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# GENERAL ELECTRIC

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ARTIFICIAL COOLING OF THE COLUMBIA RIVER BY DAM REGULATION  
1960

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February 15, 1961

ARTIFICIAL COOLING OF THE COLUMBIA RIVER  
BY DAM REGULATION  
1960

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BENEFITS RESULTING FROM  
USE OF COLD WATER FROM THE DEPTHS OF  
GRAND COULEE RESERVOIR - 1960

By Authority of *CB-PR-2*

By *WA Snyder 4/13/94*

By *DG Krisher 4/13/94*

Verified By *PM Eck 1-13-94*

by:

Harry A. Kramer  
Facilities Engineering Operation  
Irradiation Processing Department  
HANFORD ATOMIC PRODUCTS OPERATION  
Richland, Washington

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-5-

HW-68337 APP *DEI*

We have been assured that there is a gain due to river cooling during startup non-equilibrium periods of at least 1-1/2 percent. Because there is some controversy over this amount, no credit was taken for it.

Benefits are based on actual flow at Hanford which includes incremental flow from streams below Coulee. Not enough data is available to evaluate these increments at this time, but to be conservative, they are considered as having warm water temperatures although we know this is not true. Travel time shown on the curves is theoretical.



$$\Delta(MWD)_B = 0.2635 \times Q_B \times \Delta T_o \quad \Delta(MWD)_{OSI} = 0.005 \times \Delta T_o \times \sum(MWD)_{T+G} \quad \Delta(MWD)_t = \Delta T_o \left[ (0.2635)(Q_B) + (0.005)(\sum(MWD)_T) \right]$$

