50-508
50-509

Washington Public Power Supply System
Box 1223 Elma, Washington 98541 (206) 482-4428

Docket Numbers 50-508 and 50-509

February 10, 1982
G03-82-141

Document Control Desk
U. S. Nuclear Regulatory Commission
Washington D. C. 20555

Subject: PROJECT NOS. 3 AND 5
FINAL REPORT OF POTENTIAL 10CFR50.55(e)
SHUTDOWN COOLING HEAT EXCHANGER DEFECTS (D/N #007)

Attached is a copy of the final report provided to Region V concerning a potential 10CFR50.55(e) associated with the subject condition.

Should you have any questions or desire further information, please contact me directly.

R. S. Leddick, 1000
Program Director, WNP-3/5

DRC/tt

Attachment

cc: J. Adams - NESCO-WO/A
D. Smithpeter - BPA-WO/A
Ebasco - New York-WO/A
WNP-3/5 Files - Richland-WO/A

B019
S
1/1

THIS LETTER SATISFIES COMMITMENT NO. _____

THIS LETTER (DOES) (DOES NOT) ESTABLISH A NEW COMMITMENT

WPPSS CORRESPONDENCE NO. G03-82-123

INTERNAL DISTRIBUTION

COMMITMENT CONTROL-WO/A
ROUTING-WO/A
SITE FILES-WO/A
WG ALBERT/NRC-W/A
DR COODY-W/A
DE DOBSON-WO/A
JJ DORAN-WO/A
RB GLASSCOCK/280-W/A
CM KIM-W/A
DJ LAGROU-W/A
CE LOVE-WO/A
DD O'SULLIVAN/280-W/A
RG PECK-W/A
DL QUAMME-WO/A
JP SLUKA-W/A
OE TRAPP-WO/A
GC SORENSEN/440-W/A

Docket Numbers 50-508 and 50-509
February 8, 1982
G03-82-123

FOR SIGNATURE OF: RS LEDDICK

OF TRAPP 2-3-82 | JE WERLE | DE DOBSON

AUTHOR: DR COODY:tt | JP SLUKA 2/3/82 | JA PUZAUSKAS | FOR APPROVAL OF

U. S. Nuclear Regulatory Commission, Region V
Office of Inspection and Enforcement
1450 Maria Lane, Suite 260
Walnut Creek, California 94596-5368

Attention: Mr. B. H. Faulkenberry
Chief, Reactor Construction Projects Branch

Subject: PROJECT NOS. 3 AND 5
FINAL REPORT OF POTENTIAL 10CFR50.55(e)
SHUTDOWN COOLING HEAT EXCHANGER DEFECTS (D/N #007)

Reference: Letter, G03-80-1516, dated June 25, 1980, D. L. Renberger to G. S. Spencer, Reportable Deficiency, 10CFR50.55(e).

In accordance with the provisions of 10CFR50.55(e), Region V was notified of potential deficiencies associated with the Shutdown Cooling Heat Exchangers.

Attached is the Supply System approved final report for the subject condition. The report provides a detailed description of the deficiencies and items of concern, corrective steps taken and an analysis of the safety implications.

The referenced letter addressed the subject 10CFR50.55(e) as "reportable;" however, based on the evaluation detailed in the attached report, it is considered that the defects associated with the Shutdown Cooling Heat Exchangers would not adversely affect safe operations of the plant. Therefore, the subject condition is not reportable in accordance with 10CFR50.55(e).

DUPE ~~8202180332~~

Should you have any questions or desire further information, please contact me directly.

R. S. Leddick/1000
Program Director, WNP-3/5

DRC/tt

Attachment

cc: J. Adams - NESCO-WO/A
D. Smithpeter - BPA-WO/A
Ebasco - New York-WO/A
WNP-3/5 Files - Richland-WO/A

SHUTDOWN COOLING HEAT EXCHANGERS (D/N #007)

ABSTRACT

The Shutdown Cooling Heat Exchangers (SDHX's) supplied for WNP-3 and WNP-5 showed significant defects when the SDHX's were inspected at site prior to turnover to installation contractor. The defects were found on both weld overlay claddings and tubes. The tube defects were weld seam crevice and galled types, as well as contaminations with water and foreign substances containing high chloride. The weld overlay defects were cracks and below minimum thicknesses.

These units are safety related components manufactured for CE by Ametek, located at Bethayres, Pennsylvania under ASME Section III Class 2 for tube side and ASME Section III Class 3 for shell side.

Since extensive defects were found in these units, these units were returned to Ametek for indepth examinations and repairs.

