INTERIM REPORT

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INTERIM REPORT

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August 20, 1980

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Dear Joe:

MONTHLY LETTER REPORT - JULY, 1980
ACOUSTIC EMISSION CHARACTERIZATION OF
FLAW GROWTH IN A533B PRESSURE VESSEL STEEL
FIN. NO. B2088

ACCOMPLISHMENTS

- Continued work on arranging for fabrication of A533B steel insert for German vessel test.
- Received A508 test material from Germany.
- Completed evaluation of stressing stainless weld clad in ZB-1 vessel by external heating.
- Evaluated pattern recognition methods using a composite of data.
- Continued assembly of AE monitor system for vessel and reactor testing.
- Continued cylindrical bend specimen testing.
- Started arrangements for testing hydraulic noise simulation.
- Sent reports on reactor noise measurements to IZPF and Battelle Frankfurt.

- Started arrangements for weld monitoring demonstration in Germany.
- Checked status of irradiated fracture specimen testing.
- Prepared input for NRC composite quarterly report.

Some responses have been received on two requests for bids to fabricate the A533B insert for the ZB-1 test vessel. The cost estimates have ranged between $175K and $485K with the time running about 3 to 4 months compared to preliminary figures of about $30K and 6 weeks. Many of the potential fabricators that we have contacted were either too busy or did not possess appropriate equipment to perform the work. A third request for bids has been initiated after some simplifying modifications were made to the fabrication drawing. Responses to this bid request should be available by the first week of September. In addition, the option of having the patch fabricated in Germany is being explored. Dr. Gillot has indicated that if we are not able to locate a U.S. manufacturer that can meet our time and cost schedules, MPA would be willing to fabricate the patch and precrack the notches for us. This option is being followed up to establish cost and time estimates.

The degraded A508 test material has been received from MPA. Specimen design and a test matrix are currently being developed.

Simple calculations have been performed by F. A. Simonen to evaluate the feasibility of thermally stressing stainless steel weld cladding bonded to the inside of the ZB-1 test vessel by heating the outside of the vessel. It should be emphasized that simplistic considerations were used in the analyses, and the results only indicate trends. In general, the results indicate the following:

(1) Thermal cycling of the vessel O.D. at a rate of 2 Hz will be totally ineffective in stressing the I.D. stainless steel clad. Compared to thermal cycling of the vessel I.D., stresses will be lower by a factor of about 10^{-14}.

(2) The desired level of stress in the I.D. stainless steel clad can be achieved by cycling the O.D. temperature at a relatively slow rate. This rate is about 4 minutes per cycle versus 2 seconds per cycle for I.D. temperature cycling. The resulting acoustic emission rate (counts per minute) would be expected to be substantially reduced.

(3) If the I.D. clad is to be effectively stressed by O.D. temperature cycling, a substantial area (i.e., more than a wall thickness in dimension) of the O.D. would need to be heated. This could present experimental difficulties as a significant volume of the vessel would be affected.

(4) There may be substantial differences in the distribution and senses (tension versus compression) in the stainless steel clad as a function of I.D. versus O.D. thermal cycling.

In summary, stressing of the weld clad-to-base metal interface by O.D. thermal cycling seems possible. This technique may not have to be employed, however, since current test plans call for a portion of the vessel test to be performed in Mannheim. The Mannheim test loop can provide test temperatures to 550°F and would allow thermal stressing of the clad by cold water thermal shock from the vessel I.D.

A composite of waveform data (AE and various noise signals) is being evaluated for common pattern recognition features which will distinguish AE from the noise signals. Three different specimen-sensor combinations are involved: 1) a one-inch thick laboratory specimen with a conventional surface mounted sensor, 2) a three-inch wall cylindrical bend specimen with a high temperature surface mount sensor, and 3) a three-inch wall cylindrical bend specimen with a broad band wave guide sensor. Each of these sets of data treated by themselves with pattern recognition methods has shown good results (90-99% correct classification). A problem in combining the data sets is that there were different AE system gain values involved. This may preclude using common pattern recognition features which depend on amplitude in analyzing the composite data. Such a condition is, however, also atypical of continuous monitoring data. Current efforts are focusing on features that are independent of amplitude.

