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September 4, 1984

Mr. L. Frank
Materials Engineering Branch
Mail Stop P-328
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Frank:

Travel to Westinghouse Murray Center, Monroeville, Pennsylvania, August 14–17, 1984

The purpose of my visit to Westinghouse was to participate in a review of the data collected on the Indian Point unit 2 reactor vessel indication. This review meeting was a follow-on to one held in Bethesda on Saturday, August 11, 1984.

C. Y. Cheng (NRC) and I arrived at the Murray Center on Tuesday, August 14, at approximately 3:00 p.m. We met with Consolidated Edison and Westinghouse personnel to make a cursory review and provide Westinghouse with additional information for their planning of the review. Cheng had an agenda (Attachment 1) for the next three days that was distributed to attendees. Don Adamonis, Cheng, and I discussed some of the 60° pulse-echo shear wave data to give Westinghouse an idea of what we wanted to see the next morning.

W. T. Clayton [Southwest Research Institute (SWRI)] joined us late Tuesday night, and we briefed him on the afternoon session and the agenda for the review meetings. The next morning the three of us and Ron Hernan (NRC, Denton's office) drove to the Murray Center. We began a detailed review of their raw data, including the video recordings of A-scan ultrasonic data, for the indication detected in the lower shell weld 12. We asked about the controlling document and were informed that the 1974 ASME Code, with summer 1975 addenda, was the correct one.

Westinghouse showed us in-service inspection data and how they were collected. We also were shown the beam spread data collected on the flat block and agreed with their calculation showing the half angle to be 2.3° (for the search unit TR27). We asked for a demonstration on the flat block that would also collect 60° beam spread data for TR27, so that we would have this information. The beam spread data were collected on Thursday evening at Waltz Mill (Madison, Pennsylvania).

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We were given details on the layout of the array plates for the transducers and the angle used to collect the ultrasonic data in the area of the indication. The vessel at this location has a radius of 86.5 in., so the circumference is 543.49 in. Thus, 1° around the circumference on the inner surface is 1.5097 in. The data were collected so that 100 counts represented 1° around the circumference; therefore, to calculate the inches of travel, one multiplies the difference in the A-channel data (divided by 100) by 1.51. The length along weld 12 for the 50% DAC was recorded as Z-axis readings from 37,500 to 37,193 (a difference of 327 counts). One inch of travel vertically along the vessel required 166.67 counts; therefore, the calculated length of the indication is 1.96 in. (as reported by Westinghouse).

While working with beam spread data for TR27, we noted that the angle measured from the side-drilled holes is nearer to 56 or 57° than to 60°. This is also observed from the beam spread data collected on August 16. Thus we concluded that sizing by Code techniques should be done at about 56° instead of 60°. We attempted to check this on the curved calibration block by taking data off the 2% notch on Thursday night after collecting beam spread data from the flat block with TR27. TR27 was used to obtain a 100% DAC signal from the 2% notch with a metal path time of 220.4 μs. I calculated an angle of 55.76°. Therefore, it appears that Code sizing should be done with the 56° beam instead of the nominal 60°. However, it is my opinion that the Code sizing method is inadequate regardless. The Code method tends to oversize small reflectors (especially true for indications on the surface opposite the entry) and to undersize large reflectors (especially true for indications not on the surface opposite the entry). This fact has been reported by the ASTM Pressure Vessel Research Committee as well as others. However, the Code does provide good detection capability for the type of indication found in weld 12.

Since the indication was found, the next step was to do further tests in order to make a better size estimate. The Delta transducer configuration was chosen for the augmented sizing attempt (Westinghouse and Combustion Engineering made the selection). This technique uses time-of-flight measurements to determine the depth of the indication. If a tip-diffracted signal is observed from the end of the flaw, a calculation can be made for the change in time-of-flight to determine the extent of the flaw depth. A demonstration of this technique was performed at Waltz Mill on Friday, August 17, using a curved reference block with machined notches placed on the outer surface. We were told that this test block is 9 in. thick and has a representative cladding and inner radius of 86.5 in. It was obvious from the demonstration that this block was much less attenuative of ultrasound than the flat test block (used for calibration at Indian Point). This suggests that the inspection performed at Indian Point unit 2 could have been oversensitive if this test block is more representative of the vessel. Adamonis was to check further on the curved test block to get a feel for its relative usefulness for Indian Point unit 2. For example, if the test block is forged material instead of rolled plate, then it probably would not be representative of the vessel lower shell.

