COMANCHE PEAK UNITS I AND II

DEMONSTRATION OF ULTRASONIC EXAMINATION TECHNIQUES APPLIED TO WELDS IN MAIN COOLANT LOOP PIPING

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PREFACE

This report has been reviewed and checked.

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1.0 INTRODUCTION

The Comanche Peak Nuclear Power Station, near Glen Rose, Texas was the site of a meeting on March 20 and 21, 1984 to discuss issues relating to the inspectability of welds in cast austenitic stainless steel main coolant loop piping via ultrasonic techniques and to provide a demonstration of capabilities in that area. A list of attendees is attached as Appendix A.

The preservice examination of the Comanche Peak Unit I main coolant loop piping welds was conducted in the Fall of 1982. Portions of these examinations were observed by USNRC Region IV inspectors. The NRC inspectors reported that adequate material penetration could not be verified because only sporadic back reflections were identified during longitudinal wave examinations and the increased gain used during angle beam examinations saturated the CRT display such that no indications in the first half of the pipe thickness could be identified or evaluated. These conclusions were documented in NRC Inspection Report 50-445/82-19.

A demonstration concerning ultrasonic testing of cast stainless steel was conducted at the Callaway Nuclear Power Station on January 25, 1984 during a meeting among the NRC Nuclear Reactor Regulation and Region III staffs, Callaway and Wolf Creek personnel, and representatives from Westinghouse. The NRC attendees at that meeting concluded that a valid ultrasonic examination of cast austenitic piping was possible.

In light of the apparent differences between the conclusion reached at the Callaway meeting and the findings of the Region IV Comanche Peak report, the NRC requested that Texas Utilities address the technical issues identified in Inspection Report 50-445/82-19. It was determined that this could best be accomplished by a confirmatory examination or demonstration, similar to that performed at Callaway, on a minimum of three welds including weld Joint #13 on Comanche Peak Unit I isometric drawing TBX-1-4200.

This report will document results of the demonstrations which were conducted on two main coolant loop weld mock-ups containing mechnically induced fatigue cracks, one Unit I main coolant loop weld, and four Unit II main coolant loop welds.

2.0 DEMONSTRATION DETAILS

2.1 Calibration Block

The calibration block used to establish system sweep and distance amplitude calibration for demonstrations on the cracked weld mock-ups and all five field welds was identified as TBX/2, HT C1488. The block is ASTM A-351, Grade CF8M centrifugally cast stainless material, approximately 2.2 inches thick and contains 3/16-inch diameter side drilled holes at depths of 1/4T, 1/2T, and 3/4T. This block was used for calibrations for the Unit I preservice examinations.

2.2 Calibration Procedure

Sweep and distance-amplitude calibrations for demonstrations on the cracked weld mock-ups and the Unit I and II field welds were established on side drilled holes in the TBX/2 calibration block per Westinghouse procedure ISI-206, Revision 0. The ultrasonic test system consisted of a Sonic Mark I portable ultrasonic instrument, a 1.0 inch diameter, 1.0 MHz, straight beam search unit, and a nominally 40° refracted longitudinal wave, 1.0 MHz, water column search unit.

2.3 Fatigue Cracked Weld Mock-Up Demonstration

The demonstration of crack detection in cast austenitic stainless steel weldments involved examination of two weld mock-ups from the WCAP-9894 study, "Reliability of Ultrasonic Test Method for Detecting Natural Fatigue Cracks in Centrifugally Cast Stainless Steel Pipe". The weld samples were machined from two ring weldments joining 32-inch OD, SA351, CF8A, type 304

centrifugally cast stainless steel pipe fabricated specifically for the WCAP-9894 program. Both samples are on the order of two inches thick, four inches wide, and sixteen inches long.

The mock-up identified as WELD 7 DW1 contains a fatigue crack with a depth equal to 10%* of the specimen thickness (0.20 in. crack depth). The mock-up identified as WELD 6 OV 1 contains a fatigue crack with a depth equal to 14%* of the specimen thickness (0.28 in. crack depth). Both fatigue cracks were induced mechanically via three-point bending and extend over the entire weld length (4").

Both cracks were detectable at repeatable positions along the crack lengths with signal-to-noise ratios on the order of 2.5 to 1. This demonstration indicated that the 40° refracted longitudinal wave technique is capable of detecting mechanically induced fatigue cracks in these materials.

2.4 Field Weld Demonstrations

Ultrasonic examination technique demonstrations were conducted on a total of five field welds, one in Unit I and four in Unit II. All demonstrations consisted of a sample of each weld to establish general noise levels and evidence of penetration with both the straight beam and 40° refracted longitudinal wave search units.

