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Editorial

The expectation that formulation of public policy should be guided by a thorough assessment of the facts as they pertain to the issues is basic, if one subscribes to the view that in the long run reasoned argument must prevail over "gut feelings."

However, when one attempts to decipher, even at the most rudimentary level, the process that governs formulation of policies as they affect future development of nuclear technology, it becomes obvious that a magician's wand may provide more effective answers than the tools of rational analysis.

Premier Peterson, in somewhat uncharacteristic haste recently declared: "I don't see another Darlington being built." This was in response to a newspaper interview in which the Chairman of Ontario Hydro indicated that a major plant of some type would be required within a decade to avoid future energy shortages.

The Premier's uncharacteristically swift, but perhaps imprudent, response, is consistent with that of a young bride only too willing to please, suspending judgement for a later day. Conservation, rather than building a new multi-billion dollar plant, is Mr. Peterson's preferred solution with nuclear "way down the list of priorities." Such a response betrays an attitude towards nuclear power development in particular, and energy planning in general, that borders on the cavalier.

Conservation has a benign ring to it, which enhances its political acceptability. Whether the desired results, in terms of net energy savings, can be achieved by a large-scale conservation program has yet to be demonstrated. Apart from practical limitations related to technical feasibility, managing the demand side of the energy equation on a scale that would obviate the need for new capacity may well require a massive program of social engineering to modify drastically present values and life-styles.

For the planner, the uncertainty of outcome is always greater when persuasion, and not force or dictatorial authority, is the method available for realizing policy objectives. The concepts of prudence and proportionality as a guide to policy dilemmas for democracies are well recognized. Prudence would dictate that options fraught with risk and with problematic outcomes be thoroughly assessed. Proportionality suggests that action should bear a reasonable relation to its desired consequences, and does not favour, for example, the use of sledgehammers to crack nuts.

The economic and public health risks associated with conservation policies are real, and, potentially severe, if applied in a dogmatic fashion without a clear recognition of limitations and scope. To suggest conservation as a solution to the requirements of the supply side of the energy equation indicates a lack of strategy. To relegate a safe and proven technology with demonstrable economic benefits as an option of last resort in favour of an unproven and untested approach is a journey into wilderness without a compass. Sadly, it would not meet the test of either prudence or proportionality.

It is not clear whether the Premier's response reflects the results of a thorough and detailed assessment of energy policy for Ontario. Given recent international events, public unease regarding matters nuclear has certainly not decreased. Therefore, unconditional support for expansion of nuclear capacity would not be expected. It is equally important, however, that unrealistic options should not be allowed to dominate the agenda simply because they sound mellifluous, appear to be benign and meet the requirements of political expediency. There may well be a good reason for not pursuing the nuclear option any further. Such a decision must be rationally based on a thorough evaluation of all options and a clear understanding of all the ramifications. Rejection of nuclear simply because "I don't like snakes" is neither prudent nor a responsible execution of legitimate political authority.

The Premier's response can be summarized succinctly as follows:

"I do not like thee Dr. Fell,
The reason why I cannot tell
But this I know, and know full well:
I do not like thee Dr. Fell."

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Perspective

Energy and Safety

The following is a condensed version of a presentation by Ernest Siddall to the NDP inquiry into nuclear energy, 1986 November 27 in Toronto.

Industrial development is the proven way to uplift the quality and safety of human life. It has made life safer almost everywhere. As a consequence, the world population will inevitably rise to about 10 billion before it can level off in the middle of the next century. If several billions of people are to be uplifted from the poverty and squalor which is so widespread at present, the direction of industrial civilization offers hope. At the same time, the developed countries will want to advance still further along the same road. All this can only mean that much more energy will be needed. When the realities of energy demand and supply are recognized, this can only mean that much more central-station electricity will be needed. No one should be deceived by the present momentary excess of electricity generating capacity in some western countries. If there is a modest outbreak of prosperity and reduced unemployment, which is surely what we all want, the surplus will be quickly used up. It could then take 10 years of shortages before new energy sources could be brought on line. The realistic alternatives for energy expansion

in Canada and in the world are: coal, nuclear or — do without. Any human activity should be judged by its effects on the quality of human life and on the safety of human life. It is clear that in the real world these two elements go together so closely that they are for most purposes the same; however, I shall mostly address the safety issue, that is, the consequences of each of the three alternatives in respect to safety.

The basic ideas involved in safety are very simple. Improving safety amounts to saving lives; a life not saved is a life lost; in a perfectly safe society, everybody still dies, but they all die from old age; death from heart disease or a traffic accident is no less fatal than death from radiation or air pollution. A meaningful scientific measure of safety in any group is a measure of human tragedy; it represents an excessive number of deaths of children, teenagers, young adults and adults in the prime of their lives, including parents of children. Using this measure, we can start with a review of safety in the world as a whole. Table 1 shows the magnitude of the world's real safety problem. It can be calculated that if in 1987 the whole of the world's population of 5,050 million lived at the safety level of Canada, which by then will have a life expectancy of about 76 years, the lives of about 19 million people under the age of 65, including eleven million children, would be saved every year.

What about Canada? In 1984, the last year for which I have data, 53,400 people died prematurely, that is, under the age of 65. Most of these deaths could in principle have been prevented; there is still great scope for intelligent safety management.

It is well known that it is unsafe to live in a poor country. What is less often appreciated is that, even in rich countries, the poor and the unemployed are much less safe than the rich and the employed. The poorest fifth of Canadian city dwellers have a rate of premature mortality twice as high as that of the richest fifth. In the Montreal area, the life expectancy in a rich area is 9 years greater than that in a poor area a few kilometres away. All technological risks are negligible compared with these great differences.

Notwithstanding scares about pollution, toxic wastes and other newly discovered risks, the fact is that we all live better on the average than we did the year before. We also live more safely each year. This improving trend in safety is world wide; with few exceptions, the expectation of life in all countries is increasing year by year.

