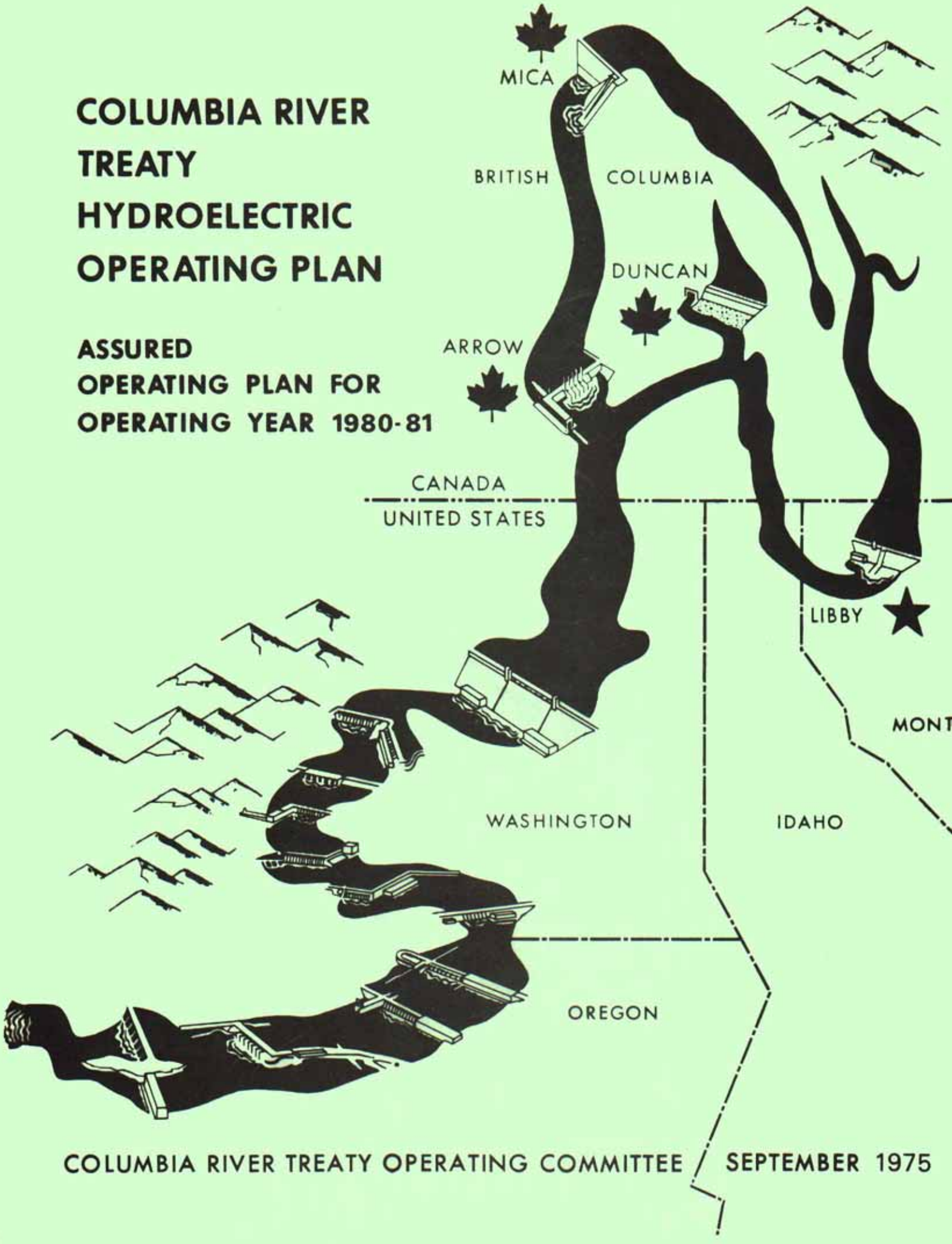
# COLUMBIA RIVER TREATY HYDROELECTRIC OPERATING PLAN

## ASSURED OPERATING PLAN FOR OPERATING YEAR 1980-81




COLUMBIA RIVER TREATY OPERATING COMMITTEE / SEPTEMBER 1975

COLUMBIA RIVER TREATY
HYDROELECTRIC OPERATING PLAN

Assured Operating Plan for
Operating Year 1980-81

TABLE OF CONTENTS


| | Page |
|---|---|
| INTRODUCTION | 1 |
| SYSTEM REGULATION STUDIES | 2 |
| DETERMINATION OF OPTIMUM GENERATION IN CANADA AND THE UNITED STATES | 3 |
| OPERATING RULE CURVES | 4 |
| OPERATING RULES | 9 |
| IMPLEMENTATION | 14 |
| REFERENCES | 16 |

TABLES

1. Composite Critical Rule Curve
2. Composite Assured Refill Curve
3. Composite Variable Refill Curve
4. Duncan Flood Control Storage Reservation Curve
5. Arrow Flood Control Storage Reservation Curve
6. Mica Flood Control Storage Reservation Curve
7. Composite Operating Rule Curve

COLUMBIA RIVER TREATY
HYDROELECTRIC OPERATING PLAN

Assured Operating Plan for
Operating Year 1980-81

## INTRODUCTION

The Treaty between Canada and the United States of America relating to the cooperative development of the water resources of the Columbia River Basin requires that each year an Assured Operating Plan be agreed by the Entities for the operation of the Columbia River Treaty Storage in Canada during the sixth succeeding year. This plan will provide to the Entities information for the sixth succeeding year for planning the power systems in their respective countries which are dependent on or coordinated with the operation of the Canadian storage projects. The data assumed for this Assured Operating Plan will undergo review by the Entities immediately prior to the 1980-81 operating year and such data may be revised to reflect data and criteria current at that time. Should the Entities fail to agree on such revisions, then this Assured Operating Plan will form the basis for the Detailed Operating Plan for 1980-81.

This Assured Operating Plan was prepared in accordance with the Principles and Procedures for the Preparation and Use of Hydroelectric Operating Plans for Canadian Treaty Storage.[1] It is based on criteria contained in Annex A and Annex B of the Columbia River Treaty,[2] Article VII of the Protocol,[3] and in Section B.1. of the Terms of Sale.[4] The other operating criteria reflected in this plan is the Columbia River Treaty Flood Control Operating Plan.[5]

The Assured Operating Plan consists of:

(a) The Operating Rule Curve for the whole of the Canadian Treaty Storage, including the Critical Rule Curve, Assured Refill Curve, Variable Refill Curves, and the individual project Flood Control Storage Reservation Curves.

(b) Operating Rules which specifically designate criteria for operation of the Canadian Treaty Projects in accordance with the principles contained in the above references.

A 40-year System Regulation Study[6] was utilized to develop and test the operating rules and rule curves. It contains the agreed-upon operating constraints such as maximum and minimum project elevations and discharges.

## SYSTEM REGULATION STUDIES

In accordance with Annex A, Paragraph 7, of the Treaty, the Columbia River Operating Committee conducted system regulation studies reflecting Canadian storage operation for optimum generation in both Canada and the United States. Downstream power benefits were computed with the Canadian storage operation based on the operating rules specified herein. There is a reduction of 2.5 average megawatts of average annual usable energy in the Canadian Entitlement of downstream power benefits. This is within the limits specified by the Treaty.

System Regulation Studies for the Assured Operating Plan were based on 1980-81 estimated loads and resources in British Columbia and in the United States Pacific Northwest System. The Entities have agreed that the 1980-81 Assured Operating Plan would be based on a 40-year streamflow period and

an operating year of 1 August to 31 July. Historical flows for the period August 1928 through July 1968, modified to estimated 1980-81 conditions,[7] were used.

The Critical Rule Curve for these studies was determined from Bonneville Power Administration Study 81-41. The study indicated a 42-month critical period for the United States system resulting from the low flows during the period from September 1928 through February 1932. It was assumed that all reservoirs, both in the United States and Canada, were full at the beginning of the critical period.

In the studies, individual project flood control criteria were followed. Although only 7.0 million acre-feet of storage content at Mica is committed for power operation purposes under the Treaty, the studies are based on a full storage content of 20 million acre-feet to test compatibility with flood control parameters. Flood Control and Variable Refill Criteria are based on historical inflow volumes.

## DETERMINATION OF OPTIMUM GENERATION IN CANADA AND THE UNITED STATES

In order to determine whether optimum generation in both Canada and the United States was achieved in the system regulation studies, the following three quantities were computed for both the Canadian and United States systems:

(a) firm energy capability

(b) dependable capacity

(c) average annual usable secondary energy.

In the studies for the 1980-81 Assured Operating Plan the Canadian storage

operation was modified to achieve a combined sum of the three quantities that was greater than the combined sum achieved under an operation of Canadian storage for optimum generation in the United States alone.

The following table shows the results from the studies adopted for the 1980-81 Assured Operating Plan and from studies designed to achieve optimum generation in the United States.

The Columbia River Treaty Operating Committee agreed that for the 1980-81 Assured Operating Plan the three quantities would be assigned the following relative values:

> firm energy (Av. MW): dependable capacity (MW): average annual usable secondary energy (Av. MW) were related in the ratio 3:1:2.

The three quantities were added after weighting on this basis and there was a net gain to the combined Canadian and United States systems with the study designed for optimum generation in Canada and the United States.

## OPERATING RULE CURVES

The operation of Canadian storage during the 1980-81 Operating Year shall be guided by an Operating Rule Curve for the whole of Canadian storage, and by Flood Control Storage Reservation Curves for the individual projects. The Operating Rule Curve is derived from the various curves described below. These curves are first determined for the individual Canadian storages and then summed to obtain the values for the whole of usable Canadian storage given by the composite tables included in this Plan. This is in accordance

## COMPARISON OF STUDY RESULTS

| | Optimum Generation in Canada and the United States Study No. 81-41 | Optimum Generation in the United States Study No. 81-11 | Loss | Gain | Net |
|---|---|---|---|---|---|
| 1. Firm Energy Capability (Av. MW) | | | | | |
| U.S. System | 12,401 | 12,403 | 2 | - | |
| Canada (Mica) | 882 | 863 | - | 19 | |
| Total (Av. MW) | 13,283 | 13,266 | 2 | 19 | 17 |
| 2. Dependable Capacity (MW) | | | | | |
| U.S. System | 29,376 | 29,537 | 161 | - | |
| Canada (Mica) | 1,564 | 1,303 | - | 261 | |
| Total (MW) | 30,940 | 30,840 | 161 | 261 | 100 |
| 3. Average Annual Usable Secondary Energy (Av. MW) | | | | | |
| U.S. System | 3,112 | 3,101 | - | 11 | |
| Canada | 4* | | - | 4 | |
| Total (Av.) | 3,116 | 3,101 | - | 15 | 15 |

* Gain in usable energy produced at Mica in the study for optimum generation in Canada and the U.S.

with the provision of Article VII(2) of the Protocol.

