

# DETAILED OPERATING PLAN FOR COLUMBIA RIVER TREATY STORAGE

1 AUGUST 1997  
THROUGH 31 JULY 1998



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# DETAILED OPERATING PLAN

## FOR COLUMBIA RIVER TREATY STORAGE

### 1 AUGUST 1997 THROUGH 31 JULY 1998

#### **I. REFERENCES AND INTERPRETATION**

In this document:

- A. "Principles and Procedures" means the document "Principles and Procedures for the Preparation and Use of Hydroelectric Operating Plans," dated December 1991.
- B. "Assured Operating Plan" (AOP) means the document "Columbia River Treaty Hydroelectric Operating Plan-Assured Operating Plan for Operating Year 1997-1998," dated October 1992."
- C. "Flood Control Plan" means the document "Columbia River Treaty Flood Control Operating Plan," October 1972. The flood control allocation for this Operating Year will be 2.56 cubic kilometers (km<sup>3</sup>) (2.08 million acre-feet (Maf)) at Mica and 6.29 km<sup>3</sup> (5.1 Maf) at Arrow as indicated respectively by Chart 5 and Chart 7 of the Flood Control Plan.
- D. "Operating Year" means the period from 1 August 1997 through 31 July 1998.
- E. "Operating Committee" means the Columbia River Treaty Operating Committee.
- F. "Detailed Operating Plan" (DOP) means a detailed operating plan prepared for the Operating Year by the Operating Committee pursuant to the guidelines provided in the Principles and Procedures and consisting of the contents of this document.
- G. "Runoff Volume Forecast Program for Canadian Columbia River Treaty Reservoirs" means the document of that title dated 1 January 1992, with subsequent modifications as agreed by the Operating Committee.
- H. "Treaty Storage Regulation" (TSR) means the Coordinated System hydroregulation study performed for the Operating Committee by Bonneville Power Administration (BPA) staff that implements the DOP operating criteria using actual and forecasted streamflow conditions.
- I. "Refill Regulations" means multi-water-year hydro regulations that determine the Power Discharge Requirements used in the calculation of the Assured Refill Curves and the Variable Refill Curves. These regulations are performed for the Operating Committee by the Corps of Engineers' staff.
- J. "Weekly Treaty Storage Operation Agreement" means the note electronically transferred (faxed or teletype) each Friday from the U.S. Section to the Canadian Section of the Operating Committee to confirm the verbal agreement by the Operating Committee for the weekly Treaty storage changes and outflows that implement this DOP.
- K. "Delivery of the Canadian Entitlement " means the Entity Agreement on Aspects of the delivery of the Canadian Entitlement for 1 April 1998 through 15 September 2024 between the Canadian Entity and the United States Entity, dated 20 November, 1996.

## II. PREPARATION AND SCOPE

This Detailed Operating Plan (DOP) has been developed from the operating criteria contained in the 1997-98 Assured Operating Plan (AOP) and its supporting hydroregulation studies. The system loads, resources, and nonpower requirements used are those agreed to by the Entities for the 1997-98 AOP, because the Entities could not agree to the major changes in U.S. nonpower requirements. This DOP will use the 1997-98 AOP four year critical period study and operating criteria for both Canadian and U.S. projects to define the Canadian Treaty storage operation. This DOP is the first to incorporate the use of Standard International (SI, or metric) measurements; for operational purposes, reliance should be placed on measurements in the English system.

The usable Columbia River Treaty storage space available for power purposes during the Operating Year is 19.12 km<sup>3</sup> (15.5 Maf) in Canada and 6.1422 km<sup>3</sup> (4.9795 Maf) at Libby in the United States, distributed as follows:

### Duncan Reservoir

1.73 km<sup>3</sup> (1.4 Maf) [1,726.81 hm<sup>3</sup> (705.8 thousand second-foot-days (ksfd))] between elevations 576.68 meters (m) (1892.0 feet) and 546.87 m (1794.2 feet) measured at Duncan forebay. (Based on British Columbia Hydro and Power Authority (BC Hydro) table dated 21 February 1973.)

### Arrow Reservoir

8.76 km<sup>3</sup> (7.1 Maf) [8,757.85 hm<sup>3</sup> (3579.6 ksf)] between elevations 440.13 m (1444.0 feet) and 419.98 m (1377.9 feet) measured at Fauquier, B.C. (Based on BC Hydro table dated 28 February 1974.)

### Kinbasket Reservoir (Mica)

8.63 km<sup>3</sup> (7.0 Maf) [8,634.54 hm<sup>3</sup> (3529.2 ksf)] measured at Mica forebay. (Based on BC Hydro table dated 25 March 1974.)

### Lake Koocanusa (Libby)

6.14 km<sup>3</sup> (4.9795 Maf) [6,142.19 hm<sup>3</sup> (2510.5 ksf)] between elevation 749.50 m (2459.0 feet) and 697.08 m (2287.0 feet) measured at Libby forebay.

The usable Canadian storage available for normal flood-control purposes for the Operating Year is 1.57 km<sup>3</sup> (1.27 Maf) in Duncan Reservoir below elevation 576.68 m (1892.0 feet); 6.29 km<sup>3</sup> (5.1 Maf) in Arrow Reservoir below elevation 440.13 m (1444.0 feet); and 2.57 km<sup>3</sup> (2.08 Maf) in Kinbasket Lake (Mica Reservoir) except that additional storage may also be operated for flood control purposes under special circumstances, as described in the Flood Control Plan. Prior to 31 December 1997, the Canadian Entity may request, and with the approval of the Operating Committee, that flood control space may be transferred between Mica and Arrow.

### **III. POWER DELIVERIES**

#### **A. Entitlement Purchase Agreement Compensation**

The Entity agreement on the Determination of Downstream Power Benefits (DDPB) for Operating Year 1997-98 indicated that the U.S. Entity is entitled to receive 2.8 aMW of energy but no dependable capacity from BC Hydro during the period 1 August 1997 through 31 March 1998, in accordance with Sections 7 and 10 of the Canadian Entitlement Purchase Agreement dated 13 August 1964. The Entity agreement on the DDPB for Operating Year 1998-99, indicated that the U.S. Entity is entitled to receive 3.7 aMW of energy and 0.4 MW dependable capacity from BC Hydro during the period 1 April 1998 through 31 July 1998, in accordance with Sections 7 and 10 of the Canadian Entitlement Purchase Agreement dated 13 August 1964. Suitable arrangements for delivery of this energy will be made between the Bonneville Power Administration (BPA) and BC Hydro.

#### **B. Delivery of the Canadian Entitlement**

The sale of the Canadian Entitlement attributable to Duncan Lake storage terminates on 31 March 1998 under Section 2. (1)(a) of the Canadian Entitlement Purchase Agreement. Under Section 2 (3) of this agreement, the Canadian Entitlement attributable to Duncan Lake is the ratio of Duncan Lake storage to the whole of Canadian storage. The storage volume at Duncan lake is 1.73 km<sup>3</sup> (1.4 Maf) while the storage volume for the whole Canadian storage is 19.12 km<sup>3</sup> (15.5 Maf), therefore the ratio is 1.4/15.5. The obligation of the United States to return Canadian Entitlement to Canada for the period 1 April 1998 through 31 July 1998 is computed to be:

$$\begin{aligned} \text{Dependable Capacity} &= 1229.6 \text{ MW} * (1.4/15.5) = 111.1 \text{ MW} \\ \text{Average Annual Energy} &= 553.3 \text{ aMW} * (1.4/15.5) = 50.0 \text{ aMW} \end{aligned}$$

Arrangement for the delivery of this Canadian entitlement power, including the point of delivery, transmission losses, and scheduling guideline are defined by the Entitlement Return Agreement and Articles V and VIII of the Columbia River Treaty.

### **IV. STORAGE OPERATIONS**

#### **A. Operation Authority**

The operation of Treaty storage by the Columbia River Treaty Operating Committee during the period 1 August 1997 through 31 July 1998 shall be in accordance with Sections I through VIII of this DOP and any operational agreements signed by the Entities during the operating year. Consistent with the operating principles in this section, the Operating Committee may from time-to-time agree to mutually beneficial changes in the operating procedures contained in this document. These changes will be documented and reported to the Entities.

#### **B. Storage Operation to TSR Level**

Except as allowed in subsection C below, the weekly Treaty Storage Operation Agreements shall be based on operating Canadian Treaty projects to the end-of-month elevations contained in the current TSR. The TSR shall be based on the operating criteria described in this document.

**C. Storage Operation Above and Below TSR Levels**

Consistent with flood control, operating limits, and the principles and limitations defined below, the Operating Committee may agree to mutually beneficial arrangements for storage above and below the TSR levels to meet power and nonpower objectives.

