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CHARLES CENTER • P. O. BOX 1475 • BALTIMORE, MARYLAND 21203

W. JAMES LIPPOLD
MANAGER
NUCLEAR ENGINEERING SERVICES DEPARTMENT

June 22, 1987

U. S. Nuclear Regulatory Commission
Region I
631 Park Avenue
King of Prussia, PA 19406

ATTENTION: Mr. W. V. Johnston, Acting Director
Division of Reactor Safety

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit Nos. 1 & 2, Docket Nos. 50-317 and 50-318
Failure Analysis Report Summary for Low Pressure Safety Injection
Relief Valve RV-439 Line

Gentlemen:

During an NRC inspection the week of May 11, 1987, your staff requested that we forward a summary of the subject Failure Analysis Report. This summary is provided as an attachment.

Should you have any additional questions, we will be pleased to discuss them with you.

Very truly yours,

W. J. Lippold

WJL/LSL/dlm

Attachment

H001
1/1

DIST PER PM

cc: D. A. Brune, Esquire
J. E. Silberg, Esquire
R. A. Capra, NRC
S. A. McNeil, NRC
W. T. Russell, NRC
T. Foley/D. C. Trimble, NRC
H. J. Kaplan, NRC

ATTACHMENT

CALVERT CLIFFS UNIT 2
SUMMARY OF MATERIALS ANALYSIS OF THE LINE LEADING TO RV-439

A visual examination of the failed 1/2 inch pipe leading to RV-439 (Low Pressure Safety Injection Relief Valve) revealed a crack on the 1/2 inch pipe that is at an angle of approximately 45° with respect to the fillet weld. The 45° crack intersects the fillet weld and follows the toe of the weld for approximately 3/8 of an inch. The cracked pipe was removed from the line leading to RV-439 for further examination (see Figure No. 1)

Microscopic examination of the pipe spool fracture surface in the laboratory indicated two cracks initiated at the toe of the fillet weld approximately 1/8 of an inch apart. These cracks grew in slightly different planes creating the step (or ratchet mark) observed at in Figure No. 2. The crack to the right of the step in Figure No. 2 continued to propagate along the toe of the weld while the crack to the left veered off at a 45° angle to the toe of the weld. A schematic is shown in Figure No. 3 that highlights the features discernible on the fracture surface. The radial lines extending from points A and B indicate these were the sites of crack initiation. There was no evidence of beach marks on the fracture surface of the crack that initiated at point B and only faint beach marks near the very end of the crack initiating from point A.

A scanning electron microscope examination of the fracture surface around the initiation sites did not reveal any latent defects that could be responsible for the initiation of these cracks. An interesting area found near initiation site A is shown in Figure No. 4. This area has a faceted appearance and river patterns indicating crack propagation along preferred crystallographic planes. This is typical of stage I fatigue often observed near the point of initiation. No discernible striations were observed in the through wall area near the initiation sites but striations were observed from the middle to the end of the 45° crack (see Figure No. 5). If the spacing for the striations in this area is projected over the entire surface the number of cycles involved in the propagation of the crack would be greater than 6000.

An axial cross section of the pipe containing the crack was prepared for metallurgical examination. This examination revealed that the through wall crack was transgranular. The microstructure was that of a typical 304 stainless steel. The chemistries of the weld and base metal were within the materials specifications. Hardness of the weld and base metal was HRB 97 and 87, respectively, which are typical and acceptable values for these materials.

Location and mode of crack propagation indicate the failure was due to cyclic torsional/bending loads. It has been estimated that greater than 6000 cycles were required to propagate the crack. Our visual inspection and assessment of the line during operation did not reveal any unusual vibration that would explain the failure. We believe it is possible that a transient high frequency vibration condition may exist that is responsible for the failure. The lack of distinct beach marks over most of the fracture surface seems to indicate that the propagation of the crack was not interrupted. This strongly suggests that a single transient vibration condition would be responsible for the failure.

