DECLASSIFIED

[redacted]

(CLASSIFICATION)

HW--65733-RD

DE93 003526

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION – RICHLAND, WASHINGTON

November 17, 1959

[X] RESTRICTED DATA

THIS DOCUMENT CONTAINS RESTRICTED DATA AS DEFINED IN THE ATOMIC ENERGY ACT OF 1954. TRANSMITTAL OR THE DISCLOSURE OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED.

[redacted]

[ ] 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 TRANSMISSION OR REVELATION OF WHICH IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

TITLE

WASTE DISPOSAL CRITERIA
EXISTING REACTOR EXPANSION STUDY

AUTHOR

R. B. Hall

THIS DOCUMENT MUST NOT BE LEFT UNATTENDED [redacted] WHERE AN UNAUTHORIZED PERSON [redacted] HAVE ACCESS TO IT. WHEN NOT IN USE, IT MUST BE STORED [redacted] IN AN APPROVED LOCKED REPOSITORY [redacted] IN AN APPROVED GUARDED AREA. WHILE IT IS IN YOUR POSSESSION AND UNTIL YOU HAVE OBTAINED A SIGNED RECEIPT FROM CLASSIFIED FILES, IT IS YOUR RESPONSIBILITY TO KEEP IT AND ITS CONTENTS WITHIN THE LIMITS OF THIS [redacted] AND FROM ANY UNAUTHORIZED PERSON. ITS TRANSMITTAL [redacted] AND STORAGE AT YOUR PLACE OF RESIDENCE IS PROHIBITED. IT IS NOT TO BE DUPLICATED. IF ADDITIONAL COPIES ARE REQUIRED, OBTAIN THEM FROM THE RELATED ISSUING FILE. ALL PERSONS READING THIS DOCUMENT ARE REQUESTED TO SIGN IN THE SPACE PROVIDED BELOW.

ROUTE TO:	PAYROLL NO.	LOCATION	FILES ROUTE DATE	SIGNATURE AND DATE
[redacted]				
[redacted]				L. B. Hall 10-22-59
R. T. Jaske	M-902	1704-F	JUN 28 '60	

Classification Cancelled And Changed To
DECLASSIFIED
By Authority of DS LEWIS,
10-19-92, CGPR 2
By TL BURBIDGE, 10-19-92
Verified By DJ Hickey 10/19/92

DISTRIBUTION RESTRICTED TO U.S. ONLY

54-3000-052 (7-59) A.E.C.-G.E.-RICHLAND, WASH.

[redacted]

(CLASSIFICATION)

DECLASSIFIED

HW-65733 RD

November 17, 1959

WASTE DISPOSAL CRITERIA EXISTING REACTOR EXPANSION STUDY

SUMMARY

Waste disposal criteria were established on the basis that the occurrence of river flow rates which were 72% of normal would not cause the effects of waste disposal to exceed limits. Since even the base case exceeds the criterion for the average body burden of phosphorus-32, provision to reduce the output of this radioisotope must be included in any expansion program. Provision to reduce the output of other radioisotopes will be required for most cases where the bulk outlet temperature limit is 105° or higher. For reactor flow rates exceeding 100,000 gpm it may be necessary to reduce sodium dichromate concentrations as low as 1.5 ppm during periods of low river flow. Heat output was discussed but no limit was set.

I. CRITERIA

A. Modifications shall be so designed that radioisotopes which are discharged to the river or which reach the river after discharge of wastes to the soil can be controlled during a year when the river flow rate is normal such that:

1. The combined effects of the radionuclides introduced from all reactors would result in an annual average concentration of radionuclides in the river at Pasco of no more than 3.6% MPC*.
2. The combined effects of the radionuclides introduced from all reactors would result in an annual average concentration of radionuclides in the drinking water at any reactor area of no more than 7.2% MPC*.

MASTER

*MPC-Maximum Permissible Concentration of radioisotopes in drinking water. The values referred to are those for continuous occupational exposure as stated in Appendix A of the Radiation Protection Standards (HW-25457 Rev. 1).

3. It would be improbable that the annual average body burden of phosphorus-32 for any individual would exceed 0.36 microcuries.

B. The release of hexavalent chromium ion to the river shall be so controlled that the concentration in drinking water will not exceed 0.05 ppm and the monthly average concentration in river water will not exceed 0.02 ppm.

