DEC 20 1982

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Docket No.: 50-354

APPLICANT: Public Service Electric & Gas Company (PSE&G)

FACILITY: Hope Creek Generating Station, Unit No. 1

SUBJECT: SUMMARY OF MEETING HELD ON DECEMBER 2, 1982 WITH PSE&G TO DISCUSS DRYWELL BET IMPINGEMENT BARRIERS AND AN ALTERNATIVE TO SUCH BARRIERS

At the request of PSE&G, licensee of Hope Creek-1, a meeting was held on December 2, 1982 in Bethesda, Maryland to discuss Drywell Jet Impingement Barriers and alternatives to such barriers. A list of attendees is given in Attachment 1.

After introductions, B. Preston of PSE&G presented the meeting agenda and provided background information on the Hope Creek-1 project (Attachment 2). Presently, Hope Creek-1 is 60% complete with an Operating License (OL) application date of March 1983.

J. Mulay of Bechtel Power Corporation reviewed the current design of jet impingemet barriers at Hope Creek-1 (Attachment 3). In the present configuration, some barriers may impede Inservice Inspection (ISI) requirements and threaten ALARA goals. These considerations led the licensee to investigate the mechanism of pipe break in instances where the barriers will impede such efforts.

K. Cotter of Fracture Proof Design Corporation presented a review of pipe break criteria and alternatives to current break postulations. He presented a methodology, and, by example, demonstrated how he would determine whether leak-before-break is the most probable method of pipe break for the affected piping (Attachment 4). The expectation is that leak before-break will be predicted in many cases. Leaking, detected by drywell monitoring devices, would allow timely initiation of corrective actions by the plant staff to prevent a pipe break. This in turn could eliminate the need for jet impingement barriers or other structural modifications to protect against the jet impingement forces which could otherwise impact targets.

8301030304 821220
PDR ADOCK 05000354
A PDR

OFFICE ▶							
SURNAME ▶							
DATE ▶							

W. Gailey of PSE&G provided a summary of the proceedings and answered staff questions. He stressed that PSE&G would only plan to seek relief from installation of barriers or other structural modifications where such installationoor modification are determined to be a significant impediment to ISI or ALARA goals.

At this time, the PSE&G staffiin attendance estimated that there are approximately fifty (50) targets around the piping and that barrier/ structural modifications relief may be proposed for less than half of these. The piping systems affected by barrier installation/structural modification include: Main Feedwater, Main Steam, Low Pressure Core Injection, and Core Spray. W. Gailey also informed the NRC that a timely response (3-4 weeks) in support of PSE&G's expenditure of resources on this effort is needed so that formal application for relief can be made on a timely basis.

/S/

David H. Wagner, Project Manager
Licensing Branch No. 2
Division of Licensing

Attachments:
As stated

cc: See next page

OFFICE ▶	DL:LB#2/PM	DL:LB#2/BC					
SURNAME ▶	DWagner:pt	ASchwencer					
DATE ▶	12/30/82	12/30/82					

DATED: DEC 2 0 1982

MEETING SUMMARY DISTRIBUTION:

Docket File (50-354)
NRC PDR
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LB#2 File
EHylton
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PMatthews
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Assistant General Solicitor
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Deputy Attorney General
State of New Jersey
Nuclear Energy Council
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PSE&G c/o Bechtel Power Corporation
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P.O. Box 3965
San Francisco, California 94119

ENCLOSURE 1

PSE&G MEETING

HOPE CREEK - 1

JET IMPINGEMENT BARRIERS

DECEMBER 2, 1982

NRC	PSE&G	BECHTEL POWER CORP.
B. Elliot	B. Preston	R. Henderson
B. Bosnak	W. Gailey	J. Bradford
S. Hou	A. Ambra	J. Mulay
P. Randall		
P. Matthews		
T. Novak		
S. Bhatt		
A. Schwencer		
D. Wagner		

FRACTURE PROOF DESIGN CORP.	OAK RIDGE NATIONAL LAB.
K. Cotter	R. Cheverton

ENCLOSURE 2

OVERVIEW

° INTRODUCTION	BRUCE PRESTON - (PSE&G LICENSING MANAGER)
° CURRENT HCGS DESIGN OF JET IMPINGEMENT	JACK MULAY - (BECHTEL POWER CORP.-ASST. PROJECT ENGINEER)
° PIPING CRACK STABILITY ANALYSIS (LEAK-BEFORE-BREAK)	CASEY COTTER - PAUL PARIS - (FRACTURE PROOF DESIGN CORP.)
° SUMMARY	BILL GAILEY (PSE&G CHIEF PROJECT ENGINEER)

MEETING OBJECTIVE

- ESTABLISH BASIS FOR ALTERNATIVE TO JET IMPINGEMENT BARRIERS WHERE SUCH BARRIERS MAY IMPEDE INSERVICE INSPECTION AND/OR AFFECT ALARA GOALS INSIDE THE DRYWELL.
- PRESENT ALTERNATIVE TO US-NRC AND REQUEST TIMELY RESPONSE FROM NRC REGARDING ACCEPTABILITY OF THIS METHODOLOGY TO JET IMPINGEMENT BARRIERS.

BACKGROUND INFORMATION
HOPE CREEK GENERATING STATION (HCGS)

° MARK I

° HISTORY

  BASIC NEWBOLD LAYOUT 1969
  NEWBOLD ISLAND MOVE TO HOPE CREEK 1973
  CONSTRUCTION PERMIT 1974
  FUEL LOAD 1986

° VOLUME COMPARISON

  MARK I CONTAINMENT HAS 68% OF THE FREE VOLUME OF MARK II CONTAINMENT

° EVOLUTION OF CRITERIA

  PIPE WHIP
  JET IMPINGEMENT
  VALVE OPERABILITY
  OTHER (EFFECT ON SYSTEMS)

PIPE BREAK CRITERIA

- SRP 3.6.2, REVISION 0, NOVEMBER 24, 1975
- BTP - MEB 3-1, NOVEMBER 24, 1975
  - BREAKS AT TERMINAL ENDS AND AT A MINIMUM OF TWO HIGH STRESS POINTS
  - PIPE WHIP RESTRAINTS
  - JET THRUSTS AND JET IMPINGEMENT LOADINGS
  - BREAK EXCLUSION ZONES

JET IMPINGEMENT

- POSTULATED PIPE BREAK LOCATIONS WERE IDENTIFIED USING MEB 3-1 CRITERIA
- FOR EACH PIPE BREAK - CIRCUMFERENTIAL AND/OR LONGITUDINAL JET GEOMETRY WAS DEFINED
- WITH HELP OF 1/2 INCH SCALE DRYWELL MODEL AND COMPOSITE DRAWINGS EXTENSIVE REVIEW WAS CONDUCTED TO IDENTIFY POTENTIAL TARGETS
- TARGETS CONSISTED OF STRUCTURAL ELEMENTS, PIPE WHIP RESTRAINTS, PIPE SUPPORTS, VALVES, ELECTRICAL CONDUITS AND CABLE TRAYS, INSTRUMENTS AND INSTRUMENT PIPING, ETC.

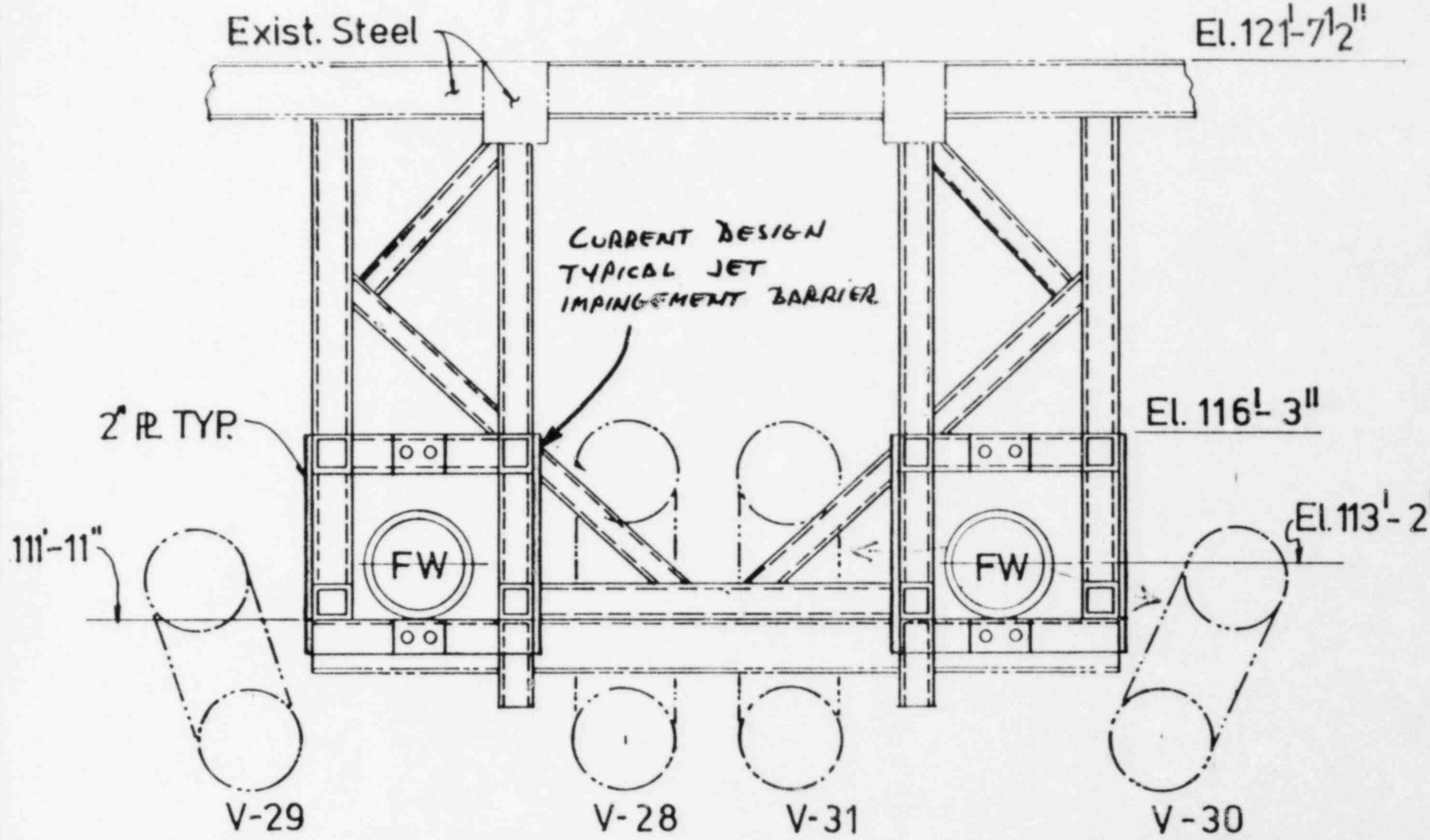
MITIGATION OF JET EFFECTS

- JET IMPINGEMENT TARGETS ANALYZED BY
  - SAFE SHUTDOWN MATRIX:
    - DETERMINE WHETHER TARGET IS SAFETY ESSENTIAL
    - DETERMINE CHANNEL SEPARATION
    - DETERMINE IF IT IS SAFETY ESSENTIAL, BUT NOT REQUIRED BECAUSE A REDUNDANT ENTITY IS AVAILABLE TO PERFORM THE INTENDED SAFETY FUNCTION
- THIS EFFORT IDENTIFIED TARGETS REQUIRING FURTHER ACTION

