UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

March 15, 1984

Docket No. 50-249
LS05-84-03-019

Mr. Dennis L. Farrar
Director of Nuclear Licensing
Commonwealth Edison Company
Post Office Box 767
Chicago, Illinois 60690

Dear Mr. Farrar:

SUBJECT: IGSCC INSPECTION PER AUGUST 26, 1983 ORDER

Re: Dresden Nuclear Power Station, Unit No. 3

On August 26, 1983 the Commission issued "IGSCC Inspection Order Confirming Shutdown" (Order) for the Dresden Nuclear Power Station, Unit 3 (Dresden 3). Section III.C required that "the facility shall remain in cold shutdown until the Director, Office of Nuclear Reactor Regulation, finds that the licensee has satisfactorily completed the following actions, or has provided adequate justification for not completing a given action." The actions included an IGSCC inspection and a report thereof.

On September 30, 1983 Dresden 3 was shut down and an IGSCC inspection was performed. By letter dated October 26, 1983 you sent a list of welds not to be inspected during this outage and the technical justifications for not conducting these examinations. By letter dated December 9, 1983, you submitted your plan for inspection and repair of the remaining welds covered in our Order of August 26, 1983. By letter dated March 5, 1984, you submitted a report on the inspection and repair of those welds and made commitments regarding the continuation of certain surveillance requirements for the upcoming operating cycle. By letter dated March 12, 1984, as requested by the staff, you provided additional information on the results of the inspection.

We have reviewed the reports and information you have provided in the aforementioned submittals and find that the Commonwealth Edison Company has satisfactorily completed the actions required by the Order and, therefore, Dresden 3 may be returned to full power operation. My decision is based on the staff review documented in the enclosed Safety Evaluation.

SE01 1/1 EX(16)

In your letters of March 5 and March 9, 1984, Commonwealth Edison Company made commitments regarding the continuation of certain surveillance requirements and the period of operation. These commitments are addressed in a forthcoming Confirmatory Order.

Sincerely,

Original Signed By
E. G. Case

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

Enclosure:
Safety Evaluation

cc w/enclosure:
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Mr. Dennis L. Farrar

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO INTERGRANULAR STRESS CORROSION CRACKING
COMMONWEALTH EDISON COMPANY
DRESDEN NUCLEAR POWER STATION, UNIT 3
DOCKET NO. 50-249

INTRODUCTION

Dresden Unit 3 was shut down on September 30, 1983, in accordance with the confirming order issued on August 26, 1983, to inspect all ASME Class 1 austenitic stainless steel piping that are susceptible to intergranular stress corrosion cracking (IGSCC) in the Recirculation, Residual Heat Removal (RHR), Core Spray (CS), and Reactor Water Clean-up (RWCU) piping systems. During this shutdown period, ultrasonic examinations were performed on 240 nonconforming welds. Of these 115 welds were in the Recirculation system, 45 welds were in the RHR system, 25 welds were in the RWCU systems, and 55 welds were in the CS system. The licensee, Commonwealth Edison Company (CECO), indicated that except for ten (10) welds, all Class 1 welds susceptible to IGSCC in the above mentioned piping systems were ultrasonically examined. Because of access limitations, these ten (10) welds (five (5) RHR welds, two (2) CS welds, and three (3) RWCU welds) cannot be ultrasonically examined.

Personnel from Lambert, MacGill, and Thomas (LMT), and Universal Testing Laboratory (UTL) performed the ultrasonic testing (UT) for the licensee. The UT results submitted by the licensee only consisted of those crack indications which were evaluated by CECO's UT personnel. Region III of NRC has determined that their UT procedures, calibration standards, equipment and IGSCC detection capabilities were satisfactorily demonstrated in accordance with I&E Bulletin 83-02, and the same procedures and techniques were used in the UT examination. Region III also indicated that all their UT personnel conducting these inspections have received appropriate training in IGSCC inspection using cracked thick-wall pipe specimens. LMT used 45° and 60° shear waves for crack detection and 25% leading and trailing movement for crack depth measurement. The results of the LMT examinations indicated that a total of 81 welds showed reportable linear indications. Some of these welds were reported by LMT to be extensively cracked in the circumferential orientation. UTL used shear wave and inside diameter (ID) creeping wave to detect and size the cracks. UTL re-examined specific sections of 31 welds, which were reported by LMT to be showing linear crack indications, and reported linear crack indications in only seven (7) welds. The UT results submitted by the licensee which combined both LMT and UTL results, indicated that a total of 64 welds showed linear crack indications. Of these, 32 are 12" Riser welds, six (6) are RWCU welds, three (3) are 22" Ringheader welds, 18 are 28" Recirculation welds, four (4) are RHR welds, and one (1) is a 10" CS weld. The detailed evaluation of the results from both inspection agencies is presented in the section entitled Ultrasonic Examination.

