Nuclear

GPU Nuclear Corporation
One Upper Pond Road
Parsippany, New Jersey 07054
201-316-7000
TELEX 136-482
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U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Gentlemen:

Subject: Oyster Creek Nuclear Generating Station (OCNGS)
Docket No. 50-219
License No. DPR-16
Feedwater Nozzle Examination
Reference: GPUN Letter 11/20/85

During 12R, GPUN completed an automated ultrasonic examination of welds, inner radii and inner bores of four feedwater nozzles from external vessel and nozzle surfaces. For this examination, GPUN contracted for a state of the art (phased-array) UT technique with advanced tomographic data analysis. Since no indications were determined as being reportable, we did not perform dye penetrant and visual examinations of the nozzle internal diameters. The results from this inspection are presented in the Attachment in accordance with the NUREG 0619 format.

As part of our commitment to the NUREG 0619 inspection requirements, Oyster Creek is scheduled to perform an internal dye penetrant examination of the feedwater and control rod drive return line (CRDR) nozzles. In light of our 12R experience with this UT technique, GPUN has concluded that this inspection technique is a suitable alternative to an internal dye penetrant examination to assess nozzle integrity. By a separate submittal, GPUN will provide our basis for eliminating the 13R internal dye penetrant examinations for both the feedwater and CRDR nozzles. If you have any questions concerning the results from the 12R examination or the future submittal, please contact Mr. M. W. Laggart at (201) 316-7968.

Very truly yours,

[signature]

J. C. DeVine
Vice President & Director
Technical Functions

DKC/DJ/cjg
Attachment

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PDR ADOCK 05000219
Q PDC

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cc: Regional Administrator
Region I
U.S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Resident Inspector
Oyster Creek Nuclear Generating Station

Mr. Alex Dromerick
U.S. Nuclear Regulatory Commission
Mail Station P1-137
Washington, D.C. 20555

50-219

ATTACHMENT
RESPONSES TO NUREG 0619

NUREG 0619 ITEM (a)

Number of startup/shutdown cycles since the previous inspection, and the total number of cycles. This will include cycles accumulated during the initial startup and testing of the plant.

Response

Between the previous feedwater nozzle inspection (7R) and the most recent inspection (12R), there have been seventy three (73) start-up/shutdown cycles (i.e. planned or forced outages). The total number of start-up/shut-down cycles accumulated up to the 12R outage is one hundred and fifty seven (157).

NUREG 0619 ITEM (b)

Summary of methods used and results of previous inspections, including maximum crack depth and number of cracks found in previous PT-and-grinding operations, and number of startup/shutdown cycles between such inspections.

Response

The summary of methods and the results from the 1977 inspection of feedwater nozzles A, B, C and D are delineated below. The number of cycles between inspections are in our response to item (a).

Initial Indications

Inspection areas were laid out on each feedwater nozzle covering from the I.D. of vessel shell to nozzle forging weld to a distance 7 1/8" into the nozzle bore from the vessel wall (the extent of cladding into the bore). The inspection areas were cleaned of all oxide with flapper wheels, rags and acetone. The results of the internal dye penetrant examination showed 54 unacceptable indications. The 45° nozzle contained the largest number of indications but the worst were in the 225° nozzle.

45° nozzle - 36 indications 1/2" - 4" long
135° nozzle - 3 indications 1" - 2 1/2" long
225° nozzle - 4 indications 2" - 12" long with numerous branches
315° nozzle - 11 indications 1" - 12" long

Indications Subsequent to Clad Removal

Upon completion of clad removal, the machined surfaces were dye penetrant inspected. The examinations revealed the following number of indications:

45° nozzle - 5 indications 1/2" - 1 1/2" long
135° nozzle - No indications
225° nozzle - 4 indications 1/2" - 3" long
315° nozzle - 3 indications 1/4" - 1" long

All indications were removed by hand with pencil grinders using tungsten carbide burrs. Ground out areas were blended to a 3:1 slope and polished with flapper wheels. The nozzles were etched with a 5% nitric acid/isopropyl alcohol solution to determine if all the cladding had been removed from the bore and radius. Patches of cladding remained at 12 and 6 o'clock positions on the blend radii of most nozzles. All of the cladding was removed using pencil grinders and tungsten carbide burrs. The ground out areas were blended and polished with flapper wheels and dye penetrant inspected.

