of radioactive materials from the Pickering Nuclear Generating Station between 1971 and 1988. In addition, composite monthly data on airborne concentrations of tritium from five Health and Welfare and six Ontario Hydro environmental ground monitoring stations located one or two kilometres from the plant were made available after a preliminary analysis of release data had been reported. Data on the prevalence at birth of birth defects, reported in the first year of life, were available for the period 1973-1988 from the Canadian Congenital Anomalies Surveillance System. Data on stillbirths and deaths during the first year of life between 1971 and 1988 were selected from summary files of Vital Statistics compiled by Statistics Canada.

4) Analysis and Results:

The data were analyzed for each of the six municipalities within the 25 kilometre radius, with attention focused on Pickering and Ajax, the two municipalities closest to the nuclear plant. The analysis had three major phases:

- a general screening of stillbirth, infant death and fatal birth defect rates by year and summarized over 1971-1988;
- an examination of birth prevalences of birth defects within three major categories in relation to airborne and water-

borne tritium emissions and in relation to ground-monitored airborne tritium concentrations during the period approximating the first trimesters of these pregnancies; and

- a screening of the 1973-1988 summary birth prevalences of specific birth defects in the communities of Ajax and Pickering, followed by an analysis of the relationship to tritium release and ground monitored levels for those defects with statistically elevated birth prevalences.

In the first phase, standardized mortality ratios were calculated for each outcome, for each of the six study municipalities by year and for the whole study period. Outcome rates for the entire province of Ontario were used for comparison throughout the study. The rates of stillbirth, neonatal mortality and infant mortality were not significantly elevated for the period 1971-1988 in any of the study areas in comparison to the rates for the entire province. The rates of central nervous system (CNS) defects and a group comprising the balance of defects were not unexpectedly high between 1973 and 1988 in any of the six study areas. The analysis did not turn up any statistically elevated or unexpectedly high rates. In fact, the rates were generally lower than for the province, sometimes significantly so.

In the second phase, average and high monthly airborne and waterborne tritium emissions over a four month period were categorized into five levels. Births, CNS defects, congenital heart defects, and the balance of defects were also categorized by month and year of birth in each study municipality. Emission levels were assigned to each month and year of birth after moving them forward nine months so that births occurring in the normal range of gestation would be assigned a tritium level approximating the tritium level during the first trimester of pregnancy. Birth defect rates were then calculated for each emission level and relative risks computed, comparing rates within each emission level to the lowest emission category.

A similar analysis was performed for Pickering using data from the three Health and Welfare Canada ground monitoring stations in the direction of Pickering on the periphery of the nuclear plant and for Ajax using the two stations in the direction of Ajax.

The only association between release levels and the three defect groups was between CNS defects in Pickering and the highest 12.5% of airborne tritium releases. However, the association could not be reproduced for the Pickering ground monitoring data; neither microcephaly (known to be related to ionizing radiation exposure in the Atomic bomb studies) nor any other specific CNS defect was particularly high; and the overall birth prevalence of CNS defects for 1973-1988 was 20 per cent lower for Pickering than for Ontario as a whole. No associations were found between higher ground monitoring levels and the birth prevalence of the three defect groups.

In the third phase, birth defects in Pickering and Ajax were divided into 22 diagnostic categories and analyzed. For those categories with statistically elevated standardized birth prevalence ratios, relative risk analyses were undertaken as above to observe whether there were any relationships to tritium levels.

In Pickering, only Down Syndrome birth prevalence was significantly elevated (maternal age-adjusted birth prevalence ratio 1.85, 95% confidence interval 1.19-2.76). A nonsignificant correlation was found between airborne tritium release levels and the Pickering Down Syndrome cases, but no correlation was found between Down Syndrome and the ground monitoring data. In Ajax, no anomalies had significantly elevated birth prevalence ratios, but Down Syndrome risk was elevated (although not statistically significantly so, maternal age adjusted risk ratio 1.46, 95% confidence interval 0.80-2.44). An association that was not statistically significant was found with the highest ground monitored tritium levels but there was no association with tritium emission levels.

5) Conclusions:

Overall, this analysis does not support a hypothesis of increased rates of stillbirths, neonatal mortality or infant mortality in the vicinity of the Pickering Nuclear Generating Station. Since the plant's start up in 1971, the rates of these conditions were neither high overall, nor were the patterns of yearly rates unexpected among any of the communities in the vicinity of the plant. Furthermore, the analysis does not support a hypothesis of increased birth prevalence of birth defects in the vicinity of the Pickering Nuclear Generating Station for 21 of the 22 diagnostic categories into which birth defects were divided for analysis.

The birth prevalence of Down Syndrome was elevated in both Pickering and Ajax, however interpretation of this elevated risk must be very cautious. There was no consistent pattern between tritium release levels and Down Syndrome birth prevalence, chance could not be ruled out for the associations between Down Syndrome and tritium releases or ground monitored concentrations, the association was detected in an analysis where multiple testing was done which may readily turn up significant associations by chance, maternal residence at birth for Down Syndrome mothers in Pickering and Ajax needs to be verified, and we have no information about place of residence early in pregnancy. Furthermore, the association between Down Syndrome and low level radiation remains indeterminate when the existing evidence from epidemiologic studies is summed. Finally, the estimated radiation exposure from the nuclear plant for residents of Pickering and Ajax is lower by a factor of 100 than the normal level of natural background radiation.

There was no consistent pattern between tritium releases and Down Syndrome prevalence ...

Nevertheless, it would seem prudent to do further investigation of Down Syndrome in Pickering and Ajax. The first step would be to examine hospital charts to confirm maternal residence at birth and the Down Syndrome diagnosis and to establish the length of gestation for the 38 Down Syndrome cases. If the residences are confirmed and permission can be obtained from the Ontario Ministry of Health, the Hospital Medical Records Institute, and the hospitals involved, we recommend a case-referent study be initiated. The case group would consist of the 38 Down Syndrome children born between 1973 and 1988 to mothers resident in

Pickering or Ajax at the time of birth. A referent (comparison) group would be compiled by selecting births from Pickering and Ajax matched on birth year and born to mothers with similar maternal ages. The study would establish maternal residence during and before pregnancy, possible exposure to other radiation before and during pregnancy (e.g., x-rays) and information on other potential confounders such as mother's and father's occupation. An attempt should be made to obtain results of chromosomal tests that may have been done for some of the Down's cases. Newly arisen trisomies might then be separated from those that were transmitted (the translocations), providing a better indication of the etiology underlying the cases.

The study has primarily addressed public health as opposed to etiologic issues. We have tried to answer two questions:

(a) Are there excess rates of specific reproductive outcomes in any of the municipalities in the vicinity of the Pickering NGS, overall or in specific years? and

(b) Are there any associations between the levels of tritium releases from the plant and the rates of specific reproductive outcomes?

The attempt to answer these questions has required screening a variety of adverse reproductive outcomes for elevated risk over a series of years, in a number of municipalities. Some statistically significant associations are a likely outcome when many statistical tests are done. Therefore, such a screening process must be viewed as a hypothesis-generating exercise and the potential for significant associations by chance alone should not be underestimated.

Fusion – Opportunities and Challenges

On October 24 the CNA and CNS joined to sponsor a seminar on "Canadian Participation in World Fusion: Opportunities and Challenges". About 150 people converged on a downtown Ottawa hotel to hear leaders of the Canadian fusion program outline their activities and discuss opportunities for companies and individuals.

David Jackson, director of the National Fusion Program office at Chalk River, set the stage with a concise review of the program. The objectives, he said, are to establish a basis for Canadian participation and to gain access to world fusion programs. He noted that Canada had been invited to join the International Thermonuclear Experimental Reactor (ITER) project through the European Community. The major partners in ITER are the EC, Japan, USA and USSR.

The NFP strategy for the 1990s, Jackson said, is to position Canada to draw the maximum benefit from the next-step fusion projects.

Richard Bolton's overview of CCFM is reprinted below.

A major component of the NFP is the Canadian Fusion Fuels Technology Project (CFFTP). Director Don Dautovich noted that CFFTP was primarily a program management office whose $13 million budget comes from the federal and Ontario governments and Ontario Hydro. CFFTP also does sub-contracting.

