

Steam Generator Evaluation
Ginna Steam Generator Tube Failure Incident
January 25, 1982
R. E. Ginna Nuclear Power Plant
Docket No. 50-244

Addendum 3
Phase II Metallurgical Examinations

Revision 0
May 18, 1982

820601 0653

No mechanical degradation of this type was seen on Tubes R43C60 and R43C61 as shown in Figures 2 and 3. However, two unusual O.D. features are evident: 1) electrical discharge cutting strikes at the top at 270° on R43C60 and at the bottom at 0° on R43C61, and 2) surface undulation at predominately 0°, 270°, 315° on R43C60 and at 0°, 30°, and 90° on R43C61. Eddy current testing in the laboratory gave no indications in Tube R43C61 and found the electrical discharge cutting strikes 3 inches from the top of R43C60.

Dimensional measurements over the bottom six inches of four tubes (R14C90, R12C91, R43C60 and R43C61) at four angular positions are given in Table 1. No significant data at elevations of 2 and 3 inches on Tubes R14C90 and R12C91 could be obtained due to the extent of mechanical degradation. On Tubes R43C60 and R43C61 there was no significant deviation from the nominal O.D. of 0.875 inches. The deviation of 48 readings was 0 to 0.004 inch from this value.

Prints of the double wall radiographs of the tubes and cutting diagrams are contained in Figures 4 through 8. Rings from the bottom of each tube were cut longitudinally at 0° or 270°, flattened by straining the I.D. in tension, and the I.D.s examined at 50X. No intergranular attack or stress corrosion cracking was detected. The possibility of intergranular attack was greatly reduced because the tubing was determined not to be sensitized. This was shown on Section 1H of Tube R15C90, which was polished and given the reactivation polarization test.⁽¹⁾ The tubing had a peak potential of 45 mV and therefore was not sensitized and susceptible to intergranular attack in environments which attack the grain boundary.

1 Metallography showed no evidence of stress corrosion cracking or intergranular attack in Tubes R43C60 and R43C61, Figures 9 and 10. Surface roughening was most pronounced at approximately 315° on Tube R43C60 and the small amount of cold work present was roughly equivalent to the cold work associated with the final polishing operation in the manufacture of the tubes.

CONCLUSIONS

1. In-plant eddy current indications of the I.D. type above the top of the tube sheet were not due to intergranular attack or stress corrosion cracking.
2. The three tubes from the Number 6 wedge area with reported I.D. indications above the top of the tube sheet were mechanically degraded after plugging to such an extent that meaningful eddy current test results or O.D. measurements could not be obtained.
3. The two tubes from the Number 4 wedge area had no significant variations from nominal O.D. and laboratory eddy current testing identified no indications other than an electrical discharge cutting strike which occurred during tube removal.

Reference

1. G. P. Airey, A. R. Vaia, N. Pessall and R. G. Aspden, "Detecting Grain Boundary Chromium Depletion in Inconel 600," Journal of Metals, p. 28, November 1981.

