

NRC Research and Technical Assistance Report

INTERIM REPORT

Accession No. _____

Contract Program or Project Title:
The Application of the Internal Friction Nondestructive Evaluation Technique for
Detecting Incipient Cracking of Bypass Lines and Pipes in Boiling Water Reactor
Subject of this Document: Piping Systems

Same as above.

Type of Document:

Progress report

Author(s):

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Date of Document:

May 1981

Responsible NRC Individual and NRC Office or Division:

J. Muscara

Division of Engineering Technology



This document was prepared primarily for preliminary or internal use. It has not received full review and approval. Since there may be substantive changes, this document should not be considered final.

NRC Research and Technical Assistance Report

Prepared for
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

INTERIM REPORT

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DAEDALEAN ASSOCIATES, INC.
NRC Research and Technical
Assistance Report

SERVING PEOPLE THROUGH INNOVATION

6 May 1981

Dr. Joseph Muscara
Nuclear Regulatory Commission
Division of Reactor Safety
Research
NL-5650, Room 228
Washington, D. C. 20555



Dear Dr. Muscara:

Enclosed are two copies of the sixteenth and seventeenth progress report for the continuation (Phase II) contract number NRC-04-78-242 covering the reporting period from 28 February 1981 to 24 April 1981.

If you have any questions concerning the enclosed information, please do not hesitate to contact us.

Sincerely,

DAEDALEAN ASSOCIATES, Inc.

Larry L. Yeager
Larry L. Yeager
Technical Director
Material Systems Division

Enclosure

cc: Accessions Unit

DAEDALEAN ASSOCIATES, Incorporated

PROGRESS REPORTS
NOS. 16 and 17

THE APPLICATION OF THE INTERNAL
FRICTION NONDESTRUCTIVE EVALUATION
TECHNIQUE FOR DETECTING INCIPIENT
CRACKING OF BYPASS LINES AND PIPES
IN BOILING WATER REACTOR PIPING SYSTEMS

Submitted to:

Nuclear Regulatory Commission
Division of Reactor Safety Research
Washington, D. C. 20555

Contract Number
NRC-04-78-242
Continuation - Phase II

Report of Progress During the Period
28 February 1981 to 24 April 1981

May 1981

THE APPLICATION OF THE INTERNAL
FRICTION-NONDESTRUCTIVE EVALUATION
TECHNIQUE FOR DETECTING INCIPIENT
CRACKING OF BYPASS LINES AND PIPES
IN BOILING WATER REACTOR PIPING SYSTEMS

PROGRESS DURING THE REPORTING PERIOD

The principal activities during the reporting period were:

- Battelle Pacific Northwest (PNL) IGSCC Welded Pipe Test Program - Testing of the first (type 304 stainless steel, four inch, Schedule 80) welded pipe test specimen was re-started on Wednesday, 25 February 1981, i.e., load cycle number 200. IFD monitoring of the test was conducted by Mr. James Heinen of DAI.

Testing parameters were as follows:

Test temperature	550 °F
Water nominal flow rate	100 gpm
Water nominal pressure	1350 psi
Water oxygen level	35-38 ppm typical

Mechanical Load Cycle:

Hold at 100% of yield* for	60 minutes
Decrease to 90% of yield* over	5 minutes
Increase to 115% of yield* over	10 minutes
Decrease to 100% of yield* over	5 minutes

* Yield strength at 550 °F

The original test plan called for continuance of this test to failure, i.e., a through-wall leak. However, due to circumstances described below, the test was terminated during load cycle number 576. Total test time was as follows:

Load cycle time	768 hours
At temperature with pressurized water flow	<u>~100</u> hours
	868 Total Hours

Internal friction damping (IFD) measurements were made periodically throughout the course of test at each of the following nominal resonant frequencies: 1870 Hz, 2430 Hz and 6350 Hz. Pertinent observations from these IFD data are as follows:

<u>Frequency Hertz</u>	<u>Load Cycle Range</u>	<u>Maximum Percentage of Change in Damping</u>
1870	449 through 474	+ 100%
6350	438* through	+ 200%

* Note - Data was not taken for cycles 439 through 448 due to restricted access to site because of security clearance status.

After this period of IFD activity, the damping value returned to the nominal steady state level characteristic of the resonant frequency.

At 2430 Hz no significant increase in IFD was noted. In contrast to the above noted behaviors, at 243 Hz a minor decrease (i.e., 38%) was noted during the 449 through 474 load cycle range followed by an upturn approaching the base line level.

It is interesting to note that in Phase I studies, the initial IFD activity occurred at approximately 16% to 19% of the time to failure. Hence, on this basis a failure time approaching 3325 hours or approximately 20 weeks would be predicted.