The only non-Canadian speaker was Stephen King of Fusion Power Associates, which he described as a non-profit organization with the objective of bringing the benefits of fusion to the public at the earliest possible time. (Canadian member organizations are OH, HQ? Spar, Spectrum, Stern, and Wardrop).

He noted that current fusion devices had almost achieved "break-even" (when energy out equals energy in).

Deploring the long lead time of the new US project, the Long Pulse Steady State Experiment, with projected start-up in 2025, and ITER, now 2015 at the earliest, he is promoting a small pilot plant which could be operational in 2010. King argued that fusion activity must move from being research oriented to application oriented. Later in the day representatives of Labserco, MPB Technologies and Wardrop Engineering outlined how private firms can participate in the fusion program.

At lunch, Stuart Smith, formerly head of the Science Council of Canada, spoke about technology transfer. The commercialization of technology is complex and especially difficult in a small country, he contended. High level agreements are needed between government laboratories and industry if there is to be effective collaboration.

A Brief Look at CCFM

Richard Bolton

Ed. Note: *The following is extracted from Dr. Bolton's talk to the CNA/CNS Fusion Seminar, October 24. Dr. Bolton, a former member of the CNS Council, is Director General of CCFM.)*

The Centre canadien de fusion magnétique (CCFM) is set up as a joint venture of Hydro-Québec, Atomic Energy of Canada Limited and the Institut national de la recherche scientifique, a graduate studies arm of the University of Québec. Since the beginning, as the Tokamak de Varennes project, undertaken by Hydro-Québec and NRC in 1981, the private sector, represented principally by MPB Technologies and Canatom Inc., has been an important part of the activities.

The centre has a current staff of 96 persons of which 38 are researchers and 11 engineers. This represents one of the largest focused and cohesive research teams in the country. Approximately ⅓ of the total staff is provided by the private sector.

The budget of the centre for 1991 exceeds $14 million. Operating the TdeV tokamak experiment consumes a large part but this budget also includes all the staff working on upgrades RF & Current drive. The RF Current drive addition is a project of major (5-6M$) size which is about halfway completed. Miscellaneous upgrades this year include a major improvement in living quarters for the centre.

The scientific value of the TdeV experiment as a research tool comes from its unique features particularly in combination. The coils are designed for 30 second (very long pulse operation for this size of machine) and have poloidal divertor action. Such divertors are rare in tokamak experiments though accepted as being an *essential* part of a fusion reactor. The plasma current of up to 300 kiloamperes is induced in the plasma by the coils coloured blue. Other coils position and shape the plasma. The 16 main confining field (TF) coils surround all the others.

The other unique feature of TdeV is that all limiters and divertor neutralization plates are electrically insulated from ground. Although this sounds trivial, it represents a daring technical feat in the presence of highly conductive plasma. These insulation neutralizing plates allow the plasma to be biased with respect to the vessel. Somewhat surprisingly, a few hundred volts can affect even the inner region of a plasma at 10 million degrees C. The external bias dramatically affects the turbulence inside the plasma. The turbulence peaks at a few tens of volts negative bias when the natural plasma rotation is cancelled. At a few hundred volts negative the plasma confinement is significantly improved, and longer pulse lengths are obtained – a new and important result.

Table 1 gives highlights of the past two years. Other important experiments were done this year on three different methods of Boronizing the plasma facing components to reduce contamination of the plasma by oxygen. TdeV has become the major testbed for the whole spectrum of boronizing methods boron-graphite limiters, and tokamak & glow discharges is tri-methyl boron.

- New proven installations:
  - ‡ Divertors and Horizontal position coils
  - ‡ Results with insulated neutralizing plates and limiters
  - ‡ Power supplies: HP, Polar. & DF
- HF Current Drive in construction phase 5M$
- New results on divertor, plasma biasing and Boronization
- Improved financing in 1991 & '92 (14M$ in '91)

Table 1: Highlights of 1990/91

The HF current drive system, which will inject one MW at 3.7 GHz, is progressing well and will be installed in 1993. This system will increase the possible pulse length from two seconds (max) obtained to the 30 sec. the experiment was designed for.

CCFM has many collaborative arrangements with other national fusion labs. Close to home CFFTP is involved with the compact toroidal injector. In the RF current drive there is ongoing collaboration with MIT and Caderache in France as well as contract work for NET in Europe. In addition to the posting of two researchers to NET/ITER design, TdeV is "signed up" to contribute to eight of the Physics tasks required for the ITER project. This list clearly shows the pertinence of the TdeV program as initially set out and modified slightly in the 10 years since the program was instituted.

The industrial impacts of an experimental program such as ours fall into several categories. There is the direct impact of work, manpower and hardware procurement given to the private sector. This work should, because of its nature, result in upgrading of design and manufacturing skills. Although the benefits are hard to measure they are undoubtedly there.

- Underwater Branching Multiplexer (MPBT)
- Timing modules - Padua, MIT, Los Alamos (MPBT)
- Matrix and corner cube detectors (INRS MPBT)
- Engineering contract for SNO (Canatom)
- Electrical research (HQ)
- Manufacturing skills, tokamak, RF system

Table 2: Spinoffs

Table 2 shows some of the major spinoffs which have been wholly or partly caused by the activities of CCFM.

Ideas generated in our activities have also spawned new research programs at Hydro-Québec of significant size.

I don't think anyone around 1980 really dared hope that the program chosen would turn out to be as successful as it has been and will continue to be. We did try to think it through correctly but there was an element of luck and serendipity as well.

Electricity and the Environment – A Report on the Helsinki Symposium

L.L. Bennett
International Atomic Energy Agency

(reprinted from the Bulletin of the IAEA)

The Senior Expert Symposium on Electricity and the Environment was held from 13 to 17 May 1991, in Helsinki, Finland. It was organized jointly by the IAEA and 10 other international organizations and was hosted by the Ministry of Trade and Industry of the Government of Finland. More than 300 experts from 40 countries and 20 different organizations took part.

The symposium's main objective was to provide assessment of the environmental, health, and economic factors involved in supplying electricity services, and to suggest a framework within which these issues should be taken into account in making future plans and decisions on electricity production and use. In so doing, the symposium produced concrete results that could be an input to the preparations for the 1992 United Nations Conference on Environment and Development (UNCED), in light of the important role electricity production and use play in both environmental and developmental issues.

As a basis for discussions, four international expert groups, composed of more than 50 experts from 21 countries and 7 different organizations, prepared key issues papers in four areas that were selected as the central themes at the symposium:

- *Energy and electricity supply and demand: implications for the global environment.* This paper assessed scenarios of future energy requirements, the share of electricity in the end use energy mix in the context of social, environmental, and technological development, and the role of electricity in minimizing impacts on the environment.
- *Energy sources and technologies for electricity generation.* This paper assessed the characteristics of different energy sources and technologies for electricity generation, namely fossil fuels, nuclear energy, and renewable energy sources, from the perspective of resource base, technological capability (including ways of protecting the environment), and economic viability.
- *Comparative environmental and health effects of different energy sources for electricity generation.* This paper assessed and compared the overall environmental and health effects of different energy systems for electricity generation, under normal operating and accident conditions, and covered the entire cycle of energy production, conversion, and end use.
- *Incorporation of environmental and health impacts into policy, planning, and decision making for the electricity sector.* This paper examined issues and options for managing the impact of the electricity sector on environment and health, and the framework for incorporating environmental and health impacts into the decision making process for electricity policies and strategies.

Energy and electricity supply and demand: implications for the global environment

The symposium concluded that the global demand for electricity services will continue to increase, subject only to constraints on economic growth. Electricity services are essential to the quality of life to which most of the world's people aspire. The global demand for these services will continue to increase during the next decades, as both population and income increase. This is especially true in developing countries, where electricity is only beginning to penetrate potential markets.

Furthermore, it was concluded that economic welfare and growth are not incompatible with a healthy environment. In developing countries, in particular, increases in electricity services are regarded as a tool for supporting industrialization, increasing productivity throughout the economy, and improving living standards.