C. Reasonable effort to limit the increase of river temperature due to the operation of the reactors during August and September is recommended. However, the present technical basis will not support the establishment of a limit on the amount of heat that may be added.

II. BASES

The criterion for the release of radioisotopes to the river was based on Radiation Protection Standards 3.1 and 7.2, on the assumption that river flow rates 72% of normal could be expected with reasonable frequency and on the premise that limits should not be exceeded when this low flow rate exists.

The criterion for the release of hexavalent chromium was based on a Public Health Service Water Standard and on recommendations of the Aquatic Biology Operation. The Public Health Service Water Standard, which is followed at HAPO, states "hexavalent chromium in excess of 0.05 ppm shall constitute grounds for rejection of the supply." This is interpreted by Industrial Hygiene to mean that 0.05 ppm hexavalent chromium shall be the maximum accpetable for drinking water at any time.(1) R. F. Foster established a limit of 0.02 ppm hexavalent chromium in river water due to its deleterious effect on juvenile fish.(2) That is, if the juvenile fish between the reactors and the confluence of the Columbia Riv the Yakima and Snake

(1) W. E. Gill - Private Communication

(2) R. F. Foster, "Recommended Limit on Addition of Dichromate to the Columbia River, April 17, 1951" (HW-19713) (Secret).

the reactors and the confluence of the Columbia with the Yakima and Snake Rivers were destroyed, the commercial fishing industry might suffer an annual loss of about $60,000. This value cannot be considered firm, but is quoted in order to give a basis for judgement.

The criterion for the release of heat is based on the opinion of the Biology Operation that temperatures over 20°C at Bonneville Dam could result in epidemic disease among salmon.(3) The usual high temperature period occurs in late August and early September which coincides with the time that a large run of Chinook Salmon are in the river. The value of this particular salmon run has been estimated to be $5,000,000 annually. Again the accuracy of this number is not guaranteed, but it is included to permit judgement of the problem.

III. EFFECTS OF REACTOR EXPANSION

A. General

The criterion for phosphorus-32 is being exceeded at this time and it is expected that the operation of Priest Rapids Dam may cause the criterion for hexavalent chromium in drinking water to be exceeded during a winter when nighttime flow rates are reduced to 36,000 cfs.

Release of effluent water at or near the shoreline except at high river flow rates could cause 100 Area drinking water to exceed these criteria and biological concentration of radioisotopes that could cause islands of foam and algae around Richland boat docks to be a radiation exposure problem.

(3) R. F. Foster, "The Effect on Fish of Increasing the Temperature of the Columbia River", March 14, 1958, HW-54858 (Secret).

[redacted]

B. Assumptions

For the purposes of forecasting the effects of proposed changes the following assumptions were made:

1. Both 105-KE and 105-KW operating with flow rates of 188,000 gpm, with a 93° bulk outlet temperature limit and at 80% time operated efficiency.
2. Normal river flow rates of 105,000 cfm annual average, 100,000 cfs average during August and September, 60,000 cfs average during minimum flow periods, and 36,000 cfs daily minimum flow during minimum flow periods.
3. Uniform distribution of effluent water in the river except for considerations of 100 Area drinking water.
4. Consumption of whitefish flesh at a uniform rate of 0.5 lb/week by a successful fisherman between October 1 and the spring freshet. Fish caught in the vicinity of Ringold.
5. Hexavalent chromium is neither lost nor reduced to the less toxic trivalent chromium between the point of injection and the point of use.

C. Phosphorus-32

Figure 1 illustrates the potential body burden of phosphorus-32 under various operating conditions. The validity of the extrapolation may be questionable, but it is felt that these values would not be high by more than 25%. It can be seen that even the base case exceeds the criteria. Phosphorus-32 may be obtained from either fish or waterfowl, but because of the large number of migrant waterfowl only the

uptake from fish was considered. Perhaps 100 people are significantly affected.

There are two possible remedies for this situation, neither of which have been proven. Treatment of the effluent water by passing it over a bed of aluminum might reduce the output of phosphorus-32 by a factor of 2. Even less is known about the other possibility which would be to substitute CO_2 for sulfuric acid for pH control. Some of the phosphorus-32 comes from the $S^{32}(n,p)\ P^{32}$ reaction, but the fraction that is derived from this reaction as opposed to the $P^{31}(n,\gamma)\ P^{32}$ reaction has been the subject of technical argument for several years.

