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COLUMBIA RIVER TEMPERATURES

RS:RDW

JUN 22 1962
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In answer to your request by teletype to me dated March 19, 1962, symbol PFR:CWS, we have assembled the following information on the effect of the operation of Hanford's production reactors on the temperature of the Columbia River water. The data are categorized as to the worst, average and best hydrographic conditions for each month (July-October) covering the years 1941-1961.

For the worst hydrographic conditions the following data were used:

1. Maximum river water temperature recorded on any one day during the month at Rock Island Dam.
2. Minimum river flow rate recorded on any one day during the month at Trinidad for years 1941-1960 and at Priest Rapids Dam during 1961.
3. Maximum flow rate of water through all eight reactors on any one day during the month.
4. Average maximum bulk outlet temperature of all eight reactors on any one day during the month.

For the average hydrographic conditions the following data were used:

1. Average river water temperature recorded during the month as measured at Rock Island Dam.
2. Average river flow rate recorded during the month at Trinidad.
3. Maximum flow rate of water through all eight reactors on any one day during the month.
4. Average maximum bulk outlet temperature of all eight reactors on any one day during the month.

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For the best hydrographic conditions the following data were used:

1. Minimum river water temperature recorded on any one day during the month at Rock Island Dam.
2. Maximum river flow rate recorded on any one day during the month at Trinidad.
3. Maximum flow rate of water through all eight reactors on any one day during the month.
4. Average maximum bulk outlet temperature of all eight reactors on any one day during the month.

The following calculation of the thermal increase in the river due to reactor operations during the month of October under the best hydrographic conditions is included to illustrate the method utilized in arriving at the figures in the table:

Q_P = Reactor Flow Rate

Q_R = River Flow Rate

T_{R_F} = River Water Temperature (Final)

T_{R_I} = River Water Temperature (Initial)

T_O = Reactor Bulk Outlet Temperature

$$Q_R T_{R_F} = (Q_R - Q_P) T_{R_I} + Q_P T_O$$

$$Q_R T_{R_F} = Q_R T_{R_I} - Q_P T_{R_I} + Q_P T_O$$

$$Q_R (T_{R_F} - T_{R_I}) = Q_P (T_O - T_{R_I})$$

$$Q_R \Delta T_R = Q_P \Delta T_P$$

$$\Delta T_R = \frac{Q_P \Delta T_P}{Q_R}$$

For October - Best Hydrographic Conditions:

$$\Delta T_R = \frac{(2041 \text{ cfs}) (147^\circ \text{F})}{130,700} = 2.296$$

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Worst Hydrographic Conditions

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<u>Month</u>	<u>Minimum River Flow (cfs)</u>	<u>Maximum River Temperature (°F)</u>	<u>Maximum Bulk Outlet Temperature (°F)</u>	<u>Maximum Reactor Flow (cfs)</u>	<u>Temperature Increase Due To Hanford (°F)</u>	<u>Resultant River Temperature (°F)</u>
July	72,261 (1941)	67 (1941)	201.2 (1961)	2,032 (1961)	3.8	70.8
August	66,656 (1961)	69.5 (1941)	200.8 (1961)	2,043 (1961)	4.0	73.5
September	46,761 (1961)	67.5 (1942)	201.2 (1961)	2,038 (1961)	5.8	73.3
October	39,958 (1945)	65 (1958)	201 (1961)	2,041 (1961)	7.0	72.0

Average Hydrographic Conditions

	<u>Average River Flow (cfs)</u>	<u>Average River Temperature (°F)</u>				
July	245,300 (1946)	59	201.2 (1961)	2,032 (1961)	1.2	60.2
August	125,000 (1946)	63.8	200.8 (1961)	2,043 (1961)	2.2	66.0
September	80,640 (1956)	63.4	201.2 (1961)	2,038 (1961)	3.5	66.9
October	66,120 (1948)	60.8	201 (1961)	2,041 (1961)	4.3	65.1

Best Hydrographic Conditions

	<u>Maximum River Flow (cfs)</u>	<u>Minimum River Temperature (°F)</u>				
July	523,600 (1950)	53 (1954)	201.2 (1961)	2,032 (1961)	0.6	53.6
August	251,000 (1955)	60 (1954)	200.8 (1961)	2,043 (1961)	1.2	61.2
September	147,400 (1959)	58.5 (1954)	201.2 (1961)	2,038 (1961)	2.0	60.5
October	130,700 (1947)	54 (1946)	201 (1961)	2,041 (1961)	2.3	56.3

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In addition to the temperature increase in the river due to the eight production reactors, there will be some increment from the NPR when it begins operation. For the worst hydrographic conditions, this would amount to an additional increase of 0.85° F for July, 0.92° F for August, 1.31° F for September and 1.53° F for October.

We caution against the unguarded use of these data since they represent strictly hypothetical situations which may never occur in reality and since such things as incomplete mixing and the influence of other factors would have a significant effect on the average downstream water temperatures. However, they may be utilized profitably as indicators of potential situations which might occur although the extreme conditions would not be expected to persist simultaneously for any length of time.

The primary concern in connection with high river water temperature is its effect on fish, especially the salmon. It is well to note that the salmon do not begin spawning in the stretch of the Columbia adjacent to the Hanford plant until mid-October and that the water temperature is decreasing by this time. However, since there is some reduction in the percentage of eggs surviving to fingerling stage when the incubation is begun at temperatures above 63° F, it is theoretically possible for the increase due to Hanford operations to have an effect on those eggs spawned downstream from the reactor outfalls. The number of salmon spawning adjacent to or below the reactor outfalls is only a small percentage of the total Columbia River run and is of fairly small economic value.

Since the fingerlings migrate back to the sea during the spring, they are not affected by the late summer water temperatures. The adult chinook salmon is known to have survived under ideal conditions at temperatures up to 77° F. The lethal temperature for adult salmon is generally considered to be 80° F. Our aquatic biologists have found no indication that the reactor effluent plumes act as blocks in the path of upstream migration and do not consider this a problem at this time. The most serious effect of high river water temperatures is the increase of the incidence of the Columnaris disease.

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