AECL-5248

ATOMIC ENERGY OF CANADA LIMITED

L'ÉNERGIE ATOMIQUE DU CANADA LIMITÉE

THE CANADIAN HEAVY WATER SITUATION*

by

A. DAHLINGER

*Presented to the 15th Annual International Conference, Canadian Nuclear Association, Ottawa, Canada, 15-18 June 1975.

Chalk River Nuclear Laboratories

Chalk River, Ontario

August 1975

THE CANADIAN HEAVY WATER SITUATION*

by

A. Dahlinger

Chalk River Nuclear Laboratories
Chalk River, Ontario
August 1975

---

*Presented to 15th Annual International Conference, Canadian Nuclear Association, Ottawa, Canada, 15-18 June 1975.

AECL-5248

Situation actuelle de l'eau lourde au Canada*

par

A. Dahlinger
Groupe de l'eau lourde
Ottawa

Résumé

Les usines d'eau lourde actuellement en service au Canada ont un taux de production satisfaisant et la capacité des usines en projet correspond à la demande prévue. En 1980, les usines installées pourront produire selon les calculs presque 600 kg d'eau lourde à l'heure. Toutes ces usines utiliseront le procédé Girdler-Sulphide. Il faut s'efforcer de réduire le plus possible les coûts de production de l'eau lourde et il faut s'assurer que ces coûts n'augmentent pas plus vite que la tendance inflationniste actuelle.

L'Energie Atomique du Canada, Limitée
Laboratoires nucléaires de Chalk River
Chalk River, Ontario

Août 1975

*Rapport présenté au 15ème Congrès international annuel de l'Association Nucléaire Canadienne tenu à Ottawa du 15 au 18 juin 1975.

AECL-5248

ATOMIC ENERGY OF CANADA LIMITED

THE CANADIAN HEAVY WATER SITUATION*

by

A. Dahlinger
Heavy Water Projects
Tunney's Pasture, Ottawa

ABSTRACT

Existing heavy water plants in Canada are producing at a satisfactory rate and currently planned capacity is in balance with projected needs. By 1980, we shall have Girdler-Sulphide plants installed with a design capacity of almost 600 kg/h. Effort is required to minimize production costs for heavy water and to ensure that costs do not increase faster than the current inflationary trend.

Chalk River Nuclear Laboratories
Chalk River, Ontario
August 1975

*Presented to 15th Annual International Conference, Canadian Nuclear Association, Ottawa, Canada, 15-18 June 1975.

AECL-5248

THE CANADIAN HEAVY WATER SITUATION

by

A. Dahlinger

SUPPLY AND DEMAND

In its support of the CANDU (Canada Deuterium Uranium) program, the Canadian heavy water industry has become the largest in the world. Its growth during the next several years will take it to the position where, by 1980, we shall have G.S. plants installed with a design capacity of almost 600 kg/h (see Table 1).

Table 1

Canadian Production Plants for Heavy Water

	Design Capacity	In Operation or Start-up Date
Port Hawkesbury	48.3	Yes
Bruce A	96.6	Yes
Glace Bay	48.3	1975
Bruce B	96.6	1978
La Prade	96.6	1979
Bruce D	96.6	1979
Bruce C	96.6	1980

During 1974, production from Canadian plants totalled 993 Mg or over 75% of design capacity. Figure 1 illustrates this production on a month-by-month basis during the last two years. Towards the end of 1974 and during early 1975, some production problems, and particularly lack of capacity in final enrichment by distillation, reduced output. During this later period, almost 100 Mg of 20% D_2O was extracted at Bruce and Port Hawkesbury which still remains to be upgraded. (It should be noted that the dotted line in Figure 1 includes this 20% water.) Because the finishing unit at Glace Bay nas just been commissioned, this available finishing capacity is being used to finish 20% D_2O from Bruce as a means of minimizing the effects of the current mis-match on extraction and finishing units.

Following the planned maintenance shut-downs at Bruce and Port Hawkesbury, we have confidence in returning to production levels of close to 80% of design. Future expectations are shown in Figure 2 using production estimates of 70% design capacity. These curves include production from the Bruce plants, La Prade, Port Hawkesbury and Glace Bay, which is currently being commissioned and which will be producing its first heavy water later this year.

