COLUMBIA RIVER TREATY HYDROELECTRIC OPERATING PLAN

ASSURED OPERATING PLAN FOR OPERATING YEAR 1983-84

COLUMBIA RIVER TREATY OPERATING COMMITTEE SEPTEMBER 1978

COLUMBIA RIVER TREATY
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Assured Operating Plan for Operating Year 1983-1984

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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 1983-1984 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 1983-1984.

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], Articles VII of the Protocol[3], Terms of Sales[4], and the Columbia River Treaty Flood Control Operating Plan[5].

The Assured Operating Plan consists of:

1. 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 upper rule curves.

2. 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 5.0 av MW 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 1983-1984 estimated loads and resources in British Columbia and in the United States Pacific Northwest System. The Entities have agreed that the 1983-1984 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 1983-1984 conditions[7], were used.

The critical rule curve for Canadian Treaty storage was determined from Bonneville Power Administration Study 84-41. The study indicated a 42-month critical period for the United States system resulting from the low flows during the period from 1 September 1928 through February 1932. It was assured that all reservoirs, both in the United States and Canada, were full at the beginning of the critical period except where minimum release requirements made this impossible.

In the studies, individual project flood control criteria were followed. Although only 7.0 million acre-feet of usable storage at Mica is committed for power operation purposes under the treaty, the studies incorporate upper rule curves designed to evacuate Mica storage up to the full storage of 12 million acre-feet as specified by the Columbia River Treaty Flood Control Operating Plan. Flood control and variable refill criteria are based on historical inflow volumes.

DETERMINATION OF OPTIMUM GENERATION IN CANADA AND THE UNITED STATES

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:

1. Firm energy capability.
2. January peaking capacity.
3. Average annual usable secondary energy.

In the studies for the 1983-1984 Assured Operating Plan the Canadian storage was operated to achieve a weighted sum of the three quantities that was greater than the weighted sum achieved under an operation of Canadian storage for optimum generation in the United States alone.

The table on page 5 shows the results from the studies adopted for the 1983-1984 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 1983-1984 Assured Operating Plan the three quantities would be assigned the following relative values:

Quantity	Relative Value
Firm energy capability	3
Average annual usable secondary energy	2
January peaking capacity	1

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 1983-1984 operating year shall be guided by an operating rule curve for the whole of Canadian storage, flood control storage reservation curves for the individual projects and operating rules for specific 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 with the provision of Article VII(2) of the Protocol.

COMPARISON OF ASSURED OPERATING PLAN STUDY RESULTS

		Optimum Generation in Canada and the United States Study No. 84-41	Optimum Generation in the United States Study No. 84-11	Loss	Gain	Net Gain
1.	Firm Energy Capability (av MW)					
	U.S. System*	12 408	12 408	-	-	
	Canada**	1 513	1 482	-	31	
	Total (av MW)	13 921	13 890	-	31	31
2.	January Peaking Capacity (MW)					
	U.S. System***	31 226	31 218	-	8	
	Canada****	3 012	2 983	-	29	
	Total (MW)	34 238	34 201	-	37	37
3.	Average Annual Usable Secondary Energy (av MW)					
	U.S. System	3 323	3 298	-	25	
	Canada	142	151	9	-	
	Total (av MW)	3 465	3 449	9	25	16

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* U.S. system firm energy capability was determined over the U.S. system critical period beginning 1 September 1928 and ending 29 February 1932.

** Canadian (Mica + Revelstoke) system firm energy capability was determined over the Canadian system critical period beginning 1 October 1940 and ending 30 April 1946.

*** U.S. system January peaking capability was determined from January 1937.

**** Canadian (Mica + Revelstoke) system January peaking capability was determined from second lowest January peak in 40 years of record for the Canadian system.

(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 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 reservoirs when applicable.

(i) Assured Refill Curve

The assured refill curve indicates the end-of-month storage content required to assure refill of Canadian storage based on the 1930-1931 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 schedule of outflows is the same as the power discharge requirements used in computing the variable refill curve discussed in (ii) below when The Dalles volume runoff is at 80 million acre-feet.

(ii) Variable Refill Curve

The variable refill curve gives end-of-month storage contents for the period January through July required to refill Canadian storage during the refill period. It was based on historical inflow volume and power discharge requirements determined in accordance with the principles and procedures for the preparation and use of Hydroelectric Operating Plans for Canadian Treaty Storage.[1] 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 at 80 million acre-feet. 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 used in computing the variable refill curves was interpolated linearly between the values shown below:

POWER DISCHARGE REQUIREMENTS IN CFS
FOR JANUARY THROUGH JULY VOLUME AT THE DALLES

Project	80 MAF			90 MAF			95 MAF
	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 in Table 3. These illustrate the probable range of these curves based on historical conditions. In the actual operation in 1983-1984, the power discharge requirements will be interpolated from the above table using the forecast of unregulated runoff at The Dalles.

(c) Upper Rule Curve

The upper rule curves[8] give end-of-month storage content to which each individual Canadian storage project shall be evacuated for flood control and other requirements. The upper rule curves used in the studies were based upon flood control storage reservation diagrams contained in the Columbia River Treaty Flood Control Operating Plan and analysis of system flood control simulations. Flood control curves for each of the Canadian Treaty projects for the 40-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 flood control storage space from Arrow to Mica. In actual operation, the flood control storage reservation

curves will be computed as outlined in the Flood Control Operating Plan, using the latest forecast of runoff available at that time.