Aug.	T <sub>o</sub>	B	C	D	DR	F	H	KE	K	KE	KW	(MWD) <sub>T+N</sub>	(Q)	(MWD)
	1.0	B 85.2	T 18.50	N 15.05	- - - -	T 16.20	B 87.3	T 33.90	T 33.90	T 33.90	T 34.80	10340	172.5	96.7
	1.5	B 85.1	T 18.50	N 15.80	- - - -	T 16.20	B 87.2	T 33.90	T 33.90	T 33.90	T 35.00	10360	172.3	145.8
	1.4	B 85.2	T 18.50	N 16.20	N 15.10	T 16.20	B 87.2	- - - -	T 33.90	- - - -	T 35.10	6980	172.4	112.5
	1.8	B 85.0	T 18.50	B 84.7	N 15.80	T 16.20	B 87.4	- - - -	T 33.90	- - - -	T 35.10	6980	257.1	184.8
	1.9	B 85.0	T 18.60	B 84.8	N 16.10	T 16.20	B 87.3	N 33.10	T 33.90	N 33.10	T 35.00	6980	257.1	195.0
	1.7	B 85.0	T 18.65	B 84.8	B 84.0	T 16.20	B 87.4	N 33.40	T 33.90	N 33.40	T 35.00	6985	341.2	212.2
	1.6	- - -	B 96.5	- - - -	2/3B 84.0	T 16.20	B 87.3	5/6N 33.60	T 33.90	6N 33.60	T 34.80	6100	239.8	149.9
	1.4	- - -	B 96.1	- - - -	- - - -	G 16.20	B 87.2	- - - -	T 33.90	- - - -	T 34.80	5100	183.3	103.3
	1.5	N 15.50	B 96.3	- - - -	N 14.75	T 16.20	B 87.1	N 33.00	- - - -	N 33.00	- - - -	1620	183.4	84.6
	1.9	T 16.00	3/4B 96.3	- - - -	N 15.50	G 16.20	B 87.1	T 32.70	- - - -	T 32.70	- - - -	6490	167.3	145.4
	2.7	T 16.00	- - - -	N 15.80	1/3N 15.50	G 16.20	B 87.1	T 32.90	- - - -	T 32.90	- - - -	6510	87.1	150.0
	2.7	G 16.05	- - - -	N 15.95	- - - -	- - - -	- - - -	T 33.15	N 34.50	T 33.15	N 34.50	4920	0	66.4
	2.3	T 16.05	- - - -	T 16.05	- - - -	- - - -	- - - -	T 33.45	N 35.25	T 33.45	N 35.25	6555	0	75.4
	2.4	T 16.10	N 18.00	T 16.20	N 12.35	- - - -	- - - -	T 33.70	G 35.25	T 33.70	G 35.25	10125	0	121.5
	2.4	T 16.25	N 18.55	T 16.45	N 12.85	N 12.20	- - - -	T 34.05	G 35.30	T 34.05	G 35.30	10205	0	122.5
	1.8	T 16.35	T 18.55	B 85.0	N 14.40	N 15.00	- - - -	T 34.15	G 35.50	T 34.15	G 35.50	10455	85.2	134.9
	1.9	T 16.35	T 18.55	B 85.0	N 15.90	N 15.40	N 16.30	T 34.55	G 35.50	T 34.55	G 35.50	10495	85.2	142.3
	2.3	B 85.2	T 18.55	B 85.0	G 15.90	G 15.90	B 87.5	T 34.55	T 33.90	T 34.55	T 35.50	12040	257.3	294.6
	2.3	B 85.2	T 18.55	B 85.0	N 12.25	G 15.95	B 87.6	1/2T 34.55	3/4T 33.90	2T 34.55	3/4T 35.50	7850	257.3	246.5
	2.3	B 85.1	T 18.55	B 85.0	N 13.60	G 16.50	B 87.7	- - - -	- - - -	- - - -	- - - -	3505	257.3	196.5
	2.6	T 16.40	T 18.55	- - - -	N 14.40	T 16.35	B 87.9	- - - -	N 33.60	- - - -	N 33.60	5130	87.9	126.9
	2.4	T 16.40	T 18.55	- - - -	N 15.45	T 16.35	B 87.5	- - - -	N 33.60	- - - -	N 33.60	5130	87.5	116.9
	2.2	T 16.40	T 18.55	N 16.20	N 16.00	T 16.35	B 87.9	- - - -	- - - -	- - - -	- - - -	5130	87.9	107.4
	1.8	T 16.40	N 18.25	N 16.30	N 16.35	T 16.40	B 87.6	- - - -	- - - -	- - - -	- - - -	3280	87.6	71.1
	2.0	T 16.40	T 18.40	N 16.45	B 83.9	T 16.50	B 87.4	- - - -	N 33.00	- - - -	N 33.00	5130	171.3	141.8
	1.7	T 16.40	T 18.40	B 85.0	N 15.65	T 16.50	B 87.4	N 33.00	N 33.00	N 33.00	N 33.25	5130	172.4	120.8
	0.6	1/2T 16.40	T 18.40	B 85.0	N 16.00	T 16.50	B 87.2	1/2N 33.00	N 33.00	1/2N 33.00	N 33.65	4310	172.2	40.2
	0.1	- - - -	T 18.40	B 85.0	HC 16.10	T 16.50	B 87.2	- - - -	T 33.90	- - - -	T 34.15	8515	172.2	8.8
	0.5	- - - -	T 18.40	B 85.0	HC 16.10	T 16.50	B 87.3	N 33.60	T 33.90	N 33.60	T 34.50	8550	172.3	44.1
	1.2	- - - -	T 18.40	B 85.0	HC 16.10	T 16.50	B 87.3	N 33.40	T 33.90	N 33.40	T 35.00	8600	172.3	106.1
	0.9	- - - -	T 18.40	B 85.0	HC 16.10	- - - -	B 87.2	T 34.85	T 33.90	T 34.85	T 35.00	10435	172.2	87.8