1. Power Objectives

Power objectives include minimizing spill and optimizing energy production, power marketing, and purchase decisions. Operations for power objectives may be combined with nonpower objectives.

2. Nonpower Objectives

Operation(s) designed to help meet nonpower objectives does not imply that either Entity acknowledges any obligation, domestic or international, to meet those objectives. The Entities agree that operation(s) for nonpower objectives does not set a precedent concerning any current or future dispute over Treaty rights and obligations, nor do they set a precedent for non-power objectives or flow objectives and contents.

Canadian nonpower objectives contemplated include but are not limited to white fish and trout spawning downstream of Keenleyside, dust storm avoidance upstream of Keenleyside, and recreation needs. U.S. nonpower objectives include but are not limited to storage up to 1.23 km<sup>3</sup> (1 MAF) for anadromous fish flow augmentation, minimum flows at Vernita Bar for fish spawning, and recreation needs. Nonpower objectives considered in this section, do not include flood control and operating limits in Section VII.

Recognizing that it may not be possible to meet all nonpower objectives, the Operating Committee shall in general attempt to share equally the risk and amount of failure. The parties shall make reasonable efforts to use available flexibility at their projects prior to requesting changes to Treaty storage operation.

**V. SCHEDULING STORAGE REGULATION**

**A. Operating Data**

The Operating Committee will exchange all current operating data necessary for the regulation of Canadian storage projects as soon as available, including the beginning and end of the flood control season.

**B. Volume Runoff Forecasts**

Seasonal runoff volume forecasts for Canadian Treaty Projects shall be made available by the Canadian Section 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. Preliminary seasonal runoff volume forecasts for the Columbia River at The Dalles, Oregon, shall be made available by the U.S. Section on the second working day of each month as required.

**C. Treaty Storage Regulation Study**

The TSR study is performed at least twice each month (within the first ten days and the last five days of each month). It is based on the loads, thermal and hydro-independent resources, critical rule curves, non-power constraints, and other plant and operating data contained in the 1997-98 AOP, except for the following significant changes

1. Brownlee storage operation is simulated instead of the fixed operation provided by Idaho Power Company for the AOP.
2. The Kootenay Lake IJC mode of operation for Duncan and Libby agreed to for the 2001-02 AOP.

The actual and forecasted unregulated streamflows, variable energy content curves, the flood control storage evacuation requirements, and the variable flood control refill curves determined by the U.S. Army Corps of Engineers will be updated for each TSR study as agreed by the Operating Committee. During the operating year the Operating Committee may agree to other changes from the AOP data. Additional weekly studies will be performed at the request of either section of the Operating Committee to reflect the most current forecast unregulated streamflows, variable energy content curves, flood control space storage evacuation requirements, and flood control refill curves for determining the Treaty Storage releases.

During the Flood Control Storage Evacuation Period and the Flood Control Refill period, the projects Upper Rule Curves will be determined through 31 July by the Northwestern Division, Corps of Engineers, in accordance with the Flood Control Plan and the Principles and Procedures as referenced in Section I. These curves will be computed consistent with the timing of the TSR Schedule.

**D. Scheduling Agreements**

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 on a regular basis in accordance with the following procedures:

- I. Weekly Agreement for Storage Regulation During the Storage Drawdown Season
  - a) Timing. A preliminary request will be made not later than noon each Thursday, followed by a final agreement by noon Friday, if necessary.
  - b) Confirmation. Confirmation of the Treaty Storage Operation Agreement will be transmitted via the hydromet reporting network or fax on Friday in accordance with the following format unless otherwise agreed:

This message confirms our verbal agreement on  
 [day, month (spell-out), year] that the (storing/drafting) of an estimated  
 \_\_\_ ksf (in/from) the whole of Canadian Treaty Storage for the Period  
 \_\_\_ through \_\_\_ is consistent with the DOP.

This agreement is based on an estimated average inflow during the above mentioned period of

\_\_\_\_\_ kcfs to Duncan Reservoir,  
\_\_\_\_\_ kcfs to Libby Reservoir,  
\_\_\_\_\_ kcfs to Mica Reservoir, and  
Estimated average regulated inflow of \_\_\_\_\_ kcfs to Arrow Reservoir, and an  
Estimated regulated outflow of \_\_\_\_\_ kcfs from the Libby Project  
That will result in average weekly Treaty discharges of \_\_\_\_\_ kcfs from the Duncan Project,  
\_\_\_\_\_ kcfs from the Mica Project, and  
\_\_\_\_\_ kcfs from the Arrow Project.

This operation is based on the DOP TSR expected end-of-month storage level for the whole of Canadian Treaty Storage of \_\_\_\_\_ ksf.

This operation includes:

Expected (*storage/draft*) (*above/below*) the end-of-month (except split April and August) DOP TSR level for the whole of Canadian Treaty Storage of \_\_\_\_\_ ksf.

- c) Period Covered by Weekly Treaty Storage Operation Agreement. The period covered by the agreement shall be from 0800 hours on the Saturday following the date of weekly request to 0800 hours on the Saturday a week later. Changes from the previous week's agreement shall commence at 0800 hours on Saturday, or as soon thereafter as permitted by the limits of VII(B)7.
- d) Release Determination. The amount of water released or stored during the period of the Weekly Treaty Operation Storage Agreement will be determined by the changes in reservoir contents based on the recorded lake stage and storage capacity tables for Duncan (Exhibit 13), Arrow (Exhibit 14), and Mica (Exhibit 15). The change in Arrow storage content will be determined using the recorded lake stage at the gauge near Fauquier, B.C.
- e) Delivery. Storage releases will be made effective at the Canadian-United States border. The Weekly Treaty Storage Operation Agreement will be deemed to have been fulfilled if the total amount of storage water agreed to is released from Duncan, Arrow, and Mica reservoirs, provided an amount equal to or greater than the storage water release from Duncan reservoir is concurrently discharged from Kootenay Lake.
- f) Modification. If any modification to a written Weekly Treaty Storage Operation Agreement is agreed by the Operating Committee, a further written Storage Agreement superseding the original 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 Agreement for Storage Regulation During Flood Control Season
  - a) Forecasts. 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 Northwestern 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 representatives. 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 determined by methods as agreed upon, and documented with a confirmation agreement by a message transmitted via the hydromet reporting network or fax from the Corps of Engineers, in Portland, Oregon. Acknowledgment of this agreement will be made by the Canadian Section of the Operating Committee or their representative via the hydromet reporting network or fax. Any modification of the documented daily request shall be agreed by the Operating Committee before being put into effect, and shall be documented immediately using the procedure described above.
3. Regulation During Winter Floods. Daily requests for project outflows from Canadian projects are normally implemented in the flood control refill period. During the occurrence of winter floods (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, then the outflows from Arrow will be regulated on a day-to-day basis by agreement of the Operating Committee in accordance with the requests of the U.S. Section of the Operating Committee. Insofar as possible the outflows from Arrow will not exceed the calculated natural lake outflows until the space obligated for this purpose as shown on Chart 5 of the Flood Control Operating Plan is filled. The requests for such regulation will be in accordance with procedures described above. If as a result of operation for winter flood control a reservoir ends up above its upper rule curve, then an appropriate outflow schedule for that reservoir will be determined to ensure that the reservoir will be drafted to its upper rule curve as soon as possible.

## VI. OPERATING GUIDES

### A. Operating Rule Curve

The Operating Rule Curve for the whole of Canadian Storage shall be the sum of the Operating Rule Curves for each of Duncan, Arrow, and Mica. The Operating Rule Curve for each of the Duncan, Arrow, and Mica Reservoirs during the period 1 August 1997 through 31 July 1998 is determined in accordance with the reference documents of Section 1, and is defined as follows:

1. During the period 1 August 1997 through 31 December 1997, it is the higher of the First Critical Rule Curve or the Assured Refill Curve.
2. During the period 1 January 1998 through 31 July 1998, it is the higher of the First

Critical Rule Curve or the Assured Refill Curve, unless the Variable Refill Curve is below the higher of the above two curves; then it is defined by the Variable Refill Curve.