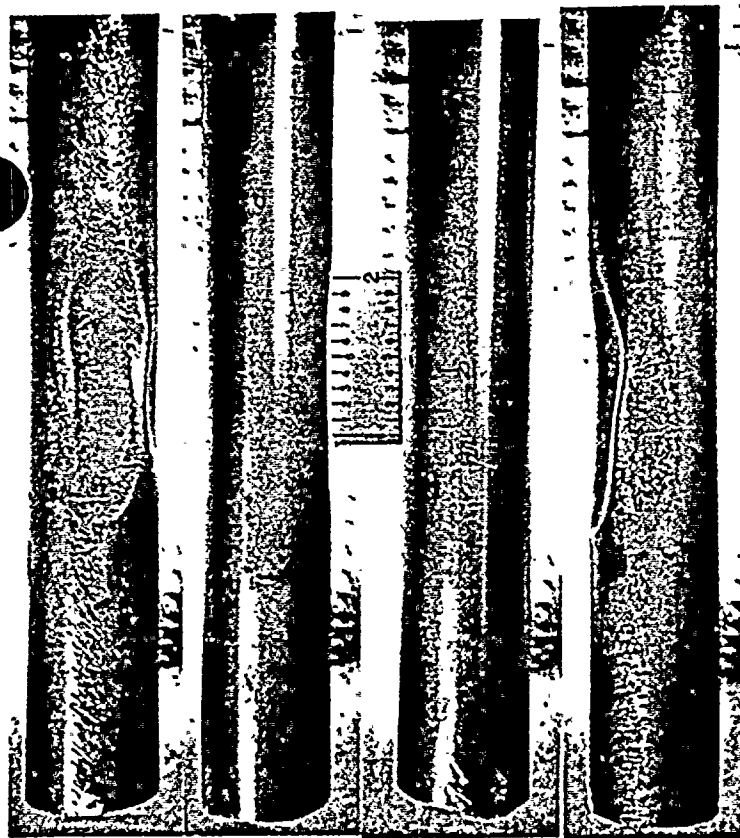


Table 1

OD measurements (in) near bottom of tube section

| Tube No. | Distance from bottom of section (in) | Angular Position° | | | |
|----------|---|-------------------|-------|-------|-------|
| | | 0 | 45 | 90 | 135 |
| R14-C90 | 0 | 0.884 | 0.878 | 0.879 | 0.877 |
| | 1 | 0.878 | 0.877 | 0.877 | 0.876 |
| | 2 | 0.875 | * | 0.876 | * |
| | 3 | * | * | * | * |
| | 4 | 0.876 | 0.878 | 0.876 | 0.875 |
| | 5 | 0.876 | 0.875 | 0.877 | 0.876 |
| | 6 | 0.878 | 0.877 | 0.876 | 0.877 |
| R12-C91 | 0 | 0.879 | 0.901 | 0.876 | 0.877 |
| | 1 | 0.876 | 0.876 | 0.892 | 0.875 |
| | 2 | * | * | * | * |
| | 3 | * | * | * | * |
| | 4 | 0.876 | 0.879 | 0.877 | 0.877 |
| | 5 | 0.875 | 0.876 | 0.875 | 0.875 |
| | 6 | 0.876 | 0.879 | 0.876 | 0.875 |
| R43-C60 | 0 | 0.876 | 0.876 | 0.875 | 0.876 |
| | 1 | 0.876 | 0.875 | 0.878 | 0.876 |
| | 2 | 0.876 | 0.875 | 0.878 | 0.875 |
| | 3 | 0.876 | 0.876 | 0.877 | 0.875 |
| | 4 | 0.876 | 0.876 | 0.876 | 0.877 |
| | 5 | 0.876 | 0.876 | 0.877 | 0.877 |
| | 6 | 0.876 | 0.876 | 0.877 | 0.879 |
| R43-C61 | 0 | 0.876 | 0.876 | 0.875 | 0.875 |
| | 1 | 0.875 | 0.875 | 0.876 | 0.875 |
| | 2 | 0.875 | 0.876 | 0.876 | 0.875 |
| | 3 | 0.876 | 0.875 | 0.875 | 0.875 |
| | 4 | 0.876 | 0.875 | 0.875 | 0.876 |
| | 5 | 0.876 | 0.876 | 0.875 | 0.876 |
| | 6 | 0.875 | 0.875 | 0.875 | 0.875 |

*No significant measurement could be made.