Up to the end of 1977, Canadian heavy water production and foreign purchases are pooled for the joint benefit of Ontario Hydro and Atomic Energy of Canada Limited (AECL). Beyond this time, Ontario Hydro will be meeting its needs from its own plants and AECL's production will be used for all other plants, i.e. in other provinces and for the export program. AECL's forecast production of heavy water is shown in Figure 3 at the 70% production level. This curve represents cumulative supply from our plants and the heavy bars indicate committed reactors (with a contingency reserve), while the dashed bars show uncommitted charges of 500 Mg, i.e. the charge of heavy water required for each 600 MW CANDU. It will be seen that there will be sufficient heavy water from existing plants for at least two reactors per year. This, as indicated above, is based on the conservative production estimate of 70% design and without any foreign purchases of heavy water.

Up to the early 1980's, we believe that the supply situation is in reasonable balance with the demand as currently foreseen for Canadian electrical power generation. Beyond this period, our knowledge of demand becomes less precise but it is our belief that the growth in nuclear power will continue even under pessimistic forecasts of total power consumption owing to the increasing cost of fossil fuel and to the limits of available hydro-electric power. In addition, we are likely to see further use made of steam from nuclear reactors in other energy intensive industries. This outlook causes us to believe that additional heavy water plants will be required in Canada and in other regions, and in view of the size and complexity of these plants, it will be necessary to commit these new plants before the end of this decade.

PRICING

The price of heavy water is established by AECL on a cost recovery basis and as with almost all other items, our costs have increased dramatically over the past year. Our heavy water costs are currently divided approximately as follows:

Table 2

Breakdown: Heavy Water Costs

Capital	60%
Thermal Energy	20%
Electrical Energy	7%
Operation & Maintenance	13%

We are now projecting costs of $134/kg (mid-1975 dollars) for water delivered 1978/79. Steps to minimize the inflationary effect of higher fuel prices have already been taken by both Ontario Hydro and AECL through the use of steam from CANDU reactors at both Bruce and La Prade. It is expected that this approach will be followed in future plants in view of the energy intensiveness of the GS process.

STATUS OF PLANTS

The performances of the Port Hawkesbury and Bruce A plants have already been referred to in the very practical terms of their production during the last year.

Late in 1974, Federal government authorization was given for AECL to negotiate the purchase of the Port Hawkesbury plant from Canadian General Electric (CGE), and last month t e purchase of this plant was completed. It is particularly relevant that the contribution of CGE staff to the Canadian heavy water program be acknowledged. This effort, and the effort of staff from the General Electric corporate research centre at Schenectady, N.Y., resulted in the first reduction to practice of the large GS (Girdler-Sulphide) plant concept and this significantly increased our knowledge of the process.

At Glace Bay, despite an extremely adverse winter, which severely retarded progress, commissioning of water treatment and the final enrichment systems is complete and, by mid-June, all units of the North plant will be undergoing commissioning. No major problems have been encountered with the equipment and systems handed over for commissioning. First heavy water production from natural water is expected before the end of 1975. Before this, a substantial amount of reactor grade product will have been upgraded from 20% concentration for the other Canadian plants where final enrichment is currently limiting.

At the La Prade plant, owing to delays in land acquisition, construction was started in November 1974. Since that date, however, work has continued on schedule and dyke work was completed in order to allow continuity of site work during the spring flood period.

All major items of equipment have been ordered although long deliveries and extended projections of site work are delaying the projected completion of construction until late 1978.

A nucleus of experienced staff has been recruited for La Prade and specialized training at heavy water plants is already underway.

Significant progress has also been made at the Bruce site by Ontario Hydro in their expansion program, and authorization was recently granted for the fourth 800 Mg plant at this site.

FURTHER DEVELOPMENT

Although the operating performance of our plants during 1974 has been highly satisfactory, there still remains considerable potential for improvement and there is ample justification for continued development.

Our activity in this area is primarily directed at improving the productivity of GS plants through increasing the reliability of equipment, through increasing the throughput of feedwater and through improving the efficiency of extracting deuterium. Our efforts are also directed at improving the process for future plants. In addition, we are continuing to investigate and develop alternative processes which show promise for improved economics.

The following comments illustrate some of the major development projects:

Sensitive simulation models of our heavy water plants have been developed and this technology has proved to be a valuable tool in diagnosing operating problems which limit production and in evaluating a number of potential process improvements at existing and new plants. This development has also assisted the design of our new La Prade plant.

Dynamic simulation models are also being used to study the dynamic response of deuterium inventory distribution to changes in process parameters. These models together with an on-line deuterium analyser developed at Chalk River Nuclear Laboratories and recently installed at the Bruce Heavy Water Plant will assist in minimizing production loss during start-ups, shut-downs and process upsets.

