GLEN CANYON DAM INTERIM OPERATIONS

Estimated Net Expense
March, April, and May 1993

August 1993

WESTERN AREA POWER ADMINISTRATION

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I. EXECUTIVE SUMMARY

Power Scheduling and Real-Time Operations

- During March (16th-20th) a forced outage of 3,000 MW of capacity (Palo Verde, Bonanza, and Laramie units) went offline forcing Western to purchase energy at 30 mills/KWh.
- In May, due to high water releases, Western was forced to sell offpeak energy for a low of 3 mills/KWh to maintain releases.
- From Saturday, May 29th through Monday, May 31st, (Memorial Day), an aerial photography study at Glen Canyon Dam reduced releases to a 8,000 cfs constant (303 MW).

Analysis of Ramping Events

- There were 82 deviations: "Control Area Regulation" accounted for most of the anomalies.

Expenses

- Net expense of interim releases:

March 1993	$344,101
April 1993	$227,469
May 1993	$311,296

- WY 1991-93 Net Expense Summary

WATER YEAR	Estimated Actual Net Expense
WY 1991	$1,065,692[1]
WY 1992	$4,245,940
WY 1993 (Year-to-date, Oct-May)	$2,913,498
WY 1993 (Cumulative Est. Actual Net Expense)	$8,225,130

[1] August and September 1991 used the previous methodology

- A table of interim release expenses for Water Year (WY) 1992 comparing the previous method with the refined method is presented.

WY 1992	Total Net Expense
Previous Method	$2,757,942
WY 1992 Refined Method	$4,245,940

Power Scheduling Concerns (Future)

- It is expected that June will be difficult to schedule due to the high Spring releases from Flaming Gorge and from the Aspinall Units.

- The period from July through September is anticipated to look good for power control operations, because Glen Canyon generation will be high and the Aspinall Unit is expected to be available.

II. INTRODUCTION

On August 1, 1991, former Interior Secretary Manual Lujan implemented interim flows at Glen Canyon Dam. These interim flows were a considerable departure from previous operation of the dam and have had a significant impact on the daily operation of Western Area Power Administration's (Western) Upper Colorado Control Area.

The impacts of this change in dam operations have required Western to implement new scheduling procedures for its customers, develop interim release guidelines for real-time operations, purchase higher-priced energy during onpeak periods, and increase the firm-power rates to its customers to cover the additional costs.

The following sections are a review of Power Operations for the reporting period.

III. SCHEDULING

A. Interim release restrictions have limited Western's ability to accommodate hourly changes in the preschedules. These restrictions have required Western to request customer prescheduling 3 days in advance in order to match firm loads to available project resources and substitute purchases for any hourly deficits. Hourly changes to preschedules have been restricted by the lack of system flexibility. The burden to adjust to changes in real-time load has shifted from the contractors' use of their SLCAIP resources to the contractors' alternate resources. A majority of these other resources are thermal and have higher costs associated with their use.

B. Power Scheduling and Real-Time Operations

1. Power Scheduling and Purchases for March 1993

March water releases from Glen Canyon totaled 606,000 acre-feet. The weekday generation pattern was pre-scheduled at approximately 6,640 cfs. (235 MW) during offpeak hours ramping up to a maximum of 12,640 cfs. (448 MW) during onpeak hours for a majority of the month. This followed the daily maximum fluctuation restriction of 6,000 cfs. (213 MW). Weekend releases were adjusted downward to follow reduced weekend loads.

The first half of March was uneventful: Weather across the region was mild and energy availability remained constant. All firm energy requirements were supplied from seasonal purchase agreements and the additional generation made available by water releases from the Aspinall Unit around March 12. However, from March 16 through March 20, the power system experienced a severe forced outage of over 3,000 MW of capacity due to Palo Verde, Bonanza, and three Laramie River station units going off line. Out of 300 MW of contracted purchases, Western could only schedule 25 MW due to these unit outages. The remainder of Western's purchase requirements were attained through "multiple" scheduled purchases across the interconnected system, raising releases from the Glen Canyon Dam for a short duration and requiring a special release from Flaming Gorge.
Prices for the supplemental non-firm energy went as high as 30 mills/KWh (scheduled from California) and was very difficult to acquire. Considering the scarcity of energy during this period, a price of 30 mills/KWh was low, according to Montrose Control Power Staff. The Salt Lake City Area (SLCAO) was not only trying to support Western's loads during this time, but also trying to assist the Loveland Area and Bonanza plant owners. The Loveland Area had water constraints; the Bonanza plant went down for maintenance. After the "energy crisis" was ameliorated, the power system resources returned to normal: All contractual purchases became available March 21.