The final condition of the nozzles was photographed. The deepest grindout was 7/32" in the 315° nozzle. The condition of the nozzles was as follows:

45° nozzle - 5 grindouts 1/32" - 1/8" depth
135° nozzle - no grindouts
225° nozzle - 3 grindouts 3/64" - 1/16" depth
315° nozzle - 3 grindouts 1/32" - 7/32" depth

<u>NUREG 0619 Item (c)</u>

Description of any additional system changes or changes in operating procedures that will affect feedwater flow or temperature and that should be considered in predicting future cracking tendencies based on past history.

<u>Response</u>:

No changes to the system or the operating procedures are currently planned for Cycle 12 which could affect normal feedwater flow or temperature. In order to more effectively control reactor water level during start-ups and shutdowns, a block valve will be installed during 13R to stop leakage from the feedwater regulating valve which can bypass the low flow feedwater regulating valve.

<u>NUREG 0619 Item (D)</u>

A detailed discussion of the inspection results, including a complete description of cracking location, dimensions, and profile, if cracking was found. Drawings and photographs, if available, are requested.

<u>Response</u>:

For the purposes of the UT inspection, the Nozzle interior was segmented into three zones. These zones were defined as follows: Zone 1 - the nozzle inner radius; Zone 2A - the nozzle inner bore region from Zone 1 to the OD blend region; and Zone 2B the nozzle inner bore region in the range of the nozzle boss (see attached sketch).

No indications were interpreted to be cracks in feedwater nozzles A, B, C, and D. A summary of the inspection results for each nozzle is provided below:

NOZZLE: FEEDWATER NOZZLE "A"

INSPECTED AREA: NOZZLE TO SHELL WELD 4-566-A (scanning limited from 210° to 305° due to adjacent nozzles on vessel OD-surface), ZONE 1, ZONE 2A AND ZONE 2B (full coverage);

EXAMINATION RESULTS:

- The required sensitivity (signal to noise ratio) was achieved in all areas.

- The calibration rechecks confirmed the system sensitivity to be within the required tolerances.

- The UT signals were evaluated utilizing the appropriate display methods:

  -C-scan
  -Tomography
  -Time Displacement
  -A-Scan
  -Soundpath Trajectory Reconstruction

- Based upon these criteria indications observed were determined to be caused by geometry.

- Multiple indications, out of the vessel mid-wall, reaching or exceeding recording threshold, were observed during scanning for lamination type indications in the vessel wall throughout the entire circumference. The amplitude of the backwall reflection did not diminish significantly; indications observed were acceptable and did not interfere with the angle beam inspection as noted by the ability to maintain angle beam signal to noise ratio.

NOZZLE: Feedwater Nozzle "B"

INSPECTION AREA: Nozzle to shell weld 4-566 B, Zone 1, Zone 2A and Zone 2B;

NOZZLE: Feedwater Nozzle "C"

INSPECTED AREA: Nozzle to Shell Weld 4-566c (scanning limited from 210° to 300° due to adjacent nozzles on vessel OD-surface), Zone 1, Zone 2A and Zone 2B (full coverage);

NOZZLE: Feedwater Nozzle "D"

INSPECTED AREA: Nozzle to Shell Weld 4-566 D, Zone 1, Zone 2A and Zone 2B;

EXAMINATION RESULTS: NOZZLES B, C, AND D

- The required sensitivity (signal to noise ratio) was achieved in all areas.

- The calibration rechecks confirmed the system sensitivity to be within the required tolerance.

- The UT signals were evaluated utilizing the appropriate display methods:

  -C-Scan
  -Tomography
  -Time Displacement
  -A-Scan
  -Southpath Trajectory Reconstruction

- Based upon these criteria indications observed were determined to be caused by geometry.

- Therefore, no reportable indications were detected.

NUREG 0619 ITEM (e)

Information regarding the results of leakage monitoring. However, the staff must be informed immediately if on-line leakage monitoring during operation discloses any leakage on welded spargers or leakage on the order of 0.3 gpm through single-sleeve/single-piston-ring spargers or triple-sleeve spargers.