A further activity which has demonstrated its value during 1974 has been gamma scanning of GS plant towers. This is permitting a precise measurement of foam and froth heights on trays, the detection of hole plugging on seive trays and other internal structural damage. It is foreseen that other process industries will also be able to benefit from this technique. Work on gamma scanning again demonstrated the cooperation in the heavy water industry through the use at Port Hawkesbury by a team from Ontario Hydro of the portable gamma scanning equipment developed and built by CRNL for Ontario Hydro.

The field of chemical analyses of process feedwaters continues to be a major activity in support of the process. Small differences in the chemistry of the feedwater supply have large effects on the rate of fouling which reduces the operating efficiency of plants. The related study of corrosion phenomena is a key to the selection of materials and their use.

As reported previously, work is continuing on two new processes for heavy water production. One of these, the amine hydrogen exchange process, is of particular interest in view of the construction of new ammonia plants in Alberta which can provide the necessary hydrogen streams. A detailed study on the economics of this process is nearing completion with the objective of establishing its competitiveness compared to the GS process.

In conclusion, the Canadian heavy water industry is in a healthy state with existing plants producing at a satisfactory rate, and with our construction program preparing to produce increasing requirements for the future. Currently planned capacity is in balance with projected needs, but care is necessary to ensure that new plants can be committed in time to meet any changing demands. Additional efforts are also required to minimize production costs for heavy water and to ensure that costs do not increase at rates higher than the current inflationary trend.