(a) Critical Rule Curve. The Critical Rule Curve indicates the end-of-month storage content of Canadian storage during the critical period. It is designed to protect the ability of the United States system to serve firm load and to protect the firm level of Mica generation with the occurrence of flows no worse than those during the most adverse historical streamflow period. A tabulation of the Composite Critical Rule Curve for the whole of Canadian storage is included in Table 1.

(b) Refill Curve. The Refill Curve is a guide to operation of Canadian storage which defines the normal limit of storage draft for secondary energy in order to provide a high probability of refilling the storage. In general, the Operating Plan does not permit serving secondary loads at the risk of failing to refill storages and thereby jeopardizing the firm load carrying capability of the system or the Mica generating plant during subsequent years. The end of the refill period is considered to be 31 July.

The Refill Curve is, in turn, defined by two curves as discussed below. In each case, adjustment should be made for water required for refill of upstream reserviors when applicable.

(1) Assured Refill Curve. The Assured Refill Curve indicates the end-of-month storage content required to assure refill of Canadian storage based on the 1930-31 water year, the system's second lowest historical volume of inflow for the period January through July as measured at The Dalles, Oregon. The tabulation of the composite Assured Refill Curve for the whole of Canadian storage is included as Table 2.

The curve was based on higher flows than the minimum discharge requirements for the period January through July. The schedule of outflows is the same as the Power Discharge Requirements used in computing the Variable Refill Curve discussed in (2) below when The Dalles volume runoff is less than 80 million acre-feet.

(2) Variable Refill Curve. The Variable Refill Curve gives end-of-month storage contents for the period January through July required to refill Canadian storage based on historical inflow volume and specified Power Discharge Requirements during the refill period. In the system regulation studies the Power Discharge Requirement was made a function of the natural January - July runoff volume at The Dalles, Oregon. In those years when this volume was lower than 80 million acre-feet, the discharge used was that required to meet firm loads while refilling. In years when the runoff volume at The Dalles exceeded 95 million acre-feet the Power Discharge Requirement was the project minimum outflow. For intermediate volumes the Power Discharge Requirement was interpolated linearly between the values shown below. The following are the January through July Power Discharge Requirements used in computing the Variable Refill Curves.

Power Discharge Requirements in cfs
For January through July Volume at The Dalles

| | 80 MAF | | | 90 MAF | | | 95 MAF |
|---|---|---|---|---|---|---|---|
| Project | Jan Feb Mar | Apr May Jun | Jul | Jan Feb Mar | Apr May Jun | Jul | All Periods |
| Mica | 3,000 | 11,600 | 14,600 | 3,000 | 6,300 | 8,300 | 3,000 |
| Arrow | 5,000 | 17,500 | 34,500 | 5,000 | 9,600 | 14,000 | 5,000 |
| Duncan | 100 | 1,700 | 1,700 | 100 | 900 | 900 | 100 |

Composite Variable Refill Curves for the whole of Canadian storage for the 40 years of historical record are recorded as Table 3. These illustrate the probable range of these curves based on historical conditions. In the actual operation in 1980-81, the Power Discharge Requirements will be based on the forecast of unregulated runoff at The Dalles.

(c) Flood Control Storage Reservation Curve. The Flood Control Storage Reservation Curves[8] give end-of-month storage content to which each individual Canadian storage project shall be evacuated for flood control and other requirements during the Storage Evacuation Period. During the Flood Control Refill Period, the flood control curves used in the studies were developed from daily system regulation studies. They reflect the use of historical inflow volumes. Flood control curves for the forty-year study period are shown on Tables 4, 5, and 6. Tables 5 and 6 reflect an assumed transfer of 2 million acre-feet of storage space from Arrow to Mica. In actual operation, the Flood Control Storage Reservation Curves will be based on the Flood Control Operating Plan, using the latest forecast of runoff available at that time.

(d) Definition of Operating Rule Curve. Prior to 1 January, the Operating Rule Curve is defined by the Critical Rule Curve or the Assured Refill Curve, whichever is higher. The Critical Rule Curve for the first year of the critical period is used in the foregoing determination. Beginning 1 January, the Operating Rule Curve is defined by first determining the higher of the Critical Rule Curve and the Assured Refill Curve; the Operating Rule Curve is the lower of the above-determined value or the Variable Refill Curve, but in no case shall it be lower than the lowest

Critical Rule Curve developed for such year during the period January 1 through March 31. Also, in all periods the Operating Rule Curve meets all requirements for flood control operation (except as noted in paragraph (d) of the Operating Rules). Composite Operating Rule Curves for the whole of Canadian storage for all 40 years of historical record are included as Table 7 to illustrate the probable future range of these curves based on historical conditions.

## OPERATING RULES

The following rules, used in the System Regulation Study, will apply to the operation of Canadian storage in the 1980-81 Operating Year.

(a) The whole of the Canadian storage may be drafted to its Operating Rule Curve as required to produce optimum generation in Canada and the United States in accordance with Annex A, Paragraph 7, of the Treaty, subject to project physical characteristics, operating constraints, and the criteria for the Mica project listed in (e) below.

(b) The whole of the Canadian storage will not be drafted below its Operating Rule Curve unless:

(1) Reservoir storage in the United States system has been drafted to its refill curve.

(2) Deliveries of secondary energy in the United States are discontinued.

(3) Committed firm thermal and miscellaneous resources not displaced by surplus firm hydro resources are in operation or other replacement energy has been secured from sources other than those committed.

(c) When the conditions of (b) above are met, and it is necessary to draft additional storage to produce optimum generation as determined by the Critical Period System Regulation study, the whole of the Canadian storage and reservoir storage in the United States system will be drafted proportionately between its Operating Rule Curve or Energy Content Curve, respectively, and its Critical Rule Curve. The proportionate draft will be made, if necessary, first to the first year Critical Rule Curve, then between the first and second year Critical Rule Curve, the second and third year Critical Rule Curve, etc. When it is necessary to operate the whole of the Canadian storage and the United States reservoir storage below their lowest Critical Rule Curves, each shall be operated proportionately between its lowest Critical Rule Curve and its normal minimum content, except that Mica Reservoir will continue to be operated in accordance with (e) below, so as to optimize generation at site as well as downstream in the United States.

(d) Each project will be operated on or below the storage content defined by its Flood Control Storage Reservation Curve, unless such content is below that indicated by the Variable Refill Curve.

(e) Mica project will be operated to the following monthly criteria as qualified in (1) to (4) below:

## Mica Project Operating Criteria

| Month | Target End-of-Period Storage Content (KSFD) | Target Average Outflow (CFS) | Minimum Outflow (CFS) |
|---|---|---|---|
| August 1-15 | 10121.1 | N/A | 10,000 |
| August 16-31 | 10121.1 | N/A | 10,000 |
| September | 10121.1 | N/A | 10,000 |
| October | N/A | 15,000 | 10,000 |
| November | N/A | 18,000 | 10,000 |
| December | N/A | 28,000 | 15,000 |
| January | N/A | 29,000 | 15,000 |
| February | N/A | 29,000 | 15,000 |
| March | N/A | 15,000 | 15,000 |
| April 1-15 | N/A | 15,000 | 15,000 |
| April 16-30 | N/A | 15,000 | 10,000 |
| May | N/A | 10,000 | 10,000 |
| June | N/A | 10,000 | 10,000 |
| July | 10121.1 | N/A | 10,000 |

(N/A - not applicable)

(1) Mica monthly outflows will be increased in the months from October to June if required to avoid violation of the Flood Control Storage Reservation Curve.

(2) Mica monthly average outflows will be increased in the months from July to March and the month of June if the Arrow reservoir storage in the previous month is within the following limits.

| Month | Arrow Reservoir End-of-Month Storage Content (KSFD) | Mica Outflow in Next Month (CFS) |
|---|---|---|
| August | 0 - 1000 | 30,000 |
| | 1001 - 2100 | 20,000 |
| September | 0 - 2000 | 20,000 |
| October | 0 - 1700 | 23,000 |
| November | 0 - 300 | 34,000 |
| | 301 - 1500 | 31,000 |
| December | 0 - 1000 | 32,000 |
| January | 0 - 1000 | 32,000 |
| February | 0 - 1000 | 17,000 |
| March | - | - |
| April | - | - |
| May | 0 - 500 | 24,000 |
| June | 0 - 1000 | 34,000 |
| | 1001 - 2100 | 20,000 |
| July | 0 - 1000 | 34,000 |
| | 1001 - 2100 | 20,000 |

If the above table indicates the Mica outflow in August should be increased, the higher outflow applies in the first half only, and the second half of August will be examined using the August 15 Arrow content and the same criteria as for the first half.

(3) Unless an adjustment to the Mica target outflows during January, February, March, or June is required as specified in (2) above, Mica outflows will be reduced to minimum values to maintain the reservoir above the following storage content:

| | |
|---|---|
| January | 8000.0 KSFD |
| February | 7600.0 KSFD |
| March | 6900.0 KSFD |
| April 15 | 6600.0 KSFD |
| April 30 | 6591.9 KSFD |
| May | 7100.0 KSFD |
| June | 8450.0 KSFD |

In this situation, the water remaining in Arrow will be sufficient to meet power draft requirements in the United States.

(4) Storage releases from Mica in excess of 7 million acre-feet may be made at the discretion of the Canadian Section of the Operating Committee. Under this Assured Operating Plan, Mica storage releases in excess of the 7 million acre-feet that are required to maintain the minimum Mica outflows specified under this plan will be retained in the Arrow reservoir, subject to flood control criteria at Arrow. The total combined storage draft from Mica and Arrow will not exceed 14.1 million acre-feet unless flood control criteria will not permit the additional Mica storage releases for minimum flow purposes to be retained at Arrow.

The operating rules set forth above are designed to produce optimum generation in Canada and the United States, as required by Annex A of the Treaty in the situation where Mica dead storage has been filled. If this does not occur, some modification of the rules may be necessary to ensure adequate and complete drafting of Canadian Treaty storage in Mica reservoir to meet United States power requirements. In that event, such modified rules will be included in the 1980-81 Detailed Operating Plan.

