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"NUCLEAR ENERGY CONTINUING BENEFITS TO CANADA"

By J.L. Gray, Hon. Director of CNA

I understand it is poor practice to quote oneself but in preparing this presentation I reviewed a number of the statements and speeches I had made during my career with AECL and fortunately found several of my predictions were proven to be correct so I will borrow from earlier presentations.

The first full public statement of the nuclear power development programme appeared as an AECL paper under my name in 1958 when the nuclear power plant division of AECL was formed. By that time of course Canada's first nuclear power station project, the 20MW Nuclear Power Demontration plant, was well underway and the course had been set to demonstrate a heavy water natural uranium pressure tube power reactor. It was the early work which had been committed to that project that gave us the confidence to commit a full scale station.

The target set, more than 20 years ago, was to provide the industrially developing areas of Canada with a new source of energy. The competition, in the case of Ontario which was a prime market for this new energy source, was United States coal. The proposal led to the joint AECL/Ontario Hydro nuclear power development programme. The basic justifications for the programme were stated as follows: "These areas are developing so rapidly that in a matter of 20 to 25 years they will be dependent for a large fraction of their electric power production upon a foreign source of fuel, ... progressively increasing purchases of coal from the U.S. will increase the undesirable imbalance of trade". It is then some satisfaction to those in the nuclear industry to realize that the 35% of Ontario's electricity now coming from nuclear plants has so far saved some 2.5 billion dollars in foreign exchange, an important benefit to the Canadian economy.

What has been delivered then, measures up to the promise we made at the outset of the programme. In partnership with the utilities and Canadian industry the economy, reliability and safety of nuclear power stations has been demonstrated.

In addition, the changes which have occurred to the world energy economy have in the main emphasized the importance of a demonstrated reliable alternative to fossil fuels. Few utilities today would-contemplate, as many were doing in the late 1950's, the construction of oil-fired stations. As a primary source of energy therefore, the choice has narrowed, world-wide, to coal or nuclear.

The major benefit which has accrued to Canada and for the next decade or two, particularly to the Province of Ontario, is of course an indigenous, reliable and long term source of low cost energy. The unknowns of the CANDU programme, the

capabilities of the system to operate without excessive heavy water losses, the integrity and burn-up characteristics of the fuel, the engineering feasibility of on-power high pressure refuelling are all questions which have now been answered. I need not remind many of you in this audience of the enormous amount of engineering and scientific effort which went into the solution of these problems and the extensive effort which had to be made to convince our critics both in the technical and political arena that these problems could indeed be overcome.

Ontario Hydro is the main beneficiary in Canada today of these nuclear power benefits, and they deserve to be. They were perhaps not quite as much at risk in the early years of the Canadian nuclear power development programme as AECL but they did have the foresight to take substantial risks and the competence to minimize these risks. It is hard to visualize what would have happened without the full participation of Ontario Hydro from the beginning - the partnership was essential to the success of the CANDU development. I would be remiss if I did not mention the support

of the Government of Canada. So-called "establishment" or "bureaucrats" or "mandarins" that I had the privilege of working with in Ottawa for nearly twenty years were certainly equal in quality to any group I have ever encountered. They were very intelligent, very hard working and when items in our programme were explained fully, they were very positive in their reactions - fortunately they usually supported our submissions to the Government. They generally believed in the nuclear programme and could see the possible ultimate benefits and were prepared to stand up and be counted when project proposals were before Cabinet committees. AECL did not, of course, always win but they had a very high batting average in a very high cost game.

The promise of low cost energy from the nuclear plants has been fulfilled. In 1974 Ontario Hydro was forecasting a cost advantage of about 13% for the Pickering plant over the comparable Lambton plant in terms of total unit energy costs.

In 1981 the actual figure revealed that the cost of the coal generated electricity was almost double that of the nuclear plants and the projections for the remainder of the life of these plants indicates that this relationship will hold. When one considers that in this same time span the average price of a barrel of crude oil rose from $3.00 in 1973 to $39.00 in 1981 the importance of the nuclear achievement becomes crystal clear.