Table 2 shows what is happening in a few selected countries and it also includes a rough estimate for the world as a whole. It is clear that we are doing something very right. We should be looking to do much more of the same, to accelerate present trends, not to slow them down. We need to think of planning measures which will reduce the avoidable loss of millions of lives per year. Even in Canada, we must think in terms of tens of thousands. So let us now look at the risks associated with the two realistic energy options for the next few decades.

The hurtful effects of coal burning remain something of a puzzle at present. An immense amount of coal has been burned in the development of our industrial civilization to its present stage, perhaps 100 billion tonnes. Almost all of this was burned in very bad conditions in regard to air pollution. Immense amounts of sulphur oxides and nitrogen oxides still go up the stacks. After further cooking by ultraviolet light from the sun, these fall to earth as fine dust and acid rain. A variety of organic compounds resulting from incomplete combustion, many of them known or suspected carcinogens, are mixed in in smaller quantities. Many toxic heavy elements, including radioactive isotopes, are included in the coal in trace amounts, and at least some of these go up the stacks. The risks associated with mining and transport of the very large amounts of coal which are involved must of course be taken into account.

In the advanced countries, most future coal fired power stations will have flue gas treatment which will reduce the hurtful emissions. These will increase the cost of the energy and thus reduce the net wealth creation, but usually not to an unreasonable degree. Published evidence shows that a gigawatt-year of typical coal fired generation would result in the death of 10 people. The victims would tend to be old or those whose lungs have been damaged by cigarette smoking, with an average loss of life expectancy of only 7 years. The measure of the risk would thus be 70 person-years loss of life expectancy per gigawatt-year, abbreviated to p-yLLE/gW-y. It is a thought provoking fact that it is difficult to be more precise about this number because the small mortality from this cause is almost completely masked by the much greater mortality from present levels of

Table 1. World population grouped according to level of safety. 1987 projection.

Group	Population	Fraction	Life expectancy years	Premature deaths (age less than 65) per year	
				Total	Infants
I	1,146 M	23%	73.7	4,000,000	238,000
II	1,659 M	33%	67.8	7,700,000	3,100,000
III	2,245 M	45%	56.6	20,700,000	12,700,000
Total	5,050 M	100%		32,400,000	16,000,000

Table 2. Trends relating to human safety.

Country	Life Exp (LE) years	Rate of increase of LE per year	Premature deaths averted per year	Energy use per person	Electricity: percent nuclear
Japan	75.5	0.20		2.9	25.0
Sweden	75.5	0.16		4.8	35.9
France	74.4	0.19		3.3	41.0
Switzerland	73.3	0.00		4.1	28.4
Canada	72.8	0.25	1,710	8.4	12.0
W. Germany	70.3	0.20		4.1	14.6
China	66.8	0.25		.5	0
Egypt	54.1	0.19		<.5	0
Malawi	47.3	1.20		<.2	0
Ethiopia	40.4	0.19		<.2	0
WORLD	64.2	0.28	590,000	1.5	

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La SNC procure aux Canadiens intéressés à l'énergie nucléaire un forum où ils peuvent participer à des discussions de nature technique. Pour tous renseignements concernant les inscriptions, veuillez bien entrer en contact avec le bureau de la SNC, les membres du Conseil ou les responsables locaux. La cotisation annuelle est de $40.00, $20.00 pour les retraités, et $5.00 pour les étudiants.

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tobacco smoking. About one fatality per gigawatt-year is incurred in mining and transporting the coal; a fatality at an average age means the loss of about 30 years of life expectancy, so that this adds 30 p-yLLE/gW-y. The total is thus 100 p-yLLE/gW-y.

Despite these and other adverse consequences, the net overall impact of coal burning has been highly beneficial. From the time of James Watt to about World War 1, coal was the principal energy source of the industrial revolution, and to a close degree of correlation, those countries which burned most coal were the ones where mortality in all age groups fell most rapidly.

In the case of nuclear energy, what most creates anxiety is the possibility of a major accident to a reactor. Large nuclear reactors have been in operation on the earth since 1942, that is, 44 years ago. There have been two accidents, Windscale in 1958 and Chernobyl in 1986, which were of importance because of hurting people. There was a third, Three Mile Island, in 1979, which caused minimal hurt.

The Windscale reactor was, by present standards, a crude machine intended solely for producing plutonium as a munition of war, with a minimum of containment. Its graphite moderator caught fire because of a human error, and it released large amounts of radioactivity to the atmosphere. A recent assessment indicates that about 25 extra fatalities from thyroid cancer in the population of Britain and West Europe in the decades following the accident will be attributable to the accident.

The significance of the recent Chernobyl accident is difficult to assess. It appears that an experiment which should never have been permitted in a reactor of this kind was being carried out by the local staff with quite inadequate thought, study and planning. The graphite moderator caught fire, and this resulted in large amounts of radioactivity being carried high into the atmosphere, to fall out over large areas in the next few days. About 30 lives were lost in the accident itself. Something like 3500 extra cancer fatalities will occur in a population of about 70 million people in the next 70 years.

The complications relating to the assessment of the accident are (1) cancer will probably be partly or completely cured in much less than 70 years; (2) in the case of the Hiroshima-Nagasaki bombs, it was found that a program of modest medical surveillance of the survivors unexpectedly saved more lives than were lost from the effects of radiation; (3) the reactor was of an unusual and probably already obsolete type, and an accident of this type could really only happen to that kind of reactor, and (4) the technological climate in the USSR is appreciably different from that in the West in many respects.

Incidentally, to put matters in perspective, if the USSR suffered a Chernobyl accident every 20 years with no cure for cancer and no medical compensation, the life expectancy of its population would be reduced by about .5 days. However, the actual life expectancy in the USSR is increasing each year by about .2 of a year, that is, 73 days.

The Three Mile Island accident resulted in a total radiation exposure of the public of about 30 person-sieverts. This indicates an LLE of about 10 person-years, with the same medical reservations as in the Chernobyl case. The accident was less serious than one fatal traffic accident. The loss of the reactor, TMI Unit 2, resulted in an unavoidable increase of 800 megawatts of coal-fired electricity generation for an indefinite period. A fully viable reactor, TMI Unit 1, was forced to shut down by the regulatory authority and was kept shut down for over five years by legalities and bureaucracy. The public was thoughtlessly exposed to the risk of a further 4 gigawatt-years of coal burning in old stations upwind of very large populations. The "ratchetting" of regulatory requirements was given a great fillip by the mishap, so that billions of dollars have been added to the total cost of nuclear power, thus reducing its competitiveness with less safe means of energy production.

