AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910

301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

1 of 1

DECLASSIFIED

DATE March 14, 1963

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

TITLE	STATUS REPORT
CARBON-14 IN THE CONDENSATE FROM THE SILICA GEL DRYERS OF THE PRODUCTION REACTORS	

AUTHOR

G. B. Barton

ISSUING FILE

THIS DOCUMENT MUST NOT BE LEFT UNATTENDED OR WHEN AN UNAUTHORIZED PERSON MAY HAVE ACCESS TO IT. WHEN NOT IN USE, IT MUST BE KEPT IN AN APPROVED LOCKED CUSTODIARY WITHIN AN APPROVED GUARDED AREA. WHILE IT IS YOUR RESPONSIBILITY TO KEEP IT FROM BEING OBTAINED, SIGNS RECEIVED FROM CLASSIFIED AREAS, IT IS YOUR RESPONSIBILITY TO KEEP IT FROM ITS CONTACTS WITHIN THE LIMITS OF THE ROOM, AND FROM AN UNAUTHORIZED PERSON. NO TRANSMITTAL AND STORAGE IN YOUR PLACE OF BUSINESS IS PROHIBITED. IT IS TO BE FILED, IF PERSONAL FILES ARE REQUESTED OF THEM FROM THE RELATED INFORMATION FILE. PERSONS READING THIS DOCUMENT ARE REQUESTED TO SIGN THE SIGNATURE PROVIDED BELOW.

[illegible]

C-3195-MB (7 - 55) A.E.C.-G.E.-RICHLAND, WASH.

(CLASSIFICATION)

DECLASSIFIED

DECLASSIFIED

HW 76784

STATUS REPORT
CARBON-14 IN THE CONDENSATE
FROM THE SILICA GEL DRYERS
OF THE PRODUCTION REACTORS

BY

G. B. Barton

This document consists of
8 pages, [REDACTED]

Radiological Chemistry
Chemical Research
HANFORD LABORATORIES OPERATION

Classification Cancelled and Changed To

DECLASSIFIED

By Authority of WA Snyder

CG-PR-2, 3-17-94

By DK Hanson, 4-16-94

Verified By Jerry Maly, 4-18-94

March 18, 1963

This document is classified as [REDACTED]
in the [REDACTED] of [REDACTED]
or the [REDACTED] of [REDACTED] to
an unauthorized person is prohibited.

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

MASTER

NOTICE!

This report was prepared for use within General Electric Company in the course of work under Atomic Energy Commission Contract AT-(45-1)-1350, and any views or opinions expressed in the report are those of the authors only. This report is subject to revision upon collection of additional data.

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission to the extent that such employee or contractor prepares, handles or distributes, or provides access to, any information pursuant to his employment or contract with the Commission.

DECLASSIFIED

HW 76784

DISTRIBUTION

	<u>NAME</u>		<u>BLDG.</u>	<u>AREA</u>
1.	A. T. Gifford	- RL00	703	700
2.	C. L. Robinson, Jr.	- RL00	703	700
3.-8.	M. R. Schneller	- RL00	703	700
9.	G. J. Alkire		222U	200W
10.	R. E. Baars		1704D	100D
11.	G. F. Bailey		762	700
12.	G. B. Barton		325	300
13.	R. S. Bell		1704K	100K
14.	R. W. Benoliel		1760D	100D
15.	R. J. Brouns		325	300
16.	L. F. Coleman		222U	200W
17.	J. P. Cooke		1703D	100D
18.	J. P. Corley		1760D	100D
19.	B. R. Cremer		105H	100H
20.	R. F. Foster		3746	300
21.	R. G. Geier		1760D	100D
22.	O. H. Greager		1760D	100D
23.	S. M. Graves		1704D	100D
24.	L. L. Grumme		105KW	100K
25.	R. B. Hall		3746	300
26.	K. M. Harmon		325	300
27.	P. J. Hollifield		1704D	100D
28.	F. E. Holt		329	300
29.	E. R. Irish		329	300
30.	P. C. Jerman		1760D	100D
31.	R. L. Junkins		309	300
32.	R. Ko		329	300
33.	H. A. Kornberg		108F	100F
34.	L. C. Lessor		1704K	100K
35.	R. W. Meisinger		329	300
36.	R. L. Moore		325	300
37.	J. E. Morrissey		1704F	100F
38.	S. L. Nelson		1704H	100H
39.	J. M. Nielsen		325	300
40.	W. H. Radtke		105DR	100D
41.	W. H. Reas		326	300
42.	D. L. Renberger		1704K	100K
43.	M. L. Smith		1760D	100D
44.	M. T. Walling, Jr.		325	300
45.	S. A. Wood, Jr.		105C	100C
46.	P. J. Zimmerman		1704B	100B
47.	300 Files		3760	300
48.	Record Center		3760	300