(d) Definition of Operating Rule Curve

During the period 1 August through 31 December, 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. During the period 1 January through 31 July, the operating rule curve is defined by the higher of the critical rule curve and the assured refill curve, unless the variable refill curve is lower than this value, then it is defined by the variable refill curve. During the period 1 January through 31 March, it will not be lower than a rule curve developed using 1936-1937 hydro conditions. The operating rule curve meets all requirements for flood control operation (except as noted in Item 4 of the Operating Rules). Composite operating rule curves for the whole of Canadian storage for all 40 years of historical record are shown in 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 1983-1984 operating year.

1. 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 Item 5 below.

2. The whole of the Canadian storage will not be drafted below its operating rule curve unless:

   a. Reservoir storage in the United States system has been drafted to its energy content curve.

   b. Deliveries of secondary energy in the United States are discontinued.

   c. 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.

3. When the conditions of Item 2 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 Item 5 below, so as to optimize generation at site as well as downstream in the United States. In the event the Mica operation results in more or less than that project's proportional share of draft from the whole of Canadian storage, compensation will be made at Arrow to the extent possible.

4. Each project will be operated on or below the storage content defined by its upper rule curve, unless such content is below that indicated by the variable refill curve or the rule curve developed for 1936 to 1937 water conditions.

5. Mica project will be operated to the target outflow or end of period storage content criteria (which depends on the end of previous period Arrow storage content) shown in the table on page 12 as qualified in Items a to c below:

   a. Mica monthly outflows will be increased in the months from October to June if required to avoid violation of the upper rule curve.

   b. Mica monthly outflows will be decreased to minimum if required to avoid withdrawing more than 7 million acre-feet of storage.

   c. 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. Should storage releases in excess of 14.1 million acre-feet be made the 31 July target Mica end of period live treaty storage content will remain as specified in the table on page 12.

The British Columbia Hydro and Power Authority has commenced construction of the Revelstoke project downstream of Mica reservoir.

MICA PROJECT OPERATING CRITERIA

Month	End of previous Period Arrow Storage Content (KSFD)	Target End of Period Live Treaty Storage Content (KSFD)	Target Average Outflow (cfs)	Minimum Outflow (cfs)
August 1-15	0 - full	3529.2	-	10 000
August 16-31	0 - full	3529.2	-	10 000
September	3000 - full	3529.2	-	10 000
	0 - 3000	-	30 000	
October	2100 - full	-	12 000	10 000
	0 - 2100	-	30 000	
November	1800 - full	-	18 000	10 000
	0 - 1800	-	30 000	
December	1500 - full	-	23 000	15 000
	0 - 1500	-	34 000	
January	2500 - full	-	23 000	15 000
	0 - 2500	-	30 000	
February	1500 - full	-	21 000	15 000
	0 - 1500	-	28 000	
March	200 - full	-	20 000	15 000
	0 - 200	-	25 000	
April 1-15	0 - full	-	18 000	15 000
April 16-30	0 - full	-	15 000	10 000
May	300 - full	-	10 000	10 000
	0 - 300	-	24 000	
June	1300 - full	-	10 000	10 000
	0 - 1300	-	20 000	
July	0 - full	3529.2	-	10 000

The present construction schedule which has been revised from the 1982-1983 schedule, calls for the following in-service dates:

Units 1 and 2	September 1983
Unit 3	December 1983
Unit 4	June 1984

Revelstoke has been included in the 1983-1984 Assured Operating Plan and has been operated as a run-of-river project. The Revelstoke reservoir encroaches upon the Mica project tailrace area causing a reduction in Mica project firm energy capability of approximately 20 average megawatts.

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 power 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 1983-1984 will reflect the latest available load, resource and other pertinent data to the extent the Entities agree these data should be included in the plan. Beginning on 1 January 1983, 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 1983-1984 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 1983-1984 operating year shall be guided by the Detailed Operating Plan.

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

The values used in the Assured Operating Plan studies 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 Sales - 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 84-41, dated 24 July 1978.

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
1983-84 OPERATING YEAR

TABLE 1

	AUG15	AUG31	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR15	APR30	MAY	JUN	JUL
1ST YR	7814.6	7814.6	7808.5	7553.0	7114.4	5889.1	3831.0	1918.3	1896.4	1382.9	943.5	2267.2	5611.4	7268.9
2ND YR	7719.8	7776.7	7590.3	7028.0	6162.2	5115.2	2645.6	1564.3	1325.7	891.5	865.6	1944.7	4659.1	6958.5
3RD YR	7362.6	7515.3	7449.8	6976.6	6093.5	4875.5	2508.0	1165.8	1147.4	772.6	376.9	1473.4	3766.5	5534.8
4TH YR	5668.1	5614.4	5433.0	4535.0	3419.1	1270.7	392.9	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
1983-84 OPERATING YEAR

TABLE 2

AUG15	AUG31	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR15	APR30	MAY	JUN	JUL
37.8	123.1	797.8	1081.8	1107.6	1173.8	1231.4	1263.5	1362.3	1267.8	1279.2	2935.6	5998.6	7814.6

COLUMBIA RIVER TREATY
COMPOSITE VARIABLE REFILL CURVES
FOR THE WHOLE OF CANADIAN STORAGE
END OF MONTH CONTENTS IN KSFD
1983-84 OPERATING YEAR