3. During the period 1 January 1998 through 31 March 1998, it will not be lower than a Limiting Rule Curve designed to protect firm loads with recurrence of 1936-37 hydro conditions unless a lower reservoir elevation is required for flood control (Exhibit 6).
4. During any period in the 1997-98 Operating Year, it will not be higher than the Upper Rule Curve, defined as the maximum elevation of each reservoir established by flood control requirements and may be modified on mutual agreement for construction and other contingency requirements.
5. Operation of Mica will be in accordance with the monthly average outflows tabulated with specified qualifications under Operating Limits. The obligation to operate Mica to produce optimum benefits in Canada and downstream in the United States will be deemed to have been fulfilled by operating to these criteria.
6. The Variable Refill Curves for Arrow, Duncan and Mica shall be constructed based on the power discharge requirement specified in Exhibit 7.
7.
  - a) The Variable Refill Curve for Arrow will be computed using the Arrow Total Inflow Method, ie., the forecast volume of inflow above the Mica project will be included. The space in Mica to be deducted from the Arrow total inflow will be equal to the amount of storage draft determined by the Operating Rule Curve for Mica as defined in paragraphs VI(A)2 and VI(A)3.
  - b) The Operating Committee may agree to use an alternative procedure for computing the Variable Refill Curve for Arrow, similar, for example, to the Arrow Local method used in previous DOPs. The Arrow Local Method used previously considered whether the projected live Mica storage content at the end of the current month using most likely Mica inflow and target outflows (expected live Mica storage content) was below the Variable Refill curve for Mica. If the Mica target content was below the VRC, then the forecast volume of inflow for Arrow (reduced by a forecast error such that there is a 95 percent probability that the reduced forecast is equaled or exceeded) excluded the volume of inflow above the Mica project (Arrow local inflow). The total Mica target outflow as specified in VII(C) was added to the Arrow forecast volume in computing water available for refill of Arrow Reservoir.

For the purpose of calculating the rule curve for the whole of Canadian storage, the Variable Refill Curve for Mica was set equal to the expected live Mica Treaty storage content.

The Operating Rule Curve for Libby Reservoir used in the TSR study is defined in a manner similar to that for Canadian storage.

**B. Rule Curves and Operating Data**

- |  |           |
|--|-----------|
| 1. Assured Refill Curve for Duncan, Arrow, Mica.   | Exhibit 1 |
| 2. First Critical Rule Curve for Duncan, Arrow, Mica, and the whole of Canadian storage.         | Exhibit 2 |
| 3. Second Critical Rule Curve for Duncan, Arrow, Mica, and the whole of Canadian storage.        | Exhibit 3 |
| 4. Third Critical Rule Curve for Duncan, Arrow, Mica, and the whole of Canadian storage.         | Exhibit 4 |
| 5. Fourth Critical Rule Curve for Duncan, Arrow, Mica, and the whole of Canadian storage.        | Exhibit 5 |
| 6. Lower Limit for Operating Rule Curve based on 1936-37 Hydro Conditions.                       | Exhibit 6 |
| 7. Variable Refill Curve Procedures.   | Exhibit 7 |
| 8. The First, Second, Third, and Fourth Critical Rule Curves and Assured Refill Curve for Libby. | Exhibit 8 |
| 9. Coordinated System Loads and Resources  | Exhibit 9 |

**C. Rule Curves for Future Operating Years**

The following tables, including adjustments, have been agreed to by the Entities:

- |   |            |
|---|------------|
| 1. Second Critical Rule Curves for Duncan, Arrow, Mica, and the whole of Canadian storage for Operating Year 1998-99. | Exhibit 10 |
| 2. Third Critical Rule Curves for Duncan, Arrow, Mica, and the whole of Canadian storage for Operating Year 1999-00   | Exhibit 11 |
| 3. Fourth Critical Rule Curves for Duncan, Arrow, Mica, and the whole Canadian storage for Operating Year 1900-01.    | Exhibit 12 |

**D. Reservoir Capacity Tables**

The following tables shall be considered to be the official storage for the projects:

- |  |            |
|--|------------|
| 1. Duncan Reservoir Capacity Table (based on BC Hydro table dated 21 February 1973).                 | Exhibit 13 |
| 2. Arrow Reservoir Capacity Table (based on BC Hydro Combined Storage Table dated 28 February 1974). | Exhibit 14 |
| 3. Mica Reservoir Capacity Table (based on BC Hydro table dated 25 March 1974).                      | Exhibit 15 |
| 4. Libby Storage above elevation 697.08 m (2287 feet).   | Exhibit 16 |

## VII. OPERATING LIMITS

### A. Duncan Project

1. Maximum outflow is 566.34 cubic meters per second ( $m^3/s$ ) (20,000 cubic feet per second (cfs)) through outlets with the limit of 283.17  $m^3/s$  (10,000 cfs) each period in the TSR model.
2. Minimum average weekly outflow is 2.83  $m^3/s$  (100 cfs).
3. Maximum rate of change in outflow is normally 113.27  $m^3/s$  (4,000 cfs) per day unless a larger change is necessary to accomplish the objectives of the Flood Control Plan.
4. Normal full pool elevation is 576.68 m (1,892.0 feet).
5. Normal minimum pool elevation is 546.87 m (1,794.2 feet).
6. Normal maximum reservoir draft in elevation during any month is limited to the equivalent of 0.30 m (1 foot) per day.

### B. Arrow Project

1. Maximum outflow is physical limits only.
2. Minimum average weekly outflow is 141.58  $m^3/s$  (5,000 cfs).
3. Maximum rate of change in outflow is normally 424.75  $m^3/s$  (15,000 cfs) per day unless a larger change is necessary to accomplish the objectives of the Flood Control Plan.
4. Normal full pool elevation is 440.13 m (1,444.0 feet).
5. Normal minimum pool elevation is 419.98 m (1,377.9 feet).
6. Normal maximum reservoir monthly draft in elevation limited to the equivalent of 0.3 m (1 foot) per day
7. Advance notice for changes in outflow for:
  - a) Drop in downstream level of
    - 0.15 m ( $\frac{1}{2}$  foot) - None,
    - 0.30 m (1 foot) - 1 hour,
    - 0.61 m (2 feet) - 2 hours,
    - 0.91 m (3 feet) - 24 hours, and

- b) Rise in downstream level of
- |                 |   |   |
|-----------------|---|---|
| 0.15 m (½ foot) | - | None,   |
| 0.30 m (1 foot) | - | 1 hour,   |
| 0.61 m (2 feet) | - | 2 hours,  |
| 0.91 m (3 feet) | - | 7 hours, only if notice is received before 10:00 a.m. that day, otherwise 24-hour notice is required. |

### C. Mica Project

The Mica Project Treaty storage will be operated according to the Mica Project Operating Criteria shown in the following table except as qualified in subsections VII(C)1 through VII(C)9.

1. Variable Refill Curves. Variable Refill Curves (VRC) shall be constructed based on a power discharge requirement as indicated in Exhibit 7 with 31 July Treaty storage content of 8,634.54 hm<sup>3</sup> (3,529.2 ksf). However, the Operating Committee may agree to set Mica's VRC July refill target equal to the Mica End of Period Storage Content of 8,211.28 hm<sup>3</sup> (3356.2 ksf) indicated on the following "Mica Project Operating Criteria" table.
2. Mica Project Operating Criteria. Mica project operation will be determined by the End of Previous Period Arrow Storage Content as shown in the following table, except for the limitations or changes required by subsections VII(C)3 through VII(C)9. The End of Previous Period Arrow Storage Content will be determined from the current TSR. Mica's operation will be defined either by a Target End of Period Storage Content or a Target Period Average Outflow.
3. Mica operation to the Target End-of-Period Treaty Storage Contents shall be limited by the Minimum Outflows shown in the table above, and a maximum outflow of 962.77 m<sup>3</sup>/s (34,000 cfs) except as modified in Note 1/ when the Target End-of-Period Storage Content is below 8,634.54 hm<sup>3</sup> (3529.2 ksf) unless needed to accomplish the objectives of the Flood Control Plan.
4. Mica operation to the Target Period Average Outflow shall be limited by the Minimum Target Treaty Content shown in the table above. Mica outflows shall be reduced as required down to a lower limit of the Minimum Outflow shown in the table above, to prevent draft below the Minimum Target Treaty Storage Content. Minimum Outflows may cause the reservoir to draft below the Minimum Target Treaty Content.
5. During July, the Mica operation to the Target Period Average Outflow shall not be less than the outflow necessary to meet the Target End-of-Period Storage Content of 8,211.28 hm<sup>3</sup> (3356.2 ksf).
6. Mica outflows will be increased during the months October through June as required to avoid violation of the Upper Rule Curve.
7. During the period January through July, if in any month an alternate method to the Arrow Total Inflow Method is used to compute the Variable Refill Curve as defined in Subsection VI(A)7(b), only the Variable Refill Curves based on the Arrow Total Inflow Method continuously from January on will be used to determine if the Arrow contents

are within the limits shown above.

