GOVERNMENT
CANADA

STATEMENTS AND SPEECHES

INFORMATION DIVISION
DEPARTMENT OF EXTERNAL AFFAIRS
OTTAWA - CANADA

No. 55/3

CANADA'S ATOMIC ENERGY PROGRAMME

An address by the President, Atomic Energy of Canada Limited, Mr. W.J. Bennett, to the Toronto Board of Trade, January 24, 1955.

It is, I believe, of special significance that I should have the privilege of addressing the Toronto Board of Trade on Canada's atomic energy programme, because in your membership there is represented every section of the business community. I suggest that my remarks may be of particular interest to such an audience since we have now reached the point in the programme where it is possible to forecast its impact on the economy of this city and the region tributary to it.

The programme has passed through two stages and is now entering a third.

The first, or wartime stage, began in 1942 with Canada's decision to join with the United Kingdom and the United States in the development of the atomic bomb. Our contribution was of two kinds. First, we supplied uranium, the raw material of the bomb. Second, we undertook to find a method of producing plutonium - one of the fissile materials which is needed for atomic bombs. This resulted in the design and construction of the NRX reactor at Chalk River. This reactor still provides facilities for experiment and testing which are not found elsewhere. Because of this, it is being used extensively by the United States and the United Kingdom.

The second stage of the raw materials part of the programme began late in 1947, following the failure of the United Nations to reach agreement on the control of atomic weapons. Our government decided to continue its wartime partnership with the United States in the production of uranium. Again the objective was a military one, although it was recognized that by increasing uranium production we would be guaranteeing an adequate supply of raw material for any future peace-time programme. Early in 1948 the mining industry was asked to participate in the search for new sources of uranium. It was our conviction that the industry would respond with its characteristic vigour, if a guaranteed market and a reasonable profit incentive were provided. The results have confirmed this. By the end of 1957 uranium production in Canada will be something over twelve times as great as it was at the end of the war. The annual gross income from that production will be approximately 100 million dollars, ranking uranium in fourth place in the gross dollar value of metal production in Canada.

It is impossible to say at this time what the demand for uranium will be after March 31, 1962, the present expiry date of the guaranteed market. The military demand may continue at the present rate or may cease altogether. On the other hand, we may have a situation in which there is still government buying but on a reduced scale. Whatever happens, it can be safely predicted that there will be some requirement for uranium for use in atomic power programmes in the early sixties. It is evident, however, that the demand for uranium in the early stages of a Canadian atomic power programme will take up only a small part of our potential production. Consequently, if the military requirement ceases or is cut back substantially, Canadian producers may have to look to export markets and should expect to meet the same conditions which prevail in the case of other base metals which are not in short supply.

The second stage of the research and development programme began in 1951 with the decision to design and construct a second reactor at Chalk River. This decision reflected the confirmation of the earlier belief that atomic energy could be used for peaceful purposes. It also took into account the continuing demands of the military programme. Hence, the new reactor has been designed for a dual purpose - to produce plutonium and to provide larger and improved experimental facilities. These experimental facilities, because of the reactor's size and high neutron flux, should be the finest in the world. This reactor is expected to go into operation in June of 1956.

This second stage of the combined programme, which might be described as the transitional stage, came to an end late in 1953 with the realization that our earlier hopes for the industrial application of atomic energy had a very good chance of being realized. My main purpose this evening will be to tell you why we think this is so.

When the nucleus of the uranium atom is split in a reactor, enormous quantities of heat and energy are released. In reactors designed exclusively for plutonium production - that is, for military purposes - the heat is exhausted in the reactor coolant. In other words, it is a waste product. The main purpose of our work at Chalk River is to find a way of using this heat. The obvious use is the making of steam to drive a turbo-generator in a power plant. This is what we mean when we speak of atomic power.

Before I discuss the engineering difficulties which must be overcome in designing a power reactor, perhaps I should state the problem in its economic context. The importance of atomic fuel as a source of power will depend on its cost, translated into cost per kilowatt hour of electric energy generated. This raises a second economic consideration - the future demand for power in Canada, the sources from which this demand can be met, and their probable cost. On the basis of this twofold economic consideration, we believe that atomic power, if it is to be used for large central power stations, must be produced for a cost not greater than the cost of producing power in a conventional thermal station using coal at $8.00 per ton, or for a cost somewhere between 5 and 7 mills per kilowatt hour.

Let us now look at some of the engineering problems and the steps which we are taking to solve these problems.

While all of the reactors now in operation were designed either to produce plutonium for the military programme or for experimental purposes, the experience gained in their design and operation has demonstrated beyond question that a nuclear reaction producing heat can be achieved, and with a high degree of efficiency. Therefore, we are over the main hurdle - and in the brief space of fourteen years. This is not to suggest that we can now abandon research and development on what is known in the jargon of this business as "reactor cores" - even from a nuclear standpoint the ideal reactor has yet to be designed - but it does mean that we have sufficient information now available to prepare us for getting over the second hurdle - the engineering of a power reactor. To put it another way, we are now able to define the engineering problems which must be solved. This I regard as the most significant achievement of the past two years.