The test was interrupted during load cycle 576 (March 18) at which time the mechanical load was removed from the test section and the loop was cooled to $\leq 200^{\circ}\text{F}$ in preparation of an in-situ ultrasonic inspection. While the total extension of the pipe section was low and not indicative of gross cracking, the IFD data suggested the onset of cracking. The hand-scan ultrasonic inspection yielded sufficient "indications" to suggest the existence of small scale cracking (i.e., 10-15% of wall) in several regions. In view of these results and the predicted approximate 15 additional weeks to failure, the decision was made to terminate the test and remove the welded pipe test sample for post-test examination.

Post test examinations conducted by PNL have included: 1) dye penetrant, 2) ultrasonic, and 3) limited sectioning and microscopic examinations. As yet, no evidence of cracking has been found. The practicality of further examination shall be reviewed with PNL personnel during the next reporting period.

In an effort to accelerate the time to failure and hence expedite completion of the planned test matrix, the following change in specimen preparation shall be made. A high heat input single fusion pass shall be made over the existing weld in order to increase the residual stress level and possibly the degree of sensitization. This approach is being implemented by PNL and will be evaluated by a pipe test loop.

- DAI Pipe Test Facility - The problem of a circumferential temperature gradient, typically 100°F in the test section as reported in the last period report, was confirmed by further tests. Modification of the inlet water system by the addition of a header has reduced this temperature gradient to an acceptable level of 50°F ; i.e., $550^{\circ}\text{F} + 25^{\circ}\text{F}$.

The development of water monitoring and sampling techniques and testing procedures is approximately 75% complete.

- On-site Reactor Piping IFD-NDE Testing - Coordination was continued with both the Zion and Dresden Nuclear Station of Commonwealth Edison Company, for implementing the on-site IFD-NDE test program during upcoming outages. In-house supporting activities are directed toward:
 - Identification of improved radiation and temperature (550°F) instrumentation cables, particularly for use in contact with high temperature insulated coolant piping.
 - Evaluate improved mechanical stand off pipe attachments to accommodate the current operating temperature limit of the minishaker.
- Automated Data Acquisition and Analysis Development - The software program for data acquisition has been debugged and is considered operational. A minor hardware problem associated with the A/D converter PDP 11/34 computer systems has been identified and is being addressed.

SUMMARY OF IMPORTANT TRIPS, CONFERENCES,
MEETINGS AND BRIEFINGS

On 8 April 1981, an information program status review was held at NRC in Silver Spring, Maryland. This meeting was attended by Dr. Joseph Muscara, NRC Program Manager, Dr. Charles Serpan, NRC, Dr. William Barnett and Mr. Ray Brasfield of DAI.

Mr. James Heinen of DAI was on-site at Battelle Pacific Northwest Laboratory from 25 February through 19 March 1981 for the purpose of monitoring the continuance of the initial Pacific Northwest Laboratory IGSCC welded pipe test loop.

UNANTICIPATED TECHNICAL OR MANAGEMENT PROBLEMS

None

ANTICIPATED PROBLEMS

The unexpected longevity (i.e., time to IGSCC pipe failure, >>5 weeks and possibly as great as 20 weeks, versus a planned time of three to four weeks, of the PNL pipe test remains an on-going problem which may impact the planned test matrix and schedule. A possible, though as yet unproven, corrective action has been described herein.

