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SUBJECT: Preliminary Zirconium Alloy Data from Loop L-2-17

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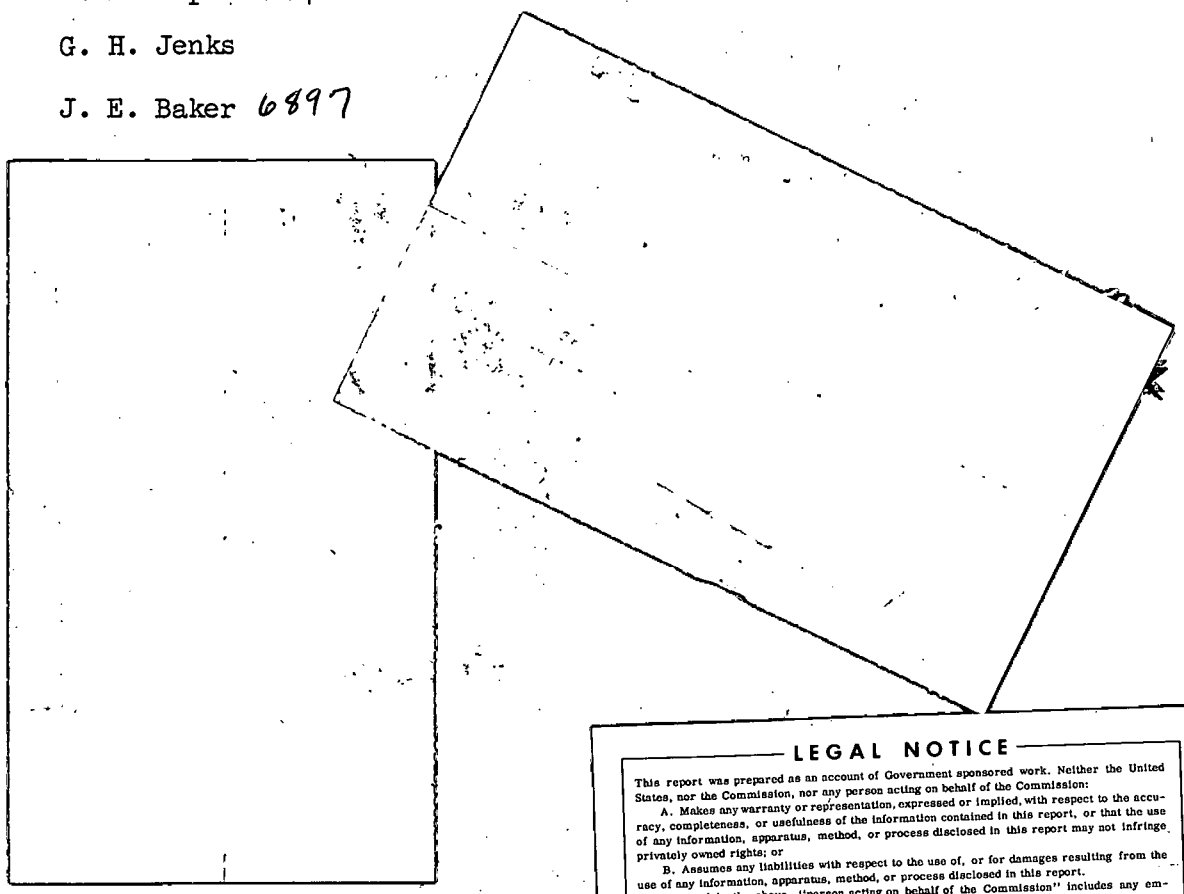

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Preliminary Zirconium Alloy Data from Loop L-2-17

In-pile loop experiment L-2-17 was the fourth experiment to contain core coupon specimens of zirconium alloys other than, and in addition to, Zircaloy-2 and crystal bar zirconium. Correlations of the zirconium and zirconium alloy radiation-corrosion data obtained from the three previous experiments (L-4-11, L-4-16 and L-2-14) have been reported[1,2]. Reported here are similar, preliminary correlations of the data obtained in loop L-2-17.

A brief summary of operating conditions for these four experiments is presented in Table I.

