UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE REQUEST FOR RELIEF UNDER 10 CFR 50.55a(g)(6)(i)

METROPOLITAN EDISON COMPANY
JERSEY CENTRAL POWER AND LIGHT COMPANY
PENNSYLVANIA ELECTRIC COMPANY
GPU NUCLEAR CORPORATION

THREE MILE ISLAND NUCLEAR STATION, UNIT NO. 1

DOCKET NO. 50-289

1.0 INTRODUCTION

The Technical Specifications for Three Mile Island Nuclear Station, Unit 1 (TMI-1), state that the surveillance requirements for inservice inspection and testing of ASME Code Class 1, 2 and 3 components shall be applicable as follows:

> Inservice Inspection of ASME Code Class 1, 2 and 3 components shall be performed in accordance with Section XI of the ASME Boiler and Pressure Vessel Code, and applicable Addenda as required by 10 CFR 50, Section 50.55a(g), except where specific written relief has been granted by the NRC.

The current TMI-1 Inservice Inspection (ISI) Program is based on the ASME Code, Section XI, 1974 Edition including Addenda through Summer 1975. Additionally, GPU Nuclear Corporation has adopted certain portions of ASME Section XI, 1977 Edition, including Addenda through Summer 1978 (specifically, IWA-2200, IWA-2300, and IWA-3000) as described in their letter dated July 6, 1981. The first 10-year inspection interval started on September 2, 1974, and is scheduled to end on April 19, 1991. The interval was interrupted from February 1979 to October 1985 because of the extended shutdown following the TMI-2 accident.

On August 8, 1989, an inspection was conducted by NRC Inspector J. L. Coley, Region II, at the Office of Specia' Products and Integrated Field Services, Babcock & Wilcox (B&W), Lynchburg, Virginia, to observe a demonstration of the ultrasonic flaw detection capability on a mock-up of the core flood nozzle-to-safe end weld. Details of the inspection are provided in Inspection Report (IR) No. 50-302/89-21.

The examination was conducted with the B&W Automated Reactor Inspection System (ARIS-II) utilizing immersion examination methods. The ASME Code requires that the reactor vessel nozzles receive both a volumetric and an outer diameter (OD) surface examination. For the demonstration, the volumetric examination was conducted from the inside surface of the pipe using the shear wave mode of transmission. The examination was required to penetrate the full thickness of the wall, which consisted of the Inconel weld, Type 304 stainless steel pipe, and the ferritic steel nozzle forging. The effectiveness of the examination of the dissimilar materials in the weld zone was questioned in IR No. 50-302/89-21. Of particular concern was the capability of the ultrasonic examination to detect flaws originating at the outside surface of the pipe.

The results of the volumetric examination demonstrated that 1) opposite surface reflectors down to 2.3% (34 mils) through-wall were detectable in two axial directions in the ferritic steel nozzle material, 2) opposite surface reflectors down to 2.3% (34 mils) through-wall were detectable in the Inconel butter material scanned in the safe end direction, 3) opposite surface reflectors down to 2.3% (34 mils) through-wall were detectable in the stainless steel safe end when scanned in the nozzle direction, and down to 5.6 (84 mils) through-wall when scanned in the safe end direction, and 4) none of the opposite surface reflectors, regardless of size or direction scanned, could be detected in the Inconel weld material.

Region II concluded, after the demonstration on August 8, 1989, that there were severe limitations to the capability of detecting flaws in the Inconel weld material. The licensee and its contractor (Babcock & Wilcox Nuclear Service Company) attributed the inability to detect opposite surface reflectors in the Inconel weld metal to the use of an ultrasonic shear wave transmitter. The limitations identified in the report by Region II were corrected through the use of an ultrasonic longitudinal wave transmitter. The latter transmitter will be used in the subject examinations, which are scheduled for October 1991.

In a letter dated October 26, 1990, GPU Nuclear Corporation (the licensee) requested relief for the Core Flood Nozzle-to-Pipe Welds from the Section XI, ASME Code examination requirement for the OD surface examinations. The purpose of this Safety Evaluation is to evaluate the information submitted in support of the determination.

2.0 EVALUATION

Components: Reactor Vessel Core Flood Safe-End Welds, Examination Category B-F, Item B1.6

Code Requirement: Section XI, ASME Code, 1974 Edition, through Summer 1975 Addenda, requires volumetric and surface examination of pressure retaining dissimilar metal welds.

Relief Requested: Relief is requested from performing the surface (OD) examination.