All reported UT indications were in the weld heat-affected-zone (HAZ). Of the 64 defective welds, 23 welds showed only axial crack indications, 22 welds showed only circumferential crack indications, and 19 welds showed mixed crack indications. The longest axial crack indication of 1.5 inches was reported in a 12" Riser weld (1M-12-K2). Circumferential crack indications with lengths exceeding one-third of the circumference were reported in 11 welds (four (4) 28" Recirculation welds, one (1) 22" Ringheader weld, and six (6) 12" Riser welds). Circumferential cracks with depths over 50% of wall thickness were reported in 17 welds (three (3) 8" RWCU welds, nine (9) 12" Riser welds, and five (5) 28" Recirculation welds).

NUTECH Engineers, Inc. (NUTECH) performed Induction-Heating-Stress-Improvement (IHSI) for the licensee on a total of 87 welds (72 Recirculation welds and 15 RHR welds), including all three unrepaired defective welds. The licensee indicated that all the large size (> 12 inches) stainless steel piping welds in the Recirculation and RHR systems up to the first isolation valves were treated with IHSI except the bimetallic welds, sweepolet welds, some overlay repaired welds, and welds with limited accessibility or requiring special heating coils because of geometry. Of the 87 IHSI-treated welds, 50 were UT inspected prior to IHSI. UT inspection was performed on each weld after IHSI. There are no significant differences in UT results before and after IHSI. Region III of the NRC indicated that IHSI was satisfactorily performed in accordance with the qualified procedures.

NUTECH performed flaw evaluations on the 64 defective welds for the licensee to determine whether overlay repair is needed or not. Forty-two (42) defective welds showing axial indications required weld overlay to preclude potential leakage during plant operation because the residual stresses resulting from welding are expected to accelerate the growth of the cracks. The flaw evaluations based on the methodology provided in the new ASME Code Section XI IWB-3640 were performed on the remaining 22 welds having only circumferential indications. The new Code IWB-3640 provides flaw acceptance criteria for the austenitic stainless steel piping based on a limit load approach which was approved by the ASME Main Committee in May 1983 and was published in the 1983 Winter Addenda. The results of NUTECH's flaw evaluations, including crack growth calculations, indicated that three (3) 12" Riser welds (1G-5, 1J-12-4, and 1J-12-5) of the 22 defective welds did not require weld overlay repair because the calculated flaw sizes of those three (3) welds at the end of an 18-month period did not exceed the staff's criteria of two-thirds of the new Code allowable limit. The other 19 welds which required weld overlay repair had deep circumferential indications or indications longer than one third of the circumference.

NUTECH also performed weld overlay design for the licensee. 61 defective welds (29 12" Riser welds, three (3) 22" Ringheader welds, 18 28" Recirculation welds, four (4) RHR welds, six (6) RWCU welds, and one (1) 10" CS weld) were weld overlay repaired. The overlay thickness was designed to meet the new IWB-3600 limits based on an assumed crack depth which is two times the reported maximum crack depth. The length of the overlay was selected to reinforce the weld structure and minimize the end effects. The NUTECH designed minimum overlay thickness varies from 0.125 inch to .46 inches and the overlay length varies from 2.25 inches (only one side) to 7 inches depending on the severity of the cracks. Region III of the NRC has confirmed that the weld overlay repairs were performed in accordance with the qualified and approved procedures consistent with ASME Code requirements.

The licensee calculated the shrinkage stresses based on the conservatively assumed axial shrinkages resulting from weld overlay. The largest shrinkage stress on the three (3) unrepaired welds was reported to be 13 ksi. In NUTECH's crack growth calculation, the shrinkage stresses due to weld overlay were considered.