The demonstration on Friday (curved test block) using 45° shear wave beams produced by TR24 and/or TR22 showed that a V-path metal distance established by pitch-catch had a total transmit time of 188.9 μs. When the pitch-catch sound beam was impeded by the ~1-in.-deep notches, secondary signals were observed with a total measured transmit time of 177.1 and 177.7 μs (notches B and C, respectively). These times should be nearly identical (if the block curvature is constant and the entry sound point is equivalent). Therefore, it appears that the metal paths for the half V-path may differ slightly for the demonstration setup. I used the measured times along with signals observed from all three notches (A, B, and C) to calculate the notch depth. According to my calculations (using a reference time of 133.8 μs and measured times of 129.9, 124.6, and 123 μs for A, B, and C, respectively), the three notch depths size within ±10% of the depths reported by Westinghouse of 0.385, 0.985, and 0.997 in. Dr. W. A. Simpson, Jr., helped me calculate values of 0.369, 0.883, and 1.039 in., respectively, for notches A, B, and C. The same kind of calculation for the indication near weld 12 in the lower shell section of the Indian Point unit 2 vessel indicates a depth of 0.263 in. One has to assume that the signal is produced by the indication's maximum penetration into the wall (i.e., the tip) and not a perturbation on the indication's path in order to arrive at the 0.263-in. number. If the discontinuity is open sufficiently, this would be a valid assumption. We must also assume that the indications observed from the machined notches are corner-diffracted signals (produced by the beam spread) fitting the model of a half V-path shear wave that is mode-converted to a longitudinal wave in order to calculate the depths.

A list, made from the three days of attendance, is Attachment 2.

Sincerely yours,

K. V. Cook

Kenneth Von Cook
Nondestructive Testing Group
Metals and Ceramics Division

KVC:jlb

Attachments

cc/att: C. Y. Cheng, NRC✓
R. W. McClung
G. M. Slaughter
J. H. Smith
K. V. Cook/File

ATTACHMENT 1

CONSOLIDATED-EDISON/WESTINGHOUSE/NRC MEETING

Review of the Indian Point 2 Reactor Vessel UT Indication

8/14-17/84

Pittsburgh, PA

AGENDA

Tuesday, 8/14/84 - Establish the schedule for the demonstration and materials to be reviewed for the following days.

Wednesday, 8/15/84 -

1. Introduction
2. Describe in detail how was ASME Sec. XI/Reg. Guide 1.150 used to determine the surface indication of 2a = 2.03" and l = 1.96".
3. How was the beam spread measurement of 2.4° half angle in vertical plane determined? How was this beam spread correction applied to the detected indication to obtain the dimension of 2a = 1.2" and l = 1.96"?
4. Demonstrate the effect of beam spread on notch sizing including the influence of notch configuration and the apparent magnification of 2% notch at different dB levels.
5. Explain how was the 45° pitch-catch experiment conducted? Demonstrate how was the delta technique used in arriving the conclusion that the indication is at or very near OD surface and has a depth of not more than 0.3".
6. NRC staff/consultants caucus.

Thursday, 8/16/84 -

1. How was non-Code and Reg. Guide techniques used to reach the conclusion that based on 60° information the indications is smaller than the beam size?
2. How was the conclusion of single indications instead of multiple indications reached?
3. Any additional review/demonstration needed.
4. NRC staff/consultant caucus.

Friday, 8/17/84 - Outline and draft the report.

ATTACHMENT 2

INDIAN POINT UNIT 2 MEETINGS

August 15–17, 1984
Monroeville, Pennsylvania

D. C. Adamonis	Westinghouse, Inspection Service
W. H. Beamford	Westinghouse
C. Y. Cheng	U.S. Nuclear Regulatory Commission
W. T. Clayton	Southwest Research Institute, NRC Consultant
K. V. Cook	Oak Ridge National Laboratory, NRC Consultant
D. A. Domey	Consolidated Edison, Quality Assurance Director
J. R. Fox	Consolidated Edison, Consultant
J. Galembush	Westinghouse, Nuclear Safety
J. H. Gieske	Sandia National Laboratories, NRC Consultant
R. Hernan	U.S. Nuclear Regulatory Commission
W. V. Johnston	U.S. Nuclear Regulatory Commission
D. Kurek	Westinghouse, Nuclear Safety
B. J. Lefebvre	Westinghouse, Inspection Service
P. Polk	U.S. Nuclear Regulatory Commission
P. Skulte	Consolidated Edison, Mechanical Engineering
T. F. Timmons	Westinghouse, Nuclear Safety
G. Wasilinko	Consolidated Edison, Quality Assurance
M. Weaver	Westinghouse, Nuclear Safety/Licensing
J. D. Woodward	Westinghouse, Nuclear Safety