## IMPLEMENTATION

The Entities have agreed that each year a Detailed Operating Plan will be prepared for the immediately succeeding operating year. Such Detailed Operating Plans are made under authority of Article XIV 2.(k) of the Columbia River Treaty which states:

> ". . . the powers and the duties of the entities include:
>
> (k) preparation and implementation of detailed operating plans that may produce results more advantageous to both countries than those that would arise from operation under the plans referred to in Annexes A and B."

The Detailed Operating Plan for 1980-81 will reflect the latest available load, resource, and other pertinent data to the extent the Entities agreed these data should be included in the plan. Beginning on 1 January 1980, the Assured Operating Plan contained herein will be reviewed and the data and criteria updated, as agreed by the Entities, to form the basis for a Detailed Operating Plan for the 1980-81 Operating Year. Failing agreement on updating the Assured Operating Plan, the Detailed Operating Plan will include all data and criteria given in this Assured Operating Plan. Actual operation during the 1980-81 Operating Year shall be guided by the Detailed Operating Plan.

The operating rules to be used in implementation of the Detailed Operating Plan are generally the same as the operating rules described in this document.

The values used in the study to define the various rule curves were month-end values only. In actual day-to-day operation it is necessary

to operate in such a manner during the course of each month that these month-end values can be observed in accordance with the operating rules. Because of the normal variation of power load and streamflow during any month, straight line interpolation between the month-end points should not be assumed.

During the storage drawdown season, Canadian storage should not be drafted below its month-end point at any time during the month unless it can be conservatively demonstrated that sufficient inflow is available, in excess of the minimum outflow required to serve power demand, to refill the reservoir to its end-of-month value as required. During the storage evacuation and refill season, operation will be consistent with the Flood Control Operating Plan. When refill of Canadian storage is being guided by Flood Control Refill Curves,[5] such curves will be computed on a day-by-day basis using the residual volume-of-inflow forecasts depleted by the volume required for minimum outflow from each day through the end of the refill season.

## REFERENCES


[1] Principles and Procedures for the Preparation and Use of Hydroelectric Operating Plans for Canadian Treaty Storage dated 25 July 1967.

[2] Treaty between Canada and the United States of America relating to Cooperative Development of the Water Resources of the Columbia River Basin dated 17 January 1961.

[3] Protocol -- Annex to Exchange of Notes dated 22 January 1964.

[4] Terms of Sale -- Attachment to Exchange of Notes dated 22 January 1964.

[5] Columbia River Treaty Flood Control Operating Plan dated October 1972.

[6] BPA Hydroelectric Power Planning Program, Assured Operating Plan 40-Year System Regulation Study 81-41, dated 16 September 1975.

[7] Provisional Report on Modified Flows at Selected Sites, 1928 to 1968 for the 1970 and 2020 Level of Development, Columbia River and Coastal Basins, Columbia River Water Management Group, Revision 2, dated April 1974 and May 1974, respectively.

[8] Summary of End-of-Month Reservoir Storage Requirement from Columbia River Flood Regulation Studies dated April 1973 and as updated March 1975.

COLUMBIA RIVER TREATY
COMPOSITE CRITICAL RULE CURVES
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1980-81 OPERATING YEAR

TABLE 1

| | AUG15 | AUG31 | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR15 | APR30 | MAY | JUN | JUL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1ST YR | 7814.6 | 7814.6 | 7513.2 | 7227.9 | 7064.1 | 5743.0 | 3755.5 | 2221.0 | 2222.4 | 1286.1 | 776.5 | 2213.8 | 5636.4 | 6999.2 |
| 2ND YR | 7204.3 | 7035.9 | 6322.2 | 5267.0 | 4506.7 | 3253.7 | 1206.2 | 665.3 | 32.8 | 48.0 | 293.4 | 1415.0 | 3370.2 | 5329.5 |
| 3RD YR | 5699.5 | 5848.2 | 5472.7 | 4691.5 | 4319.8 | 2537.7 | 1089.9 | 276.1 | 28.2 | 26.5 | 26.7 | 747.3 | 2320.0 | 3219.0 |
| 4TH YR | 3362.9 | 3324.9 | 2990.8 | 2016.5 | 1500.3 | 687.9 | 23.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

COLUMBIA RIVER TREATY
COMPOSITE ASSURED REFILL CURVE
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1980-81 OPERATING YEAR

TABLE 2

| AUG15 | AUG31 | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR15 | APR30 | MAY | JUN | JUL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 37.8 | 122.6 | 796.4 | 999.7 | 1102.8 | 1168.5 | 1225.6 | 1257.4 | 1355.9 | 1261.2 | 1272.0 | 2929.8 | 5995.8 | 7814.6 |

COLUMBIA RIVER TREATY
COMPOSITE VARIABLE REFILL CURVES
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1980-81 OPERATING YEAR

TABLE 3

| FLOW YEAR | AUG15 | AUG31 | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR15 | APR30 | MAY | JUN | JUL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928-29 | | | | | | | 5291.5 | 5104.0 | 5120.1 | 5087.4 | 5054.5 | 5411.7 | 6889.2 | 7814.6 |
| 1929-30 | | | | | | | 2796.5 | 2487.5 | 2587.9 | 2781.9 | 2976.0 | 4243.7 | 6418.2 | ,, |
| 1930-31 | | | | | | | 3469.1 | 3322.9 | 3360.9 | 3418.2 | 3475.4 | 4207.2 | 6583.5 | ,, |
| 1931-32 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1002.0 | 4837.1 | ,, |
| 1932-33 | | | | | | | ,, | ,, | ,, | ,, | ,, | 981.4 | 4495.8 | ,, |
| 1933-34 | | | | | | | ,, | ,, | ,, | ,, | ,, | 1314.9 | 5415.2 | ,, |
| 1934-35 | | | | | | | 783.3 | 533.9 | 581.4 | 627.0 | 672.7 | 2113.2 | 5143.6 | ,, |
| 1935-36 | | | | | | | 715.5 | 520.5 | 481.7 | 453.6 | 425.6 | 2205.2 | 5843.8 | ,, |
| 1936-37 | | | | | | | 5492.6 | 5299.9 | 5299.8 | 5293.1 | 5286.2 | 5587.4 | 6933.9 | ,, |
| 1937-38 | | | | | | | 72.8 | 2.2 | 0.0 | 148.8 | 297.6 | 1977.1 | 5227.7 | ,, |
| 1938-39 | | | | | | | 2823.8 | 2691.1 | 2745.6 | 2857.5 | 2969.3 | 4083.5 | 6919.2 | ,, |
| 1939-40 | | | | | | | 2322.7 | 2076.8 | 2219.5 | 2431.5 | 2643.5 | 3766.9 | 6585.1 | ,, |
| 1940-41 | | | | | | | 4263.2 | 4098.2 | 4184.9 | 4442.8 | 4699.0 | 5551.2 | 6991.6 | ,, |
| 1941-42 | | | | | | | 2312.3 | 1928.5 | 1897.7 | 2103.1 | 2308.6 | 3477.4 | 5956.9 | ,, |
| 1942-43 | | | | | | | 1945.3 | 1551.2 | 1488.6 | 1776.1 | 2063.4 | 3593.5 | 5727.3 | ,, |
| 1943-44 | | | | | | | 6383.7 | 6170.8 | 6201.9 | 6105.3 | 6008.7 | 6203.7 | 7154.1 | ,, |
| 1944-45 | | | | | | | 5467.8 | 5270.9 | 5346.4 | 5337.1 | 5327.8 | 5621.1 | 6976.7 | ,, |
| 1945-46 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1001.7 | 5055.4 | ,, |
| 1946-47 | | | | | | | ,, | ,, | ,, | ,, | ,, | 1708.2 | 5233.7 | ,, |
| 1947-48 | | | | | | | ,, | ,, | ,, | ,, | ,, | 1180.9 | 5039.0 | ,, |
| 1948-49 | | | | | | | 1753.8 | 1420.3 | 1482.8 | 1884.9 | 2287.7 | 3624.4 | 6513.2 | ,, |
| 1949-50 | | | | | | | 13.4 | 0.0 | 0.0 | 0.0 | 0.0 | 1351.4 | 4464.4 | ,, |
| 1950-51 | | | | | | | 0.0 | ,, | ,, | 87.5 | 174.9 | 1725.1 | 5330.3 | ,, |
| 1951-52 | | | | | | | 320.0 | 118.7 | 72.2 | 230.5 | 389.1 | 2147.1 | 5469.6 | ,, |
| 1952-53 | | | | | | | 986.1 | 614.6 | 588.7 | 806.2 | 1023.7 | 2399.4 | 5392.0 | ,, |
| 1953-54 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 592.3 | 4414.0 | ,, |
| 1954-55 | | | | | | | 236.0 | 65.4 | 54.3 | 158.5 | 262.5 | 1737.1 | 4595.7 | ,, |
| 1955-56 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1427.0 | 5132.4 | ,, |
| 1956-57 | | | | | | | ,, | ,, | ,, | ,, | ,, | 1295.0 | 5605.4 | ,, |
| 1957-58 | | | | | | | ,, | ,, | ,, | ,, | ,, | 1114.3 | 5195.6 | ,, |
| 1958-59 | | | | | | | ,, | ,, | ,, | ,, | ,, | 966.1 | 4516.3 | ,, |
| 1959-60 | | | | | | | 290.0 | 107.5 | 103.2 | 267.3 | 431.3 | 2003.0 | 4929.0 | ,, |
| 1960-61 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 916.9 | 4826.2 | ,, |
| 1961-62 | | | | | | | 492.6 | 297.9 | 285.9 | 348.0 | 410.1 | 2104.8 | 5168.4 | ,, |
| 1962-63 | | | | | | | 337.5 | 138.1 | 165.8 | 379.3 | 592.9 | 2218.7 | 5258.5 | ,, |
| 1963-64 | | | | | | | 165.2 | 0.0 | 0.0 | 41.4 | 82.7 | 819.3 | 4241.0 | ,, |
| 1964-65 | | | | | | | 261.9 | 71.9 | 69.9 | 171.7 | 273.4 | 2039.5 | 5142.6 | ,, |
| 1965-66 | | | | | | | 336.7 | 146.3 | 147.2 | 217.5 | 287.8 | 1543.0 | 5090.6 | ,, |
| 1966-67 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 40.6 | 3778.1 | ,, |
| 1967-68 | | | | | | | 3207.5 | 2992.2 | 3194.1 | 3678.3 | 4162.4 | 4917.5 | 6952.9 | ,, |