Due to daily fluctuation limitations, increased onpeak hourly generation releases requires an increased offpeak release and greater offpeak generation. Glen Canyon generation was "backed down" to make up for the additional water released during the middle of March. When the weather turned cold, loads did not increase because customers used much of their energy allocations during the March 16-20 period. Prices on the economy energy market remained high: 27.5 mills/KWh onpeak; 18.5 mill/KWh offpeak (Secretary's Report, March 19, 1993). All firming energy was acquired through seasonal and long-term purchase contracts.

2. Power Scheduling and Purchases for April 1993

April water releases from Glen Canyon totaled 595,000 acre-feet. The weekday generation pattern was pre-scheduled at approximately 7,200 cfs (257 MW) during offpeak hours, ramping up to a maximum of 13,200 cfs (472 MW) during onpeak hours for most of the month.

This followed the maximum daily fluctuation limit of 6,000 cfs per day (215 MW). Weekend releases were adjusted (downward) to follow (reduced) weekend loads.
Releases from the Aspinall Unit were increased to maximum generation at Crystal (30 MW) and "full bypass" (for a total of 4,100 cfs with water released through the turbine for 2,100 cfs and through the bypass tubes for 2,000 cfs) towards the end of the month. Scheduling this release created some unwanted offpeak generation at the beginning of the month when a Morrow Point unit went off line.

In April, Flaming Gorge releases were increased enabling generation through high-load periods. The Flaming Gorge releases provided Western with full operational flexibility on the Aspinall Unit, making it possible for Montrose to "back down" firm purchases, ". . . saving Western a few million dollars in purchased power expenses over the course of March through April," according to Montrose Power Control Staff. The economy energy market in April became tight but all deficits were satisfied through seasonal and long term purchase agreements. Prices on the energy market remained steady at 20 mills/KWh (onpeak), to 14 mills/KWh (offpeak) for the first 3 weeks, then jumping to 27 mills/KWh (onpeak) for the last week in April. This tightening in prices was attributed to several unit outages in New Mexico and Arizona (Secretary's Report, April 30, 1993.)

3. Power Scheduling and Purchases for May 1993

Water releases from Glen Canyon powerplant totaled 592,000 acre-feet for May. Daily fluctuation rate was limited to 6,000 cfs; the weekday generation pattern was prescheduled at approximately 7,200 cfs (263 MW) during offpeak hours ramping up to approximately 13,200 cfs (482 MW) during onpeak hours. A daily generation fluctuation limit of 219 MW. Weekend releases were adjusted downward to follow reduced weekend loads.

Releases from Flaming Gorge and the Aspinall Unit were high due to high spring runoff, providing Western with sufficient generating capacity, allowing for reduced onpeak and offpeak purchases.

On May 14, the Flaming Gorge "Spring Endangered Fish Release" commenced, coinciding with peak Spring runoff. Power scheduling from May 14 through the end of the month became very difficult for Montrose. Due to high, regulated river flows on the Green River and the Gunnison River, and unregulated flows on the Yampa River, generation was either curtailed or increased to help alleviate localized flooding. The "real time" generation reductions and fish release coordination problems with the Fish and Wildlife Service (F&WS) at Flaming Gorge created operational problems, resulting in several release deviations at Glen Canyon. Crystal reservoir began spilling on May 20th and continued through the remainder of the month. Aspinall flexibility was reduced with the high flow requirements. Energy prices in May, ranged from (onpeak) 16-22 mills/KWh to (offpeak) 12-15

mills/KWh. Offpeak energy was sold for as low as 3 mills/KWh (forced sales) to maintain releases. Onpeak purchases continued over high-load periods due to release restrictions at Glen Canyon.

a. Special Releases

From Saturday, May 29, through Monday, May 31 (Memorial Day weekend), an aerial photography study at the Glen Canyon Dam reduced releases to an 8,000 cfs constant (303 MW).

