Canadian Nuclear Society
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CNS BULLETIN SNC

Vol. 3, No. 3 May/mai 1982

PREVENTING NUCLEAR WEAPONS PROLIFERATION

ANNUAL CONFERENCE PREVIEW

CNS QUESTIONNAIRE REPORT

THE UNFASHIONABLE SIDE

La Société Technique de l'Association Nucléaire Canadienne
The Technical Society of the Canadian Nuclear Association

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CNS provides Canadians interested in nuclear energy with a forum for technical discussion. For membership information, contact the CNS office, a member of the Council, or local branch executive. Membership fee is $25.00 annually.

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EDITORIAL

Exploding the Myths of Proliferation

Many years ago the acid-tongued Tom Lehrer introduced a song on nuclear weapons proliferation with the words "Recently everyone got quite alarmed when China, which we call 'Red China' exploded a nuclear bomb -- which we called a 'device' ... ." This is a good illustration of the important point emphasized by Archie Robertson at the Toronto CNS meeting in April: when we use terms such as "proliferation" or "safeguards" we must be very careful to attach rather precise definitions to them - or face the prospect of adding further intellectual pollution to an already complex subject.

It could, for example, be argued that proliferation began and ended with the atomic bomb attacks on Hiroshima and Nagasaki. At that time it was unequivocally demonstrated that nuclear weapons using uranium-235 and plutonium-239 could be built, could be transported by conventional bomber aeroplanes, and could be caused to detonate at a specified time and place. With that demonstration it became only a matter of time before any nation with the political will to do so developed nuclear weapons of its own. That procedure could be accelerated by a pre-existing nuclear research programme, ready availability of raw materials or an efficient espionage service. But such elements are secondary to the main point: the atomic bomb had been demonstrated as a practical proposition.

The misconception that there exists a scientific and engineering key, or set of keys, that will unlock the secret of nuclear weapons (the "secret formula syndrome") has been around since 1945, and continues to hamper the rational discussion of nuclear weapons control.

"Proliferation", as the term is used now doesn't mean letting the cat out of the bag on the part of an existing weapons country, but rather, enticing the cat inside the house on the part of a would-be owner of nuclear weapons.

Extending that metaphor, it could be said that "safeguards" do not comprise a series of padlocks and chains to keep the cat in the bag, but rather an arrangement to provide nations with assistance in giving houseroom to a much more beneficial resident than that particular cat. Acceptance of that assistance carries with it acceptance of visits from a cat control officer.

Limitation of nuclear weapons development will not be achieved by the application of draconian controls to the interchange of scientific and engineering information but rather by providing people with something much more useful than nuclear bombs on which to spend their money.

This Issue

This month we offer two new sections in the Bulletin. A heartening response from readers to the question of "issue management" has prompted the opening of a Letters section. We hope that anyone who's got something to say will say it in the Bulletin. Letters need not be polite -- nor need they be long. They just need to be sent. At the very least letters from our readers tell us that the Bulletin isn't simply used to line the bottom of the parrot's cage. With some misgivings we've also started a section devoted to comment of a humorous or whimsical nature. Entitled "The Unfashionable Side" this section will be under the aegis of "Ernest Worthing." Little is know of this dubious character who, doubtlessly for excellent reasons, chooses to hide himself (herself?) in this pseudonymous manner. Suffice it to say that the editorial office of the Bulletin keeps a ten-foot forked vermin stick handy should he/she ever make a personal appearance. It is understood that "Mr. Worthing" will entertain contributions from CNS members, though why anybody not forced to should have any contact, however distant, with this unsavoury character is difficult to imagine.

LETTERS

Issue Management Illustrated

You are standing in a rattlesnake pit in southern Manitoba. It is early spring, and the morning sun slowly reaches down, deeper and deepr into the pit. Clicks and slithers punctuate the silence. Luckily, a stout rope hangs directly in front of you.

Issue management tells you how to get out of the hole.

(PS: Do not begin by placing both hands over your backside)

Dan Meneley

A Nixon Legacy?

Historically I suspect that "issue management" is a piece of US jargonese that first entered the English language in the Nixon era. Simply defined, it is the art of telling half-truths in such a way to convince the news media of the soundness of your own position and, at the same time, discredit your opponents. The principle proponents of this art are Canadian politicians, as evidenced by almost any statement made on the National Energy Programme, and most anti-nuclear witnesses at public enquiries, as evidenced by their testimony. This definition must be accurate since the definition itself is its own perfect example.

Alan Wyatt

Dreaming on ...

I am somewhat puzzled that you failed to notice the very clear example of issue management in the story "I have dream ..." in your April edition. Simply put, one predicts the issues one might have to face (for example, an attack from outer space, a lycanthropy epidemic in Ottawa or a nuclear meltdown), talks about those issues, then does something about them. However, I've noticed that application of modern management techniques has streamlined the process by eliminating the third stage. Traditionally prediction has involved such activities as reading animals entrails, consulting oracles and sacrificing virgins, but with an increasingly acute personnel shortage and the development of a revisionist Freudian analytic technique, dreaming has become the most cost-effective prediction system. Thus, in a nutshell, "issue management" consists of (a) dreaming about something and (b) talking about it. Or maybe it's the other way round...

B. Allen

PERSPECTIVE

Archie Robertson doesn't really need to be introduced to anyone in the CNS -- which saves us having to write an introduction. It should be noted, however, that in his frequent appearances before a variety of audiences Archie has provided convincing proof that technical impeccability does not preclude witty and elegant discourse.

Introducing his lecture at the 20 April meeting of the CNS Toronto Branch, Archie entered the caveat that while his subject concerned the relationship between nuclear weapons and nuclear electricity (or lack of it), his own information on nuclear weapons was limited to what is in the open literature. At Chalk River there was no programme of weapons design, construction or testing. Archie feels very strongly that it is certainly true that many decisions related to the development of nuclear energy (or, indeed, the application of society's resources to any endeavour) must be based on value judgements. It is equally true, he emphasizes, that these value judgements must be made using facts rather than fantasies.

Although Archie did not speak from a "final text" he was kind enough to lend the Bulletin some of his notes from which we extracted the highlights of his argument, presented below. But it must be emphasized that these are highlights, not verbatim transcript.

PREVENTING NUCLEAR WEAPONS PROLIFERATION: A POSITIVE FACTOR FOR PEACE

Reactions against a new technology are not unprecedented in human experience. Pliny (AD 23-79) is quoted by Agricola: "Iron is used not only in hand to hand fighting, but also to form winged missiles of war, sometimes for hurling engines, sometimes for lances, sometimes even for arrows. I look upon it as the most deadly fruit of human ingenuity."

