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U. S. Nuclear Regulatory Commission
Att: Document Control Desk
Washington, DC 20555

Gentlemen:

Subject: Oyster Creek Nuclear Generating Station (OCNGS)
Docket No. 50-219
Request for Additional Information - Oyster Creek
Revision to NUREG 0619 Routine Inspection Criteria
for Feedwater and Control Rod Drive Return Line Nozzles

On May 11, 1994 representatives of GPU Nuclear met with the Nuclear Regulatory Commission Staff to discuss GPU Nuclear's proposal to eliminate the routine dye penetrant (PT) examinations of the feedwater (FW) and Control Rod Drive Return (CRDR) nozzles. In addition, GPU Nuclear has proposed that ultrasonic testing (UT) of the nozzles be extended to once in every Inservice Inspection period. The purpose of the meeting was to summarize previously submitted material for a new NRC reviewer. By letter dated May 18, 1994 the NRC Staff requested additional information on the demonstration of the phased array ultrasonic process on implanted thermal fatigue cracks. The Staff further requested information on the expected service life of the thermal sleeves/baffles and the basis of the projection.

To provide a context for GPUN's response, an overview of the thermal fatigue cracking issue and GPUN's actions will be presented including the testing and use of the phased array technique. In addition, a discussion of the demonstration of the technique's ability to detect thermal cracks will be provided. Finally, the information regarding the thermal sleeves and baffles will be presented.

The discovery of thermal fatigue cracking in the feedwater nozzles of several BWRs resulted in the NRC issuance of NUREG-0619. In 1977, the Oyster Creek NGS performed PT examinations of the four FW nozzles and the CRDR nozzle. Numerous indications were found in the FW nozzles. The indications were ground out and the cladding surrounding the nozzle inner radius was removed. New improved thermal sleeve assemblies having a single piston ring seal and flow baffles were installed. When the CRDR nozzle was examined, no cracks were found. The clad was left intact and a new thermal sleeve was installed. The thermal sleeves and baffle plates are designed to prevent further cracking.

APO1

GPU Nuclear constructed full size FW and CRDR Nozzle mock ups (in 1988 and 1990 respectively) with electron discharge machined (EDM) notches for the purpose of conducting a demonstration to determine the best ultrasonic technique to perform subsequent examinations. The phased array ultrasonic technique was chosen based on successful detection of all the EDM notches. Ultrasonic examination of the 4 FW nozzles was performed during Oyster Creek's 12R outage (1988) and the CRDR nozzle during the 13R outage (1991). The inspections found no indications interpreted to be cracks.

In June 1992, thermal fatigue cracks were implanted in both mock ups to confirm the UT systems' ability to detect "real" thermal fatigue cracks. In August 1992, GPU Nuclear requested a demonstration of the Siemens phased array process on those cracks. At the request of GPU Nuclear, the EPRI NDE Center supplied one of its staff members to oversee the blind demonstration. Siemens began data collection on August 11. The EPRI representative arrived at the Siemens facility on August 12, to observe data collection, review mock up design, discuss demonstration protocol, and review examination procedures. By August 20 Siemens had completed the data collection and the analysis/evaluation of the feedwater nozzle mock up. On August 20, EPRI reviewed Siemens results and compared it to the actual flaws on the feedwater mock-up. EPRI considered Siemens' results to be good.

The CRDR nozzle mock up is clad and the implanted cracks are under clad cracks. It was recognized that detection would be much harder due to the cladding interface. Because of the difficulty presented by the clad interface noise on the CRDR mock up, Siemens requested to know their error precisely on the FW nozzle mock up before continuing their analysis of the CRDR nozzle mock-up. Both GPU Nuclear and EPRI agreed to the request.

