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FINAL REPORT ON THE FUEL AND TARGET ELEMENT EVALUATION AT INCREASED IRRADIATION LEVELS FOR TRITIUM PRODUCTION-PRODUCTION TESTS 313-105-35-M AND 105-562-A

INTRODUCTION

At the time this production test was conducted, J-N loadings for producing tritium had not been tested under C Reactor operating conditions, which were considerably more severe than in the old reactors. Since C Reactor was not subject to the power restrictions imposed on old reactors for graphite heating from the increased gamma radiation, it was proposed as a more efficient reactor for the production of tritium. To evaluate the performance of enriched (7 percent U-235) uranium-aluminum J elements fabricated by hot pressing, Al-Si canning, and the C process, and natural Li-Al alloy (3.5 percent Li) target (N) elements fabricated by hot pressing and cold canning, 60 charges containing both J and N pieces were irradiated under a variety of conditions in C Reactor. A small number of BDF tubes were used to evaluate surface corrosion under higher inlet water temperature conditions, comparable to those experienced during summer months.

OBJECTIVE[1]

The objective of this test was to determine if fuel and target elements used in tritium production, both of current and improved designs could be successfully irradiated at higher tube powers.

SUMMARY

1. No ruptures were sustained in this test. Tube 3276-C was discharged because of a suspect; however, no rupture was found.
2. Based on data from eight charges, corrosion rates of J elements were not significantly worse than for natural uranium irradiated under the same conditions. The differences between the corrosion of the J elements prepared by the three methods did not appear to be significant.

DISCUSSION

Assuming no ruptures would be experienced, this test was an attempt to evaluate the corrosion rate and related conditions arising from in-reactor irradiation at elevated tube powers.

1. HW-30532, PRODUCTION TEST 105-562-A AND PRODUCTION TEST 313-105-35-M, SLUG EVALUATION AT INCREASED IRRADIATION LEVELS FOR TRITIUM PRODUCTION, L. W. Lang. January 18, 1954. (Secret)

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The charges were arranged in such a manner as to investigate the variation of corrosion rate with temperature. The nominal target exposure was set at 100 MWD/Tube.

All charges were basically the same, consisting of a normal dummy pattern, one eight-inch uranium piece, twenty J-N pairs and a normal uranium piece.

Although a suspected rupture caused early discharge of Tube 3276-C, no rupture was found. The corrosion data for J elements apparently did not fit models for corrosion for natural uranium fuel elements; however, corrosion of the J elements did not appear to be significantly different than expected for the natural fuel irradiated under the same conditions. The corrosion rates of the J elements canned by different techniques were not significantly different.

CONCLUSION

This test did not indicate a significant difference in performance between J elements canned by (a) the C process (unbonded); (b) the Al-Si dip process (Al-Si bond) and the hot-press process (diffusion bond).

W. H. Hodgson

W. H. Hodgson, Engineer
Process Engineering

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REFERENCES

1. HW-30532 "PRODUCTION TEST 105-562-A AND PRODUCTION TEST 313-105-35-M - SLUG EVALUATION AT INCREASED IRRADIATION LEVELS FOR TRITIUM PRODUCTION." L. W. Lang, January 18, 1954. (Secret)

2. HW-4725-T "P-10 DATA (Notebook)." L. W. Lang. (Secret)

3. HW-47029 "PROCESS SPECIFICATIONS, FUEL ELEMENT MANUFACTURING PROCESSES." Fuels Preparation Department. (Confidential)

4. HW-4725-T "P-10 DATA (Notebook)." L. W. Lang. (Secret)

5. Undocumented "CORROSION OF J PIECES FROM PT-105-562-A." D. R. De Halas, March 30, 1955. (Confidential)

6. HW-34196 "THE CORROSION OF HANFORD FUEL ELEMENTS - METHOD FOR TREATMENT AND ANALYSIS OF IN-PILE CORROSION DATA." D. R. De Halas, December 21, 1954. (Secret)

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APPENDIX

1. Description of Fuel and Target Elements[2]

Four types of canned J alloy elements (nominal length eight inches) and two types of canned target elements (nominal length four inches) were prepared for this production test. Each piece was marked with consecutive number. The following identification was used for the types indicated.

