50-247
PDR

Sandia National Laboratories

Albuquerque, New Mexico 87185

August 29, 1984

Mr. Louis Frank
USNRC
Materials Engineering Branch
Washington, DC 20555

Dear Mr. Frank:

Subject: Review and Evaluation of the Indian Point 2 Reactor Vessel UT Indication

On August 15,16, and 17, 1984 meetings and laboratory demonstrations on the basic calibration block used at Indian Point 2 and a full-thickness mockup block were attended at Westinghouse, Pittsburgh. The data presented by Westinghouse in these demonstrations were intended to show that the flaw indication in the Indian Point 2 vessel at 236 inch elevation and 345 1/2 degree azimuth was approximately 0.3 inches deep. The 0.3 inch depth evaluation was based on the ultrasonic examinations performed with the pitch-catch and delta technique.

The first demonstration performed by Westinghouse was a full scale calibration with beam spread measurements of the 60 degree angle beam examination on the flat basic calibration block. After this calibration, a scan of 5 OD notches was performed on the full-thickness mockup block which simulated the actual vessel curvature and cladding surface. This demonstration was to show that the correct beam angle of the examination was 56 degrees instead of the nominal 60 degrees and that the 56 degree angle was experimentally verified on the curved mockup block. Although a larger signal, by as much as 30 dB, was obtained from the same size notch in the mockup as in the basic calibration block, the calculated beam angles for the 1/2 maximum, maximum, and 1/2 maximum amplitudes were 54.64, 56.02, and 58.39 degrees for the basic calibration block and 54.61, 55.76, and 58.81 degrees for the mockup. Therefore, it is concluded that an angle of 56 degrees is appropriate for calculating path lengths and 50% DAC points according to ASME code requirements. The beam spread contributes to oversizing the flaw indication by the 50% DAC method.

The increased signal is thought to be partly due to the converging lens effect of the ID curvature of the mockup on the broad immersion beam. Figure 1 illustrates the difference in the refracted beam widths due to a flat and curved surface. The measured beam widths given above, however, are in very good agreement which indicates that some other reason for the 30 dB increase in signal is responsible.

A 45 degree demonstration was not conducted but the same conclusions in all respects can be made. From the 45 degree calibration sheets for the vessel UT examination, a 43.7 degree angle for transducer TR22 and a 43.8 degree angle for TR24 were caluclated from the notch indication of the basic calibration block. Therefore, since the pitch-catch and delta techniques used these transducers, an angle of 43.7 seems appropriate in all metal path and flaw depth calculations.

The second demonstration performed by Westinghouse showed use of the delta technique to collect time interval data for artificial reflectors (slots) which were machined in the OD portion of the mockup. Two slots in the center of the mockup were 0.385 inches deep and 0.985 inches deep. The response and time interval measurements from these slots are to be compared with values measured for the actual Indian Point 2 vessel crack indication. During this demonstration, time interval measurements were measured and jotted down for appropriate peaks of the diffracted waves as the slots were scanned. Figure 2 shows where this data falls with respect to theoretical values calculated by time-of-flight information of the S-wave and diffracted L-wave for the geometry of the vessel which is illustrated in Figure 3. The shortest time interval recorded in the demonstration for the 0.385 inch slot was 129.9 microseconds and for the 0.985 inch slot it was 118.9 microseconds. For these time intervals and from a calculation of the slot depth using the 9 inch block thickness, values of 0.24 inches and 1.02 inches are calculated for the slot depths.

The time interval can be measured to within 0.1 microsecond so that depth information can be potentially determined to within 0.01 inch. Knowing the exact geometry of beam angle, vessel thickness, and determining the water path delay accurately, may be the greatest sources of error. The demonstration was set up in a hurry and some of these factors may haved influenced the time interval measurements of the slots. The main purpose of the demonstration was to experimentally show NRC and consultants that the tip diffracted L-wave was present and could be used to make depth measurements of the crack indication in the vessel. Even so, the determined slot depths by this technique for the demonstration were in good agreement with actual values as shown in Figure 2.