In summary, during the current Dresden Unit 3 confirming order outage, a total of 240 nonconforming austenitic stainless steel welds were ultrasonically examined. This includes all the UT examinable stainless steel welds in the Recirculation, RHR, CS, and RWCU piping systems. In addition, 87 welds were treated with IHSI including all three (3) unrepaired defective welds. The UT results based on combined LMT and UTL examinations indicated that 64 welds showed linear crack indications. Of these, 61 welds were weld overlay repaired.

Ultrasonic Examination

The staff's review of the UT methods used by the licensee for the detection of IGSCC is based on the evaluation of the examination results from two (2) inspection agencies employed by the licensee and two (2) independent research teams funded by the NRC. Each organization used different ultrasonic techniques and instrumentation. Both of the licensee's inspection agencies used examination personnel and procedures qualified at the EPRI NDE Center under IE Bulletin 83-02. The licensee performed destructive metallography on regions of selected welds and supplemental nondestructive examinations (NDE) to provide verification of his conclusions.

LMT was contracted by the licensee to perform the ultrasonic examinations during the ordered inspection using commercial instrumentation and techniques that have been used at other plant sites. Examinations were performed at relatively high ultrasonic sensitivity to permit the discrimination of IGSCC from inherent geometric conditions. The welds were examined with 0° longitudinal wave and 45° shear wave techniques. To evaluate the nature of ultrasonic indications in certain welds, supplemental 60° shear wave examinations were performed. Flaw dimensions were reported in a conservative manner by determining the overall length and maximum depth of the suspected IGSCC and attributing the maximum reported depth to the entire measured length. The licensee made repair decisions based on the LMT results for axially-oriented IGSCC, i.e., flaws transverse to the weld centerline. However, the licensee believed that the characterization on some welds of the circumferentially-oriented IGSCC was overly conservative and contracted with UTL to repeat the examination of thirty-one welds in regions of the maximum reported depth using a different ultrasonic technique.

The technical reason for initiating the second inspection program was the large number of 360° intermittent crack indications, some with significant depth dimensions, reported by LMT.. The interpretation of a

360° intermittent reflector is frequently associated with inherent geometric conditions, such as, reflections from the weld root or the counterbore of the pipe. In principle, the UTL procedure uses a 30° shear wave and its associated 70° longitudinal wave component. The 30° shear wave undergoes a mode conversion at the inner surface of the pipe that propagates as a longitudinal wave at a shallow angle along the inside surface of the pipe. Experienced NDE personnel identify cracks by the intersection and reinforcement of the two (2) longitudinal waves and other parameters. The UTL procedure was developed based on a concern about interpreting flaws from geometric or metallurgical conditions, i.e., innocuous reflectors from the weld root or fusion line, when using conventional 45° shear wave techniques at the high ultrasonic sensitivities required for the detection of IGSCC. The ultrasonic transducers used by UTL are commercially available. Although the UTL procedure was designed to be less influenced by innocuous geometric and metallurgical conditions than the combined 45° and 60° shear wave examination, the UTL procedure might be less sensitive for detecting shallow IGSCC adjacent to the weld root if the ID contour near the weld root is irregular, the weld crown is wide, or a component permits only one-side access.

In almost all the welds examined by both UTL and LMT, UTL reported that the IGSCC was either shorter in length, shallower in depth or the weld was not cracked because the reflectors were either geometric or metallurgical in origin in the limited region inspected by UTL. The licensee combined the examination results from both inspection agencies on thirteen welds and made a conservative decision to repair by weld overlay or to perform IHSI. CECO used UTL for supplemental examinations to make a decision concerning known ultrasonic reflectors reported by LMT. On eighteen welds the licensee reached the conclusion that the UTL results are accurate; and, therefore, the welds are not cracked or the IGSCC is of such a length and depth that does not warrant repairs. The licensee justified his conclusion by cutting two (2) metallurgical plug specimens and by disassembling one (1) valve in regions of welds where the LMT results indicated significant IGSCC and UTL results indicated cracks were not present. The attached table provides a comparison of the ultrasonic examination results and the supplemental inspection data. The licensee was able to identify specific geometric and metallurgical conditions, i.e., a weld overlay repair and a slight degree of undercut that could have contributed to "over-calling" a circumferentially-oriented geometric reflector as IGSCC by any inspection agency relying on 45° shear wave techniques.