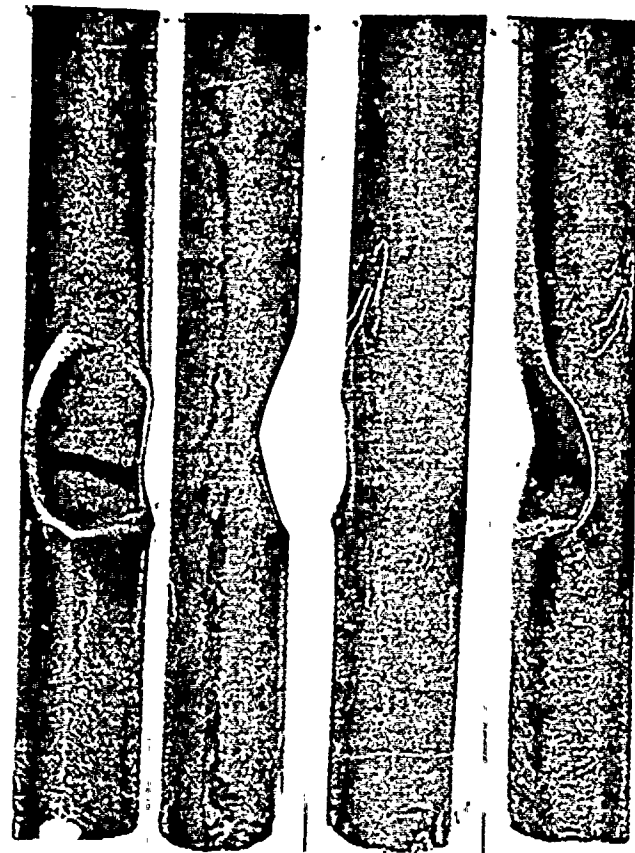


0°
R14-C90

90

180

270

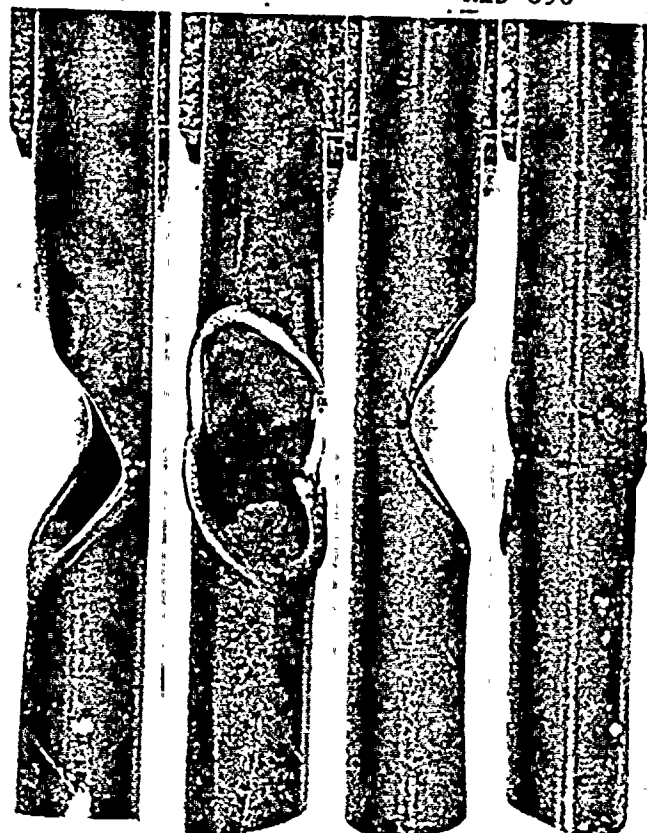


0°
R15-C90

90

180

270



0°
R12-C91

90

180

270

FIGURE 1. Photographs at various angular positions of the bottom 6" of tube sections from Tubes R14-C90, R15-C90, and R12-C91, hot leg, SG "B", Ginna

