(CLASSIFICATION)

DOCUMENT NO.

RL-REA-689

SERIES AND COPY NO.

DATE
February 26, 1965

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

[X] THIS DOCUMENT CONTAINS RESTRICTED DATA AS
DEFINED BY THE EXECUTIVE ORDER OF 1955
IT IS THE POLICY OF THE AEC TO PREVENT THE
CONTENTS FROM BEING DISCLOSED TO AN UNAUTHORIZED
PERSON IS PROHIBITED.

TITLE

RIVER TEMPERATURE FLUCTUATION PROBLEM

☐ OTHER OFFICIAL CLASSIFIED INFORMATION
THIS MATERIAL CONTAINS INFORMATION AFFECTING
THE NATIONAL DEFENSE OF THE UNITED STATES
WITHIN THE MEANING OF THE ESPIONAGE LAWS,
TITLE 18, U. S. C. , SECS. 793 AND 794, THE TRANS-
MISSION OR REVELATION OF WHICH IN ANY MANNER
TO AN UNAUTHORIZED PERSON IS PROHIBITED BY
LAW.

AUTHOR

L. D. Gustafson
Mfg. Systems Eng.

ISSUING FILE

[illegible][illegible]

54-3000-340 (3-57) AEC-GE RICHLAND, WASH.

(CLASSIFICATION)

 

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

DECLASSIFIED

-1-

RL-REA-689

This document classified

by: L. D. Gustafson

This document consists of
8 pages.

February 26, 1965

RIVER TEMPERATURE FLUCTUATION PROBLEM

Distribution

1. R. S. Bell
2. R. E. Dunn
3. M. L. Faught
4. R. F. Foster Battelle-NW
5. O. H. Greager
6. A. B. Greninger
7. C. N. Gross
8. R. T. Jaske Battelle-NW
9. R. T. Jessen
10. A. R. Maguire
11. W. W. McIntosh
12. S. L. Nelson
13. O. C. Schroeder
14. F. F. Vlacil
15. 700 Files
16. Record Center

Classification Cancelled and Changed To

DECLASSIFIED

By Authority of DS Lewis

CG-nmp-1, 5-3-94

By DK Hanson, 5-25-94

Verified By J E Sawley 5-26-94

This document contains information as
defined in Executive Order 11652.
It is the policy of the Department of the Interior
to make this information available to the public
person is prohibited.

DECLASSIFIED

February 26, 1965

RIVER TEMPERATURE FLUCTUATION PROBLEM

INTRODUCTION

Observed fluctuations of river temperature have on occasion required that power level be reduced so as to stay within coolant temperature limits. D Reactor has experienced the greatest variation with sizeable fluctuations also observed at H and F Reactors. Temperature fluctuations beyond about 1 °C require either undesirable power fluctuations or reduced power levels. The result of either consequence is lost production from increased outage time or from operation below desired outlet temperature.

PURPOSE

It is the purpose of this investigation to better define the magnitude and boundaries of this river temperature fluctuation problem.

SUMMARY

River temperature fluctuations have recently been amplified by the operation of N Reactor. At D Reactor, the temperature cycles have been nearly doubled and the H and F Reactor cycles increased about 50 per cent. The heat input required to generate temperature cycling problems is almost entirely generated from upstream reactor effluent. However, temperature cycling is not a problem unless the river flow is adjusted for power production or flood control purposes at or above Priest Rapids Dam. During the low river flow season extending from October through March, it is common practice to vary river flow daily at Priest Rapids by as much as a factor of four. Consequently, at D Reactor, this temperature fluctuation problem will occur frequently during about half of the year. The upstream reactors (B, C, KE, and KW) normally have little more than the natural diurnal temperature fluctuations which seldom exceed 1 °C.

It is estimated that the temperature cycling problem at D Reactor may now cause an annual production loss of about two per cent. It is believed that with improved information and a better understanding of the temperature fluctuation, operating procedures can be developed to appreciably minimize this production loss.