In general, the licensee used the LMT results to make a decision concerning axial IGSCC. The technical problem with interpreting deep axial flaws is less difficult because reflections from the weld root and metallurgical conditions are less of an influencing factor. However, all axial IGSCC that may exist in welds might not be detected for reasons such as scanning limitations from the outside contour of the weld or the axial flaw is too short or shallow for discrimination. During IHSI and weld overlay repairs, leakage was observed in nine (9) welds in the 12-inch diameter pipe. Leakage occurred in welds where LMT reported axial IGSCC, some with significant depths. The source of the leakage was at known axial indications or a series of axial indications except one circumferential indication which was through wall at a spot location only. The staff has determined that IGSCC oriented transverse to the weld centerline does not represent a safety problem because axial flaws tend to be short in length and arrest within the HAZ of the weld, and eventually will lead to leakage rather than rupture.

To provide additional information about the characteristics of the circumferentially-oriented IGSCC, arrangements were made for two (2) research teams from Battelle Pacific Northwest Laboratories (PNL) and Argonne National Laboratory (ANL) funded by the NRC to examine several welds. ANL used an experimental multi-element skew angle (MESA) ultrasonic probe to examine selected areas of two (2) 28-inch pipe. At this time, examinations with the MESA probe are limited to straight pipe inspections. Coupling of the probe to the pipe under field conditions was found to be very difficult and not as reproducible as under laboratory conditions.

Analysis of the data suggested that the presence of circumferential cracks at Dresden Unit 3 could not be confirmed using the MESA probe under field conditions. ANL took measurements to support research activities on the detection of axial IGSCC.

Among the two (2) research organizations, PNL performed the more extensive investigation using SAFT-UT, a high resolution computer-based ultrasonic imaging system. An automatic scanner was used to examine selected regions of four (4) welds previously inspected by LMT and UTL. Ultrasonic "A" scans were taken at .1 inch intervals on a grid over the entire area scanned with shear waves pulsed with a center frequency of 2.25 MHz or 5 MHz. Each volume was scanned three (3) times. After the data was collected, it was sent to PNL for computer processing with the SAFT algorithm and analyzed. Flaw indications were not evident except in weld 28-10 of "A" loop. An indication was visible in this weld approximately 3/16 inch from the weld centerline. An unusual rear surface reflection was also observed. When the licensee cut a plug from weld 28-10, an inside surface clad overlay was found in the region where the flaw indication was detected by SAFT-UT. PNL has fabricated a mockup of the configuration of weld 28-10 to perform research on the nature of the observed ultrasonic indication. The results from the NRC-supported research contractor with SAFT-UT tended to support the UTL data that circumferentially-oriented IGSCC was not present in the sections of the weld examined.

EVALUATION

We reviewed the licensee's submittals, including the ultrasonic examination results, NUTECH's analysis of the weld overlay designs, and the calculation of IGSCC crack growth to support the continuing service for an 18-month fuel cycle of the 61 overlay repaired welds and the three (3) ISHI mitigated, unrepaired defective welds (three (3) 12" Riser welds).

The staff review of the information provided by the licensee regarding the examination results from two (2) inspection agencies qualified under IE Bulletin 83-02 has determined that circumferentially-oriented IGSCC of significant depth is not present in the 18 welds identified by the licensee. This determination is based on the following conclusions:

1. LMT used personnel, examination procedures and instrumentation that are technically similar to most inspection agencies performing UT for the detection of IGSCC in BWR piping.

2. The widely recognized technical problem is the ability to differentiate between ultrasonic responses from IGSCC and innocuous conditions adjacent to the weld root and along the weld fusion line especially for the large diameter piping. The amount of supplemental or re-inspection is limited by ALARA constraints. Therefore, "over-calling" of suspected IGSCC may occur with high ultrasonic sensitivity 45° shear wave techniques when unanticipated geometrical anamolies or metallurgical structures such as inside diameter weld metal buildup produces ultrasonic reflectors in regions where IGSCC typically occurs.

3. Specific geometric and metallurgical conditions were observed when the licensee performed the metallurgical analyses and supplemental NDE. These conditions may have contributed to "over-calling" these inherent reflectors as IGSCC. Over-calling geometric or metallurgical reflectors as flaws in a weld normally results in a conservative decision.

4. The instrumentation and procedure used by UTL appears to be less sensitive to the plant-specific geometric and metallurgical conditions of the welds at Dresden Unit 3. This is based on the correct characterization of the reflectors observed by UTL when the licensee performed the metallurgical analyses and supplemental NDE. UTL qualified their examination personnel and procedure for the detection of IGSCC at the EPRI NDE Center under IE Bulletin 83-02.

