Docket File

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

June 21, 1993

Docket No. 50-410

LICENSEE: Niagara Mohawk Power Corporation

FACILITY: Nine Mile Point Nuclear Station, Unit 2

SUBJECT: SUMMARY OF JUNE 10, 1993, MEETING TO DISCUSS THE INSPECTION AND POSSIBLE REPAIR OF A FLAW IN HIGH PRESSURE CORE SPRAY NOZZLE WELD KC-32 AT NINE MILE POINT NUCLEAR STATION, UNIT 2

A meeting was held in the NRC One White Flint North Office in Rockville, Maryland, with Niagara Mohawk Power Corporation (NMPC) and NRC staff representatives to discuss the inspection and possible repair of a flaw in the weld (KC-32) joining the high pressure core spray nozzle safe end to safe end extension at Nine Mile Point Unit 2 (NMP-2). The licensee had requested this meeting. Enclosure 1 is a list of meeting attendees. Enclosure 2 is a copy of the handout material provided by NMPC.

BACKGROUND

The flaw in weld KC-32 was discovered during the first NMP-2 refueling outage in October 1990 and subsequently treated with the Mechanical Stress Improvement Process (MSIP). Ultrasonic examination (UT) after MSIP showed an indication depth of 41 percent of the wall thickness and a length that was 11.3 percent of the weld circumference. Ultrasonic reexaminations midway through the second operating cycle and during the second refueling outage revealed no growth in the flaw. The staff has reviewed and approved NMPC submittals that provided justification for continued operations since discovery of the flaw. The staff's most recent letter regarding operations with the flaw was dated May 6, 1992.

In the letter of May 6, 1992, the staff agreed with NMPC's proposal to operate NMP-2 for up to 9700 hours during the current (third) operating cycle. Operations beyond 9700 hours required NMPC to either justify such operations prior to exceeding 9700 hours of operation or to repair or replace the weld prior to exceeding 9700 hours of operation. The staff's letter of May 6, 1992, noted that NMPC had committed to repair or replace weld KC-32 during the third refueling outage if it is not repaired or replaced during the third operating cycle.

By letter dated March 16, 1993, NMPC provided the staff with the results of a fracture mechanics analysis that provided a basis for operations beyond 9700 hours during the third operating cycle. The staff is currently evaluating this NMPC proposal for continued operations. The NMPC letter of March 16, 1993, also advised the staff that NMPC was reevaluating the merits of replacing the safe end extension during the third refueling outage. NMPC

Memo of Dcl 6/11

expressed concern at that time that replacement of the safe end extension, without fully evaluating other possible options, could result in excessive costs, significant radiation exposure, and extension of the refueling outage with no net safety gain. NMPC committed to provide additional information to the staff regarding these evaluations in the near future.

MEETING DISCUSSIONS

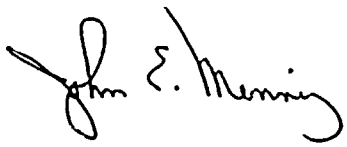
The NMPC representatives initially indicated that they intended to provide the staff with NMPC's assessment of the flaw in weld KC-32 and to discuss their commitment to replace the safe end during the third refueling outage. NMPC then reviewed the history of the flaw, including the UT examinations that have been performed. NMPC indicated that the weld was ultrasonically scanned many times during each examination and that both automated and manual UT data indicate that the flaw depth is no greater than 41 percent of the wall thickness, and not growing in length.

NMPC then discussed the results of a finite element inelastic analysis that considered welding residual stresses, MSIP application, and operating loads. The results of this analysis indicated that the flaw in weld KC-32 remains in the compressive stress region and that no further fracture mechanics analysis is necessary. NMPC stated that they intended to propose to the staff that the weld not be repaired during the third refueling outage if examination of the flaw shows no increase in length or depth. If any growth is observed, NMPC would then implement a weld overlay repair plan.

NMPC reviewed some of its incentives for repairing weld KC-32 instead of replacing it. For instance, repair would involve approximately 4.3 person rem of exposure, and replacement would involve about 43.75 person rem. Repair would increase critical path outage time by about 7 days and replacement would involve an increase of approximately 21 critical path days. NMPC also indicated that repair would not require cutting into the reactor coolant pressure boundary, and that the risks associated with implementing a repair are lower than those associated with replacement.

NMPC summarized their position relative to inspection and repair of the flaw near the conclusion of the meeting. Specifically, results of the finite element inelastic analysis and UT examinations indicate the flaw growth has been arrested. Based on mitigation of flaw growth, NMPC has reassessed its commitment to replace the safe end extension and will propose to repair the weld with an overlay during the third refueling outage if examination of the

flaw reveals growth in length or depth. No repair would be performed if the examination shows no increase in length or depth. NMPC indicated that a written submittal for the staff's consideration would likely be forwarded in 3 to 4 weeks.



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Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosures:
1. List of Attendees
2. Licensee Handout Material

cc w/enclosures:
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ENCLOSURE 1

June 10, 1993

Inspection and Possible Repair of a Flaw

in a High Pressure Core Spray Nozzle Weld

at Nine Mile Point Unit 2

ATTENDANCE LIST

Name	Position	Organization
Robert Capra	Project Director	NRC/NRR/PDI-1
John Menning	Project Manager	NRC/NRR/PDI-1
Jack Strosnider	Branch Chief	NRC/NRR/EMCB
Robert Hermann	Section Chief	NRC/NRR/EMCB
William Koo	Sr. Materials Engineer	NRC/NRR/EMCB
Robert McBrearty	Reactor Engineer	NRC/Region I
Carl Terry	Vice President - Nuclear Engineering	Niagara Mohawk
Keith Ward	Manager - Nuclear Engineering for Unit 2	Niagara Mohawk
David Greene	Licensing Manager	Niagara Mohawk
W. David Baker	Program Director	Niagara Mohawk
S. K. Dhar	Engineer	Niagara Mohawk
Gary Wilson	Attorney	Niagara Mohawk
Kenneth Korcz	Licensing Engineer	Niagara Mohawk
John Swenskowski	NDE Lead	Niagara Mohawk
Manu Badlani	Consultant	A.A. O'Donnell
Mark Wetterhahn	Attorney	Winston and Strawn
Michael Heath	ISI Project Manager	General Electric

