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Characterization of Irradiated Current-Practice Welds and A533 Grade B Class 1 Plate for Nuclear Pressure Vessel Service

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R. K. Nanstad
K. R. Thoms

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Metals and Ceramics Division

CHARACTERIZATION OF IRRADIATED CURRENT-PRACTICE WELDS AND A533 GRADE B CLASS 1 PLATE FOR NUCLEAR PRESSURE VESSEL SERVICE

J. J. McGowan, R. K. Nanstad, and K. R. Thoms

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FOREWORD

The work reported here was performed at Oak Ridge National Laboratory (ORNL) under the Heavy-Section Steel Technology Program, C. E. Pugh, Program Manager. The program is sponsored by the Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission (NRC). The technical monitor for the NRC is Michael E. Mayfield.

This report is designated HSST Program Technical Report 88. It is published in two volumes. Volume 1 contains the main body with Appendices A and B. Volume 2 contains only Appendices C through F which provide detailed load-displacement traces, fracture surfaces, etc. In recognition of its very large size, Volume 2 will be distributed only to those in the RF distribution requesting a copy from the HSST Program Office. Other reports in this series include:

1. S. Yukawa, *Evaluation of Periodic Proof Testing and Warm Prestressing Procedures for Nuclear Reactor Vessels*, HSSTP-TR-1, General Electric Company, Schenectady, N.Y., July 1, 1969.

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CHARACTERIZATION OF IRRADIATED CURRENT-PRACTICE WELDS AND A533 GRADE B CLASS 1 PLATE FOR NUCLEAR PRESSURE VESSEL SERVICE*

J. J. McGowan,† R. K. Nanstad, and K. R. Thoms‡

ABSTRACT

Studies of the effects of neutron irradiation on fracture toughness properties of steels have generally included a minimum number of tests for each material condition. The present study attempts to apply statistical analyses, with multiple testing at selected temperatures, to assess the accuracy and reliability of the results. Fracture toughness test specimens were irradiated in the Bulk Shielding Reactor at Oak Ridge National Laboratory at 288°C to target neutron fluences of 2×10^{23} neutrons/m^2 (>1 MeV). The materials were ASTM A533 grade B class 1 plate (HSST Plate 02) and four submerged-arc welds representing the current fabrication practice for nuclear pressure vessels. Both unirradiated and irradiated specimens were tested by two separate laboratories, and multiple tests were conducted at selected temperatures. Statistical analyses permitted the determination of material and test variability and an interlaboratory comparison. Behavior in both the transition and ductile-shelf regions was studied. The results demonstrated the relatively low radiation sensitivity of low copper/nickel welds and the qualitative agreement between Charpy impact and fracture toughness observations of toughness degradation.

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Appendix C

LOAD-DISPLACEMENT AND J-R CURVES, SUPPLIED BY MATERIALS ENGINEERING ASSOCIATES, FOR UNIRRADIATED MATERIAL

MEA UNIRRADIATED 1TCS DATA SHEETS
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MEA VALIDITY INDEX

K_{Ic} (ASTM E399)

1. $K_{Ic} > \sigma_{ys} * \sqrt{a_o/2.5}$

2. $K_{Ic} > \sigma_{ys} * \sqrt{(B*B_N)^{0.5}/2.5}$

3. $P_{Max}/P_Q > 1.1$

J_{Ic} (ASTM E813)

a. < 4 data points between 0.15 and 1.5 mm exclusion lines.

b. Data clustering problem.

c. Delta-a prediction error too large,
$|(\text{delta-a})_{pred} - (\text{delta-a})_{meas}| > 0.15\ (\text{delta-a})_{meas}$

d. $B_N < 25\ J_Q/\sigma_y$

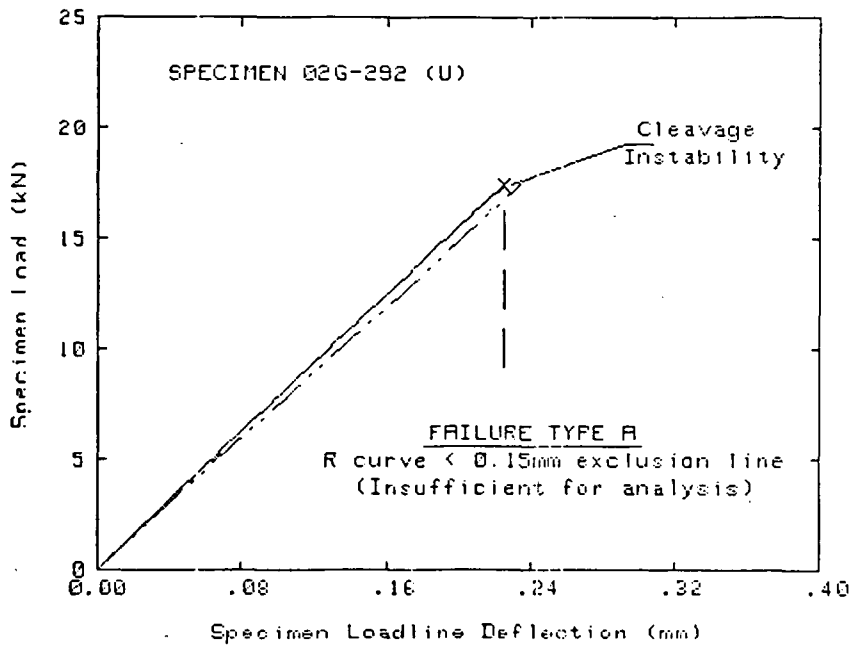
e. $b_o < 25\ J_Q/\sigma_y$

Tentative J_I - R Curve Procedure

1. < 3 data points between (delta-a)=0 and secant line [$J=4/3*\sigma_y*(\text{delta-a})$]

2. < 10 data points between secant line and $(\text{delta-a})_{max}$ [$0.1*b_o$]

3. (delta-a) prediction error too large,
$|(\text{delta-a})_{pred} - (\text{delta-a})_{meas}| >$
MINIMUM [$0.15*(\text{delta-a})_{meas}, 0.15*(\text{delta-a})_{max}$]



TEST SPECIMEN DATA

Material Type	= A533-B PLATE 02	
Test Temperature	= -95 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .617	
Init crack length a	= 31.34 mm	
Flow stress	= 677.5 MPa	
Yield stress	= 592.9 MPa	
Youngs modulus E	= 212600 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

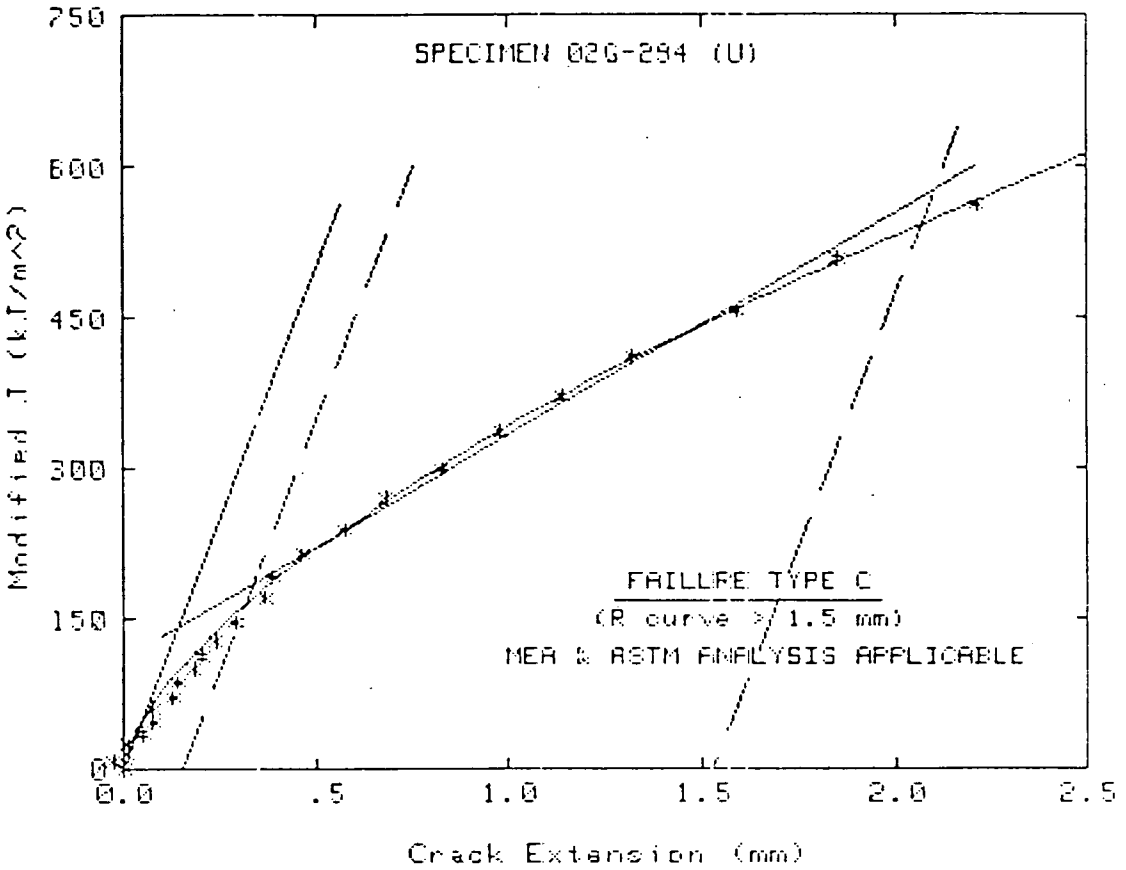
Jic	= 8.8 kJ/m^2	
Kjc=(EJic)^.5	= 43.2 MPa √m	ν=.3
Kic (Beta Corrected)	= 42.1 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 17.41 kN	
5% Secant Offset Pq	= 17.41 kN	
Kic	= 44.4 MPa √m	
Validity	= VALID Kic value	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-2.46635535753E-04 in.
Specimen rotation Load intercept elastic slope = .0000002 lb
Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

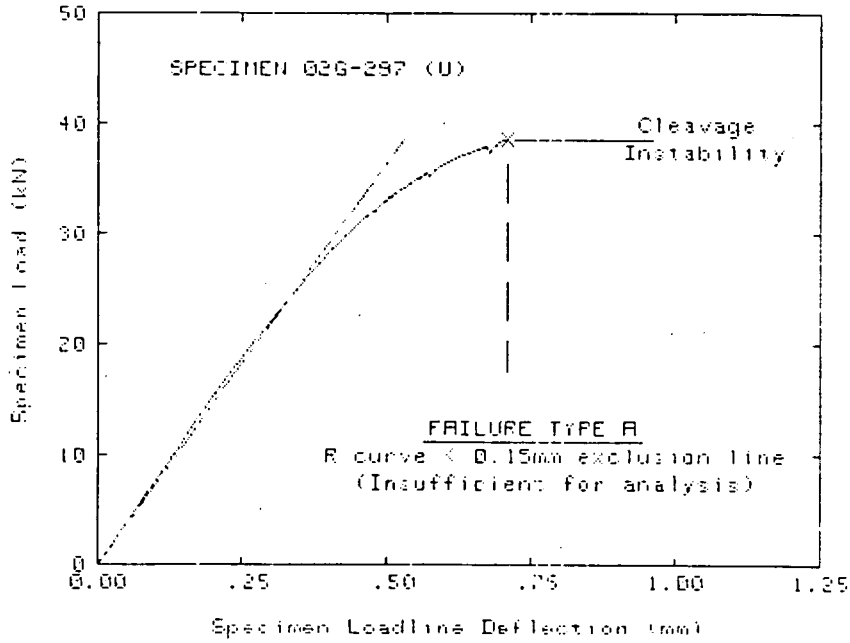
Material Type	= A533-B PLATE 02	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.65 mm	Init a/W = .623
Final crack length	= 40.6 mm	Final a/W = .799
Flow stress	= 500.2 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 164.3 kJ/m^2	
Kjc	= 181.4	J (@J/T=8.8) = 752.6 kJ/m^2
Exponent N	= .6362	
Coefficient C	= 341.4 kJ/m^2	
T (average)	= 168	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 141.6 kJ/m^2	
Kjc	= 168.4	Slope M = 222003.2 kJ/m^3
Intercept B	= 110.2 kJ/m^2	
T (ASTM)	= 178	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--3 (.3 vs .28)	
J maximum allowed	= 478.6 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.91 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	=	A533-B PLATE 02
Test Temperature	=	-5 C
Percent Side Groove	=	0 %
Specimen Thickness B	=	25.4 mm
Initial a/W	=	.619
Init crack length a	=	31.44 mm
Flow stress	=	573.4 MPa
Yield stress	=	496.1 MPa
Youngs modulus E	=	207500 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	=	74.2 kJ/m^2
Kjc=(EJic)^.5	=	124.1 MPa \/m v=.3
Kic (Beta Corrected)	=	79.5 MPa \/m v=.3

ASTM E399-81 ANALYSIS

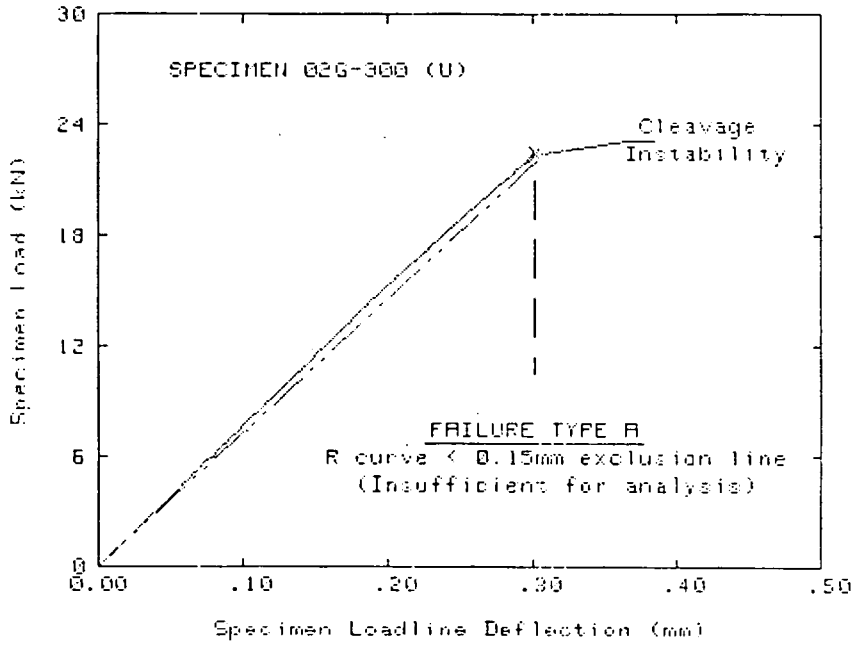
Modified Kic Equation; B = (BBn)^.5		
Maximum Load P	=	38.63 kN
5% Secant Offset Pq	=	23.55 kN
Kic	=	60.6 MPa \/m
Validity	=	INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-5.44819894379E-04 in.

Specimen rotation Load intercept elastic slope = 2.37142857143E-07 lb

Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533-B PLATE 02	
Test Temperature	= -95 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .623	
Init crack length a	= 31.65 mm	
Flow stress	= 677.5 MPa	
Yield stress	= 592.9 MPa	
Youngs modulus E	= 212600 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 15.6 kJ/m^2	
Kjc=(EJic)^.5	= 57.6 MPa √m	v=.3
Kic (Beta Corrected)	= 53.8 MPa √m	v=.3

ASTM E399-81 ANALYSIS

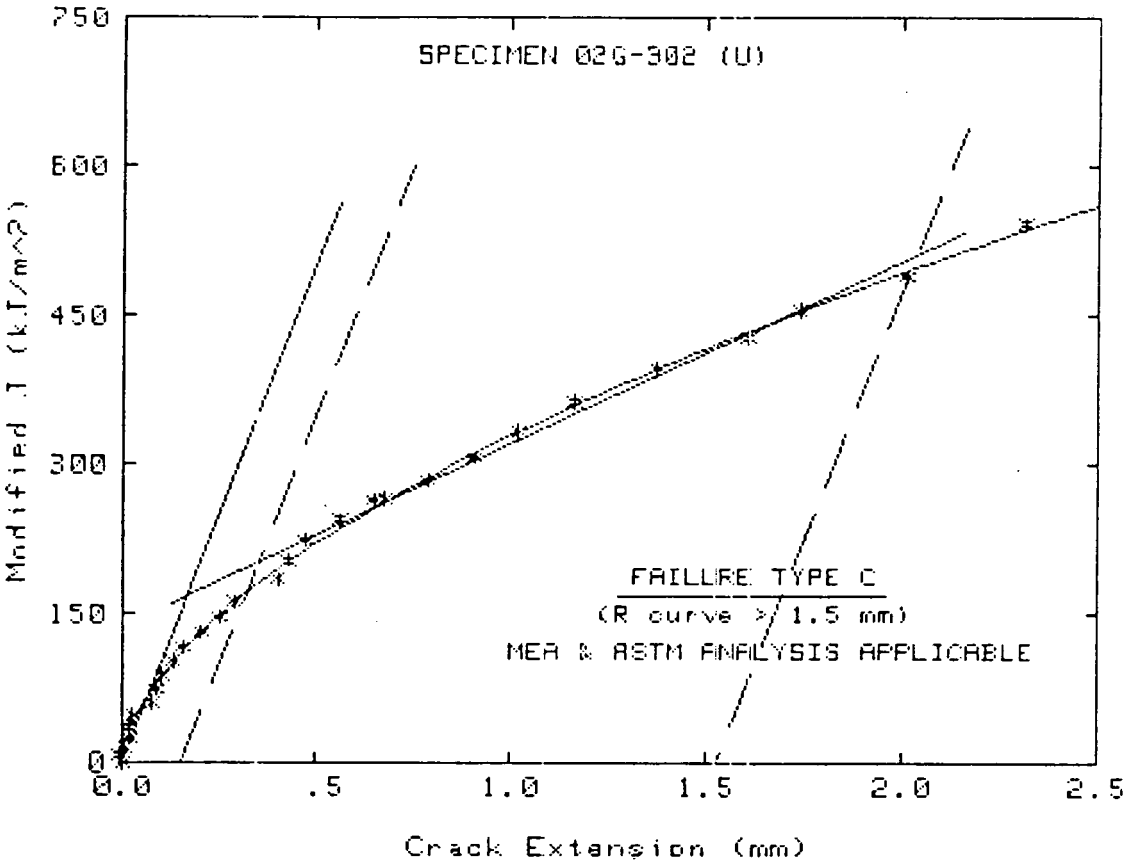
Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 22.44 kN	
5% Secant Offset Pq	= 22.44 kN	
Kic	= 58.7 MPa √m	
Validity	= VALID Kic value	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-3.60799207871E-05 in.

Specimen rotation Load intercept elastic slope = 3.57142857143E-08 lb

Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

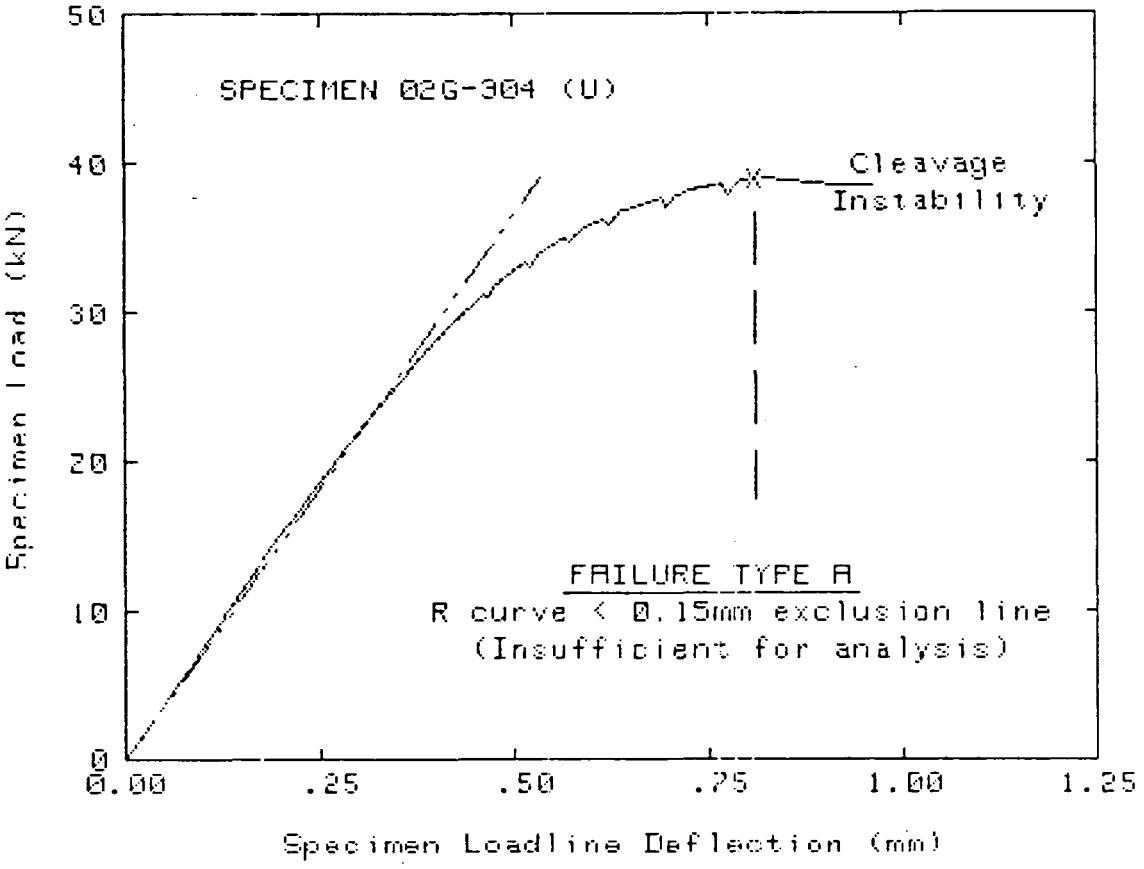
Material Type = A533-B PLATE 02
Test Temperature = 121 C
Percent Side Groove = 20 %
Specimen Thickness = 25.4 mm
Init crack length = 31.41 mm Init a/W = .618
Final crack length = 41 mm Final a/W = .807
Flow stress = 500.2 MPa
Youngs modulus = 200300 MPa (Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic = 170.2 kJ/m^2
Kjc = 184.6 J (@J/T=8.8) = 746.3 kJ/m^2
Exponent N = .5825
Coefficient C = 328.9 kJ/m^2
T (average) = 149

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic = 167 kJ/m^2
Kjc = 182.9 Slope M = 183860.6 kJ/m^3
Intercept B = 136.3 kJ/m^2
T (ASTM) = 147
Validity (Jic) = VALID
Validity (R-curve) = INVALID--3 (.52 vs .29)
J maximum allowed = 484.5 kJ/m^2 (Jmax=Bnet*Flow stress/20)
Delta a max. allowed = 1.94 mm (Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B PLATE 02	
Test Temperature	= -5 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .619	
Init crack length a	= 31.46 mm	
Flow stress	= 573.4 MPa	
Yield stress	= 496.1 MPa	
Youngs modulus E	= 207500 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 90.6 kJ/m^2	
Kjc=(EJic)^.5	= 137.2 MPa √m	v=.3
Kic (Beta Corrected)	= 83.2 MPa √m	v=.3

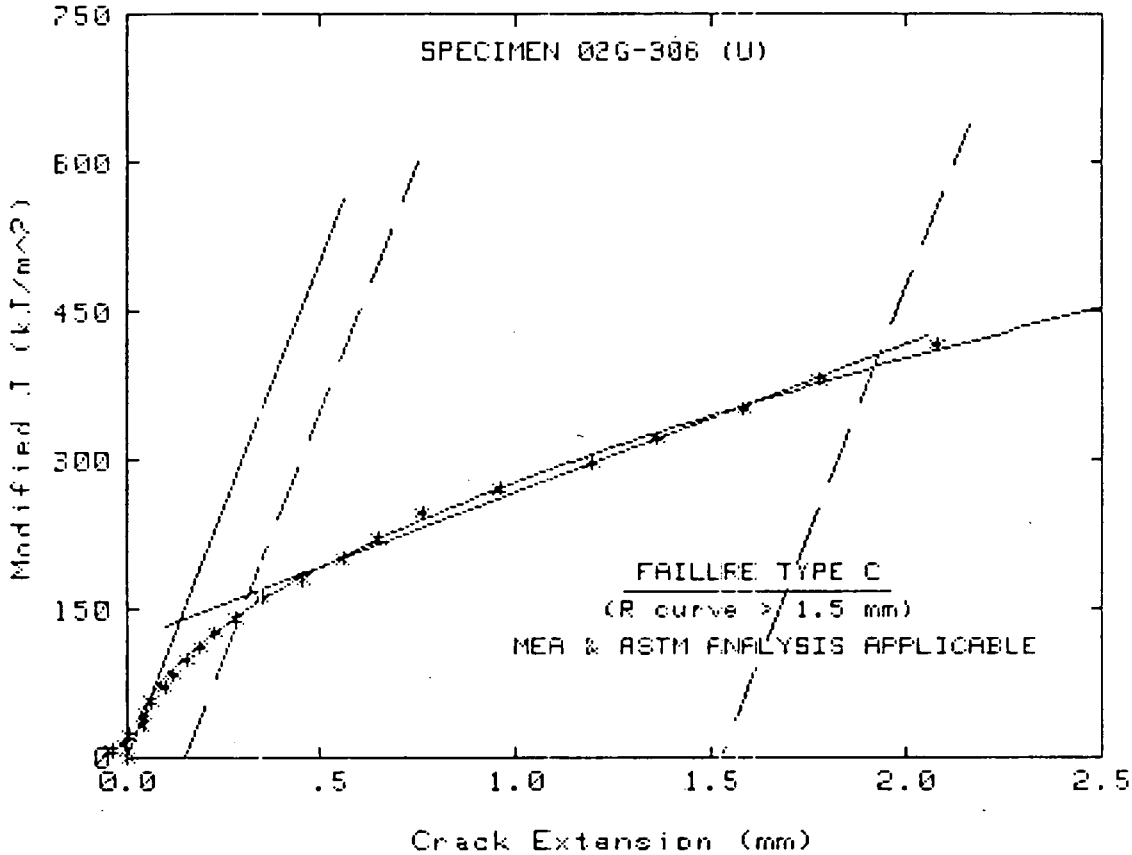
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 39.01 kN	
5% Secant Offset Pq	= 22.9 kN	
Kic	= 59 MPa √m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

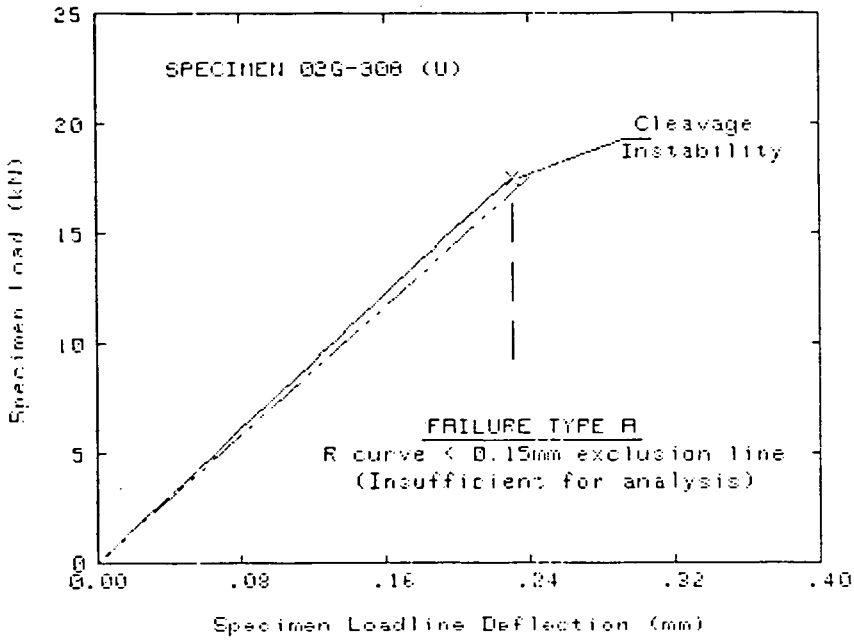
Material Type	= A533-B PLATE 02		
Test Temperature	= 204 C		
Percent Side Groove	= 20 %		
Specimen Thickness	= 25.4 mm		
Init crack length	= 31.53 mm	Init a/W	= .62
Final crack length	= 41.84 mm	Final a/W	= .823
Flow stress	= 498.3 MPa		
Youngs modulus	= 195500 MPa	(Estimated Value)	

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 145.1 kJ/m^2		
Kjc	= 168.4	J (@J/T=8.8)	= 558.4 kJ/m^2
Exponent N	= .5355		
Coefficient C	= 277.4 kJ/m^2		
T (average)	= 117		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 139.8 kJ/m^2		
Kjc	= 165.3	Slope M	= 149722.3 kJ/m^3
Intercept B	= 118.7 kJ/m^2		
T (ASTM)	= 118		
Validity (Jic)	= VALID		
Validity (R-curve)	= INVALID--3 (.48 vs .28)		
J maximum allowed	= 479.7 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 1.93 mm	(Delta a max = 0.1*bo)	



TEST SPECIMEN DATA

Material Type	= A533-B PLATE 02	
Test Temperature	= -95 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .62	
Init crack length a	= 31.48 mm	
Flow stress	= 677.5 MPa	
Yield stress	= 592.9 MPa	
Youngs modulus E	= 212600 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 9.1 kJ/m^2	
Kjc=(EJic)^.5	= 44.1 MPa \/m	v=.3
Kic (Beta Corrected)	= 42.8 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

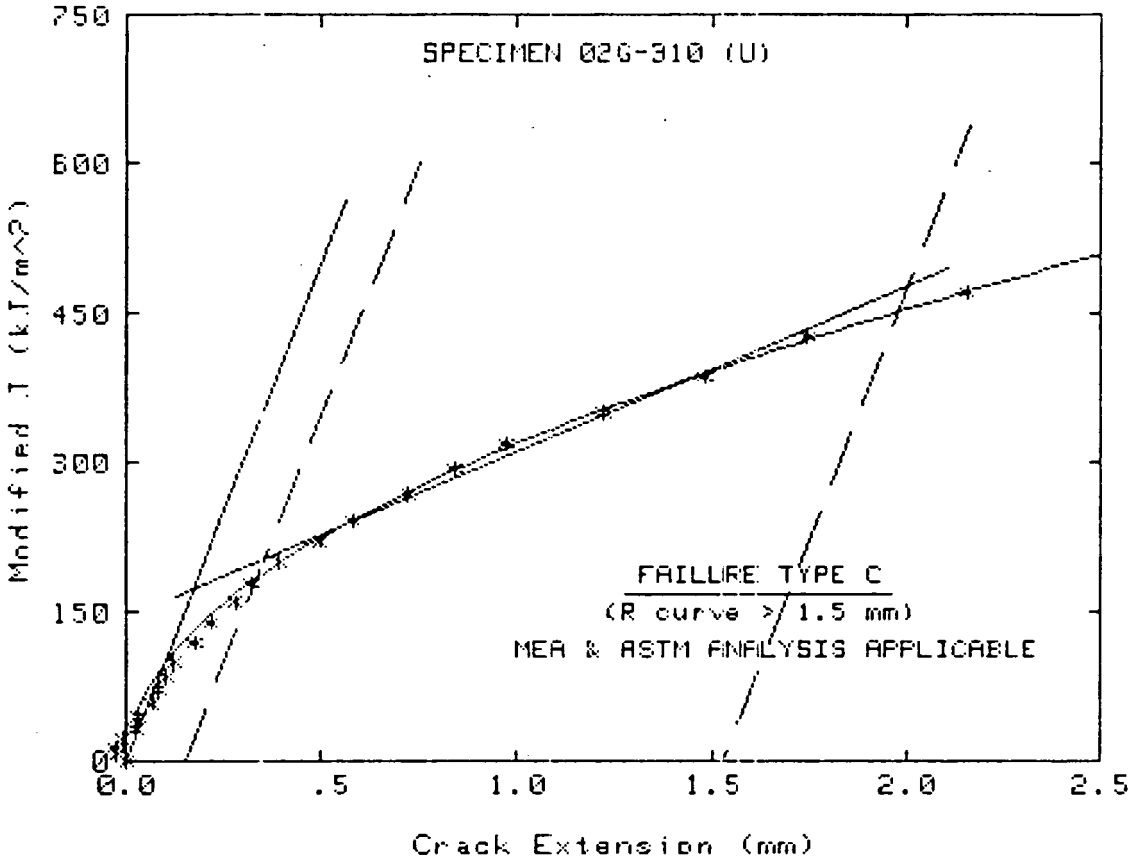
Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 17.5 kN	
5% Secant Offset Pq	= 17.5 kN	
Kic	= 45.2 MPa \/m	
Validity	= VALID Kic value	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-5.69003647720E-04 in.

Specimen rotation Load intercept elastic slope = 4.32142857143E-07 lb

Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

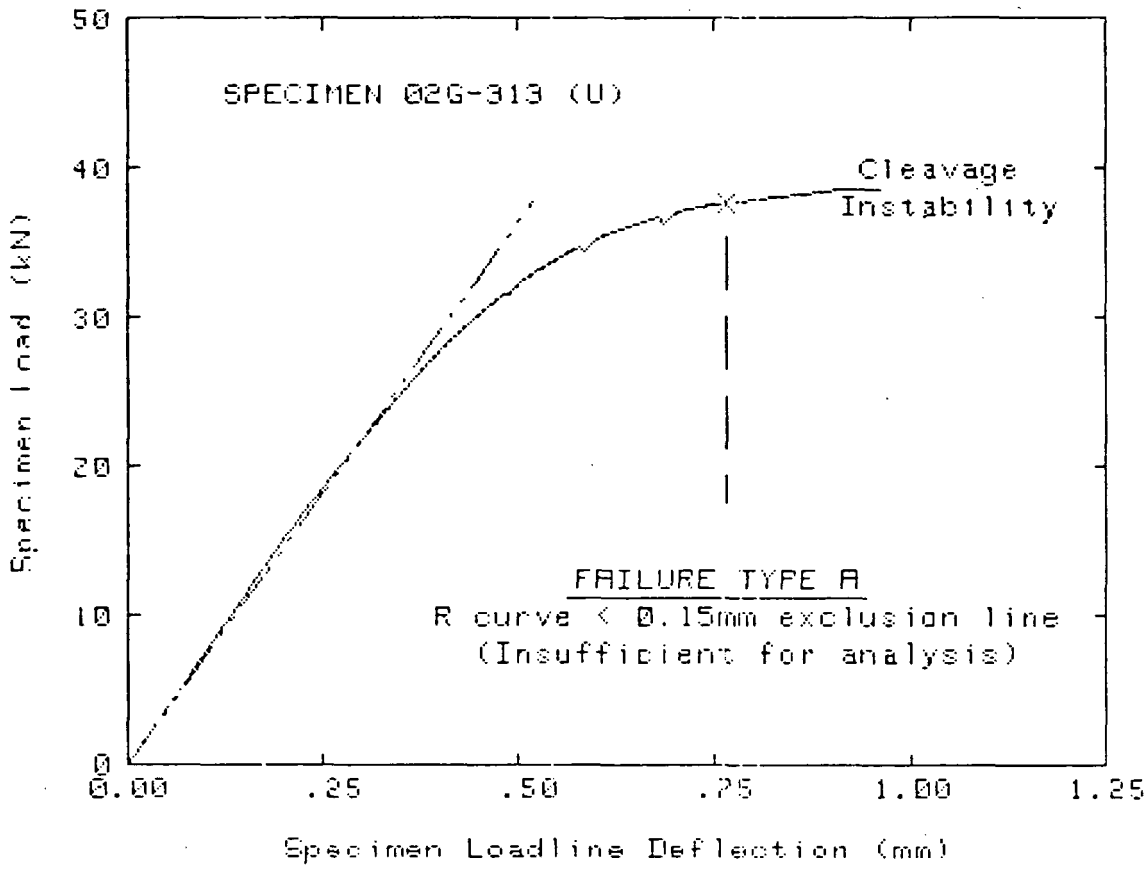
Material Type	= A533-B PLATE 02		
Test Temperature	= 121 C		
Percent Side Groove	= 20 %		
Specimen Thickness	= 25.4 mm		
Init crack length	= 31.62 mm	Init a/W	= .622
Final crack length	= 37.62 mm	Final a/W	= .74
Flow stress	= 500.2 MPa		
Youngs modulus	= 200300 MPa	(Estimated Value)	

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 183.3 kJ/m^2		
Kjc	= 191.6	J (@J/T=8.8)	= 696 kJ/m^2
Exponent N	= .5088		
Coefficient C	= 319.4 kJ/m^2		
T (average)	= 127		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 173.9 kJ/m^2		
Kjc	= 186.6	Slope M	= 166189.8 kJ/m^3
Intercept B	= 145 kJ/m^2		
T (ASTM)	= 133		
Validity (Jic)	= VALID		
Validity (R-curve)	= VALID		
J maximum allowed	= 479.5 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 1.92 mm	(Delta a max = 0.1*bo)	



TEST SPECIMEN DATA

Material Type	=	A533-B PLATE 02
Test Temperature	=	-5 C
Percent Side Groove	=	0 %
Specimen Thickness B	=	25.4 mm
Initial a/W	=	.619
Init crack length a	=	31.43 mm
Flow stress	=	573.4 MPa
Yield stress	=	496.1 MPa
Youngs modulus E	=	207500 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

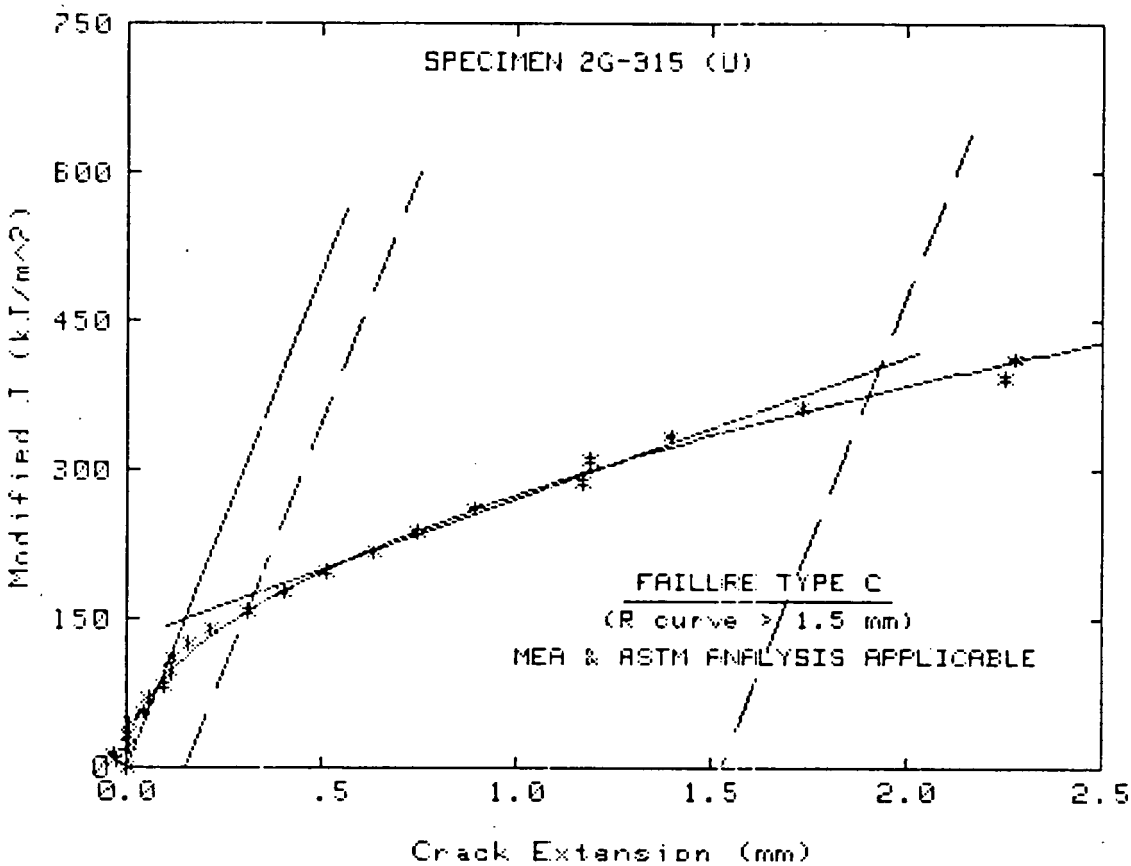
Jic	=	81.8 kJ/m^2
Kjc=(EJic)^.5	=	130.3 MPa √m v=.3
Kic (Beta Corrected)	=	81.3 MPa √m v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation; B	=	(BBn)^.5
Maximum Load P	=	37.68 kN
5% Secant Offset Pq	=	22.39 kN
Kic	=	57.6 MPa √m
Validity	=	INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

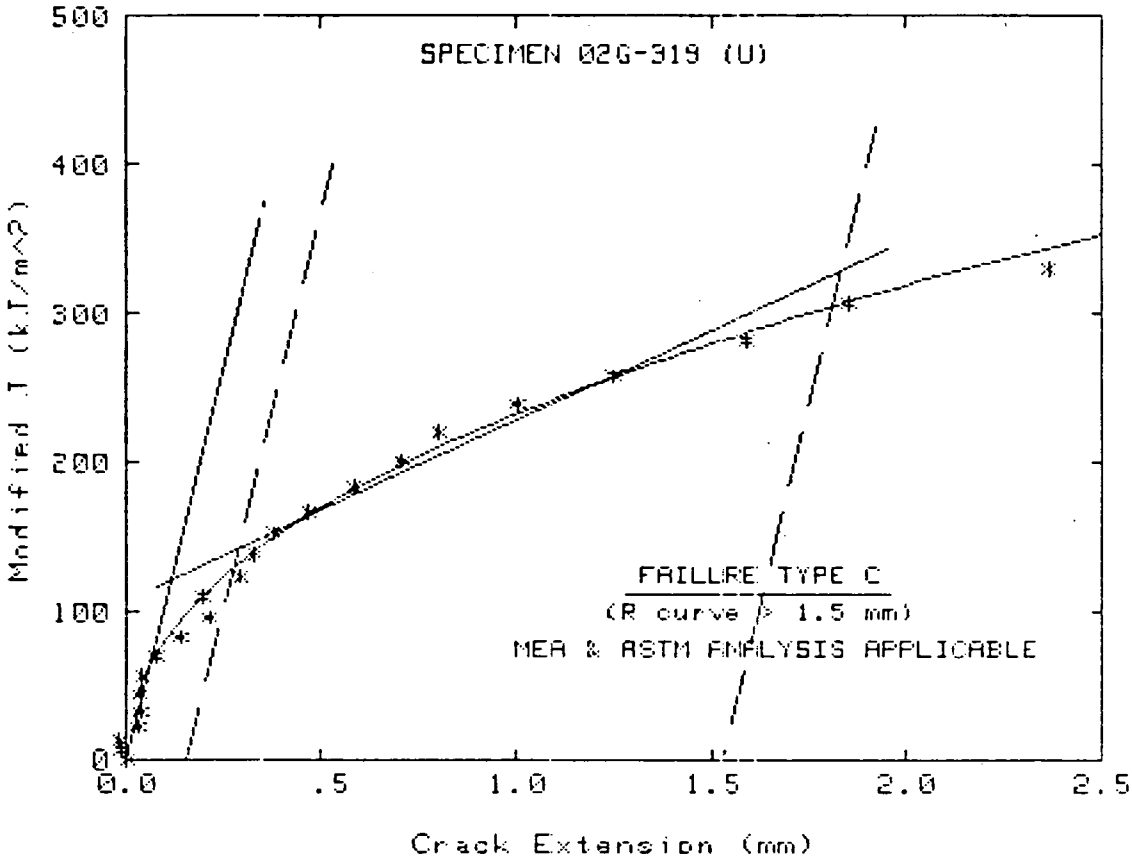
Material Type	= A533-B PLATE 02	
Test Temperature	= 204 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.66 mm	Init a/W = .623
Final crack length	= 42.06 mm	Final a/W = .827
Flow stress	= 498.3 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 156.3 kJ/m^2	
Kjc	= 174.8	J (@J/T=8.8) = 459 kJ/m^2
Exponent N	= .4825	
Coefficient C	= 275.4 kJ/m^2	
T (average)	= 104	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 148.5 kJ/m^2	
Kjc	= 170.4	Slope M = 143428.5 kJ/m^3
Intercept B	= 127.1 kJ/m^2	
T (ASTM)	= 113	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 476.6 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.91 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

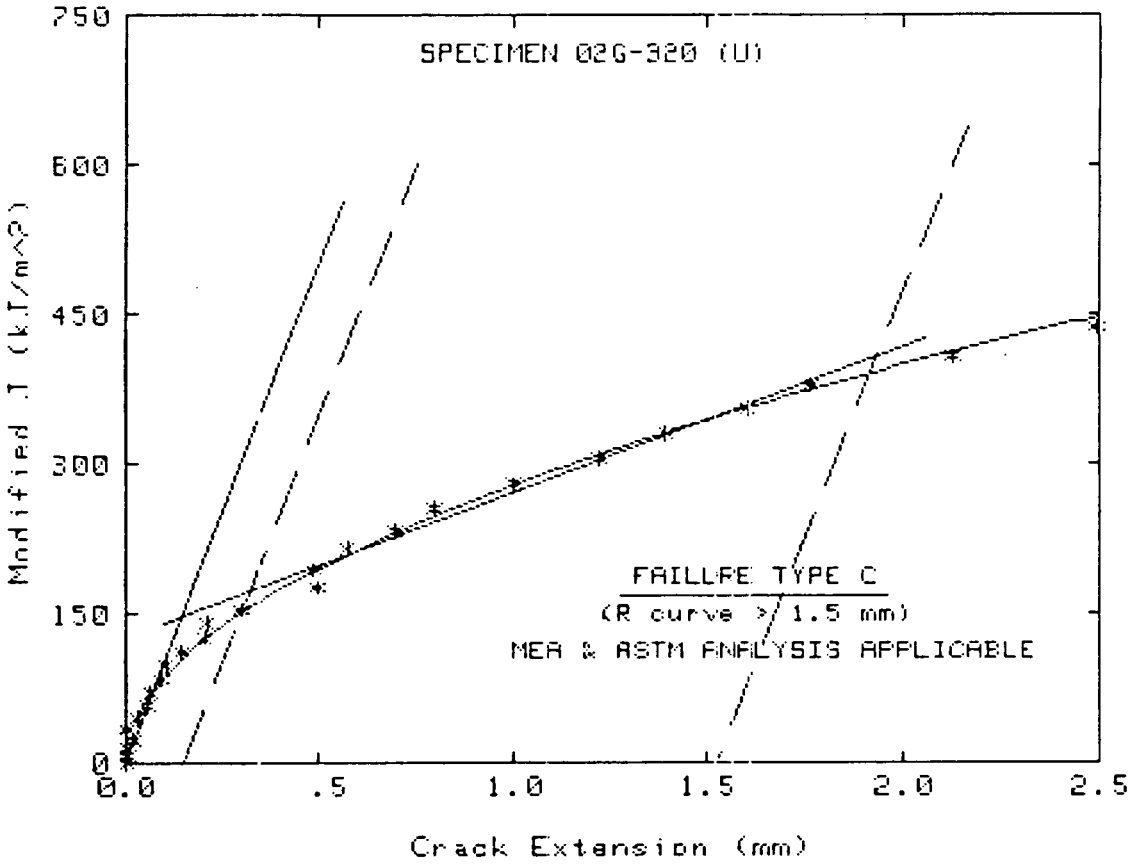
Material Type	= A533-B PLATE 02	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.63 mm	Init a/W = .622
Final crack length	= 40.36 mm	Final a/W = .794
Flow stress	= 533.8 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 128.6 kJ/m^2	
Kjc	= 156.6	J (@J/T=8.8) = 431.1 kJ/m^2
Exponent N	= .4563	
Coefficient C	= 232.6 kJ/m^2	
T (average)	= 73	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 121.3 kJ/m^2	
Kjc	= 152.1	Slope M = 120602.1 kJ/m^3
Intercept B	= 107.6 kJ/m^2	
T (ASTM)	= 81	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--3 (.31 vs .28)	
J maximum allowed	= 511.4 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.92 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

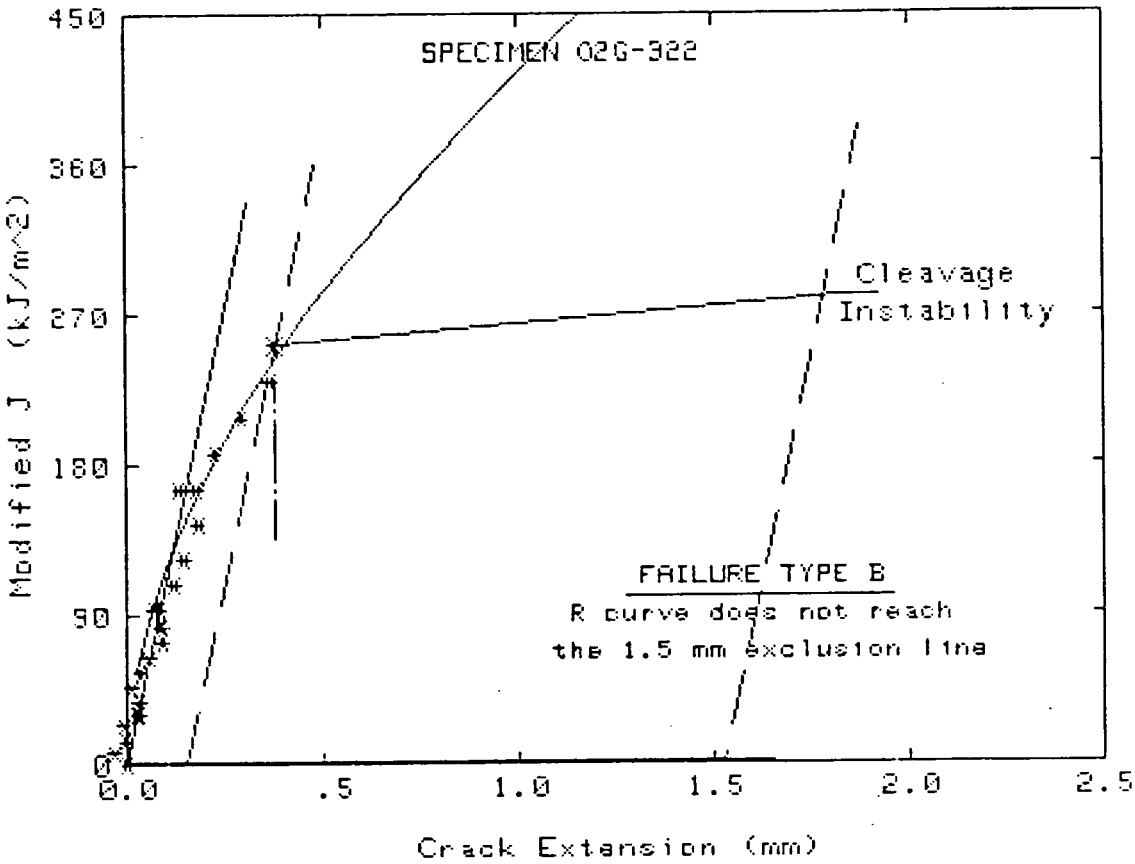
Material Type	= A533-B PLATE 02		
Test Temperature	= 204 C		
Percent Side Groove	= 20 %		
Specimen Thickness	= 25.4 mm		
Init crack length	= 31.65 mm	Init a/W	= .623
Final crack length	= 42.61 mm	Final a/W	= .838
Flow stress	= 498.3 MPa		
Youngs modulus	= 195500 MPa	(Estimated Value)	

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 150.5 kJ/m^2		
Kjc	= 171.5	J (@J/T=8.8)	= 535.6 kJ/m^2
Exponent N	= .517		
Coefficient C	= 278.8 kJ/m^2		
T (average)	= 113		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 147.3 kJ/m^2		
Kjc	= 169.7	Slope M	= 146270.1 kJ/m^3
Intercept B	= 125.7 kJ/m^2		
T (ASTM)	= 115		
Validity (Jic)	= VALID		
Validity (R-curve)	= INVALID--3 (.5 vs .28)		
J maximum allowed	= 476.8 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 1.91 mm	(Delta a max = 0.1*bo)	



TEST SPECIMEN DATA

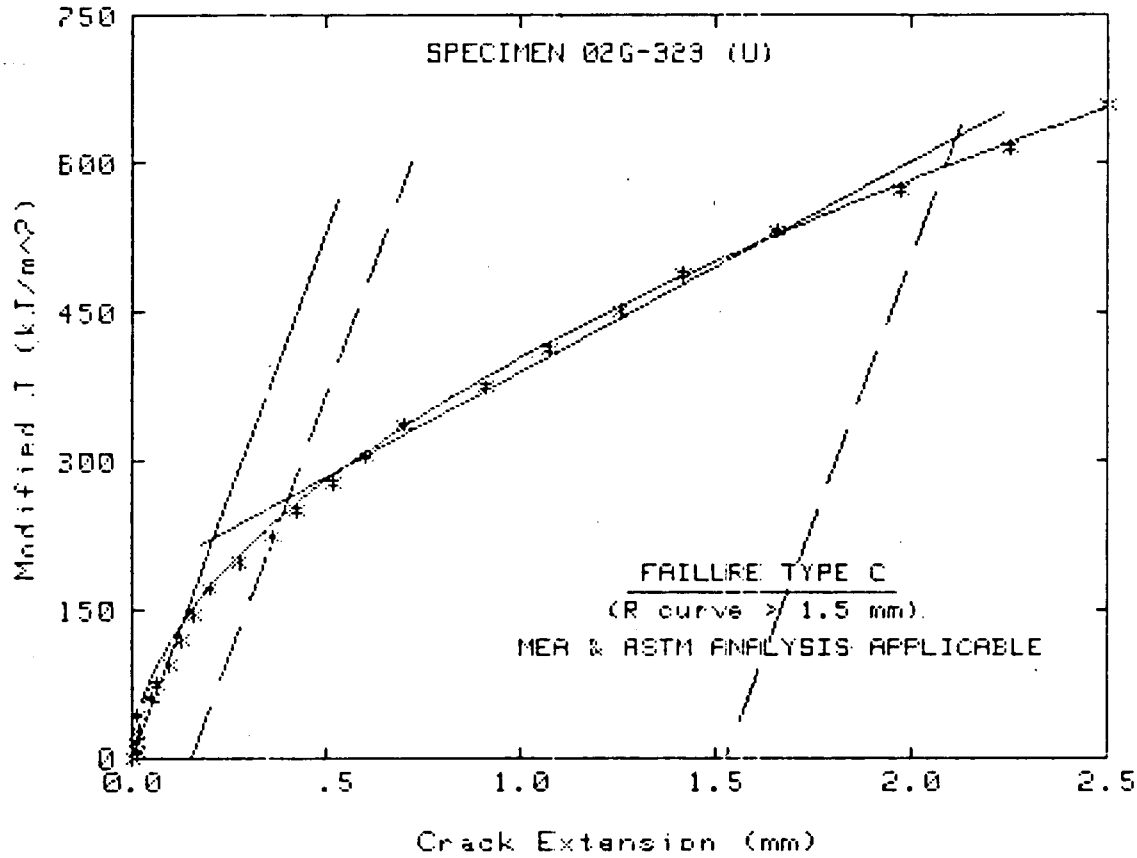
Material Type	= A533-B 02 REF	
Test Temperature	= 22 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.61 mm	Init a/W = .622
Flow stress	= 549.9 MPa	
Youngs modulus	= 205900 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 240.8 kJ/m^2	
Kjc	= 222.6	Exponent N = .5496
Coefficient C	= 414.9 kJ/m^2	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 1.7 kJ/m^2	
Kjc	= 18.5	Slope M = 3.8 kJ/m^3
Intercept B	= 1.7 kJ/m^2	
Validity (Jic)	= INVALID--a, b	
Validity (R-curve)	= INVALID--2	
J maximum allowed	= 527.3 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.92 mm	(Delta a max = 0.1*bo)
Poisson's Ratio (v)	= 0	



TEST SPECIMEN DATA

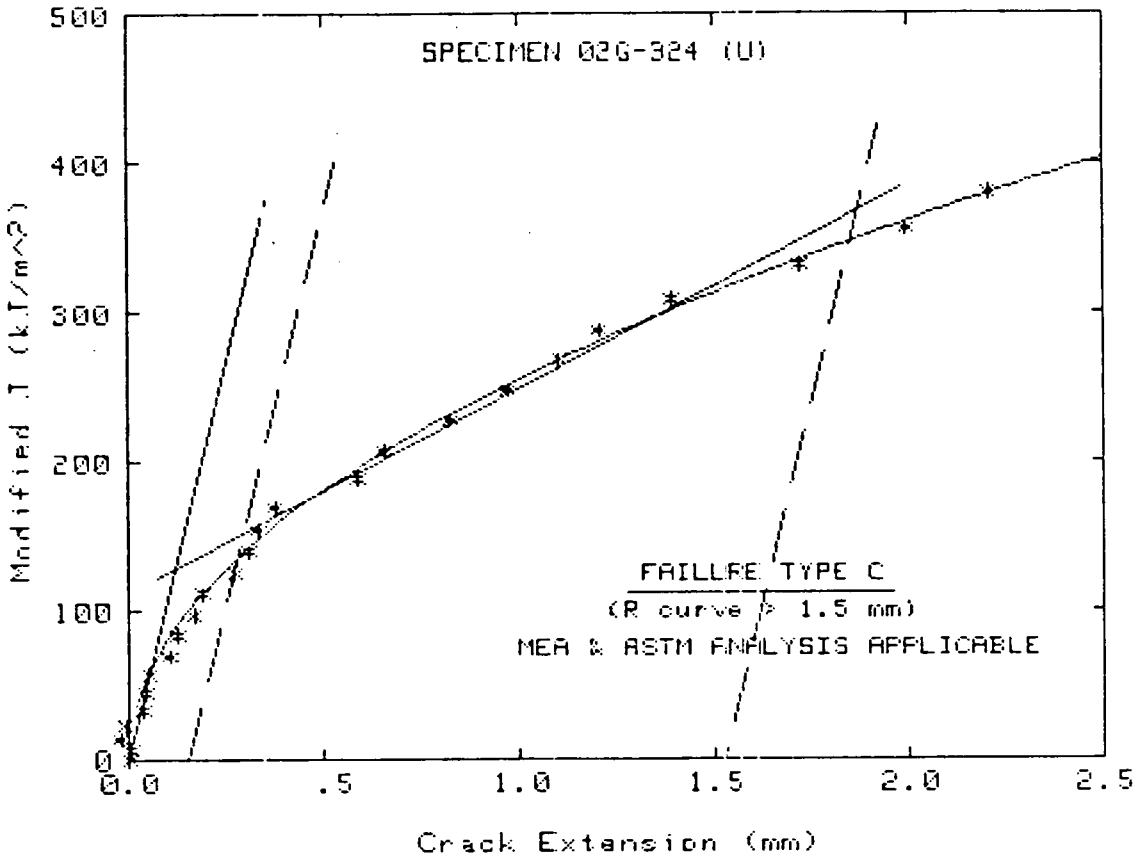
Material Type	= A533-B PLATE 02	
Test Temperature	= 50 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.46 mm	Init a/W = .619
Final crack length	= 40.37 mm	Final a/W = .794
Flow stress	= 531.1 MPa	
Youngs modulus	= 204400 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 243.2 kJ/m^2	
Kjc	= 222.9	J (@J/T=8.8) = 763.7 kJ/m^2
Exponent N	= .5272	
Coefficient C	= 404.2 kJ/m^2	
T (average)	= 145	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 221.7 kJ/m^2	
Kjc	= 212.8	Slope M = 211469.5 kJ/m^3
Intercept B	= 177.5 kJ/m^2	
T (ASTM)	= 153	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--3 (.53 vs .29)	
J maximum allowed	= 513.3 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.93 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

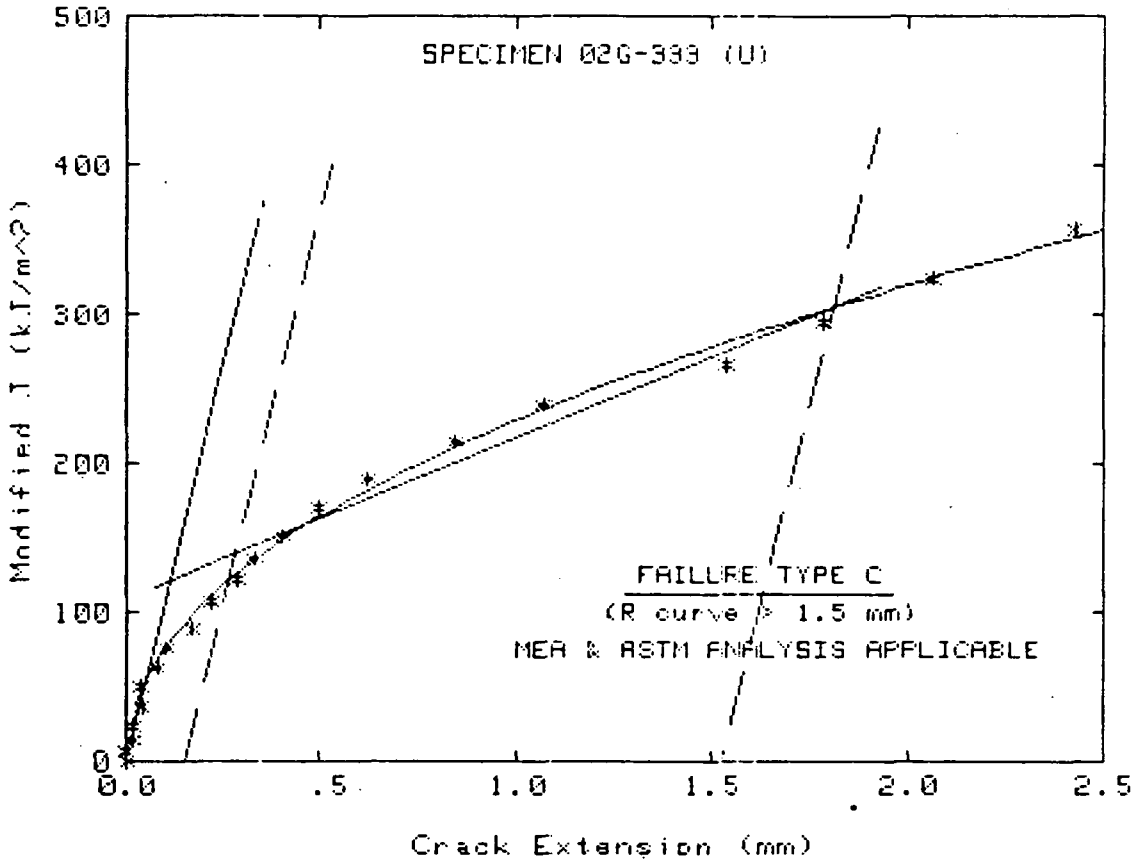
Material Type	= A533-B PLATE 02	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.62 mm	Init a/W = .622
Final crack length	= 40.12 mm	Final a/W = .789
Flow stress	= 533.8 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 135.1 kJ/m^2	
Kjc	= 160.5	J (@J/T=8.8) = 509.7 kJ/m^2
Exponent N	= .4994	
Coefficient C	= 255.6 kJ/m^2	
T (average)	= 87	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 128 kJ/m^2	
Kjc	= 156.3	Slope M = 137844.6 kJ/m^3
Intercept B	= 111.5 kJ/m^2	
T (ASTM)	= 92	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 511.5 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.92 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

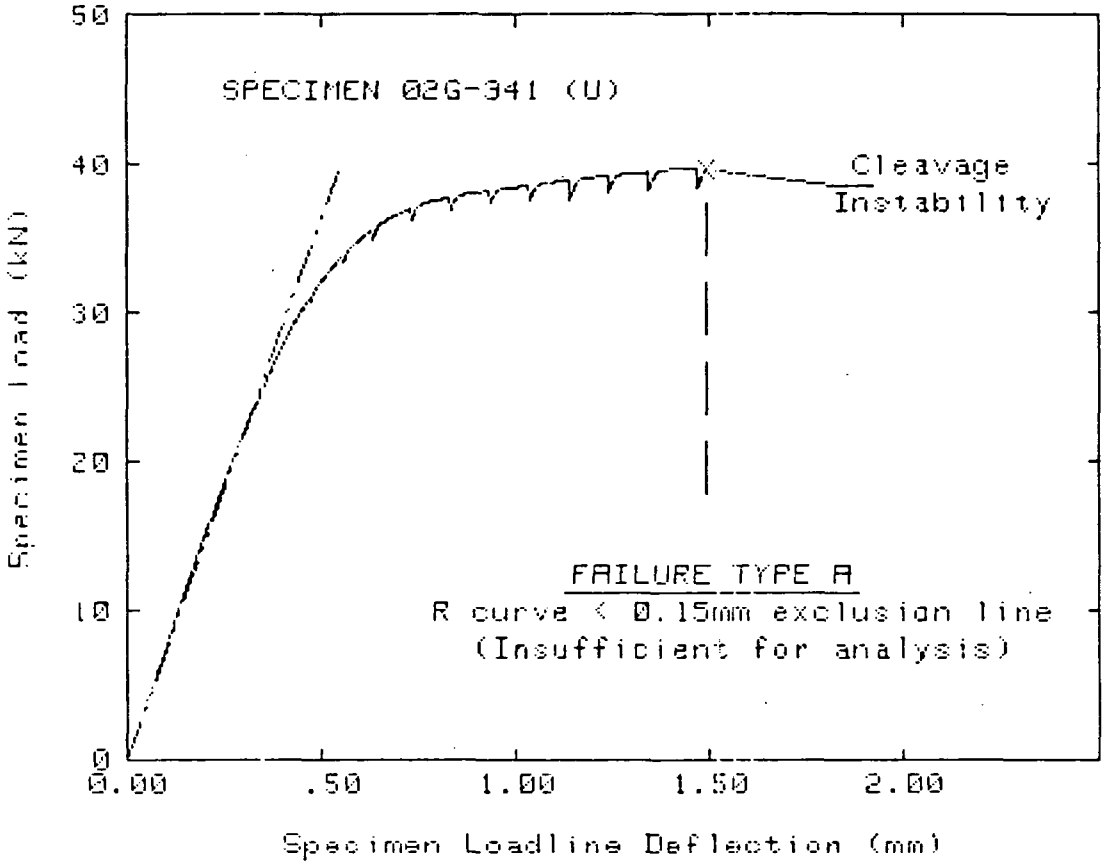
Material Type	= A533-B PLATE 02	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.81 mm	Init a/W = .626
Final crack length	= 37.65 mm	Final a/W = .741
Flow stress	= 533.8 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 121.1 kJ/m^2	
Kjc	= 152	J (@J/T=8.8) = 475.4 kJ/m^2
Exponent N	= .4816	
Coefficient C	= 229.2 kJ/m^2	
T (average)	= 76	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 121.6 kJ/m^2	
Kjc	= 152.3	Slope M = 108965.3 kJ/m^3
Intercept B	= 109.1 kJ/m^2	
T (ASTM)	= 73	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 506.5 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.9 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B PLATE 02	
Test Temperature	= 23 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .623	
Init crack length a	= 31.64 mm	
Flow stress	= 549.9 MPa	
Yield stress	= 473.9 MPa	
Youngs modulus E	= 205900 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

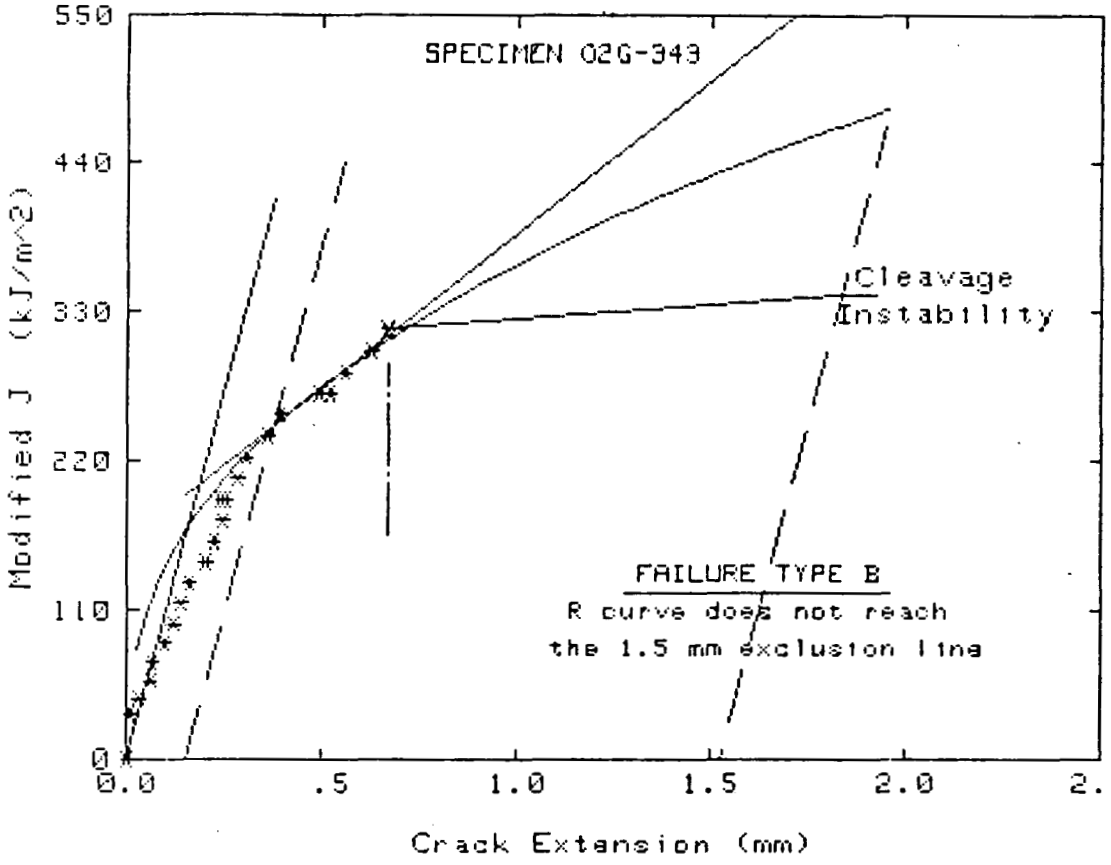
Jic	= 209.5 kJ/m^2	
Kjc=(EJic)^.5	= 207.8 MPa √m	ν=.3
Kic (Beta Corrected)	= 96.1 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 39.61 kN	
5% Secant Offset Pq	= 22.27 kN	
Kic	= 58.3 MPa √m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

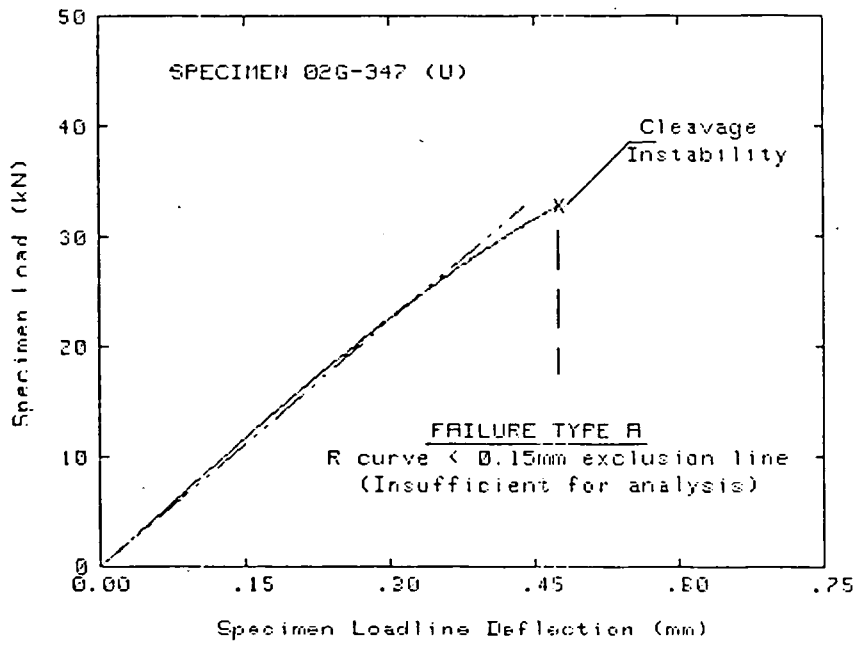
Material Type	= A533-B 02 REF		
Test Temperature	= 22 C		
Percent Side Groove	= 20 %		
Specimen Thickness	= 25.4 mm		
Init crack length	= 32.06 mm	Init a/W	= .631
Flow stress	= 549.9 MPa		
Youngs modulus	= 205900 MPa	(Estimated Value)	