Assuming that an ideal geometry is known for the vessel indication, the crack depth for the observed shortest time interval measurement of 130.0 microseconds is 0.14 inches for a 43.7 degree S-wave and 0.26 inches for a 45 degree S-wave. Therefore, the 0.3 inch depth evaluation by Westinghouse is valid.

The third demonstration performed by Westinghouse showed the amplitude shadowing responses of the slots in the pitch-catch mode of operation which is also illustrated in Figure 3. This demonstration verified that a significant reduction of the received signal was observed (100% to 15%) as the beam traversed the 0.985 depth slot and only a slight reduction was observed as the 0.385 depth slot was scanned. However, shadowing of the signal during the vessel examination was inconclusive since similar amplitude reductions were observed in locations away from the crack indication and exact positions of the pitch-catch transducers with respect to the crack indication could not be determined from the video tape data. For this demonstration, the 2S time interval measurement was 188.9 microseconds which is in good agreement with the theoretical values of 188.2 for a 9.0 inch thickness and a 43.7 degree angle beam. The theoretical value for a 45 degree angle beam is 191.8 microseconds.

Sincerely,

John H. Gieske

J. H. Gieske
Nondestructive Testing Technology
Division 7552

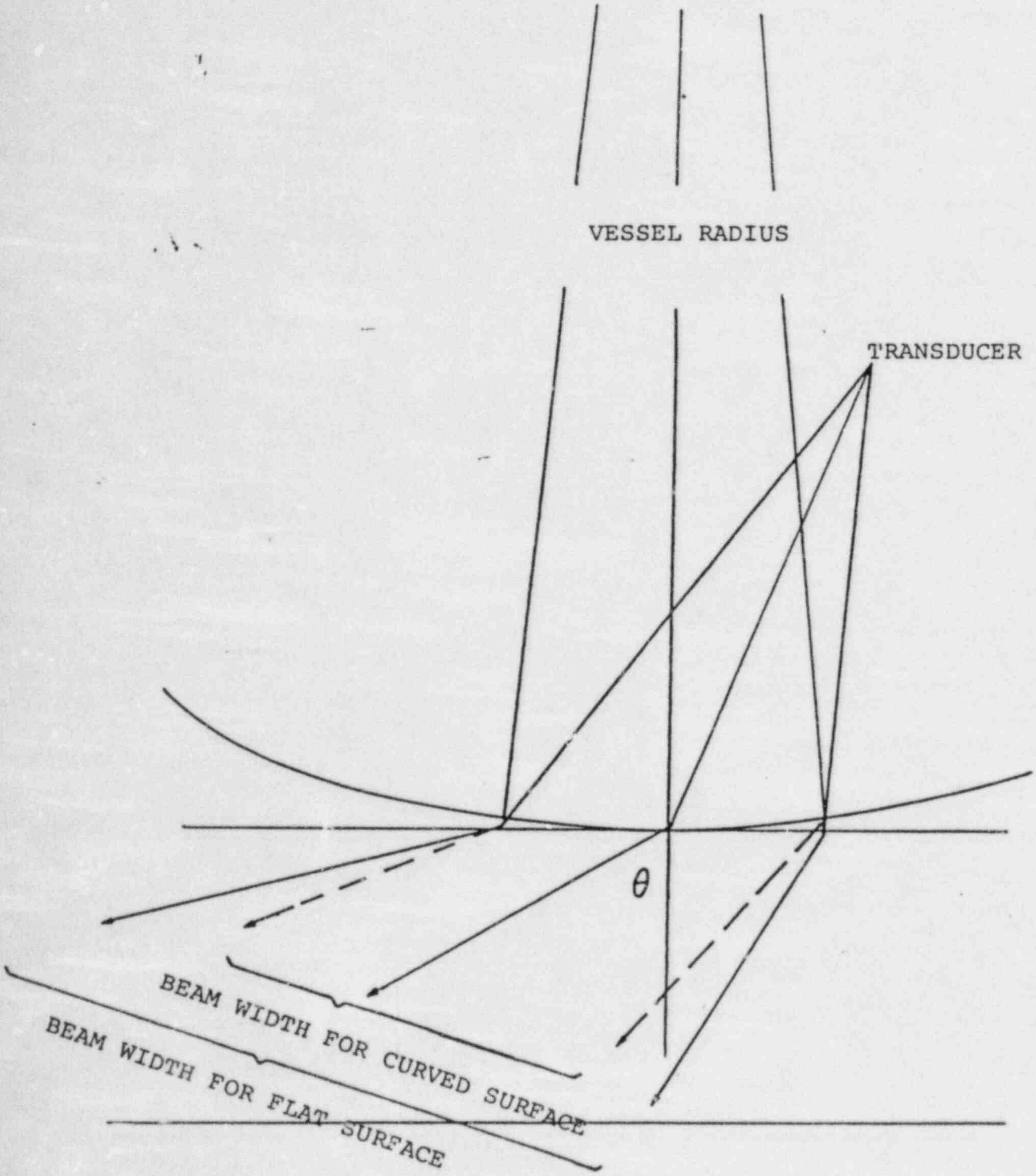

Figure 1. Refractive Beam Widths as a Function of a Flat Surface or a Curved Surface.