8. Each month, within two working days of determination of the final TSR, normally available within the first ten days of the month, one correction to the adjusted Mica outflow may be made, consistent with subsection VII(C)3 above.
9. Storage releases from Mica in excess of  $8.63 \text{ km}^3$  (7 Maf) that result from operating Mica under the criteria described in VII(C)2 through VII(C)8 above will be retained in the Arrow reservoir, subject to flood control criteria at Arrow, and Mica will be reduced to Minimum Outflow as required to minimize releases in excess of  $8.63 \text{ km}^3$  (7 Maf). The total combined storage draft from Mica and Arrow will not exceed  $17.39 \text{ km}^3$  (14.1 Maf) unless flood control criteria will not permit the additional Mica storage releases for minimum flow purposes to be retained at Arrow.

## Mica Project Operating Criteria (English)

Month	End of Previous Month Arrow Storage Content (KSFd)	Target Operation		Minimum Target Treaty Content at Mica (KSFd) 2/	Minimum Outflow (CFS)
		Month Average Outflow (CFS)	End of Month Storage Content 1/ (KSFd)		
August 1-15	1,300 - Full 0 - 1,300	--- 27,000	3,456.2	0.0	10,000
August 16-31	3,400 - Full 800 - 3,400 0 - 800	--- 28,000 30,000	3,529.2	0.0	10,000
September	3,340 - Full 900 - 3,340 0 - 900	--- 22,000 32,000	3,529.2	0.0	10,000
October	3,260 - Full 2,400 - 3,260 0 - 2,400	15,000 23,000 32,000	---	0.0	10,000
November	3,340 - Full 2,300 - 3,340 0 - 2,300	19,000 24,000 32,000	---	0.0	10,000
December	3,200 - Full 2,300 - 3,200 0 - 2,300	23,000 28,000 30,000	---	0.0	15,000
January	2,320 - Full 1,250 - 2,320 0 - 1,250	24,000 27,000 30,000	---	0.0	15,000
February	1,284 - Full 1,100 - 1,284 0 - 1,100	22,000 25,000 29,000	---	106.2	15,000
March	1,220 - Full 1,000 - 1,220 0 - 1,000	19,000 26,000 28,000	---	0.0	15,000
April 1-15	0 - Full	---	106.2	0.0	15,000
April 16-30	0 - Full	---	0.0	0.0	10,000
May	0 - Full	10,000	---	0.0	10,000
June	450 - Full 0 - 450	10,000 21,000	---	0.0	10,000
July	2,300 - Full 720 - 2,300 0 - 720	--- 20,000 25,000	3,356.2	0.0	10,000

**Notes:**

- (1) A maximum outflow of 34 000 cfs will apply if the target end-of-period storage content is less than 3529.2 ksfed except in April where a maximum outflow of 32 000 cfs will apply from April 1-15, a maximum outflow of 27 000 cfs will apply from April 16-30, and a maximum outflow of 30 000 cfs will apply in May.
- (2) Mica outflows will be reduced to minimum to maintain the reservoir above the minimum Treaty storage content. This will override any target flow.

### Mica Project Operating Criteria (SI)

Month	End of Previous Month Arrow Storage Content (hm <sup>3</sup> )	Target Operation		Minimum Target Treaty Content at Mica (hm <sup>3</sup> ) 2/	Minimum Outflow (m <sup>3</sup> /s)
		Month Average Outflow (m <sup>3</sup> /s)	End of Month Storage Content 1/ (hm <sup>3</sup> )		
August 1-15	3,180.6 - Full 0 - 3,180.6	--- 764.55	8,455.9	0.0	283.17
August 16-31	8,318.4 - Full 1,957.3 - 8,318.4 0 - 1,957.3	--- 792.87 849.50	8,634.5	0.0	283.17
September	8,171.6 - Full 2,201.9- 8,171.6 0 - 2,201.9	--- 622.97 906.14	8,634.5	0.0	283.17
October	7,975.9 - Full 5,871.8 - 7,975.9 0 - 5,871.8	424.75 651.29 906.13	---	0.0	283.17
November	8,171.6 - Full 5,627.2 - 8,171.6 0 - 5,627.2	538.02 679.60 906.14	---	0.0	283.17
December	7,829.1 - Full 5,627.2 - 7,829.1 0 - 5,627.2	651.29 792.87 849.50	---	0.0	424.75
January	5,676.1 - Full 3,058.3 - 5,676.1 0 - 3,058.3	679.60 764.55 849.50	---	0.0	424.75
February	3,141.4 - Full 2,691.3 - 3,141.4 0 - 2,691.3	622.97 707.92 821.19	---	259.8	424.75
March	2,984.9 - Full 2,446.6 - 2,984.9 0 - 2,446.6	538.02 736.24 792.87	---	0.0	424.75
April 1-15	0 - Full	---	259.8	0.0	424.75
April 16-30	0 - Full	---	0.0	0.0	283.17
May	0 - Full	283.17	---	0.0	283.17
June	1,101 - Full 0 - 1,101	283.17 594.65	---	0.0	283.17
July	5,627.2 - Full 1,761.6- 5,627.2 0 - 1,761.6	--- 566.34 707.92	8,211.3	0.0	283.17

**Notes:**

- (1) A maximum outflow of 962.76 m<sup>3</sup>/s will apply if the target end-of-period storage content is less than 8634.5 hm<sup>3</sup> except in April where a maximum outflow of 906.13 m<sup>3</sup>/s will apply from April 1-15, a maximum outflow of 764.55 m<sup>3</sup>/s will apply from April 16-30, and a maximum outflow of 849.5 m<sup>3</sup>/s will apply in May.
- (2) Mica outflows will be reduced to minimum to maintain the reservoir above the minimum Treaty storage content. This will override any target flow.

**D. Libby Project**

1. Maximum Outflow - When the spillway capacity is insufficient to pass the required flow, the regulating outlets may be used.

<b>Forebay Elevation</b>	<b>One Sluice</b>	<b>Three Sluices</b>
749.50 m (2459 ft.)	574.83 m <sup>3</sup> /s (20,300 cfs)	1,727.33 m <sup>3</sup> /s (61,000 cfs)
739.14 m (2425 ft.)	538.02 m <sup>3</sup> /s (19,000 cfs)	1,614.06 m <sup>3</sup> /s (57,000 cfs)
733.05 m (2405 ft.)	515.37 m <sup>3</sup> /s (18,200 cfs)	1,546.10 m <sup>3</sup> /s (54,600 cfs)
716.28 m (2350 ft.)	438.91 m <sup>3</sup> /s (15,500 cfs)	1,316.73 m <sup>3</sup> /s (46,500 cfs)
697.08 m (2287 ft.)	331.31 m <sup>3</sup> /s (11,700 cfs)	991.09 m <sup>3</sup> /s (35,000 cfs)

2. Minimum instantaneous outflow is 56.63 m<sup>3</sup>/s (2,000 cfs) and the normal minimum daily outflow is 113.27 m<sup>3</sup>/s (4,000 cfs).
3. Maximum rate of tailwater change
  - a) May - September - 0.30 m (1 ft.) per hour  
1.22 m (4 ft.) per 24 hours
  - b) October - April - 0.30 m (1 ft.) per ½ hour  
1.83 m (6 ft.) per 24 hours
4. Normal full pool elevation - 749.50 m (2459.0 ft)
5. Minimum CRC elevation - 720.24 m (2363.0 ft) in December only  
697.08 m (2287.0 ft) in all other month

**VIII. EXPECTED LIBBY OPERATION**

The US Entity plans to regulate Libby to the following operating requirements, in order to meet requirements for species listed under the Endangered Species Act. The Canadian Entity and the US Entity do not agree on the use of these operating requirements. The Canadian Entity has not, and does not agree these operating requirements are appropriate for the Libby project operation. The US Entity has determined that these operating requirements are appropriate.

<u>Rule Curves:</u>	<u>Critical Rule Curve</u>	<u>Assured Refill Curve</u>
September:	4915.2 hm <sup>3</sup> (2009.0 ksf)	3805.0 hm <sup>3</sup> (1555.2 ksf)
October	4554.6 hm <sup>3</sup> (1861.6 ksf)	3797.4 hm <sup>3</sup> (1552.1 ksf)
November	4407.8 hm <sup>3</sup> (1801.6 ksf)	3728.4 hm <sup>3</sup> (1523.9 ksf)
Dec. to Aug.	Not used	Not used

Target Content:

August 31	5043.2 hm <sup>3</sup> (2061.3 ksf),	743.41 m (2439 feet)
December 31	3675.8 hm <sup>3</sup> (1502.4 ksf),	734.87 m (2411 feet)
January 31	Flood Control Rule Curve	
February 28	Flood Control Rule Curve	
March 31	Flood Control Rule Curve	
April 15	Flood Control Rule Curve	

Minimum Outflows: Draft Libby as needed to support the following flows at Bonners Ferry:

April 16-30	424.75 m <sup>3</sup> /s (15,000 cfs)
May 1-31	643.98 m <sup>3</sup> /s (22,742 cfs)
June 1-30	991.09 m <sup>3</sup> /s (35,000 cfs)
July 1-31	247.52 m <sup>3</sup> /s (8,741 cfs)

Maximum Outflow: Powerhouse Full Gate Flow in all months (without spill).