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Sept.	To	B	C	D	DR	F	H	KE	H	KE	KW	(MWD)	(Q)	(MWD)
	1.1	- - - -	T 18.40	B 85.0	HC 16.10	- - - -	B 87.3	T 35.15	87.3	T 35.15	T 34.30	10395	172.3	107.1
	0.9	- - - -	T 18.40	B 85.0	G 16.10	- - - -	B 87.3	T 35.20	87.3	T 35.20	T 35.45	10515	172.3	88.2
	1.1	- - - -	T 18.40	B 85.0	G 16.10	- - - -	B 87.3	T 35.30	87.3	T 35.30	T 35.50	10530	172.3	107.9
	0.7	N 13.75	1/2T 18.40	- - - -	HC 16.10	N 14.50	B 87.3	T 35.50	87.3	T 35.50	T 35.50	9630	87.3	49.8
	0.3	N 15.85	- - - -	- - - -	HC 16.10	N 15.90	B 87.3	T 35.60	87.3	T 35.60	T 35.50	8720	87.3	53.3
	0.6	N 16.00	- - - -	N 15.50	G 16.10	N 15.90	3/4B 87.3	T 35.45	4/87.3	T 35.45	4/5T 35.50	7995	65.5	34.3
	0.8	T 16.10	- - - -	N 15.70	G 16.10	T 16.10	- - - -	T 35.45	- - - -	T 35.45	- - - -	8375	0	33.5
	1.3	T 16.10	- - - -	N 16.20	- - - -	T 16.30	- - - -	T 35.45	- - - -	T 35.45	- - - -	6785	0	44.1
	1.1	G 16.10	N 18.45	B 85.0	- - - -	T 16.35	- - - -	1/3T 35.45	- - - -	1/3T 35.45	N 34.75	4425	85.0	49.0
	0.8	G 16.10	T 18.50	B 85.0	- - - -	T 16.35	N 16.10	- - - -	16.10	- - - -	G 34.95	8590	85.0	52.3
	1.1	1/5G 16.10	T 18.50	5/6B 85.0	- - - -	T 16.35	N 16.10	- - - -	16.10	- - - -	G 35.05	7310	70.8	60.7
	C.9	- - - -	T 18.50	- - - -	N 15.45	B 86.3	B 87.3	N 34.70	87.3	N 34.70	T 35.25	5375	173.6	65.4
	0.7	N 13.80	T 18.50	- - - -	N 15.80	T 16.40	3/4B 87.3	N 34.85	87.3	N 34.85	T 35.55	7045	21.8	28.7
	0.4	N 16.00	T 18.50	- - - -	B 84.5	B 86.3	- - - -	T 35.10	- - - -	T 35.10	T 35.60	8920	170.8	35.8
	0.4	N 16.30	T 18.50	- - - -	B 84.3	B 86.3	N 15.50	T 35.10	15.50	T 35.10	T 35.60	8920	170.6	35.8
	0.1	B 85.2	T 18.50	- - - -	B 84.3	B 86.3	N 16.00	B179.5	16.00	B179.5	T 35.60	5410	435.3	14.2
	C.5	B 85.2	T 18.50	- - - -	B 84.0	B 86.3	N 16.10	(T)35.10	16.10	B179.5	T 35.60	5410	435.0	70.8
	0.4	2/3B 85.2	T 18.50	- - - -	B 83.8	B 86.3	N 16.10	(T)35.30	16.10	(T)35.30	T 35.60	5410	414.4	54.5
	0.1	- - - -	T 18.50	N 16.00	- - - -	B 86.3	B 87.5	T 35.35	87.5	T 35.35	T 35.70	8955	173.8	9.1
	C.1	- - - -	T 18.50	B 84.9	- - - -	B 86.3	B 87.5	T 35.40	87.5	T 35.40	T 35.75	8965	258.7	11.3
	C.4	N 15.35	T 18.55	B 85.0	B 83.5	B 86.3	B 88.1	T 35.45	88.1	T 35.45	T 35.80	8980	342.9	54.1
	C.8	N 16.10	T 18.55	B 84.9	B 82.6	B 86.3	B 87.9	B179.5	87.9	B179.5	T 35.80	5435	521.2	131.6
	0.5	N 16.20	- - - -	B 84.9	B 82.8	B 86.3	B 87.9	T 35.50	87.9	T 35.50	T 35.80	7130	341.9	62.9
	0.5	N 16.40	- - - -	1/2B 84.9	B 82.6	T 16.70	B 87.8	T 35.55	87.8	T 35.55	T 35.80	8805	212.8	50.0
	C.9	G 16.50	- - - -	- - - -	B 82.6	T 16.70	B 87.9	T 35.55	87.9	T 35.55	T 35.80	10455	180.5	89.9
	1.3	T 16.50	N 18.20	N 16.00	- - - -	B 86.3	B 87.8	B179.5	87.8	B179.5	T 35.80	5230	353.6	155.1
	1.4	G 16.60	T 18.30	N 16.40	N 15.30	B 86.3	B 87.9	(T)35.55	87.9	(T)35.55	T 35.80	7070	354.2	180.2
	1.4	G 16.60	T 18.40	B 84.8	N 15.90	B 86.3	B 88.0	B180.0	88.0	B180.0	T 35.80	7080	439.1	211.5
	1.2	T 16.70	T 18.65	B 84.8	(N)84.8	B 86.3	2/5B 87.9	(T)36.00	87.9	(T)36.00	- - - -	3535	488.6	175.7
	1.2	B 85.2	T 18.80	B 84.8	B 84.8	B 86.1	N 16.20	B180.0	16.20	B180.0	- - - -	1880	520.9	176.0
						(T) 16.72		(T)36.05		(T)36.05				

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HM-68337 APP-NEC



Oct.