4. Future Scheduling Concerns for June 1993 through September 1993

Glen Canyon generation, with the exception of September, will be high and all firm purchase requirements will have been prescheduled. It is anticipated that resources will be tight, but will not create any problems with Western's seasonal and long-term contractual purchase arrangements. The Aspinall Unit should be available, which will allow for system flexibility. Flaming Gorge should be available from August through September. If resources remain reliable and if the Southwest does not experience any "heat waves", it is expected that the system should not face any problems.

5. 1993-94 Winter Season Outlook

Generation capability during the 1993-94 winter season looks very good at this time. Firm purchase requirements will be reduced significantly if the projected release schedule in the Bureau's Annual Operating Plan (AOP) for WY 1994 remains unadjusted. Winter operations at Flaming Gorge must be planned with the F&WS by mid-July.

IV. ANALYSIS OF RAMPING EVENTS

A study was made to analyze hourly release rates which appeared to deviate from interim flow criteria. Operational records and logs kept during the study period, March 1, 1993, through May 31, 1993 were reviewed.

The operational records and logs are contained within the packet Glen Canyon Dam Interim Flows—Glen Canyon Power Plant Operations, for March 1993 through May 1993 and provide specific explanations for each ramping event.

Each page within the packet contains (1) a strip chart of real-time Glen Canyon Dam operations during the ramping event, (2) a graph of the USGS Lees Ferry Gauge showing river elevation during the ramping event, (3) a graph of hourly integrated Glen Canyon Dam generation during the ramping event, and (4) a brief written explanation of the ramping event.

For the study period, 82 instances of deviations were found. Most of the conditions were caused by more than one factor: for example, control area regulation and imports/exports different than preschedule;

therefore, multiple variations can be explained by one anomaly. A majority of the deviation for Control Area Regulation is attributed to problems associated with Loveland consolidation in May.

The following table summarizes the causes and frequency of the 51 deviations:

Primary Cause(s) of Deviation	Number Of Instances	Percent Of Events
Control Area Regulation	27/82	33
CRSP Resource Availability	7/82	9
Aspinall Operations	5/82	6
Flaming Gorge Operations	5/82	6
Imports/Exports Different than Preschedule	21/82	26
Glen Canyon Operations	2/82	2
Other	15/82	18

V. Expenses

A. Net Expense

The estimated net expense of interim releases for March, April and May 1993 are summarized below:

	Net Expense
March 1993	$344,101
April 1993	$227,469
May 1993	$311,296

Attached are Tables 1, 2, and 3 detailing the net expense analysis by component for March 1993, April 1993, and May 1993.

B. Purchases

A comparison of Base Case purchases to Actual purchases are summarized below:

Energy Purchase Comparison			
Months	Simulated Base Case Purchases	Actual Purchases	Differences
March 1993	62,664 MWh	52,676 MWh	9,988 MWh
April 1993	58,418 MWh	57,748 MWh	670 MWh
May 1993	35,699 MWh	27,860 MWh	7,839 MWh

For all months (March, April, and May 1993) actual purchases were less than projected for Base Case conditions. This is due to a

shift in deficits from onpeak to offpeak hours in the Base Case, resulting in higher purchases during offpeak hours.

C. Economy Energy Sales (Surplus)

For all months, actual nonfirm energy sales were (also) less than projected for Base Case conditions. Revenues foregone are estimated below:

Energy Sales and Revenues Foregone

Months	Base Case	Actual	Revenues Foregone
March 1993	$361,145	$140,332	($220,813)
April 1993	61,844	48,263	(13,581)
May 1993	566,384	287,533	(278,851)

D. Average Purchase Prices—Base Case

The average monthly purchase price estimates are derived from the actual nonfirm energy purchase prices. With the help of the Power Control staff (Montrose), some of the higher purchase prices for March that are associated directly with interim release constraints, were excluded. There were no changes in the purchase prices for April and May because it reflected market purchase prices if restrictions were not in place at the Glen Canyon Dam, according to Montrose. An adjusted weighted average of remaining purchase amounts and prices are rendered to calculate the base case offpeak and onpeak purchase prices.