**Exhibit 1 - Assured Refill Curves (English) 1/**

Month	DUNCAN					MICA						ARROW					
	1931		Water Available		ARC	1931		Water Available				1931		Water Available		MICA	
	Inflow	PDR	for Refill			Inflow	PDR	for Refill		CRC1	ARC	Inflow	PDR	for Refill		Refill	ARC
	CFS	CFS	CFS	KSFD	KSFD	CFS	CFS	CFS	KSFD	KSFD	KSFD	CFS	CFS	CFS	KSFD	KSFD	KSFD
3/	4/					4/						4/			2/		
July	7320	2000	5320	164.9	705.8	56477	22000	34480	1068.9	3091.1	3529.2	88586	40000	48590	1506.3	1068.9	3579.6
June	8030	1500	6530	195.9	540.9	60178	22000	38180	1145.4	2109.5	2460.3	114636	40000	74640	2239.2	1145.4	3142.2
May	5170	1500	3670	113.8	345.0	28058	22000	6060	187.9	461.0	1314.9	68098	40000	28100	871.1	187.9	2048.4
Apr2	981	1000	-20	-0.3	231.2	7217	22000	-14780	-221.7	0.0	1127.1	20504	25000	-4500	-67.5	-221.7	1365.2
Apr1	981	400	580	8.7	231.5	4679	20000	-15320	-229.8	252.2	1348.8	10700	25000	-14300	-214.5	-229.8	1211.0
Mar	555	400	160	5.0	222.8	3219	20000	-16780	-520.2	821.5	1578.6	7653	5000	2650	82.2	-520.2	1195.7
Feb	428	400	30	0.8	217.9	2593	20000	-17410	-487.5	1376.8	2098.7	5813	5000	810	22.7	-487.5	593.3
Jan	428	100	330	10.2	217.0	2834	3000	-170	-5.3	1914.0	2586.2	6430	5000	1430	44.3	-5.3	83.2
Dec	461	100	360	11.2	206.8	3533	3000	530	16.4	2516.2	2591.5	6694	5000	1690	52.4	-486.7	33.6
Nov	684	100	580	17.4	195.6	5176	3000	2180	65.4	3078.2	2575.1	9483	5000	4480	134.4	-270.3	0.0
Oct	1090	100	990	30.7	178.2	8751	3000	5750	178.3	3348.5	2509.7	14691	5000	9690	300.4	4.9	0.0
Sep	2310	100	2210	66.3	147.5	23110	3000	20110	603.3	3343.6	2331.4	39739	5000	34740	1042.2	-185.6	0.0
Aug2	4530	100	4430	70.9	81.2	38261	3000	35260	564.2	3529.2	1728.1	62605	5000	57610	921.8	0.0	0.0
Aug1	4530	100	4430	66.5	10.4	53542	3000	50540	758.1	3529.2	1164.0	82249	5000	77250	1158.8	0.0	0.0

Notes:

- 1/ The Assured Refill Curve indicates the end-of-month storage content required to assure refill of Canadian storage by 31 July based on 1931 historical monthly inflow. The monthly inflow at each reservoir is reduced by deducting the Power Discharge Requirements and water required for refill, if any, at upstream reservoirs. The Entities may agree to revise the data upon the completion of the Refill Study by the Operating Committee.
- 2/ Upstream refill requirement: these values are computed by subtracting current month from previous month's higher of Mica's ARC or CRC1 except July value is Mica full minus previous month's higher of Mica's ARC or CRC1. CRC1 is shown in Exhibit 2.
- 3/ Inflows are from 1990 Level Modified streamflow (Hydrosim file).
- 4/ PDRs are from 1997-98 AOP study.

Exhibit 1M - Assured Refill Curves (SI) 1/

Month	DUNCAN					MICA						ARROW					
	1931 Inflow	PDR	Water Available		ARC	1931 Inflow	PDR	Water Available		CRC1	ARC	1931 Inflow	PDR	Water Available		MICA Refill	ARC
			for Refill					for Refill						for Refill			
	m <sup>3</sup> /s	m <sup>3</sup> /s	m <sup>3</sup> /s	hm <sup>3</sup>	hm <sup>3</sup>	m <sup>3</sup> /s	m <sup>3</sup> /s	m <sup>3</sup> /s	hm <sup>3</sup>	hm <sup>3</sup>	hm <sup>3</sup>	m <sup>3</sup> /s	m <sup>3</sup> /s	m <sup>3</sup> /s	hm <sup>3</sup>	hm <sup>3</sup>	hm <sup>3</sup>
3/	4/					4/						4/			2/		
July	207.28	56.63	150.65	403.49	1726.81	1599.25	622.97	976.36	2615.12	7562.69	8634.54	2508.47	1132.67	1375.91	3685.3	2615.12	8757.85
June	227.38	42.48	184.91	479.29	1323.32	1704.05	622.97	1081.14	2802.34	5161.10	6019.42	3246.13	1132.67	2113.57	5478.4	2802.34	7687.68
May	146.40	42.48	103.92	278.35	844.03	794.51	622.97	171.60	459.62	1127.88	3217.08	1928.32	1132.67	795.70	2131.2	459.62	5011.59
Apr2	27.78	28.32	-0.57	-0.73	565.68	204.36	622.97	-418.52	-542.41	0.00	2757.46	580.61	707.92	-127.43	-165.1	-542.41	3339.98
Apr1	27.78	11.33	16.42	21.29	566.41	132.49	566.34	-433.81	-562.23	617.03	3299.88	302.99	707.92	-404.93	-524.8	-562.23	2962.71
Mar	15.72	11.33	4.53	12.14	545.13	91.15	566.34	-475.16	-1272.67	2009.88	3862.10	216.71	141.58	75.04	201.0	-1272.67	2925.28
Feb	12.12	11.33	0.85	2.06	532.99	73.42	566.34	-493.00	-1192.67	3368.48	5134.78	164.61	141.58	22.94	55.5	-1192.67	1451.62
Jan	12.12	2.83	9.34	25.03	530.94	80.25	84.95	-4.81	-12.89	4682.79	6327.45	182.08	141.58	40.49	108.5	-12.89	203.46
Dec	13.05	2.83	10.19	27.30	505.91	100.04	84.95	15.01	40.20	6156.13	6340.34	189.55	141.58	47.86	128.2	-1190.78	82.11
Nov	19.37	2.83	16.42	42.57	478.60	146.57	84.95	61.73	160.01	7531.12	6300.14	268.53	141.58	126.86	328.8	-661.32	0.00
Oct	30.87	2.83	28.03	75.09	436.03	247.80	84.95	162.82	436.11	8192.44	6140.13	416.00	141.58	274.39	734.9	11.99	0.00
Sep	65.41	2.83	62.58	162.21	360.95	654.40	84.95	569.45	1476.03	8180.45	5704.03	1125.28	141.58	983.73	2549.8	-454.09	0.00
Aug2	128.28	2.83	125.44	173.42	198.74	1083.43	84.95	998.45	1380.27	8634.54	4227.99	1772.77	141.58	1631.33	2255.2	0.00	0.00
Aug1	128.28	2.83	125.44	162.58	25.32	1516.14	84.95	1431.13	1854.77	8634.54	2847.72	2329.03	141.58	2187.47	2835.0	0.00	0.00

Notes:

- 1/ The Assured Refill Curve indicates the end-of-month storage content required to assure refill of Canadian storage by 31 July based on 1931 historical monthly inflow. The monthly inflow at each reservoir is reduced by deducting the Power Discharge Requirements and water required for refill, if any, at upstream reservoirs. The Entities may agree to revise the data upon the completion of the Refill Study by the Operating Committee.
- 2/ Upstream refill requirement: these values are computed by subtracting current month from previous month's higher of Mica's ARC or CRC1 except July value is Mica full minus previous month's higher of Mica's ARC or CRC1. CRC1 is shown in Exhibit 2.
- 3/ Inflows are from 1990 Level Modified streamflow (Hydrosim file).
- 4/ PDRs are from 1997-98 AOP study.