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 243.9 kJ/m^2		
Kjc	= 224.1	Exponent N	= .4113
Coefficient C	= 365.4 kJ/m^2		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 200.9 kJ/m^2		
Kjc	= 203.4	Slope M	= 228766.2 kJ/m^3
Intercept B	= 159.1 kJ/m^2		
Validity (Jic)	= INVALID--b		
Validity (R-curve)	= VALID.		
J maximum allowed	= 515 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 1.87 mm	(Delta a max = 0.1*bo)	
Poisson's Ratio (v)	= 0		



TEST SPECIMEN DATA

Material Type	= A533-B PLATE 02	
Test Temperature	= -40 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .62	
Init crack length a	= 31.51 mm	
Flow stress	= 608.9 MPa	
Yield stress	= 529.4 MPa	
Youngs modulus E	= 209500 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

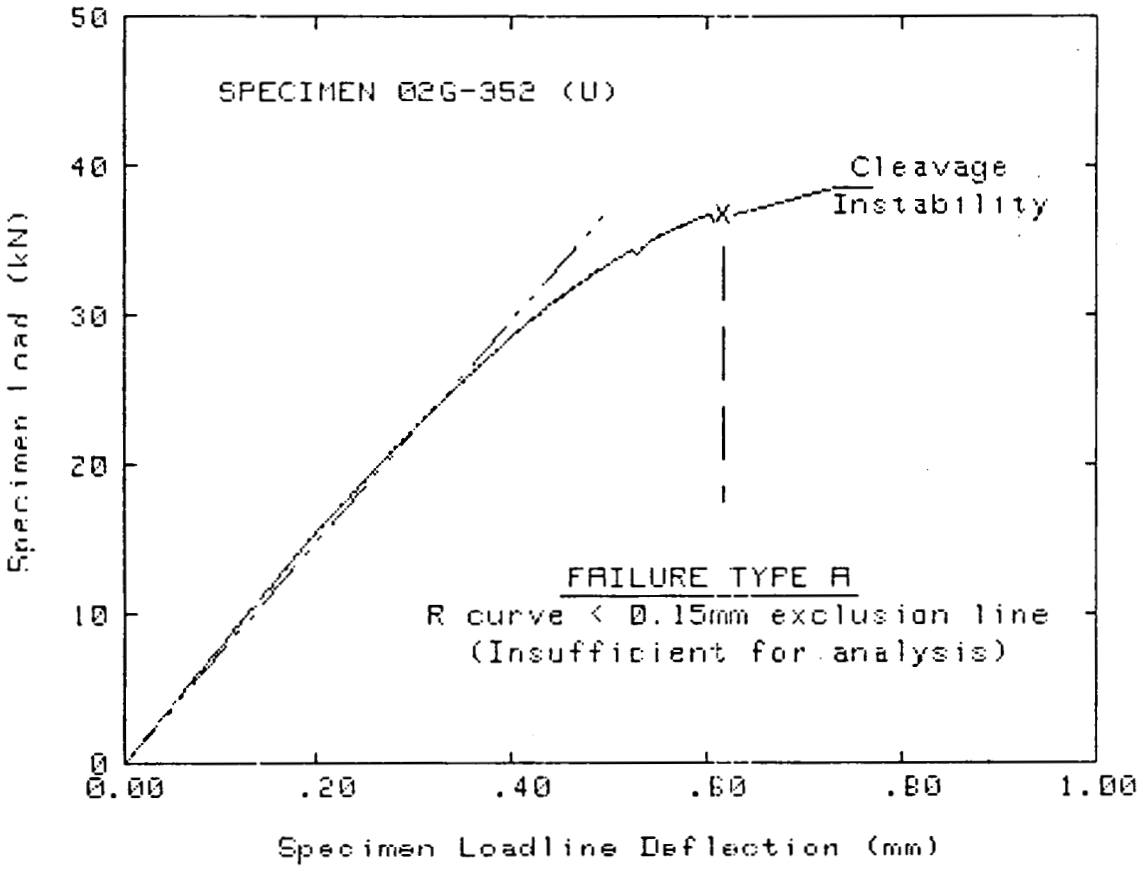
Jic	= 37.6 kJ/m^2	
Kjc=(EJic)^.5	= 88.8 MPa \/m	v=.3
Kic (Beta Corrected)	= 69.4 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 32.78 kN	
5% Secant Offset Pq	= 23.92 kN	
Kic	= 61.9 MPa \/m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-1.74271021242E-04 in.
Specimen rotation Load intercept elastic slope =-2.53658536585E-07 lb
Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533-B PLATE 02	
Test Temperature	= -40 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .622	
Init crack length a	= 31.61 mm	
Flow stress	= 608.9 MPa	
Yield stress	= 529.4 MPa	
Youngs modulus E	= 140500 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

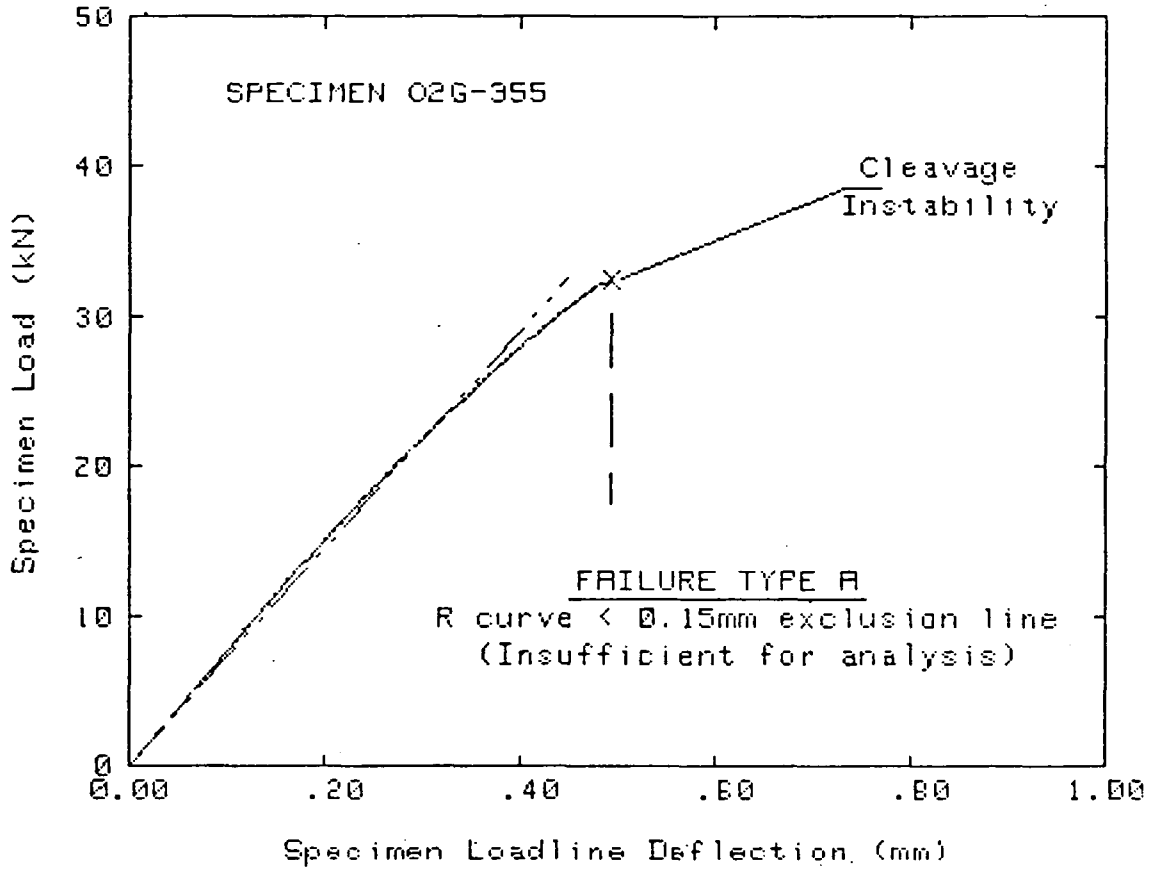
Jic	= 59.7 kJ/m^2	
Kjc=(EJic)^.5	= 91.6 MPa √m	ν=.3
Kic (Beta Corrected)	= 70.6 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 36.8 kN	
5% Secant Offset Pq	= 23.14 kN	
Kic	= 60.4 MPa √m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533-B 02 REF	
Test Temperature	= -40 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .622	
Init crack length a	= 31.58 mm	
Flow stress	= 608.9 MPa	
Yield stress	= 529.4 MPa	
Youngs modulus E	= 209500 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

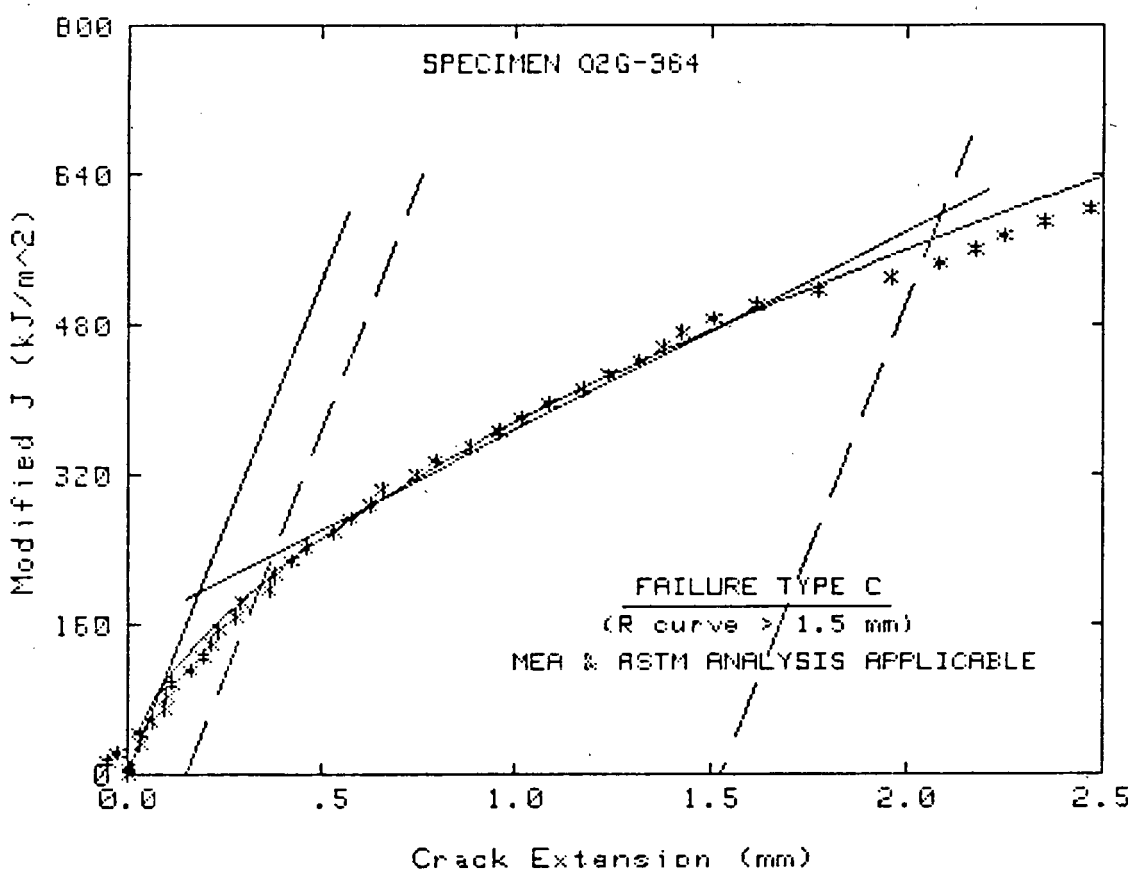
Jic	= 39.3 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 90.8 MPa \/m	v=.3
Kic (Beta Corrected)	= 70.2 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 32.5 kN	
5% Secant Offset Pq	= 22.9 kN	
Kic	= 59.6 MPa \/m	
Validity	= INVALID--1, 2, 3	
K at Maximum Load	= 84.6 MPa \/m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

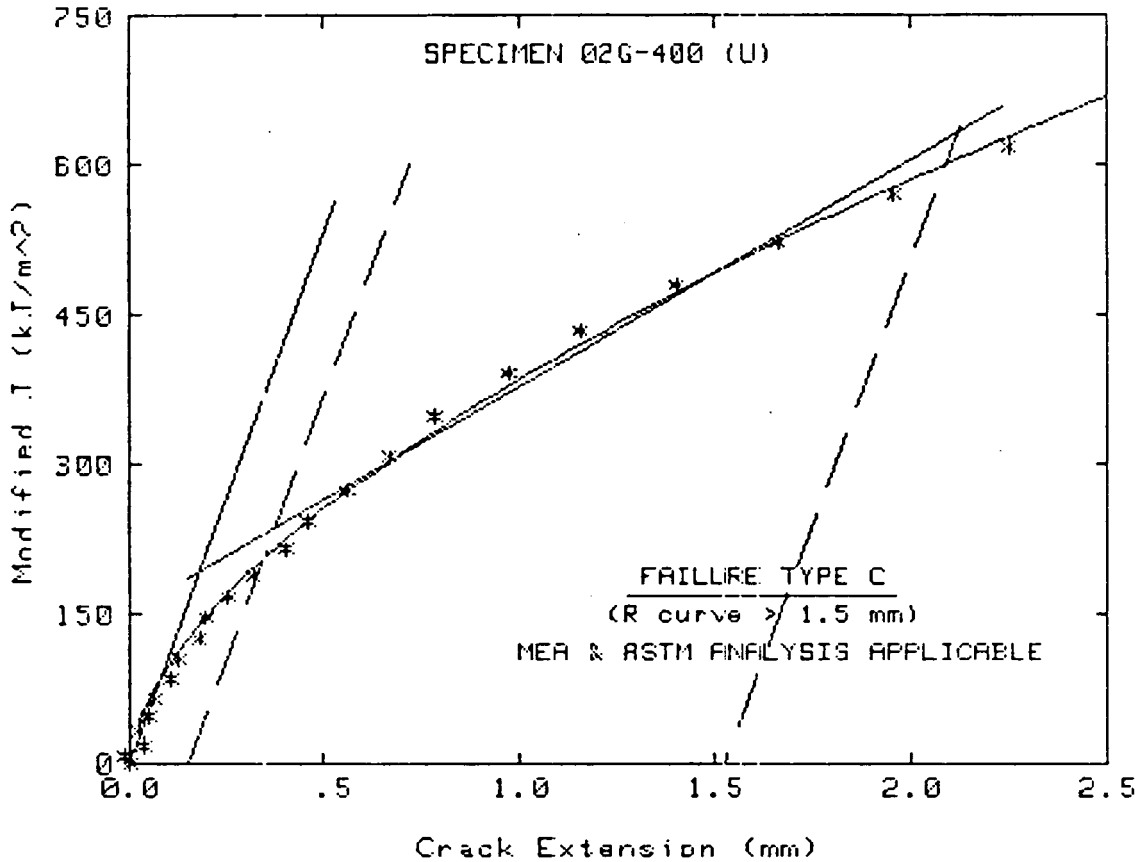
Material Type	= A533-B 02 REF	
Test Temperature	= 50 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 32.17 mm	Init a/W = .633
Final crack length	= 34.79 mm	Final a/W = .684
Flow stress	= 531.2 MPa	
Youngs modulus	= 204400 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 202.9 kJ/m^2
Kjc	= 203.6 MPa √m
J (@J/T=8.8)	= 611.1 kJ/m^2
Exponent N	= .5769
Coefficient C	= 375.8 kJ/m^2
T (average)	= 151

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 194.1 kJ/m^2	
Kjc	= 199.2 MPa √m	
Slope M	= 213000.5 kJ/m^3	
Intercept B	= 155.2 kJ/m^2	
T (ASTM)	= 154	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 494.4 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.86 mm	(Delta a max = 0.1*bo)
Final Delta a	= 2.55 mm	
Poisson's Ratio (v)	= 0	



TEST SPECIMEN DATA

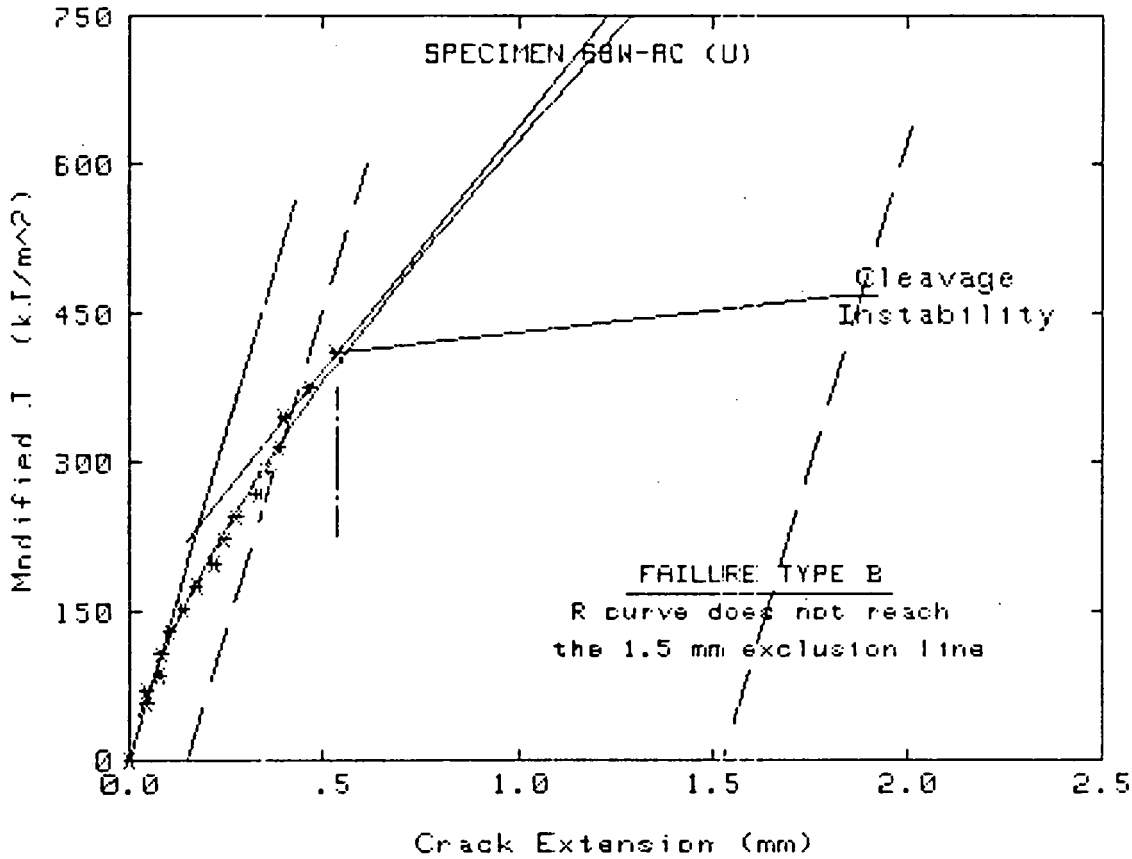
Material Type	= A533-B PLATE 02		
Test Temperature	= 50 C		
Percent Side Groove	= 20 %		
Specimen Thickness	= 25.4 mm		
Init crack length	= 31.27 mm	Init a/W	= .615
Final crack length	= 39.64 mm	Final a/W	= .78
Flow stress	= 531.1 MPa		
Youngs modulus	= 204400 MPa	(Estimated Value)	

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 203.5 kJ/m^2		
Kjc	= 203.9	J (@J/T=8.8)	= 812.8 kJ/m^2
Exponent N	= .5995		
Coefficient C	= 385.8 kJ/m^2		
T (average)	= 160		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 192.2 kJ/m^2		
Kjc	= 198.2	Slope M	= 226743.4 kJ/m^3
Intercept B	= 151.2 kJ/m^2		
T (ASTM)	= 164		
Validity (Jic)	= VALID		
Validity (R-curve)	= INVALID--3 (.46 vs .29)		
J maximum allowed	= 518.4 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 1.95 mm	(Delta a max = 0,1*bo)	



TEST SPECIMEN DATA

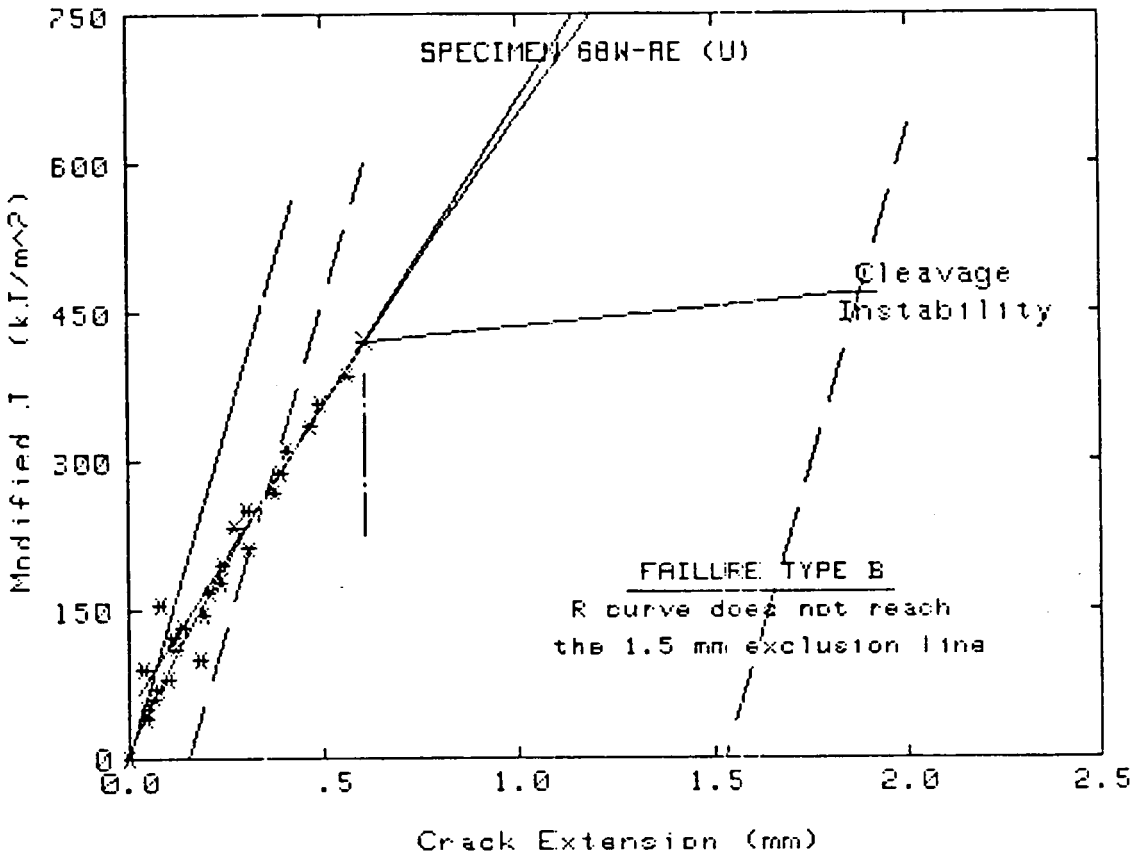
Material Type	= A533-B HSST WELD		
Test Temperature	= -30 C		
Percent Side Groove	= 0 %		
Specimen Thickness	= 25.4 mm		
Init crack length	= 30.33 mm	Init a/W	= .596
Flow stress	= 652.5 MPa		
Youngs modulus	= 208900 MPa	(Estimated Value)	

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 324.9 kJ/m^2		
Kjc	= 260.5	Exponent N	= .7192
Coefficient C	= 626.2 kJ/m^2		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 234.6 kJ/m^2		
Kjc	= 221.4	Slope M	= 494267.2 kJ/m^3
Intercept B	= 145.7 kJ/m^2		
Validity (Jic)	= INVALID--a, b		
Validity (R-curve)	= INVALID--2		
J maximum allowed	= 667.5 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 2.05 mm	(Delta a max = 0.1*bo)	



TEST SPECIMEN DATA

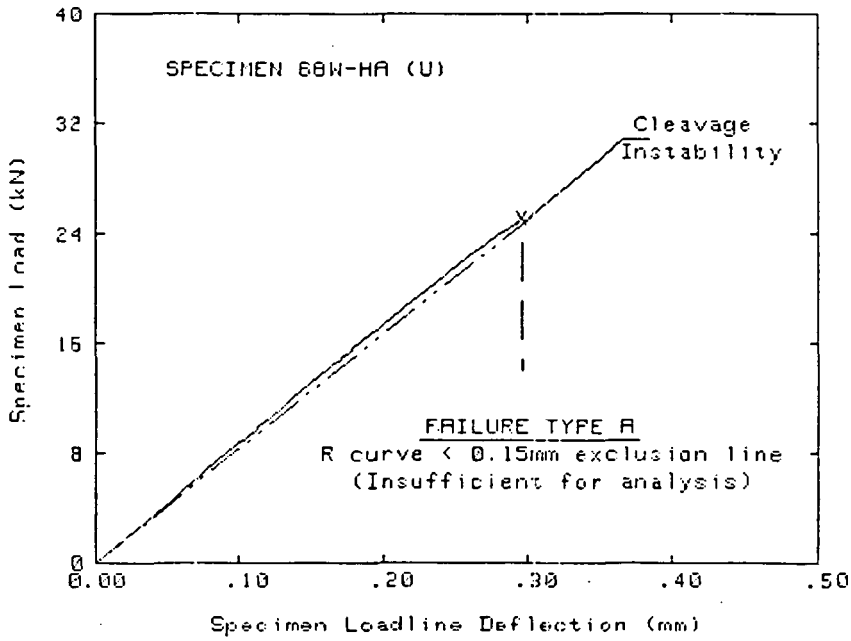
Material Type	= A533-B HSST WELD	
Test Temperature	= -40 C	
Percent Side Groove	= 0 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.52 mm	Init a/W = .6
Flow stress	= 663.8 MPa	
Youngs modulus	= 209500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 262.3 kJ/m^2		
Kjc	= 234.4	Exponent N	= .8619
Coefficient C	= 648.2 kJ/m^2		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 93.6 kJ/m^2		
Kjc	= 140	Slope M	= 610763.2 kJ/m^3
Intercept B	= 50.5 kJ/m^2		
Validity (Jic)	= INVALID--b		
Validity (R-curve)	= VALID		
J maximum allowed	= 672.7 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 2.03 mm	(Delta a max = 0.1*bo)	



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= -120 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .599	
Init crack length a	= 30.42 mm	
Flow stress	= 775.3 MPa	
Yield stress	= 748.7 MPa	
Youngs modulus E	= 214100 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

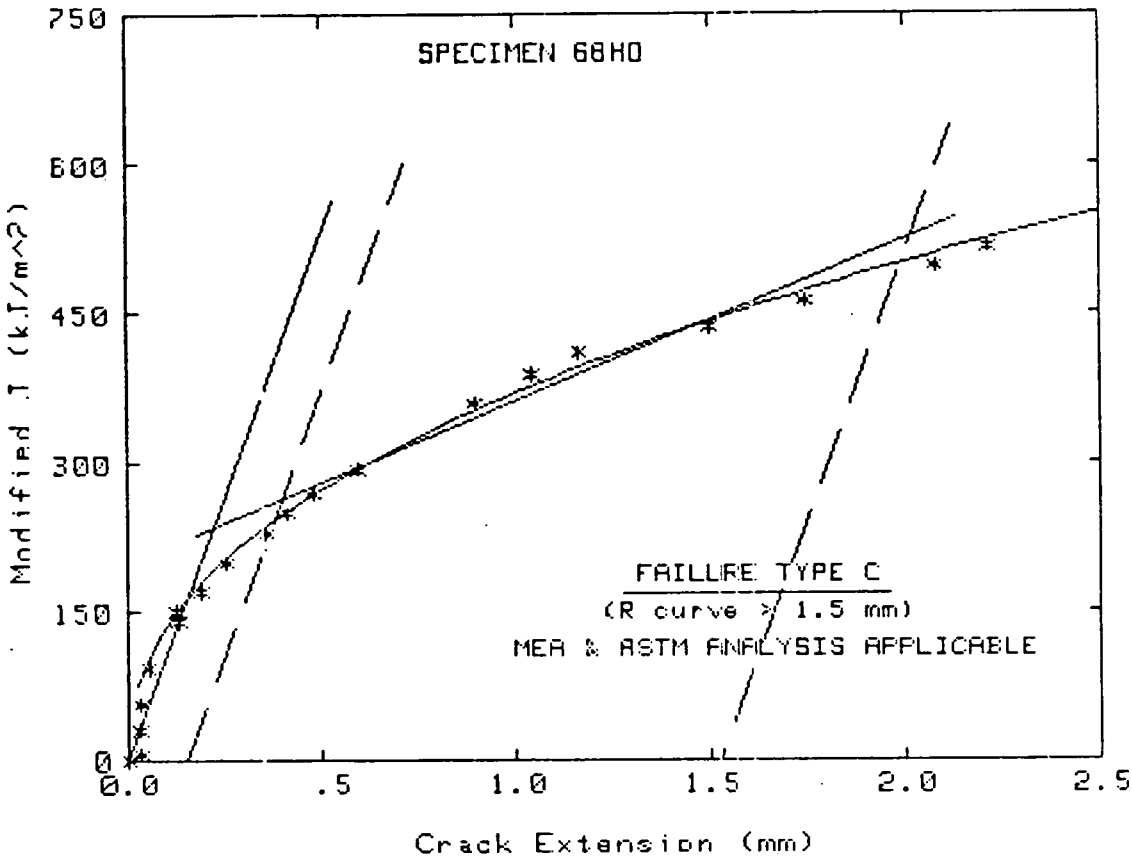
Jic	= 16.2 kJ/m^2	
Kjc=(EJic)^.5	= 58.9 MPa √m	ν=.3
Kic (Beta Corrected)	= 56.9 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 25.18 kN	
5% Secant Offset Pq	= 25.18 kN	
Kic	= 59.8 MPa √m	
Validity	= VALID Kic value	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-4.13591647198E-05 in.
Specimen rotation Load intercept elastic slope =-2.47058823529E-07 lb
Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

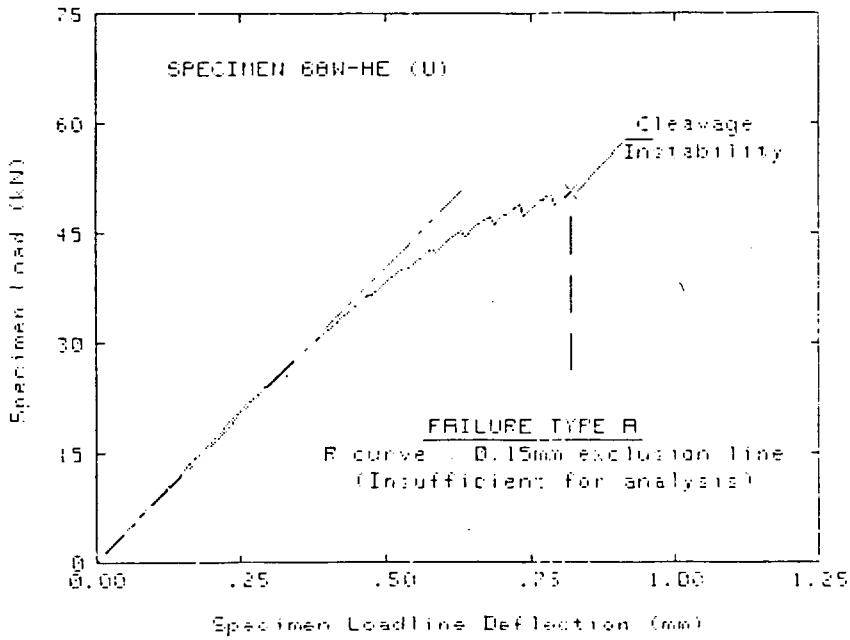
Material Type	= A533-B HSST WELD	
Test Temperature	= 200 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.81 mm	Init a/W = .606
Final crack length	= 34.88 mm	Final a/W = .686
Flow stress	= 533.4 MPa	
Youngs modulus	= 195800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 242.3 kJ/m^2	
Kjc	= 217.8	J (@J/T=8.8) = 575.9 kJ/m^2
Exponent N	= .4366	
Coefficient C	= 369.8 kJ/m^2	
T (average)	= 106	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 236.1 kJ/m^2	
Kjc	= 215	Slope M = 161510.1 kJ/m^3
Intercept B	= 200.3 kJ/m^2	
T (ASTM)	= 111	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 532.6 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= -80 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a W	= .608	
Init crack length a	= 30.87 mm	
Flow stress	= 715.3 MPa	
Yield stress	= 683.5 MPa	
Youngs modulus E	= 211800 MPa	(Estimated Value

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

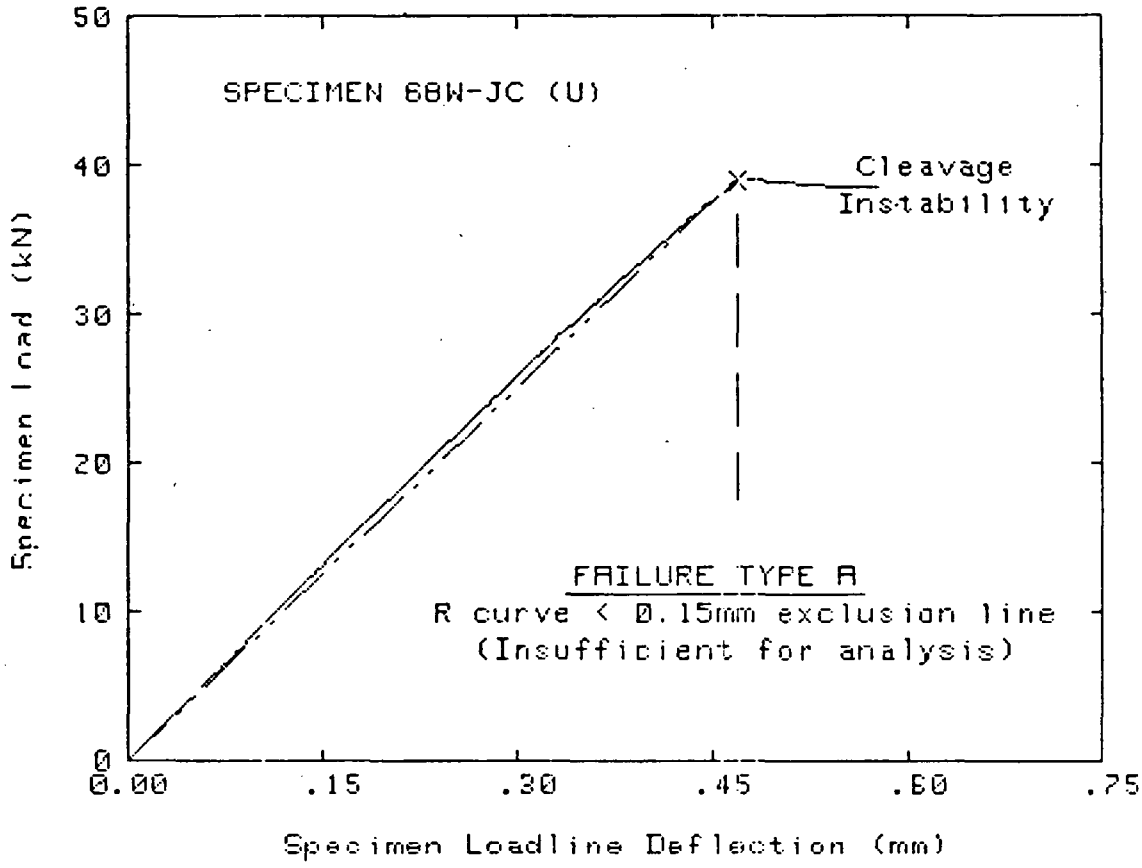
Jic	= 107.3 kJ/m^2	
Kjc=(EJic)^.5	= 150.8 MPa √m	ν=.3
Kic (Beta Corrected)	= 103.3 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 50.77 kN	
5% Secant Offset, Pq	= 28.96 kN	
Kic	= 71.2 MPa √m	
Validity	= INVALID--2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-7.748666064270E-05 in.
Specimen rotation Load intercept elastic slope =-1.11111111111E-08 lb
Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= -95 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .597	
Init crack length a	= 30.34 mm	
Flow stress	= 736.8 MPa	
Yield stress	= 706.9 MPa	
Youngs modulus E	= 212600 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

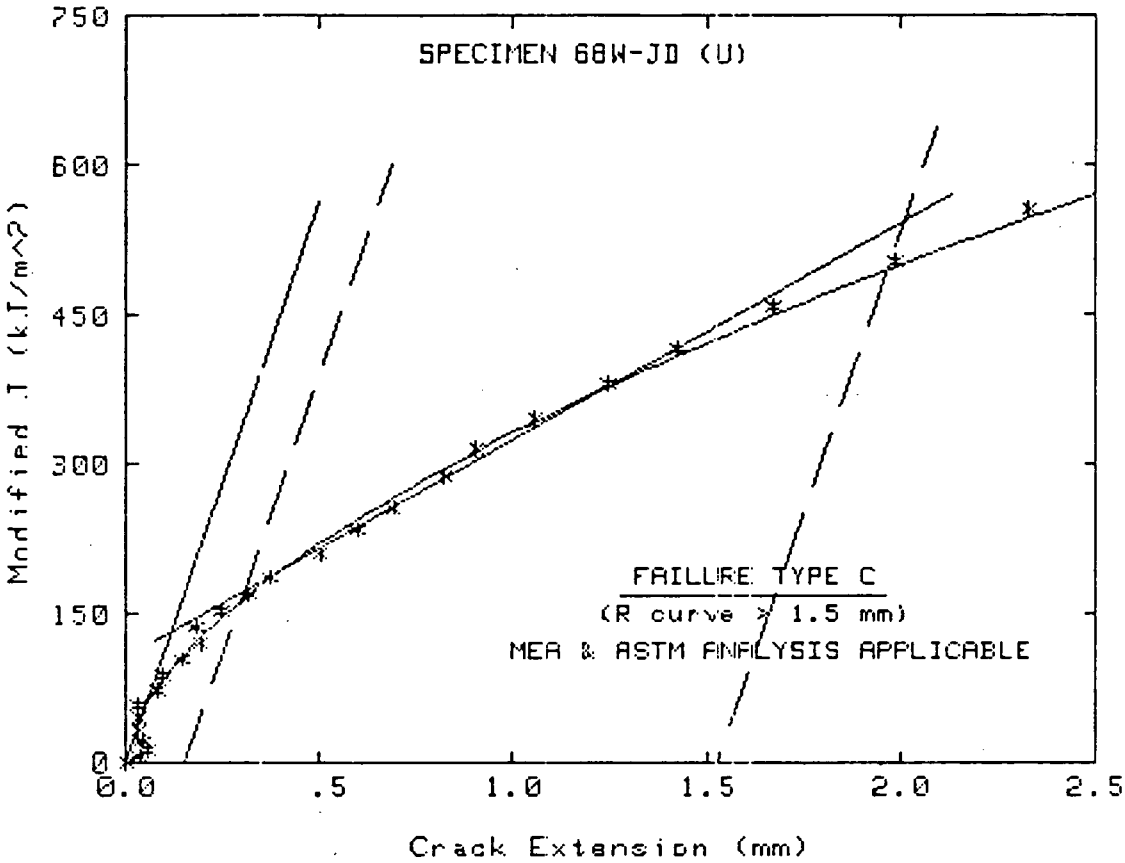
Jic	= 40.2 kJ/m^2	
Kjc=(EJic)^.5	= 92.5 MPa √m	ν=.3
Kic (Beta Corrected)	= 79.6 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 39.01 kN	
5% Secant Offset Pq	= 38.17 kN	
Kic	= 90.1 MPa √m	
Validity	= INVALID--1, 2	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

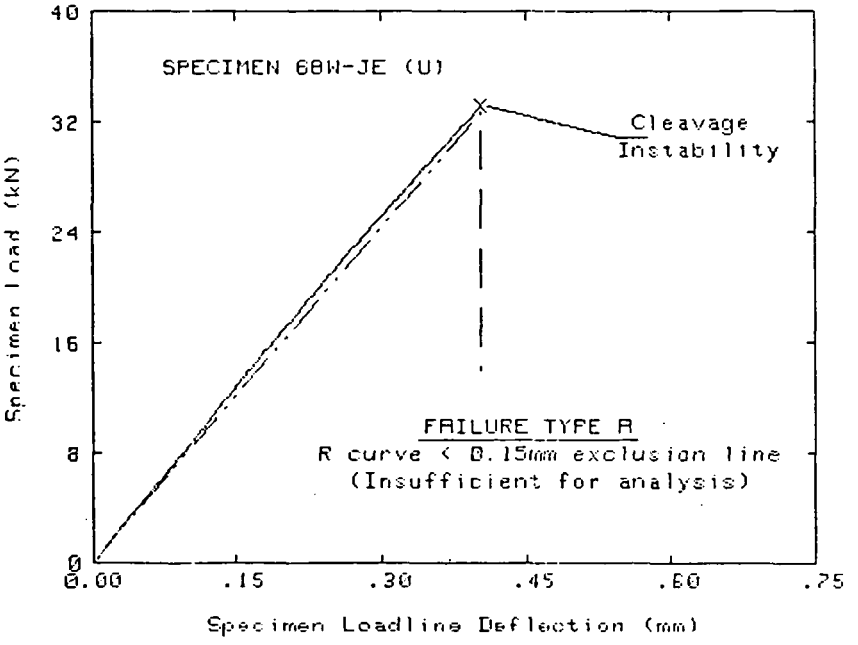
Material Type	= A533-B HSST WELD		
Test Temperature	= 288 C		
Percent Side Groove	= 20 %		
Specimen Thickness	= 25.4 mm		
Init crack length	= 30.72 mm	Init a/W	= .604
Final crack length	= 37.81 mm	Final a/W	= .744
Flow stress	= 561.4 MPa		
Youngs modulus	= 190800 MPa	(Estimated Value)	

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 161.3 kJ/m^2		
Kjc	= 175.4	J (@J/T=8.8)	= 651 kJ/m^2
Exponent N	= .5914		
Coefficient C	= 331.3 kJ/m^2		
T (average)	= 117		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 131.5 kJ/m^2		
Kjc	= 158.4	Slope M	= 217894.8 kJ/m^3
Intercept B	= 106 kJ/m^2		
T (ASTM)	= 132		
Validity (Jic)	= VALID		
Validity (R-curve)	= VALID		
J maximum allowed	= 563.4 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 2.01 mm	(Delta a max = 0.1*bo)	



TEST SPECIMEN DATA

Material Type	= HSST WELD	
Test Temperature	= -125 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .603	
Init crack length a	= 30.63 mm	
Flow stress	= 783.4 MPa	
Yield stress	= 757.5 MPa	
Youngs modulus E	= 214300 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

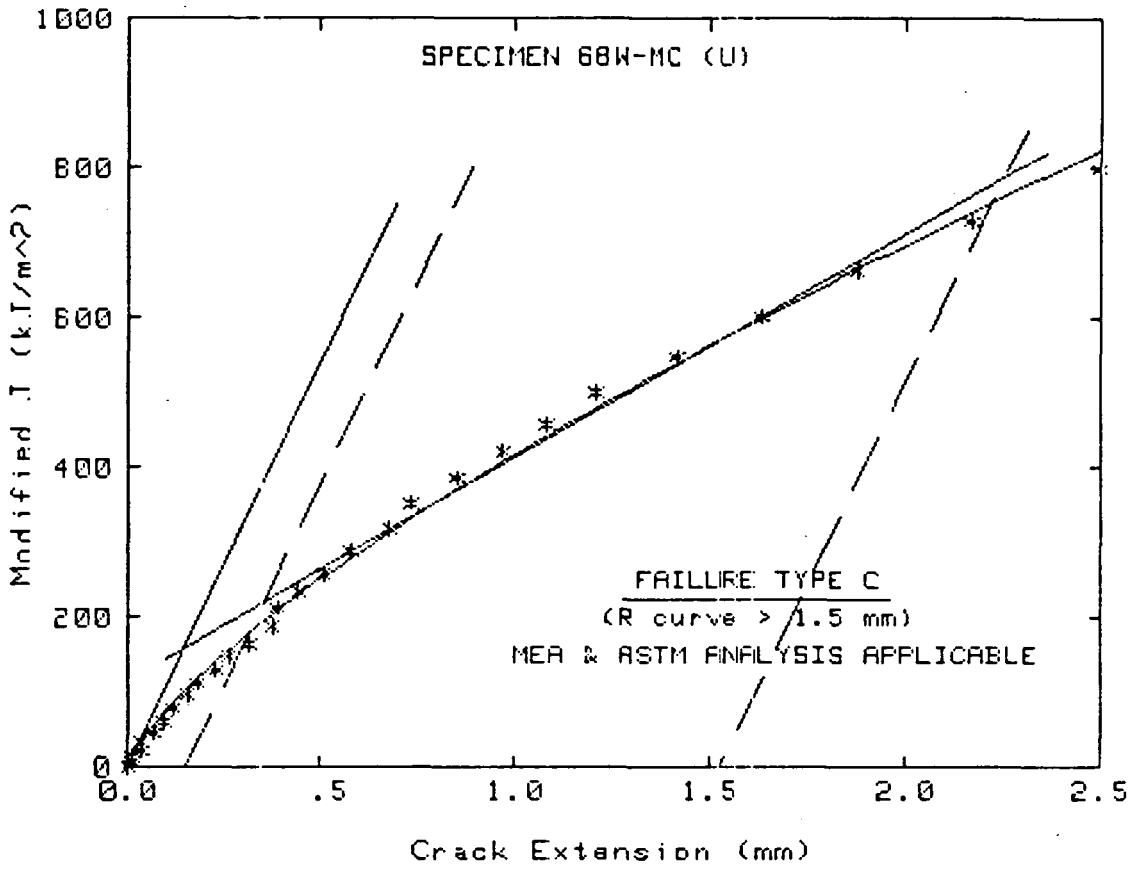
Jic	= 29.4 kJ/m^2	
Kjc=(EJic)^.5	= 79.4 MPa √m	ν=.3
Kic (Beta Corrected)	= 72.9 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 33.15 kN	
5% Secant Offset Pq	= 33.14 kN	
Kic	= 80 MPa √m	
Validity	= INVALID--2	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 6.83164835108E-05 in.
Specimen rotation Load intercept elastic slope =-.00000003 lb
Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

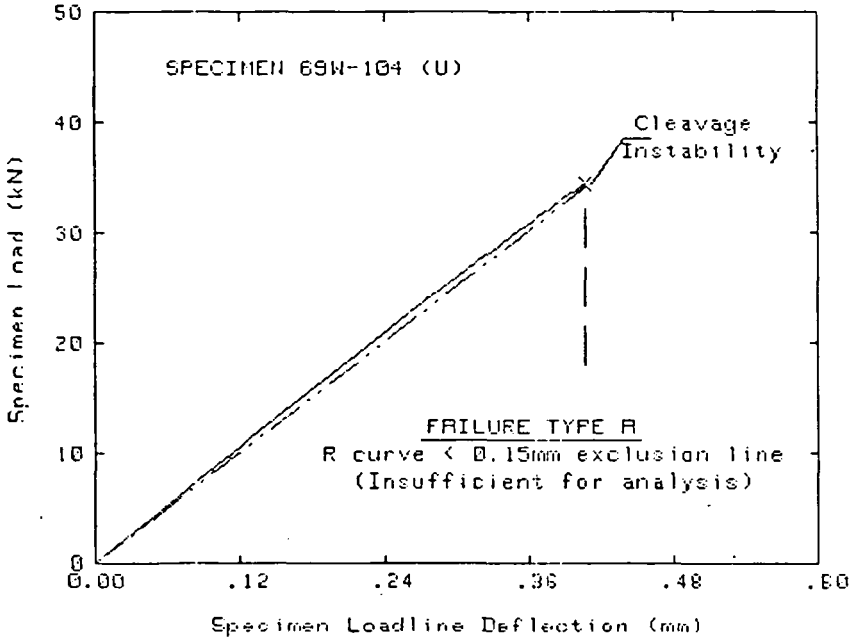
Material Type	= A533-B HSST WELD		
Test Temperature	= 121 C		
Percent Side Groove	= 20 %		
Specimen Thickness	= 25.4 mm		
Init crack length	= 30.82 mm	Init a/W	= .606
Final crack length	= 38.83 mm	Final a/W	= .764
Flow stress	= 542.3 MPa		
Youngs modulus	= 200300 MPa	(Estimated Value)	

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 177.5 kJ/m^2		
Kjc	= 188.5	J (@J/T=8.8)	= 1054.8 kJ/m^2
Exponent N	= .742		
Coefficient C	= 417.1 kJ/m^2		
T (average)	= 203		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 156.1 kJ/m^2		
Kjc	= 176.8	Slope M	= 299157.5 kJ/m^3
Intercept B	= 113 kJ/m^2		
T (ASTM)	= 204		
Validity (Jic)	= VALID		
Validity (R-curve)	= INVALID--1		
J maximum allowed	= 541.5 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 2 mm	(Delta a max = 0.1*bo)	



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= -60 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .597	
Init crack length a	= 30.34 mm	
Flow stress	= 766 MPa	
Yield stress	= 725.3 MPa	
Youngs modulus E	= 210600 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

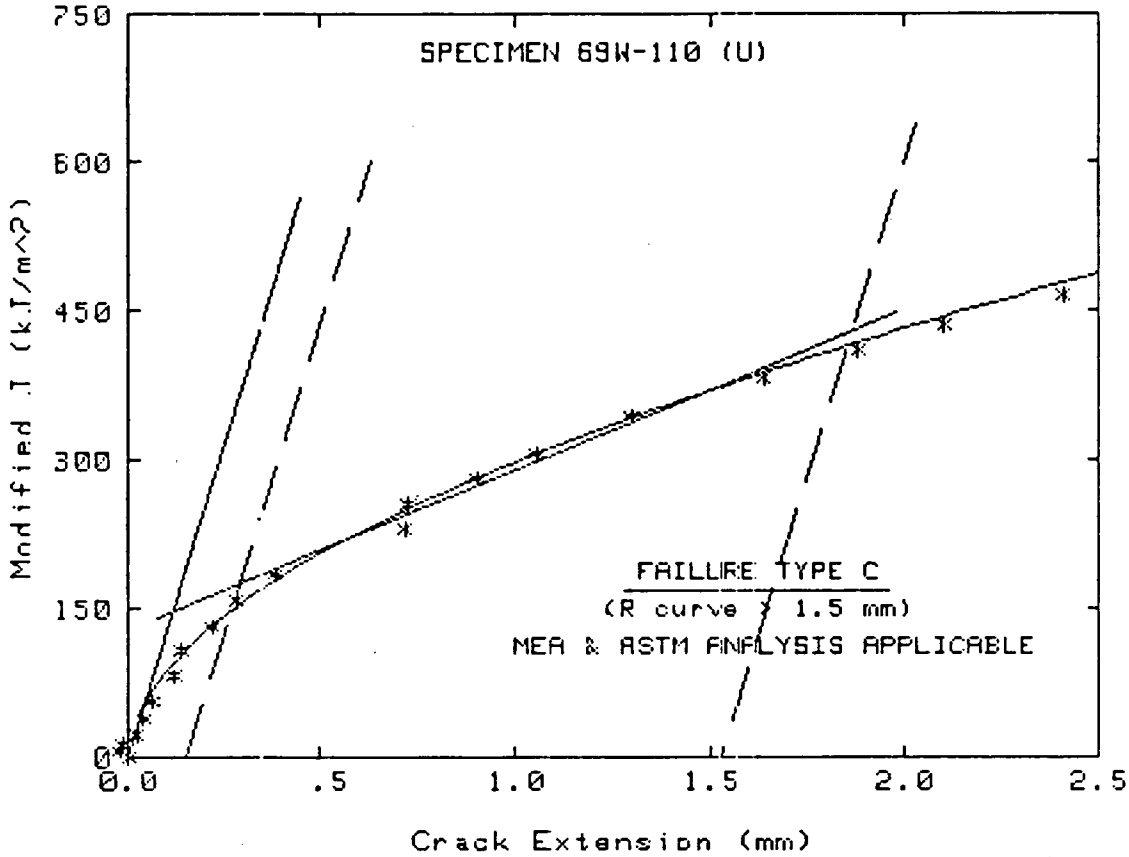
Jic	= 30.6 kJ/m^2	
Kjc=(EJic)^.5	= 80.3 MPa √m	ν=.3
Kic (Beta Corrected)	= 72.7 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 34.53 kN	
5% Secant Offset Pq	= 34.53 kN	
Kic	= 81.4 MPa √m	
Validity	= INVALID--1, 2	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-6.01662083404E-05 in.
Specimen rotation Load intercept elastic slope =-.0000000209375 lb
Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

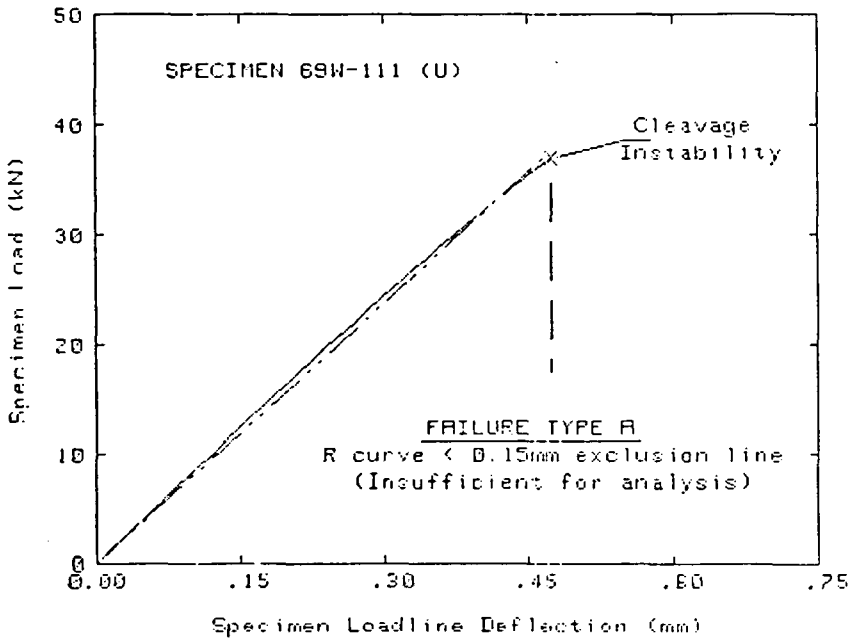
Material Type	= A533-B HSST WELD	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.64 mm	Init a/W = .603
Final crack length	= 40.62 mm	Final a/W = .799
Flow stress	= 630.3 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 147.4 kJ/m^2	
Kjc	= 171.8	J (@J/T=8.8) = 466.9 kJ/m^2
Exponent N	= .5364	
Coefficient C	= 297.9 kJ/m^2	
T (average)	= 82	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 147.3 kJ/m^2	
Kjc	= 171.8	Slope M = 161876.3 kJ/m^3
Intercept B	= 128.4 kJ/m^2	
T (ASTM)	= 82	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 634.8 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.02 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= -5 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .604	
Init crack length a	= 30.66 mm	
Flow stress	= 707.4 MPa	
Yield stress	= 664.6 MPa	
Youngs modulus E	= 207500 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

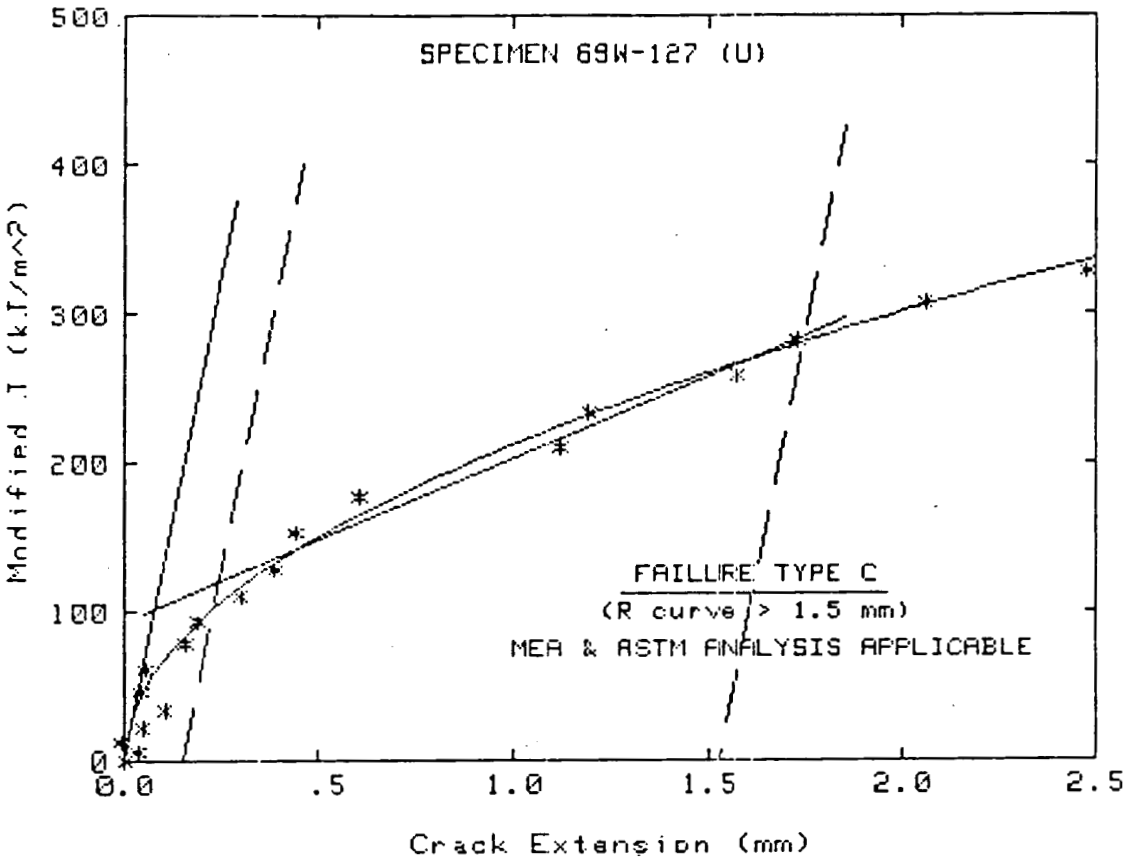
Jic	= 39.4 kJ/m^2	
Kjc=(EJic)^.5	= 90.5 MPa √m	ν=.3
Kic (Beta Corrected)	= 76.8 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 37.01 kN	
5% Secant Offset Pq	= 33.25 kN	
Kic	= 80.4 MPa √m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-2.46783178095E-04 in.
Specimen rotation Load intercept elastic slope = 6.12903225806E-03 lb
Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

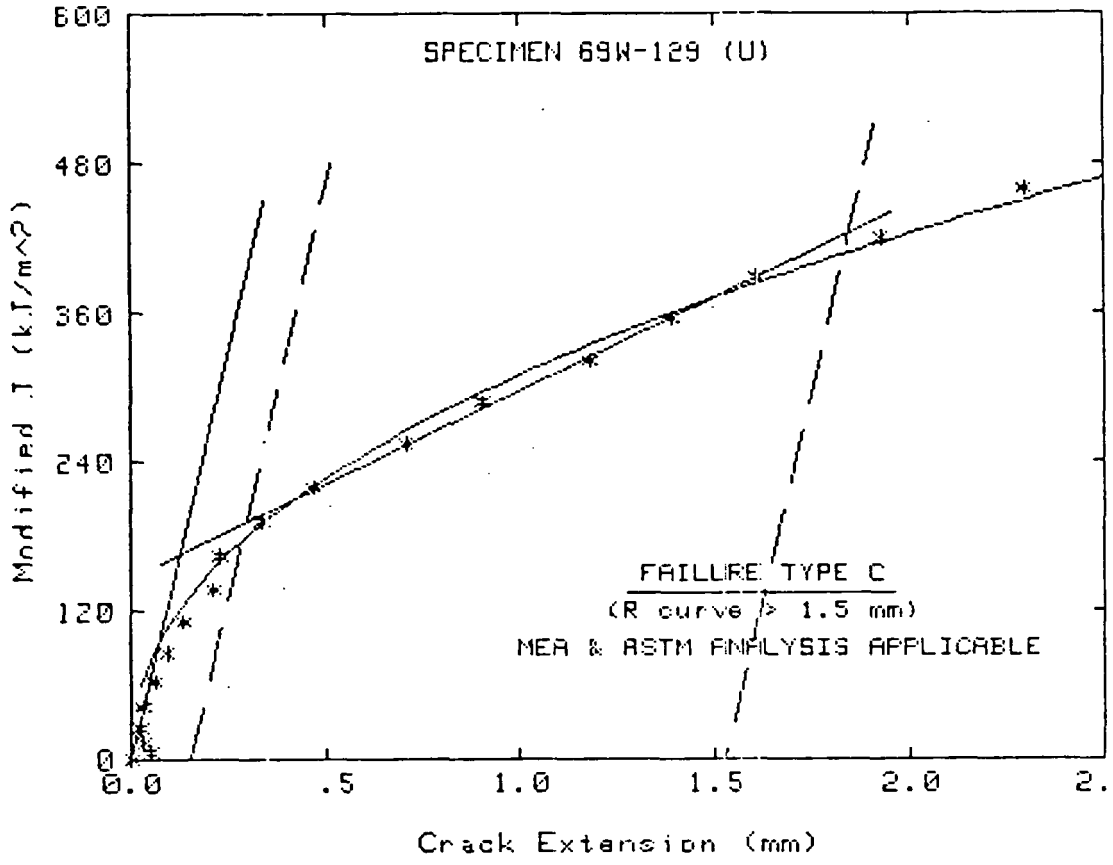
Material Type	= A533-B HSST WELD		
Test Temperature	= 288 C		
Percent Side Groove	= 20 %		
Specimen Thickness	= 25.4 mm		
Init crack length	= 30.57 mm	Init a/W	= .601
Final crack length	= 41.07 mm	Final a/W	= .808
Flow stress	= 650.7 MPa		
Youngs modulus	= 190800 MPa	(Estimated Value)	

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 101.5 kJ/m^2		
Kjc	= 139.2	J (@J/T=8.8)	= 299.7 kJ/m^2
Exponent N	= .5029		
Coefficient C	= 212.4 kJ/m^2		
T (average)	= 51		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 102 kJ/m^2		
Kjc	= 139.5	Slope M	= 109743.2 kJ/m^3
Intercept B	= 93.4 kJ/m^2		
T (ASTM)	= 49		
Validity (Jic)	= VALID		
Validity (R-curve)	= VALID		
J maximum allowed	= 657.6 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 2.02 mm	(Delta a max = 0.1*bo)	



TEST SPECIMEN DATA

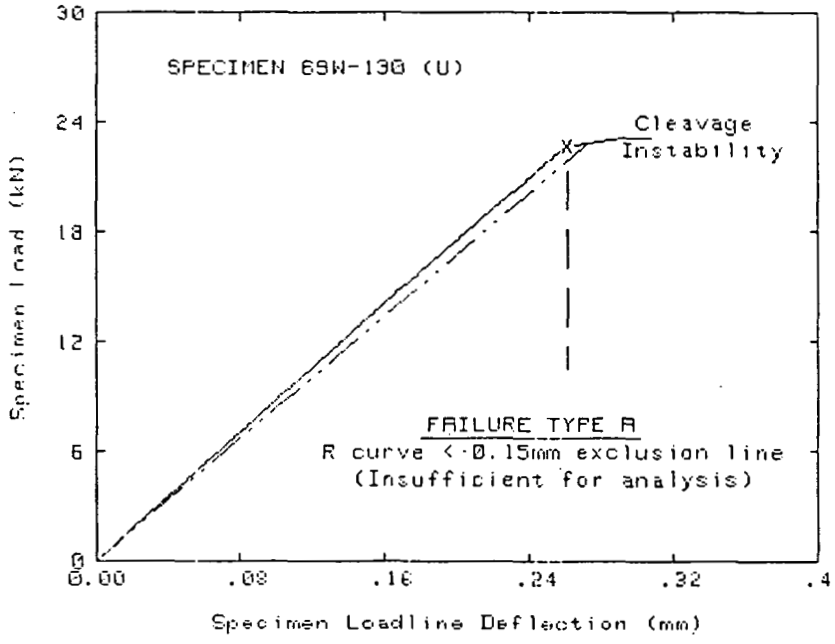
Material Type	= A533-B HSST WELD		
Test Temperature	= 50 C		
Percent Side Groove	= 20 %		
Specimen Thickness	= 25.4 mm		
Init crack length	= 30.72 mm	Init a/W	= .604
Final crack length	= 41.53 mm	Final a/W	= .817
Flow stress	= 664.1 MPa		
Youngs modulus	= 204400 MPa	(Estimated Value)	

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 176.4 kJ/m^2		
Kjc	= 189.8	J (@J/T=8.8)	= 434.8 kJ/m^2
Exponent N	= .4495		
Coefficient C	= 309.9 kJ/m^2		
T (average)	= 66		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 165.6 kJ/m^2		
Kjc	= 184	Slope M	= 150592.3 kJ/m^3
Intercept B	= 146.8 kJ/m^2		
T (ASTM)	= 70		
Validity (Jic)	= VALID		
Validity (R-curve)	= INVALID--3 (.33 vs .3)		
J maximum allowed	= 666.4 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 2.01 mm	(Delta a max = 0.1*bo)	



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= -60 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .599	
Init crack length a	= 30.45 mm	
Flow stress	= 766.2 MPa	
Yield stress	= 725.5 MPa	
Youngs modulus E	= 210700 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 12.8 kJ/m^2	
Kjc=(EJic)^.5	= 51.9 MPa \/m	v=.3
Kic (Beta Corrected)	= 50.6 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

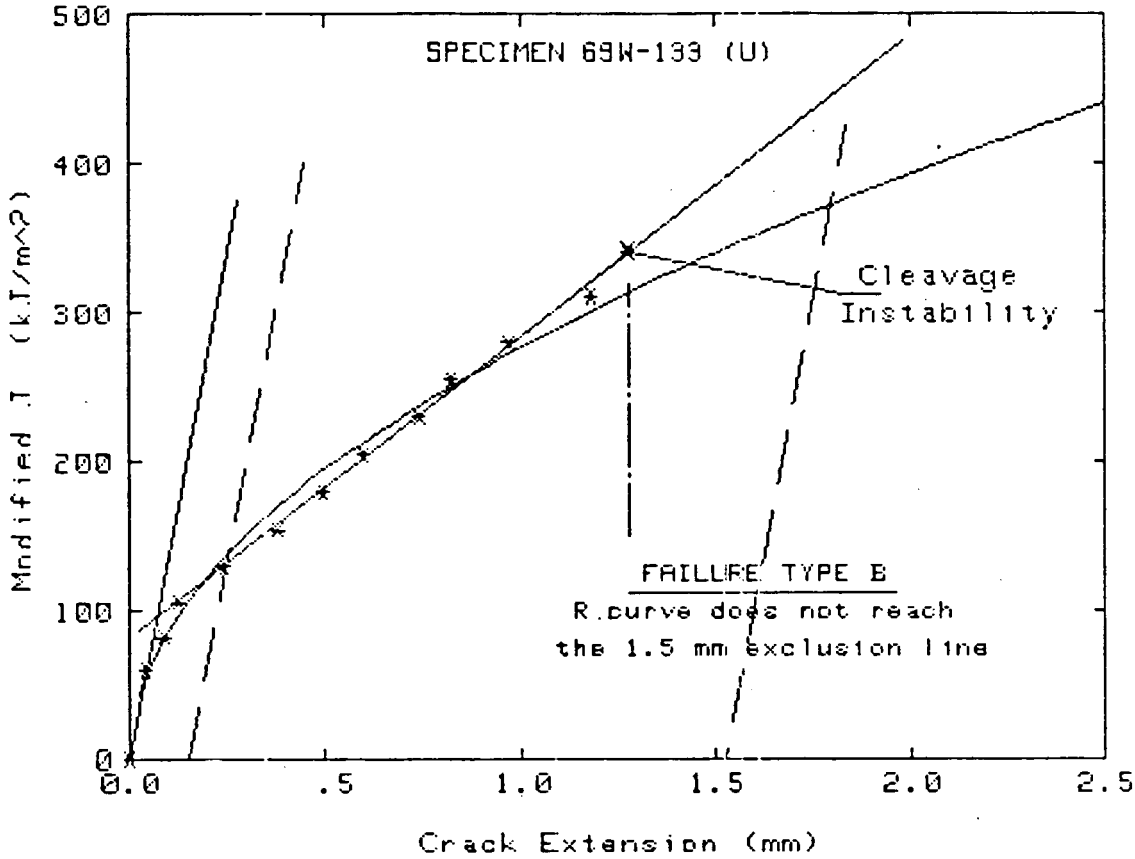
Maximum Load P	= 22.72 kN	
5% Secant Offset Pq	= 22.72 kN	
Kic	= 54.1 MPa \/m	
Validity	= VALID Kic value	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-1.13744517044E-04 in.

