INTERIM REPORT

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M. Vagins, RES Headquarters

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Prepared for
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Under Contract No. AT(49-24)-0293

INTERIM REPORT

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June 6, 1979

Mr. Milton Vagins
U.S. Nuclear Regulatory
Commission
Mail Station 1130 SS
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Dear Mr. Vagins:

Task Agreement Number 6, to
Contract No. AT(49-24)-0293

This is the monthly letter report for May, 1979, on the subject contract. In our progress letter dated April 11, 1979, we reported preliminary results of crack arrest tests on irradiated A508 submerged arc weld metal. As pointed out in that letter, two of the four specimens failed in the electron beam weld and provided no useful data. We have now completed the analysis of the other two tests, as described in the following paragraphs.

Figure 1 shows the results of Charpy V-notch and crack arrest tests as a function of test temperature for both unirradiated and irradiated specimens. Included in the upper portion of the figure is the predicted influence of irradiation on both the CVN upper shelf and on the shift of transition temperature. The actual drop in upper shelf energy is very close to that predicted, whereas the actual shift in transition temperature is somewhat less than predicted. The shift in transition temperature is seen to depend on the energy level chosen for comparison. At the 50 ft-lb level, the shift is very close to that predicted.

The K_{ID} and K_{Ia} results for irradiated specimens in Figure 1 were derived as follows. The data point labeled A represents a test at 104° C in which the crack arrested at the electron beam weld without penetrating the test section. To calculate lower bound K_{ID} and K_{Ia} values, it was assumed that the crack actually penetrated the test section for a distance B_n, the specimen thickness at the base of the side-grooves and the minimum permissible crack arrest point for a valid test.

Data obtained from a second irradiated specimen are labeled B, B_1, B_2, etc., in Figure 1. Details of the testing of this specimen were included in our letter of April 11. In that letter, it was reported that the crack did not penetrate the test section at a temperature of 93° C. Subsequent examinations proved this statement to be incorrect. Figure 2 is a sketch of the fracture surface of this specimen. Region 1 is the crack jump observed in the initial test at 93° C. Clearly the crack penetrated the test section

