**Cover Sheet for a Hanford
Historical Document
Released for Public Availability**

Released 1995

**Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830**

**Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute**

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

DOCUMENT NO.

HW-33874

7a

HANFORD TECHNICAL RECORD

RESTRICTED DATA

THIS DOCUMENT CONTAINS RESTRICTED DATA AS
DEFINED IN THE ATOMIC ENERGY ACT OF 1946.
ITS TRANSMITTAL OR THE DISCLOSURE OF
CONTENTS IN ANY MANNER TO AN UNAUTHORIZED
PERSON IS PROHIBITED.

300 N

DATE

11-23-54

COPY NO. AND SERIES

7

TITLE

CURRENT STATUS OF THE ISOTOPIC PURITY
OF HANFORD PLUTONIUM

AUTHOR

R. O. Gumprecht

☐ 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.

THIS DOCUMENT MUST NOT BE LEFT UNATTENDED OR WHERE AN UNAUTHORIZED PERSON MAY HAVE ACCESS
TO IT. WHEN NOT IN USE, IT MUST BE STORED IN AN APPROVED LOCKED REPOSITORY WITHIN 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
THE PROJECT AND FROM AN UNAUTHORIZED PERSON. TRANSMITTAL, AND STORAGE AT YOUR PLACE
OF RESIDENCE IS PROHIBITED. IT IS NOT TO BE REPRODUCED. 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:

READ BY:

DATE

ROUTE TO:

READ BY:

DATE

RECORD
COPY

Indefinite Retention

Disposal Date

Authority

Authority

DECLASSIFIED

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

MASTER

DECLASSIFIED

HW-33874

1. W.G. Albert
2. R.W. Bown
3. R.O. Brugge
4. V.R. Cooper
5. D.H. Curtiss-J.C. Fox
6. R.L. Dickeman
7. G.C. Fullmer
8. P.F. Gast
9. O.H. Greager
10. R.O. Gumprecht
11. T.W. Hauff
12. R.E. Heineman
13. O.F. Hill
14. E.M. Kinderman
15. R.O. Mehann
16. J.F. Music

17. E.T. O'Sullivan
18. W.J. Ozeroff
19. C.A. Priode
20. P.H. Reinker
21. R.B. Richards
22. O.C. Schroeder-R.E. McGrath
23. A.E. Smith
24. H.G. Spencer
25. J.W. Underwood
26. J.H. Warren
27. 300 File
28. Yellow File
29. Extra
30. Extra
31. Extra

CLASSIFICATION CANCELLED AND CHANGED TO
DECLASSIFIED

BY AUTHORITY OF CG-PR-2

RM-Hen 8-12-92

BY J.E. Savelle 9-16-92

VERIFIED BY R.O. Schmitt 9-21-92

RESTRICTED DATA

This document contains restricted data as defined in the Atomic Energy Act of 1946. It is transmitted for the purpose of its content and any other to unauthorized persons is prohibited.

This document consists of
6 pages. No. 7 of
31 copies. Series

NOT UCN!

November 23, 1954

CURRENT STATUS OF THE ISOTOPIC PURITY OF HANFORD PLUTONIUM

INTRODUCTION

The purpose of this document is to present in graphical form a current "picture" of the quality of the Hanford plutonium product.

DISCUSSION

The three graphs presented here show recent Hanford plutonium quality data as a function of uranium exposure. In each case the term n/g-s refers to the number of neutrons emitted per gram of plutonium per second as a result of spontaneous fissions of the Pu-240 isotope. The term "weighted exposure" refers to the average exposure of the discharge obtained by weighting by the square of the exposure of each tube in the discharge and is described in more detail elsewhere. (1) All n/g-s values given except those marked "Rocky Flats shape counts" were measured at Hanford and reported* by A.E. Smith of Plant Processes Unit. Exposure data were obtained from W.G. Albert of Production Scheduling, Reactor Section.

(1) HW-31952, "Plutonium Product Quality," R.O. Gumprecht, 5-28-54.

* Personal communication.

MASTER

DECLASSIFIED

-2-

HW-33874

Figure I

Figure I shows recent n/g-s data plotted vs. uranium exposure for exposures up to 900 MWD/t. The solid curve is obtained from the equation presented in HW-31952 as follows:

$$n/g-s = 0.76 M_{av} e^{-(2.11 M_{av} \times 10^{-3})}$$

where: M_{av} refers to the average tube MWD in the discharge

The exposures plotted in the vicinity of 600 and 900 MWD/t are the ordinary arithmetic average exposures. In the vicinity of 200 MWD/t the exposures plotted are weighted.