Specimen rotation Load intercept elastic slope =-.0000002975 lb

Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

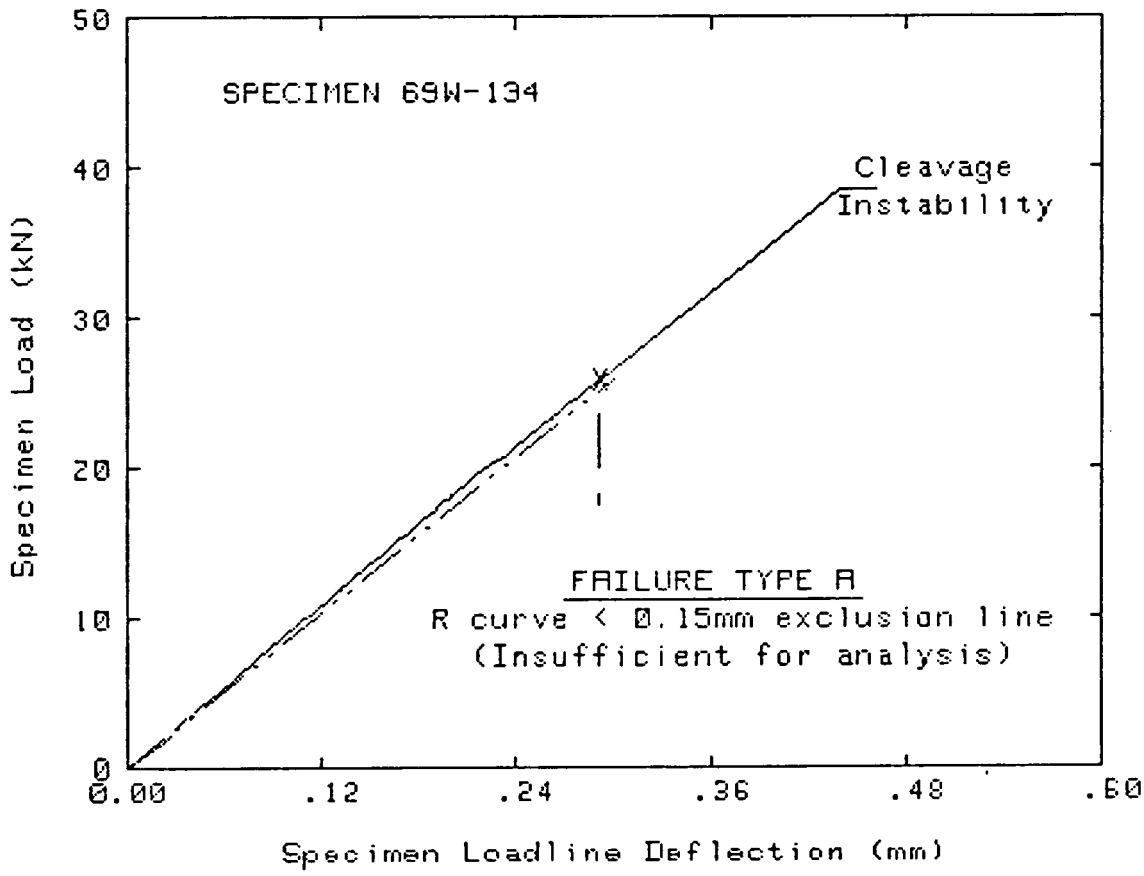
Material Type	= A533-B HSST WELD	
Test Temperature	= 23 C	
Percent Side Groove	= 0 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 29.93 mm	Init a/W = .589
Flow stress	= 684.2 MPa	
Youngs modulus	= 205900 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 138.3 kJ/m^2		
Kjc	= 168.8	Exponent N	= .5054
Coefficient C	= 276.8 kJ/m^2		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 95.7 kJ/m^2		
Kjc	= 140.4	Slope M	= 202079.6 kJ/m^3
Intercept B	= 81.5 kJ/m^2		
Validity (Jic)	= VALID		
Validity (R-curve)	= INVALID--1		
J maximum allowed	= 713.4 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 2.09 mm	(Delta a max = 0.1*bo)	



TEST SPECIMEN DATA

Material Type	= A533-B 02 REF	
Test Temperature	= -100 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .593	
Init crack length a	= 30.12 mm	
Flow stress	= 818.4 MPa	
Yield stress	= 778.8 MPa	
Youngs modulus E	= 212900 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

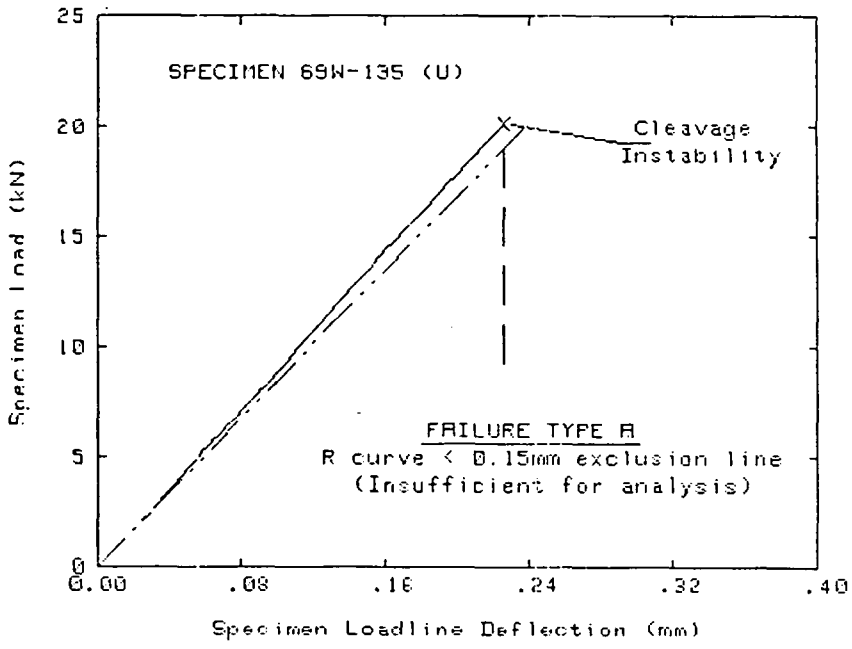
Jic	= 16.1 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 58.6 MPa \/m	v=.3
Kic (Beta Corrected)	= 56.9 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 25.89 kN	
5% Secant Offset Pq	= 25.89 kN	
Kic	= 60.1 MPa \/m	
Validity	= VALID Kic value	
K at Maximum Load	= 60.1 MPa \/m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= -100 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .592	
Init crack length a	= 30.07 mm	
Flow stress	= 819.1 MPa	
Yield stress	= 778.6 MPa	
Youngs modulus E	= 212900 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

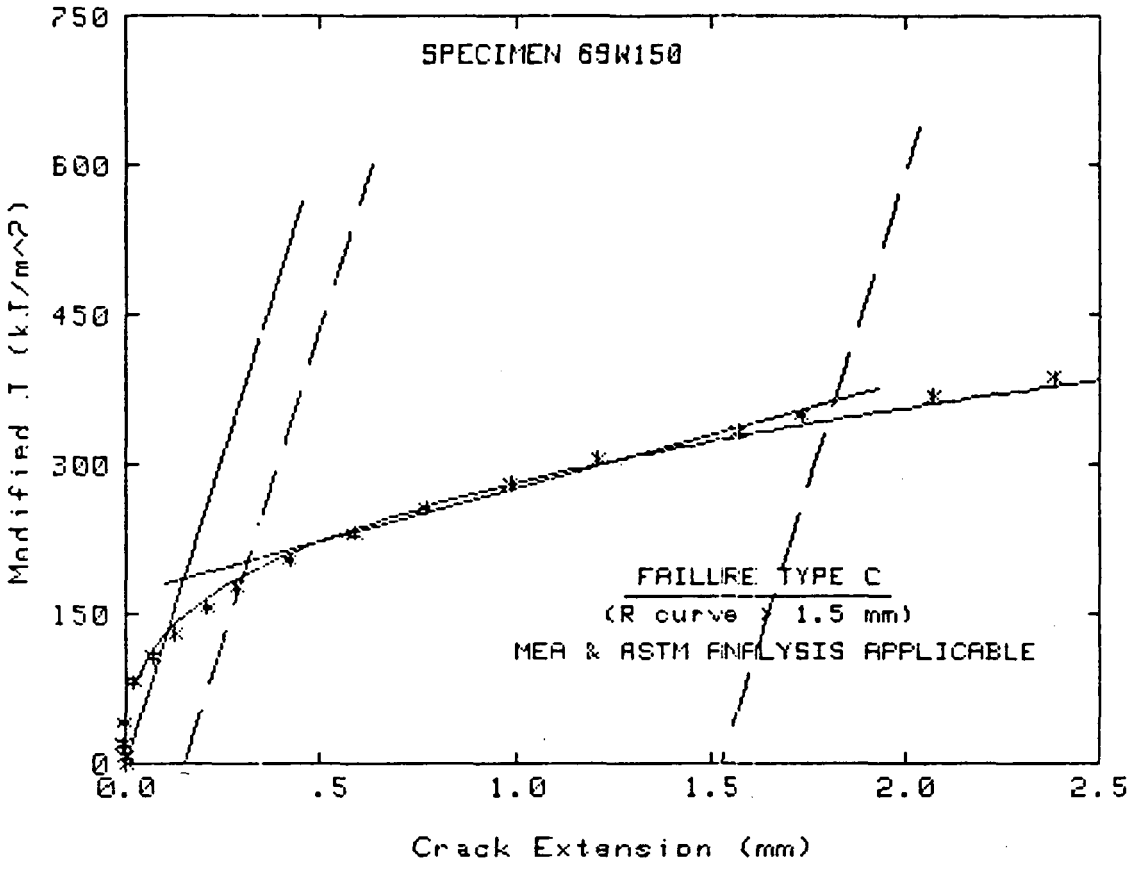
Jic	= 9.6 kJ/m^2	
Kjc=(EJic)^.5	= 45.1 MPa √m	ν=.3
Kic (Beta Corrected)	= 44.6 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 20.14 kN	
5% Secant Offset Pq	= 20.14 kN	
Kic	= 46.6 MPa √m	
Validity	= VALID Kic value	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-1.931673075E-04 in.
Specimen rotation Load intercept elastic slope =-2.305555555E-07 lb
Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

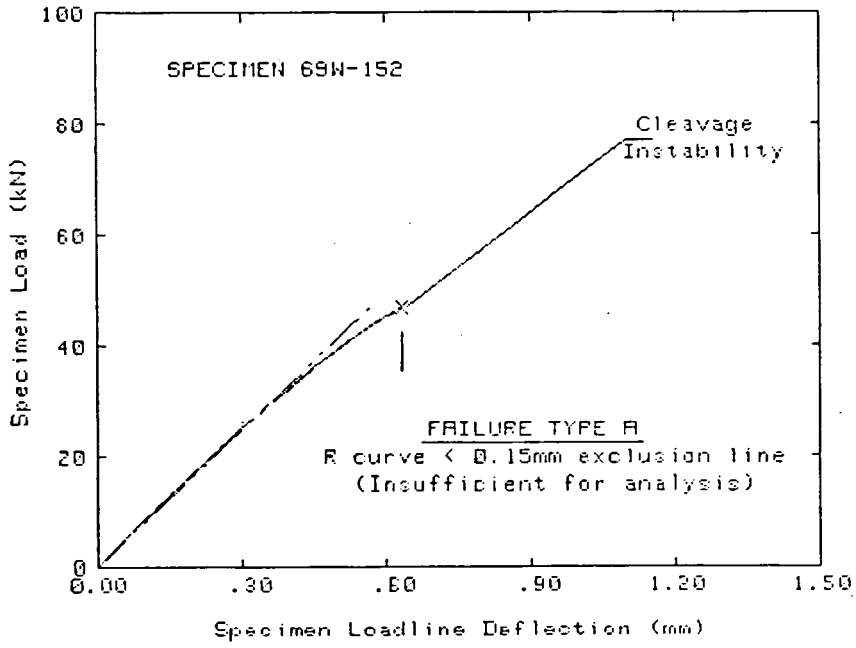
Material Type	= A533-B HSST WELD	
Test Temperature	= 200 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.6 mm	Init a/W = .602
Final crack length	= 35.29 mm	Final a/W = .694
Flow stress	= 623 MPa	
Youngs modulus	= 195800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 187.6 kJ/m^2	
Kjc	= 191.6	J (@J/T=8.8) = 323.1 kJ/m^2
Exponent N	= .3399	
Coefficient C	= 281.4 kJ/m^2	
T (average)	= 50	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 184.3 kJ/m^2	
Kjc	= 190	Slope M = 107548.3 kJ/m^3
Intercept B	= 168.4 kJ/m^2	
T (ASTM)	= 54	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--2	
J maximum allowed	= 628.8 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.02 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B 02 REF	
Test Temperature	= -5 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .601	
Init crack length a	= 30.55 mm	
Flow stress	= 707.4 MPa	
Yield stress	= 664.6 MPa	
Youngs modulus E	= 207500 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

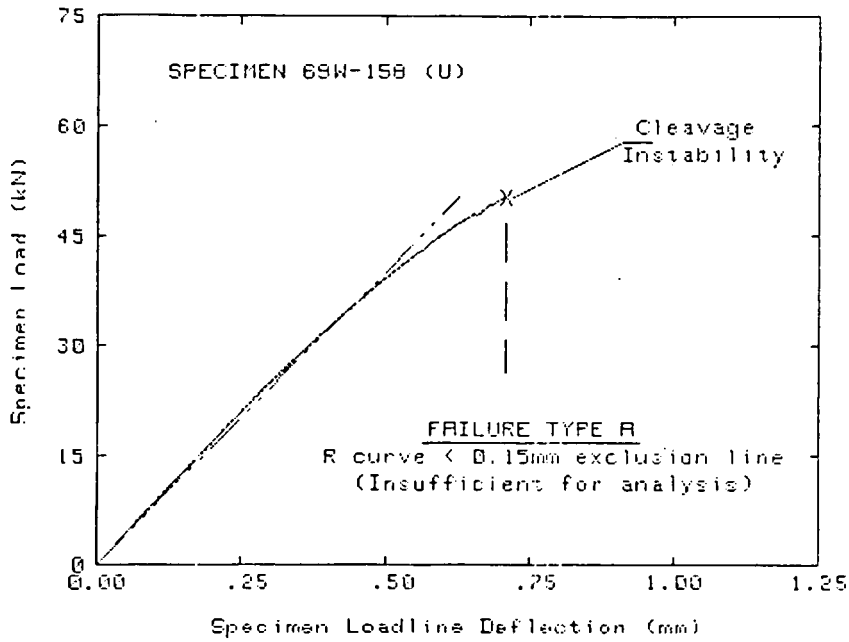
Jic	= 69.1 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 119.8 MPa √m	v=.3
Kic (Beta Corrected)	= 90.6 MPa √m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 47 kN	
5% Secant Offset Pq	= 29.9 kN	
Kic	= 71.7 MPa √m	
Validity	= INVALID--2, 3	
K at Maximum Load	= 112.7 MPa √m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-3.80866713023E-04 in.
Specimen rotation Load intercept elastic slope =-9.78571428571E-07 lb
Fitted elastic load range= 3000 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= -5 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .6	
Init crack length a	= 30.5 mm	
Flow stress	= 707.4 MPa	
Yield stress	= 664.6 MPa	
Youngs modulus E	= 207500 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 84.4 kJ/m^2	
Kjc=(EJic)^.5	= 132.4 MPa √m	ν=.3
Kic (Beta Corrected)	= 95.5 MPa √m	ν=.3

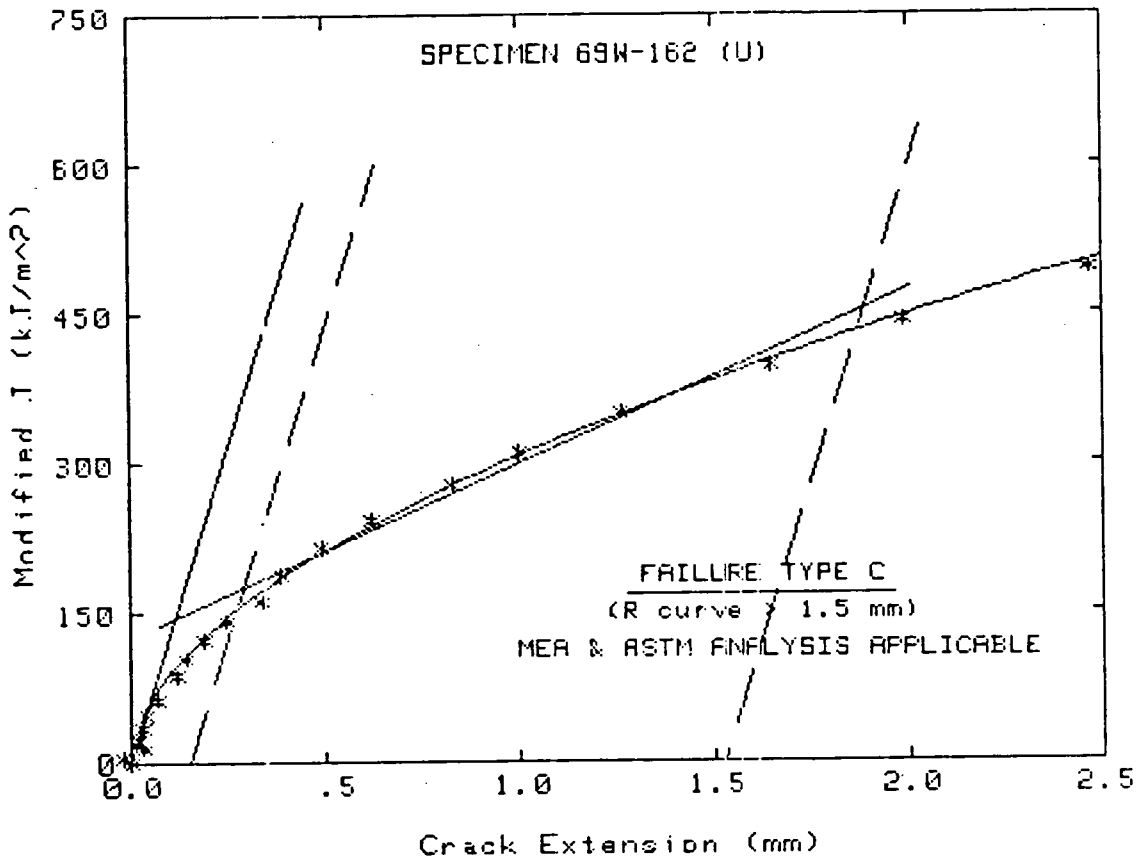
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 50.33 kN	
5% Secant Offset Pq	= 34.68 kN	
Kic	= 82.8 MPa √m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-2.8667648444E-04 in.
Specimen rotation Load intercept elastic slope = .000000484375 lb
Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

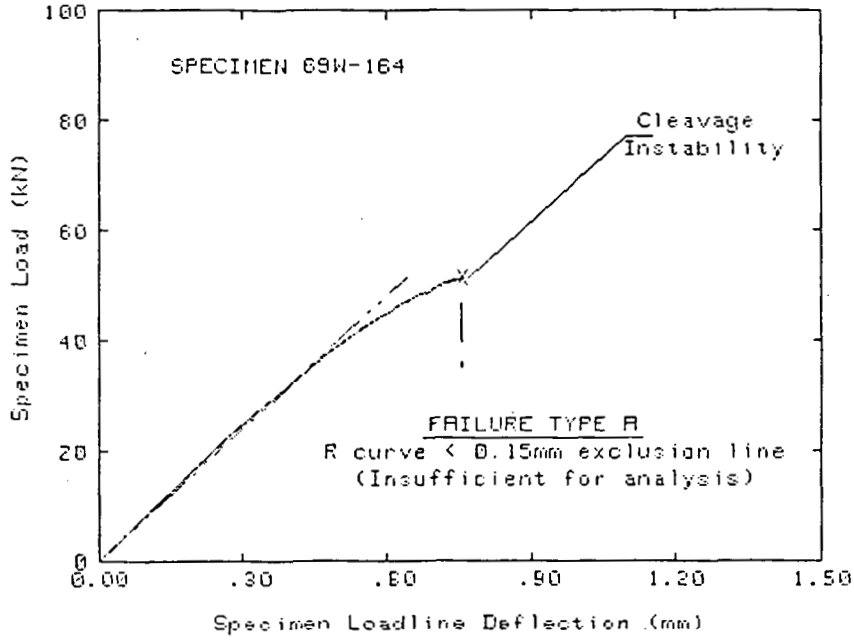
Material Type	= A533-B HSST WELD	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.42 mm	Init a/W = .598
Final crack length	= 40.14 mm	Final a/W = .79
Flow stress	= 630.3 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 152.9 kJ/m^2	
Kjc	= 175	J (@J/T=8.8) = 493.2 kJ/m^2
Exponent N	= .5409	
Coefficient C	= 308.1 kJ/m^2	
T (average)	= 85	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 144.2 kJ/m^2	
Kjc	= 169.9	Slope M = 175781.2 kJ/m^3
Intercept B	= 124.1 kJ/m^2	
T (ASTM)	= 89	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 639.9 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.04 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B 02 REF	
Test Temperature	= 20 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .593	
Init crack length a	= 30.12 mm	
Flow stress	= 686 MPa	
Yield stress	= 641.9 MPa	
Youngs modulus E	= 206100 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 92.9 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 138.4 MPa \/m	v=.3
Kic (Beta Corrected)	= 95.9 MPa \/m	v=.3

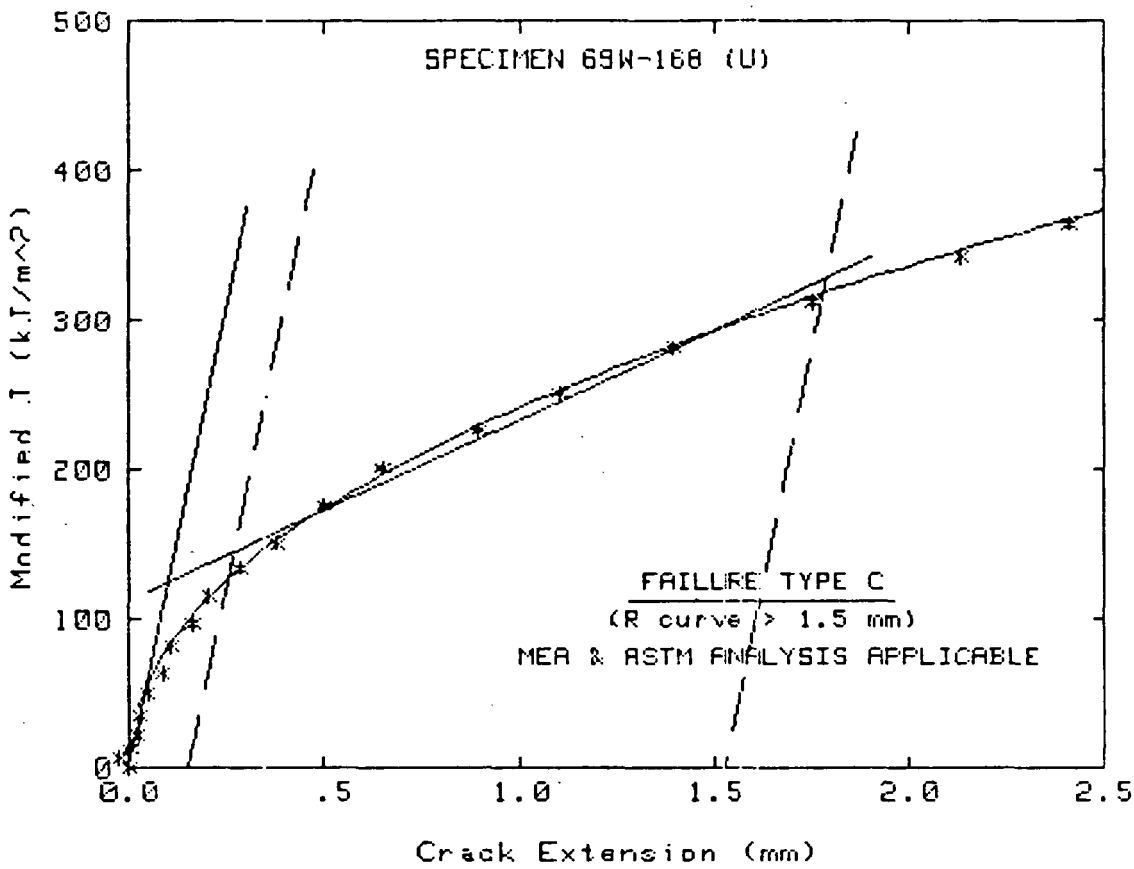
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 51.45 kN	
5% Secant Offset Pq	= 34.21 kN	
Kic	= 79.4 MPa \/m	
Validity	= INVALID--1, 2, 3	
K at Maximum Load	= 119.4 MPa \/m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-3.105178989696E-04 in.
Specimen rotation Load intercept elastic slope = 5.586206899655E-06 lb
Fitted elastic load range= 3000 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

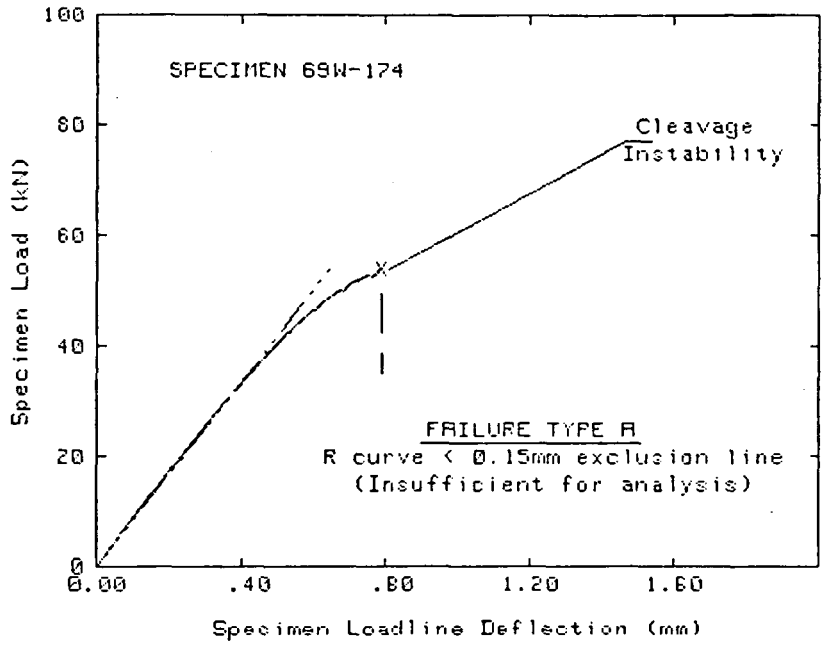
Material Type	= A533-B HSST WELD	
Test Temperature	= 204 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.88 mm	Init a/W = .607
Final crack length	= 40.86 mm	Final a/W = .804
Flow stress	= 623 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 126.1 kJ/m^2	
Kjc	= 157	J (@J/T=8.8) = 343 kJ/m^2
Exponent N	= .4744	
Coefficient C	= 241.7 kJ/m^2	
T (average)	= 61	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 124 kJ/m^2	
Kjc	= 155.7	Slope M = 120457.5 kJ/m^3
Intercept B	= 112 kJ/m^2	
T (ASTM)	= 61	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 620.2 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.99 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B 02 REF	
Test Temperature	= 20 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .595	
Init crack length a	= 30.21 mm	
Flow stress	= 686 MPa	
Yield stress	= 641.9 MPa	
Youngs modulus E	= 199200 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

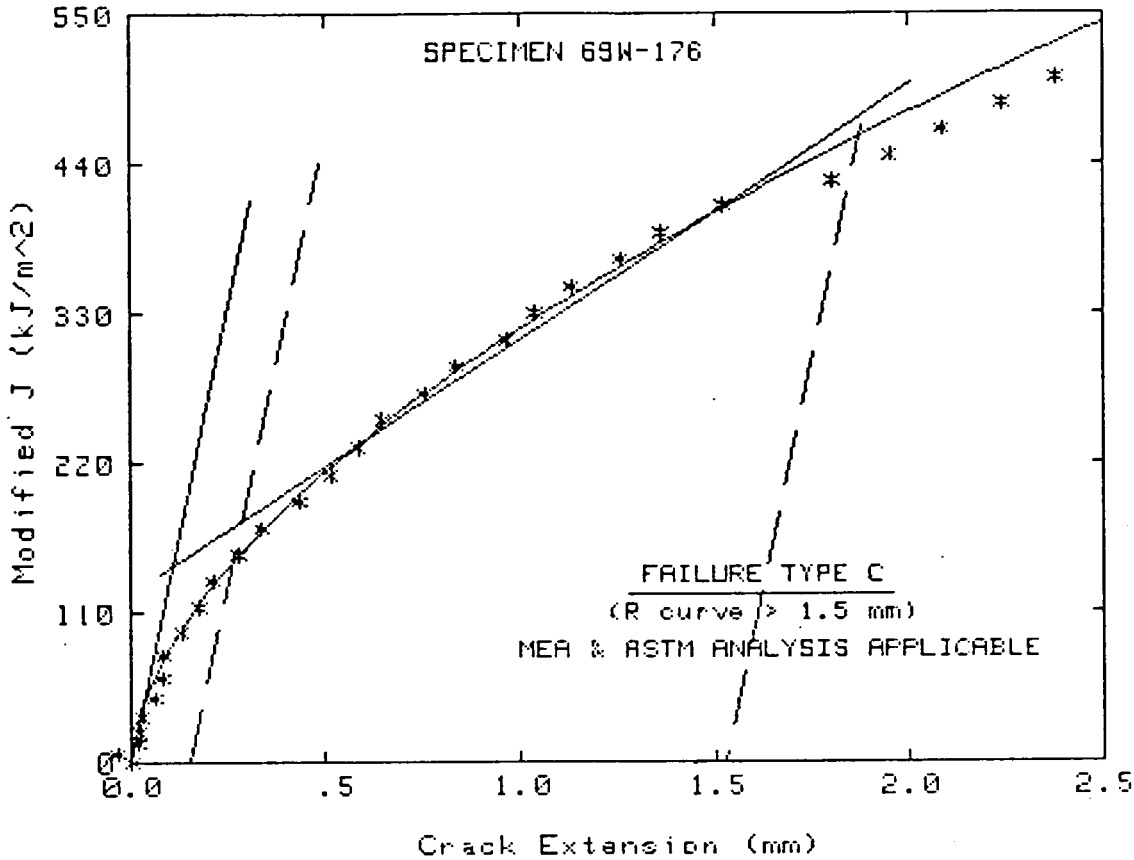
Jic	= 103.2 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 143.4 MPa \/m	v=.3
Kic (Beta Corrected)	= 97.6 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 53.9 kN	
5% Secant Offset Pq	= 31.76 kN	
Kic	= 74.2 MPa \/m	
Validity	= INVALID--1, 2, 3	
K at Maximum Load	= 125.9 MPa \/m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-4.5145595047 6E-04 in.
Specimen rotation Load intercept elastic slope =-7.53571428571E-06 lb
Fitted elastic load range= 3000 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

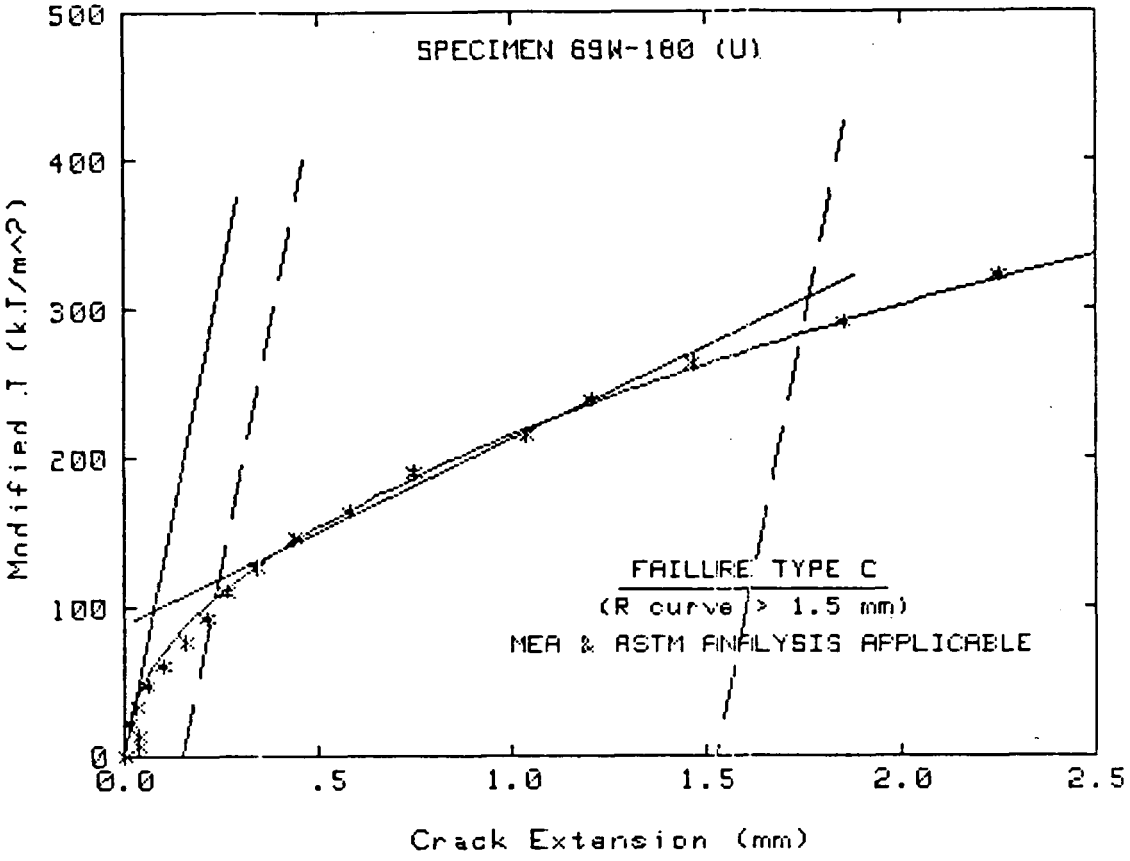
Material Type	= A533-B 02 REF	
Test Temperature	= 50 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.89 mm	Init a/W = .608
Final crack length	= 41.9 mm	Final a/W = .824
Flow stress	= 664 MPa	
Youngs modulus	= 204400 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 147.1 kJ/m^2
Kjc	= 173.4 MPa √m
J (@J/T=8.8)	= 492.2 kJ/m^2
Exponent N	= .5808
Coefficient C	= 319.3 kJ/m^2
T (average)	= 87

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 144.7 kJ/m^2	
Kjc	= 172 MPa √m	
Slope M	= 187250.7 kJ/m^3	
Intercept B	= 124.3 kJ/m^2	
T (ASTM)	= 87	
Validity (Jic)	= VAL'D	
Validity (R-curve)	= VALID	
J maximum allowed	= 660.6 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.99 mm	(Delta a max = 0.1*bo)
Final Delta a	= 10.97 mm	
Poisson's Ratio (v)	= 0	



TEST SPECIMEN DATA

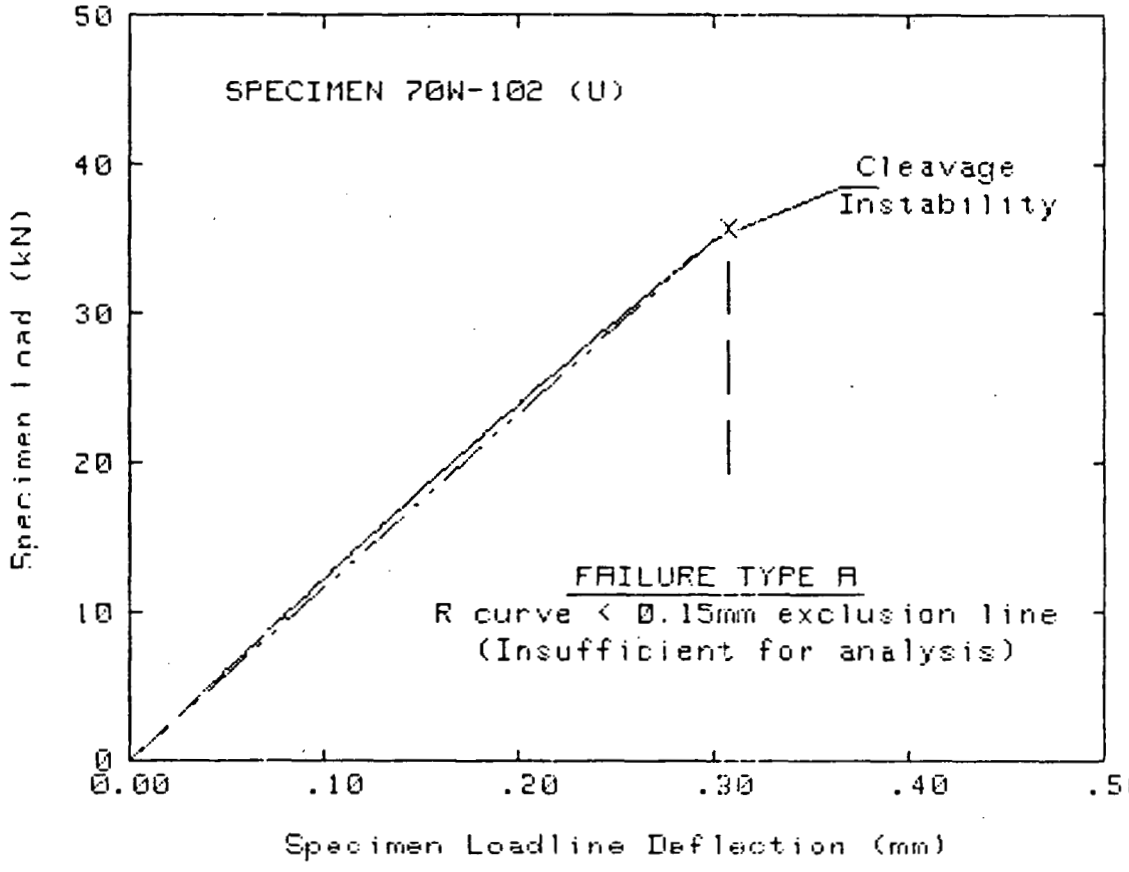
Material Type	= A533-B HSST WELD	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.76 mm	Init a/W = .605
Final crack length	= 41.56 mm	Final a/W = .818
Flow stress	= 650.7 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 106.4 kJ/m^2	
Kjc	= 142.4	J (@J/T=8.8) = 296.3 kJ/m^2
Exponent N	= .487	
Coefficient C	= 215.7 kJ/m^2	
T (average)	= 50	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 97.2 kJ/m^2	
Kjc	= 136.2	Slope M = 124238 kJ/m^3
Intercept B	= 87.9 kJ/m^2	
T (ASTM)	= 56	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--1	
J maximum allowed	= 651.4 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= -115 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .544	
Init crack length a	= 27.61 mm	
Flow stress	= 689.6 MPa	
Yield stress	= 625.1 MPa	
Youngs modulus E	= 213700 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

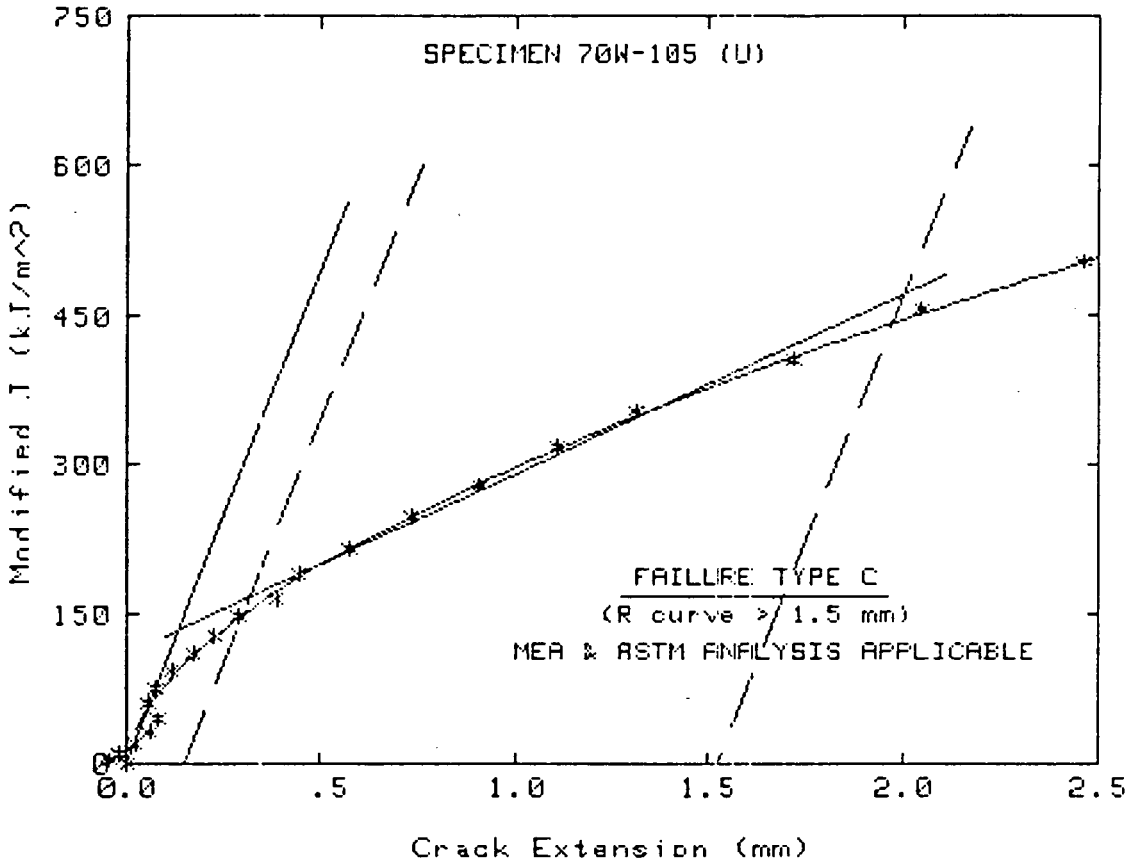
Jic	= 21.4 kJ/m^2	
Kjc=(EJic/(1-ν^2))^.5	= 71 MPa √m	ν=.3
Kic (Beta Corrected)	= 65.5 MPa √m	ν=.3

ESTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 35.74 kN	
5% Secant Offset Pq	= 33.99 kN	
Kic	= 66 MPa √m	
Validity	= INVALID--1, 2	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

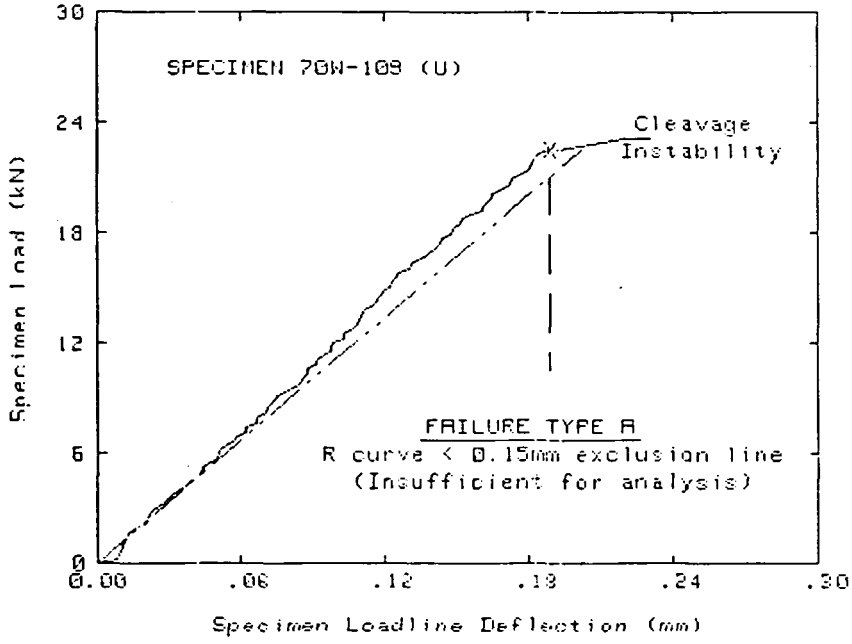
Material Type	= A533-B HSST WELD	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.8 mm	Init a/W = .547
Final crack length	= 38.39 mm	Final a/W = .755
Flow stress	= 494.2 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 148.4 kJ/m^2	
Kjc	= 172.4	J (@J/T=8.8) = 684.5 kJ/m^2
Exponent N	= .5823	
Coefficient C	= 297.6 kJ/m^2	
T (average)	= 140	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 135.4 kJ/m^2	
Kjc	= 164.7	Slope M = 179761.7 kJ/m^3
Intercept B	= 110.8 kJ/m^2	
T (ASTM)	= 148	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 501.8 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.3 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	=	A533-B HSST WELI
Test Temperature	=	-115 C
Percent Side Groove	=	0 %
Specimen Thickness B	=	25.4 mm
Initial a/W	=	.546
Init crack length a	=	27.75 mm
Flow stress	=	689.6 MPa
Yield stress	=	625.2 MPa
Youngs modulus E	=	213800 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

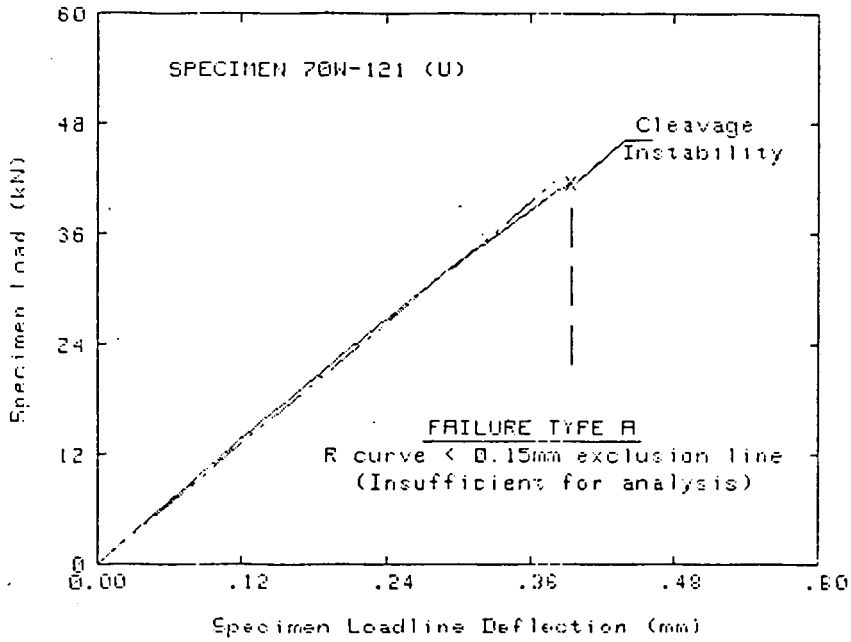
Jic	=	8.3 kJ/m^2
Kjc=(EJic)^.5	=	42 MPa √m ν=.3
Kic (Beta Corrected)	=	41.2 MPa √m ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5		
Maximum Load P	=	22.53 kN
5% Secant Offset Pq	=	22.53 kN
Kic	=	44.1 MPa √m
Validity	=	VALID Kic value

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-6.68469603022E-03 in.
Specimen rotation Load intercept elastic slope = 2.84782608696E-06 lb
Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELI	
Test Temperature	= -65 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .546	
Init crack length a	= 27.74 mm	
Flow stress	= 626.8 MPa	
Yield stress	= 565.7 MPa	
Youngs modulus E	= 210900 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 32.8 kJ/m^2	
Kjc=(EJic)^.5	= 83.2 MPa \/m	v=.3
Kic (Beta Corrected)	= 68.6 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

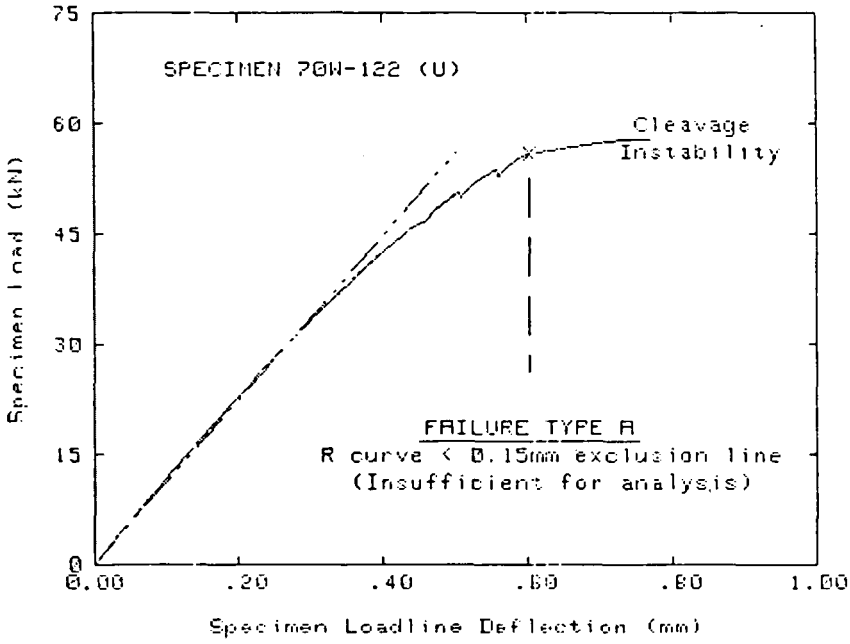
Maximum Load P	= 41.58 kN	
5% Secant Offset Pq	= 33.54 kN	
Kic	= 65.7 MPa \/m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-4.63766807671E-05 in.

Specimen rotation Load intercept elastic slope = .00000036875 lb

Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	=	A533-B HSST WELD
Test Temperature	=	-65 C
Percent Side Groove	=	0 %
Specimen Thickness B	=	25.4 mm
Initial a/W	=	.548
Init crack length a	=	27.84 mm
Flow stress	=	626.8 MPa
Yield stress	=	565.7 MPa
Youngs modulus E	=	210900 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	=	73 kJ/m^2
Kjc=(EJic)^.5	=	124.1 MPa √m ν=.3
Kic (Beta Corrected)	=	85.2 MPa √m ν=.3

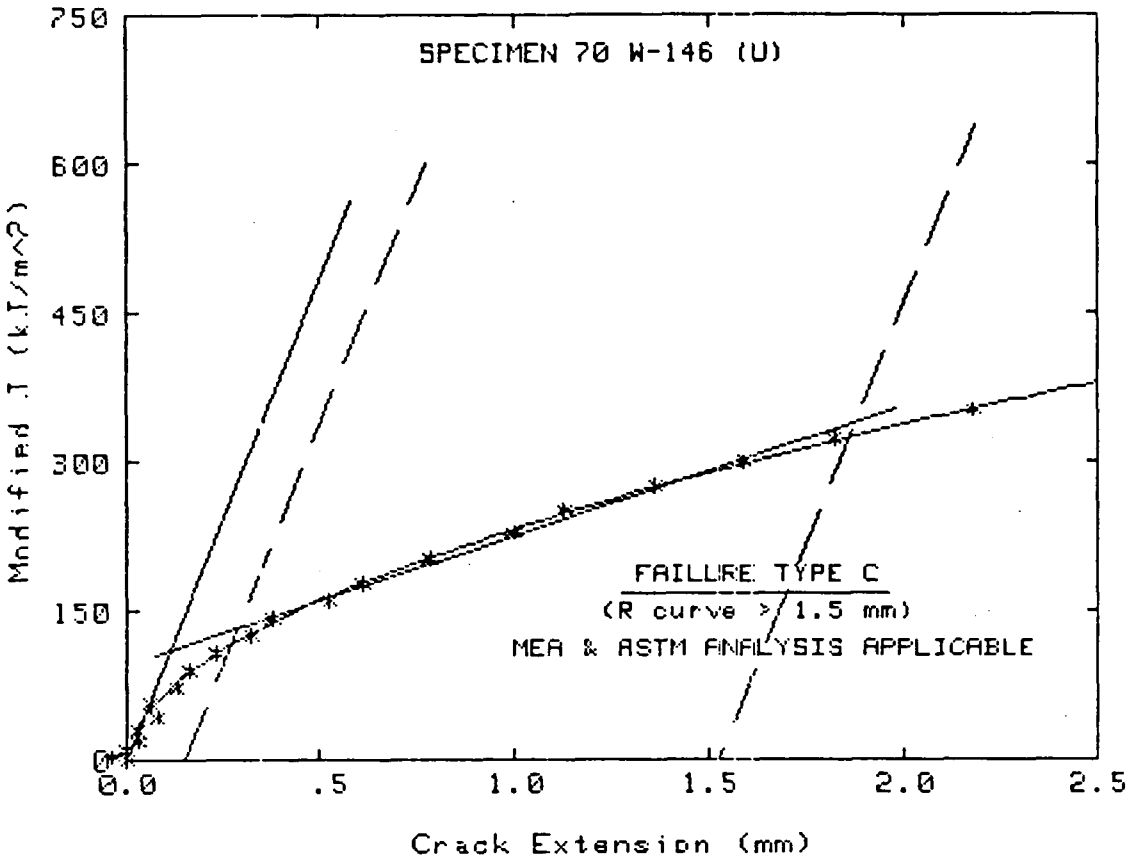
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	=	56.02 kN
5% Secant Offset Pq	=	31.23 kN
Kic	=	61.6 MPa √m
Validity	=	INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-3.421673788833E-05 in.
Specimen rotation Load intercept elastic slope = 1.923076923088E-07 lb
Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

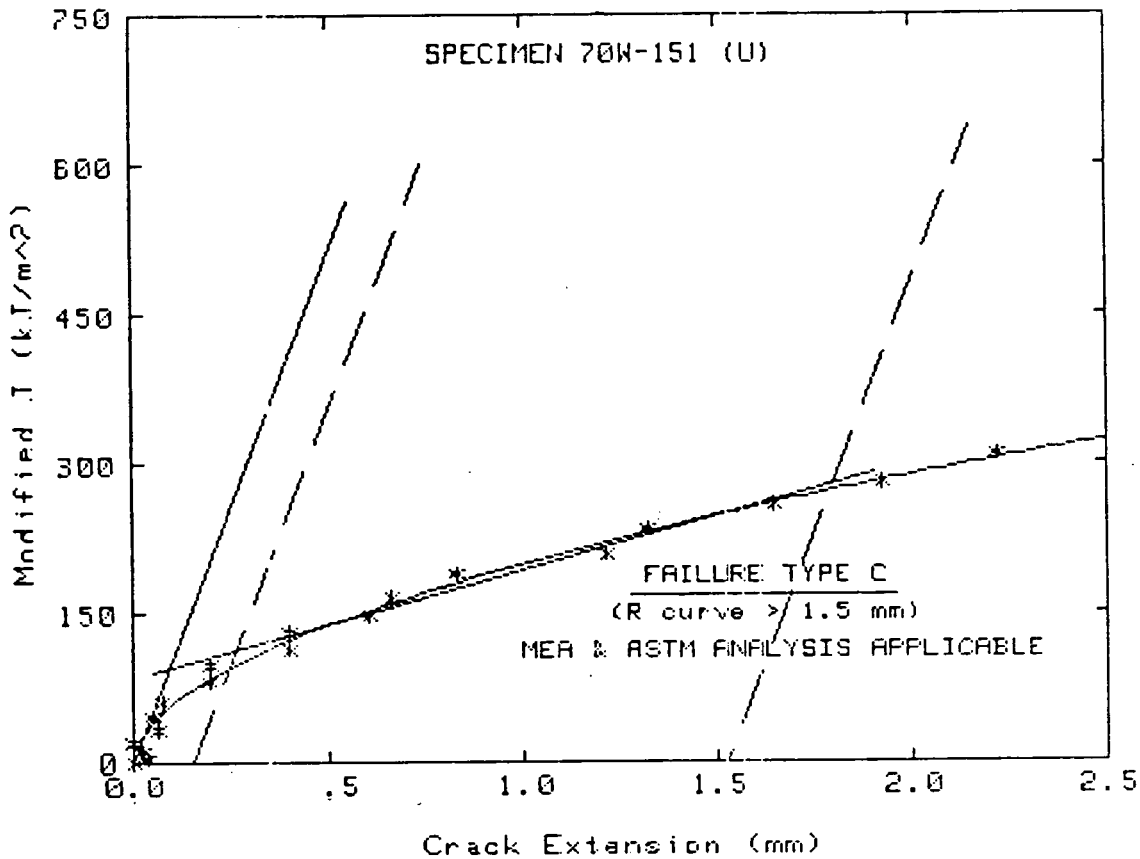
Material Type	= A533-B HSST WELD		
Test Temperature	= 204 C		
Percent Side Groove	= 20 %		
Specimen Thickness	= 25.4 mm		
Init crack length	= 27.86 mm	Init a/W	= .548
Final crack length	= 37.81 mm	Final a/W	= .744
Flow stress	= 486.5 MPa		
Youngs modulus	= 195500 MPa	(Estimated Value)	

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 115.6 kJ/m^2		
Kjc	= 150.3	J (@J/T=8.8)	= 480.1 kJ/m^2
Exponent N	= .5356		
Coefficient C	= 232.5 kJ/m^2		
T (average)	= 105		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 109.3 kJ/m^2		
Kjc	= 146.2	Slope M	= 130597.6 kJ/m^3
Intercept B	= 94.6 kJ/m^2		
T (ASTM)	= 108		
Validity (Jic)	= VALID		
Validity (R-curve)	= VALID		
J maximum allowed	= 494 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 2.29 mm	(Delta a max = 0.1*bo)	



TEST SPECIMEN DATA

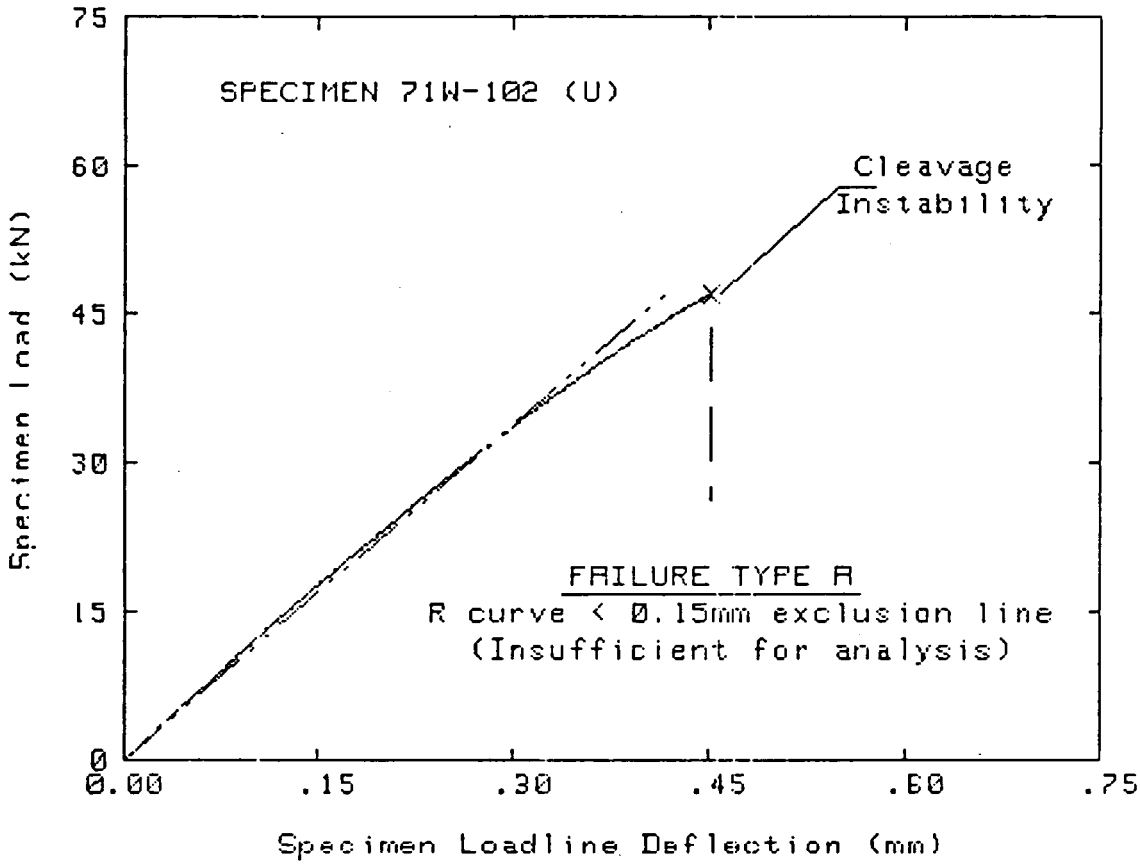
Material Type	= A533-B HSST WELD		
Test Temperature	= 288 C		
Percent Side Groove	= 20 %		
Specimen Thickness	= 25.4 mm		
Init crack length	= 28.05 mm	Init a/W	= .552
Final crack length	= 38.07 mm	Final a/W	= .749
Flow stress	= 511 MPa		
Youngs modulus	= 190800 MPa	(Estimated Value)	

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 94.6 kJ/m^2		
Kjc	= 134.4	J (@J/T=8.8)	= 380.7 kJ/m^2
Exponent N	= .5299		
Coefficient C	= 199.4 kJ/m^2		
T (average)	= 80		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 95.5 kJ/m^2		
Kjc	= 135	Slope M	= 108126.5 kJ/m^3
Intercept B	= 85.4 kJ/m^2		
T (ASTM)	= 79		
Validity (Jic)	= VALID		
Validity (R-curve)	= VALID		
J maximum allowed	= 518.9 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 2.28 mm	(Delta a max = 0.1*bo)	



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= -50 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .546	
Init crack length a	= 27.73 mm	
Flow stress	= 607.4 MPa	
Yield stress	= 540.7 MPa	
Youngs modulus E	= 210100 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

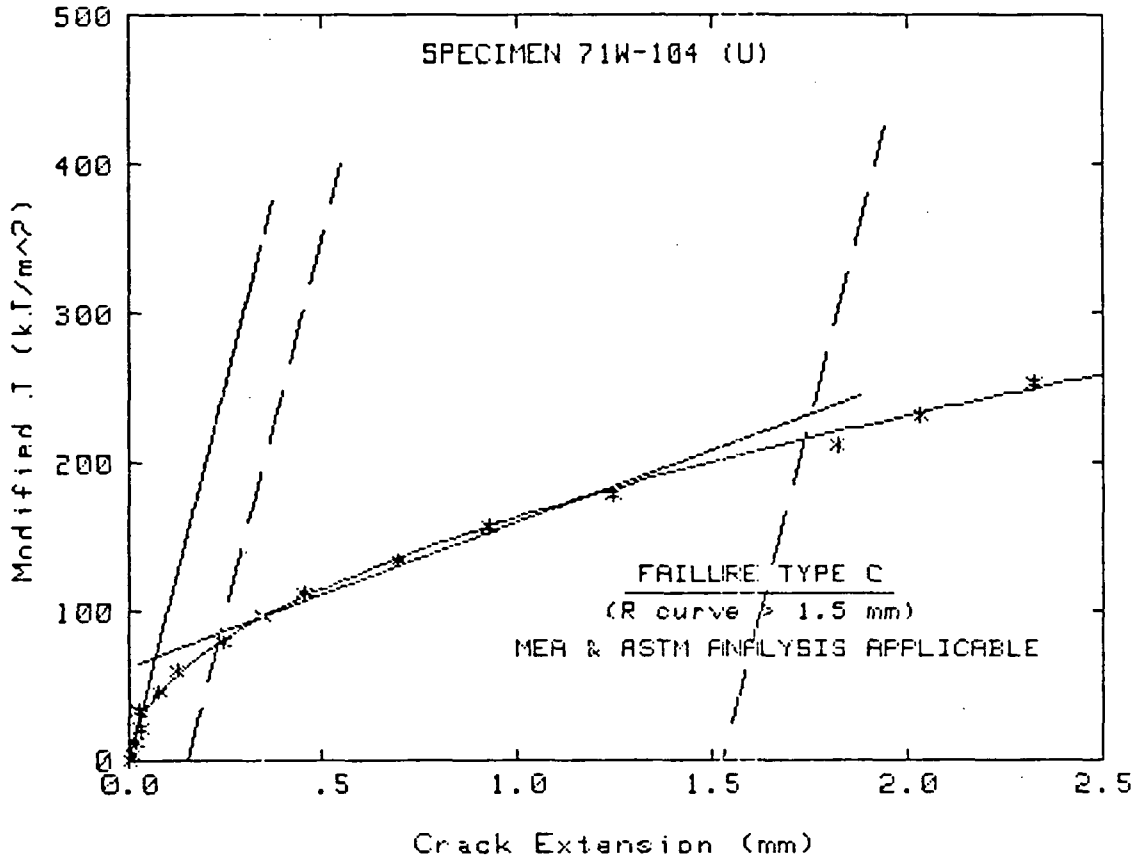
Jic	= 43.4 kJ/m^2	
Kjc=(EJic)^.5	= 95.5 MPa √m	ν=.3
Kic (Beta Corrected)	= 72.9 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 46.96 kN	
5% Secant Offset Pq	= 32.37 kN	
Kic	= 63.3 MPa √m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

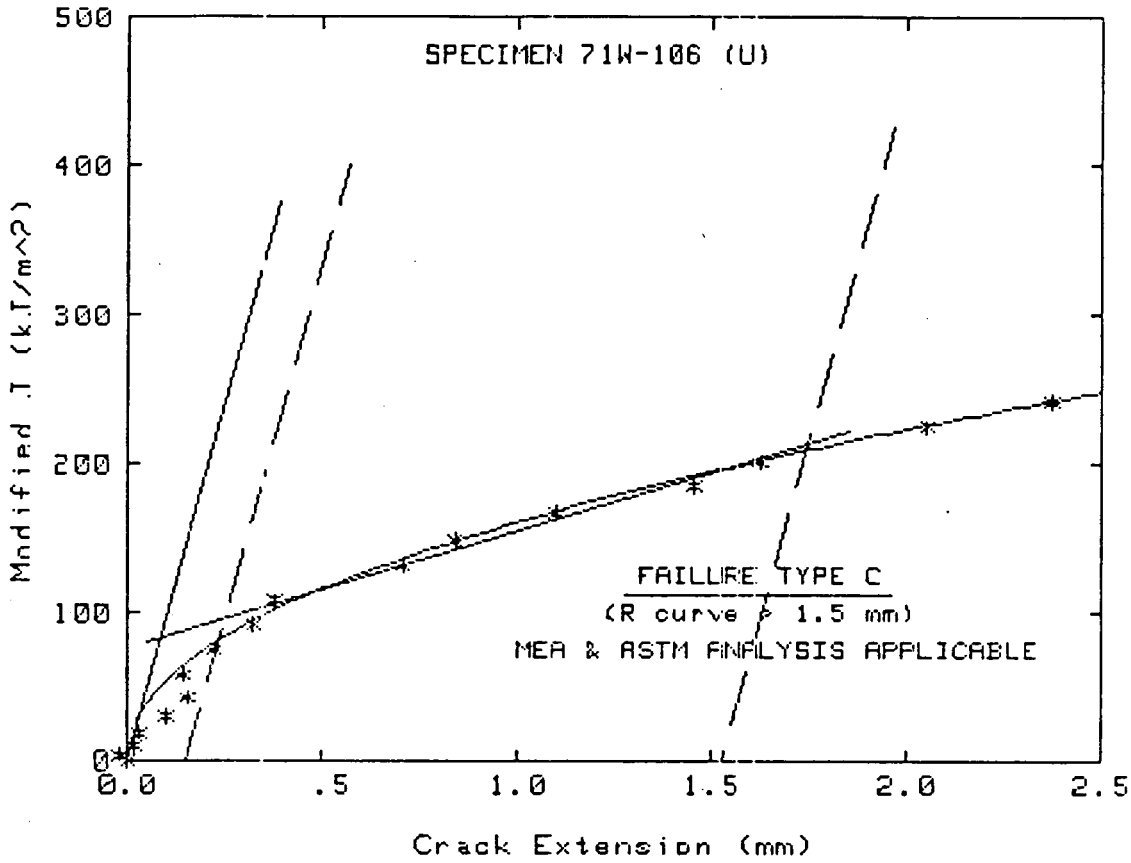
Material Type	= A533-B HSST WELD	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.71 mm	Init a/W = .565
Final crack length	= 38.82 mm	Final a/W = .764
Flow stress	= 508.1 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 77.5 kJ/m^2	
Kjc	= 121.6	J (@J/T=8.8) = 296.9 kJ/m^2
Exponent N	= .5052	
Coefficient C	= 163.2 kJ/m^2	
T (average)	= 65	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 69.9 kJ/m^2	
Kjc	= 115.5	Slope M = 97110.3 kJ/m^3
Intercept B	= 63.2 kJ/m^2	
T (ASTM)	= 72	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 515.8 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.21 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

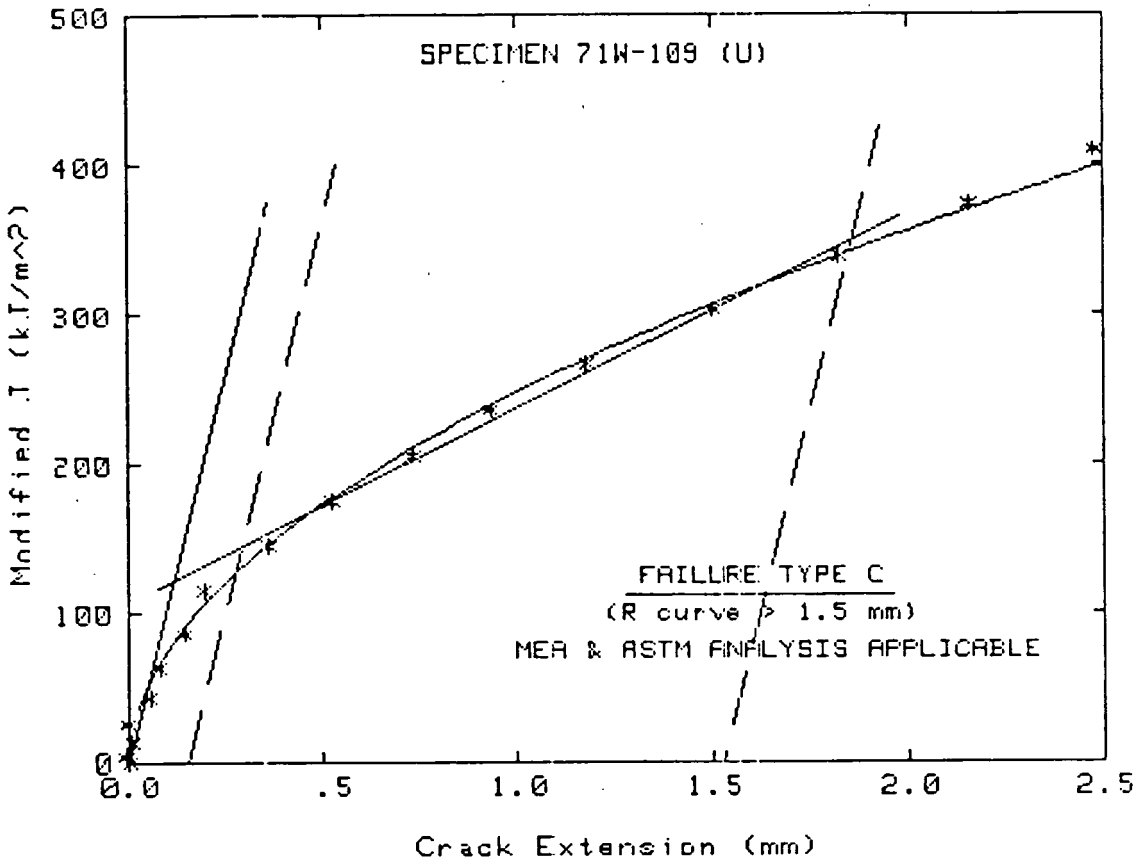
Material Type	= A533-B HSST WELD	
Test Temperature	= 204 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.64 mm	Init a/W = .544
Final crack length	= 38.12 mm	Final a/W = .75
Flow stress	= 482 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 81 kJ/m^2		
Kjc	= 125.8	J (@J/T=8.8)	= 291.3 kJ/m^2
Exponent N	= .4751		
Coefficient C	= 160.7 kJ/m^2		
T (average)	= 68		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 82.1 kJ/m^2		
Kjc	= 126.7	Slope M	= 78632.3 kJ/m^3
Intercept B	= 75.4 kJ/m^2		
T (ASTM)	= 66		
Validity (Jic)	= VALID		
Validity (R-curve)	= INVALID--1		
J maximum allowed	= 489.3 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 2.32 mm	(Delta a max = 0.1*bo)	



TEST SPECIMEN DATA

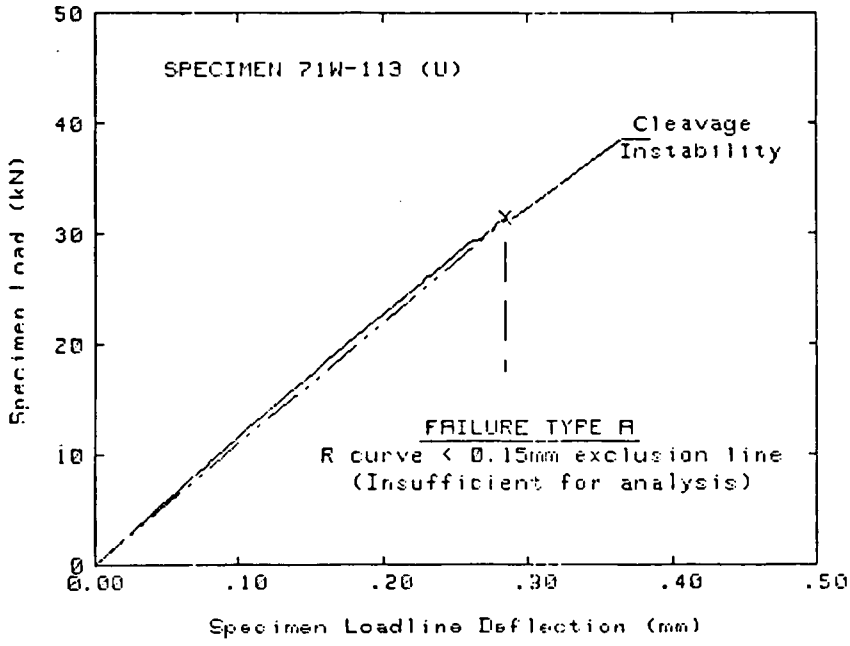
Material Type	= A533-B HSST WELD	
Test Temperature	= 50 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.58 mm	Init a/W = .562
Final crack length	= 40.54 mm	Final a/W = .798
Flow stress	= 521.4 MPa	
Youngs modulus	= 204400 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 126.7 kJ/m^2	
Kjc	= 160.9	J (@J/T=8.8) = 529.2 kJ/m^2
Exponent N	= .5195	
Coefficient C	= 248.2 kJ/m^2	
T (average)	= 99	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 122.5 kJ/m^2	
Kjc	= 158.2	Slope M = 130702.9 kJ/m^3
Intercept B	= 107.1 kJ/m^2	
T (ASTM)	= 98	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--3 (.33 vs .33)	
J maximum allowed	= 529.4 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.22 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= HSST WELD	
Test Temperature	= -95 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .548	
Init crack length a	= 27.85 mm	
Flow stress	= 661.5 MPa	
Yield stress	= 593.1 MPa	
Youngs modulus E	= 212600 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 17.7 kJ/m^2	
Kjc=(EJic)^.5	= 61.4 MPa √m	ν=.3
Kic (Beta Corrected)	= 56.5 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

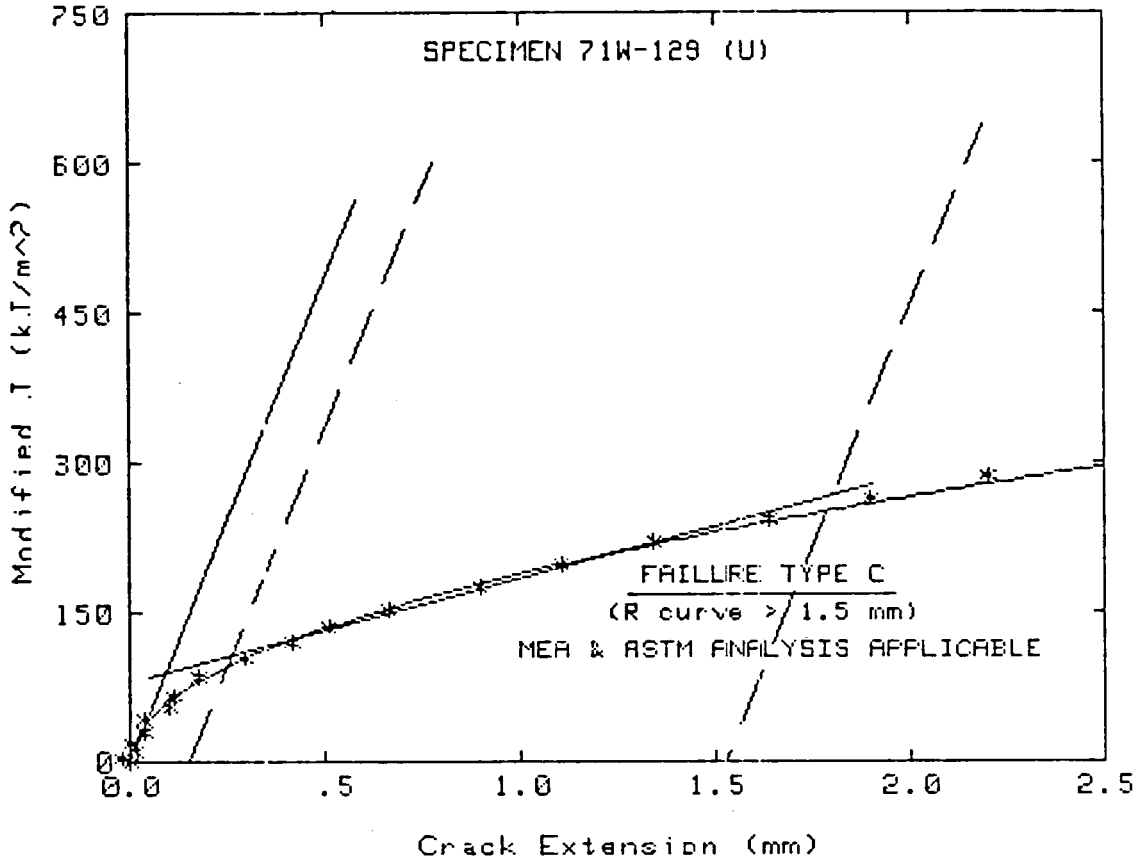
Maximum Load P	= 31.46 kN	
5% Secant Offset Pq	= 31.46 kN	
Kic	= 62.1 MPa √m	
Validity	= INVALID--2	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-7.97325082815E-04 in.