TABLE 3

FLOW YEAR	AUG15	AUG31	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR15	APR30	MAY	JUN	JUL
1928-29							4653.5	4560.7	4838.5	4819.3	4800.0	5318.3	6924.6	7814.6
1929-30							2690.5	2339.2	2333.3	2531.5	2729.4	4165.6	6651.1	,,
1930-31							3066.5	2782.6	3086.8	3157.7	3229.1	4135.8	6814.8	,,
1931-32							1897.4	960.5	221.4	0.0	0.0	1185.3	5122.4	,,
1932-33							,,	,,	,,	,,	,,	1092.5	4809.3	,,
1933-34							,,	,,	,,	,,	,,	1409.5	5640.3	,,
1934-35							,,	968.5	478.2	479.2	578.2	2197.1	5428.4	,,
1935-36							,,	960.5	378.7	383.3	317.7	2290.9	6076.2	,,
1936-37							4853.7	4755.1	5016.2	5023.9	5031.4	5486.9	6942.8	,,
1937-38							1897.4	960.5	221.4	96.7	193.4	2058.2	5471.2	,,
1938-39							2714.8	2361.7	2471.7	2680.1	2728.4	4087.3	6928.8	,,
1939-40							2216.2	1876.2	1948.4	2176.5	2404.6	3697.9	6756.3	,,
1940-41							3679.2	3555.0	3985.1	4176.3	4447.5	5447.2	6997.7	,,
1941-42							2205.3	1828.2	1801.8	1931.3	2060.8	3428.2	6155.3	,,
1942-43							1897.4	1450.3	1398.9	1641.8	1892.7	3489.4	5917.2	,,
1943-44							5744.9	5624.4	5914.6	5885.0	5855.5	6066.7	7152.5	,,
1944-45							4829.0	4726.0	5062.1	5066.9	5071.9	5516.9	6982.3	,,
1945-46							1897.4	960.5	221.4	0.0	0.0	1182.9	5315.8	,,
1946-47							,,	,,	,,	,,	,,	1787.6	5475.1	,,
1947-48							,,	,,	,,	,,	,,	1278.5	5302.9	,,
1948-49							1999.0	1434.4	1230.6	1632.9	2035.4	3528.9	6634.8	,,
1949-50							1897.4	960.5	221.4	0.0	0.0	1443.8	4788.4	,,
1950-51							,,	,,	,,	27.2	54.3	1883.2	5559.6	,,
1951-52							,,	,,	,,	142.1	284.4	2214.8	5686.8	,,
1952-53							,,	,,	523.6	709.5	915.4	2457.9	5615.5	,,
1953-54							,,	,,	221.4	0.0	0.0	793.8	4741.6	,,
1954-55							,,	,,	,,	81.1	162.2	1815.8	4903.3	,,
1955-56							,,	,,	,,	0.0	0.0	1514.4	5383.9	,,
1956-57							,,	,,	,,	,,	,,	1388.1	5808.9	,,
1957-58							,,	,,	,,	,,	,,	1211.1	5441.4	,,
1958-59							,,	,,	,,	,,	,,	971.9	4833.1	,,
1959-60							,,	,,	,,	163.3	326.8	2075.3	5203.7	,,
1960-61							,,	,,	,,	0.0	0.0	1019.8	5109.3	,,
1961-62							,,	,,	,,	196.6	298.2	2174.6	5418.5	,,
1962-63							,,	,,	,,	244.6	487.6	2287.0	5504.9	,,
1963-64							,,	,,	,,	0.0	0.0	928.0	4589.2	,,
1964-65							,,	,,	,,	84.7	169.2	2111.6	5395.7	,,
1965-66							,,	,,	230.9	104.5	179.2	1644.5	5381.4	,,
1966-67							,,	,,	221.4	0.0	0.0	29.6	4176.7	,,
1967-68							,,	,,	,,	,,	,,	706.3	4701.5	,,

FLOOD CONTROL STORAGE RESERVATION CURVES
DUNCAN
KSFD
1983-84 OPERATING YEAR

TABLE 4

	AUG15	AUG31	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR15	APR30	MAY	JUN	JUL
1928-29	785.8	785.8	785.8	785.8	785.8	584.1	397.2	303.0	303.0	311.0	324.6	416.4	568.6	785.8
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	689.5	"
1932-33	"	"	"	"	"	"	"	"	"	75.1	94.2	191.5	573.2	"
1933-34	"	"	"	"	"	"	"	"	"	65.5	127.0	339.6	685.5	"
1934-35	"	"	"	"	"	"	"	"	"	"	83.7	187.8	488.8	"
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	186.8	311.0	508.2	"
1941-42	"	"	"	"	"	"	302.0	121.0	121.0	131.0	155.2	291.9	483.8	"
1942-43	"	"	"	"	"	"	305.0	126.8	126.8	141.1	172.9	248.8	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	388.4	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	184.8	525.3	"
1950-51	"	"	"	"	"	"	"	"	"	79.6	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	88.6	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	785.8	"
1958-59	"	"	"	"	"	"	"	"	"	65.5	65.5	129.5	513.7	"
1959-60	"	"	"	"	"	"	"	"	"	"	"	161.3	545.5	"
1960-61	"	"	"	"	"	"	"	"	"	"	"	193.6	785.8	"
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

