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ARF 2198-16

U.S. Atomic Energy Commission
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois

Attention: Mr. H. N. Miller
Contracts Division

Subject: EURATOM PROGRAM
"Improved Zirconium Alloys"
Contract No. AT(11-1)-578
Project Agreement No. 1

Gentlemen:

This is the twelfth monthly report, covering the period April 1 to April 30, 1961, on the subject program. The program objectives are development of alloys having superior 680° F water and/or 750° to 900° F steam corrosion resistance and development of higher strength alloys for current temperature ranges while maintaining corrosion resistance comparable to Zircaloy-2. Corrosion behavior in water and steam provides a screening test for acceptance of experimental alloys.

During this report period, specimens which previously showed promising corrosion resistance in 750° F steam after 329 hours exposure were re-entered in test for an additional 480 hours. Since binary tin alloys in 750° F steam had exhibited improved corrosion properties as the tin content increased to 7 per cent, additional compositions of Zr-10Sn and Zr-12Sn were included. Table I summarizes the corrosion behavior of selected alloys after 809 hours in 750° F steam. From the series of tin alloys, it appears that a minimum in corrosion rate occurs at 7 per cent tin; the corrosion resistance is not, however, sufficiently high to consider this alloy for further development. Nevertheless, the compositions Zr-0.5Nb, Zr-1V, and Zr-1Sb and the alloys Zr-Fe, Zr-Cr, and Zr-Mo appear promising for development of steam-resistant material. Promising compositions in Table I will be further exposed to 750° F steam.

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DISCLAIMER

The results of 680°F water tests after 1902 hours were reported last month in ARF 2198-15 (Quarterly Report No. 2). Compositions showing promising corrosion resistance were placed in test for further determination of corrosion behavior. Also being exposed to 680°F water are the compositions Zr-(0.25, 1, 2)In, a specimen of electron-beam melted zirconium, one of high-purity crystal bar, and an as-quenched (retained beta) alloy of Zr-30Nb-5Mo. Approximately 350 hours' exposure time has elapsed, and the test will be interrupted sometime in May. The indium alloys have not previously been tested; the crystal bar and electron-beam melted zirconium are being investigated for determination of purity effects on corrosion resistance, and the Zr-30Nb-5Mo alloy should indicate corrosion behavior of beta-zirconium as compared to corrosion of an equilibrium microstructure.

In anticipation of a second year's work, experimental continuity has been maintained. The data on corrosion resistance of binary alloys in superheated water and steam are being used for planning ternary compositions; hopefully, a number of successful alloys will result. Work on hydrogen pickup during corrosion will be initiated during the second year.

Respectfully submitted,

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TABLE I

CORROSION BEHAVIOR OF SELECTED EXPERIMENTAL ALLOYS IN 750°F STEAM

Composition	Weight Gain, mg/dm^2 329 hours	809 hours
Zircaloy-2	24.88	41.57
Zr-0.5Nb	27.42	42.66
Zr-2Nb	51.20	84.32
Zr-5Nb	72.20*	---
Zr-10Nb	101.75*	---
Zr-25Nb	136.46*	---
Zr-30Nb	134.73*	---
Zr-0.5Sn	a*	---
Zr-1.5Sn	1202.88a*	---
Zr-3Sn	4763.23a*	---
Zr-5Sn	603.63*	---
Zr-7Sn	252.18	812.57*
Zr-10Sn	---	a* (480 hours)
Zr-12Sn	---	550.a* (480 hours)
Zr-0.25V	277.41a*	---
Zr-1V	27.19	46.32
Zr-3V	a*	---
Zr-0.25Sb	1745.a*	---
Zr-1Sb	29.51	47.83
Zr-2.5Sb	37.01	87.38
Zr-4Sb	41.65	113.73*
Zr-6Sb	75.40	217.14a*

TABLE I (continued)

Composition	Weight Gain, mg/dm^2 329 hours	809 hours
Zr-0.25Cr	22.44	38.76
Zr-1Cr	58.44	91.24a*
Zr-3Cr	23.09	33.12
Zr-0.25Cu	24.78	40.63
Zr-0.25Fe	26.77	40.65
Zr-1Fe	27.79	41.69
Zr-3Fe	38.65	59.47
Zr-0.25Si	56.96a*	---
Zr-0.25W	671.19a*	---
Zr-1W	652.00a*	---
Zr-0.25Mo	17.04	28.06
Zr-1Mo	20.08	57.24
Zr-0.25Ta	35.31	50.44*
Zr-0.25Co	38.90	48.88
Zr-1Co	27.30	41.45
Zr-3Co	33.13	52.20
Zr-0.25Pt	37.84	47.80*
Zr-1Pt	54.43*	---
Zr-0.25Pd	34.53	49.32
Zr-1Pd	48.83	68.76
Zr-0.25Rh	40.31*	---
Zr-1Rh	53.91*	---
Zr-0.25As	131.27*	---
Zr-1As	a*	---
Zr-0.25Bi	1481.27a*	---

TABLE I (continued)

Composition	Weight Gain, mg/dm^2	
	329 hours	809 hours
Zr-0.25Te	19.01	37.03
Zr-1Te	39.09	65.14*
Zr-0.25Ge	43.30*	---
Zr-1Ge	202.96*	---
Zr-1Ag	1916.99*	---
Zr-0.25Ni	32.84	45.78
Zr-1Ni	33.23	46.33
Zr-3Ni	103.25	---

* Unacceptable corrosion resistance - discontinued from further testing.

a Severe spalling or disintegration.