JET IMPINGEMENT BARRIER DESIGN
- CONSIDERATIONS -

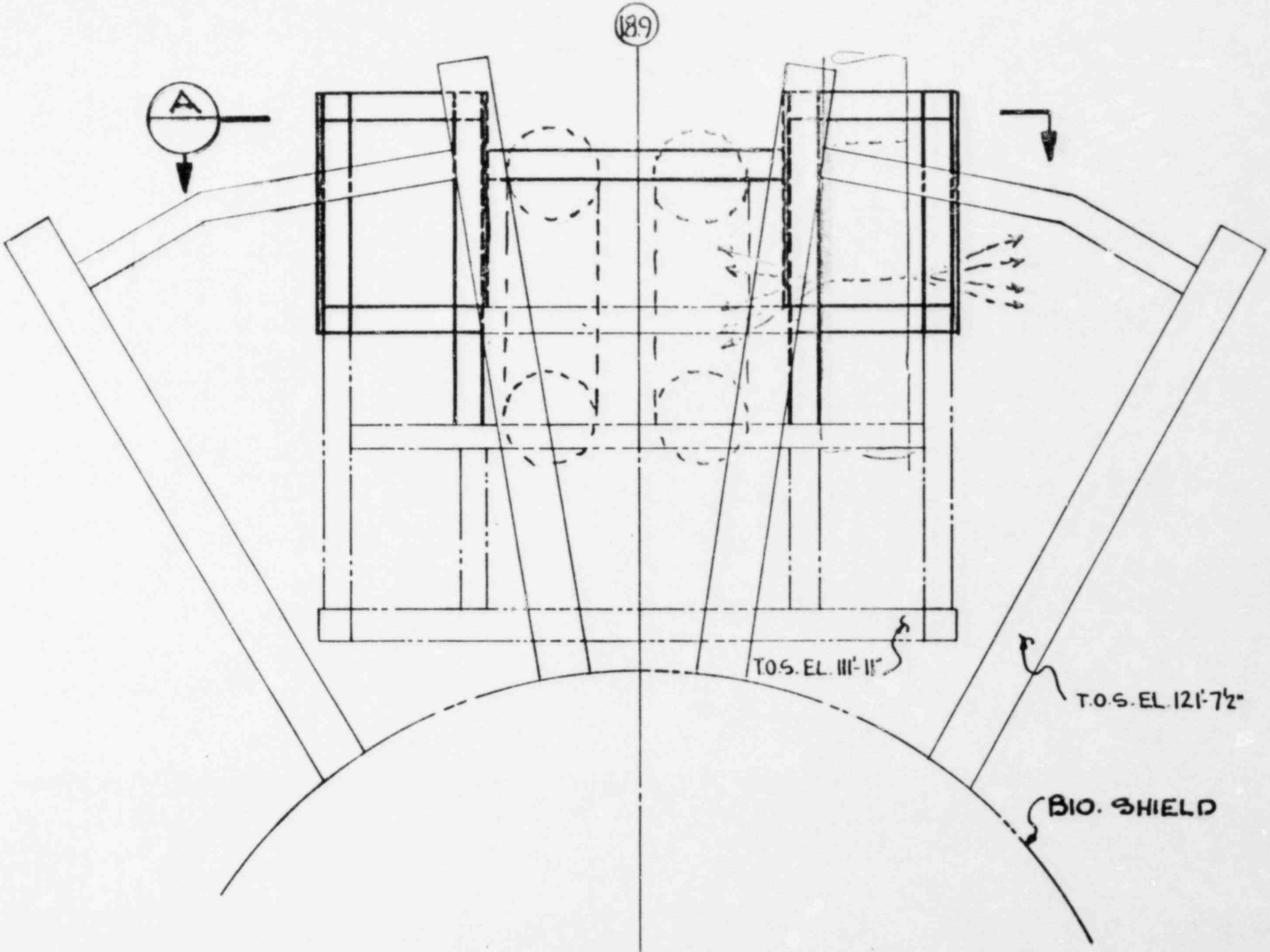
- o DESIGNED TO WITHSTAND DYNAMIC JET LOADING
- o FACILITATE ISI AND/OR MAINTENANCE
- o SOME BARRIERS MAY:
  - o IMPEDE ISI WHICH IS IMPORTANT TO THE SAFETY OF THE PLANT
  - o INCREASE EXPOSURE TO WORKERS WHICH IS CONTRARY TO PHILOSOPHY OF ALARA

THESE CONSIDERATIONS LED US TO REVIEW THE BASIC MECHANISM OF PIPE BREAK IN CASES WHERE BARRIERS WILL BE AN IMPEDIMENT TO ISI AND WILL INCREASE RADIATION EXPOSURE TO WORKERS.



SECTION A

ENCLOSURE 3


189
A
T.O.S. EL. 111'-11"
T.O.S. EL. 121'-7½"
BIO. SHIELD

ENCLOSURE 4

HOPE CREEK GENERATING STATION
RECIRCULATION SYSTEM PIPING (LOOP A)
CRACK STABILITY ANALYSIS (LBB)

PRESENTATION BY

K. H. COTTER AND PAUL C. PARIS
FRACTURE PROOF DESIGN CORPORATION
ST. LOUIS, MO

ON BEHALF OF
PUBLIC SERVICE ELECTRIC & GAS
NEWARK, NJ

2 DECEMBER 1982

OBJECTIVE

ESTABLISH BASIS FOR ALTERNATIVES TO CURRENT JET IMPINGEMENT BARRIER REQUIREMENTS WHERE BARRIER WILL CREATE OTHER PROBLEMS.

APPROACH

REVIEW CURRENT PIPE BREAK CRITERIA

EVALUATE ALTERNATIVES TO CURRENT BREAK POSTULATION

DEMONSTRATE NO INSTANTANEOUS BREAKS ARE LIKELY IN HCGS RECIRC LOOP A

ESTABLISH BASIS FOR APPLICATION

CURRENT PIPE BREAK CRITERIA

10CFR50, APP. A, CRITERION 4

PROTECT FOR EFFECTS OF:

- PIPE WHIP
- DISCHARGING FLUIDS (JETS)

SAFE HARBOR:

MEB 3-1

REG. GUIDE 1.46

PIPE BREAK POSTULATION UNDER MEB 3-1

CIRCA 1972^{+}

ONLY LEFM

USE OF LEFM FOR NUCLEAR PIPING:

- FAULTED LOADS (STRESSES)
- CONSERVATIVE FLAW SIZE
- K_{Ic} (OR J_{Ic})

CONCLUDE THAT EITHER:

- FAILURES LIKELY, OR
- LEFM NOT VALID

CONCLUDE

MEB 3-1 VALID WHEN DEVISED

PIPE BREAK POSTULATION USING CURRENT TECHNOLOGY

CIRCA 1976

PARIS DEVELOPED TEARING STABILITY THEORY

BREAK POSTULATION

USE EPFM (TEARING)

PROPERLY ACCOUNTS FOR

- LEVEL D LOADS
- LARGE POSTULATED FLAW SIZES
- J ABOVE J_{Ic}

MANY LINES STABLE

CONCLUDE

MEB 3-1 & REG GUIDE 1.46 MAY BE OVERLY CONSERVATIVE

INSTANTANEOUS BREAKS SHOWN UNREASONABLE

APPLICATION OF TEARING STABILITY
TO NUCLEAR PIPING

DATE	APPLICATION
JUNE 78	DUANE ARNOLD, RECIRC LINE CRACK
NOV 79	MILLSTONE 2, F/W CRACK
APR 80	USNRC, PCSG BEAVER VALLEY, CVCS
OCT 81	INDIAN POINT 3, RCS ANAL
MAR 81	MILLSTONE 1, ISO COND
JULY 81	INDIAN POINT 3, RCS SUBMITTAL
AUG 81	EPRI T118-9, 4 BWR & 4 PWR
DEC 81	USNRC, SEP ALT CRITERIA
APR 82	RANCHO SECO, HPI CRACK
JUNE 82	OYSTER CREEK, EMER COND (SEP)
OCT 82	TMI-1, HOT LEG (ANAL)

OTHER 10CFR50, APP. A CRITERIA

INTRODUCTION -

CONSIDERATION OF TYPE, SIZE & ORIENTATION OF BREAKS

CRITERION 2 -

UNCERTAINTIES OF MAGNITUDE OF NATURAL PHENOMENA

CRITERION 14 -

PRESSURE BOUNDARY DESIGNED & FABRICATED TO HAVE EXTREMELY LOW PROBABILITY OF RAPID FAILURE

CRITERION 31 -

FRACTURE PREVENTION & UNCERTAINTIES IN:

- MATERIAL PROPERTIES
- IRRADIATION EFFECTS
- STRESS (RESIDUAL, STEADY-STATE & TRANSIENT)
- FLAW SIZE & DISTRIBUTION

SEP CRITERIA (ABBREVIATED)

A. DETECTABLE LEAK

- LONG & CIRC CRACK ORIENT
- ASSUME 0.1 - 10 GPM FOR HCGS
- USE LEVEL A LOADS
- FIND $2C_A$, (MIN = 2T)

B. CRACK STABILITY

1. LEVEL D
   - $2C_D = 2c_A + 2\ T$
     - ● MIN 4T
     - ● LONG & CIRC
   - INSURE ΔA   SMALL
     - ● $J \quad J_{IC}$
   - $J = K^2\ (C_D+R_Y)/\ E$
   - NO PLAS INSTAB
   - NO JET ACTION

B.2. FULLY PLASTIC

- CIRC CRACK
- LARGER OF $2C_D$ OR 90°
- SNUBBERS INOPER
  - UNLESS SPECIAL JUST.
- SHOW
  - NO CRACK INSTAB
  - NO PLAS INSTAB
  - NO JET ACTION

C. USE LOWER BOUND MAT'L PROP.

OTHER CRITERIA

A - POSTULATED DEFECT SIZES
  - CIRCUMFERENTIAL LENGTHS OF 60, 120, 180 AND 240°
  - PER 10CFR50, APP. A, CRITERION 14

B - UPPER-BOUND LOADING
  - DETERMINISTIC CONSIDERATION OF MAX LOADS
  - PER 10CFR50, APP. A, CRITERIA 2 AND 31.