Response:

Up to the 12R refueling outage, Oyster Creek had no on-line leakage monitoring system. During 12R, Oyster Creek installed a Thermal Transient Monitoring System (TTMS), a modified version of EPRI "Fatique-Pro", which has the capability for leakage monitoring.

The TTMS not only provides a record of the actual transients encountered in service, but also gives a real time update of the remaining fatigue resistance of the nozzles. In addition, the minimum flaw detection performance of the regulatory required UT inspection is also shown to be satisfactory by the TTMS. Actual transients are translated into pressure and thermal stresses which are interacted, by means of linear elastic fracture mechanics, with established minimum detectable crack size, in order to show that such a hypothetical flaw will not propagate, by the next scheduled inspection, to a depth requiring repair, using ASME Section XI criteria.

Five RTD's were placed on the FW nozzle and pipe. Four RTD's were located downstream of the piston ring seal at one axial position and one upstream. Leak detection sensitivity is enhanced by the placement of the RTD's which are located more toward the bottom of the annulus than the top. Cooler, more dense leakage past the seal tends to fall and collect at the bottom of the annulus where the instruments are located.

A calibration option allows comparison of measured with calculated outer surface temperatures. The calculated value has the built-in assumption that there is very low leakage. A trend of increasing departure over a long period of time of predicted surface temperature from measured values is evidence of increasing leakage. A leakage increase detection threshold equal to 2.0 gpm is the theoretical sensitivity of the leak detection capability.

NUREG 0619 ITEM (f)

Information regarding all UT crack-like indications and any subsequent PT indications. Information regarding UT techniques should be as precise and as extensive as possible in order that it may be of benefit in future inspections.

Response:

Information regarding all UT indications is described in response to Item D. Since no indications were considered reportable, no PT examinations were performed.

GPUN established two objectives to be fulfilled by the 12R ultrasonic examinations (UT). The first objective was to complete the ASME Section XI examinations required for the present 10 Year Interval. The second objective was to complete a UT examination of the four feedwater nozzles which would comply with the requirements of NUREG-0619, BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking. GPUN chose to add a condition onto the second objective which required the examination technique to be capable of reliably detecting a 1/8" deep by 1/4" long axial crack on the nozzle interior yet be capable of distinguishing a flaw of this size from non-flaw conditions such as nozzle repair grindouts.

Access to the nozzles was limited to the OD surface because feedwater sparger disassembly would be necessary for ID access. The flaws of interest are predominantly axially oriented originating on the nozzle interior in the presently unclad portion of the nozzle.

The geometry of the vessel nozzle involves a cylinder being intersected by a second cylinder. This geometry requires an approach involving three dimensional logic rather than the normal two dimensional logic required for examining most welds such as vessel longitudinal or circumferential welds. The geometry required that the nozzle interior be segmented into three distinct zones in order to track all parameters from the examination development stage through the final field examination evaluation stage. These zones are delineated on the attached sketch.

GPUN evaluated potential contractors based on the results of a "blind run" on a full scale Oyster Creek feedwater nozzle mock-up. The simulated flaws were axially oriented end mill notches located in all three zones both in simulated grindouts and outside simulated grindouts. Grindouts were those local areas of grinding that occurred after cladding removal to facilitate flaw removal. Zone 1 contained thirteen total flaws ranging in depth from 0.030" to 0.468" and lengths of 0.250" to 1.570" with two located in grindouts. Zone 2A contained nine total flaws ranging in depth from 0.070" to 0.365" and lengths of 0.250" to 2.0" with two located in grindouts. Zone 2B contained eleven total flaws ranging in depth from .091" to 0.435" and lengths of 0.250" to 1.010". The vendor was allowed access to four flaws in Zone 1, three flaws in Zone 2A, and three flaws in Zone 2B for use as calibration reflectors.

The Contractor chose Zone 1 and 2A examination incidence and lateral skew angles based on 3-D finite modeling and experimentation; Zone 2B is basically a hollow cylinder and the examination approach is the same as for a piece of pipe. Skew angle is extremely important for examination of Zones 1 and 2A because the corner trap for sound reflection is formed 3 dimensionally as a result of skew and incidence angle rather than incidence angle alone. The skew angle necessary is dependent on incidence angle, distance from the nozzle centerline, and circumferential location around the nozzle.