Some of the same benefits of nuclear power could well have been gained by the employment of other nuclear systems such as the U.S. PWR or BWR or even the systems adopted and investigated by the U.K. for its programme. There was constant pressure from our critics, particularly before we were able to demonstrate the economic feasibility of CANDU in the Pickering plants, to switch to other systems.

What, then, has the development of an indigenous reactor system meant to this country's economy? We felt

from the outset that Canadian nuclear power requirements could be met by a Canadian developed nuclear system. The obvious result of our endeavour has been the creation of a nuclear business in this country which now employs about 35,000 people and is capable of supplying almost all the equipment for the nuclear power programme. In the Bruce A and Pickering A stations Canadian content was over 70% and in the Pickering B and Bruce B stations it will be over 85%.

This has not been achieved easily. The problems of securing a proper level of quality particularly in the early years placed a heavy strain on our resources and the need to raise the general level of technology of Canadian industry has been one of the foremost tasks both of the utilities and AECL's Engineering organization and the Laboratories. Much has been achieved and again this is an area where the achievements have been enhanced by the recognition of the increasing need for CANADA to expand in the high technology fields.

The CANDU reactor was designed with the capabilities and limitations of the Canadian manufacturing industry in mind. There is an additional bonus from this plant design principle as there are many countries around the world with industrial capabilities similar to Canada's, one of the reasons for the very wide interest in the CANDU system for other national energy programmes.

Canada has benefitted and will continue to benefit, from nuclear plant export orders in the face of fierce competition. The sales to Argentina, Korea and Romania have been secured in a period when the domestic markets of the major U.S. competitors and most of their licensees have been in a state of decline. Canada has secured a foothold in the export market and each 600 MWe reactor sale brings more than 500 million (1980) dollars to Canadian industry. Such a situation is a far cry from what would prevail if we were mere licensees of a foreign reactor vendor paying license fees and importing the more sophisticated components for the stations.

At this point it seems appropriate to speak a little more about the benefits which have arisen because of the technical characteristics of the CANDU system i.e., the use of natural uranium and the consequent employment of heavy water both as a moderator and coolant. The efficiency of such a reactor which extracts about 20 per cent more energy per pound of mined uranium as the enriched uranium fuelled reactors has placed us in an advantageous position during the period of heart searching on advanced fuel cycles. Although reprocessing and recycling of spent fuel will undoubtedly come some time in the future, we here in Canada unlike many of the other countries have no pressing need to undertake the development of such a programme and the public and political repercussions which such a step would entail. The extensive uranium resources in Canada ensure ample fuel supplies for any Canadian nuclear power programme well into the next century. We have in natural uranium an energy source which is not only indigenous and secure but, because of the characteristics of its use in CANDU, virtually inflation proof, surely an important benefit.

An outstanding attraction of the CANDU reactor is the achievement of good fuel performance from good quality fuel. Of approximately 200,000 CANDU bundles irradiated to date, more than 99.8% have performed to their design specification without defects. This remarkable performance is due in part to the fundamental nature of the CANDU reactor system. The ability to detect defected fuel and remove it without shutting the reactor down has made possible the identification of causes of defects and has facilitated the development of improved fuel designs. The necessity of good reliable fuel was of course recognized at the very beginning of the nuclear development programme and conscious decisions were taken to pursue a fuel development programme that would ensure the availability of proven reliable fuel when the power reactors were to come on stream. One fundamental decision was to build exceptionally good experimental facilities - NRX, NRU and WR-I which are capable of irradiating experimental fuel under power reactor conditions. It was also decided to contract the actual manufacture of nuclear fuel to private sector companies which have proven to be very good suppliers and

presumably prosperous. The active participation of the scientists and engineers, the fabricators and of course the users has paid off. We not only have extremely good fuel for the CANDU system, we also know why it is good.

The requirements of an assured supply of heavy water have brought a new industry to Canada. It employed some 2700 people in the production process alone in 1980, many of them highly skilled professional and technical staff, and the value of the product produced since first production in 1970 to the end of 1980 at today's prices is $2000 million dollars.