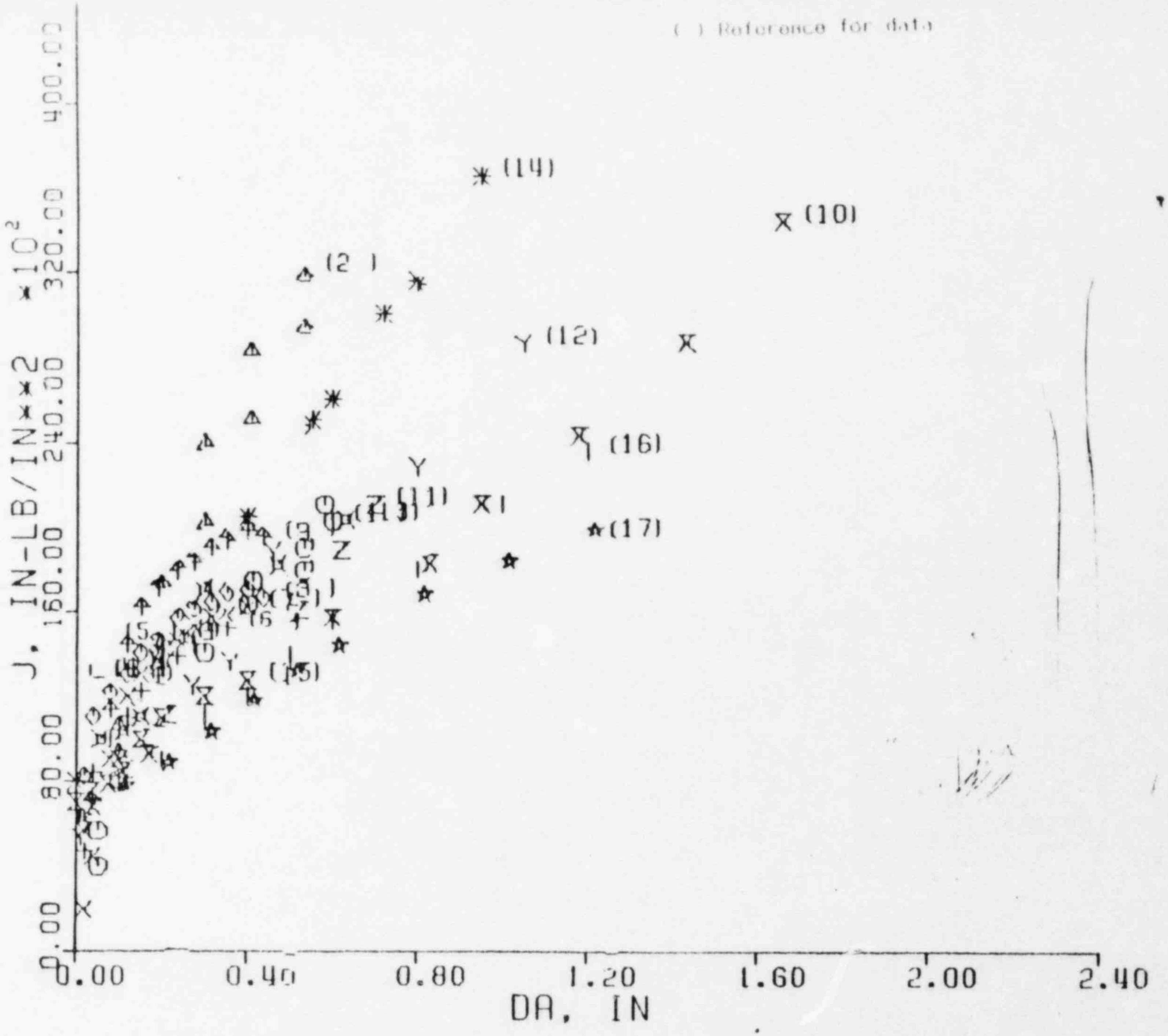


Figure B-1 J-Resistance Data for TP304 Stainless Steel

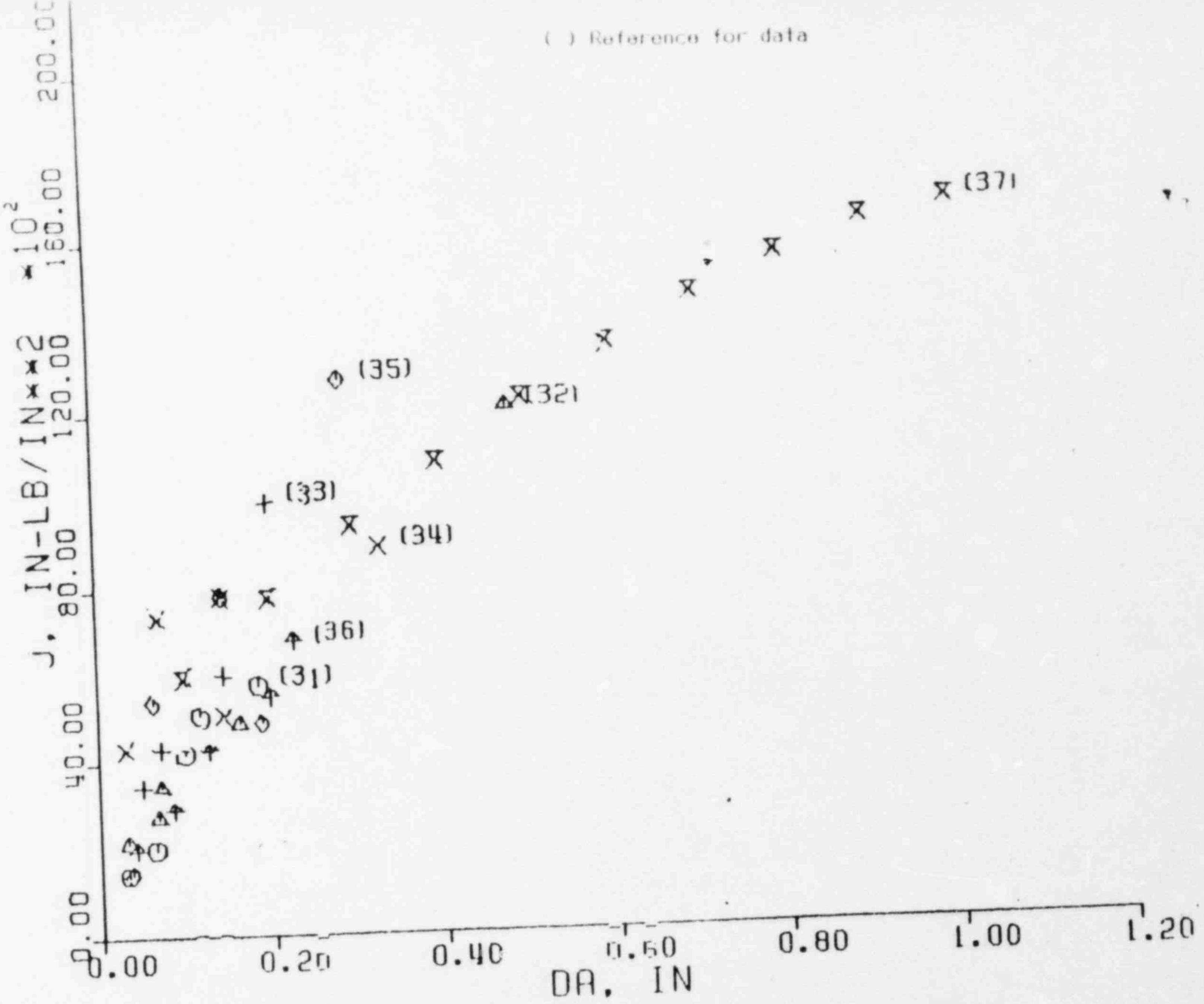


Figure B-2 J-Resistance Data for TP304 Stainless Steel

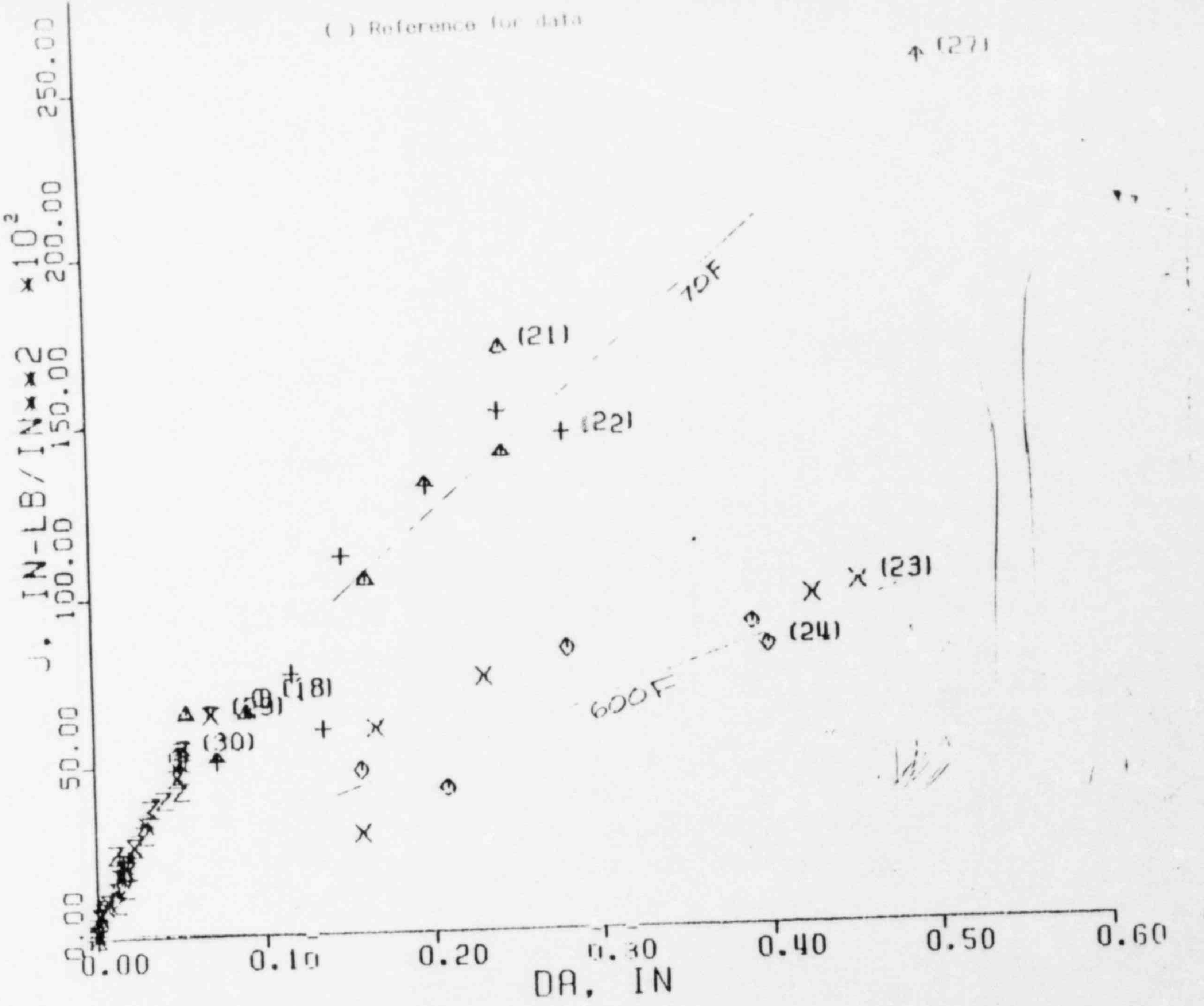


Figure B-3 J-Resistance Data for TP316 Stainless Steel(Castings)

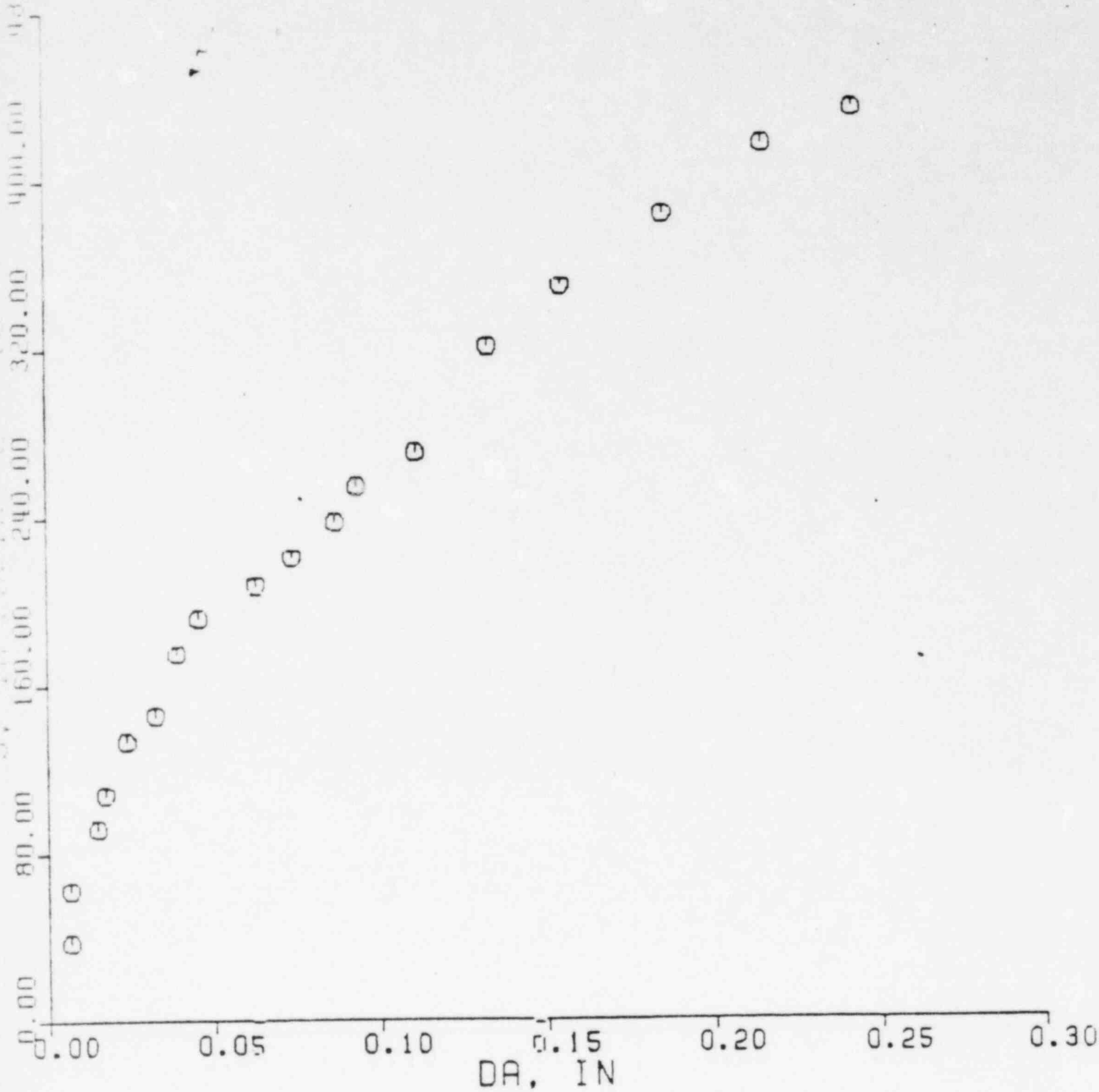


Figure B-4 CF8A Stainless Steel Weld of J-Resistance Curve (B-28)