Experiment L-2-10[3] employed a solution similar to that used in the present experiment, but was operated at 280°C. Experiment L-2-10 contained CC and CA coupons of Zircaloy-2 but did not contain coupons of other zirconium alloys. The radiation-corrosion behavior of the Zircaloy-2 coupons from that experiment is described by the equation:

(I)
$$R = 2.45\ P\ (1-e^{-95/R^{1.5}})$$

where: R = corrosion rate, mpy (based on exposed specimen area and radiation time)

P = fission power density in solution, w/ml

Corrosion rates observed on the CC and CA Zircaloy-2 coupons contained in L-2-17, listed in Table II, are also reasonably well described by eq. (I). The rates are shown plotted against the fission power density in solution adjacent to the specimens, in Fig. 1. Also plotted for comparison are the corrosion rates observed on the CC and CA Zircaloy-2 coupons from L-2-10.

TABLE I

Loop Operating Conditions

	L-4-11	L-4-16	L-2-14	L-2-17
Original Solution:				
UO_2SO_4, m	0.17	0.17	0.17	0.04
$CuSO_4$, m	0.031	0.015	0.15	0.005
H_2SO_4, m	0.04	0.025	0.40	0.025
Make-up Solution:				
UO_2SO_4, m	0.17	0.17	0.17	0.04
$CuSO_4$, m	0.031	0.015	0.015	0.005
H_2SO_4, m	0.04	0.07	0.07	0.06
Cr, ppm	---	100	100	100
Mean H_2SO_4 concentration, m	0.022	0.024	0.39	0.024
Main Stream Temperature, °C	250	280	280	300
Average Power Density in Core, w/ml				
Cesium	2.38	2.11	7.74	1.67
Specimen Activity	4.34	3.80	14.30	3.98

ZIRCALOY-2 CORE COUPON CORROSION RATES VS. SOLUTION FISSION POWER DENSITY

FIG. 1

Core channel coupons — Core annulus coupons

● L-2-17 ○

▲ L-2-10 △

Rate based on exposed area and radiation time

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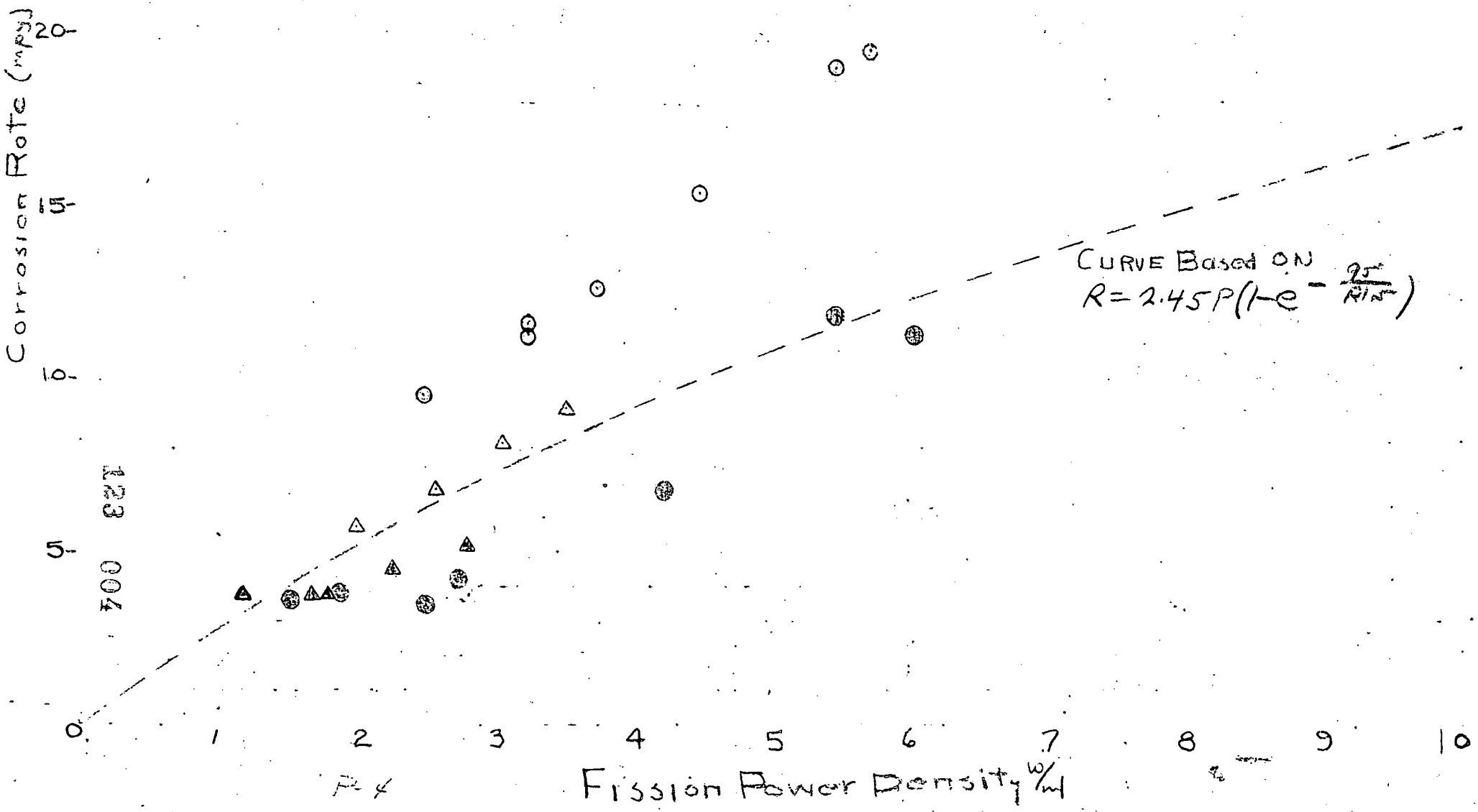