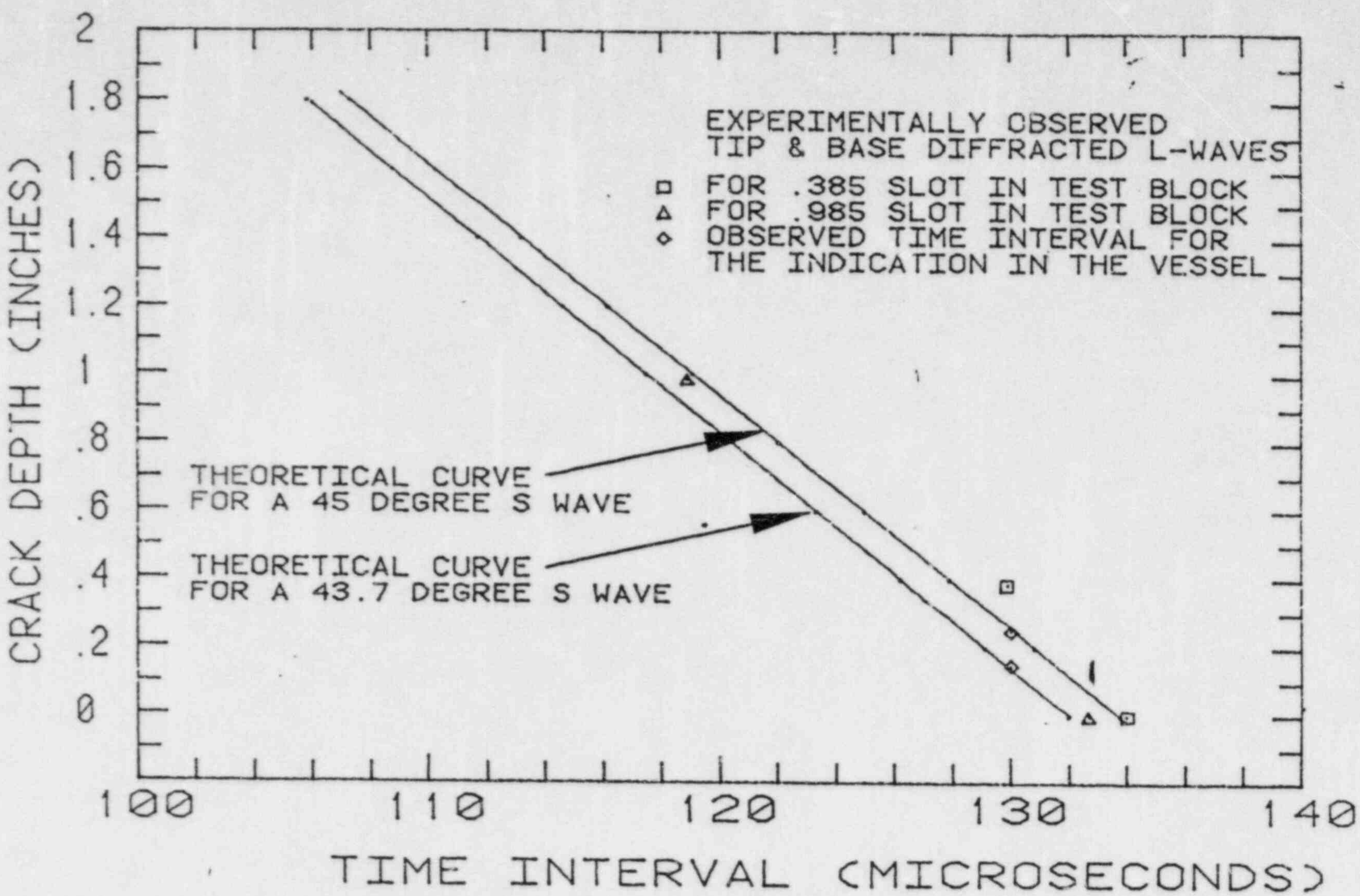

FIGURE 2. CRACK THROUGH WALL DEPTH VERSUS TIME INTERVAL RESULTING FROM A TIP DIFFRACTED L-WAVE AT 0 DEGREES FOR INCIDENT