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1949

GENERAL ELECTRIC  
COMPANY

HW--31282

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Classified by W. Lang

April 1, 1954

This document consists of 22 pages.

RUPTURED SLUG DATA AND COMPARATIVE RUPTURE RATES

JANUARY THROUGH MARCH 1954

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CG-PR-3

BY Ted Davis

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## **DISCLAIMER**

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This document contains in Part I past and current rupture information which may be pertinent to future rupture rates.

Part II contains an extension of the data formerly reported. Comparative rupture rates are tabulated by pile charge, by individual operating areas, and by metal groupings. These rates are computed by the "Equivalent Exposure" method of rupture rate evaluation outlined in some detail in HW-25145.

Part III contains data on the slugs which ruptured from January 1 through March 31, 1954.

## PART I

### FAILURES OF SPECIAL LOADINGS

From January 1 through March 31, 1954, six ruptured "C" Metal enrichment pieces were discharged from five H Pile tubes. Three of the pieces had pinholes or cracks at the weld. The other three showed evidence of water penetration of the side wall.

During this period seven ruptured "J" Metal enrichment pieces were discharged from DR Pile. Five of the pieces exhibited cracks in the can wall near the weld end. One piece, which had been in the pile for two weeks, had a pinhole in the weld. Subsequent examination of pre-charging radiographs revealed the faint outlines of a bubble in the weld. The seventh piece, which had been in-pile for four days, had no visible hole in the jacket or weld. However, the piece was markedly swollen. Pre-charging radiographs of the piece disclosed no flaws. The ruptures, except for the two which had been operating only a short time, emitted fission gasses, contaminating the storage area.

A side failure occurred in a 10-66 thorium piece at H Pile. Beneath the hole in the can wall the metal was recessed as if the piece had been machined to a cylindrical shape and then approximately one-half of the piece had been machined about a different center, leaving a "step" on one side. At the time of failure this metal had reached an exposure of approximately 500 MWD/AT.

A uranium cleavage failure of a 0.4% Cr-U alloy piece occurred at D Pile at an exposure of 832 MWD/T. Five tubes had been charged, each containing six alloy pieces and fifty-eight four-inch uranium pieces. The other four tubes had been discharged at exposures from 150 to 700 MWD/T.

Ten broken eight-inch pieces were discovered in the metal discharged from H Pile on 1-6-54. The pieces were all broken transversely near the center. They were flattened at each end as if they had fallen, striking both ends against something solid. (1) One slug, when first noticed was in one piece, with a sunken ring around the middle of the can, and while being handled it broke along this ring and fell into two separate halves. This was the largest discharge to date at H Pile, and

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(1) O'Keefe, D. P., "Broken Slugs from January 5, 1954 Discharge at 100-H", HW-30910, 2-19-54.

consequently the metal was piled higher in the chutes than it was during previous discharges. The appearance of the pieces indicates that they may have fallen to the pile of metal with forces sufficient to break them. The appearance of the one which broke while being handled, however, indicates that the slugs were defective when discharged.

Canning data on these broken pieces showed no similarities in their pre-irradiation histories.

In addition one broken piece was discovered in the low exposure metal discharged from H-Pile on 3-15-54.

#### RELATIONSHIP BETWEEN RUPTURE RATE AND EXPOSURE

The number of equivalent tubes, EN, used in calculating rupture rates is calculated by use of a plot of exposure vs. percent of total ruptures occurring by the time this exposure is attained. For example, should one-half of the ruptures occurring in metal exposed to 600 MWD/T have occurred by the time the metal was exposed to 500 MWD/T, than one tube at an exposure of 500 MWD/T would be equivalent to one-half tube at goal. The relationship used has held fairly constant for various break-downs by type of failure, by metal group, or by region of charging.

Since the region 0 to 600 MWD/T showed merely the lower end of a rapidly increasing curve, however, it was not possible to extrapolate to high exposures with much accuracy. In view of the proposed increase in goal exposures, therefore, metal in the "Hot-spot" at C-Pile was allowed to reach an exposure of 900 MWD/T in order (2) to discover if a prohibitive rupture rate might be reached in this exposure region.