The CANDU reactor system, then, represents an important achievement unique in Canada in the sense that the essential sequence of events from pure research, applied research and development through research reactors, prototype power reactors to commercial power reactors was continuous with a successful end result - the CANDU family. The development has provided

many scientific and technological benefits to this country. It has called for a broad participation of scientists and engineers in government, the private sector and the universities. It has brought together officials of both the federal and provincial governments in cooperative programmes. It attracted top quality personnel from other countries, particularly the UK which contributed people like Sir John Cockcroft and of course Dr. W.B. Lewis and many more. There can be no doubt that the influx of people attracted to the career opportunities offered by the nuclear programme has been to the benefit of the country.

The quality of personnel made available to the programme from the utilities and the consultants assited greatly in the solution of many formidable technical problems in a new field of science and engineering. For this help we have to thank men like Dr. R.L. Hearn then General Manager and Chief Engineer of Ontario Hydro and a Director of AECL who identified a highly qualified technical engineer from his own organization to head the Ontario Hydro group. That engineer was of course Dr. Harold Smith and it was his inspired leadership which

helped secure so many of Canada's finest engineers for the nuclear programme.

No less noteworthy on the consulting side was the late Dr. G.A. Gaherty, President of Montreal Engineering Company an original AECL director whose interest in Canada and the nuclear programme led another promising engineer Dr. John Foster to join the nuclear programme.

While I have named some of the major contributors to the programme there were many more. Brigadier Eric Wallace from the private sector, an original, long term and influential Director of AECL; from the universities, Dr. Andrew Gordon, Dr. Gordon Shrum and Dr. Harry Thode, all AECL Directors who were all very influential in shaping the programme and giving AECL the stature it needed in the early years. With an excellent Board of Directors and with top flight senior staff, including of course Dr. Ben Lewis who kept the science right, it was possible to attract teams of Canadian scientists and engineers and assemble them in projects which provided ample scope for their talents and the opportunity to form a nucleus of expertise which has now spread to various parts of the country and many establishments.

The benefits of the programme are clear to see in the flourishing departments of nuclear engineering and science in our Canadian universities. Canada has become a training centre in nuclear science and technology not only in the nuclear establishments such as those of Chalk River, Whiteshell and Ontario Hydro but in the universities and other institutions where "AECL graduates" pursue their careers.

All this has supported Canada's move from a purveyor of natural resources to an industrialized nation capable of supplying large scale high technology products. The quality control and demand for sophisticated and dependable components imposed by the nuclear programme has rubbed off on many of our manufacturers. While there are few Canadian manufacturers solely in nuclear work, I am sure that all manufacturers here today would agree that no one handles a nuclear contract without being a changed man. The quality standards required by the nuclear industry have in this country as in others advanced industrial standards overall.

In a different but still nuclear field I was pleased to learn quite recently that AECL's Radiochemical Company had achieved full Canadianization of the medical accelarator for cancer therapy a development which originated in the laboratories at Chalk River. Yet another Chalk River development, the Slow Poke reactor, has now found its way into research centers and is fully accepted as a safe, fool-proof research tool for undergraduate students as well as a work horse in the uranium assay programme so vital to our identification of future energy resources.

I believe that nuclear power will make its greatest contribution in the next century when the more conventional energy resources of the world will have diminished to the point where nuclear energy is no longer an option but a necessity. I also believe it will be nuclear fission not fusion that will be the main future energy source which suggests, to me at least, that we should get on with the development of alternative fuel cycles including the use of thorium.

Perhaps in terms of nuclear energy benefits to humanity the development and use of radioisotopes may have, so far, made the greatest contribution. The fact that more than 97% of AECL's Radiochemical Company's business is for export suggests that the enormous contribution made by this new nuclear industry are rarely recognized in this country. It is a Canadian industry which today has annual revenues of nearly 60 million dollars. Its cancer radiation treatment equipment is installed in almost every country in the world. Canada, I must remind you, was the first in the world in the development of Cobalt 60 beam therapy treatment units. The initial commercial unit was installed in the Ontario Cancer Foundation clinic in the Victoria Hospital in London, Ontario in 1951. Since that time it is estimated that more than 11 million hours of human life have been added to patients receiving treatment from such equipment. In Canada alone the figure is 50,000 added years of life amounting to an addition to the gross national product of around $300 million.