Specimen rotation Load intercept elastic slope =-1.57575757576E-07 lb

Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

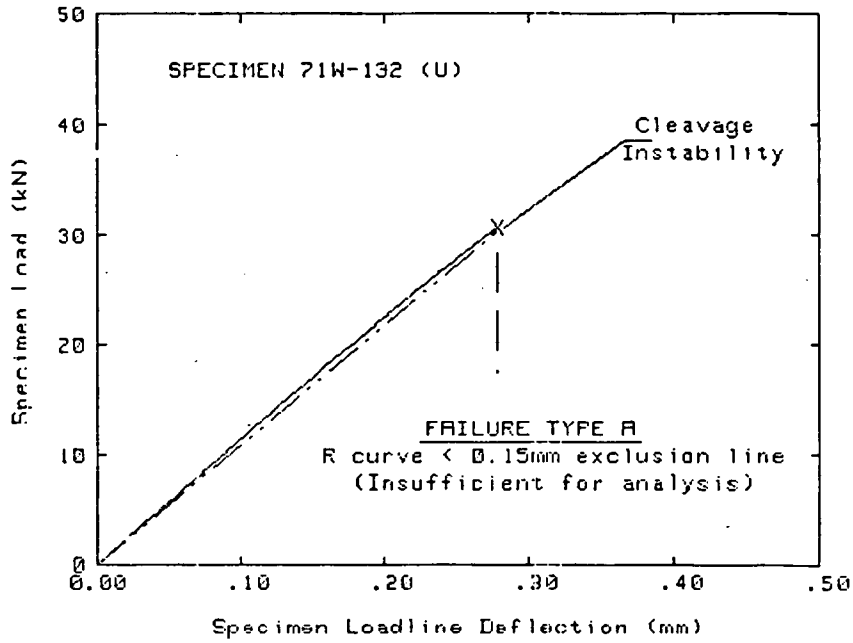
Material Type	= A533-B HSST WELD	
Test Temperature	= 204 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.23 mm	Init a/W = .555
Final crack length	= 39.17 mm	Final a/W = .771
Flow stress	= 482 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 95.5 kJ/m^2	
Kjc	= 136.7	J (@J/T=8.8) = 355.5 kJ/m^2
Exponent N	= .4925	
Coefficient C	= 188.5 kJ/m^2	
T (average)	= 82	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 89.7 kJ/m^2	
Kjc	= 132.4	Slope M = 103315.7 kJ/m^3
Intercept B	= 80 kJ/m^2	
T (ASTM)	= 87	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 489.3 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.26 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= -95 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .551	
Init crack length a	= 27.98 mm	
Flow stress	= 661.5 MPa	
Yield stress	= 593.1 MPa	
Youngs modulus E	= 212600 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

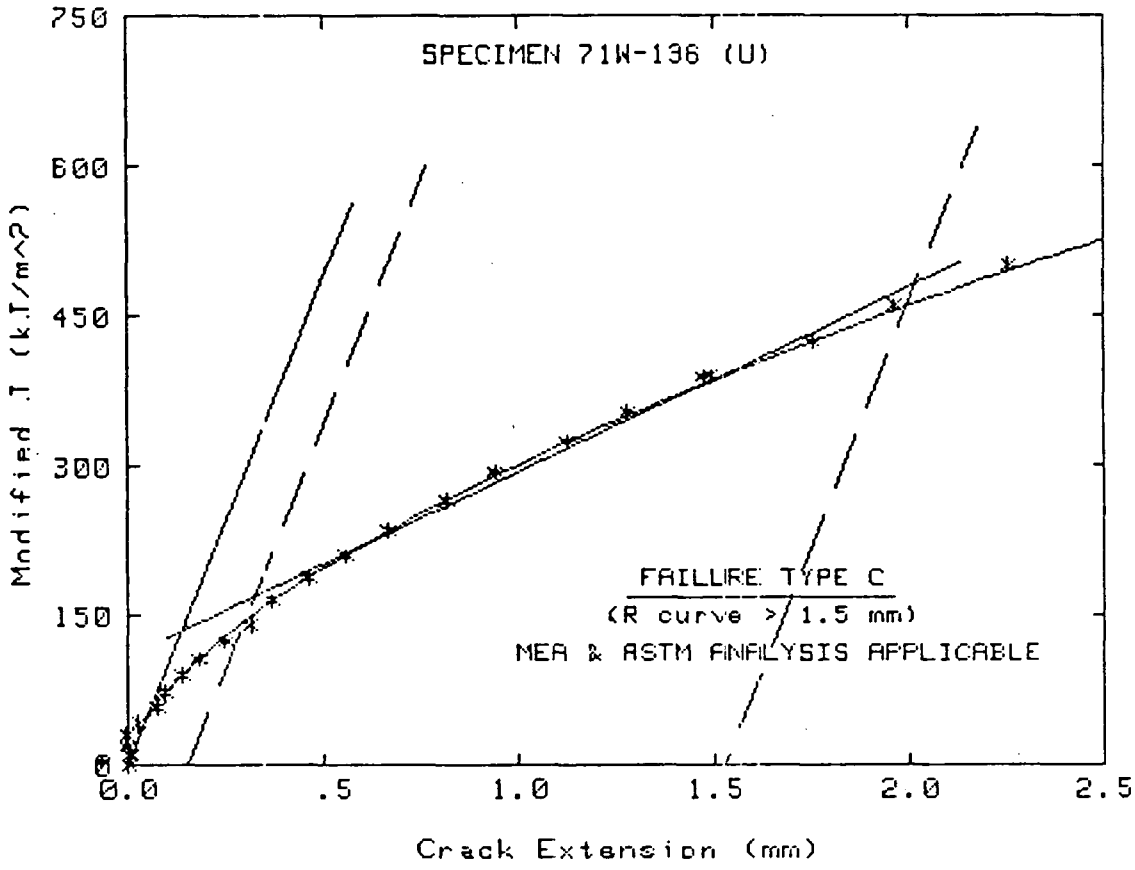
Jic	= 16.8 kJ/m^2	
Kjc=(EJic)^.5	= 59.8 MPa √m	ν=.3
Kic (Beta Corrected)	= 55.4 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 30.73 kN	
5% Secant Offset Pq	= 30.73 kN	
Kic	= 61.1 MPa √m	
Validity	= INVALID--2	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-2.57653887628E-04 in.
Specimen rotation Load intercept elastic slope =-1.15151515152E-07 lb
Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

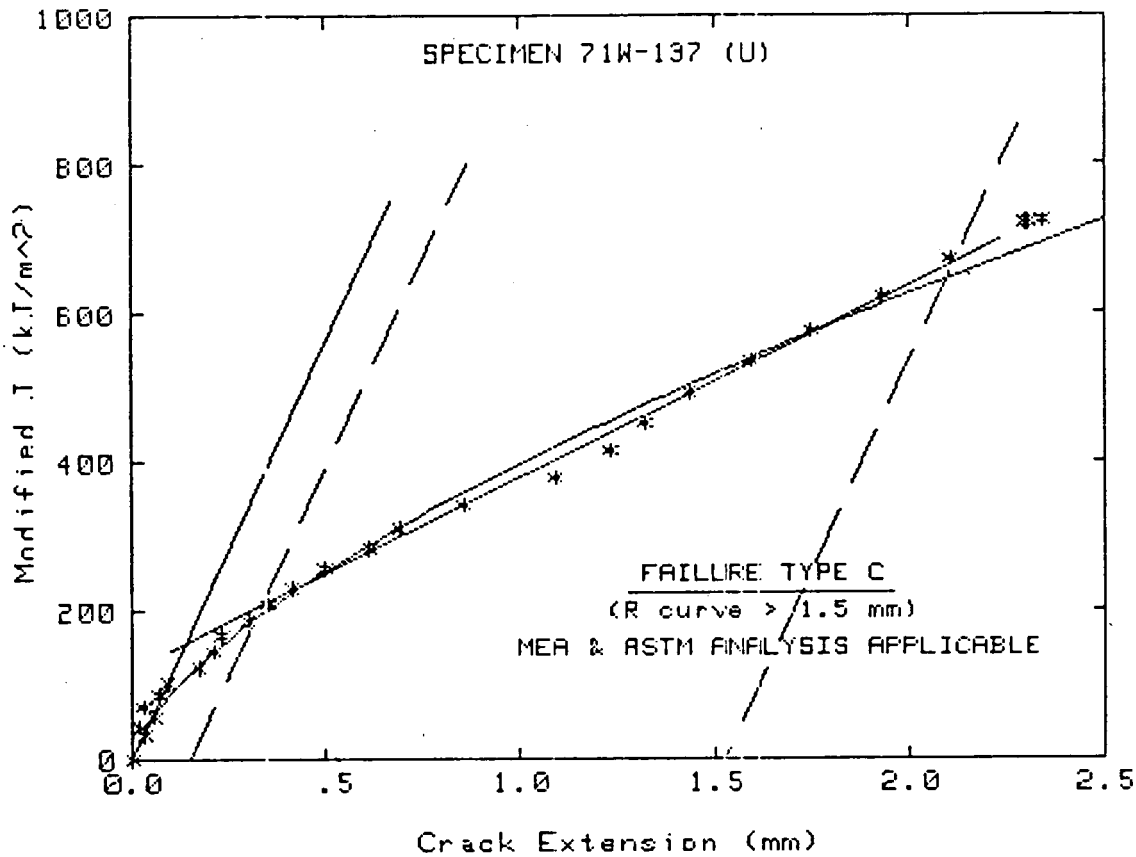
Material Type	= A533-B HSST WELD	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.16 mm	Init a/W = .554
Final crack length	= 40.1 mm	Final a/W = .789
Flow stress	= 489.2 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 144.4 kJ/m^2	
Kjc	= 170.1	J (@J/T=8.8) = 750.8 kJ/m^2
Exponent N	= .6103	
Coefficient C	= 301 kJ/m^2	
T (average)	= 151	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 135.2 kJ/m^2	
Kjc	= 164.6	Slope M = 185096.9 kJ/m^3
Intercept B	= 109.6 kJ/m^2	
T (ASTM)	= 155	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 496.6 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.26 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

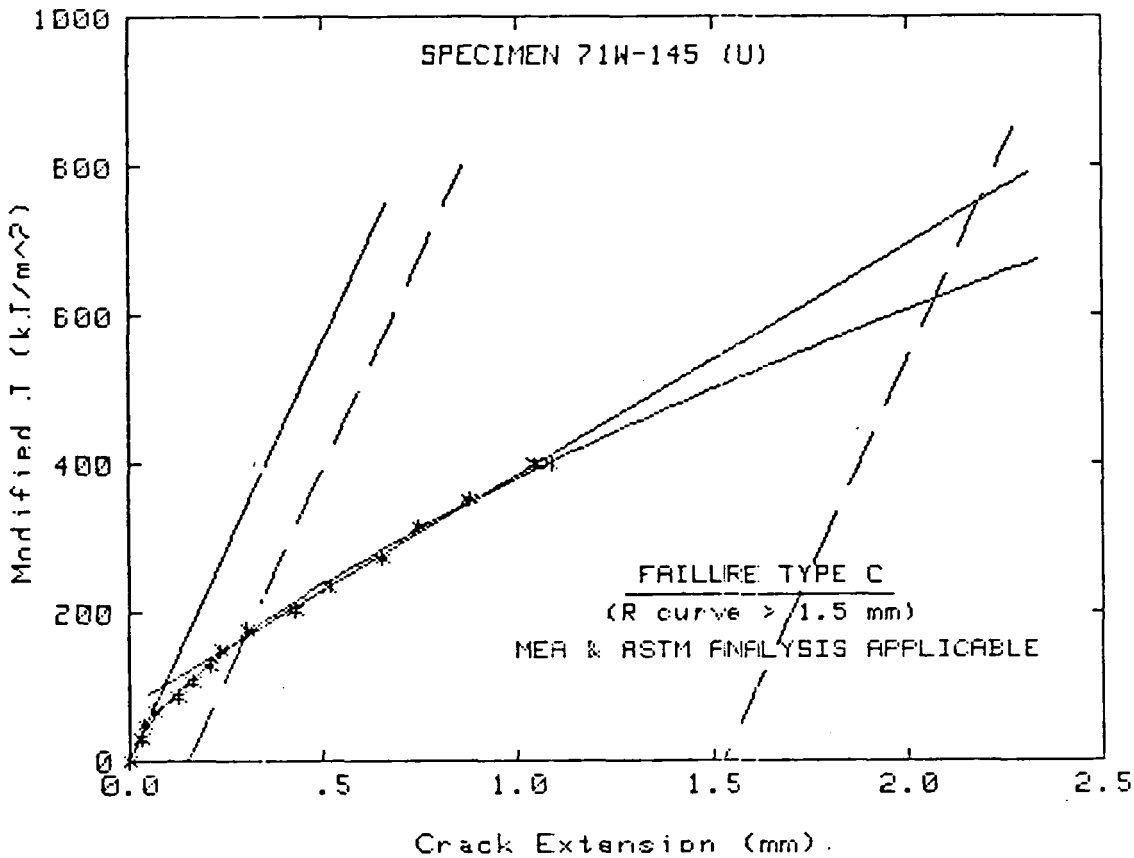
Material Type	= A533-B HSST WELD	
Test Temperature	= -5 C	
Percent Side Groove	= 0 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.29 mm	Init a/W = .556
Final crack length	= 31.43 mm	Final a/W = .618
Flow stress	= 562.7 MPa	
Youngs modulus	= 207500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 188.3 kJ/m^2	
Kjc	= 197.7	J (@J/T=8.8) = 0 kJ/m^2
Exponent N	= .6549	
Coefficient C	= 397.2 kJ/m^2	
T (average)	= 165	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 155.3 kJ/m^2	
Kjc	= 179.5	Slope M = 258532.2 kJ/m^3
Intercept B	= 119.6 kJ/m^2	
T (ASTM)	= 170	
Validity (Jic)	= INVALID--c (.82 vs .47)	
Validity (R-curve)	= INVALID--3 (.82 vs .33)	
J maximum allowed	= 632.8 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.25 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

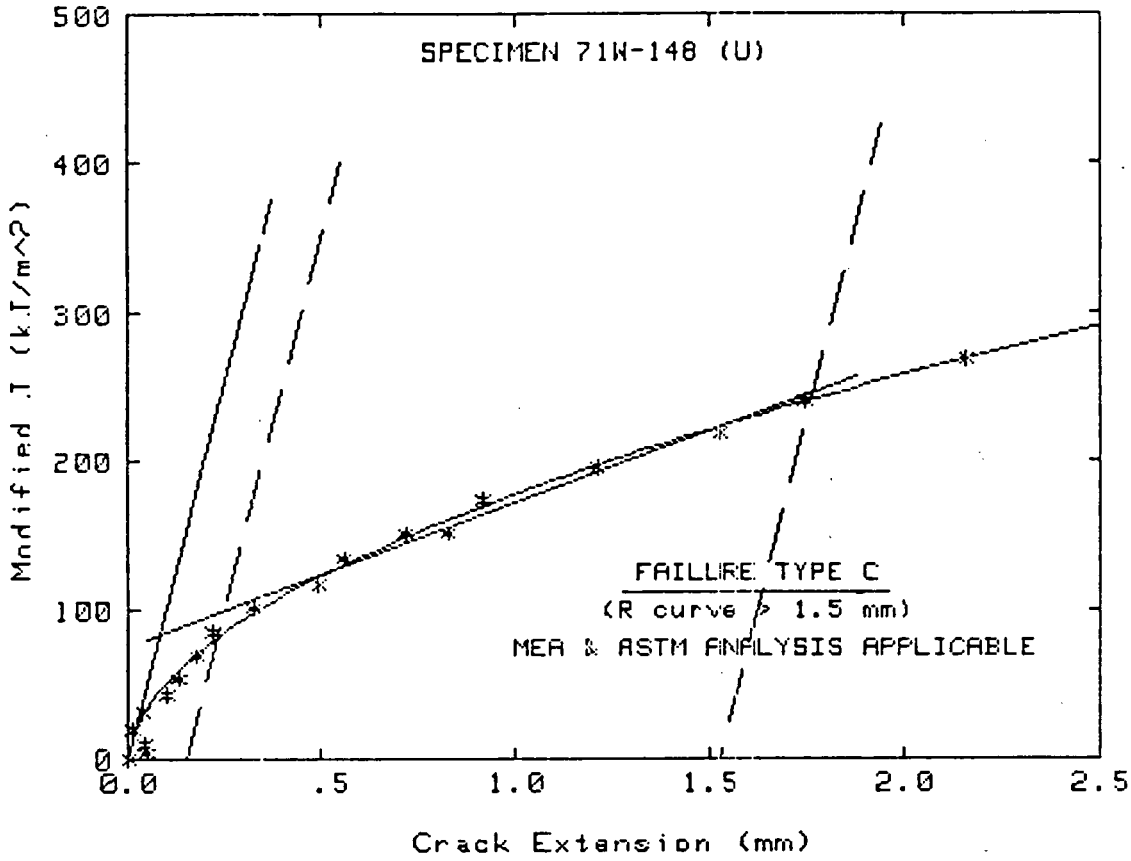
Material Type	= A533-B HSST WELD	
Test Temperature	= -10 C	
Percent Side Groove	= 0 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.22 mm	Init a/W = .555
Final crack length	= 29.65 mm	Final a/W = .583
Flow stress	= 567.2 MPa	
Youngs modulus	= 207800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 168.9 kJ/m^2	
Kjc	= 187.3	J (@J/T=8.8) = 0 kJ/m^2
Exponent N	= .676	
Coefficient C	= 379.9 kJ/m^2	
T (average)	= 162	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 101.7 kJ/m^2	
Kjc	= 145.3	Slope M = 310925.1 kJ/m^3
Intercept B	= 73.8 kJ/m^2	
T (ASTM)	= 201	
Validity (Jic)	= INVALID--b, c (.38 vs .21)	
Validity (R-curve)	= INVALID--3 (.38 vs .21)	
J maximum allowed	= 639.9 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.26 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

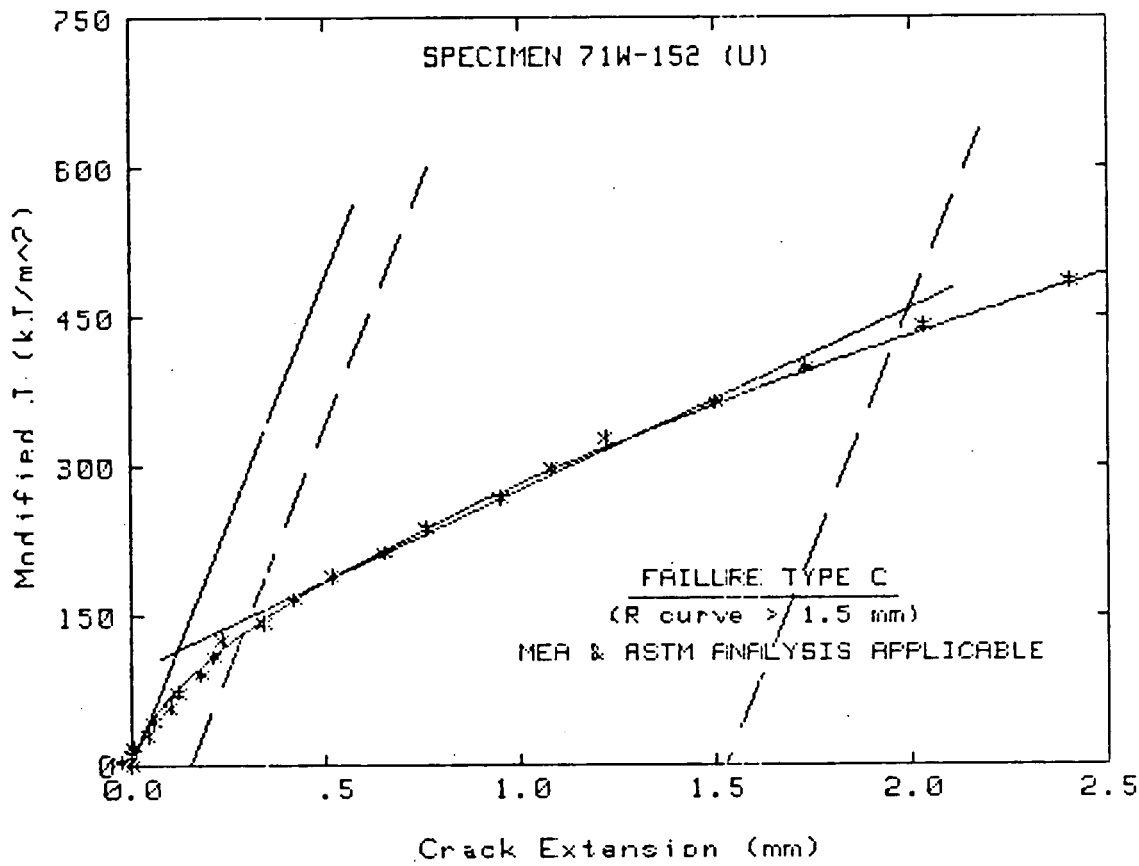
Material Type	= A533-B HSST WELD		
Test Temperature	= 288 C		
Percent Side Groove	= 20 %		
Specimen Thickness	= 25.4 mm		
Init crack length	= 27.71 mm	Init a/W	= .545
Final crack length	= 38.76 mm	Final a/W	= .763
Flow stress	= 508.1 MPa		
Youngs modulus	= 190800 MPa	(Estimated Value)	

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 81.1 kJ/m^2		
Kjc	= 124.4	J (@J/T=8.8)	= 347.2 kJ/m^2
Exponent N	= .5375		
Coefficient C	= 177.7 kJ/m^2		
T (average)	= 74		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 83.8 kJ/m^2		
Kjc	= 126.5	Slope M	= 96099.6 kJ/m^3
Intercept B	= 75.9 kJ/m^2		
T (ASTM)	= 71		
Validity (Jic)	= VALID		
Validity (R-curve)	= INVALID--1		
J maximum allowed	= 515.8 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 2.31 mm	(Delta a max = 0.1*bo)	



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.13 mm	Init a/W = .553
Final crack length	= 38.21 mm	Final a/W = .752
Flow stress	= 489.2 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 131.6 kJ/m^2		
Kjc	= 162.4	J (@J/T=8.8)	= 705.5 kJ/m^2
Exponent N	= .6111		
Coefficient C	= 282.2 kJ/m^2		
T (average)	= 143		

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 114.4 kJ/m^2		
Kjc	= 151.4	Slope M	= 183219 kJ/m^3
Intercept B	= 92.9 kJ/m^2		
T (ASTM)	= 153		
Validity (Jic)	= VALID		
Validity (R-curve)	= VALID		
J maximum allowed	= 496.6 kJ/m^2	(Jmax=Bnet*Flow stress/20)	
Delta a max. allowed	= 2.27 mm	(Delta a max = 0.1*bo)	

Appendix D

LOAD-DISPLACEMENT AND J-R CURVES AND PHOTOGRAPHS, SUPPLIED BY OAK RIDGE NATIONAL LABORATORY, FOR UNIRRADIATED MATERIAL

ORNL VALIDITY INDEX

J_{Ic} (ASTM E813)

1. < 4 data points between 0.15 and 1.5 mm exclusion lines.

2. Data clustering problem.

3. $B_N < 25\ J_Q/\sigma_y$

4. $b_o < 25\ J_Q/\sigma_y$

5. $dJ/da > \sigma_{flow}$

6. Delta-a prediction error too large,
   $|(\text{delta-a})_{pred} - (\text{delta-a})_{meas}| > 0.15\ (\text{delta-a})_{meas}$

Tentative J_I - R Curve Procedure

1. < 3 data points between (delta-a)=0 and secant line [$J=4/3*\sigma_y*(\text{delta-a})$]

2. < 10 data points between secant line and $(\text{delta-a})_{max}$ [$0.1*b_o$]

3. (delta-a) prediction error too large,
   $|(\text{delta-a})_{pred} - (\text{delta-a})_{meas}| >$
   MINIMUM [$0.15*(\text{delta-a})_{meas}, 0.15*(\text{delta-a})_{max}$]

ORNL UNIRRADIATED 1TCS DATA SHEETS
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D-85.	02G293	D-181	70W120
D-87	02G296	D-183	70W127
D-89	02G299	D-185	70W135
D-91	02G301	D-187	70W143
D-93	02G303	D-189	70W144
D-95	02G309	D-191	70W147
D-97	02G312	D-193	70W149
D-99	02G321	D-195	70W150
D-101	02G325	D-197	70W152
D-103	02G326	D-199	71W103
D-105	02G327	D-201	71W105
D-107	02G350	D-203	71W107
D-109	02G357	D-205	71W114
D-111	02G361	D-207	71W124
D-113	02G367	D-209	71W125
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D-157	69W138		
D-159	69W140		
D-161	69W141		
D-163	69W145		
D-165	69W151		
D-167	69W154		
D-169	69W161		
D-171	69W170		
D-173	69W175		
D-175	70W103		
D-177	70W114		

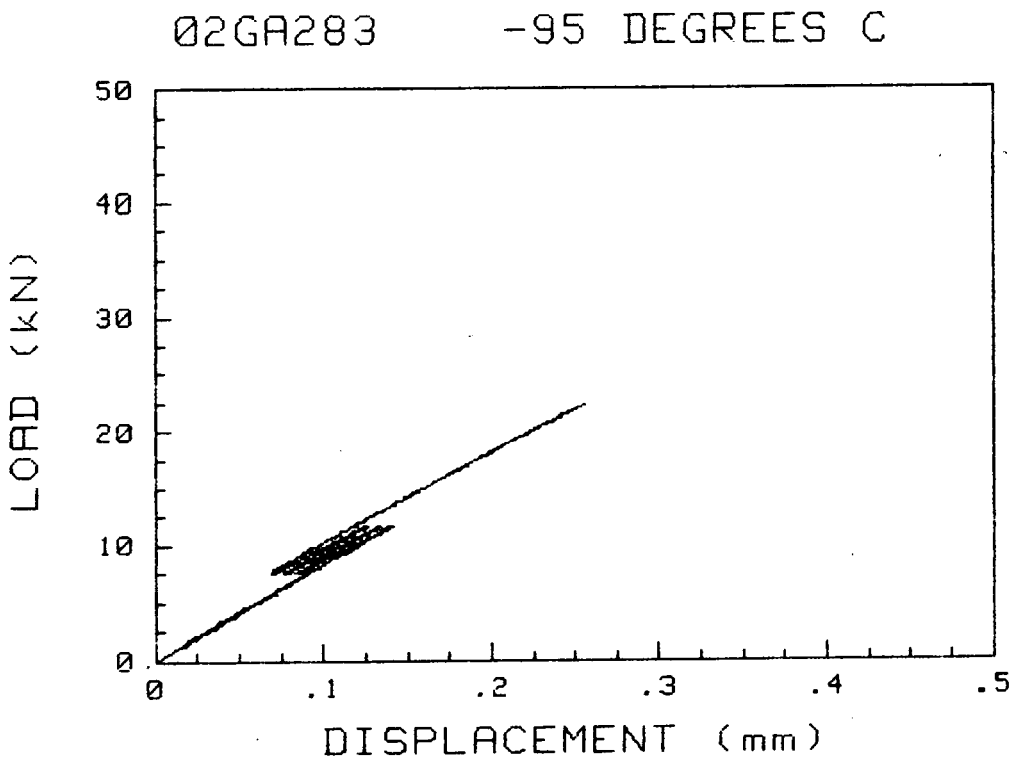
SPECIMEN ID= 02GA283
MATERIAL TYPE= A533-B-1
TEST TEMPERATURE= -95 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.6 mm a/W)i= .619
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 593 MPa
FLOW STRENGTH= 678 MPa
ESTIMATED YOUNG'S MODULUS= 213 GPa

SPECIMEN CLEAVED AT KIc= 57.2 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 13.3 kJ/m^2	J-INTEGRAL= 13.3 kJ/m^2
KJc= 53.2 MPa SQR[m]	KJc= 53.2 MPa SQR[m]
K-beta-c= 50.4 MPa SQR[m]	K-beta-c= 50.4 MPa SQR[m]

YP1247

ORNL-DWG 87-7893



SPECIMEN ID= 02GA293
TEST TEMPERATURE= 23 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.5 mm a/W)i= .619
MEASURED DUCTILE DELTA-A= 1.06 mm
YIELD STRENGTH= 474 MPa
FLOW STRENGTH= 550 MPa
ESTIMATED YOUNG'S MODULUS= 206 GPa

SPECIMEN CLEAVED AT K = 102.2 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 248.6 kJ/m^2
KJc= 226.2 MPa SQR[m]
K-beta-c= 99.3 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 381.1 kJ/m^2
KJc= 280.1 MPa SQR[m]
K-beta-c= 107.6 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 153.6 kJ/m^2
K-JIc= 177.8 MPa SQR[m]
POWER= .7307
COEFFICIENT= 379.7 kJ/m^2
T (AVERAGE)= 184

ASTM LINEAR PROCEDURE

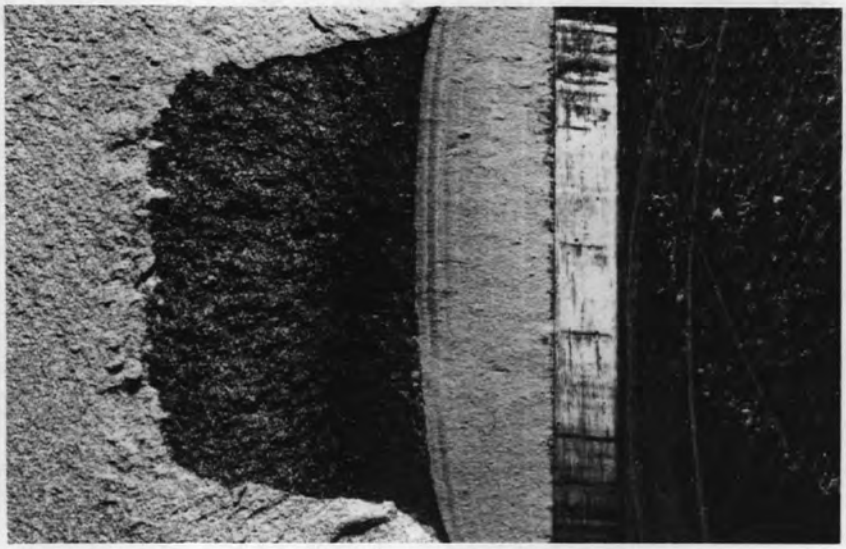
JIc= 112.4 kJ/m^2
K-JIc= 152.1 MPa SQR[m]
SLOPE= 291420 kJ/m^3
INTERCEPT= 82.6 kJ/m^2
T (ASTM)= 198
INVALID, 2

JI-R CURVE CALCULATIONS

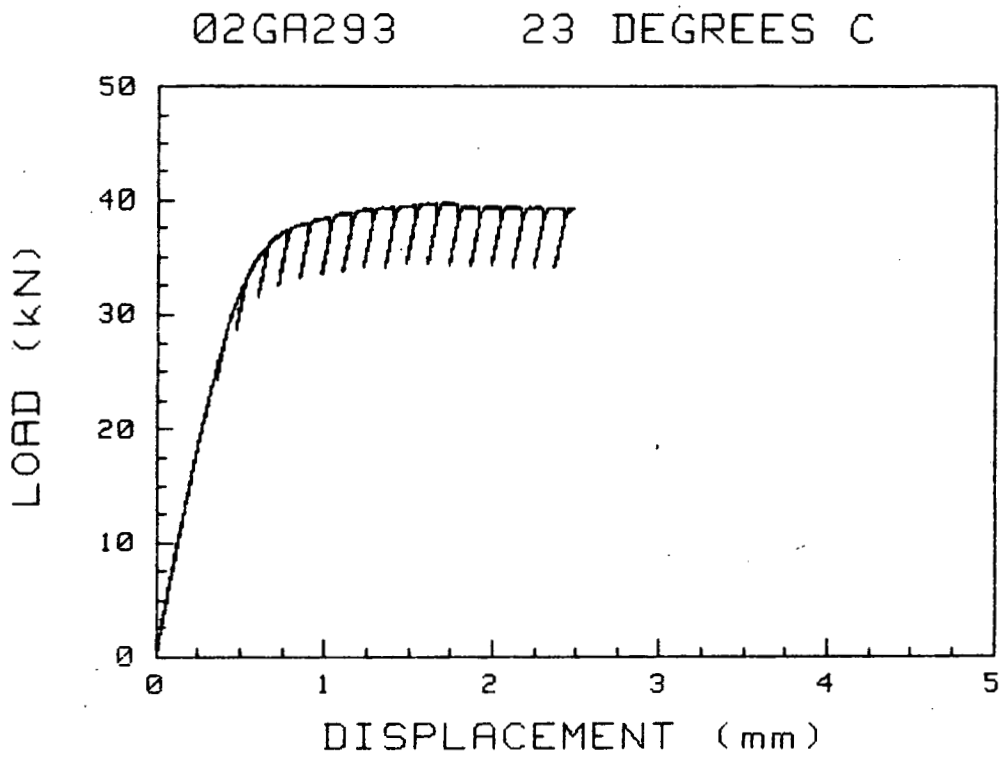
J (@J/T=8.8)= 877.4 kJ/m^2
POWER= .6473
J-MAX ALLOWED= 533.9 kJ/m^2

COEFFICIENT= 364.9 kJ/m^2
DELTA-A MAX ALLOWED= 1.94 mm
VALID R-CURVE

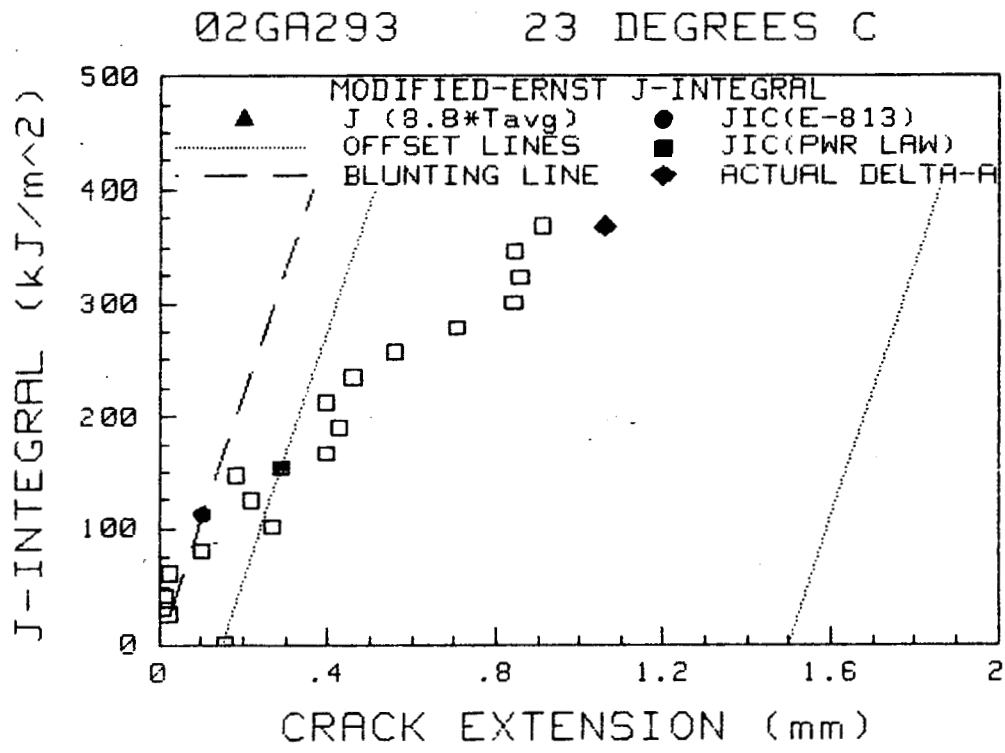
YP1248



ORNL-DWG 87-7894



ORNL-DWG 87-7895



SPECIMEN ID= 02GA296
MATERIAL TYPE= A533B
TEST TEMPERATURE= -40 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.4 mm a/W)i= .617
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 529 MPa
FLOW STRENGTH= 609 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT K = 69 MPa SQR[m] (NOT VALID KIc)

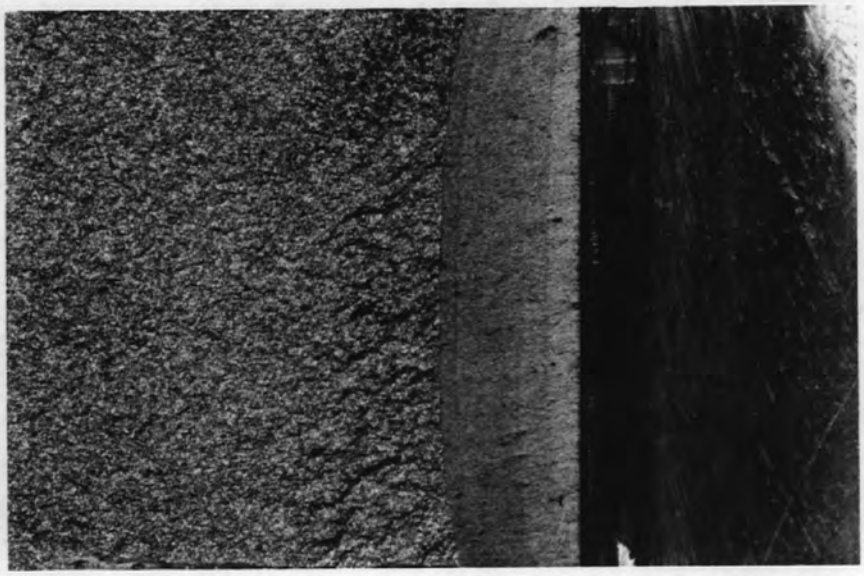
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 22.8 kJ/m^2
KJc= 69.1 MPa SQR[m]
K-beta-c= 59.5 MPa SQR[m]

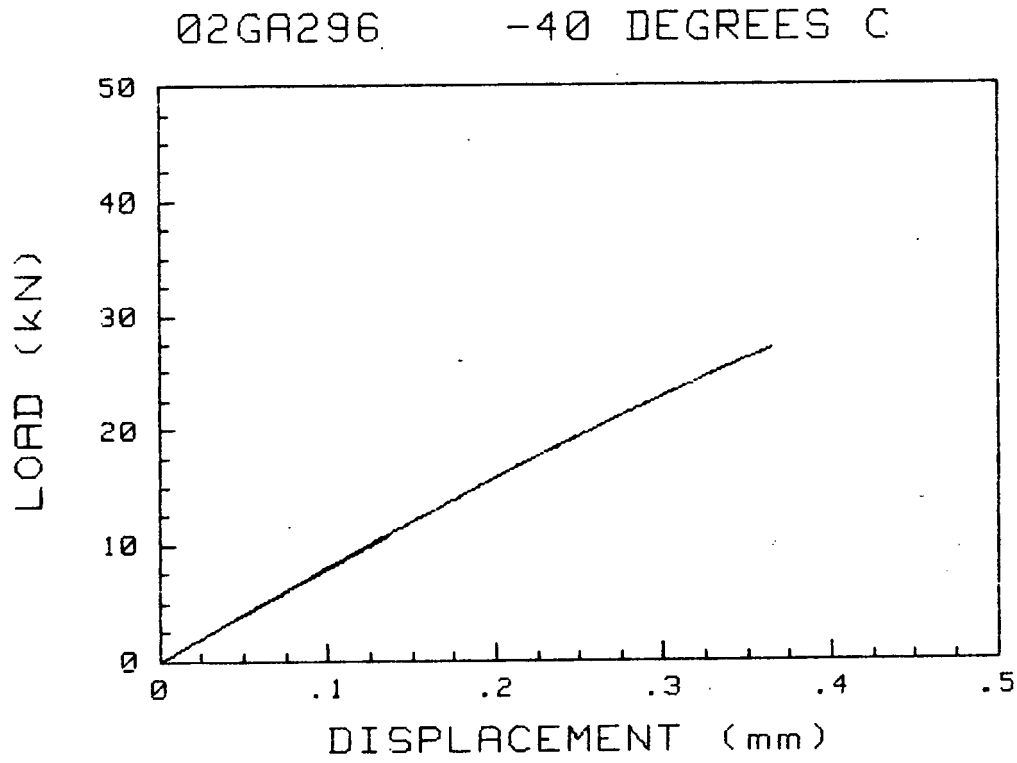
VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 22.8 kJ/m^2
KJc= 69.1 MPa SQR[m]
K-beta-c= 59.5 MPa SQR[m]

YP1246



ORNL-DWG 87-7896



SPECIMEN ID= 02GA299
TEST TEMPERATURE= 50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 31.6 mm a/W)i= .62
MEASURED DUCTILE DELTA-A= 3.09 mm
YIELD STRENGTH= 456 MPa
FLOW STRENGTH= 531 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 265.5 kJ/m^2
KJ-MAX LOAD= 232.9 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 213.9 kJ/m^2
K-JIc= 209.1 MPa SQR[m]
POWER= .5363
COEFFICIENT= 374.9 kJ/m^2
T (AVERAGE)= 140

ASTM LINEAR PROCEDURE

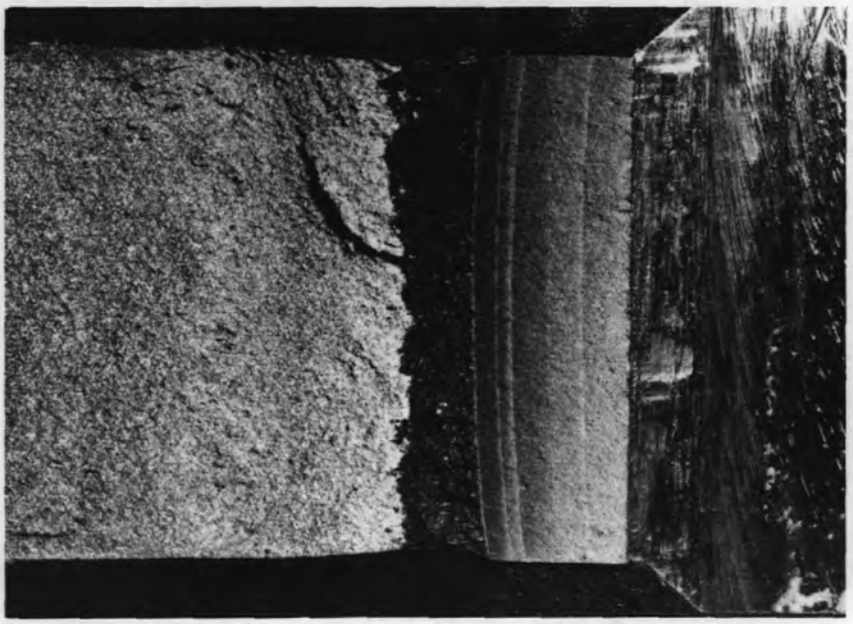
JIc= 207.6 kJ/m^2
K-JIc= 206 MPa SQR[m]
SLOPE= 194064 kJ/m^3
INTERCEPT= 169.7 kJ/m^2
T (ASTM)= 141
VALID, E813

JI-R CURVE CALCULATIONS

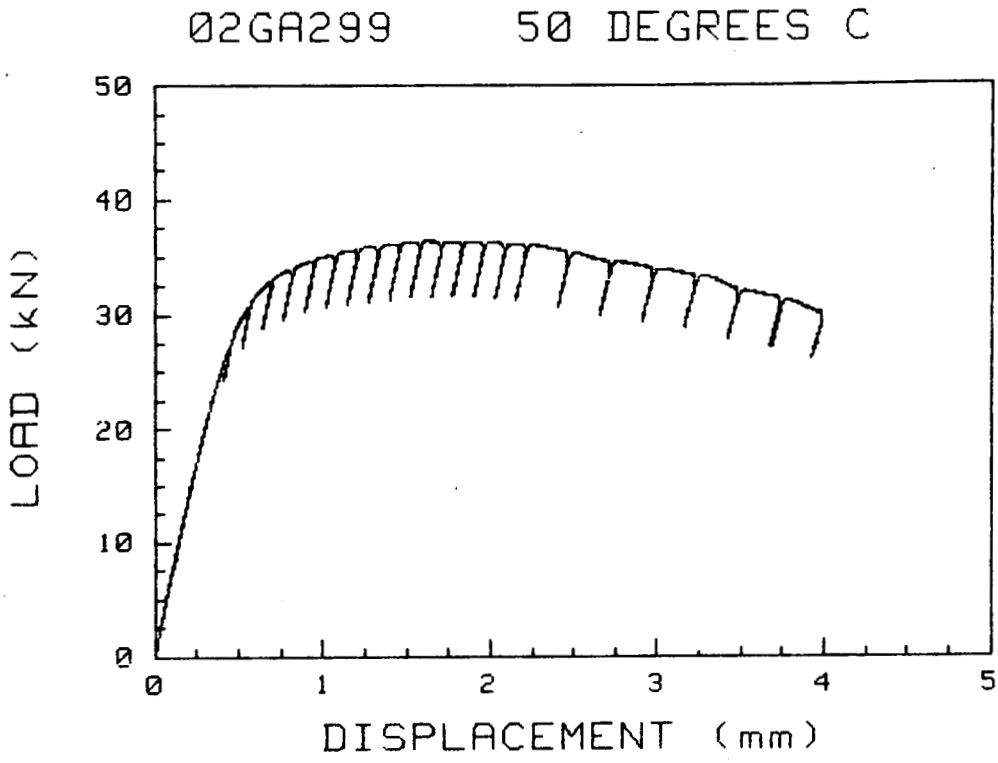
J (@J/T=8.8)= 663.8 kJ/m^2
POWER= .4978
J-MAX ALLOWED= 513.2 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 373.6 kJ/m^2
DELTA-A MAX ALLOWED= 1.93 mm

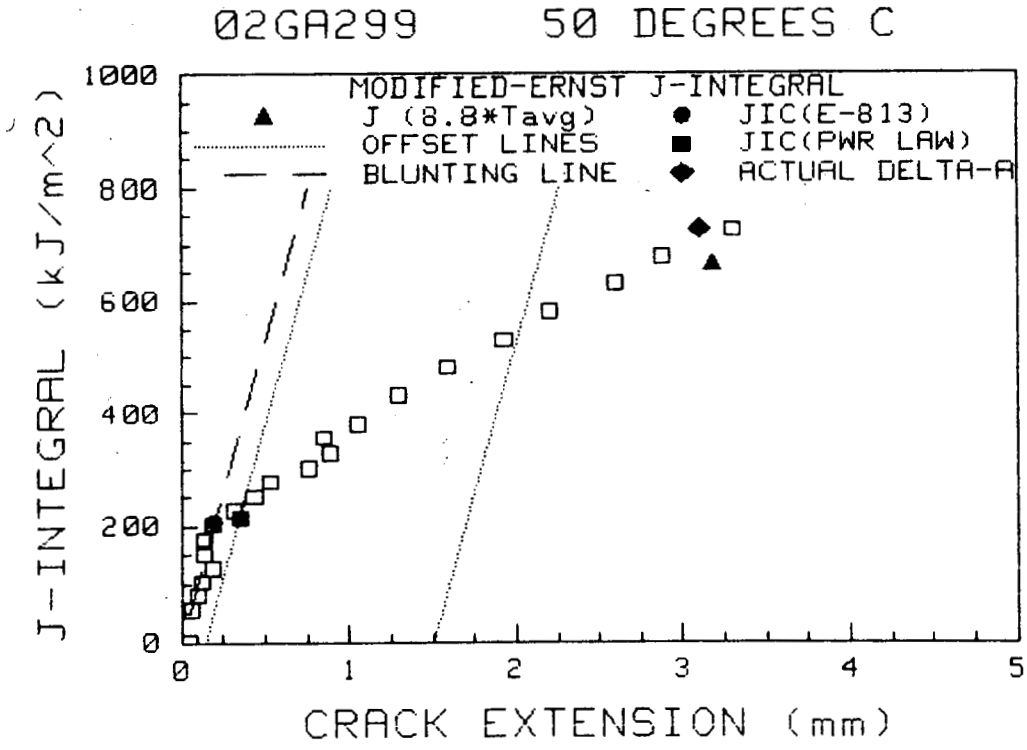
YP1245



ORNL-DWG 87-7897



ORNL-DWG 87-7898

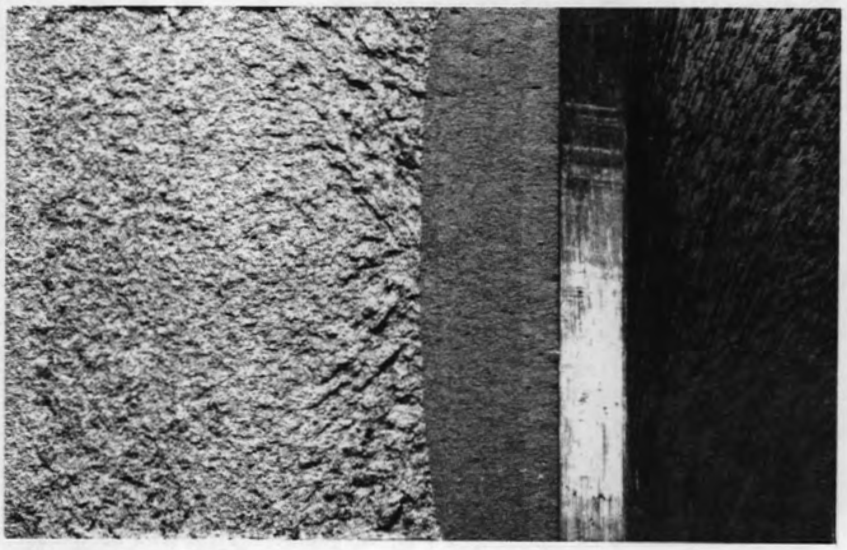


SPECIMEN ID= 02GA301
MATERIAL TYPE= A533B
TEST TEMPERATURE= -40 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.6 mm a/W)i= .621
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 529 MPa
FLOW STRENGTH= 609 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

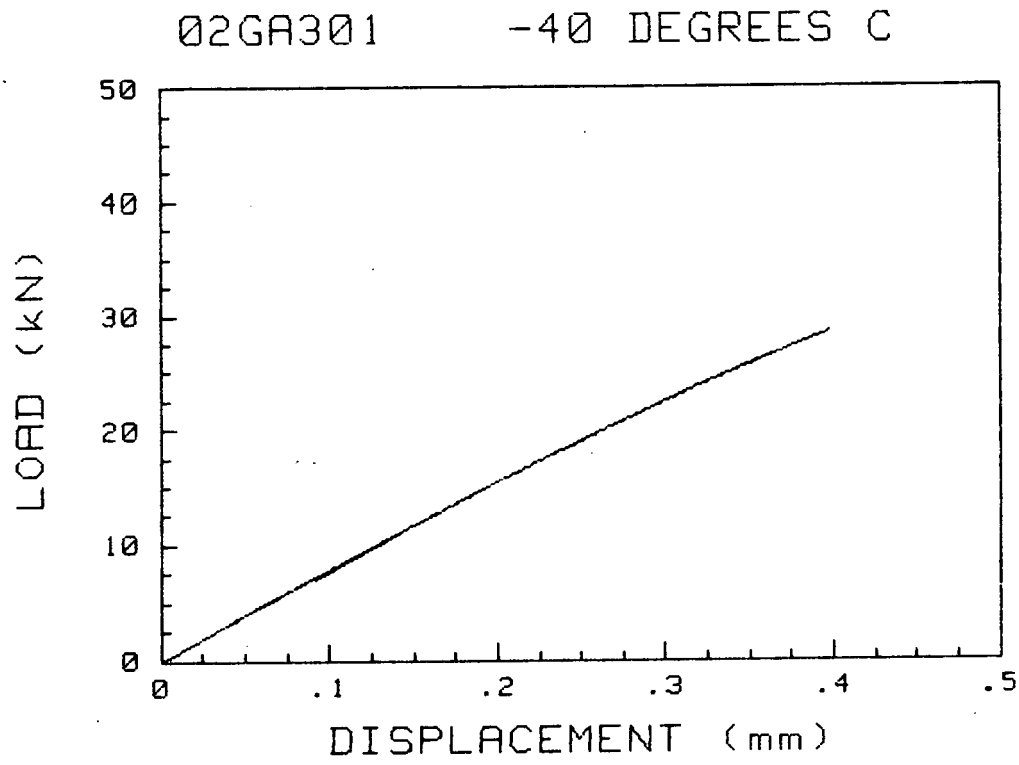
SPECIMEN CLEAVED AT K = 73.8 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 26.6 kJ/m^2	J-INTEGRAL= 26.6 kJ/m^2
KJc= 74.6 MPa SQR[m]	KJc= 74.6 MPa SQR[m]
K-beta-c= 62.6 MPa SQR[m]	K-beta-c= 62.6 MPa SQR[m]

YP1244



ORNL-DWG 87-7899



SPECIMEN ID= 02GA303
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 31.7 mm a/W)i= .62
MEASURED DUCTILE DELTA-A= 3.06 mm
YIELD STRENGTH= 424 MPa
FLOW STRENGTH= 500 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 233.1 kJ/m^2
KJ-MAX LOAD= 216.1 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 171 kJ/m^2
K-JIc= 185.1 MPa SQR[m]
POWER= .5717
COEFFICIENT= 327.5 kJ/m^2
T (AVERAGE)= 146

ASTM LINEAR PROCEDURE

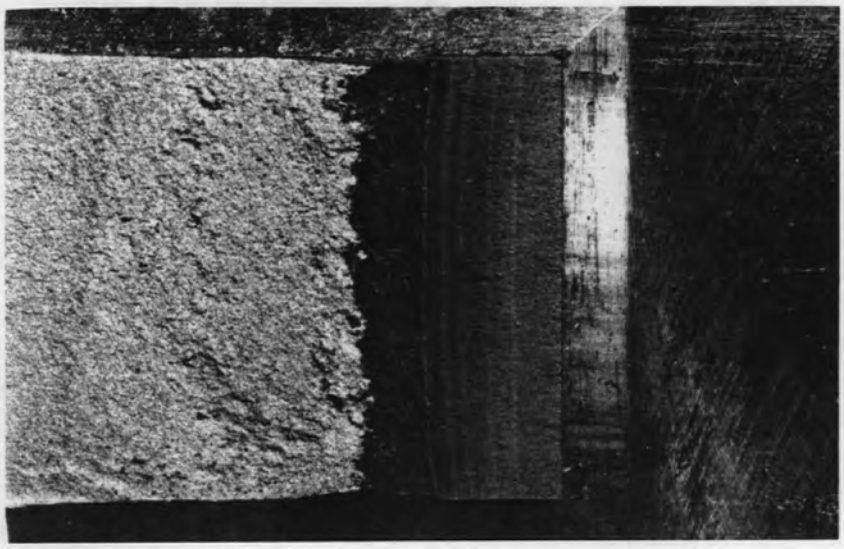
JIc= 177 kJ/m^2
K-JIc= 188.3 MPa SQR[m]
SLOPE= 172848 kJ/m^3
INTERCEPT= 146.4 kJ/m^2
T (ASTM)= 138
VALID, E813

JI-R CURVE CALCULATIONS

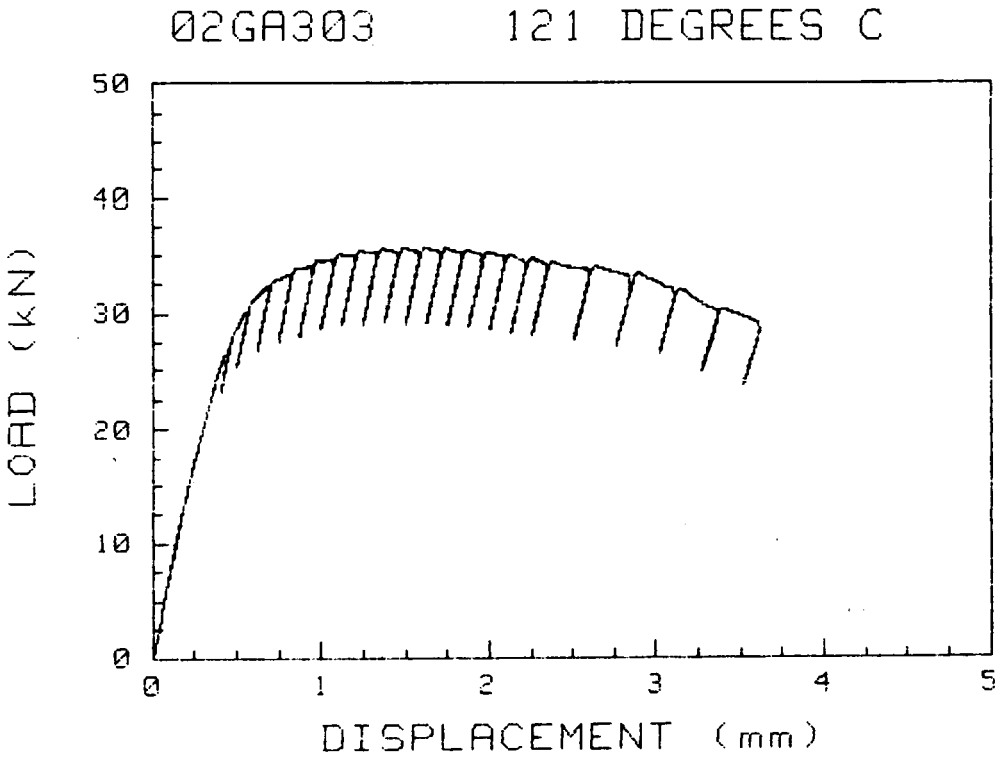
J (@J/T=8.8)= 595.8 kJ/m^2
POWER= .4869
J-MAX ALLOWED= 484.6 kJ/m^2
RCURVE INVALID, 1

COEFFICIENT= 327 kJ/m^2
DELTA-A MAX ALLOWED= 1.94 mm

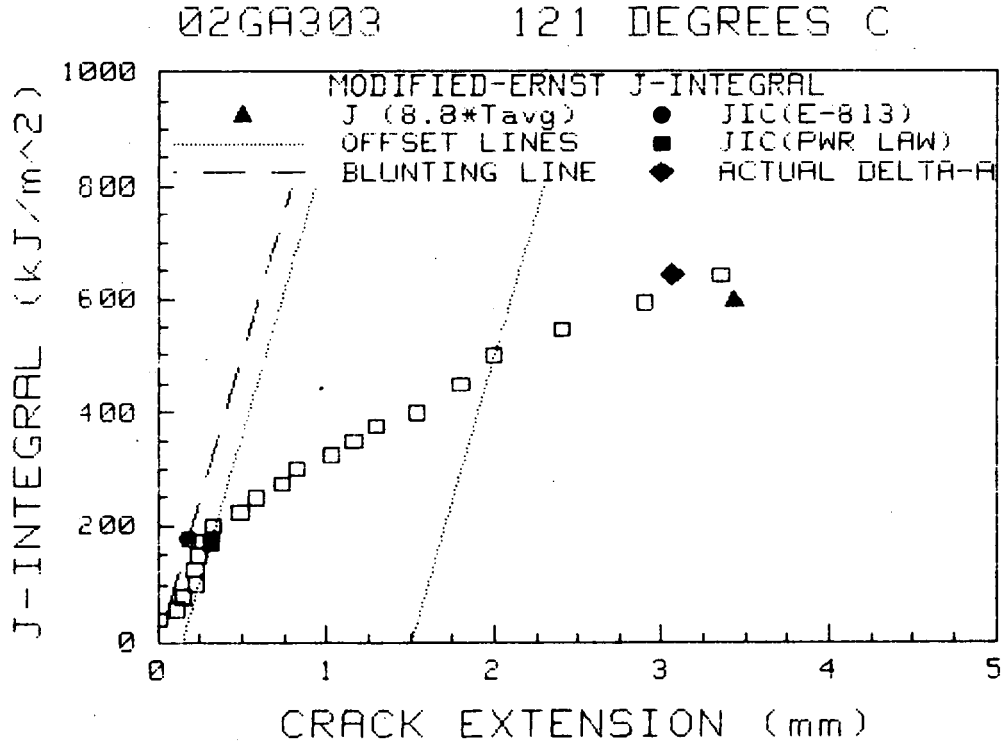
YP1213



ORNL-DWG 87-7900



ORNL-DWG 87-7901



SPECIMEN ID= 02GA309
TEST TEMPERATURE= 23 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.3 mm a/W)i= .617
MEASURED DUCTILE DELTA-A= .56 mm
YIELD STRENGTH= 474 MPa
FLOW STRENGTH= 550 MPa
ESTIMATED YOUNG'S MODULUS= 206 GPa

SPECIMEN CLEAVED AT K = 238.9 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 277 kJ/m^2
KJc= 238.9 MPa SQR[m]
K-beta-c= 101.4 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 277 kJ/m^2
KJc= 238.9 MPa SQR[m]
K-beta-c= 101.4 MPa SQR[m]

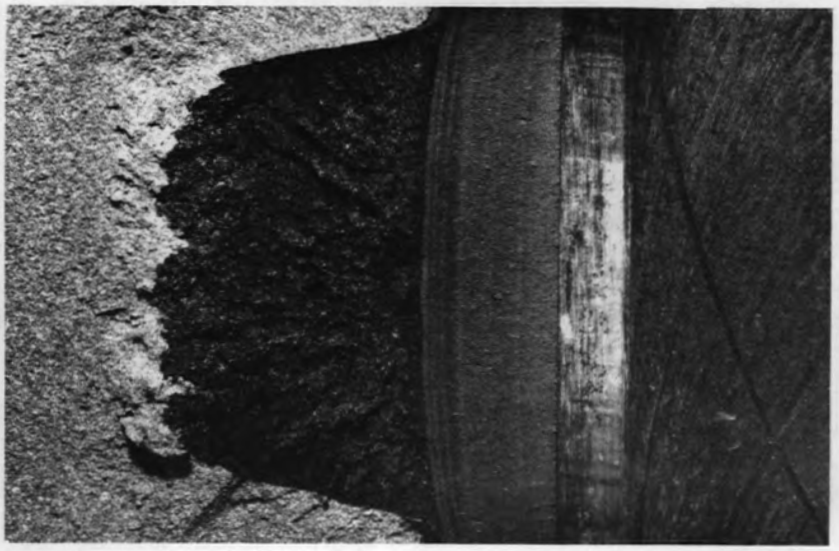
POWER LAW PROCEDURE

JIc= 216.6 kJ/m^2
K-JIc= 211.2 MPa SQR[m]
POWER= .7556
COEFFICIENT= 481.9 kJ/m^2
T (AVERAGE)= 235

ASTM LINEAR PROCEDURE

JIc= 0 kJ/m^2
K-JIc= 0 MPa SQR[m]
SLOPE= 0 kJ/m^3
INTERCEPT= 0 kJ/m^2
T (ASTM)= 0
INVALID, 1

YP1242



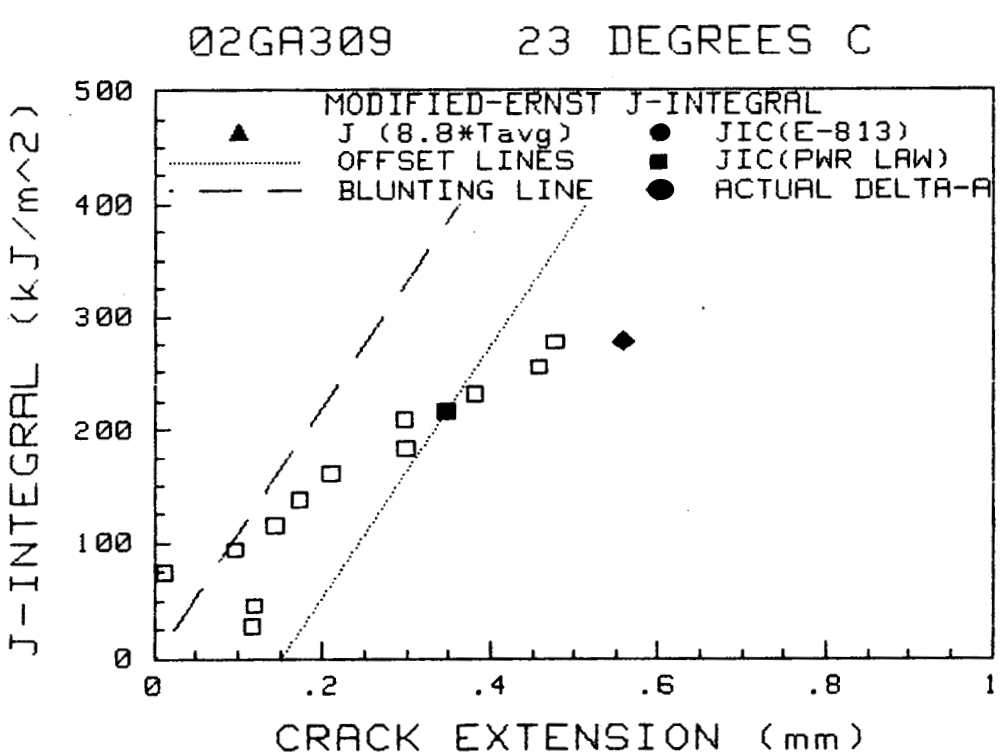
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 773.9 kJ/m^2
POWER= .5503
J-MAX ALLOWED= 535 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 401.4 kJ/m^2
DELTA-A MAX ALLOWED= 1.95 mm

LOAD-DISPLACEMENT CURVE UNAVAILABLE

ORNL-DWG 87-7902



SPECIMEN ID= 02GA312
MATERIAL TYPE= A533-B-1
TEST TEMPERATURE= -95 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.2 mm a/W)i= .612
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 593 MPa
FLOW STRENGTH= 678 MPa
ESTIMATED YOUNG'S MODULUS= 213 GPa

SPECIMEN CLEAVED AT KIc= 41.8 MPa SQR[m] (VALID ASTM E399)

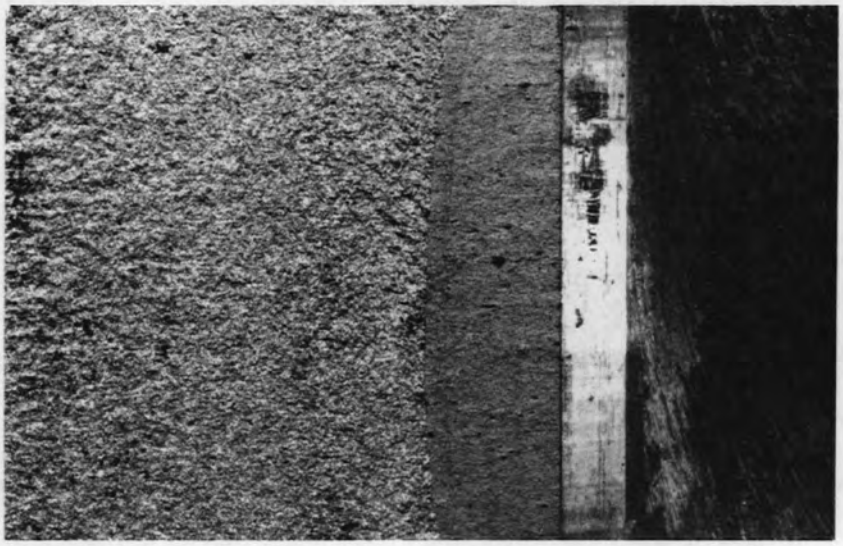
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 6.4 kJ/m^2
KJc= 36.8 MPa SQR[m]
K-beta-c= 36.3 MPa SQR[m]