Our target of a kilowatt cost between 5 and 7 mills requires that certain conditions be met. First, the cost of the moderator and the uranium fuel must not be excessive. We see no difficulty on this score. Second, we must achieve an efficient utilization of the natural uranium fuel which is entered to the reactor. In order to do this, the uranium fuel elements must undergo long irradiation. In this respect we have already established some records with the NRX reactor. We must also be able to re-cycle the plutonium and depleted uranium which are extracted from the irradiated fuel elements. Finally, the power reactor must be capable of producing the kind of temperatures in a coolant which will permit the production of steam. These several conditions will give you some indication of the wide range of engineering problems which must be solved. I will mention a few of these. The reactor materials, especially the sheathing for the uranium fuel, must be resistant to high temperatures and corrosion, and at the same time must have the optimum neutron-capture characteristics. Sheathing materials now in use in the NRX reactor will not perform satisfactorily at temperatures in excess of 250°F. A cheap and efficient chemical process must be found for extracting plutonium, depleted uranium, and fission products from the irradiated fuel elements. While the generating equipment in the power reactor can be designed along conventional lines, the handling of the coolant in the reactor and the production of steam from the coolant will require a broad programme of engineering development in such fields as heat transfer, fluid flow, and steam cycles. As we have reason to know at Chalk River, a reactor can get out of control in a matter of seconds. Consequently, adequate instrumentation and control mechanisms are a prime necessity. Amongst other things, the advantage of an atomic power station, as compared with a conventional thermal power station, is the low annual fuel bill. However, the capital cost of an atomic station will undoubtedly exceed the capital cost of a conventional thermal station. Experience to date indicates that capital costs must be reduced very greatly, if the benefits of lower fuel costs are not to be offset entirely by capital charges.

How are we going about solving these problems?

First, it seemed obvious that at some stage we should apply the nuclear technology which we have developed at Chalk River since 1947. We know of no better way of doing this than by designing and building a power reactor using existing nuclear data. Early in 1954 a power reactor feasibility study was started at Chalk River. The objective of this study was to determine an outline specification for a small power reactor with an electric output of somewhere between 5,000 and 10,000 kilowatts, and to prepare a rough estimate of its cost.

As a result of the study, it has now been decided to design and construct a small or prototype power reactor. Proposals have been invited from a group of companies which have available the necessary design and development experience and shop capacity. The prime contractor will be responsible for designing and building the reactor and for mechanical performance. The contractor will also be expected to make some contribution to the cost of the project. The nuclear data will be supplied by Chalk River. Since it is unlikely that any single company can provide the full range of engineering resources needed for the job, it is expected that other companies with engineering experience in special fields will be employed by the prime contractor. In this way the participation of industry will be on the broadest possible scale.

While final specifications have not been determined, it is probable that the reactor will be designed to produce steam sufficient to generate 20,000 kilowatts electric. It will use heavy water as a moderator and possibly also as a primary coolant. The heavy water will be pressurized and will raise steam from ordinary water in a heat exchanger. The nuclear fuel will be, in the main, natural uranium, but some separated plutonium may also be used as a fuel in order to reduce the physical size of the reactor. The uranium fuel will be in the form of metal rods or tubes clad in zirconium alloy. It is not expected that this reactor will produce power at competitive costs but it will produce the kind of design, operating and cost experience which will permit a scale-up to a large and economic power reactor. The detailed design of the reactor will begin in the second quarter of 1955, with a view to the completion of construction early in 1958.

We would like to have one of the utilities join with us in the small reactor project. We envisage an arrangement whereby the utility would provide the power plant and site, and would undertake to purchase steam from the reactor at some agreed price. The reactor and the power plant would be operated by the utility and the power generated would be fed to an existing power system.

At Chalk River we will continue and expand the present programme of research and development. Its main objective will be a preliminary design study for a large power reactor capable of producing 100,000 kilowatts electric. This will involve research on reactor cores, the testing of fuel systems and materials in the NRX and NRU reactors - which are ideally suited for this purpose - and engineering development. It is our hope that a large part of the engineering development will be undertaken by industry.