**Exhibit 2 - First Critical Rule Curves (English)**

(End-of-Month Usable Storage Content in 1000 SFD)

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Total</u>
August 15	705.8	3579.6	3529.2	7814.6
August 31	705.8	3579.6	3529.2	7814.6
September	705.8	3449.0	3343.6	7498.4
October	647.3	3301.6	3348.5	7297.4
November	600.0	3214.2	3078.2	6892.4
December	433.0	2806.6	2516.2	5755.8
January	297.2	1620.6	1914.0	3831.8
February	185.6	662.3	1376.8	2224.7
March	124.6	517.2	821.5	1463.3
April 15	41.3	385.2	252.2	678.7
April 30	17.2	69.7	0.0	86.9
May	134.5	775.2	461.0	1370.7
June	409.3	2318.2	2109.5	4837.0
July	552.0	3220.3	3091.1	6863.4

Source: First-year critical rule curves from the AOP 1997-98.

**Exhibit 2M - First Critical Rule Curves (SI)**

(End-of-Month Usable Storage Content in cubic hectometers hm<sup>3</sup>)

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Total</u>
August 15	1726.81	8757.85	8634.54	19119.20
August 31	1726.81	8757.85	8634.54	19119.20
September	1726.81	8438.32	8180.45	18345.59
October	1583.68	8077.69	8192.44	17853.82
November	1467.96	7863.86	7531.12	16862.95
December	1059.38	6866.63	6156.13	14082.14
January	727.13	3964.96	4682.79	9374.88
February	454.09	1620.38	3368.48	5442.95
March	304.85	1265.38	2009.88	3580.11
April 15	101.04	942.43	617.03	1660.51
April 30	42.08	170.53	0.00	212.61
May	329.07	1896.60	1127.88	3353.55
June	1001.39	5671.71	5161.10	11834.20
July	1350.52	7878.79	7562.69	16791.99

Source: First-year critical rule curves from the AOP 1997-98.

**Exhibit 3 - Second Critical Rule Curves (English)**

(End-of-Month Usable Storage Content in 1000 SFD)

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Total</u>
August 15	566.5	3496.0	3042.2	7104.7
August 31	614.6	3250.2	3085.5	6950.3
September	471.2	3280.1	3085.5	6836.8
October	282.0	2777.9	3099.2	6159.1
November	227.4	2425.6	2172.5	4825.5
December	197.2	1917.8	1759.9	3874.9
January	60.0	1042.5	902.1	2004.6
February	59.0	197.5	644.0	900.5
March	0.0	6.5	144.9	151.4
April 15	0.0	6.6	0.0	6.6
April 30	0.0	69.7	0.0	69.7
May	107.9	622.1	456.2	1186.2
June	212.4	1369.9	1537.4	3119.7
July	335.0	2784.9	2753.9	5873.8

Adjusted for Cross-over

Source: The 1997-98 second-year critical rule curves from the 1996-97 DOP unless higher than the first year critical rule curve.

**Exhibit 3M - Second Critical Rule Curves (SI)**

(End-of-Month Usable Storage Content in hm<sup>3</sup>)

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Total</u>
August 15	1386.0	8553.3	7443.0	17382.4
August 31	1503.7	7951.9	7549.0	17004.6
September	1152.8	8025.1	7549.0	16726.9
October	689.9	6796.4	7582.5	15068.9
November	556.4	5934.5	5315.2	11806.1
December	482.5	4692.1	4305.8	9480.3
January	-146.8	2550.6	2207.1	4904.5
February	144.3	483.2	1575.6	2203.2
March	0.0	15.9	354.5	370.4
April 15	0.0	16.1	0.0	16.1
April 30	0.0	170.5	0.0	170.5
May	264.0	1522.0	1116.1	2902.2
June	519.7	3351.6	3761.4	7632.7
July	819.6	6813.5	6737.7	14370.8

Adjusted for Cross-over

Source: The 1997-98 second-year critical rule curves from the 1996-97 DOP unless higher than the first year critical rule curve.

**Exhibit 4 - Third Critical Rule Curves (English)**

(End-of-Month Usable Storage Content in 1000 SFD)

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Total</u>
August 15	282.3	3106.1	2956.2	6344.6
August 31	321.7	3066.6	3067.7	6456.0
September	207.8	3018.8	3085.5	6312.1
October	138.6	2654.2	2937.2	5730.0
November	118.0	2417.4	2063.5	4598.9
December	80.6	1739.0	1333.3	3152.9
January	58.9	989.4	739.9	1788.2
February	58.0	132.7	407.5	598.2
March	0.0	6.5	0.0	6.5
April 15	0.0	6.6	0.0	6.6
April 30	0.0	10.5	0.0	10.5
May	5.3	277.3	287.7	570.3
June	104.6	625.2	1433.5	2163.3
July	120.0	895.9	2381.5	3397.4

Adjusted for Cross-over

Source: The 1997-98 third-year critical rule curves from the 1995-96 DOP unless higher than the first or second year critical rule curves.

**Exhibit 4M - Third Critical Rule Curves (SI)**

(End-of-Month Usable Storage Content in hm<sup>3</sup>)

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Total</u>
August 15	690.7	7599.4	7232.6	15522.7
August 31	787.1	7502.7	7505.4	15795.2
September	508.4	7385.8	7549.0	15443.2
October	339.1	6493.8	7186.2	14019.0
November	288.7	5914.4	5048.6	11251.7
December	197.2	4254.6	3262.1	7713.9
January	144.1	2420.7	1810.2	4375.0
February	141.9	324.7	997.0	1463.6
March	0.0	15.9	0.0	15.9
April 15	0.0	16.1	0.0	16.1
April 30	0.0	25.7	0.0	25.7
May	13.0	678.4	703.9	1395.3
June	255.9	1529.6	3507.2	5292.7
July	293.6	2191.9	5826.6	8312.1

Adjusted for Cross-over

Source: The 1997-98 third-year critical rule curves from the 1995-96 DOP unless higher than the first or second year critical rule curves.

**Exhibit 5 - Fourth Critical Rule Curves (English)**

(End-of-Month Usable Storage Content in 1000 SFD)

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Total</u>
August 15	130.0	<u>831.7</u>	2381.4	3343.1
August 31	81.0	<u>701.2</u>	2381.3	3163.5
September	2.0	826.9	2005.4	2834.3
October	37.0	882.9	1243.4	2163.3
November	58.5	1174.3	122.0	1354.8
December	0.0	382.4	0.0	382.4
January	0.0	5.1	0.0	5.1
February	0.0	0.0	0.0	0.0

Adjusted from PNCG 6(d) meeting for the 1994-95 DOP

Source: The 1997-98 fourth-year critical rule curves from the 1994-95 DOP unless higher than the first, second, or third year critical rule curves.

**Exhibit 5M - Fourth Critical Rule Curves (SI)**

(End-of-Month Usable Storage Content in hm<sup>3</sup>)

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Total</u>
August 15	318.1	<u>2034.8</u>	5826.3	8179.2
August 31	198.2	<u>1715.6</u>	5826.1	7739.8
September	4.9	2023.1	4906.4	6934.4
October	90.5	2160.1	3042.1	5292.7
November	143.1	2873.0	298.5	3314.7
December	0.0	935.6	0.0	935.6
January	0.0	12.5	0.0	12.5
February	0.0	0.0	0.0	0.0

Adjusted from PNCG 6(d) meeting for the 1994-95 DOP

Source: The 1997-98 fourth-year critical rule curves from the 1994-95 DOP unless higher than the first, second, or third year critical rule curves.

**Exhibit 6 - Lower Limit for Operating Rule Curve (English)**

(End-of-Month Usable Storage Contents in 1000 SFD)

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Libby</u>
January	0.0	1185.9	698.4	34.1
February	0.0	308.9	187.4	0.0
March	0.0	0.0	0.0	0.0

Source: ECC Lower Limits for Duncan, Arrow, Mica and Libby are from 1997-98 AOP

**Exhibit 6M- Lower Limit for Operating Rule Curve (SI)**

(End-of-Month Usable Storage Contents in hm<sup>3</sup>)

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Libby</u>
January	0.0	2901.4	1708.7	83.4
February	0.0	755.8	458.5	0.0
March	0.0	0.0	0.0	0.0

Source: ECC Lower Limits for Duncan, Arrow, Mica and Libby are from 1997-98 AOP.