Work is continuing on an AE monitor/analysis system for application initially to the ZB-1 vessel test in Germany. The NRC-owned Dunegan/Endevco 1032 system which will constitute the data acquisition-source location subsystem has been at D/E for upgrading. We have been notified that it will be completed by August 22. Four staff members will visit D/E August 27, 28 and 29 for training in use of the system. Justification for four people is to provide backup in system operation and to obtain detailed information needed for interfacing to the data analysis subsystem.

On the data analysis subsystem, design of data transfer from the NRC-owned Biomation 8100 waveform recorder to a Kennedy 9-track tape transport is in progress. A Z-80 microprocessor (μP) with a Direct Memory Access (DMA) interface will be used. In addition to the 4K of buffer memory in the Kennedy, the μP will have 32K of buffer itself. The buffer memory provides a transfer storage since the system can acquire data faster than the tape transport can record it. Yet to be configured is the methodology of relating the source located signals from the Dunegan system to the recorded and digitized signals. We expect to define this during the training session at D/E in late August. The only key equipment item outstanding on a purchase order for the waveform acquisition system is the tape transport which is promised for early September.

Added testing of the cylindrical bend specimen is in progress. The main objectives are to obtain slow cycle (1 cycle/minute) fatigue data, to obtain additional waveform da ' for pattern recognition and to gather data in the presenc' of hydraulic flow noise induced by throttling water flow through the specimen.

Arrangements are in progress to test the feasibility of effectively simulating reactor flow noise in the ZB-1 vessel test by throttling flow through a closed loop running along the inside wall of the vesse. An existing autoclave vessel at PNL will be used for this work.

Two reports describing earlier reactor background noise measurements performed in the U.S. have been sent to IZFP at Saarbrucken and Battelle-Frankfurt as promised during the vessel test planning meeting in Stuttgart, Germany in June.

Action has been taken on arranging a demonstration of weld monitoring with AE at MPA, Stuttgart, Germany. The work will be performed by GARD (Dave Prine) under subcontract from this program. Further progress awaits a proposal from GARD.

The current schedule on testing 4-T baseline and irradiated fracture specimens at NRL was checked in late July. Testing is still scheduled for FY-81; probably the first half.

Input for the PNL composite quarterly report to NRC was submitted in July.

As was discussed earlier by telephone, a cost summary (Table 1) and a schedule for the program (Figure 1) has been added to this report. The schedule format is a variation on PERT charting which gives critical path, milestones and percent completion. Although this is different than the previous Buff Book schedule, it has proven to be quite useful on other programs currently in progress. If this presentation is satisfactory, we will continue to include them in monthly reports.

Funding appears to be adequate for the remainder of FY-80. The cost of preparing the A533 insert for the ZB-1 vessel is one significant uncertainty at this point; however, most of this cost should fall into FY-81. We also estimate that $20-30K in addition to the remaining $30K capital equipment funds will be needed to complete the total AE monitor system.

WORK PLANNED FOR AUGUST

- Finalize arrangements for A533 insert fabrication for the ZB-1 vessel.
- Prepare test specimens from A508 degraded material.
- Complete staff training on D/E 1032 AE monitor system.
- Continue efforts to arrange for testing of the AE monitor system on a reactor.
- Continue evaluation of reactor flow noise simulation methods.
- Continue AE monitor system fabrication.
- Complete pattern recognition evaluation of composite data.

Yours very truly,

P. H. Hutton
Project Manager

PHH:kw

Attachments

Table 1

SUMMARY OF FUNDING 8/1/80

NRC AE/Flaw Characterization Program
Fin. No. B2088

Total Funding:	Expense - FY 80			$400K
	FY 79 carry over			0
			Total	$400K
	Capital - FY 80			$ 70K
	FY 79 carry over			68K
			Total	$138K
Status 8/1/80:	Expense - *Spent			$238.5K (60%)
	Balance			161.5K
	Capital - *Spent			$108K (78%)
	Balance			30K

*Includes Outstanding Commitments

Planned Expenditure - Balance FY-80

Expense:

Cylindrical Bend Specimen Testing		$ 5K
Pattern Recognition Development		5K
Irradiated Fracture Base Line Tests		15K
Arrange for Reactor Installation		10K
Vessel Test - Fabricate A533 Insert		50K
- Test A508 Specimens		15K
- Flow Noise Simulation Development		20K
Weld Monitor Demonstration		20K
Reporting, Program Management, Travel		20K
	Total	$160K