Average Base Case monthly purchase prices are estimated as follows:

Energy Purchase Prices - Base Case

Months	Offpeak	Onpeak
March 1993	$15.93/MWh	$23.15/MWh
April 1993	15.69/MWh	22.73/MWh
May 1993	13.08/MWh	19.53/MWh

E. Purchase Price—Actual

Average actual monthly purchase prices from all sources are as follows:

Energy Purchase Prices - Actual

Months	Offpeak	Onpeak
March 1993	$16.86/MWh	$23.51/MWh
April 1993	15.69/MWh	22.73/MWh
May 1993	13.08/MWh	19.53/MWh

F. Economy Energy Sales Prices—Base Case

The sales price for the Base Case is determined with the help of the Montrose Power Control Staff (Montrose). The estimate of economy energy sales prices involve three steps:

1. Identification of the range of market prices through review of Montrose District Office Power Control staff's summaries of then-current weekly market prices, as reflected in Western's Weekly Reports to the Secretary.

2. Review of the actual monthly economy energy sales summary and, with the help of the Power Control staff, identification of those forced sales directly associated with interim release constraints.

3. Assumption of expected sales price based on then-current market conditions for that portion of sales identified in step 2.

   In most instances, Western would have had the flexibility of making all or most of the nonfirm energy sales during periods when the value is greatest. For March and April, the economy energy sales prices under the Base Case is the same as the actual sales price, reflecting no forced sales within this period. However, for May there is a $5.85 per MWh difference between Base Case and actual sales prices. This is due to high releases that occurred in May, forcing Western to sell offpeak energy to the market for a low of $3/MWh, in the last week of May.

Average monthly economy energy sales prices for Base Case conditions are as follows:

Economy Energy Sales Prices - Base Case

Months	Prices
March 1993	$22.11/MWh
April 1993	20.27/MWh
May 1993	18.20/MWh

G. Economy Energy Sales Prices—Actual

The actual consummated average monthly economy energy sales prices are as follows:

Economy Energy Sales Prices - Actual

Months	Prices
March 1993	$22.11/MWh
April 1993	20.27/MWh
May 1993	12.35/MWh

Table 1
Glen Canyon Dam Interim Release
for March 1993
Net Expense Analysis

Base Case (Without Interim Release)		Actual (With Interim Release)	
Firm Load & Losses:	460,225 MWh	Firm Load & Losses:	460,225 MWh
GC Generation:	260,667 MWh	GC Generation:	260,668 MWh
Other CRSP/IP Generation:	153,228 MWh	Other CRSP/IP Generation:	153,228 MWh
Total Generation:	413,895 MWh	Total Generation:	413,896 MWh
Purchases:	62,664 MWh	Purchases:	52,676 MWh
Off Peak:	61,194 MWh	Off Peak:	15,981 MWh
On Peak:	1,470 MWh	On Peak:	36,695 MWh
Surplus:	16,334 MWh	Surplus:	6,347 MWh
Off Peak:	1,973 MWh	Off Peak:	2,383 MWh
On Peak:	14,361 MWh	On Peak:	3,964 MWh
Purchase Prices:		Purchase Prices:	
Off Peak:	$15.93/MWh	Off Peak:	$16.86/MWh
On Peak:	$23.15/MWh	On Peak:	$23.51/MWh
Sales Price:	$22.11/MWh	Sales Price:	$22.11/MWh
Purchase Expense:	$1,008,851	Purchase Expense:	$1,132,139
Off Peak:	$ 974,820	Off Peak:	$ 269,440
On Peak:	$ 34,031	On Peak:	$862,699
Surplus Sales:	$361,145	Surplus Sales:	$ 140,332
Base Case Expense:	$647,706	Change Case Expense:	$ 991,807