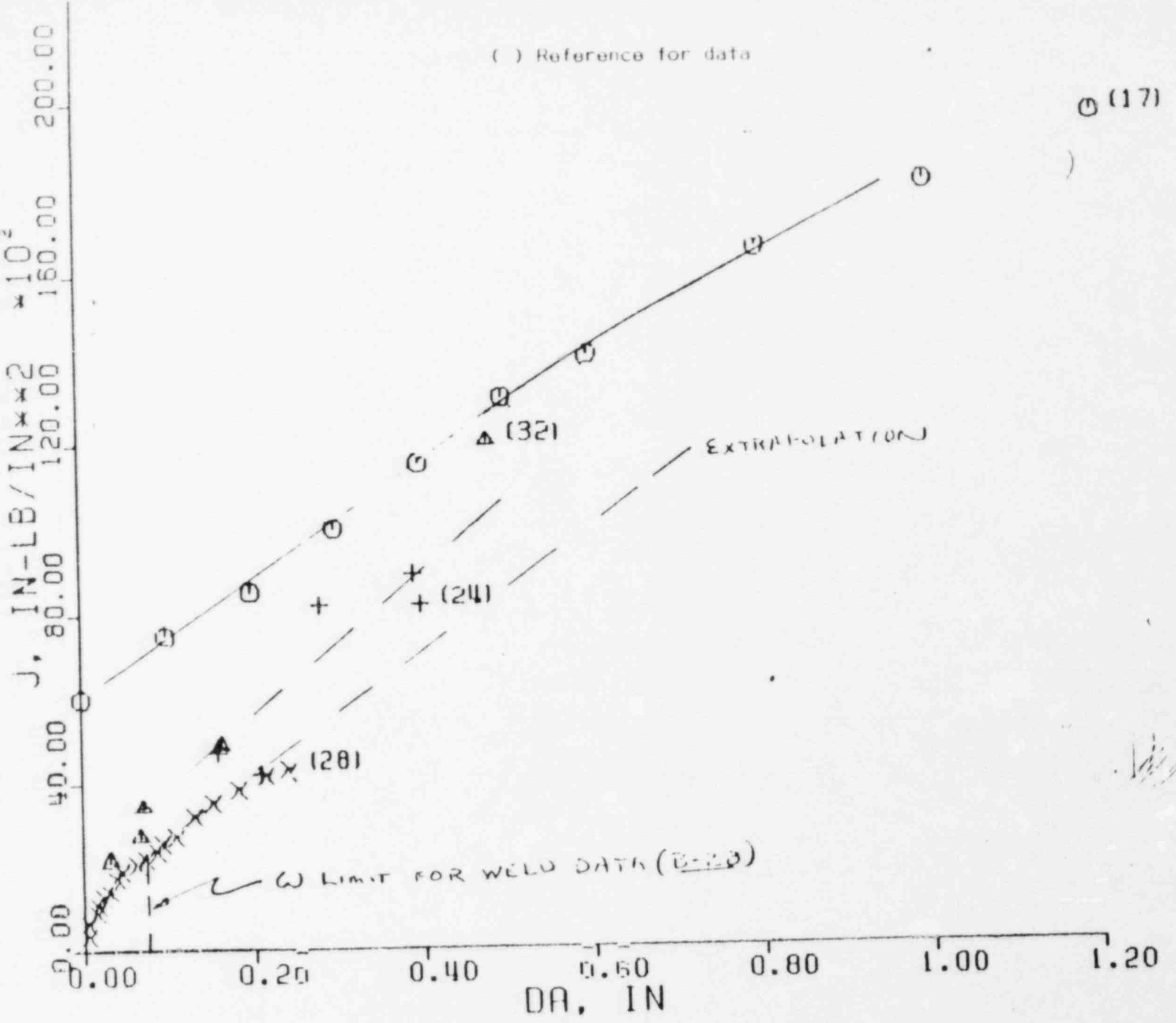


Figure B-5 Minimum J-R Curves from Figures B-1 thru B-4

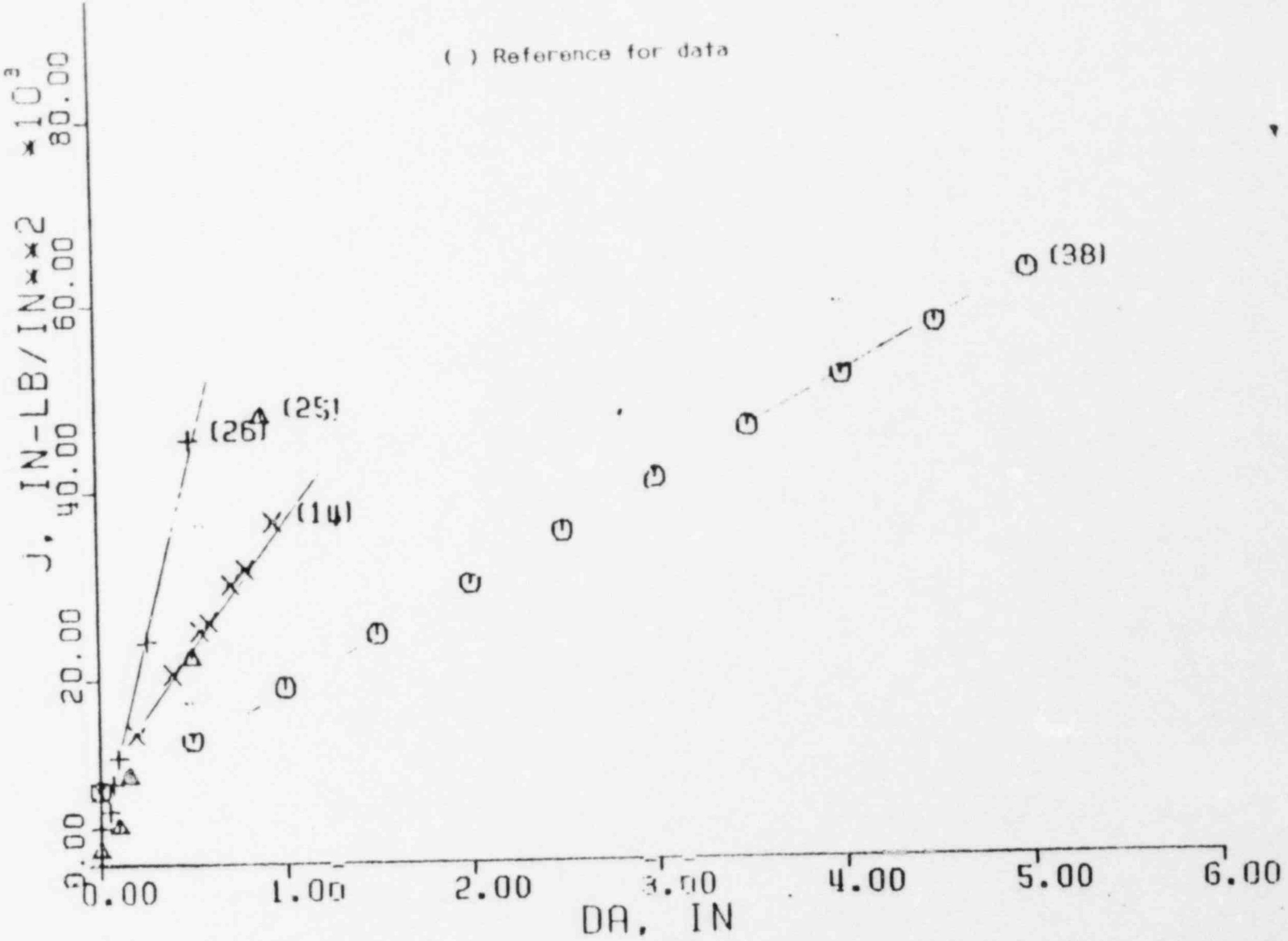


Figure B-6 Selected Maximum J-Resistance Curves, TP304 & 316

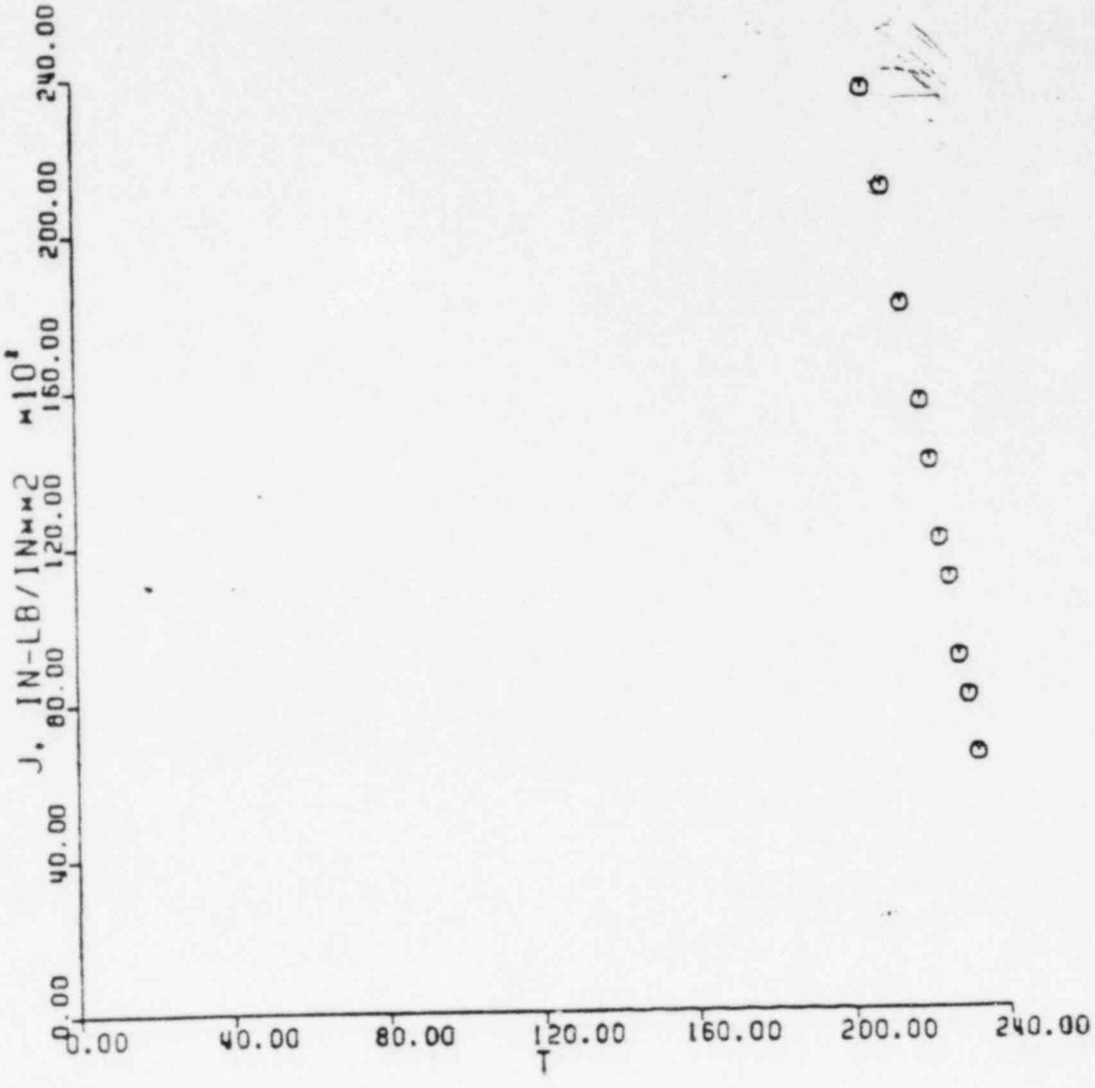


Figure B-7 J_{mat} - T_{mat} Curve Derived from Reference (B-17)

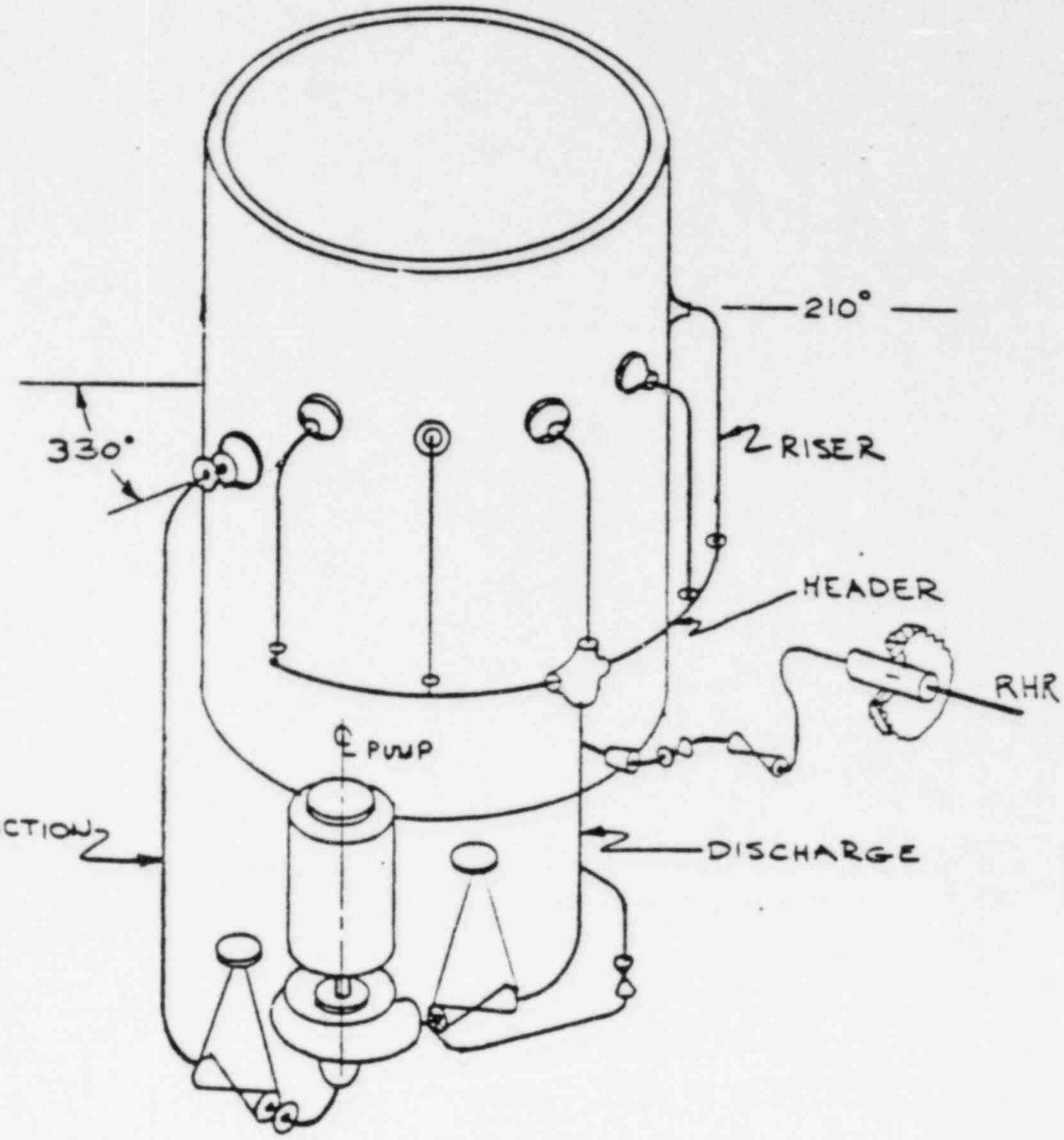


Figure 5-1 Isometric View of Recirculation System, Loop A

SECTION PROPERTIES/PRESSURES

LINE	O.D. (IN)	THICKNESS (IN)	PRESSURES (PSI) OPERATING	DESIGN
SUCTION	28.00	1.076*	1050.	1250.
DISCHARGE	28.00	1.285	1303.	1500.
HEADER	22.00	1.009	1303.	1500.
RISER	12.75	0.586	1303.	1500.