D. Plant Drinking Water

Hexavalent chromium in plant drinking water may exceed the criterion for drinking water under present operating conditions. This forecast is based on the assumption that none of the hexavalent chromium is lost or reduced and on an estimate of the fraction of B, C, KW, and KE effluents that would be taken into 100-D at low river flow rates.(4) Efficient operation of Priest Rapids Dam will probably drop the flow rate to 36,000 cfs during the night while releasing a daily average of 60,000 cfs. The reduction of hexavalent to trivalent chromium and loss of chromium in filter plants has not been studied. Routine analyses of 100-D and 100-F drinking water have shown hexavalent chromium in concentrations slightly above the detection limit of 0.005 ppm on a few measurements when the river flow rate was low..

(4) J.P. Corley - Private Communication

[redacted]

Radiological limits should not be exceeded in plant drinking water before the limits for river water at Pasco are exceeded. Decontamination by the water treatment process by a factor of 2 or 3 and a higher limit operates in support of this opinion. Even though channeling of effluent water from upstream reactors into a downstream reactor intake could quickly use up this margin of safety, the fact that radiological effects may be averaged would insure that the hexavalent chromium limit would be exceeded first.

E. Radioactivity in River Water

Figure 2 illustrates the effects of various conditions relative to the radiological criterion for river contamination. The choice of Pasco as the point of interest does not ignore the possibility of navigation in the river past the reactors, but does assume that recommended radiological controls would be enforced.(5,6) The method of extrapolation used has been successfully used in the past and is, therefore, expected to be reasonably accurate.

F. Hexavalent Chromium in River Water

Figure 3 illustrates the concentration of hexavalent chromium in the river under various operating conditions assuming no loss and no reduction to trivalent chromium which is less toxic. An average river flow rate of 60,000 cfs was assumed. Since the deleterious effect on the fish is dependent upon persistence of these

(5) R. T. Jaske, et al, "Effects on Hanford Works of a Navigation Channel in the Columbia River", dated June 6, 1958, HW-55950. (Confidential)

(6) R. T. Jaske, et al, same title, dated June 30, 1959, HW-55950 Sup. (Confidential)

[redacted]

concentrations for a month or so, and since an average flow rate of about 60,000 cfs is required for the hydroelectric facilities to meet their commitments, these curves represent the most probable condition. If it is desirable to consider the effects of lower flow rates, it can be done on this graph by lowering the line representing the criterion by the fraction of 60,000 cfs that is being considered.

G. River Temperature

Figure 4 illustrates the theoretical temperature increase immediately downstream from the reactor which would result under various operating conditions. Since the actual temperature of the river represents a balance between the forces which tend to increase the temperature such as heat absorbed directly fromthe sun, return flow ofirrigation water, and the operation of industrial facilities including reactors, and those forces which tend to remove heat from the water such as evaporation and heat transfer to the soil, the effect of the additional heat added will influence the balance but will not be felt as a simple addition to the temperature some distance downstream.

The deleterious effect on the salmon run is caused by a virulent strain of bacteria. The probability of an epidemic of disease among the salmon increases with temperature over 20°C and with the length of time that such temperatures are maintained. The river temperature at the reactors normally exceeds 20°C for a few days every year, and in 1958 epidemic disease was reported when temperatures between 19° and 21.5°C persisted for nearly ten weeks.

The complexity of the problem which is further aggrevated by political forces makes it impossible to state a limit on the amount

of heat which reactors may add to the river without establishing similar limits on other contributors over which we have no control.

H. Rupture Products

Control of the release of fission products due to fuel element ruptures would not be required in the usual case.(7) However, protection against the unusual case is indicated. Andersen, et al, in reference(8) discuss the consequences of failure of several elements in the same channel in some detail. The effects of increasing production levels on the probability of such an occurrence have not been evaluated. It seems unlikely that HAPO would wish to incur the cost of decontamination and unfavorable public opinion which would result even though the consequences are described as being troublesome and not (technically) a major hazard to individuals in the environs.

(7) J. D. McCormack, L. C. Schwendiman, "Significance of Rupture Debris in the Columbia River", August 17, 1959, HW-61325 (Confidential).