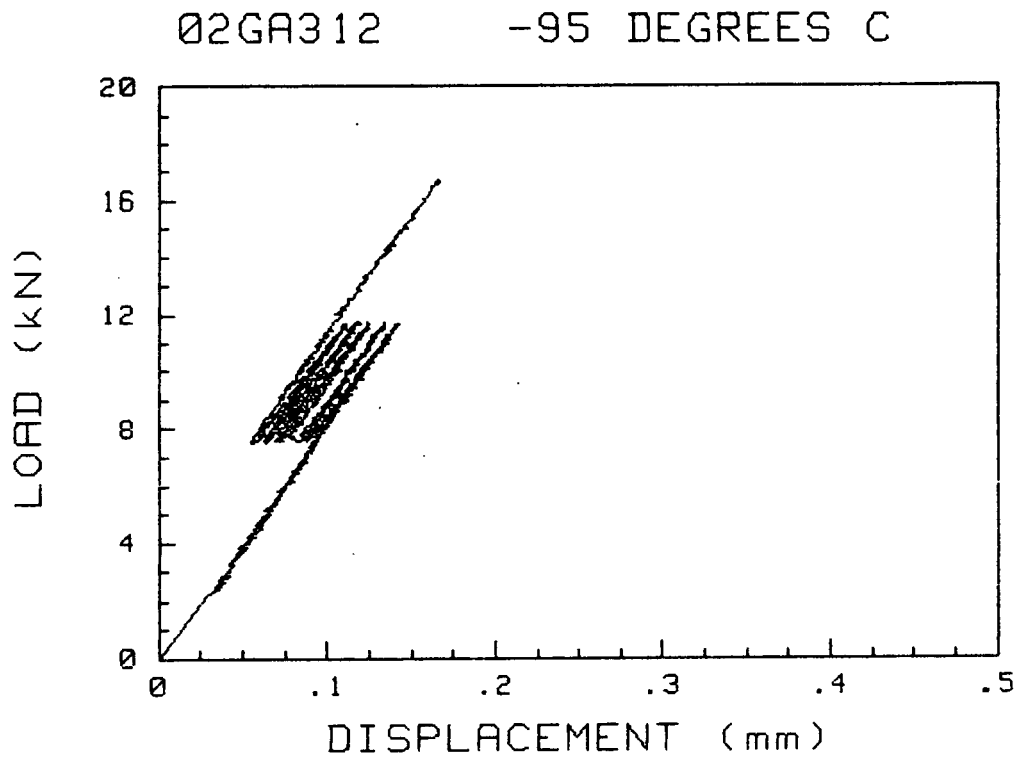
VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 6.4 kJ/m^2
KJc= 36.8 MPa SQR[m]
K-beta-c= 36.3 MPa SQR[m]

YP1211



ORNL-DWG 87-7903



SPECIMEN ID= 02GA321
TEST TEMPERATURE= 204 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 31.9 mm a/W)i= .626
MEASURED DUCTILE DELTA-A= 3.09 mm
YIELD STRENGTH= 418 MPa
FLOW STRENGTH= 498 MPa
ESTIMATED YOUNG'S MODULUS= 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 248.2 kJ/m^2
KJ-MAX LOAD= 220.3 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 199.3 kJ/m^2
K-JIc= 197.4 MPa SQR[m]
POWER= .3993
COEFFICIENT= 303.1 kJ/m^2
T (AVERAGE)= 94

ASTM LINEAR PROCEDURE

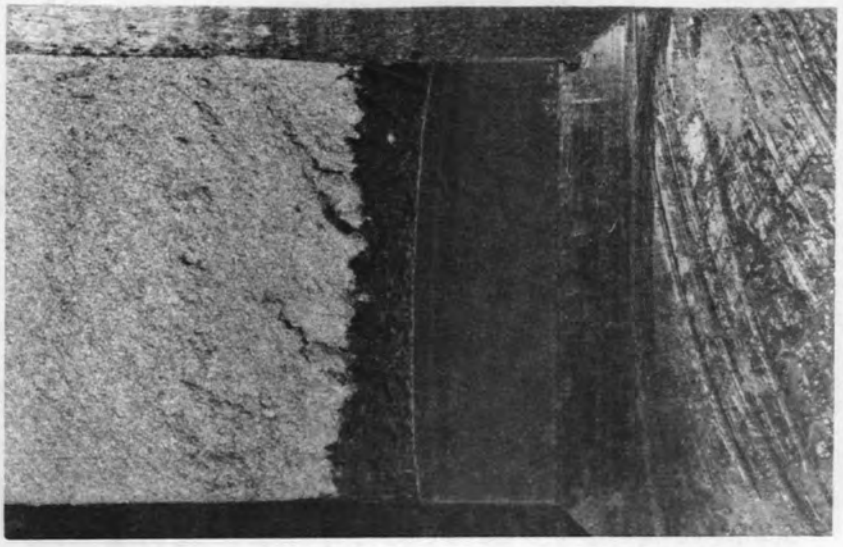
JIc= 191.4 kJ/m^2
K-JIc= 193.5 MPa SQR[m]
SLOPE= 127287 kJ/m^3
INTERCEPT= 167 kJ/m^2
T (ASTM)= 100
VALID, E813

JI-R CURVE CALCULATIONS

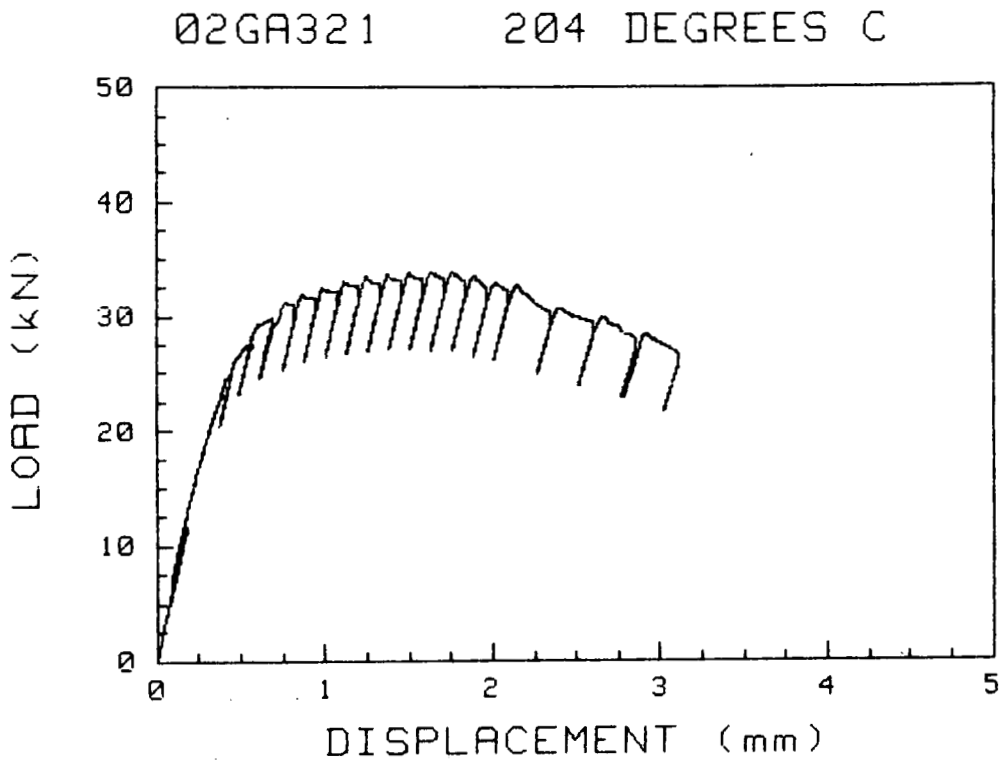
J (@J/T=8.8)= 425.3 kJ/m^2
POWER= .3664
J-MAX ALLOWED= 474.8 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 302.3 kJ/m^2
DELTA-A MAX ALLOWED= 1.91 mm

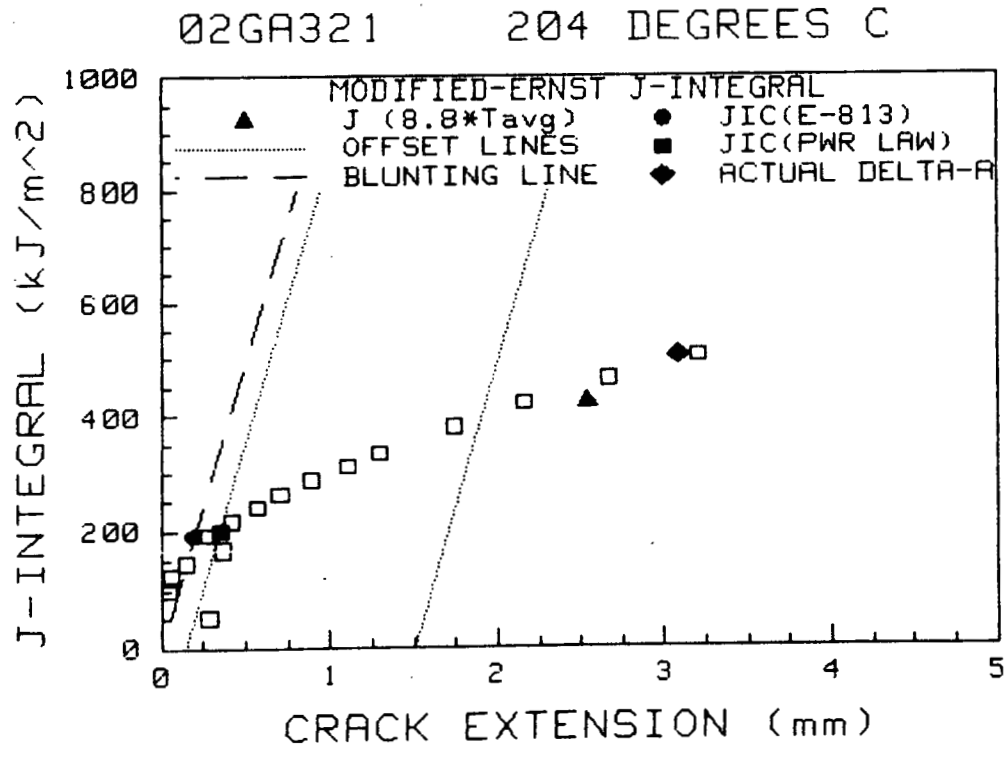
YP1240



ORNL-DWG 87-7904



ORNL-DWG 87-7905



SPECIMEN ID= 02GA325
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 24 %
INITIAL CRACK LENGTH= 31.7 mm a/W)i= .622
MEASURED DUCTILE DELTA-A= 4.11 mm
YIELD STRENGTH= 424 MPa
FLOW STRENGTH= 500 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 282.5 kJ/m^2
KJ-MAX LOAD= 237.9 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 139.8 kJ/m^2
K-JIc= 167.3 MPa SQR[m]
POWER= .5976
COEFFICIENT= 293.1 kJ/m^2
T (AVERAGE)= 139

ASTM LINEAR PROCEDURE

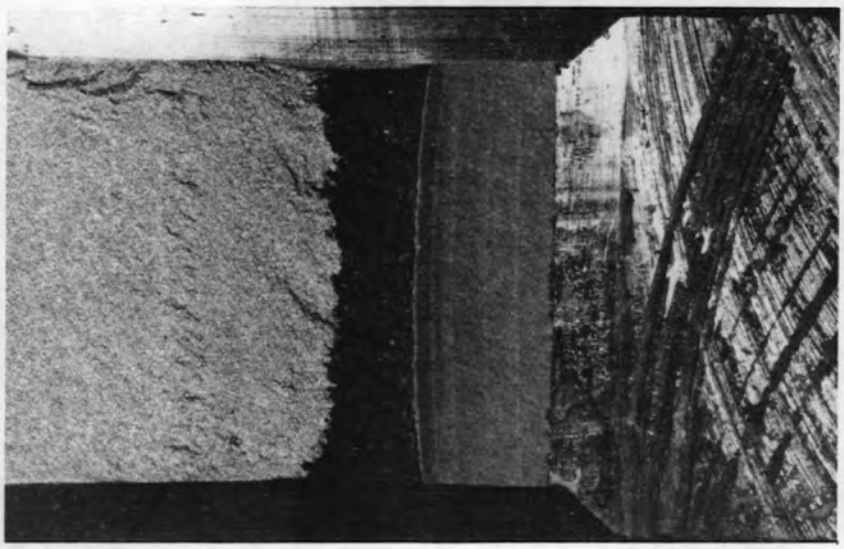
JIc= 114.5 kJ/m^2
K-JIc= 151.5 MPa SQR[m]
SLOPE= 195314 kJ/m^3
INTERCEPT= 92.2 kJ/m^2
T (ASTM)= 156
VALID, E813

JI-R CURVE CALCULATIONS

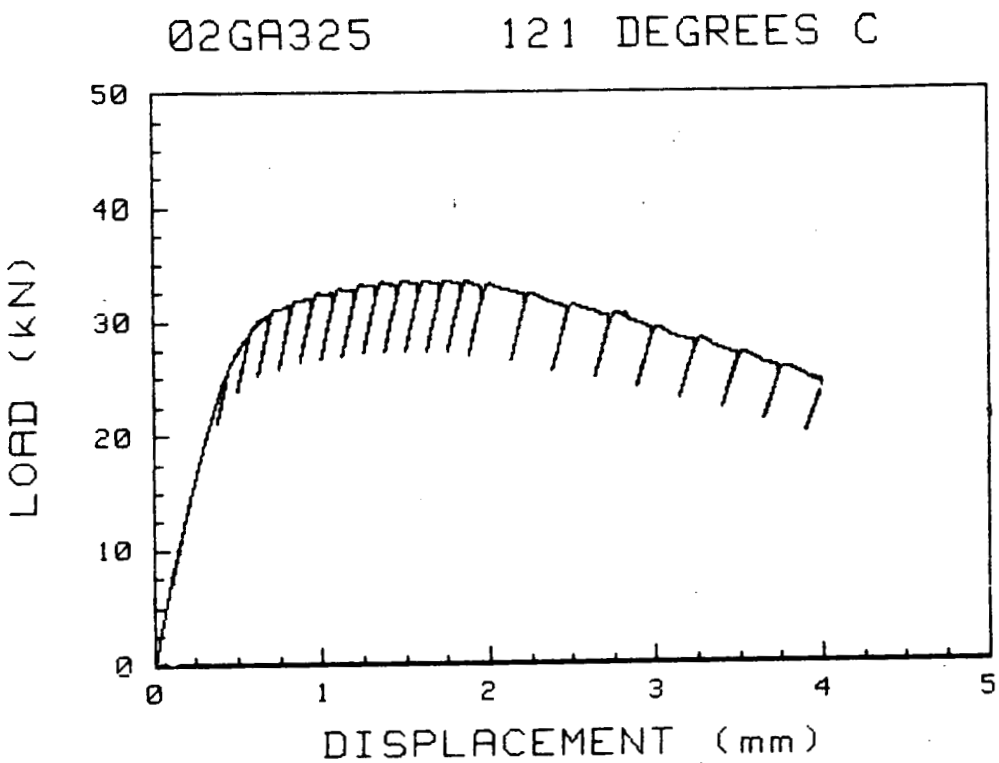
J (@J/T=8.8)= 688 kJ/m^2
POWER= .5958
J-MAX ALLOWED= 482.7 kJ/m^2
RCURVE INVALID, 1

COEFFICIENT= 292.8 kJ/m^2
DELTA-A MAX ALLOWED= 1.93 mm

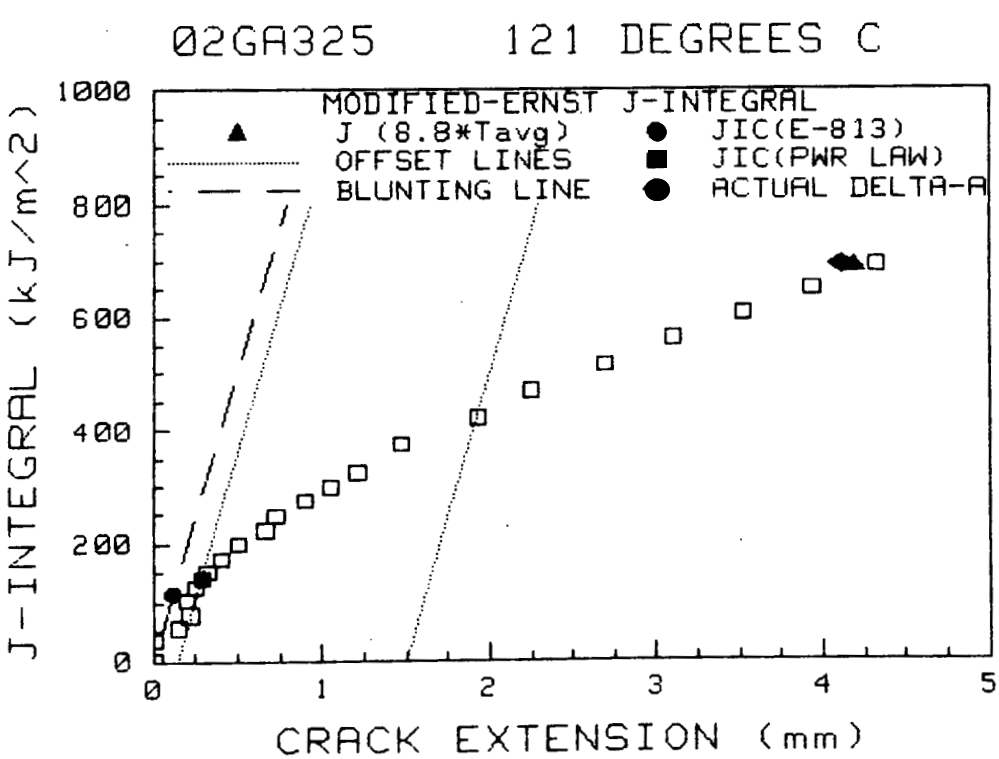
YP1239



ORNL-DWG 87-7906



ORNL-DWG 87-7907



SPECIMEN ID= 02GA326
TEST TEMPERATURE= 204 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 31.7 mm a/W)i= .623
MEASURED DUCTILE DELTA-A= 5.73 mm
YIELD STRENGTH= 418 MPa
FLOW STRENGTH= 498 MPa
ESTIMATED YOUNG'S MODULUS= 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 250 kJ/m^2
KJ-MAX LOAD= 221.1 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 148.4 kJ/m^2
K-JIc= 170.3 MPa SQR[m]
POWER= .4626
COEFFICIENT= 259.4 kJ/m^2
T (AVERAGE)= 96

ASTM LINEAR PROCEDURE

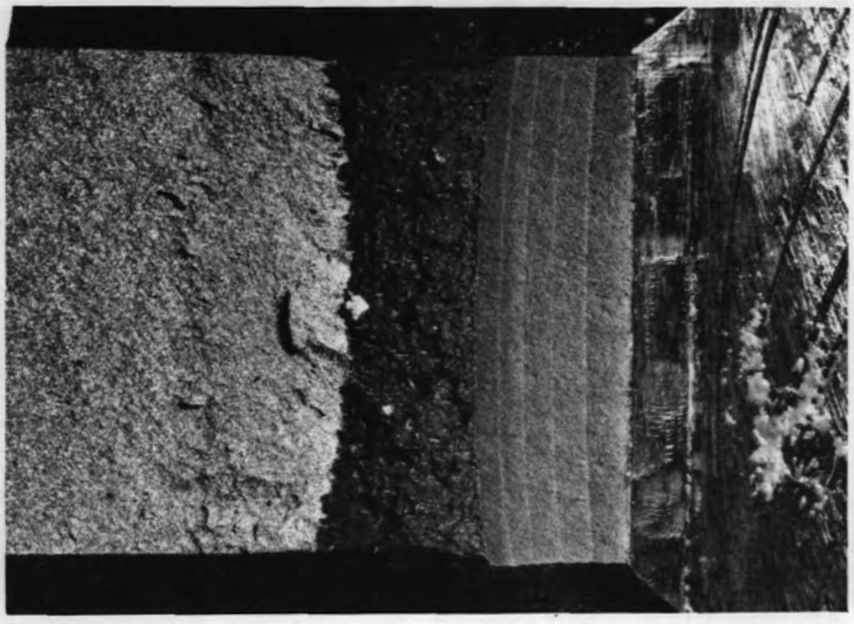
JIc= 142.5 kJ/m^2
K-JIc= 166.9 MPa SQR[m]
SLOPE= 126090 kJ/m^3
INTERCEPT= 124.4 kJ/m^2
T (ASTM)= 99
VALID, E813

JI-R CURVE CALCULATIONS

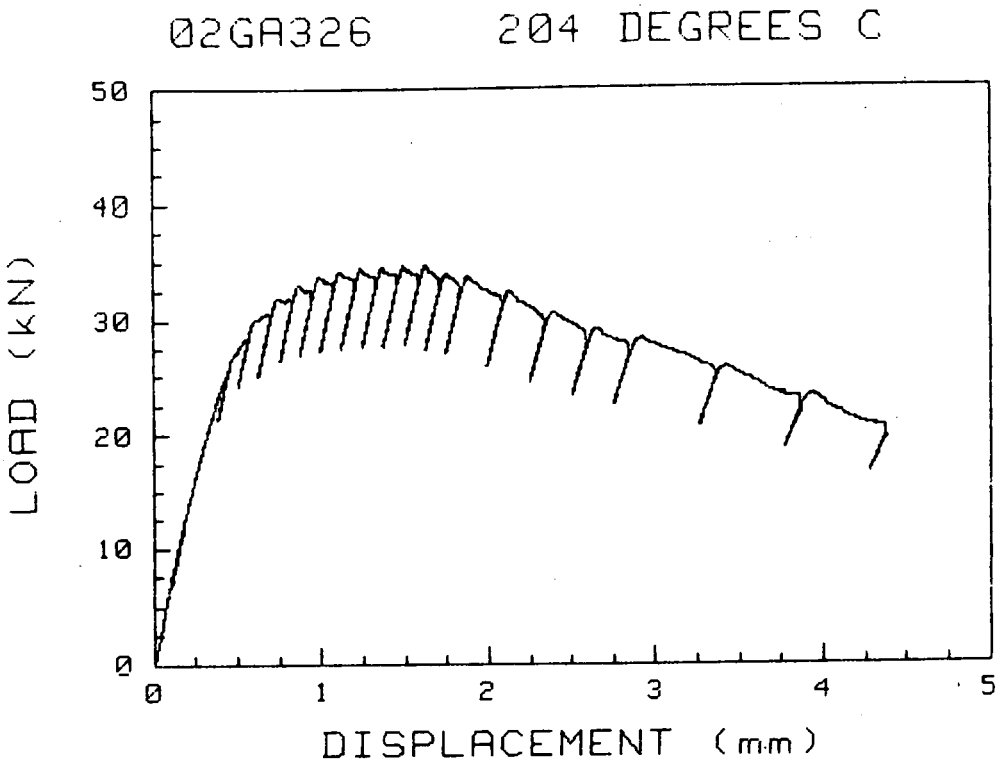
J (@J/T=8.8)= 439.1 kJ/m^2
POWER= .4576
J-MAX ALLOWED= 478.1 kJ/m^2

COEFFICIENT= 259 kJ/m^2
DELTA-A MAX ALLOWED= 1.92 mm
VALID R-CURVE

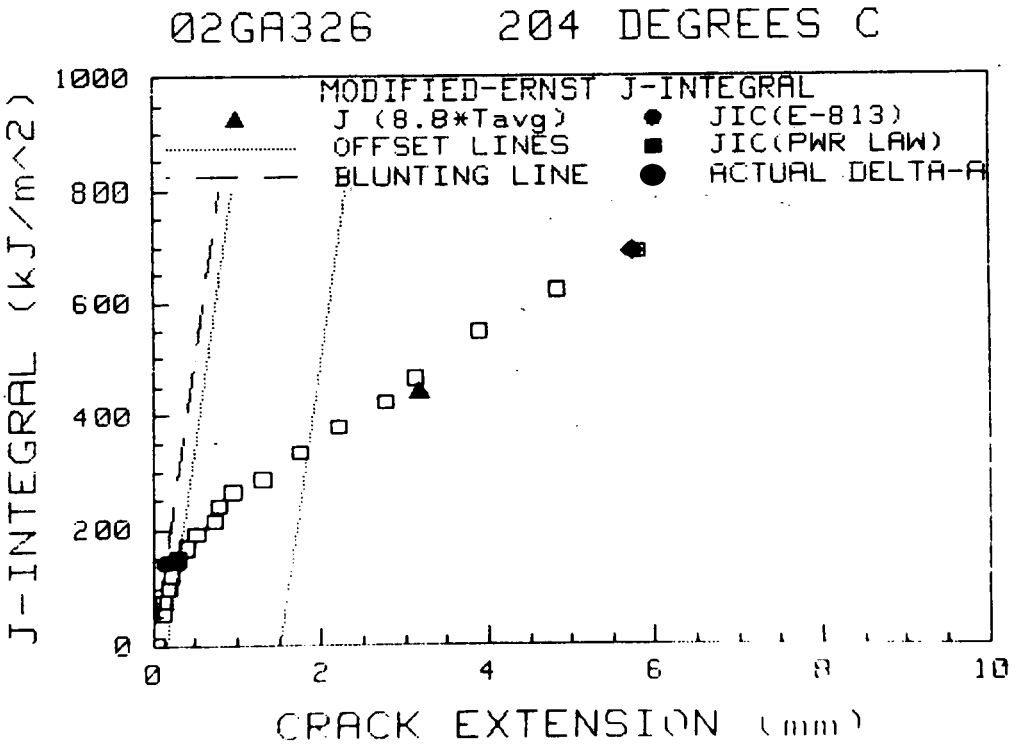
YP1238



ORNL-DWG 87-7908



ORNL-DWG 87-7909



SPECIMEN ID= 02GA327
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 32.2 mm a/W)i= .632
MEASURED DUCTILE DELTA-A= 6.01 mm
YIELD STRENGTH= 444 MPa
FLOW STRENGTH= 534 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 168.9 kJ/m^2
KJ-MAX LOAD= 179.5 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 130.9 kJ/m^2
K-JIc= 158 MPa SQR[m]
POWER= .455
COEFFICIENT= 236.4 kJ/m^2
T (AVERAGE)= 75

ASTM LINEAR PROCEDURE

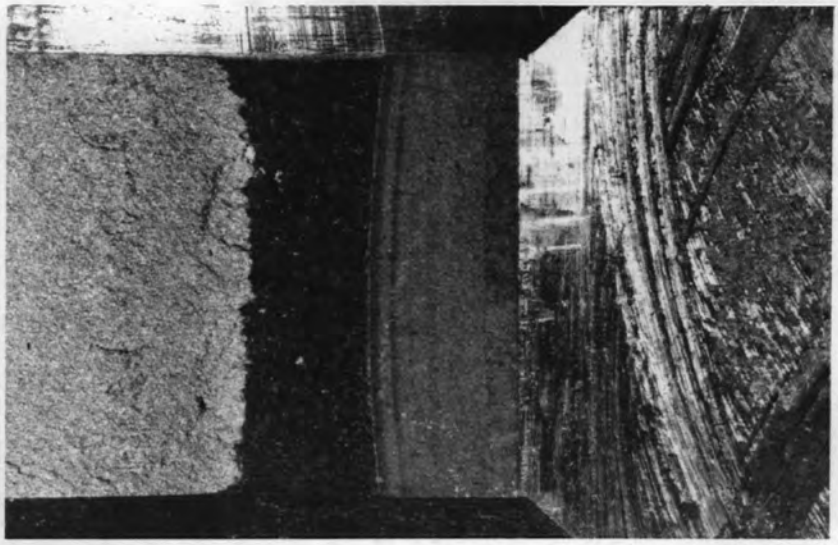
JIc= 132.2 kJ/m^2
K-JIc= 158.8 MPa SQR[m]
SLOPE= 109068 kJ/m^3
INTERCEPT= 118.7 kJ/m^2
T (ASTM)= 73
VALID, E813

JI-R CURVE CALCULATIONS

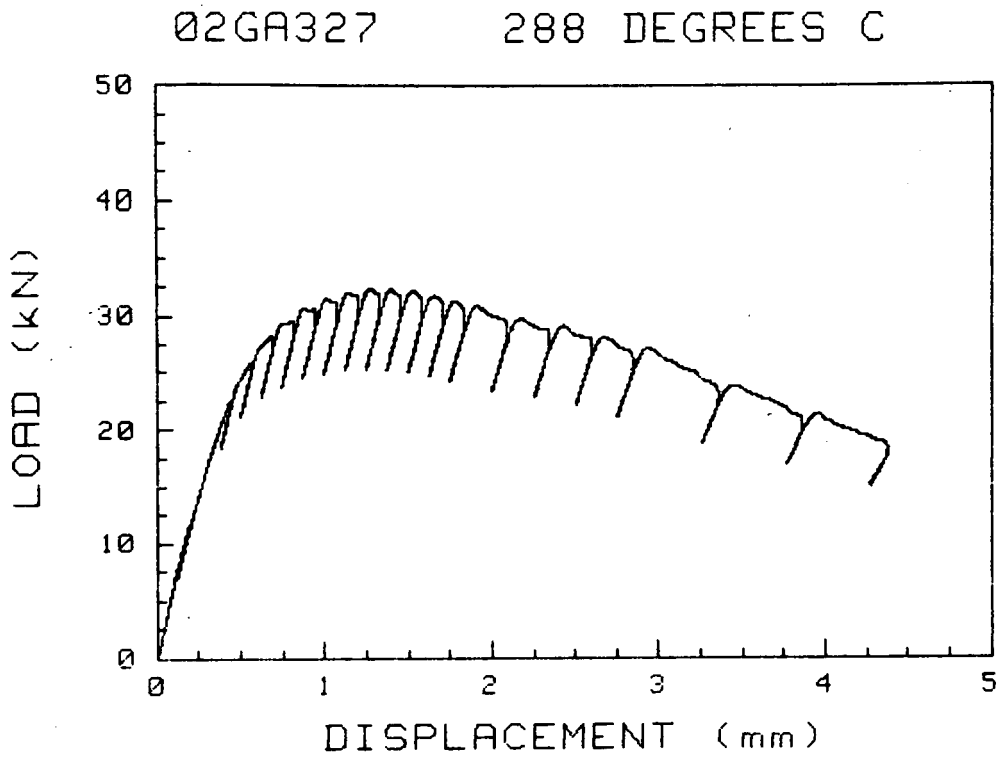
J (@J/T=8.8)= 337.8 kJ/m^2
POWER= .4083
J-MAX ALLOWED= 500.8 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 236.1 kJ/m^2
DELTA-A MAX ALLOWED= 1.88 mm

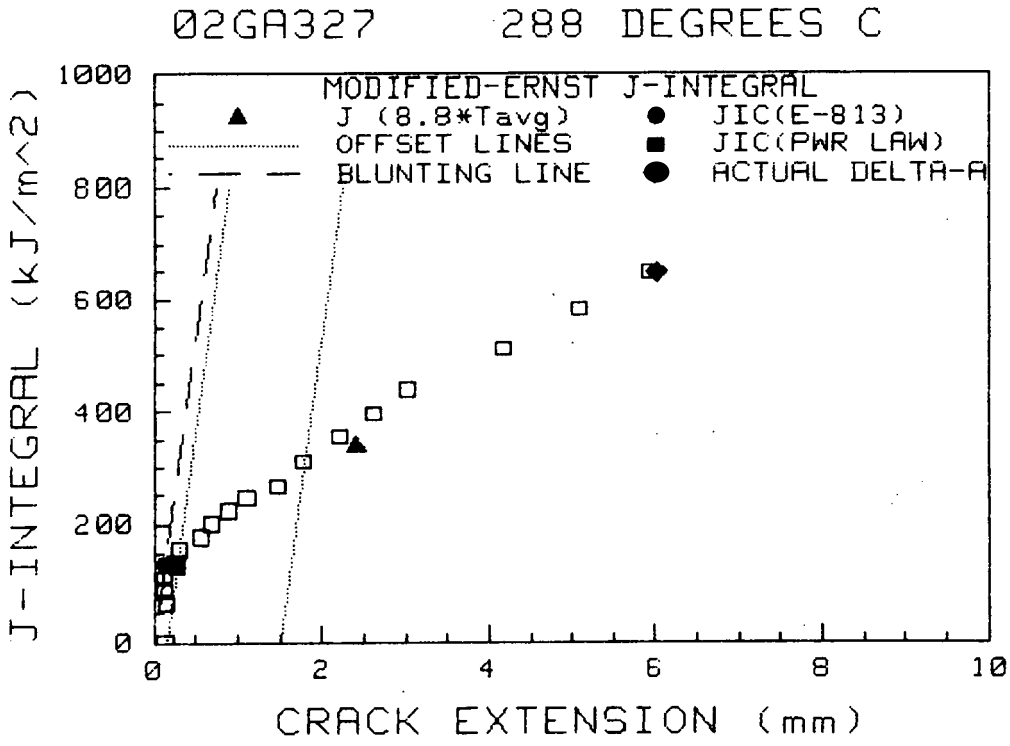
YP1237



ORNL-DWG 87-7910



ORNL-DWG 87-7911

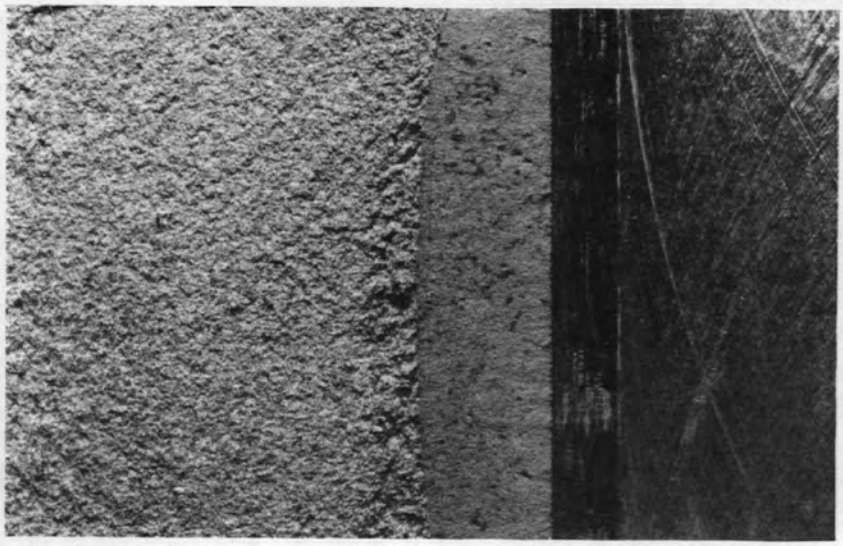


SPECIMEN ID= 02GA-350
MATERIAL TYPE= A533-B-1
TEST TEMPERATURE= -80 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.7 mm a/W)i= .622
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 574 MPa
FLOW STRENGTH= 657 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

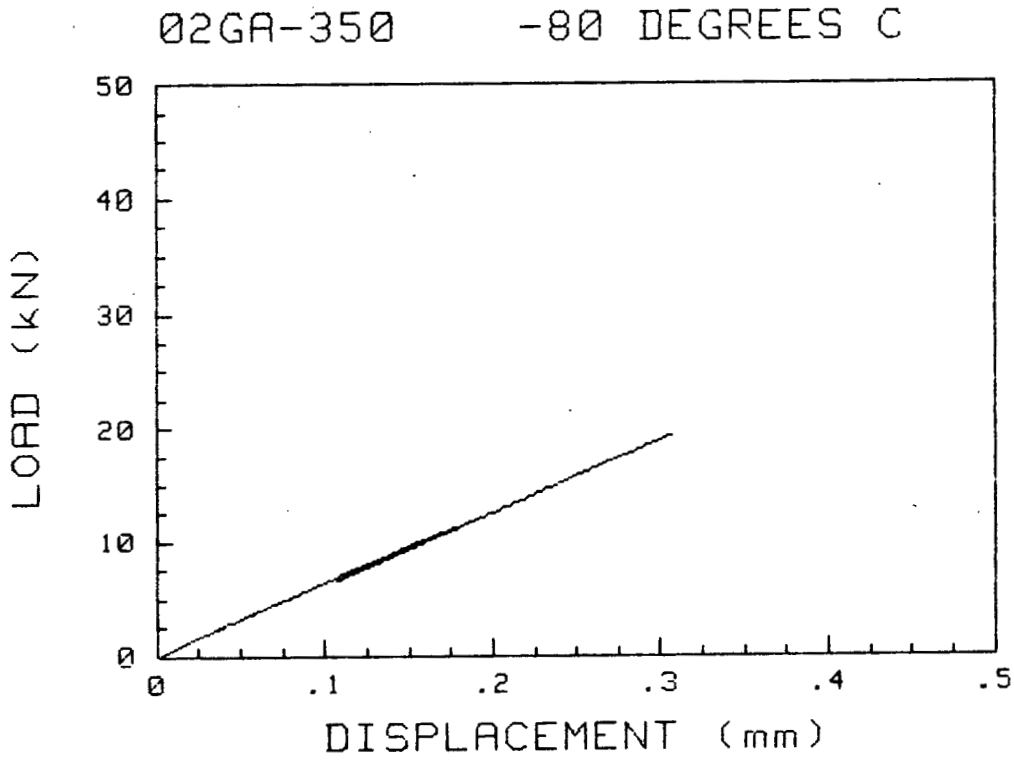
SPECIMEN CLEAVED AT KIc= 50.3 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 13.3 kJ/m^2	J-INTEGRAL= 13.3 kJ/m^2
KJc= 53.1 MPa SQR[m]	KJc= 53.1 MPa SQR[m]
K-beta-c= 50.1 MPa SQR[m]	K-beta-c= 50.1 MPa SQR[m]

YP1236



ORNL-DWG 87-7912



SPECIMEN ID= 02GA357
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 31.9 mm a/W)i= .627
MEASURED DUCTILE DELTA-A= 3.73 mm
YIELD STRENGTH= 444 MPa
FLOW STRENGTH= 534 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 200.1 kJ/m^2
KJ-MAX LOAD= 195.4 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 140.4 kJ/m^2
K-JIc= 163.7 MPa SQR[m]
POWER= .5065
COEFFICIENT= 266.8 kJ/m^2
T (AVERAGE)= 92

ASTM LINEAR PROCEDURE

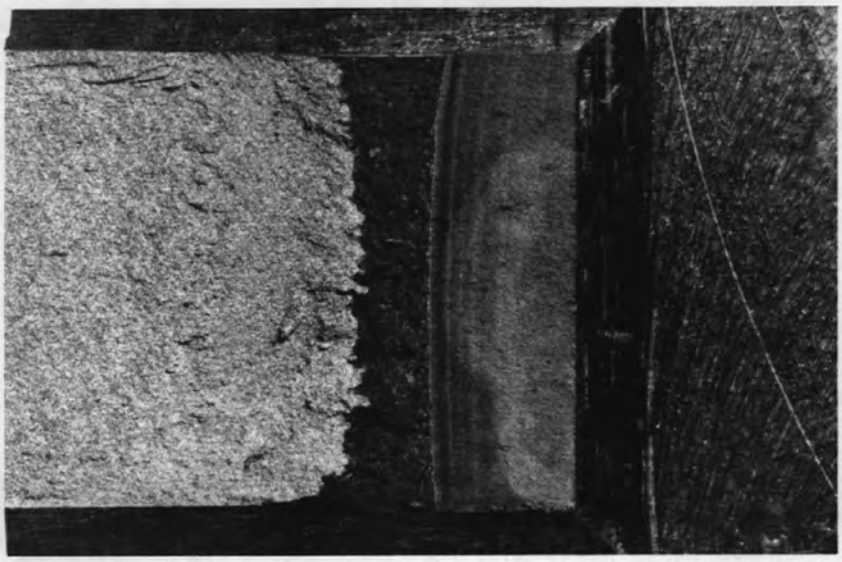
JIc= 143.7 kJ/m^2
K-JIc= 165.6 MPa SQR[m]
SLOPE= 133412 kJ/m^3
INTERCEPT= 125.7 kJ/m^2
T (ASTM)= 89
VALID, E813

JI-R CURVE CALCULATIONS

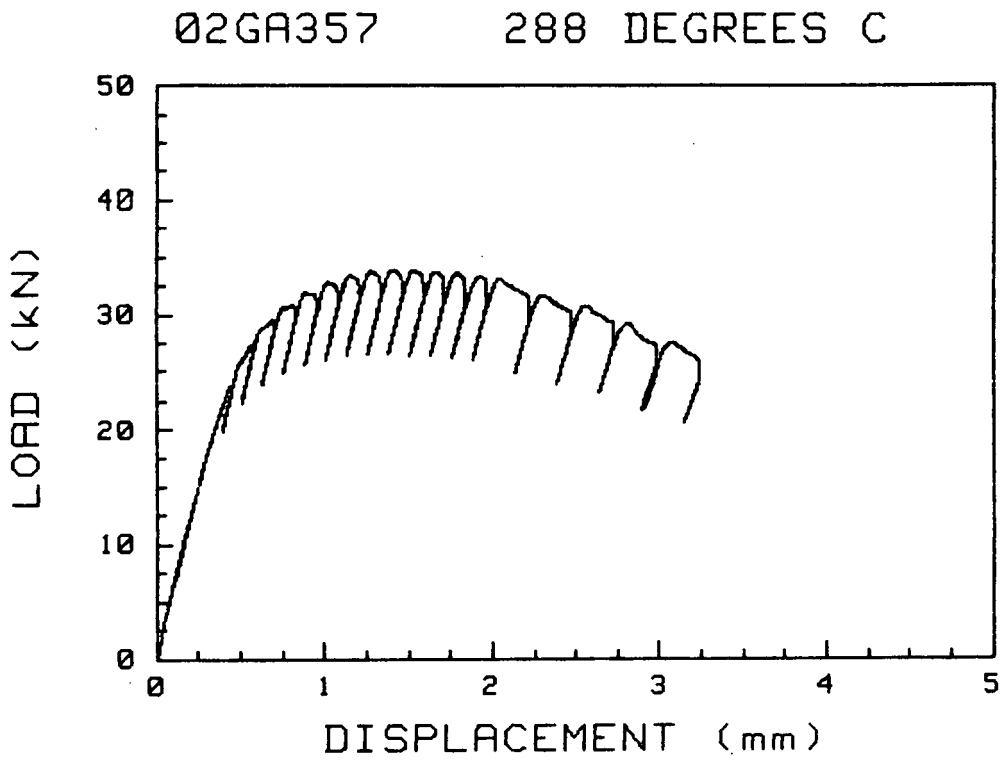
J (@J/T=8.8)= 414.3 kJ/m^2
POWER= .4526
J-MAX ALLOWED= 507.7 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 265.9 kJ/m^2
DELTA-A MAX ALLOWED= 1.9 mm

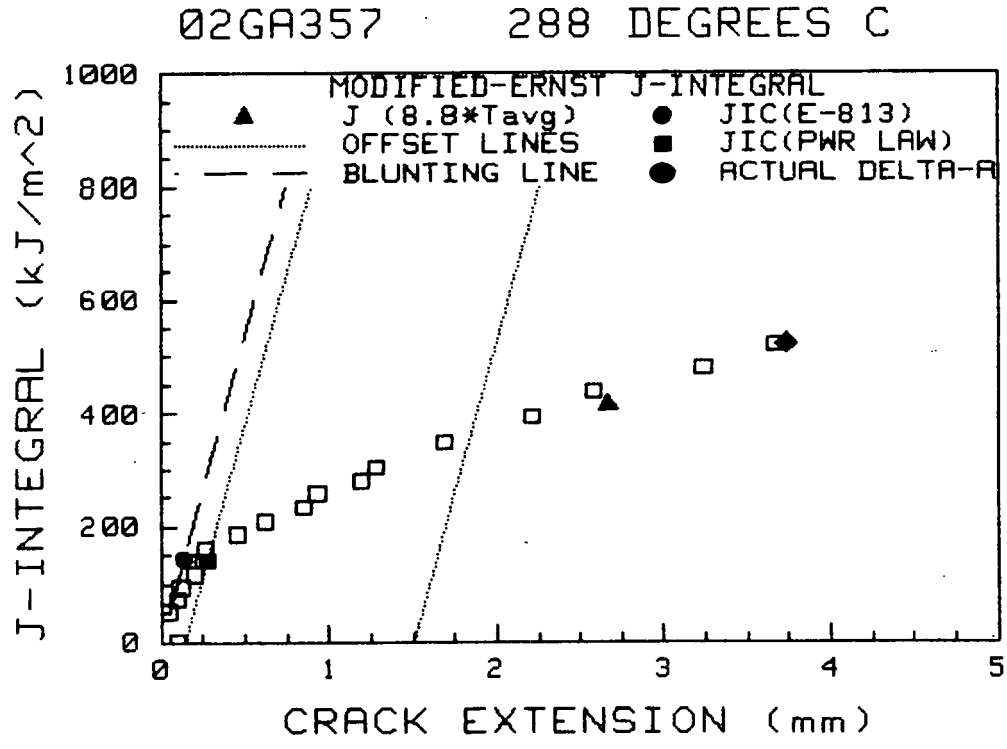
YP1306



ORNL-DWG 87-7913



ORNL-DWG 87-7914

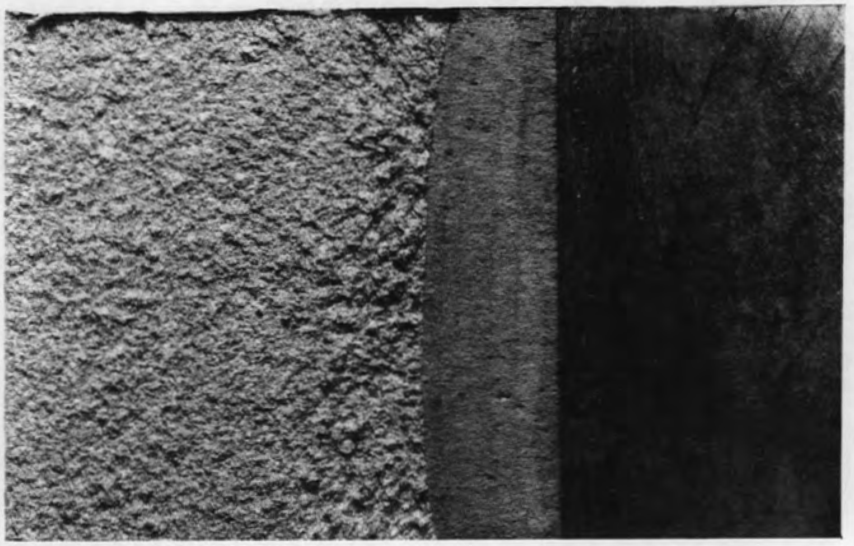


SPECIMEN ID= 02GA361
MATERIAL TYPE= A533B
TEST TEMPERATURE= -40 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.5 mm a/W)i= .62
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 529 MPa
FLOW STRENGTH= 609 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

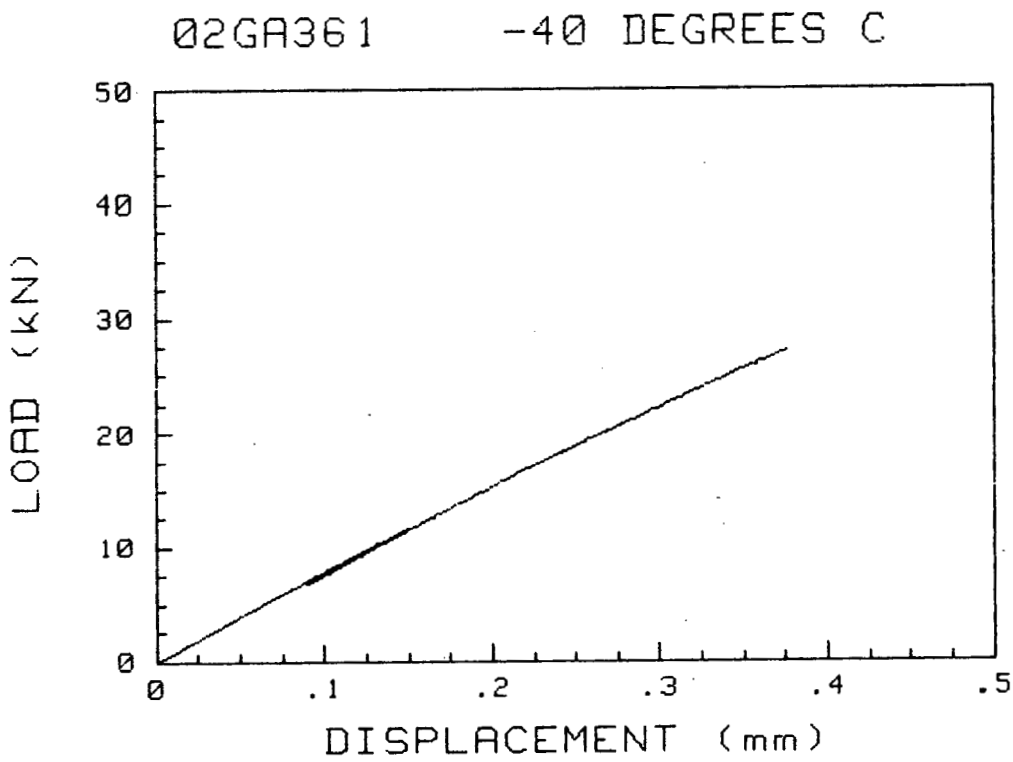
SPECIMEN CLEAVED AT K = 69.7 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 23.6 kJ/m^2	J-INTEGRAL= 23.6 kJ/m^2
KJc= 70.3 MPa SQR[m]	KJc= 70.3 MPa SQR[m]
K-beta-c= 60.2 MPa SQR[m]	K-beta-c= 60.2 MPa SQR[m]

YP1235



ORNL-DWG 87-7915



SPECIMEN ID= 02GA-367
MATERIAL TYPE= A533-B-1
TEST TEMPERATURE= 0 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.7 mm a/W)i= .622
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 492 MPa
FLOW STRENGTH= 569 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

SPECIMEN CLEAVED AT K = 98.6 MPa SQR[m] (NOT VALID KIc)

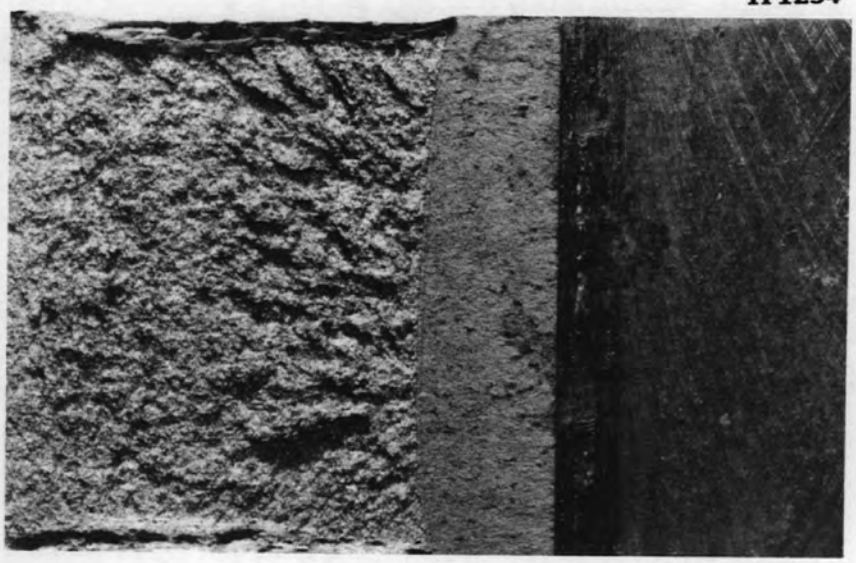
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 80.7 kJ/m^2
KJc= 129.3 MPa SQR[m]
K-beta-c= 80.7 MPa SQR[m]

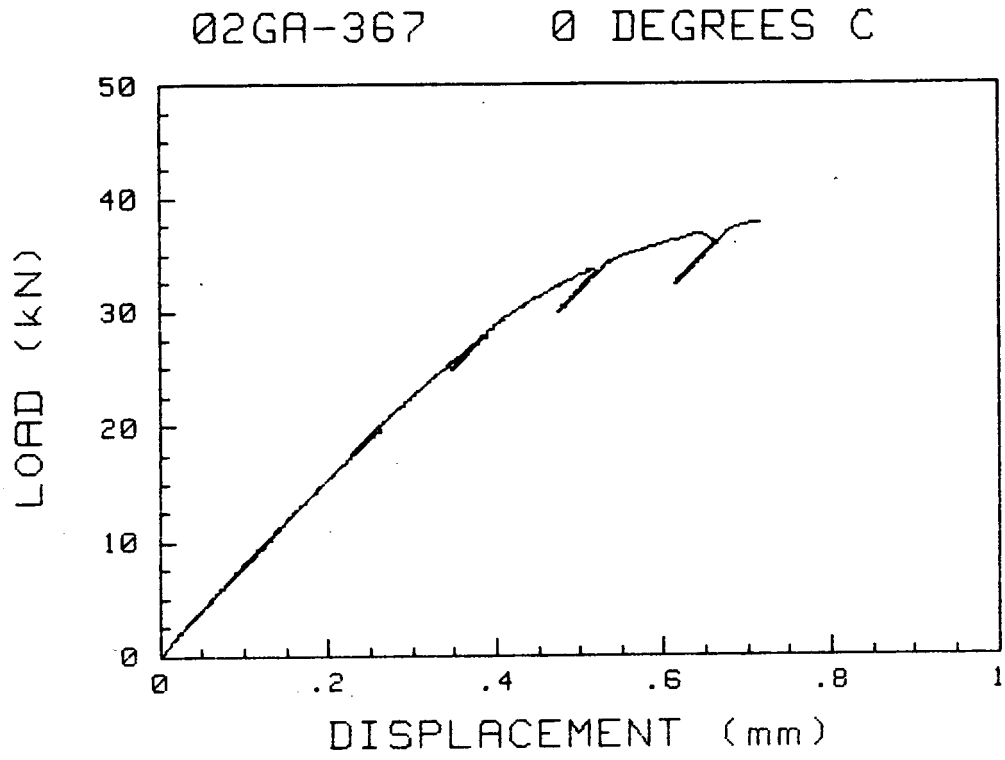
VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 75.1 kJ/m^2
KJc= 124.7 MPa SQR[m]
K-beta-c= 79.4 MPa SQR[m]

YP1234



ORNL-DWG 87-7916



SPECIMEN ID= 02GA-374
TEST TEMPERATURE= 40 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.7 mm a/W)i= .623
MEASURED DUCTILE DELTA-A= 3.84 mm
YIELD STRENGTH= 462 MPa
FLOW STRENGTH= 538 MPa
ESTIMATED YOUNG'S MODULUS= 205 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 450.5 kJ/m^2
KJ-MAX LOAD= 303.8 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 164.3 kJ/m^2
K-JIc= 183.5 MPa SQR[m]
POWER= .8396
COEFFICIENT= 448.1 kJ/m^2
T (AVERAGE)= 258

ASTM LINEAR PROCEDURE

JIc= 102.4 kJ/m^2
K-JIc= 144.9 MPa SQR[m]
SLOPE= 375940 kJ/m^3
INTERCEPT= 66.6 kJ/m^2
T (ASTM)= 267
INVALID, 6

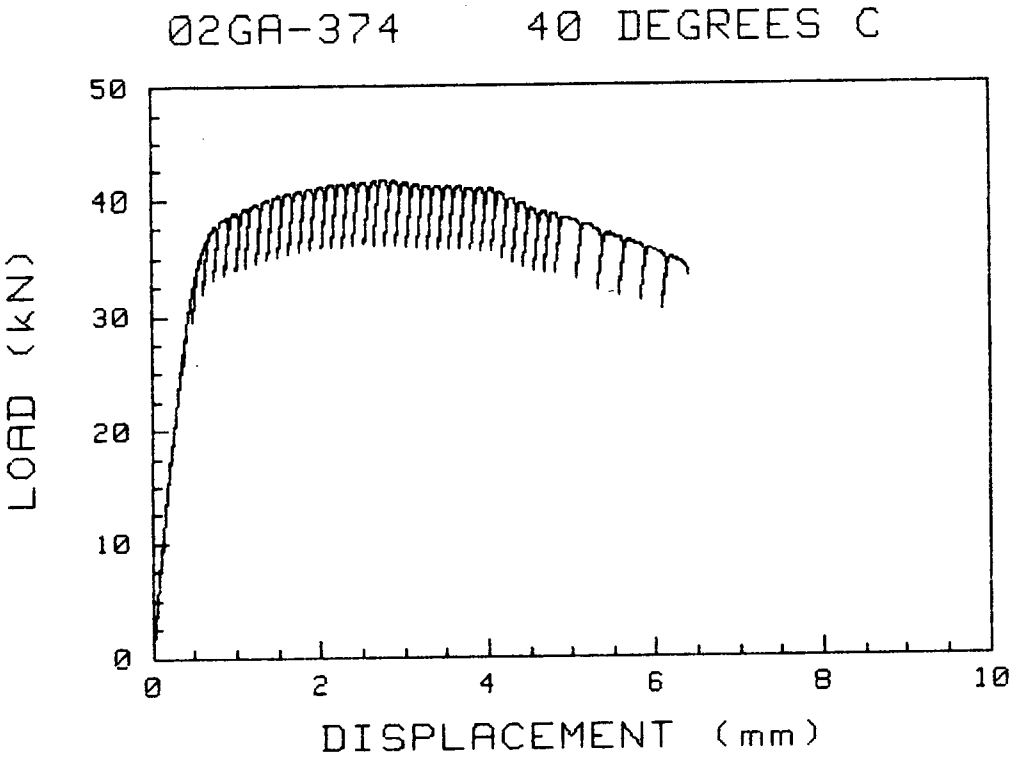
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 1774.2 kJ/m^2
POWER= .836
J-MAX ALLOWED= 516.1 kJ/m^2
RCURVE INVALID, 3

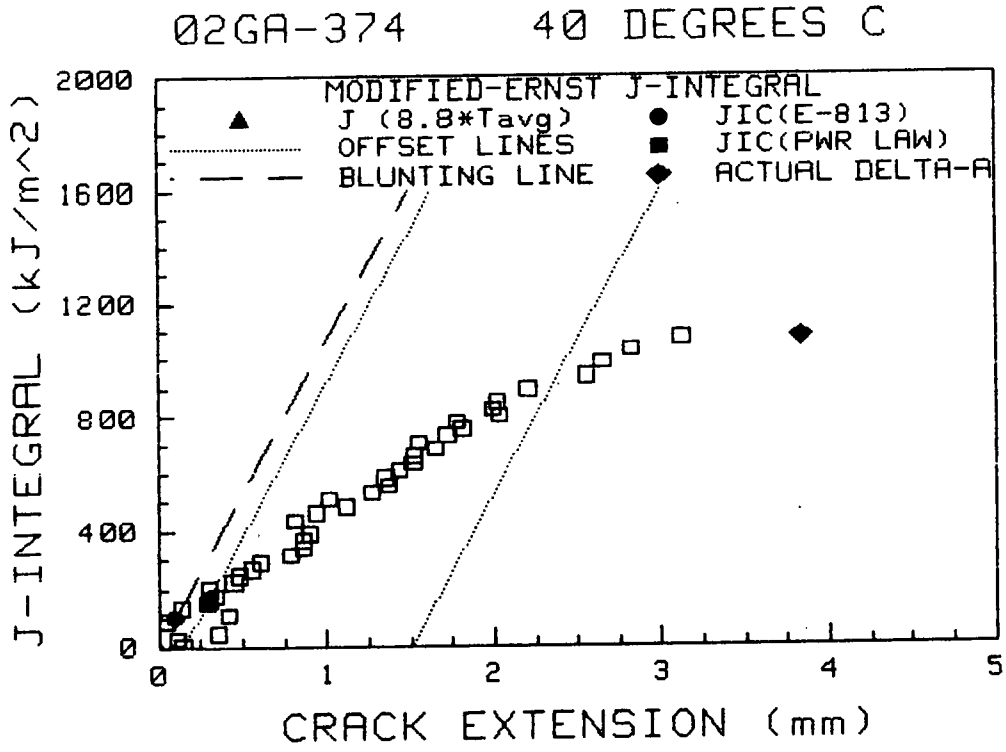
COEFFICIENT= 446.1 kJ/m^2
DELTA-A MAX ALLOWED= 1.92 mm

YP1233

ORNL-DWG 87-7917



ORNL-DWG 87-7918

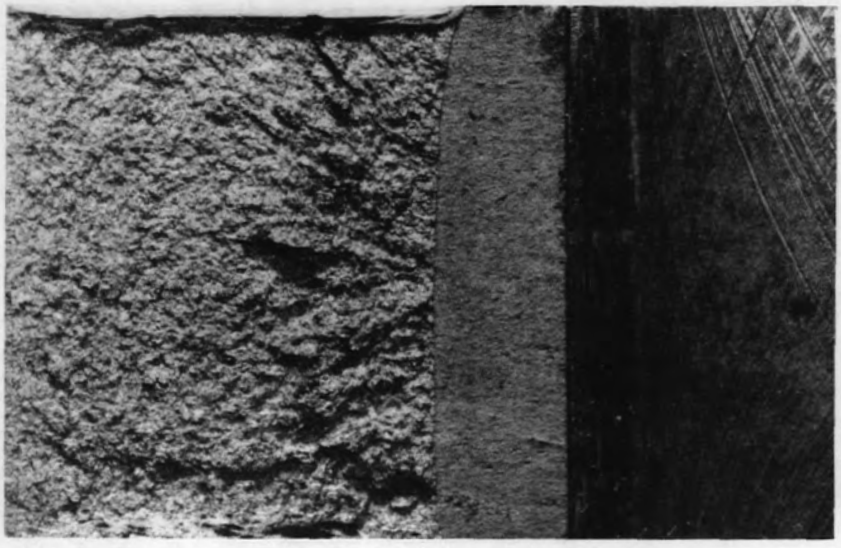


SPECIMEN ID= 02GA405
MATERIAL TYPE= A533B
TEST TEMPERATURE= -5 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.2 mm a/W)i= .612
MEASURED DUCTILE DELTA-A= .07 mm
YIELD STRENGTH= 496 MPa
FLOW STRENGTH= 574 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

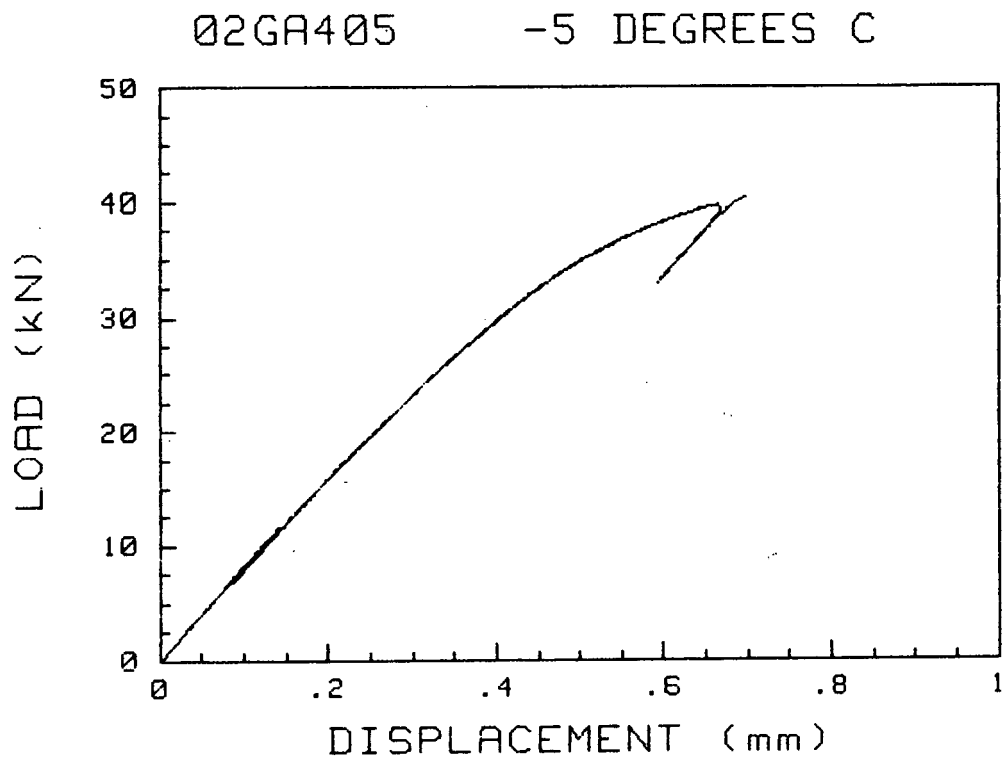
SPECIMEN CLEAVED AT K = 101.1 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 74.3 kJ/m^2	J-INTEGRAL= 74.3 kJ/m^2
KJc= 124.2 MPa SQR[m]	KJc= 124.2 MPa SQR[m]
K-beta-c= 79.6 MPa SQR[m]	K-beta-c= 79.6 MPa SQR[m]

YP1232



ORNL-DWG 87-7919



SPECIMEN ID= 02GA408
TEST TEMPERATURE= 24 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 31 mm a/W)i= .609
MEASURED DUCTILE DELTA-A= .17 mm
YIELD STRENGTH= 473 MPa
FLOW STRENGTH= 549 MPa
ESTIMATED YOUNG'S MODULUS= 206 GPa

SPECIMEN CLEAVED AT K = 100 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 207.5 kJ/m^2
KJc= 206.6 MPa SQR[m]
K-beta-c= 89.5 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 206.9 kJ/m^2
KJc= 206.4 MPa SQR[m]
K-beta-c= 89.4 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 152.7 kJ/m^2
K-JIc= 177.3 MPa SQR[m]
POWER= .8108
COEFFICIENT= 417.8 kJ/m^2
T (AVERAGE)= 225

ASTM LINEAR PROCEDURE

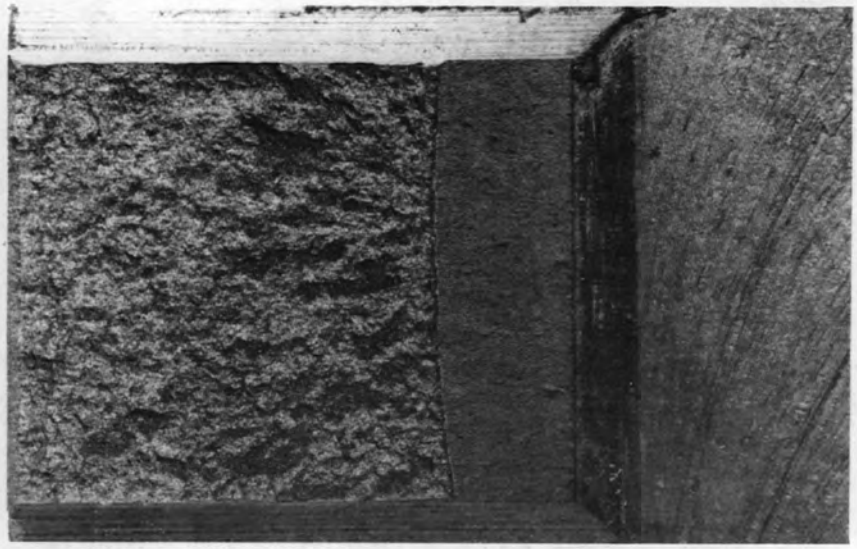
JIc= 0 kJ/m^2
K-JIc= 0 MPa SQR[m]
SLOPE= kJ/m^3
INTERCEPT= 0 kJ/m^2
T (ASTM)= 0
INVALID, 1 6

JI-R CURVE CALCULATIONS

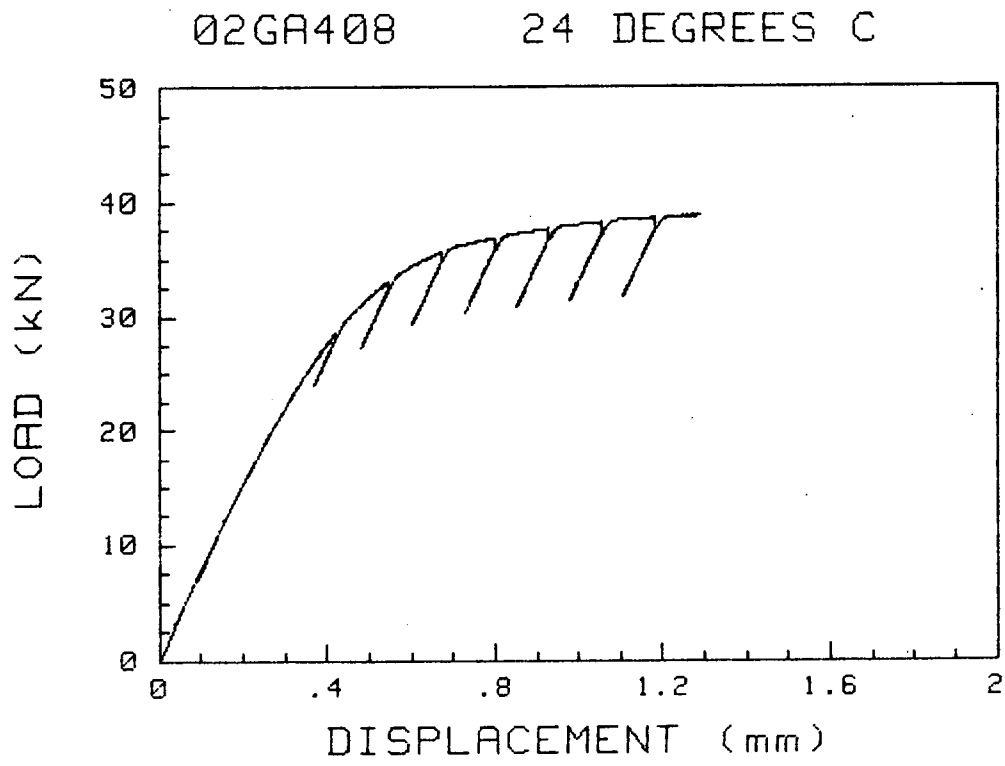
J (@J/T=8.8)= 728.8 kJ/m^2
POWER= .6093
J-MAX ALLOWED= 545.5 kJ/m^2
RCURVE INVALID, 1 2 3

COEFFICIENT= 330.6 kJ/m^2
DELTA-A MAX ALLOWED= 1.99 mm

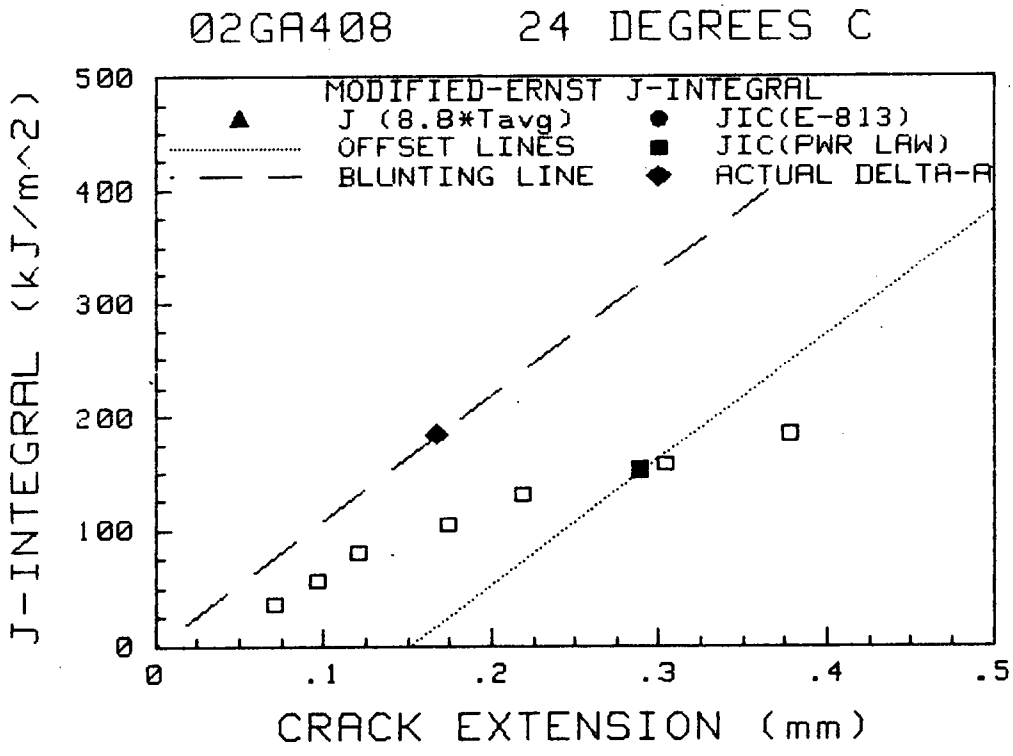
YP1231



ORNL-DWG 87-7920



ORNL-DWG 87-7921



SPECIMEN ID= 02GA410
TEST TEMPERATURE= 50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 31.9 mm a/W)i= .627
MEASURED DUCTILE DELTA-A= 2.95 mm
YIELD STRENGTH= 456 MPa
FLOW STRENGTH= 531 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 339.8 kJ/m^2
KJ-MAX LOAD= 263.5 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 177.5 kJ/m^2
K-JIc= 190.5 MPa SQR[m]
POWER= .6771
COEFFICIENT= 386.4 kJ/m^2
T (AVERAGE)= 183