Table I

TYPES OF ELEMENT AND CANNING PROCESS

Type	Description
A	Unbonded J alloy cores canned in thick wall, thick base cans by the C process.
B	Al-Si bonded J alloy cores canned in thick wall, thick base cans by a single Al-Si dip technique.
C	Diffusion bonded J alloy cores canned in thick wall, thick base cans using the hot-pressing technique.
D	Diffusion bonded J alloy cores canned in thick wall, thin base cans using the hot-pressing technique.
N	Unbonded Li-Al target cores canned in thin wall, thin base cans by the C process.
NA	Li-Al Target cores, canned in thin wall, thin base cans using the hot-pressing technique and an air quench.
NB	Li-Al target cores, canned in thin wall, thin base cans using the hot-pressing technique and a water quench.

2. HW-4275-T, "P-10 DATA (Notebook)." L. W. Lang. (Secret)

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2. An outline of the hot-press canning process for J material is shown below on this page. The C process is described in the fuel element Process Specifications.[3]

HOT-PRESS CANNING PROCESS FOR J MATERIAL[4]

Cap Preparation

Degrease
↓
Rinse
↓
Deoxidize (Diversey 514)
↓
Rinse
↓
Dry

Can Preparation

Anneal (575 C)
↓
*Expand Inside Diameter (1.375 from 1.350)
↓
*Anneal (575 C)
↓
Degrease
↓
Rinse
↓
Deoxidize
↓
Rinse
↓
Dry

Core Preparation

Degrease and Clean
↓
Rinse
↓
Deoxidize
↓
Rinse
↓
Dry

↓

Assemble
↓
Lubricate Outside of Assembly
↓
Size (1.434")
↓
Trim Extruded Portion of Can
↓
*Graphite Coat
↓
*Press (600C/10-30 min./6-12tsi)
↓
*Eject
↓
*Clean in Modified Alcoa Solution R-3
↓
*Face Cap End
↓
Finished Element

*Steps not required by present C process

3. HW-47029, "PROCESS SPECIFICATIONS, FUEL ELEMENT MANUFACTURING PROCESSES." Fuels Preparation Department. (Confidential)

4. op. cit. HW-4275-T

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3. Conditions under which those fuel elements were irradiated are contained in the following table:

Table II

EXPOSURE CONDITIONS-PT-105-562-A

Tube Number	Type J	Type N	Location	Discharge Date	Ave. Power KW/Tube	Ave. Exposure MWD/Tube
1475	JA	NA	Outside HS*	6 /23/54	593	55
1478	JD	NA	Outside HS	6 /23/54	620	58
1577	JB	NA	Outside HS	6 /23/54	612	57
1877	JB	N	Inside HS	10/25/54	566	109
1972	JB	NA	Inside HS	7 /2 /54	616	46
1976	JD	N	Inside HS	7 /2 /54	627	34
2073	JC	NA	Inside HS	7 /2 /54	664	99
2077	JB	N	Inside HS	9 /2 /54	635	59
2168	JA	N	Inside HS	11/27/54	609	130
2176	JA	N	Inside HS	7 /2 /54	642	48
2183	JA	NA	Inside HS	6 /26/54	630	59
2270	JB	NA	Inside HS	10/18/54	664	122
2273	JA	N	Inside HS	7 /2 /54	693	37
2277	JC	N	Inside HS	9 /2 /54	665	99
2374	JC	N	Inside HS	7 /2 /54	665	36
2376	JD	NA	Inside HS	7 /2 /54	683	51
2380	JA	NA	Inside HS	7 /2 /54	665	50
2469	JC	NA	Inside HS	7 /2 /54	602	56
2473	JC	NA	Inside HS	11/6 /54	717	144
2479	JD	NB	Inside HS	9 /14/54	703	112
2483	JD	NA	Inside HS	11/27/54	650	139
2570	JB	N	Inside HS	11/27/54	664	142
2572	JC	NA	Inside HS	5 /29/54	686	51
2577	JB	N	Inside HS	9 /2 /54	661	98
2582	JD	N	Inside HS	9 /2 /54	653	97
2585	JC	N	Inside HS	9 /2 /54	682	102
2667	JB	NA	Outside HS	9 /2 /54	674	100
2673	JC	N	Inside HS	7 /29/54	681	63
2675	JD	N	Inside HS	7 /2 /54	596	45
2678	JB	NA	Inside HS	9 /2 /54	642	96
2680	JC	N	Inside HS	9 /2 /54	656	98
2684	JD	N	Inside HS	9 /2 /54	663	99
2685	JB	N	Inside HS	9 /2 /54	631	94
2686	JB	NA	Outside HS	9 /2 /54	632	94
2764	JA	N	Outside HS	10/18/54	628	115
2768	JA	NA	Outside HS	11/27/54	593	127
2771	JB	NA	Inside HS	7 /2 /54	685	51
2776	JD	N	Inside HS	7 /29/54	624	58
2779	JD	N	Inside HS	9 /2 /54	643	96

