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ARTIFICIAL COOLING OF THE COLUMBIA RIVER
BY DAM REGULATION

PART THREE

BENEFITS RESULTING FROM
USE OF COLD WATER FROM THE DEPTHS OF
GRAND COULEE RESERVOIR

-by-

H. A. Kramer
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IRRADIATION PROCESSING DEPARTMENT

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ARTIFICIAL COOLING OF THE COLUMBIA RIVER
BY DAM REGULATION

PART THREE

BENEFITS RESULTING FROM
USE OF COLD WATER FROM THE DEPTHS OF
GRAND COULEE RESERVOIR

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BENEFITS RESULTING FROM
USE OF COLD WATER FROM THE DEPTH OF
GRAND COULEE RESERVOIR

SUMMARY

As noted in Part One, an increase in the flow of water from the lower depths of Grand Coulee Reservoir was used to reduce the river temperature at HAPO.

A net reduction in maximum temperature of more than 2.3°C resulted at HAPO. The following table relates the estimated value of the increased production at each area.

100 B
100 C
100 KW
100 KE
100 D
100 DR
100 H
100 F

Total =

Conclusions and Recommendations

The temperatures of the Columbia River was reduced 1 to 3° Centigrade with beneficial effects at HAPO. It is reasonable to expect that future benefits may be possible. It is desirable that the temperature of the river be controlled each year to the maximum extent possible. Instrumentation improvements requested to effect optimum savings. Records of river temperatures and flows should continue to be maintained by IPD as a necessary part of temperature optimization.

Where possible, the coincident use of the river cooling technique should be made for the benefit of anadromous fish.

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DISCUSSION

For the use of additional cold water at Grand Coulee to effect a savings at Hanford, several conditions are necessary:

1. Cooling should have been under way for some time in order to stabilize the temperature of the bed of the river.
2. Cooling must occur so that the effect would be at a timely period. Reactors are not regulated hourly but controls are set to operate for rather lengthy periods.
3. Cooling must be significant for periods of at least three hours, since this is the time lag through a plant water treatment system.

In August, 1958, bulk outlet coolant temperatures limited production. Part of the month, top of annulus temperatures (corrosion) were the limits in 100-C, 100-KE and 100-KW. Part of the month, 100 D operated on tube power limits. Actual production was less than potential because of reduced temperatures of outlet water during scrams, start-ups, and shutdowns. (Actual) average ΔT are calculated from production.

TABLE I

Operating Data
August, 1958

<u>Area</u>	<u>Reactor Cooling Flow GPM Average</u>
B	72,000
C	93,000
D	76,000
DR	77,000
F	75,000
H	73,000
KE	173,000
KW	171,000

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Data Used in Computation of Saving

			<u>100 C Inlet</u>	<u>Check</u>
		<u>Cooling Effect</u>	<u>Temp. After Cooling</u>	<u>Reading</u>
August 1	3 p.m.	3.01° C	21.5° C	
	4 p.m.	3.00° C	21.7° C	
	5 p.m.	3.01° C	21.7° C	
	6 p.m.	3.51° C	21.7° C	
	7 p.m.	2.6° C	21.1° C	21.1° C
August 2	1 p.m.	2.8° C	21.7° C	
	2 p.m.	2.8° C	21.7° C	
	3 p.m.	2.8° C	21.7° C	
	4 p.m.	2.8° C	21.7° C	
	5 p.m.	2.8° C	21.4° C	
	6 p.m.	2.8° C	21.5° C	
	7 p.m.	2.6° C	21.2° C	21.1° C
August 3	2 p.m.	2.9° C	20.8° C	
	3 p.m.	2.7° C	20.9° C	
	4 p.m.	2.7° C	21.0° C	
	5 p.m.	2.8° C	21.0° C	
	6 p.m.	2.6° C	20.6° C	
	7 p.m.	2.4° C	20.6° C	20.7° C
August 4	1 p.m.	2.7° C	20.3° C	
	2 p.m.	2.8° C	20.6° C	
	3 p.m.	2.8° C	20.8° C	
	4 p.m.	2.7° C	20.8° C	
	5 p.m.	2.6° C	20.8° C	
	6 p.m.	2.6° C	20.6° C	
	7 p.m.	2.3° C	20.3° C	20.4° C
	8 p.m.	2.0° C	20.3° C	
August 7	1 p.m.	2.0° C	21.4° C	
	2 p.m.	2.0° C	21.6° C	
	3 p.m.	2.0° C	21.7° C	
	4 p.m.	2.0° C	21.7° C	
	5 p.m.	2.0° C	21.7° C	
	6 p.m.	2.0° C	21.1° C	21.1° C
August 8	1 p.m.	2.7° C	20.5° C	
	2 p.m.	2.5° C	20.6° C	
	3 p.m.	2.6° C	21.0° C	
	4 p.m.	2.4° C	21.0° C	
	5 p.m.	2.4° C	21.1° C	
	6 p.m.	2.4° C	20.9° C	
	7 p.m.	2.05° C	20.6° C	20.6° C