Efficiency improvement throughout the electricity sector, from generation to end use, was seen as having a substantial potential to reduce impacts and should be pursued vigorously. However, it was concluded that efficiency improvements will not obviate the need for investments in electricity supply facilities. In spite of all practical and economic measures to improve the efficiency of electricity production and use, there will be a need to build additional electric power capacity, and existing power plants will have to be replaced as they reach the end of their useful lifetimes. Therefore, it is necessary to consider what the power generation options are that will be available in the considered time horizon, that is, up to 2020.

"There will be a need to build additional electric power capacity..."

The electricity sector has made and can make further significant contributions towards a reduction in future environmental impacts. Efficiency improvements, demand side management, and the use of non-fossil fuel supply side alternatives are options that are available to contribute towards a substantial reduction in emissions. Moreover, increased use of electricity may lead to a reduction in emission from the total energy system by permitting substitution of electricity from cleaner generation sources for fossil fuels

burned directly at the point of end use, and also by improving the efficiency of industrial processes.

One striking conclusion reached by the symposium was that the most ambitious feasible global target for carbon emissions from total energy sources in the year 2010 would involve emissions that are above the 1990 levels. This stands in stark contrast to stringent global targets being discussed in many international fora, calling for substantial reductions from present levels of CO_2 emissions. For example, the Toronto Conference (1988) called for a 20% reduction by 2005, relative to 1988 emission levels. The symposium concluded that such targets cannot be met by the electricity sector without socially and economically unacceptable curtailments in electricity services in many countries.

Less stringent global impact reduction targets could be met by the electric power sector without curtailing electricity services significantly, but only with forceful policy intervention. Such targets can be met through a combination of widespread efficiency improvements, increased use of nuclear energy and other non-fossil energy sources, and switching from coal to lower impact fossil fuels.

Symposium discussions showed that there is a wide diversity of viewpoints, both between regions and within regions, and that there is also great divergence between actions that experts judge to be needed and actions that policy makers and the general public consider to be acceptable. This is strikingly illustrated in developing countries, where the first priority is economic and social development.

Energy sources and technologies for electricity generation

The symposium considered that a technology response is needed to cope with the increasing evidence of the risk of global warming and climate change. The key elements of an interim response strategy will include expanded use of nuclear power based on the deployment of improved and advanced nuclear power plants, upgrading the efficiency of existing fossil plants, expanding the use of natural gas as a substitute for coal, expanding the use of hydropower resources wherever available, promoting other renewable energy sources where economically viable, and accelerating investment in cost-effective measures for demand management and end use efficiency improvement.

Nuclear power was seen as being the most likely non-fossil energy source which can be deployed on a much larger scale and with costs competitive with fossil fuels for base load generation. Nuclear energy has the potential for expanding its already significant contribution towards a reduction in carbon emissions. Technologies and resources are available to support greatly expanded use of nuclear energy in higher and middle income countries, but public concerns about health, safety risks, and waste disposal have currently blocked nuclear energy as an option in many countries. Technology advances are being made to improve the already good performance of existing reactor technologies, to develop advanced reactors with passive safety features, and to provide the means for better management of wastes. These advances would help to improve public acceptance of increased deployment of nuclear power. Social attitudes towards nuclear energy will also be influenced by

"Nuclear energy has [made] a significant contribution to a reduction in carbon emissions."

social and environmental concerns about other energy sources.

Hydroelectric energy continues to be attractive on a large and small scale, in particular in developing countries because of the large economic resource base still unharnessed. However, the financial constraints faced by many countries, and also environmental impacts such as land use requirements, risk of accidents, and possible local climate changes, may limit its development.

Renewable energy sources other than hydropower are unlikely to meet a large share of the global electricity demand. While the renewable sources are an essential part of any impact reduction strategy, and they may be important locally, their overall contribution towards global electricity generation is likely to remain small. Most of these sources still require considerable development effort before they are ready for large-scale deployment as economic options for base load generation.

A wide range of technology options needs to be maintained and developed in order to cope with uncertainties that may affect future energy markets and to meet the variety of local and regional resource endowments. Therefore, all technology options should be kept open, and none of them should be dismissed. Enhanced international co-operation in research and development (R&D) and technology transfer is needed to facilitate implementation of the most efficient electricity generation systems.

Comparative environmental and health effects of different energy sources for electricity generation

All fuel cycles within the electricity generating system involve some health risks and environmental impacts. The symposium concluded, however, that all the major fuel cycles in the electricity generation systems, when fitted to state-of-the-art technology, are able to deliver electricity at relatively low risks to health and the environment. An exception is CO_2 emissions from fossil fuels. Therefore, the problem of CO_2 emission control is at the top of the current environmental impacts agenda. The implications of global climate change have strong social, political, and economic linkages that also require adequate consideration in the overall decision making process. The potential global impacts of CO_2 emissions from fossil fuel are apparent, as are the potential regional impacts through acid rain. For such issues, energy mixes with a high component of fossil fuels are at the high end of the environmental risk spectrum.

Data presented to the symposium showed that, under routine operating conditions, nuclear power and renewable energy systems are in the lower range of health risk and that energy systems based on coal and oil are in the higher spectrum of health risk. However, variations in technologies, the state of equipment, and safety and environmental controls can lead to variations in the levels of risk from different systems.

Most energy systems have a potential for severe accidents

at various stages of their fuel cycles. The Chernobyl accident, the worst to have taken place in the nuclear fuel cycle, resulted in 31 immediate deaths, and the risk of delayed fatalities has yet to be established. There was also contamination of large areas of land and evacuation of a large number of people; the social consequences of the accident are particularly significant. Major accidents also have occurred in the coal, oil, and gas fuel cycles.

Rough estimates suggest that the human health risk from severe accidents from nuclear, oil, and natural gas systems are of the same order of magnitude and two orders of magnitude smaller than that from the hydroelectric option. On the basis of a normalized per unit of electricity produced, the hydroelectric option appears to have caused more immediate fatalities during the period 1969-86 than other energy sources. Any direct comparisons of severe accidents in the electricity generation sector must, however, be interpreted with great caution, as no internationally co-ordinated database on severe accidents exists, except for the nuclear fuel cycle. Delayed health effects and long-term environmental damage from major accidental emissions are particularly difficult to determine.

Therefore, the establishment of a comprehensive, internationally co-ordinated data-base on the health and environmental impacts of different energy sources is a priority issue. This should include the establishment of appropriate mechanisms for the collection and dissemination of such data. There is also a need for further R&D of quantifiable environmental indicators and on related methodologies for the comparative health and environmental risk assessment of different energy sources and technologies for the generation of electricity.

There is further a need to ensure formalized co-ordinating and liaison mechanisms among the various international organizations with an interest or role in the health, environment, and energy sectors to deal creatively with the range of research, policy, and other issues. A number of international initiatives are warranted, in particular on the interpretation and integration of comparative environmental and health impacts into the decision making process to ensure that all electricity generating options are considered in their proper perspective. The methodological initiatives that should be focused upon include: agreement on definition of the boundaries of the fuel cycles to be compared; how to take into account future technological developments in estimating and comparing risks; estimation of delayed and indirect health effects; and the development of appropriate environmental indicators and comparative methods.

Policy, planning, and decision making for the electricity sector

The integration of health and environmental impacts into energy planning for electricity will have significant implications that go beyond traditional current practices. First, considerations of the health and environmental impacts from the entire fuel cycle elevate the decision making to at least the level of the overall energy sector. Second, the global environmental dimension of electricity generation by different energy sources implies that it is necessary to look beyond the energy sector, since other sectors have similar greenhouse gas effects. Third, the time scale of many health impacts (e.g., long-term or delayed effects) and of environmental impacts (e.g., irreversible damage to ecosystems) means that a perspective much longer than the traditional capacity planning horizon of 7 to 10 years for power utilities is necessary. These factors highlight the complexity and multi-level nature of future electricity planning.