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Table II (Continued)

EXPOSURE CONDITIONS

Tube Number	Type J	Type N	Location	Discharge Date	Ave. Power KW/Tube	Ave. Exposure MWD/Tube
2781	JB	N	Inside HS	9 /2 /54	639	95
2783	JB	N	Inside HS	9 /2 /54	645	96
2784	JB	N	Inside HS	11/27/54	626	134
2785	JB	NA	Outside HS	4 /5 /54	608	20
2786	JB	NA	Outside HS	9 /2 /54	640	95
2787	JA&JB	NA	Outside HS	9 /16/54	635	101
2870	JC	N	Inside HS	11/6 /54	707	142
2884	JB	NA	Outside HS	9 /2 /54	626	93
2885	JC	NA	Outside HS	9 /2 /54	645	96
2886	12-8 JC-JD	N	Outside HS	9 /16/54	644	102
2975	JD	N	Inside HS	N. C.	714	39
2985	JC and/ or JD	NA	Outside HS	9 /2 /54	630	94
3272	JD	NA	Outside HS	9 /2 /54	668	100
3274	JD	NA	Outside HS	9 /2 /54	670	100
3276**	JA	NA	Outside HS	7 /29/54	618	75
3278	JD	NA	Outside HS	9 /2 /54	649	97
3282	JD	NA	Outside HS	9 /2 /54	707	105
3371	JD	N	Outside HS	9 /2 /54	672	100
3373	JD	NA	Outside HS	9 /2 /54	665	99
3377	JC	N	Outside HS	10/18/54	666	122
3379	JB	NA	Outside HS	9 /2 /54	640	95

*HS designates the higher temperature zone of C Reactor.
**3276-C Pushed July 29, 1954, rupture suspect swabbed. No rupture found.

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4. Corrosion of J Pieces From PT-105-562-A[5]

Eight charges of J-N loadings from PT-562-A were weighed and examined after reactor exposure. These represent the only data available from elements which experienced enough corrosion to give significant results.

Data from the following tubes were examined: 2768-C, 1972-C, 2077-C, 2784-C, 2473-C, 2572-C, 2870-C and 1478-C.

The corrosion rates of the J pieces from these tubes were compared to the corrosion rates for natural uranium fuel elements as calculated by the method outlined in HW-34196. Ninety-five percent of the data for natural uranium pieces run under identical conditions would be expected to fall within the confidence bands on the graph in Figure 1. The position of these bands is dependent upon corrosion penetration; i.e., they become narrower as the penetration increases.

The excessive scatter in the data indicates that the method of calculating corrosion rates may not be directly applicable to J material. However, an examination of the graph shows that there is a tendency for J pieces to corrode slower than would be predicted for ordinary fuel elements under identical conditions. It appears that for practical purposes, the corrosion rate of J pieces can be taken as being the same as for natural uranium; this is especially true for higher penetrations.

Pitting noted on the elements was no more serious than is normally found on regular metal fuel elements. There are indications that the type or location of some of the pitting may be rather unusual, but nothing that was both unusual and of a serious nature was reported by the Fuel Examination Unit.

