

DETAILED OPERATING PLAN
FOR COLUMBIA RIVER TREATY STORAGE
1 JULY 1972 THROUGH 31 JULY 1973

19 September 1972

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1. REFERENCES AND INTERPRETATION

In this document

- (a) "The Principles and Procedures" means the document "Principles and Procedures for the Preparation and Use of Hydroelectric Operating Plans for Canadian Treaty Storage", dated 25 July 1967;
- (b) "Assured Operating Plan" means the document "Columbia River Treaty Hydroelectric Operating Plans for Canadian Storage, Operating Years 1969-70 through 1974-75", dated 15 February 1969;
- (c) "The Flood Control Plan" means the document "Columbia River Treaty Flood Control Operating Plan" draft, dated September 1972;
- (d) "The Operating Year" means the period from 1 July 1972 through 31 July 1973;
- (e) "Operating Committee" means the Columbia River Treaty Operating Committee;
- (f) "Detailed Operating Plan" means a detailed operating plan prepared for the Operating Year by the Operating Committee pursuant to the Principles and Procedures and consisting of the contents of this document;
- (g) "Program for Initial Filling of Mica Reservoir" means the document of that title dated 26 July 1967;
- (h) "Runoff Volume Forecast Program for Canadian Columbia River Treaty Reservoirs" means the document of that title dated 15 August 1969, with subsequent modifications agreed to by the Operating Committee;
- (i) "Libby Project Forecasting Procedure" means Snowmelt Runoff Forecasts set forth in Supplement Number 1 to Design Memorandum Number 4 for Libby Dam and Reservoir Project, U. S. Corps of Engineers, Seattle District Office, dated March 1970.

2. PREPARATION AND SCOPE

This Detailed Operating Plan has been developed from the Assured Operating Plan for the 1972-73 Operating Year. System load and resource estimates, duration of critical period, flood control and other criteria have been reviewed and revised in accordance with Section 16 of the Principles and Procedures and adjusted as necessary. A revised Critical Period System Regulation was developed to reflect current load estimates and resource schedules including operations required for construction purposes at Libby, Dworshak and Grand Coulee projects. The Critical Period System Regulation was based on historical streamflows for the

19½-month period extending from 1 September 1943 through 15 April 1945. The data, criteria and procedures presented herein will be used as described for the formulation and use of Operating Rule Curves for each of the Canadian storage reservoirs, Duncan, Arrow and Mica; for the whole of the Canadian storage; and for Libby storage reservoir.

The usable Canadian storage available for power purposes during the Operating Year is 8.5 million acre-feet until 1 April 1973 and 15.5 million acre-feet thereafter, distributed as follows:

Duncan Reservoir

1.411 million acre-feet (711.4 thousand second-foot-days) between elevations 1892.0 feet and 1792.4 feet measured at Duncan forebay. (Based on B. C. Hydro table dated 24 April 1968.)

Arrow Reservoir

7.089 million acre-feet (3573.4 thousand second-foot-days) between elevations 1444.0 feet and 1377.7 feet, measured at Fauquier, B.C. (Based on data supplied B. C. Hydro by K. A. Henry, C.B.A. Engineering Ltd., dated 11 October 1966.)

Mica Reservoir

7.0 million acre-feet (3529.8 thousand second-foot-days) measured at Mica forebay. (Based on Mica storage table dated 20 February 1967.) The initial closure of Mica is scheduled for 1 April 1973 with the objective of filling 7.0 million acre-feet of usable storage by 31 July 1973. Any storage filled in excess of 7.0 million acre-feet will be allocated in accordance with the Program for Initial Filling of Mica Reservoir.

The usable Canadian storage available for normal flood control purposes for the Operating Year is 1.27 million acre-feet (640.3 thousand second-foot-days) in Duncan Reservoir below elevation 1892.0 feet and 5.1 million acre-feet (2571.3 thousand second-foot-days) in Arrow Reservoir below elevation 1444.0 feet, except that additional storage in Arrow Reservoir between elevations 1444.0 feet and 1446.0 feet may also be operated for flood control purposes under special circumstances, as described in the Flood Control Plan. The initial closure of Mica Reservoir beginning 1 April 1973 will provide the primary usable Canadian storage for flood control at that project of 2.08 million acre-feet (1048.7 thousand second-foot-days). The foregoing assumes a 2.0 million acre-feet transfer of flood control storage from Arrow Reservoir to Mica Reservoir as detailed in the Flood Control Plan.

