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Prepared for
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INTERIM REPORT

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August 21, 1980

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JUNE-JULY BI-MONTHLY STATUS LETTER: LWR PRESSURE VESSEL IRRADIATION SURVEILLANCE DOSIMETRY PROGRAM

The objective 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 data and dosimetry, damage correlation, and the associated reactor analysis procedures used for predicting the integrated effect of neutron exposure for light-water reactor [LWR] pressure vessel [PV] steel test irradiation and surveillance programs. The task 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, Figures 1 and 2.

PROGRAM REVIEW AND DEFINITION

Work was started on the preparation of the NRC LWR-PV Surveillance Dosimetry Improvement Program report for the NRC 8th Research Information Meeting, October 27-31, 1980 at National Bureau of Standards. An expanded version of this document is also being prepared for the NRC 1980 Annual Report (this report will also serve as the NRC program quarterly progress report for July-September 1980).

The Emulsion Scanning Processor (ESP) an interactive computer-controlled microscope system for scanning proton tracks in emulsions has been checked out and is now fully operational. Data collection rates are about 250 tracks/day using a team of about eight trained scanners. Hence, a complete neutron spectral measurement, constituting about 10,000 tracks, takes 2-3 months. Different techniques to increase the data collection rates are under consideration. The ESP system has been developed at HEDL in support of both FBR and LWR program work. It is currently being used for FBR measurements associated with the FFTF startup Reactor Characterization Program. Starting in FY81 it will be used in support of the LWR PCA Pressure Vessel Mockup studies.

The γ-spectrometer Janus probe and associated data acquisition system is continuing to be tested and improved for in- and ex-vessel reactor measurements in support of both FBR and LWR program work. Response function testing of the new Janus probe reveals adequate sensitivity up to about 6.2 MeV. Based on these results, gamma spectrometry with this probe is expected to extend up to the neighborhood of 7 MeV. Results of this calibration work are reported in a paper on "Continuous Gamma-Ray Spectrometry in the Fast Flux Test Facility" prepared by R. Gold, B. J. Kaiser, F. S. Moore, W. L. Bunch, W. N. McElroy, and E. M. Sheen for the September 14-17, 1980 ANS Topical Meeting on 1930 Advances in Reactor Physics and Shielding, Sun Valley, Idaho.

TASK A - NEUTRON FIELDS

PCA-PSF

All nuclear emulsions that were exposed in PCA have been processed. Scanning of these emulsions awaits a decision on the priority of the emulsion data in relation to other program work and the time (2 to 3 months) required for data analysis.

^{238}U fission rates have been remeasured using solid state track recorders in 13 PVS block locations in the PCA 8/7 configuration and the results have been reported. ^{232}Th fission rates for 13 block locations and 3 void box locations for both the 8/7 and 12/13 configurations have been previously reported along with mid-plane ^{237}Np and ^{235}U (bare and cadmium covered) fission rates.

The SSTR subcapsules from the PSF perturbation experiment have been retrieved and are ready for processing.

Brown's Ferry 3 (BWR)

SSTR dosimeters irradiated in BF-3 have finally arrived at HEDL. Processing of these BF-3 SSTR will not start until a review of GE and EPRI requests for this work have been received and evaluated, including accuracy requirements.

McGuire I (PWR)

A total of 28 dosimetry sets were prepared by the HEDL Reactor Dosimetry Center for irradiation in the McGuire reactor cavity. These sets are a maximum 3/4 inch in diameter and from 1/4" to 1" thick. They will be inserted on plates along with the dosimeters provided by IRT Corporation at 16 cavity locations (4 azimuthal positions with 4 axial positions each) and 4 outer positions. At one of the azimuthal cavity locations sets containing SSTR and Cd covered sets are included in addition to the standard set.

TASK B - RECOMMENDED ASTM STANDARDS

A revised draft of the "IA" ASTM Standard, "Analysis and Interpretation of Nuclear Reactor Surveillance Results", Figures 1 and 2, was prepared by S. Anderson of Westinghouse. This and the revised E706-80 draft of the "0" Master Matrix Guide of Figures 1 and 2 will be attached as Appendices to the FY80 NRC Program Annual Report.