*MINIMUM ALLOWABLE

STRESSES FOR LEAK RATE

AND

LEV. D CRACK STABILITY

LEV. A STRESS SUMMARY -

- INCLUDES BENDING TERMS
- CONSERVATIVE TO USE ONLY AXIAL STRESS DUE TO INTERNAL PRESSURE

LEV. D STRESS SUMMARY -

- TOTAL STRESS INCLUDES AXIAL PLUS BENDING
- SEPARATE BY SUBTRACTING AXIAL COMPONENT DUE TO PRESSURE

  LET, $S_D = S_B + S_T$

  WHERE S_T DUE TO PRESSURE
- CONSERVATIVELY, USE LARGEST VALUE OF S_D ALONG LINE SEGMENT (BY SECTION PROPERTIES)

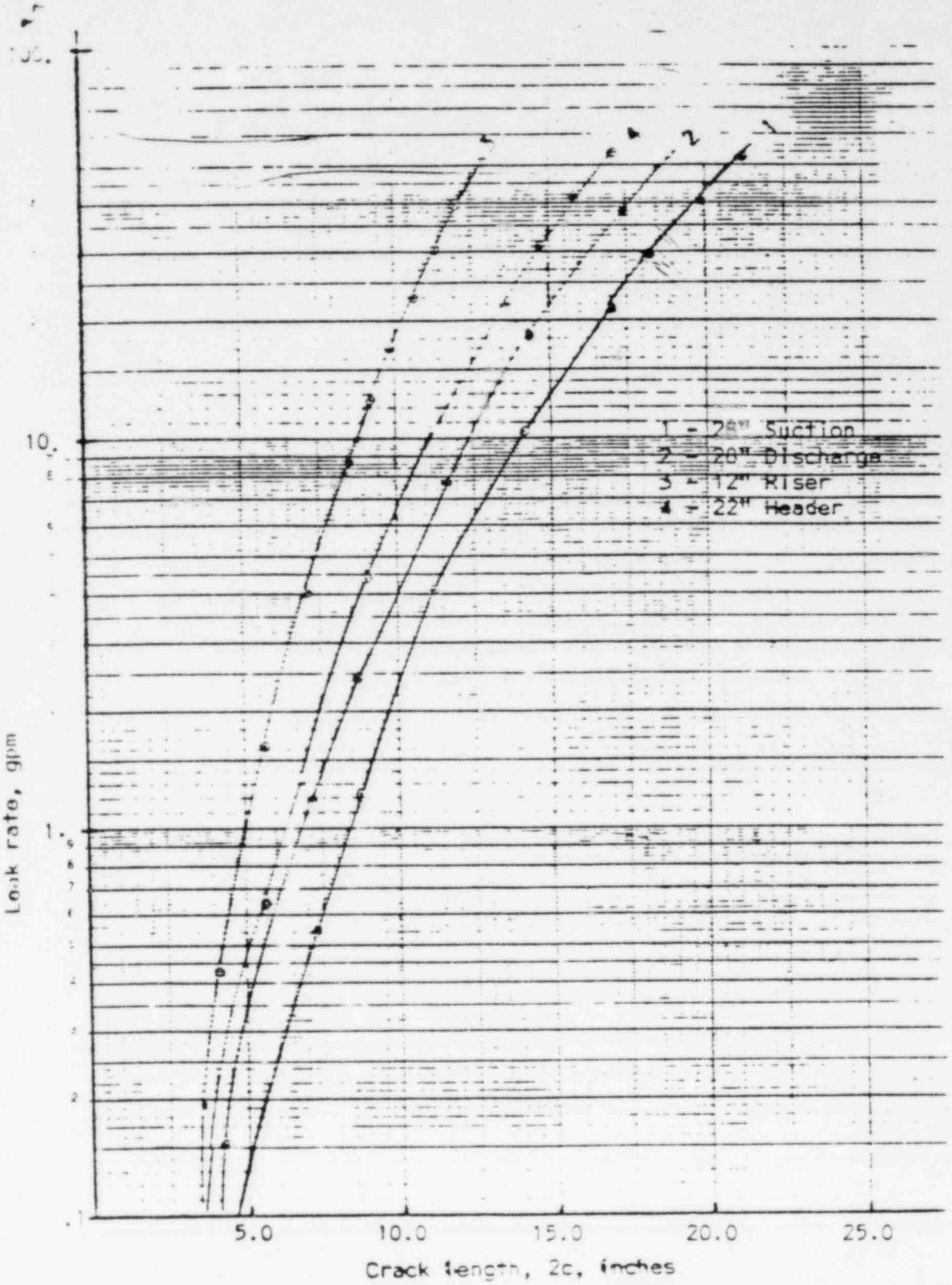


Figure 3.1 Leak Rates Through Circumferential Cracks, Hope Creek Recirculation Piping

LEAK RATE vs CRACK LENGTH (2c)

(CIRCUMFERENTIAL CRACKS)

LINE	STRESS* (PSI)	2c(.1)** (IN)	2c(1.) (IN)	2c(10.) (IN)
SUCTION	5165.	4.6	8.4	14.1
DISCHARGE	6320.	4.1	6.8	12.3
HEADER	6320.	3.7	6.4	11.2
RISER	6320.	3.5	5.0	8.8

* AXIAL COMPONENT DUE TO NORMAL OPERATING PRESSURE

** NUMBER IN ( ) IS LEAK RATE IN GPM

LEAK RATE vs CRACK LENGTH (2c)

(CIRCUMFERENTIAL CRACKS)

LINE	STRESS* (PSI)	2c(.1)** (IN)	2c(1.) (IN)	2c(10.) (IN)	LEV. D STRESS (PSI)	J_{APP}*** $\frac{IN-LB}{IN^2}$
SUCTION	5165.	4.6	8.4	14.1	19751.	559.
DISCHARGE	6320.	4.1	6.8	12.3	18007.	347.
HEADER	6320.	3.7	6.4	11.2	19413.	427.
RISER	6320.	3.5	5.0	8.8	19413.	472.

* AXIAL COMPONENT DUE TO NORMAL OPERATING PRESSURE

** NUMBER IN ( ) IS LEAK RATE IN GPM

*** USE 2c (10GPM) PLUS 2T

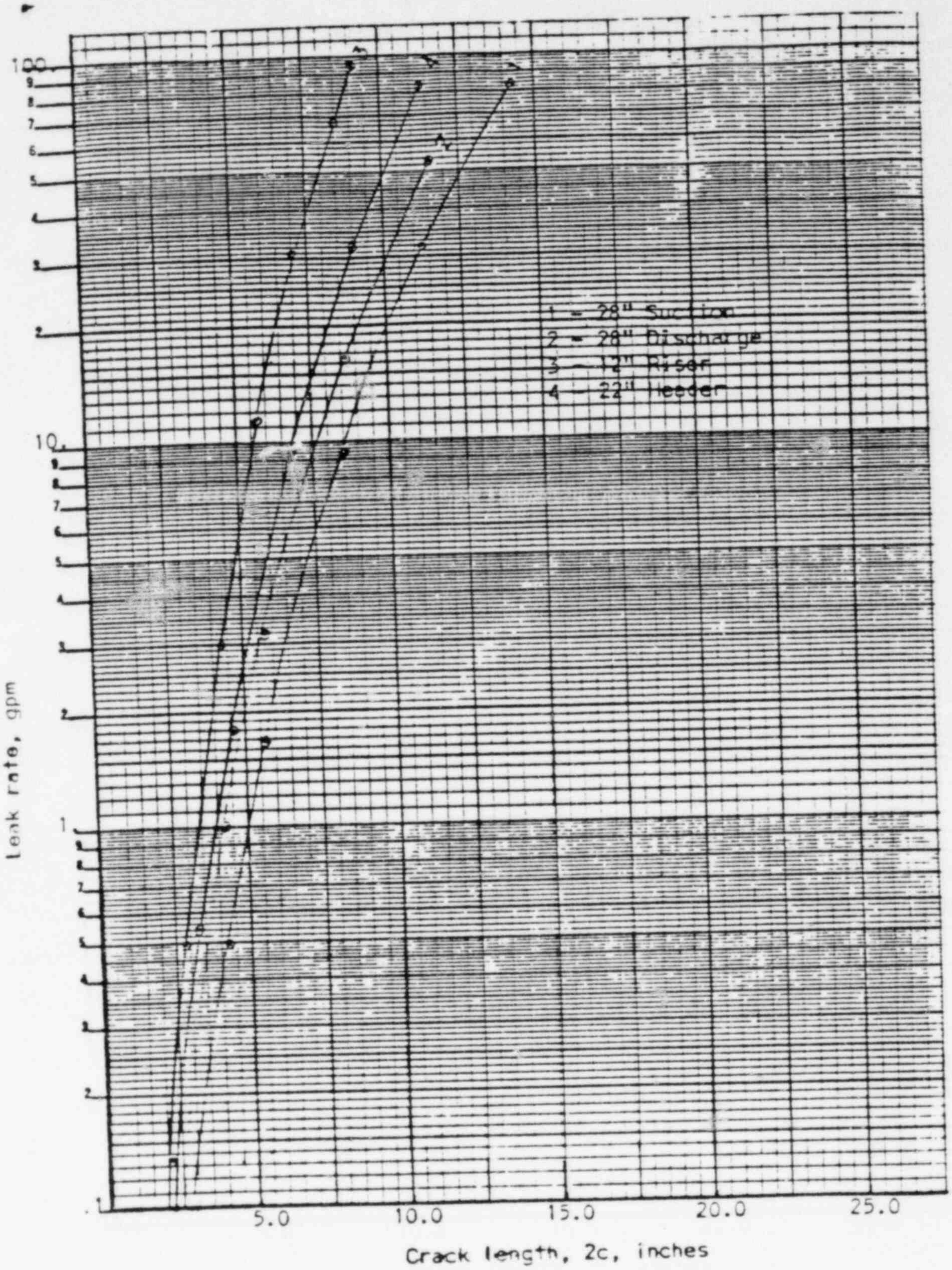


Figure 3.2 Leak Rates Through Longitudinal Cracks Hope Creek Recirculation Piping

LEAK RATE vs CRACK LENGTH (2c)

(LONGITUDINAL CRACKS)

LINE	STRESS• (PSI)	2c(.1)•• (IN)	2c(1.) (IN)	2c(10.) (IN)
SUCTION	10330.	2.8	5.0	8.6
DISCHARGE	12640.	2.5	4.2	7.7
HEADER	12640.	2.3	4.0	6.8
RISER	12640.	2.0	3.4	5.6

• HOOP STRESS DUE TO NORMAL OPERATING PRESSURE

•• NUMBER IN ( ) IS LEAK RATE IN GPM

LEAK RATE vs CRACK LENGTH (2c)

(LONGITUDINAL CRACKS)

LINE	STRESS(1) (PSI)	2c(.1)(2) (IN)	2c(1.) (IN)	2c(10.) (IN)	LEV. D STRESS (PSI)	J_{APP}(3) $\frac{\text{IN-LB}}{\text{IN}^2}$
SUCTION	10330.	2.8	5.0	8.6	15001.	999.
DISCHARGE	12640.	2.5	4.2	7.7	14824.	545.
HEADER	12640.	2.3	4.0	6.8	14835.	626.
RISER	12640.	2.0	3.4	5.6	14800.	539.(4)