5. Undocumented, "CORROSION OF J PIECES FROM PT-105-562-A." D. R. De Halas, March 3, 1955. (Confidential)

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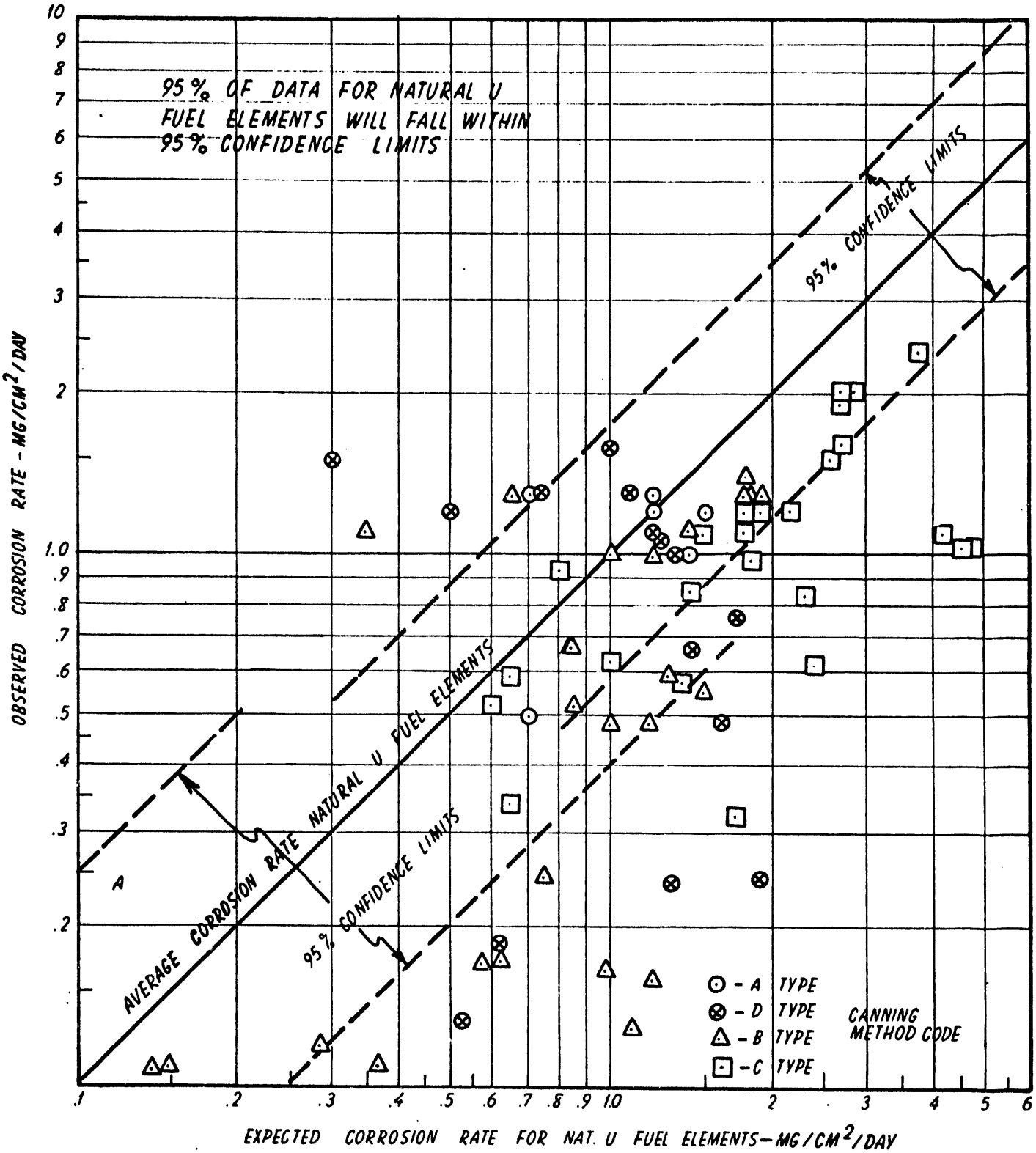

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FIG. 1 - RELATIVE CORROSION RATES OF J ELEMENTS AND NAT. U FUEL ELEMENTS

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