During the Operating Year, by agreement with BPA, B. C. Hydro will provide 0.256 million acre-feet (129,000 second-foot-days) of storage between elevation 1444 and 1446 feet in addition to Canadian storage in

Arrow Reservoir. Operation of this storage is not part of this Detailed Operating Plan and the Operating Committee will ensure that any storages and releases carried out under the BPA - B. C. Hydro agreement will not conflict with any of the provisions of this Detailed Operating Plan.

The usable storage in Libby Reservoir for normal operation will be 4.934 million acre-feet (2487.6 thousand second-foot-days) between elevations 2459 feet and 2287 feet measured at the Libby forebay. (Based on U.S. Corps of Engineers' table dated 17 March 1972.)

3. SPECIAL REGULATION OF LIBBY PROJECT

Libby Reservoir (Lake Kootenay) will be drafted, starting 12 September, to elevation 2,230 feet during the fall of 1972. The plan is to increase the reservoir outflow gradually on 12 and 13 September to reach a draw-down rate of 1.5 feet per day by 14 September. That drawdown rate will be maintained until the reservoir level falls to elevation 2,380 feet, after which it will be increased to the maximum rate of draft consistent with the following constraints.

- a. The Libby Reservoir evacuation will not cause a violation of the International Joint Commission Order for Kootenay Lake. It is estimated that the maximum discharge which can be passed at Corra Linn Dam without causing a violation is about 45-46,000 cfs. In the event that Kootenay Lake should threaten to rise above elevation 1,745.32 feet even though Corra Linn Dam is passing the maximum, the Libby outflow will be reduced to preclude such a rise.
- b. Through most of the drawdown, Libby Reservoir draft will not exceed three feet per day, even if it could exceed that rate without causing a violation of the International Joint Commission Order. There is a possibility that the drawdown rate will be increased above the three feet per day when the reservoir elevation approaches the minimum elevation of the planned special regulation.

The plan to draft Libby Reservoir to elevation 2,230 feet, which is 57 feet below the normal minimum elevation of 2,287 feet, requires the evacuation of 3.35 million acre-feet between elevation 2,404.5 feet and 2,230 feet. The purpose of this operation is to permit construction of a rock-fill buttress at the base of the left bank immediately upstream of the dam. It is planned to maintain the reservoir near elevation 2,230 feet, insofar as possible, during the period that the lower portion of the buttress is being placed. Hydraulic capacity of the two outlets at elevation 2,230 feet is approximately 10,000 cfs. Should the inflow appreciably exceed 10,000 cfs water will be stored involuntarily and the reservoir will rise.

The base of the buttress will be near elevation 2,125-2,150 feet so the lowest portions will have to be placed underwater. All portions of the buttress fill above elevation 2,230 feet will be placed in the dry. Some controlled refill of the reservoir above elevation 2,230 feet may be permitted during placement provided the rising water does not approach within 10 feet of the level at which the rock is being placed.

It is anticipated that the buttress will be raised high enough so that filling to the normal full pool, elevation 2459.0 feet, may commence with the start of the spring refill period. Ultimately the buttress will be raised to elevation 2,500 feet. Work required for the Montana State Highway Number 39 fill will be completed as previously scheduled.

Libby storage between elevation 2,230 feet and 2,287 feet will be treated as new reservoir "dead storage" and filled in accordance with paragraph 5, "Program for Initial Filling of Mica Reservoir."

4. OPERATING RULE CURVE

The Operating Rule Curve for each of the Duncan, Arrow and Mica Reservoirs during the period 1 July 1972 through 31 July 1973, to be determined in accordance with the reference documents of Section 1 is defined as follows:

- a. During 1 July 1972 through 31 December 1972, it is the higher of the Critical Rule Curve and the Assured Refill Curve.
- b. During 1 January 1973 through 31 March 1973, it is the higher of the Assured Refill Curve or the appropriate Critical Rule Curve unless the Variable Refill Curve is lower.
- c. During 1 April 1973 through 31 July 1973, it is the lower of the Assured Refill Curve and the Flood Control Refill Curve.
- d. Under no conditions shall the Operating Rule Curve be higher in any period than the Flood Control Storage Reservation Curve.