FLOOD CONTROL STORAGE RESERVATION CURVES

DUNCAN

KSFO

1968-81 OPERATING YEAR

TABLE 4

| | AUG15 | AUG31 | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR15 | APR30 | MAY | JUN | JUL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928-29 | 705.8 | 705.8 | 705.8 | 705.8 | 705.8 | 504. | 397.2 | 303.0 | 303.0 | 311.0 | 324.6 | 416.4 | 560.6 | 705.8 |
| 1929-30 | ,, | ,, | ,, | ,, | ,, | ,, | 385.7 | 281.3 | 281.3 | 289.9 | 304.0 | 400.8 | 553.0 | ,, |
| 1930-31 | ,, | ,, | ,, | ,, | ,, | ,, | 368.5 | 248.0 | 248.0 | 257.1 | 272.7 | 377.1 | 540.9 | ,, |
| 1931-32 | ,, | ,, | ,, | ,, | ,, | ,, | 272.2 | 65.5 | 65.5 | 80.6 | 108.9 | 281.3 | 609.5 | ,, |
| 1932-33 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 75.1 | 94.2 | 191.5 | 573.2 | ,, |
| 1933-34 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 65.5 | 127.0 | 339.8 | 605.5 | ,, |
| 1934-35 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 83.7 | 187.0 | 488.0 | ,, |
| 1935-36 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 71.1 | 119.5 | 351.9 | 705.8 | ,, |
| 1936-37 | ,, | ,, | ,, | ,, | ,, | ,, | 353.9 | 219.8 | 219.8 | 229.4 | 246.0 | 356.9 | 538.9 | ,, |
| 1937-38 | ,, | ,, | ,, | ,, | ,, | ,, | 272.2 | 65.5 | 65.5 | 77.1 | 83.7 | 217.3 | 542.4 | ,, |
| 1938-39 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 82.6 | 107.4 | 385.7 | 705.8 | ,, |
| 1939-40 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 78.1 | 103.8 | ,, | ,, | ,, |
| 1940-41 | ,, | ,, | ,, | ,, | ,, | ,, | 321.1 | 156.3 | 156.3 | 167.3 | 186.0 | 311.0 | 508.2 | ,, |
| 1941-42 | ,, | ,, | ,, | ,, | ,, | ,, | 302.0 | 121.0 | 121.0 | 131.0 | 155.2 | 291.9 | 483.0 | ,, |
| 1942-43 | ,, | ,, | ,, | ,, | ,, | ,, | 305.0 | 126.0 | 126.0 | 141.1 | 172.9 | 248.0 | 647.8 | ,, |
| 1943-44 | ,, | ,, | ,, | ,, | ,, | ,, | 392.7 | 294.4 | 294.4 | 302.5 | 316.6 | 418.4 | 557.6 | ,, |
| 1944-45 | ,, | ,, | ,, | ,, | ,, | ,, | 361.5 | 234.4 | 234.4 | 235.9 | 236.9 | 349.9 | 567.7 | ,, |
| 1945-46 | ,, | ,, | ,, | ,, | ,, | ,, | 272.2 | 65.5 | 65.5 | 75.6 | 95.8 | 322.1 | 647.3 | ,, |
| 1946-47 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 77.1 | 101.8 | 314.1 | 629.7 | ,, |
| 1947-48 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 65.5 | 65.5 | 300.4 | 705.8 | ,, |
| 1948-49 | ,, | ,, | ,, | ,, | ,, | ,, | 348.3 | 208.7 | 208.7 | 215.2 | 236.9 | 408.8 | ,, | ,, |
| 1949-50 | ,, | ,, | ,, | ,, | ,, | ,, | 272.2 | 65.5 | 65.5 | 72.1 | 84.7 | 184.0 | 525.3 | ,, |
| 1950-51 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 79.5 | 103.3 | 285.3 | 534.4 | ,, |
| 1951-52 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 65.5 | 67.5 | 92.2 | 255.1 | ,, |
| 1952-53 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 72.1 | 84.7 | 234.4 | 522.8 | ,, |
| 1953-54 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 73.1 | 84.2 | 236.9 | 547.5 | ,, |
| 1954-55 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 72.1 | 80.6 | 154.7 | 488.5 | ,, |
| 1955-56 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 26.7 | 26.7 | 26.7 | 26.7 | 239.9 | 578.2 | ,, |
| 1956-57 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 65.5 | 65.5 | 74.6 | 89.7 | 376.1 | 655.9 | ,, |
| 1957-58 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 77.1 | 96.3 | 359.4 | 705.8 | ,, |
| 1958-59 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 65.5 | 65.5 | 129.5 | 513.7 | ,, |
| 1959-60 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 161.3 | 545.5 | ,, |
| 1960-61 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 193.6 | 705.8 | ,, |
| 1961-62 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 78.1 | ,, | 545.5 | ,, |
| 1962-63 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1963-64 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 65.5 | 161.3 | 513.7 | ,, |
| 1964-65 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 129.5 | 225.3 | 545.5 | ,, |
| 1965-66 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 97.3 | ,, | ,, | ,, |
| 1966-67 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 65.5 | 193.6 | 577.7 | ,, |
| 1967-68 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 513.7 | ,, |

FLOOD CONTROL STORAGE RESERVATION CURVES

TABLE 5

ARROW
KSFD
1980-81 OPERATING YEAR

| | AUG15 | AUG31 | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR15 | APR30 | MAY | JUN | JUL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928-29 | 3579.6 | 3579.6 | 3579.6 | 3453.6 | 3453.6 | 3075.4 | 3075.4 | 3075.4 | 3075.4 | 3088.5 | 3111.2 | 3235.8 | 3579.6 | 3579.6 |
| 1929-30 | ,, | ,, | ,, | ,, | ,, | ,, | 3060.8 | 3047.7 | 3033.1 | 3047.2 | 3071.9 | 3207.0 | ,, | ,, |
| 1930-31 | ,, | ,, | ,, | ,, | ,, | ,, | 3075.4 | 3075.4 | 3075.4 | 3088.5 | 3111.2 | 3235.8 | ,, | ,, |
| 1931-32 | ,, | ,, | ,, | ,, | ,, | ,, | 2364.6 | 1719.2 | 1008.3 | 1015.9 | 1126.8 | 2224.4 | ,, | ,, |
| 1932-33 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1008.3 | 1036.6 | 1761.6 | 3034.6 | ,, |
| 1933-34 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1784.8 | 2327.2 | 3579.6 | ,, |
| 1934-35 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1008.3 | 1725.8 | 3034.6 | ,, |
| 1935-36 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1069.9 | 1373.4 | 2134.7 | 3579.6 | ,, |
| 1936-37 | ,, | ,, | ,, | ,, | ,, | ,, | 2998.3 | 2927.7 | 2850.6 | 2869.7 | 2902.5 | 3082.5 | ,, | ,, |
| 1937-38 | ,, | ,, | ,, | ,, | ,, | ,, | 2364.6 | 1719.2 | 1008.3 | 1083.0 | 1278.1 | 1831.1 | 3147.5 | ,, |
| 1938-39 | ,, | ,, | ,, | ,, | ,, | ,, | 2687.8 | 2243.6 | 1905.9 | 1869.5 | 1983.4 | 2735.1 | 3579.6 | ,, |
| 1939-40 | ,, | ,, | ,, | ,, | ,, | ,, | 2849.6 | 2645.4 | 2420.0 | 2454.8 | 2536.0 | 2995.8 | ,, | ,, |
| 1940-41 | ,, | ,, | ,, | ,, | ,, | ,, | 3075.4 | 3075.4 | 3075.4 | 3088.5 | 3111.2 | 3235.8 | ,, | ,, |
| 1941-42 | ,, | ,, | ,, | ,, | ,, | ,, | 2364.6 | 1719.2 | 1008.3 | 1064.8 | 1149.5 | 1934.0 | ,, | ,, |
| 1942-43 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1111.2 | 1321.9 | 1440.4 | 2389.3 | ,, |
| 1943-44 | ,, | ,, | ,, | ,, | ,, | ,, | 3075.4 | 3075.4 | 3075.4 | 3088.5 | 3111.2 | 3235.8 | 3579.6 | ,, |
| 1944-45 | ,, | ,, | ,, | ,, | ,, | ,, | 2641.8 | 2251.6 | 1818.0 | 1842.7 | 1908.3 | 2477.0 | 3368.4 | ,, |
| 1945-46 | ,, | ,, | ,, | ,, | ,, | ,, | 2364.6 | 1719.2 | 1008.3 | 1072.4 | 1242.3 | 2201.2 | 3579.6 | ,, |
| 1946-47 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1075.4 | 1350.8 | 2147.3 | ,, | ,, |
| 1947-48 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1036.6 | 1183.3 | 2216.8 | ,, | ,, |
| 1948-49 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1144.5 | 1375.9 | 2494.6 | ,, | ,, |
| 1949-50 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1103.6 | 1113.7 | 1113.7 | 2232.5 | ,, |
| 1950-51 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1052.2 | 1101.1 | 1355.2 | 3338.1 | ,, |
| 1951-52 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1069.9 | 1345.1 | 1792.3 | 3013.9 | ,, |
| 1952-53 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1057.3 | 1172.7 | 1476.2 | ,, | ,, |
| 1953-54 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1134.4 | 1628.0 | 1898.2 | ,, |
| 1954-55 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1075.4 | 1090.5 | 1653.7 | 3224.7 | ,, |
| 1955-56 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 857.1 | 0.0 | 0.0 | 289.9 | 1367.3 | 2763.4 | ,, |
| 1956-57 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1719.2 | 1008.3 | 1077.9 | 1224.1 | 2651.4 | 3579.6 | ,, |
| 1957-58 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1046.7 | 1190.9 | 2242.5 | ,, | ,, |
| 1958-59 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1008.3 | 1008.3 | 1394.0 | 3322.5 | ,, |
| 1959-60 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1779.7 | 3579.6 | ,, |
| 1960-61 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1651.2 | ,, | ,, |
| 1961-62 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 2036.8 | 3322.5 | ,, |
| 1962-63 | ,, | ,, | ,, | ,, | ,, | ,, | 2484.5 | 1950.1 | 1359.2 | 1359.2 | 1359.2 | 1914.3 | 3579.6 | ,, |
| 1963-64 | ,, | ,, | ,, | ,, | ,, | ,, | 2364.6 | 1719.2 | 1008.3 | 1008.3 | 1008.3 | 1255.5 | 3322.5 | ,, |
| 1964-65 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1651.2 | 3579.6 | ,, |
| 1965-66 | ,, | ,, | ,, | ,, | ,, | ,, | 2529.4 | 2034.8 | 1487.8 | 1487.8 | 1487.8 | 2324.7 | ,, | ,, |
| 1966-67 | ,, | ,, | ,, | ,, | ,, | ,, | 2364.6 | 1719.2 | 1008.3 | 1008.3 | 1008.3 | 1394.0 | 3322.5 | ,, |
| 1967-68 | ,, | ,, | ,, | ,, | ,, | ,, | 2367.1 | 1723.8 | 1015.4 | 1015.4 | 1015.4 | 1528.6 | 3579.6 | ,, |