Upon completion of indepth examinations, tubes for WNP-3 units supplied by Allegheny-Ludlum Tubing were rejected in their entirety and replaced with tubes supplied by Plymouth Tubing. Tubes for WNP-5 units supplied by Greenville Tubing were accepted for use.

Existing cladding overlays for WNP-3 units were removed and reclad in most areas. For WNP-5 units only flange areas were reclad after removing orignal cladding. For other areas only thin areas were built up.

Following the repair, the Supply System reviewed and inspected the units at Ametek in July to August, 1981 and released the units for shipment for reinstallation at site.

Shop Numbers of these units and original and final installation locations are:

Shop No.	Original Location	Final Location
N80-45600	WNP-3S	WNP-5S
N80-45601	WNP-3N	WNP-5N
N80-45602	WNP-5S	WNP-3S
N80-45603	WNP-5N	WNP-3N

The deficiencies identified above indicate a significant breakdown in Ametek's quality assurance program as defined by 10CFR50.55(e).

1.0 DESCRIPTION OF THE DEFICIENCY AND ITEMS OF CONCERN

The defects found in tube walls and in the weld overlay claddings are described below.

Tubes for the WNP-3 SDHX's were manufactured by Allegheny Ludlum Steel Corporation and the tubes for the WNP-5 SDHX's were manufactured by Greenville Tube Corporation.

The Ametek purchase orders required the tubes (1" OD, .049" wall thickness) to meet the requirements of ASME Section III, 1974 Edition, Winter '75 Addenda and ASME Section II SA-249 Type 304.

A. Defects in Tube wall

1) Finding of Contaminants

Water contaimination of WNP-3 SDHX's was not discovered until August, 1979 after the first SDHX was received at site on June 30, 1978 because the SDHX was nitrogen purged and the existing procedure in effect did not require opening of the equipment for inspection of internals until the time of turnover to the installing contractor.

Stagnant water with a high concentration of chloride (50 ppm for unit 45600 and 32 ppm for unit 45601) was found submerging the lower 4-6 rows of tubes on both units of WNP-3.

Also, unidentified black and yellow "crud" and a scale-like substance containing up to 7.58% chloride and heavy metal was collected from I.D. tube surfaces of both WNP-3 and WNP-5 units.

2) Eddy Current Test Results of the Supply System

As a result of the potential impact due to contamination, the Supply System performed Eddy Current (ECT) examination on two SDHX's of WNP-3 units.

They observed indications of the tube pitting, and O.D. imperfections, tube dents and distorted tube support signals.

ECT on WNP-5 was attempted but was discontinued after crud and scale like substances were picked up on the ECT probe.

3) Metallurgical and Nondestructive Examination by CE

As a result of ECT, two tubes from SDHX #45600 and three tubes from SDHX #45603 were removed to observe directly the tube defect.

a) Visual Examination After Tube Slitting

#45600

Tube O.D. showed severely galled indications around the entire circumference and along the entire length. Tube I.D. showed clearly evident weld seam.

#45603

No lack of side wall fusion (LOF) condition was evident. Shallow, longitudinal scratches were found on I.D. Several tungsten inclusions were observed in the weld with maximum depth of 0.012". No weld seam was evident on I.D.

b) Metallographic Observations - #45600

Two types of defects were observed; first type is a defect involving O.D. and I.D. weld centerline surface imperfections. (ie., shrinkage cavities, inclusions)

The second type is characterized by intermittent LOF at the I.D. of the tube.

c) Bend Test Results - #45600

A bend test was made. The sample was bent such that the I.D. of the weld was strained in tension. The weld readily tore open from the I.D. and exposed a portion of tube wall, clearly indicating LOF over approximately one-third of the tube wall. The test results confirmed that these tubes furnished to SA-249 Specification did not meet the applicable requirements of SA-450.

B. Defects in Overlay Weld Cladding

1) Finding of Defects

Rust, crack-like indications and pitted areas in certain small areas of the flange I.D. were discovered after two WNP-3 SDHX's were cleaned.

This network of cracks was found to exist only in the stainless overlay, most extended down to the interface of overlay and base metal. In no case did the cracks extend into the carbon steel base metal.