<u>To</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>DR</u>	<u>F</u>	<u>H</u>	<u>KE</u>	<u>H</u>	<u>KE</u>	<u>KW</u>	<u>(MWD)<sub>T</sub></u>	<u>Q<sub>T</sub></u>	<u>(MWD)</u>
1.0	B 85.2	T 18.80	B 84.8	B 84.8	---	B 88.1	B180.0 (T)36.05	B 88.1	B180.0 (T)36.05	N 33.10	1880	522.9	147.2
1.1	B 85.2	T 18.80	B 84.8	B 84.7	---	B 88.0	B180.0 (T)36.05	B 88.0	B180.0 (T)36.05	N 34.40	1880	522.7	161.7
0.7	B 85.2	T 18.80	B 84.8	3/4B 84.7	---	B 88.0	B180.0 (T)36.05	B 88.0	B180.0 (T)36.05	N 34.90	1880	501.5	99.1
0.3	1/5B 85.2	T 18.85	B 84.8	---	---	B 87.9	5/6B180.0	B 87.9	5/6B180.0	N 35.50	1885	339.7	29.7
0.4	---	T 18.85	B 84.8	---	---	B 88.1	---	B 88.1	---	T 36.10	5495	172.9	29.2
0.5	---	T 18.85	B 84.8	---	---	B 88.0	---	B 88.0	---	T 36.35	5520	172.8	36.6
0.9	---	T 18.85	B 84.8	---	---	B 88.0	---	B 88.0	---	T 36.50	5535	172.8	65.9
0.6	N 15.90	T 18.90	B 84.8	N 15.65	N 14.60	B 88.0	N 36.10	B 88.0	N 36.10	T 36.55	5545	172.8	44.0
0.7	N 16.35	T 18.90	B 84.8	N 16.80	---	B 87.9	N 36.10	B 87.9	N 36.10	T 36.60	5550	172.7	51.3

= 664.7  
= 6910.4

HM-68337 APP-DEA

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BULK OUTLET TEMPERATURE - °C

1960 - 11:30 P.M.

<u>DATE</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>DR</u>	<u>F</u>	<u>H</u>	<u>KE</u>	<u>KW</u>
September 11	25.2	91.7	25.4	60.0	92.6	92.1	89.8	91.6
September 12	20.9	92.1	23.8	88.9	93.2	92.8	92.1	92.2
September 13	75.2	92.2	32.0	92.5	93.0	31.3	92.9	92.7
September 14	89.4	92.5	25.5	94.3	93.3	74.2	93.6	93.2
September 15	92.0	92.8	25.0	94.3	93.3	88.2	93.4	93.2
September 16	92.5	92.0	23.2	94.7	93.1	91.2	93.8	93.3
September 17	92.5	92.0	23.3	94.3	93.3	92.7	93.6	93.0
September 18	27.3	92.3	85.8	94.7	93.1	92.8	94.0	93.1
September 19	24.5	91.2	92.0	23.5	93.2	92.3	93.5	92.7
September 20	79.1	91.2	93.1	88.0	93.3	93.0	93.7	92.9
September 21	85.2	91.6	93.3	94.0	93.1	92.6	93.5	92.8
September 22	89.7	91.5	93.2	94.3	93.2	92.8	93.4	92.6
September 23	90.0	20.8	93.2	94.0	93.0	93.4	93.0	92.1
September 24	90.9	24.1	24.0	93.6	92.2	92.8	92.9	92.0
September 25	92.0	82.3	21.0	23.1	92.8	93.3	93.0	92.3
September 26	92.0	89.6	86.2	26.0	93.3	93.5	83.6	92.5
September 27	92.2	89.8	92.6	85.2	93.2	93.0	93.2	92.4
September 28	92.5	90.0	93.0	91.0	93.4	93.2	93.8	92.4
September 29	92.6	91.3	93.1	93.0	93.0	86.2	93.9	CU
September 30	93.1	92.3	93.4	94.2	93.0	90.5	94.2	30.8
October 1	93.1	92.4	93.2	94.3	23.0	92.9	93.9	83.6
October 2	93.2	91.8	93.1	94.3	22.5	93.0	93.8	88.3
October 3	92.9	91.9	93.0	23.1	21.6	92.8	93.7	89.2
October 4	24.5	92.0	93.0	22.0	22.8	92.8	22.3	90.8
October 5	23.5	92.2	93.0	85.2	23.0	92.9	CU	82.2
October 6	21.8	91.8	93.0	22.0	22.1	92.6	25.9	92.5
October 7	72.0	91.5	93.1	19.2	55.3	93.0	89.4	92.5
October 8	84.8	95.5	92.7	88.8	76.2	93.1	91.7	92.4
October 9	88.4	22.8	93.1	93.2	22.8	92.4	92.2	92.2
October 10	88.7	23.6	92.4	93.7	18.5	25.2	92.0	91.5

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BULK OUTLET TEMPERATURE - °C

1960 - 11:30 P.M.