It is important to note that the implanted cracks are small, isolated, and were clad over. At the time of implantation, through clad crack implantation with control over crack size was not possible. Actual thermal fatigue cracks found in the field were through clad, numerous, and wide. Therefore, GPU Nuclear considered that detection of the under clad cracks in the mock up would show that detection of through clad cracks would be highly probable. The initial analysis on the CRDR was difficult given the clad to base metal interface. The Siemens process was able to correctly identify the location of all but one of the implanted cracks. At that point, GPU Nuclear was informed about the situation. GPU Nuclear requested that Siemens first report their results, and then be directed to perform further analysis on selected areas providing general over/undersizing information on their performance. After the locations of the cracks were provided to Siemens, they reevaluated the data. The final results of that analysis applied to the FW and CRDR nozzles are included on Attachment 1.

At several points throughout the process of testing the phased array technique on the mockups and in the field, the NRC was informed of the activities. On September 9, 1992, a meeting was held at the Siemens facility in Chattanooga, Tennessee to review the demonstration results. In attendance were GPU Nuclear, EPRI, Siemens and the NRC Staff. Following this demonstration, the Oyster Creek FW and CRDR nozzles were ultrasonically examined during the 14R outage (1993). No indications interpreted to be cracks were detected. The NRC closely monitored the field examination process during the outage.

Procedure Enhancement

As a result of the qualification process, one change was made to the ultrasonic phased array procedure which had been used during the 12R and 13R outages. The procedure had used a 8db instrument sensitivity and it was changed to a 12db instrument sensitivity above reference level for the FW nozzles, zone 2A only. This is the region where one isolated implanted thermal fatigue crack required an additional 4db to confidently make the correct evaluation. In the absence of code guidance for determining the initial gain, actual UT performance was used to optimize the initial setting.

The increase of 4db from a perfect corner reflector, such as a notch, would increase that response by approximately 30% of full Screen Height (FSH) (e.g., in practice, an increase of 4db on a 50% FSH notch reflection would increase the signal to approximately 80% FSH). This methodology is not as clear cut when considering reflections from an actual crack. The nature of cracks is such that they are not always perfect corner reflectors. Some cracks are not perpendicular to the angle of incidence of the sound beam. In such cases, some or possibly all the sound energy is reflected away from the transducer or may even be transmitted through the crack if it is tight crack.

The actual thermal fatigue cracks that have been seen in the field are much larger/wider, and if these were used as the implants, it is likely that there would not have been the need for adding the 4db. This increase has been shown by experimentation on the FW nozzle mockup to be an improvement to the technique. Therefore, 4db was added to the Siemens procedure for scanning the specific zone corresponding to the zone in the FW mock-up in which increased sensitivity improved the confidence level. As in any examination performed, when improvements are made which are verified by experimentation, those improvements will be incorporated. During Oyster Creek's 14R outage, the 4 feedwater nozzles were inspected using the phased array ultrasonic technique with the addition of the 4db to Zone 2A. No crack like indications were detected in any of the 4 feedwater nozzles.

Crack Detection / Manufacturing Process

As indicated above, one thermal fatigue crack in Zone 2A of the CRDR nozzle was not detected during the 1992 demonstration. The original 1990 demonstration using only notches proved that the sound energy was providing coverage to area 2A, (based on correctly detecting all area notches). At the time of the 1992 demonstration, it was the consensus of GPU Nuclear, Siemens, and EPRI that the problem may exist with the manufacturing process rather than the examination process. No change to the procedure was made since no amount of gain to Siemens' system made the implanted flaw detectable. This supported the consensus that the problem lay with the manufacturing process.

In March 1993, GPU Nuclear sent our CRDR Nozzle mock up to the EPRI NDE Center to determine if the manufacturing process was the cause for not detecting the crack in Zone 2A. EPRI applied the time of flight diffraction technique (TOFD) to the ID of the CRDR Nozzle mock-up using a mechanical scanner to mount the transducers and performed the examination. Based on the results of the TOFD examination from the ID, (Bore surface), the existence of the crack in Zone 2A was verified. Detection from the OD surface could not be verified using this technique and is thought to be complicated by signals from closely associated reflectors (notches) in at least one of the examining directions.