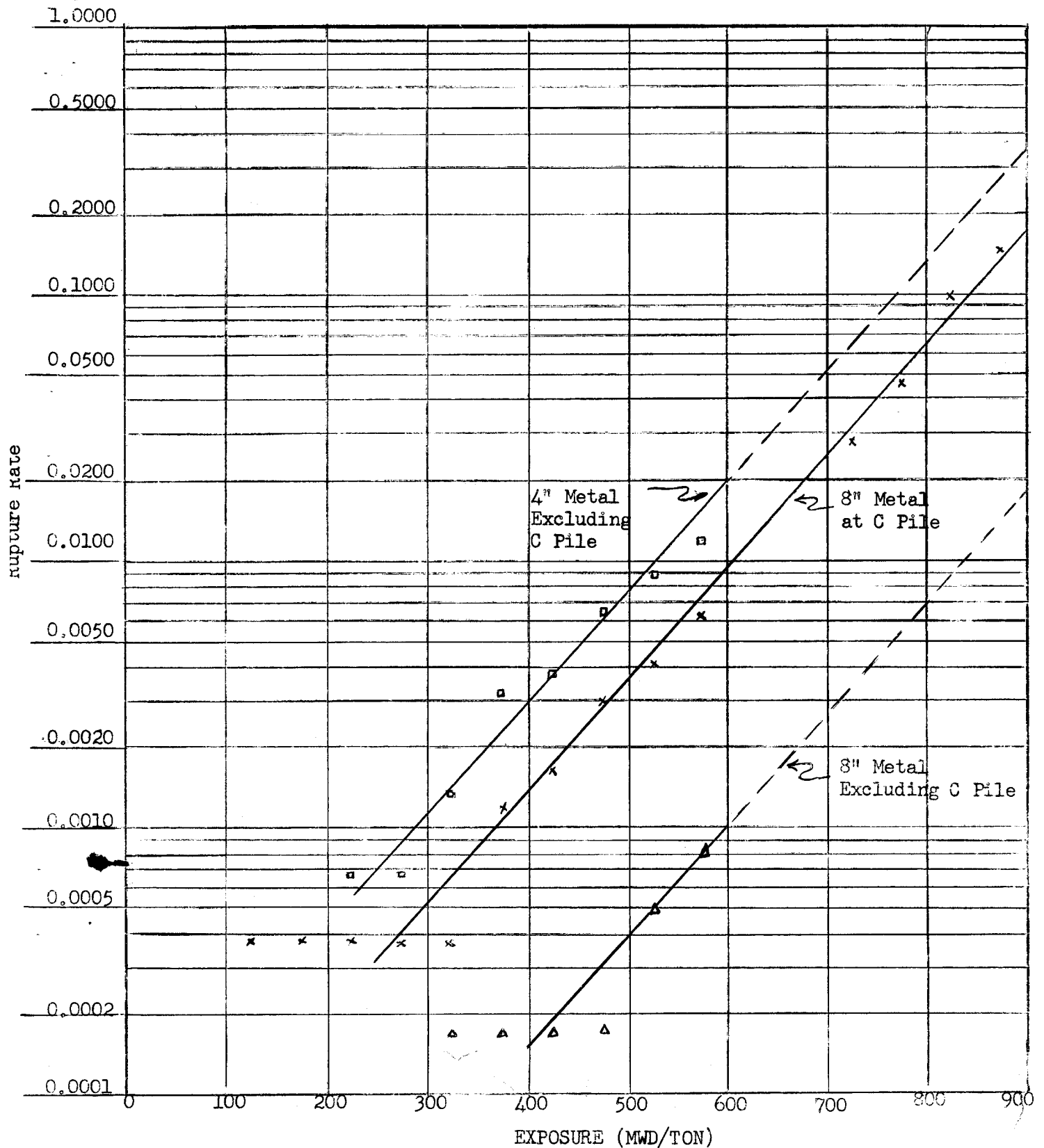
In Figure I data from this test are plotted with other data, for metal at lower exposures, taken from C-Pile. This plot shows an exponential increase, reaching a rupture rate of  $\sim 0.17$  failures per tube irradiated to 900 MWD/T. Data are also plotted for four-inch metal and for eight-inch metal at piles other than C. Some eight-inch metal at B, F, and H Piles is presently being irradiated to an exposure of 900 MWD/T in order to test the validity of the extrapolation shown in Figure I and to determine what exposures are feasible for this metal. In any event it appears that the irradiation of present metal at C-Pile or of present four-inch metal at any pile to exposures much above 600 MWD/T is not feasible.

The difference between the rupture rates at C Pile and at other piles may be due in part to the higher powers at C. However, a study of rupture rate vs. tube power at C-Pile showed no definite relationship; however, the data on which this study was based were not as good as might be desired. It may be that there exists a correlation which is not detectable from the present data. There may also be other operational factors which have not yet been considered and which might help explain the higher rate at C-Pile.

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(2) Lang, L. W., "Production Test 105-549-A - Exposure Increases In High Power Tubes at C-Pile", HW-29638, 10-15-53.