What is meant by the diversion of nuclear materials into weapons production? There are two separate concerns. One is that countries that do not yet possess nuclear weapons will manufacture them using materials associated with electricity generation. The other and quite distinct concern is that sub-national groups will obtain nuclear materials with which to make weapons. Obviously, measures to prevent one of these activities should not be expected necessarily to prevent the other, although critics sometimes confuse the two.

Nuclear explosives consist of the same "fissile materials" whose fission energy is converted to electricity in nuclear generating stations. Thus, uranium can be used as the raw material for producing nuclear explosives instead of fuel for power reactors in

the same way that crude oil can be used to produce napalm instead of furnace oil. In either case, the raw material has to be specially processed to make weapons.

The fissile material for a weapon would be chosen from one of the following three: uranium-233, uranium-235 or plutonium-239. The only one occurring naturally in useful amounts is uranium-235, present as 0.7 per cent of all natural uranium, which is far too dilute for making weapons.

Until recently only countries with nuclear weapons have had the capability to concentrate uranium-235. They have used a process of gaseous diffusion, for which the key technology is still largely secret, in huge, costly plants that consume as much electricity as a large city.

In recent years, simpler processes such as the centrifuge, aerodynamic and laser methods have raised the possibility of smaller, less costly and less easily detected enrichment plants.

It can be argued that any increase in enrichment capacity increases the accessibility of enriched uranium. Any industrialized country could, however, enrich uranium if it wished, and this capability may soon extend to less developed nations and even sub-national groups. Thus, while the magnitude of the problem may be affected by the introduction of enrichment plants, the problem itself exists regardless of whether nuclear energy is exploited for peaceful purposes.

The other fissile materials, plutonium-239 and uranium-233, are produced in uranium and thorium fuels, respectively, in nuclear reactors. Fissile material is a by-product of producing electricity from a power reactor, but a "production reactor" specifically designed to produce fissile material, or even a research reactor, would be cheaper to build and easier to less than one per cent of the irradiated fuel and cannot be used for weapons unless chemically separated from the highly radioactive fuel at a processing plant.

Thus, to provide the explosive for a nuclear weapon one needs either an enrichment plant or the combination of a reactor and a processing plant.

The basic principles of nuclear weapons are simple and widely known. The same can be said of aircraft, missiles, and biological or chemical weapons. Detailed design and manufacture of all these, however, are highly sophisticated. Although the details for nuclear weapons are still secret, enough has been published to indicated what would be required.

In discussing countries that <u>may</u> acquire nuclear weapons, one should distinguish between two distinct categories since they require different responses: On the one hand, those that aspire

to major power status (comparable to the US, the USSR, the UK, France and China) and that would therefore require fully developed nuclear arsenals; on the other hand, small countries that might want to possess one or two nuclear weapons, perhaps for prestige, to threaten their neighbours or to deter aggression. A country in the first category would require an efficient nuclear-weapons industry capable of producing tens or hundreds of weapons per year. (The US arsenal, for example, contains tens of thousands of nuclear weapons.) It would seek sophisticated weapons with an explosive yield that can be reliably predetermined and demonstrated in tests. Such capability cannot be concealed.

A country in the second category might be interested in a few cheap weapons, even though these were unreliable and untested, without having the capacity for sustained production. Such a country could conceivably be interested in diverting fissile material from a civil nuclear program into weapons at short notice. While there can be no complacency over the existence of even a single nuclear weapon, the difference in magnitude of the threats posed by the two categories is enormous. Only the first has the potential for widespread destruction, the so-called "Doomsday Scenario"; the second could cause serious, but limited and localized, harm. The human suffering that could result from a few nuclear weapons is comparable to that from conventional wars, or even internal oppressions, already recorded in history. It is always possible for a local war to escalate and so involve the major powers, but it seems as likely that a conventional war affecting their own vital interests, e.g., oil supplies, would provoke such an escalation.

Despite the major differences between nuclear weapons and power reactors there is concern that the existence of a domestic nuclear power program could make the subsequent acquisition of weapons easier. However, there is little hard evidence that this factor is important in practice. Currently there are five nuclear weapons countries, all permanent members of the UN Security Council. In addition, in 1974 India demonstrated its capacity to detonate a nuclear explosive. None of these countries used fuel from a power reactor in developing its weapons capability, although the US has since announced that this is technically possible. Indeed, all except India tested their first weapon several years before operating their first nuclear power station.

The period 1945 to 1954 produced three nuclear-weapons countries before there was any commercial nuclear power; by 1965 two more nuclear-weapons countries had been added while the installed commercial capacity had reached nearly 5000 megawatts; in the 14 years since then only one further country, India, has demonstrated a possible weapons capability while commercial nuclear power has now passed 100,000 megawatts in 22 countries. Thus, whatever may be the fears, the facts do not support any belief that weapons proliferation accompanies the spread of civilian nuclear power stations.

Today, perhaps 20 to 30 countries have the technical capability to make nuclear weapons if they wanted to do so. The availability of uranium is no real problem since it is relatively abundant and widespread. However, technical ability is not the only factor determining which countries develop nuclear weapons, and may not even be the major factor. The political will to acquire and if necessary to use nuclear weapons is at least as important and it is far from obvious that this should be taken for granted. Several countries have had the technical capability for decades but have elected not to exercise the option, e.g., Canada, Sweden, Switzerland, Belgium and the Netherlands. Presumably these countries have evaluated the costs and risks as well as the benefits of developing nuclear weapons and have decided that this course is not in their own best interests.

Unpalatable though it may be, the fact is that the prolifertion of nuclear weapons cannot be prevented by technical means alone. Even if all peaceful uses of nuclear energy were suspended immediately, the problem of nuclear weapons would still be with us.

In late 1945, just four months after the explosion of the first nuclear weapon, the US, the UK and Canada jointly called for international control, under effective safeguards, through the United Nations, of both military and peaceful applications of nuclear energy. However, even at that early stage, they recognized that "no system of safeguards will of itself provide an effective guarantee against the production of atomic weapons, or of new methods of warfare". Unfortunately, an inability to reach agreement with the USSR resulted in a stalement in efforts to achieve international control from the outset.

The US then adopted a policy of strict secrecy and non-cooperation with all other countries including her former wartime allies, confident in the belief that her monopoly on nuclear weapons' technology was secure. The fallacy in this policy was demonstrated dramatically in 1949 when the USSR exploded her first atomic bomb. The UK and France followed suit in 1952 and 1959, respectively. It was then still possible to believe that only major powers with a strong technological infrastructure (or alternatively a brilliant espionage system) could development a nuclear weapons' capability. This comforting illusion was shattered by China's and India's explosions in 1964 and 1974, respectively. Once something has been shown to be possible it is only a question of time until others possess the capability. Secrecy can delay but not prevent the spread of a technology.

