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MANUFACTURING OPPORTUNITIES IN THE CANADIAN "CANDU" AND HEAVY WATER PROGRAMS

INTRODUCTION

I welcome this opportunity to talk to you about the manufacturing opportunities that come out of the CANDU program. As many of you may know, the Department of Industry, Trade & Commerce has recently completed a study of the nuclear industry, jointly with AECL & EM&R in the light of the new demands that are emerging. As a result, today I would like to outline what we see in the way of opportunities for Canadian industry to participate to the fullest extent possible in the CANDU program, and, at the same time, indicate what we think Canadian industry might do, or might have to do, in order to be able to take advantage of these opportunities. I am hopeful that my remarks will provide some encouragement to those companies that are already involved in the nuclear area and are considering major expansions and, at the same time, may dispel reservations that other companies may have with regard to the advantages of going into the nuclear business.

I would like to start with an outline of how we see the nuclear business in terms of the size of the market, the technical complexities involved and the unusual marketing situations that prevail. Next, I will talk about the types of components and products that are involved and the kinds of facilities needed to produce them. I will then discuss the investments that appear to be required for industry to increase its capacity and upgrade its capability to meet nuclear requirements.

If I were to characterize the nuclear business in a few words, I would say that it is big, it is demanding, it is concentrated, it is important and, even though it has an element of risk, it should be very rewarding and profitable.

The market is big because it involves over the next ten years the construction of more than 40 nuclear reactors in Canada with an estimated

value of $5 billion in terms of machinery and equipment for the NSSS and the PGS. In addition, we can expect about $1 billion of equipment for exports and another billion dollars for heavy water plants. This means a total estimated market of $, billion over ten years or $700 million per year at today's prices.

If this "economic pie" is divided amongst 100 companies, it represents, on the average, $7 million per year, per company. Even if it were divided amongst 1000 companies, it would still be fairly good business. It should be realized that the large contracts would go to relatively few companies. The study, for instance, identified some 60 suppliers of major components. However, it should also be noted that most of the major contractors will need to let sub-contracts of substantial size. Eventually, the economic benefits of the CANDU program could very well extend to a thousand companies or more. It is also interesting to note that this figure of $700 million of annual nuclear equipment business is twice as large as the current annual production of conventional power plant equipment and also corresponds to approximately 20% of the annual Canadian production of all industrial machinery.

Looking at it another way, Canadian industry recently has supplied the equivalent of about one reactor per year. It is now facing a demand of about 4 reactors per year and in some years may be called upon to supply up to six. With present facilities, we estimate that the industry can supply between 2 to 3 reactors per year.

I have also said that the nuclear business was demanding. This stems primarily from the extreme precautions that are taken against any possible hazard due to radiation or other nuclear accident. There is also the fact that the heavy water circulating in the system is so expensive that it justifies the taking of very stringent and costly measures to avoid any leakage.

In order to meet these requirements, Canadian manufacturers must work to extremely close tolerances, must be able to handle exotic and difficult materials and must exercise a level of Quality Control which, in some instances is on a par with, and may even exceed, that required in the aerospace industry. For example, the material used in each individual nuclear component and all the work done on it must be traceable to the original ingot. Our recent survey of the industry has indicated that, on the average, 20% of the cost of nuclear components goes toward quality control, as compared to about 5% for conventional machinery products. The added quality control costs are accounted for by such things as: (a) the purchase and use of precise and sophisticated testing and inspection equipment; (b) special training for engineers, technicians and highly skilled production workers; (c) the development and upgrading of quality control manuals and procedures; (d) close control and monitoring of work done by sub-suppliers; and (e) the large amount of rework which is required to maintain nuclear standards.

In addition, the large size of some nuclear assemblies poses a problem in itself. Some assemblies which, in the past, were put together on site, now are built in the factory. These are unusually large, difficult to handle and test, and in some cases can only be shipped by water. Moreover, some of the new designs call for pieces of equipment that cannot be accommodated in present factory installations.

Another word I used to characterize the nuclear business is that it is "concentrated". By that I mean that the demand is concentrated in the hands of AECL and a few purchasers - the provincial utilities. For the individual company this means a marketing approach quite different from the usual. It means that you must be prepared to satisfy the customer regarding your capabilities even before the quotation stage and expect very close supervision while the work is in progress. On the other hand, you are

dealing with an informed and technically proficient client who has an interest in helping you to overcome problems you might encounter. In addition, the utilities and AECL have a strong desire to source as much of their requirements as possible in Canada. To this end, I should point out that representatives from provincial utilities and AECL will be on hand this afternoon for individual discussion with you regarding their future needs and the opportunities available to you.

In addition to the primary demand which originates with the utilities, there is, of course, the secondary demand which is represented by the large amount of sub-contract work available from the suppliers of the major pieces of equipment. For this reason, smaller companies that are interested in this sub-contract work could find it advantageous to talk not only to the utilities, but also to some of the prime equipment contractors.