(8) B. V. Andersen, et al, "Environmental Consequences of Proposed Changes in Reactor Operations", February 11, 1958, HW-54953 (Secret).

[redacted]

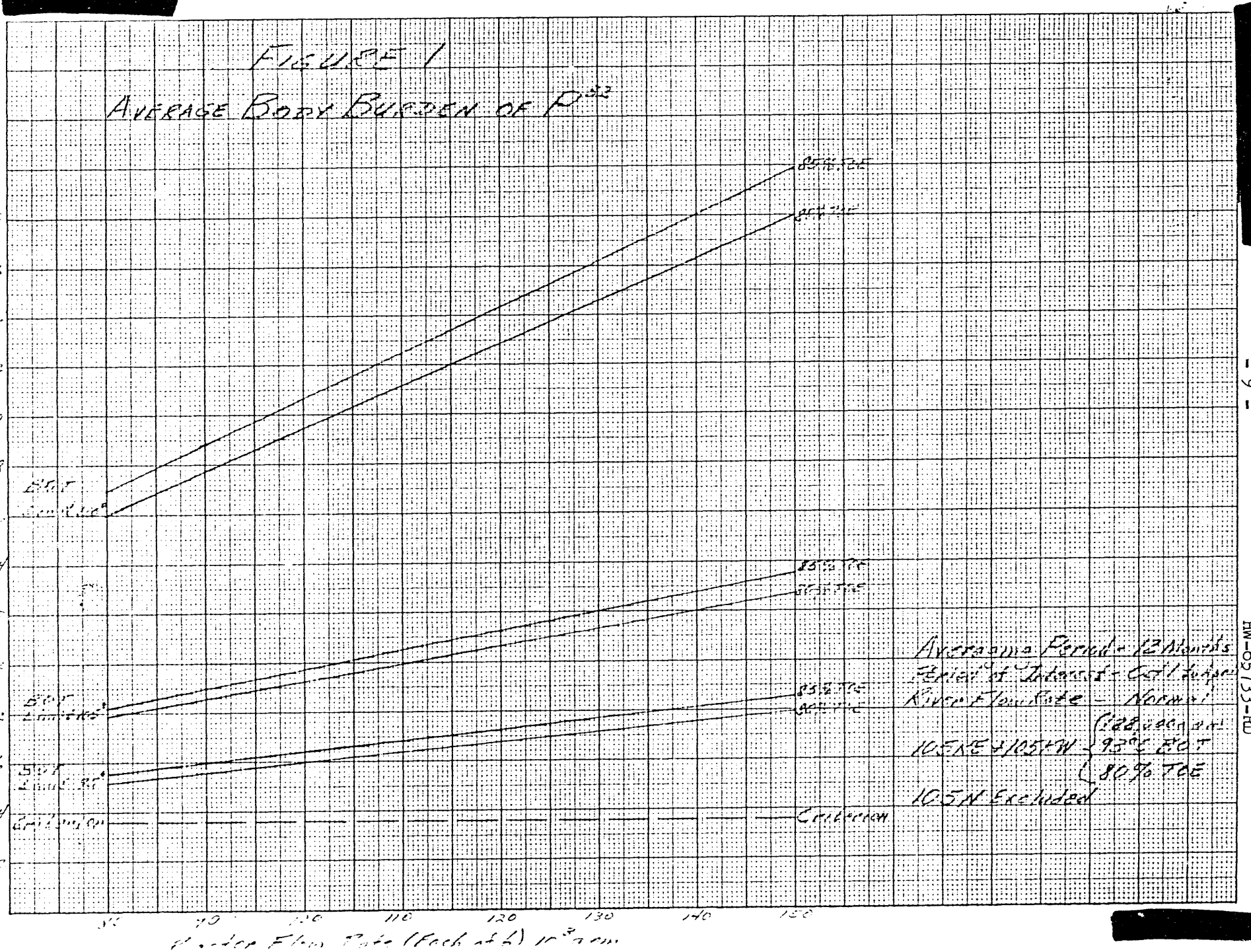


FIGURE 2

AVERAGE RADIOACTIVITY IN RIVER AT PASCO

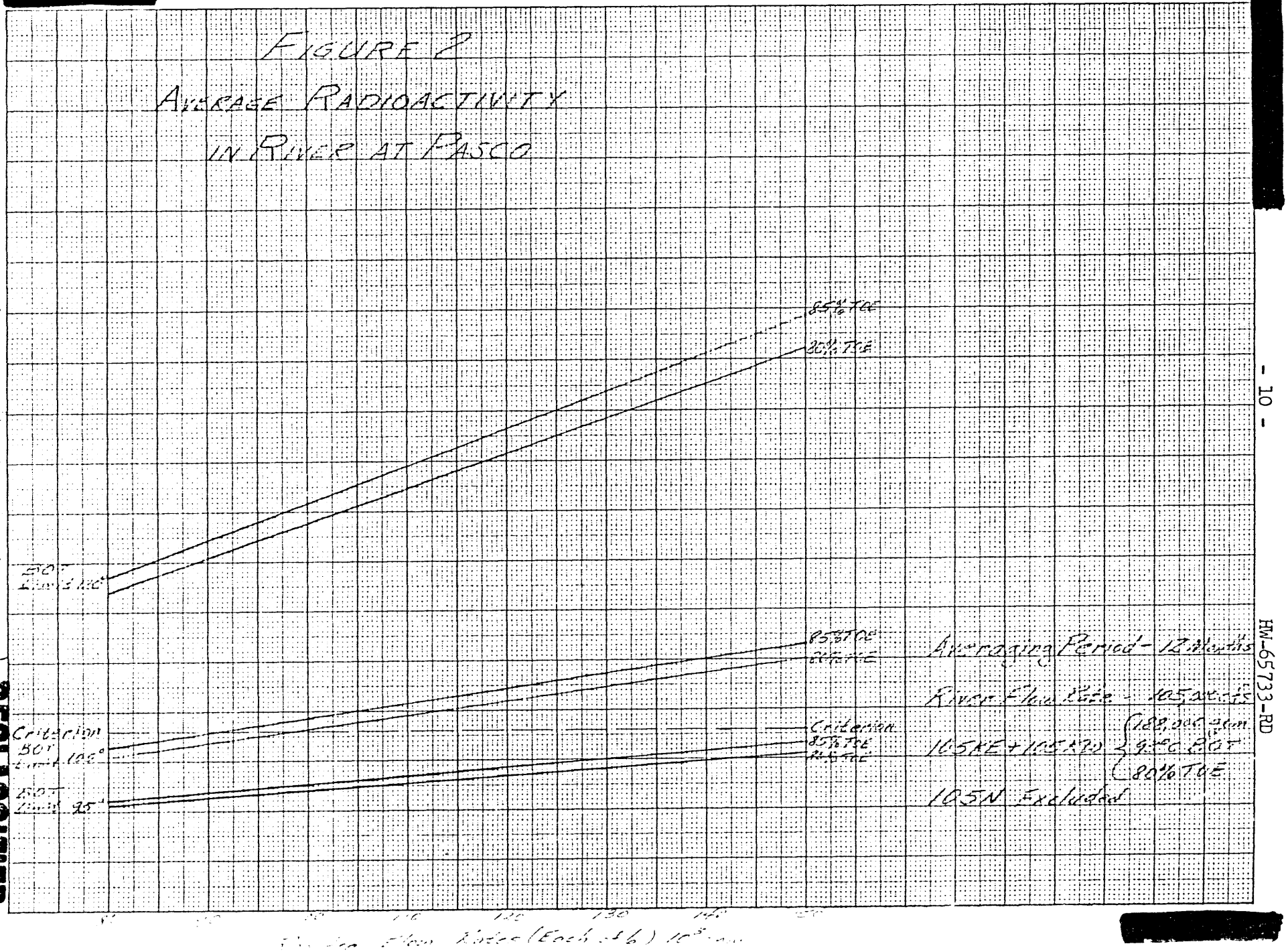


FIGURE 3

HEXAVALENT CHROMIUM IN RIVER