Policies in the electricity sector should be based on considerations of the full cost to society of different options, including the costs associated with health and environmental impacts, which need to be internalized. Comprehensive energy and electricity planning has to take into account the costs of health and environmental damages, which are an important component of the full social cost of energy supply. Some participants in the symposium questioned whether the developing countries can afford to concern themselves with environmental cost internalization when they have so many other problems. However, it cannot be overlooked that the environmental costs of local pollution are borne by the local population anyway if they are not internalized by the power companies, so society as a whole pays. Health and environmental costs also affect the productive economy directly, in addition to indirect effects. The full costs need to be carefully evaluated and internalized, based on the best available scientific data, consistent assumptions, and reliable methodologies. In many respects this will tend to make electricity generating decisions more realistic and result in more efficient practices.

Integrated least-cost planning approaches should be used as the basis for policy formulation and decision making, with consideration of energy conservation and efficiency improvement options as well as new supply options.

The symposium recommended that national governments should follow the precautionary principle when setting health and environmental protection standards, rules, and regulations to be met by electricity producers and users, as well as by other sectors of the economy.

International organizations should target their programmes, including policy criteria, dissemination of public information, and technical assistance, in support of sustainable development. They should undertake policy and technical studies and research appropriate to their expertise and role; these should be aimed at the design and implementation of feasible sustainable paths of electricity development, including international agreements on the standards to be met in relation to protecting health and the environment.

Commercial and development banks should establish and adopt formal guidelines governing their appraisal of electricity projects in accordance with their overall impact as assessed under a broadly agreed framework. When appraising projects for financing, they should take into account the complete range of alternatives, including rational use of electricity and all the available supply options.

The symposium further underscores the importance of public involvement. Each citizen of the world should be concerned with the need for sustainable development and contribute, to the extent possible, to its achievement.

Another Parliamentary Review

Yet another parliamentary committee has conducted a review – albeit brief – of the nuclear industry.

The Standing Committee on Energy, Mines and Resources began its review of the entire energy sector with two days of hearings in nuclear energy, October 9 and 10. The objective of this committee in these hearings is to develop a Canadian energy perspective on the environment for the international conference on the environment to be held in Rio de Janeiro next spring.

Because of the limited time available the Committee invited the Canadian Nuclear Association to speak on behalf of the nuclear industry, AECL Research on waste management, and Gordon Edwards and Norman Rubin to represent critics.

In its brief the CNA presented a number of observations:

- worldwide demand for electricity is growing
- nuclear power has very low environmental impact
- the Canadian nuclear industry has "impeccable credentials"
- nuclear technology has "delivered technical excellence and industrial benefits for Canada"
- a strong nuclear industry can foster international competitiveness
- public acceptance of nuclear energy is increasing
- the federal environmental review process results in unreasonable financial burdens for uranium mining
- Canada's uranium exports equal (in energy terms) the fossil fuel we consume.

Among the recommendations the CNA proposed that the federal government:

- continue to fund adequately the national nuclear R and D program
- invest in the construction of a CANDU 3
- avoid federal-provincial duplication in environmental assessments
- have regulatory costs associated with environmental assessment paid out of general revenues
- delay implementation of new (AECB) uranium mining worker exposure limits

The brief was presented by CNA president John Reid, together with Ian Wilson, CNA vice-president, technology, and Tim Meadley, VP uranium.

Meadley expressed strong concern about the expense of environmental hearings and noted, particularly, the AECB's fee increase, from $84,600 to $1,608,000 for a uranium mine construction licence.

His strongest attack was against the AECB's proposed new dose and exposure limits (based on new ICRP recommendations) which, he argued, could have "serious economic consequences". Meadley stated that the new limits could increase the cost of uranium by $2 to $3 per pound.

Edwards and Rubin, on the other hand, said that the nuclear industry and uranium mining in particular, was not meeting even minimal environmental standards.

The report of a consultant engaged by the Committee was quite critical of the CNA brief for not dealing with many of the questions posed by the Committee prior to the hearing. These dealt with topics such as environmental standards and technologies being developed to meet them. It noted that the CNA brief focussed primarily on the uranium industry and its perceived problems.

SaskPower – AECL Agreement

AECL and SaskPower have signed a memorandum of understanding (MOU) to create a new business venture in Saskatchewan managed jointly by AECL and SaskPower. Among projects to be pursued are a CANDU 3 power plant.

SaskPower has agreed to advance $25 million toward design completion of CANDU 3. AECL expects to have a team of about 170 personnel in Saskatchewan within a year and AECL CANDU will continue to finance the remaining standard design work from its revenue. About 20 AECL CANDU personnel will locate in Saskatchewan in the near-term to work on such tasks as setting up a design office, site selection studies, and environmental impact requirements.

This MOU is a sequel to a general agreement on energy between the federal and Saskatchewan governments covering exploration of clean coal technology, energy efficiency, alternative energy sources and nuclear capability in the Western province.

Other elements of the memorandum include AECL sponsorship of a Chair of Nuclear Science at the University of Saskatchewan; the assessment of possible business ventures in such areas as Slowpoke Energy Systems, applications for accelerator technology, laser isotope separation, nuclear fuel-cycle industries and a nuclear simulator and training facility.

CAIRS Opens New Lab

CAIRS (the Canadian Institute for Radiation Safety) opened its National Laboratories and Centre for Public Education in Saskatoon, November 6.

Sylvia Fedoruk, Lieutenant Governor of Saskatchewan performed the official opening. Ms. Fedoruk was formerly a professor of radiation physics and oncology at the University of Saskatchewan and for ten years a member of the board of the Atomic Energy Control Board. (An article on CAIRS is planned for the next issue.)

AECL's OSS Initiative

Last spring, AECL's president, Dr. Stanley Hatcher, in discussion with Ontario Hydro's chairman, Robert Franklin, offered to contribute 20 to 30 senior AECL people to support Ontario Hydro's operating stations.

Thus began AECL's Operating Station Support (OSS) initiative.

As Don Lawson, AECL CANDU president, wrote to those initially assigned: "Good performance of Ontario Hydro's nuclear plants is an essential element of a strong CANDU program."

Ken Hedges of AECL CANDU and Dave Torgerson of AECL Research were given the task of coordinating the participation of those two organizations. As of the end of September 12 AECL staff had been assigned, nine from AECL CANDU and three from AECL Research. All are senior people, managers or specialists.

Topics being addressed include generic issues such as the annulus gas systems as well as specific problems at Pickering, Bruce and Darlington.

At Pickering are Jerry Cuttler and John Sainsbury. Bruce has a team of John Dunn and Don Harrington from AECL CANDU and A. Hinds, M. Garakani and Dave Winfield from AECL Research. At Darlington Doug Benton is part of the Unit-2 team.

In addition, a number of AECL Research people have been involved on the investigation team for the channel problems at Darlington.

To coordinate the AECL contribution a joint planning and implementation team has been set up, composed of Don Milley and Brian Churchill of Ontario Hydro, Doug Benton and Dave Harris of AECL CANDU, and George Taylor from AECL Research.

Korean regulators at AECB

Six staff members of the Korean Institute of Nuclear Safety (KINS) arrived in Canada in September for two months of on-the-job training at the AECB. The purpose of this training is to familiarize the KINS staff with the Canadian approach to reactor licensing. The training program will be carried out by the AECB's recently-formed Training Centre.

The special on-the-job training program was requested following the recent Korean purchase of a heavy water CANDU unit, Wolsung 2. The program will involve guiding the KINS staff, through practice, on the Canadian requirements, methods used to assess licence submissions, and the preparation of recommendations to licensing authorities. The principal objective of the training program is for the Korean officials to achieve a high level of acquaintance with the licensing requirements and processes.

The experience of KINS is primarily in the area of light water reactors using the licensing approach of the United States Nuclear Regulatory Commission (USNRC). Licensing of Wolsung 1, the first CANDU unit in Korea, stemmed from the USNRC methodology but relied on AECB decisions related to similar units in Canada.

AECL is assisting the AECB's Training Centre by providing lecture sessions on the CANDU design and design differences between the existing Wolsung 1 and the new Wolsung 2 reactors, and the implications of these changes on plant safety and licensing.

Luncheon speaker, Dr. Stuart Smith, and Richard Bolton of Centre Canadien de Fusion Magnétique, converse during lunch at the CNA/CNS Fusion Seminar, October 24.