Despite aberrations like this, the nuclear industry as a whole, that is, including the regulatory bodies, has become the leader in systematic risk assessment of complex processes. In approximately 4000 reactor years of plant operation in the world, together with experience of similar equipment in other industries, a vast pool of knowledge of how, why and how often failures occur has been built up. The three well known accidents are only a very small part of this pool; it is a measure of the success of the overall safety effort that the vast majority of mishaps have had only minor consequences.

Putting all the available experience and thinking together, a measure of the risk of generating nuclear power can be arrived at as follows:

- A very pessimistic assumption is that an accident of Chernobyl severity will occur only once every 8000 reactor-years, that is, about once every 20 years, with no cancer cure and no medical amelioration. There will then be 3500 fatalities per 8000 reactor-years, that is .44 fatalities per reactor year, or about 19 p-yLLE/gW-y.
- At the optimistic end, if the reactors of the Chernobyl type are separated out as requiring special care (which they will certainly receive anyway); if the safety record of other kinds of reactors remains as it seems to be at present or if cancer is cured; the risk will be to all intents zero.
- From this, I suggest that a level-headed working figure to be used for decision making is half way between these extremes, that is, 10 p-yLLE/gW-y, which is one tenth of the risk of the coal alternative.

What of the positive side, that is, the saving of lives through wealth production in our energy and industry-based civilization? The figures are potentially enormous, as indicated by Tables 1 and 2.

In a paper published in 1982, I related the saving of lives (that is, the reduction in premature death rates) in the world with the growth of real GNP per person and then deduced the extent to which electrical energy contributed to the generation of GNP. I made the assumption that half of the relationship was either cause-and-effect or was essential, so that I could then arrive at the number of lives saved per gigawatt-year of generation. The answer was roughly 40, or about 1200 p-yGLE/gW-y (the G is for gain as opposed to loss). This compares with 100 p-yLLE/gW-y for coal and 10 p-yLLE/gW-y for nuclear, showing safety benefit/detriment ratios of 12 and 120 respectively.

Drs. D.K. Myers, M.M. Werner and N.E. Gentner have approached the question in a different way in a series of papers. They relate energy use more directly with life expectancy. They made the assumption that 10% of the safety benefit could be attributed to the increased use of energy. They classify energy sources as involving "higher" and "lower" risk, corresponding roughly to coal and nuclear respectively, and divide the world into more advanced and less advanced countries. Table 3 is derived from their conclusions.

The numbers in Table 3 represent the expected gain (GLE) or loss (LLE) of life expectancy of the population of a typical country per additional gigawatt of energy used. It will be seen that, even in the worst combination, the gain is 4 times the loss. The 220 to 7.3 (30 to 1) ratio which would apply to coal burning in less advanced countries accords well with what happened in the earlier years of the industrial revolution.

It will be seen that the safety benefit to detriment ratio for nuclear power in Canada is given as 30 to .37 or 80 to 1. Since Canada would like to export nuclear power plants to less fortunate parts of the world, the 600 to 1 ratio which would apply in such cases is also relevant. Unfortunately, most decisions about nuclear energy in particular so far have not taken any account of the credit side of these comparisons.

The indications of Table 3 are not inconsistent with Table 2, which shows the six of the safest countries in the world, according to the UN and World Bank data, together with the energy use per person and the fraction of the electrical power in the country which is nuclear. It also shows some countries with low LEs. China, with a relatively high LE, burns over half a billion tonnes of coal per year.

Some other issues call for comment.

The release of nuclear energy simply speeds up a natural process which is going on in the earth's crust on a greater scale. The earth's crust also contains enormous quantities of toxic elements. When the problem of nuclear waste disposal is placed in proper quantitative

Table 3. Safety benefit/detriment comparisons

	More advanced countries	Less advanced countries
Lower risk energy source	GLE 30 days LLE .37 days	GLE 220 days LLE .37 days
Higher risk energy source	GLE 29 days LLE 7.3 days	GLE 220 days LLE 7.3 days
None	GLE, LLE 0	GLE, LLE 0

perspective as an element in the overall process of improving human safety by industrial development, it will be seen to be quite minor. Small risks from radioactive wastes will persist far into the future. Many of the great safety benefits of the present era will also persist indefinitely; the excess of safety benefits over safety detriments is likely to be no less in the long term than it is at present.

Nuclear power could possibly have an important role in the prevention of conflict. Poverty and shortage of fertile land are potent elements in arousing tensions and strife. There are thousands of miles of arid and almost unpopulated tropical coast regions in Africa and Asia. It would be a relatively small extension of present technology to produce electricity and desalinated sea water from dual-purpose nuclear power plants, and this would make it possible for large communities to live well in such areas. As an example of what would be possible, only the fresh water of the Nile is needed to permit the intensive agriculture of northern Egypt amidst the barren sands of the Sahara.

Through the creation of wealth, nuclear power adds to the safety and the quality of life. Its contribution would be greater if we could only start using our brains a little more where human safety is involved and let our imagination soar a little more in shaping the world's future.

E. Siddall

FYI

Ken Hare to Investigate Ontario Nuclear Safety

(Ministry of Energy)

Professor Kenneth Hare of the University of Toronto has been appointed Commissioner of the Ontario Nuclear Safety Review, Energy Minister Vincent G. Kerrio announced in December.

The safety review was recommended in the July 1986 report of the Ontario Select Committee on Energy, and will cover the design, operating procedures and emergency plans associated with Ontario Hydro's CANDU nuclear generating plants.

Kerrio said the review will be conducted with the full support and co-operation of Ontario Hydro and the federal government and its associated agencies, and in close collaboration with the Royal Society of Canada.