Top

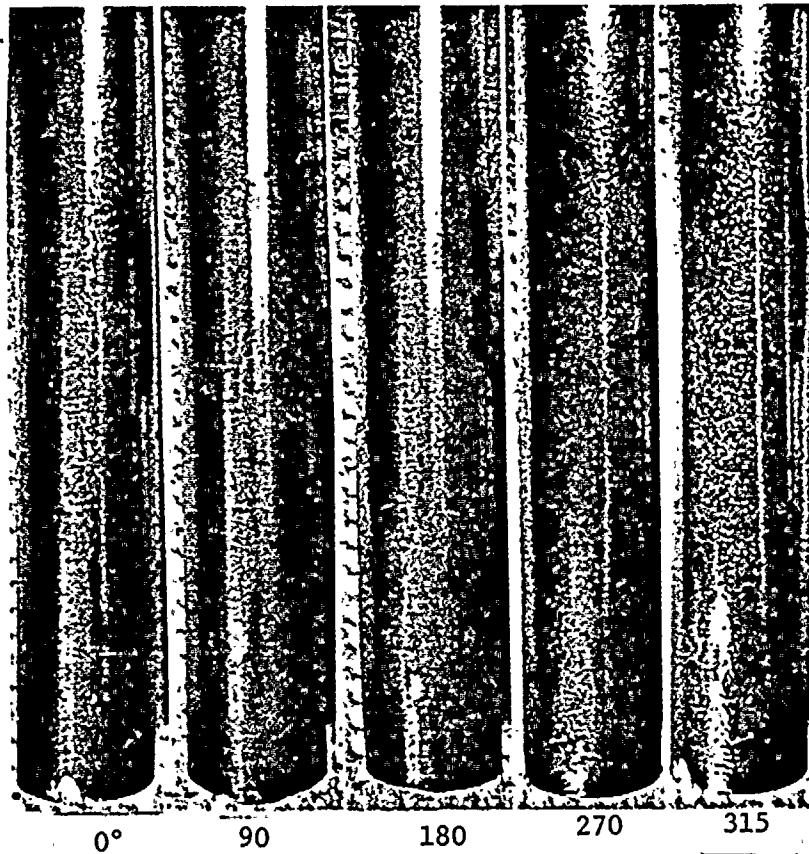
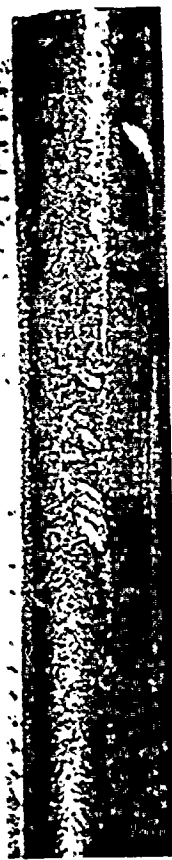
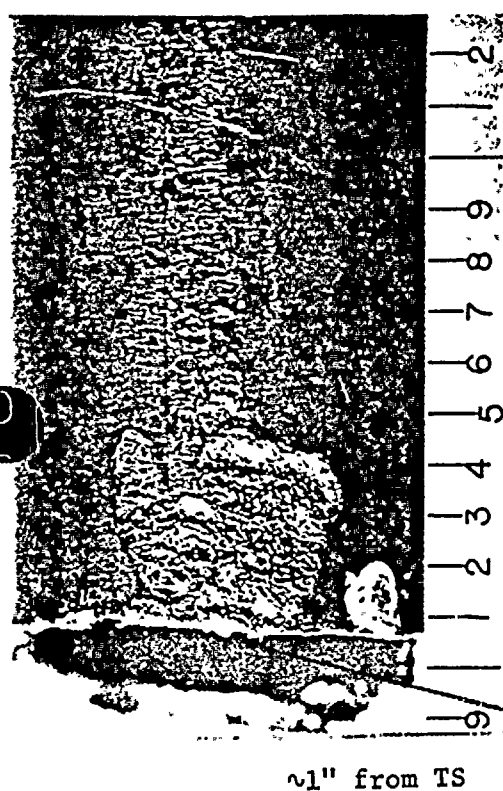