ARROW
KSFD
1983-84 OPERATING YEAR

TABLE 5

	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	3875.4	3875.4	3875.4	3875.4	3088.5	3111.2	3235.8	3579.6	3579.6
1929-30	"	"	"	"	"	"	3060.8	3047.7	3033.1	3047.2	3071.9	3287.0	"	"
1930-31	"	"	"	"	"	"	3875.4	3875.4	3875.4	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	3834.6	"
1933-34	"	"	"	"	"	"	"	"	"	"	1784.8	2327.2	3579.6	"
1934-35	"	"	"	"	"	"	"	"	"	"	1008.3	1725.8	3034.6	"
1935-36	"	"	"	"	"	"	"	"	"	1869.9	1373.4	2134.7	3579.6	"
1936-37	"	"	"	"	"	"	2998.3	2927.7	2858.6	2869.7	2902.5	3082.5	"	"
1937-38	"	"	"	"	"	"	2364.6	1719.2	1008.3	1083.8	1278.1	1831.1	3147.5	"
1938-39	"	"	"	"	"	"	2637.8	2243.6	1805.9	1869.5	1983.4	2735.1	3579.6	"
1939-40	"	"	"	"	"	"	2849.6	2645.4	2428.8	2454.8	2536.0	2999.8	"	"
1940-41	"	"	"	"	"	"	3875.4	3875.4	3875.4	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	"	"	"	"	"	"	3875.4	3875.4	3875.4	3088.5	3111.2	3235.8	3579.6	"
1944-45	"	"	"	"	"	"	2641.8	2251.6	1818.0	1842.7	1908.3	2477.8	3368.4	"
1945-46	"	"	"	"	"	"	2364.6	1719.2	1008.3	1072.4	1242.3	2281.2	3579.6	"
1946-47	"	"	"	"	"	"	"	"	"	1075.4	1360.8	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	1098.5	1653.7	3224.7	"
1955-56	"	"	"	"	"	"	"	857.1	8.8	8.0	289.9	1367.3	2763.4	"
1956-57	"	"	"	"	"	"	"	1719.2	1008.3	1077.9	1224.1	2651.4	3579.6	"
1957-58	"	"	"	"	"	"	"	"	"	1046.7	1198.9	2242.5	"	"
1958-59	"	"	"	"	"	"	"	"	"	1008.3	1008.3	1394.8	3322.5	"
1959-60	"	"	"	"	"	"	"	"	"	"	"	1779.7	3579.6	"
1960-61	"	"	"	"	"	"	"	"	"	"	"	1651.2	"	"
1961-62	"	"	"	"	"	"	"	"	"	"	"	2036.8	3322.5	"
1962-63	"	"	"	"	"	"	2484.5	1958.1	1359.2	1359.2	1359.2	1914.3	3579.6	"
1963-64	"	"	"	"	"	"	2364.6	1719.2	1008.3	1008.3	1008.3	1265.5	3322.5	"
1964-65	"	"	"	"	"	"	"	"	"	"	"	1651.2	3579.6	"
1965-66	"	"	"	"	"	"	2528.4	2034.8	1487.8	1487.8	1487.8	2324.7	"	"
1966-67	"	"	"	"	"	"	2364.6	1719.2	1008.3	1008.3	1008.3	1394.8	3322.5	"
1967-68	"	"	"	"	"	"	2367.1	1723.8	1015.4	1015.4	1015.4	1528.6	3579.6	"