ASTM LINEAR PROCEDURE

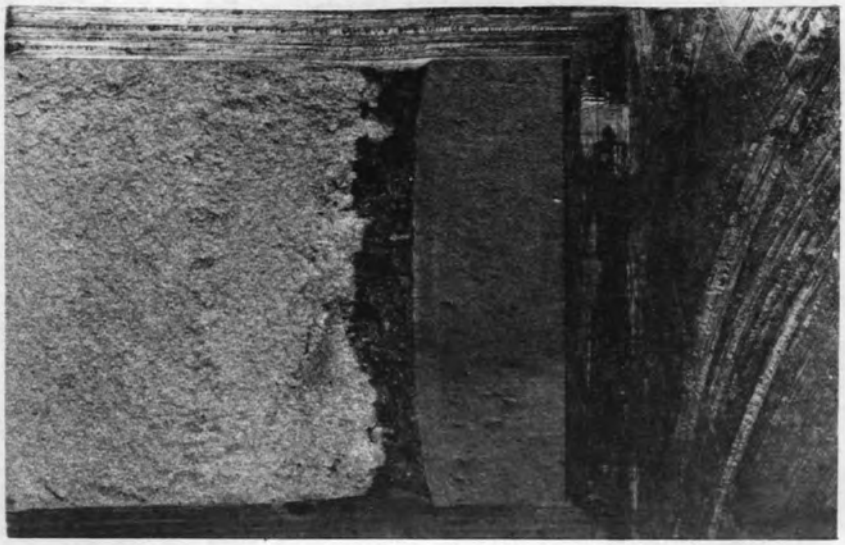
JIc= 118.8 kJ/m^2
K-JIc= 155.8 MPa SQR[m]
SLOPE= 271806 kJ/m^3
INTERCEPT= 88.4 kJ/m^2
T (ASTM)= 197
INVALID, 6

JI-R CURVE CALCULATIONS

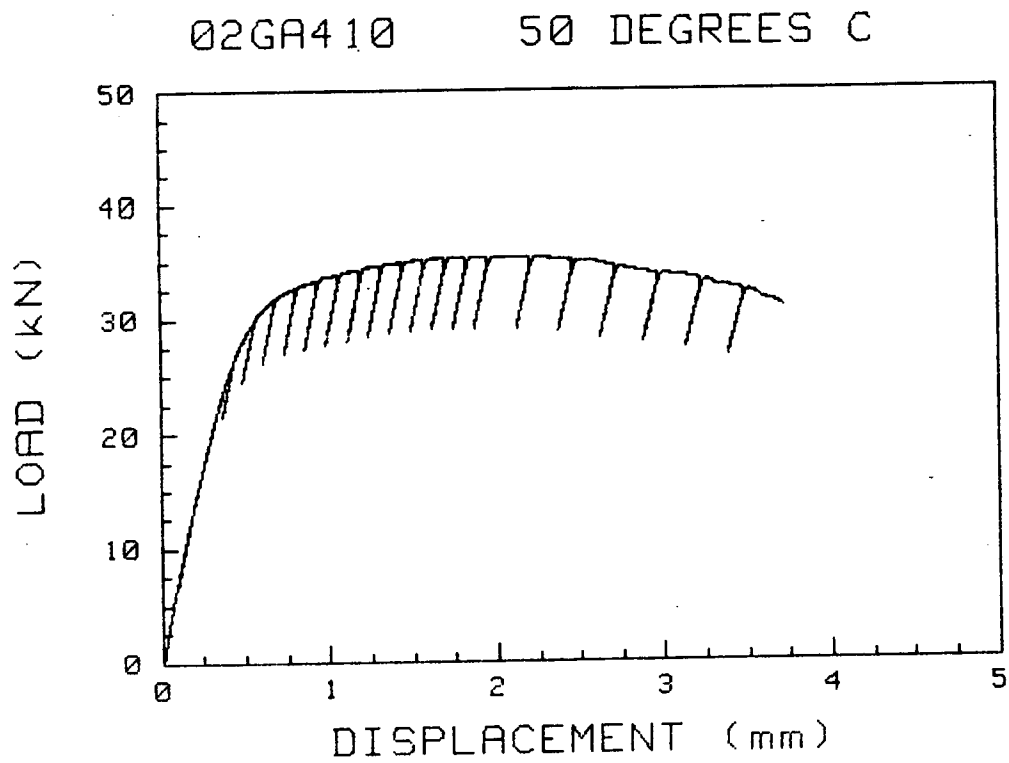
J (@J/T=8.8)= 1194 kJ/m^2
POWER= .7361
J-MAX ALLOWED= 503.6 kJ/m^2
RCURVE INVALID, 1 3

COEFFICIENT= 382.7 kJ/m^2
DELTA-A MAX ALLOWED= 1.9 mm

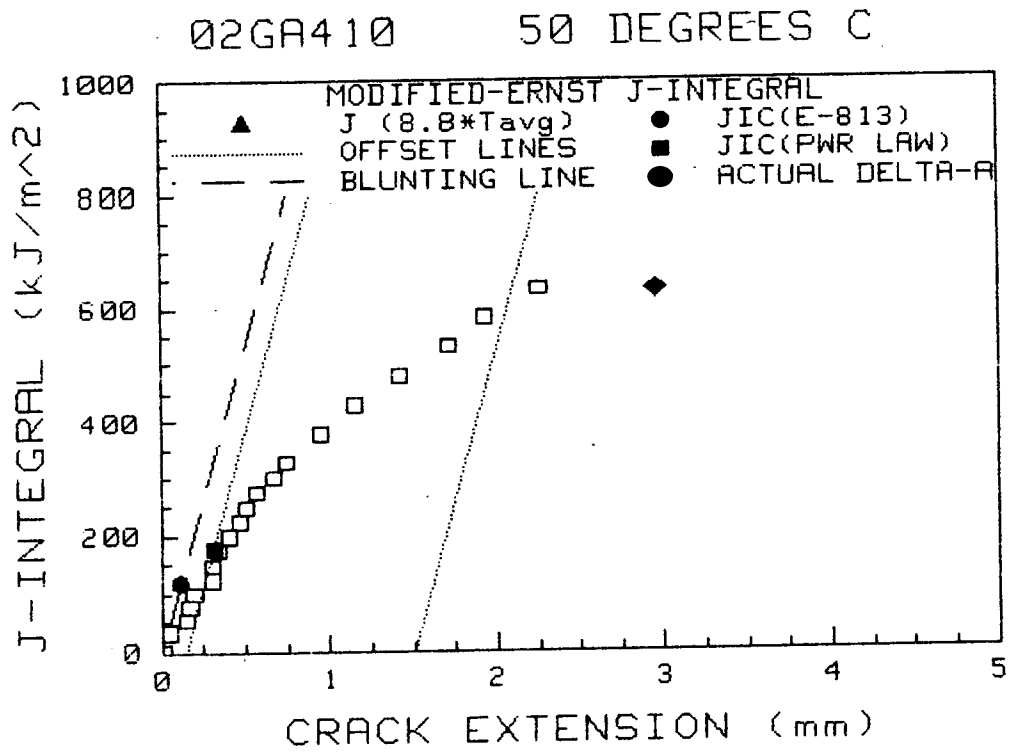
YP1230



ORNL-DWG 87-7922



ORNL-DWG 87-7923

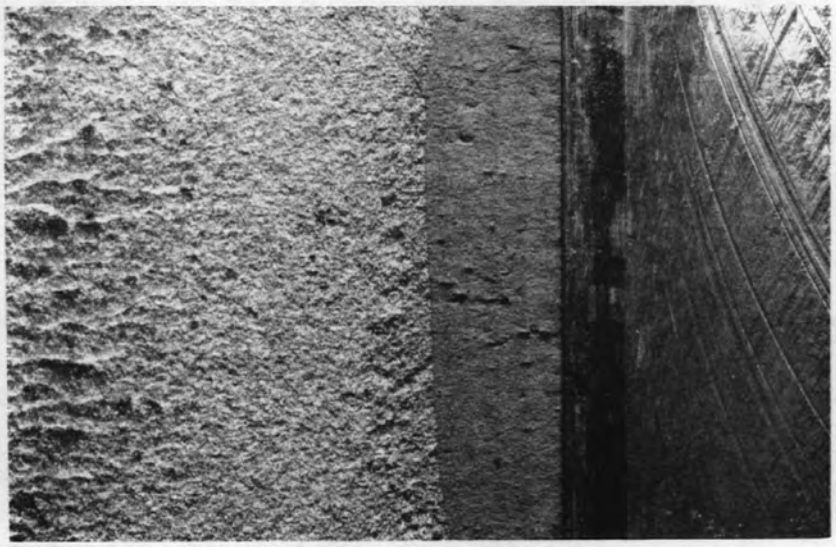


SPECIMEN ID= 02GA415
MATERIAL TYPE= A533-B-1
TEST TEMPERATURE= -100 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.2 mm a/W)i= .614
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 600 MPa
FLOW STRENGTH= 685 MPa
ESTIMATED YOUNG'S MODULUS= 213 GPa

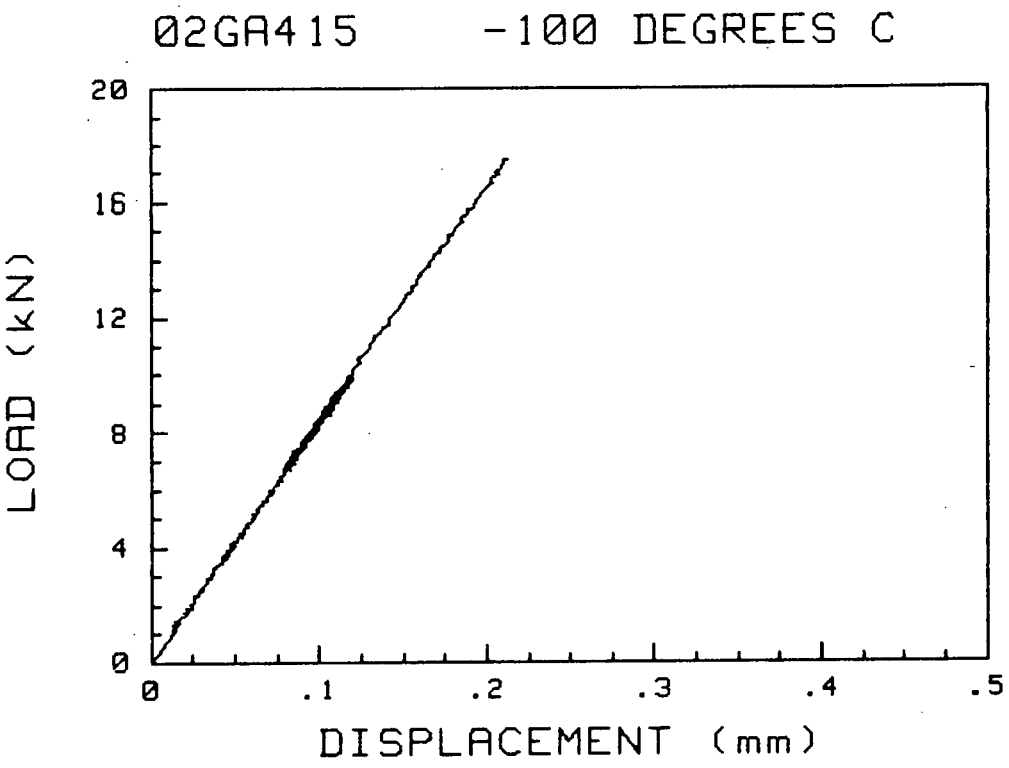
SPECIMEN CLEAVED AT KIc= 44 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 8.3 kJ/m^2	J-INTEGRAL= 8.3 kJ/m^2
KJc= 41.9 MPa SQR[m]	KJc= 41.9 MPa SQR[m]
K-beta-c= 41 MPa SQR[m]	K-beta-c= 41 MPa SQR[m]

YP1227



ORNL-DWG 87-7924

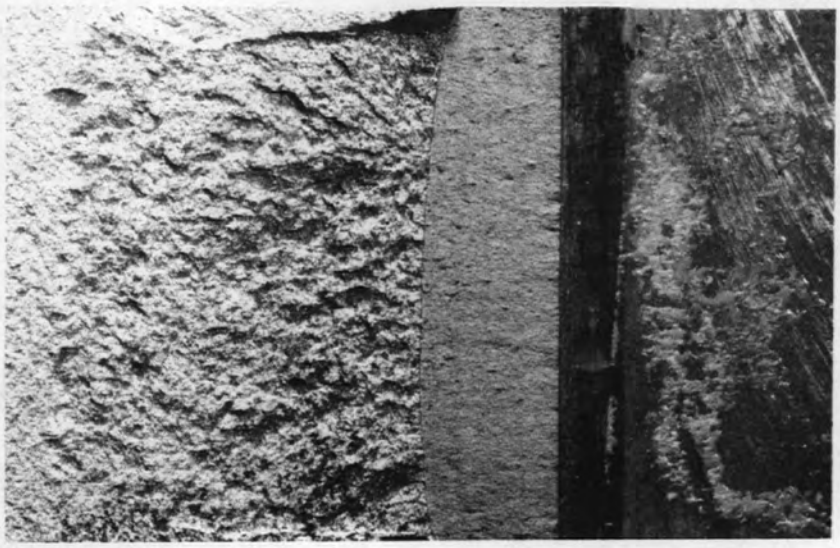


SPECIMEN ID= 02GA417
MATERIAL TYPE= A533B
TEST TEMPERATURE= 0 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.8 mm a/W)i= .606
MEASURED DUCTILE DELTA-A= .1 mm
YIELD STRENGTH= 492 MPa
FLOW STRENGTH= 569 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

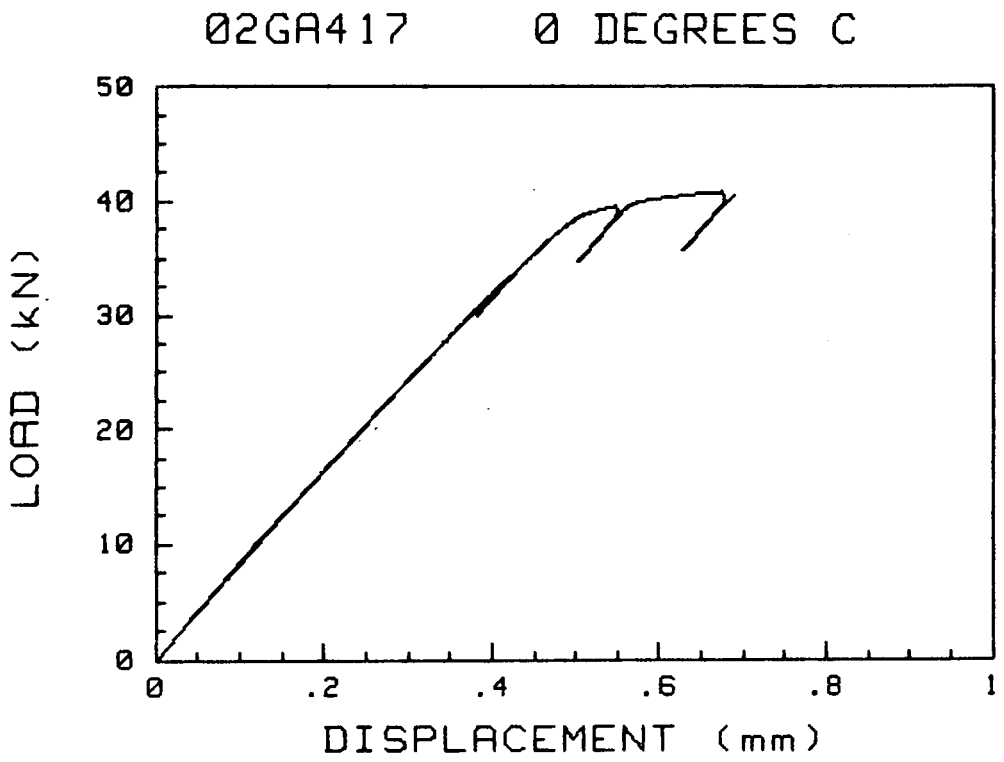
SPECIMEN CLEAVED AT K = 99.7 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 73.5 kJ/m^2	J-INTEGRAL= 75.9 kJ/m^2
KJc= 123.4 MPa SQR[m]	KJc= 125.4 MPa SQR[m]
K-beta-c= 79 MPa SQR[m]	K-beta-c= 79.6 MPa SQR[m]

YP1228



ORNL-DWG 87-7925



SPECIMEN ID= 68WAA
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.3 mm a/W)i= .598
MEASURED DUCTILE DELTA-A= 3.21 mm
YIELD STRENGTH= 500 MPa
FLOW STRENGTH= 562 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 348.6 kJ/m^2
KJ-MAX LOAD= 257.9 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 229.1 kJ/m^2
K-JIc= 209.1 MPa SQR[m]
POWER= .5528
COEFFICIENT= 406.8 kJ/m^2
T (AVERAGE)= 130

ASTM LINEAR PROCEDURE

JIc= 206.8 kJ/m^2
K-JIc= 198.6 MPa SQR[m]
SLOPE= 227436 kJ/m^3
INTERCEPT= 164.9 kJ/m^2
T (ASTM)= 138
VALID, E813

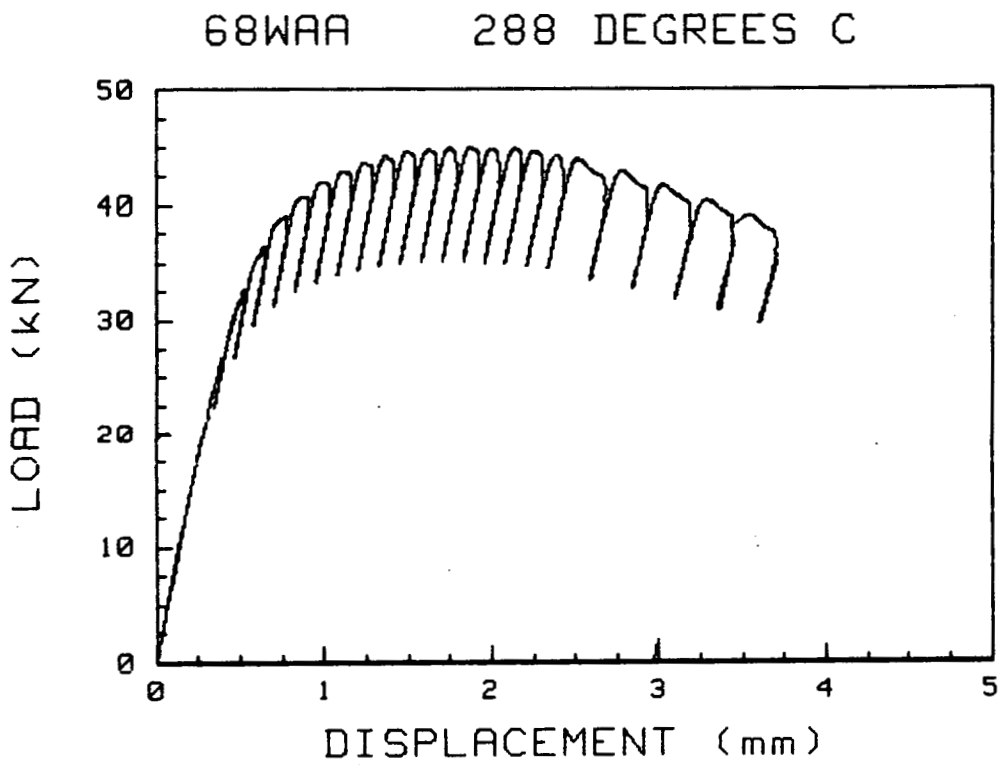
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 769.8 kJ/m^2
POWER= .5725
J-MAX ALLOWED= 570.6 kJ/m^2
VALID R-CURVE

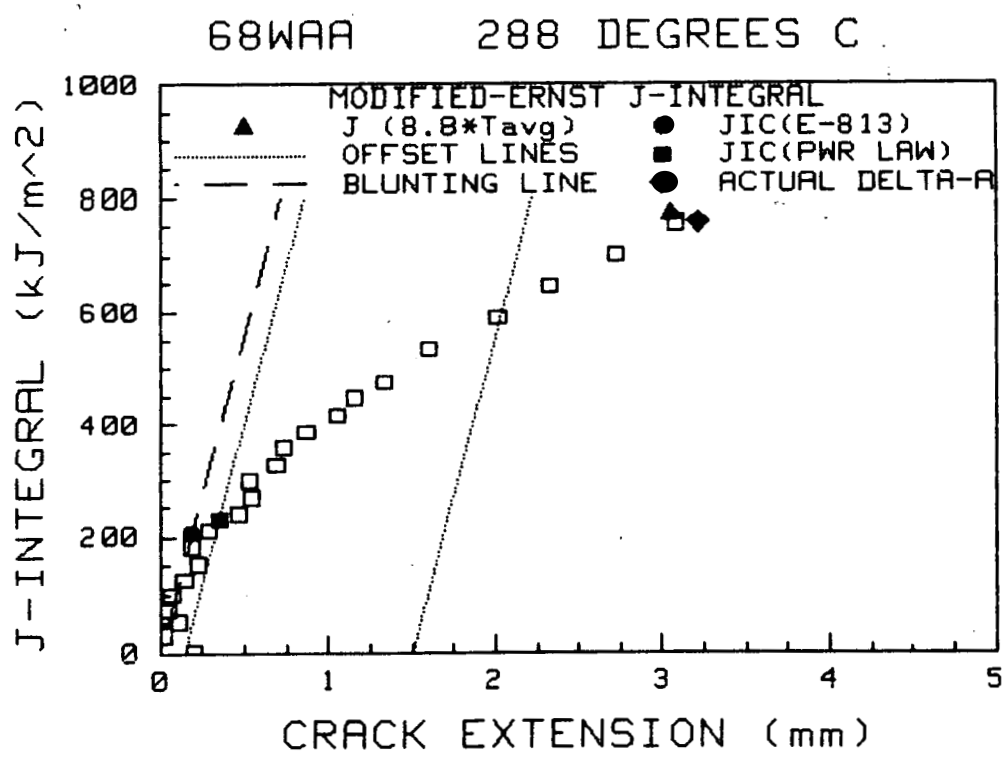
COEFFICIENT= 406.7 kJ/m^2
DELTA-A MAX ALLOWED= 2.04 mm

YP1226

ORNL-DWG 87-7926



ORNL-DWG 87-7927



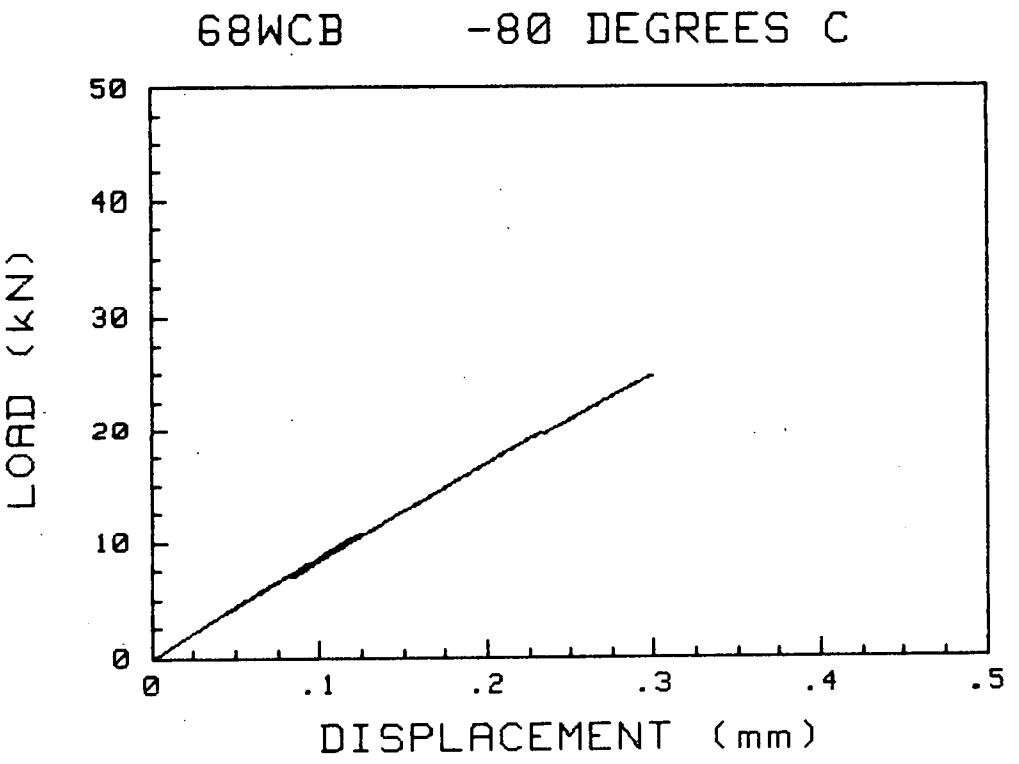
SPECIMEN ID= 68WCB
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -80 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.5 mm a/W)i= .601
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 684 MPa
FLOW STRENGTH= 716 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

SPECIMEN CLEAVED AT KIc= 59.5 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 16.2 kJ/m^2	J-INTEGRAL= 16.2 kJ/m^2
KJc= 58.6 MPa SQR[m]	KJc= 58.6 MPa SQR[m]
K-beta-c= 55.9 MPa SQR[m]	K-beta-c= 55.9 MPa SQR[m]

YP1225

ORNL-DWG 87-7928

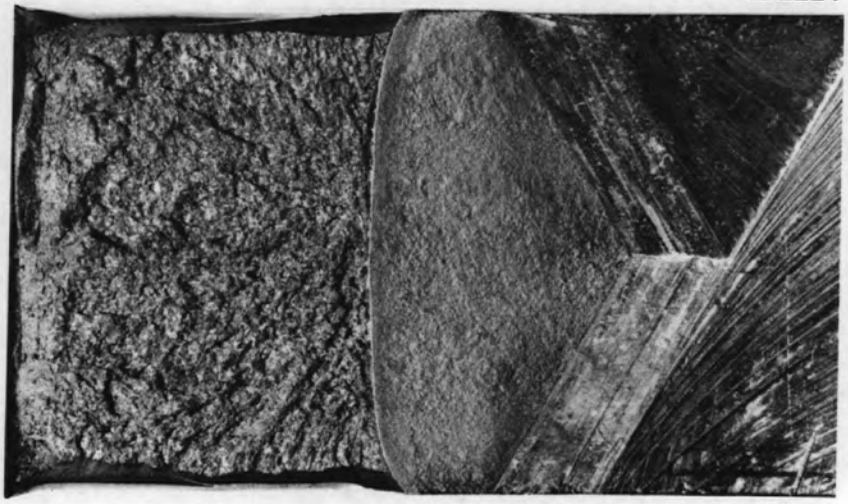


SPECIMEN ID= 68WDD
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -30 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.3 mm a/W)i= .616
MEASURED DUCTILE DELTA-A= .26 mm
YIELD STRENGTH= 615 MPa
FLOW STRENGTH= 652 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

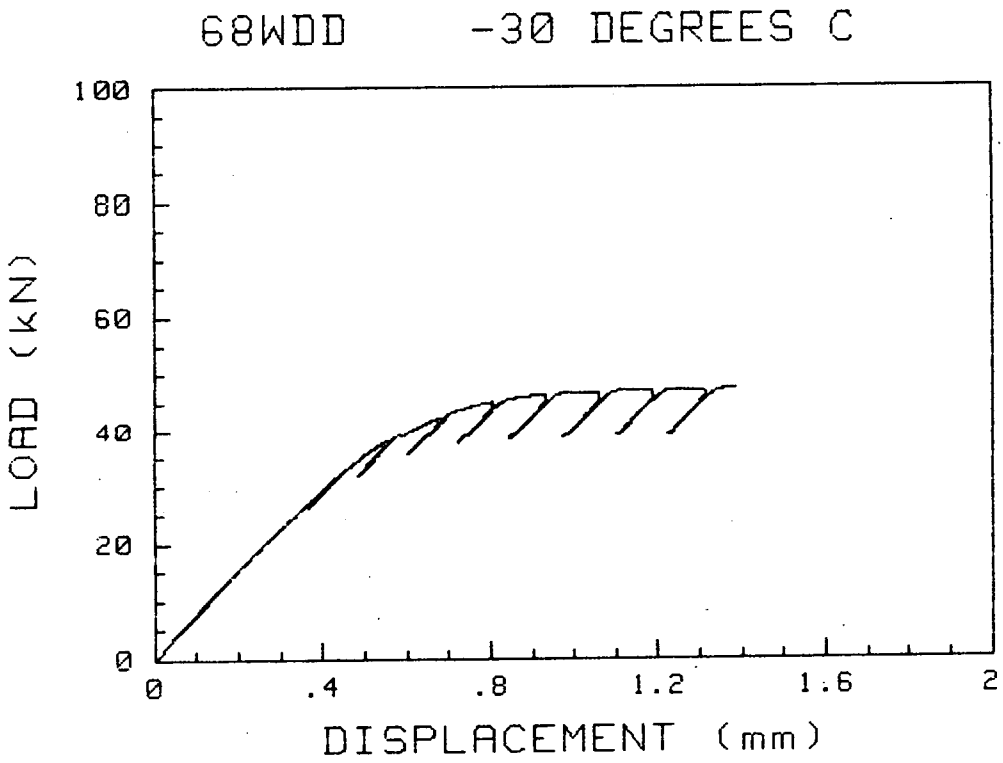
SPECIMEN CLEAVED AT K = 120.8 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 213.5 kJ/m^2	J-INTEGRAL= 215.7 kJ/m^2
KJc= 211.2 MPa SQR[m]	KJc= 212.3 MPa SQR[m]
K-beta-c= 113.1 MPa SQR[m]	K-beta-c= 113.3 MPa SQR[m]

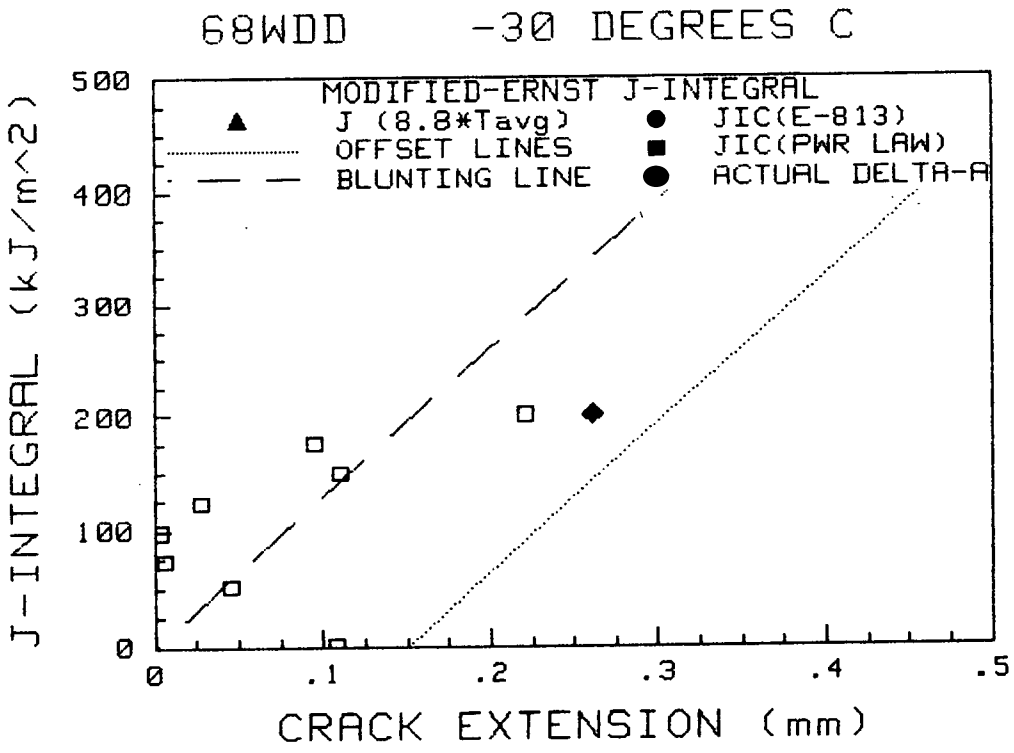
YP1224



ORNL-DWG 87-7929



ORNL-DWG 87-7930



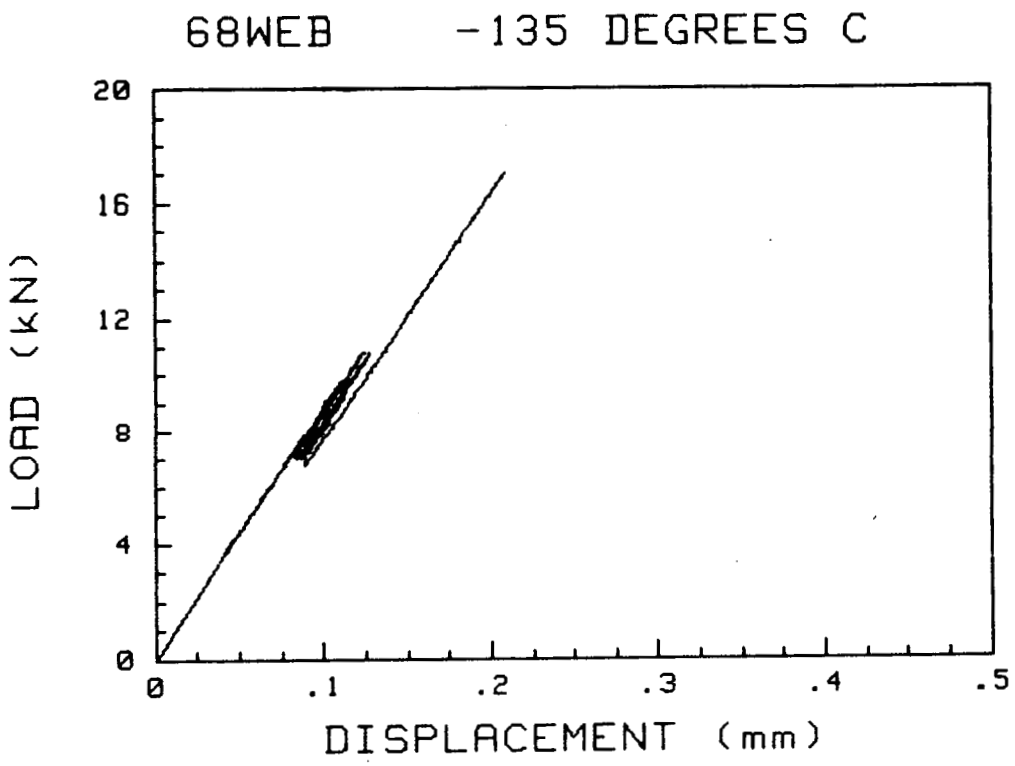
SPECIMEN ID= 68WEB
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -135 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.3 mm a/W)i= .597
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 776 MPa
FLOW STRENGTH= 800 MPa
ESTIMATED YOUNG'S MODULUS= 215 GPa

SPECIMEN CLEAVED AT KIc= 40.2 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 7.6 kJ/m^2	J-INTEGRAL= 7.6 kJ/m^2
KJc= 40.4 MPa SQR[m]	KJc= 40.4 MPa SQR[m]
K-beta-c= 40 MPa SQR[m]	K-beta-c= 40 MPa SQR[m]

YP1223

ORNL-DWG 87-7931



SPECIMEN ID= 68WHB
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.8 mm a/W)i= .607
MEASURED DUCTILE DELTA-A= 3.12 mm
YIELD STRENGTH= 490 MPa
FLOW STRENGTH= 542 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 355.5 kJ/m^2
KJ-MAX LOAD= 266.8 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 243.1 kJ/m^2
K-JIc= 220.6 MPa SQR[m]
POWER= .6496
COEFFICIENT= 460.5 kJ/m^2
T (AVERAGE)= 191

ASTM LINEAR PROCEDURE

JIc= 203.3 kJ/m^2
K-JIc= 201.8 MPa SQR[m]
SLOPE= 299044 kJ/m^3
INTERCEPT= 147.2 kJ/m^2
T (ASTM)= 204
VALID, E813

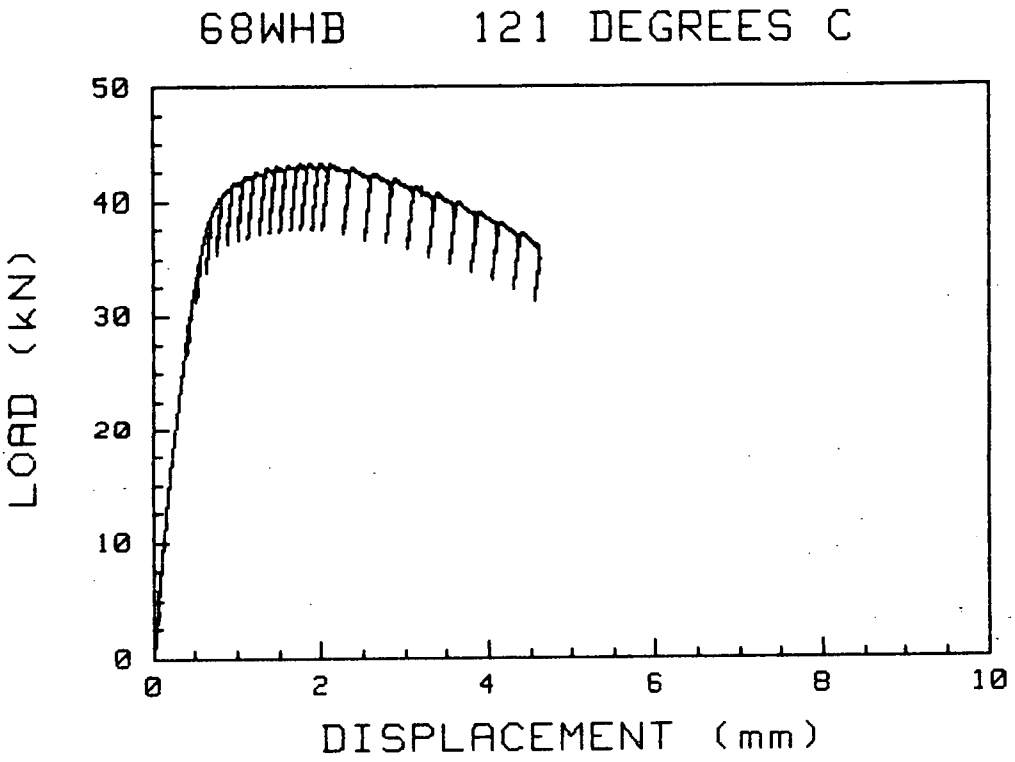
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 1070.5 kJ/m^2
POWER= .6363
J-MAX ALLOWED= 541.3 kJ/m^2
VALID R-CURVE

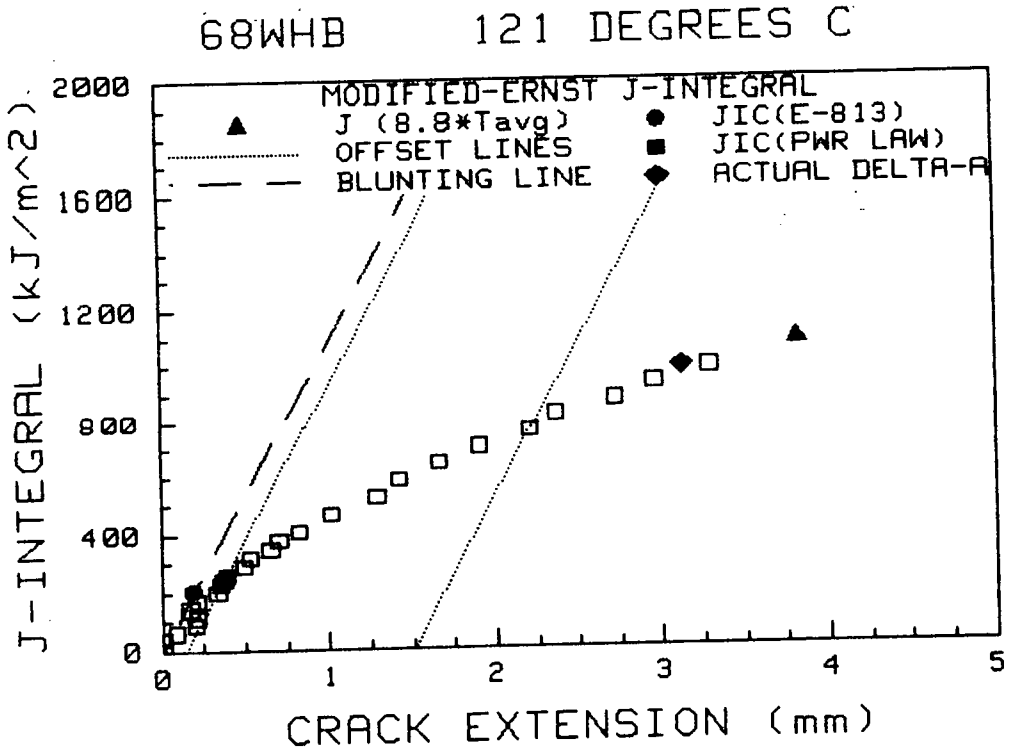
COEFFICIENT= 457 kJ/m^2
DELTA-A MAX ALLOWED= 2 mm

YP1222

ORNL-DWG 87-7932



ORNL-DWG 87-7933



SPECIMEN ID= 68WKA
TEST TEMPERATURE= 23 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.6 mm a/W)i= .604
MEASURED DUCTILE DELTA-A= 2.78 mm
YIELD STRENGTH= 557 MPa
FLOW STRENGTH= 600 MPa
ESTIMATED YOUNG'S MODULUS= 206 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 423.2 kJ/m^2
KJ-MAX LOAD= 295.2 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 223.5 kJ/m^2
K-JIc= 214.5 MPa SQR[m]
POWER= .7398
COEFFICIENT= 500.6 kJ/m^2
T (AVERAGE)= 202

ASTM LINEAR PROCEDURE

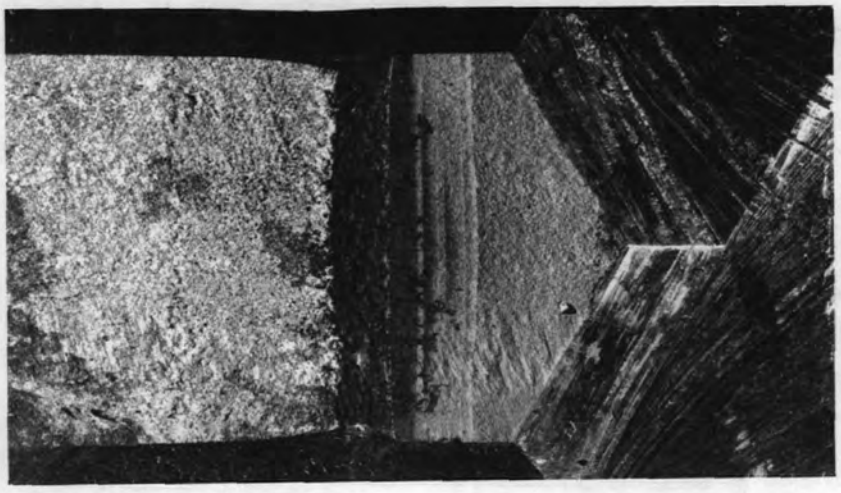
JIc= 160.9 kJ/m^2
K-JIc= 182 MPa SQR[m]
SLOPE= 383755 kJ/m^3
INTERCEPT= 109.4 kJ/m^2
T (ASTM)= 219
VALID, E813

JI-R CURVE CALCULATIONS

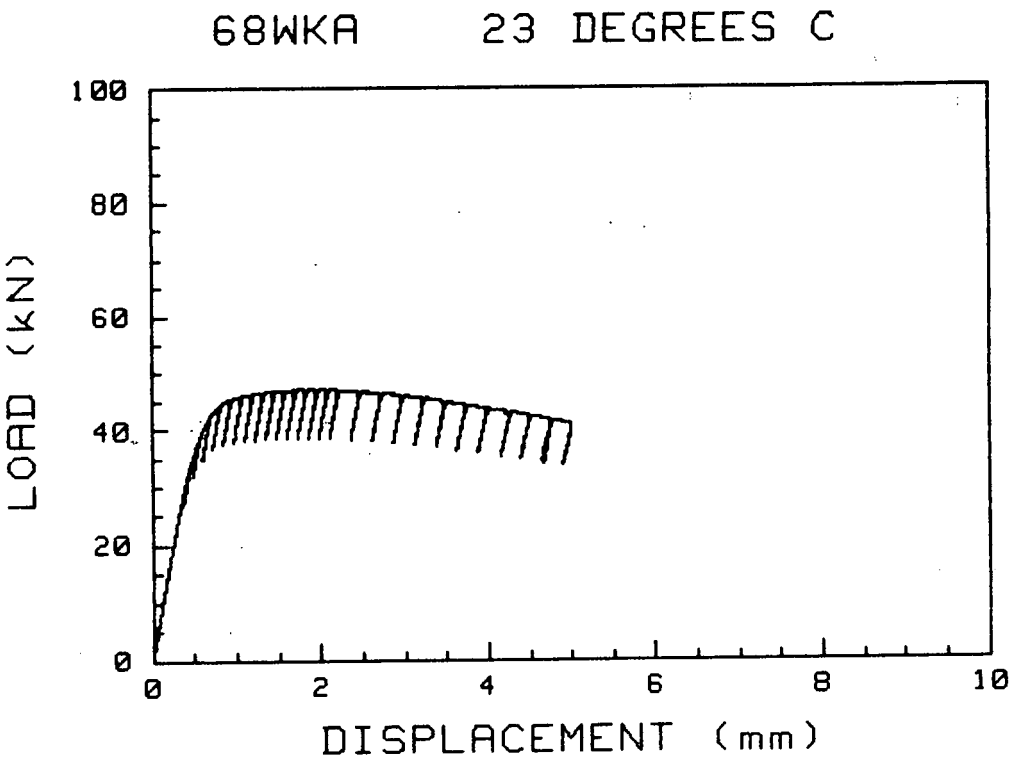
J (@J/T=8.8)= 1321.3 kJ/m^2
POWER= .7421
J-MAX ALLOWED= 602.1 kJ/m^2
RCURVE INVALID, 3

COEFFICIENT= 497.1 kJ/m^2
DELTA-A MAX ALLOWED= 2.01 mm

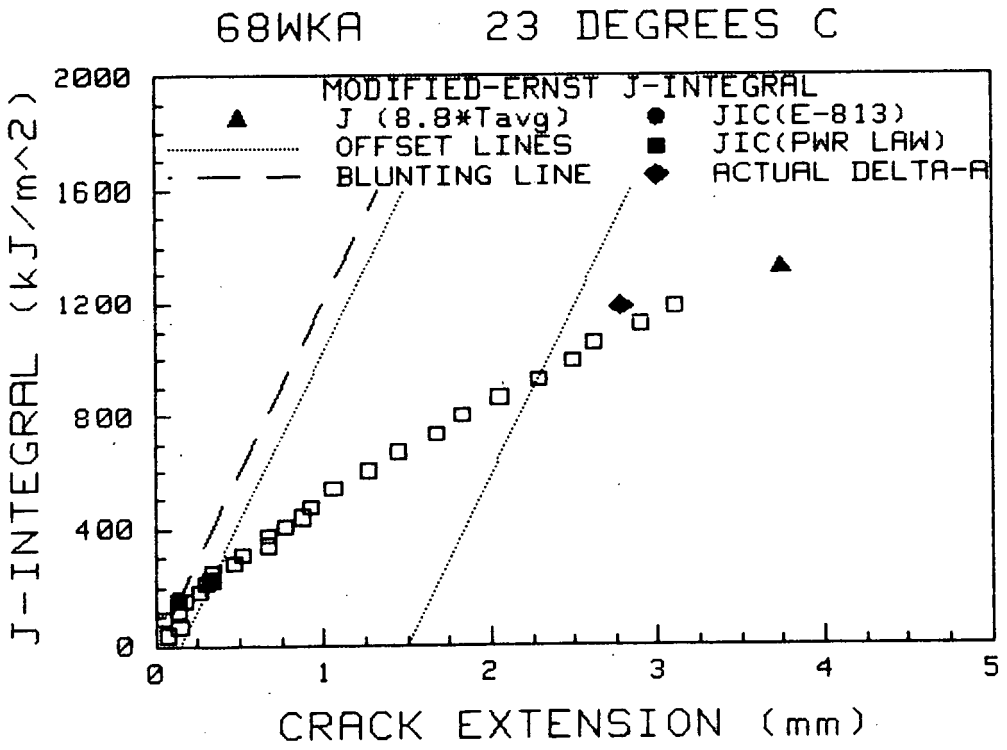
YP1221



ORNL-DWG 87-7934



ORNL-DWG 87-7935

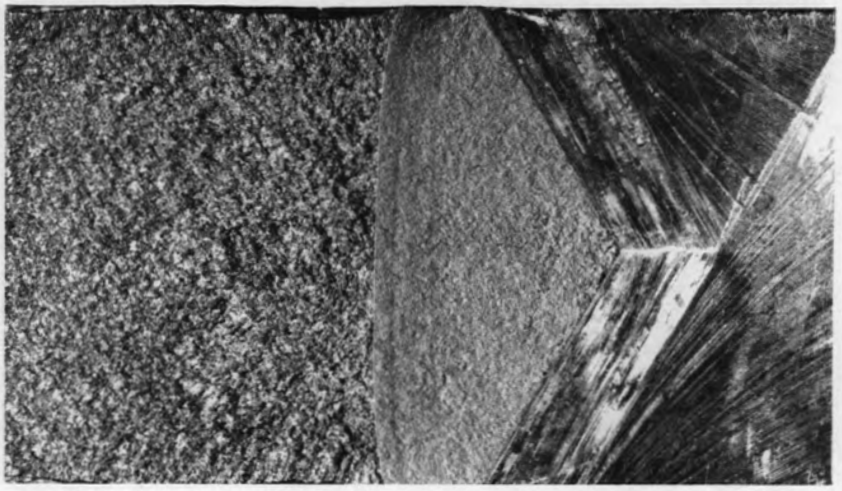


SPECIMEN ID= 68WKD
TEST TEMPERATURE= -80 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.6 mm a/W)i= .604
MEASURED DUCTILE DELTA-A= .07 mm
YIELD STRENGTH= 684 MPa
FLOW STRENGTH= 716 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

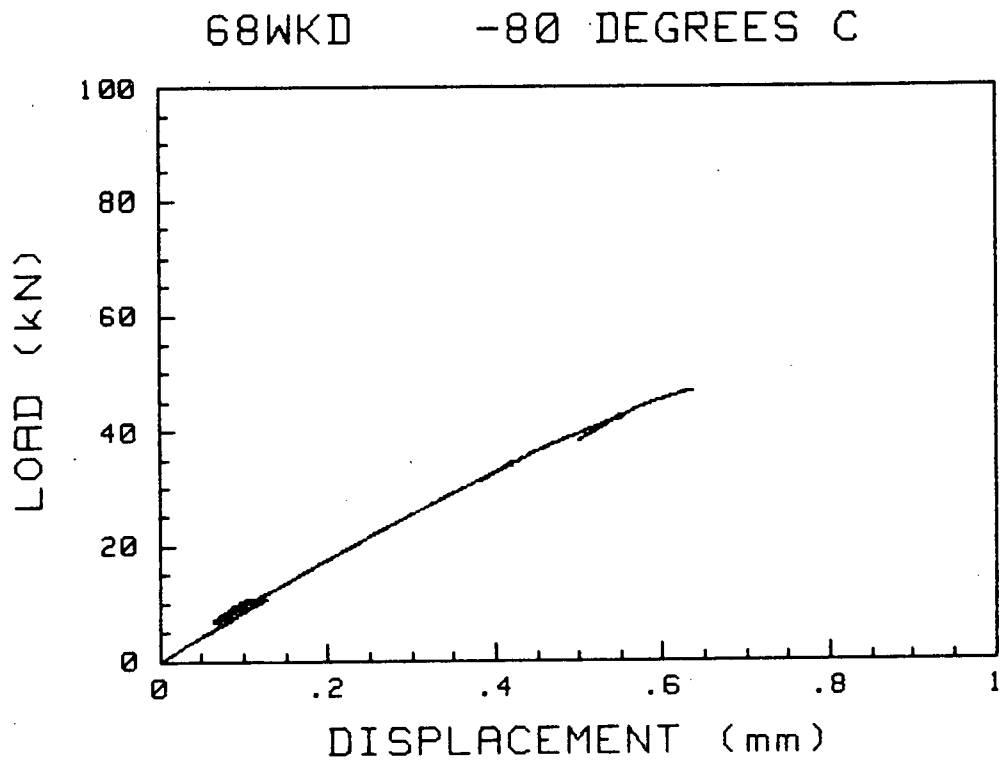
SPECIMEN CLEAVED AT K = 113.8 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 71.3 kJ/m^2	J-INTEGRAL= 71.3 kJ/m^2
KJc= 122.9 MPa SQR[m]	KJc= 122.9 MPa SQR[m]
K-beta-c= 93 MPa SQR[m]	K-beta-c= 93 MPa SQR[m]

YP1220



ORNL-DWG 87-7936

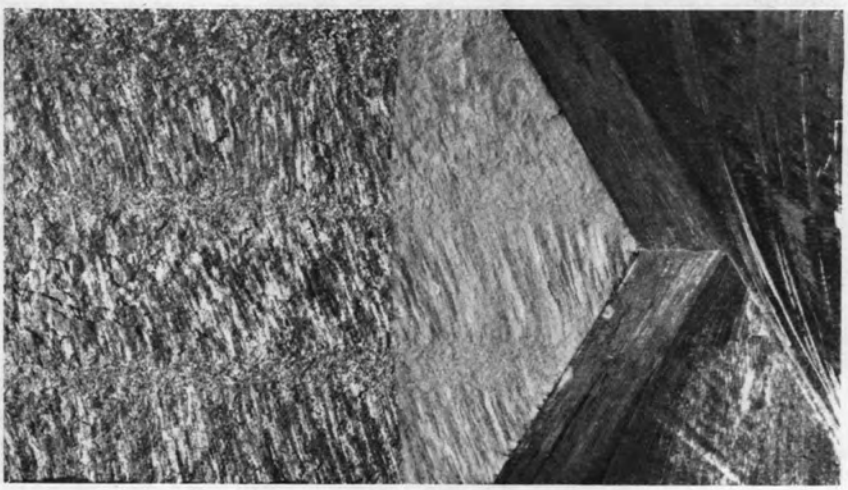


SPECIMEN ID= 69W-103
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -100 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.2 mm a/W)i= .595
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 779 MPa
FLOW STRENGTH= 818 MPa
ESTIMATED YOUNG'S MODULUS= 213 GPa

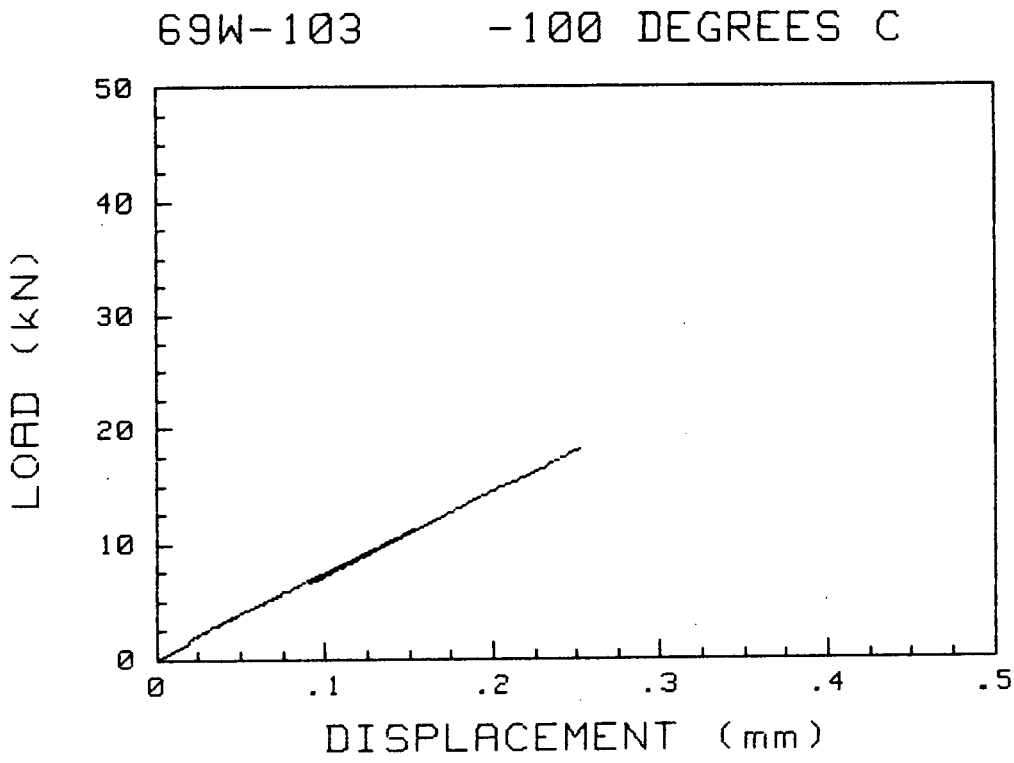
SPECIMEN CLEAVED AT KIc= 42.6 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 9.9 kJ/m^2	J-INTEGRAL= 9.9 kJ/m^2
KJc= 45.9 MPa SQR[m]	KJc= 45.9 MPa SQR[m]
K-beta-c= 45.3 MPa SQR[m]	K-beta-c= 45.3 MPa SQR[m]

YP1219



ORNL-DWG 87-7937

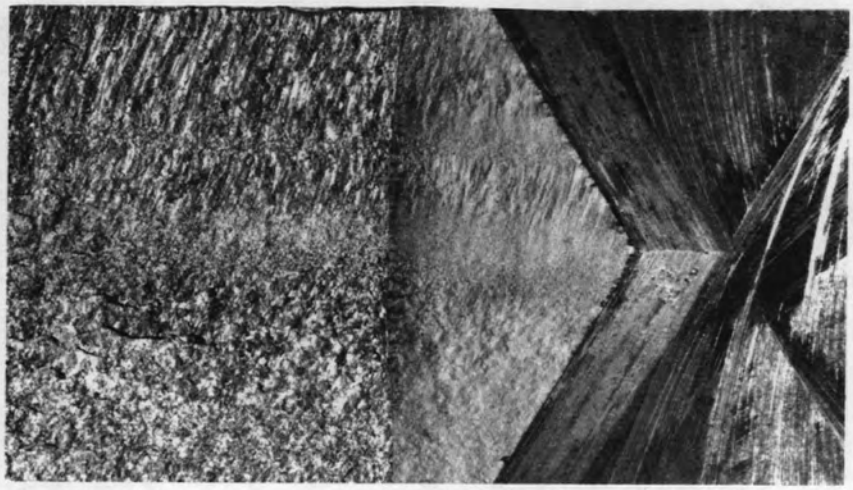


SPECIMEN ID= 69W109
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -100 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.3 mm a/W)i= .597
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 779 MPa
FLOW STRENGTH= 818 MPa
ESTIMATED YOUNG'S MODULUS= 213 GPa

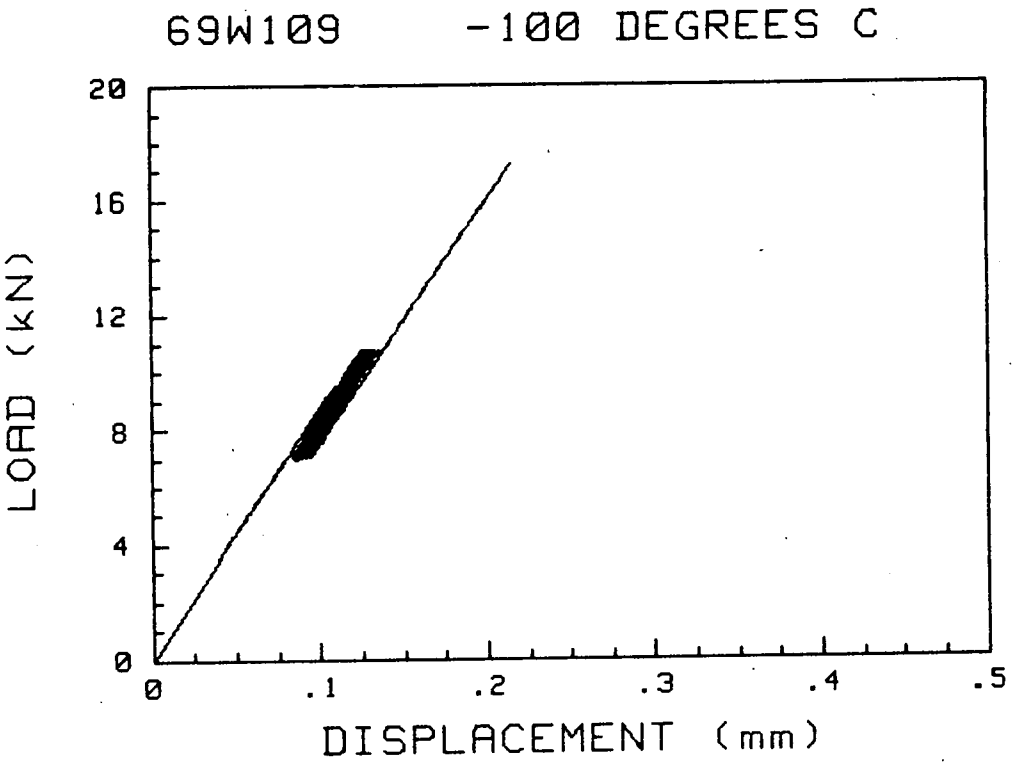
SPECIMEN CLEAVED AT KIc= 40.7 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 7.8 kJ/m^2	J-INTEGRAL= 7.8 kJ/m^2
KJc= 40.8 MPa SQR[m]	KJc= 40.8 MPa SQR[m]
K-beta-c= 40.5 MPa SQR[m]	K-beta-c= 40.5 MPa SQR[m]

YP1218



ORNL-DWG 87-7938



SPECIMEN ID= 69W117
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.3 mm a/W)i= .598
MEASURED DUCTILE DELTA-A= 3.18 mm
YIELD STRENGTH= 580 MPa
FLOW STRENGTH= 630 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 231.7 kJ/m^2
KJ-MAX LOAD= 215.4 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 164.6 kJ/m^2
K-JIc= 181.6 MPa SQR[m]
POWER= .5155
COEFFICIENT= 317 kJ/m^2
T (AVERAGE)= 84

ASTM LINEAR PROCEDURE

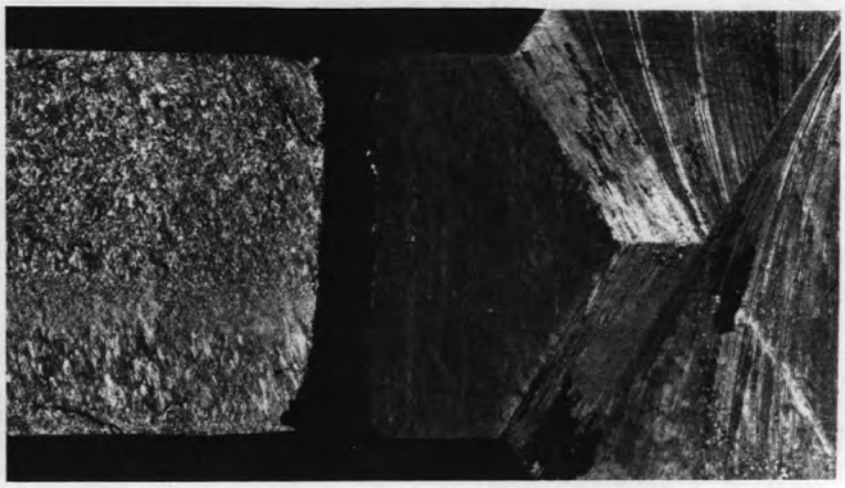
JIc= 146.4 kJ/m^2
K-JIc= 171.2 MPa SQR[m]
SLOPE= 184777 kJ/m^3
INTERCEPT= 124.9 kJ/m^2
T (ASTM)= 93
VALID, E813

JI-R CURVE CALCULATIONS

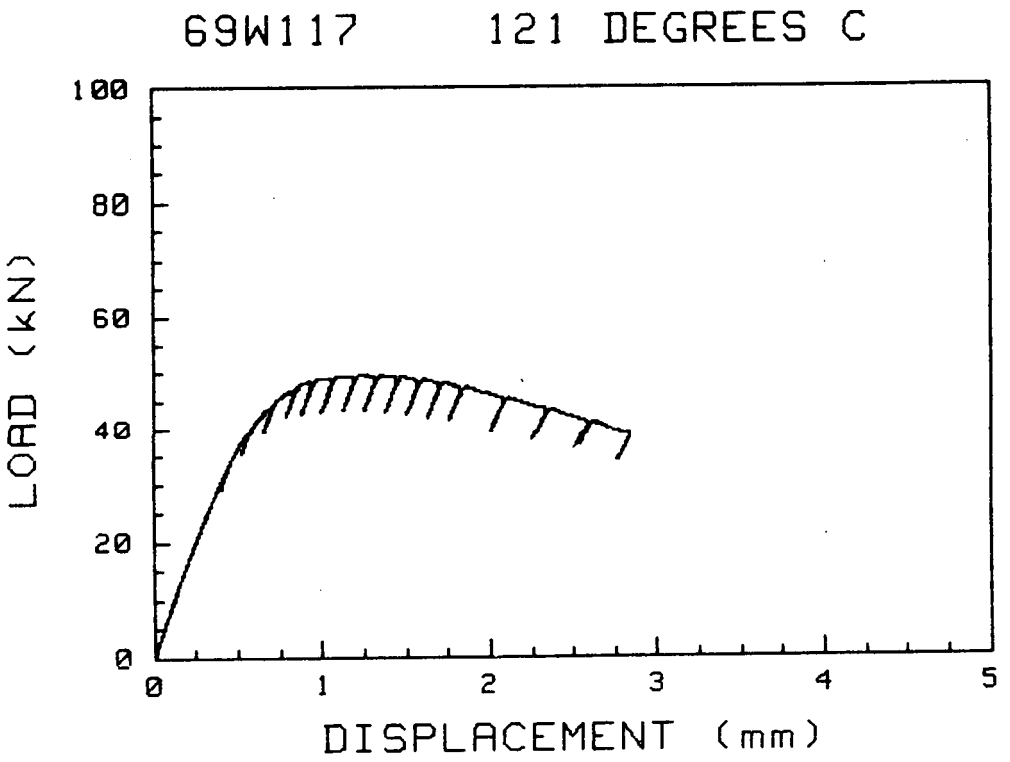
J (@J/T=8.8)= 460.6 kJ/m^2
POWER= .4875
J-MAX ALLOWED= 640.6 kJ/m^2
RCURVE INVALID, 2 3

COEFFICIENT= 316.3 kJ/m^2
DELTA-A MAX ALLOWED= 2.04 mm

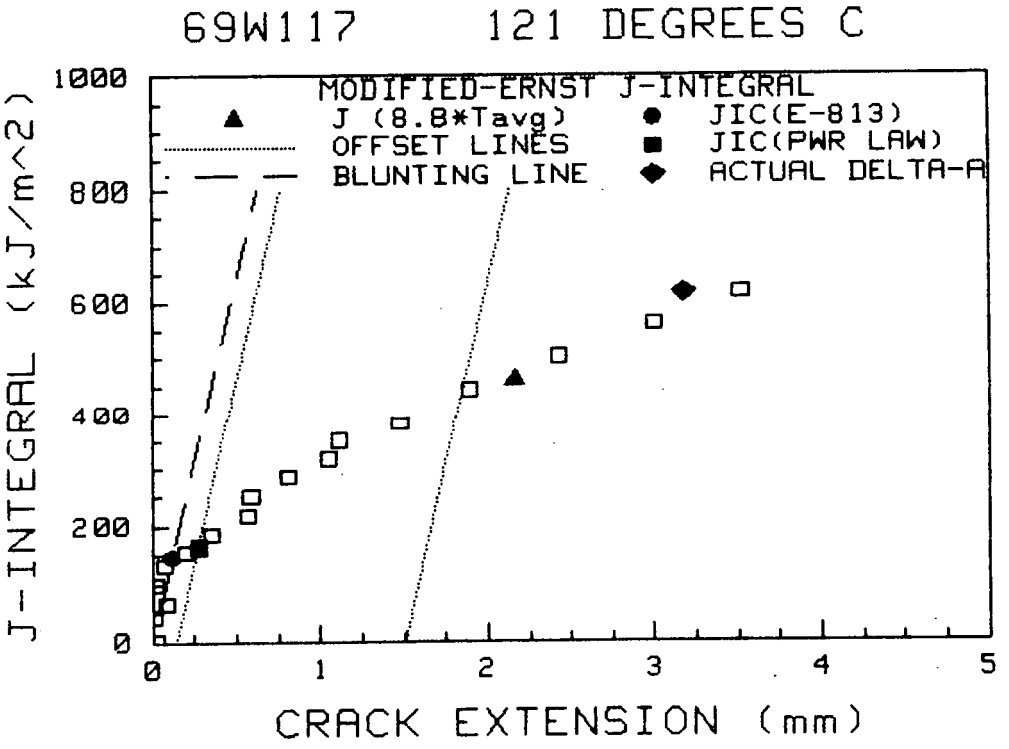
YP1276



ORNL-DWG 87-7939



ORNL-DWG 87-7940

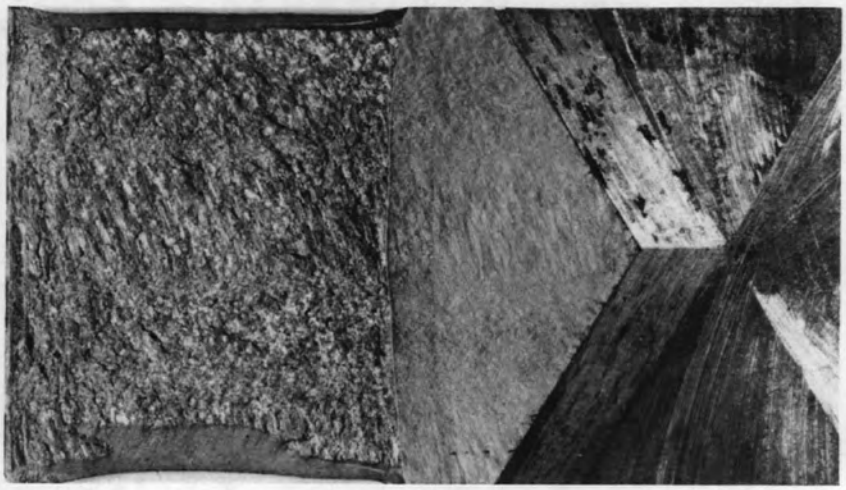


SPECIMEN ID= 69W-124
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -20 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.7 mm a/W)i= .605
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 680 MPa
FLOW STRENGTH= 722 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