FLOOD CONTROL STORAGE RESERVATION CURVES

TABLE 6

MICA

KSFD

1980-81 OPERATING YEAR

| | AUG15 | AUG31 | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR15 | APR30 | MAY | JUN | JUL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928-29 | 3529.2 | 3529.2 | 3529.2 | 3428.4 | 3428.4 | 3428.4 | 3406.7 | 3387.0 | 3365.3 | 3369.9 | 3380.5 | 3412.2 | 3469.7 | 3529.2 |
| 1929-30 | ,, | ,, | ,, | ,, | ,, | ,, | 3378.5 | 3332.6 | 3282.7 | 3290.2 | 3305.9 | 3353.2 | 3440.0 | ,, |
| 1930-31 | ,, | ,, | ,, | ,, | ,, | ,, | 3428.4 | 3429.4 | 3428.4 | 3431.4 | 3437.9 | 3457.1 | 3492.9 | ,, |
| 1931-32 | ,, | ,, | ,, | ,, | ,, | ,, | 3100.7 | 2808.2 | 2480.5 | 2511.8 | 2577.8 | 2781.5 | 3149.6 | ,, |
| 1932-33 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1933-34 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1934-35 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1935-36 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1936-37 | ,, | ,, | ,, | ,, | ,, | ,, | 3353.2 | 3283.7 | 3208.5 | 3218.1 | 3239.3 | 3300.8 | 3413.2 | ,, |
| 1937-38 | ,, | ,, | ,, | ,, | ,, | ,, | 3100.7 | 2808.2 | 2480.5 | 2511.8 | 2577.8 | 2781.5 | 3149.6 | ,, |
| 1938-39 | ,, | ,, | ,, | ,, | ,, | ,, | 3213.1 | 3018.5 | 2806.7 | 2828.4 | 2873.8 | 3013.9 | 3267.5 | ,, |
| 1939-40 | ,, | ,, | ,, | ,, | ,, | ,, | 3296.8 | 3174.3 | 3042.7 | 3057.3 | 3088.1 | 3182.3 | 3353.2 | ,, |
| 1940-41 | ,, | ,, | ,, | ,, | ,, | ,, | 3428.4 | 3429.4 | 3428.4 | 3431.4 | 3437.9 | 3457.1 | 3492.9 | ,, |
| 1941-42 | ,, | ,, | ,, | ,, | ,, | ,, | 3100.7 | 2808.2 | 2480.5 | 2511.8 | 2577.8 | 2781.5 | 3149.6 | ,, |
| 1942-43 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1943-44 | ,, | ,, | ,, | ,, | ,, | ,, | 3428.4 | 3429.4 | 3428.4 | 3431.4 | 3437.9 | 3457.1 | 3492.9 | ,, |
| 1944-45 | ,, | ,, | ,, | ,, | ,, | ,, | 3214.6 | 3021.5 | 2811.3 | 2832.9 | 2878.3 | 3017.5 | 3269.6 | ,, |
| 1945-46 | ,, | ,, | ,, | ,, | ,, | ,, | 3100.7 | 2808.2 | 2480.5 | 2511.8 | 2577.8 | 2781.5 | 3149.6 | ,, |
| 1946-47 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1947-48 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1948-49 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1949-50 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1950-51 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1951-52 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1952-53 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1953-54 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1954-55 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1955-56 | ,, | ,, | ,, | ,, | ,, | 3025.0 | 2067.1 | 1058.8 | 100.9 | 100.9 | 100.9 | 993.7 | 2363.6 | ,, |
| 1956-57 | ,, | ,, | ,, | ,, | ,, | 3428.4 | 3100.7 | 2808.2 | 2480.5 | 2511.8 | 2577.8 | 2781.5 | 3149.6 | ,, |
| 1957-58 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1958-59 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1959-60 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1960-61 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1961-62 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1962-63 | ,, | ,, | ,, | ,, | ,, | ,, | 3150.6 | 2902.0 | 2626.7 | 2654.8 | 2718.4 | 2885.9 | 3202.5 | ,, |
| 1963-64 | ,, | ,, | ,, | ,, | ,, | ,, | 3100.7 | 2808.2 | 2480.5 | 2511.8 | 2577.8 | 2781.5 | 3149.6 | ,, |
| 1964-65 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1965-66 | ,, | ,, | ,, | ,, | ,, | ,, | 3168.7 | 2936.3 | 2680.2 | 2705.9 | 2759.3 | 2923.7 | 3221.7 | ,, |
| 1966-67 | ,, | ,, | ,, | ,, | ,, | ,, | 3100.7 | 2808.2 | 2480.5 | 2511.8 | 2577.8 | 2781.5 | 3149.6 | ,, |
| 1967-68 | ,, | ,, | ,, | ,, | ,, | ,, | 3101.7 | 2810.3 | 2483.6 | 2514.8 | 2580.9 | 2783.5 | 3150.6 | ,, |

COLUMBIA RIVER TREATY
COMPOSITE OPERATING RULE CURVES
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1980-81 OPERATING YEAR

TABLE 7

| FLOW YEAR | AUG15 | AUG31 | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR15 | APR30 | MAY | JUN | JUL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928-29 | 7814.6 | 7814.6 | 7513.2 | 7227.9 | 7064.1 | 5743.0 | 3755.5 | 2221.0 | 2503.2 | 1655.8 | 1272.0 | 2952.4 | 6292.3 | 7814.6 |
| 1929-30 | ,, | ,, | ,, | ,, | ,, | ,, | 2692.4 | ,, | 2294.2 | ,, | ,, | ,, | ,, | ,, |
| 1930-31 | ,, | ,, | ,, | ,, | ,, | ,, | 3123.9 | ,, | 2503.2 | ,, | ,, | ,, | ,, | ,, |
| 1931-32 | ,, | ,, | ,, | ,, | ,, | ,, | 23.8 | 0.0 | 0.0 | 0.0 | 0.0 | 1002.0 | 4837.1 | ,, |
| 1932-33 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 981.4 | 4495.8 | ,, |
| 1933-34 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1314.9 | 5415.2 | ,, |
| 1934-35 | ,, | ,, | ,, | ,, | ,, | ,, | 807.1 | 583.9 | 581.4 | 627.0 | 672.7 | 2113.2 | 5143.6 | ,, |
| 1935-36 | ,, | ,, | ,, | ,, | ,, | ,, | 739.3 | 520.5 | 481.7 | 453.6 | 425.6 | 2205.2 | 5828.0 | ,, |
| 1936-37 | ,, | ,, | ,, | ,, | ,, | ,, | 3755.5 | 2221.0 | 2503.2 | 1655.8 | 1272.0 | 2952.4 | 6292.3 | ,, |
| 1937-38 | ,, | ,, | ,, | ,, | ,, | ,, | 86.6 | 2.2 | 0.0 | 148.8 | 297.6 | 1977.1 | 5227.7 | ,, |
| 1938-39 | ,, | ,, | ,, | ,, | ,, | ,, | 2821.8 | 2163.2 | 2401.2 | 1635.2 | 1243.0 | 2319.3 | 6292.3 | ,, |
| 1939-40 | ,, | ,, | ,, | ,, | ,, | ,, | 2322.7 | 1973.1 | 1984.6 | 1637.5 | 1251.5 | 2921.5 | 6286.2 | ,, |
| 1940-41 | ,, | ,, | ,, | ,, | ,, | ,, | 3727.7 | 2221.0 | 2503.2 | 1655.8 | 1272.0 | 2952.4 | 6292.3 | ,, |
| 1941-42 | ,, | ,, | ,, | ,, | ,, | ,, | 2312.3 | 1928.5 | 1897.7 | 1618.2 | 1237.8 | 2918.6 | 5956.9 | ,, |
| 1942-43 | ,, | ,, | ,, | ,, | ,, | ,, | 1945.3 | 1551.2 | 1488.5 | 1413.8 | 1171.7 | 2893.1 | 5727.3 | ,, |
| 1943-44 | ,, | ,, | ,, | ,, | ,, | ,, | 3755.5 | 2221.0 | 2503.2 | 1655.8 | 1272.0 | 2952.4 | 6292.3 | ,, |
| 1944-45 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, |
| 1945-46 | ,, | ,, | ,, | ,, | ,, | ,, | 23.8 | 0.0 | 0.0 | 0.0 | 0.0 | 1001.7 | 5055.4 | ,, |
| 1946-47 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1708.2 | 5233.7 | ,, |
| 1947-48 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1180.9 | 5039.0 | ,, |
| 1948-49 | ,, | ,, | ,, | ,, | ,, | ,, | 1758.8 | 1369.6 | 1327.7 | 1574.8 | 1209.7 | 2906.7 | 6229.1 | ,, |
| 1949-50 | ,, | ,, | ,, | ,, | ,, | ,, | 37.2 | 0.0 | 0.0 | 0.0 | 0.0 | 1351.4 | 4464.4 | ,, |
| 1950-51 | ,, | ,, | ,, | ,, | ,, | ,, | 23.8 | ,, | ,, | 87.5 | 174.9 | 1725.1 | 5330.3 | ,, |
| 1951-52 | ,, | ,, | ,, | ,, | ,, | ,, | 343.8 | 118.7 | 72.2 | 230.5 | 389.1 | 2147.1 | 5469.6 | ,, |
| 1952-53 | ,, | ,, | ,, | ,, | ,, | ,, | 986.1 | 614.6 | 588.7 | 805.2 | 833.0 | 2399.4 | 5392.0 | ,, |
| 1953-54 | ,, | ,, | ,, | ,, | ,, | ,, | 23.8 | 0.0 | 0.0 | 0.0 | 0.0 | 682.3 | 4414.0 | ,, |
| 1954-55 | ,, | ,, | ,, | ,, | ,, | ,, | 259.8 | 65.4 | 54.3 | 168.5 | 282.5 | 1737.1 | 4595.7 | ,, |
| 1955-56 | ,, | ,, | ,, | ,, | ,, | ,, | 23.8 | 0.0 | 0.0 | 0.0 | 0.0 | 1427.0 | 5132.4 | ,, |
| 1956-57 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1295.0 | 5605.4 | ,, |
| 1957-58 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 1114.3 | 5195.6 | ,, |
| 1958-59 | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | ,, | 866.1 | 4516.3 | ,, |
| 1959-60 | ,, | ,, | ,, | ,, | ,, | ,, | 313.8 | 107.5 | 103.2 | 267.3 | 431.3 | 2003.0 | 4929.0 | ,, |
| 1960-61 | ,, | ,, | ,, | ,, | ,, | ,, | 23.8 | 0.0 | 0.0 | 0.0 | 0.0 | 916.9 | 4826.2 | ,, |
| 1961-62 | ,, | ,, | ,, | ,, | ,, | ,, | 516.4 | 287.8 | 285.9 | 348.0 | 410.1 | 2104.8 | 5168.4 | ,, |
| 1962-63 | ,, | ,, | ,, | ,, | ,, | ,, | 361.3 | 138.1 | 165.8 | 379.3 | 592.9 | 2218.7 | 5259.5 | ,, |
| 1963-64 | ,, | ,, | ,, | ,, | ,, | ,, | 189.0 | 0.0 | 0.0 | 41.4 | 82.7 | 819.3 | 4241.0 | ,, |
| 1964-65 | ,, | ,, | ,, | ,, | ,, | ,, | 285.7 | 71.9 | 69.3 | 171.7 | 273.4 | 2039.9 | 5142.6 | ,, |
| 1965-66 | ,, | ,, | ,, | ,, | ,, | ,, | 360.9 | 145.7 | 147.2 | 217.5 | 287.8 | 1543.0 | 5090.6 | ,, |
| 1966-67 | ,, | ,, | ,, | ,, | ,, | ,, | 23.8 | 0.0 | 0.0 | 0.0 | 0.0 | 40.6 | 3778.1 | ,, |
| 1967-68 | ,, | ,, | ,, | ,, | ,, | ,, | 2620.5 | 2190.0 | 2266.7 | 1655.8 | 1272.0 | 2952.4 | 6292.3 | ,, |