ENCLOSURE 2

NIAGARA MOHAWK POWER CORPORATION

NINE MILE POINT NUCLEAR STATION

UNIT 2

HIGH PRESSURE CORE SPRAY
SAFE END TO SAFE END EXTENSION WELD
2-RPV-KC32

JUNE 10, 1993

NIAGARA MOHAWK

NIAGARA MOHAWK POWER CORPORATION

HPCS CORE SPRAY NOZZLE MEETING AGENDA

JUNE 10, 1993

		SPEAKERS
I.	INTRODUCTION/PURPOSE	K. D. WARD
II.	BACKGROUND INFORMATION	K. D. WARD
III.	ULTRASONIC TESTING	M. HEATH (GENERAL ELECTRIC)
IV.	MECHANICAL STRESS IMPROVEMENT ANALYSIS	M. BADLANI (AEA O'DONNELL, INC)
V.	CONTINGENCY REPAIR PLAN	K. D. WARD
VI.	SUMMARY	K. D. WARD

PURPOSE

PURPOSE

TO PROVIDE NMPC'S ASSESSMENT OF THE HPCS SAFE END TO SAFE END EXTENSION WELD FLAW AND DISCUSS OUR COMMITMENT TO REPLACE THE SAFE END AT REFUEL OUTAGE 3:

- FLAW HAS BEEN ARRESTED BY MECHANICAL STRESS IMPROVEMENT PROCESS

- REPAIR OR REPLACEMENT IS NOT REQUIRED PROVIDING THE PROPOSED INSPECTION ACCEPTANCE CRITERIA ARE MET

- REPAIR BY WELD OVERLAY IS ACCEPTABLE ALTERNATIVE TO REPLACEMENT SHOULD ACCEPTANCE CRITERIA NOT BE MET

BACKGROUND INFORMATION ON HPCS NOZZLE KC-32 FLAW

- FLAW WAS DISCOVERED DURING FIRST REFUELING OUTAGE IN-SERVICE INSPECTIONS (OCTOBER 1990). MECHANICAL STRESS IMPROVEMENT PROCESS (MSIP) WAS APPLIED TO MITIGATE CRACK GROWTH.

- INITIAL FRACTURE MECHANICS ANALYSIS SUBMITTED TO NRC ON DECEMBER 28, 1990. REVISED ANALYSIS SUBMITTED ON JUNE 28, 1991 TO:

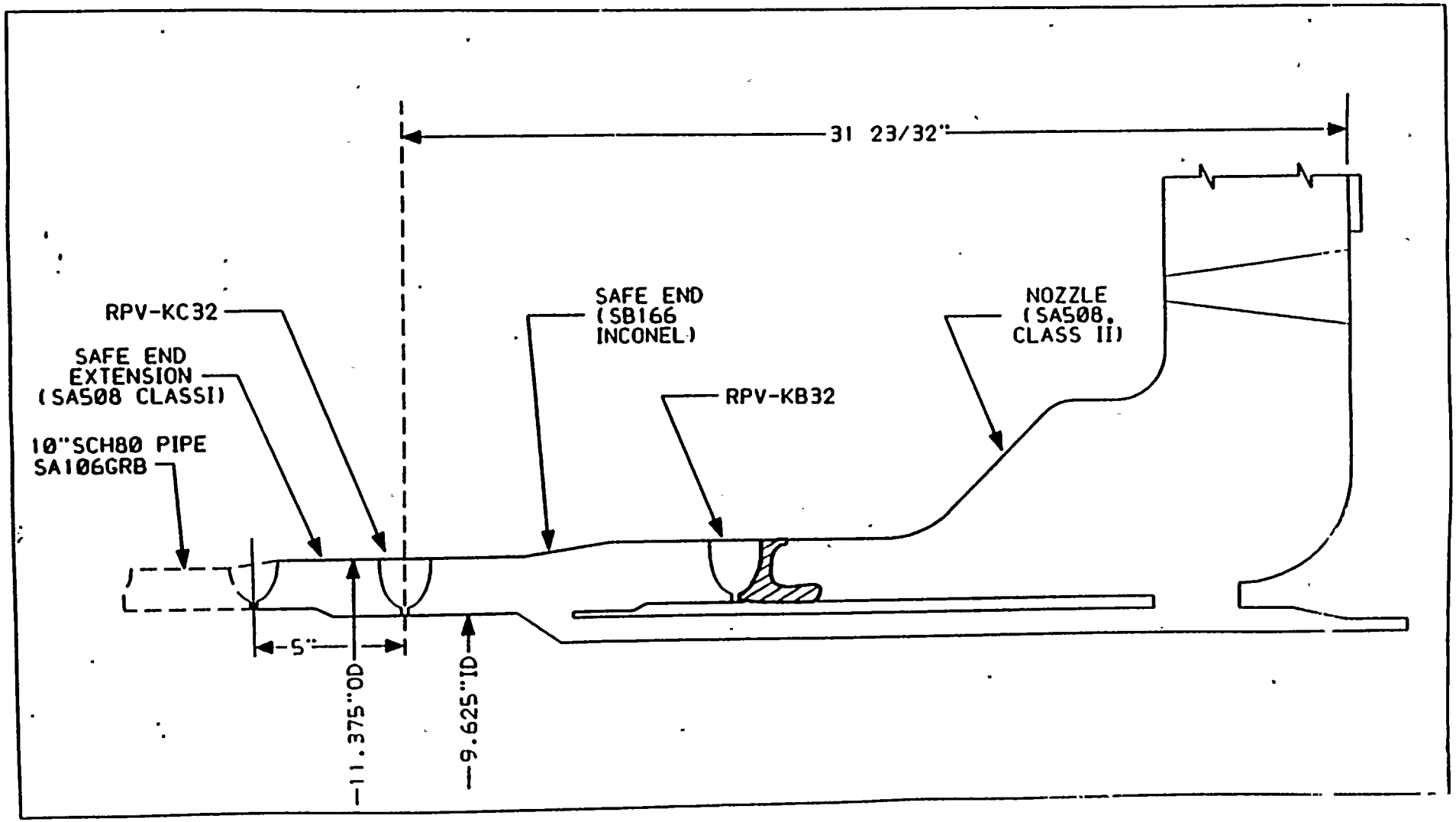
  - ASSESS FLAW WITH AS-WELDED RESIDUAL STRESS FOR SMALL DIAMETER PIPE AS SPECIFIED IN NUREG 1061