Canada too led the way in the radiation sterilization of medical materials such as sutures and syringes, a business which now provides the preferred means of sterilization for such medical supplies in most advanced countries. And Canada has supplied more than three quarters of all the world's units.

In hospitals today radioisotopes have taken a leading role in diagnostic techniques. Again in this fast growing market Canada has secured a leading position both in the provision of new short-lived isotopes and in the services which are needed to deliver the product.

World interest in the use of radiation to retard food spoilage has recently been renewed. Canada was a pioneer in the food irradiation experiments in the early 1960s using a mobile food irradiator to demonstrate the processes. While these early experiments were not a commercial success they have contributed to the

body of knowledge which now appears to be reaching maturity. The advantages, particularly to the developing countries where absence of refrigerating capacity reduces shelf life and infestation of bulk stocks of food is rife makes the contribution of radiation processing important.

One could go on in this field with many examples. The use of radioisotopes in smoke detectors must surely have saved many lives. The advances made in the treatment of sewage waste, the development of nuclear imaging instruments for brain examinations are exciting possibilities which owe their origin to the technological spin offs from Canada's nuclear research program.

So far I have spoken of the economic, scientific and technical benefits to Canada and to the world from our nuclear programme. But there are social benefits as well and I have already emphasized what I believe to be the major social benefit,

the supply of low cost, dependable and readily available energy. It is a benefit which has been subjected to some criticism over the past few years. Criticism, which seems to be more pronounced in countries like our own which enjoy the luxury of a secure supply of energy. The blackouts and brownouts which are now becoming a feature of life in countries such as Mexico and Italy and which have always been present in the less developed countries provide a warning of the consequences both industrially and socially, of a shortfall in energy supply.

I believe that we are rapidly reaching a situation where we as a supplier of nuclear technology cannot afford to ignore the plight of our neighbours in the developing countries on the grounds of political expediency. We must be prepared to reassess our moral attitudes in the light of an energy situation which may result in the total destruction of the social order in a number of countries. European countries without indigenous

natural resources are now faced with grossly inflated balances of payments to keep the oil flowing. Greece, for example, uses nearly 40% of its foreign exchange for oil. In Israel, the future for the country is bleak indeed unless some means can be found to supply nuclear generated electricity in substantial amounts before the end of this century. India, a nation of some 700 hundred million people, struggles to develop its indigenous competence based on a technology which Canada provided in the 1950's and 60's but has withheld since 1974. India is one of many nations which simply can't afford the luxury of present oil costs. There are others which face an even poorer future unless we are willing to share with them the technology which we have acquired in the nuclear field. The application of nuclear energy is absolutely essential in the developing world if we ever hope to have world stability. These nations cannot be expected to stand by when we in the industrialized world increase our living standards at a rate that steadily widens the gap between us. With today's communications procedures the word gets around as to

how others live and one must question how long the world could go on with an ever widening gap affecting hundreds of millions of people without some kind of world revolution or collapse of whole regions.

The nuclear industry in Canada has contributed significantly to the raising of the professional and technical standards of the work force. Of the 35 thousands employees in nuclear work some eight thousands are professional workers and some eighteen thousands are skilled technical workers. Nuclear establishments in areas such as Cape Breton and Bruce County have provided high quality jobs for local people who in former times were forced to leave their regions in order to secure suitable employment.

We have, then, developed in Canada a pool of experienced, knowledgeable and technically advanced people who have launched a nuclear programme which is now acknowledged to be one of the most successful in the world. These people have spread to

institutions throughout Canada and in many parts of the world where they have in their turn made substantial contributions either in the nuclear or other professional fields.

The nuclear programme has made a substantial contribution to the body of published knowledge in the nuclear field. AECL itself has now published more than seven thousand scientific papers, not to mention the speeches, the symposia and the individual monographs which have found their way into every library of scientific note in the world.

All this has given a new dimension to Canada in the eyes of the world. International prestige is, of course, an intangible but we have only to reflect for a moment on our perceptions of other countries to realize the importance of international prestige in the pursuit of international trade. The advantages of the reputation for technical competence which I believe the nuclear programme has given to Canada is of vital importance and I would expect to see these advantages

assist us not only in the nuclear market but in other high technology efforts in the export field which are of increasing importance to our survival as an industrial trading nation.