5. OPERATION

The operation of Treaty storage by the Columbia River Treaty Operating Committee during the period 1 July 1972 through 31 July 1973 will be in accordance with the reference documents of Section 1, and the following operating guides:

- | | |
|---|-----------|
| a. Critical Rule Curve and Assured Refill Curve for Duncan, Arrow and Mica and the whole of Canadian storage. | Exhibit 1 |
| b. Critical Rule Curve 2, 1973-74 for Duncan, Arrow and Mica and the whole of Canadian storage. | Exhibit 2 |
| c. A modification of the Assured and Variable Refill Curve Procedures for Duncan, Arrow and Mica, applicable to Operating Year 1972-73. | Exhibit 3 |

6. SCHEDULING STORAGE REGULATION

- a. The Operating Committee will exchange all current operating data necessary to the regulation of Canadian Storage projects.

- b. Unless otherwise agreed, requests by the U. S. Section of the Operating Committee for the regulation of the Canadian Storage content will be made to the Canadian Section of the Operating Committee on a regular basis in accordance with the following procedures:

(1) Weekly Requests for Storage Regulation During the Storage Drawdown Season

- (a) Timing of Requests. A preliminary request will be made not later than noon each Thursday, followed by a final request by noon Friday if necessary.
- (b) Confirmation of Requests. Written confirmation of the request will be dispatched on Friday in accordance with the following format unless otherwise agreed:

"This message will confirm our verbal request of this date for the (storing/drafting) of _____ KSPD (in/from) the whole of Canadian storage for the period (_____) through (_____) (date). This request is based on an estimated average inflow of _____ KCPS to Arrow Reservoir, _____ KCPS to Duncan Reservoir, and beginning 1 April 1973, of _____ KCPS to Mica Reservoir, and _____ KCPS to Libby Reservoir during the above mentioned period, and an average discharge of _____ KCPS from the Arrow project, _____ KCPS from the Duncan project, _____ KCPS from the Mica project and _____ KCPS from the Libby project."

- (c) Period Covered by Request. The period covered by the request shall be from 0800 hours on the Sunday following the date of the weekly request to 0800 hours on the Sunday a week later.
- (d) Release Determinations. The amount of water released or stored during the period of the request will be determined by the changes in reservoir elevation at Duncan, Arrow and Mica. The change in Arrow storage content will be determined using the gauge near Fauquier, B.C., for the Lower Arrow Lake and using the gauge near Nakusp, B.C., for the Upper Arrow Lake. The reservoir volume tables which will be used are for Duncan dated 24 April 1968, for Upper Arrow and Lower Arrow dated April 1968 and for Mica dated 20 February 1967.
- (e) Delivery. Requested storage releases will be made effective at the Canadian-United States border. The request will be deemed to have been fulfilled if the total amount of storage water requested is released from Duncan, Arrow and Mica reservoirs, provided an amount equal to or greater than the Duncan storage water release is concurrently discharged past Corra Linn Dam.

- (f) Modifications. If any modification to a written request is agreed by the Operating Committee, a further written request superseding the original written request will be dispatched immediately by the U.S. Section of the Operating Committee to the Canadian Section of the Operating Committee.
- (g) Non-Routine Operation. Any special operation which is agreed by the Operating Committee will be suitably documented.
- (2) Daily Request for Storage Regulation During the Flood Control Season
- (a) Forecasts. Seasonal runoff volume forecasts shall be made available by the Section responsible for the forecast no later than the seventh of each month, as required. Forecasts of seasonal runoff volume at periods other than those representing month-end conditions may be requested by the Operating Committee if hydrologic conditions warrant. Day-to-day streamflow forecasts will be accomplished by use of computer simulation by the Columbia River Forecasting Service. The regulation center required by the Flood Control Plan for the flood regulation will be located in the North Pacific Division Office, Corps of Engineers, Portland, Oregon.
- (b) Daily Requests for Project Outflows. Pursuant to the operating rules in the Flood Control Plan, the outflows from individual Canadian storage projects are specified on a day-to-day basis. Requests will be coordinated by telephone daily or on an as-needed basis, by conference calls between members of the Operating Committee or their authorized assistants. The requests will normally prescribe the requested outflows as a mean daily discharge in cubic feet per second, for the 24-hour period from noon-to-noon of each day. Daily requests for project outflows will be documented by message dispatched on the Columbia Basin Teletype Circuit from the regulation center in Portland, Oregon. Acknowledgement of the teletype request will be made by the Canadian authority by teletype message. The project outflows from Canadian projects will be determined from gauged values by methods as agreed upon for the Hydrometeorological Reporting Network. Any modification of the documented daily request shall be agreed upon by the Operating Committee before being put into effect, and shall be documented by teletype immediately thereafter.
- (3) Regulation During Winter Floods. Daily requests for project outflows from Canadian projects are normally confined to the flood control refill period. During periods of high winter