FIGURE I  
RUPTURE RATES OF FOUR AND EIGHT-INCH METAL VS. EXPOSURE  
FOR IRRADIATION FROM JULY 1, 1953 THROUGH MARCH 31, '54



PART IICOMPARATIVE RUPTURE RATES

To determine the rupture resistance of manufactured metal by pile irradiation requires approximately 8 to 12 months from the time the metal is charged into the pile. By use of the "Equivalent Exposure" method outlined in HW-25145, early estimates of slug rupture rates can be made with a fair degree of accuracy as soon as 3 or 4 months after pile charging. This method is based on the observation that the relationship between rupture rate and exposure has been fairly constant for all metal groups. Rupture rates are determined by evaluating the fraction,  $R/EN$ , where  $R$  is the number of ruptures that have occurred in a considered number of tubes,  $N$ , and where  $EN$  is a summation of the weighted fractional exposures of each tube. Tests of past data indicate that the uncertainty of the rupture rate computed on this basis, where only a few ruptures have occurred, can be approximately represented by  $\pm 1/EN$  when compared to the final rate established when all tubes under consideration have been discharged at 600 MWD/T. Since these rates are expressed as ruptures per tube exposed to 600 MWD/T, ruptures in tubes at higher exposures are not included in the tabulations.

By use of this method it is possible to calculate the effect of changed operating conditions or changed metal quality upon rupture characteristics of metal without waiting for final discharge. It is also a convenient and fairly accurate method of tabulating rupture experience for given intervals of time to aid in correlating ruptures with operating and manufacturing variables.

In the following pages, rupture rates are tabulated by date of pile charge, by individual operating areas, and by metal groupings. The rupture experience from January 1 through March 31, 1954 is shown for four-inch and eight-inch metal. Group 9 Metal was first charged in January, 1952. In Table 1, rupture rates for Group 9 Metal and for Group 8 Metal charged after January 1, 1952 are given so that the performances of the two metal groups under similar operating conditions may be compared. The rate for Group 9 Metal charged after May 1, 1953 is also given for a comparison with that of Group 10 and 11 metal under similar operating conditions. In this case, however, the lack of knowledge as to how many tubes of each type of metal were charged and as to the positions of charging necessitate assumptions which decrease the accuracies of these rates.

TABLE IRUPTURE RATES FOR DIFFERENT METAL GROUPS  
(Rates Determined as of March 31, 1954 )

<u>Type Metal</u>	<u>Equivalent Number of Tubes (EN)</u>	<u>Number of Ruptures (R)</u>	<u>Rupture Rate</u>
Group 7(1)	2,356	86	0.0365
Group 8	12,237	117	0.0096
Group 8:B,C,D,DR,H Piles	9,850	76	0.0077
Group 8 Charged Jan. 1, 1952 or Later: B,C,D,DR, H Piles	5,413	35	0.0065
Group 9	10,161	14	0.0014
Group 9 Charged May 1, 1953 or Later	1,130	7	0.0062
Groups 10 and 11	4,056	13	0.0032
Group 12	275	1	0.0036
PT 313-105-3-M Metal	666	0	-----
PT 313-105-7-M Metal	283	1	0.0035
PT 313-105-25-M Metal	626	1	0.0016

(1) Charged January 1, 1951 to May 1, 1951.

TABLE II

GROUP 8 AND GROUP 12 RUPTURE RATES BY CHARGE DATES — ALL PILES

Rates Determined as of March 31, 1954

<u>Metal Charged</u>	<u>Equivalent Number of Tubes (EN)</u>	<u>Cap Failures</u>		<u>Uranium Cleavage Failures</u>		<u>Total Failures*</u>	
		<u>No. Ruptures (R)</u>	<u>Rate</u>	<u>No. Ruptures (R)</u>	<u>Rate</u>	<u>No. Ruptures (R)</u>	<u>Rate</u>
May-Dec. 1951	5367	25	0.0047	16	0.0030	60	0.0112
Jan-June 1952	3535	21	0.0059	2	0.0006	33	0.0093
July-Dec. 1952	2078	2	0.0010	4	0.0019	6	0.0029
Jan-Feb. 1953	439	0	-----	2	0.0046	3	0.0068
Mar-Apr. 1953	296	2	0.0068	0	-----	3	0.0101
May-June 1953	307	4	0.0130	1	0.0033	8	0.0261
July-Aug. 1953	209	1	0.0048	1	0.0048	2	0.0096
Sept-Oct. 1953	150	1	0.0067	0	-----	2	0.0133
Nov.-Dec. 1953	116	0	-----	0	-----	0	-----
Jan.-Feb. 1954	15	0	-----	0	-----	0	-----

\* Not necessarily equal to the sum of cap failures and uranium cleavage failures since some ruptures do not fall into either category.