The majority of the training takes place at the Board's head office in Ottawa. In addition, training sessions will take place at Ontario Hydro's Darlington Nuclear Generating Station and New Brunswick Power's Pt. Lepreau Nuclear Generating Station. The KINS staff will also attend CANDU-6 licensing meetings with AECB staff.

AECB Committees Survey Research

The Advisory Committees of the Atomic Energy Control Board (AECB), namely the Advisory Committee on Radiological Protection (ACRP) and the Advisory Committee on Nuclear Safety (ACNS), are conducting a survey to determine the extent of health-related research programs in Canada that are concerned with radiation and radioactive materials.

The topics of research of interest could fall within one or more of the following areas:

(1) Biological effects of ionizing radiation
(2) Dosimetric aspects of internal and external radiation
(3) Metabolism of internally incorporated radionuclides and radiopharmaceuticals
(4) Environmental pathways leading to human exposure
(5) Operational radiation protection (health physics)
(6) Epidemiological studies concerned with radiation exposures
(7) Health protection considerations in the use of radioactive tracers, radioactive materials, and radiation emitting devices
(8) Instrumentation for radiation protection purposes
(9) Radiotherapy of cancers
(10) Other relevant research

Anyone with relevant information is invited to contact:

R.J. Atchison
Scientific Secretary
Joint Subcommittee on Regulatory Research
P.O. Box 1046, Station B
Ottawa, Ontario K1P 5S9
Tel. (613) 995-8433
FAX. (613) 995-5086

Cernavoda 1 Contract

In September AECL signed a contract covering completion of Cernavoda Unit 1 of the five unit CANDU power station in southeastern Romania.

The agreement was signed by AECL, Ansaldo of Italy and the Romanian utility RENEL, which owns the station. Under the agreement AECL and Ansaldo have formed a consortium known as AAC. AAC will provide construction and project management services, led by AECL CANDU Project Director Roland Boucher. Ansaldo is responsible for the balance of plant and AECL will assume the overall project management function. Financing for the agreement was authorized by the Government of Canada through the Export Development Corporation.

The C$315 million loan enables Romania to retain Canadian expertise to finish construction and to manage the operation of the power plant for the first 18 months. The money will pay for project management, engineering support, operator training, commissioning and plant operation as well as quality assurance and technical assistance to RENEL. The Italian government financing worth C$175 million for Ansaldo's portion of the work has also been approved.

Companies and organizations involved are:

- AECL CANDU
- Nuclear Construction Managers
- Manufacturing companies of the Organization of CANDU Industries
- Canadian CANDU utilities

Cernavoda Unit 1 is now almost 50 per cent complete. First criticality is expected for October of 1994 with synchronization to the grid in December 1994. The four other CANDU units are at various stages of completion.

Currently, AECL has almost 35 staff on site at Cernavoda. Romanian operating staff will begin training in January of 1992. As well the Atomic Energy Control Board will be engaged in training Romanian regulatory authorities.

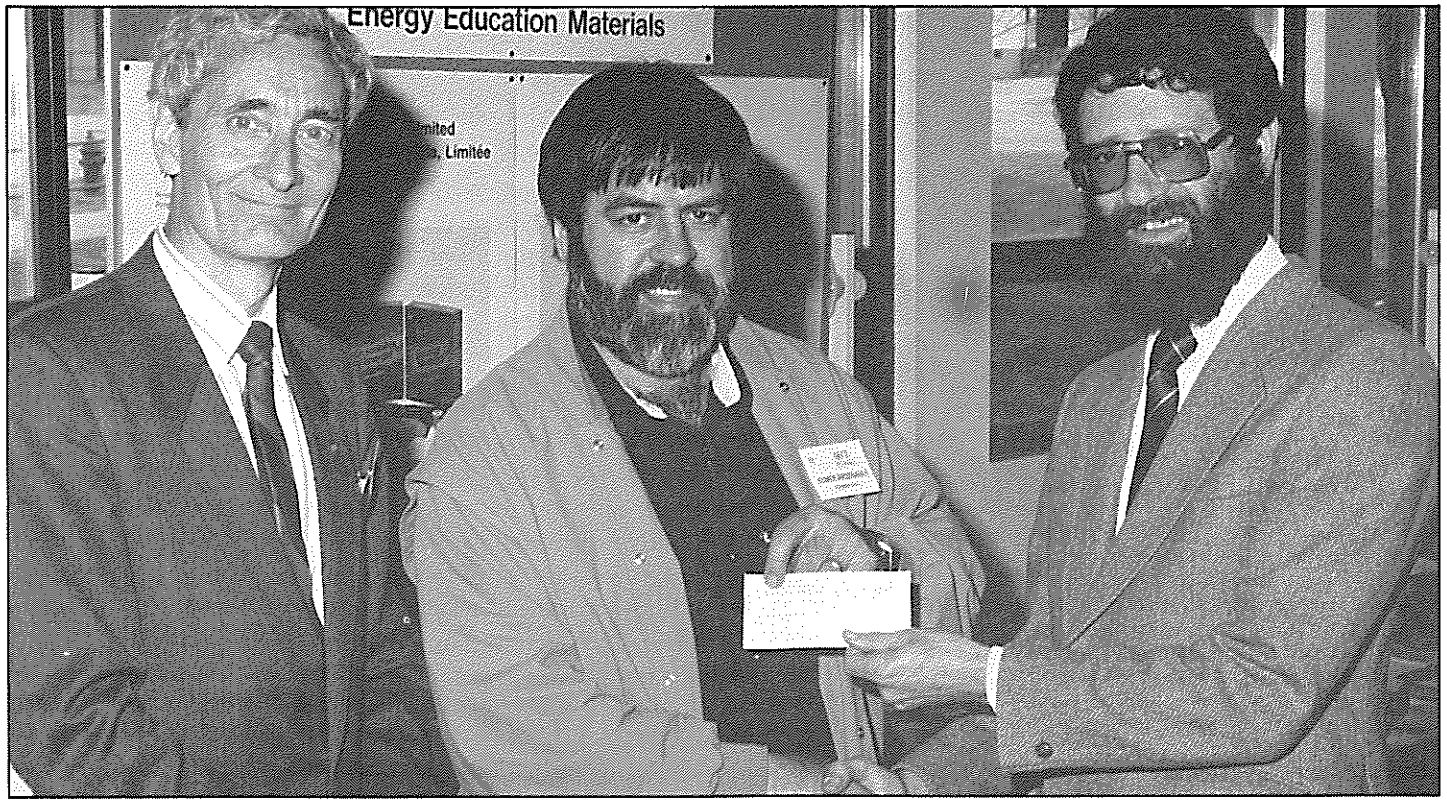
The Atomic Golf Ball

Ed. Note: *Although the following is not "news" there may be some readers not aware of this offer from Whiteshell and who may be in need of more "bounce".*

AECL Research has developed an irradiated or 'atomic' golf ball. It is intended to stimulate interest in, and discussion about, radiation processing and its many applications.

Although it is visually no different from its untreated counterpart, the atomic golf ball appears to have more "bounce". Simple in-house "bounce" tests with a variety of brand name golf balls suggest that the 'atomic' golf ball has between 3 and 8 per cent more bounce. The irradiation process changes the molecular structure of the ball's latex core, so that larger molecules are formed. This causes the increased bounce. The 'atomic' golf ball receives about the same amount of radiation (3 kGy) as would be used to eliminate salmonella bacteria in fresh poultry.

Golfers are invited to send their golf balls to Whiteshell Laboratories with their name, address, telephone number and return postage for processing. For further information call 1-800-665-0436.



Mr. J. Elmer Arsenault (centre) receives a cheque to cover expenses incurred in his attendance at the Science for Educators Seminar from Dr. Wally Kalechstein (right), secretary-treasurer of the Chalk River Branch of the CNS, while Dr. Malcolm Harvey (left), program chairman for the Seminar, looks on.

Membership Time

The Membership Committee is sending out the membership renewal notice for the 1992 February 1 – 1993 January 31 year. The fees are unchanged (regular $55; retirees $30; students $20) and may be paid by cheque or credit card.