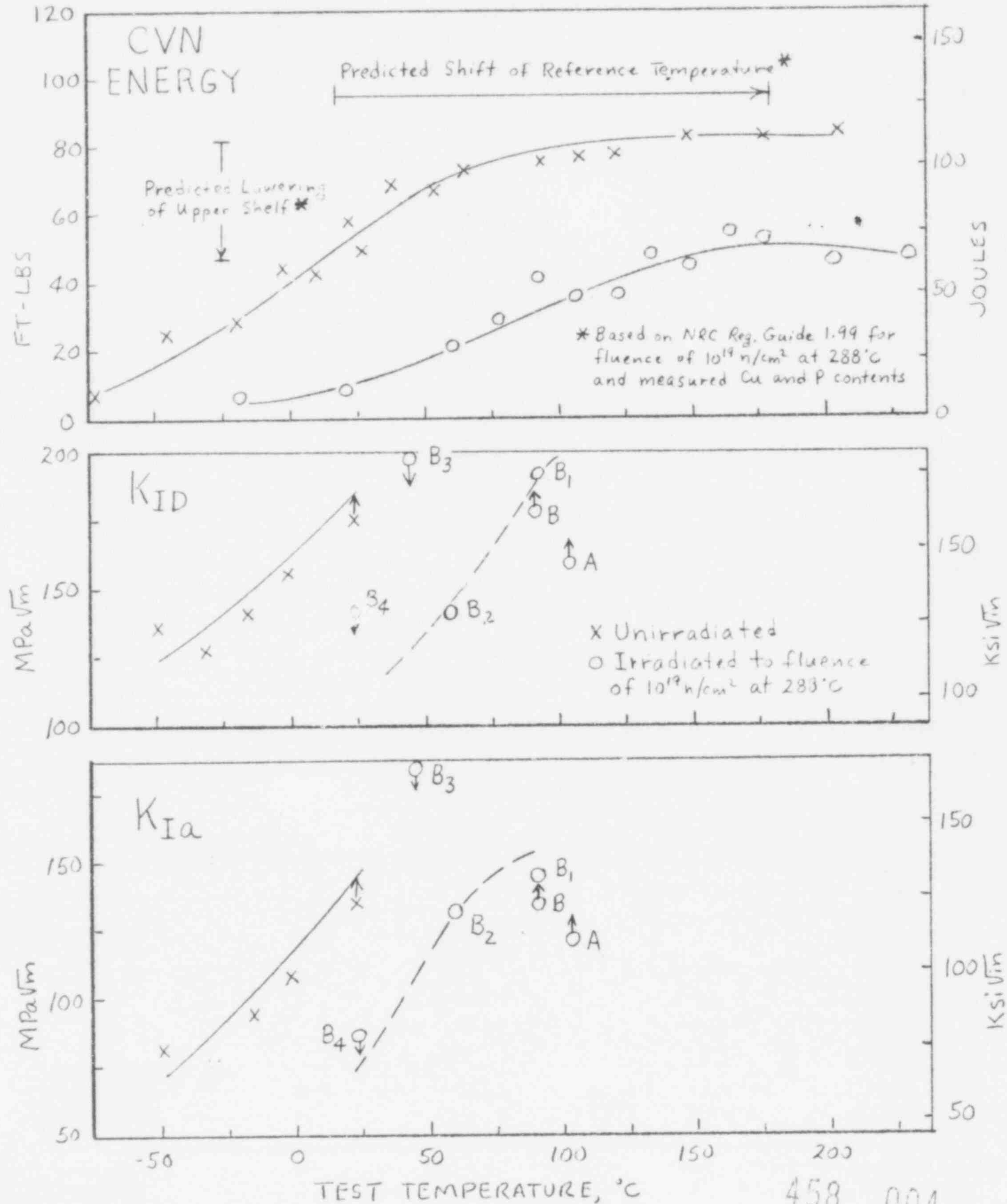

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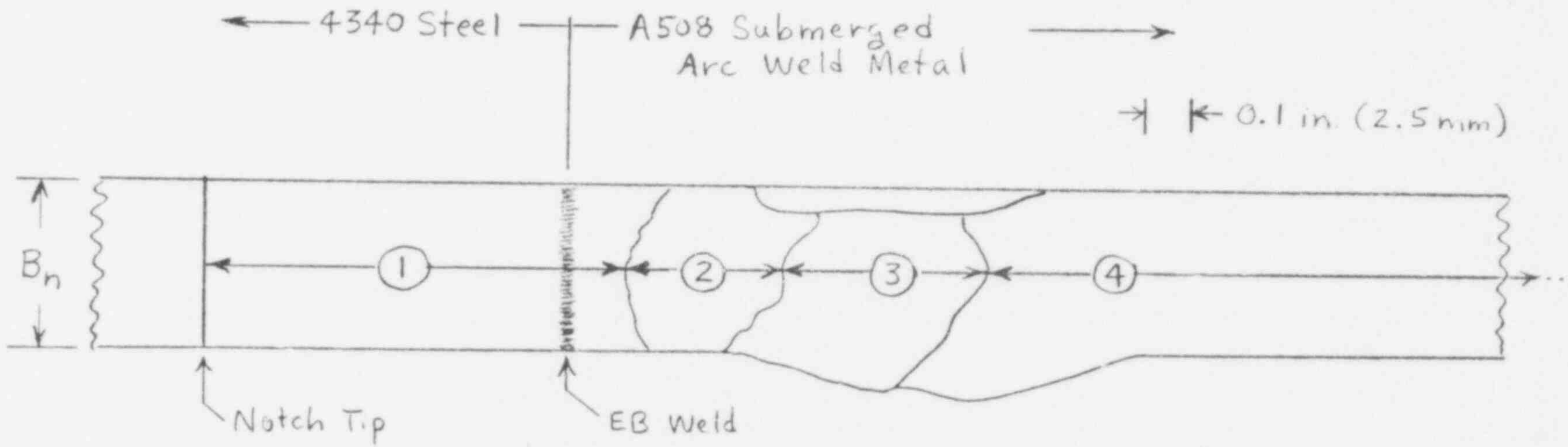
FIGURE 1. EFFECT OF EXPOSURE TO FAST NEUTRON IRRADIATION ON TOUGHNESS IF A508 SUBMERGED ARC WELD METAL

POOR ORIGINAL



Test No.	Temp. °C	a_o In.	a_o mm	Δa In.	Δa mm
1	93	2.26	57.4	0.95	24
2	61	3.21	81.5	0.34	8.6
3	43	[illegible]	90.2	0.40	10
4	24	[illegible]	100	3.05[a]	77[a]

(a) Crack actually extended to back edge of specimen; this is beyond the limit for a valid test. To calculate upper bound values of K_{ID} and K_{Ia}, the crack was assumed to arrest at the maximum length permitted by validity considerations.

FIGURE 2. SKETCH OF FRACTURE SURFACE OF IRRADIATED DUPLEX DCB SPECIMEN TESTED AT FOUR DIFFERENT TEMPERATURES

but not to the distance B_n required for a valid test. In Figure 1, data point B represents a lower bound toughness value based on the assumption that the crack actually extended to a distance of B_n in the test section. Data point B_1, on the other hand, is calculated for the actual crack extension.

At this point, the specimen was treated as an ordinary DCB specimen and three additional crack arrest experiments were conducted at progressively lower temperatures. Data point B_2 in Figure 1 is calculated from the crack jump denoted by region 2 in Figure 2 at a test temperature of 61° C. In the third experiment on this specimen, conducted at 43° C, the crack ran well out of the side groove. This is believed to account for the high toughness values represented by the data points labeled B_3. Finally, the specimen was tested at room temperature where the crack ran all the way through the specimen. To calculate an upper bound toughness at this temperature, it was assumed that the crack arrested at the maximum distance permitted by validity considerations. The toughness values thus obtained are labeled B_4 in Figure 1.

Due to the limited number of crack arrest tests, no firm conclusions can be drawn on the effect of irradiation on crack arrest properties. However, the data in Figure 1 suggest that the shift in transition temperature for both K_{ID} and K_{I_a} is no greater than the shift in the Charpy transition temperature or than that predicted by NRC Reg. Guide 1.99. In fact, the shift appears to be less for K_{ID} and K_{I_a} than for CVN energy. Part of this may be due to higher fluence levels in the midregion of the irradiation capsule where the Charpy specimens were located. Dosimetry results are still being analyzed and will be described in a subsequent report.

Sincerely,

A. R. Rosenfield
Metal Science Section

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