TABLE III

GROUP 8 AND GROUP 12 RUPTURE RATES BY CHARGE DATES -- B, C, D, DR, H PILES

Rates Determined as of March 31, 1954

Metal Charged	Equivalent Number of Tubes (EN)	<u>Cap Failures</u>		<u>Uranium Cleavage Failures</u>		<u>Total Failures*</u>	
		<u>No. Ruptures (R)</u>	<u>Rate</u>	<u>No. Ruptures (R)</u>	<u>Rate</u>	<u>No. Ruptures (R)</u>	<u>Rate</u>
May-Dec. 1951	4437	20	0.0045	8	0.0018	42	0.0095
Jan.-June 1952	2719	10	0.0037	2	0.0007	16	0.0059
July-Dec. 1952	1966	2	0.0010	4	0.0020	6	0.0031
Jan.-Feb. 1953	198	0	-----	1	0.0051	2	0.0101
Mar.-Apr. 1953	198	2	0.0101	0	-----	2	0.0101
May-June 1953	224	2	0.0089	1	0.0045	5	0.0223
July-Aug. 1953	131	1	0.0076	1	0.0076	2	0.0153
Sept.-Oct. 1953	93	1	0.0108	0	-----	2	0.0215
Nov.-Dec. 1953	56	0	-----	0	-----	0	-----
Jan.-Feb. 1954	11	0	-----	0	-----	0	-----

\* Not necessarily equal to the sum of cap failures and uranium cleavage failures since some ruptures do not fall into either category.

TABLE IV

GROUPS 9, 10, AND 11 RUPTURE RATES BY CHARGE DATES -- ALL FILES

Rates Determined as of March 31, 1954

<u>Metal Charged</u>	<u>Equivalent Number of Tubes (EN)</u>	<u>Cap Failures</u>		<u>Uranium Cleavage</u>		<u>Side Failures</u>		<u>Total Failures*</u>	
		<u>No. Ruptures (R)</u>	<u>Rate</u>	<u>No. Ruptures (R)</u>	<u>Rate</u>	<u>No. Ruptures (R)</u>	<u>Rate</u>	<u>No. Ruptures (R)</u>	<u>Rate</u>
Jan.-June 1952	2014	0	-----	0	-----	5	0.0025	5	0.0025
July-Dec. 1952	4950	0	-----	1	0.0002	0	-----	1	0.0002
Jan.-Feb. 1953	1031	0	-----	0	-----	0	-----	0	-----
Mar-Apr. 1953	1081	0	-----	1	0.0009	0	-----	1	0.0009
May-June 1953	1803	0	-----	7	0.0039	2	0.0011	10	0.0055
July-Aug. 1953	1296	0	-----	0	-----	2	0.0015	3	0.0023
Sept.-Oct. 1953	1349	0	-----	4	0.0030	0	-----	6	0.0044
Nov.-Dec. 1953	544	0	-----	1	0.0018	0	-----	1	0.0018
Jan.-Feb. 1954	149	0	-----	0	-----	0	-----	0	-----

\* Not necessarily equal to the sum of cap, side, and uranium cleavage failures since some ruptures do not fall into these categories.

TABLE V

RUPTURE RATES BY INDIVIDUAL AREAS — GROUPS 8 THROUGH 12

Rates Determined as of March 31, 1954

Manufacturing Area	Equivalent Number of Tubes (EN)	Cap Failures		Uranium Cleavage Failures		Total Failures*	
		No. Ruptures (R)	Rate	No. Ruptures (R)	Rate	No. ruptures (R)	Rate
B	4114	15	0.0036	5	0.0012	28	0.0068
C	4676	1	0.0002	18	0.0038	23	0.0049
D	4345	11	0.0025	1	0.0002	13	0.0030
DR	4043	4	0.0010	4	0.0010	14	0.0035
F	4134	19	0.0046	9	0.0022	41	0.0099
H	5417	7	0.0013	3	0.0006	25	0.0046

\* Not necessarily equal to the sum of cap failures and uranium cleavage failures since some ruptures do not fall into either category.