TASK C - DAMAGE ANALYSIS AND CORRELATION

The re-analysis of the LWR power plant surveillance reports is continuing. The Table 1 re-analysis of nineteen Westinghouse reports for errors in reported exposure values has provided more reliable neutron exposure data for analyzing the reported shifts in the Charpy 30 ft. lb. transition temperature. Analysis of the shifts reported for the so-called "ASTM reference heat" of A302 steel shows that a simple law of the type $\Delta NDTT = f(c)*(\phi t)^n$ fits the data as well as laws containing terms specifically introduced to account for annealing effects or rate effects. In the expression above, f(c) is a function of chemical composition (e.g. A+B·Cu%) and ϕt is the fluence.

A HEDL statistical analysis of a large data base for evidence of errors in reported values of neutron fluence indicates that the errors in neutron fluence values, while important, do not constitute the major source of scatter in data relating irradiation induced shift in Charpy transition temperature to exposure and chemistry. However this analysis was based on the use of power reactor data for both development and application of the laws relating Charpy shift to neutron exposure and chemistry. The intermixture of test reactor data with power reactor data can be expected to add to the importance of correct procedures in calculating neutron exposure. Additionally, the magnitude of scatter is not the sole measure of merit in considering the effect of errors in dosimetry, as the laws derived from faulty data not only have a slightly larger scatter, but incorrect values for the fitting constants. A HEDL study has also shown that when a more complicated fitting formula is used which includes a saturation term, the standard deviation of the fit does not improve, but the saturation time constant is a realistic 7 years. Extrapolation to a 30 year exposure using the more complete formula shows typically a 20% reduction in the 30 ft. lb. Charpy temperature shift compared to the shift predicted by the more simple formulation which does not explicitly contain a saturation term.

Cooperative work with EPRI aimed at analyzing a data bank collected by EPRI has been delayed pending receipt of EPRI data tapes. The tapes contain chemistry and Charpy test information placed on the tapes by Fracture Control Corporation, an EPRI contractor in Goleta, California.

Current plans for the dis-assembly of the 1st PSF "Simulated Surveillance Capsule" metallurgical irradiation package at Oak Ridge is scheduled for early September 1980.

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Irradiation Environment

CONCURRENCE:

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Enclosures

LWR PRESSURE VESSEL IRRADIATION SURVEILLANCE

DOSIMETRY PROGRAM BI-MONTHLY STATUS LETTER

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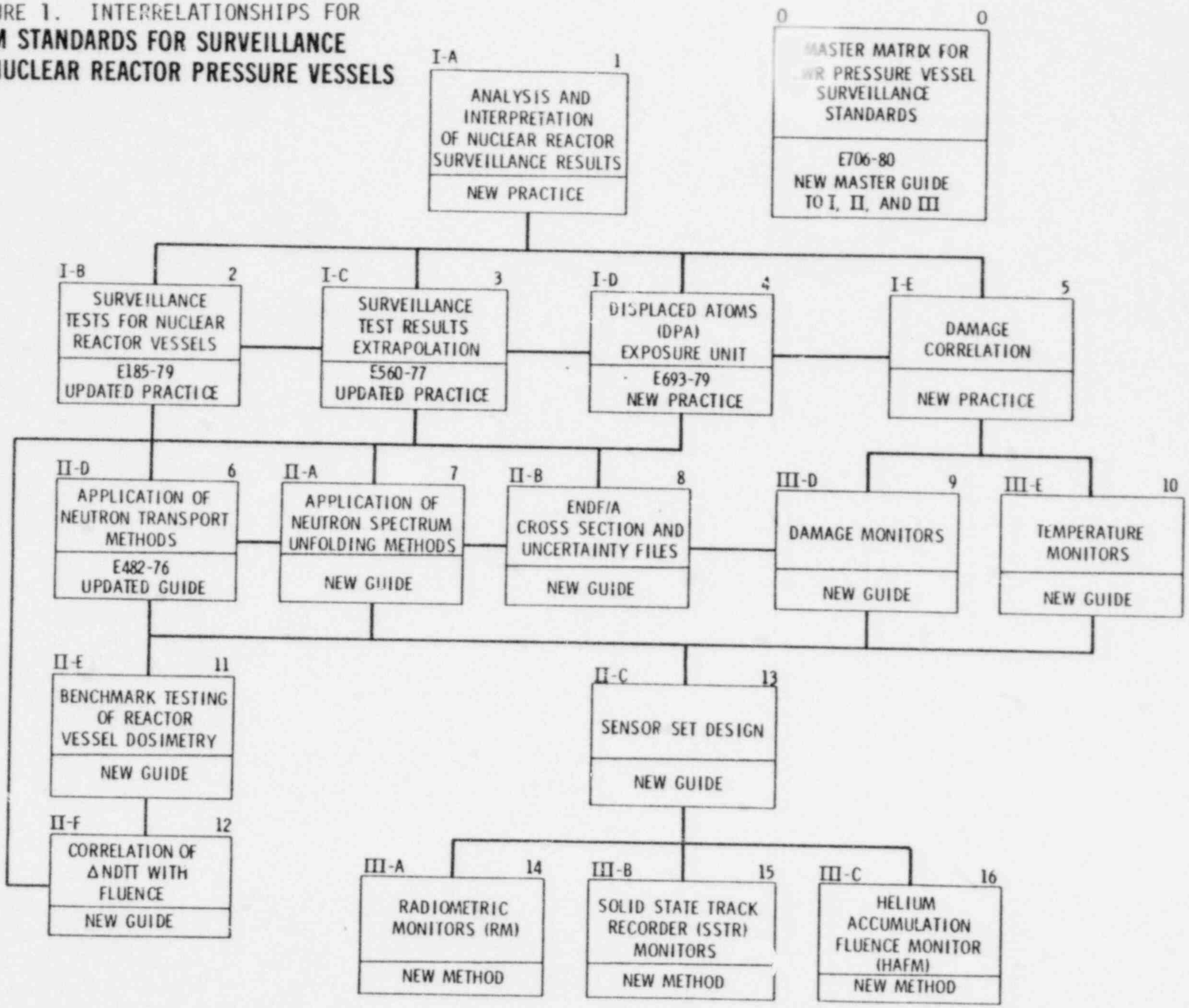
FIGURE 1. INTERRELATIONSHIPS FOR
ASTM STANDARDS FOR SURVEILLANCE OF NUCLEAR REACTOR PRESSURE VESSELS



