

INTERIM REPORT

Accession No. _____

Contract Program or Project Title: Integration of NDE Reliability and Fracture Mechanics
Fin. No. B2289

Subject of this Document: Monthly Letter Report

Type of Document: Informal Letter Report

Author(s): F.L. Becker; S.H. Bush

Date of Document: June 22, 1979

Responsible NRC Individual and NRC Office or Division:

J. Mustara
Metallurgy and Materials Res. Br. RSR

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.

Battelle
Pacific Northwest Laboratory
P.O. Box 999
Richland, WA 99352

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

446 142

INTERIM REPORT

NRC Research and Technical
Assistance Report

(6)
7908020317

FIN. NO.: B2289

RSR CONTACT: Dr. Joe Muscara

PROJECT TITLE: INTEGRATION OF NDE RELIABILITY AND
FRACTURE MECHANICS

PNL PROGRAM MANAGER: G.J. Posakony

PNL PROJECT MANAGER: F.L. Becker/S.H. Bush

MAY MONTHLY REPORT

During the month of May, primary emphasis was placed on sample fabrication and completion of the data collection phase of the state-of-practice survey. A trip to England, Germany and France for the purpose of information exchange was also completed. The trip report for this travel will be submitted separately. A summary of activities by task is given below.

TASK 1: DRAFT WHITE PAPER

Chapter 9 (NDE for Measurement of Physical and Mechanical Properties) has been completed and is currently being reviewed. Distribution is expected to be completed during August.

TASK 2: STATE-OF-PRACTICE SURVEY

The data collection phase of the state-of-practice survey has been completed. The data are presently being compiled and analyzed. It is expected that the first draft of the report will be completed by July. Excellent cooperation has been displayed by ISI organization in the collection of data for this report.

TASK 3: ANALYSIS BEFORE TEST DOCUMENT

Task has been completed.

446 143

TASK 4: FRACTURE MECHANICS ANALYSIS

Efforts in the area of fracture mechanics have been limited to information exchanges with BCL on the cold leg evaluation. Calculations will be performed to determine critical flaw sizes under various service conditions. For the elastic case, linear elastic fracture mechanics will be used. For the fully plastic case, reduction in load capacity as a function of flaw size and limit loads will be calculated.

TASK 5: STATISTICAL PROGRAM DESIGN

The major statistical effort underway at this time, is the design of the Phase Two test matrix. The approach being followed in this effort is described below:

1. The test matrix is sufficiently large to provide suitable confidence levels using conventional statistics.
2. The measurements to be taken will be suitable for testing more advanced models for probability of detection (POD).
3. The test matrix will concentrate on a limited number of test variables (fixed at conservative limits). Limited test data will be taken under other conditions to determine their impact on the POD curves and to test the more advanced statistical methods.
4. A cost evaluation is also included in the test matrix. These cost estimates will help to optimize the cost effectiveness of the test as well as demonstrate the advantages of the advanced methods of analysis.

We expect that the Phase Two test matrix will be defined during August of this year.

TASK 6: SAMPLE FABRICATION

Sample material from the vessel located at NSRDC has been cut and is ready for shipment to PNL. It is expected that this material will be received by mid-July and samples can be fabricated during FY-79. The amount of data obtained in FY-79 may be limited due to the delay in receiving the material.

Thermal Fatigue Facility

The parametric study initiated last quarter to study the effects of the thermal cycle rate and maximum surface temperature on the crack growth rate has continued this month. The evaluation of the 25 second off and 5 second on water jet cycle, which characterizes the thermal cycle, has been completed. The crack growth rate for the 25/5 cycle is shown in Figure 1 as crack depth versus number of cycles. These results confirm that crack initiation occurs between one and two thousand cycles, which will allow for reliable prediction of the crack depths. The crack growth rate for the 25/5 cycle decreases with increased numbers of cycles leveling off at a crack depth of 0.25 inches. Production of cracks greater than half through wall will require greater temperature (stress) gradients. To address this problem, the crack growth characteristic of the 25/10 (off/on) cycle are currently being evaluated. The 25/10 cycle produces temperature gradients very similar to the 30/10 cycle used in the feasibility study to produce a through wall crack.

Equipment for the thermal fatigue facility arrived this month. A notable exception was the temperature controllers which had an extended delivery time and will arrive in mid-June. Construction of the facility has been delayed approximately three weeks due to availability of craftsmen. Construction is now projected to be completed by mid-June. The costs of the facility are running very close to the estimates of \$10K for equipment and \$6K for installation.