TABLE VI

JANUARY - MARCH RUPTURE EXPERIENCE FOR REGULAR PRODUCTION METAL

(PT 313-105-25-M Not Included)

Area	No. Equivalent Tubes (EN) Irradiated from Jan. 1 Through March 31, 1954	<u>Cap Failures</u>		<u>Uranium Cleavage Failures</u>		<u>Total Failures*</u>	
		No. Ruptures (R)	Rate	No. Ruptures (R)	Rate	No. Ruptures (R)	Rate
B - 8" Metal	304	0	---	0	---	0	---
C - 8" Metal	1005	0	---	5	0.0050	6	0.0060
D - 8" Metal	389	0	---	0	---	0	---
DR - 8" Metal	250	0	---	0	---	0	---
F - 8" Metal	317	0	---	0	---	0	---
H - 8" Metal	616	0	---	0	---	2	0.0032
8" Metal at all Piles	2881	0	---	5	0.0017	8	0.0028
4" Metal at all Piles	689	4	0.0058	1	0.0015	8	0.0116

\* Not necessarily equal to the sum of cap failures and uranium cleavage failures since some ruptures do not fall into either category.

RUPTURED SLUG DATA

The following table contains the data for those slugs which ruptured during the period January 1, 1954 through March 31, 1954.

Data Sources

1. Tube number - Reactor Section ruptured slug reports
2. Failure number - Chronological order of failures from Reactor Section daily report sheets.
3. Date charged - Reactor Section file of charge cards.
4. Days in pile - Calculated from charge dates and failure dates.
5. Days of operation - Days in the pile minus days down.
6. Tube exposure - Reactor Section production scheduling.
7. Tube power at failure -  $(.264) (\Delta T) (\text{flow})$
8. Tube power average -  $(\text{Exposure}) (\text{Charge Weight})$
9. Slug power = 
$$\frac{(3) (\text{Tube Power}) (\text{Radiation Level of Rupture})(12)}{(\text{Sum of Radiation Levels}) (\text{Length of Active Metal in Slug})}$$
10. Local H<sub>2</sub>O temperature - Assumed cosine flux distribution reported for exact position only because of error in estimated slug position.
11. Slug position - Only exact slug position reported. Slug positions estimated from weasel data were found to be in error as much as 30 per cent due to pile flattening and non-cosine flux distribution.
12. Canning date - Visual inspection of piece.
13. Type metal - Regularly machined pieces, or re-processed rejects from slug markings and Metal Preparation Section.
14. Manufacturing truck number and line number - Obtained from slug markings and Metal Preparation Section.
15. Lot number - Metal from which slug manufactured. Obtained from slug markings and Metal Preparation Section.
16. Metal group number - Obtained from canning date and/or lot number.
17. Days up since last start-up - Reactor Section daily report sheets.
18. Total number of shutdowns - Reactor Section daily report sheets.
19. Number of rapid shutdowns - Reactor Section daily report sheets.
20. Tube zone - Technical Section temperature maps.
21. Type of failure - Visual inspection of piece.
22. Downtime due to rupture - Reactor Section rupture slug reports.

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(3) The factor 12/(Length of active metal in slug) is introduced to get the power in KW/foot of active metal. Use of this unit will allow powers of slugs of any length to be compared directly with one another.

Possible Errors in Data

1. Tube power  $\pm$  5 per cent because flow not certain.
2. Slug power  $\pm$  10 per cent because of tube power error.
3. Local H<sub>2</sub>O temperature  $\pm$  10 per cent because of non-cosine flux distribution.

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JK Anderson/bam

TABLE VII

RUPTURED SLUG DATA

Tube Number	2178-C	0456-C	0978-C	0668-H	2478-C	3486-C
Failure Number	299	300	301	302	303	304
Date Failed	1-3-54	1-7-54	1-8-54	1-17-54	1-18-54	1-20-54
Date Charged	8-3-53	11-18-52	10-5-53	8-2-53	8-3-53	10-24-53
Days in Pile	154	415	95	168	168	88
Days of Operation	123	362	75	136	135	72
Tube Exposure	703	584	353	525	769	352
Tube Power at Failure	870	383	456	537	877	612
Tube Power Average	732	206	602	494	729	626
Slug Power	40.3	21.9	26.3	*	49.3	36.2
Local H <sub>2</sub> O Temperature	*	*	*	*	*	*
Slug Position	*	*	*	*	*	*
Canning Date	5-19-53	12-26-51	8-24-53	6-20-53	6-22-53	6-12-53
Type Metal	Reg.	Reg.	Reg.	Reprocess	Reprocess	Reg.
Manufacturing Truck No. and Line No.	B-7	G-8	B-4	H-6	H-11	B-9
Lot Number	F-94	252-H	70	Z-34	Z-35	F-125
Metal Group Number	11	8	9	11	11	11
Days up Since Last Startup	<1	3	<1	5	8	1
Total Number of Shutdowns	69	126	54	55	73	32
Number of Rapid Shutdowns	66	114	52	47	70	30
Tube Zone	.385	.318	.385	.313	.385	.385
Type of Failure	Split	Cap	Non. Class.	Side	Non Class.	Split
Downtime Due to Rupture	26.7	0.4	27.0	28.2	0.4	31.7

\* Data not available.