We reviewed NUTECH's IGSCC crack growth calculations and agree with their conclusion that the continued operation for an 18-month fuel cycle with the three (3) defective riser welds in as-is configuration is justified because the Code design safety margin would be maintained. Our conclusion is based on the considerations that the crack indications in the three (3) unrepaired riser welds are short (< 1.5 inches) and shallow (< 27% of wall thickness), and cracks of this size are not expected to grow to any significant extent during the next fuel cycle after the IHSI treatment.

NUTECH performed overlay design for the 61 defective welds. For the 23 welds having only axial indications, a thin overlay with thickness varying from 0.125 inch to 0.25 inches, was designed for each weld to provide a leakage barrier. For the remaining 38 welds having circumferential indications, the overlay design was based on assuming the crack depth to be two times the reported maximum crack depth. The favorable residual stress distribution resulted from weld overlay repair is depended upon to inhibit further crack growth. The residual stress distribution used in their analyses was calculated using a finite element model. The required overlay thickness determined this way is much thinner than that determined by assuming all cracks are completely through-wall. Although there are many important advantages in using thin overlay (lower fabrication time and cost, less radiation exposures, increased UT inspectability of the overlaid weld, and less distortion in the piping system), the thinner overlays do not provide complete Code compliance if the cracks were to continue to grow until it reaches the overlay.

The specific residual stress distribution used by NUTECH in this analysis appears to us to be somewhat more favorable than can be justified at this time; therefore, for our analysis, we relied on distributions derived from other sources and results from closely related work performed under EPRI contracts. Even with our more conservative approach, we also concluded that all repairs will provide reasonable assurance of safe operation during the next fuel cycle of 18 months.

Among the eighteen welds that the licensee determined were not cracked, based on UTL examination results, are two (2) 22-inch header to sweepolet welds which LMT reported axial indications. In weld 22 A-4 LMT reported one (1) 2.15 inch axial flaw with a depth of 44%, and in weld 22 B-8 LMT reported three (3) axial flaws with the largest .55 inch long and 22% deep. To provide additional information about the nature of the indications, CECO personnel repeated the ultrasonic examination of the regions and concluded that the reflectors were geometric in origin. The licensee requested that LMT re-assess the original strip-chart recordings and computer plots from their examination. LMT has revised their characterization of the reflectors based on factors such as ultrasonic beam spread and location of the indications, and concluded that the reflectors may be from geometric conditions and if axial IGSCC is present in the two (2) welds, the actual length and depth is significantly less than originally reported.

NUTECH performed a cursory calculation of the crack growth of the worst LMT reported crack in the two (2) sweepolet welds for the licensee. The results of the calculations indicated that the small axial crack will not grow through the wall during the next fuel cycle. We have concern regarding NUTECH's calculation because the crack growth rate and the residual stress distribution they used in the calculations may not be conservative. To resolve our concern, the licensee agreed to perform an additional ultrasonic examination of the two (2) sweepolet welds during the period of six (6) to 12 months after startup. We conclude that an interim ultrasonic examination as described above will provide added assurance that uninspected crack growth in the two (2) solution annealed sweepolet welds will not be left undetected during the plant operation of the next fuel cycle. We also conclude that even if the axial cracks in the two (2) sweepolet welds were to grow through the wall, it will not be a safety problem because the length of the axial cracks is short and is limited to the HAZ.

There are ten (10) welds (6 RHR welds, 2 CS welds and 2 RWCU welds) not examinable by UT because of access limitations. Of these, five (5) are flued head penetration welds, and five (5) are reinforced branch welds. The licensee indicated that nine (9) of the ten (10) welds are isolable, and one (1) reinforced RHR branch weld (12") is not isolable. During normal plant operation, there is no flow in the piping of this nonisolable RHR branch weld, and the temperature is less than 200°F. Therefore, we do not expect this uninspected RHR branch weld to be extensively cracked. We conclude that the 10 uninspected welds will not be a major safety problem during the continuous operation of the plant for an 18-month fuel cycle.