At the same time (March 1993), Siemens re-evaluated their data. Siemens' conclusion was the same as after the 1992 demonstration. That is, due to the implantation process (implant placement and clad welding), the acoustical behavior in the area in question prohibits sufficient signal-to-noise ratio necessary to distinguish between relevant and non-relevant indications. These findings support the earlier conclusions regarding the implant process: 1) under clad cracks which are manually overlayed create an acoustical problem for ultrasonics and 2) the placement of the thermal fatigue crack may have hindered detection from the O.D., (notch may have shadowed crack).

Recently, the EPRI NDE Center developed a 3-D mathematical model of acoustical behavior to support the ASME Section XI, Appendix VIII requirements. GPU Nuclear asked EPRI to use this program to develop a procedure to verify the examination technique/procedure used at Oyster Creek on the CRDR nozzle. The 3-D modelling program was not available a year ago. Current advances in technology have allowed GPU Nuclear to further verify earlier conclusions.

The EPRI NDE Center completed their 3-D modeling and experimentation guided by this modeling on May 24, 1994. The EPRI report is included as Attachment 2. The following conclusions are taken from EPRI's report:

1) Problems associated with the flaw in Zone 2A of the CRDR nozzle mock-up are from the flaw implantation process and/or subsequent cladding over of the implant.

2) The beam angles, skew angles, and probe position used by Siemens match closely with model predications for optimum procedure. These predications have been independently verified at the EPRI NDE Center using nozzle mock-ups.

3) There is reason to believe that the flaw is being shadowed by the weld interface at the implant/weld filler or weld filler/parent material or was affected when the cladding was applied.

Expected Service Life of Nozzle Thermal Sleeves/Baffles

The thermal sleeves and baffles in the nozzles are designed so that maintenance is not required for continued performance under normal, upset, and faulted conditions for an indefinite but extended period of time.

There are common features used in both types of nozzles that ensure the intended performance of the thermal sleeve/baffles. In each, a radial interference fit at the most upstream end is used to axially secure the thermal sleeve. Axial resistance is additionally provided for the feedwater thermal sleeve and baffle by means of pin secured cold-springing at the extremes of the feedwater spargers. A bayonet lock as part of the CRDR baffle assembly provides axial resistance. The flow baffles are cold-sprung into place against these axial resistances, respectively. In both cases, these axial resistances are never overcome either hydrodynamically, seismically, or thermally, individually or in combination.

Failure by metal fatigue due to vibration of the thermal sleeve assemblies due either to the pipe flow or downcomer flow is avoided because of the stiffness and, consequently, high natural frequency of the assemblies with respect to the much lower frequency fluid excitation. The baffles do not vibrate either since these remain in contact with the vessel inner surface because of cold-springing, flow holes that relieve any annulus pressure, and the absence of unseating force from the slow moving downcomer flow. The flow holes will remain open because flow through the annulus is very low and is single phase.

Both assemblies are restrained at the downstream sections of the respective nozzle so that surface wear of the baffles on the vessel inner surface is prevented.

Each of these features will remain functional because there will be no stress relaxation due to creep strain at locations where interference fits are relied upon. Specifically, for the Inconel feedwater thermal sleeve/baffle and for the stainless steel CRDR thermal sleeve/baffle there is no evidence of stress relaxation at operating temperature.

Degradation of these assemblies by a corrosive process, such as IGSCC, should not occur because stresses are generally low. Where stresses are not low, cold interference was the joining process used instead of welding of potentially susceptible materials.

Potential deterioration of the intended design function of the nozzle thermal sleeve/baffles has been avoided by assembly mechanical features and material selection. Routine IVVI of the vessel internals is of the appropriate scope and local detection sensitivity required to provide assurance of ongoing intended design function of the thermal sleeves and baffles in the nozzles.

Summary

Since the publication of NUREG 0619, GPU Nuclear has made significant effort in assuring that a qualified ultrasonic technique is capable of detecting thermal fatigue cracks. The phased array technique was successfully demonstrated by blind testing both on notches and actual thermal fatigue cracks. The follow up work done on the CRDR nozzle mock up, further supports our high degree of confidence in the phased array technique.