In 1957 the UN founded the International Atomic Energy Agency (IAEA) to administer all aspects of the international collaboration to promote the peaceful uses of atomic energy. To deter diversion of the technology and materials to military applications the IAEA introduced a system of "safeguards". However, it was recognized from the start that these safeguards alone could not prevent diversion but could only detect it if it occurred and hence act as a deterrent.

The founding of the IAEA acknowledged the essential duality of nuclear energy with its capacity for both military and peaceful applications. If one ignores the peaceful applications, the control of nuclear weapons presents a problem no different from that of controlling any other weapons system, including chemical and biological agents. Inclusion of the peaceful applications opens up the possibility of a bargain in which a country may acquire the peaceful benefits if it will forego the military applications. As part of the bargain the country agrees to accept international inspection of its nuclear installations, a step without parallel in attempts to control other weapons systems. Once assistance is accepted, and unless the country achieves a completely independent nuclear industry, its own domestic energy supply becomes a hostage to observance of its undertaking to forego military applications. The possibility of an embargo on nuclear aid, fuel and other supplies, with a resulting shutdown of nuclear electric generating stations, or of an even broader trade embargo, would be a powerful deterrent against breaking the undertaking.

The system of safeguards introduced and operated by the IAEA during the 1960s still had its weaknesses. The next step in the evolutionary process was the UN's Non-Proliferation Treaty (NPT), which came into force in 1970. This treaty requires tht nuclear-weapons countries negotiate in good faith toward the cessation of the nuclear arms race, nuclear disarmament and the goal of complete disarmament; that they do not furnish nuclear weapons to countries in the peaceful development of nuclear energy. In return, a non-nuclear-weapons country agrees not to acquire nuclear weapons or any other nuclear explosive device; and to accept IAEA safeguards with their associated inspections, for all relevant facilities within its territory, under its jurisdiction or carried out under its control anywhere.

The NPT has overcome some of the deficiencies in the earlier arrangements, but it is not perfect. Indeed, no technical or institutional procedures can ever guarantee that nuclear weapons will remain restricted to those countries that already have them. The NPT is supported by most of the world's countries with 107 parties early in 1979, but there are still several countries with important nuclear programs that have not signed. Some of these countries nevertheless accept IAEA safeguards and inspection. France, though not a party, has stated that she will behave as though she were one.

While refusal to ratify the NPT may give rise to suspicion over the country's intentions it must be realized that there is widespread criticism of the NPT, particularly among some Third World countries. At the NPT Review Conferences in 1975 and 1980 there were accusations that the treaty represented an East-West conspiracy to deny development opportunities to the Third World, and furthermore, that the nuclear-weapons countries were not

living up to their commitments under the NPT. Under these circumstances it cannot be taken for granted the NPT will win continuing support from all its present parties, let alone attract new supporters.

Imperfect as the NPT may be, one has only to imagine a world without any agreement to control the spread of nuclear weapons (regardless of whether there be any peaceful applications) to appreciate the need to improve some aspects of the existing treaty so that it may be more acceptable to both existing and potential parties.

The word "safeguards" has been potentially misleading since it was first used by the UN in 1945. The average individual, unaware of any special meaning, could be expected to believe that safeguards offer some assurance of preventing misuse of nuclear materials, whereas all that is claimed for them is that they should be capable of detecting and and hence deterring any diversion of these materials. It is only when the limitations of safeguards of clearly recognized that the need for complementary political actions, such as sanctions against those detected diverting nuclear materials, becomes apparent. Safeguards can be compared to a burglar alarm. On its own, a burglar alarm can only detect crime and cannot prevent it, but can act as an effective deterrent.

In combatting weapons proliferation, safeguards mean a system of procedures with suitable equipment that provides, through IAEA inspectors, independent confirmation that a country operating nuclear facilities can properly account for all relevant fissile material. Accounting procedures, with frequent stock-taking and reporting, form the basis for international safeguards. These are supplemented by containing the fissile material within secure confines and by surveillance of any access routes penetrating the containment. A variety of technical methods support these objectives. For instance, irradiated fuel bundles can be loaded into a cage in the presence of an inspector who would then close it with a tamper-proof seal. On subsequent visits he would merely have to check that the seal was undisturbed to assure himself that no bundles had been removed. Similarly, automatic, tamper-proof cameras and radiation-detecting monitors can be used to assure that bundles are not taken out by unauthorized access routes. There are many similarities to a bonded distillery where alcohol is produced, processed, dispensed and stored but must not be released without the knowledge of government inspectors. In the case of nuclear safeguards, much more sophisticated methods are available partly because radioactive materials are much more difficult to conceal than alcohol.

Absolute accuracy, and hence confidence, in accounting is possible only when it is done by counting individual objects, such as dollar bills, gold bricks or fuel bundles. Where accounting is by

weighing or measuring, however, there are inevitable uncertainties in the result. There are inherent limits to the accuracy of any method used (for instance, a balance robust enough to weigh a gold brick is probably not precise to less than half a gram) and repeated determinations will yield a range of values distributed statistically about an average. In safeguarding nuclear materials, the difference in weight (whether positive or negative) between what is believed to be present from the accounts and what is found to be present by stock-taking is referred to as "Material Unaccounted For", or MUF. Some MUF is inevitable and to be expected; media reports or "losses" generally refer to MUF. If stock-taking were to be performed at Fort Knox one would expect the number of gold bricks to check exactly but a discrepancy of one gram in several hundred bricks would not be at all surprising in view of the weighing errors. Indeed, with the safeguards on the access routes at Fort Knox a MUF of this magnitude is more likely to represent accounting error than diversion.

The MUF in the nuclear industry is expected to be greater than that at Fort Knox for several reasons, including: the amount of fissile material produced and consumed in a reactor has to be calculated or estimated from samples; irradiated fuel must be weighed remotely behind shielding and allowance made for the structural material in the fuel bundle; the fissile content of solutions has to be calculated from analyses with their own uncertainties; and more processes are involved with the consequent production of wastes in which the amount of fissile material can only be estimated. However, the IAEA inspector can use statistical techniques and other information including surveillance records to determine whether the MUF in a particular plant is reasonable in the light of his experience with similar operation. If there is cause for suspicion further investigations or more frequent inspections may be warranted.