He added that he will ask the federal government to request the Vienna-based International Atomic Energy Agency to establish an Operational Safety Review Team to study the design features and operational safety practices now in place at Ontario Hydro's nuclear generating stations.

"The results of this study will be provided to Professor Hare, as part of the evidence available to him for review," Kerrio added.

"I have asked Professor Hare to include in his review any steps that have already been taken within Canada as a result of information received about the Chernobyl incident," Kerrio said.

The minister added that Professor Hare will obtain a cross-section of technical and scientific information, and will also invite submissions from interested groups on the scientific and engineering dimensions of nuclear safety.

Kenneth Hare is University Professor Emeritus of Geography at the University of Toronto, as well as former Provost of Trinity College.

He is internationally recognized for his research work in meteorology, climate and bio-geography, and has been an Officer of the Order of Canada since 1978.

He chaired the Royal Society of Canada's Committee on the Environmental Consequences of Nuclear War, which published its report in 1984. He played a leading role in reviewing the research to be undertaken by Canada and the United States on acid rain, and is currently winding up his work as chairman of the Royal Society's Commission on Lead in the Environment. He was also chairman of the Federal Study Group on Nuclear Waste Management, in 1977.

Radwaste Task Force Appointed

(EMR Canada)

On December 11th the appointment of an independent seven-member Task Force on Low Level Radioactive Wastes that will examine and recommend a process that will lead to the selection of a site for a disposal facility in Ontario was announced.

Members of the Task Force include:

- Audrey Armour, Assistant Professor in Environmental Studies, York University.
- Dr. Michael Chamberlain, Chief of Nuclear Medicine, University Hospital, and Professor and Chairman, Division of Nuclear Medicine, at the University of Western Ontario in London.
- Gerard Gervais, a professional urban and regional planner.
- Marilyn McComb, a long-time resident of Port Hope.
- Dr. James McTaggart-Cowan, Director, Office of Environmental Affairs, Energy, Mines and Resources Canada, who will serve as the Task Force coordinator.
- Dr. Arthur Porter, Professor Emeritus of Industrial Engineering, University of Toronto.
- Paul Rennick, Senior Environmental Management Consultant in Burlington, Ontario.

The Task Force's primary mandate will be to investigate the most promising approaches for site selection that might be employed within Ontario to deal with low-level waste in the Port Hope area.

W.B.Lewis Dies

(CANDU Update)

It has been said that the CANDU reactor would not exist if it hadn't been for Wilfrid Bennett Lewis. It has also been said that W. Bennett Lewis will be remembered as one of the foremost accelerators of charged particles, whether they be in the form of atoms, ideas or men.

Dr. Lewis died on January 10 in the Deep River and District Hospital. The father of the CANDU reactor system and the director of science for the Canadian nuclear program from 1946 to 1973, Dr. Lewis had been ill for some time. He was 78.

Over a long and brilliant career the tributes to his contributions flowed steadily. He had been recognized with honorary doctor of science and doctor of laws degrees from no fewer than 13 universities in Canada, the United States and the United Kingdom.

His list of distinctions include the Outstanding Award of the Public Service of Canada, of which he was the first recipient; Companion of the Order of Canada; the U.S. Atoms for Peace Award; the Royal Medal of the Royal Society of London and the U.S. Enrico Fermi Award.

Dr. Lewis was a Fellow of the Royal Societies of Canada and London, and an Honorary Fellow of the University of Manchester. As an Honorary Fellow of the Institution of Electrical Engineers, he is listed among such illustrious names as Kelvin, Edison, Marconi and Alexander Graham Bell. Among other contributions, Dr. Lewis was the Canadian representative on the United Nations Scientific Advisory Committee; was a member of the International Atomic Energy Agency Advisory Committee and was a charter member of he American Nuclear Society.

Dr. Lewis was born in England at Castle Carrock, Cumberland, in 1908. At Cambridge he earned B.A., M.A., and PhD. degrees, completing the latter in 1934. Throughout the 1930s he worked at the famed Cambridge Cavendish Laboratories with such renowned figures as Lord Ernest Rutherford and Sir John Cockcroft.

During World War II, Dr. Lewis was placed on loan to the British Air Ministry to work on radar and became chief superintendent of the Telecommunications Research Establishment. His wartime work was officially recognized by appointment as Commander of the Order of the British Empire and the award of the American Medal of Freedom with Silver Palms.

In 1946 Dr. Lewis succeeded John Cockcroft as director of Atomic Energy Research at Chalk River, which was then operated under the National Research Council. When Atomic Energy of Canada Limited was formed in 1952, Dr. Lewis was named vice-president of research and development and in 1963 he became senior vice-president, science. He retired in 1973 and lectured as professor of science in the Physics Department at Queen's University.

Following the NRX accident in 1952, Dr. Lewis was instrumental in sustaining morale of those who feared the Canadian program was doomed and he organized reconstruction to produce a more powerful reactor.

Dr. George Laurence, eminent Canadian physicist, later recalled that reaction of staff was that it looked like the end of the program. Dr. Laurence was quoted in *Nuclear Canada Yearbook 1983:* "But Lewis took it all in his stride. He called the staff back to the site within a few days, got us to work cleaning up the mess, and began reorganizing and planning for

the future. He seemed to just take it for granted, and that settled the question."
Dr. Lewis was a prime catalyst in the decision to build NRU and in 1951, his paper entitled Atomic Power Proposal, argued that atomic energy could possibly compete economically with coal in thermal electrical plants.
He was among the first to recognize the advantage of pressure tubes and, with the concurrence of Harold Smith's design team, sought to change the intended vertical pressure-vessel design of NPD to a horizontal pressure-tube design. This important basic design change led eventually to the CANDU system.
A description of Dr. Lewis was once aptly provided by Professor R.E. Bell at McGill University: "Any of us would be happy to be a leader in either academic research, or electronic development, or the electronic applications of science, or scientific administration, or international co-operation. Wilfrid Bennett Lewis has been a national and world leader in all these fields."
In 1973 the Canadian Nuclear Association struck a medal in his name, to be awarded annually for outstanding contribution by a Canadian in the field of nuclear science and engineering. To the delight of Dr. Lewis, the first recipient was Harold Smith.
Dr. Lewis is survived by a sister, Mrs. Gwynedd Gerry, Deep River; and a brother, Jack, in England.