flows in the lower Columbia River, if a special regulation of Arrow storage becomes necessary to preserve the natural flood control storage effect, the outflows from Arrow will be regulated on a day-to-day basis in accordance with the requests of the U. S. Section of the Operating Committee. The requests for such regulation will be in accordance with procedures described above.

6. OPERATING LIMITS

a. Duncan Project

- (1) Maximum outflow - 20,000 cfs through outlets.
- (2) Minimum average weekly outflow - 100 cfs.
- (3) Maximum rate of change in outflow - 4,000 cfs per day.
- (4) Normal full pool elevation - 1,892 feet.
- (5) Minimum pool elevation - 1,792.4 feet.

b. Arrow Project

- (1) Maximum outflow - physical limits only.
- (2) Minimum average weekly outflow - 5,000 cfs.
- (3) Maximum rate of change in outflow - 25,000 cfs per day.
- (4) Normal full pool elevation - 1,444 feet. (The Critical Rule Curve in this Detailed Operating Plan shows storage operation to elevation 1446 feet to reflect the BPA - B. C. Hydro agreement for use of an additional two feet of storage to be operated with no conflict with Treaty Storage.)
- (5) Minimum pool elevation - 1,377.7 feet.
- (6) Advance notice for changes in outflow for:
 - (a) Drop in downstream level of:

1/2 foot	None
1 foot	1 hour
2 feet	2 hours
3 feet or more	24 hours

(b) Rise in downstream level of:

1/2 foot	None
1 foot	1 hour
2 feet	2 hours
3 feet	7 hours - only if notice is received early (before 1000 hours) in the day. Otherwise 24 hour notice is required.
More than 3 feet	24 hours

NOTE: Each 5,000 cfs change causes about one foot variation in the downstream level.

c. Mica Project

(1) Minimum average weekly outflow - 3,000 cfs

NOTE: In order to accelerate the initial filling of Mica Reservoir, and when other conditions permit, the minimum average weekly outflow from the Mica project will normally be set at 1,000 cfs during the 1973 filling season.

DETAILED OPERATING PLAN FOR COLUMBIA RIVER TREATY STORAGE
CRITICAL RULE CURVE & ASSURED REFILL CURVE
1972-73

End-of-Month Usable Storage Content in 1000 SFD

Month	Critical Rule Curve ^{1/}				Assured Refill Curve ^{2/}			
	Duncan	Arrow	Mica	Total	Duncan	Arrow	Mica	Total
July	711.4	3702.4	0	4413.8	--	--	--	
August	711.4	3702.4	0	4413.8	--	--	--	
September	711.4	3570.7	0	4282.1	--	--	--	
October	711.4	3389.7	0	4101.1	--	--	--	
November	651.4	2989.8	0	3641.2	--	--	--	
December	341.4	2022.8	0	2364.2	--	--	--	
January	248.4	684.2	0	932.6	313.7	1714.6	--	2028.3
February	134.0	684.2	0	818.2	322.9	1735.9	--	2058.8
March	111.4	684.2	0	795.6	337.0	1819.3	--	2156.3
April	141.4	457.2	4.6	603.2	297.4	1366.3	1023.2	2686.9
May	171.4	121.8	297.8	591.0	386.1	1846.8	1297.6	3530.5
June	351.4	524.0	1095.7	1971.1	557.1	2829.9	2426.5	5813.5
July	351.4	438.8	1570.0	2360.2	711.4	3573.4	3529.8	7814.6

- 1/ The 129,000 SFD of storage shown for Arrow in addition to the Treaty amount of 3,573,400 SFD reflects an agreement between BPA and B. C. Hydro for the use of 2 feet of storage space between elevations 1444 and 1446 feet in 1972-73. This agreement provides that such use will in no way conflict with the optimum operation of the Treaty storage.
- 2/ The Assured Refill Curve indicates the end-of-month storage content required to assure refill of Canadian storage based on 1931 historical volume of inflow for the whole or remaining portion of the refill period. The year 1931 represents the second lowest historical January-July volume inflow for the system as measured at The Dalles, Oregon. The natural volume of inflow at each reservoir is reduced by deducting the Power Discharge Requirement, non-power requirements at site and upstream (if any) and water required for refill at upstream reservoirs.