  - INCREASE MAXIMUM UT INDICATION SIZE BY 5% IN DEPTH AND LENGTH TO ADD ADDITIONAL MARGIN

- RESPONSE TO NMPC IN NRC LETTER OF MAY 6, 1992, INDICATED NMPC'S COMMITMENT TO REPLACE SAFE END EXTENSION IN THE THIRD REFUELING OUTAGE

- NMPC HAS REEVALUATED REPLACEMENT OF SAFE END EXTENSION BASED ON SAFETY, EXPOSURE AND COST CONSIDERATIONS

(HIGH PRESSURE CORE SPRAY)



ULTRASONIC TESTING

ULTRASONIC EXAMINATIONS OF WELD 2-RPV-KC32

- UT EXAMINATIONS WERE PERFORMED IN ACCORDANCE WITH THE ASME SECTION XI CODE, WITH ENHANCEMENTS ENDORSED BY THE EPRI NDE CENTER

- ALL OF THE EXAMINERS, EQUIPMENT, AND PROCEDURES WERE QUALIFIED AT THE EPRI NDE CENTER ON SAMPLES WITH ACTUAL CRACKS OF KNOWN DEPTHS

- IN ADDITION TO THE ABOVE, ALL (4) OF THE EXAMINERS OF RECORD WERE CERTIFIED LEVEL III'S IN THE ULTRASONIC METHOD

	MAXIMUM RECORDED	
INSPECTION	**CRACK DEPTH**	**CRACK LENGTH**
1ST REFUEL OUTAGE - POST MSIP (1990)	41% (.35")	11.3% (3.4")
MID-CYCLE (1991)	38% (.32")	11.0% (3.3")
2ND REFUEL OUTAGE (1992)	29% (.25")	11.0% (3.3")

ULTRASONIC EXAMINATIONS OF WELD
2-RPV-KC32 (Cont'd)

- VARIATIONS IN MAXIMUM DEPTH OF .1 INCH ARE NOT UNEXPECTED FOR A NARROW FLAW
- IN ADDITION TO THE SIZING EXAMINATIONS, OVER 30 AUTOMATED UT SCANS HAVE BEEN PERFORMED ON THIS WELD TO DATE
- NO TRANSDUCER READINGS HAVE SHOWN THIS INDICATION TO BE DEEPER THAN 41%T, AND (9) SEPARATE TRANSDUCER READINGS HAVE INDICATED THIS FLAW TO BE SHALLOWER
- EPRI PERSONNEL HAVE REVIEWED ALL OF THE COLLECTED DATA TO DATE, AND THEY CONCUR THAT THE VARIATION NOTED IS REASONABLE
- BOTH AUTOMATED AND MANUAL DATA INDICATE THE FLAW DEPTH TO BE NO DEEPER THAN 41%T, AND NOT GROWING IN THE LENGTH DIRECTIONS

ULTRASONIC EXAMINATIONS OF WELD
2-RPV-KC32 (Cont'd)

- BASED ON THE ABOVE, WE ARE CONFIDENT THAT THIS INDICATION IS NO DEEPER THAN 41%T AND IS NOT GROWING IN EITHER THE LENGTH OR DEPTH DIRECTIONS

MSIP ANALYSIS

FOR

CORE SPRAY SAFE-END-TO-EXTENSION WELDMENT

VERIFICATION

ANALYSES

- FINITE ELEMENT INELASTIC ANALYSIS

TESTS

- $MgCl_2$ TEST
  EPRI

- RESIDUAL STRESS MEASUREMENTS
  ARGONNE NATIONAL LABORATORY FOR NRC
  EPRI FOR BWR OWNERS GROUP

OPERATION

- PROCESS APPLIED FOR WELDMENTS WITH AND WITHOUT CRACKS FOR ABOUT 1,000 JOINTS

TESTS & OPERATION EXPERIENCE QUALIFIED THE METHOD OF ANALYSIS USED FOR INDIVIDUAL WELDMENTS

MARTIN MARIETTA KNOLLS & WESTINGHOUSE BETTIS VERIFICATION OF MECHANICAL STRESS IMPROVEMENT PROCESS FOR NAVY SPECIFICATION

USE OF MECHANICAL STRESS IMPROVEMENT PROCESS IN NUCLEAR PLANTS

Utility	Plant	Year	Pipe & Fittings	Nozzles and S.E.s	Total	Notes
CECo	Dresden 3	1986	50	2	52	
CECo	LaSalle 2	1987	25	29	54	
CECo	Quad Cities 1	1987	36	2	38	
CP&L	Brunswick 2	1988	0	15	15	1
CECo	Quad Cities 2	1988	43	4	47	
Nuclenor	Santa Maria de Garona	1988	24	0	24	
OKG Aktiebolag	Oskarshamn	1988	1	0	1	1
CP&L	Brunswick 1	1988	0	10	10	
CECo	LaSalle 1	1988	15	15	30	
CECo	LaSalle 2	1988	8	0	8	
CECo	Dresden 2	1988	82	22	104	
PECo	Limerick 2	1989	2	16	18	
Northeast	Millstone 1	1989	0	22	22	
Detroit Edison	Fermi 2	1989	6	21	27	
CECo	Quad Cities 1	1989	28	12	40	
CP&L	Brunswick 2	1989/90	16	20	36	2
CECo	Quad Cities 2	1990	30	14	44	2
Teollisuuden Voima Oy	TVO	1990	5	0	5	
Niagara Mohawk	Nine Mile Pt 2	1990	0	1	1	1
Taiwan Power Co	Kuosheng 2	1990	2	0	2	1
CP&L	Brunswick 1	1990/91	10	24	34	
Northeast	Millstone 1	1991	34	9	43	
Iberdrola	Cofrentes	1991	0	42	42	
Boston Edison	Pilgrim 1	1991	16	0	16	2
PECo	Peach Bottom 3	1991	10	0	10	
PECo	Limerick 1	1992	0	7	7	
Cleveland Elec	Perry 1	1992	0	27	27	1
TVA	Browns Ferry 3	1992	81	29	110	2
GPU	Oyster Creek	1992	70	0	70	2
Georgia Power	Hatch 1	1993	11	18	29	
TVA	Browns Ferry 2	1993	12	0	12	2
Totals			617	361	978	