Unit I

The weld selected for field demonstrations in Unit I was the loop 2 reactor vessel inlet nozzle safe end-to- 27½" x 22° cast elbow weld identified as weld #13 on Comanche Peak isometric drawing TBX-1-4200, attached as Figure 1. Source data for the cast elbow is provided below:

Item	Material/Heat	Manufacturer/Date
27½" x 22° Elbow	SA351, CF8A Ht. 3-3249-1620, Ser. #4	Breda Fucine Meridionali, Bari, Italy/1976

* - As measured from side of block.

The field demonstration conducted on this particular weld confirmed findings noted in the NRC report. The surface condition of the elbow, adjacent to the weld, appeared to be the major factor contributing to the examination difficulties. The condition of the surface was, for the most part, as-cast. As such, it is typical of cold leg 22° elbows in other four loop plants. The configuration of the 22° elbow did not allow the supplier to machine the OD surface for a significant distance as measured from the edge of the weld prep. Complete coupling of the straight beam search unit was difficult, thus a consistent backwall reflection could not be maintained during scanning. The CRT display during 40° refracted longitudinal wave angle beam scanning was saturated with noise over to about one-half the calibrated sweep length. This condition was not considered extremely significant as the inner 1/3 of the pipe thickness constitutes the required examination volume per Section XI of the ASME Boiler and Pressure Vessel Code, 1980 Edition. No evidence of the counterbore was detected via angle beam from the elbow side of the weld.

A continuous back reflection was maintained during straight beam scans on the nozzle safe end side of the weld. Evidence of the counterbore was detected during 40° refracted longitudinal wave examinations from the safe end of the weld.

Unit II

The four welds selected for demonstrations in Unit II were in the loop 4 crossover leg, identified as welds #5, #6, #7, and #8 in Comanche Peak isometric drawing TCX-1-4400, attached as Figure 2. Weld #5 joins the steam generator nozzle to a 31" I.D. x 40° cast elbow, weld #6 joins the 31" I.D. x 40° cast elbow to a 4'6-7/8" length of 31" I.D. centrifugally cast pipe, weld #7 joins the 4'6-7/8" length of 31" I.D. pipe to a 31" I.D. x 90° cast elbow and weld #8 joins the 31" I.D. x 90° elbow to a 3'5-3/4" length of 31" I.D. centrifugally cast pipe. Source data for these components of the piping system are provided below:

Item	Material/Heat	Manufacturer/Date
31" I.D. x 40° Elbow	SA351, CF8A/ Ht. 3-3612-0762, Ser. #12	Breda Fucine Meridionali, Bari, Italy/1977
31" I.D. x 4'6-7/8" Pipe	SA351, CF8A/ Ht. 156375, Pc. 2*	Sandusky Foundry, Sandusky, Ohio/1978
31" I.D. x 90° Elbow	SA351, CF8A/ Ht. 3-3729-1939, Ser. #18	Breda Fucine Mendionali, Bari, Italy/1976
31" I.D. 3'5-3/4" Pipe	SA351, CF8A/ Ht. 156375, Pc. 2*	Sandusky Foundry, Sandusky, Ohio/1978

* - Both pipe lengths cut from same heat of pipe.

In contrast to the results from weld #13 in Unit I, consistent backwall reflections were easily maintained during straight beam scanning, noise levels on CRT displays during 40° refracted longitudinal wave examinations were significantly lower, and ID geometry in the form of a counterbore response was consistently detected when scanning weld #5 from both sides. Counterbores adjacent to the other three welds were not detected because of access limitations. Slightly more access though, would have made detection of the counterbores adjacent to the other welds possible. Surface condition adjacent to these welds was better than that noted for weld #13 of Unit I. In particular, the elbow OD surfaces were machined by the supplier for a greater distance as measured from the edge of the weld prep.

3.0 CONCLUSIONS

(1) Demostrations performed on Unit I, loop 2, weld #13 confirmed the observations of NRC inspection report 50-445/82-19. Surface condition of the elbow appeared to be the major factor contributing to difficulties in obtaining consistent backwall echoes during straight beam scanning and high noise levels during the 40° refracted longitudinal wave scans of this particular weld. This is due to the configuration of the 22° elbow which did not allow the supplier to machine the OD surface for a significant distance as measured from the edge of the weld prep.

(2) Demonstrations performed on four welds in the Unit II, loop 4, cross-over leg demonstrated the ability to penetrate the welds and adjacent base material on both sides of the welds. Consistent backwall echoes were maintained during straight beam scanning and noise levels during 40° refracted longitudinal wave scans were significantly lower than noted during scans of weld #13 in Unit I. This improvement is attributed to the fact that surface conditions of the elbows adjacent to these welds are good. These particular elbow OD surfaces were machined by the supplier for a greater distance as measured from the edge of the weld prep because of the longer tangent configuration.