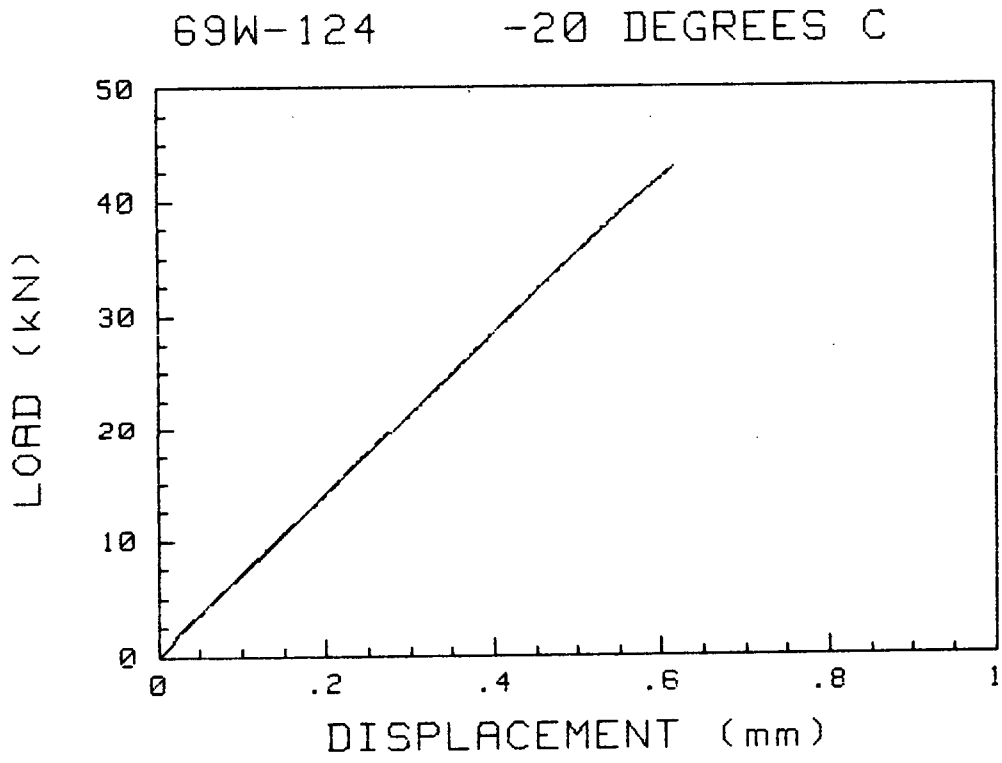
SPECIMEN CLEAVED AT K = 104.5 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 58.3 kJ/m^2	J-INTEGRAL= 58.3 kJ/m^2
KJc= 110.2 MPa SQR[m]	KJc= 110.2 MPa SQR[m]
K-beta-c= 87.4 MPa SQR[m]	K-beta-c= 87.4 MPa SQR[m]

YP1277



ORNL-DWG 87-7941



SPECIMEN ID= 69W125
TEST TEMPERATURE= 50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30 mm a/W)i= .591
MEASURED DUCTILE DELTA-A= 2.72 mm
YIELD STRENGTH= 619 MPa
FLOW STRENGTH= 664 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 215.3 kJ/m^2
KJ-MAX LOAD= 209.8 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 160.4 kJ/m^2
K-JIc= 181.1 MPa SQR[m]
POWER= .5106
COEFFICIENT= 312.6 kJ/m^2
T (AVERAGE)= 76

ASTM LINEAR PROCEDURE

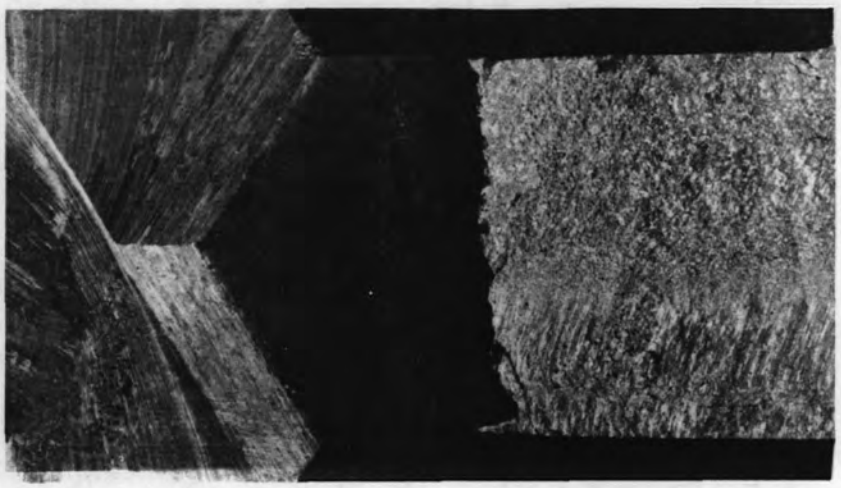
JIc= 149.8 kJ/m^2
K-JIc= 174.9 MPa SQR[m]
SLOPE= 172774 kJ/m^3
INTERCEPT= 130.3 kJ/m^2
T (ASTM)= 80
INVALID, 6

JI-R CURVE CALCULATIONS

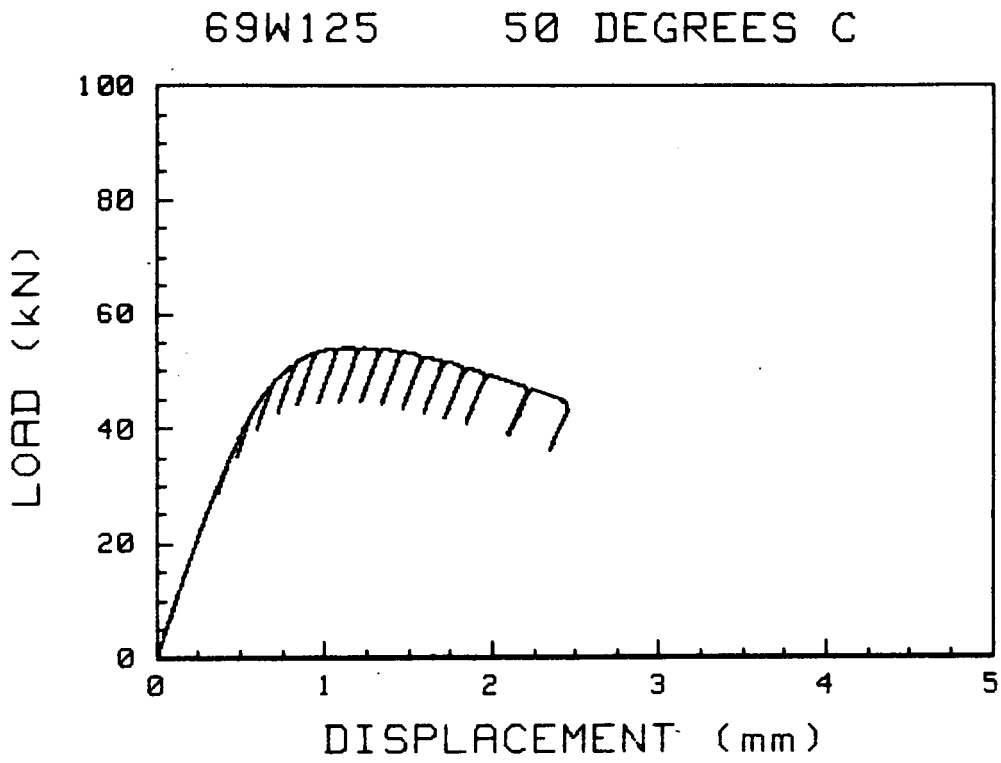
J (@J/T=8.8)= 454.2 kJ/m^2
POWER= .5102
J-MAX ALLOWED= 675 kJ/m^2
RCURVE INVALID, 1 3

COEFFICIENT= 312.6 kJ/m^2
DELTA-A MAX ALLOWED= 2.08 mm

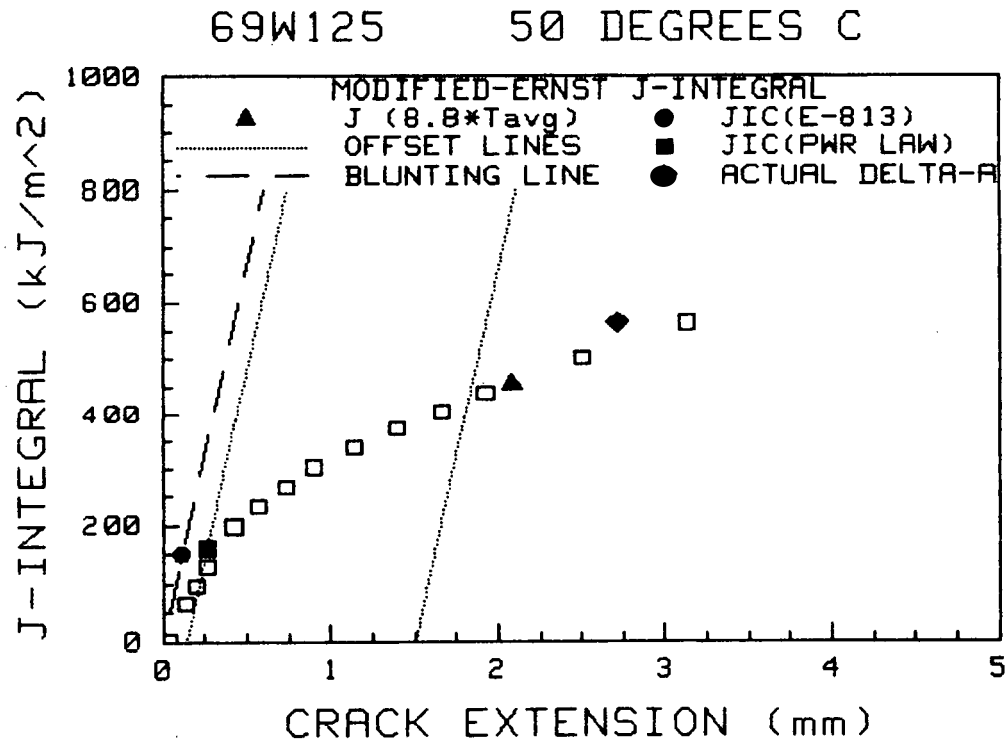
YP1278



ORNL-DWG 87-7942



ORNL-DWG 87-7943

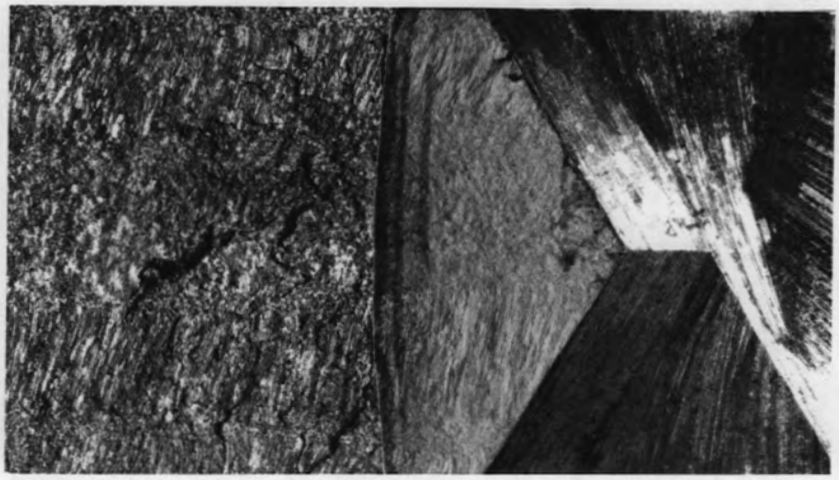


SPECIMEN ID= 69W128
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -5 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.4 mm a/W)i= .599
MEASURED DUCTILE DELTA-A= .06 mm
YIELD STRENGTH= 665 MPa
FLOW STRENGTH= 708 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

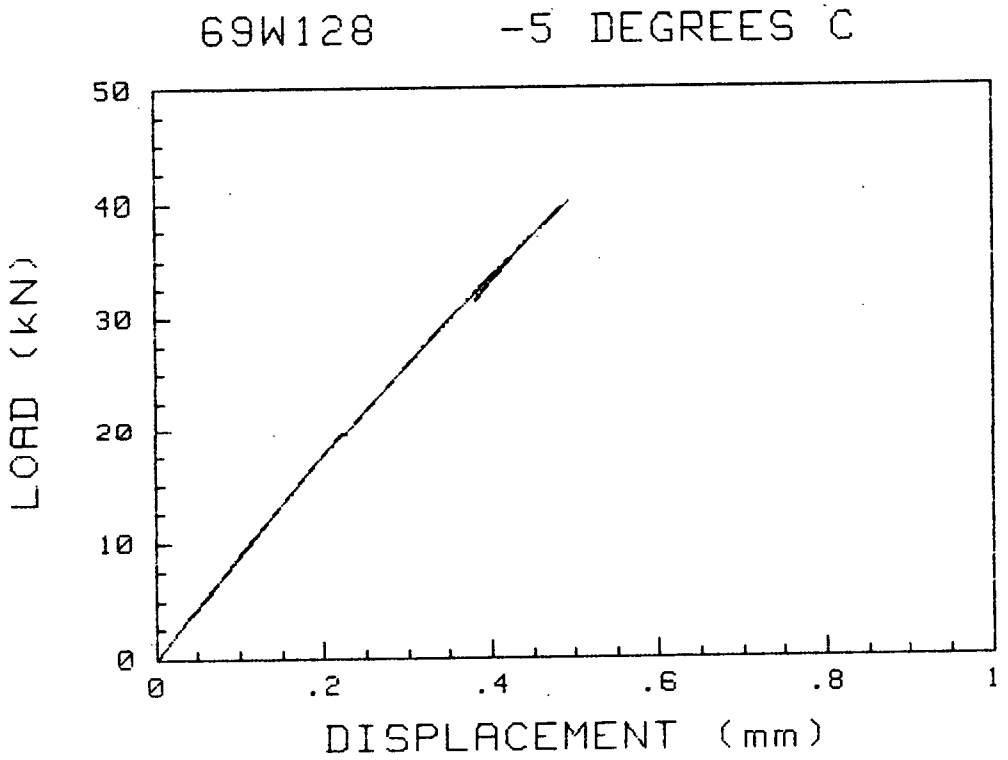
SPECIMEN CLEAVED AT K = 95.1 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 44.4 kJ/m^2	J-INTEGRAL= 44.4 kJ/m^2
KJc= 95.9 MPa SQR[m]	KJc= 95.9 MPa SQR[m]
K-beta-c= 79.7 MPa SQR[m]	K-beta-c= 79.7 MPa SQR[m]

YP1279



ORNL-DWG 87-7944



SPECIMEN ID= 69W-132
TEST TEMPERATURE= 24 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30 mm a/W)i= .592
MEASURED DUCTILE DELTA-A= 7.92 mm
YIELD STRENGTH= 640 MPa
FLOW STRENGTH= 684 MPa
ESTIMATED YOUNG'S MODULUS= 206 GPa

SPECIMEN CLEAVED AT K = 138.2 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 183.2 kJ/m^2
KJc= 194.2 MPa SQR[m]
K-beta-c= 111.8 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 253.6 kJ/m^2
KJc= 228.5 MPa SQR[m]
K-beta-c= 119.7 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 89.2 kJ/m^2
K-JIc= 135.5 MPa SQR[m]
POWER= .717
COEFFICIENT= 268.3 kJ/m^2
T (AVERAGE)= 87

ASTM LINEAR PROCEDURE

JIc= 49.3 kJ/m^2
K-JIc= 100.8 MPa SQR[m]
SLOPE= 235704 kJ/m^3
INTERCEPT= 40.8 kJ/m^2
T (ASTM)= 104
INVALID, 2 6

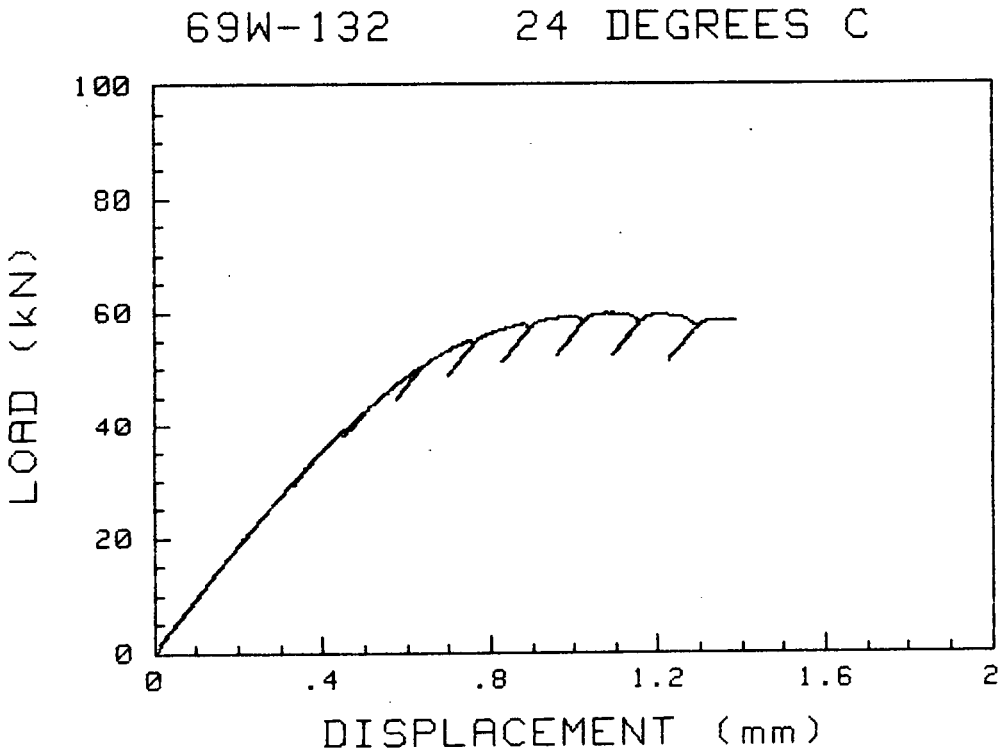
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 532 kJ/m^2
POWER= .7017
J-MAX ALLOWED= 706.5 kJ/m^2
RCURVE INVALID, 2 3

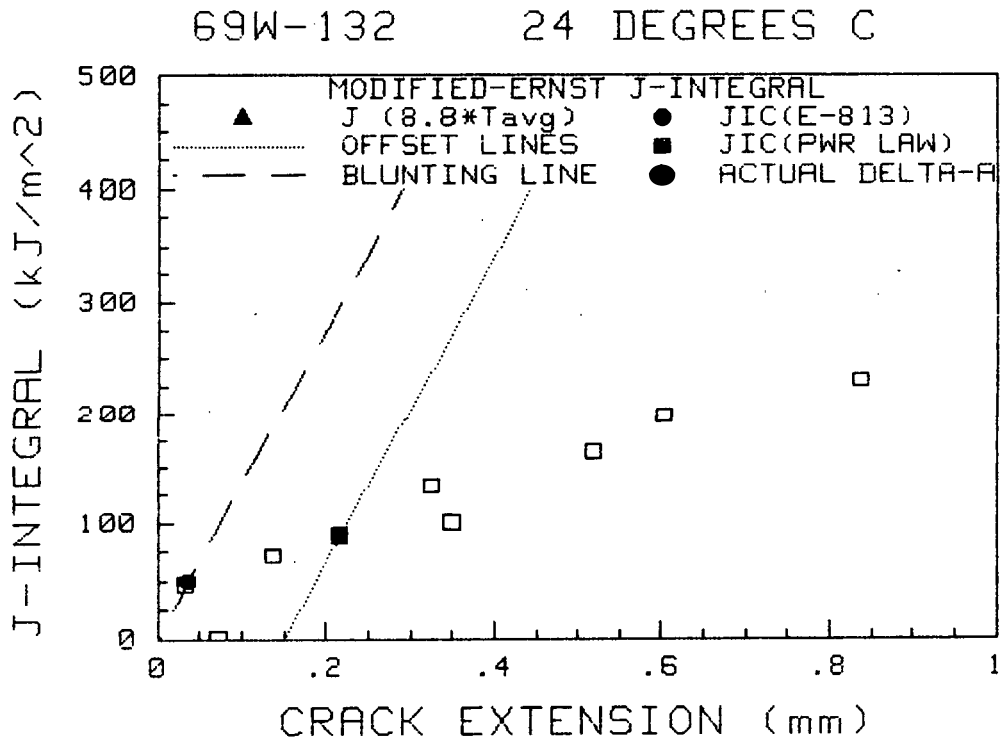
COEFFICIENT= 264.1 kJ/m^2
DELTA-A MAX ALLOWED= 2.06 mm

YP1280

ORNL-DWG 87-7945



ORNL-DWG 87-7946



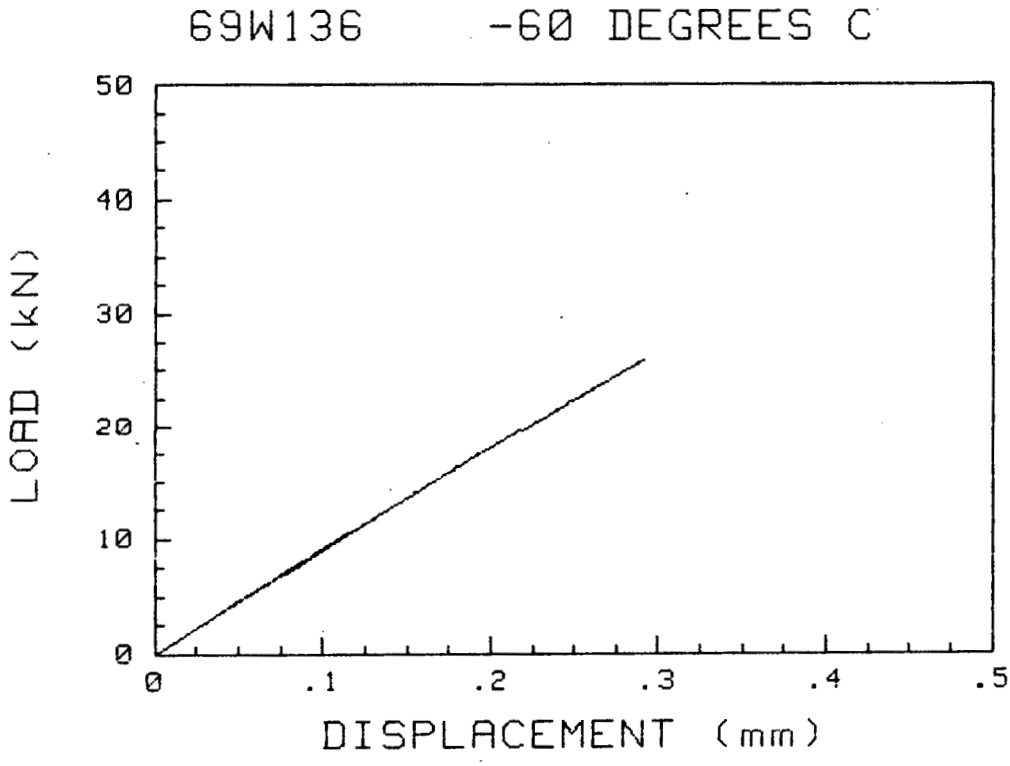
SPECIMEN ID= 69W136
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -60 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.3 mm a/W)i= .596
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 726 MPa
FLOW STRENGTH= 766 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

SPECIMEN CLEAVED AT KIc= 60.8 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 16.2 kJ/m^2	J-INTEGRAL= 16.2 kJ/m^2
KJc= 58.4 MPa SQR[m]	KJc= 58.4 MPa SQR[m]
K-beta-c= 56.2 MPa SQR[m]	K-beta-c= 56.2 MPa SQR[m]

YP1270

ORNL-DWG 87-7947



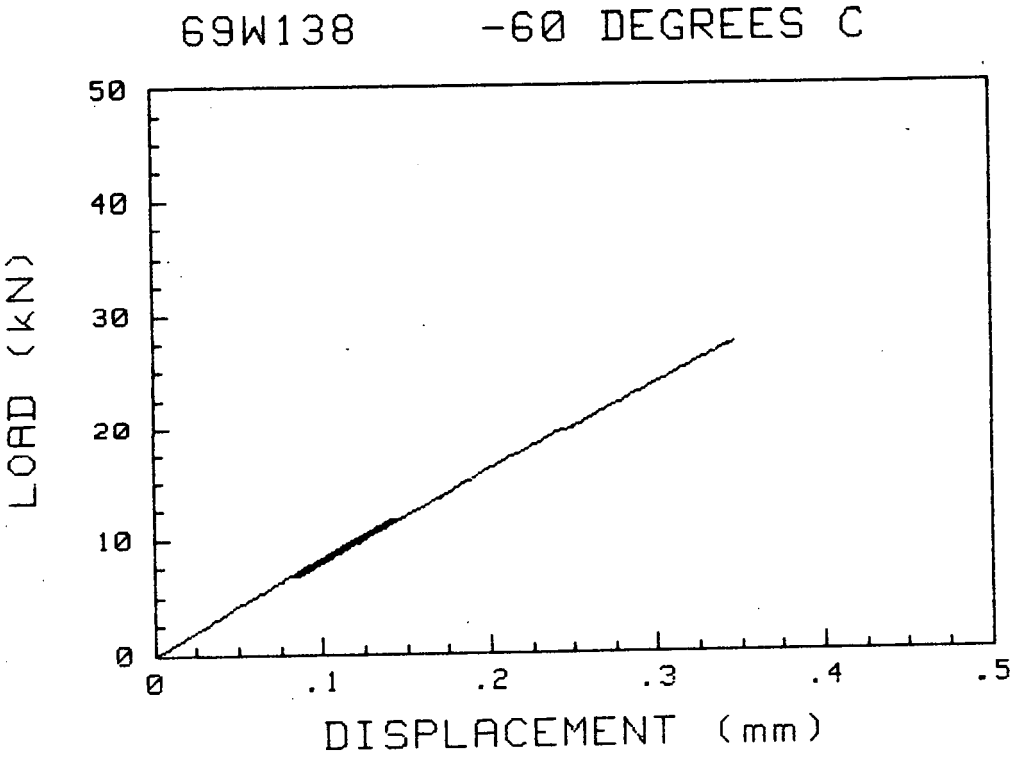
SPECIMEN ID= 69W138
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -60 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31 mm a/W)i= .612
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 726 MPa
FLOW STRENGTH= 766 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

SPECIMEN CLEAVED AT KIc= 68.4 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 21.1 kJ/m^2	J-INTEGRAL= 21.1 kJ/m^2
KJc= 66.6 MPa SQR[m]	KJc= 66.6 MPa SQR[m]
K-beta-c= 62.9 MPa SQR[m]	K-beta-c= 62.9 MPa SQR[m]

YP1272

ORNL-DWG 87-7948



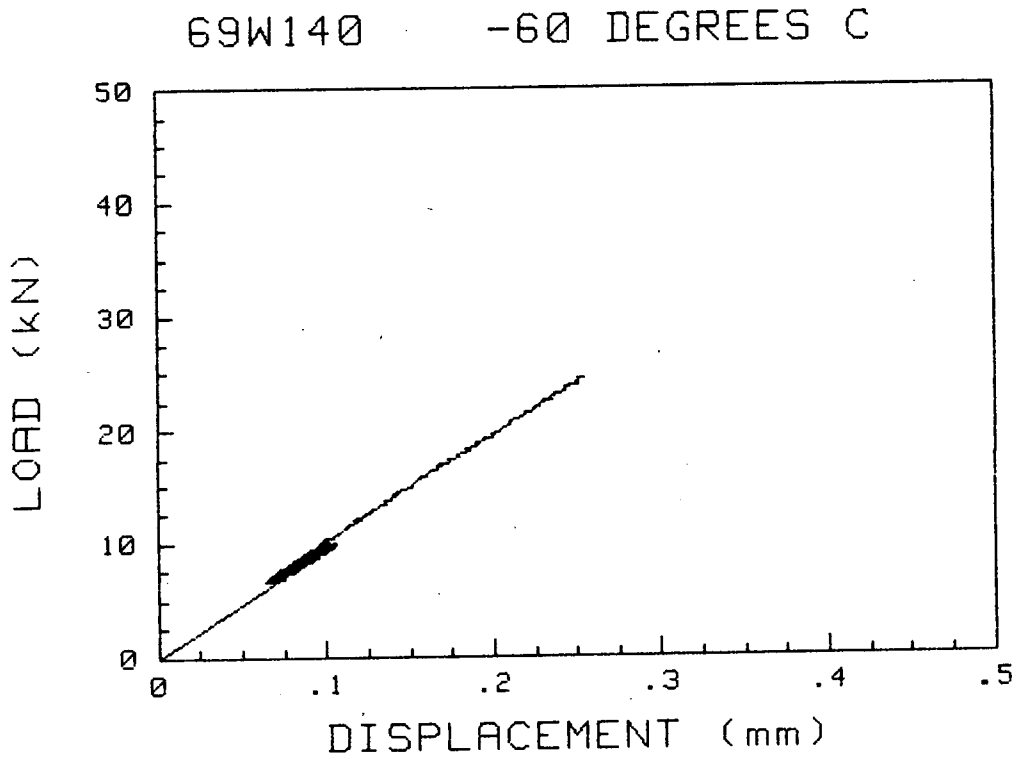
SPECIMEN ID= 69W140
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -60 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 29.7 mm a/W)i= .587
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 726 MPa
FLOW STRENGTH= 766 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

SPECIMEN CLEAVED AT KIc= 55.8 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 12.3 kJ/m^2	J-INTEGRAL= 12.3 kJ/m^2
KJc= 50.8 MPa SQR[m]	KJc= 50.8 MPa SQR[m]
K-beta-c= 49.6 MPa SQR[m]	K-beta-c= 49.6 MPa SQR[m]

YP1273

ORNL-DWG 87-7949



SPECIMEN ID= 69W141
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.2 mm a/W)i= .595
MEASURED DUCTILE DELTA-A= 3.2 mm
YIELD STRENGTH= 580 MPa
FLOW STRENGTH= 630 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 219.6 kJ/m^2
KJ-MAX LOAD= 209.7 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 178.8 kJ/m^2
K-JIc= 189.3 MPa SQR[m]
POWER= .4954
COEFFICIENT= 329.2 kJ/m^2
T (AVERAGE)= 83

ASTM LINEAR PROCEDURE

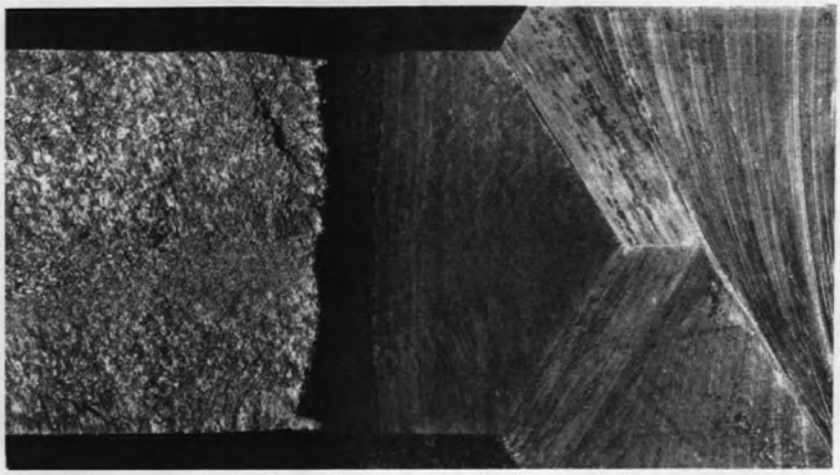
JIc= 164 kJ/m^2
K-JIc= 181.3 MPa SQR[m]
SLOPE= 174908 kJ/m^3
INTERCEPT= 141.3 kJ/m^2
T (ASTM)= 88
VALID, E813

JI-R CURVE CALCULATIONS

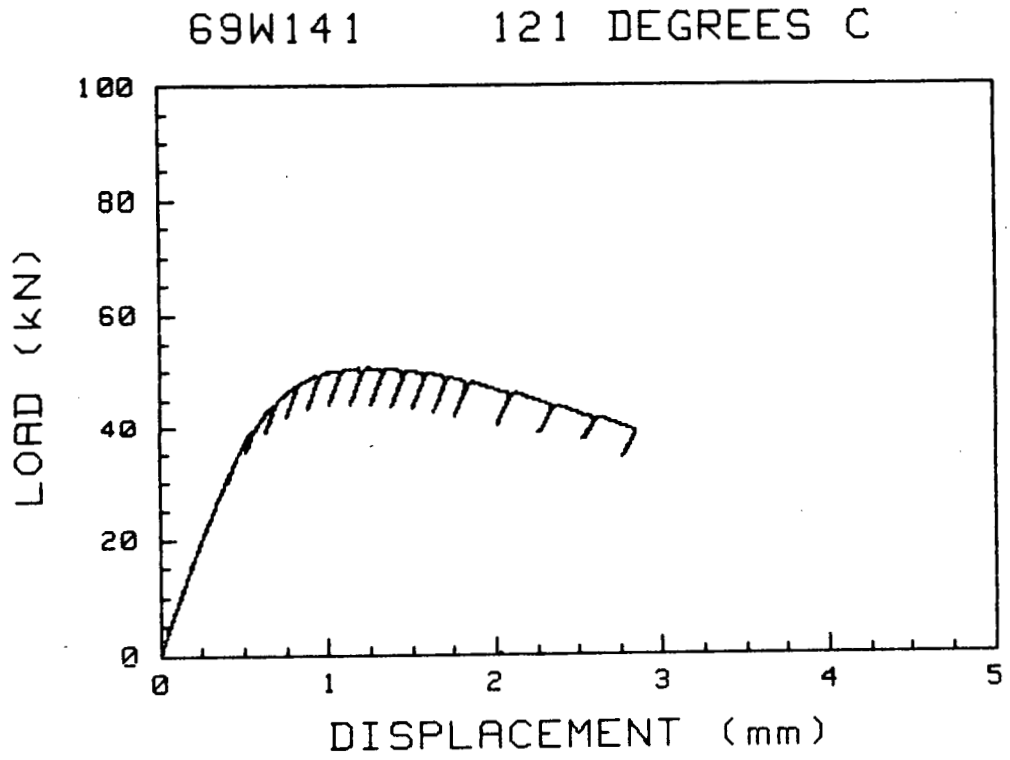
J (@J/T=8.8)= 466.5 kJ/m^2
POWER= .4727
J-MAX ALLOWED= 640.6 kJ/m^2
RCURVE INVALID, 3

COEFFICIENT= 328.7 kJ/m^2
DELTA-A MAX ALLOWED= 2.06 mm

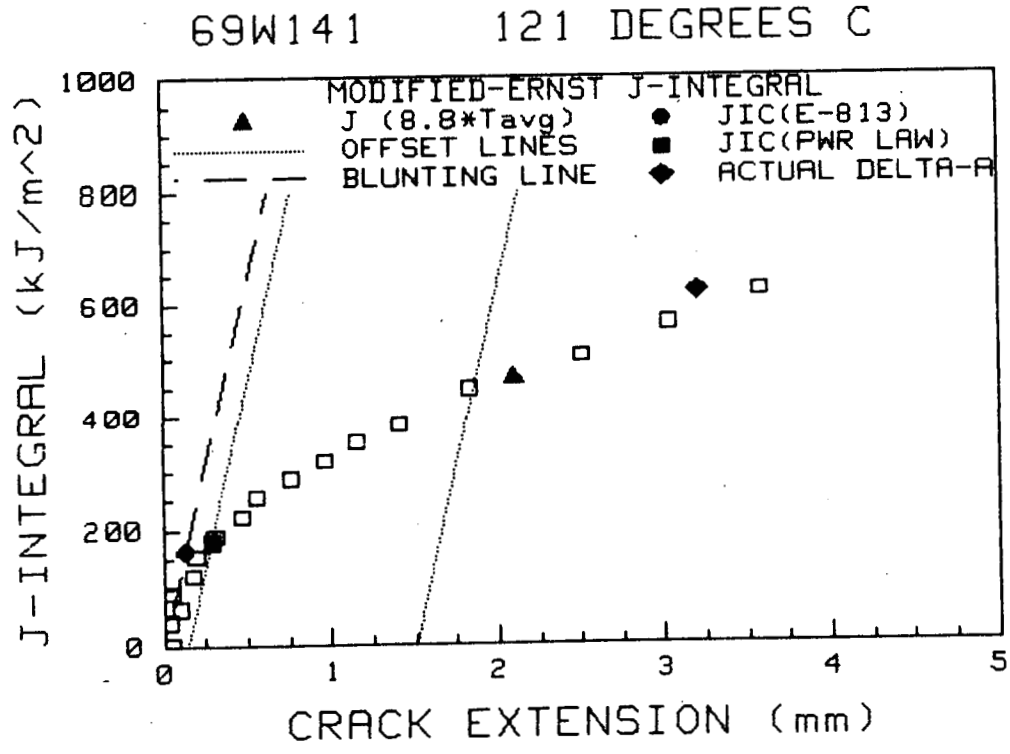
YP1274



ORNL-DWG 87-7950



ORNL-DWG 87-7951



SPECIMEN ID= 69W145
TEST TEMPERATURE= 204 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.6 mm a/W)i= .603
MEASURED DUCTILE DELTA-A= 3.66 mm
YIELD STRENGTH= 566 MPa
FLOW STRENGTH= 623 MPa
ESTIMATED YOUNG'S MODULUS= 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 225.2 kJ/m^2
KJ-MAX LOAD= 209.9 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 137.7 kJ/m^2
K-JIc= 164.1 MPa SQR[m]
POWER= .475
COEFFICIENT= 260.9 kJ/m^2
T (AVERAGE)= 65

ASTM LINEAR PROCEDURE

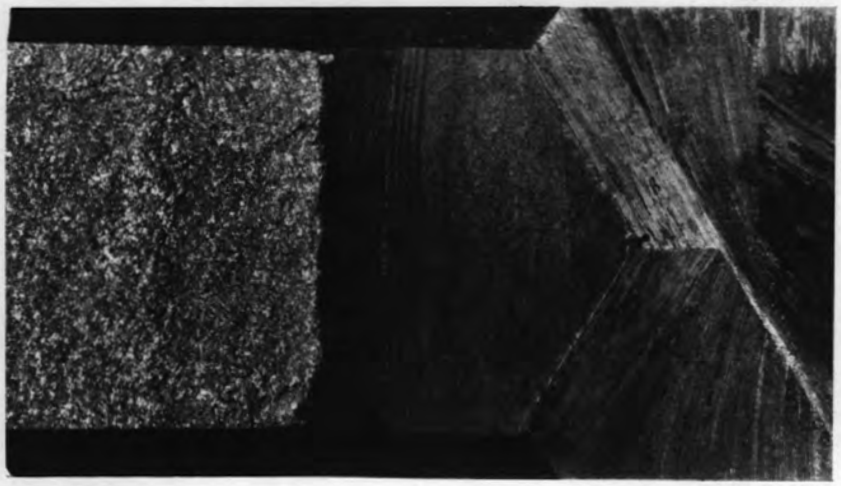
JIc= 104.5 kJ/m^2
K-JIc= 143 MPa SQR[m]
SLOPE= 150078 kJ/m^3
INTERCEPT= 91.9 kJ/m^2
T (ASTM)= 76
VALID, E813

JI-R CURVE CALCULATIONS

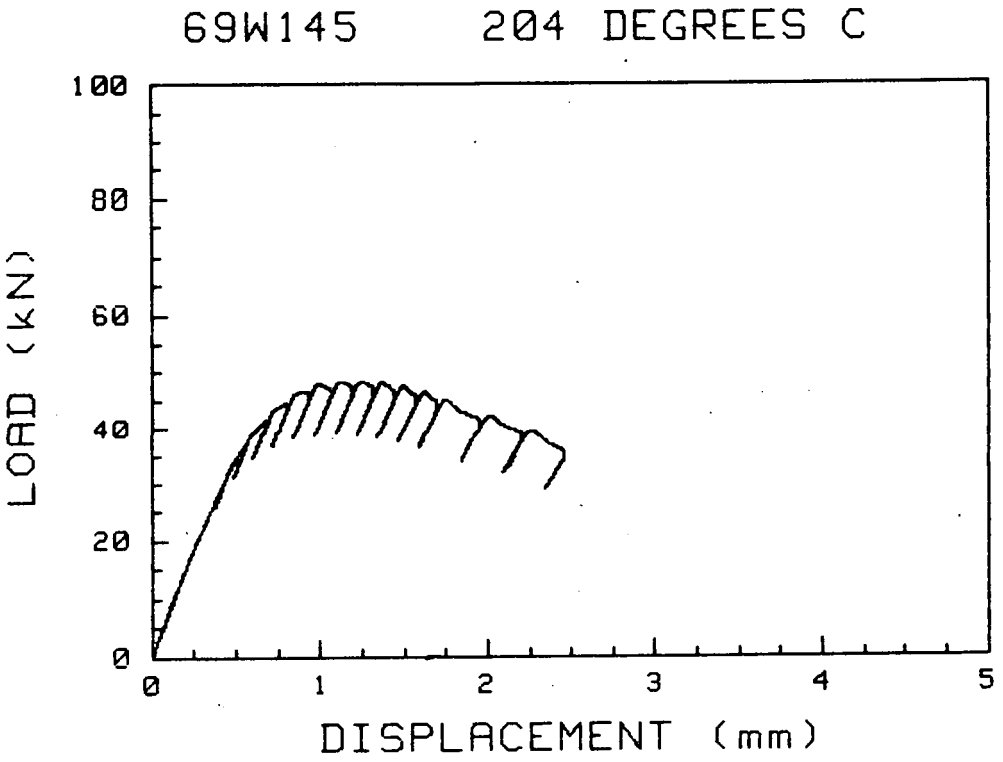
J (@J/T=8.8)= 369.3 kJ/m^2
POWER= .4986
J-MAX ALLOWED= 626.9 kJ/m^2
RCURVE INVALID, 2 3

COEFFICIENT= 248.7 kJ/m^2
DELTA-A MAX ALLOWED= 2.01 mm

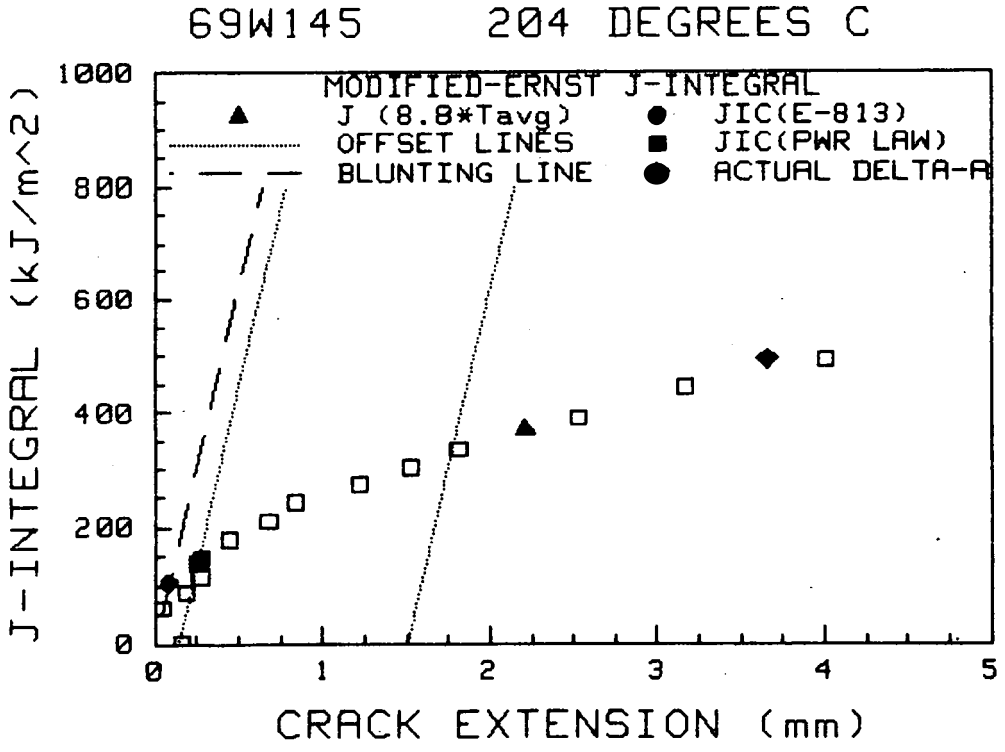
YP1275



ORNL-DWG 87-7952



ORNL-DWG 87-7953



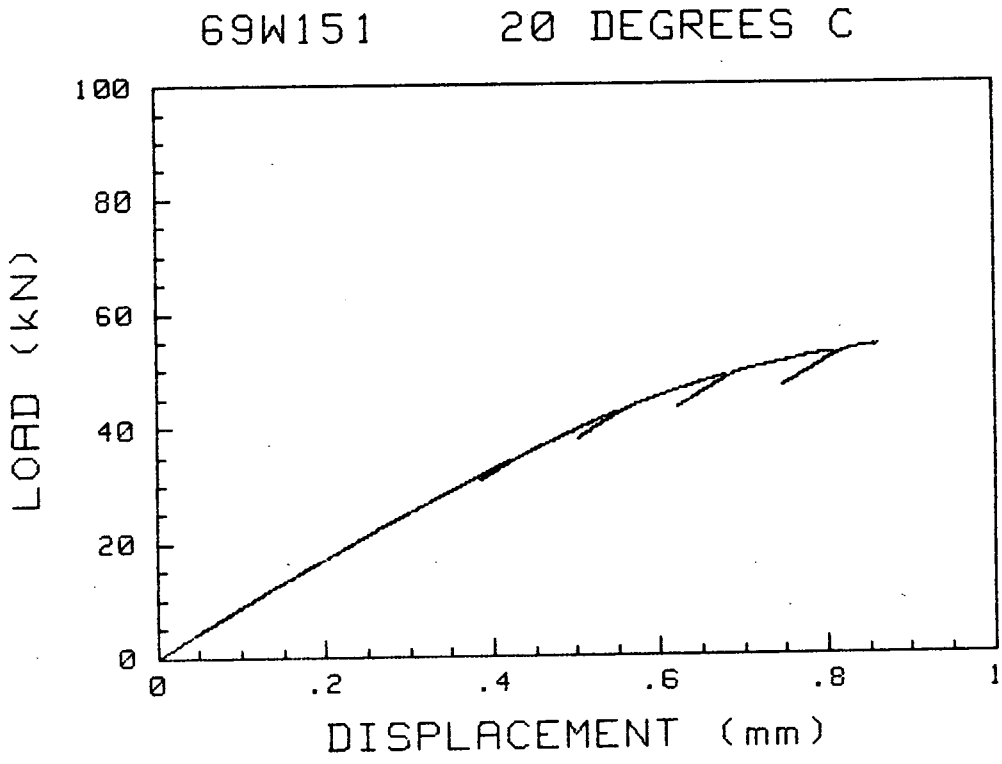
SPECIMEN ID= 69W151
MATERIAL TYPE= A533BW
TEST TEMPERATURE= 20 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.4 mm a/W)i= .6
MEASURED DUCTILE DELTA-A= .1 mm
YIELD STRENGTH= 642 MPa
FLOW STRENGTH= 686 MPa
ESTIMATED YOUNG'S MODULUS= 206 GPa

SPECIMEN CLEAVED AT K = 128 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 118.2 kJ/m^2	J-INTEGRAL= 118.4 kJ/m^2
KJc= 156.1 MPa SQR[m]	KJc= 156.2 MPa SQR[m]
K-beta-c= 101.6 MPa SQR[m]	K-beta-c= 101.6 MPa SQR[m]

YP1271

ORNL-DWG 87-7954



SPECIMEN ID= 69W154
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.3 mm a/W)i= .598
MEASURED DUCTILE DELTA-A= 3.31 mm
YIELD STRENGTH= 585 MPa
FLOW STRENGTH= 651 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 216.6 kJ/m^2
KJ-MAX LOAD= 203.3 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 123.2 kJ/m^2
K-JIc= 153.3 MPa SQR[m]
POWER= .4538
COEFFICIENT= 233.4 kJ/m^2
T (AVERAGE)= 51

ASTM LINEAR PROCEDURE

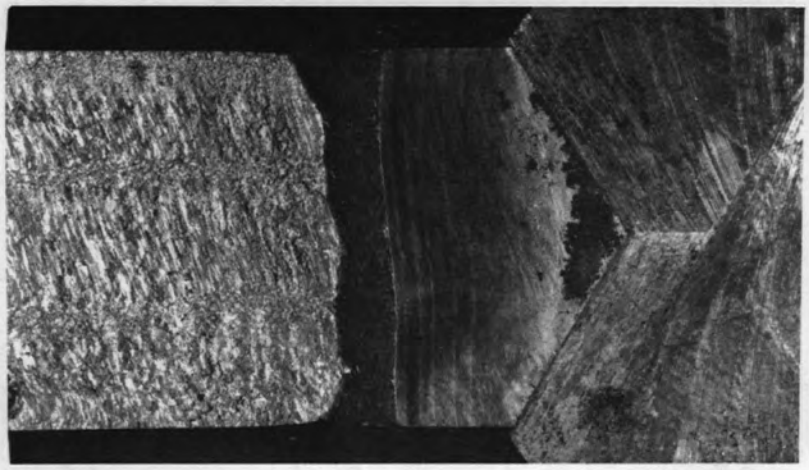
JIc= 112.5 kJ/m^2
K-JIc= 146.5 MPa SQR[m]
SLOPE= 123281 kJ/m^3
INTERCEPT= 101.8 kJ/m^2
T (ASTM)= 56
VALID, E813

JI-R CURVE CALCULATIONS

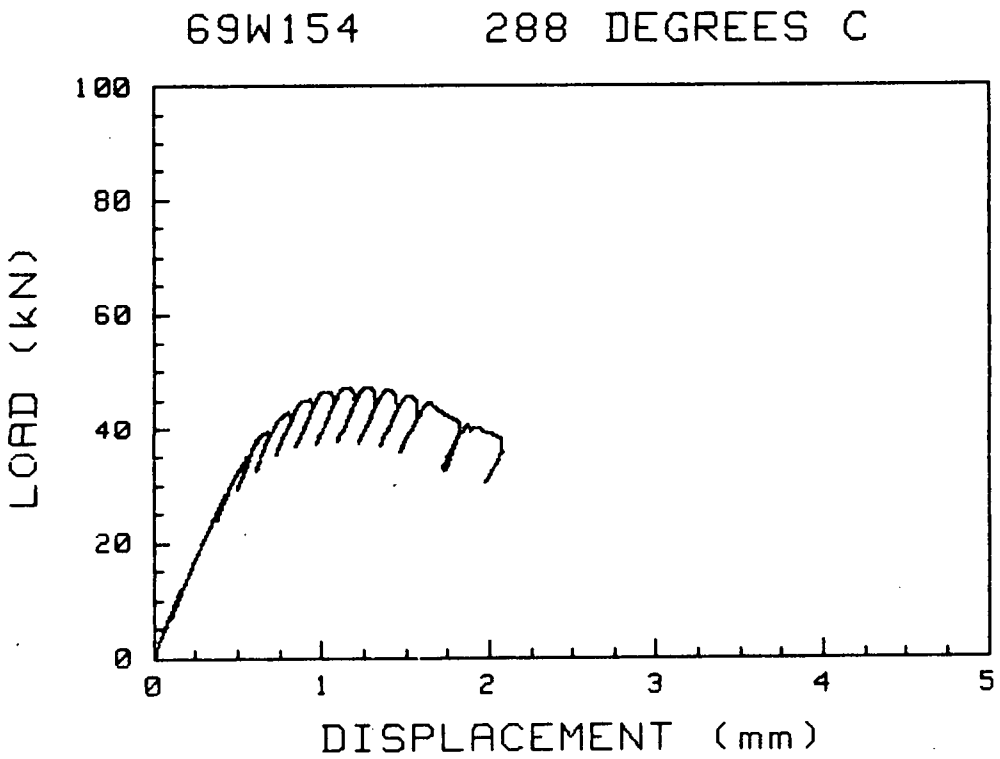
J (@J/T=8.8)= 302.6 kJ/m^2
POWER= .4506
J-MAX ALLOWED= 661 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 233 kJ/m^2
DELTA-A MAX ALLOWED= 2.04 mm

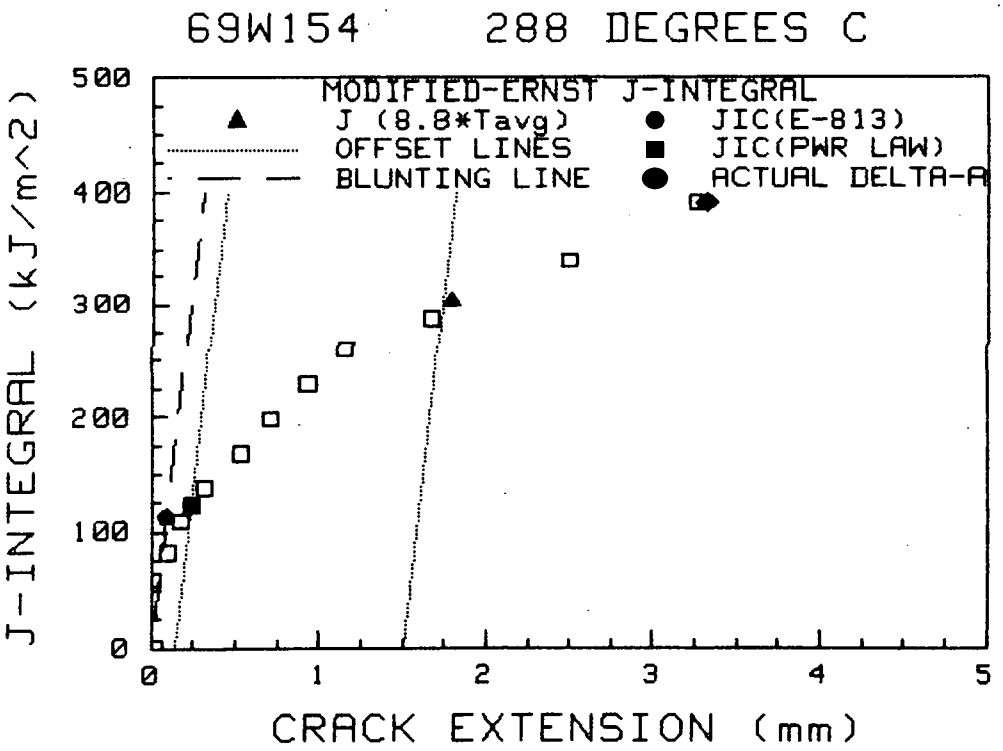
YP1268



ORNL-DWG 87-7955



ORNL-DWG 87-7956



SPECIMEN ID= 69W161
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.3 mm a/W)i= .598
MEASURED DUCTILE DELTA-A= 3.93 mm
YIELD STRENGTH= 585 MPa
FLOW STRENGTH= 651 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 226.1 kJ/m^2
KJ-MAX LOAD= 207.7 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 147 kJ/m^2
K-JIc= 167.5 MPa SQR[m]
POWER= .4186
COEFFICIENT= 257.1 kJ/m^2
T (AVERAGE)= 51

ASTM LINEAR PROCEDURE

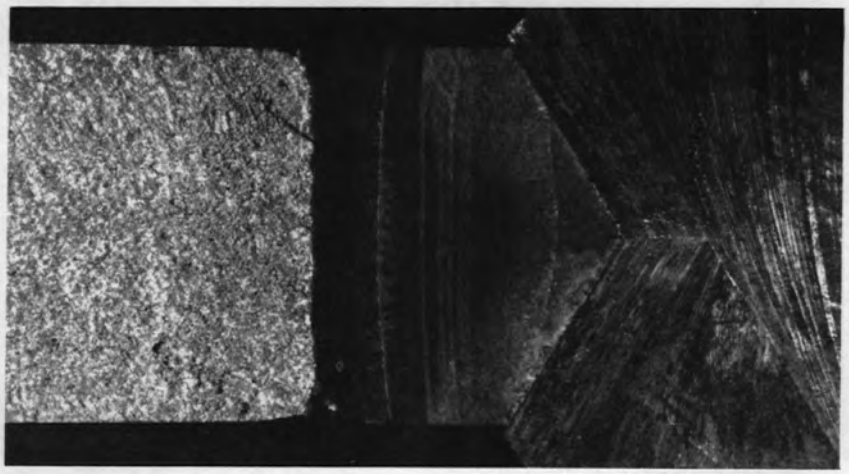
JIc= 140.2 kJ/m^2
K-JIc= 163.6 MPa SQR[m]
SLOPE= 123937 kJ/m^3
INTERCEPT= 126.8 kJ/m^2
T (ASTM)= 56
VALID, E813

JI-R CURVE CALCULATIONS

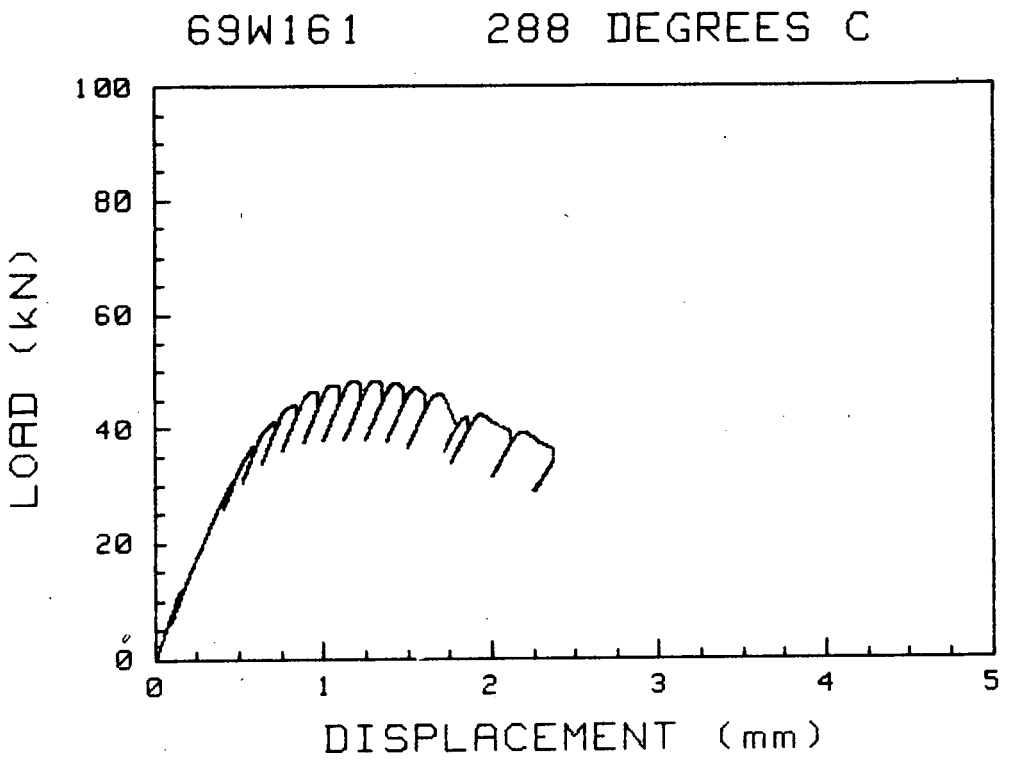
J (@J/T=8.8)= 301.6 kJ/m^2
POWER= .3867
J-MAX ALLOWED= 661.6 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 255.7 kJ/m^2
DELTA-A MAX ALLOWED= 2.04 mm

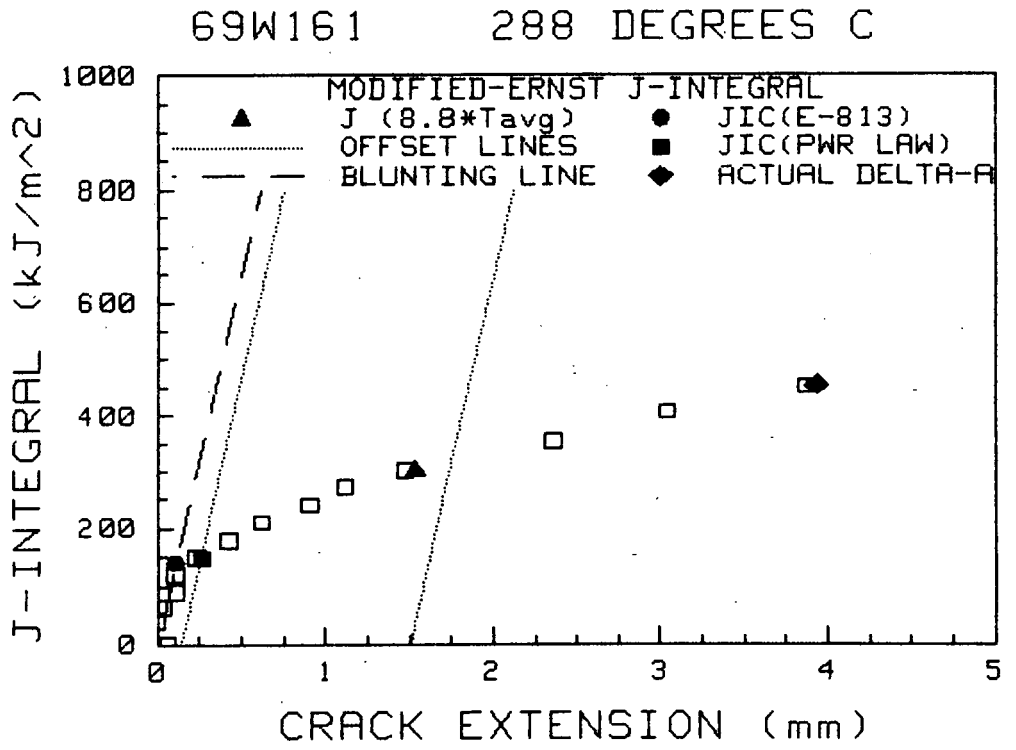
YP1269



ORNL-DWG 87-7957



ORNL-DWG 87-7958

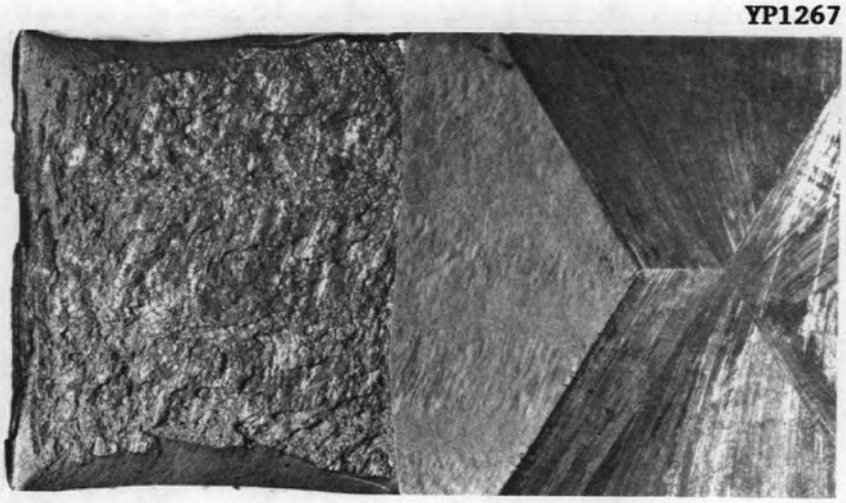


SPECIMEN ID= 69W170
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -5 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.7 mm a/W)i= .605
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 665 MPa
FLOW STRENGTH= 708 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

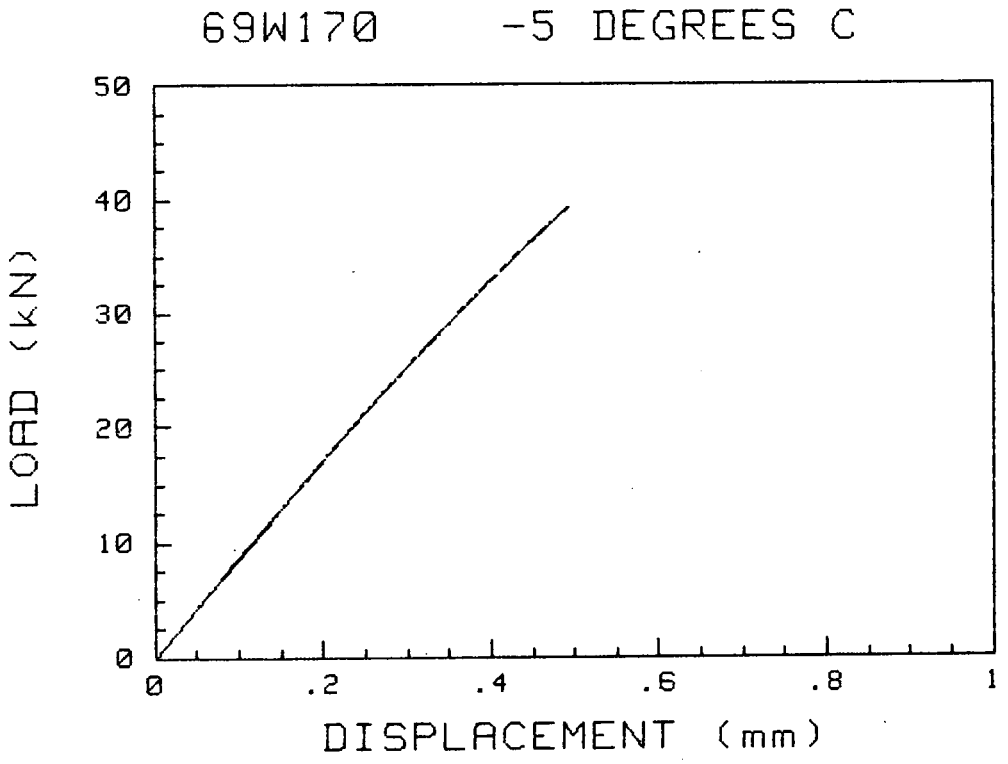
SPECIMEN CLEAVED AT K = 95.8 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 44 kJ/m^2	J-INTEGRAL= 44 kJ/m^2
KJc= 95.5 MPa SQR[m]	KJc= 95.5 MPa SQR[m]
K-beta-c= 79.5 MPa SQR[m]	K-beta-c= 79.5 MPa SQR[m]

YP1267



ORNL-DWG 87-7959



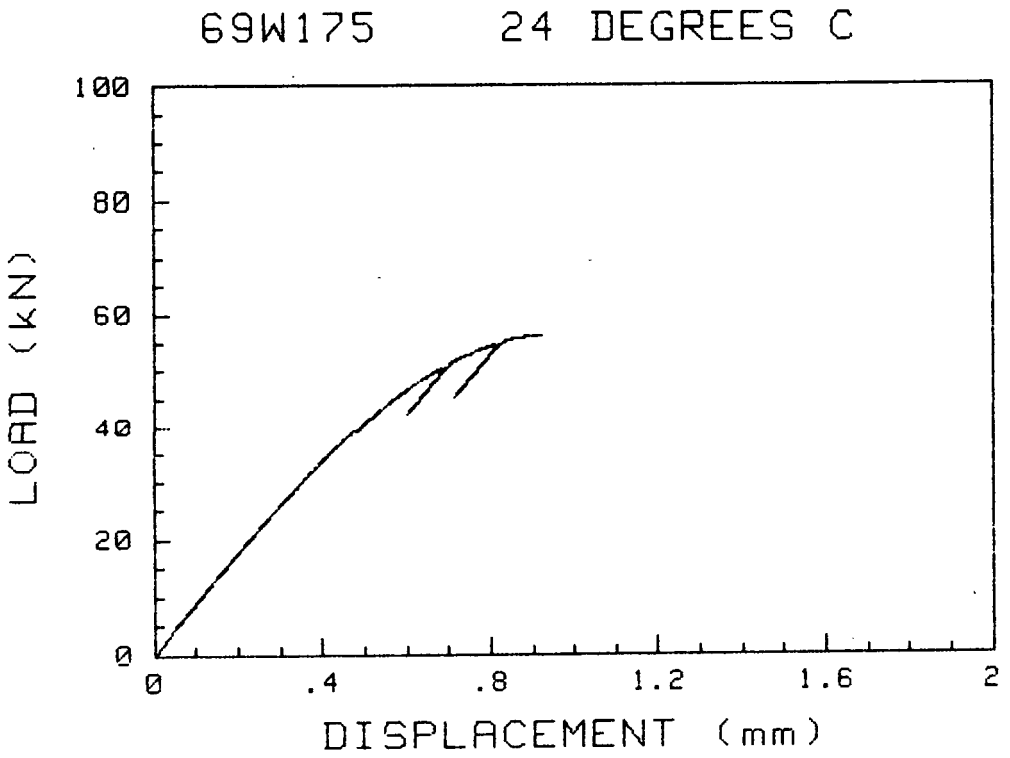
SPECIMEN ID= 69W175
MATERIAL TYPE= A533BW
TEST TEMPERATURE= 24 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.4 mm a/W)i= .599
MEASURED DUCTILE DELTA-A= .1 mm
YIELD STRENGTH= 639 MPa
FLOW STRENGTH= 683 MPa
ESTIMATED YOUNG'S MODULUS= 206 GPa

SPECIMEN CLEAVED AT K = 133.7 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 134 kJ/m^2	J-INTEGRAL= 136.3 kJ/m^2
KJc= 166.1 MPa SQR[m]	KJc= 167.5 MPa SQR[m]
K-beta-c= 104.2 MPa SQR[m]	K-beta-c= 104.6 MPa SQR[m]

YP1266

ORNL-DWG 87-7960

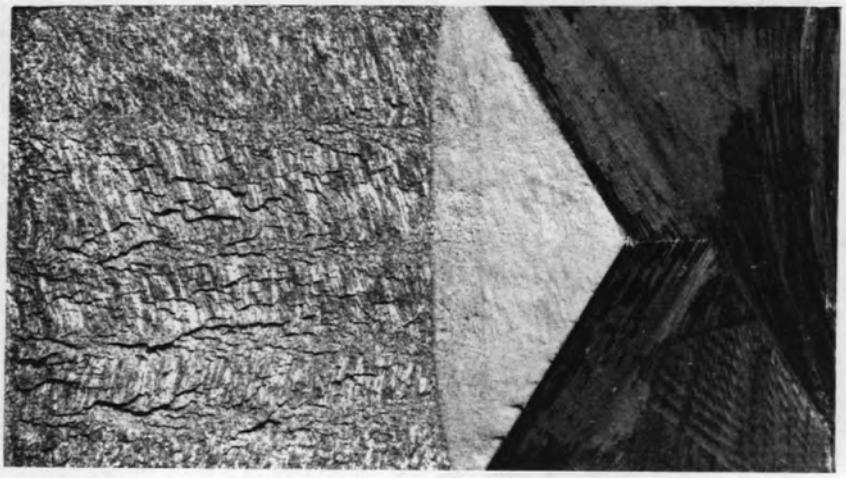


SPECIMEN ID= 70W103
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -135 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.9 mm a/W)i= .55
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 652 MPa
FLOW STRENGTH= 718 MPa
ESTIMATED YOUNG'S MODULUS= 215 GPa

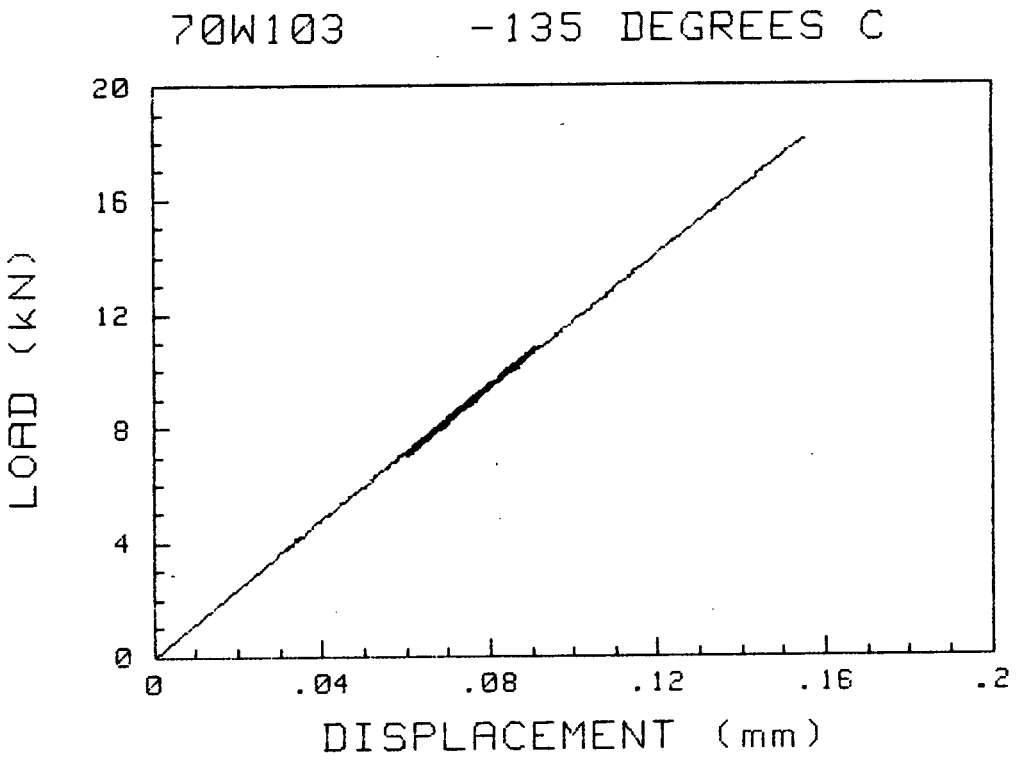
SPECIMEN CLEAVED AT KIc= 35.9 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 5.5 kJ/m^2	J-INTEGRAL= 5.5 kJ/m^2
KJc= 34.2 MPa SQR[m]	KJc= 34.2 MPa SQR[m]
K-beta-c= 34 MPa SQR[m]	K-beta-c= 34 MPa SQR[m]