TABLE II

L-2-17 CC and CA Zr-2 Coupon Corrosion Rates

CC Coupons			CA Coupons			
Corrosion Rate* (mpy)	Power Density (w/ml)	Velocity (fps)	Corrosion Rate* (mpy)	Power Density (w/ml)	Velocity (fps)	Array No.
11.3	6.03	9.4	19.5	5.79	1.0	ZB-1
11.9	5.68	10.2	19.0	5.46	"	SA-6
6.8	4.14	18.2	15.4	4.48	"	"
4.2	2.85	41.2	12.7	3.76	"	"
3.5	2.68	37.3	11.6	3.09	"	ZB-1
3.8	1.96	13.8	11.4	3.09	"	SA-6
3.6	1.63	10.0	9.6	2.56	"	"

* Based on exposed coupon area and radiation time.

Corrosion rates observed on the core annulus coupons of crystal bar zirconium-15% Nb, 15% Nb-2% Pd and 15% Nb-1% Fe, sponge zirconium-15% Nb, and crystal bar zirconium-20% Nb, contained in L-2-17, are compared in Table III with the corrosion rates observed on the Zircaloy-2 core annulus coupons for the same experiment. The data are presented as ratios of the observed zirconium alloy corrosion rate to the observed Zircaloy-2 corrosion rate, (all rates based on exposed coupon area and radiation time) at similar power densities. The Zircaloy-2 rates used for the comparisons are the averages of the rates observed on the coupons in annulus arrays ZB-1 and SA-6. The results are plotted in the usual manner in Fig. 2. Alloys subjected to the Beta quench heat treatment exhibited the best corrosion behavior, and the rates for all alloys with this heat treatment are about 70% of those for Zircaloy-2.

TABLE III

Ratio of Zirconium Alloy CA Coupon Corrosion Rates to Zircaloy-2 CA Coupon Corrosion Rates at Similar Power Densities

Alloy	Power Density (w/ml)	Heat Treatment A	B	C	D	E
Xtal Bar - 20% Nb	3.09					1.03
	5.79					0.84
Xtal Bar-15% Nb-1% Fe	2.40				0.86	
	2.56			1.34		
	2.74		0.94			
	2.90	0.70				
	3.29				1.03	
	3.48			1.34		
	3.76		0.87			
	3.96	0.71				
Xtal Bar-15% Nb	3.29				0.85	
	3.49			1.35		
	3.76		0.93			
	3.97	0.79				
	4.48				0.82	
	4.80			1.25		
	5.10		0.88			
	5.46	0.72				
Sponge Zr-15% Nb	2.40				0.82	
	2.56			1.29		
	2.73		0.95			
	2.90	0.74				
	4.48				0.85	
	4.80			1.24		
	5.10		0.95			
	5.46	0.71				

A - Beta quenched (1000°F for 2 hr, water quenched)
B - 600°C for 2 weeks - air cooled
C - 500°C for 2 weeks - air cooled
D - 400°C for 2 hr. - water quenched
E - Beta quenched - pre-oxidized

Zirconium Alloy Corrosion Rates Vs. Fission Power Density
(L-2-17)