2) Results of NDE Examination by the Supply System

Following the discovery of overlay cladding defects during the attempted repair in the field, liquid penetrant (LP) and ultrasonic (UT) examinations were conducted.

a) Liquid Penetrant (LP) Examination

Unacceptable linear indications, beyond code allowable, were found on vessel's channel in 45600, on closure head and flange face in 45601, and on vessel flange in 45602 and 45603.

b) Cladding Thickness

The CE SDHX Specification calls for a minimum stainless steel overlay of 1/8 inch on all channel sections except for the tube sheet which is required to have a minimum 3/16 inch overlay. UT examination of overlays shows the following thicknesses which are much less than the minimum thicknesses specified in the SDHX Specification on certain spots.

45600 - Vessel - 0.03" - 0.07"
45601 - Vessel - 0.06" - 0.08"
45602 - Head - 0.1", Tube Sheet - 0.04", Shell - 0.07"
45603 - Vessel Flange - 0.012", Vessel Head - 0.05", Tube Sheet - 0.06", Vessel - 0.04" - 0.08".

3) Evaluation of Manufacturing Processes at Ametek

Because of the severity of defects confirmed by the Supply System following their LP and UT examinations, the Supply System reviewed the manufacturing processes at Ametek. The review revealed the following:

a) Unit 3 Exchangers: The weld overlay applied to the tubesheet, flange, and channel cover was produced by the submerged arc welding (SAW) process using a single bare wire plus a supplementary powder filler material to increase deposition rates. The overlay was produced in one layer only and had a 308L chemistry. This process was found to be unacceptable.

b) Unit 5 Exchangers: The overlay was performed using the SAW strip cladding process. Dimensions of the strip filler metal are 60 mm wide by 0.5 mm thick. The overlay was produced in two layers - the first with a 309L chemistry and the second with a 308L chemistry. This process was found to be acceptable.

c) In general, none of the weld overlay procedures were properly qualified to the requirements of ASME Code Section IX because the selection of the location for the weld chemistry sample was not documented.

4) Metallurgical Investigation by CE

CE reviewed the welding procedures used by Ametek as well as undertook metallurgical investigation of boat samples from selected locations of overlay weld cladding.

Examination of boat samples showed the cladding in two layers using SAW method gave satisfactory results, i.e., austenitic microstructure, low hardness and no cracks.

However, the cladding obtained using SAW method with one layer of ER-308L filler metal gave martensitic microstructure, high hardness and many cracks.

The average chemical composition of the martensitic SAW cladding was 13.2% Cr and 6.4 % Ni representing an average dilution factor of 36.5% which is very high. The hardness of the martensitic SAW cladding was found to vary from 365 to 460 DPH.

The overall effect of cooling and change of the microstructure of cladding from austenite to martensite is found to cause a 2.06% linear contraction of cladding during cooling. This contraction of the very thin cladding on the thick base metal results in tension stress within the cladding, with peak stresses occuring just above the interface cladding/base metal causing the cracking observed.

In conclusion, CE rejected the cladding carried out using SAW method in one layer with supplementary metal powder on the channel cover, tube sheet and the flange of WNP-3 SDHX's.

2.0 CORRECTIVE STEPS TAKEN

2.1 Defects in Receiving Inspection and Maintenance Procedures

To prevent recurrence of a delay in discovery of nonconforming conditions of Class I equipment, revised source inspection and/or receiving inspection procedures now require internal examination prior to acceptance.

2.2 Rejection of SDHX's

Based on the unacceptable condition of the SDHX's as confirmed by NDE performed by the Supply System and evaluation of unsatisfactory manufacturing processes and QA program implementation at Ametek's facility, the Supply System formally notified CE in June, 1980 that the current Certificate of Equipment on all of the SDHX's manufactured by the Ametek for WNP-3/5 projects was not acceptable.

2.3 CE Submittal of Repair Plan and Procedures

On July 11, 1980, CE formally requested from the Supply System permission to remove four SDHX's from site to Ametek's facility for repair and inspection.

On September 3, 1980, the Supply System directed CE to remove all four SDHX's installed at site for the purpose of inspection and rework as necessary to bring these SDHX's in full compliance with the contract requirements. This direction was contingent upon CE furnishing detailed plans, methods, procedures and schedules for accomplishing the repairs.

In early October, 1980, CE drafted preliminary repair plans and procedures. CE, then submitted the plans and procedures, to the Supply System for its review and insertion of witness and hold points. On October 28, 1980, CE submitted approved Ametek repair plans and procedures incorporating the Supply System's comments and witness and hold points.

By mid-October 1980, CE removed all four units from the site.

2.4 Tube Repair

A) 45600 and 45601

The lack of fusion (LOF) on I.D. of the longitudinal weld seam discovered during the destructive examination of the tubes pulled from 45600 resulted in CE's rejecting the WNP-3 tube bundles (Alleghey-Ludlum tubes) in their entirety.