FLOOD CONTROL STORAGE RESERVATION CURVES

MICA
KSFD
1983-84 OPERATING YEAR

TABLE 6

	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	3387.8	3365.3	3369.9	3388.5	3412.2	3469.7	3529.2
1929-30	"	"	"	"	"	"	3378.5	3332.6	3282.7	3298.2	3305.9	3353.2	3440.0	"
1930-31	"	"	"	"	"	"	3428.4	3428.4	3428.4	3431.4	3437.9	3457.1	3492.9	"
1931-32	"	"	"	"	"	"	3100.7	2808.2	2488.5	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	3238.3	3380.8	3413.2	"
1937-38	"	"	"	"	"	"	3100.7	2808.2	2488.5	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	3428.4	3428.4	3431.4	3437.9	3457.1	3492.9	"
1941-42	"	"	"	"	"	"	3100.7	2808.2	2488.5	2511.8	2577.8	2781.5	3149.6	"
1942-43	"	"	"	"	"	"	"	"	"	"	"	"	"	"
1943-44	"	"	"	"	"	"	3428.4	3428.4	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	2488.5	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	"	"	"	"	"	3825.8	2067.1	1858.8	188.9	188.9	188.9	883.7	2363.6	"
1956-57	"	"	"	"	"	3428.4	3100.7	2808.2	2488.5	2511.8	2577.8	2781.5	3149.6	"
1957-58	"	"	"	"	"	"	"	"	"	"	"	"	"	"
1958-59	"	"	"	"	"	"	"	"	"	"	"	"	"	"
1959-60	"	"	"	"	"	"	"	"	"	"	"	"	"	"
1960-61	"	"	"	"	"	"	"	"	"	"	"	"	"	"
1961-62	"	"	"	"	"	"	"	"	"	"	"	"	"	"
1962-63	"	"	"	"	"	"	3150.6	2902.8	2626.7	2654.8	2718.4	2885.9	3202.5	"
1963-64	"	"	"	"	"	"	3100.7	2808.2	2488.5	2511.8	2577.8	2781.5	3149.6	"
1964-65	"	"	"	"	"	"	"	"	"	"	"	"	"	"
1965-66	"	"	"	"	"	"	3168.7	2936.3	2668.2	2705.9	2759.3	2923.7	3221.7	"
1966-67	"	"	"	"	"	"	3100.7	2808.2	2488.5	2511.8	2577.8	2781.5	3149.6	"
1967-68	"	"	"	"	"	"	3101.7	2818.3	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
1983-84 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	7808.5	7553.8	7114.4	5889.1	3831.0	1969.8	1961.2	1519.2	1279.2	2935.6	6095.7	7814.6
1929-30	"	"	"	"	"	"	2542.5	1579.0	1942.8	"	"	"	"	"
1930-31	"	"	"	"	"	"	2973.9	1969.8	1961.2	"	"	"	"	"
1931-32	"	"	"	"	"	"	1897.4	960.5	221.4	0.0	0.0	1185.3	5122.4	"
1932-33	"	"	"	"	"	"	"	"	"	"	"	1092.5	4809.3	"
1933-34	"	"	"	"	"	"	"	"	"	"	"	1489.5	5640.3	"
1934-35	"	"	"	"	"	"	"	968.5	478.2	479.2	570.2	2197.1	5428.4	"
1935-36	"	"	"	"	"	"	"	960.5	378.7	383.3	317.7	2298.9	6058.2	"
1936-37	"	"	"	"	"	"	3831.0	1969.8	1961.2	1519.2	1279.2	2935.6	6095.7	"
1937-38	"	"	"	"	"	"	1897.4	960.5	221.4	96.7	193.4	2858.2	5471.2	"
1938-39	"	"	"	"	"	"	2714.8	1684.9	1892.8	1498.7	1264.8	2892.2	6095.7	"
1939-40	"	"	"	"	"	"	2216.2	1547.5	1888.9	1508.8	1273.0	2894.4	"	"
1940-41	"	"	"	"	"	"	3663.1	1963.6	1961.2	1519.2	1279.2	2935.6	"	"
1941-42	"	"	"	"	"	"	2205.3	1265.0	1647.3	1394.7	1256.2	2858.5	6071.7	"
1942-43	"	"	"	"	"	"	1897.4	988.8	1252.1	1117.7	1118.5	2866.2	5917.2	"
1943-44	"	"	"	"	"	"	3831.0	1969.8	1961.2	1519.2	1279.2	2935.6	6095.7	"
1944-45	"	"	"	"	"	"	"	"	"	"	"	"	"	"
1945-46	"	"	"	"	"	"	1897.4	960.5	221.4	0.0	0.0	1182.9	5315.8	"
1946-47	"	"	"	"	"	"	"	"	"	"	"	1748.1	5475.1	"
1947-48	"	"	"	"	"	"	"	"	"	"	"	1278.5	5302.9	"
1948-49	"	"	"	"	"	"	1999.0	1434.4	1238.6	1443.8	1227.2	2879.9	6095.7	"
1949-50	"	"	"	"	"	"	1897.4	960.5	221.4	0.0	0.0	1443.8	4788.4	"
1950-51	"	"	"	"	"	"	"	"	"	27.2	54.3	1883.2	5559.6	"
1951-52	"	"	"	"	"	"	"	"	"	142.1	284.4	2214.8	5686.8	"
1952-53	"	"	"	"	"	"	"	"	523.6	709.5	724.2	2399.9	5615.5	"
1953-54	"	"	"	"	"	"	"	"	221.4	0.0	0.0	793.8	4741.6	"
1954-55	"	"	"	"	"	"	"	"	"	81.1	162.2	1815.8	4903.3	"
1955-56	"	"	"	"	"	"	"	"	"	0.0	0.0	1514.4	5383.9	"
1956-57	"	"	"	"	"	"	"	"	"	"	"	1388.1	5808.9	"
1957-58	"	"	"	"	"	"	"	"	"	"	"	1211.1	5441.4	"
1958-59	"	"	"	"	"	"	"	"	"	"	"	971.9	4833.1	"
1959-60	"	"	"	"	"	"	"	"	"	163.3	326.8	2075.3	5203.7	"
1960-61	"	"	"	"	"	"	"	"	"	0.0	0.0	1819.8	5109.3	"
1961-62	"	"	"	"	"	"	"	"	"	196.6	298.2	2174.6	5418.5	"
1962-63	"	"	"	"	"	"	"	"	"	244.6	487.6	2287.0	5584.9	"
1963-64	"	"	"	"	"	"	"	"	"	0.0	0.0	928.0	4589.2	"
1964-65	"	"	"	"	"	"	"	"	"	84.7	169.2	2111.6	5395.7	"
1965-66	"	"	"	"	"	"	"	"	230.9	184.5	179.2	1644.5	5381.4	"
1966-67	"	"	"	"	"	"	"	"	221.4	0.0	0.0	29.6	4176.7	"
1967-68	"	"	"	"	"	"	"	"	"	"	"	706.3	4701.5	"

DETERMINATION OF DOWNSTREAM POWER BENEFITS RESULTING FROM CANADIAN STORAGE FOR OPERATING YEAR 1983-84
September 1978

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 require 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, 1983-84, and for the storage 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 9 September 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 (84-41 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 (84-42 study).

Step III - based on the U.S. base hydro and thermal system operated for optimum generation in the U.S. (84-13 study).

In addition to the determination of downstream power benefits for the operating year 1983-84, separate determinations were carried out in accordance with the document, "Operation 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	=	1,446.5 MW
Average Annual Energy	=	536.0 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	=	1,419.5 MW
Average Annual Energy	=	535.0 MW

In accordance with Paragraph 5 of the document dated 15 November 1971, the minimum permitted downstream power benefits for the 1983-84 operating year are as follows:

Dependable Capacity = 1,466.5 - (1,466.5 - 1,419.5) = 1,419.5 MW
Average Annual Energy = 562.0 - (567.5 - 535.0) = 529.5 MW

The above computations are based on the formula X - (Y - Z), where the quantities X, Y, and Z are defined in the 15 November 1971 document. The quantities X and Y are derived from the downstream power benefit computations set out in the 1982-83 agreement. The computed downstream power benefits exceed these amounts.

III. Effect on Canadian Entitlement.

The Canadian Entitlement to downstream power benefits was sold to the United States of America under the Canadian Entitlement Purchase Agreement dated 13 August 1964. By definition, the Canadian Entitlement for 1983-84 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	= ½ of 2,893 MW or	1,446.5 MW
Average Annual Energy	= ½ of 1,082 MW or	541.0 MW

Since the 1983-84 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 1983-84 Assured Operating Plan was determined as:

Dependable Capacity	= ½ of 2,893 MW or	1,446.5 MW
Average Annual Energy	= ½ of 1,072 MW or	536.0 MW

The comparison indicates a reduction in Canadian Entitlement of 5.0 average megawatts of average annual usable energy, but not reduction in dependable capacity. This reduction would be in respect of the period 1 April 1983 through 31 March 1984 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 1983 through 31 March 1984, from B.C. Hydro & Power Authority, 5.0 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 Paragraphs 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 Compuation

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 0.98788 and 0.95805, respectively);

(4) Pro rate the average annual Step II and 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 become the firm energy considered usable according to Annex B, Paragraph 3(a).