TABLE VII

RUPTURED SLUG DATA (Cont'd.)

Tube Number	2375-C	2479-C	3284-H	3684-B	2190-C	4067-D
Failure Number	305	306	307	308	309	310
Date Failed	1-25-54	1-26-54	2-1-54	2-2-54	2-4-54	2-5-54
Date Charged	8-3-53	8-3-53	7-18-53	8-13-53	10-4-53	4-23-53
Days in Pile	175	176	198	173	123	288
Days of Operation	140	140	163	149	98	256
Tube Exposure	837	847	581	487	483	832
Tube Power at Failure	878	925	502	457	663	557
Tube Power Average	765	774	456	418	631	416
Slug Power	34.3	34.6	*	*	27.8	33.8
Local H <sub>2</sub> O Temperature	*	*	*	*	*	61.6
Slug Position	*	*	*	*	*	40
Canning Date	6-23-53	6-20-53	5-29-53	6-2-53	8-21-53	*
Type Metal	Reg.	Reg.	Reprocess	Reg.	Reg.	*
Manufacturing Truck No. and Line No.	B-	B-3	H-	G-6	B-7	*
Lot Number	F-130	F-131	Z-30	F-32	76	*
Metal Group Number	11	11	11	12	9	PT 313-105-13-M
Days up Since Last Startup	2	<1	1	18	8	<1
Total Number of Shutdowns	76	77	67	32	60	53
Number of Rapid Shutdowns	73	74	59	20	58	33
Tube Zone	.385	.385	.313	.240	.385	.283
Type of Failure	Split	Split	Side	Split	Split	Split
Downtime Due to Rupture	32.4	2.2	0.6	27.0	0.6	0.6

TABLE VII

## RUPTURED SLUG DATA (Cont'd.)

Tube Number	2474-C	2471-C	2372-C	2182-C	2672-C	3880-B
Failure Number	311	312	313	314	315	316
Date Failed	2-6-54	2-6-54	2-7-54	2-7-54	2-8-54	2-9-54
Date Charged	8-3-53	6-27-53	8-3-53	8-3-53	8-5-53	6-30-53
Days in Pile	187	224	188	188	187	224
Days of Operation	151	187	151	151	152	194
Tube Exposure	888	1056	885	840	884	487
Tube Power at Failure	833	755	773	752	701	364
Tube Power Average	753	723	750	712	744	321
Slug Power	*	*	*	*	*	22.1
Local H <sub>2</sub> O Temperature	*	*	*	*	*	22.1
Slug Position	*	*	*	*	*	25
Canning Date	6-22-53	5-19-53	6-24-53	6-20-53	6-23-53	1-17-53
Type Metal	Reprocess	Reg.	Reg.	Reg.	Reg.	Reg.
Manufacturing Truck No. and Line No.	B-1	H-2	B-9	B-6	B-10	G-9
Lot Number	Z-35	F-119	F-134	F-131	F-130	F-11
Metal Group Number	11	11	11	11	11	8
Days up Since Last Startup	<1	<1	<1	<1	<1	3
Total Number of Shutdowns	80	83	81	81	83	42
Number of Rapid Shutdowns	77	79	78	78	80	24
Tube Zone	.385	.385	.385	.385	.385	.240
Type of Failure	Split	Split	Non Class.	Split	Split	Non.
Downtime Due to Rupture	(1)	(1)	(2)	(2)	0.6	28.0

\* Data not available

- (1) These two ruptures were discharged during one outage. A total of 28.0 hours was charged to them.  
 (2) These two ruptures were discharged during one outage. A total of 2.1 hours was charged to them.

TABLE VII

RUPTURED SLUG DATA (Cont'd.)

Tube Number	2473-C	2273-C	2374-C	2472-C	2377-C (4)	2676-C (4)
Failure Number	317	318	319	320	321	322
Date Failed	2-10-54	2-12-54	2-14-54	2-19-54	2-25-54	3-1-54
Date Charged	8-3-53	8-3-53	9-3-53	9-3-53	9-3-53	9-3-53
Days in Pile	191	193	164	169	175	179
Days of Operation	154	155	131	134	137	141
Tube Exposure	927	953	793	758	828	831
Tube Power at Failure	874	766	785	718	818	827
Tube Power Average	770	787	775	724	774	754
Slug Power	*	*	*	*	39.0	*
Local H <sub>2</sub> O Temperature	*	*	*	*	20.3	*
Slug Position	*	*	*	*	9	*
Canning Date	5-19-53	5-19-53	7-22-53	7-16-53	7-21-53	7-16-53
Type Metal	Reg.	Reg.	Reg.	Reg.	Reg.	Reg.
Manufacturing Truck No. and Line No.	H-5	B-8	H-3	H-7	H-2	G-7, 9
Lot Number	F-94	F-94	57-H	46-H	53-H	46
Metal Group Number	11	11	9	9	9	9
Days up Since Last Startup	2	< 1	1	< 1	2	< 1
Total Number of Shutdowns	84	86	76	78	82	84
Number of Rapid Shutdowns	81	83	74	75	78	80
Tube Zone	.385	.385	.385	.385	.385	.385
Type of Failure	Split	Split	Split	Split	Split	Split
Downtime Due to Rupture	29.6	8.0	28.7	3.3	29.0	(3)