When I said that the nuclear business was important, I was not only referring to its obvious importance in terms of meeting the future energy needs of the country, but also to its importance to the manufacturing industry. How often have we heard it said that the Canadian industry would not have any real problem if only it had a large enough market. Here we <u>have</u> a big enough domestic demand to sustain, by itself, a strong manufacturing sector in a high technology area. CANDU is a new area of sophistication and high technology which can raise the technological competence of Canadian industry to unprecedented levels. If this technology is widely disseminated throughout industry through optimum participation in the nuclear construction program, it will provide added benefits in terms of international competitiveness in both nuclear and other product areas.

Because of the intermittent demand to date, coupled with the evolving nature

of the componentry and technology, the nuclear business in the past has not always been all that profitable. However, indications now are that the demand for nuclear components will be continuous and much larger, and the trend is towards greater standardization. This should provide a broad enough base to enable Canadian industry to obtain a level of profit that should justify the heavy investments that are needed.

SPECIFIC MANUFACTURING OPPORTUNITIES

In my earlier remarks I discussed the size of the nuclear market on an overall basis. I would now like to talk about specific opportunities for particular kinds or types of equipment. First, I want to acknowledge the assistance we have had from a number of people in putting together information about nuclear components. This includes information obtained from manufacturers of equipment, many of whom are here today. It also includes AECL people, in particular Mr. W. S. Philip, who have been very generous and patient in providing us with details regarding the NSSS equipment which they specify, and the facilities required to meet their technical requirements. We also owe a particular debt of gratitude to Mr. J. D. Wilson of Ontario Hydro for his cooperation in providing details of their procurement requirements and procedures.

In the time available today, I cannot give a detailed account of every nut and bolt that goes into a nuclear station. I will, therefore, try to confine my remarks to just the major pieces of equipment, with some indication of the volume of business that is foreseen in each case.

For the purpose of this discussion, I thought I would talk in terms of the cost components of the 600MW CANDU reactor. The cost of all equipment, materials and services on a 600 MW unit is in the order of $350 million, in 1974 dollars. This covers such items as building materials, heavy water and fuel, engineering design and construction

commissioning and equipment. Of the $350 million total, $115 million represents the cost of equipment and, of that, $55 million is for the nuclear steam supply system and $60 million for the more conventional power generation system.

NSSS EQUIPMENT

Of the $55 million of equipment that goes into the NSSS, about 1/3 consists of specialized items manufactured to AECL designs and, while the remainder is somewhat more conventional in design, it still calls for the rigid "nuclear" quality assurance requirements.

The major components involved in the NSSS can be divided into five broad groups: the reactor, the primary heat transport system, the fuel handling system, the moderator circulation system, and auxiliary systems.

The reactor vessel assembly in total represents a value of about $13 million. Its major component parts are the calandria, fuel channel assemblies, end fittings and reactivity control mechanisms. The calandria itself is, of course, a massive structure which would be assembled in one plant and several suppliers may be involved in making the components. For each calandria there are 380 fuel channel assemblies, 760 end fittings, and 21 reactivity control mechanisms, which together add up to about $6 million.

The primary heat transfer system is comprised mainly of 4 steam generators, valued at approximately $4.5 million, and 4 heat transport pumps worth another $4.5 million. There are also a number of smaller pumps, condensers, and heat exchangers which together add another $10 million to the package. The steam generators and heat transport pumps used in the 600 MW reactor are within the capabilities of Canadian industry. However, we understand that some of the larger reactors contemplated by Ontario Hydro will utilize equipment that is so large that present Canadian facilities may not be able to handle them.

One of the unique features of the CANDU reactor is on-power fuelling. In competing designs, the reactor must be shut down in order to replace fuel elements. This, of course, means that the Canadian approach requires very sophisticated equipment. The two fuelling machines required for one 600 MW reactor, plus the auxiliary equipment, cost approximately $6 million. While it is widely known that only two companies at present manufacture fuelling machines they depend on sub-contractors for many of their components. These components include such things as: carriage drives, ram tubes, ball screws, control and relief valves.

The moderator circulation system consists in the main of 2 - 1000 h.p. pumps and two heat exchangers, together with tanks, ion exchangers and other small parts, for a total value of $2 million. There are other auxiliary systems which are comprised mostly of pumps, valves, heat exchangers and piping which add up to a further $3 million.

While I have tried to speak in terms of major components, I realize that this is not the complete picture. What we have in a nuclear reactor is, in essence, two closed loops of circulating liquids, which require a large number of assorted pumps and valves and massive quantities of piping and other fabrications. For instance, the system includes over $7 million of seamless tubing, $1 million of misc. heat exchangers, and $1-1/2 million of valves.

As in all power plants, equipment control is of great importance and sophistication. In a nuclear plant it becomes more so since operators do not have access to hazardous areas of the reactor building during operation. As a result, the cost of instruments and control for a NSSS exceeds $6 million.

PGS COMPONENTS

With regard to the conventional part of the power plant, the equipment required does not present the same problems of access as is the case for the NSSS. Nevertheless, the PGS equipment is also specialized

because of the low quality of steam generated by the NSSS. The major components of the power generation system include: the turbine-generator, condensers, feed water reactors and miscellaneous heat exchangers, pumps, valves, and various electrical apparatus such as transformers, switchgear, small motors and process control equipment. In total, these components add up to about $60 million per reactor.