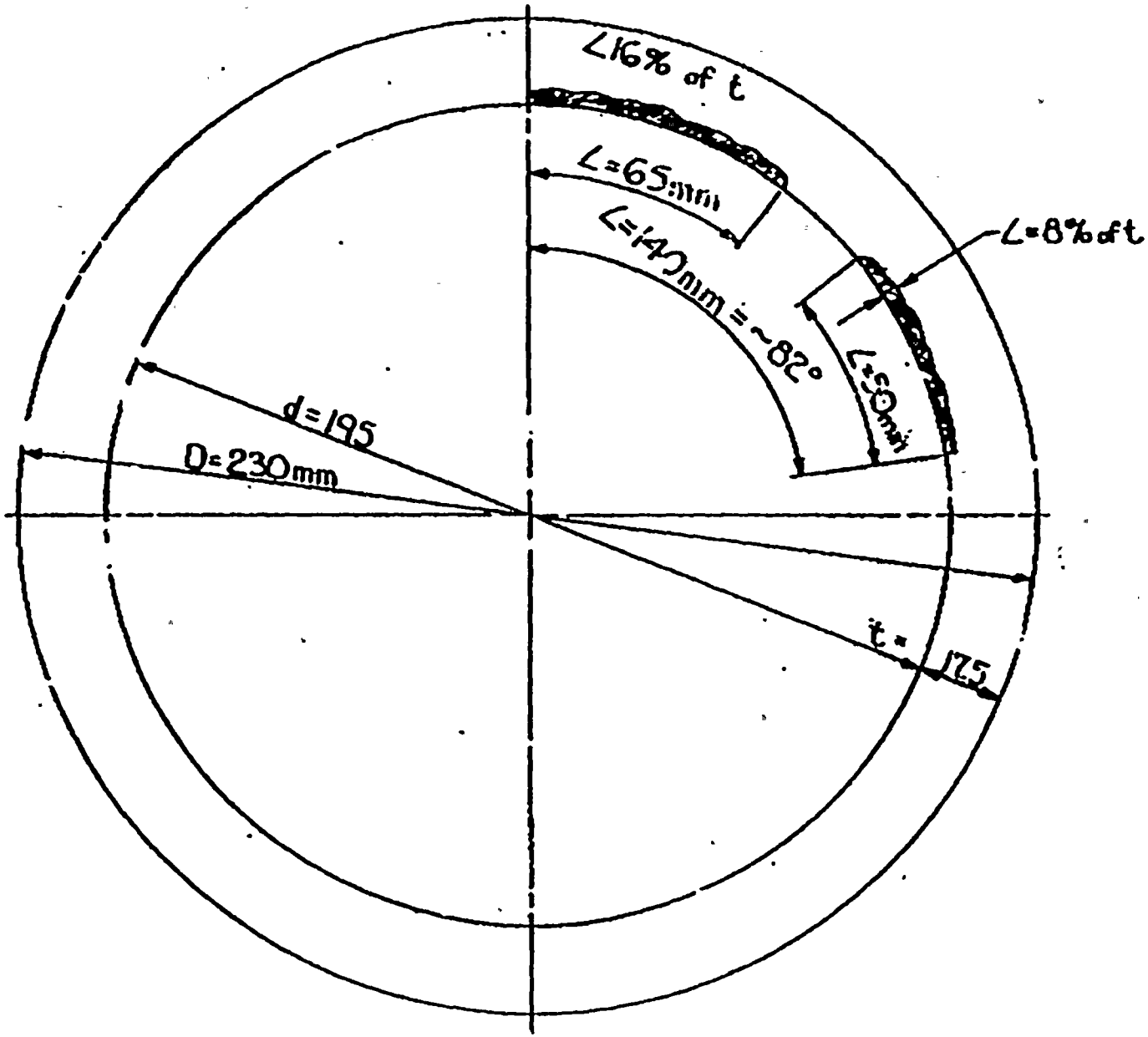
Recent Application for PWR Inconel 600 Nozzles and Small Diameter Piping

Notes: 1) Some weldments with preexisting cracks
2) Weldments for replacement piping made of SCC immune materials

CRACKS ARRESTED BY MSIP

NOMINAL PIPE SIZE	FLAW SIZE LENGTH	DEPTH	CYCLES OF OPERATION
10"	0.5"	.09" (15%)	1
20"	2.1"	0.25" (20%)	1
10"	5.5"	0.11" (16%)	3