The Power Discharge Requirement for each reservoir is defined in Exhibit 3.

The volume of inflow used to define the Assured Refill Curve for Arrow Reservoir assumed the following runoff volumes were deducted for the filling of Mica Reservoir:

- (1) For 31 January, 28 February and 31 March -- 7.0 MAF
- (2) For 30 April, 31 May and 30 June -- Mica inflow less 3000 cfs until 7.0 MAF is filled.

EXHIBIT 2

DETAILED OPERATING PLAN FOR COLUMBIA RIVER TREATY STORAGE
CRITICAL RULE CURVE 2
1973-74

End-of-Month Usable Storage Content in 1000 SFD

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Total</u>
July	351.4	438.8	1570.0	2360.2
August	251.4	191.5	1881.8	2324.7
September	151.4	94.1	1875.2	2120.7
October	51.4	293.3	1507.1	1851.8
November	0	191.7	1027.5	1219.2
December	2.5	0	519.3	521.8
January	0	0	111.9	111.9
February	0	0	35.2	35.2
March	0	0	10.2	10.2
April 15	0	0	0	0
April 30	0	0	0	0
May	143.3	1033.5	559.9	1736.7
June	397.7	2411.1	1816.3	4625.1

DETAILED OPERATING PLAN FOR COLUMBIA RIVER TREATY STORAGE
1972-73
MODIFICATION OF FLOOD CONTROL REFILL CURVE
AND VARIABLE REFILL CURVE PROCEDURES

The Flood Control and Variable Refill Curves indicate the end-of-month storage content required to refill Canadian storage based on forecast natural inflow volume. The natural inflow volume at each reservoir is reduced by deducting the 95% confidence forecast error, Power Discharge Requirement, non-power requirements upstream (if any), and water required for refill at upstream reservoirs. Studies made for the U. S. Coordinated System Operation for 1972-73 indicate that the Power Discharge Requirement for all cyclic reservoirs must be greater than project minimum release to allow filling in accordance with the Principles and Procedures coincident with carrying system firm load when The Dalles natural January-July runoff volume is lower than 90 million acre-feet. In years when the runoff volume at The Dalles exceeds 90 million acre-feet, the Power Discharge Requirement will be project minimum release. Hence the following schedule for Power Discharge Requirements will apply for 1972-73:

<u>Project</u>	<u>Power Discharge Requirement, CFS, for Jan-Jul Volume at The Dalles Less than 90 MAF</u>		<u>Power Discharge Requirement, CFS, for Jan-Jul Volume at The Dalles Exceeding 90 MAF</u>
	<u>Jan-Feb-Mar</u>	<u>Apr-May-Jun-Jul</u>	<u>All Periods</u>
Mica	3,000	18,300	3,000
Arrow	5,000	28,200	5,000
Duncan	100	2,300	100
Libby	2,000	3,200	2,000

The "stepped" Power Discharge Requirement is possible because the cyclic reservoirs would tend to be operated on or below their critical rule curves in years whose runoff volumes are less than 90 million acre-feet at The Dalles during the months of January, February and March.

Upstream storage for Arrow reservoir shall be based on the following:

<u>Period</u>	<u>Upstream Storage ^{1/}</u>
Feb - July { Mar - July { Apr - July {	Mica, April - July most probable inflow volume less power discharge requirement.
May - July	Mica, May - July most probable inflow volume, less power discharge requirement.
June - July	Mica June - July most probable inflow volume less power discharge requirement.
July - July	Mica July most probable inflow volume less power discharge requirement.

^{1/} In no case will the computed Arrow upstream storage be greater than 7 million acre-feet less that amount of usable Treaty storage filled at Mica as computed by the Flood Control Refill Curve at the beginning of each forecast period. The Jan-July volume forecast for The Dalles will be supplied as necessary by the U.S. Section of the Operating Committee.