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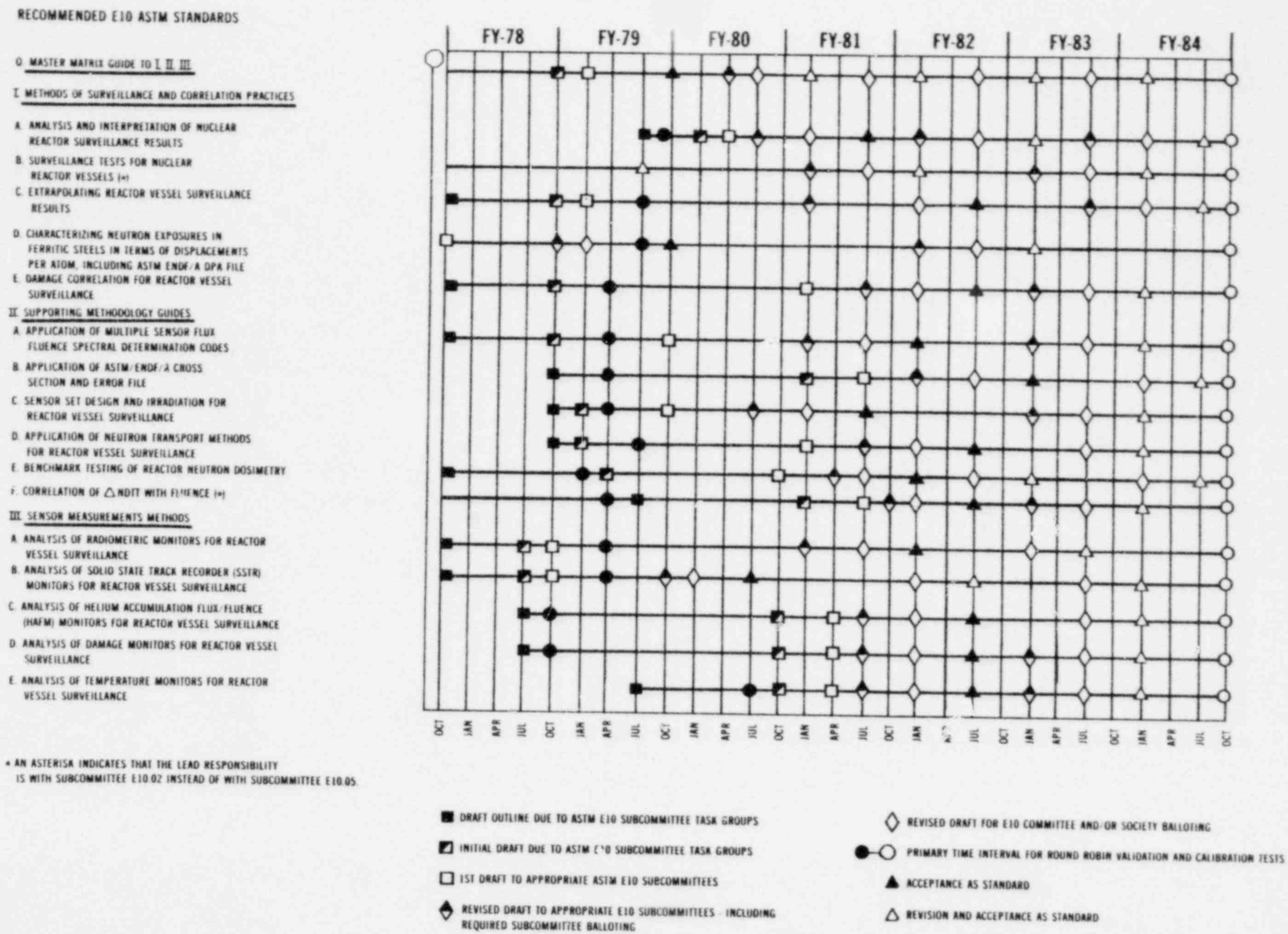