1" = 25.4mm

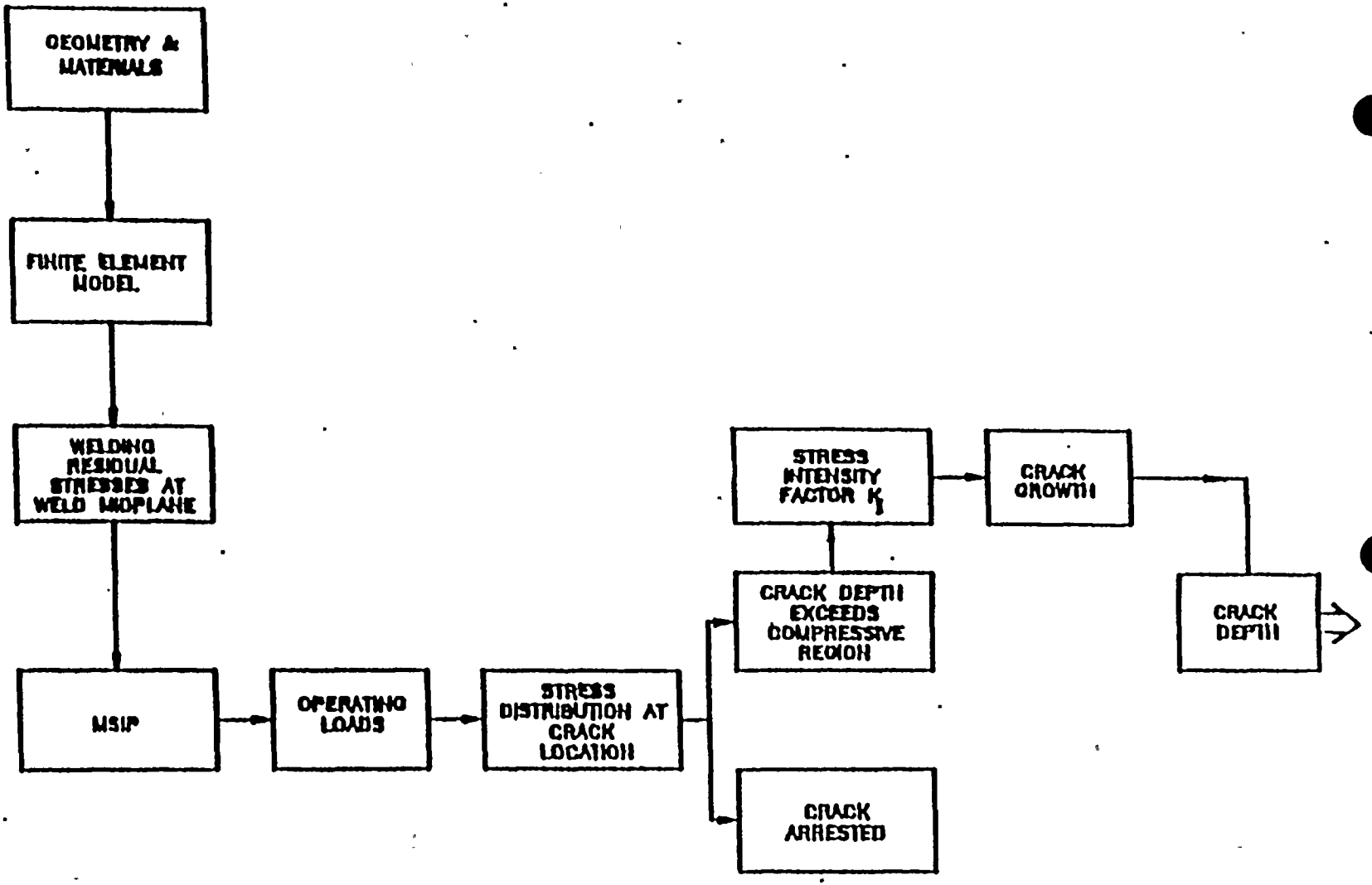


CIRCUMFERENTIAL CRACK TREATED BY MSIP

ANALYSIS

INELASTIC FINITE ELEMENT ANALYSIS INCLUDING