DISCUSSION

The temperature fluctuations observed in the reactor inlet waters are almost entirely generated from the Hanford reactor effluent streams. River temperature measurements at and above the upstream reactors show diurnal cycles to rarely exceed 1 °C. The larger river temperature cycles observed at the downstream reactors are generated from incomplete mixing of upstream reactor effluent aggravated by river channeling and flow cycling. During the lower river flow season (normally October through March), the typical daily high-to-low flow cycle ratio varies by a factor between three and four to one. With uniform

DECLASSIFIED

river mixing and all upstream reactors operating, F Reactor as the furthest downstream reactor would, under these conditions, normally have a temperature cycle of about 3 °C at the river pumphouse. The F Reactor and H Reactor temperature cycles are in close agreement to this uniform river mixing case. Water plant holdup normally reduces the magnitude of the daily cycle at the reactor by about one-third. Consequently, a typical 3 °C cycle at the river normally is reduced to about 2 °C at the reactor.

Recent temperature cycles of up to 5 and 6 °C have been measured at D Reactor. Analysis of upstream reactor operation and river flow cycles shows that N Reactor operation has been primarily responsible for the unusual magnitude of the D Reactor temperature cycles. River channeling at low river flows (about 40,000 cfs) magnifies the N Reactor river heat input as measured at D Reactor by nearly a factor of four. The other upstream reactors contribute about 50 per cent more to the D Reactor cycle than would be predicted with uniform river mixing. As shown in Table I, N Reactor operation has nearly doubled the magnitude of the D Reactor temperature cycles. N Reactor effluent channeling effects are also noted at H and F Reactors; however, the added effect is only about one-half that noted at D Reactor. Because H and F Reactors are soon to be deactivated, only the problem at D Reactor has been extensively studied for this report.

The average flow of the Columbia River at Hanford during the October through March period is generally in the 60,000 to 80,000 cfs range. Flow from Priest Rapids Dam is regulated so that higher flows are available during the daily peak power consumption periods. During the January-February, 1965, period, it has been quite typical that river flow be cut to about 40,000 cfs each night and raised to a maximum between 130,000 and 160,000 cfs in the early evening. Figure 1 shows the typical flow cycle pattern as measured at the Priest Rapids Gaging Station (about 2 miles below Priest Rapids Dam). This plot shows that the normal minimum flow (and level) at this river location lasts for about six hours. Comparison with river elevation at 181-B shows that the "stable" low water period at B Reactor is about one hour shorter than at the gaging station. The added distance below the Priest Rapids Dam provides measurable cycle dampening.

Study of recent temperature and flow data shows that the maximum temperature impact at the 181-D river pumphouse is not observed during "typical" six hour low flow cycle operation. However, if the low flow cycle is extended about two hours, the full impact of the reduced flow will be observed at 181-D. Because of water plant holdup, the "typical" cycle is reduced in magnitude at 105-D by about one-third. The full temperature impact at 105-D of reduced flow requires a cycle three to four hours longer than the "typical" cycle. For this reason, as shown in Table I, the more severe cycles will only occur occasionally. Most of more severe temperature cycles will occur on weekends and holidays. The weekend and holiday electrical power demands require less power generation from Priest Rapids. Consequently, the Dam operator (Grant County PUD) will frequently maintain the low water cycle for longer periods so as to accumulate water storage. The occasional cycles in Table I are expected to occur once or twice a month. The required flow conditions may occur more frequently; however, reactor outages will often reduce the impact of these cycles. The

DECLASSIFIED

maximum anticipated temperature fluctuation will probably occur only once or twice a year when the contributing factors of river flow, reactor operation, and climatic conditions combine for maximum or near-maximum effect.