FIGURE 2. Photographs of 10-1/8" section of Tube R43-C60



~1" from TS

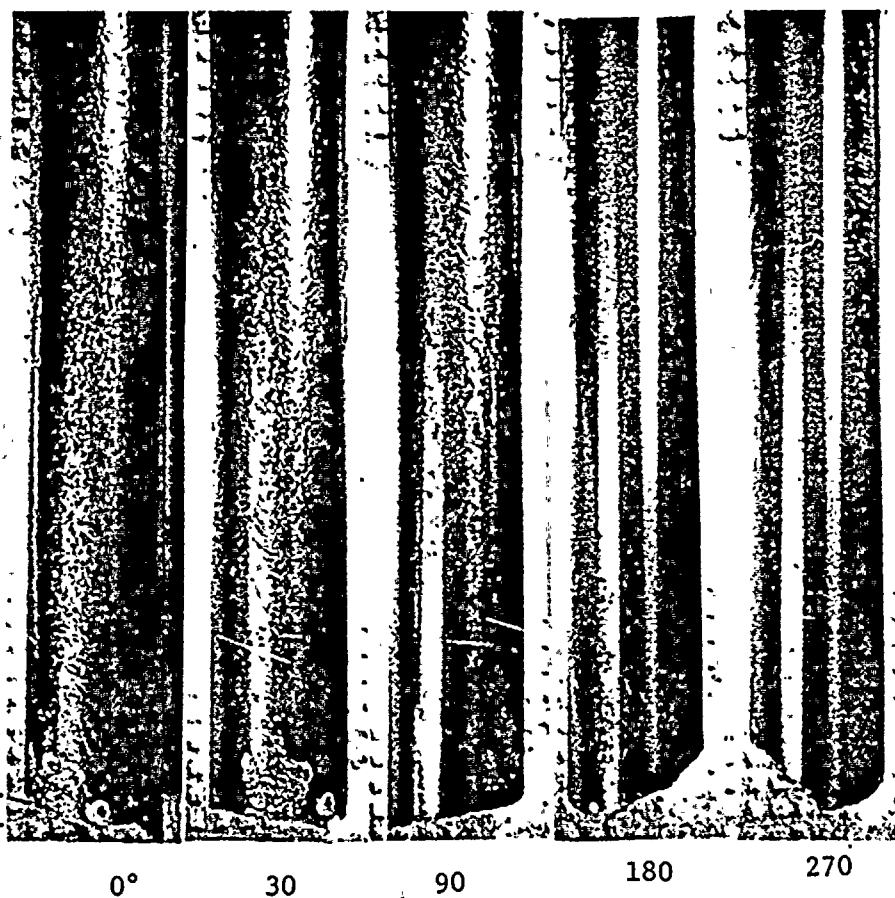
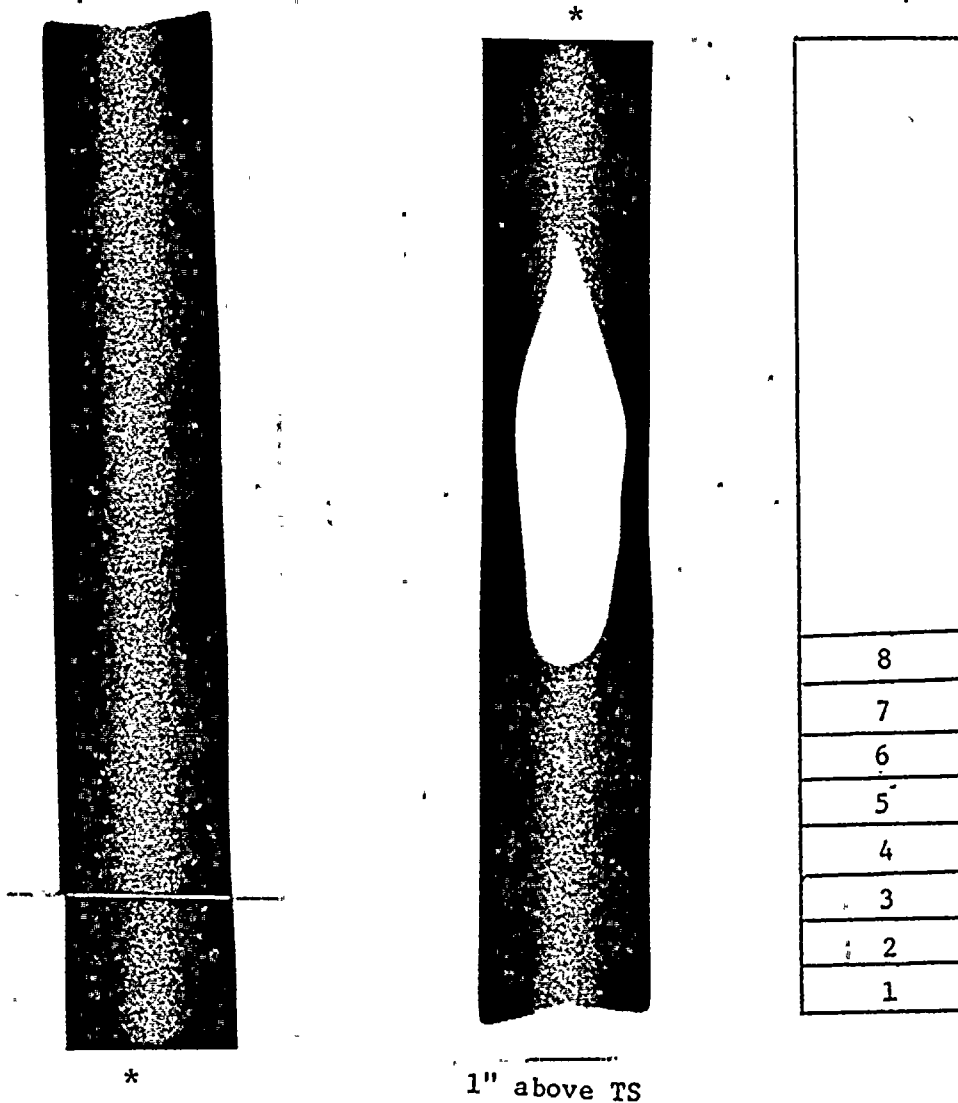


FIGURE 3. Photographs of bottom portion of Tube R43-C61



Rings were cut at 270°, flattened to strain ID in tension, and IDs examined

* - matching surfaces

FIGURE 4. Print of 0° double wall X-ray radiograph and cutting diagram from Tube (R14-C90)