DETERMINATION OF DOWNSTREAM POWER BENEFITS RESULTING FROM CANADIAN STORAGE
FOR OPERATING YEAR 1980-81
September 1975

I. Introduction.

The Treaty between Canada and the United States of America and related documents relating to the cooperative development of the water resources of the Columbia River Basin requires that downstream power benefits from Canadian storage be determined in advance by the two entities. The purpose of this report is to set out the results of downstream power benefit computations for the sixth succeeding year, 1980-81, and for the storages for which the Assured Operating Plan was developed.

The procedures followed in the benefit studies are those provided in Annex A, Paragraph 7, in Annex B of the Treaty; in Articles VIII, IX, and X of the Protocol; and in the document, "Procedures for the Determination of Downstream Power Benefits Resulting from Canadian Storage," dated September 9, 1968.

The Canadian Entitlement Benefits were computed as follows:

Step I - based on the total U.S. planned hydro and thermal system with 15½ maf of Canadian storage operated for optimum generation in both countries (81-41 study).

Step II - based on the U.S. base hydro and thermal system with 15½ maf of Canadian storage operated for optimum generation in both countries (81-42 study).

Step III - based on the U.S. base hydro and thermal system operated for optimum generation in U.S. (81-13 study).

In addition to the determination of downstream power benefits for the operating year 1980-81, separate determinations were carried out in accordance with the document, "Operating Plans with Mica Generation," dated 15 November 1971, which was agreed by the Entities to implement the provisions of Annex A, paragraph 7, relating to the limit of year-to-year change in the operation of Canadian storage in operating plans designed to achieve optimum generation at-site in Canada and downstream in Canada and the United States of America.

II. Results of Study.

(a) The Canadian Entitlement, which is one-half the total computed downstream power benefits, was computed to be:

Dependable Capacity = 1,449 mw

Average Annual Energy = 559 mw

(b) One-half of the downstream power benefits determined for 15 maf of Canadian storage operated for optimum generation in the United States was computed to be:

Dependable Capacity = 1,423.0 mw

Average Annual Energy = 552.5 mw

In accordance with paragraph 4 of the document dated 15 November 1971, the above figures represent the minimum permitted downstream power benefits for the 1980-81 operating year. The computed downstream power benefits exceed these amounts.

III. Effect on Canadian Entitlement.

The Canadian Entitlement to downstream power benefits was sold in the United States of America under the Canadian Entitlement Purchase Agreement dated 13 August 1964. By definition, the Canadian Entitlement for 1980-81 which was sold was that which would have been computed if the 1980-81 Assured Operating Plan had been designed to achieve optimum generation downstream in the United States alone. The Canadian Entitlement determined for the conditions above would have been:

Dependable Capacity = $\frac{1}{2}$ of 2,898 mw or 1,449.0 mw

Average Annual Energy = $\frac{1}{2}$ of 1,123 mw or 561.5 mw

Since the 1980-81 Assured Operating Plan was in fact designed to achieve optimum generation at-site in Canada and downstream in the United States of America, Section 7 of the Agreement requires that "any reduction in the Canadian Entitlement resulting from action taken pursuant to paragraph 7 of Annex A of the Treaty shall be determined in accordance with subsection (3) of Section 6 of this Agreement." The Canadian Entitlement of downstream power benefits under the 1980-81 Assured Operating Plan was determined as:

Dependable Capacity = $\frac{1}{2}$ of 2,898 mw or 1,449 mw

Average Annual Energy = $\frac{1}{2}$ of 1,118 mw or 559 mw

The comparison indicates a reduction in Canadian Entitlement of 2.5 average megawatts of average annual usable energy, but no reduction in dependable capacity. This reduction would be in respect of the period 1 April 1980 through 31 March 1981 in accordance with the document, "Procedures for the Determination of Downstream Power Benefits Resulting from Canadian Storage," dated 9 September 1968.

The Entities are agreed that the United States Entity is entitled to receive during the period 1 April 1980 through 31 March 1981, from B. C. Hydro & Power Authority, 2.5 average megawatts of energy in accordance with Sections 7 and 10 of the Canadian Entitlement Purchase Agreement dated 13 August 1964.

IV. Computation of Entitlement.

The following Tables and Charts are attached and summarize the study:

Table 1. Computation of Canadian Entitlement

The essential elements used in the computation of the Canadian Entitlement as provided in Paragraph 2 and 3 of Annex B are shown in this table.

Table 2. Summary of Power Regulations for the Computation of Canadian Entitlement to Downstream Benefits

This table summarizes the Step I, II, and III regulations by projects.

Table 3. Determination of Load Shape for Steps II and III, Canadian Entitlement Computation

The load shape for Steps II and III carry the same ratio between each month and the annual average as does the Pacific Northwest area load. The Northwest area firm loads on this table were based on the current forecast data. The Grand Coulee pumping load is also included in this estimate.

The firm load for Steps II and III is computed as follows:

(1) Estimate the hydro nominal prime power for the critical period.

(2) Add the thermal from Step I less reserve and minimum thermal generation;

(3) Multiply (2) by the ratio of the area annual average firm load to the area critical period firm load to obtain the annual average firm load for Steps II and III (the ratios used in this study were 0.98894 and 0.96179, respectively);

(4) Pro rate the average annual Step II or III load determined in (3) by months in the ratio that each monthly area load bears to the annual average area load; and

(5) Subtract the thermal in each month to obtain the monthly firm hydro load. The average annual hydro loads for Steps II and III also becomes the firm energy considered usable according to Annex B, Paragraph 3(a).

Chart 1 & 2. Secondary Energy Duration Curve, Steps II and III

These charts are duration curves of the secondary energy for Steps II and III. The secondary energy is the capability each month which exceeds the firm hydro loads shown in Table 3. The usable secondary energy shown in average megawatts for each step is computed in accordance with Annex B, Paragraphs 3(b) and 3(c). The "other usable secondary" was computed on the basis of 40% of the remainder after thermal replacement. The thermal replacement was limited to the existing and scheduled thermal energy capability after allowance for reserve and minimum thermal generation, except when an energy surplus condition occurs; then the thermal replacement must not exceed the total of the thermal energy required to supply firm plus the estimated secondary load.

| | |
|---|---|
| Thermal Energy Capability - mw | 7,183 |
| Less 5% Reserve - mw | 359 |
| Less Minimum Thermal Generation | 1,580 |
| Thermal Replacement - mw | 5,244 |

The following tabulation shows the ordinate values for usable secondary energy:

| | Step II | Step III |
|---|---|---|
| Thermal Replacement | 5,244 | 5,244 |
| Other | 1,417 | 2,434 |
| Total - mw | 6,661 | 7,678 |

TABLE 1

COMPUTATION OF CANADIAN ENTITLEMENT

Generation Figures are in Average Megawatts; Load Factors, in Percent

Determination of Dependable Capacity Credited to Canadian Storage

| | |
|---|---|
| Critical Period Average Rate of Generation with Canadian Storage, Step II | 9,060 |
| Critical Period Average Rate of Generation without Canadian Storage, Step III | 7,047 |
| Gain Due to Canadian Storage | 2,013 |
| Estimated Average Critical Period Load Factor -- Percent | 69.467 |
| Dependable Capacity Gain 1/ | 2,898 |
| Canadian Share of Dependable Capacity | 1,449 |

Determination of Increase in Average Annual Usable Energy

Step II (with Canadian Storage)

| | |
|---|---|
| Annual Firm Hydro Energy | 8,902 |
| Thermal Replacement Energy | 2,066 |
| Other Usable Secondary Energy | 227 |
| System Annual Average Usable Energy | 11,195 |

Step III (without Canadian Storage)

| | |
|---|---|
| Annual Firm Hydro Energy | 6,577 |
| Thermal Replacement Energy | 2,860 |
| Other Usable Secondary Energy | 640 |
| System Annual Average Usable Energy | 10,077 |
| Average Annual Usable Energy Gain | 1,118 |
| Canadian Share of Average Annual Energy Gain | 559 |

1/ Dependable capacity gain credited to Canadian storage equals gain in critical period average rate of generation divided by the estimated average critical period load factor.