New Energy/Environment Committee Formed (Government of Canada)

The Honourable Marcel Masse, Minister of Energy, Mines and Resources, and The Honourable Tom McMillan, Minister of Environment, announced Jan. 14 a ministerial committee to integrate energy and environmental issues at the federal level.
The ministers met January 14th with representatives of some leading Canadian environmental groups, including Energy Probe and CCNR, to request their help in developing an integrated approach to environment and energy issues. Cooperation between environmental groups and government is seen as a key to the success of the new ministerial committee.
Mr. McMillan noted that the World Commission on Environment and Development (the Brundtland Commission), a major United Nations task force that conducted Canada-wide hearings last year, called for greater integration of environmental and economic decisions. He said the new initiative he and Mr. Masse are taking is consistent with what the Brundtland Commission has urged.

CNS News

New Editor for *Bulletin*

David Mosey, Editor of the *CNS Bulletin* since late 1980, has handed over the job to Jatin Nathwani with effect from 31 December 1986. In a letter to CNS President Nabila Yousef, Dr. Mosey noted that while his desire to have more time for other CNS activities was a contributory factor in his decision, a more important consideration was that the *Bulletin* could benefit from some fresh ideas and a fresh outlook.
The new editor, who assumed his responsibilities with the January/February issue, received his PhD. in chemical engineering from the University of Toronto in 1979. He subsequently joined Ontario Hydro and currently works with the safety concepts and studies group in Ontario Hydro's Nuclear Studies and Safety Department. Dr. Nathwani's areas of interest include communications both within and outside the "nuclear community" and the ethical and moral dimensions to the development of nuclear energy systems.
Concurrent with the change in Editor has come a formal revision to the *Bulletin* editorial structure. To improve the timeliness and extent of coverage, the *Bulletin* is seeking a News Editor to maintain contact with the nuclear industry and associated research installations and report on activities and developments.

PRV

The End of the Chain

Some black day, when everything seems to be going wrong, when you think the industry is uttering its death rattle and is finally on the skids, when confusion and controversy reign everywhere, look around at what the nuclear industry has accomplished and take heart.
There are reasons to take heart. Take a look around the heaving barque of misfortune on which you find yourself. You're not the only slave in the galley. Other industries have their own closets full of skeletons and assorted horrors. A recent document points to one such entity, LEAD.
"Lead is a very useful heavy metal." Thus begins the main body of the report by the Commission on Lead in the Environment. Over the years, lead has been used in piping, alloys, paints, dyes, electrical cable, solder, as well as a range of minor products, and still is most important in vehicle batteries and in gasoline. Both in use and in disposal, lead gives rise to problems. Paints have caused cases of acute lead poisoning and death by being ingested by children; car batteries are not required to be disposed of so that the lead which they contain can be dealt with properly; lead from gasoline is got rid of by dispersing it in the atmosphere.
In 1982, 73,000 tonnes of lead were discharged into the environment in Canada. Of this, 7278 (precision not mine) tonnes were from leaded gasoline, emitted in a form that makes their recovery impossible, as solid lead aerosols, 35% as particles less than 0.25 micron MMD, and 40% greater than 10 microns MMD. Although this aspect of the lead problem is coming under control, others remain. Each day 15,000 vehicle batteries are junked in Canada; the recycle rate is stated to be 98%, and the recovery rate for the lead is reported to be 98% as well. In the United States, the problem is more serious since there are many more expired batteries to be junked per day. The recycle rate is estimated at only 66% (and going down) and some of the remainder are exported to Canada. It has also been estimated that by 1990, nearly 1.4 million tonnes of spent lead-acid batteries will have been improperly disposed of in the U.S. during the previous decade.
There is no joy in all this. Nobody revels in reading about high blood lead levels in children, yet this is the situation we find ourselves in. Blood and tissue levels of lead are far above prehistoric levels, giving rise to, or thought to be contributing to a whole array of actual and potential disorders. In the extreme, overt cases of lead poisoning have been reported in the U.S. In that country, the blood lead levels of people inhabiting some of the inner city areas are in the red zone, requiring treatment with chelating agents to scavenge some of the lead from the bloodstream. In Canada the situation seems to be much better, with lower blood levels, but still there are local hot spots of lead contamination that need to be cleaned up. No cause for gloating or cheering, although certainly some cause for reflection. Another cause for reflection, and a situation with which many in the nuclear industry are familiar, is the technical disputes that arose out this inquiry.
Some of the statements made by the Commission in their draft report, or an impression that they gave, or some disagreement that arose out of the inquiry precipitated a difference of opinion. Doctors at the Montefiore Health Center in New York disagreed strongly enough with the report that they requested the Commission to include their dissenting statement as an appendix to the final report. Some very strong statements are made, about objectivity, about use of data, about ignoring evidence. The whole report makes fascinating reading, in a ghoulish sort of way, because of the strong sense of déja vu.
All this is no cause to cheer, nor is it reason for any special pleading or lamentations of double standards that sometimes may seem to be applied to the nuclear industry on one hand, and everybody else on the other. The report of the Commission on Lead in the Environment is yet another indication that ALARA will soon be upon us all; it also serves as a reminder that the nuclear industry is particularly clean, health-conscious and in the vanguard.

Keith Weaver

CNS Division Update

Nuclear Science and Engineering (NSE) Division Election

Three members are to be elected to the 1987 Nuclear Science Engineering Division (NSED) Executive to fill the vacant positions on the 1987 Executive.
Enclosed with this edition of the *Bulletin* are a

ballot and an addressed envelope. CNS members, who belong to NSED, are asked to vote for up to three of the five candidates, and to place the completed ballot in the envelope. The member's name and signature are to be written in the indicated place on the envelope to allow the Returning Officer to verify that the ballot comes from a CNS member. The ballot should be mailed to reach the CNS office by March 6, 1987.