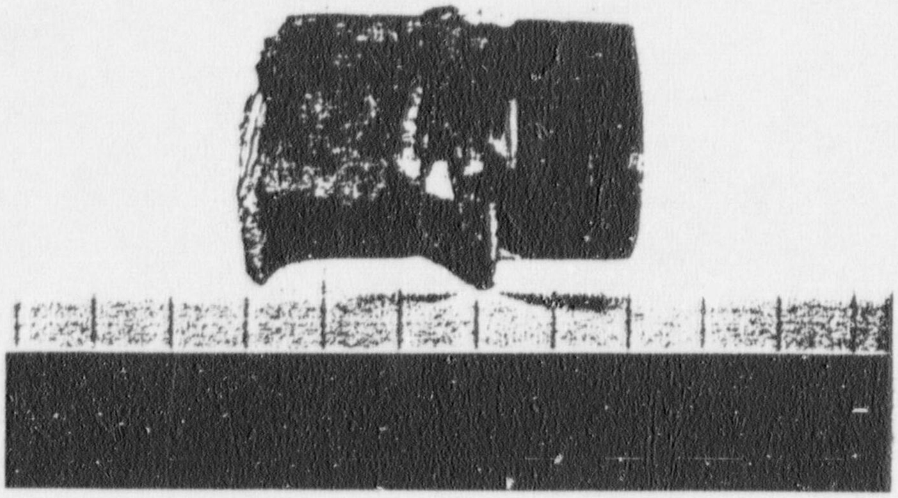

Figure No. 1 Section Containing Crack in as Removed Condition

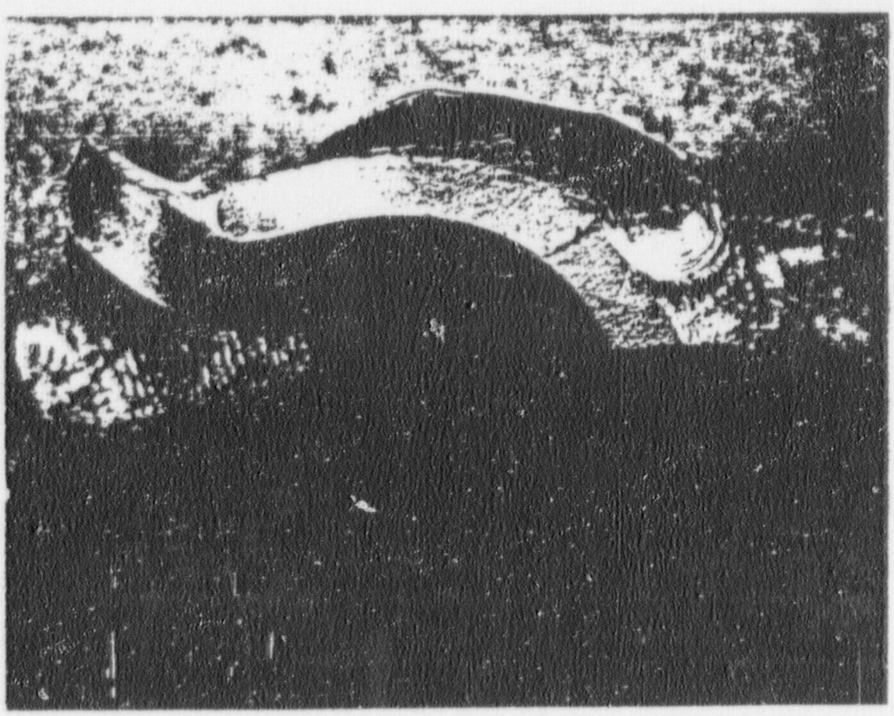

Figure No. 2 Fracture Surface of Cracked Pipe Showing a Ratchet Mark at Point 1

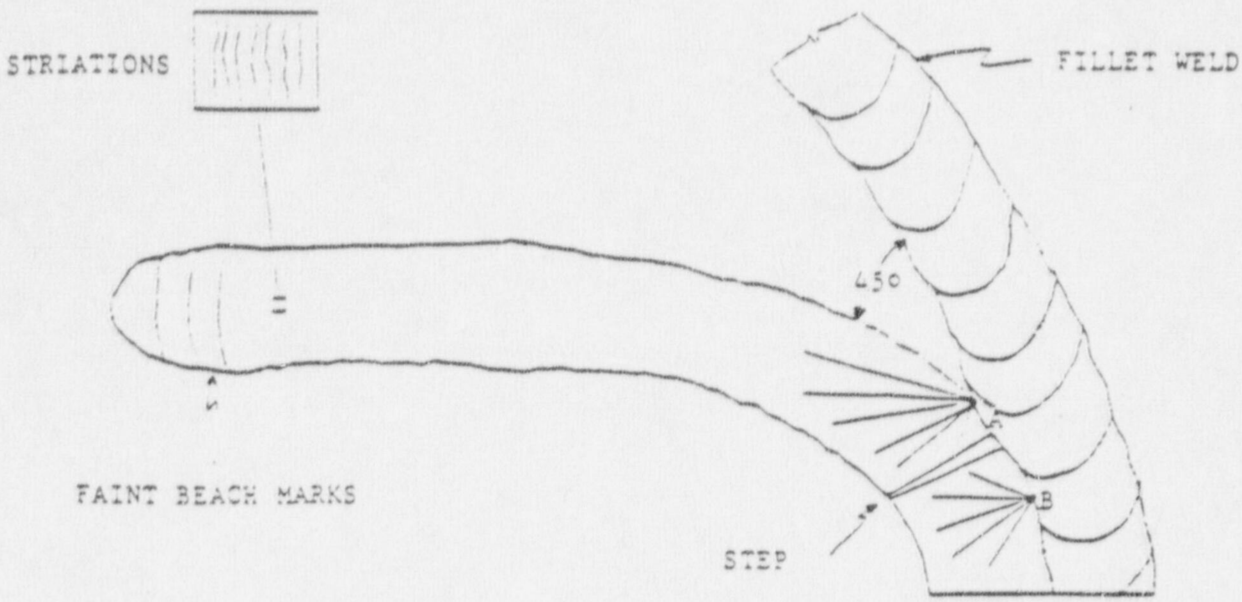