FIG. 2

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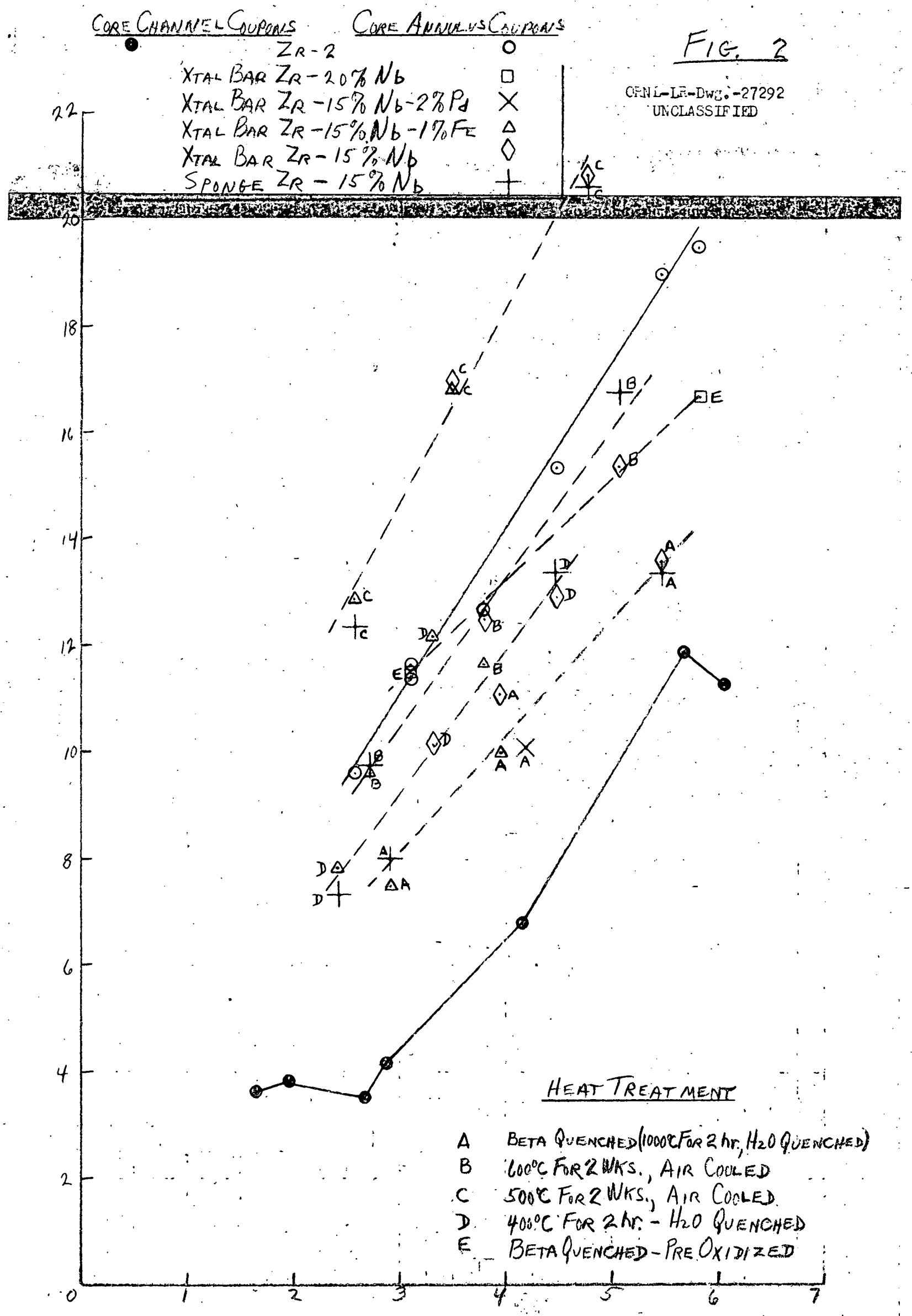

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REFERENCES

1. J. E. Baker, Zirconium Alloy Data from Loops L-4-11 and L-4-16, ORNL CF-57-7-84.

2. J. E. Baker, Preliminary Zirconium Alloy Data from Loop L-2-14, ORNL CF-57-8-121 (Revised), August 28. 1957.

3. G. H. Jenks et al., HRP Quar. Prog. Rep., Jan. 31, 1957, ORNL-2272, p 104.