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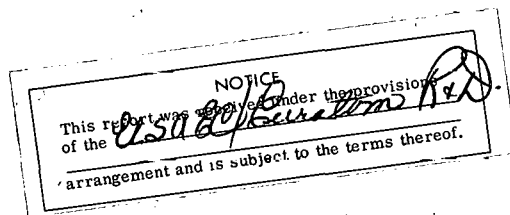
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WCAP-3677-2

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FRACTURE MECHANICS EVALUATION
OF REACTOR VESSEL STEELS
QUARTERLY PROGRESS REPORT
FOR THE PERIOD ENDING
DECEMBER 31, 1966



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PROGRAM DESCRIPTION

An experimental program will be performed directed towards further development and evaluation of a fracture mechanics approach to the problem of brittle fracture of reactor vessel materials, based upon the use of modified Wedge Opening Loading (WOL) specimens. Experimental testing of a group of reactor vessel steels will be performed to investigate the application of the fracture mechanics technique to these materials in both the unirradiated and irradiated conditions. Because of test reactor dimensional constraints, scaled-up specimens can only be used to obtain pre-irradiation data; therefore, irradiation effects will be determined on small specimens.

Testing in the unirradiated and irradiated conditions will be conducted to determine the variability in fracture toughness of various materials. Materials to be investigated will include base metal, weld and heat affected zone samples from two different heats of a nickel modified, manganese-molybdenum steel and a European forging grade material. Tensile, Charpy V-notch and drop weight specimens from those materials will also be included in the program in order to provide correlation data.

EUFM-100 - Program Management (Summary of Progress)

W. F. Eanes - Project Engineer

This is the second technical progress report on a USAEC-Euratom joint program on fracture mechanics. The first technical progress report was:

EURAEC-1720 "Fracture Mechanics Evaluation of Reactor Vessel Steels.
WCAP-3677-1 Technical Progress Report for the Period Ending
September 30, 1966"

Progress during the period October 1, 1966 through December 31, 1966 may be summarized as follows:

- 1) Babcock and Wilcox (B&W) completed the design of the calibration capsule. Fabrication of the major components of the calibration capsule is in progress, but final assembly will not be made until calculations indicate that the design is satisfactory. B&W issued the hazards report for the irradiation portion of the program.
- 2) The procurement of materials with exception of the twelve (12) inch plate proceeded as planned. A substitute will have to be found for the twelve (12) inch thick plate because of inability of the vendor to meet the originally expected delivery date.

EUFM-200 - Irradiation and Analysis

W. S. Hazelton T. R. Mager R. E. Schreiber S. E. Yanichko

This Task provides for the planning of the irradiation experiment, including the design, manufacture and assembly of the irradiation capsules. Technical direction shall be also provided during the capsule irradiation, capsule disassembly, and post-irradiation examination of specimens. Analysis and evaluation of the experimental results will be performed under this Task.

Babcock and Wilcox (B&W) completed the design of the calibration capsule. In the calibration capsule, there will be twelve (12) Chromel-Alumel thermocouples embedded in the specimens or frame. From these thermocouples, it should be possible to determine the temperature variations within the specimen holder. B&W's preliminary calculations indicate that the greatest flexibility of temperature control can be achieved with internal heaters. Varying the gas composition in the capsule can provide a wide range of temperature control, but not nearly as broad as that achieved with internal heaters. Control of the temperature using a flexible outer can to vary the gap was also considered. This method was not believed to be suitable for the long-term exposures required in this program because of potential fatigue failure of the can. The three dimensional heat transfer calculations were initiated utilizing a computer. Fabrication of the major components of the calibration capsule is in progress, but final assembly will not be made until the three dimensional heat transfer calculations indicates that the design is satisfactory. The frame for holding the fracture mechanics specimens is shown in Figure 1.

B&W issued the hazards report for the irradiation portion of the program. This report is required before any new irradiation in the B&W Test Reactor (BAWTR) can begin. Although the hazards analysis was based on the calibration capsule, with only minor modifications it should be adequate for the other capsules. It is anticipated that the calibration capsule will be inserted in the BAWTR early in the next report period.