- WELDING RESIDUAL STRESSES
- MSIP APPLICATION
- OPERATING LOADS



ANALYSIS FLOW CHART

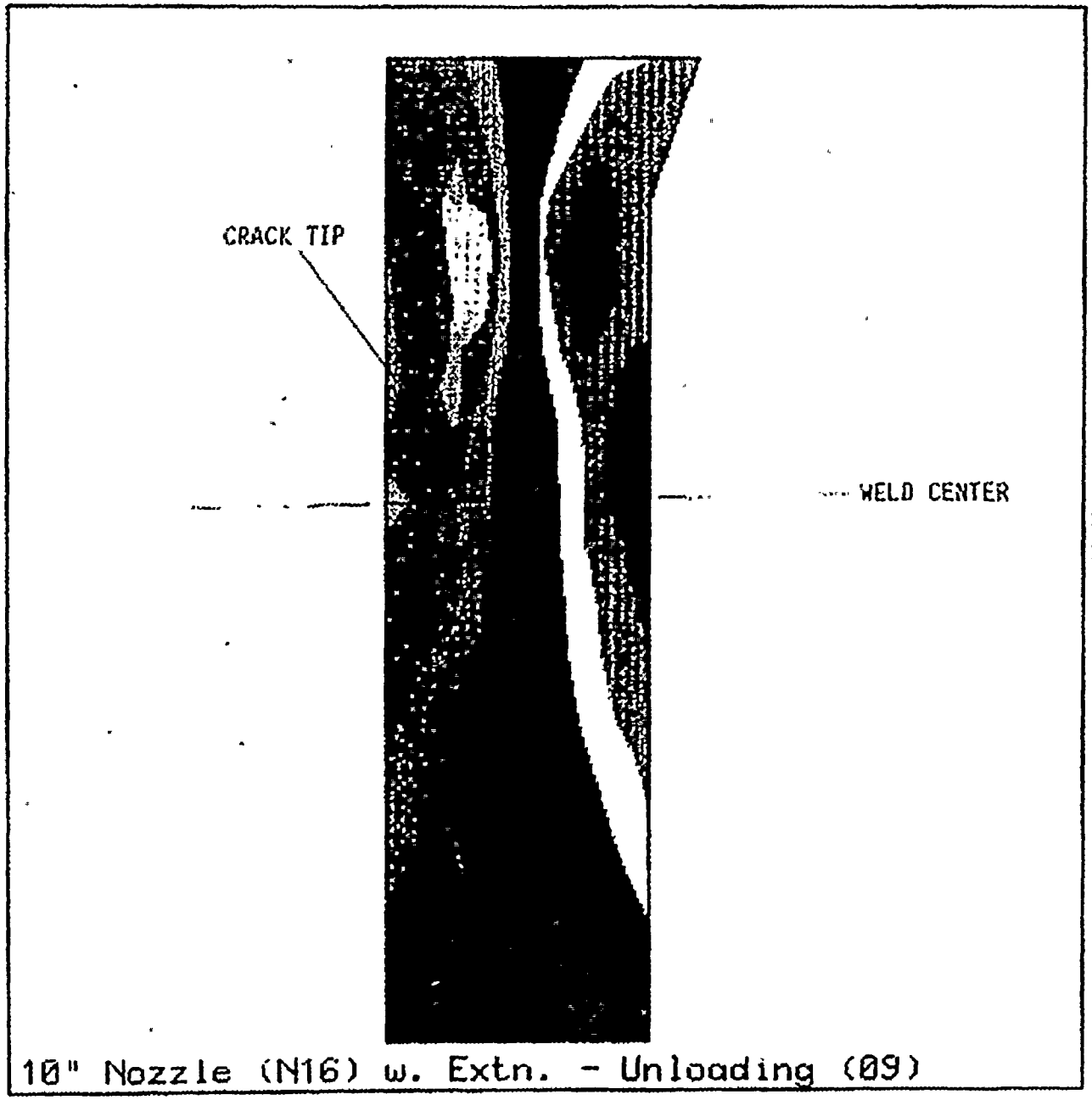


FIGURE 3.7 POST MSIP