### Exhibit 7 - Variable Refill Curve Procedures (English)

The Variable Refill Curves (VRC) indicate the end-of-month storage content required to refill Canadian storage based on forecasts of natural inflow volume. The probable forecast volume at each reservoir is reduced by deducting the 95 percent confidence forecast error, Power Discharge Requirements (PDR), and water required for refill at upstream reservoirs. The 1997-98 AOP studies made for the U.S. Coordinated System operation indicate that the PDR's 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 Columbia River at The Dalles natural January-July runoff volume is lower than 95 million acre-feet. The following schedule for PDR's will apply when computing the VRC's during the period January 1 through June 1, unless the Operating Committee agrees to updated study results.

#### POWER DISCHARGE REQUIREMENT, IN CFS FOR JANUARY-JULY VOLUME RUNOFF OF THE COLUMBIA RIVER AT THE DALLES, OREGON

Project	Jan	Feb	Mar	Apr	May	Jun	Jul
<b>Mica PDRs</b>							
ARC	3000	20000	20000	20000	22000	22000	22000
80 MAF	3000	15000	15000	15000	20000	30000	25000
95 MAF	3000	3000	3000	3000	10000	10000	20000
110 MAF	3000	3000	3000	5000	5000	5000	15500
<b>Arrow PDRs</b>							
ARC	5000	5000	5000	25000	25000	40000	40000
80 MAF	5000	10000	10000	15000	15000	30000	30000
95 MAF	5000	5000	5000	5000	5000	15000	25000
110 MAF	5000	5000	5000	5000	5000	8000	35000
<b>Duncan PDRs</b>							
ARC	100	400	400	400	1000	1500	2000
80 MAF	100	1000	1000	1000	2000	2000	2000
95 MAF	100	100	100	100	100	100	100
110 MAF	100	100	100	100	100	100	100
<b>Libby PDRs</b>							
ARC	4000	4000	4000	4000	4000	6000	6000
80 MAF	4000	4000	4000	6000	6000	6000	8000
95 MAF	4000	4000	4000	4000	5000	5000	7000
110 MAF	4000	5000	5000	5000	5000	5000	15000

**Notes:**

(1) If the forecasted natural January through July volume runoff at The Dalles is less than 80 MAF, the Power Discharge Requirement in the 80 MAF schedule will be used. For intermediate forecasted volumes, the Power Discharge Requirement will be interpolated linearly between the values shown above.

(2) Data is from 1997-98 AOP for Libby and Canadian projects.

Data may be revised upon completion of the Operating Committee Refill Studies. The Canadian Entity reserves the right to request changes to the revised data.

### Exhibit 7M - Variable Refill Curve Procedures (SI)

The Variable Refill Curves (VRC) indicate the end-of-month storage content required to refill Canadian storage based on forecasts of natural inflow volume. The probable forecast volume at each reservoir is reduced by deducting the 95 percent confidence forecast error, Power Discharge Requirements (PDR), and water required for refill at upstream reservoirs. The 1997-98 AOP studies made for the U.S. Coordinated System operation indicate that the PDR's 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 Columbia River at The Dalles natural January-July runoff volume is lower than 117.2 cubic kilometers. The following schedule for PDR's will apply when computing the VRC's during the period January 1 through June 1, unless the Operating Committee agrees to updated study results.

#### POWER DISCHARGE REQUIREMENT, IN M<sup>3</sup>/S FOR JANUARY-JULY VOLUME RUNOFF OF THE COLUMBIA RIVER AT THE DALLES, OREGON

Project	Jan	Feb	Mar	Ap1	Ap2	May	Jun	Jul
<b>Mica PDRs</b>								
ARC	84.95	566.34	566.34	566.34	622.97	622.97	622.97	622.97
98.7 km <sup>3</sup>	84.95	424.75	424.75	424.75	566.34	849.50	849.50	707.92
117.2 km <sup>3</sup>	84.95	84.95	84.95	84.95	283.17	283.17	566.34	566.34
135.7 km <sup>3</sup>	84.95	84.95	84.95	141.58	141.58	141.58	438.91	438.91
<b>Arrow PDRs</b>								
ARC	141.58	141.58	141.58	707.92	707.92	1132.67	1132.67	1132.67
98.7 km <sup>3</sup>	141.58	283.17	283.17	424.75	424.75	849.50	849.50	849.50
117.2 km <sup>3</sup>	141.58	141.58	141.58	141.58	141.58	424.75	707.92	707.92
135.7 km <sup>3</sup>	141.58	141.58	141.58	141.58	141.58	226.53	991.09	991.09
<b>Duncan PDRs</b>								
ARC	2.83	11.33	11.33	11.33	28.32	42.48	42.48	56.63
98.7 km <sup>3</sup>	2.83	28.32	28.32	28.32	56.63	56.63	56.63	56.63
117.2 km <sup>3</sup>	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83
135.7 km <sup>3</sup>	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83
<b>Libby PDRs</b>								
ARC	113.27	113.27	113.27	113.27	113.27	169.90	169.90	169.90
98.7 km <sup>3</sup>	113.27	113.27	113.27	169.90	169.90	169.90	226.53	226.53
117.2 km <sup>3</sup>	113.27	113.27	113.27	113.27	141.58	141.58	198.22	198.22
135.7 km <sup>3</sup>	113.27	141.58	141.58	141.58	141.58	141.58	424.75	424.75

**Notes:**

(1) If the forecasted natural January through July volume runoff at The Dalles is less than 98.7 km<sup>3</sup>, the Power Discharge Requirement in the 98.7 km<sup>3</sup> schedule will be used. For intermediate forecasted volumes, the Power Discharge Requirement will be interpolated linearly between the values shown above.

(2) Data is from 1997-98 AOP for Libby and Canadian projects.

Data may be revised upon completion of the Operating Committee Refill Studies. The Canadian Entity reserves the right to request changes to the revised data.

**Exhibit 8 - Libby Critical and Assured Refill Curves (1) (English)**

(End-of-Month Usable Storage Content in 1000 SFD)

<b>Rule Curves Used in AOP98 Hydroregulation Studies (2)</b>					
<b>Critical Rule Curves (CRCs)</b>					<b>Assured Refill Curve (3)</b>
<b>Month</b>	<b>1st</b>	<b>2nd</b>	<b>3rd</b>	<b>4th</b>	
August 15	2510.5	2510.5	2510.5	1505.0	1648.1
August 31	2510.5	2510.5	2510.5	1492.0	1697.7
September	2450.0	2365.0	2364.7	1404.5	1732.8
October	2450.0	2345.5	2344.8	1379.0	1729.4
November	2106.6	2078.0	2076.2	963.0	1700.9
December	1502.4	1502.4	1502.4	415.0	1650.0
January	1441.5	1384.0	1032.2	138.0	1599.2
February	1397.0	1265.5	516.6	0	1547.3
March	1245.0	1040.4	359.8	0	1494.8
April 15	1170.0	1055.0	298.4	0	1479.8
April 30	1175.1	1175.1	261.6	0	1477.8
May	1539.1	1539.1	718.2	0	1872.4
June	2510.5	2510.5	1267.2	0	2361.4
July	2510.5	2510.5	1475.0	0	2510.5
Source	1997-98 AOP (1st yr)	1997-98 AOP (2nd yr)	1997-98 AOP (3rd yr)	1997-98 AOP (4th yr)	1997-98 AOP

Adjusted for Cross-over

1. These rule curves are from the hydroregulation studies used to develop AOP98 and will be used in the TSR98 study. The Canadian Entity considers the Libby rule curves developed in the AOP hydroregulation studies to be the appropriate rule curves to be used in the determination of the Libby project operation.
2. The U.S. Entity does not agree that the AOP rule curves are appropriate to determine the operation of Libby.
3. This Assured Refill Curve was determined using Power Discharge Requirements (PDRs) and 1980 Level Modified Streamflows from the 1997-98 AOP.