Charts 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 percent 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	7,745 1/
Less Minimum Thermal Generation	1,625
Thermal Replacement - MW	6,120

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

	Step II	Step III
Thermal Replacement	6,120	6,120
Other	1,650	2,434
Total - MW	7,770	8,554

1/ Thermal energy capabilities are based on an annual plant factor of 60 percent the first full year of operation and 75 percent thereafter. These annual plant factors include deductions for energy reserves and scheduled maintenance.

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	9,085
Critical Period Average Rate of Generation without Canadian Storage, Step III	7,055
Gain Due to Canadian Storage	2,030
Estimated Average Critical Period Load Factor -- Percent	70.175
Dependable Capacity Gain 1/	2,893
Canadian Share of Dependable Capacity	1,446.5

Determination of Increase in Average Annual Usable Energy

Step II (with Canadian Storage)

Annual Firm Hydro Energy	8,901
Thermal Replacement Energy	2,207
Other Usable Secondary Energy	237
System Annual Average Usable Energy	11,345

Step III (without Canadian Storage)

Annual Firm Hydro Energy	6,502
Thermal Replacement Energy	3,173
Other Usable Secondary Energy	598
System Annual Average Usable Energy	10,273
Average Annual Usable Energy Gain	1,072
Canadian Share of Average Annual Energy Gain	536.0

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 OF POWER REGULATIONS FOR 1983-84
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 FEDERAL SYSTEM													
Hungry Horse	4	328	3,161	255	100	3,008	231	116	103	3,008	280	213	101
Albeni Falls	3	49	1,155	25	25	1,155	23	22	22	1,155	24	26	25
Grand Coulee	24 + 2	6,415	5,185	6,403	1,990	5,072	6,364	1,770	2,382	5,072	6,012	1,230	2,282
Chief Joseph	27	2,412		2,412	1,087		2,412	1,000	1,325		2,412	711	1,250
Ice Harbor	6	693		693	216		693	222	302		693	170	302
McNary	14	1,127		1,127	640		1,124	590	756		1,124	430	711
John Day	16	2,484	535	2,484	923		2,484	923	1,260		2,484	683	1,225
The Dalles	22	2,018		2,018	818		2,018	794	1,036		2,018	633	1,015
Bonneville	18	1,114		1,114	609		1,114	591	736		1,114	465	704
Subtotal		16,640	10,036	16,531	6,408	9,235	16,463	6,028	7,922	9,235	16,161	4,561	7,615
BASE SYSTEM NON-FEDERAL													
Kootenay Lake (Canadian)			649			427				427			
Kerr	3	160	1,219	150	110	1,219	152	101	114	1,219	151	139	116
Thompson Falls	6	40		40	35		40	39	32		40	37	32
Noxon Rapids	5	542	231	538	148		542	138	211		542	158	210
Cabinet Gorge	4	230		230	105		230	93	123		230	106	124
Box Canyon	4	74		71	46		71	45	48		71	51	48
Coeur d'Alene & Long Lake			327			223				223			
Wells	10	842		842	436		842	409	512		842	289	473
Chelan	2	54	677	51	38	676	51	37	46	676	51	49	45
Rocky Reach	11	1,267		1,267	589		1,267	553	712		1,267	394	668
Rock Island	18	544		544	279		544	262	330		544	182	303
Wanapum	10	986		986	557		986	524	656		986	367	598
Priest Rapids	10	912		912	530		912	498	619		912	358	565
Brownlee	4	450	980	450	207	974	450	249	261	974	450	250	255
Oxbow	4	220		220	87		220	109	115		220	114	116
Subtotal		6,321	4,083	6,301	3,167	3,519	6,307	3,057	3,779	3,519	6,306	2,494	3,553
TOTAL BASE SYSTEM HYDRO		22,961	29,619	22,832	9,575	28,254	22,770	9,085	11,701	12,754	22,467	7,055	11,168
ADDITIONAL STEP I PROJECTS													
bby	4-8	966	4,934	675	188								
bby Rereg.	0-3	18		18	14								
Boundary	4	650		650	359								
Spokane River Plants		153		152	90								
Hells Canyon	3	450		437	171								
Dworshak	3	460	2,015	445	165								
Lower Granite	6	930		930	217								
Little Goose	6	930		930	217								
Lower Monumental	6	930		930	215								
Pelton and Round Butte		454	274	438	124								
Subtotal		5,941	7,223	5,605	1,760								
Independent Resources		4,818	8,353	4,097	1,740								
TOTAL HYDRO RESOURCES		33,720	45,195	32,534	13,075								
MISCELLANEOUS CONTRACTS				23	9								
THERMAL RESOURCES 1/													
Small Existing Thermal Plants				1,488	165								
Centralia #1 & #2				1,313	931								
Jim Bridger #1, #2, #3, & #4				2,000	1,382								
Colstrip #1 & #2				330	254								
Trojan				1,130	813								
Boardman				530	405								
WNP #2				1,100	710								
Colstrip #3 & #4				980	683								
WNP #1				1,220	671								
WNP #3				0	103								
Added Thermal Requirement				2,714	1,628								
TOTAL THERMAL RESOURCES				12,805	7,745								
TOTAL IMPORTS				284	482								
ESTIMATED HYDRO MAINTENANCE				-340	-51								
TOTAL RESOURCES (HYDRO AND THERMAL)				45,306	21,260								
RESERVES 2/				-2,711	0								
RESOURCES AVAILABLE FOR LOAD				42,595	21,260								
ESTIMATED LOAD													
Pacific Northwest Area				33,888	21,260								
SURPLUS OR (DEFICIT)				8,707	0								
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				84-41			84-42				84-13		

1/ Thermal energy capabilities are based on an annual plant factor of 60 percent the first full year of operation and 75 percent thereafter. These annual plant factors include deductions for energy reserves and scheduled maintenance.