(3) Ruptures in tubes 2676-C and 2874-C were discharged during one outage. A total of 29.4 hours was charged to them.

(4) Metal from these three tubes was mixed in the chutes. Five ruptured pieces were found and were arbitrarily assigned, two to tube 2377, two to tube 2676, and one to tube 2874. All five pieces were split

\* Data not available.

TABLE VII

RUPTURED SLUG DATA (Cont'd.)

Tube Number	2874-C <sup>(4)</sup>	3673-D	1183-C	3870-F	2262-C	2674-C
Failure Number	323	324	325	326	327	328
Date Failed	3-1-54	3-2-54	3-4-54	3-5-54	3-7-54	3-8-54
Date Charged	9-3-53	9-21-53	10-6-53	6-21-53	10-10-53	11-10-53
Days in Pile	179	162	149	257	148	118
Days of Operation	141	147	115	218	114	90
Tube Exposure	819	619	589	747	565	446
Tube Power at Failure	807	560	729	476	696	803
Tube Power Average	743	539	656	439	634	634
Slug Power	*	*	*	27.2	*	*
Local H <sub>2</sub> O Temperature	*	*	*	*	*	*
Slug Position	*	*	*	*	*	*
Canning Date	7-22-53	*	8-21-53	11-18-52	3-10-53	9-10-53
Type Metal	Reg.	*	Reg.	Reg.	Reg.	Reg.
Manufacturing Truck No. and Line No.	G-1	*	B-2	B-3	H-6	H-3
Lot Number	57-H	*	72	333	18-H	F-182
Metal Group Number	9	8	9	8	9	11
Days up Since Last Startup	<1	<1	1	4	1	<1
Total Number of Shutdowns	84	30	79	47	65	51
Number of Rapid Shutdowns	80	19	75	31	61	49
Tube Zone	.385	.283	.385	.313	.385	.385
Type of Failure	Split	Comp. Cap	Split	Side	Split	Split
Downtime Due to Rupture	(3)	0.6	29.0	30.6	27.5	12.2

(3) Ruptures in tubes 2676-C and 2874-C were discharged during one outage. A total of 29.4 hours was charged to them.

\* Date not available.

TABLE VII

## RUPTURED SLUG DATA (Cont'd.)

Tube Number	3666-B	4085-D	3666-D <sup>(5)</sup>	2664-D	3860-B	2382-C
Failure Number	329	330	331	332	333	334
Date Failed	3-8-54	3-18-54	3-18-54	3-18-54	3-19-54	3-19-54
Date Charged	7-6-53	8-19-53	6-19-53	9-21-53	9-10-53	10-20-53
Days in Pile	245	211	272	178	190	150
Days of Operation	205	188	241	160	144	117
Tube Exposure	674	565	872	592	384	670
Tube Power at Failure	518	413	598	537	318	713
Tube Power Average	421	382	463	474	341	733
Slug Power	*	*	*	*	*	*
Local H <sub>2</sub> O Temperature	*	*	*	*	*	*
Slug Position	*	*	*	*	*	*
Canning Date	5-28-53	6-26-53	*	8-4-53	6-4-53	7-22-53
Type Metal	Reg.	Reprocess	*	Reg.	Re-work	Reg.
Manufacturing Truck No. and Line No.	G-3	G-7	*	C-5	G-2	C-5
Lot Number	F-19	ZR-21	*	F-170	RW-6	61-H
Metal Group Number	8	8	PT 313-105-3-M	PT 313-105-25-M	8	9
Days up Since Last Startup	1	4	<1	<1	<1	10
Total Number of Shutdowns	46	43	52	37	39	61
Number of Rapid Shutdowns	26	27	31	24	24	57
Tube Zone	.313	.240	.238	.283	.250	.385
Type of Failure	Split	Cap	*	Split	Side	Non Class.
Downtime due to Rupture	27.0	0.8	(6)	(6)	27.0	30.6

(5) The ruptured piece from this tube was mixed with discharged metal and was lost.