(1) HOOP STRESS DUE TO NORMAL OPERATING PRESSURE

(2) NUMBER IN ( ) IS LEAK RATE IN GPM

(3) USE 2c (10 GPM) PLUS 2T

(4) FOR 2c (3 GPM) PLUS 2T

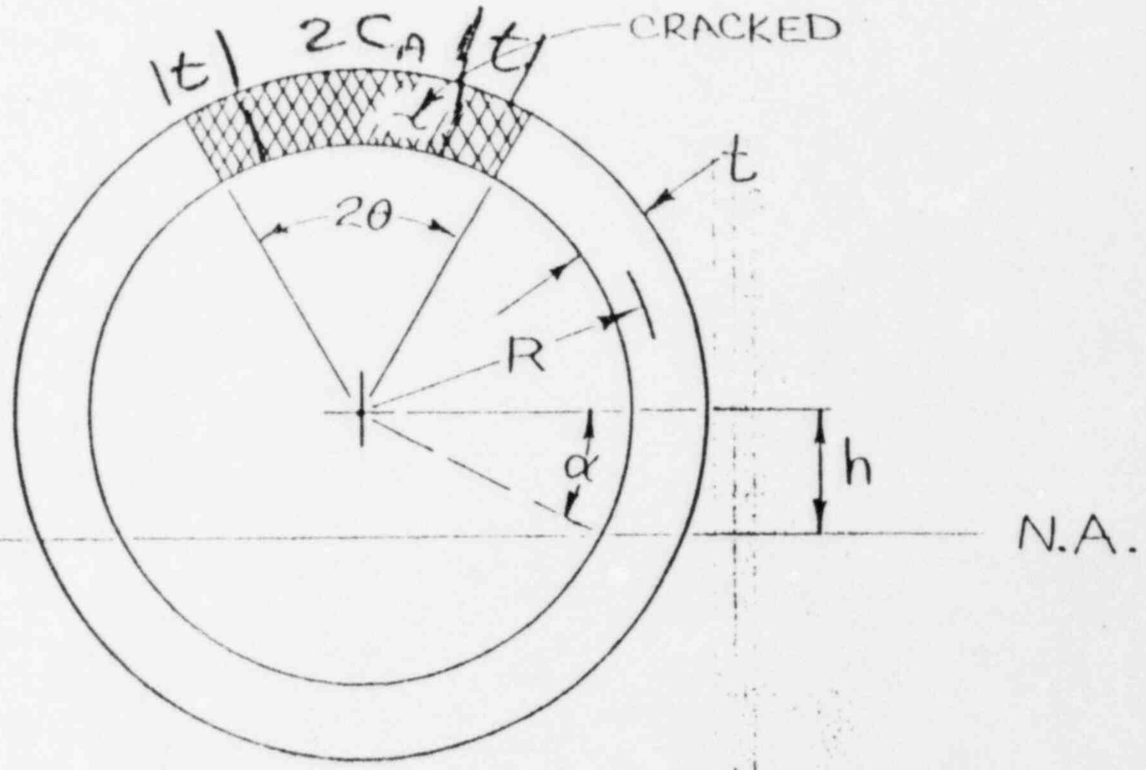


Figure 4.1 Geometry of Cracked Cross-section of Pipe

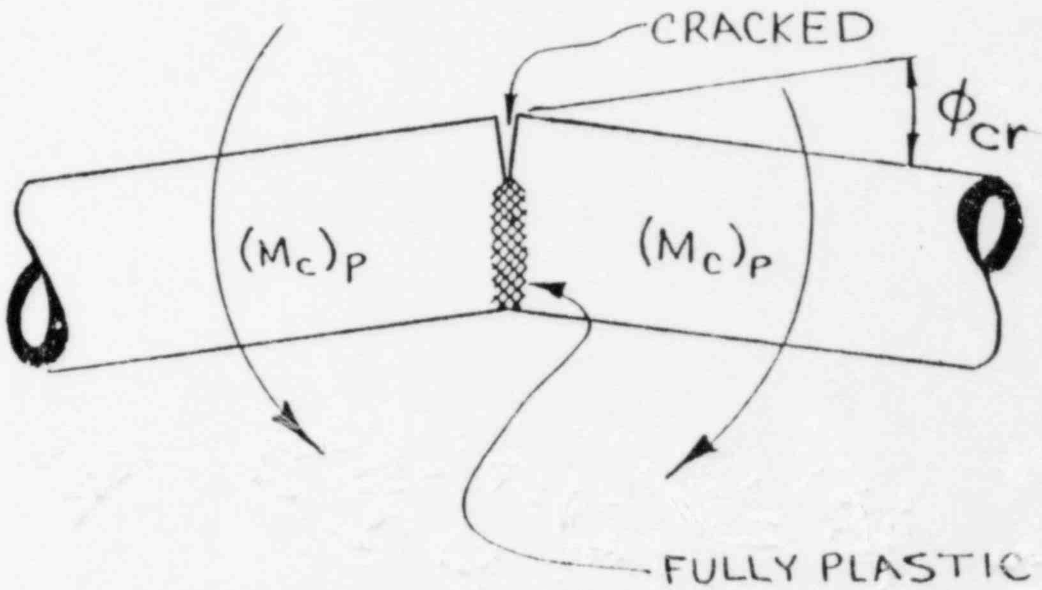


Figure 4.2 Fully Plastic Bending of a Pipe

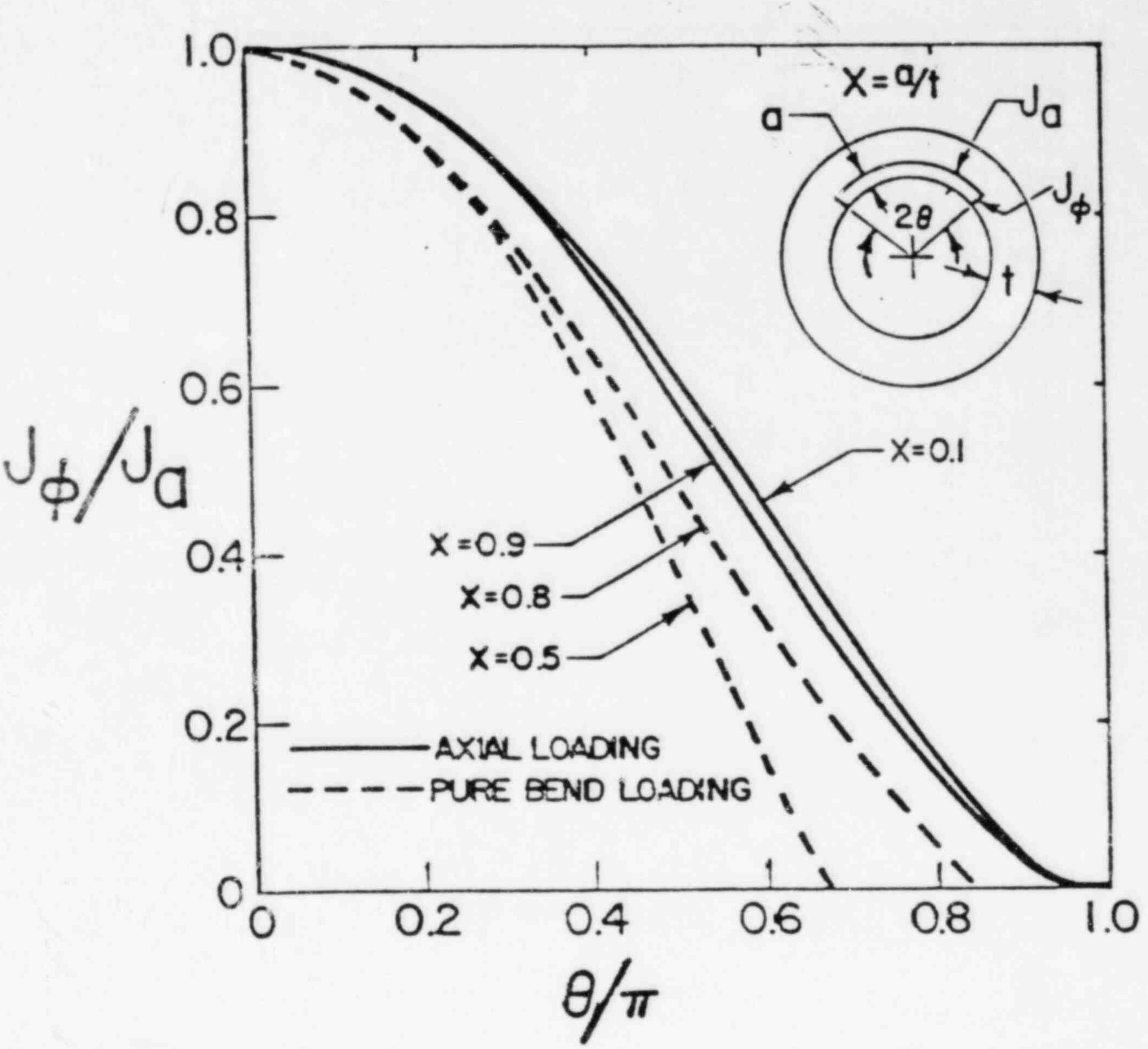


Figure 4.3 Stability of Part-through Crack Under Fully Plastic Bending

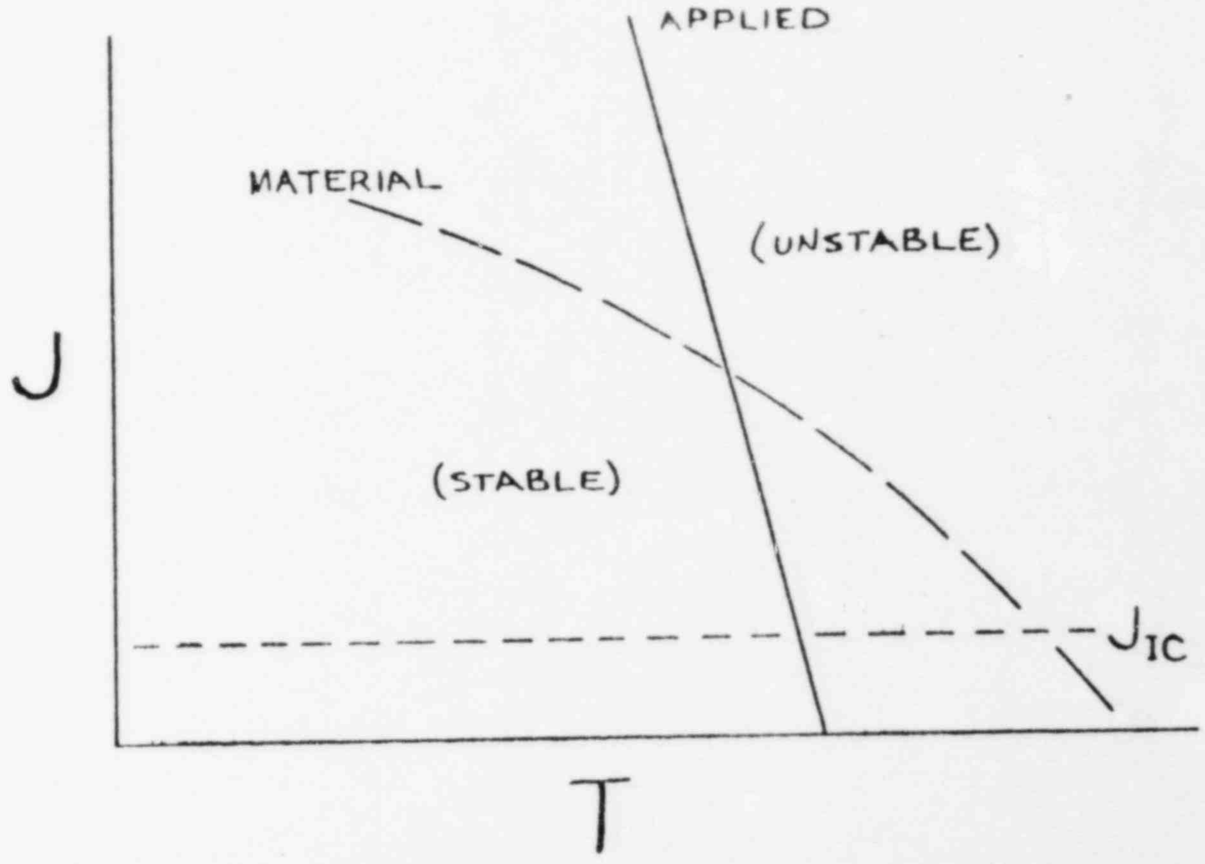


Figure 4.4 Schematic of J-T Stability Diagram

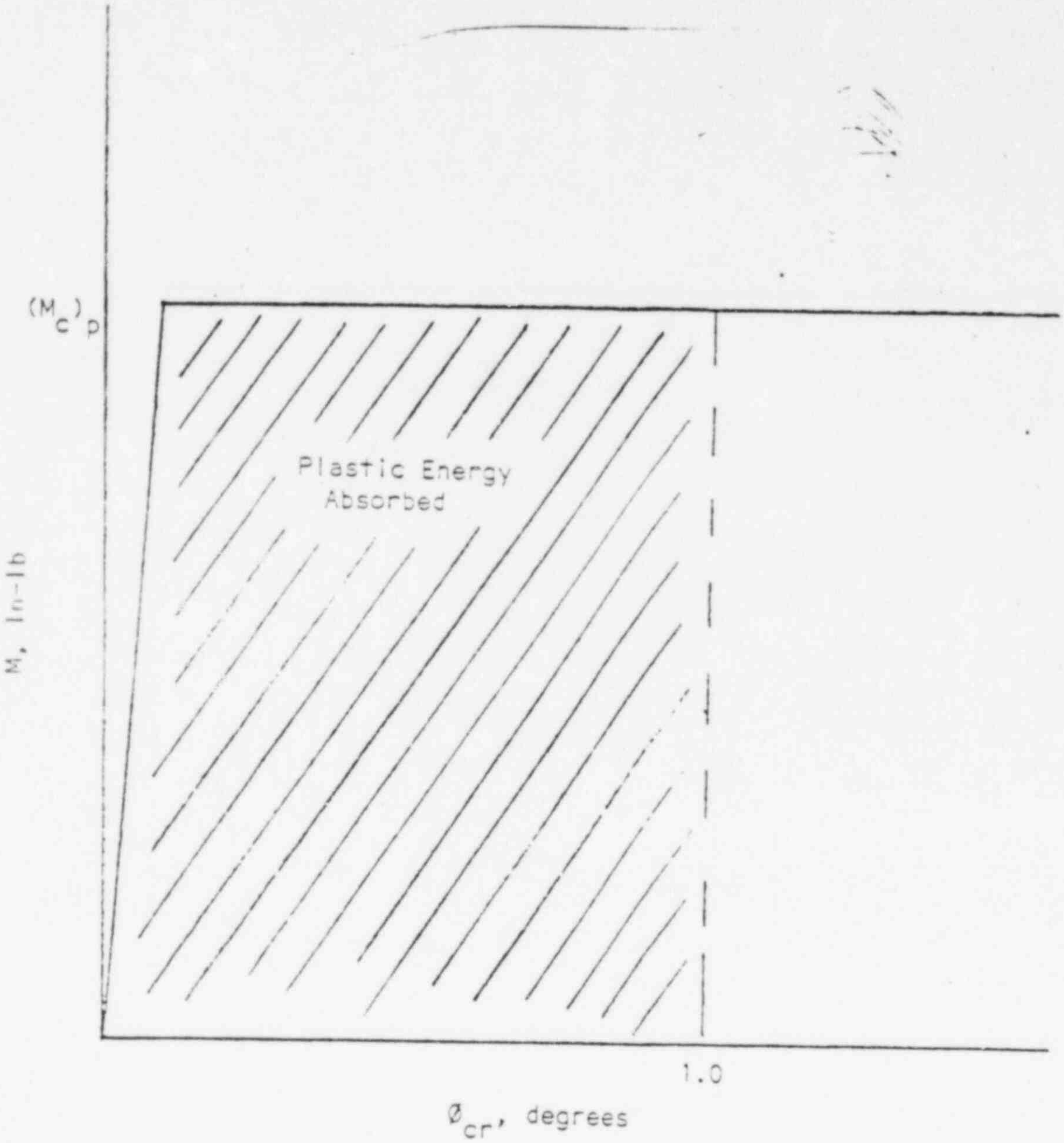
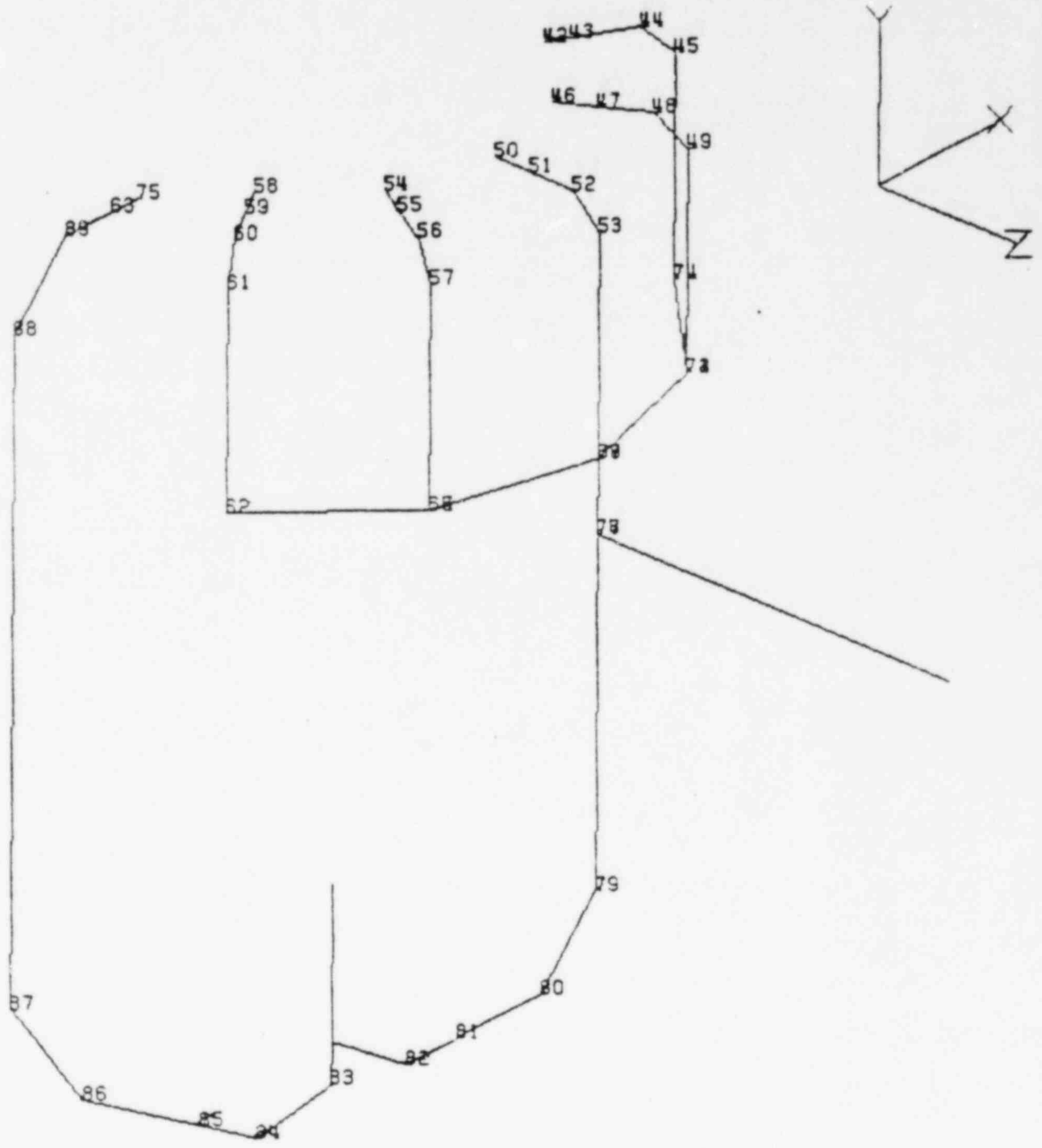