AXIAL STRESSES IN THE SAFE-END-TO-EXTENSION WELD (0.788% CONTRACTION)

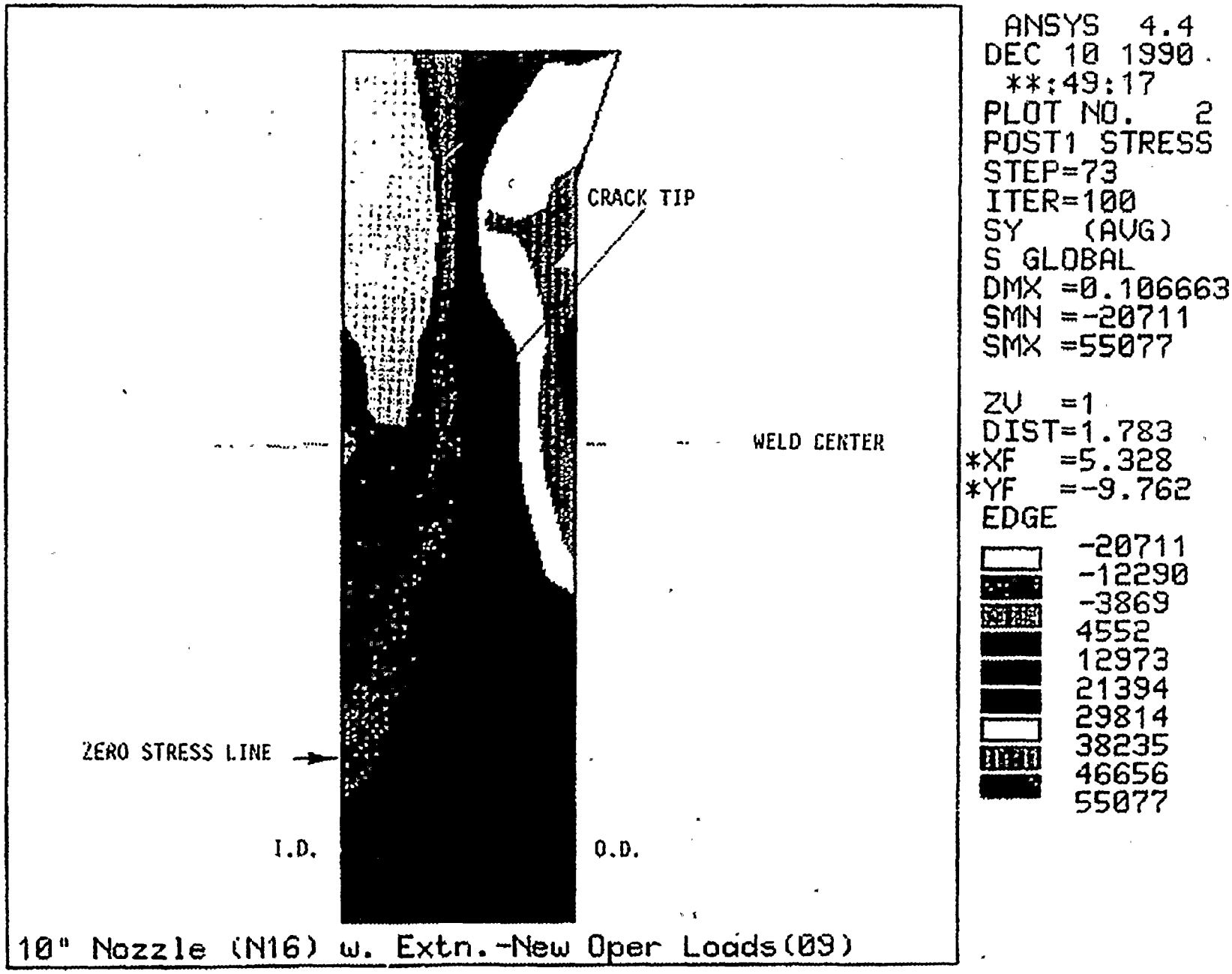
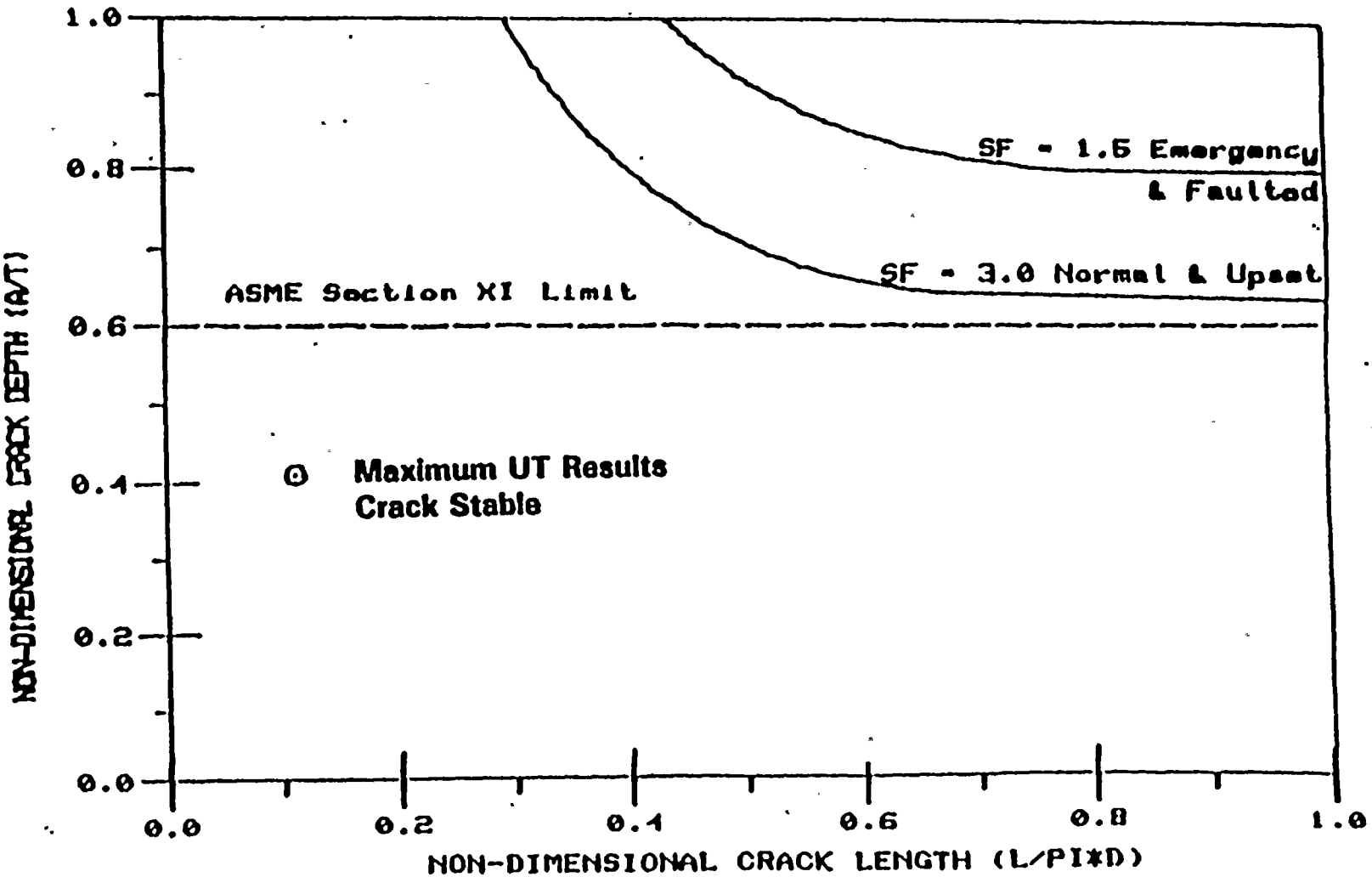