SUMMARY OR POWER REGULATIONS FOR 1980-81
FOR THE
COMPUTATION OF CANADIAN ENTITLEMENT
TO DOWNSTREAM BENEFITS

TABLE 2

| PROJECTS | BASIC DATA | | STEP I | | | STEP II | | | | STEP III | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of Units | Nominal Installed Peaking Capacity mw | Usable Storage 1000 AF | January Peaking Capability mw | Critical Period Average Generation mw | Usable Storage 1000 AF | January Peaking Capability mw | Critical Period Average Generation mw | Average Annual Generation mw | Usable Storage 1000 AF | January Peaking Capability mw | Critical Period Average Generation mw | Average Annual Generation mw |
| CANADIAN | | | | | | | | | | | | | |
| Mica | | | 7,000 | | | 7,000 | | | | | | | |
| Arrow | | | 7,100 | | | 7,100 | | | | | | | |
| Duncan | | | 1,400 | | | 1,400 | | | | | | | |
| Subtotal | | | 15,500 | | | 15,500 | | | | | | | |
| BASE SYSTEM FEDERAL | | | | | | | | | | | | | |
| Hungry Horse | 4 | 328 | 3,161 | 176 | 103 | 3,008 | 244 | 116 | 103 | 3,008 | 280 | 212 | 101 |
| Albeni Falls | 3 | 49 | 1,155 | 22 | 24 | 1,155 | 22 | 22 | 22 | 1,155 | 23 | 25 | 24 |
| Grand Coulee | 24 + 2 | 6,529 | 5,232 | 5,969 | 2,014 | 5,072 | 6,475 | 1,771 | 2,336 | 5,072 | 6,033 | 1,225 | 2,267 |
| Chief Joseph | 27 | 2,412 | | 2,412 | 1,089 | | 2,412 | 1,001 | 1,328 | | 2,412 | 710 | 1,258 |
| Ice Harbor | 6 | 693 | | 693 | 219 | | 693 | 224 | 303 | | 693 | 170 | 304 |
| McNary | 14 | 1,127 | | 1,127 | 642 | | 1,124 | 591 | 759 | | 1,124 | 429 | 712 |
| John Day | 16 | 2,484 | 535 | 2,484 | 928 | | 2,484 | 924 | 1,266 | | 2,484 | 681 | 1,231 |
| The Dalles | 22 | 2,018 | | 2,018 | 820 | | 2,018 | 795 | 1,039 | | 2,018 | 631 | 1,020 |
| Bonneville | 10 - 12 | 574 | | 574 | 563 | | 574 | 549 | 568 | | 574 | 458 | 556 |
| Subtotal | | 16,214 | 10,083 | 15,475 | 6,402 | 9,235 | 16,046 | 5,993 | 7,722 | 9,235 | 15,641 | 4,541 | 7,473 |
| BASE SYSTEM NON-FEDERAL | | | | | | | | | | | | | |
| Kootenay Lake (Canadian) | | | 649 | | | 427 | | | | 427 | | | |
| Kerr | 3 | 185 | 1,219 | 173 | 113 | 1,219 | 174 | 101 | 120 | 1,219 | 178 | 148 | 122 |
| Thompson Falls | 6 | 40 | | 40 | 35 | | 38 | 38 | 32 | | 37 | 36 | 31 |
| Noxon Rapids | 5 | 542 | 231 | 501 | 148 | | 542 | 138 | 211 | | 542 | 158 | 211 |
| Cabinet Gorge | 4 | 230 | | 230 | 112 | | 230 | 99 | 128 | | 230 | 111 | 129 |
| Box Canyon | 4 | 74 | | 70 | 47 | | 70 | 45 | 48 | | 71 | 51 | 48 |
| Coeur d'Alene & Long Lake | | | 327 | | | 223 | | | | 223 | | | |
| Wells | 10 | 842 | | 842 | 438 | | 842 | 409 | 515 | | 842 | 289 | 476 |
| Chelan | 2 | 54 | 677 | 50 | 38 | 676 | 50 | 38 | 46 | 676 | 51 | 49 | 45 |
| Rocky Reach | 11 | 1,267 | | 1,267 | 591 | | 1,267 | 553 | 715 | | 1,267 | 393 | 672 |
| Rock Island | 18 | 544 | | 544 | 279 | | 544 | 262 | 332 | | 544 | 182 | 305 |
| Wanapum | 10 | 986 | | 986 | 558 | | 986 | 524 | 661 | | 986 | 367 | 600 |
| Priest Rapids | 10 | 912 | | 912 | 531 | | 912 | 498 | 624 | | 912 | 357 | 567 |
| Brownlee | 4 | 450 | 980 | 450 | 214 | 974 | 450 | 252 | 264 | 974 | 450 | 251 | 257 |
| Oxbow | 4 | 220 | | 220 | 90 | | 220 | 110 | 116 | | 220 | 114 | 117 |
| Subtotal | | 6,346 | 4,083 | 6,285 | 3,194 | 3,519 | 6,325 | 3,067 | 3,812 | 3,519 | 6,330 | 2,594 | 3,580 |
| TOTAL BASE SYSTEM HYDRO | | 22,560 | 29,666 | 21,760 | 9,596 | 28,254 | 22,371 | 9,060 | 11,534 | 13,754 | 21,971 | 7,047 | 11,053 |
| ADDITIONAL STEP I PROJECTS | | | | | | | | | | | | | |
| Libby | 4 | 483 | 4,934 | 245 | 193 | | | | | | | | |
| Boundary | 4 | 650 | | 650 | 361 | | | | | | | | |
| Spokane River Plants | | 153 | | 147 | 90 | | | | | | | | |
| Hells Canyon | 3 | 450 | | 450 | 176 | | | | | | | | |
| Dworshak | 3 | 460 | 2,015 | 401 | 167 | | | | | | | | |
| Lower Granite | 6 | 930 | | 930 | 220 | | | | | | | | |
| Little Goose | 6 | 930 | | 930 | 220 | | | | | | | | |
| Lower Monumental | 6 | 930 | | 930 | 218 | | | | | | | | |
| Pelton and Round Butte | | 454 | 274 | 423 | 174 | | | | | | | | |
| Subtotal | | 5,440 | 7,223 | 5,106 | 1,769 | | | | | | | | |
| Independent Resources | | 4,617 | 8,531 | 3,612 | 1,704 | | | | | | | | |
| TOTAL HYDRO RESOURCES | | 32,617 | 45,420 | 30,478 | 13,069 | | | | | | | | |
| MISCELLANEOUS CONTRACTS | | | | 71 | 0 | | | | | | | | |
| THERMAL RESOURCES | | | | | | | | | | | | | |
| Existing Thermal Plants | | | | 1,427 | 487 | | | | | | | | |
| Centralia #1 & #2 | | | | 1,400 | 1,260 | | | | | | | | |
| Jim Bridger #1, #2, #3, & #4 | | | | 2,000 | 1,800 | | | | | | | | |
| Colstrip #1 & #2 | | | | 330 | 297 | | | | | | | | |
| Trojan | | | | 1,130 | 1,017 | | | | | | | | |
| Colstrip #3 & #4 | | | | 980 | 882 | | | | | | | | |
| WNP #2 | | | | 1,100 | 990 | | | | | | | | |
| Carty Coal | | | | 500 | 450 | | | | | | | | |
| TOTAL THERMAL RESOURCES | | | | 8,867 | 7,183 | | | | | | | | |
| TOTAL IMPORTS | | | | 279 | 537 | | | | | | | | |
| TOTAL RESOURCES (HYDRO AND THERMAL) | | | | 39,647 | 20,798 | | | | | | | | |
| RESERVES 1/ | | | | -2,578 | -359 | | | | | | | | |
| RESOURCES AVAILABLE FOR LOAD | | | | 37,069 | 20,439 | | | | | | | | |
| ESTIMATED LOAD | | | | | | | | | | | | | |
| Pacific Northwest Area | | | | 32,228 | 20,026 | | | | | | | | |
| SURPLUS OR (DEFICIT) | | | | 4,841 | 413 | | | | | | | | |
| CRITICAL PERIOD | | | | | | | | | | | | | |
| Starts: | | | | September 1928 | | | September 1943 | | | | September 16, 1936 | | |
| Ends: | | | | February 1932 | | | April 1945 | | | | April 15, 1937 | | |
| Length (Months): | | | | 42 Months | | | 20 Months | | | | 7 Months | | |
| STUDY IDENTIFICATION | | | | 81-41 | | | 81-42 | | | | 81-13 | | |

1/ Peak Reserves are 8% of peak load; energy reserves are 5% of thermal plant energy capability.