Figure 6.1 Energy Absorption Capability of Cracked Section



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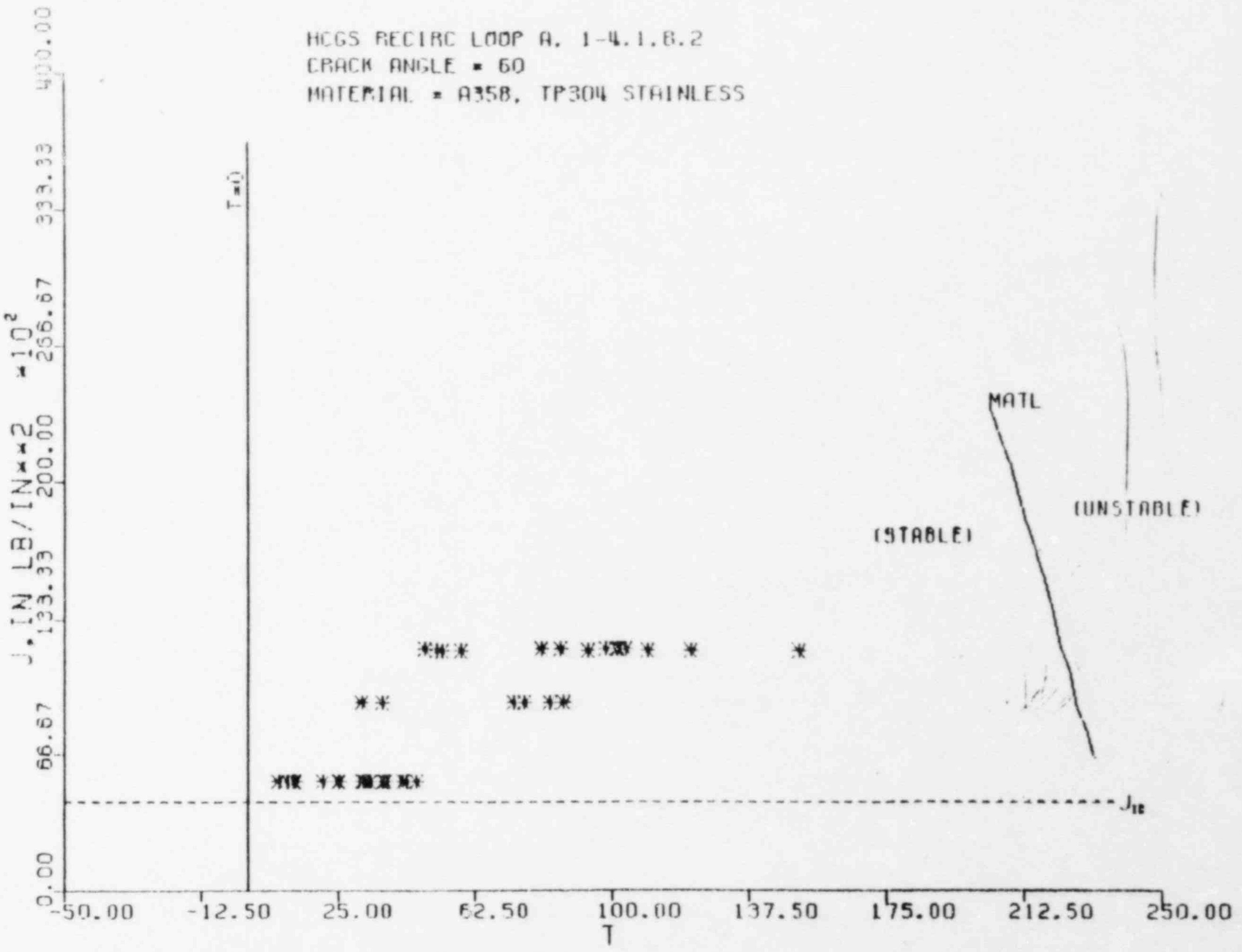
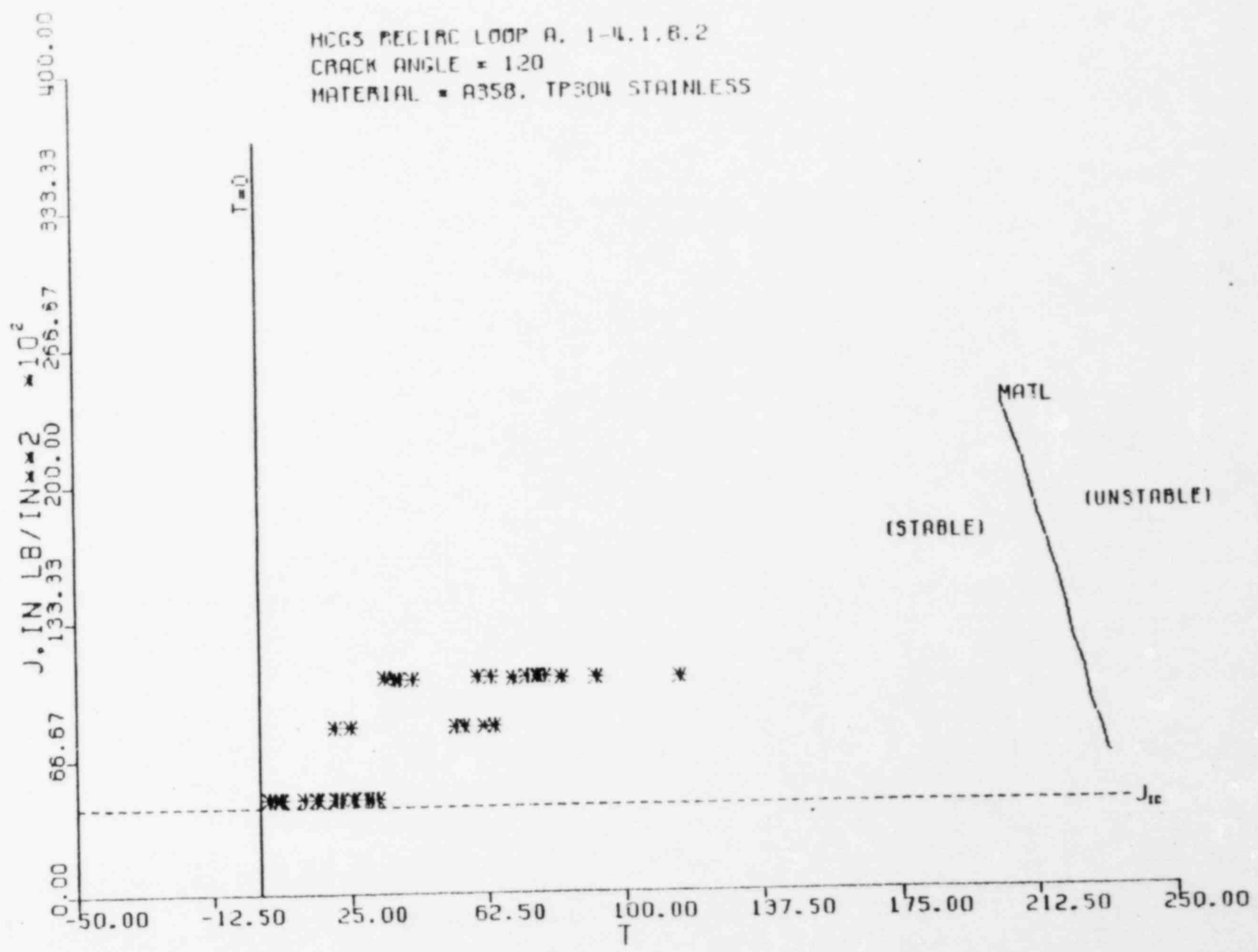
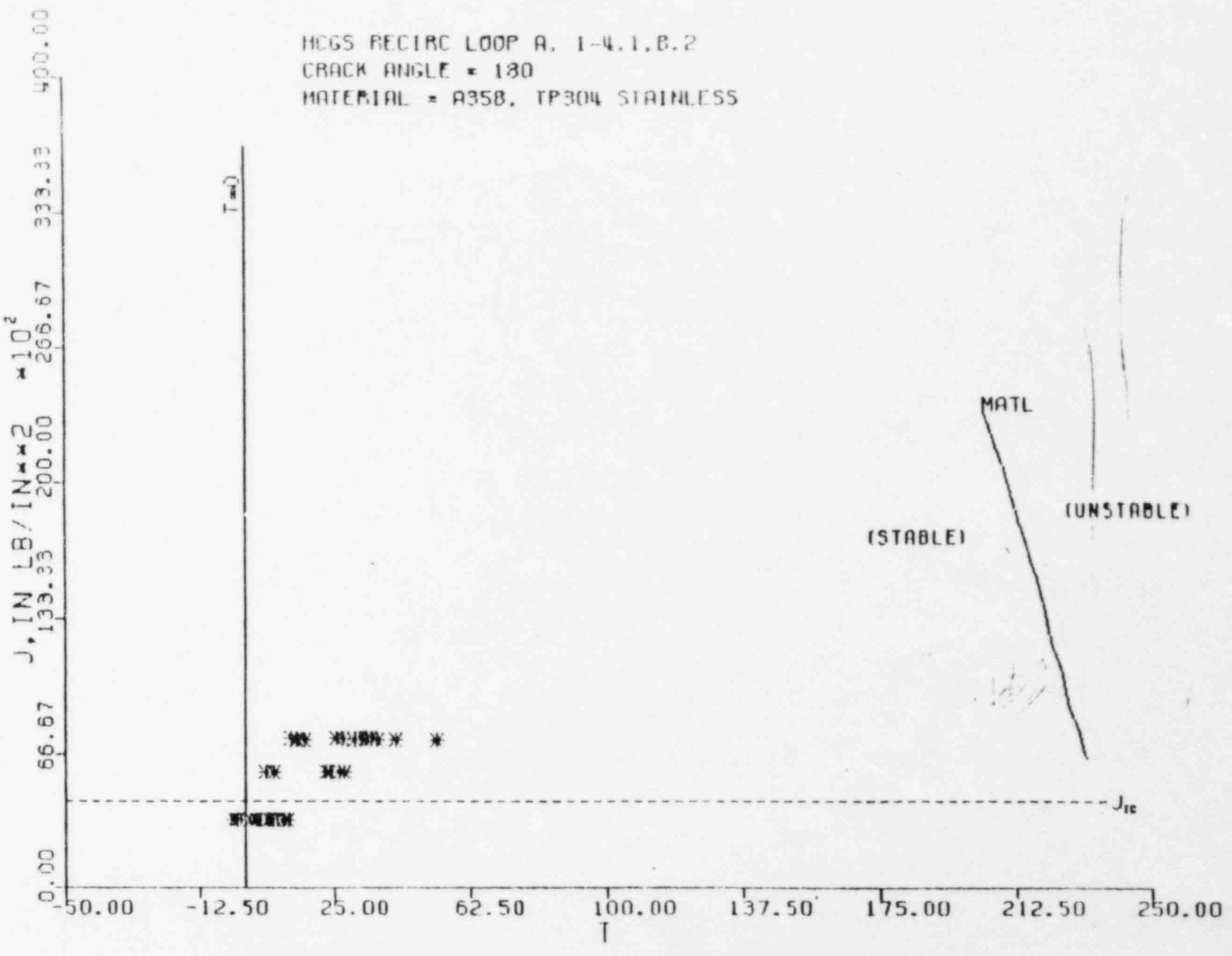
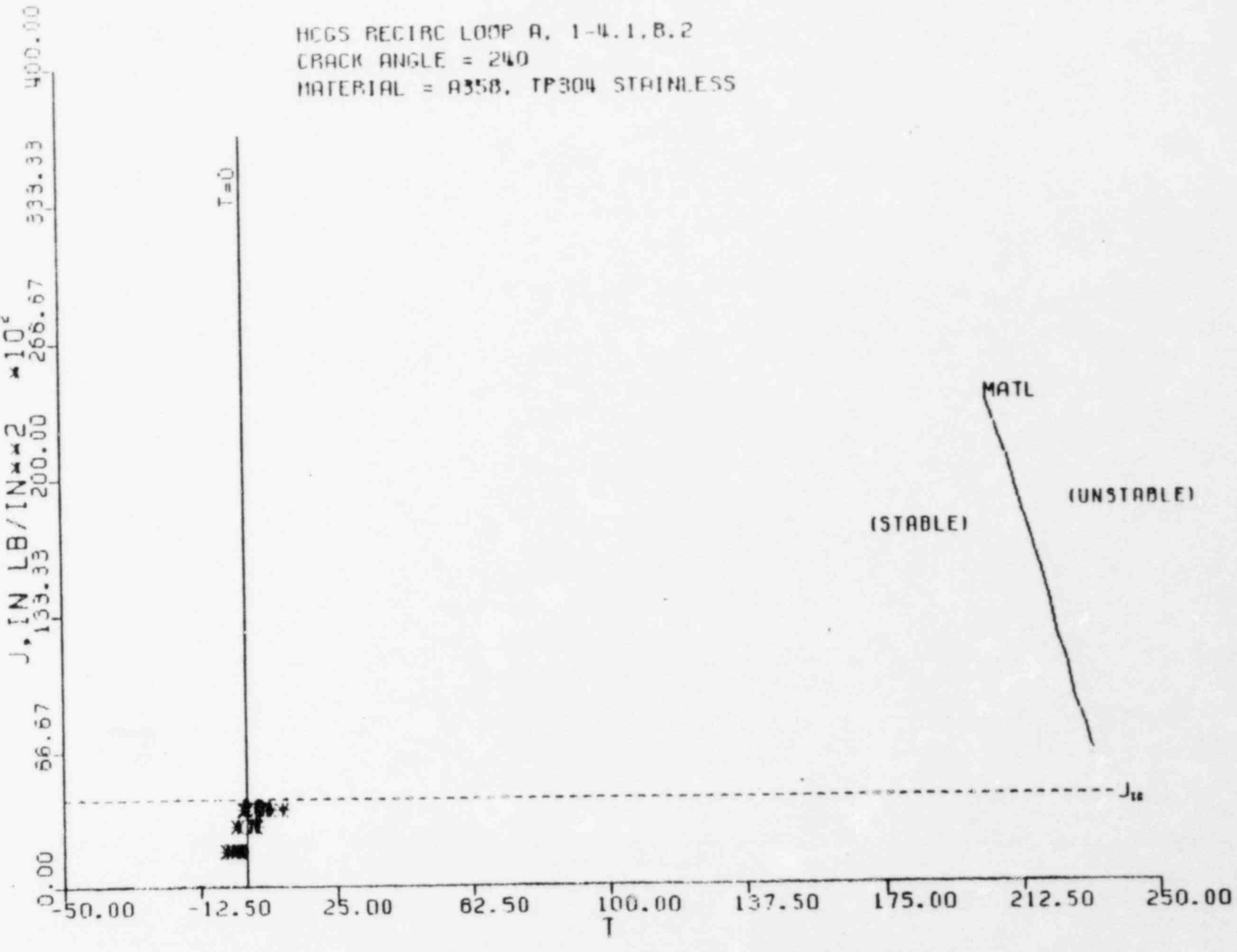