This year paid-up membership has grown from 528 to 683 and further efforts will be required to continue this trend. A gift will be included with each receipt, and a CNS tie or scarf will be sent to those who sign up a new member.

A non-member who attends a CNS event (conference/course) will receive a $15 discount on first-year dues. The membership directory will be revised in February and issued in April.

Membership Committee:

Silvie Caron	(416) 977-7620
Jerry Cuttler	(416) 823-9040
Kathy Murphy	(416) 977-7620
Hong Huynh	(514) 344-0561

Branch News

Toronto Branch

The Toronto Branch of the CNS has again organized an excellent Public Presentation Series for the 1991/92 season. The talks usually take place at the University of Toronto main campus and are co-sponsored by the U of T's Centre for Nuclear Engineering.

The first two presentations in this year's series were Dr. W.A. Adams of the University of Ottawa in September speaking on "Recent Developments in Electric Vehicle Technology" and Don Anderson of Ontario Hydro in October on "Managing Ontario's Nuclear Energy Program: A Look at the Future". (Anderson's talk is reprinted in this issue.)

Coming up are:

November 26	Dr. R.A. Brown Ontario Hydro "Recent Developments at Darlington: Fuel Damage at Units 1 & 2"
January	Dr. John Simpson University of Guelph "An Update on the Neutrino Puzzle"
February 25	Robert Keating AECL CANDU "Recycle of Spent Fuel for the CANDU"
March 24	Amir Shalaby Ontario Hydro "The Demand/Supply Hearing: Process, Status, Update and Issues"
April 21	Dr. Bernard Cohen University of Pittsburgh "Does Low-Level Radiation Cause Cancer?"

For information on the Toronto Branch contact Shayne Smith at (416) 637-3788 or 592-3312.

Ottawa Branch

The Ottawa Branch has a new executive. Dr. Stefan Kupca, currently on attachment to the Department of National Defence as Director of Nuclear Studies and Safety Analyses, from AECL Research, is the new Chairman. Terry Jamieson is Vice-Chairman and Fred Boyd, Secretary.

Because of a number of problems this season's program will not begin until January. Details had not been finalized at the deadline for this issue.

Chalk River Branch

The Chalk River Branch provided financial support for a science teacher from Tignish, PEI to attend the 16th annual Science for Educators Seminar held at the Chalk River Laboratories (CRL) 1991 April 18 to 20.

The Science for Educators Seminar is an annual three day event held at the Chalk River Laboratories (CRL) of AECL Research in co-operation with the Canadian Nuclear Association and the Science Teachers' Association of Ontario. Formerly known as the Science Teachers' Seminar, the title of the Seminar was changed for the 15th edition in 1990 to recognize the growing interest that educators of varying disciplines have in science and its importance in our society. Participants are exposed to current research activity in diverse areas such as basic condensed matter and nuclear physics, underlying research on the environment and cancer formation, and applied research on nuclear reactor safety and design. Participants are also able to tour the laboratory facilities and interact informally with CRL researchers in the area(s) of their choice. This year's seminar was attended by 130 educators representing all provinces from Saskatchewan to Newfoundland.

Mr. Arsenault found the Seminar interesting and informative. What struck him most was the range of products that are produced in nuclear reactors. He is preparing a report on the Seminar for his school board encouraging other teachers to attend.

The Chalk River Branch was able to fund Mr. Arsenault's attendance at the Seminar thanks to a grant from the CNS/CNA Education Fund. The Education Fund was set up in 1987 with profits from the 1987 CNA/CNS Annual Conference and has been augmented each year with profits from successive annual conferences.

CNS support for the Seminar, either through providing funds to improve or expand the program or encourage greater participation by educators, is in line with the purpose of the Fund, which is to support branch initiatives in education on energy-related topics, with an emphasis on reaching the greatest possible number of people of high school age and above. The Chalk River Branch hopes to be able to provide continuing support for the Seminar in future years.

CNS/SFEN Exchange Program

The Canadian Nuclear Society and the Société Française d'Énergie Nucléaire have developed an exchange program for students and young professionals.

The exchange was achieved through the efforts of Hugues Bonin during his tenure as CNS president.

Full details of the exchange program are in announcements elsewhere in this issue.

News of Members

Ken Smith, who recently took early retirement from the Uranium and Nuclear Office of Energy, Mines and Resources, has begun a monthly newsletter, *UNECAN News*, covering the nuclear energy and uranium industries. Before joining EMR in 1986 he had been with AECL CANDU for 27 years. For information on *UNECAN News* call (416) 828-8216.

Jim Weller officially retired from the staff of the CNA and was joined at a retirement dinner September 12 by several dozen of his friends and former colleagues. General Manager of the CNA for over 20 years Jim was a strong supporter of the CNS since the Society's formation. He is continuing to edit the CNA newsletter, *Nuclear Canada*, until the future of that publication is decided.

CNS President Gil Phillips presents a gift from the Society to Jim Weller at his retirement dinner, September 12.

Lettre d'appel de présentations

Treizième conférence annuelle de la Société nucléaire canadienne
Du 7 au 10 juin 1992 • Saint-Jean, Nouveau Brunswick, Canada

La treizième conférence annuelle de la Société nucléaire canadienne (SNC) aura lieu à Saint-Jean (Nouveau Brunswick), au Canada, parallèlement à la 32e Conférence internationale annuelle de l'Association nucléaire canadienne, du 7 au 10 juin 1992. La conférence de la SNC sert de tribune pour l'échange d'information et la présentation d'articles invités et offerts. Les présentations offertes sont sujettes à l'examen d'un groupe de membres de la SNC et à l'approbation du Comité des programmes.

On invite des présentations sur les derniers développements dans les sciences et technologies nucléaires, ainsi que sur les applications de la technologie.

Renseignements d'ordre général destiné aux auteurs

Les personnes souhaitant faire une présentation peuvent en faire parvenir un résumé (moins que 900 mots) au Président de la conférence pour fins d'examen au plus tard le **30 novembre 1991**. Les résumés doivent comprendre une récapitulation des principales conclusions. Tous les résumés seront soumis au Comité d'examen technique aux fins d'approbation et l'auteur principal sera avisé de la décision prise au plus tard le **16 janvier 1992.**

Date limite de remise des résumés

Les résumés doivent être postés au plus tard le **30 novembre 1991**. Quatre ensembles (l'original et trois copies de chaque page couverture) doivent être transmis au Président de la conférence, à l'adresse suivante :

V.S. Krishnan
Conférence annuelle de la SNC 1992
EACL CANDU
2251 rue Speakman
Mississauga, Ontario, Canada
L5K 1B2

Tél.: (416) 823-9040, Poste 4555
Fax: (416) 823-8006
Telex: 06-982372

Chernobyl: A Kiev Resident's View

A.W.L. (Duke) Segel

"... the statistical probability of an accident, even if reduced, does not eliminate the danger. In Kiev, the statistics were not right – the accident happened. Nobody, and certainly not statistics, could have forecast the result. In the last year much information concerning the consequences of Chernobyl has come to light, and it has been ***terrifying****."*

This article is based on an interview with a former resident of Kiev about the effect of the Chernobyl reactor accident on his life and attitudes. It should be noted that during the interview there was no attempt to challenge or contradict his sources of information or views, nor was he made aware of the currently publicized findings of the recently completed multinational UN study.

The interviewee, Victor Kheifets, born and resident in Kiev until he came to Canada as a landed immigrant this past summer, is a graduate of a technical school curriculum in electrical engineering. He is currently employed as a computer programmer. Both his mother and sister are gynaecologists; his father is also an M.D.

Before Chernobyl

Prior to the Chernobyl accident, Victor had not developed any particular position with respect to nuclear power generation; nor did he have any depth of understanding of nuclear technology. He had been schooled in the potential dangers of released radioactivity and chemicals within the context of civil defense, but the studies, in addition to being boring and abstract, were not taken seriously because the potential danger was not perceived as a real threat. His limited knowledge of power reactor technology was obtained from 'popular' magazines. He did distinguish, though, between weapons and peaceful uses of nuclear technology; the former focused more on the American threat whereas the latter was the prime interest for the Soviets. All training was based on concern over the threat of nuclear war; none with respect to reactors.