DECLASSIFIED

STATUS REPORT
CARBON-14 IN THE CONDENSATE
FROM THE SILICA GEL DRYERS
OF THE PRODUCTION REACTORS

by

G. B. Barton

Introduction

Volatile compounds containing C^{14} produced in the cooling gas systems of Hanford reactors can be lost from the cooling gas by two routes. These are (a) escape via the reactor stacks through leaks in the cooling gas system and (b), adsorption with water vapor on the silica gel of the dryers for the cooling gas with subsequent regeneration of the silica gel and condensation of the water for disposal. Information relative to the release rates by the stack gas route was reported in HW-75618⁽¹⁾. The present report provides data relative to the C^{14} loss rates through the condensate obtained from regeneration of the silica gel dryers of the reactor gas cooling systems.

The C^{14} -containing compounds in the reactor gas are produced by n,p reaction on the nitrogen in the coolant gas, an n, γ reaction on carbon in the CO_2 component of the coolant gas, or an n, γ reaction on the graphite moderator with subsequent volatilization ("burnout"). Studies are presently under way to determine the contribution of graphite "burnout" to the C^{14} -containing volatile compounds in the coolant gas. Upon completion of these studies a topical formal report will be issued which will include the findings on the graphite "burnout", the stack gas losses (HW-75618), and the condensate losses (this report).

(1) HW-75618 G. B. Barton, "Release of Carbon-14 from the K Reactor Stacks", November 20, 1962. Confidential

DECLASSIFIED

Summary

Loss of Carbon-14 from the reactor cooling gas system through the condensate is a significant but minor route of loss of this material. Values reported herein vary from 2 - 8% of the total loss with the major loss occurring through the reactor stacks.

Experimental

Because of the probability that the volatile C^{14} compounds removed by the silica gel were in various chemical states, three separations procedures were performed on aliquots of each sample. One procedure was intended to oxidize most of the materials to the carbonate form which were not already in that form. This gave the " $C^{14}O_2$ plus oxidizable" fraction. The procedure consisted of treating the condensate aliquot with alkaline permanganate (which oxidizes many carbon-containing materials to carbonate) and then treating the solution with sulfuric acid to liberate $C^{14}O_2$. This carbon dioxide was absorbed in potassium hydroxide from which it was later again liberated by sulfuric acid and absorbed in the liquid scintillation solution for determination of the C^{14} content. Since it was expected that most of the C^{14} -containing materials in the condensate were already in the carbonate form the $C^{14}O_2$ content was determined by liberating it with sulfuric acid followed by adsorption and counting. The liquid scintillator solution consisted of 1:7:10 ethanolamine:methoxyethanol:toluene with 6 g/l PPO and 0.05 g/l POPOP in the toluene.

Most of the condensate samples were of a deep blue color which appeared to be the copper ammonia complex color. When an aliquot from sample KE 3-28-62 was diluted and acidified a precipitate formed which appeared to be cupric ferrocyanide. The ferrocyanides are resistant to oxidation by alkaline permanganate so that little, if any, C^{14} present in this form would be included in the " $C^{14}O_2$ plus oxidizable" measurement. The C^{14} present as cyanide, ferrocyanide, and ferricyanide

DECLASSIFIED

ions was determined by precipitation of silver cyanide, ferrocyanide, and ferricyanide from an aliquot of the condensate after addition of carrier sodium cyanide. For counting, the precipitate was suspended in the liquid scintillator solution gelled with Cab-O-Sil.

In addition to the C^{14} measurements, chemical measurements were made of the carbonate and ammonium ion contents and the pH of the solutions. The carbonate was determined by liberating CO_2 with sulfuric acid, absorbing the CO_2 in Ascarite, and weighing. The ammonia was liberated with sodium hydroxide, distilled into standard HCl, and determined by back titration with sodium hydroxide solution.

Results and Discussion

The results from the C^{14} analyses on the condensate samples are tabulated in Table I. The "Total" C^{14} column values are the sums of the " $C^{14}O_2$ plus oxidizable" and the $C^{14}N^-$ values. This probably includes all of the C^{14} compounds in the condensate, but the values could be high if some of the cyanide compounds are oxidizable, or could be low if there are C^{14} -containing compounds present which are not oxidizable by alkaline permanganate. Since the presence of unoxidizable compounds other than the ferrocyanides seems unlikely and since the purpose of these studies was met with the present measurements, no total C^{14} measurement was made. Individual sample results vary widely, with an especially marked difference between the K reactors and D, DR and F reactors.