The contractor chose to control the automated examination system search unit skew angle electronically by steering the sound rather than mechanically by physically rotating the search unit. This required use of a "Phased Array" technique. The phased array system utilizes a transducer which is segmented to allow for individual excitation of each segment. Each segment is sequentially excited to produce a steering effect (skewed angle beam), yet the timing allows the transducer to act as a single standard search unit of similar size and frequency. Conversely, when the search unit is in the receive mode, each segment is individually listened to and electronically delayed to produce results similar to a standard search unit. This description is applicable to search units designed for skewing; however, the same principal may be applied to search units segmented in the opposite direction (lateral) for controlling incidence angle.

The Oyster Creek nozzle mock-up was shipped to the contractor to allow for improvement of exam techniques in mutually agreed areas. A reproduceability qualification was performed following system improvements. This qualification required locating and sizing of three flaws each in Zones 1, 2A, and 2B with three separate mountings of the examination manipulator. The final examination technique for Zone 1 required the use of 57° and 65° shear wave phased array search units from the vessel shell skewed ±14° to ±30°. The zone 2A technique utilized 72° shear wave and creeping wave phased array search units from the vessel shell skewed ±12° to ±25°. The Zone 2B technique utilized 21° and 33° phased array incidence angles with no search unit skew angles from the nozzle boss.

The examination manipulator consisted of a circular split mounting ring mounted on the nozzle safe-end with separate control arms for the nozzle boss and vessel shell exams. Scanning motion was circumferential around the nozzle (Zones 1 and 2A) or nozzle boss (Zone 2B) indexed in distance from the nozzle centerline (zones 1 and 2A) or vessel wall (Zone 2B). Demineralized water couplant was supplied to the search unit which was designed to form a water film containment thus eliminating coupling pressure as an essential variable.

All digitized A-scan responses from specifically gated regions were recorded during the examination. This method of recording allowed for reconstruction of numerous display presentations which could be used during data evaluation performed off-line.

Seven different data displays were utilized for data evaluation. The displays and descriptions are as follows:

Presentation	Description
A-Scan	Displays the digitized A-Scan information within a gated sound path region along with probe position, skew angle, and screen pixel size.
TD-Time Displacement	Displays each single A-scan over the scan line in a horizontal line with an amplitude related grey scale. The display is available for each activated angle and probe.
Echo-Dynamic	Displays the maximum signal in a specifically gated region over the full scan line (example 0° to 360°).
Echotomographic "A"	Displays the complete UT-Data along one scan line through a summation process. For each probe location along the scan line the A-scan information is assigned to pixels along with the sound path and compensation for examination skew angle. The presentation undergoes a

summation process which switches through the different skew angles and probe positions by summarizing the signal amplitudes at each pixel location. The resultant amplitudes are displayed in a grey scale mode.