The predictions in Table I are based on a normal year. Should river flow drop well below normal, the Priest Rapids Dam operator would probably cut night flows to nearer the 36,000 cfs license agreement and hold low flows longer and more frequently. This might result in "typical" cycles at 105-D of 4 to 5 °C. Table I cycles will usually occur only during the general October through March period. However, the problem of cycles may occur quite frequently in September and occasionally in April. Temperature cycles in September might also be aggravated by the added diurnal effects of hot weather. Except for possible maintenance and flood control operations, there should be no low water flow problem between April and September.

The low flow effects were well demonstrated during the January 29-31, 1965, weekend. Figure 2 shows a plot of 181-D inlet temperature during this period. The river flow was cut to about 40,000 cfs shortly after midnight January 29, and was held between 38,000 and 40,000 cfs throughout the weekend and until about 7:00 AM February 1. The effects of a KE Reactor and an N Reactor startup are shown in Figure 1. Had there been uniform mixing in the river, the KE startup would have increased 181-D temperature about 0.9 °C versus an observed increase of about 1.4 °C. N Reactor startup with uniform mixing should have increased 181-D temperature about 0.7 °C versus the observed increase of about 2.7 °C. These same relative effects have been observed at other times; however, the observations on this weekend were quite clear cut and informative.

It is difficult to forecast the exact loss of production at D Reactor due to river temperature cycles. However, it is estimated that the annual loss of production under existing operating conditions might be nearly two per cent. Assuming a production value of \$10 per MWD, the total economic loss at D Reactor would be about \$120,000 per year. Reducing the temperature cycle problem by 50 per cent would then have a value of about \$60,000 per year. Although the river temperature cycle at D Reactor could be reduced by modified Priest Rapids Dam operation, river dredging or modified effluent disposal, it appears unlikely that any of these methods could be justified for economic and political reasons.

It is unlikely that a realistic method can be found to reduce the river temperature cycling at D Reactor. Consequently, the best course of action appears to exist through adapting operating techniques and procedures to minimize production loss. Through better information and understanding of the temperature cycle, it is believed that production losses may be appreciably reduced. It is suggested that, as a first step, a 181-D river water temperature recorder be installed in the 105-D control room. This recorder would provide about five hours warning of cycle magnitude as well as valuable information about temperature trends and cycle behavior. Unusual river flow cycle information, as observed from river level instrumentation, should be immediately communicated to the 105-D control room. A recorder at 105-D from the Priest Rapids telemetering station would prove very useful and could quite likely be economically justified provided production can be assigned an appropriate dollar value. Communication

DECLASSIFIED

with the Grant County PUD might also be reviewed to assure that adequate and reasonable information about unusual flow conditions is made available to D Reactor. Improved communication could possibly reduce some of the temperature fluctuation problem, although it appears that the Dam operator has been regulating river flows within the limits of previous agreements.

L. D. Gustafson, Senior Engineer
Manufacturing Systems Engineering
Manufacturing Engineering

LDG:bdt

DECLASSIFIED

Table I

Predicted Variations in Water Temperature
At 100-D Reactor - October Through March

	All Upriver Reactors Operating (B, C, KE, KW, N)		All Upriver Reactors Except N Operating	
	181-D Inlet ΔT °C	105-D Inlet ΔT °C	181-D Inlet ΔT °C	105-D Inlet ΔT °C
"Typical" Daily Fluctuation (Minimum river flow 38,000 to 40,000 cfs)	4-1/2	3	2-1/2	1-1/2
Occasional Daily or Weekend Fluctuations (Minimum river flow 36,000 to 40,000 cfs)	5 to 7	4 to 7	3 to 4	2 to 4
Maximum Anticipated Fluctua- tion (Minimum river flow 36,000 cfs)	8	8	4-1/2	4-1/2
Maximum Fluctuation Believed Possible (Minimum river flow 36,000 cfs)	10	10	6	6

DECLASSIFIED

Figure 1

"Typical" Daily River Flow Patterns
At Priest Rapids Gaging Station

DECLASSIFIED

REF ID: A66544

Figure 2

181-D Water Temperature At Low River Flow
(Flow maintained at about 38,000 cfs Thursday night through Monday morning)