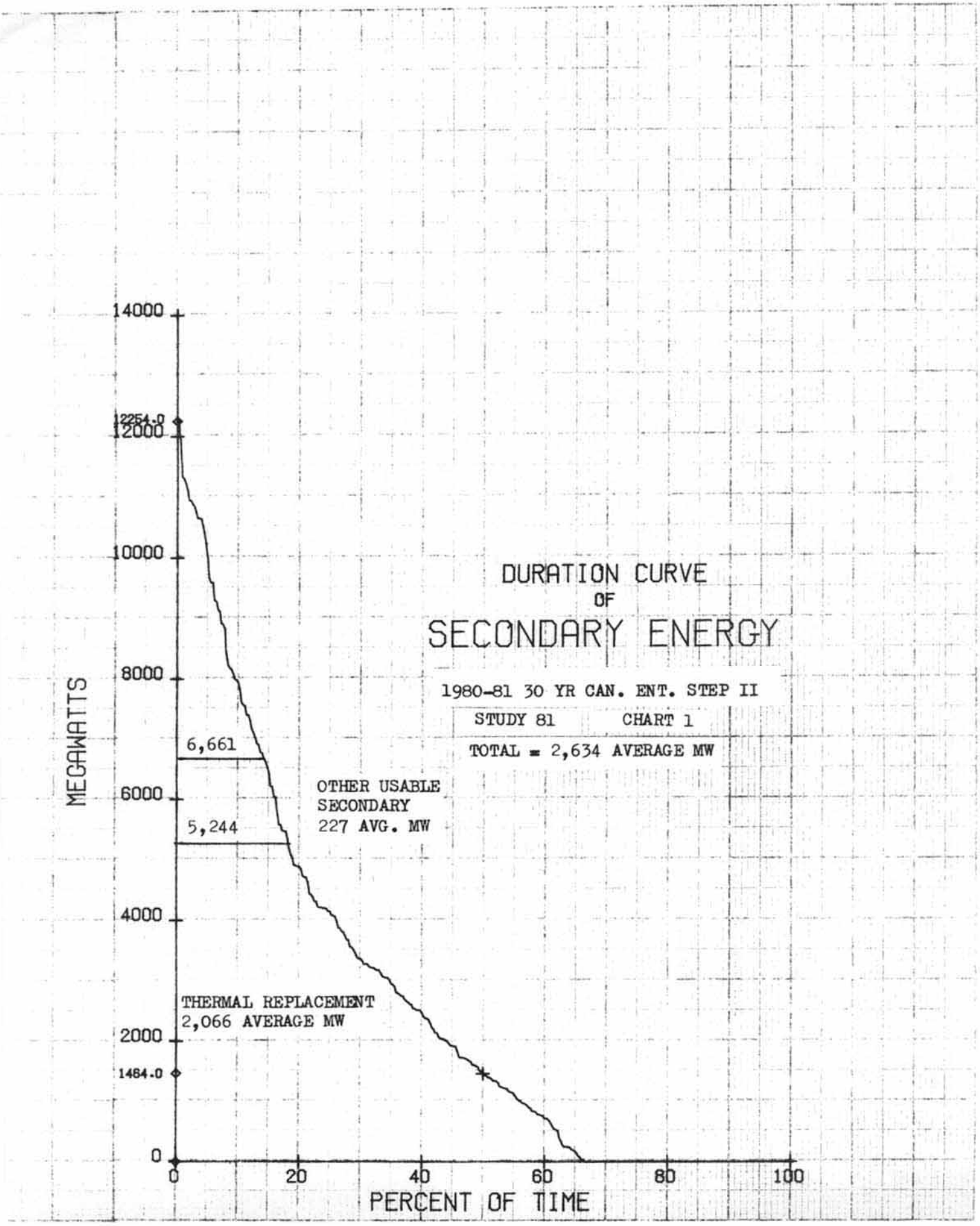
DETERMINATION OF LOAD SHAPE FOR STEP II AND III
CANADIAN ENTITLEMENT COMPUTATION

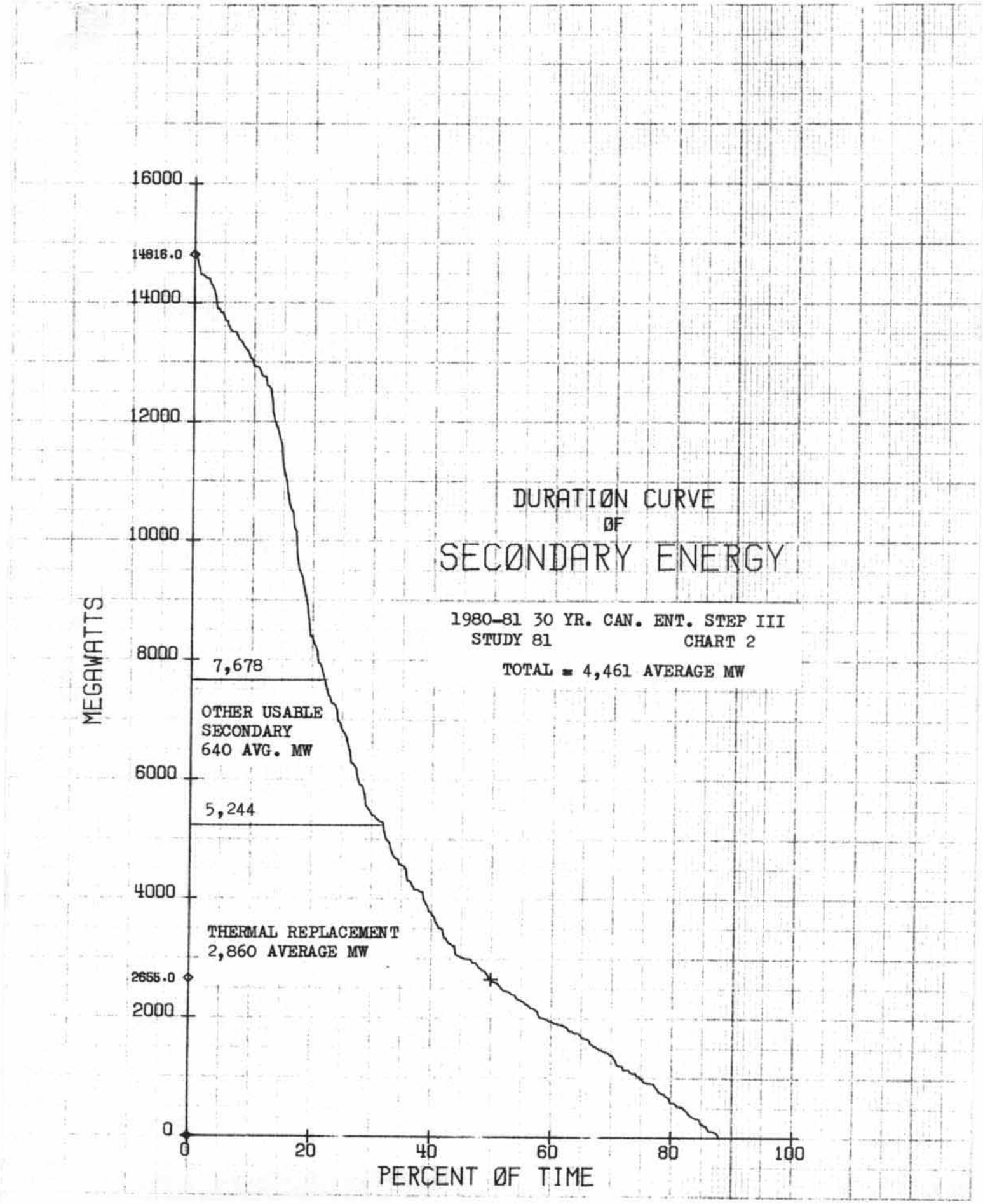
| | Pacific Northwest Area Load | | | Step II | | | Step III | | |
|---|---|---|---|---|---|---|---|---|---|
| | Peak | Avg. | Load Factor % | Total Firm Load 1/ | Thermal Firm Load | Hydro Firm Load | Total Firm Load 1/ | Thermal Firm Load | Hydro Firm Load |
| Aug. 1-15 | 26,490* | 18,411 | 69.50 | 13,072 | 5,244 | 7,828 | 10,924 | 5,244 | 5,680 |
| Aug. 16-31 | 26,412* | 18,314 | 69.34 | 13,003 | 5,244 | 7,759 | 10,866 | 5,244 | 5,622 |
| Sept. 1-15 | 26,719* | 17,974 | 67.27 | 12,761 | 5,244 | 7,517 | 10,664 | 5,244 | 5,420 |
| Sept. 16-30 | 26,674* | 17,936 | 67.24 | 12,734 | 5,244 | 7,490 | 10,642 | 5,244 | 5,398 |
| October | 28,205* | 18,812 | 66.70 | 13,356 | 5,244 | 8,112 | 11,162 | 5,244 | 5,918 |
| November | 29,077* | 20,355 | 70.00 | 14,452 | 5,244 | 9,208 | 12,077 | 5,244 | 6,833 |
| December | 32,057* | 22,177 | 69.18 | 15,746 | 5,244 | 10,502 | 13,158 | 5,244 | 7,914 |
| January | 32,228* | 22,909 | 71.08 | 16,265 | 5,244 | 11,021 | 13,593 | 5,244 | 8,349 |
| February | 30,365* | 21,618 | 71.19 | 15,349 | 5,244 | 10,105 | 12,827 | 5,244 | 7,583 |
| March | 28,717* | 20,403 | 71.05 | 14,486 | 5,244 | 9,242 | 12,106 | 5,244 | 6,862 |
| Apr. 1-15 | 27,397* | 19,555 | 71.38 | 13,884 | 5,244 | 8,640 | 11,603 | 5,244 | 6,359 |
| Apr. 16-30 | 27,407* | 19,609 | 71.55 | 13,922 | 5,244 | 8,678 | 11,635 | 5,244 | 6,391 |
| May | 27,670* | 19,009 | 68.69 | 13,494 | 5,244 | 8,250 | 11,277 | 5,244 | 6,033 |
| June | 27,786* | 18,902 | 68.03 | 13,420 | 5,244 | 8,176 | 11,215 | 5,244 | 5,971 |
| July | 27,189* | 19,077 | 70.16 | 13,544 | 5,244 | 8,300 | 11,319 | 5,244 | 6,075 |
| Critical Period Avg. | | 20,026 | 69.467 | 14,304 | 5,244 | 9,060 | 12,291 | 5,244 | 7,047 |
| Annual Average | | 19,924 | | 14,146 | 5,244 | 8,902 | 11,821 | 5,244 | 6,577 |
| January Peak | 32,228* | | | | | | | | |
| Step I Critical Period Sept. 1, 1928 - Feb. 29, 1932 42 Months | | | | Critical Period Sept. 1943 - Apr. 1945 20 Months | | | Critical Period Sept. 16, 1936 - Apr. 15, 1937 7 Months | | |

1/ Total firm load of Step II and Step III systems, computed for each system to have an average energy load equivalent to the average energy capability within the critical period and to bear a constant ratio, month by month, to the Pacific Northwest Area Load.

* Figures so marked are peak megawatts. All other figures are monthly or semi-monthly energy in average megawatts.

TABLE 3


DURATION CURVE
OF
SECONDARY ENERGY
1980-81 30 YR CAN. ENT. STEP II
STUDY 81 CHART 1
TOTAL = 2,634 AVERAGE MW
MEGAWATTS
14000
12000
10000
8000
6000
4000
2000
0
12254.0
1484.0
6,661
5,244
OTHER USABLE
SECONDARY
227 AVG. MW
THERMAL REPLACEMENT
2,066 AVERAGE MW
0
20
40
60
80
100
PERCENT OF TIME


DURATIØN CURVE
ØF
SECØNDARY ENERGY
1980-81 30 YR. CAN. ENT. STEP III
STUDY 81
CHART 2
TOTAL = 4,461 AVERAGE MW
MEGAWATTS
16000
14816.0
14000
12000
10000
8000
7,678
OTHER USABLE
SECONDARY
640 AVG. MW
6000
5,244
4000
THERMAL REPLACEMENT
2,860 AVERAGE MW
2655.0
2000
0
0
20
40
60
80
100
PERCENT ØF TIME