HCGS RECIRC LOOP A, 1-4.1.B.2
CRACK ANGLE = 60
MATERIAL = A358, TP304 STAINLESS
T=0
MATL
(STABLE)
(UNSTABLE)
J_{IC}
J, IN LB/IN**2 *10²
T
0.00
66.67
133.33
200.00
266.67
333.33
400.00
-50.00
-12.50
25.00
62.50
100.00
137.50
175.00
212.50
250.00

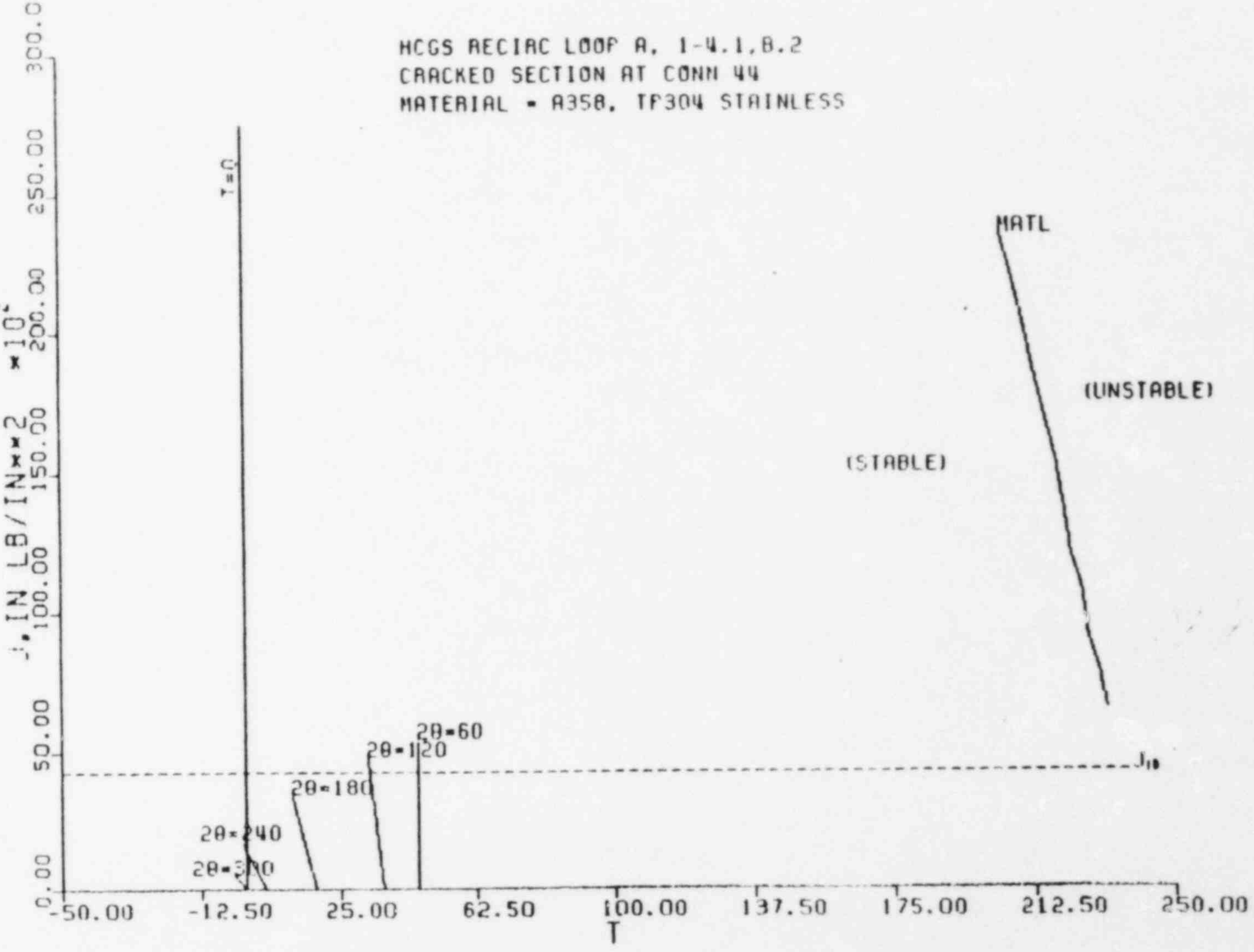


MCGS RECIRC LOOP A. 1-4.1.8.2
CRACK ANGLE = 120
MATERIAL = A358. TP304 STAINLESS

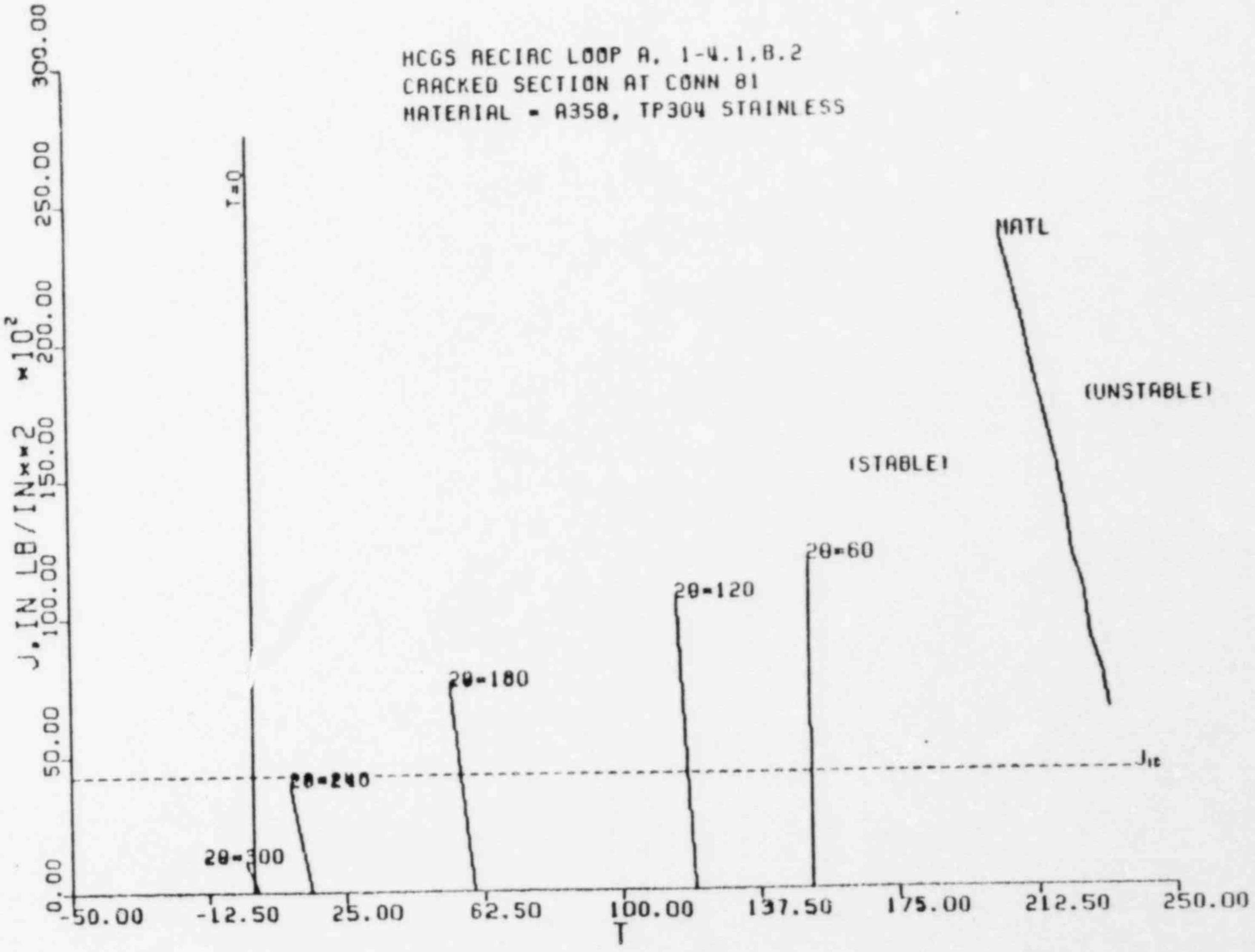
HCGS RECIRC LOOP A, 1-4.1.B.2
CRACK ANGLE = 180
MATERIAL = A358, TP304 STAINLESS
J, IN LB/IN**2 *10²
400.00
333.33
266.67
200.00
133.33
66.67
0.00
-50.00
-12.50
25.00
62.50
100.00
137.50
175.00
212.50
250.00
T
T=0
MATL
(STABLE)
(UNSTABLE)
J_{Ic}



HCGS RECIRC LOOP A. 1-4.1.B.2
CRACK ANGLE = 240
MATERIAL = A358. TP304 STAINLESS



HCGS RECIRC LOOP A, 1-4.1.B.2
CRACKED SECTION AT CONN 44
MATERIAL = A358, TP304 STAINLESS



HCGS RECIRC LOOP A, 1-4.1.B.2
CRACKED SECTION AT CONN 81
MATERIAL - A358, TP304 STAINLESS