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100 C Inlet

		<u>Cooling Effect</u>	<u>Temp. After Cooling</u>	<u>Check Reading</u>
August 9	1 p.m.	2.6° C	20.6° C	20.6° C
	2 p.m.	2.7° C	20.7° C	
	3 p.m.	2.6° C	20.8° C	
	4 p.m.	2.5° C	21.1° C	
	5 p.m.	2.5° C	21.1° C	
	6 p.m.	2.5° C	21.1° C	
	7 p.m.	2.1° C	20.6° C	
August 10	1 p.m.	2.3° C	21.0° C	21.0° C
	2 p.m.	2.1° C	21.4° C	
	3 p.m.	2.1° C	21.7° C	
	6 p.m.	1.9° C	21.7° C	
	7 p.m.	1.7° C	21.1° C	
August 11	1 p.m.	2.4° C	21.7° C	21.6° C
	2 p.m.	2.2° C	21.7° C	
	3 p.m.	2.0° C	21.7° C	
	4 p.m.	1.8° C	21.7° C	
	5 p.m.	1.7° C	21.7° C	
	6 p.m.	1.7° C	21.5° C	

CALCULATION

Savings Formula:

$$\frac{\Delta T^{\circ}C \times Q (0.2635)}{1000} = \text{Theoretical Savings MW}$$

$$\text{MW} \times \text{Effective T.O.E.} \times \$ \text{ per MWD} \times \text{Days} = \text{Savings}$$

100-B AREA

$$\text{Savings} = 1072 \text{ MWD}$$

100-C AREA

$$\text{Savings} = 1242 \text{ MWD}$$

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100-C AREA (cont'd)

File Actually Operating T.O.A.
Ratio T.O.A. to Bulk T.

$$\frac{0^\circ / 4.2^\circ}{0^\circ / 20.0^\circ} = 21\%$$

100-KW AREA

Savings = 2796 MWD

T.O.A. Limit

$$\frac{0^\circ / 4.2^\circ}{0^\circ / 20.0^\circ} = 21\%$$

100-KE AREA

Savings = 2602 MWD

T.O.A. Limit

$$\frac{0^\circ / 4.2^\circ}{0^\circ / 20.0^\circ} = 21\%$$

100-D AREA

Savings = 1242 MWD

Tube Limit

$$\frac{0^\circ / 4.2^\circ}{0^\circ / 20.0^\circ} = 21\%$$

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100-DR AREA

Savings = 972 MWD

100-H AREA

Savings = 1202 MWD

100-F AREA

Savings = 1157 MWD

COOLING EFFECT

Average of three high readings	August 1	3.17° C
	August 2	2.80° C
	August 3	2.77° C
	August 4	2.77° C
	August 8	2.60° C
	Average	2.82° C

* Ratio of river flow to active river bed storage 4 to 5 or 80%.

$$2.8 \times .8 = 2.3^{\circ} \text{ C}$$

* Chief Joseph Reservoir has 20% dead storage and cold water might be retained in this storage.

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1. Daily Operating Reports, All Reactors
2. Rough Draft Letter, P. C. Walkup to H. A. Kramer,
dated July 10, 1958

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