<u>DATE</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>DR</u>	<u>F</u>	<u>H</u>	<u>KE</u>	<u>KW</u>
August 1	92.5	92.3	87.2	22.7	91.2	92.8	90.4	91.8
August 2	93.2	93.0	90.9	92.2	91.7	93.4	90.9	92.8
August 3	92.8	92.5	92.0	88.1	91.3	92.9	-	92.6
August 4	93.1	91.9	93.0	90.6	91.2	93.2	70.0	92.9
August 5	93.0	92.2	93.0	92.0	91.6	93.3	83.6	92.7
August 6	25.0	93.1	93.0	93.2	92.2	93.4	90.0	93.2
August 7	27.2	93.0	22.2	24.4	91.9	93.4	24.0	93.0
August 8	65.5	92.9	-	22.5	92.0	93.3	20.6	93.0
August 9	85.1	93.0	23.5	84.1	92.1	93.5	87.6	-
August 10	91.9	31.0	87.0	89.2	92.5	93.4	88.7	-
August 11	92.1	32.8	89.2	23.8	81.3	26.5	89.1	82.8
August 12	92.2	84.8	92.6	26.0	24.7	29.8	89.4	90.8
August 13	91.4	84.5	92.0	70.0	24.0	30.9	89.7	92.7
August 14	91.1	88.6	91.8	74.2	44.3	28.5	89.9	92.2
August 15	91.1	90.8	92.7	77.5	68.0	21.7	90.0	92.1
August 16	91.5	91.2	93.1	81.1	82.9	84.7	90.3	92.2
August 17	92.6	91.8	93.2	90.2	85.8	91.0	91.8	92.8
August 18	93.2	92.1	93.2	82.3	90.1	93.2	92.3	93.3
August 19	92.9	92.0	92.9	75.5	90.8	92.8	-	-
August 20	92.8	91.7	93.4	80.8	91.1	92.9	73.4	20.0
August 21	91.8	91.0	26.2	83.4	91.2	92.9	20.4	84.0
August 22	92.0	91.2	79.8	88.2	92.0	93.1	34.0	89.4
August 23	92.0	91.0	90.7	90.4	91.3	93.1	85.4	19.0
August 24	91.9	89.0	92.0	92.7	91.7	93.0	-	80.8
August 25	91.8	90.0	92.4	94.5	92.0	93.3	70.0	85.8
August 26	91.4	90.0	92.9	87.0	92.5	93.1	86.0	86.7
August 27	24.7	90.4	92.6	92.3	92.3	92.3	-	87.2
August 28	24.0	90.3	93.1	92.4	92.0	92.7	71.5	88.4
August 29	27.2	90.3	93.2	93.1	92.5	93.2	87.4	89.2
August 30	37.0	91.0	93.2	93.2	23.6	93.4	90.5	90.6
August 31	18.7	90.7	92.8	92.9	22.8	93.1	91.1	90.6
September 1	36.0	90.8	93.0	92.3	22.8	93.3	92.2	91.3
September 2	24.3	91.3	93.3	93.2	23.2	93.3	92.8	92.0
September 3	45.2	92.0	93.0	93.8	49.8	93.4	93.1	92.5
September 4	73.9	26.2	23.3	93.0	81.7	92.7	92.8	91.7
September 5	87.1	26.3	72.2	93.2	91.8	92.5	93.0	91.6
September 6	90.5	25.8	88.2	93.2	92.3	25.2	92.9	-
September 7	91.0	22.2	89.4	92.3	90.4	21.0	93.3	-
September 8	90.8	82.5	91.9	22.2	90.9	24.7	93.4	80.6
September 9	91.0	90.0	93.3	22.1	92.2	83.0	-	89.0
September 10	91.0	91.1	93.1	22.8	92.0	91.1	20.0	90.8

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V. REFERENCES

1. Daily Operating Reports.
2. Rough Draft of letter from S. M. Graves, February 10, 1961.
3. Bill from Bureau of Reclamation A-39.
4. Memo from G. W. Owsley, January 30, 1961.

VI. ACKNOWLEDGMENTS

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