(3) Demonstrations performed on two centrifugally cast pipe weld mock-ups indicates the 40° refracted longitudinal wave technique is capable of detecting mechanically induced fatigue cracks in these materials.

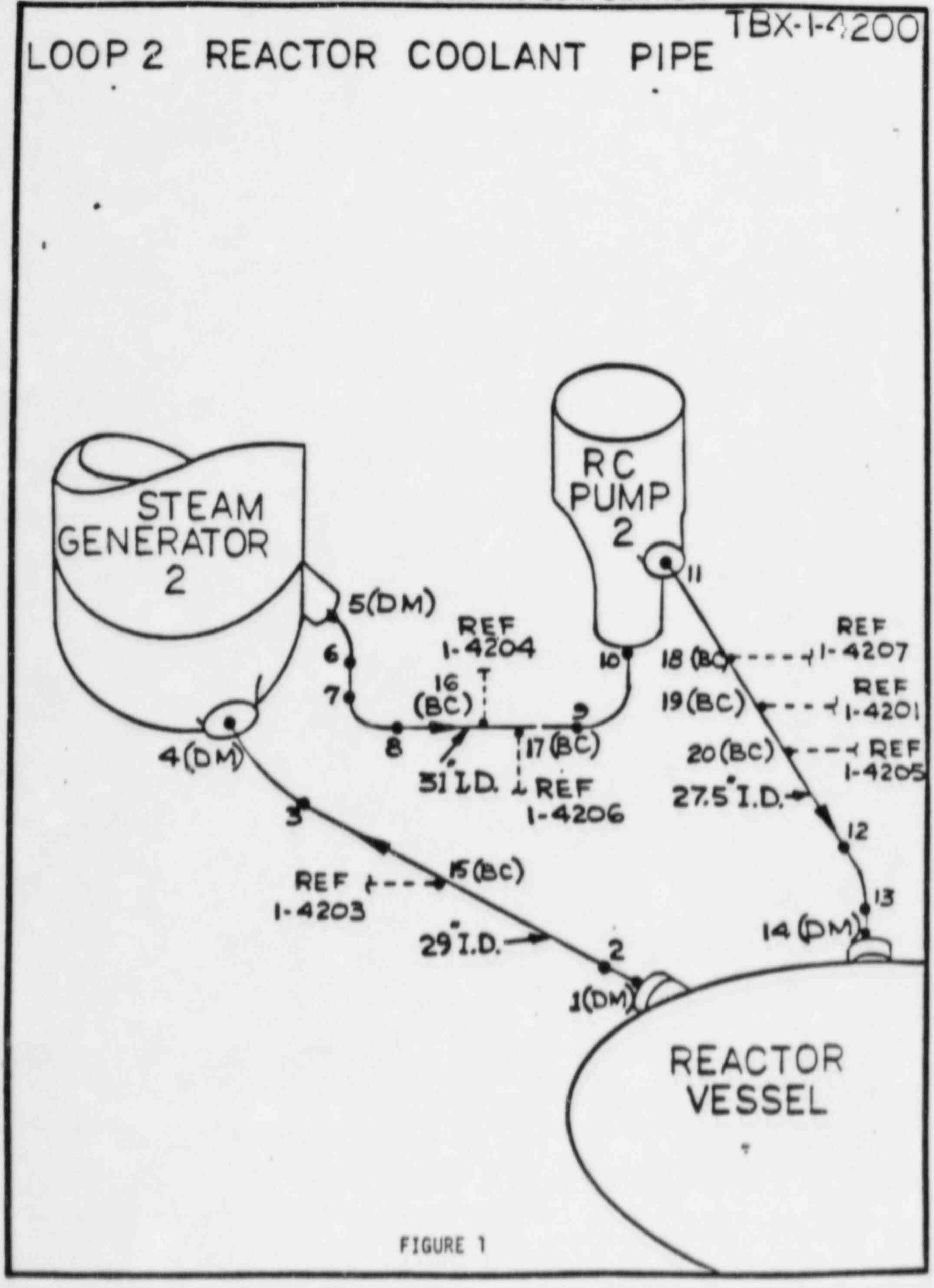
TBX-1-4200
LOOP 2 REACTOR COOLANT PIPE
STEAM GENERATOR 2
RC PUMP 2
REACTOR VESSEL
1(DM)
2
3
4(DM)
5(DM)
6
7
8
9
10
11
12
13
14(DM)
15(BC)
16 (BC)
17(BC)
18 (BC)
19(BC)
20(BC)
REF 1-4203
REF 1-4204
REF 1-4206
REF 1-4207
REF 1-4201
REF 1-4205
29" I.D.
31" I.D.
27.5" I.D.