2/ Peak reserves are 8 percent of peak load; energy reserve deductions have been included in thermal plant energy capability.

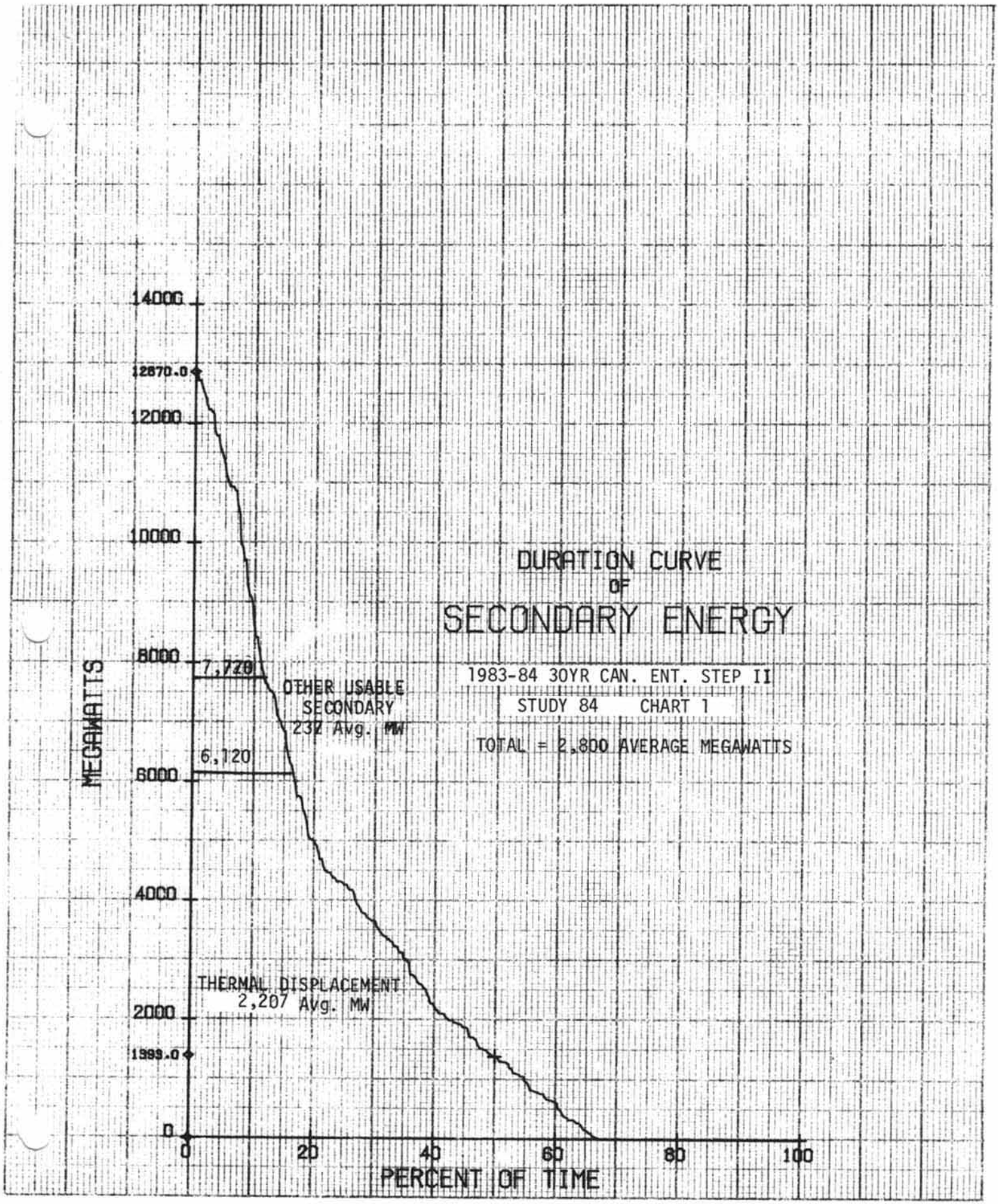
DETERMINATION OF LOAD SHAPE FOR STEPS II AND III
1983-84 CANADIAN ENTITLEMENT COMPUTATIONS