Basis for Request: Pursuant to ASME Code requirements, nozzles to reactor vessel and core flood pipe welds require both a volumetric examination and surface examination of the weld. The volumetric examination is to be performed from the internal diameter (ID) of the nozzle using the B&W ARIS tool, while the surface examination would be done using the liquid penetrant (PT) examination technique. Due to the high radiation levels at the nozzle locations, it is proposed that an ultrasonic examination of the weld OD surface be performed from the nozzle ID using the ARIS tool in lieu of the required surface examination from the OD using the PT technique. To justify this proposed alternative, a demonstration of the opposite surface flaw detection capabilities utilizing state-of-the-art examination techniques and equipment was performed at the B&W Lynchburg, Virginia, facility on August 8, 1989.

The purpose of the demonstration was to define the capabilities of detecting the minimum size (through-wall dimension) reflector originating at the opposite (OD) surface which could be detected during an actual ARIS examination from the ID of the nozzle. Data were acquired and analyzed using the B&W state-of-the-art data acquisition and imaging system (ACCUSONEX). The ultrasonic system was calibrated using side drilled holes to establish a calibrated sweep range with a Distance Amplitude Correction (DAC) curve. The gain level for the DAC curve was used as a reference for the gain adjustment during this benchmark demonstration. To lower the recording threshold, the DAC curve was adjusted to a 20% full screen height (FSH) flat recording threshold. The test block was then scanned several times at increased gain levels until all of the notches were detectable. The result was that all the notches were detectable at a gain level of 24 dB above reference with a recording threshold of 20% FSH. Due to the low material noise of the carbon steel test block, excessive noise signals were not encountered allowing the use of high gain levels.

A GPUN letter dated August 20, 1986, stated that the ASME Code allows acceptance of rejectable liquid penetrant detected flaws based on sizing using ultrasonic examination methods. The GPUN approach of performing ultrasonic examination only is considered within the basis of Code requirements. GPUN also stated that cumulative exposure to perform the liquid penetrant examination is estimated to be 43 Person-Rem. Because the installation of temporary shielding in the core flood nozzle area is impractical and an acceptable alternate examination technique is available, the required Section XI Code inspection requirements are determined to be impractical.

The actual field examination will use a 70-degree refracted longitudinal wave for detection of flaws located in the inner 1/3 volume (ID) in the area of interest and a 45-degree refracted longitudinal wave will be used to examine the remaining area of interest. Use of refracted longitudinal waves for crack detection has been recognized as the best UT method available for flaw detection in dissimilar metal welds as documented in NRC Information Notice 90-30, "Ultrasonic Inspection Techniques for Dissimilar Metal Welds."

Assessment: The staff concurs with the licensee that conducting both the surface and volumetric examination are redundant in that they should provide equivalent information on the detection and distribution of surface flaws. There has been an extensive effort by B&W to provide ultrasonic technology to detect and characterize flaws. The ultrasonic techniques and technology using a longitudal wave form provide essentially complete effective volumetric examination of welds and adjacent material so that the ASME Code required surface examination is not important in the characterization of surface defects. The surface examination is redundant and requires approximately 40 man-hours for surface preparation and an additional 10 man-hours of inspection time. Because of the location of the nozzles, radiation levels are expected to result in an estimated total exposure of 43 man-rem, which is an unnecessary hardship without a compensating increase in the level of quality and safety. Thus, the code examination is impractical and would result in a burden on the licensee if imposed on the facility.

3.0 CONCLUSION:

The staff has reviewed and evaluated the information submitted by the licensee in support of this relief request from the Section XI ASME Code requirement for the surface examination of the Core Flood Nozzle-to-Pipe Welds at TMI-1. The ultrasonic procedures developed by Babcock & Wilcox, including using a longitudinal wave form, have demonstrated the capability to identify flaws in welds originating at the outside surface, thus negating the importance of the surface examination requirement. The proposed ultrasonic examination is capable of detecting opposite surface flaws and would provide an acceptable level of quality and safety. Based on the staff's review, it has been determined that the testing for which this relief has been requested is impractical to perform and that the alternative requirement for enhanced UT is authorized by law and will not endanger life or property or the common defense and security and is otherwise in the public interest. In making this determination, due consideration has been given to the burden that would result if the surface examinations were imposed on the facility. The relief is granted as requested pursuant to 10 CFR Part 50.55a(g)(6)(i) and 50.55a(a)(3)(ii).

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