It is expected that this election will be primarily of interest to members of NSE Division. Because of the self-selecting feature of NSED membership, the Returning Officer will not reject ballots received from CNS members who are shown on the membership list as not belonging to NSED. Rather it will be assumed that the member is now interested in belonging to NSED and will advise the CNS office of this in due course.

Short biographical sketches of the candidates are printed below.

Evan Young, NSED Returning Officer

T.J. Jamieson

Terry Jamieson holds a B.A.Sc. in Engineering Science (1979) and an M.A.Sc. in Chemical Engineering (1981) from the University of Toronto. From 1981 until 1984 he was employed as a Nuclear Design Engineer in the Nuclear Studies and Safety Department of Ontario Hydro, specializing in post-accident long-term containment response calculations for licensing of CANDU reactors. From 1984 to 1985 he served as a Scientific Research Officer with the Federal Library of Parliament, providing technical expertise to members of both Houses of Parliament. At present, he holds the position of Senior Nuclear Engineer with the Reactor Development Group of ECS Power Systems Inc. in Ottawa, where he is currently in charge of radiation protection for the SAGA-N sea shuttle project. Terry is a charter member of the CNS, a member of the Canadian Radiation Protection Association and a Professional Engineer (APEO).

W.I. Midvidy, P.Eng., Ph.D

Bill Midvidy has worked in the nuclear industry for the past fourteen years, both in the private and public sectors. During this time, he has been involved in several organizations including the Westinghouse Association of Professional Engineers and various CNS bodies, e.g. CNS Program Committee and the recent CNS conference on Simulation. He is currently a Supervising Design Engineer in the Nuclear Studies and Safety Department of Ontario Hydro.

Ronald Carl Robinson, B.Eng., M.Eng., P.Eng.

Mr. Robinson attended McMaster University in Hamilton, Ontario and graduated in 1976 with a B.Eng. and M.Eng. degree in Engineering Physics.

In 1976 he started work with Ontario Hydro with the Radioactivity Management and Environmental Protection Department of the Nuclear Generating Division. His main area of work was in Nuclear Safety Systems and Safety Analysis. In 1981 Mr. Robinson left Ontario Hydro to become Vice President of Atlantic Nuclear Services Limited. Located in Fredericton, New Brunswick, Atlantic Nuclear Services Limited provides analytical services and engineering support to the Canadian nuclear industry. Mr. Robinson is also a member of CNS and the Association of Professional Engineering of New Brunswick.

B. Rouben

Ben Rouben received an Honours B.Sc. in Physics from McGill University in 1965. He did postgraduate studies at the Massachusetts Institute of Technology, where he received a Ph.D. in Theoretical Nuclear Physics in 1969. From 1969 to 1975 he was a Research Associate at the Université de Montréal, carrying on research in nuclear structure. In 1975 he joined Atomic Energy of Canada Limited in Mississauga, where he has worked in Reactor Physics. He has been Section Head in the Physics Branch since 1981.

Mamdouh Shoukri, Ph.D., P.Eng.

Dr. Shoukri is an Associate Professor in the Mechanical Engineering Department of McMaster University where he is involved in activities related to nuclear engineering. He obtained his Ph.D. degree from McMaster in 1977. Dr. Shoukri joined Ontario Hydro as a research engineer where he worked on different nuclear reactor thermal-hydraulic projects. In 1980 he was appointed head of the then newly formed thermo-fluids unit at Ontario Hydro Research Division (OHRD). Dr. Shoukri joined McMaster University in 1984 where he is continuing his research activities in reactor thermal-hydraulics and safety.

Dr. Shoukri is a registered professional engineer in the province of Ontario. He is a member of the Canadian and American Nuclear Societies (CNS and ANS) and the American Society of Mechanical Engineers (ASME). He is active with the CNS where he is a member of the CNS Communication Committee and acted as the technical program chairman for its 12th Simulation Symposium. Dr. Shoukri has published over thirty-five papers in technical journals and refereed symposia.

CNS Branch Programs

New Brunswick Branch:

Seminar on Safety in the World Nuclear Industry

On Wednesday, September 24, 1986, the New Brunswick Branch of the Canadian Nuclear Society presented a seminar titled: "Safety in the World Nuclear Industry," which took place in Saint John. Roger McKenzie, plant manager at Point Lepreau, and Victor Snell, Richard Osborne and Roger Humphries, all from AECL, were participants with Dan Meneley (University of New Brunswick) as chairman and moderator. The topics discussed ranged from the Chernobyl accident to Candu's operating safety and included descriptions of the Chernobyl accident sequence and its radiological consequences. A parallel was drawn with the Canadian system, with emphasis on the licensing process and the plant operation.

The seminar attracted a large audience, mostly from the nuclear industry. The presentations by the speakers were followed by a question- discussion period between the panel and the audience. Questions reflected an active interest in the Soviet accident, but little concern was shown for the safety of Canadian plants.

Ken Soilows (UNB-Saint John) was responsible for all arrangements and a skillful handling of public relations for the event. He was instrumental in the successful outcome of the evening.

J.-F. Lafortune

Ottawa Branch News:

Science Policy

The fall seminar program of the Ottawa Branch began on November 19 with a presentation on "Strategic Technologies and Industrial Competitiveness" by Dr. Henry Rothschild. Dr. Rothschild is the Director General of the Strategic Technologies Branch of the Ministry of State for Science and Technology.

Dr. Rothschild began with a discussion of the characteristics of the new strategic technologies of the 1980's, namely:

- knowledge-intensive rather than capital intensive
- multidisciplinary
- generic application
- synergistic and rapidly developing

In such a dynamic technological setting, "new" national economies based on:

- knowledge-intensive products
- economic growth through value-added enterprise rather than on volume expansion
- government leadership through strategic planning (e.g. MITI and MICOT in Japan), must evolve if a nation is to remain competitive.

The importance of a carefully structured government policy for generic technology development was thematic throughout the presentation.

Also in attendance at the meeting was CNS President Nabila Yousef, who conveyed greetings from the Council and gave a brief update on recent Council activities.

Details of the remaining branch program for 1986/1987 are almost complete and branch members can look forward to an interesting and varied series of events.