FIGURE 3.11 POST MSIP AXIAL STRESSES WITH OPERATING LOADS INCLUDED FOR THE SAFE-END-TO-EXTENSION WELD (0.788% CONTRACTION)



FAILURE ANALYSIS DIAGRAM

CONCLUSIONS

- INELASTIC ANALYSIS BASED ON THE ACTUAL POST-MSIP DISTRIBUTION CORRESPONDING TO FIELD MEASURED PIPE CONTRACTION INDICATES THAT THE CRACK REMAINS IN THE COMPRESSIVE REGION. NO FURTHER FRACTURE MECHANICS EVALUATION NECESSARY

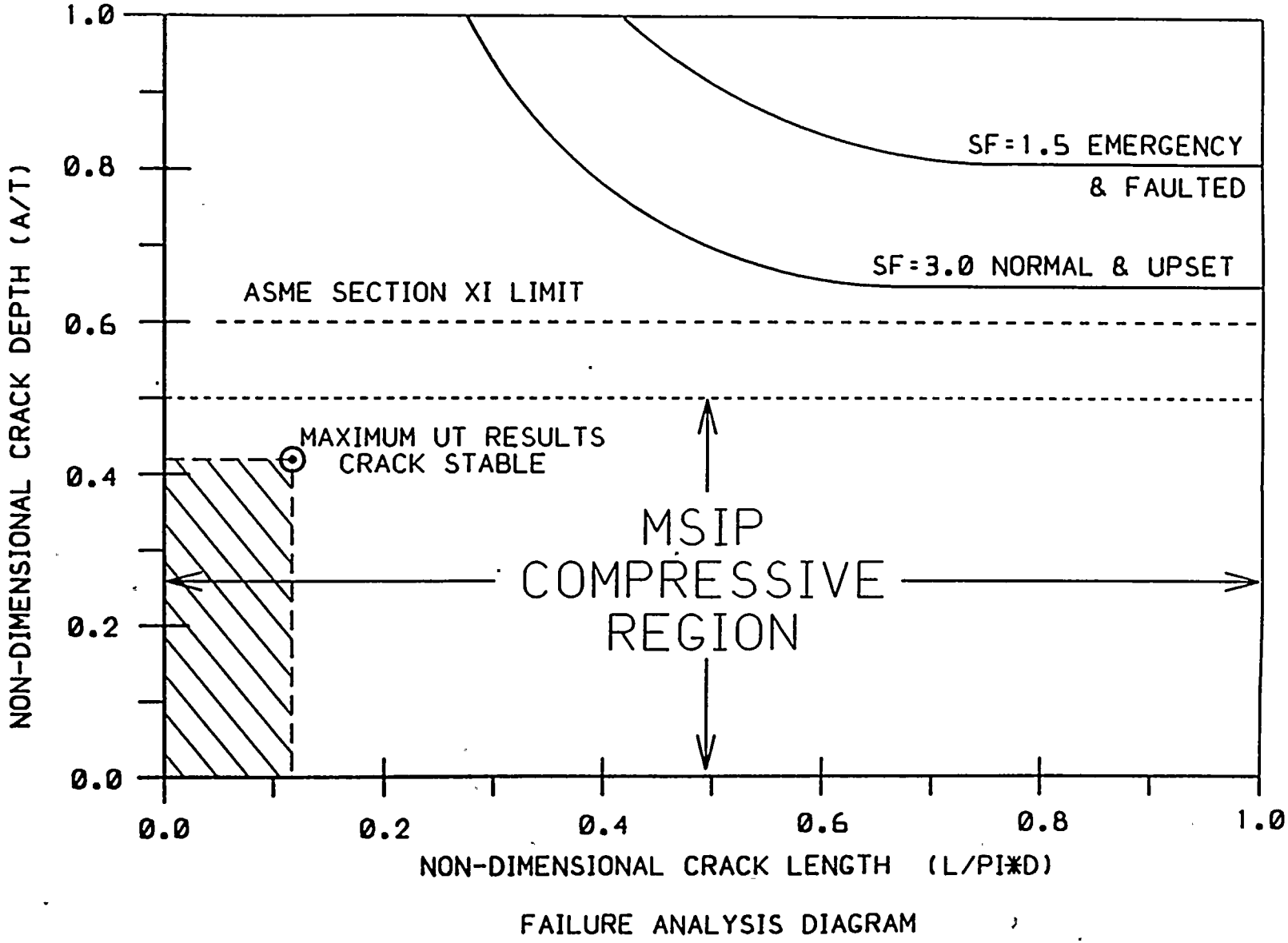
- UT INSPECTIONS CONFIRM THAT CRACK HAS BEEN ARRESTED

- ANALYSIS RESULTS RECONFIRM THAT SAFE OPERATION CAN BE CONTINUED

INSPECTION CRITERIA

INSPECTION CRITERIA

- PROPOSING INSPECTION OF FLAW AT THE NEXT OUTAGE
  - IF DEPTH $\leq$ .41T AND LENGTH $\leq$ .113L, THEN NO FURTHER ACTION
  - IF DEPTH > .41T OR LENGTH > .113L, IMPLEMENT REPAIR PLAN
- COMPLETION OF THE CURRENT CYCLE WILL ENCOMPASS APPROXIMATELY 22,000 HOURS OF OPERATION



FAILURE ANALYSIS DIAGRAM

COMPARISON OF REPLACEMENT AND REPAIR PLANS

	REPLACEMENT	REPAIR
Exposure (manrem)	43.75	4.3
Increase in Critical Path Days During a Typical Refueling Outage	21	7
Cost (dollars)*	1.5 million	0.6 million

* Cost does not include loss of power generation revenue due to increase in outage duration

- REPLACEMENT OPTION IS MUCH MORE SIGNIFICANT EVOLUTION THAN REPAIR
- THE REPLACEMENT REQUIRES COMPLETE DEFUELING AND DEWATERING OF VESSEL
- REPAIR PLAN DOES NOT REQUIRE CUTTING INTO REACTOR COOLANT PRESSURE BOUNDARY
- ASSOCIATED RISKS OF REPAIR PLAN ARE LOWER THAN REPLACEMENT PLAN

REPAIR PLAN

REPAIR PLAN PROVIDES PRESSURE BOUNDARY COMPARABLE TO REPLACEMENT PLAN

- NMPC SUBMITTED WELD OVERLAY REPAIR PLAN JUNE 10, 1991, (NMP2L 1303) AND ADDRESSED STAFF'S CONCERNS IN MARCH 3, 1992, LETTER (NMP2L 1341)

- WELD OVERLAY IS LONG-TERM REPAIR

  - REPAIR WILL MEET DESIGN CRITERIA IN NUREG-0313, REV. 2

    - Crack Depth Assumed Through Wall
    - Crack Length Assumed to be 360° Circumference
    - Overlay Thickness has Factor of Safety of 3.0 Against Net Section Collapse for Normal and Upset Conditions
    - Factor of Safety of 1.5 is Maintained for Emergency and Faulted Conditions
    - Weld Design is a Full Structural Overlay

  - CERTIFIED DESIGN REPORT WILL DEMONSTRATE NEW CONFIGURATION MEETS FLAW EVALUATION CRITERIA OF 1986 ASME CODE, SECTION XI, IWB-3640, FOR CLASS 1 COMPONENTS

SUMMARY

CONCLUSIONS

- ANALYSIS BASED ON THE ACTUAL POST MSIP DISTRIBUTION CORRESPONDING TO FIELD MEASURED PIPE CONTRACTION INDICATES THAT THE CRACK REMAINS IN THE COMPRESSIVE REGION

- UT INSPECTIONS CONFIRM THAT CRACK HAS BEEN ARRESTED

- BASED ON MITIGATION OF CRACK GROWTH, NMPC HAS REASSESSED ITS COMMITMENT TO REPLACE THE SAFE END EXTENSION

- PROPOSING INSPECTION OF FLAW AT THE NEXT OUTAGE

  - IF DEPTH $\leq$.41T AND LENGTH $\leq$.113L, THEN NO FURTHER ACTION

  - IF DEPTH $>$.41T OR LENGTH $>$ .113L, PROVIDE OVERLAY TO THE PIPE

- WELD OVERLAY IS AN ACCEPTABLE ALTERNATIVE TO REPLACEMENT

flaw reveals growth in length or depth. No repair would be performed if the examination shows no increase in length or depth. NMPC indicated that a written submittal for the staff's consideration would likely be forwarded in 3 to 4 weeks.

Original signed by:

John E. Menning, Project Manager
Project Directorate I-1
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

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