"Soviet reactors posed no danger as they were the most modern ..."

His indifferent acceptance of power reactors was influenced by propaganda which held that Soviet reactors posed no danger as they were the most modern with superb defences against accidents and the release of radioactivity; as well, nuclear reactors provided the cleanest power. However, he was aware that 'knowledgeable' Kiev residents perceived a danger in the proximity of Chernobyl to Kiev (130 km); no other station was closer. Whether or not Kiev ecology could be perturbed by Chernobyl was not a matter of formal, official discussion. Some scientists were concerned about the consequence of intentional damage to the reactor which would be a main target in the event of war. Indeed, calculations of potential fallout done by junior scientists before the accident only became common knowledge and acquired 'fame' afterwards, for it was understood that they concluded that fallout from the station inventory would be more harmful than that from the nuclear weapon that destroyed the station!

Victor had never been associated with any 'peace' or 'green' movement; he was not particularly concerned, and indeed such movements were then illegal in the Soviet Union. Even in 1986, the second year of perestroika, they were not legal. Although aware of the activities of such movements, e.g. Greenpeace, Soviets understood they were only needed in the 'West' where there was much waste of land and resources, but not in the Soviet Union. However, despite the illegality, there was a limited amount of activity in the green movement before Chernobyl. For example, there were some protests about cutting forests in the vicinity of Kiev to provide land for government office buildings. And a few dissident voices, particularly Sakharov's, expressed concern about the ecological effects of underground weapons testing. Sakharov did say that the Soviet nuclear power reactors were a danger – but this position was generally assumed to have been political, a consequence of his dislike for Alexandrov, the head of the Soviet Academy of Science, who was in charge of the reactor program.

Only recently did the Soviet people find out that Soviet industry has been most wasteful and very dirty. Today Greenpeace and a green political party are legal and active; Chernobyl was a major factor in bringing forward such movements. In fact, the Ukrainian government has a Ministry of Ecology, and the current minister, Sherbac, was the founder of the local Greenpeace group!

The Chernobyl Accident as Experienced in Kiev

There were rumours almost immediately following the accident that something had happened at Chernobyl, but there was no official or confirmed information. Even the day before the May 1 and 2 holiday, four days after the accident, there were orders from Moscow not to restrict the annual holiday parades and events, primarily a bicycle race, which the local Kiev authorities were considering because of the rumours. People did observe, however, that many of the cyclists departed before the race because they had heard some news about Chernobyl from western radio stations.

On the holiday Victor was vacationing on the Dnieper river and heard western news; but it was hard to believe that western sources did not exaggerate the extent of the accident. The vacationers laughed at the news and didn't fully believe it. But when they were told that water from the river was then restricted, even for agricultural use, and open wells had to be covered with polythene plastic sheeting, Victor

believed him. From his training he recognized 'the use of polythene with respect to radioactive fallout'.

After the holiday and much later in May many of the children and some mothers were evacuated from the Kiev area to the south, even though it was the school examination period. Rumours were rampant! Still there was no official information; the Ukrainian minister of health had some programs to try to quiet the population, but as he focused on saying "no danger" he only managed to heighten the panic as everyone 'had eyes'. The populace were to take iodine (KI) tablets, but there were few KI pills to be had; apparently the stocks had been sent off to the Chernobyl area. Before the accident they were easily available, although there had been no advice as to what they were for; also there were rumours that there had been some poisoning due to uncontrolled consumption of the pills. Only later were instructions given and an explanation offered as to the purpose and action of the KI pills. Victor recalled that there was also some 'strange' advice to scratch the skin and apply liquid iodine.

"The first official statement was that there had been a small fire ..."

The first official statement that Victor recalls was that there had been a small fire at the Chernobyl station but not a nuclear accident. Subsequently there was an admission of a nuclear accident but all radioactivity had been contained. However, the people knew that the evacuation of Chernobyl began May 2; although authorized by the local authorities, the evacuation actually was illegal as there had been no high level official permission. Buses for the evacuation were sent from Kiev; the drivers had no instructions, and indeed, while waiting at Chernobyl they lounged on the ground unaware of the intense local fallout. Even on return to their routine in Kiev the vehicles were not completely 'cleaned' (decontaminated).

Throughout the summer there were no official announcements with respect to any fallout or what to do to minimize ingestion and exposure. There were only rumours! For example, it was believed that officials, who likely knew the truth about fallout on the local dairy farms, imported all of their milk. On the other hand, it was known that milk for the general populace consisted of the local product diluted with imported milk. During the summer, foods at the market were monitored, but those found contaminated were not confiscated; instead the vendor was told not to sell them, which of course he did after the monitoring team departed. Although the evacuation of children during May and June was official, it was attributed to improving their health in the country, not to escaping from the contamination. No figures on radiation levels were given, except that it was admitted that some of the fuel inventory was released from the reactor – the amount was variously rumoured as 0.3%, 3%, 30 kg and 3000 Ci. Officially there was no danger, but: some pine forest trees near Kiev did yellow and many were culled out and buried; road check points were established to monitor cars and indeed some cars (presumably from nearer the Chernobyl region) were confiscated and 'buried'.

There were many rumours, but negligible official information, about radiation exposures in Kiev and whether or not any biological damage was being observed. About a year after the accident foreign researchers, particularly Japanese, visited to gather statistics for the Chernobyl area, but dose measurements were incomplete because the instruments *in situ* at the time of the accident saturated. In Kiev there were some radiation detection instruments which were associated with civil defense, but there were none for individuals. Some of the latter appeared through cooperatives, but none could be purchased through stores.

"There were many rumours but negligible official information ..."

Following the accident there was a lot of illness, such as colds and flu, which the authorities in the ministry of health attributed to 'radiophobia', i.e. fears that developed as a result of the accident. About two years after the accident Victor learned from articles in the 'popular' press (as distinct from science or medical journals) that these illnesses were actually caused by the exposure to radiation weakening the immune system. He recalled that perhaps some two months *before* the accident there was an article in a magazine, *Nature* (apparently not the science publication), which on theoretical grounds argued that radiation could affect the immune system; indeed, following the accident, underground copies of the article circulated, and the theory had predicted what happened quite accurately.

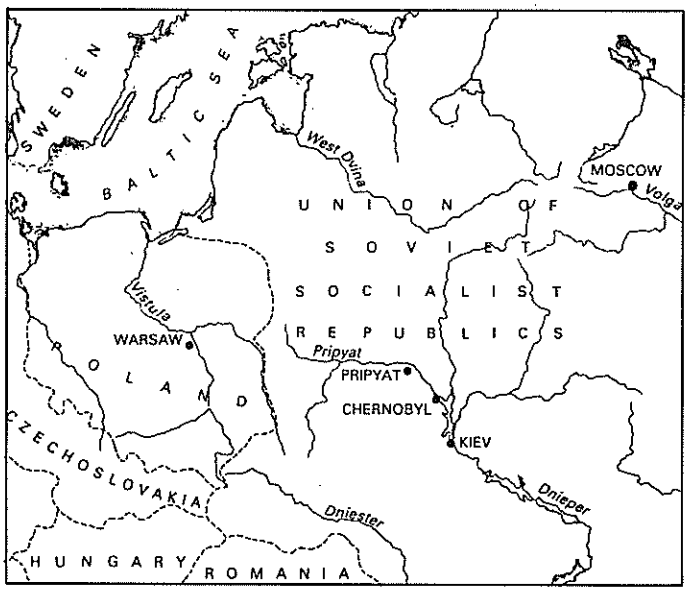
Victor understood there were leukaemia cases amongst young children, and even babies born in the autumn to mothers who either would not or could not leave Kiev immediately after the accident had leukaemia. There were more than the usual number of cases of difficult deliveries, including pregnant women who had been evacuated but returned to Kiev much before the delivery. Although not aware of whether or not there was a rise in birth defects, he did know of one attempt to collect data for analysis, which was abruptly terminated. A friend who worked at a gynaecological hospital said that a scientist there accumulated genetic data relevant to birth defects for half a year, but his records were then confiscated by the authorities and classified as top secret.