(6) These two tubes were discharged during one outage. A total of 26.0 hours was charged to them.

\* Data not available.

TABLE VII

RUPTURED SLUG DATA (Cont'd.)

Tube Number	4366-C	2378-H	4362-F	2051-B
Failure Number	335	336	337	338
Date Failed	3-21-54	3-28-54	3-28-54	3-30-54
Date Charged	8-3-53	6-26-53	5-5-53	3-2-52
Days in Pile	230	275	327	758
Days of Operation	180	228	271	616
Tube Exposure	663	900	519	510
Tube Power at Failure	597	603	292	150
Tube Power Average	470	505	245	106
Slug Power	*	34.6	14.8	*
Local H <sub>2</sub> O Temperature	*	63.5	*	*
Slug Position	*	20	*	*
Canning Date	6-23-53	5-19-53	1-7-53	*
Type Metal	Reg.	Special	Reprocess	*
Manufacturing Truck No. and Line No.	H-6, 7, 9	*	B-9	*
Lot Number	F-130	Special	ZR-218	*
Metal Group Number	11	11	8	8
Days up Since Last Startup	<1	8	8	<1
Total Number of Shutdowns	101	88	55	152
Number of Rapid Shutdowns	96	75	35	90
Tube Zone	.385	.313	.221 - .316	.149 - .182
Type of Failure	Split	Side	Comp. Cap	*
Downtime due to Rupture	1.4	26.0	49.0	29.0

\* Data not available.

TABLE VIII

RUPTURED AL-U<sup>235</sup> ALLOY SLUGS

Tube Number	0579-H	0579-H	0686-H	1955-H	4159-H	2966-DR
Failure Number	C-31	C-32	C-33	C-34	C-35	J-4
Date Discharged	1-6-54	1-6-54	1-6-54	1-6-54	1-6-54	1-13-54
Date Charged	12-22-52	12-22-52	1-18-53	11-25-52	12-22-52	7-1-53
Days in Pile	380	380	353	407	380	196
Days of Operation	304	304	278	329	304	188
Tube Exposure (U <sup>235</sup> Depletion)	26.5%	26.5%	23.2%	23.9%	23.1%	11.2%
Tube Exposure (MWD/AT)	976	976	855	880	851	552
Tube Power Near Discharge	462	462	463	459	380	410
Tube Power Average	376	376	361	340	324	372
Slug Power (KW/ft.)	30.3	31.6	30.3	*	24.2	31.3
Local H <sub>2</sub> O Temp.	50.7	44.7	32.0	*	49.0	*
Slug Position with Respect to Upstream Enriched Piece	20	17	11	*	21	7
Lot and Piece Number	C-2;1089	C-2;1092	C-2;1387	C-2;42	C-2;392	J-2; R-2-29
Type of Failure	Cap	Cap	Side	Cap	Side	Side Tear

\* Data Unavailable.

TABLE VII

RUPTURED AL-U<sup>235</sup> ALLOY SLUGS

Tube Number	3186-DR	1967-DR	0573-DR	2964-DR	2955-H	3368-DR	2063-DR
Failure Number	J-5	J-6	J-7	J-8	G-36	J-9	J-10
Date Discharged	1-15-54	3-2-54	3-2-54	3-9-54	3-17-54	3-17-54	3-21-54
Date Charged	4-7-53	6-9-53	5-1-53	5-1-53	12-23-52	3-3-54	3-17-54
Days in Pile	283	266	305	312	449	14	4
Days of Operation	264	252	286	291	356	12	~1
Tube Exposure (U <sup>235</sup> Depletion)	14.2%	16.3%	13.0%	16.6%	28.2%	0.6%	~0
Tube Exposure (MWD/AT)	700	803	637	818	1038	32	~0
Tube Power Near Discharge	390	478	417	413	403	492	-----
Tube Power Average	336	405	284	358	342	*	-----
Slug Power (KW/ft.)	29.8	36.4	31.8	31.5	25.7	*	*
Local H <sub>2</sub> O Temp.	*	50.7	48.6	37.6	48.9	*	*
Slug Position with Respect to Upstream Enriched Piece	3	9	9	7	21	*	*
Lot and Piece Number	J-2;36-20	J-2;173-8	J-2;102-36	J-2;R-19-38	C-2;916	J-3;221-24	J-3;301-36
Type of Failure	Side Tear	Side Tear	Side Tear	Side	Side	Cap	(1)

\* Data Unavailable.

(1) There was no visible hole in the jacket or weld of this piece. However, it was badly swollen.