Total Net Expense for March 1993 ..... $344,101

Table 2
Glen Canyon Dam Interim Release
for April 1993
Net Expense Analysis

Base Case (Without Interim Release)		Actual (With Interim Release)	
Firm Load & Losses:	471,249 MWh	Firm Load & Losses:	471,249 MWh
GC Generation:	259,263 MWh	GC Generation:	259,263 MWh
Other CRSP/IP Generation:	156,619 MWh	Other CRSP/IP Generation:	156,619 MWh
Total Generation:	415,882 MWh	Total Generation:	415,882 MWh
Purchases:	58,418 MWh	Purchases:	57,748 MWh
Off Peak:	44,300 MWh	Off Peak:	11,755 MWh
On Peak:	14,118 MWh	On Peak:	45,993 MWh
Surplus:	3,051 MWh	Surplus:	2,381 MWh
Off Peak:	225 MWh	Off Peak:	1,340 MWh
On Peak:	2,826 MWh	On Peak:	1,041 MWh
Purchase Prices:		Purchase Prices:	
Off Peak:	$15.69/MWh	Off Peak:	$15.69/MWh
On Peak:	$22.73/MWh	On Peak:	$22.73/MWh
Sales Price:	$20.27/MWh	Sales Price:	$20.27/MWh
Purchase Expense:	$1,015,969	Purchase Expense:	$1,229,857
Off Peak:	$695,067	Off Peak:	$ 184,436
On Peak:	$320,902	On Peak:	$1,045,421
Surplus Sales:	$61,844	Surplus Sales:	$ 48,263
Base Case Expense:	$ 954,125	Change Case Expense:	$1,181,594

Total Net Expense for April 1993 ..... $227,469

Table 3
Glen Canyon Dam Interim Release
for May 1993
Net Expense Analysis

Base Case (Without Interim Releases)		Actual (With Interim Release)	
Firm Load & Losses:	476,567 MWh	Firm Load & Losses:	476,567 MWh
GC Generation:	264,604 MWh	GC Generation:	264,605 MWh
Other CRSP/IP Generation:	207,384 MWh	Other CRSP/IP Generation:	207,384 MWh
Total Generation:	471,988 MWh	Total Generation:	471,989 MWh
Purchases:	35,699 MWh	Purchases:	27,860 MWh
Off Peak:	34,114 MWh	Off Peak:	5,348 MWh
On Peak:	1,585 MWh	On Peak:	22,512 MWh
Surplus:	31,120 MWh	Surplus:	23,282 MWh
Off Peak:	3,877 MWh	Off Peak:	13,825 MWh
On Peak:	27,243 MWh	On Peak:	9,457 MWh
Purchase Prices:		Purchase Prices:	
Off Peak:	$13.08/MWh	Off Peak:	$13.08/MWh
On Peak:	$19.53/MWh	On Peak:	$19.53/MWh
Sales Price:	$18.20/MWh	Sales Price:	$12.35/MWh
Purchase Expense:	$ 477,166	Purchase Expense:	$ 509,611
Off Peak:	$ 446,211	Off Peak:	$ 69,952
On Peak:	$ 30,955	On Peak:	$ 439,659
Surplus Sales:	$ 566,384	Surplus Sales:	$ 287,533
Base Case Expense:	($89,218)	Change Case Expense:	$ 222,079

Total Net Expense for May 1993 ..... $311,296

Table 4
Glen Canyon Dam Interim Release
Summary of Estimated Actual Net Expense
Associated With Interim Release

WY 1992 Cumulative

Net Expense $5,311,632

Month	Estimated Actual Net Expense	Cumulative Estimated Actual Net Expense
October	$336,662	$5,648,294
November	$375,274	$6,023,568
December	$471,698	$6,495,266
January	$466,684	$6,961,950
February	$380,314	$7,342,264
March	$344,101	$7,686,365
April	$227,469	$7,913,834
May	$311,296	$8,225,130

WY 1993 Net Expense $2,913,498