Retrospect

In retrospect Victor realizes that the authorities, probably in order to protect themselves, were less than honest about the extent of the accident. The communist government structure fostered lying for self-protection; full information disclosing the extent and seriousness of the accident would reveal weaknesses, or even errors, in the planning and implementation of the reactor program, for which heads would fall. Initially there was an effective cover-up to prevent full disclosure reaching the highest levels where the authority to make the necessary decisions rested. For example, the senior (nuclear) scientists tried to stop the May 1 and 2 parades so

people would not be out on the streets, but they couldn't get their message through the bureaucracy in Moscow, and indeed were put under house arrest. The official bureaucratic line was that there was no problem. There were only rumours that resulted in some self-imposed restrictions.

Victor believes that many factors contributed to causing the accident. An article by an engineer appeared some months before the accident claiming there had been a lot of mistakes during construction, many of which were due to the political pressure of maintaining a schedule. He understands that the poor design was certainly a factor; the control system was very old (inadequate?) with many components that could only be activated by hand-operation. The revamping and testing of safety devices, originally scheduled to be completed in May, were rushed to meet an April completion date. The information on what happened and the inadequacies of the design and construction slowly became available, much of it only within this past year; except that on the safety tests, which was released early, probably to place the fault and blame on a specific person, the head of the reactor who was in charge of the tests.



Relationship of Kiev to Chernobyl

It had been claimed that the probability of an accident was one in many millions, but to Victor it is obvious it had to have been much higher because several factors must have contributed. His attitude towards nuclear power has changed. He has seen the results of an accident; with hindsight, Chernobyl was a danger! Since then he has become cautious about nuclear power, and indeed, is today probably negative. And it is not Victor alone; it is the attitude of many Kiev citizens. In fact, the deputies in the Ukrainian parliament would like to close down the reactors. But Moscow, even in 1986, wanted to build a fifth reactor; it was a Ukrainian decision not to proceed.

Victor had no training or background in nuclear technology, other than the minimum instruction given for defense purposes. Nor apparently did many others in Kiev have any comprehension of the technology, except perhaps the staff and students at the institute for physics; he realized they understood nuclear radiation, for on May 1 and 2 they stayed in their apartments with all the windows closed. After the accident he, and others, tried to obtain information and understand nuclear radiation. Some with more science (and facilities) tried to make detection devices; those with higher education became interested and dug into the literature – both technical and popular – so many acquired an understanding. The less educated could not understand and indeed didn't recognize the post-accident danger from fallout as they had a problem dealing with something that could not be seen, touched, heard or smelled.

Even though suffering in Kiev was small relative to that experienced by the people at Chernobyl, and he personally did not suffer much, why did Victor change his mind about nuclear power? Before he had no ill health; since he has had colds at least twice a year which he suspects is a result of the effect of radiation on the immune system. And he has seen the effect on others – a friend has developed skin cancer attributed to exposure to radioactive fallout from Chernobyl. He also understands there have been increases in cancer, in thyroid gland problems, in children's disabilities, etc. And he understands the full effects of the exposures might not be manifest for another 20 years. In Kiev, many more old people are now dying from cancer; he was told by friends that the number of burials in the Kiev area has more than doubled in the 5 years since Chernobyl. According to Victor, emigration from the Kiev region has increased significantly since Chernobyl, much beyond that than can be accounted for by other motives.

Of the aspects of nuclear power generation that usually arouse concern, viz: (1) releases of radiation during normal operation, (2) safety and accidents, and (3) waste disposal, the accident is of most concern to him. The consequences of an accident are clear to everybody. On the other hand, normal operation emissions present only a relatively slight danger, and only experts need pay any attention to them; waste disposal is remote – in the future – and the waste will not be physically close to people. There could be a danger for the future in waste disposal, which is recognized by the experts. Indeed, there is controversy in the Soviet Union about disposal, particularly in the open pit method used in the mid-50's, which, despite decay, still presents a danger, as does the disposal of waste shipped by other countries to Africa (which apparently was not well buried). But waste disposal is of no concern to the ordinary worker as it is remote in space and time.

"The only acceptable form of energy generation is the one with the least danger ..."

Does Victor reject nuclear power no matter what the cost, or is he prepared to compromise? With respect to the Soviet Union, he says that there are so many restrictions and shortages that a few more to avoid the dangers of nuclear would not be a problem; for himself, he accepts that some compromise might be necessary, but it would be a 'last resort'. Improving the design to reduce the probability of an accident is almost irrelevant; he feels that one of the main

dangers of Chernobyl was, and still is, its proximity to Kiev (at 130 km!); that concern cannot be relieved by design improvements. Hence, any nuclear plant, to be acceptable, must be remote from population centres. He recognizes alternative sources of power have their negative aspects: transport costs for coal and oil, ecological costs for fossil fuels, and even hydro is not without an ecological price – damming of the river near Kiev for a water reservoir caused noticeable local changes in climate. Thus he realizes and accepts that there has to be a compromise amongst the ecological costs, the financial burden and the benefits of power. But he has seen the terrible consequences of a nuclear mishap! Minimizing danger is the only important issue to him, and the only acceptable form of energy generation is the one with the least danger.

Victor understands that nuclear stations can be built more safely, such as by 'burying them underground'; but the danger (consequences of an accident), although possibly reduced by burial, is still very great.

"The probability of an accident, i.e., statistical chance, even if reduced does not eliminate the danger. In Kiev, the statistics were not right – the accident happened. Nobody, and certainly not statistics, could have forecast the result. In the last year much information concerning the consequences of Chernobyl has come to light, and it has been *terrifying*."

Calendar

1992

March 27-28 **CNA/CNS Student Conference**
McMaster University, Hamilton, Ontario
contact: Dr. J.S. Chang
Dept. of Engineering
McMaster University
Hamilton, Ontario
L8S 4L7
Tel.: 416-525-9140 Ext. 4924
Fax: 416-577-9099

May 17-22 **8th World Congress of the International Radiation Protection Association**
Montreal, Quebec
contact: Jean-Pierre Gauvin
2155 rue Guy, Bureau 820
Montreal, Quebec
H3H 2L9
Tel.: 514-932-9552

May 25-29 **Meeting on Radiation Safety in Uranium Mining**
Saskatoon, Saskatchewan
contact: L.D. Brown
Saskatchewan Human Resources
1870 Albert St.
Regina, Saskatchewan
S4P 3V7
Tel.: 306-787-4486

June 7-10 **CNA/CNS Annual Conference**
Saint John, New Brunswick
contact: Dr. V.S. Krishnan
AECL—CANDU
Tel.: 416-823-9040
Dr. K. Scott
Atlantic Nuclear Services
Tel.: 506-458-9552
CNA/CNS office

June 7-12 **ANS Annual Meeting**
Boston, Massachusetts
contact: Dr. W..I. Midvidy
Ontario Hydro
Tel.: 416-592-5543

August 17-18 **17th CNS Nuclear Simulation Symposium**
Kingston, Ontario
contact: Dr. H.W. Bonin
Royal Military College
Tel.: 613-541-6613
Fax: 613-547-3053

September 21-23 **Design and Review of Software-Controlled Safety-Related Systems**
Waterloo, Ontario
contact: Ms D. Del Belluz
Institute for Risk Research
University of Waterloo
Tel.: 519-885-1211

September 20-25 **15th Congress of World Energy Council**
Madrid, Spain
contact: Dr. E.P. Cockshutt
CANWEC
Tel.: 613-993-4624

October 4-8 **3rd International Conference on CANDU Fuel**
Chalk River, Ontario
contact: Dr. P.J. Fehrenbach
AECL/CRNL
Tel.: 613-584-3311

October 25-29 **International Conference on Design and Safety of Advanced Nuclear Power Plants**
Tokyo, Japan
contact: Prof. Y. Oka
Nuclear Engineering Research Laboratory
7-3-1 Hongo, Bunkyo-ku
Tokyo, Japan

November 15-20 **ANS Winter Meeting and concurrent meeting on Fifty Years of Controlled Nuclear Chain Reaction, Past, Present, Future**
Chicago, Illinois
contact: Dr. W.I. Midvidy
Ontario Hydro Tel.: 416-592-5543

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