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MEMORANDUM FOR: Distribution

FROM: R. E. Johnson, TAP A-11 Manager
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SUBJECT: REPORT ON MEETING OF TECHNICAL TEAM, TAP A-11

The third technical meeting of the TAP A-11 team was held at NRC Headquarters, Bethesda, Maryland, on May 15-16, 1980.

Enclosure 1 is a copy of the Meeting Notice. Enclosure 2 is a copy of the Agenda. Enclosure 3 is a list of attendees.

It was agreed that ORNL would compile and issue a technical summary of the prepared presentations. Toward that end, each presentor was asked to send a copy of his visual aids and notes as he judged appropriate to Mr. Slaughter. Consequently, this report will include highlights only.

Merkle reported on efforts at ORNL to correlate elastic-plastic fracture test results with Charpy V-notch impact energy. J-R curves were obtained by fitting the equation: $J = c\,(\Delta a)^n$ to the data. The parameters "c" and "n" were related with the empirical equation:

$$y = A\,x^3/(B + x^3)$$

where:

$$y = n$$

$$x = c\,(15 + \sigma_o)/2$$

σ_o = flow stress

A graph of "c" against related E_{c-v} values, based on test results, was constructed. Thus, one could take a Charpy energy value, enter the graph to determine "c," solve the empirical equation to calculate "n" and construct a J-R curve. On comparison with some of the available data, there was good news and bad news. The calculated J-R curves were generally close to the results from one laboratory but not very close at all to the results from a different lab. More work needs to be done. Could this be a Q.C. test for J-R curve data?

Berggren reported that Lowe of B&W promised to provide some useful data.

Loss said that NRL revisited J-R curve data, made a adjustments to J and found that within the ASTM exclusion lines the changes generally were quite small.

Riccardella presented analyses of the HSST ITV results. Marston (EPRI) shared in the guilt because they worked on the problem together during the eastward flight. Using the reported ITV pressure-strain data, the material's σ- ϵ curve was used to obtain ϵ for the vessel. The elastic pseudostress was calculated from: $\sigma = \epsilon E$ and, in turn, σ was used in an appropriate LEFM equation to calculate K, then J, T and J/T. When calculated and observed failure strains were compared, the results were rather good, getting worse with increasing vessel test temperature (vessels V-2, V-4, V-1, V-3 and V-6, in order of increasing temp.). As an approximation, the method seemed to have merit and could be a fall-back position if exact RPV calculations prove too complicated.

Strosnider discussed the NRC RPV data storage and retrieval computer program MATSURV and the NRC RPV computer programs then went into the relationships, current and projected, between those computations and the data base. A NUREG document on MATSURV is in preparation. The data bank will be available to the industry and professional societies (e.g., the ASME and PV Code Committees).

Irwin talked about side grooves on fracture specimens and how he related aspects of the issue to the elastic-plastic stress state and to relative conservatism of data. With agreement from Merkle and Riccardella, he concluded that we want side grooves because they increase the mechanical constraint, thus giving us a more relevant model for the RPV. Paris agreed that side-grooved specimens provide lower (hence, conservative) J-R curves but argued that they are not a better model of the crack in a heavy section component. Also, we have the unresolved issue of how to correct J for the side-groove geometry; at best today the correction(s) being used is (are) empirical and unverified. I suggested that Paris and Irwin might propose work to be done to resolve the issue and RES/NRC (Serpan) consider funding it.

Because it seemed to me that there are other elastic-plastic fracture mechanics approaches with their champions, it followed that the A-11 NUREG should have a chapter dealing with comparison of methods. In response, it was noted that Landes (Westinghouse) has compiled a list of methods (20 was the number remembered). Cooper suggested that the ASME might respond to a request to make such a comparison, and that the task might fall within the responsibilities of the Sub Group on Toughness which is chaired by Corten. I agreed to ask Bosnak (NRC) to initiate the action (later note: the action is underway).

Another ongoing effort is the testing of 1.6T irradiated weld metal CT specimens at NRL. Loss responded that a new extensometer had to be built to accommodate the recommendation of this Review Team that each unloading compliance test be continued to large crack extensions, well beyond the ASTM proposed

limit. The tests should begin in early June and at least 6 results (representing three weldments) will be available for discussion at the next Review Team meeting.

With no claim of completeness, I restated some of the issues facing the A-11 Review Team as follows:

1. side grooving;
2. margin of safety;
3. application of the J-T analysis to IRC results and to data from large tensile fracture specimens (tested at Sw RI);
4. try to correlate Charpy lateral expansion data with J-R curve parameters;
5. systematically, thoroughly, review data and search for correlations (ORNL major effort);
6. revisit the WCAP Reports, if necessary;
7. review the B&W program on the 50 ft.-lb C_VUSE;
8. consider how much data are needed and how close to satisfactory are we now;
9. can bending data be applied to tensile problems;
10. consider the role of crack arrest (this has its own sub-set of problems); and,
11. develop a test method for the old WOL (e.g., 1X) irradiated specimens (a task for Serpan, NRC).

Some actions now are underway which relate to some of the above. Specifically, Merkle and Riccardella are moving toward a thorough analysis of the HSST ITV data. Also, Riccardella agreed that he could revisit the ASME Section XI sample problems, but I believe others (e.g., NRL, EPRI) could give him some support; this is an organization job for Slaughter. ORNL also needs to organize the task of analyzing the large tensile fracture specimen data, starting with what Steve Gregory (Sw RI) provided for HSST Reports. Gudas will assemble data which bear on the question of side groove efficacy as a function of material mechanical properties other than J-R curve parameters (e.g., tensile strength and E_{C-V}). Cooper is preparing a draft paper dealing with design safety margins; Irwin is preparing the background for leak-before-burst concepts.

Individuals working on materials aspects and on analytic aspects of the A-11 task will organize and attend meetings within about a month. The

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A-11 task will organize and attend meetings within about a month. The next scheduled meeting of the Review Team will be at NRC on July 30, 1980.

Corten has asked that the current J-R approach to the A-11 problem be reviewed at his ASME Section III Code Committee meeting in New York City on September 8, 1980. Riccardella asked that an A-11 review be given at his Section XI meeting in Mystic, Connecticut, during the week of September 15, 1980.

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Enclosures:
1. Meeting Notice: Review of A-11 Progress
2. Agenda: Reactor Pressure Vessel Toughness 5/15-16, 1980
3. List of Attendees