This is due in part to the much lower moisture content of the K reactors. Also, because of the low moisture content of the K reactor cooling gas the dryers are used for long times before regeneration. This allows the ammonium ion content of the silica gel to build up. The direct adsorption of ammonia by silica gel is much greater than for CO_2 and the adsorption of ammonia increases the retention of the CO_2 by formation of ammonium carbonate or bicarbonate.

DECLASSIFIED

HW 76784

Typical volumes of condensate produced during this period are 3-10 gal/wk (~1500-5000 ml/day) for the K reactors and 100 gal/wk (~50,000 ml/day) for D reactor. Thus the K reactors produce 1500-5000 ml/day x 1.29 $\mu\text{c/ml}$ = 1930 - 6450 $\mu\text{c/day}$, or .002 to .006 curies of C^{14} per day. D reactor produces 50000 ml/day x 0.016 $\mu\text{c/ml}$ = 800 $\mu\text{c/day}$ or 0.0008 curies C^{14} per day. The C^{14} released via stack gases as reported in HW-75618 were 0.07 c/day for the K reactors and 0.035 c/day for B and C reactors. Thus for the K reactors

$$\left(\frac{0.002}{0.07-0.002}\right)100 = 3\% \text{ to } \left(\frac{0.006}{0.07 + 0.006}\right)100 = 8\% \text{ of}$$

the C^{14} from the reactor coolant gas is released via the condensate. For the D reactor the value is $\left(\frac{0.0008}{0.035 + 0.0008}\right)100 = 2\%$. Thus the release via the condensate is a significant but minor route of loss of C^{14} from the reactor coolant gas.

The results of the chemical analyses on the condensate samples are presented in Table II. In most of the samples there is an excess of ammonia over that required to combine with the measured amount of carbon dioxide for the formation of ammonium carbonate. The measured pH generally reflects the excess ammonia rather than the total ammonia. The samples from D and F reactors show the effect of more rapid water collection with consequent shorter time to accumulate ammonia.

DECLASSIFIED

TABLE I
CONDENSATE C¹⁴ ANALYSES

Sample	C ¹⁴ O ₂ plus Oxidizable μc/ml	C ¹⁴ O ₂ μc/ml	C ¹⁴ N ⁻ μc/ml	"Total"* C ¹⁴ μc/ml
KE 3-28-62	3.95	3.24	0.78	4.73
KE 9-28-62	1.15	1.10	0.32	1.47
KE 10-24-62	0.59	0.57	0.36	0.85
KE 11-30-62	0.58	0.27	0.089	0.67
KE 12-3-62	0.49	0.30	0.15	0.54
KW 6-23-61	0.025	0.0077	0.16	0.19
KW 12-3-62	<u>0.38</u>	<u>0.35</u>	<u>0.20</u>	<u>0.58</u>
Average K Reactors	1.02	0.83	0.29	1.29
D 10-31-62	0.0003	1.9 x 10 ⁻⁵	0.0064	0.0067
DR 6-5-59	0.00034	0.09 x 10 ⁻⁵		
DR 6-9-59	0.00017		0.025	0.025
F 11-30-62	<u>0.00063</u>	<u>14 x 10⁻⁵</u>		
Average D, DR, F Reactors	0.00036	5.3 x 10 ⁻⁵	0.015	0.016

* "Total" C¹⁴ column values are the sums of the C¹⁴O₂ plus oxidizable and the C¹⁴N⁻ columns. (See text).

DECLASSIFIED

HW 76784

TABLE II
CONDENSATE CHEMICAL ANALYSES

<u>Sample</u>	<u>CO₂ M</u>	<u>NH₃ M</u>	<u>pH</u>
KE 3-21-62	1.73	3.19	9.32
KE 9-28-62	0.87	1.72	9.47
KE 10-24-62	0.41	1.59	9.90
KE 11-30-62	0.28	1.11	9.80
KE 12-3-62	0.28	1.03	9.77
KW 6-23-61	0.16	1.28	9.00
KW 12-3-62	0.40	0.91	9.60
D 10-31-62	0.002	<0.001	6.58
F 11-30-62	0.0039	0.015	7.72

DECLASSIFIED

DATE

FILMED

8/2/94

END