Capital:

Monitor System Assembly	$ 30K

SCHEDULE AND MILESTONES FOR NRC AE/FLAW CHARACTERIZATION PROGRAM, FIN. #B2088

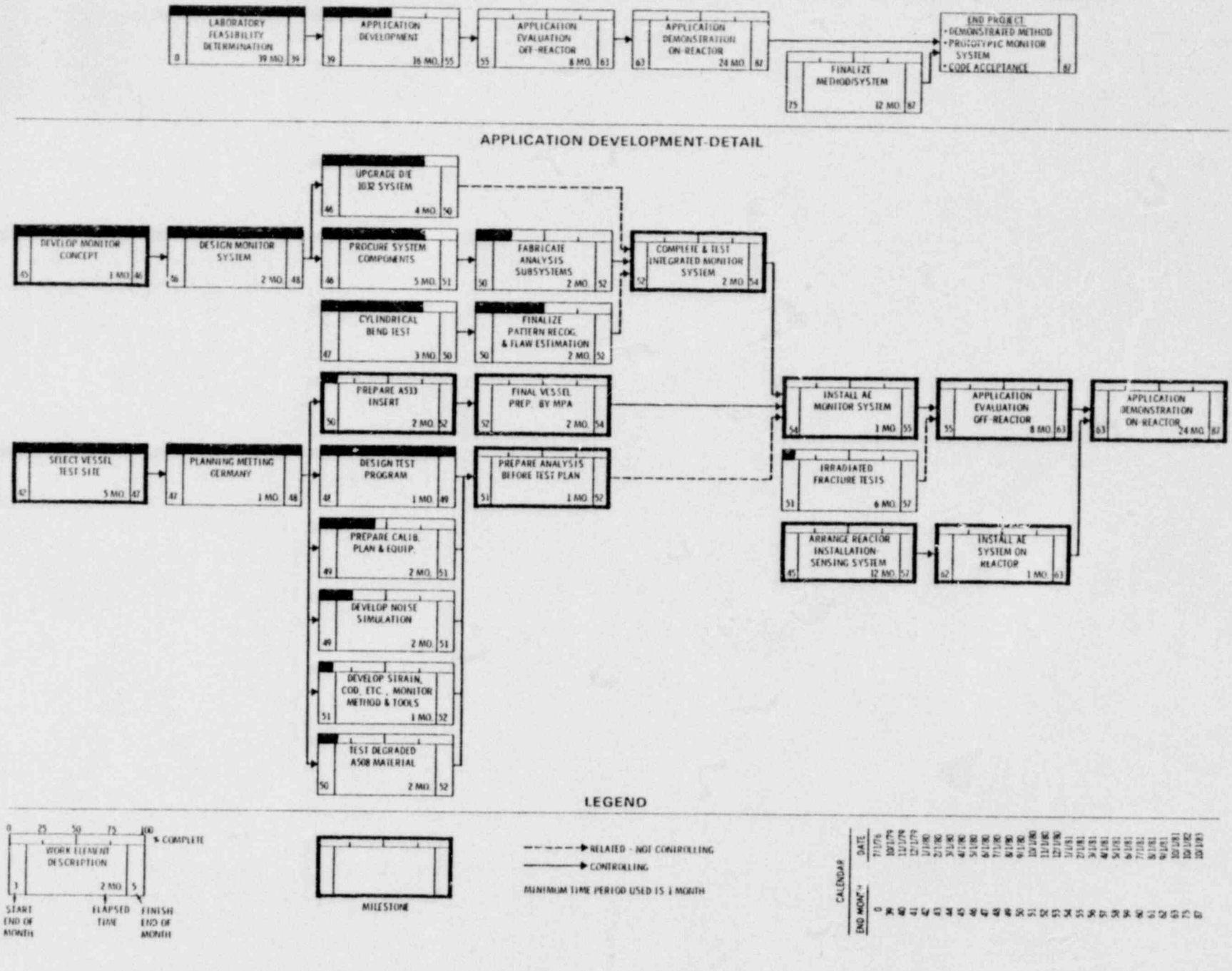

Figure 1 - Schedule Status 8/1/80