The second economic factor which must be considered in planning the power reactor programme is the future power demand in Canada, the resources which will be available to meet the demand, and their probable cost. Early in 1954 an Advisory Committee, consisting of representatives of the various power corporations and provincial power commissions, was appointed. This committee serves as the medium by which those in the power business may be kept abreast of our progress and at the same time may assist us in giving the correct economic evaluation to the programme. While I wish to make it clear that I accept the sole responsibility for the forecast which I shall give you, I wish to acknowledge the assistance we have received from the members of the committee in compiling the statistics on which the forecast is based. These statistics show that the annual increase in power demand for the country as a whole will be at the rate of 5-1/2 per cent for the period 1955-1960, 5 per cent for the period 1960-1965, and 4-1/2 per cent for the period 1965-1975. Such an increase will require a total installed capacity of approximately 40 million kilowatts by 1975 as against the present installed capacity of 15 million kilowatts. They also show that the average national cost of power to all consumers is now 0.69¢ per kilowatt hour. I need hardly point out that these figures require careful interpretation. First, the estimated percentage of increase over the next twenty years varies considerably from region to region. In the first five-year period, 1955-1960, the estimated average annual increase is as high as 8 per cent in some regions and as low as 4 per cent in others. Similarly, with the figures for the present national average cost, regional costs vary from a high of 3.97¢ per kilowatt hour to a low of .5¢ per kilowatt hour. The wide variation of conditions from region to region also must be taken into account in any attempt to make an appraisal of the power sources, and their cost, which will be available to meet the future demand. In some regions there are large resources of economic hydro power which are as yet untapped. In other regions thermal fuels are available in abundance, and at a low cost. Therefore, in assessing the probable role of atomic power in meeting the future power demand, we must look at those regions where hydro power is unavailable or can only be made available with extremely high transmission costs, or where conventional thermal fuels are not available or, if available, at a high cost. It so happens that southern Ontario is such a region.

The rate of growth in the demand for power in southern Ontario for the past thirty years has been approximately 5.7 per cent per annum. It seems reasonable to assume that this rate of growth will continue during the next twenty years, unless we are prepared to put a limit on the future development of this region - a proposition which will hardly be entertained by this audience. This rate of growth represents a doubling in demand every twelve and one-half years. On this basis, the estimated power demand in southern Ontario in 1975 would be about 9,500,000 kilowatts. On the completion of the St. Lawrence development in 1959 there will be approximately 4,600,000 kilowatts of capacity, leaving approximately 5,000,000 kilowatts of capacity to be provided between 1960 and 1975. With the completion of the St. Lawrence development, large-scale hydro resources in southern Ontario will have been fully developed. The major portion of this 5,000,000 kilowatts will, therefore, have to be met from thermal installations or from large blocks of hydro power which may be available elsewhere at competitive costs. Bearing in mind that Ontario has no indigenous supplies of conventional thermal fuels and that power from untapped hydro resources in other parts of the country must be transmitted for very great distances, we believe that atomic power can meet southern Ontario's future needs.

I have used the example of southern Ontario since it is of particular interest to this audience. Where similar conditions exist in other parts of Canada, atomic power will be available to supply the deficiency of competitive power from other sources.

The plans for the third stage of the programme which I have just described reflect our thinking as to the respective roles of the government and industry in the atomic energy programme. The government got into this business during the war years. This, in itself, gave the government the dominant position. Likewise, in the period of transition when the military objective was still paramount, it was to be expected that the full burden of the effort would still be carried by the government. However, as we enter upon the third stage of the programme, some modification of policy is desirable. That we have been able in Canada to carry out a research and development programme of a quality quite comparable with that in the United States and in the United Kingdom, is an achievement of which we can all be proud. But let us recognize that this has been done at considerable cost. The projected programme will also be costly. It is my view that the continued expenditure of large amounts of government money should have some justification beyond enhancing Canada's reputation in international scientific circles. That justification I see in the probability that atomic power will meet the demand for additional power in those areas of Canada which have exhausted their hydro resources and where the cost of conventional thermal fuels is excessive. I see it also in the creation of a new industry in Canada which will be capable of supplying the commercial market for reactors, reactor components and materials, and reactor fuels, here and abroad. Because of this, I believe the time has come when industry and the utilities should accept some share of the responsibility for the power reactor programme. As I see it, the future role of Chalk River will be to maintain a research and development centre which will permit Canada to hold her position in this new field. It will be the role of industry and the utilities to apply the results of this research and development effort. While the programme at Chalk River for the present will be concentrated on the small reactor project and the preliminary design study for a large reactor, we will co-operate fully with any company which is interested in pursuing a different line of approach. In this connection I might suggest the design of a small package reactor for use in the North. The proposed partnership of government and business is not peculiar to Canada. A similar trend is now under way in the United States and in the United Kingdom.

Over the years that I have been in Ottawa I have had occasion to read many resolutions concerning the relations of government and industry which are passed from time to time by Boards of Trade throughout Canada. Underlying most of these resolutions is the principle - with which I wholly concur - that private enterprise should be allowed the maximum freedom in developing our country. A corollary of this principle must be the willingness of private enterprise to risk capital in new fields. I know of no field which more neatly satisfies this condition than the industrial application of atomic energy.

S/A