*= matching surfaces

1" above TS

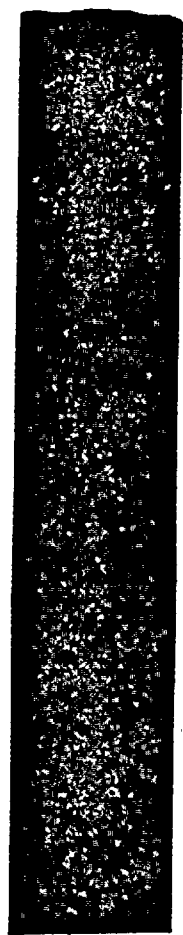
- 1K
- 1J
- 1I
- 1H
- 1G
- 1F
- 1E
- 1D
- 1C
- 1B
- 1A

All ring cut at 0°, flattened to strain ID in tension, and then ID's were examined

Sensitization Test.- 1/4" circumferential length

FIGURE 5. Print of 45° double wall X-ray radiograph and cutting diagram for Tube (R15-C90).





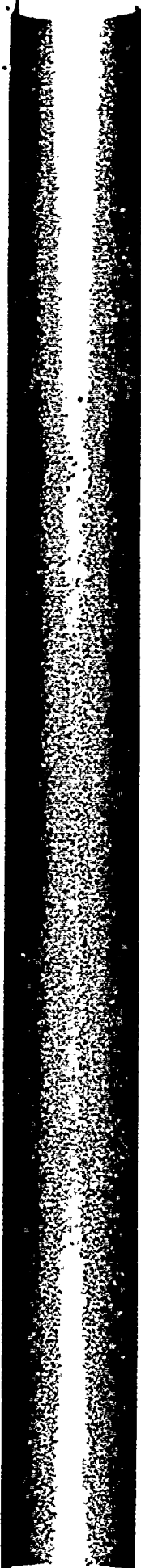
| |
|---|
| |
| 8 |
| 7 |
| 6 |
| 5 |
| 4 |
| 3 |
| 2 |
| 1 |

Rings were cut at 270°, flattened to strain ID in tension, and IDs examined

* = matching surfaces

1" above TS

FIGURE 6. Print 90° double wall X-ray radiograph and cutting diagram for Tube (R12-C91)



V A

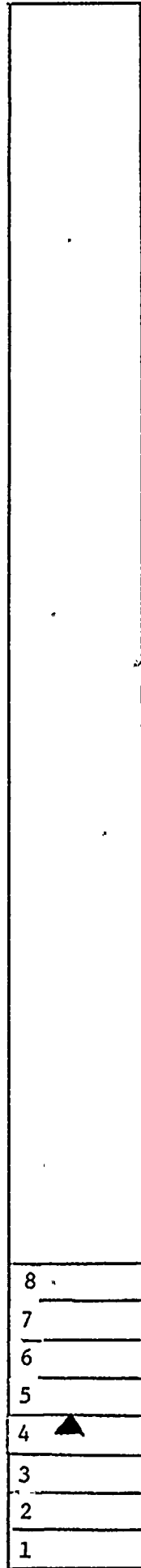


FIGURE 7. Point of 90° double wall X-ray radiograph of Tube R43-C60 and cutting diagram. Spots marked A were cutting tool strikes. ▲ Rings: designates plane polished in metallography; other rings examined like for Tube R14-C90.