Terry Jamieson

Toronto Branch

"Enriched Uranium in CANDU" was the subject of an informative seminar given by Mr. A.R. Dastur of AECL-CANDU Operations at the University of Toronto on December 2, 1986. The seminar was jointly sponsored by the CNS and the Centre for Nuclear Engineering at the University of

Toronto.
Mr. Dastur described studies of the Low Enriched Uranium (LEU) fuel cycle carried out by AECL under contract to foreign utilities who were investigating enrichment of reprocessed LWR fuel for use in CANDU. The studies show that enrichments up to about 1.6% are feasible when a novel fuelling scheme, referred to as checkerboard fuelling, is implemented. This fuelling scheme minimizes local power peaking associated with introduction of enriched bundles in a fuel channel, and flattens the axial power profile.
The financial savings associated with LEU were stated to be about 22% of fuelling cost, or about $1.5 million per year for a 600 MW reactor at 80% capacity factor. In addition, substantial savings associated with isotope production could also be expected with the LEU fuel cycle.

Glenn Archinoff

Conferences & Meetings

International Marketing Seminar
Sponsored by CNA, to be held **Feb. 23-24, 1987** in Ottawa. For information contact: **Canadian Nuclear Association, 111 Elizabeth St., 11th floor, Toronto, Ontario, M5G 1P7, (416) 977-6152.**

Symposium on Prolongation of the Age of Nuclear Installations
Sponsored by OECD Nuclear Energy Agency, to be held **Feb. 24-27, 1987** in Paris, France. For information contact: **OECD NEA, 38 boulevard Suchet, F-75016 Paris, France.**

CNS/CNA Student Conference 1987
The 12th Annual Student Conference sponsored by the Committee on Education and Human Resources of the Canadian Nuclear Association and by the Canadian Nuclear Society will be held in Ottawa on **March 20 and 21, 1987**. The conference is being organized jointly by students and faculty members at Carleton University and the University of Ottawa. An invitation is extended to undergraduate and graduate students in nuclear-related disciplines and programs to participate in the conference by presenting papers on their work. For further information contact: **Prof. J.T. Rogers, Dept. of Mech. & Aero. Engineering, Carleton University, Ottawa, Ontario K1S 5B6, (613) 231-2787.**

International Topical Meeting on Remote Systems and Robotics in Hostile Environments
Sponsored by ANS, cosponsored by CNS et al., to be held **March 29-April 2, 1987** in Pasco, Washington. For information contact: **J.D. Berger, P.O. Box 928, Richland, WA 99352,** or Dennis Richards, (416) 823-9040.

International Conference on Methods and Applications of Radioanalytical Chemistry
Sponsored by ANS, CNS et al., to be held **April 5-10, 1987** in Kona, Hawaii. For information contact: **Dr. R.C. Ragaini, Lawrence Livermore National Laboratory, P.O. Box 808, Mail Stop L-128, Livermore, CA 94550,** or **Dr. R.E. Jervis, University of Toronto,** (416) 978-3071.

Workshop on Chemical Reactivity of Oxide Fuel and Fission Product Release
Sponsored by CEGB, cosponsored by CNS, to be held **April 7-9, 1987** at Berkeley Nuclear Lab., UK. For information contact: **K.A. Simpson, CEGB, Berkeley Nuclear Lab., Berkeley, Glous., GL13 9PB, UK,** or Tom Carter, (416) 592-6024.

Seminar on Integrated Information Management
Sponsored by CNA, cosponsored by Ontario CAD/CAM Centre, to be held **April 22, 1987** in Toronto, Ontario. Technical tours planned April 23, 1987. For information contact: **Gillian Whitehead, AECL CANDU Operations, Sheridan Park Research Community, Mississauga, Ontario, L5K 1B2.** (416) 823-9040.

CNS Simulation Symposium — Call for Papers
Sponsored by the Nuclear Science and Engineering Division of CNS, the 13th annual Simulation Symposium will be held **April 27 and 28, 1987** at Chalk River Nuclear Laboratories, Chalk River, Ontario. The scope of the symposium covers all aspects of nuclear power plant modelling and simulation and usually includes sessions on system simulation, thermalhydraulics and reactor physics. Last year, the symposium also had a session on pressure-tube integrity. 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 Canadian 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. Papers are usually 10 to 20 pages but shorter papers (and short presentations) are quite acceptable.
The deadline for receipt of your 300 word (or less) abstract is **February 23.** This should be sent for review to: **Norm Spinks, Station 91, Chalk River Nuclear Laboratories, Chalk River, Ontario, K0J 1J0.** Authors will be notified of the results by **March 9.** For further information call Norm at (613) 584-3311 (ext. 2176).

Canadian Engineering Centennial Convention
Sponsored by CNS, CSME, et al, to be held **May 18-22, 1987** in Montréal. For information contact: **Engineering Centennial Board Inc., Suite 410, 276 Saint-Jacques St., Montréal, Québec H2Y 1N3.**

14th International Reliability, Availability and Maintainability Conference
Sponsored by IEEE, cosponsored by CNS et al., to be held **May 26-29, 1987** in Toronto. For information contact: **M.S. Grover, Ontario Hydro, H14-G4, 700 University Ave., Toronto, Ontario, M5G 1X6,** (416) 592-7728.

Nuclear Power Plant Aging and Life Extension
Sponsored by ASM, cosponsored by CNS, to be held **June 7-12, 1987** in Lincolnshire, Illinois. For information contact: **P.D. Stevens-Guille, Ontario Hydro, 700 University Ave., Toronto, Ontario, M5G 1X6,** (416) 592-5211.

27th Annual International Conference of the CNA and 8th Annual Conference of the CNS
To be held **June 14-17, 1987** in Saint John, New Brunswick. For information contact **CNS Office,** (416) 977-6152.

International Meeting on Nuclear Power Plant Operation
Sponsored by ANS, CNS, ENS and Atomic Energy Society of Japan, to be held **Aug. 31-Sept. 3, 1987** in Chicago, Illinois. For information contact: **Norman Wandke, Commonwealth Edison Co., P.O. Box 767, Chicago, IL 60690,** or Ken Talbot, (416) 839-1151.