Almost half of this $60 million goes into the turbo-generator set and its related condensing and feed water heating systems. There are relatively few prime contractors for this equipment; however, the amount of business available on a sub-contract basis could be substantial. Most other items of machinery and electrical apparatus in this part of the nuclear plant are standard products which represent a business that is available to a wide range of existing manufacturers.

While I have mentioned some of the individual pieces of equipment that go into a single 600 MW reactor, it should be remembered that there is a potential demand of about 40 reactors in Canada over the next ten years. Most of these 40 reactors will be in the 600 - 750 MW range, however we understand that Ontario Hydro is now thinking of installing some 1200 MW units. This means an even larger expenditure per unit than I have indicated.

HEAVY WATER PLANTS

In addition to the nuclear power construction program itself, there are large manufacturing opportunities arising from the projected construction of ten 400-ton heavy water plants within the next ten years, at a total estimated cost of $2 billion. The construction of a 400-ton capacity heavy water production unit represents a cost of approximately $200 million (in 1974 dollars) of which approximately $30 million is required for engineering services and $140 million consists of various kinds of equipment.

Major equipment components for a 400-ton heavy water unit such as La Prade include:

- 26 large towers
- 230 pumps in sizes up to 2,500 h.p.
- 19 compressors up to 7,000 h.p.
- 45,000 valves
- 116 heat exchangers
- 40 other tanks and vessels
- 3,500 tons of structural steel, and
- 7,000 tons of pipe, up to 52" diameter.

The quality standards for the production of this equipment are very high due to the containment features required for the expensive heavy water produced and the corrosive nature of the hydrogen sulfide gas used as a catalyst. Nevertheless, most of the equipment falls within existing Canadian capabilities.

IMPLICATIONS OF CANDU EXPORTS

While I have been talking so far about manufacturing opportunities arising from the domestic nuclear program, it might be helpful at this point to put some kind of perspective on the additional opportunities that may develop from export sales of CANDU reactors.

There would appear to be three different kinds of export markets for CANDU reactors. First, there are developing countries with limited financial resources. Even though they might need the energy, obviously Canada cannot afford to help them to the extent of providing them with CANDU power plants strictly on an aid basis. There are also limitations to the number of reactors we can sell with EDC financing. At a cost of some $350 million per reactor, Canada cannot afford very many credit sales - to the exclusion of other export opportunities. A second market is represented by other developing countries

who have adequate capital but little technology. Such countries could pursue a much more independent policy with regard to the purchase of conventional equipment and some specialized CANDU equipment from third countries. Finally, there may be opportunities to sell CANDUs to certain industrialized countries not yet committed to a nuclear power technology of their own, such as Denmark, Norway and Italy. Such countries could provide the bulk of the equipment required themselves or purchase it from traditional suppliers. They are generally more interested in license agreements providing for the supply from Canada of only the essential technology and perhaps certain highly specialized items of equipment. There is also the problem of safeguards which will further restrict the number of countries that can be considered as potential clients.

While initial orders could include a large amount of Canadian equipment, subsequent installations will most likely involve a decreasing level of Canadian participation as the purchasing country would gradually add more and more components from its own resources. Nevertheless, CANDU component exports will provide important benefits in helping individual companies to amortize the costs of plant expansions and upgrading of capabilities to meet nuclear standards as well as filling production gaps between orders for the domestic program. Such sales could also bring about indirect benefits in terms of enhancement of the international reputation of Canadian industry as a supplier of high technology equipment which would also help to sell other equipment.

CAPACITY AND CAPABILITY EXPANSION

Our study has confirmed that the manufacturing opportunities I have just outlined cannot all be met with existing capacity and facilities. In fact, it would appear that the nuclear program will require a doubling

of present capacity. This may have to be achieved in a number of ways:

(a) present suppliers may have to increase their facilities through plant expansion, or the purchase of additional equipment to increase their output of nuclear components;

(b) other suppliers will have to expand or modify their facilities to accommodate new designs coming into use;

(c) new entrants into the nuclear field will have to invest in facilities and equipment to meet nuclear standards;

(d) present or new suppliers may have to invest in new facilities in order to take advantage of manufacturing opportunities for products which heretofore were supplied from foreign sources.

In total, it is estimated that about $200 million of new capital investment is required to expand production capabilities to meet the manufacturing needs required by the CANDU program. On the basis of what individual companies have told us, about $100 million has already been committed or is being spent for this purpose. This leaves a shortfall of $100 million which it appears the industry is hesitant to commit because of the large size of the investments involved compared to the resources available.

I hope that the discussions that are taking place today will serve to dispel many reservations that some companies may have had with regard to opportunities to participate in the nuclear program and at the same time remove some concerns with regard to the possible risks involved in committing capital expenditures in this area. I can assure you that the Department of Industry, Trade & Commerce, and I am sure that this holds true as well for AECL and the utilities, is prepared to do whatever it can to assist industry to participate to the fullest extent possible in the CANDU power program.