1" above TS



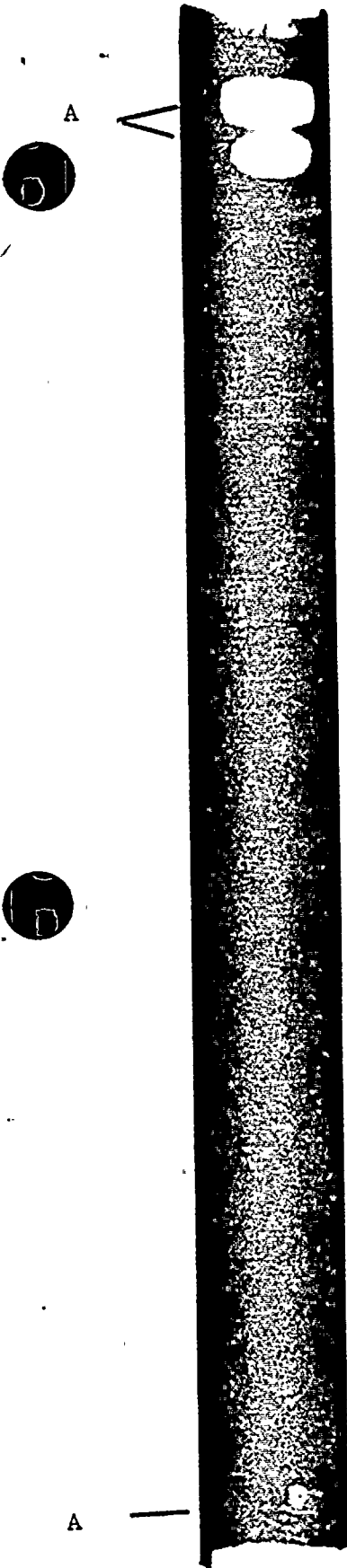



FIGURE 8. Print of 45° double wall X-ray radiograph for Tube R43-C61 from the hot leg of "B" steam generator and Cutting diagram. Topography of Spots A was like that of cut tube and indicating they resulted from cutting tool strikes. Rings examined as for Tube R43-C60.

| |
|---|
| 8 |
| 7 |
| 6 |
| 5 |
| 4  |
| 3 |
| 2 |
| 1 |

~1" above TS .

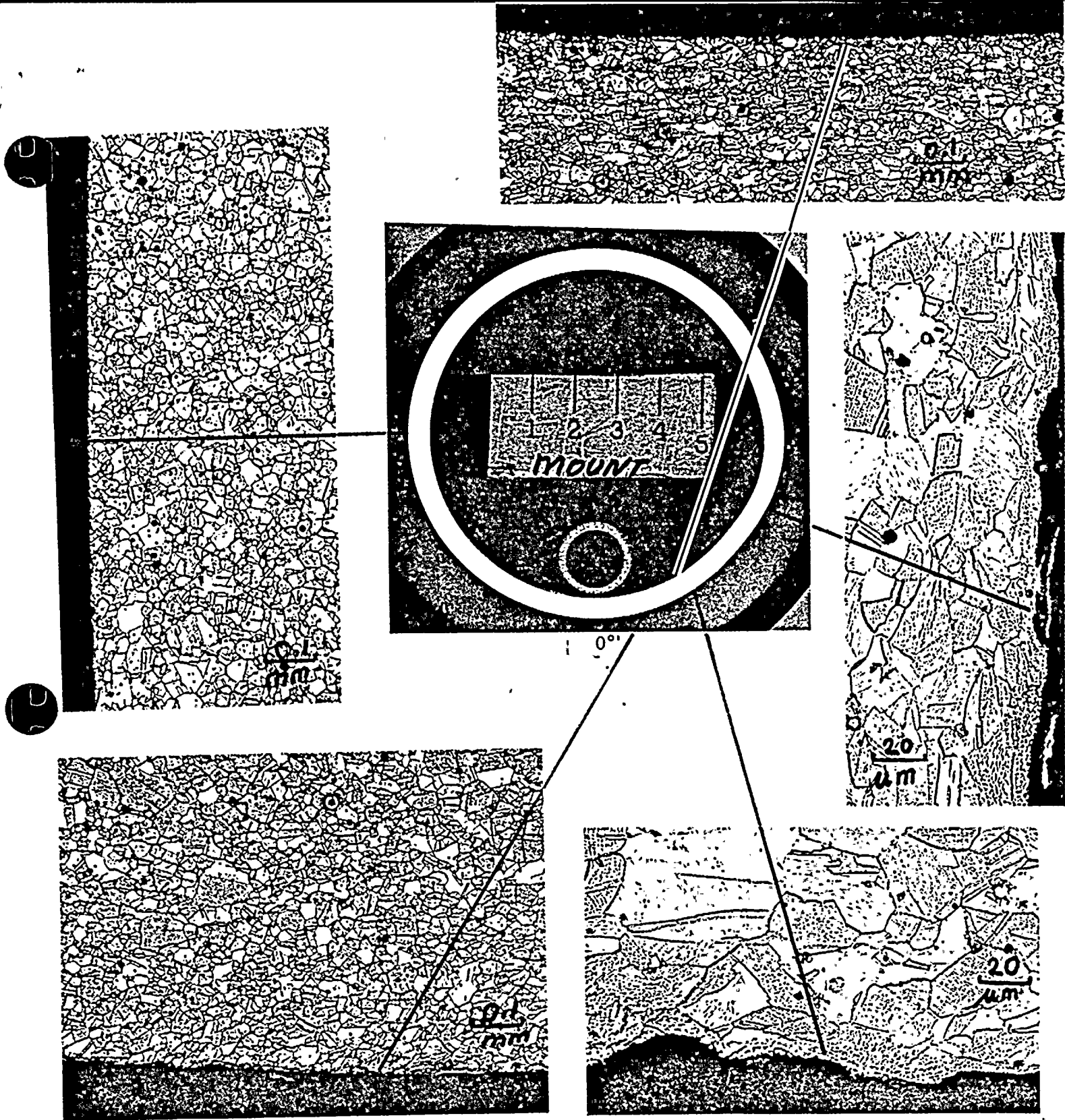


FIGURE 9. Metallography on Ring No. 4,
Tube No. R43-C60.