International Topical Meeting on Probabilistic Safety Assessment and Risk Management
Sponsored by SNS, ENS, ANS, CNS et al., to be held **Aug. 31-Sept. 4, 1987** in Zurich, Switzerland. For information contact: **PSA '87, c/o ENS, P.O. Box 2613, CH-3001 Berne, Switzerland,** or F. King, (416) 592-7597.

International Conference on CANDU Maintenance
Sponsored by CNS, cosponsored by CNA, to be held **November 22-24, 1987** in Toronto. For information contact: **D.F. Meraw, Darlington NGS, P.O. Box 4000, Bowmanville, Ontario, L1C 3Z8,** (416) 623-6606.

1987 International Waste Management Conference
Sponsored by ASME and IAEA, cosponsored by ANS, CNS et al., to be held **Nov. 30-Dec. 5, 1987** in Kowloon, Hong Kong. For information contact: **L.C. Oyen, Sargent & Lundy, 55 E. Monroe St., Chicago, IL 60603,** (312) 269-6750.

Third Topical Meeting on Tritium Technology in Fission, Fusion and Isotopic Applications
Sponsored by Canadian Nuclear Society, cosponsored by American Nuclear Society, to be held **May 1-6, 1988** in Toronto, Ontario. For information contact: **C.D. Burnham, CFFTP, 2700 Lakeshore Rd. W., Mississauga, Ontario, L5J 1K3,** (416) 823-6364.

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The Unfashionable Side

Special to the CNS Bulletin: *Deus ex Machina*

In the interests of historical fidelity, the following despatch by the Bulletin's sometime contributor, George Bauer, is reprinted uncut and unedited as it was filed at the height of the recent fuelling machine crisis.

CHICHEVACHE-BYCORNE, ONT. — It has now been three days since the fuelling machine crisis first rocked this small southern Ontario town. What started then as a minor "incident" has now become a story of major world interest as Ontario Hydro, the Atomic Energy Control Board (AECB) and various Federal Government departments struggle to regain control of the situation.

The story began at Bellerophon N.G.S. which is aptly located directly south of Waterloo on the shores of Lake Erie. The station is the newest nuclear plant in Ontario and is a showplace of advanced technology.

In the early hours of the morning of November 17, all four reactors at the 4000 MW station were abruptly shut down, an action which caused some local power problems. Early reports from Hydro indicated that there had been a mechanical failure in one of the two fuelling machines and that the reactors had been shut down as a precaution. "All four reactors are now in a cold shutdown state and there is no danger to the public" purred the statement unctuously.

Within hours it was evident that the problem, whatever it was, had become acute. Roadblocks were thrown up within ten miles of the plant in all directions and a helicopter and two light planes could be seen circling overhead in the early light. At ten o'clock that same morning the station manager and senior Hydro officials held a news conference and broke the shocking news: one of the two highly sophisticated fuelling machines was missing and was feared to have escaped. This statement was met with derision until it was explained what these machines were capable of.

The two fuelling machines at Bellerophon were bristling with advanced technology. They each had three powerful computers built into them, and they were capable not only of refuelling the reactor completely automatically, but also of diagnosing faults in any of the systems within the containment building, making repairs to the reactors without needing to shut them down and performing equipment inspections. Most importantly, they were each supplied with emergency power and water and could function fully in the event that all outside power to the station was lost. They were also capable of repairing themselves.

In the previous six months, these machines had more than repaid their $47 million cost by saving manpower, cutting the station's man-rem budget by 93% and by maintaining the station capacity factor at 99.3%. They were hailed throughout the world as the embodiment of the best of computing, manipulator, control, pattern recognition and advanced software technology. Dubbed Brian and Joe, they had been photographed extensively, showing off the capabilities of their twelve manipulator arms, six radiation hardened television cameras and ten fuel bundle magazines, each capable of holding a full channel's worth of bundles. And now one of them was at large somewhere in southern Ontario, pursuing an objective that nobody understood and for reasons that were almost certainly dark.

By noon of the same day, the worst had been confirmed. Workers at the plant verified that the machine had managed to take control of the station computers and let itself out of containment. It had then commandeered a spent fuel cask transporter, raised itself onto the trailer, thrust three arms through the rear window of the cab and started the vehicle. Workers were dumbfounded to see the transporter moving back and forth across the station car park: the machine was teaching itself how to drive!

When they had recovered their wits they advanced toward the transporter with the intention of disconnecting the machine's power supply. But before they could get within two hundred yards of it, the machine began lobbing deadly spent fuel bundles at them. The first one tumbled way off the mark and crashed into the deserted administration building. The machine quickly got its eye in, however, and the second passed within feet of the men and shattered against the wall of the station. Immediately radiation alarms and geiger counters went off like sex-crazed cicadas and the men all fled in terror. The machine was last seen perched behind the transporter cab, three eyes looking forward and three looking back, as it turned the corner out of the station gate and onto the main road.

After the initial delays, response to the crisis was quick. A task force was formed and the Solicitous General contacted. Following hurried discussions, his office announced that there were no emergency measures in place to handle situations of this sort but that they were now being implemented and should be operational in about three weeks. At Queen's Park, the Opposition benches erupted in abuse. Did the Solicitous General realize that at the rate the machine appeared to be moving it would have left Ontario in less than three days. The Minister noted their concerns but to this question he only smiled enigmatically before retiring to his weekend retreat in P.E.I.

In the U.S., the official response was confusing. The most recent statement from a White House spokesman "regrets that Canada is turning to terrorist threats" but was adamant that "under no circumstances would the shakes and shingles tariff be lifted." He went on to stress that his Government "would not be intimidated by actions of this sort." This was an abrupt change from an earlier stance and was interpreted as a face-saving measure to limit the political damage.

In a previous statement, issued on the second day of the crisis, the President's national security advisor announced that Wright-Patterson Air Force Base had been put on full alert in case the machine attempted to swim Lake Erie. This had raised such alarm among the people that the entire population of Cleveland had fled inland.

(End of Part 1)

George Bauer