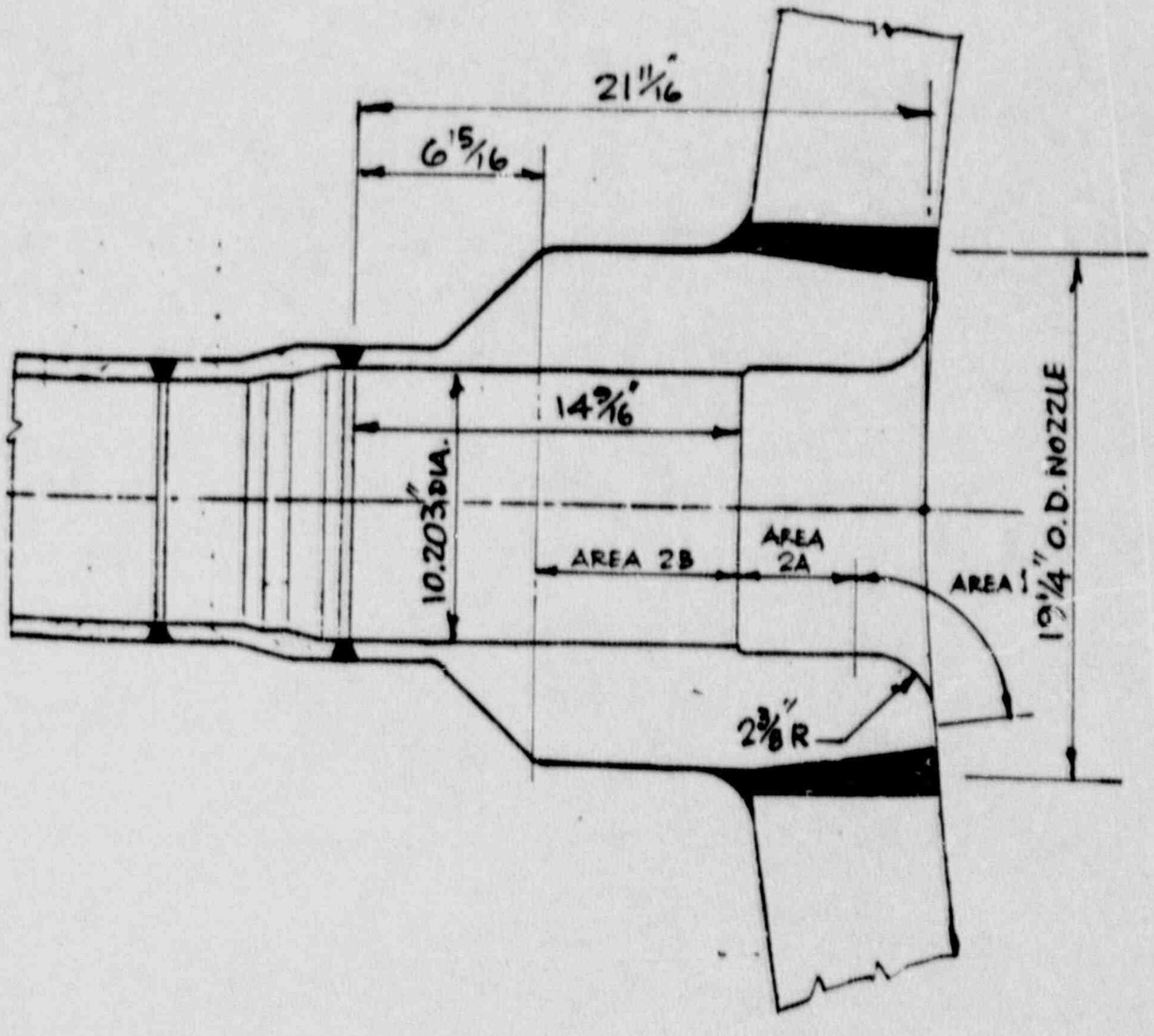
This process of spatial summation produces a high potential for signal to noise ratio enhancement.

Echotomographic "B"	This display uses the same process as the Echotomatraphic "A" display but accounts for search unit effective beam spread.
3D-Echotomographic	Displays the echotomagraphic information described above in a 3-dimensional model with amp [illegible]e representative of vertical extent.
C-Scan	Displays data from a selected soundpath range assuming a constant skew angle.

Data evaluation was performed by personnel responsible for the examination system design and personnel who evaluated data from the examination technique qualifications. All personnel responsible for UT data acquisition and evaluation were also qualified and certified in accordance with the requirements of ASME Section XI.

Full examination coverage (no limitation) was achieved to examine the interior surface of Zones 1, 2A, and 2B. Adjacent nozzles prevented scanning from 210° to 305° on nozzle A and 210° to 300° on nozzle C for the nozzle to shell weld Section XI examinations.

Laminar indications were detected in the vessel shell midwall region which exceeded recording criteria for angle beam scan interference but did not exhibit a complete loss of back reflection, and therefore were acceptable per Section XI. These small indications were not considered to have interfered with the angle beam examinations because there were no obvious changes in the interior surface noise pattern as displayed during data evaluation. No indications interpreted to be cracks were detected in Zones 1, 2A, or 2B.



FEEDWATER NOZZLE CROSS SECTION
OYSTER CREEK NUCLEAR STATION