Apart from these technical safeguards, more conventional means should not be ignored in deciding whether a country has embarked on a nuclear weapons program. A sizeable program would be hard to conceal; the cessation of open publications by certain scientists, or the suppression of free international exchange between scientists, would be cause for suspicion, as would be the importing of key materials such as zirconium or high-purity graphite by a country without any overt nuclear program. Satellite-borne infra-red cameras are probably capable of detecting the heat from a production reactor or a diffusion plant for enriching uranium.

In the final analysis, all methods of detecting diversion are ineffective without political will in the international community to invoke sanctions against those who breach their commitment to peaceful uses. Safeguards can deter diversion and the benefits of peaceful nuclear energy can be used as an incentive to discourage weapons proliferation, but neither of these measures offers a

guarantee. The world community must be prepared to take action against any country misusing nuclear energy, and this is true whether or not there are any civilian nuclear reactors.

Within the Canadian contract, technical equipment and procedures already exist for use by the IAEA in safeguarding CANDU reactors. The capacity for on-power fuelling in CANDU reactors required the development of different methods from those suited to the more common Light Water Reactors but, once developed, these methods are no less effective. This question has been specifically examined by two academics, Morrison and Wonder, one from Canada and the other from the US, who concluded that CANDU reactors are no more likely than LWRs to be used for the clandestine production of weapons material.

The rest of the CANDU fuel cycle offers little opportunity for covert weapons production. With the use of natural uranium as fuel there is not need for any enrichment plants from which separated fissile material might be diverted. Similarly, the ability to store the used fuel safely and indefinitely without reprocessing avoids the presence of any weapons-useable material.

These same factors make the present CANDU system virtually impregnable to terrorists. To obtain enough fissile material for a single weapon they would have to seize over a hundred used fuel bundles, weighing over two tonnes. If all these radioactive bundles were in a single shipment they would have to be transported in a massive (50-tonne) shielded container. Without such protection the thieves would be exposed to potentially lethal radiation. The successful seizure of multiple smaller shipments is even less likely. The terrorists would then have to transport this heavy container on specially constructed vehicles, by road or rail, to a previously built reprocessing plant in order to extract the fissile material and make a weapon. A minimum sized plant would have to be operated for several weeks or months to process enough fuel, while a larger plant would have been much more difficult to have built surreptitiously. It is simply not credible that all this could be done without any intervention by the police or the armed forces.

The heavy water moderator enabled CANDU reactors to produce more new fissile material per unit or electricity produced than other commercial power reactors. This feature, which can help to conserve uranium, has led to the mistaken claim that used fuel from CANDU reactors would be more attractive than light water reactor fuel to those wishing to make weapons. In fact just the opposite is the case since the concentration of plutonium in used CANDU fuel is about half that in Light Water Reactor Fuel. Both fuels have closely similar concentrations of the heavier isotopes that complicate the design of nuclear weapons. Thus both are regarded as "high burnup" fuel and neither is specially attractive for weapons production.

Along with the rest of the world Canada is examining fuel recycling as a means of reducing the demand for uranium. The good fuel economy of CANDU reactors means that the need for commercial reprocessing is less urgent in Canada than in some other countries. Thus, Canadian work on fuel recycling will remain at the laboratory level pending further government decisions. However, when required, CANDU reactors can exploit fuel recycling to yield a virtually inexhaustible fuel supply, without having to introduce Fast Breeder Reactors which represent a completely new reactor type. If a plant for recycling used fuel were to be built it might increase the vulnerability to theft of fissile material to some extent, dependent on the protective measures instituted. The recycled fuel for CANDU reactors would contain only very low concentrations of fissile material, around one per cent, and so would not be immediately weapons-useable. Also current investigations are aimed at reducing any possible access to fissile materials. For instance, in Canada it has long been assumed that if fuel were to be recycled the plutonium recovery and its fabrication into fresh fuel would be done in adjacent plants, avoiding the need for shipment of separated fissile material on public highways. More recently, it has appeared technically possible to recycle the fuel without ever separating fissile material, by a method termed "coprocessing". Other techniques are being developed and tested for instantaneously accounting for fissile material through the use of computer-aided equipment, and for detecting amounts of plutonium less than one gram by door-way monitors on all access routes to fuel recycling plants. But most important, fuel recycling would not be introduced unless adequate protection is available.

Finally, there is the question of whether Canada should export nuclear reactors and other related equipment, materials and technology. The concern here, of course, is that we could be increasing the probability of the proliferation of nuclear weapons. However, even if all nuclear suppliers, including Canada, denied exports, and even if all existing reactors were shut down immediately, the stock-piles of nuclear weapons and the knowledge of how to make them would remain. Thus the basic problem of nuclear weapons would still be with us. Worse, a scarcity of energy resulting partly from a denial of nuclear energy could precipitate the conflict we are striving to avoid. The real question is whether the developing countries will introduce nuclear energy openly, with our help and hence under international inspection, or on their own, not subject to inspection, and perhaps even surreptitiously. The only responsible course is that inherent in the Non-Proliferation Treaty - to export nuclear energy to those countries that have the means to benefit from it, provided that they accept internationally agreed safeguards, and at the same time to work for international political agreements on nuclear weapons to complement technical safeguards. And that is exactly what Canada is doing.

Peaceful nuclear energy not only provides an incentive for those countries willing to forego nuclear weapons. By relieving the pressure on world oil supplies it contributes to international stability. In both these ways it is a positive factor for world peace.

Archie Robertson

FYI

Canadian Fusion Project (Tom Drolet)

In late March this year an agreement was signed between the federal government, the Ontario government and Ontario Hydro to establish a Canadian Fusion Fuels Technology Project (FFTP).

Until now, Canada has been involved in the development of fusion power by concentrating on some aspects of the physics of plasmas and the diagnostics required to measure plasma content and stability. The effort has been primarily within the National Research Council of Canada and at universities across the country. Hydro Quebec and the National Research Council have recently established a programme to build a Tokamak at Varennes near Montreal. The objectives of this programme are to aid in the development of a quasi-steady-state fusion machine technology and to develop and apply advanced diagnostic methods.

The latest initiative, resulting in the FFTP agreement, will bring Canada into the development of fusion power system technolgies by concentrating on well-defined areas. The prime areas of focus for this jointly-funded programme will be the fusion fuel cycle itself, with emphasis on the development of tritium management system technologies. Other areas to be covered in some detail will be remote maintenance, materials developments and environmental pathways analysis for tritium. The rationale for concentrating on these areas is Ontario Hydro's experience with the CANDU fission reactor system, a by-product of which is tritium, produced in the heavy-water coolant and moderator. Recently the decision was made to remove this tritium and concentrate it using a combination of catalytic exchange and cryogenic distillation. The concentrated tritium will be stored on metal beds.