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Figure 2. Schedule for the preparation of ASTM Standards for Surveillance of Nuclear Reactor Pressure Vessels.

TABLE 1

RE-EVALUATED EXPOSURE VALUES FOR SURVEILLANCE CAPSULES

Reactor	Unit	Capsule	old $\phi t > 1$	new $\phi t > 1$	Ratio new/old	dpa	Ratio dpa/ϕt new	D_ϕ	A302B ΔTT Correlation Monitor (°F)	time(sec)
Turkey Point	4	S	1.25+19	1.81+19	1.45	.032	1.77-21	2.96-10	115*	1.084+8
"	4	T	6.05+18	8.57+18	1.42	.0140	1.62-21	3.66-10	100	3.840+7
"	3	S	1.41+19	1.99+19	1.40	.0350	1.77-21	3.14-1[illegible]	139	1.114+8
"	3	T	5.68+18	6.44+18	1.13	.0123	1.90-21	3.99-10	82	3.094+7
H. B. Robinson	2	S	3.2+18	5.09+18	1.59	.00936	1.83-21	2.14-10	80	4.385+7
"	2	V	4.51+18	7.76+18	1.72	.0137	1.77-21	1.29-10	105	1.061+8
Praire Island	1	V	5.21+18	6.29+18	1.21	.0109	1.73-21	2.51-10	---	4.350+7
"	2	V	5.49+18	7.18+18	1.31	.0122	1.70-21	2.74-10	---	4.454+7
Point Beach	1	S	---	9.52+18	--	.0157	1.65-21	1.35-10	---	1.163+8
"	1	R	2.22+19	2.69+19	1.21	.0442	1.64-21	2.71-10	110	1.632+8
R. E. Ginnea	1	R	7.60+18	1.33+19	1.75	.0247	1.86-21	2.87-10	---	8.628+7
"	1	V	5.32+18	6.91+18	1.30	.0110	1.84-21	2.80-10	90	3.923+7
Kewaunee		V	5.59+18	7.23+18	1.29	.0123	1.71-21	2.96-10	---	4.167+7
San Onofre	1	A	1.20+19	1.48+19	1.23	.0310	2.04-21	5.30-10	115	5.846+7
"	1	D	2.36+19	4.98+19	2.11	.0887	1.78-21	9.95-10	150	8.914+7
Point Beach	2	T	9.45+18	1.02+19	1.08	.0170	1.67-21	1.55-10	105*	1.098+8
"	2	V	4.74+18	7.71+18	1.63	.0127	1.65-21	2.61-10	90*	4.859+7
Conn. Yank.		A	2.08+18	2.85+18	1.37	.00516	1.81-21	9.59-11	85	5.377+7
"		F	4.04+18	5.54+18	1.37	.00977	1.76-21	1.26-10	80	7.728+7
				Average	1.42					

*A533B Steel

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