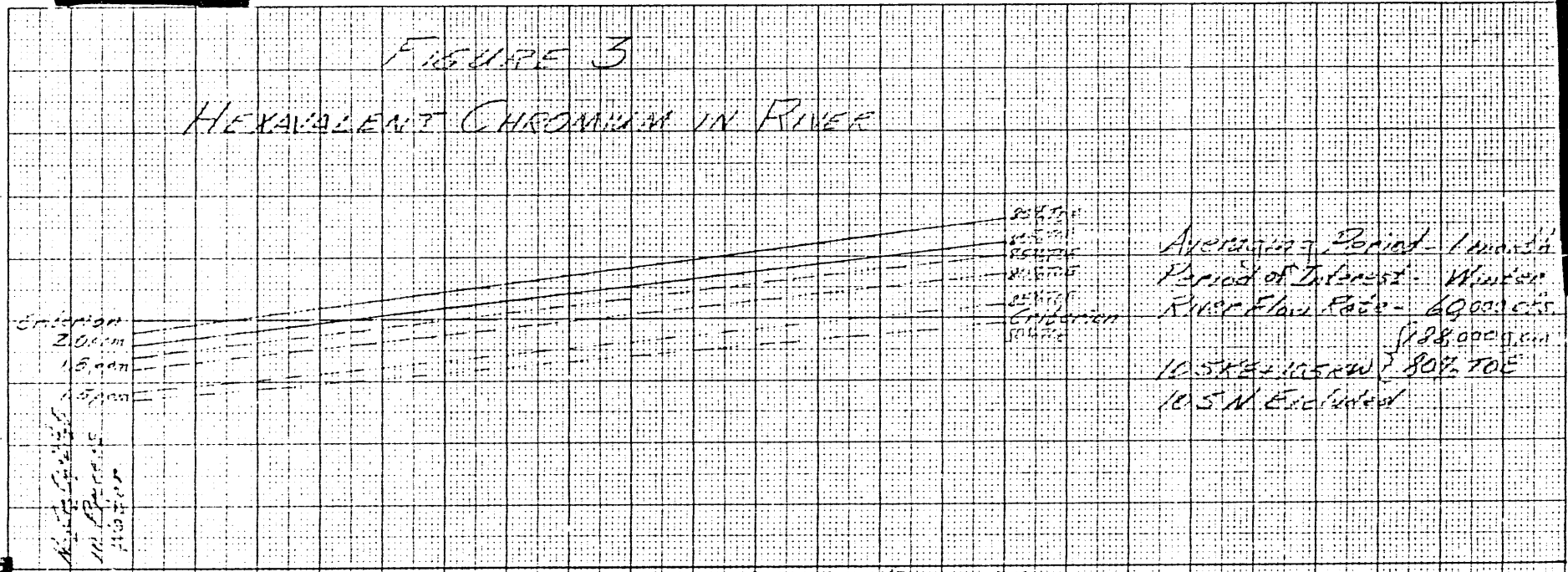
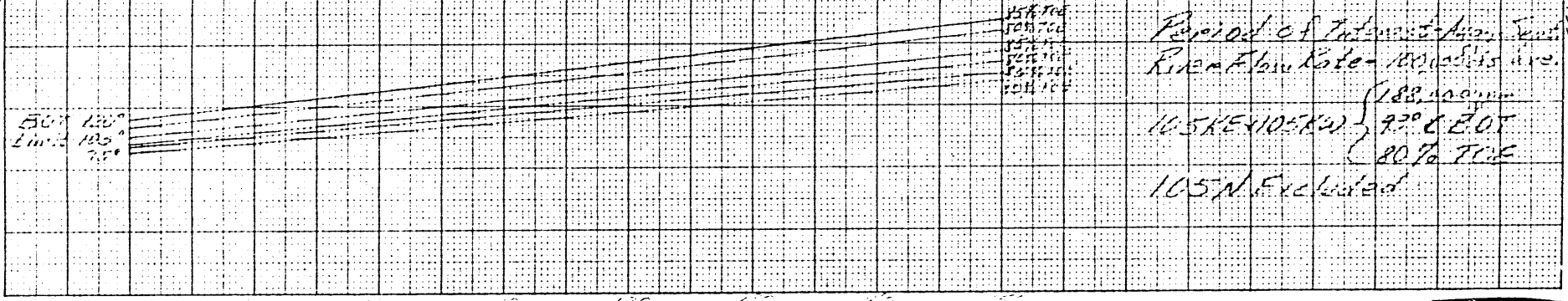


FIGURE 4

RIVER TEMPERATURE INCREASE



END

DATE
FILMED
02/19/93