Figure II

In Figure II it is noted that the most recent n/g-s data from nominal 600 MWD/t plutonium seem to show an upward trend, i.e., higher n/g-s per MWD/t. Part of this upward trend may be due to higher graphite temperatures ⁽²⁾ and part may be due to an increase in the spread of tube discharge concentrations leading to a larger difference between weighted exposures and ordinary average exposures. At the present time, weighted exposures are not being calculated for discharges other than "low G/t" discharges.

Figure III

In Figure III, the codes 3-14-H, 7-2-C, etc. refer to the shipping key dates for discharges from the various reactors. Thus, 7-2-C refers to the material discharged from C Reactor on or about July 2, 1954. All discharges shown in this figure are 1954 discharges.

In trying to determine the best relationship between n/g-s and weighted exposure, more weight should be assigned to those points which represent data obtained from relatively large quantities of plutonium. The three button count data points shown for 4-21-H, 3-1-F, and the mixture 3-18-D with 3-14-H were obtained early in the present "low G/t" program. Each of these three points represents a rather small sample of the plutonium contained in the respective discharges. For example, the 3-18-D and 3-14-H discharges contained about 57 tons of uranium, whereas the corresponding button count data were obtained from plutonium extracted from about 3-5 tons of uranium.

A fairly high degree of reliability can be placed on the shape-count point shown at 200 MWD/t because the data were obtained from a practically total sample of the plutonium contained by this discharge. In addition, the T plant was flushed out prior to the running of this material and the stated exposure was double-checked by examination by the author of approximately 20 temperature maps from C Reactor covering the exposure period.

(2) HW-32933, "The Dependence of Pu-240 Content of Pile-Produced Plutonium on Neutron Temperature," R.E. Heineman, 9-2-54.

FIGURE II
PRODUCT QUALITY
VS.
URANIUM EXPOSURE
(NOMINAL 600 MWD/T MATERIAL)

DECLASSIFIED

HW-33874

FIGURE III
PRODUCT QUALITY VS. URANIUM EXPOSURE

The Rocky Flats shape-count data point is also quite reliable in that it was obtained from about half of the low G/t plutonium discharged through April. This point is representative of plutonium produced in the B,D,F, and H Reactors since during this period C and DR Reactors discharged only a very small quantity of low exposure material (ends of J-N columns, etc.) Due to the fact that some of the early low G/t discharges were accidentally contaminated with high exposure material at the time of shipment from the reactor, an uncertainty of about ± 3 MWD/t is assigned to this point. If no allowance for contamination were made, the point would fall at 212 MWD/t; but when allowances are made for the fact that several shipments contained more MWD/s and yet less tonnage than their corresponding discharges, it is found that the point could fall as high as 218 MWD/t.

The shape-count data points shown for 7-2-C at 221 MWD/t were obtained from the plutonium contained by about 7 tons of uranium from this discharge. The discharge itself consisted of about 70 tons of uranium. In order to minimize the possibility of cross-contamination of plutonium from this particular discharge with that from other discharges preceding it through the T plant, about 20 consecutive runs of 7-2-C material were allowed to pass through the T plant before the plutonium for this data point was obtained. The fact that two different data points were obtained from the same plutonium is illustrative of the influence which chemical purity has on the n/g-s value. Each gram of plutonium suffers radioactive decay by α particle emission at a rate of about two billion α particles per second. If any of these α particles collide with nuclei of a light element impurity such as magnesium, an α -n reaction can occur. The magnesium nucleus is converted into a silicon nucleus and a neutron is produced. Extra neutrons produced in this fashion are counted along with the neutrons produced as a result of the spontaneous fissions of Pu-240. The second data point for the 7-2-C shape-count was obtained from highly purified plutonium and shows how the n/g-s value dropped as a result of the removal of the light element impurities.

CONCLUSIONS

At present the data seem to indicate that plutonium produced in the C Reactor contains slightly more Pu-240 than does the plutonium from the older reactors. Part of this difference may be due to higher graphite temperatures at C Reactor due to a flatter graphite temperature distribution and part of the difference could be due to a bias in the measurement of C Reactor power output as compared with the measurement of the power output of the older reactors. The bias in this case would be equivalent to under-stating the power output of C Reactor by about 2 1/2 per cent.

The latest information available on the neutron absorption cross-section of Np-239 is 80 ± 20 barns.⁽³⁾ The improvement in quality expected from C Reactor due to high tube power and low Np-239 cross-section⁽⁴⁾ appear to have been cancelled by other effects.

No revision in the equation giving n/g-s as a function of exposure⁽¹⁾ is contemplated until further data become available.

R.O. Gumprecht
 Pile Physics Sub-Unit
 Technical Section
 ENGINEERING DEPARTMENT

R.O. Gumprecht:mbs

(3) Halperin, et.al., CF-54-10-11, p. 69, 10-8-54.

(4) See curves in HW-31431, "Variation of Exposure of Low G/t Material Due to the Dependency of Pu-240 Concentration on Tube Power," J.O. Erkman, 4-12-54.