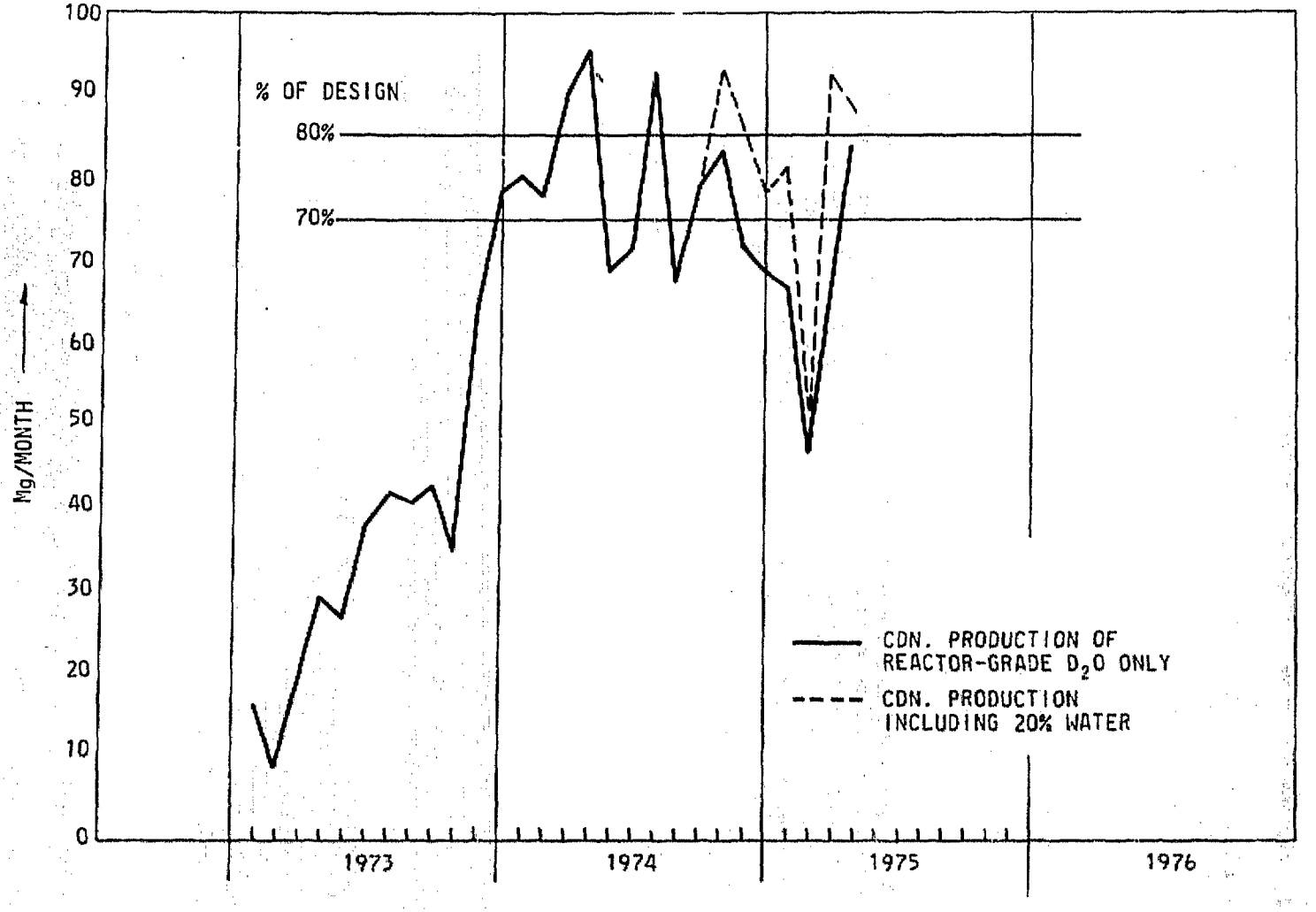

FIGURE 1 - Canadian heavy water production

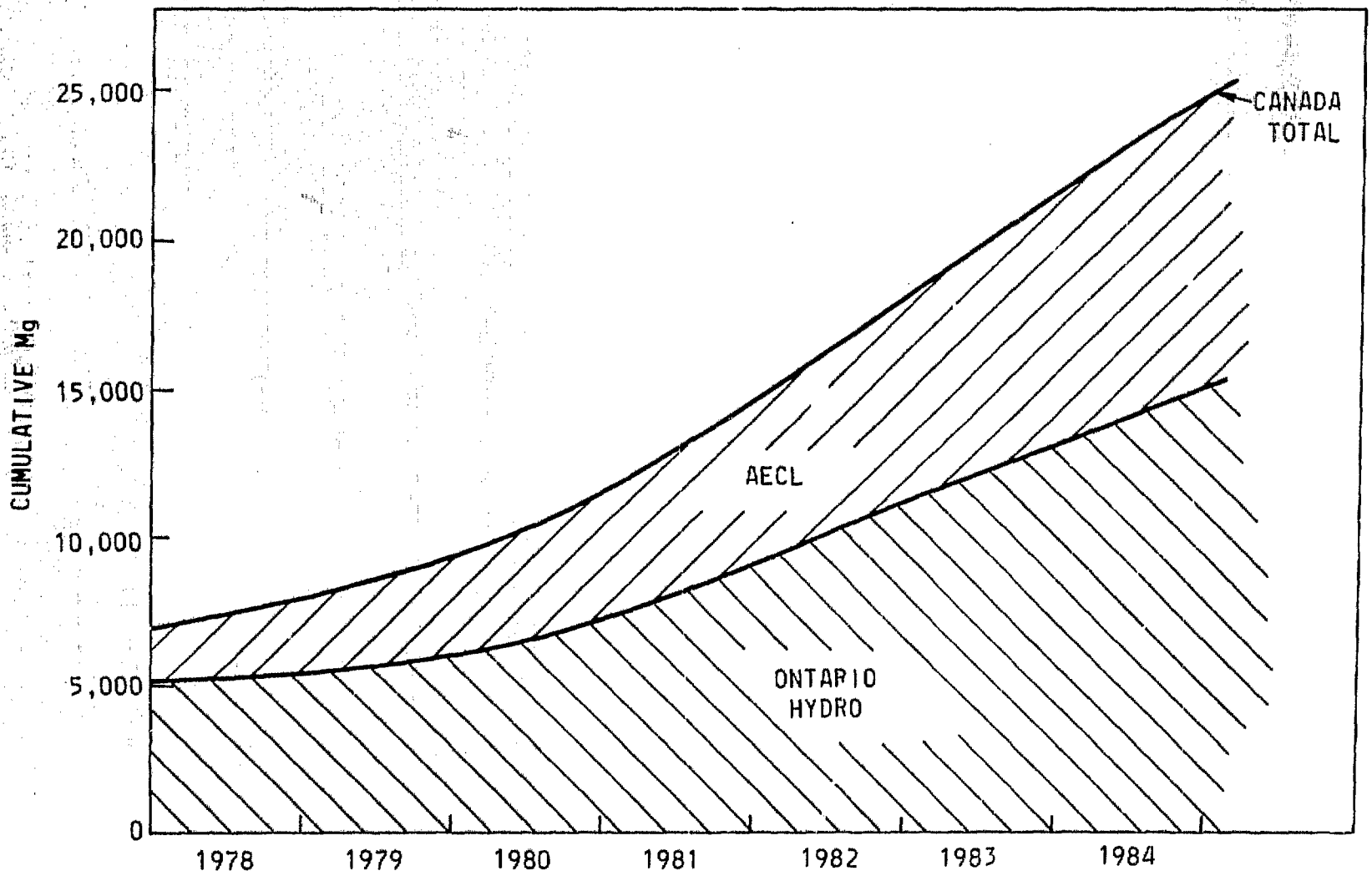

FIGURE 2 - Cumulative Canadian heavy water production

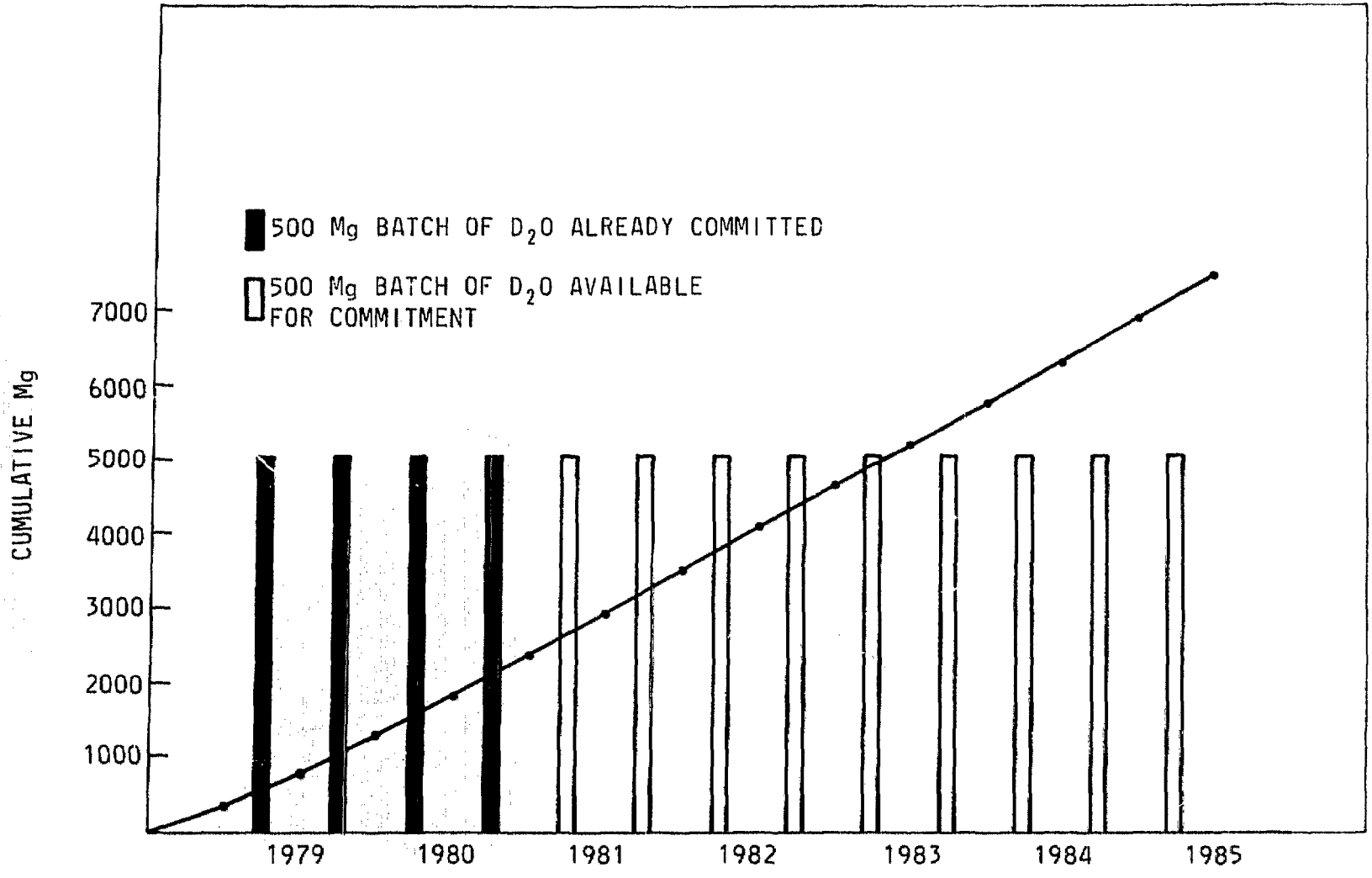

FIGURE 3 - Estimated AECL production (70% of design capacity) of heavy water

The International Standard Serial Number

CN ISSN 0067–0367

has been assigned to this series of reports.

To identify individual documents in the series we have assigned an AECL– number.

Please refer to the AECL– number when requesting additional copies of this document from

Scientific Document Distribution Office
Atomic Energy of Canada Limited
Chalk River, Ontario, Canada
K0J 1J0

Price - 50¢ per copy

1770-75