FIGURE 1

TCX-1-4400

LOOP 4 REACTOR COOLANT PIPE

SKETCH

NOT FINAL

Preliminary Only

For Information Only

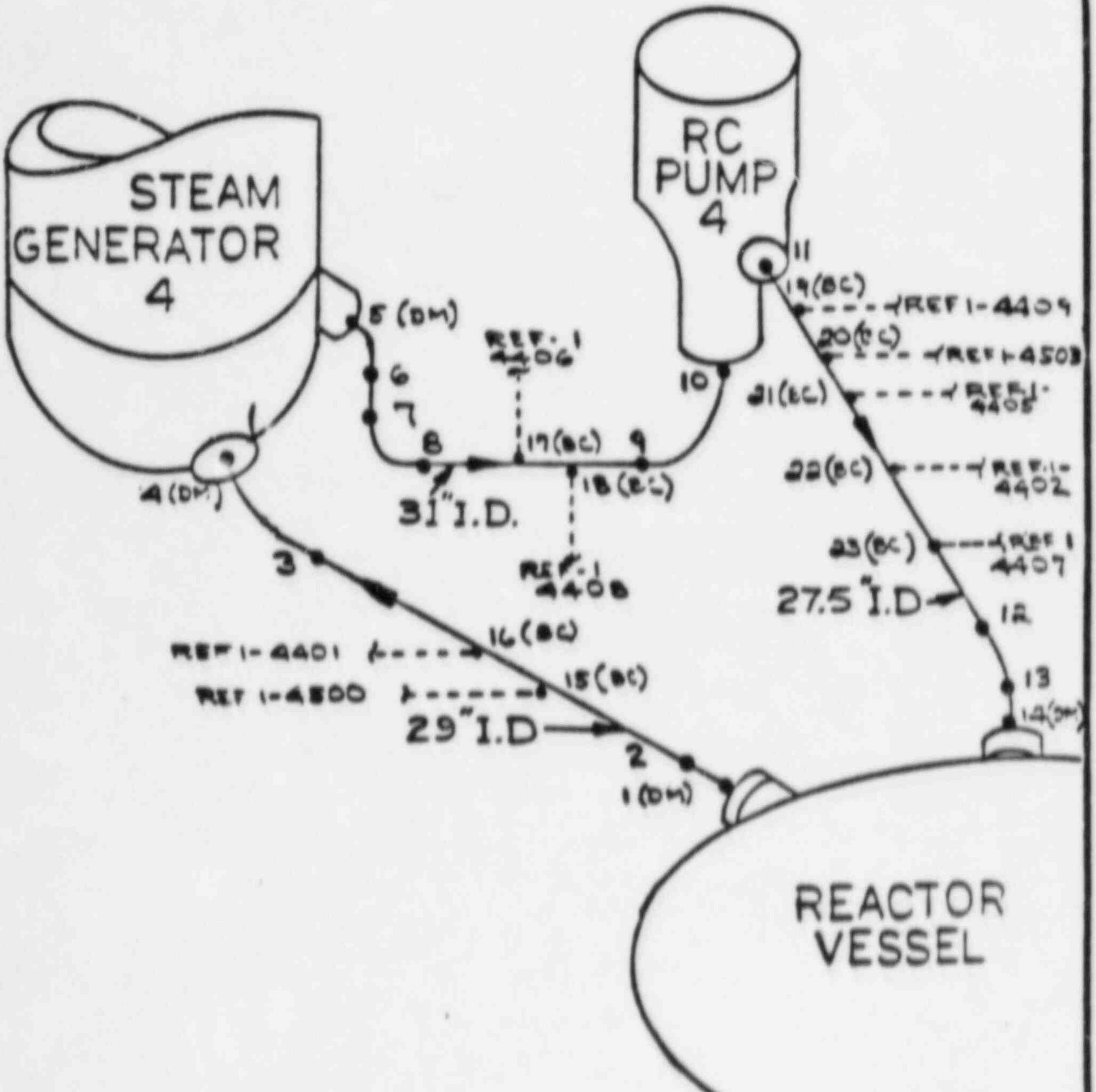

FIGURE 2

APPENDIX A

LIST OF ATTENDEES

COMANCHE PEAK

CAST STAINLESS MAIN COOLANT LOOP PIPING UT DEMONSTRATION

March 20-21, 1984

Name	Company
D. C. Adamonis	Westinghouse NTD
M. Blew	Westinghouse Support Services
K. V. Cook	Oak Ridge National Laboratories
R. Dacko	Texas Utilities Generating Company
D. Davis	Texas Utilities Generating Company
J. F. Enrietto	Westinghouse NTD
J. Keller	Texas Utilities Generating Company
W. M. McNeill	US Nuclear Regulatory Commission
W. G. Paul	Texas Utilities Generating Company
T. Taylor	Pacific Northwest Laboratories
D. Tomlinson	US Nuclear Regulatory Commission
K. Waida	Westinghouse Support Services