The attachments contain Proprietary Information as defined in 10 CFR 2.790(a)(4). An affidavit as required by 10 CFR 2.790(b)(1) is attached to this letter. GPU Nuclear believes that this correspondence, along with previous submittals, provides all the necessary data to support our proposal. We would appreciate an expeditious resolution of this matter. Should you have any questions, please contact Dennis Kelly of Corporate Nuclear Licensing (201-316-7885).

RW Keaten

R. W. Keaten
Director, Technical Functions

cc: Administrator, Region I
Oyster Creek NRC Project Manager
Sr. Resident Inspector, OC

The attachments contain Proprietary Information as defined in 10 CFR 2.790(a)(4). An affidavit as required by 10 CFR 2.790(b)(1) was submitted as part of a GPU Nuclear letter dated June 20, 1994.

ALL PROPRIETARY INFORMATION
HAS BEEN REMOVED FROM THIS COPY

AFFIDAVIT

STATE OF PENNSYLVANIA)
SS:
COUNTY OF DAUPHIN)

Before me, the undersigned notary public this day personally appeared John S. Jandovitz, GPU Nuclear Corpration, to me known who being duly sworn according to law, deposes and states that:

1. He is the acting Manager Non-Destructive Examination/Inservice Inspection (NDE/ISI) Services, GPU Nuclear Corporation ("GPUN") and has been delegated the function of reviewing the information described in paragraph 2 below, which is sought to be withheld and I have been authorized to apply for its withholding.

2. The information sought to be withheld is contained in Attachments 1 and 2 of the letter from Robert W. Keaten, Director, Technical Functions, GPUN to the U. S. Nuclear Regulatory Commission, entitled Oyster Creek Nuclear Generating Station (OCNGS) Docket No. 50-219, Request for Additional Information - Oyster Creek Revision to NUREG 0619 Routine Inspection Criteria for Feedwater and Control Rod Drive Return Line (CRDR) Nozzles.

3. In designating the information as proprietary and subject to withholding from the public, GPUN relies upon 10 CFR§2.790, "Public inspections, exemptions, requests for withholding" and the definition of trade secrets and proprietary information set forth in the American Law Institute's Restatement of the Law of Torts, Section 757.

4. GPUN has thoroughly evaluated the information sought to be withheld and described in further detail below. It has been found to include information that constitutes trade secrets and proprietary information on the grounds that it contains test data and confidential results that are critical to future management evaluations and plans.

5. Attachment 1 contains two (2) tables which contain the actual size and location of the implanted thermal fatigue cracks in the CRDR nozzle mock up and the Feedwater Nozzle mock up respectively. Attachment 2 is a report dated May 26, 1994 provided to GPUN at our request by the EPRI NDE Center. This report also contains the size and location of the implanted flaws. It further describes an optimized examination procedure including sound beam and skew angles.

6. Both nozzle mock ups are one of a kind items fabricated at great expense to GPUN. Additional expense was incurred in implanting notches and thermal fatigue cracks into the mock ups. At some future point GPUN may want or need to employ another vendor. In addition, there may be commercial value in permitting other utilities to qualify vendors using GPUN's mock ups. In either case, public disclosure of the information sought to be withheld would reduce the competitive nature of such tests and complicate the evaluation of alternate equipment, vendors and techniques.

AFFADAVIT
(Continued)

7. The information to the best of my knowledge and belief has consistently been held in confidence by the GPUN, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties have been made pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence.

That he has read the foregoing affidavit and the matters stated therein are true and correct to the best of his knowledge, information, and belief.

John S. Jandovitz
John S. Jandovitz
GPU Nuclear Corporation

Subscribed and sworn to before me
this 15th day of June, 1994.

Melody Kim Kulp
Notary Public

Notarial Seal
Melody Kim Kulp, Notary Public
Londonderry Twp., Dauphin County
My Commission Expires Aug. 21, 1997
Member, Pennsylvania Association of Notaries