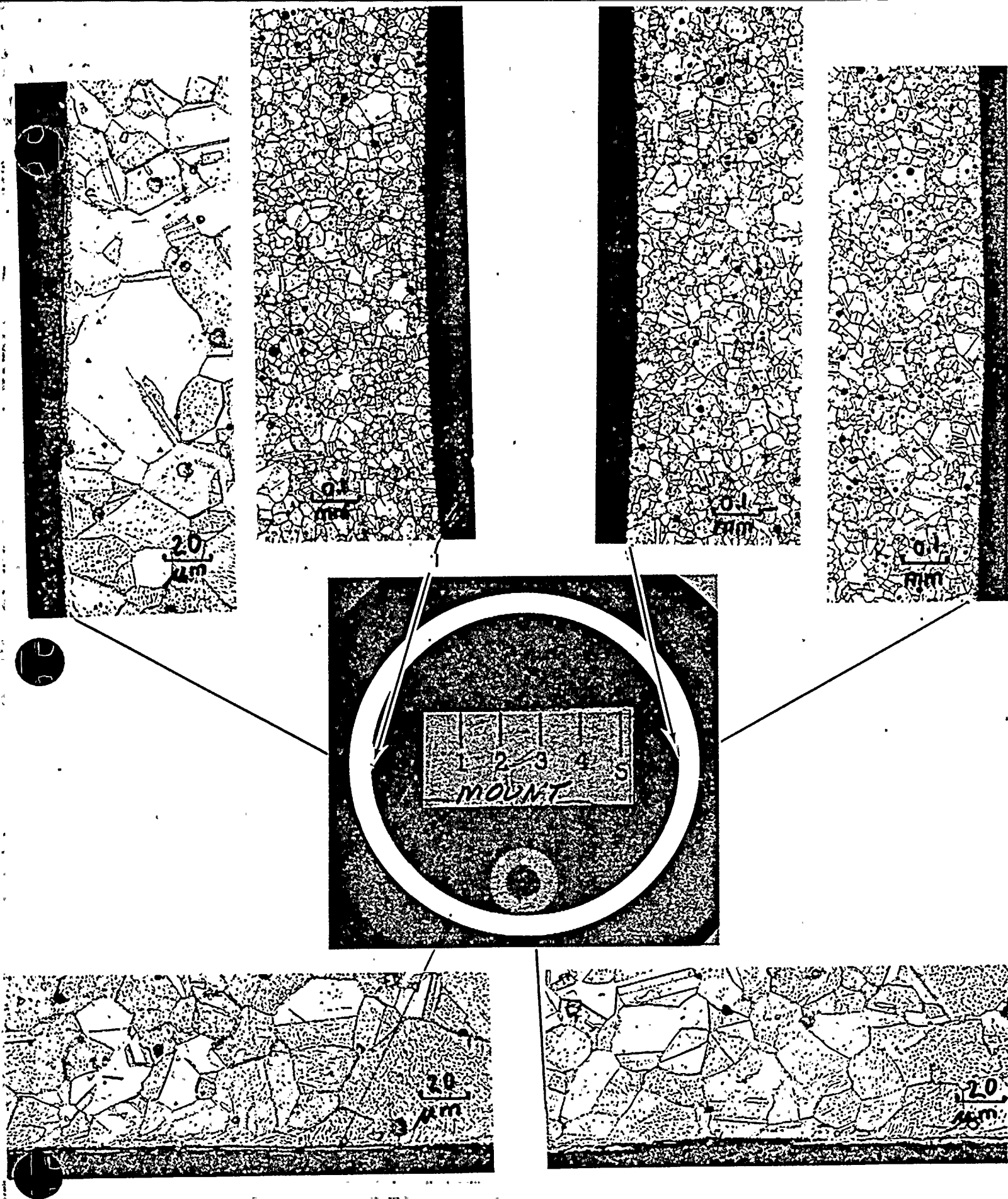


FIGURE 10. Metallography on Ring No. 4,
Tube R43-C61