CRACK DEPTH, mm

INCHES

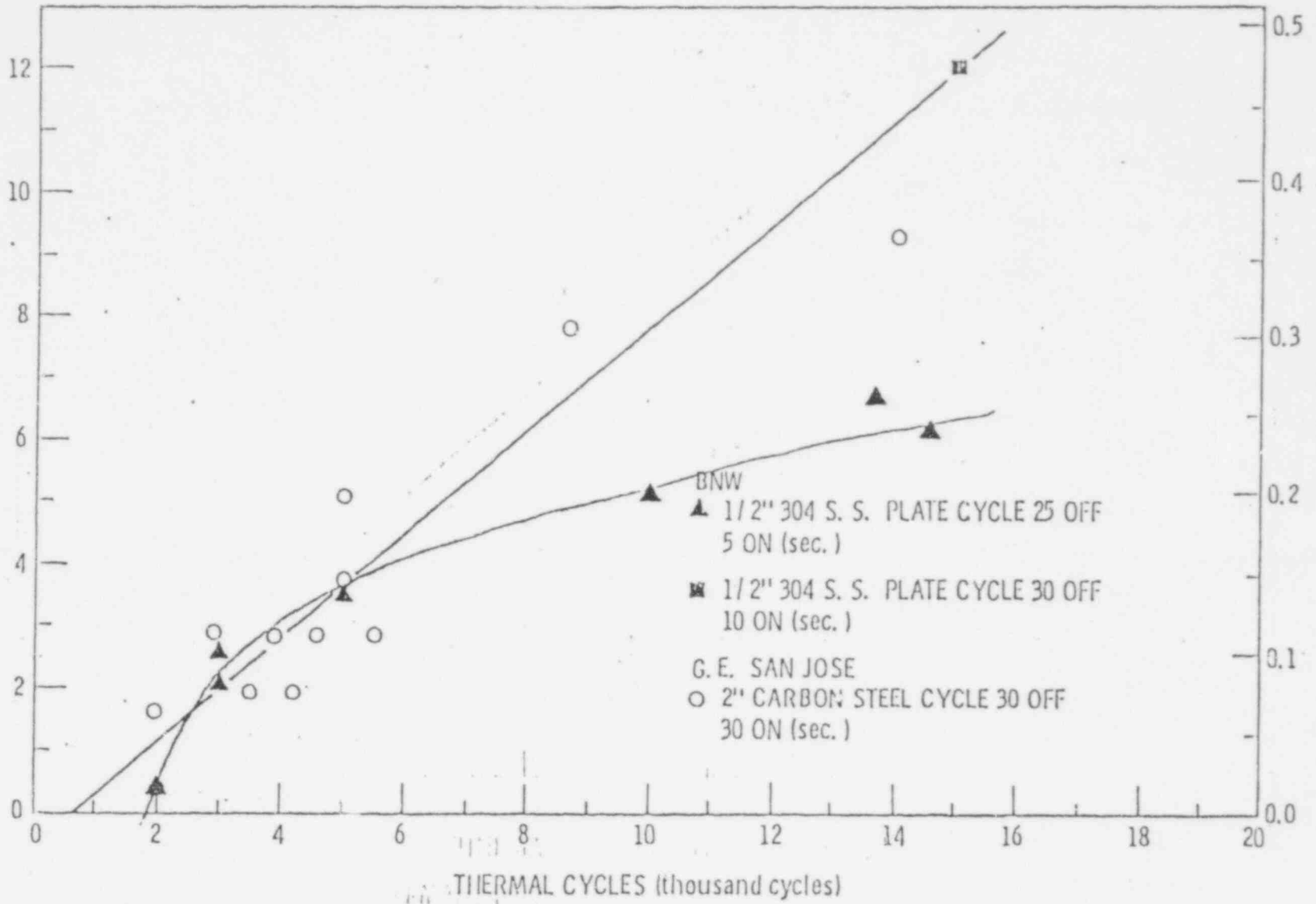


FIGURE 1. CRACK DEPTH vs THERMAL CYCLES

446
146

Flaw Characterization Samples

Fatigue of the 26 flaw characterization samples has been completed. The starter notches in the samples are presently being machined off. The flaw sizes will be measured by conventional and advanced laboratory techniques to assure the suitability of the flaws. Finish machining or further fatigue will be performed to provide flaws of a suitable size.

TASK 7: MEASUREMENT AND EVALUATION

Measurement and evaluation efforts have been directed at initial evaluation of the flaw characteristic and thermal fatigue samples (sizing). One of the two field instruments has been received and characterization of the unit is in progress.

Flaw characteristic and flaw orientation samples should be ready for measurements, according to the test plan by July 1, 1979. Thermal fatigue flaws in 10 in. Schedule 80 stainless pipe should be fabricated during July. Thermal fatigue flaws in centrifugally cast stainless and ferritic pipe will proceed as soon as the material is received from NSRDC.

FUTURE PLANS

Primary emphasis during the coming month will be placed on completion of sample fabrication and initiating the measurement program.

446 147