Canada believes that the existing knowledge it has in living with substantial amounts of tritium in large engineered systems, together with the design and operating experience gained from the development of tritium removal systems, will be of benefit to the people in the world's fusion power programmes and will help Canada establish herself as a serious contributor to this developing power system.

Ontario Hydro will act as Programme Manager for this new venture which will involve essentially a $20 million programme over the next 5 years.

Guerrillas Kill Nuclear Plant Director (New York Times)

Separatist guerrillas killed the director of a nuclear plant in Spain's Basque region May 5 in an apparent attempt to stop it from coming into operation, but the government said the project would go ahead. Police said Angel Pascual Mugica, 45 years old, was riddled with 20 submachine-gun bullets as he drove to work with

his 18-year-old son who was injured slightly. Four bodyguards following in a car returned fire, apparently wounding one of the two gunmen who escaped in a waiting car.

Bruce "A" Gets Go-Ahead for Full Power Tests (Staff)

The Atomic Energy Control Board has announced that Ontario Hydro has been authorized to conduct a series of short term tests, each of no more than 24 hours duration, of the Bruce "A" reactors at levels of up to 100 per cent of rated thermal power. Until now the station has been restricted to 88 per cent of full thermal power, the level at which the station generates 100 per cent of its electrical power output. Commenting on the Board announcement, Bruce Production Manager Bob Coutts said that this represented "a major step forward" in development of the full potential of the Bruce Energy Centre. He noted that testing of Unit 1 would probably take place towards end of the month, with the reactor being brought up to about 96 per cent full thermal power.

India to Start Producing Plutonium (New York Times)

India is preparing to begin reprocessing atomic waste at a plant designed to produce weapons-grade as well as fuel-grade plutonium, it was announced in New Delhi last month. The Department of Atomic Energy said in a report to parliament that "preparations are on to start reprocessing of the power reactor fuel at the reprocessing plant in Tarapur to recover plutonium." The report said the plutonium produced would be of fuel grade, but an Indian nuclear scientist who did not want to be identified said last year that "the reprocessing plant has been so designed as to produce both weapons-grade or fuel-grade plutonium, depending on what the government wants." Trial runs of the Tarapur reprocessing plant were carried out during several months last year. The plant is near Bombay, in northwestern India.

First Hand Operational Experience (David Beattie)

A highlight of the June 23 conference on the Human Dimension in Energy Technology will be Jim Ryder's keynote address. Former manager of the Pickering Nuclear Generating Station, Mr. Ryder is now Ontario Hydro's Group Manager - Staffing. With his combination of first-hand experience in running one of the world's best performing nuclear stations and dealing with the problems of recruiting and training people to work in the complicated and challenging environment of a nuclear installation Mr. Ryder will be able to provide the conference with some unique insights into the problems and the opportunities presented by the man-machine interface as seen from "the sharp end" of operations. Jointly sponsored by the Canadian Nuclear Association and the Human Factors Association of Canada the conference aims to improve the communication between those involved in nuclear design and operations and human factors practitioners.

GPU Reaction to TMI Restart Referendum (Atomic Industrial Forum)

In a non-binding referendum that was part of primary elections, voters in threee countries near Three Mile Island voted May 18 by a two to one margin to oppose the restart of TMI unit 1. General Public Utilities has issued the following statement in regard to the vote:

"The results of the referendum appear to reflect the complexity of the restart question as most people perceive it. Of the total adult (over 18) population in the three counties, 85 per cent of the people chose not to express themselves on the referendum. Those who voted "no" represented only 10 per cent of the adult population in the three counties. In the actual voting, the referendum apparently had no effect in drawing voters to the polls. Participation in the referendum ran behind the overall turnout of about 30 per cent of the registered voters. Only 26 per cent of the registered voters expressed themselves on the referendum, and only 17 per cent of the registered voters expressed opposition to the restart. To put it another way, a large majority of the registered voters -- 74 per cent -- did not participate in the referendum and an even larger percentage of the eligible adult population -- 85 per cent -- chose not to express an opinion.

"GPU Nuclear did not actively participate in the referendum campaign. The results, though, are fully consistent with the position that GPU Nuclear has taken on this referendum from the start -- that a simple "yes" or "no" vote is not appropriate to decide so complex an issue as the restart. The issue is, and remains, the safety of unit 1. The safety issue must be addressed in a careful, thorough manner. The established procedure for doing that is through the Nuclear Regulatory Commission and the Atomic Safety and Licensing Board. GPU Nuclear will continue to cooperate fuly in that process. We have always said we are not in favour of restart until all the safety issues are resolved. The referendum results were not a resounding expression of public concern against the restart of TMI Unit 1. Rather, they showed that a large majority of the eligible voting population chose, for whatever reason, not to be heard on the issue. We take that as at least tacit recognition of the complexity of the issue among many people in the area around TMI".

Nuclear Fuel Design (EPRI Annual Report)

To expand the operating limits of nuclear fuel assemblies, suppliers have redesigned fuel bundles. The new, larger fuel arrays have improved heat transfer characteristics, but NRC requires pre- and post-irradiation measurements of dimensional changes in fuel rods and bundles before the new assemblies can be approved for extended operating limits. EPRI funded research by Combustion Engineering Inc. to precharacterixe fuel pellets and rods and take post-irradiation measurements of the new 16 x 16

fuel assemblies. An irradiated fuel inspection stand was also developed to gather data from irradiated fuel at Arkansas Power & Light Co.'s ANO-2 nuclear unit and other reactors. AP&L now has sufficient data to verify fuel design margins for expanded operating limits. AP&L estimates its savings will be $1.9 million by 1983. Similar PWR plants with 16 x 16 assemblies will be able to use the data from this project to avoid possible lengthy licensing reviews of this new fuel configuration.

CNS NEWS

CNS Annual Conference

Professor Umberto Colombo, guest speaker at this year's luncheon session, has entitled his talk "The Future of Electricity in the Economy and Society." Professor Colombo believes that nuclear power will be a growing segment of the energy matrix for most of our societies. Nevertheless, he also sees an important role for other technologies and his own agency's mandate has been broadened to include alternatives to nuclear electricity. He stresses the flexibility of electricity and its ability to substitute for other energy forms that may become obsolete or in short-supply.

A plenary session titled "The Role and Qualification of Nuclear Plant Operators - A Reassessment" will be held in the afternoon. This issue is central for nuclear plant managers. It also involves the plant designer through his impact on the operator's role. Finally, it involves the regulator through his audit and approval function.