Figure No. 3 A Schematic of the Fracture Surface Highlighting Discernible Features from the Examination

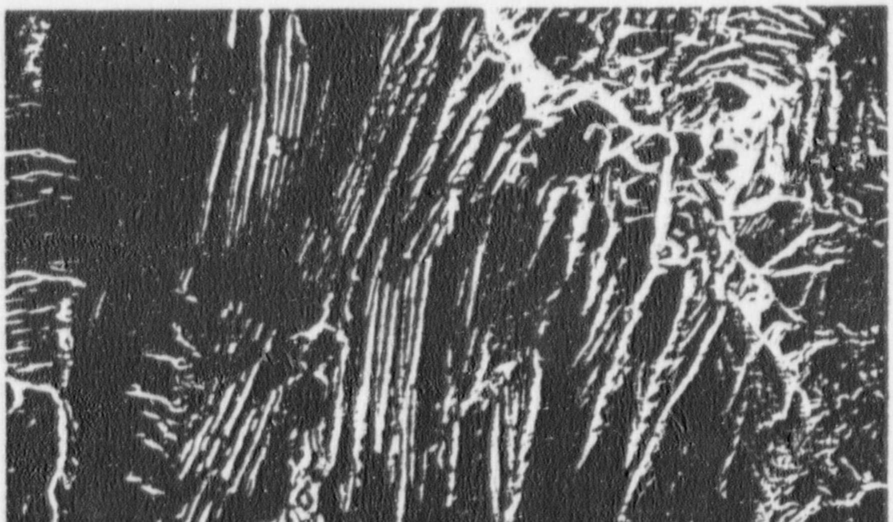

Figure No. 4 Faceted Area Near the Initiation Site

Figure No. 5   Striations Observed on the Fracture Surface Near the End of the 45° Crack