Leak Detection

Although the conservative calculations discussed above indicate that the cracks in the unreinforced welds will not progress to the point of leakage during the next fuel cycle, and very wide margins are expected to be maintained over crack growth to the extent of compromising safety, uncertainties in crack sizing and growth rate still remain. Further, not all welds were UT examinable, and cracks could be present in welds that were not examined. Because of these uncertainties, it is prudent to tighten the requirements for the monitoring of unidentified leakage.

The licensee has agreed to additional monitoring and tighter limits on unidentified leakage, which are summarized below:

(1) The reactor coolant system leakage will be limited to a 2 gpm increase in unidentified leakage within any 24 hour period. Leakage shall be monitored and recorded once every 4 hours. Should this leakage limit be exceeded, the unit will immediately start an orderly shutdown. The unit will be placed in at least hot shutdown within the next 12 hours and in cold shutdown within the following 24 hours.

(2) At least one (1) primary containment sump collection and flow monitoring system will be operable. With the primary containment sump collection and flow monitoring system inoperable, restore the inoperable system to operable status within 24 hours or immediately initiate an orderly shutdown and be in a least hot shutdown within the next 12 hours and in cold shutdown within the following 24 hours.

We conclude that implementation of the above measures will provide adequate assurance that possible cracks in pipes will be detected before growing to a size that could compromise the safety of the plant.

SUMMARY AND CONCLUSIONS

We have reviewed CECO's submittals regarding the actions taken or to be taken during this refueling outage on the inspection, analyses and repairs of Recirculation, RHR, RWCU, CS piping systems in the Dresden Unit 3 plant. This includes a description of the defects found, description of repairs, stress and fracture mechanics analyses.

We conclude that the Dresden Unit 3 plant can be safely returned to power and operated in its present configuration at least for one 18-month fuel cycle provided that the following items are satisfactorily completed:

(1) The Code required system pressure tests and NDE on overlay repaired welds should be satisfactorily completed prior to startup.

(2) The additional leak detection requirements as listed in the section on Leak Detection should be properly implemented prior to startup.

(3) An additional ultrasonic examination of two (2) sweepolet welds (22A-4 and 22B-8) should be performed during the period of six (6) to 12 months after start-up. The examination results should be submitted to the NRC for information within two (2) weeks after completion of the examination.

Nevertheless, there remains a residual concern regarding the long term growth of small IGSCC cracks that may be present but not detected during this inspection. Therefore, we require that plans for inspection and/or modification of the recirculation and other reactor coolant pressure boundary piping systems during the next refueling outage be submitted for our review at least three (3) months before the start of the next refueling outage.

ACKNOWLEDGEMENT

This evaluation was prepared by the following NRC personnel: W. Koo, M. Hum, W. Hazelton, and C. Cheng.

Dated: March 15, 1984

TABLE [illegible]-1

TREPAN AND RADIOGRAPH RESULTS

Weld No.	Size and Type	LMT Results	UTL Results	Plug Taken	Examiniations Mode
28-K8[1]	28" P-E	31% x 0.37 inch Axial Pipe 39% x 0.40 inch Axial El 33% x 0.1 inch Axial El 33% x 1.5 inch Circ. Pipe	No Circ.	Yes	PT, M, RT, VI
28-10	28" P-E	44% x 360° Int. - Pipe 50% x 360° Int. - Pipe	Weld Geometry	Yes	PT, M, RT, VI
16-13[2]	28" P-V	47% x 360° Int. - Pipe	Weld Geometry	No	RT and VI
16-14[2]	16" P-P	47% x 360° Int. - Downstream 28% x 360° Int. - Upstream	Weld Geometry	No	RT and VI
02BS-S12[3]	28" E-P	16% x 32 inch - Circ	No Circ	Yes	PT, M, RT, VI

RT - Radiograph - Single Wall using R-Type film
VI - Visual or Boroscope Examination
PT - Penetrant Testing
M - Metallographical Examination

Notes (1): Three axials were seen in the radiographs, all of which were found in the initial UT examination

(2): Weld Geometry present, Convex in nature with some areas showing a slight degree of undercut. Two small circular indications were seen on weld 16-13. No IGSCC. Visual Examination limited to 1/3 of circumference via the open check valve. Visual inspection confirmed weld geometry.

(3): One circumferential indication was seen on radiograph. Boro scopic examination proved the indication to be a tool mark. See B. Rybak letter to H. R. Denton letter dated January 27, 1984 for for more details. This plug was removed from a weld in Quad Cities Unit 2.