One of the speakers in this session will be Jim Ryder, Manager of Ontario Hydro's Nuclear Training Department and formerly Pickering Station Manager. He feels we have to do a better job of matching training to the tasks an operator has to perform in the real environment of a nuclear station. Perhaps the industry has inadvertantly projected an image of demanding more from people than is humanly possible. The expectations of both the operator and the regulatory body may have, therefore, been set at unrealistic levels. Jim notes, however, the whole business of matching operator to environment (the man-machine interface) is still at an early stage of development: "We're still at the stage of getting to know how to make the best use of data processing units, computerized annunciation systems, computerized serveillance systems - I think we've really only scratched the surface."

Another panelist will be Mr. Fred Davediuk, Manager of Operator Certification and Research Facility Licencing for the Atomic Energy Control Board. He sees possible improvements in the man-machine interface and feels it's important to ensure that knowledge keeps pace with changes and modifications to specific plants. The ball, however, must remain firmly in the utilities' court and the Control Board's program requirements are designed only to ensure a minimum standard of satisfactory operation.

Mr. R. M. (Bob) Koehler and Mr. K. A. (Ken) Strahm, both from the US, also will be panel members. Bob is Manager of Technical Training at Duke Power, NC. Bob will address several issues of current interest to Duke Power. "We have some very strong opinions," says Bob, "for example, with respect to college training requirements for operators. We feel that industry people must make their substantial knowledge of these topics known."

Ken Strahm is Manager of Human Resources Development at the Institute of Nuclear Power Operations, Atlanta, GA. Ken will concentrate on the training of operators, in particular the differences between Ontario Hydro and U.S. training systems. He will then present his evaluation of how operators actually should be trained.

The session Chairman is Dan Meneley, Group Manager (Nuclear) in Hydro's Design and Development Division and Chairman of this year's CNS Annual Conference. "Designers sometimes complicate an operator's life", Dan says, "In the design stage we must think carefully about his role and must simplify his job as much as we can. This does not man we should try to make the plant idiot-proof, but only that his correct response should become simpler as the importance of the task increases and as the time he has to respond decreases."

P.J. Armstrong

Conference Organizing Committee

CNS Questionnaire -- Summary Report

A total of 237 people responded to the questionnaire of which 162 were members and 75 non-members.

The interim results are tabulated below.

Comments:

1. There appears to be a significant number of technically competent persons among the membership in every technical area listed. These persons are being listed and can expect to be asked to review papers in their fields of competence.

2. The interest and competence numbers do not always agree. Areas where additional information should be most useful are probably those where the interest is high and the competence relatively low. For example the area of the first CNS International Conference - Radioactive Waste - seems to respond to a real need.

3. The answers to 2 a) b) and c) reflect the expected preference for reading and hearing rather than writing and publishing papers.

4. The CNS executive has noted the interest in printed material and is gearing up to start publishing our own technical journal in about a year's time.

5. The interest shown in small group discussions is being catered to by CNS to date through Branch and Technical Division activities. The success of these efforts and their future development will depend on membership response.

Statistical Results of CNS Questionnaire

		TECHNICALLY COMPETENT	TECHNICAL INTEREST
A.	**Nuclear Science & Engineering Division**		
1.	Reactor Physics	26	28
2.	Reactor Thermal-hydraulics	25	45
3.	Control Systems	35	49
4.	Nuclear Generating Station Plant Simulation	35	45
5.	Other Nuclear Plant Simulations	6	17
6.	Mathematics & Computation	34	37
7.	Isotopes and Radiation	28	48
8.	Advanced Fuel Cycles	17	61
9.	Other Areas	19	22
B.	**Design & Materials Division**		
	Design		
1.	Civil/Structural	8	9
2.	Process/System	22	25
3.	Mechanical	31	24
4.	Electrical	11	12
5.	Control and Instrumentation	26	29
6.	Equipment/Component	15	17
7.	Piping	14	18
8.	Other	10	10
	Materials		
9.	Application to nuclear systems	15	43
10.	Application to conventional systems	16	15
11.	Welding and joining	11	19
12.	Non-destructive testing	14	29
13.	Other	6	6
C.	**Mining, Manufacturing & Operations Division**		
	Mining		
1.	Geology	5	17
2.	Uranium exploration	3	20
3.	Mining engineering	7	13
4.	Ore processing	11	19
	Manufacturing		
5.	Product design development	13	16
6.	Manufacturing engineering, Process development	11	13
7.	Quality control	18	18
8.	Plant engineering & maintenance	22	24

C. Mining, Manufacturing & Operations Division (Cont'd)	TECHNICALLY COMPETENT	TECHNICAL INTEREST
Operations		
9. Commissioning techniques	40	48
10. Quality Assurance	23	23
11. Fuel Management	12	20
12. Maintenance Engineering	30	35
13. Planning Techniques	25	18
14. Information Retrieval	20	19
15. Manpower Management	16	16
16. Heavy Water	11	29
D. Environmental Health & Public Affairs Division		
1. Effect of ionizing radiation on humans	21	62
2. Effects of releases of radiation to the environment	24	62
3. Environmental pathways analysis	15	43
4. Occupational and public dose issues	16	56
E. Radioactive Waste		
1. Conditioning of nuclear materials packaging, transportation and storage	24	46
2. Manufacturing engineering processes development of nuclear materials	8	29
3. Quality Control, reliability and maintainability	10	22
4. Disposal of Low and Medium Level fuel cycle waste	19	51
5. Disposal of nuclear fuel cycle waste	21	63

2. Program Planning

Please indicate your answers to the following questions.	YES	NO
a) Would you like to have more chances for technical discussions in your areas of interest and technical competence?	101	11
b) Would you like to have more chances for publication of papers in your areas of interest and technical competence?	49	40
c) For your technical information would you like to see more		
- printed material?	70	19
- small discussion groups?	88	10
- large technical meetings?	43	25

J. Howieson

CNS BRANCH PROGRAMMES

Ottawa Branch

The meeting of the Ottawa Chapter scheduled for March 31 had, unfortunately, to be cancelled as the guest speaker, J. G. Russell of CANATOM, was unexpectedly out of the country. His talk on "Overseas Projects" will be rescheduled for the fall.

On April 28 about 50 members and guests heard Jon Jennekens, President of the Atomic Energy Control Board, speak on the status of international safeguards. Jennekens addressed the subject not only from his present and past positions with the AECB but also from his role as Chairman of the IAEA's Senior Advisory Group on Safeguards Implementation.

The last meeting of the season will be held May 26 when A. R. Bancroft of AECL-CRNL will report on studies for the application of nuclear energy to extraction of petroleum from oil sands.