The tubes to replace the scraped tubes bundles were ordered from Plymouth Tubing, Inc. of West Monroe, Louisiana.

Prior to acceptance of Plymouth Tubes, a review of their manufacturing procedures was made and 100% of the Plymouth tubes were ECT'd utilizing a CE developed procedure.

B) 45602 and 45603

Since the Greenville tubes in these units had exhibited high chloride contaminants in the inside, these tubes were cleaned with a mechanical rotary stainless steel wire brush combined with a continuous flushing with a warm detergent solution followed by a flush with demineralized water. In addition, U-bend specimens cut from a cleaned tube were run for 90 days in an autoclave under operating environmental conditions with no signs of cracking.

After the satisfactory cleaning operation, all the tubes in these units were subsequently ECT'd utilizing a C-E developed procedure. A review of the ECT data revealed some signals in the Greenville tubes that could be interpreted as a LOF condition. Subsequently three tubes exhibiting these signals were removed from 45603 for destructive examination.

The examination of three tubes, showed only minor scratches. The rest of the tubes for these two units were accepted based on this examination.

2.5 Cladding Overlay Repair

Upon arrival of four (4) SDHX's to the Ametek facility from the site, each SDHX was inspected for any shipping damage and the channel cover was removed. The front support was removed from the tube sheet and the channel was parted from the tube sheet at their circumferential weld. Dye penetrant examination of all weld overlay cladding was done. Metallurigical boat samples of the cladding including some base metal where practical were taken. Boat samples location were selected by CE based on the results of the dye penetrant examinations.

Among the boat samples taken, the samples taken out of the area clad with the submerged arc (SAW) strip cladding process in two layers were deemed acceptable and the samples taken out of the areas clad with the SAW process in one layer, which used E-308L electrode with a supplementary metal powder, were deemed unacceptable by C-E.

Unacceptable areas include the channel cover, the flange face, the flange ID and the tubesheet face on SDHX's 45600 and 45601. These same areas on SDHX's 45602 and 45603 were clad with an acceptable two layer strip clad technique by the SAW process. However, the cladding on the flange faces of these latter two heat exchangers were removed because of incorrect weld wire issuance slips.

The unacceptable cladding noted above was machined off to the carbon steel base metal. Prior to recladding some surfaces were built up with carbon steel weld metal. The cladding was then redone using the two layer strip clad technique. Areas that were determined to be under minimum clad thickness by EMT were built up. Clad thicknesses were remeasured using an UT method on all four SDHX's. All unacceptable dye penetrant (PT) indications were repaired and PT'd again; this process continued until an acceptable PT result was achieved.

Following the completion of the above, the SDHX's were reassembled. The channels were rewelded to the tubesheets; the front supports were welded back on; as noted previously, the clad thickness was measured by UT; the channels were cleaned; the covers were put back on. 45600 and 45601 were hydrostatically tested on the tube and shell sides; 45602 and 45603 were hydrostatically tested on the tube side. All four units were re N-stamped and the N-I data forms corrected.

2.6 Vendor Surveillance by the Supply System

The Supply System monitored the progress and quality of inspection/repair activities of CE and Ametek to verify that proper corrective steps are taken by CE and Ametek in the repair of SDHX's meeting the requirement of the repair plan.

In addition, the Supply System conducted vendor surveillance to witness inspection and review documentation at Ametek prior to acceptance of repaired units for shipment to site. The surveillance and release of 45602 and 45603 were done during July 2-15, 1981 and of 45600 and 45601 were done during August 17-25, 1981.

During the surveillance, the Supply System reviewed and inspected shop travelers, cladding, accessible welds, cleanliness, coating, radiographs, and QA records to assure the repairs are completed meeting both specifications and QA requirements of the purchase order.

3.0 ANALYSIS OF THE SAFETY IMPLICATION

The SDHX'S are used to remove decay heat and pump heat during reactor cool down and cold shutdown. There are two SDHX's in each unit of WNP-3 and WNP-5. Failure of one of the SDHX's during residual heat removal will not result in a loss of core cooling capability. The reactor coolant system can be brought to refueling temperature using one of the low pressure safety injection pumps and one SDHX. Simultaneous failure of both SDHX would be possible but very unlikely since the nature of the defects would not result in an instantaneous failure of the heat exchanger. If a tube to shell leak develops in the SDHX, the water level in the component cooling water surge tank would increase resulting in a high level alarm and the leaking SDHX can be isolated. Therefore, there is no safety implication from failure of one of two SDHX's.