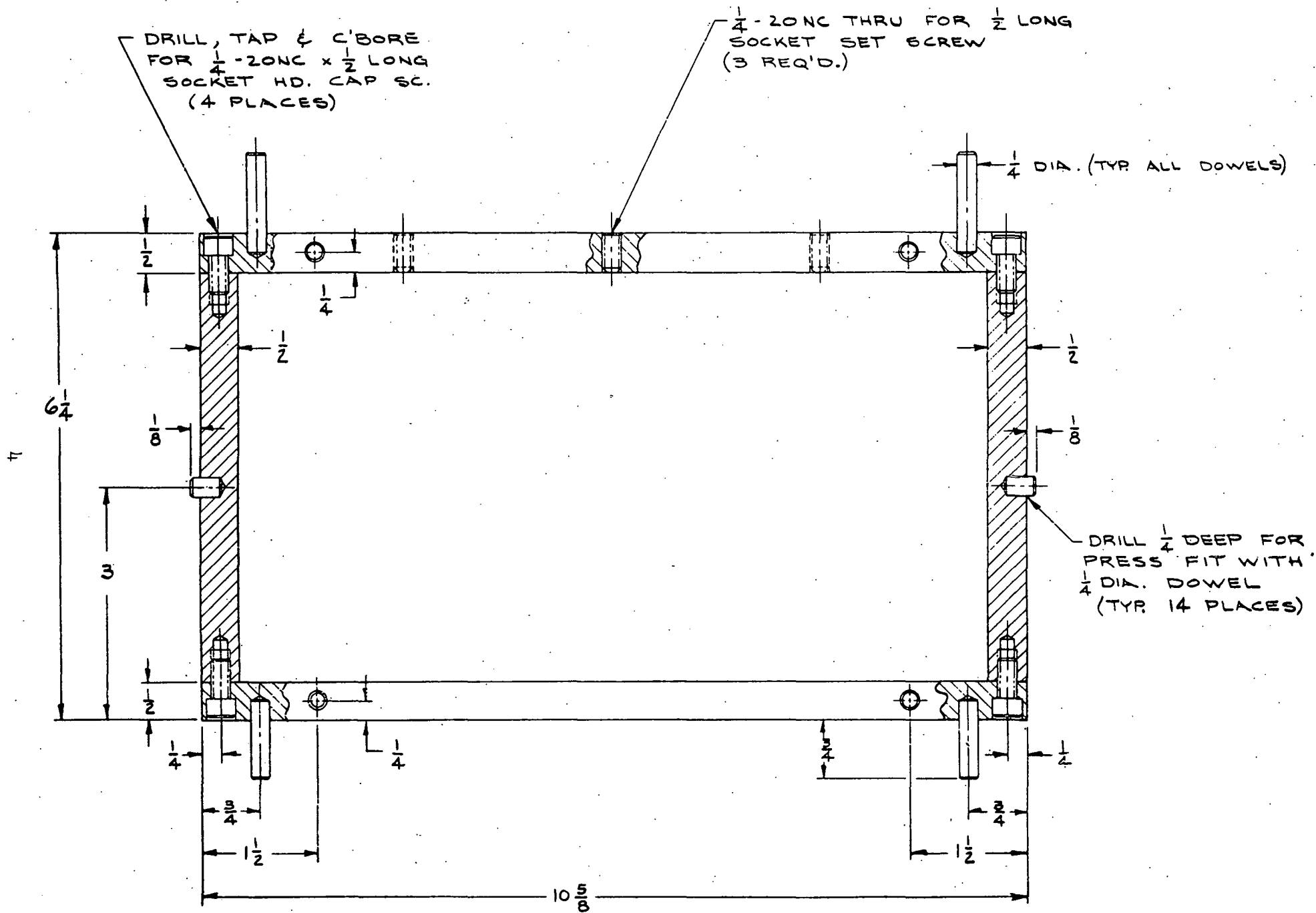


Figure 1

Frame for Holding Fracture Mechanics Specimens

EUFM-300 - Pre-Irradiation Testing

W. S. Hazelton T. R. Mager S. E. Yanichko

Under this Task, the material required for the test specimens will be procured and the pre- and post-irradiation specimens will be manufactured. The testing of the pre-irradiation specimens will be carried out and the results developed for analysis and evaluation under Task EUFM-200.

The procurement of materials, with the exception of the twelve (12) inch thick plate, proceeded as planned. The SA533 Grade B Class I (MnMo with Ni, quenched and tempered) twelve (12) inch thick plate was originally anticipated to be available for our use in about November 1966, but based on unofficial information received from ORNL the availability date was changed to July 1967. It is now apparent that the procurement schedule of the 12 inch plate is not compatible with B&W's capsule irradiation schedule (Task EUFM-200) and a substitute material must be utilized.

Sectioning of the AEC approved materials (SA 533 Grade B Class I - eight (8) inch thick plate and SA 508 Class II European forging grade steel) was completed. The material was sectioned into specimen blanks and the blanks are ready for specimen fabrication. The capability of the machine shop that submitted the lowest bid in response to requests for quotations for machining the specimens was evaluated and found to meet the specifications. This machine shop has now announced that due to labor difficulties they may go out of business. Requests for quotations for machining the specimens were submitted to several additional machine shops in the Pittsburgh area.

The test equipment at WAPD is being checked out very carefully before testing on this program. The required pull rods and universal joint assemblies were designed, machined and then heat treated to obtain maximum strength. The clip gauge which will be used for the crack opening displacement measurements was fabricated and calibrated. Four (4) 1T and three (3) 2T WOL (wedge opening loading) specimens were machined and fatigue cracked. These specimens will be utilized to check out the equipment. It is anticipated that the equipment check out will be initiated early in the next report period.