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March 22, 1978

2/22/78

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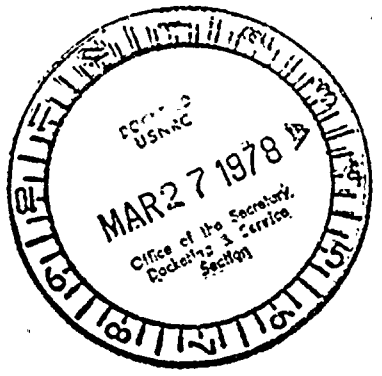

Re: Docket No. 50-275-OL
Diablo Canyon Unit 1

Dear Mr. Engelken:

This is a final report on investigations concerning steam generator feedwater and main steam nozzle to pipe welds. We have sent you a preliminary report discussing the leak found in the weld at steam generator No. 1-2 feedwater nozzle and two status reports. These reports are dated April 18, 1977, June 3, 1977, and August 15, 1977. A metallurgical report describing the cause of the weld failure was issued August 29, 1977.

All steam generator feedwater and main steam nozzle to pipe welds have been visually examined on the interior surface using the liquid penetrant method. This included four main steam and four feedwater nozzle to pipe welds in Unit 1 and four main steam nozzle to pipe welds in Unit 2. Representatives from your office witnessed most of these examinations. The Unit 2 steam generator feedwater nozzle to pipe welds will be made in the near future.

The main steam nozzle to pipe weld examinations showed all the Unit 1 and three of the Unit 2 welds to have root bead rollover. In most cases, penetrant examination of the root bead rollover yielded linear bleed-out indications. These indications were eliminated by grinding the root bead flush with the weld prep inside diameter.

The feedwater nozzle to pipe welds (FNPW) on steam generators (S/G) 1-1, 1-3, and 1-4 are the original welds. Liquid penetrant examination of these welds revealed linear indications which were determined to be caused by root bead rollover and slight lack of fusion. The indications on the FNPW at S/G 1-3 were removed by grinding the root bead

flush with the weld prep inside diameter. The indications on the FNPW at S/G's 1-1 and 1-4 were removed by grinding about 1/8" below the weld prep inside diameter surface. After removal of the indications, the ground out areas were weld repaired.

The feedwater nozzle to pipe repair weld at steam generator No. 1-2 had a slight degree of root bead rollover. This was polished flush and further examination revealed one indication 1/2" long at about the 3 o'clock position and several small indications at the 6 o'clock position about 1/8" long. The two areas were polished and the surface etched and plastic replicas taken. The indications at the 6 o'clock position were apparently removed during the polishing operation as no evidence of any crack-like features was found on the plastic replicas of that area. A subsequent penetrant examination of this area also had negative results. The plastic replicas of the 1/2" long indication at the 3 o'clock position were examined using light and scanning electron microscopy. The indication was found to be entirely within the weld metal, a tempered, low carbon martensite, near the pipe side of the weld. It was linear in nature with no appreciable branching. The indication follows what are apparently prior austenite grain bounders. These characteristics are indicative of a hot fissuring type mechanism in which the fissuring occurs during the initial cooling of the weld metal. The half-inch long indication was removed by very light grinding. Approximately 0.005" of metal was removed to eliminate this indication. The indication found on the feedwater nozzle to pipe repair weld at S/G 1-2 was not similar in appearance to those indications found on the other FNPW's, or to the crack found in the original FNPW at S/g 1-2. The indication in the repair weld was a single crack-like indication located within the weld metal.

After the rollover and indications were removed from steam generator 1-2 feedwater nozzle to pipe weld, wall thickness measurements were taken. A portion of the weldment was found to be under nominal minimum wall requirements. One area, approximately 2" long, measured from 0.535 to 0.540 inches and another area, approximately 3" long, measured 0.550 inches. The nominal minimum wall requirement is 0.563 inches. Minimum wall calculations were made using the actual physical properties of the pipe material in lieu of the minimum physical requirements required by ASTM specification. The pipe material is A106 GR B and the measured tensile strength for the pipe spool is 71,500 psi. Design pressure is 1085 psig. The calculations showed an allowable minimum wall of 0.474". Based on this calculation, the wall condition was accepted as is.

At this time, all steam generator nozzle to pipe welds have been accepted, based on internal and external surface examination and an ultrasonic and radiographic volumetric examination. PGandE, Westinghouse and Pullman Power Products metallurgists and engineers have met and discussed the welding difficulties encountered on the steam generator nozzle to pipe welds. All three parties are in agreement on the cause

and recommendations to eliminate further problems.

The four steam generator feedwater nozzle to pipe welds in Unit 2 will be made in the near future. The contractor, Pullman Power Products, Incorporated, has developed and qualified a new weld procedure. The pertinent changes are:

1. Use of E-70S-6 consumable ring in lieu of E-70S-2;

2. Use of E-7018 electrode for weld out in lieu of E-8018;

3. Modify the post weld heat treatment to reflect the present Westinghouse requirement of 1125°F ± 25°F in lieu of 1150°F ± 50°F as allowed by ASME Code Section I.

The E-70S-6 consumable insert does not contain the aluminum, titanium or zirconium deoxidizers that are used in the E-70S-2 material. This will yield a weld metal that is more tolerant of shrinkage stresses during weld solidification. This should reduce the chance of hot fissuring in the root pass, as occurred on the repair weld at S/G 1-2. The use of E-7018 in lieu of E-8018 for the weld out will eliminate overmatching of the weld metal to the pipe material. This, in addition to a previous modification to the preheat procedure (as was recommended in the Metallurgical Report and used on No. 1-2 repair weld), should lessen the chance of cold cracking as was experienced on the original FNPW at S/g 1-2. In addition to these weld procedure changes, the weld inside surface diameter will be liquid penetrant inspected. Access for this inspection will be accomplished by welding a short section of pipe onto the feedwater nozzle. After the feedwater nozzle to pipe stub weld has been accepted, the feedwater piping will be connected to the pipe stub.

PGandE, Westinghouse and Pullman Power Products are confident that the existing welds are structurally sound and that the Unit 2 feedwater nozzle to pipe welds will be structurally sound.

Very truly yours,

Philip A. Crane, Jr.

CC: Director, Office of Inspection and Enforcement
Washington, D. C. 20555
ASLB
Parties