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UNITED STATES DEPARTMENT OF COMMERCE
National Bureau of Standards
Gaithersburg, Maryland 20899

April 1, 1987

Mr. Everett A. Wick
Division of Waste Management
Office of Nuclear Materials Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Wick:

Recently you requested a comparison of estimates of the sensitivities of various measures of crack extension that might be used in fracture testing. The sensitivity of the measurement of crack extension depends on the test method, the material, the thickness of the test specimen and the duration of the test. Comparisons are given here for three types of measures: (1) compliance, (2) electric resistance and (3) acoustic emission (a.e.). For the calculations given below, it was assumed that tests would be conducted over a period of one week, using a one-inch thick fracture-mechanics test specimen of steel with an average grain diameter of 10 micrometers.

Compliance is the method commonly used in the DoE tests; electric resistance has been used in my laboratory for a number of years; and a.e. is a method that we have been using for the past year or so. Using compliance, the minimum length crack extension is about 2 mm; using electric resistance it is about an order of magnitude better. For 1/4-inch thick specimens we can measure 0.3 mm of extension, and for the 1-inch thick specimen in question for this calculation it will be assumed here that we can improve our method sufficiently to get this same 0.3 mm of extension, but at present it actually is not that good in our laboratory. This assumption makes results of calculations for the a.e. method in question conservative when compared with results for the electric resistance method.

For a.e., it is felt that fracture of the area around one grain is a reasonable minimum level of detectability, in theory if not in practice. Our experience indicates that the value is very small, but more work is needed to compute the minimum area associated with a detectable emission.

Although DoE is using the (less sensitive) compliance method, they could use the electric-resistance method, so the following is based on the electric-resistance method.

With the above assumptions (the one-inch test specimen tested over a period of a seven-day week), 0.3 mm of extension can be detected using electric resistance, and .05 micrometers extension can be detected over the same period for the a.e. method. Thus, the sensitivities of the two methods differ by a factor of 6000. In a period 52 times as long (one year) these limiting values of detectability, the undetected extensions could be 16 mm (16,000 micrometers) and about 3 micrometers, respectively for the electric resistance and a.e. methods. If it is assumed that the period of the test can be extended to the full year, one could argue that this difference of 6000 times might be reduced by a factor of 52, if the accuracy of each method remains unchanged in a one-year test. Nevertheless, one-week tests are commonly used and the calculation does highlight the fact that potential differences between the sensitivities of these methods is truly remarkable and worthy of further exploration on behalf of the HLW program.

Sincerely,

Charles G. Interrante

Charles G. Interrante
Program Manager
Corrosion and Wear Group
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