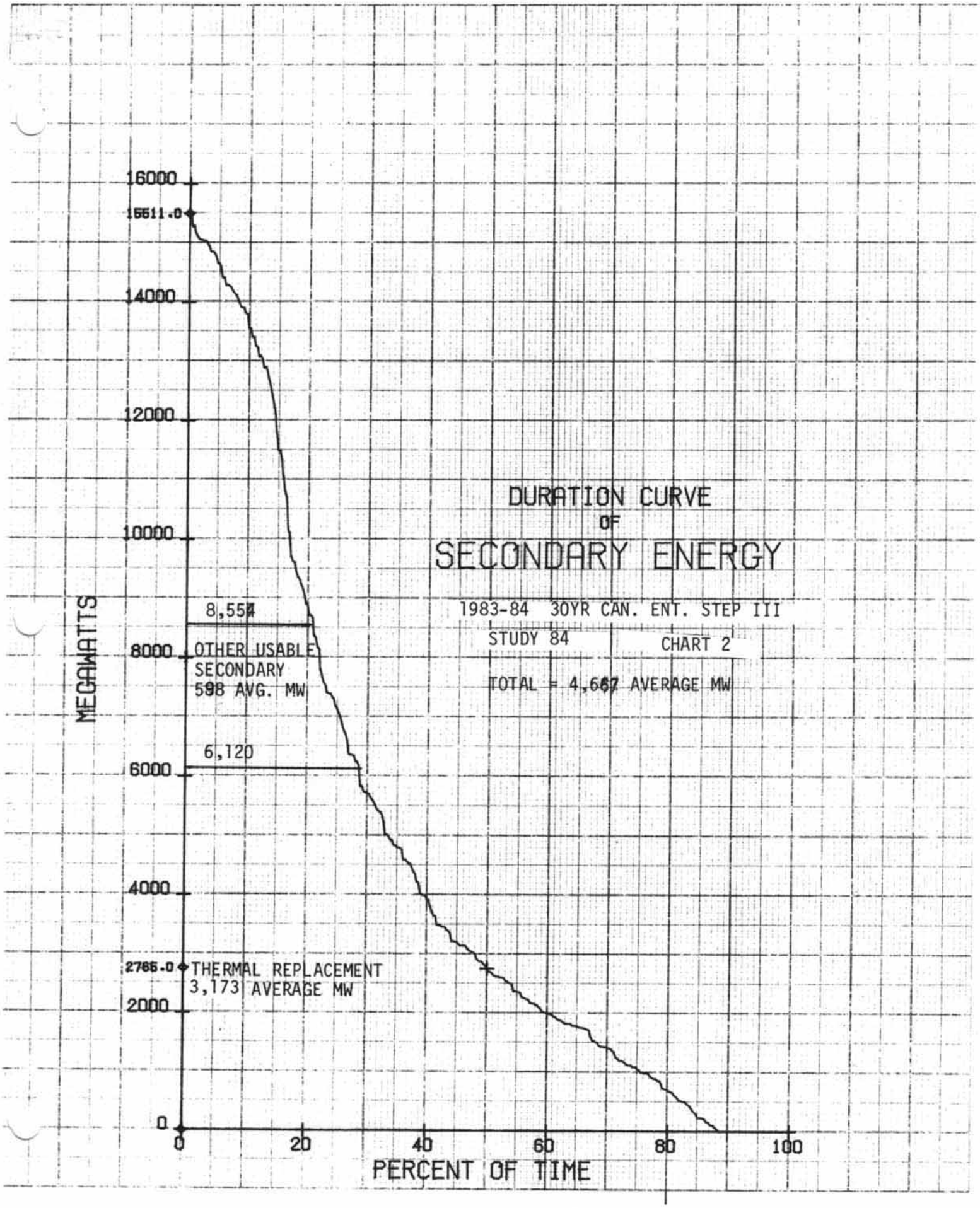
	Pacific Northwest Area Load			Step II			Step III		
	Peak	Avg.	Load Factor %	Total Firm Load 1/	Thermal Firm Load	Hydro Firm Load	Total Firm Load 1/	Thermal Firm Load	Hydro Firm Load
Aug. 1-15	27,433*	19,294	70.33	13,705	6,120	7,585	11,517	6,120	5,397
Aug. 16-31	27,356*	19,198	70.18	13,637	6,120	7,517	11,460	6,120	5,340
Sept. 1-15	28,103*	18,847	67.06	13,388	6,120	7,268	11,250	6,120	5,130
Sept. 16-30	27,916*	18,809	67.38	13,361	6,120	7,241	11,227	6,120	5,107
October	29,390*	19,825	67.45	14,082	6,120	7,962	11,834	6,120	5,714
November	30,809*	21,821	70.83	15,500	6,120	9,380	13,025	6,120	6,905
December	33,301*	23,680	71.11	16,821	6,120	10,701	14,135	6,120	8,015
January	33,888*	24,365	71.90	17,307	6,120	11,187	14,544	6,120	8,424
February	32,106*	23,162	72.14	16,453	6,120	10,333	13,826	6,120	7,706
March	30,706*	21,918	71.38	15,569	6,120	9,449	13,083	6,120	6,963
Apr. 1-15	29,044*	20,702	71.28	14,705	6,120	8,585	12,357	6,120	6,237
Apr. 16-30	29,054*	20,756	71.44	14,744	6,120	8,624	12,389	6,120	6,269
May	29,200*	19,988	68.45	14,198	6,120	8,078	11,931	6,120	5,811
June	28,959*	20,151	69.58	14,314	6,120	8,194	12,028	6,120	5,908
July	28,461*	20,128	70.72	14,298	6,120	8,178	12,015	6,120	5,895
Critical Period Avg.		21,260	70.175	15,205	6,120	9,085	13,175	6,120	7,055
Annual Average		21,146		15,021	6,120	8,901	12,622	6,120	6,502
January Peak	33,888*								
Step I Critical Period Sep. 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
1983-84 30YR CAN. ENT. STEP II
STUDY 84 CHART 1
TOTAL = 2,800 AVERAGE MEGAWATTS
MEGAWATTS
14000
12870.0
12000
10000
8000
7,720
OTHER USABLE
SECONDARY
232 Avg. MW
6,120
6000
4000
THERMAL DISPLACEMENT
2,207 Avg. MW
2000
1999.0
0
0
20
40
60
80
100
PERCENT OF TIME


DURATION CURVE
OF
SECONDARY ENERGY
1983-84 30YR CAN. ENT. STEP III
STUDY 84
CHART 2
TOTAL = 4,667 AVERAGE MW
MEGAWATTS
16000
15611.0
14000
12000
10000
8000
6000
4000
2765.0
2000
0
8,554
OTHER USABLE
SECONDARY
598 AVG. MW
6,120
THERMAL REPLACEMENT
3,173 AVERAGE MW
0
20
40
60
80
100
PERCENT OF TIME