F.C. Boyd

Toronto Branch

While he was careful to note that he didn't have any "good news", John Boulton was guardedly optimistic about prospects for a CANDU sale to Mexico when he spoke to the Toronto Branch May 20. "We're in there with a fair chance" he told the meeting, "and we could well be successful". Dr. Boulton, AECL International's Director of Technology Transfer and Proposal Production, presented an informative and incisive outline of the trials and tribulations attendant on preparing a very complex proposal, and the subsequently even more trying tribulations involved in responding to questions raised by evaluation teams whose experience was almost totally with light-water reactors. There was, Dr. Boulton noted, very little understanding of the CANDU system by these teams who, it seemed, at times forgot that a major criterion Mexico established when calling for proposals was that all reactors should be licensable in the country of origin. A generally gloomy world economic climate, combined with an oil glut, meant that the future of Mexico's originally very ambitious plan for nuclear development (20,000 MW by 2000) was now questionable, Dr. Boulton warned, but at the same time it was important to note that since all bids expire on August 1 and no bid extensions had been requested, the indications were that an announcement was not too far away. Dr. Boulton saw further grounds for optimism in the fact that Mexico attaches great importance to the technology transfer aspect of its proposed reactor purchase, and "I don't think any other supplier can match the Canadian technology transfer proposal."

Boulton's lecture was the concluding meeting for the Toronto Branch Spring programme. At the moment the fall programme is being put together and full details will appear in the next Bulletin.

Arthur Guthrie

CONFERENCE & MEETINGS

22nd Annual International Conference of the CNA

Sponsored by the CNA, to be held at the Royal York Hotel, Toronto, **June 6-8** , with **Nuclear Show '82** , **June 6-9** . Further information from the **Canadian Nuclear Association, 111 Elizabeth Street, 11th Floor, Toronto, Ontario, M5G 1P7** .

3rd Annual Conference of the Canadian Nuclear Society

Sponsored by the CNS, to be held at the Royal York Hotel, Toronto, **June 9** . Further information from **Dr. D.A. Meneley, Ontario Hydro, 700 University Avenue, H16 A3, Toronto, Ontario, M5G 1X6** . Also, see CNS News section of this Bulletin.

CAMS Annual Meeting

The recently formed Canadian Applied Mathematics Society will be holding its annual meeting in Edmonton, **June 21-23** . The meeting will include a symposium on manpower shortage and its impact on the mathematical sciences. Registration is $35 ($15 students) and fees should be sent to **Professor H. Freedman, Department of Mathematics, University of Alberta, Edmonton, Alberta, T6G 2G1** .

Human Factors in Control Room Design and Operation

The Human Factors Association of Canada in conjunction with the Canadian Nuclear Association will be holding a one-day conference at Toronto's Constellation Hotel, **June 23, 1982.** For information call:

The Canadian Nuclear Association, (416) 977-6152, or
The Human Factors Association of Canada, (416) 675-2235.
See also FYI section of this Bulletin.

The Hazards of Low-Levels of Ionizing Radiations

A one day course sponsored by the Canadian College of Physicists in Medicine, to be held at Queen's University, Kingston, Ontario, **June 24, 1982.** Further information from **J.R. Cunningham, Physics Division, The Ontario Cancer Institute, 500 Sherbourne Street, Toronto, Ontario, M4X 1P9** .

International Meeting on Thermal Nuclear Reactor Safety:

Sponsored by CNS, ANS, ENS and JAES, the meeting will be held at Chicago, Illinois, **August 29 to September 2, 1982.** Further information available from **Jan B. van Erp, Co-Chairman, Technical Program Committee, Argonne National Laboratory, Bldg. 208, Argonne, IL 60439.**

Uranium '82

In conjunction with the Canadian Nuclear Association the Hydrometallurgy Section of the CIM Metallurgical Society is holding its 12th Annual Hydrometallurgical Meeting at the Royal York Hotel, Toronto, from **August 29 to September 2, 1982** . For information contact:

Dr. I. J. Itzkovitch, Eldorado Nuclear Ltd., 400-255 Albert Street, Ottawa, Ontario, K1P 6A9, Phone: (613) 238-5222 .

International Conference on Radioactive Waste Management

An International Conference on Radioactive Waste Management, sponsored by the Canadian Nuclear Society, will be held in conjunction with the Annual Information Meeting of the Canadian Nuclear Fuel Waste Management Program on **September 12 to 16, 1982** at the Winnipeg Convention Centre, Winnipeg, Manitoba. The object of this conference is to present all aspects of the Canadian Waste Management Program in an international context. For additional information please contact the **Canadian Nuclear Society, 111 Elizabeth Street, Toronto, Ontario, M5G 1P7 or phone (416) 977-6152.**

Decontamination of Nuclear Facilities

Sponsored by the CNS, the CNA and the ANS the conference will be held at Niagara Falls, Ontario, **September 19-22, 1982.** Further information from **Eric LeSurf, London Nuclear Services Inc., 2 Buffalo Avenue, Niagara Falls, N.Y. 14303** .

A Symposium on the Assessment and Perception of Risk to Human Health in Canada

Sponsored by the Royal Society of Canada and the Science Council of Canada, to be held at the Ontario Science Centre **October 18-19, 1982** . Further information from **Laurier Forget, Conference Services Office, National Research Council of Canada, Ottawa, Ontario, K1A 0R6** .

Thermalhydraulics for CANDU Reactors

A course sponsored by AECL, Ontario Hydro, CNS and the McMaster Institute for Energy Studies. To be held at McMaster University, Hamilton, **December 13-17, 1982** . For information contact: **Dr. Jack Kirkaldy, McMaster Institute for Energy Studies, 1280 Main Street West, General Sciences Room 203, Hamilton, Ontario, L8S 4K1.**

THE UNFASHIONABLE SIDE

One of the news items that will not be seen this year

The Canadian Home Insulation Programme should be halted immediately, a moratorium placed on all thermal insulation activities, and urgent steps should be taken to decommission the insulation installations in existing homes. These three principal recommendations headed up an open letter to the Minister of Energy from Toronto Home Energy Requirement Measurement Inc. (THERM), the well-known energy activist group. "Already we have what amounts to a public health disaster" noted THERM's Chairperson Frank Quills in an accompanying news release, "countless Canadian citizens are suffering from the effects of deadly releases from urea-formaldehyde insulation." In addition to an insulation moratorium, Mr. Quills said THERM would be pushing for a wide-ranging public enquiry into all aspects of thermal insulation. "For too long the politicians have been content to accept glib statements from scientists and engineers about how conservation is the cheapest energy source," said Mr. Quills "but they've deliberately ignored the massive environmental and public health costs." THERM has long opposed thermal insulation programmes, but with little effect until controversy erupted over urea-formaldehyde insulation earlier this year. But now, Mr. Quills feels, THERM will be able to mobilize public support for the abandonment of "this costly and uniquely hazardous energy technology."