S-WAVES AT 45 AND 43.7 DEGREES.

TRANSDUCER CONFIGURATION

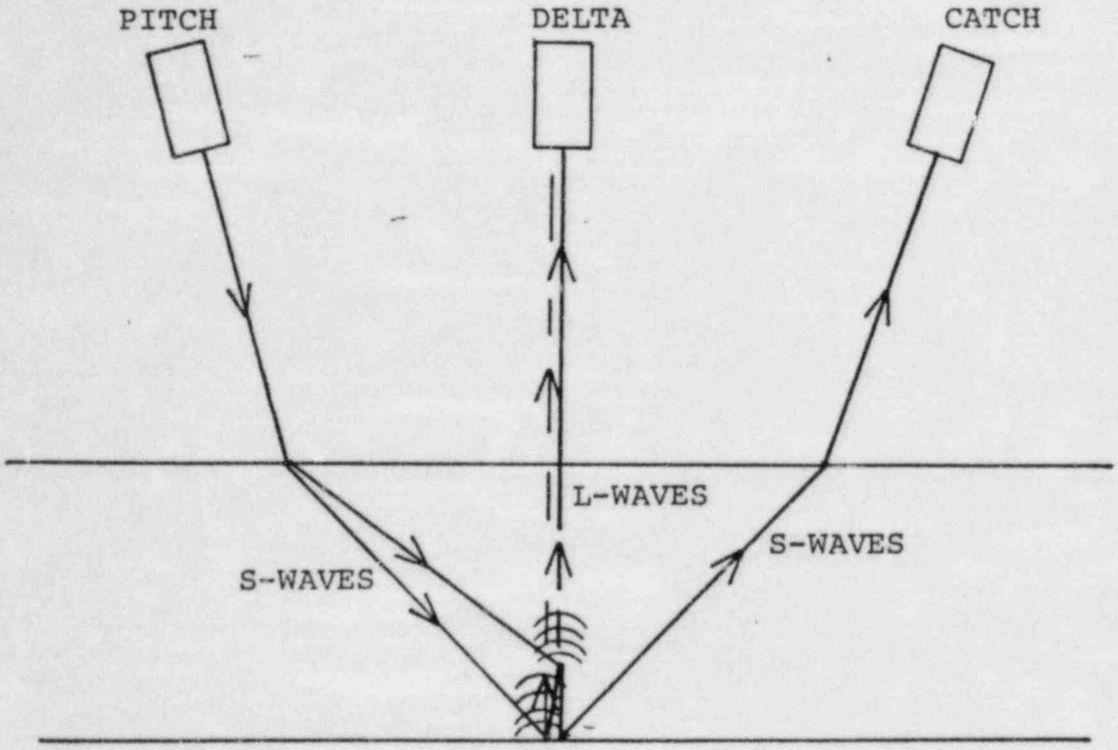

Figure 3. Geometry of the Delta and Pitch -Catch Techniques.