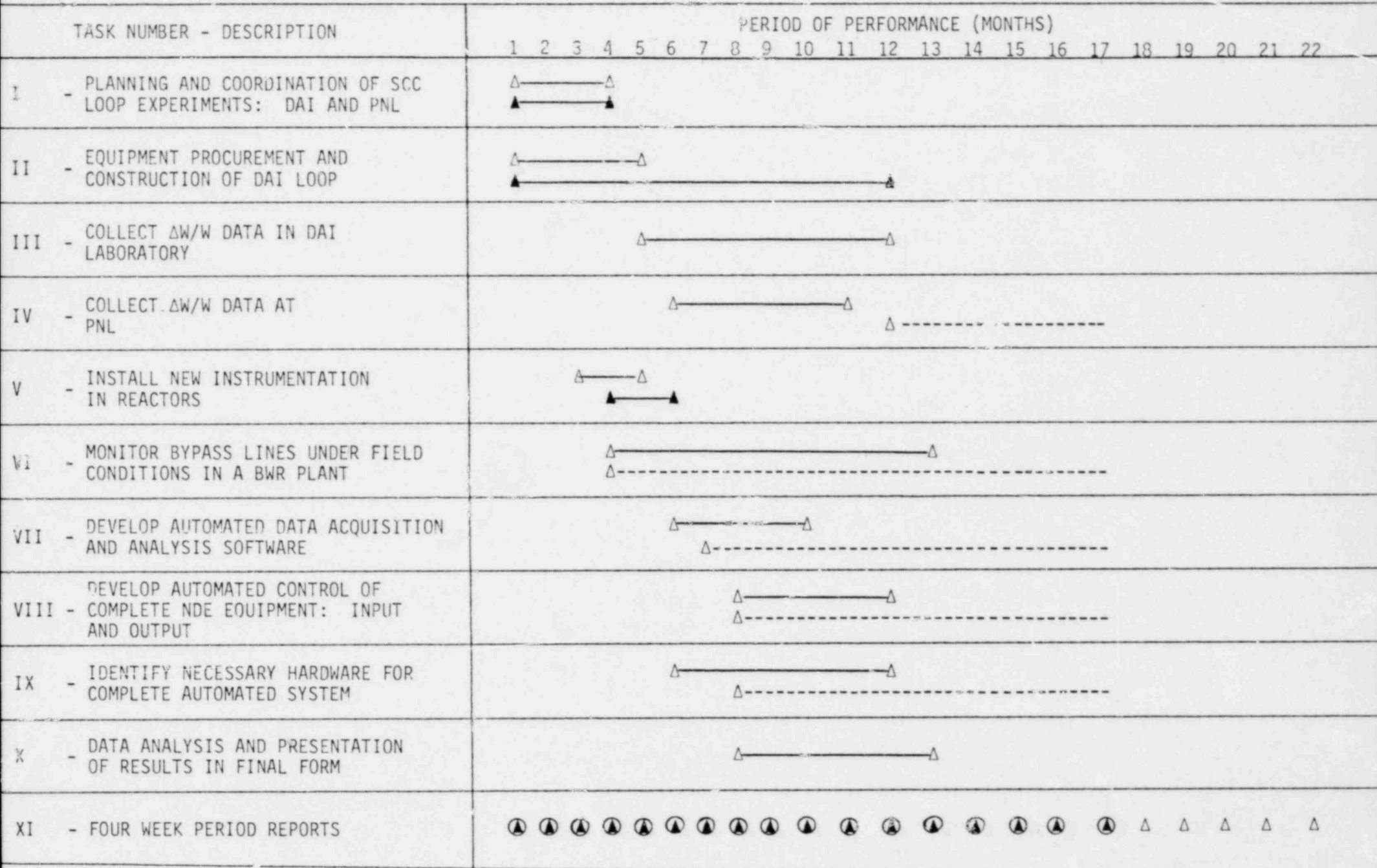
REQUIREMENTS FOR CHANGES IN KEY PERSONNEL

None

ANTICIPATED COST AND COMPLETION SCHEDULE

The work completion schedule including the progress to date for this phase of the program indicates that the program will be completed on schedule and within the estimated cost. Completion of the IGSCC pipe test matrix cannot be completed within the schedule with the present test parameters

GANTT CHART FOR PHASE II OF THE APPLICATION OF THE INTERNAL FRICTION NONDESTRUCTIVE EVALUATION TECHNIQUE FOR DETECTING INCIPIENT CRACKING OF BYPASS LINES AND PIPES IN BOILING WATER REACTOR PIPING SYSTEMS



1. REPORT NUMBER
N/A

NRC FORM 426
(6-76)
NRCM 3201

2. DISTRIBUTION CATEGORY NO.
N/A

PUBLICATIONS RELEASE FOR UNCLASSIFIED FORMAL
NRC STAFF, CONSULTANT, AND CONTRACTOR REPORTS

3. TITLE AND SUBTITLE (State in full as shown on document.)
N/A

4. AUTHOR(S) (If more than three, name first author followed by "and others")
DAEDALEAN ASSOCIATES, Inc.

5. ORGANIZATIONAL UNIT (If contract, give organizational unit of author to whom inquiries may be addressed.)
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6. REPORT DATE(S)

BASIS FOR EACH DATE (e.g. date manuscript submitted, date manuscript published.)

7. CONTRACT NUMBER
NRC-04-78-242

8. NAME OF NRC PROGRAM SPONSOR FOR CONTRACT
Dr. Joseph Muscara

TELEPHONE NO.
427-4262

9. TYPE OF DOCUMENT ("X" one)
 a. REGULATORY REPORT (e.g. Environmental Impact Statement, Safety Evaluation Report, etc.)
 b. TECHNICAL REPORT
 c. CONFERENCE PAPER
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Progress Report

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11. ADDITIONAL INFORMATION AND REMARKS (Use this space if necessary to expand on answers given above. Continue on reverse or separate sheet.)

12. FIELD CLEARANCE
Forward completed, signed NRC Form 426 together with the related document for review.
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c. DIVISION
Springlake Research Center
d. SIGNATURE (NRC responsible staff member.)
Larry L. Yeager
e. DATE: 6 May 1981

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