Energy Policy Planning -- a new approach

"A major step forward in the democratization of energy policy formulation" was how Dr. William Spineways described Aphasia University's three-day conference on the People's Energy Policy. Dr. Spineways is chairman of the University's Department of Environmental Sociology which sponsored the conference, and he's widely regarded as one of Canada's leading experts in policy planning. "Traditionally, energy policy formulation has remained in the hands of a small group -- politicians and self-appointed "experts" -- but now we think it's time to change that" Dr. Spineways says. He explains that the three day conference was particularly valuable since in brought together a wide variety of people from a wide range of occupations "and this meant that the whole question of energy policy formulation could be explored from a fresh perspective." The major achievement of the conference, Dr. Spineways feels, was the decision that the general public should have some say in establishing fundamental quantities and values such as the acceleration due to gravity or the latent heat of vaporization of steam. "This sort of decision is too important to leave to scientists alone" says Dr. Spineways, "we must democratize the whole process." Accordingly, Aphasia University is launching a nationwide referendum which will ask all voting-age Canadians to rule on the following proposals:

- The acceleration due to gravity should be reduced by 50%, except in the vicinity of hydraulic generating stations. Not only will immense energy savings in the transportation sector be effected but also death and injury rates in the construction industry should be reduced.

- Rolling friction will be abolished.

- The latent heat of vaporization of H20 will be reduced to 200 calories per gram.

- The heat output of Western Canadian coal to be doubled to 18,000 Btu/lb.

- To discourage further nuclear expansion the energy release from fissioning uranium will be reduced to 50Mev per fission.

It is understood that Aphasia University has organized a small task force, under the direction of Dr. Spineways, to develop more proposals of this nature. They should do the trick.

Effective Communication

While all professions have had their share in mangling the English language and impairing the flow of information and understanding, the social sciences have, not totally unjustifiably, been generally regarded as the most accomplished practitioners of linguistic mayhem. This view may have to be revised in light of the following memo from Ohio's Summit County Juvenile Court, published in a recent New Yorker:

Guidelines for Correcting Non-Compliance With Established Task Standards

In recent years, there has been an effort to achieve implementation of measurable objectives for departments and sections of court operation followed by establishment of measurable task objectives for individual employees' roles. In many areas, tasks are being monitored on a consistent basis. The problem arises over a plan of action if non-compliance with basic task standards is a chronic problem on the part of the individual. Upon implementation of corrective action, there should be consideration of:

1. The prioritization of the task relevant to the role and the chronicity, seriousness and gestalt of the non-compliance in one or more areas...

If anybody can (a) provide a translation of this, or (b) provide a better example of intellectual sludge and sub-literate lexical encrustation, please write to me, c/o the Bulletin.

Ernest Worthing

Canadian Nuclear Society
Société Nucléaire Canadienne

111 Elizabeth St., 11th Floor,
Toronto, Ont., Canada M5G 1P7

☐ Request For Further Information
(Complete Only Name and Address)
☐ MEMBERSHIP APPLICATION

A. PERSONAL DATA:

Surname: _____ Given Names _____
(underline name used)

Indicate desired mailing address in one of the check boxes:

☐ Home Address: _____ (Street) _____ (City) _____ (Province)
_____ (Postal Code) _____ (Phone Number)

☐ Business Address: _____ (Street) _____ (City) _____ (Province)
_____ (Postal Code) _____ (Phone Number)

B. MEMBERSHIP DATA:

Employer _____

Business Title (if applicable) _____

Please list any Technical or Scientific Societies, Institutes and Professional Associations of which you are a member.

_____ _____

EDUCATION

University, College Institute, etc.	Discipline	Degree/Diploma	Date of Degree or Diploma

Your Association with Nuclear technology

_____

Please indicate the one or two CNS Technical Divisions most accurately reflecting your interests.

A. Nuclear Science ☐
B. Design and Materials ☐
C. Mining, Manufacturing and Operation ☐
D. Environment, Health and Public Affairs ☐

Are you interested in attending local Branch events? ☐ Yes ☐ No

Are you willing to serve as an executive on Canadian Nuclear Society Committees?

Administration	☐ Yes	☐ No
Technical Division	☐ Yes	☐ No
Branch	☐ Yes	☐ No

Previous experience on Committees:

_____

_____ _____
Date (Signature of Applicant)

Language for correspondence _____

C. FEES:

MEMBER: $25.00 for Calendar Year - January 1 to December 31.
STUDENT: $ 5.00 for Calendar Year - January 1 to December 31.
Cheque payable to: CANADIAN NUCLEAR SOCIETY

Canadian Nuclear Society
Société Nucléaire Canadienne

111 Elizabeth St., 11th Floor,
Toronto, Ont., Canada M5G 1P7

☐ Demande pour de plus amples renseignements (Noms et adresse complets)
☐ Demande d'adhesion

A. RENSEIGNEMENTS PERSONNELS:

Nom de famille: _____ Prénoms: _____
(soulignez le prénom usuel)

Cochez la case appropriée pour l'adresse où vous désirez recevoir votre courrier:

Adresse au domicile: _____ _____ _____
(rue) (ville) (province)

_____ _____
(code postal) (numéro de téléphone)

Adresse au bureau _____ _____ _____
(rue) (ville) (province)

_____ _____
(code postal) (numéro de téléphone)

B. RENSEIGNEMENTS PROFESSIONNELS:

Employeur: _____

Fonction (s'il y a lieu): _____

Veuillez indiquer les sociétés ou associations de caractère technique ou scientifiques vous êtes membre.

_____ _____

EDUCATION:

Université, collège, institut, etc.	Discipline	Diplôme	Année décerné

Domaine d'activité ou d'intérêt relié à la technologie nucléaire

_____

Veuillez indiquer **un ou deux** groupes techniques de la SNC qui représentent le mieux vos intérêts.

A. la science nucléaire .....
B. la conception et les matériaux .....
C. l'exploitation minière, la fabrication, l'exploitation des centrales .....
D. l'environnement, la santé et les affaires publiques .....

Vous intéressez-vous à assister aux événements des sections locales? oui non

Désirez-vous participer aux comités de la Société nucléaire canadienne?

Conseil d'administration	oui	non
groupes techniques	oui	non
sections régionales	oui	non

Expérience antérieure comme membres de comité:

_____

_____ _____
Date (Signature du candidat)

Langue de correspondance _____

C. **MONTANT DE LA COTISATION:**

MEMBRE: $25 par année civile - 1er janvier au 31 décembre

ETUDIANT: $5 par année civile - 1er janvier au 31 décembre
(Payable à la Société Nucléaire Canadienne)