**Exhibit 8M - Libby Critical and Assured Refill Curves (1) (SI)**

(End-of-Month Usable Storage Content in hm<sup>3</sup>)

<b>Rule Curves Used in AOP98 Hydroregulation Studies (2)</b>					
<u>Month</u>	<u>Critical Rule Curves (CRCs)</u>				<u>Assured Refill Curve (3)</u>
	<u>1st</u>	<u>2nd</u>	<u>3rd</u>	<u>4th</u>	
August 15	6142.2	6142.2	6142.2	3682.1	4032.2
August 31	6142.2	6142.2	6142.2	3650.3	4153.6
September	5994.2	5786.2	5785.5	3436.2	4239.5
October	5994.2	5738.5	5736.8	3373.9	4231.2
November	5154.0	5084.0	5079.6	2356.1	4161.4
December	3675.8	3675.8	3675.8	1015.3	4036.9
January	3526.8	3386.1	2525.4	337.6	3912.6
February	3417.9	3096.2	1263.9	0.0	3785.6
March	3046.0	2545.4	880.3	0.0	3657.2
April 15	2862.5	2581.2	730.1	0.0	3620.5
April 30	2875.0	2875.0	640.0	0.0	3615.6
May	3765.6	3765.6	1757.1	0.0	4581.0
June	6142.2	6142.2	3100.3	0.0	5777.4
July	6142.2	6142.2	3608.7	0.0	6142.2
Source	1997-98 AOP (1st yr)	1997-98 AOP (2nd yr)	1997-98 AOP (3rd yr)	1997-98 AOP (4th yr)	1997-98 AOP

Adjusted for Cross-over

1. These rule curves are from the hydroregulation studies used to develop AOP98 and will be used in the TSR98 study. The Canadian Entity considers the Libby rule curves developed in the AOP hydroregulation studies to be the appropriate rule curves to be used in the determination of the Libby project operation.
2. The U.S. Entity does not agree that the AOP rule curves are appropriate to determine the operation of Libby.
3. This Assured Refill Curve was determined using Power Discharge Requirements (PDRs) and 1980 Level Modified Streamflows from the 1997-98 AOP.

**Exhibit 9 - Coordinated System Loads and Resources  
used in the TSR  
(ENERGY IN AVERAGE MW)**

LOADS		RESOURCES						Regulated Hydro Load
Period	Total Loads 1/	Hydro Indep. 2/	Imports 3/ (large & small)	Thermal	Combst. Turbine	Misc. 4/	Total	
August 15	20220	1131	1261	5538	888	1161	9979	10240.6
August 31	20137	1107	1248	5538	758	1161	9812	10325.5
September	19507	1002	931	5538	797	1140	9408	10099.5
October	19949	1019	1142	5538	1015	1128	9842	10106.7
November	21944	1150	1788	5544	987	1125	10594	11350.1
December	23439	1310	2047	5537	1041	1110	11045	12393.8
January	24230	1194	2017	5544	1043	1120	10918	13311.9
February	23081	978	1998	5544	1040	1128	10688	12393.4
March	21868	1172	1648	5336	863	1140	10159	11708.6
April 15	20780	1341	1277	4026	496	1188	8328	12451.9
April 30	20879	1389	1151	3331	556	1188	7615	13263.7
May	23062	1577	1136	2264	948	807	6732	16329.9
June	22553	1534	1171	4195	962	1003	8865	13688.5
July	20532	1158	1302	5531	1007	1192	10190	10341.6

**Note:**

- 1/ The total loads are the sum of PNW Area load, firm exports, maintenance, and firm surplus.
- 2/ Based on the 40 year average instead of 50 year average due to the double counting of hydro independent resources in the last 10 years of the 50 years data used in the AOP98 study. The average hydro independent generation is used in the DOP TSR because the actual values are not known until after the DOP TSR is completed.
- 3/ Imports include 132.0 average annual MW of seasonal exchanges.
- 4/ Miscellaneous resources include PURPA, cogeneration, renewable, and energy management system.

Source: Loads and resources are from 1997-98 AOP DDPB Document, Table 1.

**Exhibit 10 - Second Critical Rule Curves for OY 98-99 (English)**

(End-of-Month Usable Storage Content in 1000 SFD)

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Total</u>
August 15	630.0	3525.4	3480.3	7635.7
August 31	667.1	3443.3	3523.2	7633.6
September	577.8	3475.9	3401.8	7455.5
October	460.0	3148.7	3185.9	6794.6
November	232.5	2768.2	2560.8	5561.5
December	243.0	2258.0	1777.4	4278.4
January	222.0	1285.5	1277.5	2785.0
February	214.1	1164.0	565.7	1943.8
March	222.8	674.6	596.6	1494.0
April 15	232.0	496.0	28.3	756.3
April 30	242.3	337.4	0.0	579.7
May	140.0	404.4	210.4	754.8
June	228.5	1238.3	1274.8	2741.6
July	339.9	2790.9	2631.3	5762.1

Source: These rule curves are from 1998-99 2nd year AOP study.

**Exhibit 10M - Second Critical Rule Curves for OY 98-99 (SI)**(End-of-Month Usable Storage Content in hm<sup>3</sup>)

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Total</u>
August 15	1541.4	8625.2	8514.9	18681.5
August 31	1632.1	8424.4	8619.9	18676.4
September	1413.6	8504.1	8322.8	18240.6
October	1125.4	7703.6	7794.6	16623.7
November	568.8	6772.7	6265.3	13606.8
December	594.5	5524.4	4348.6	10467.5
January	543.1	3145.1	3125.5	6813.8
February	523.8	2847.8	1384.0	4755.7
March	545.1	1650.5	1459.6	3655.2
April 15	567.6	1213.5	69.2	1850.4
April 30	592.8	825.5	0.0	1418.3
May	342.5	989.4	514.8	1846.7
June	559.0	3029.6	3118.9	6707.6
July	831.6	6828.2	6437.7	14097.6

Source: These rule curves are from 1998-99 2nd year AOP study.

**Exhibit 11 - Third Critical Rule Curves for OY 99-00 (English)**

(End-of-Month Usable Storage Content in 1000 SFD)

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Total</u>
August 15	400.0	2466.7	3100.4	5967.1
August 31	470.9	2739.9	3100.5	6311.3
September	452.5	3073.2	2800.8	6326.5
October	278.7	2846.5	2541.7	5666.9
November	200.6	2315.5	2079.0	4595.1
December	173.8	1401.3	1787.6	3362.7
January	1.7	559.1	843.1	1403.9
February	4.0	592.0	631.7	1227.7
March	18.0	667.4	638.4	1323.8
April 15	19.4	385.8	247.3	652.5
April 30	0.0	151.1	0.0	151.1
May	5.3	486.6	0.0	491.9
June	31.2	1342.1	411.2	1784.5
July	230.0	1319.3	1639.6	3188.9

Source: These rule curves are from 1999-00 3rd year AOP study.

**Exhibit 11M - Third Critical Rule Curves for OY 99-00 (SI)**(End-of-Month Usable Storage Content in hm<sup>3</sup>)

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Total</u>
August 15	978.6	6035.0	7585.4	14599.1
August 31	1152.1	6703.4	7585.7	15441.2
September	1107.1	7518.9	6852.4	15478.4
October	681.9	6964.2	6218.5	13864.6
November	490.8	5665.1	5086.5	11242.4
December	425.2	3428.4	4373.5	8227.2
January	4.2	1367.9	2062.7	3434.8
February	9.8	1448.4	1545.5	3003.7
March	44.0	1632.9	1561.9	3238.8
April 15	47.5	943.9	605.0	1596.4
April 30	0.0	369.7	0.0	369.7
May	13.0	1190.5	0.0	1203.5
June	76.3	3283.6	1006.0	4366.0
July	562.7	3227.8	4011.4	7802.0

Source: These rule curves are from 1999-00 3rd year AOP study.

**Exhibit 12 - Fourth Critical Rule Curves for OY 00-01 (English)**

(End-of-Month Usable Storage Content in 1000 SFD)

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Total</u>
August 15	183.0	1057.4	2122.2	3362.6
August 31	108.9	979.6	2110.0	3198.5
September	170.0	1124.0	1611.8	2905.8
October	60.0	1264.4	816.4	2140.8
November	53.0	783.9	348.3	1185.2
December	1.0	239.0	39.3	279.3
January	0.0	0.0	0.0	0.0
February	0.0	0.0	0.0	0.0
March	0.0	0.0	0.0	0.0
April 15	0.0	0.0	0.0	0.0
April 30	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0
June	0.0	0.0	0.0	0.0
July	0.0	0.0	0.0	0.0

Source: These rule curves are from 1999-00 4th year AOP study.

**Exhibit 12M - Fourth Critical Rule Curves for OY 00-01 (SI)**(End-of-Month Usable Storage Content in hm<sup>3</sup>)

<u>Month</u>	<u>Duncan</u>	<u>Arrow</u>	<u>Mica</u>	<u>Total</u>
August 15	447.7	2587.0	5192.2	8226.9
August 31	266.4	2396.7	5162.3	7825.5
September	415.9	2750.0	3943.4	7109.3
October	146.8	3093.5	1997.4	5237.7
November	129.7	1917.9	852.2	2899.7
December	2.4	584.7	96.2	683.3
January	0.0	0.0	0.0	0.0
February	0.0	0.0	0.0	0.0
March	0.0	0.0	0.0	0.0
April 15	0.0	0.0	0.0	0.0
April 30	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0
June	0.0	0.0	0.0	0.0
July	0.0	0.0	0.0	0.0

Source: These rule curves are from 1999-00 4th year AOP study.