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APRIL-MAY STATUS LETTER: LWR PRESSURE VESSEL IRRADIATION SURVEILLANCE DOSIMETRY PROGRAM

The object of this program is to make measurements in neutron fields ["Benchmark" and reactor "Test and Surveillance Regions"] for the subsequent validation/ calibration of available state-of-the-art dosimetry, damage correlation, and che associated reactor analysis data and procedures. The data and procedures are in turn used for predicting the integrated effect of neutron exposure for light-water reactor (LWR) pressure vessel (PV) and support structure steel test irradiation and surveillance programs. The program work includes selection of the neutron fields, the validation/calibration of dosimetry and damage exposure and correlation procedures in these fields, and the establishment of a set of seventeen ASTM recommended standard practices, guides, and methods (see Figures 1 an/1 2).

PROGRAM REVIEW AND DEFINITION

- The 7th LWR Program Review Meeting was held at Babcock and Wilcox Lynchburg Research Laboratory during the week of May 18-22, 1981. Preparation of the meeting report is in progress, but has been delayed because of work on the completion of the NUREG CR-1861 document.
- A draft of the NRC NUREG CR-1861 document on the "PCA Experiment and Blind Test" was completed. A review of this document was accomplished by key program participants, including C. Serpan of NRC, during the LWR Program Review Meeting at B & W.
- A new method of scanning Nuclear Research Emulsion (NRE) has been developed for reactor neutron dosimetry. Emulsion scanning has customarily been carried out in the differential mode to provide differential neutron spectra. A new concept, namely integral mode scanning of emulsions, has been advanced. In this integral mode, emulsions provide absolute integral proton-recoil reaction rates that can be used in spectral adjustment codes. In the past, such adjustment codes have not utilized integral reaction rates based on

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emulsions. The beauty of emulsion integ.al reaction rates is their tie to the elastic scattering cross section of hydrogen. This $\sigma_{n,p}(E)$ cross section is universally accepted as a standard cross section and is known to an accuracy of roughly 1%. Hence, emulsion integral reaction rates will afford a significant new dimension for work with spectral adjustment codes.

Two different integral relationships can be established using proton-recoil emulsion data. These absolute integral reaction rates can be obtained with roughly an order of magnitude reduction in scanning effort. Consequently, this integral mode is an important complementary alternative to the customary differential mode of emulsion spectrometry. The integral mode can be applied over extended regions, e.g., perhaps up to as many as 10 in-situ locations can be covered for the same scanning effort expended for a single differential measurement. Hence, the integral mode is especially advantageous for dosimetry applications that require extensive spatial mapping, such as exist in LWR-PV benchmark environments.

A more detailed exposition of integral mode NRE scanning can be found in: "PCA Experiments and Blind Test", NUREG/CR-1861, Section 3.3.

- The following abstracts have been prepared for the 4th ASTM-EURATOM International Symposium on Reactor Dosimetry, NBS (March 1982).
 - James H. Roberts, Raymond Gold, and Frank H. Ruddy, "Light Water Reactor Neutron Dosimetry with Nuclear Research Emulsions"
 - (2) James H. Roberts, Raymond Gold, and Frank H. Ruddy, "Comparison Between Absolute Fission Rates as Measured with Muscovite Mica Solid State Track Recorders and NBS Fission Chambers"

TASK A NEUTRON FIELDS

PCA-PSF

- Comparisons were made between HEDL Solid State Track Recorder, NBS Fission Chamber, and CEN/SCK Fission Chamber fission rate measurements for 235 U, 238 U and 237 Np in the PCA 8/7 and 12/13 configurations. In general, agreement is within the expected uncertainties ($^{\circ}$ 3%). An average $^{\circ}$ 7% descrepancy for 238 U and $^{\circ}$ 4% for 237 Np exists between the NBS and the HEDL measurements for the 8/7 configurations, with HEDL values being lower. An average $^{\circ}$ 11% descrepancy exists for 237 Np for the 12/13 configuration, with HEDL values being higher. These descrepancies are thought to be associated with insitu perturbations and/or problems.
- Comparison between HEDL and MOL radiometric analyses of ${}^{58}Ni(n,p){}^{58}Co,$ 115In(n,n')^{115m}In and ${}^{27}A1(n,\alpha){}^{24}Na$ dosimeters irradiated in PCA in 1978 and 1979 was made for inclusion in the NUREG CR-1861. In general correlations were extremely good (within 2%).

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 Updated analyses were run with the FERRET code to provide comparisons of the experimental data and calculated spectra in the 1/4 T, 1/2 T, and 3/4 T positions for the PCA 8/7 and 12/13 configurations. These analyses were also used to derive integral flux E>0.1 MeV and E>1 MeV, and dpa alues. Comparisons were made with independent analyses conducted at ORNL and the results are discussed and reported in the NUREG CR-1961 "PCA Experiment and Blind Test" document.

TASK B-RECOMMENDED ASTM STANDARDS

• The schedule, Figure 2, for the preparation of the 19 ASTM Standards, Figure 1, has been upd_ted and a revision of Figure 2 will be included in the minutes of the May LWR Program Review meeting. The results of the ASTM balloting of a number of the standards (0*, 1A, IID, IIC, IIIB, and IIIC of Figure 1), will be reviewed at the June 22-25, 1981 ASTM meeting at Myrtle Beach, SC.

TASK C-DAMAGE EXPOSURE AND CORRELATION PROCEDURES

A least squares fitting procedure has been used to obtain a simple law giving a relation between irradiation embrittlement (Charpy shift) and irradiation temperature for reactor pressure vessel surveillance specimens. A combined data set was used, consisting of data from U. S. 'e t reactor and power reactor irradiations combined with British data from HERALL, DIDO, and PLUTO reactor irradiations. The British data is from irradiations at 482°F while the US irradiations are principally from irradiations near 550°F. A report on the results will be prepared for the May 1981, 7th LWR Program Review meeting at Lynchburg and the June 1981 ASTM E10.05.06 Task Group** meeting at Myrtle Beach, SC.

C.C. Preston

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W. N. McElroy, Manager Irradiation Environment

cpr

* Only the update of Table 3, "Metallurgical Steel Irradiations - Test Facilities Estimated Environmental Parameter Values for Assessing Temperature, Flux Level, and Spectral Effects."

** On the determination of improved Exposure Parameters and Values for the MPC and EPRI metallurgical data bases.



FIGURE 1

FIGURE 2

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LWR PRESSURE VESSEL IRRADIATION SURVEILLANCE

DOSIMETRY PROGRAM BI-MONTHLY STATUS LETTER

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