YP1257



ORNL-DWG 87-7961



SPECIMEN ID= 70W114
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 27.9 mm a/W)i= .552
MEASURED DUCTILE DELTA-A= 3.27 mm
YIELD STRENGTH= 436 MPa
FLOW STRENGTH= 494 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 190.4 kJ/m^2
KJ-MAX LOAD= 195.3 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 164 kJ/m^2
K-JIc= 181.3 MPa SQR[m]
POWER= .5312
COEFFICIENT= 302.5 kJ/m^2
T (AVERAGE)= 130

ASTM LINEAR PROCEDURE

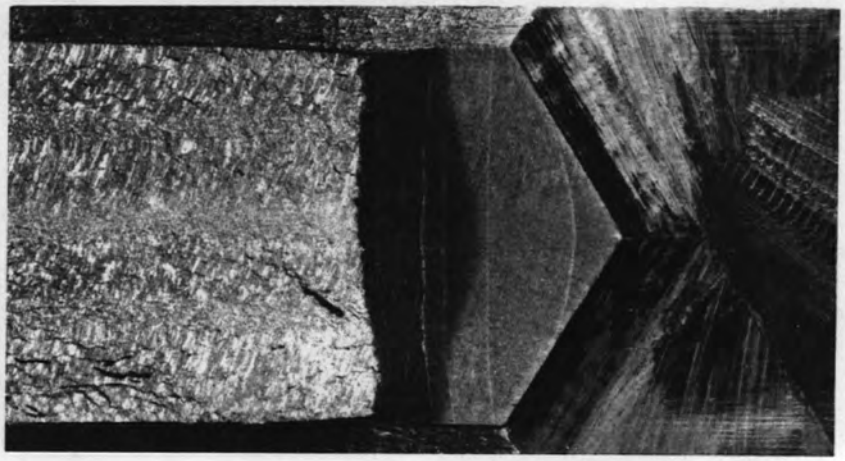
JIc= 147.6 kJ/m^2
K-JIc= 171.9 MPa SQR[m]
SLOPE= 171413 kJ/m^3
INTERCEPT= 122 kJ/m^2
T (ASTM)= 140
VALID, E813

JI-R CURVE CALCULATIONS

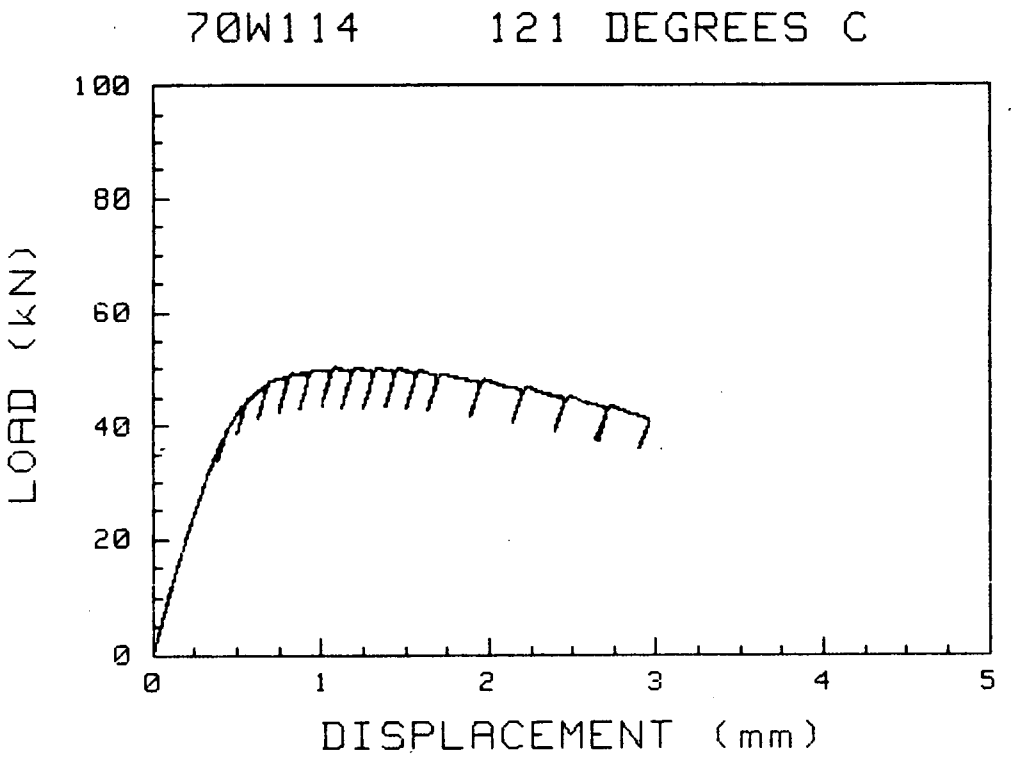
J (@J/T=8.8)= 617.4 kJ/m^2
POWER= .5299
J-MAX ALLOWED= 502.5 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 303.5 kJ/m^2
DELTA-A MAX ALLOWED= 2.27 mm

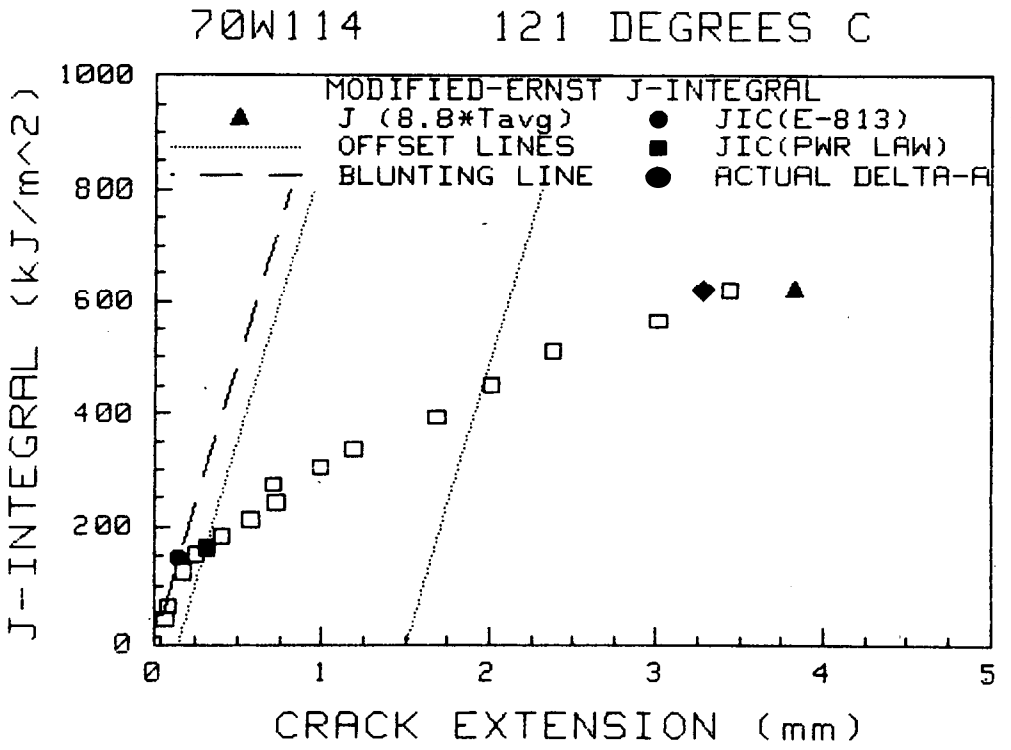
YP1250



ORNL-DWG 87-7962



ORNL-DWG 87-7963



SPECIMEN ID= 70W116
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 28.1 mm a/W)i= .553
MEASURED DUCTILE DELTA-A= 3.8 mm
YIELD STRENGTH= 442 MPa
FLOW STRENGTH= 511 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 188.9 kJ/m^2
KJ-MAX LOAD= 189.9 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 125.8 kJ/m^2
K-JIc= 154.9 MPa SQR[m]
POWER= .4664
COEFFICIENT= 230.5 kJ/m^2
T (AVERAGE)= 81

ASTM LINEAR PROCEDURE

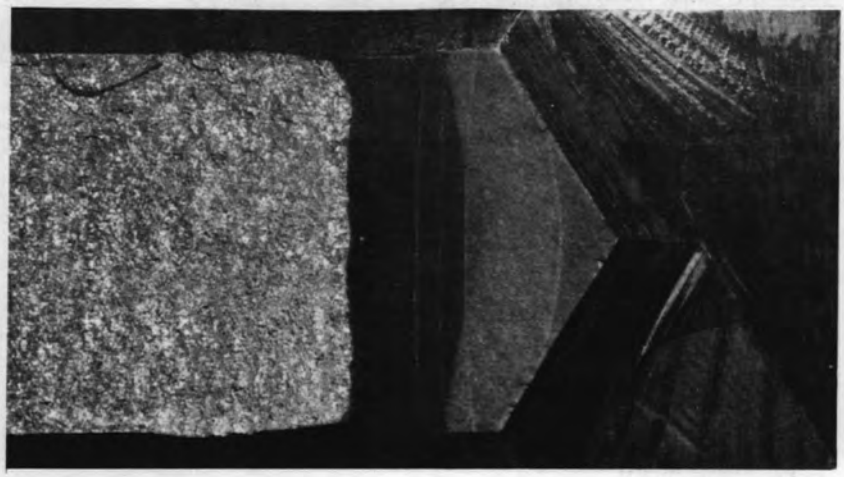
JIc= 115 kJ/m^2
K-JIc= 148.2 MPa SQR[m]
SLOPE= 121180 kJ/m^3
INTERCEPT= 101.4 kJ/m^2
T (ASTM)= 88
VALID, E813

JI-R CURVE CALCULATIONS

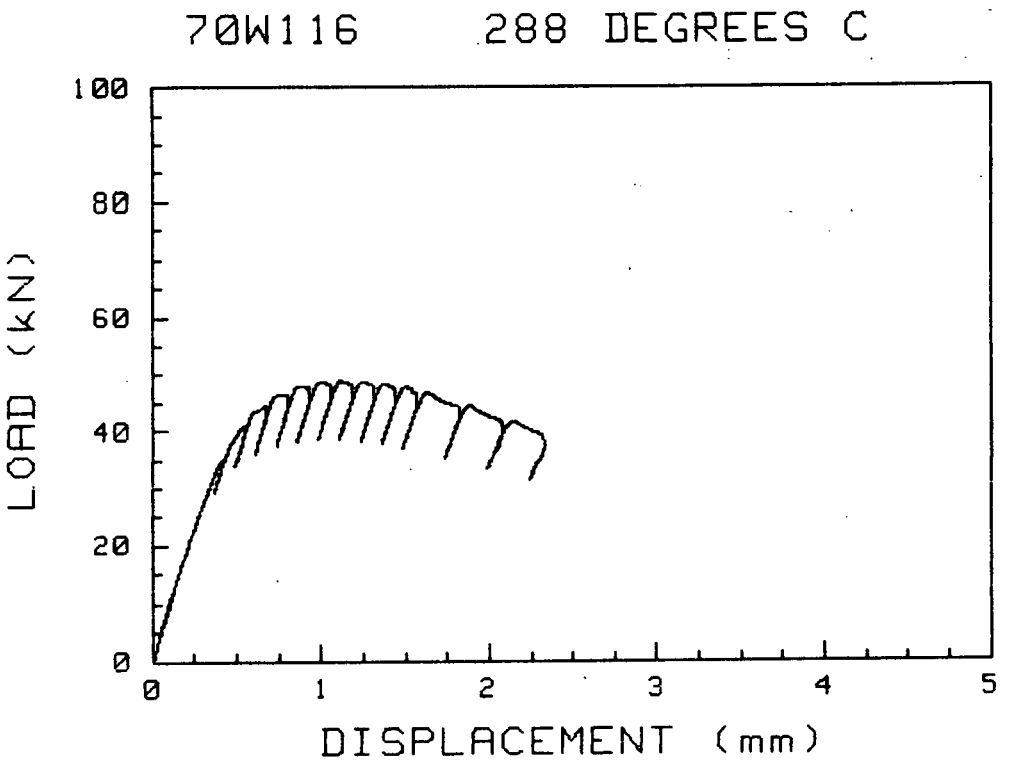
J (@J/T=8.8)= 398.7 kJ/m^2
POWER= .4833
J-MAX ALLOWED= 519.4 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 230.6 kJ/m^2
DELTA-A MAX ALLOWED= 2.27 mm

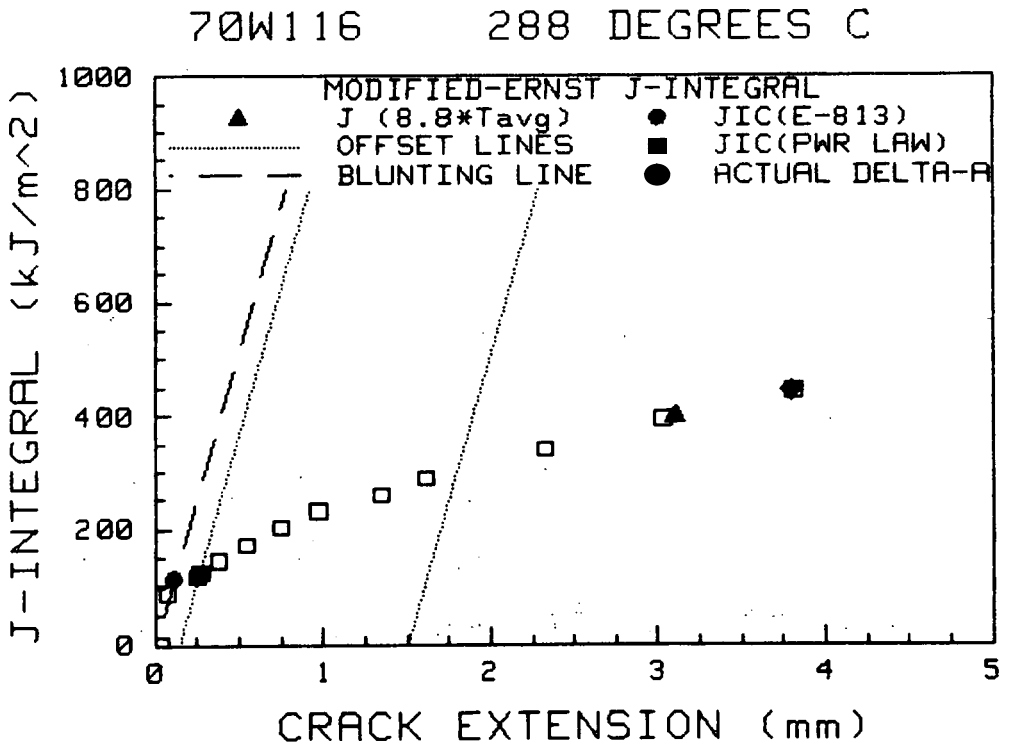
YP1249



ORNL-DWG 87-7964



ORNL-DWG 87-7965

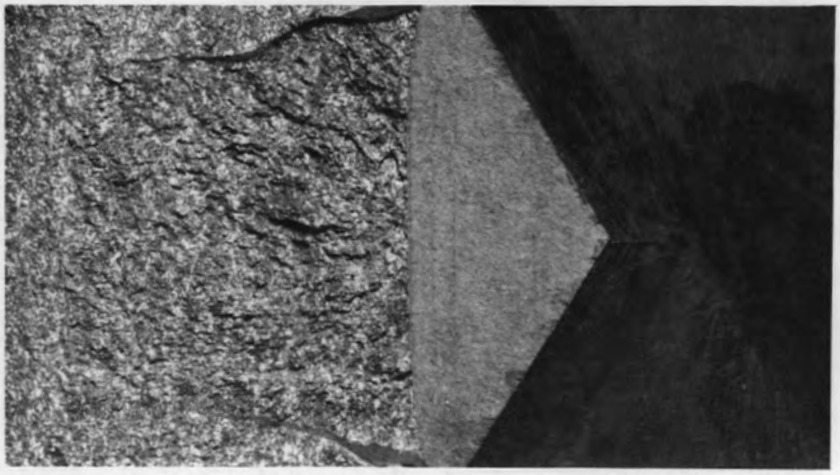


SPECIMEN ID= 70W120
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -40 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 28 mm a/W)i= .552
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 540 MPa
FLOW STRENGTH= 600 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

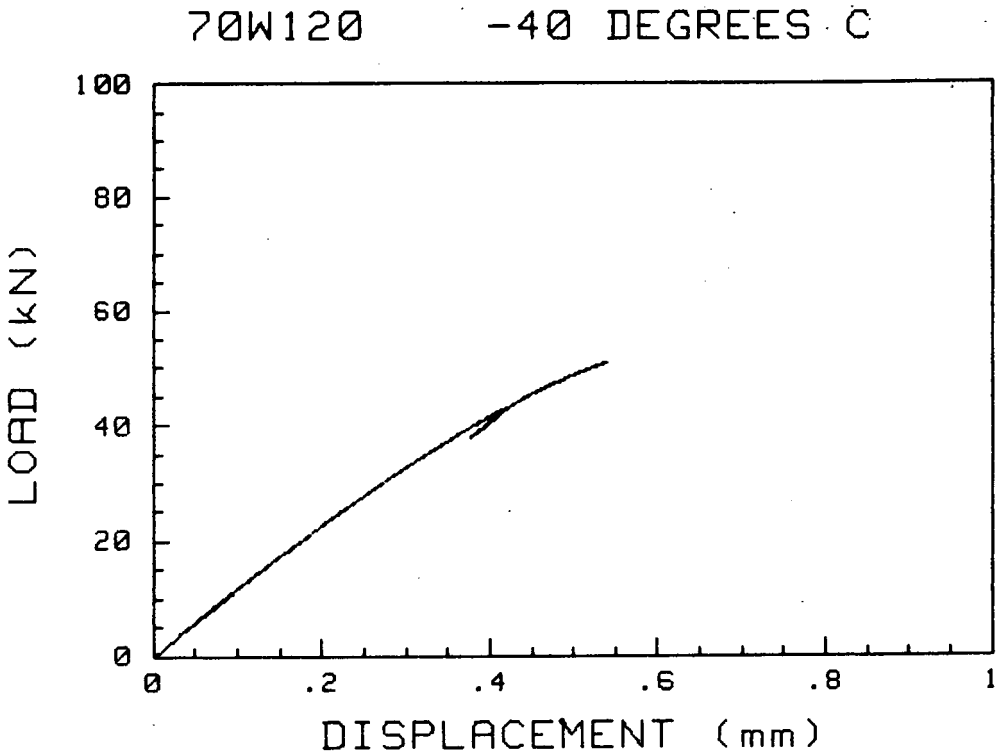
SPECIMEN CLEAVED AT K = 101.8 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 59.3 kJ/m^2	J-INTEGRAL= 59.3 kJ/m^2
KJc= 111.4 MPa SQR[m]	KJc= 111.4 MPa SQR[m]
K-beta-c= 79 MPa SQR[m]	K-beta-c= 79 MPa SQR[m]

YP1258



ORNL-DWG 87-7966

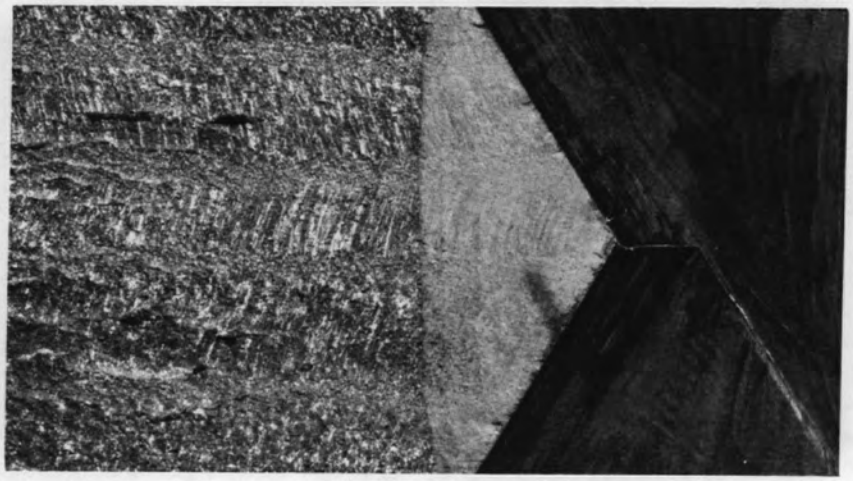


SPECIMEN ID= 70W127
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -135 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.9 mm a/W)i= .549
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 652 MPa
FLOW STRENGTH= 718 MPa
ESTIMATED YOUNG'S MODULUS= 215 GPa

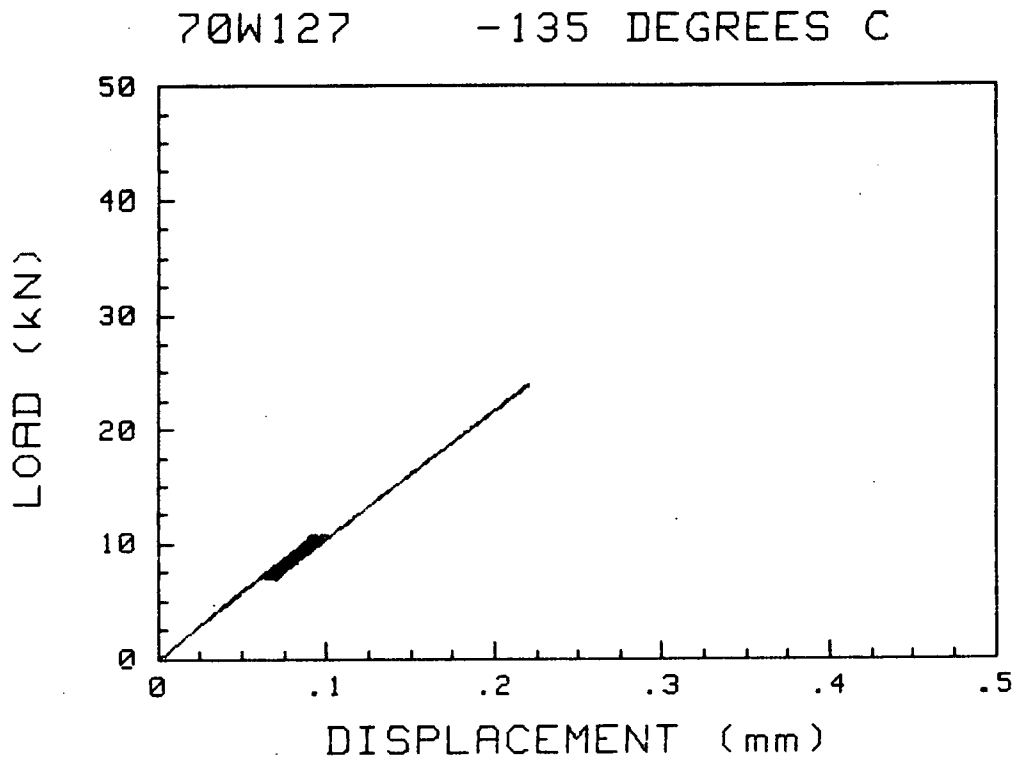
SPECIMEN CLEAVED AT KIc= 47.3 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 10 kJ/m^2	J-INTEGRAL= 10 kJ/m^2
KJc= 46.4 MPa SQR[m]	KJc= 46.4 MPa SQR[m]
K-beta-c= 45.3 MPa SQR[m]	K-beta-c= 45.3 MPa SQR[m]

YP1259



ORNL-DWG 87-7967



SPECIMEN ID= 70W135
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 27.8 mm a/W)i= .548
MEASURED DUCTILE DELTA-A= 2.98 mm
YIELD STRENGTH= 436 MPa
FLOW STRENGTH= 494 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 224.2 kJ/m^2
KJ-MAX LOAD= 211.9 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 155.5 kJ/m^2
K-JIc= 176.5 MPa SQR[m]
POWER= .5925
COEFFICIENT= 312.9 kJ/m^2
T (AVERAGE)= 149

ASTM LINEAR PROCEDURE

JIc= 131.6 kJ/m^2
K-JIc= 162.4 MPa SQR[m]
SLOPE= 194013 kJ/m^3
INTERCEPT= 105.8 kJ/m^2
T (ASTM)= 159
VALID, E813

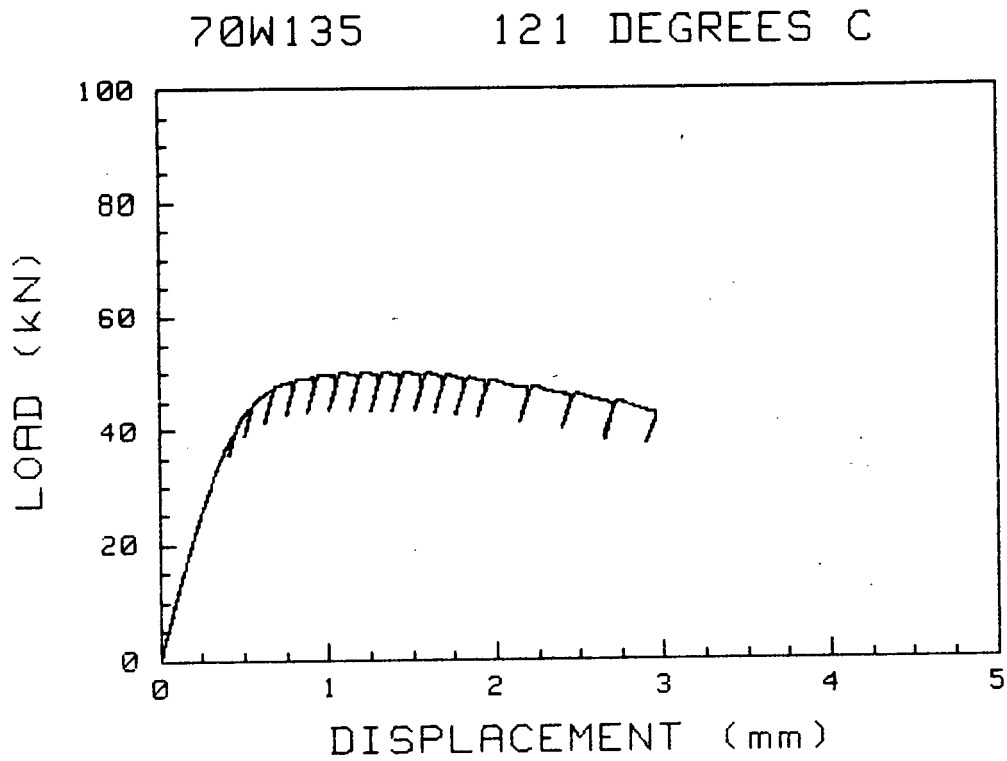
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 751.5 kJ/m^2
POWER= .6021
J-MAX ALLOWED= 502.5 kJ/m^2
VALID R-CURVE

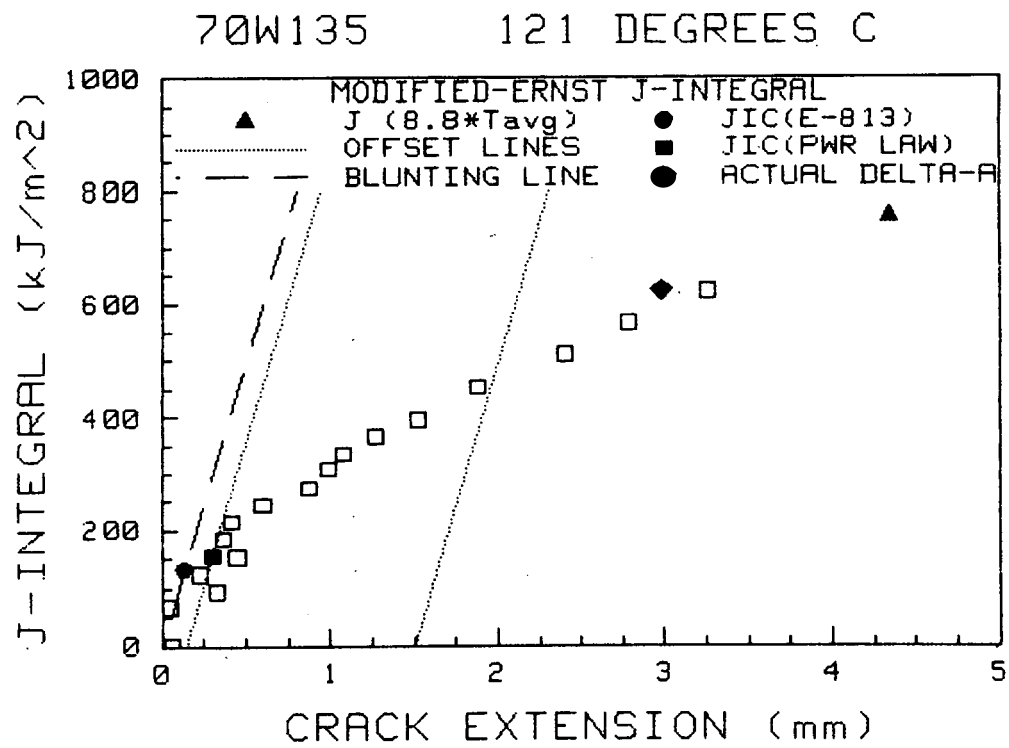
COEFFICIENT= 310.4 kJ/m^2
DELTA-A MAX ALLOWED= 2.29 mm

YP1251

ORNL-DWG 87-7968



ORNL-DWG 87-7969

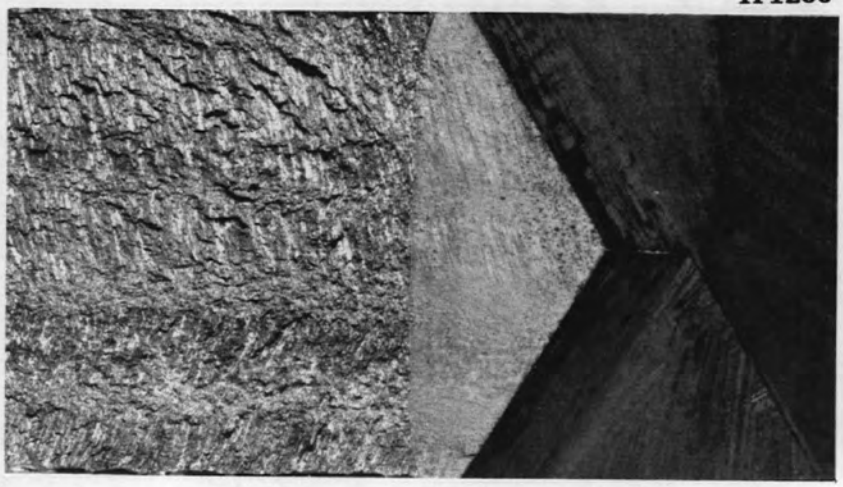


SPECIMEN ID= 70W143
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -65 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.7 mm a/W)i= .546
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 566 MPa
FLOW STRENGTH= 627 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

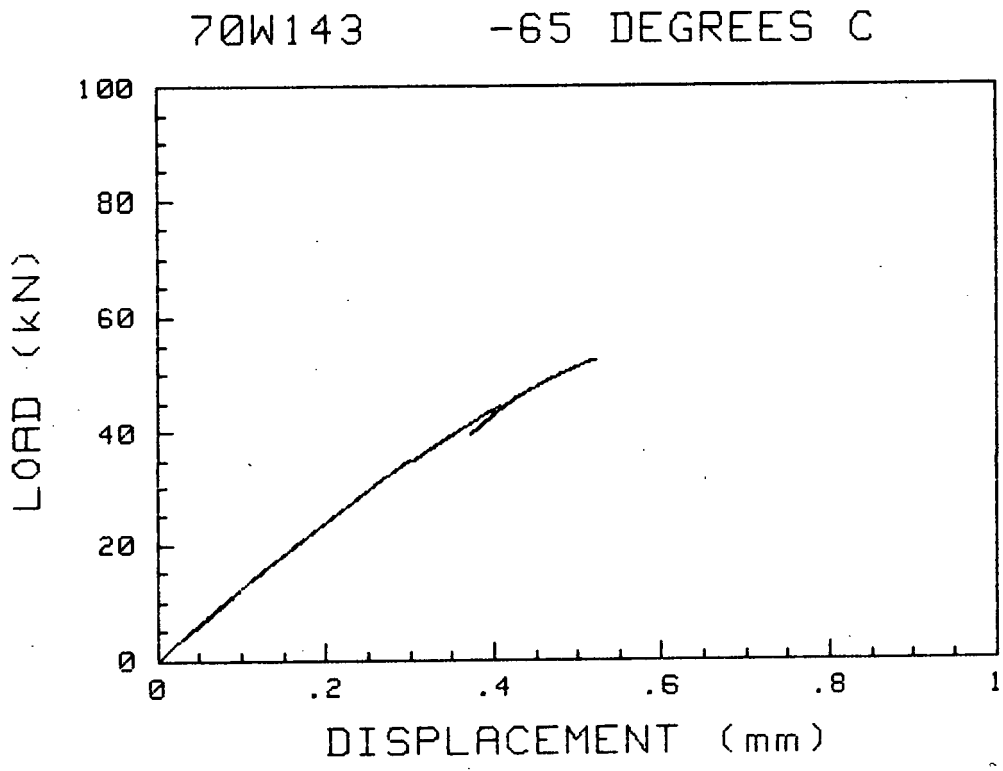
SPECIMEN CLEAVED AT K = 103.1 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 58.1 kJ/m^2	J-INTEGRAL= 58.1 kJ/m^2
KJc= 110.7 MPa SQR[m]	KJc= 110.7 MPa SQR[m]
K-beta-c= 80.5 MPa SQR[m]	K-beta-c= 80.5 MPa SQR[m]

YP1260



ORNL-DWG 87-7970



SPECIMEN ID= 70W144
TEST TEMPERATURE= 204 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 28.1 mm a/W)i= .553
MEASURED DUCTILE DELTA-A= 2.81 mm
YIELD STRENGTH= 424 MPa
FLOW STRENGTH= 487 MPa
ESTIMATED YOUNG'S MODULUS= 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 159.2 kJ/m^2
KJ-MAX LOAD= 176.4 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 132.1 kJ/m^2
K-JIc= 160.7 MPa SQR[m]
POWER= .5724
COEFFICIENT= 270.6 kJ/m^2
T (AVERAGE)= 128

ASTM LINEAR PROCEDURE

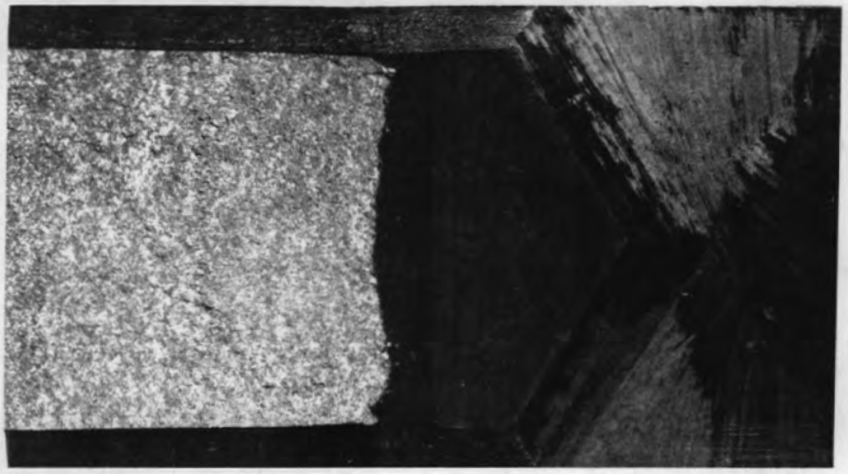
JIc= 118.4 kJ/m^2
K-JIc= 152.2 MPa SQR[m]
SLOPE= 161461 kJ/m^3
INTERCEPT= 98.8 kJ/m^2
T (ASTM)= 133
VALID, E813

JI-R CURVE CALCULATIONS

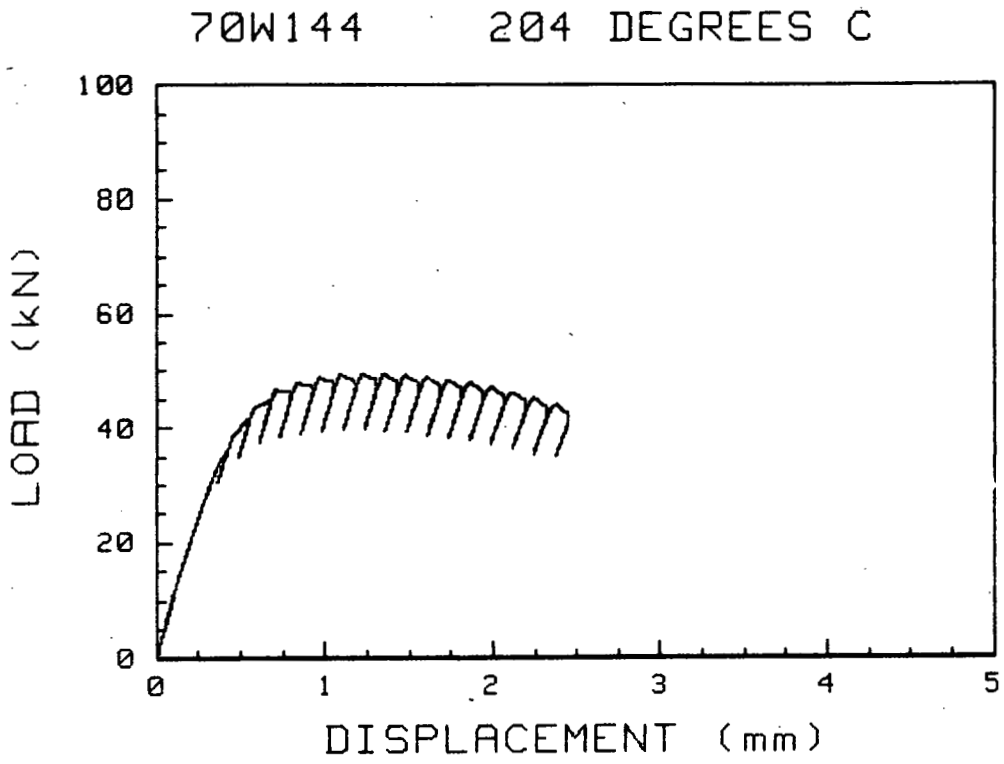
J (@J/T=8.8)= 566.3 kJ/m^2
POWER= .5415
J-MAX ALLOWED= 494.7 kJ/m^2
RCURVE INVALID, 1

COEFFICIENT= 269.7 kJ/m^2
DELTA-A MAX ALLOWED= 2.27 mm

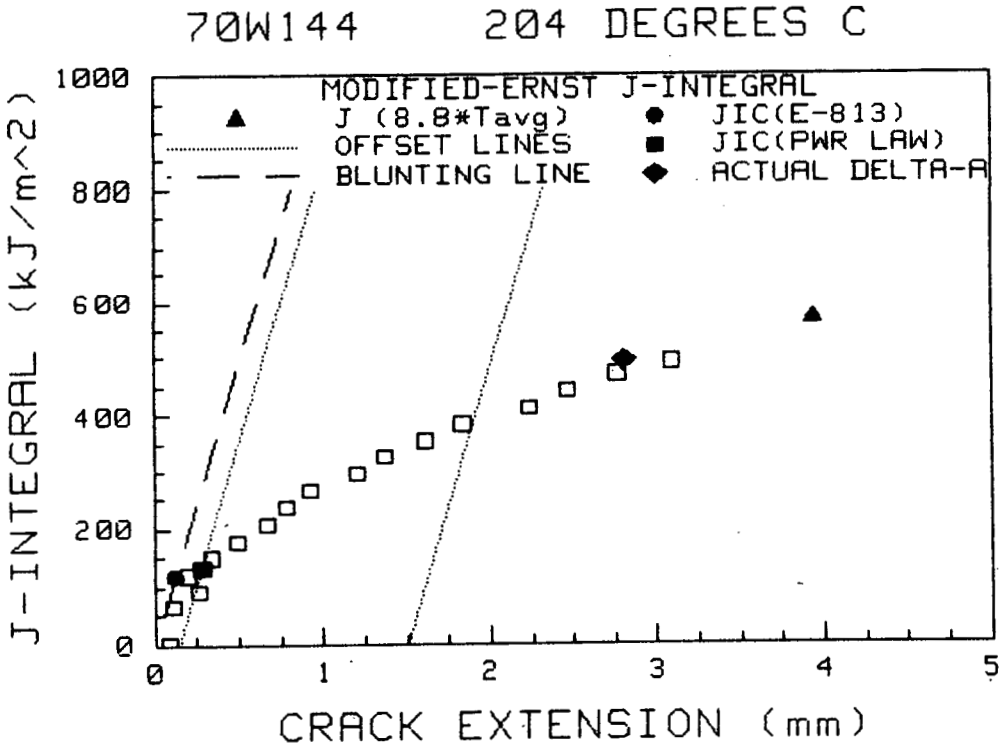
YP1252



ORNL-DWG 87-7971



ORNL-DWG 87-7972



SPECIMEN ID= 70W147
TEST TEMPERATURE= 204 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 28 mm a/W)i= .553
MEASURED DUCTILE DELTA-A= 3.01 mm
YIELD STRENGTH= 424 MPa
FLOW STRENGTH= 487 MPa
ESTIMATED YOUNG'S MODULUS= 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 216.9 kJ/m^2
KJ-MAX LOAD= 205.9 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 137.6 kJ/m^2
K-JIc= 164 MPa SQR[m]
POWER= .4989
COEFFICIENT= 254.6 kJ/m^2
T (AVERAGE)= 106

ASTM LINEAR PROCEDURE

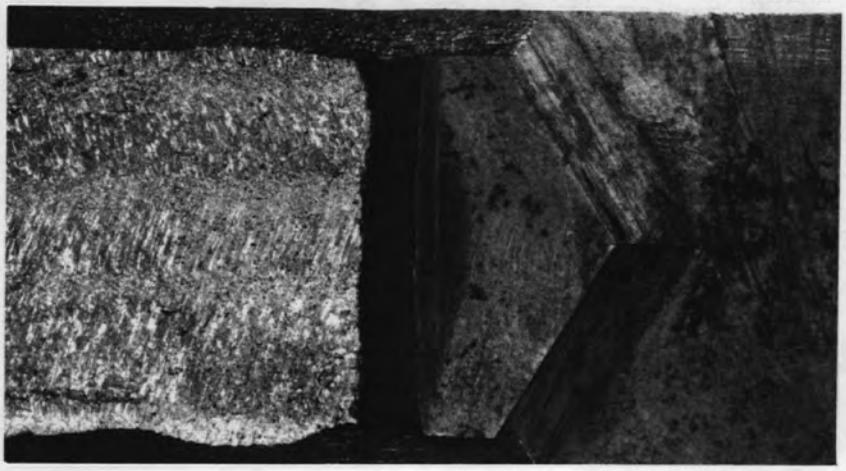
JIc= 128.8 kJ/m^2
K-JIc= 158.7 MPa SQR[m]
SLOPE= 133223 kJ/m^3
INTERCEPT= 111.2 kJ/m^2
T (ASTM)= 110
VALID, E813

JI-R CURVE CALCULATIONS

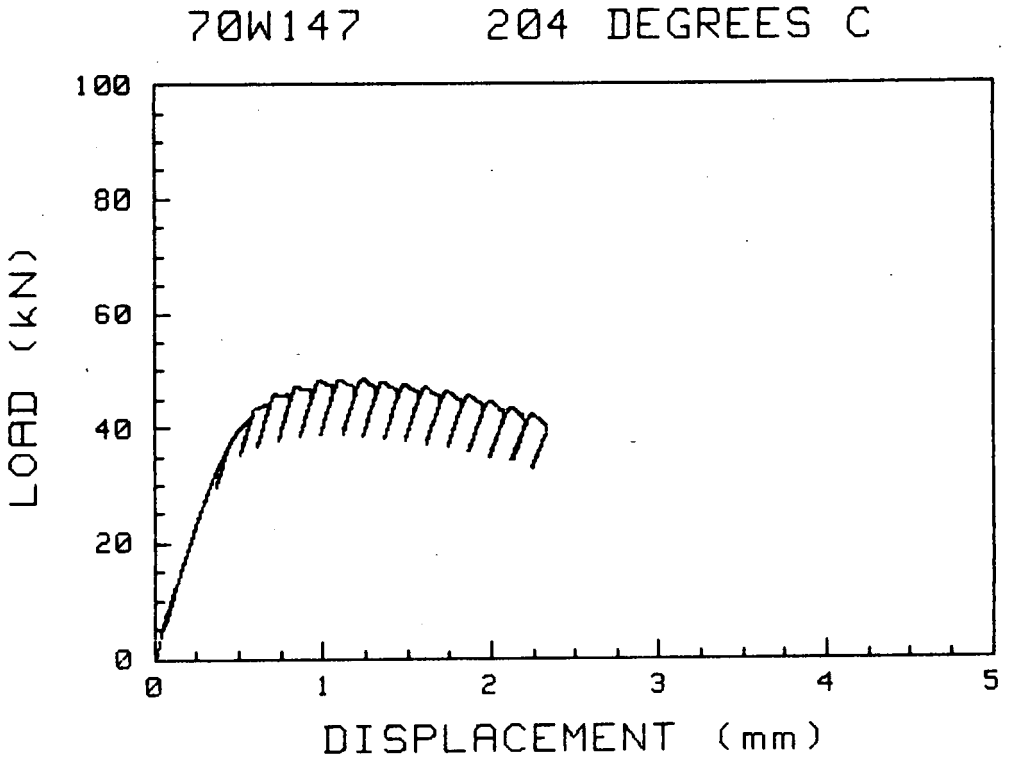
J (@J/T=8.8)= 445 kJ/m^2
POWER= .4565
J-MAX ALLOWED= 494.2 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 257.4 kJ/m^2
DELTA-A MAX ALLOWED= 2.27 mm

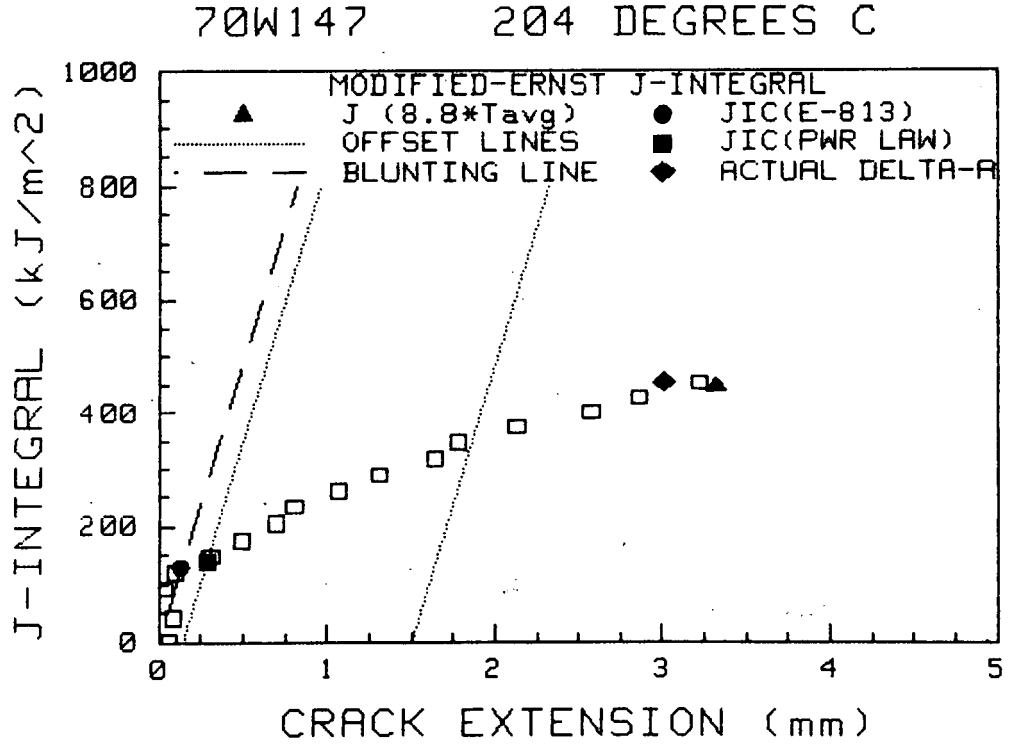
YP1253



ORNL-DWG 87-7973



ORNL-DWG 87-7974



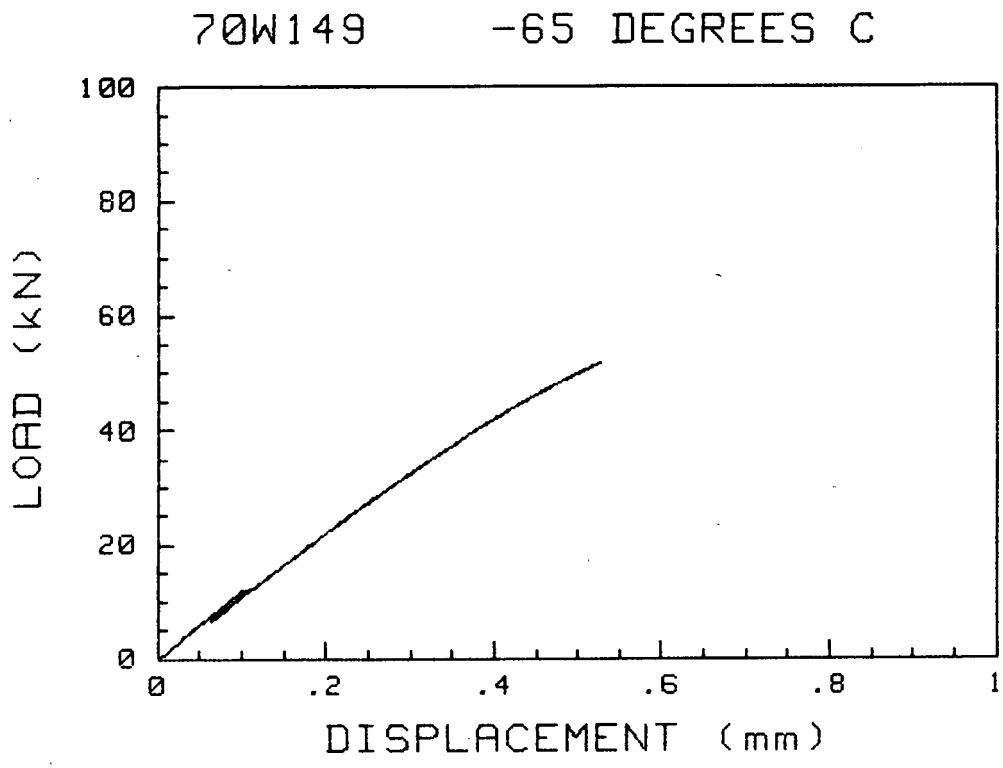
SPECIMEN ID= 70W149
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -65 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.7 mm a/W)i= .546
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 566 MPa
FLOW STRENGTH= 627 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

SPECIMEN CLEAVED AT K = 101.3 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 56 kJ/m^2	J-INTEGRAL= 56 kJ/m^2
KJc= 108.7 MPa SQR[m]	KJc= 108.7 MPa SQR[m]
K-beta-c= 79.8 MPa SQR[m]	K-beta-c= 79.8 MPa SQR[m]

YP1261

ORNL-DWG 87-7975



SPECIMEN ID= 70W150
TEST TEMPERATURE= 50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 27.5 mm a/W)i= .543
MEASURED DUCTILE DELTA-A= 2.99 mm
YIELD STRENGTH= 468 MPa
FLOW STRENGTH= 526 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 255 kJ/m^2
KJ-MAX LOAD= 228.3 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 151.3 kJ/m^2
K-JIc= 175.8 MPa SQR[m]
POWER= .675
COEFFICIENT= 345.8 kJ/m^2
T (AVERAGE)= 169

ASTM LINEAR PROCEDURE

JIc= 107.5 kJ/m^2
K-JIc= 148.2 MPa SQR[m]
SLOPE= 254126 kJ/m^3
INTERCEPT= 81.5 kJ/m^2
T (ASTM)= 188
VALID, E813

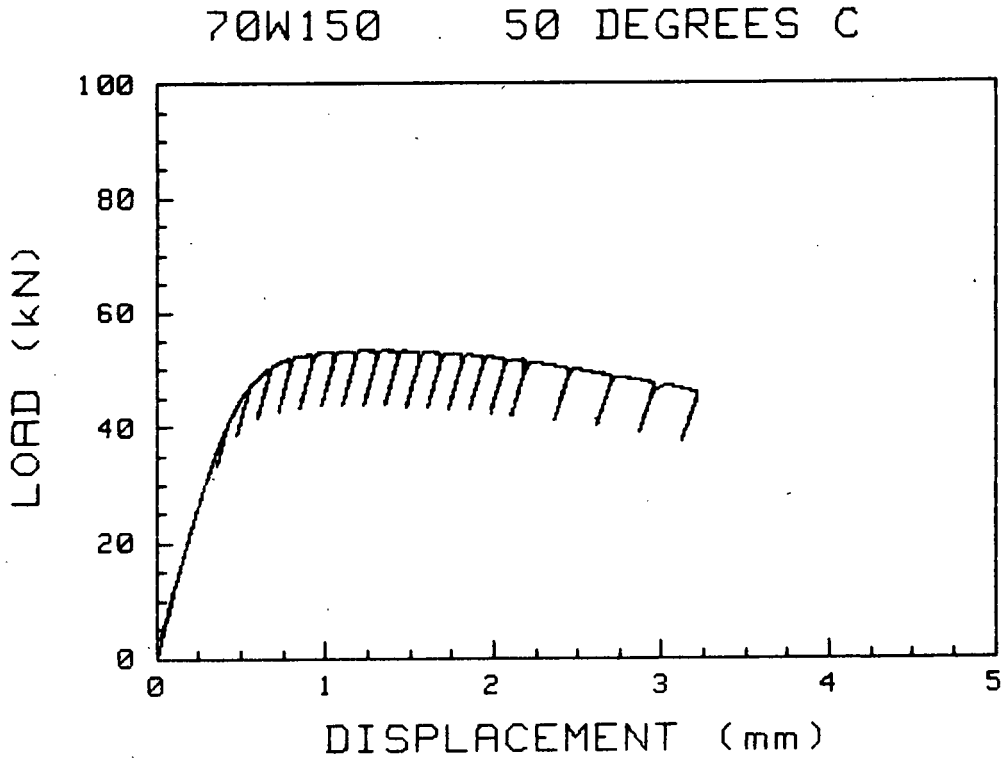
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 925.4 kJ/m^2
POWER= .671
J-MAX ALLOWED= 534.6 kJ/m^2
RCURVE INVALID, 3

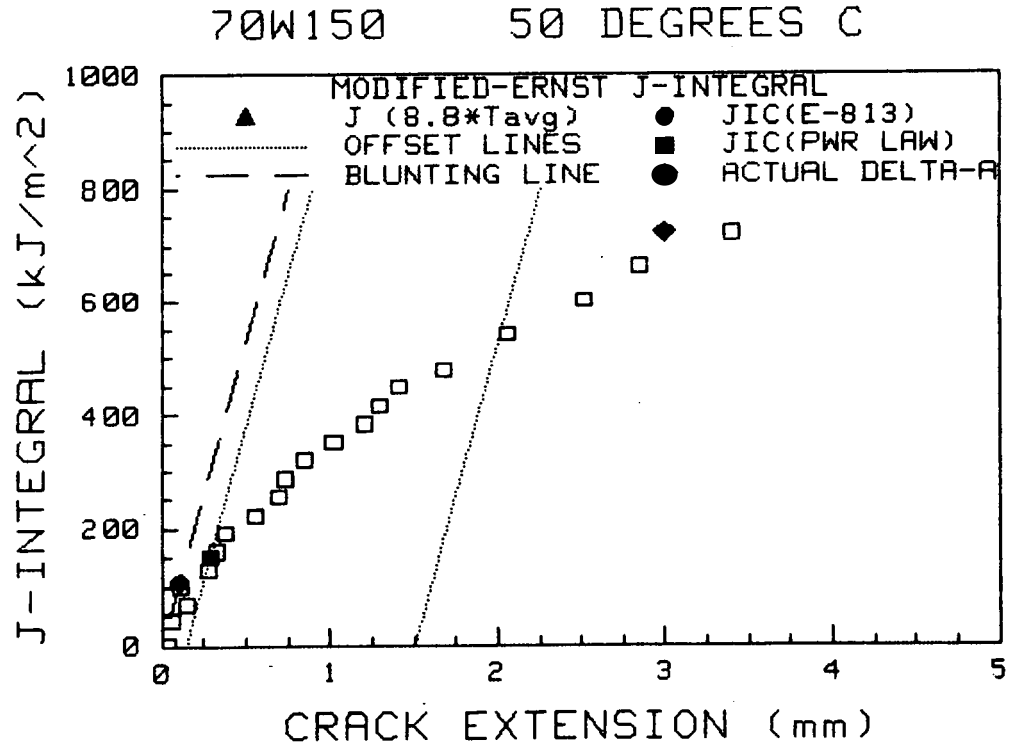
COEFFICIENT= 344.6 kJ/m^2
DELTA-A MAX ALLOWED= 2.32 mm

YP1254

ORNL-DWG 87-7976



ORNL-DWG 87-7977



SPECIMEN ID= 70W152
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 27.6 mm a/W)i= .545
MEASURED DUCTILE DELTA-A= 3.05 mm
YIELD STRENGTH= 442 MPa
FLOW STRENGTH= 511 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 184.7 kJ/m^2
KJ-MAX LOAD= 187.7 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 122.1 kJ/m^2
K-JIc= 152.7 MPa SQR[m]
POWER= .5059
COEFFICIENT= 237.1 kJ/m^2
T (AVERAGE)= 90

ASTM LINEAR PROCEDURE

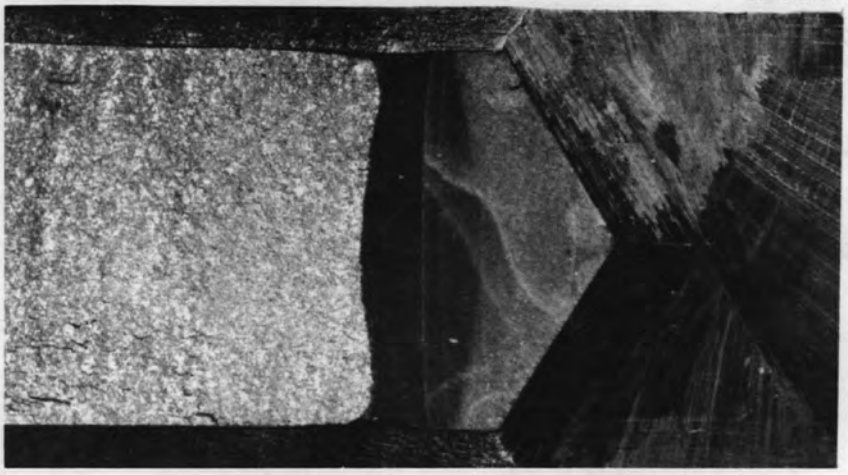
JIc= 114.6 kJ/m^2
K-JIc= 147.8 MPa SQR[m]
SLOPE= 127306 kJ/m^3
INTERCEPT= 100.3 kJ/m^2
T (ASTM)= 93
VALID, E813

JI-R CURVE CALCULATIONS

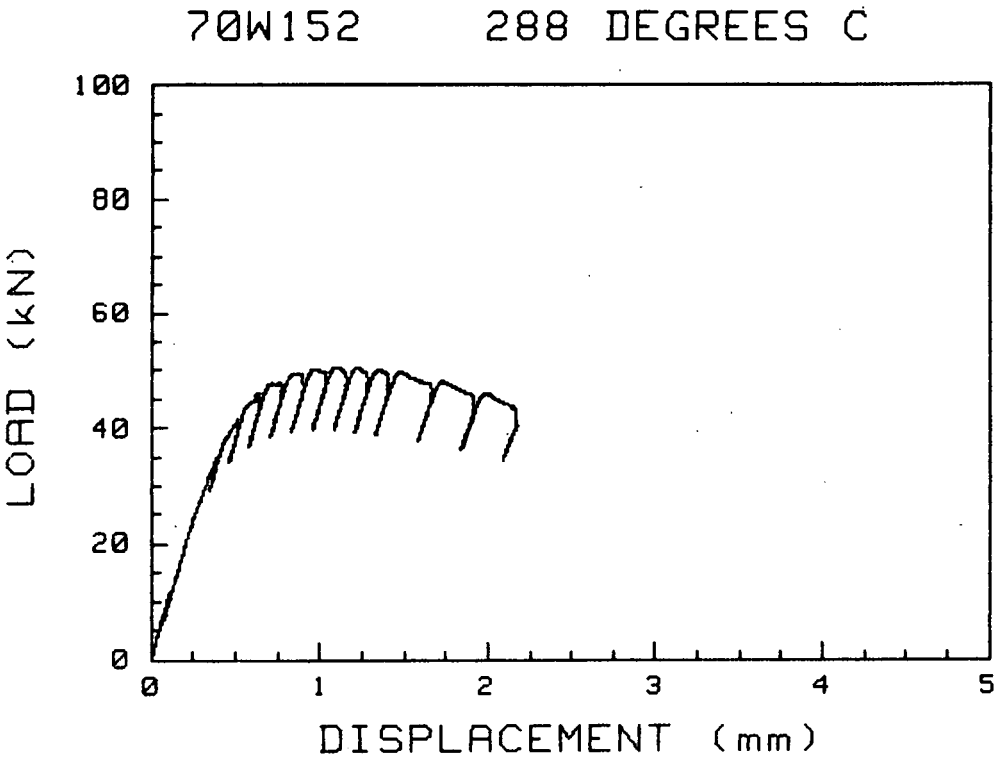
J (@J/T=8.8)= 403.9 kJ/m^2
POWER= .4776
J-MAX ALLOWED= 519.6 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 236.4 kJ/m^2
DELTA-A MAX ALLOWED= 2.31 mm

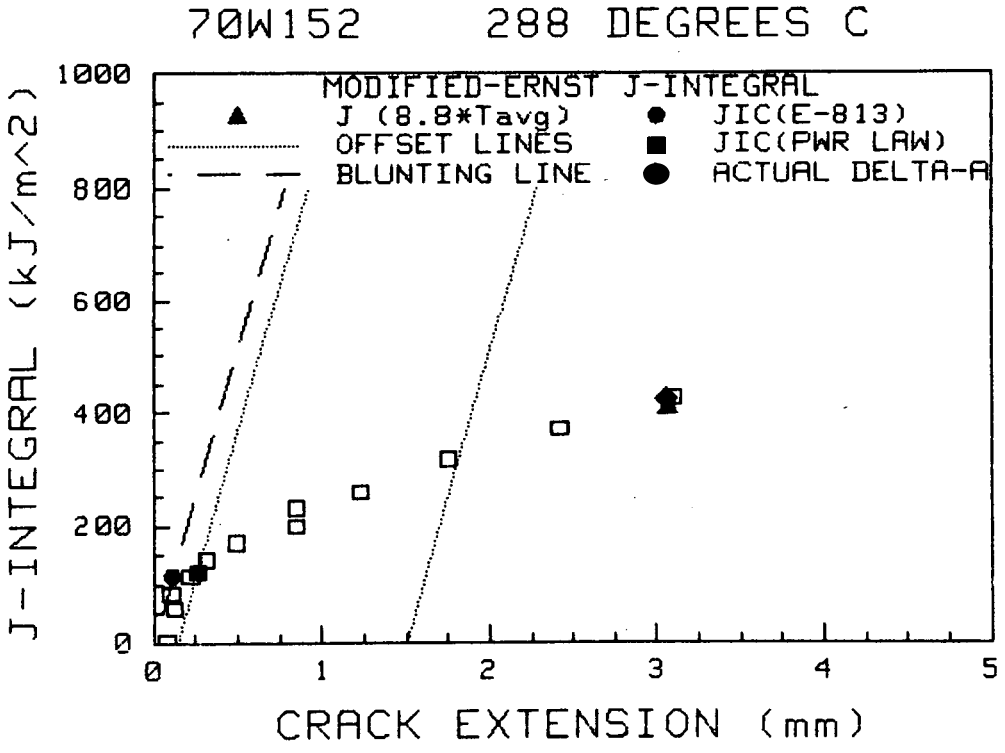
YP1255



ORNL-DWG 87-7978



ORNL-DWG 87-7979



SPECIMEN ID= 71W103
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 28.2 mm a/W)i= .556
MEASURED DUCTILE DELTA-A= 3.33 mm
YIELD STRENGTH= 424 MPa
FLOW STRENGTH= 489 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 188 kJ/m^2
KJ-MAX LOAD= 194.1 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 125.9 kJ/m^2
K-JIc= 158.8 MPa SQR[m]
POWER= .5307
COEFFICIENT= 248 kJ/m^2
T (AVERAGE)= 112

ASTM LINEAR PROCEDURE

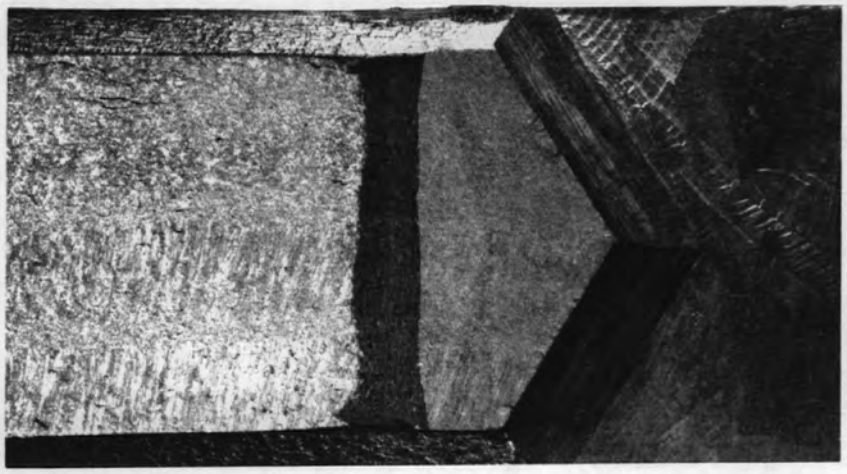
JIc= 130.8 kJ/m^2
K-JIc= 161.9 MPa SQR[m]
SLOPE= 125341 kJ/m^3
INTERCEPT= 114.1 kJ/m^2
T (ASTM)= 105
VALID, E813

JI-R CURVE CALCULATIONS

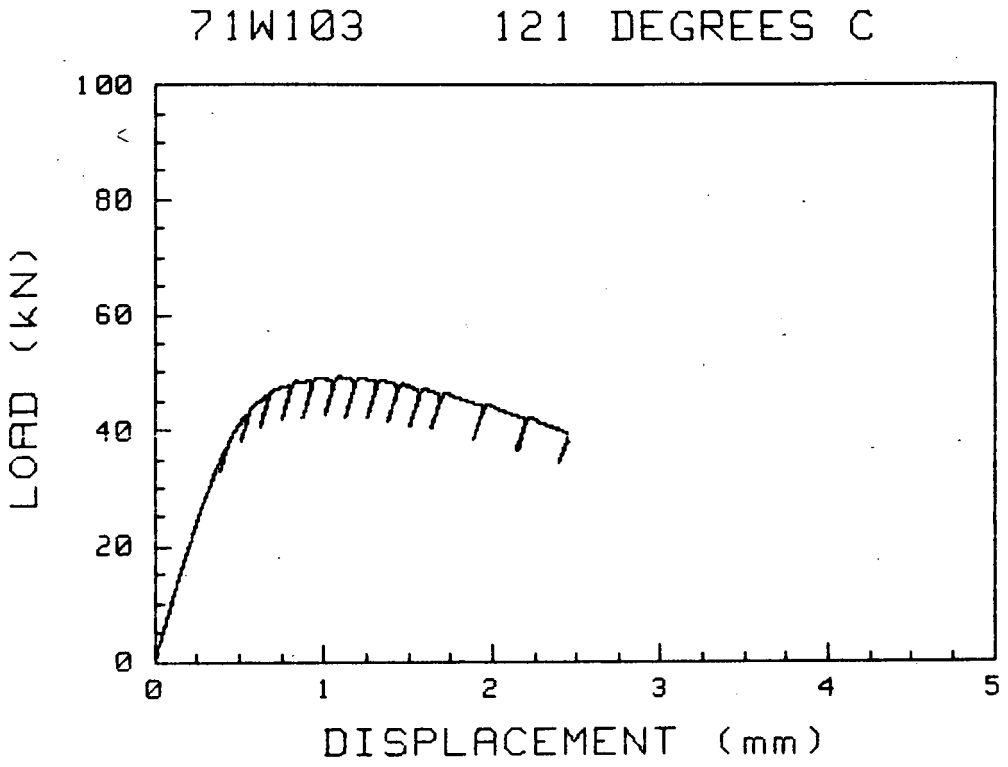
J (@J/T=8.8)= 424.8 kJ/m^2
POWER= .4516
J-MAX ALLOWED= 497.1 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 246.9 kJ/m^2
DELTA-A MAX ALLOWED= 2.25 mm

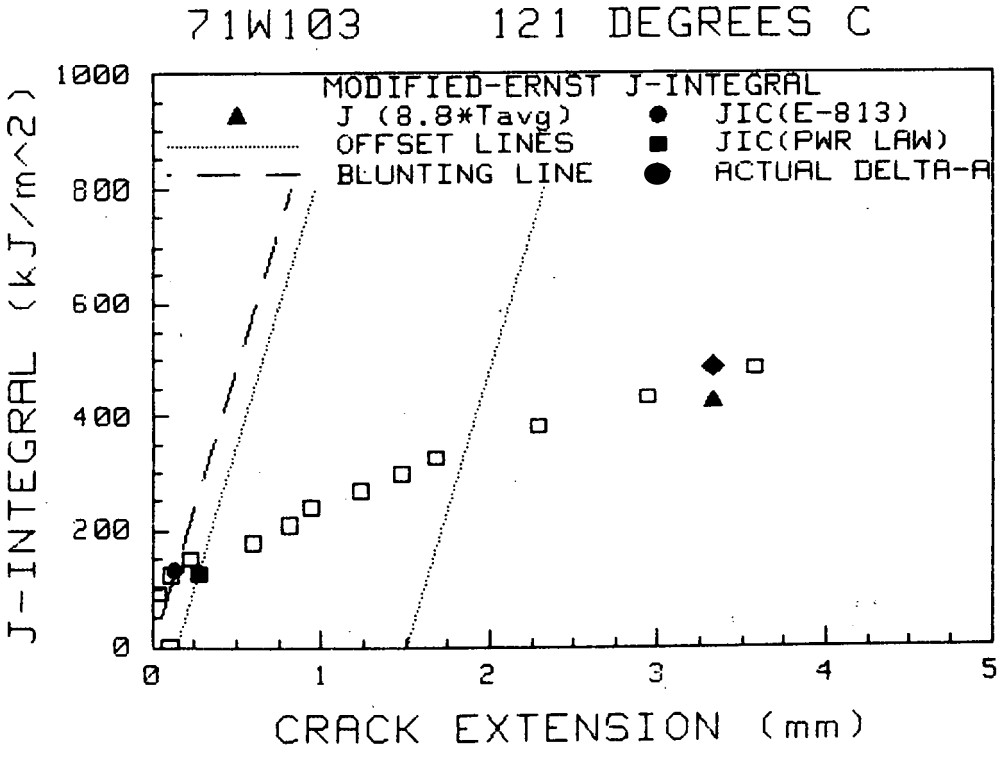
YP1256



ORNL-DWG 87-7980



ORNL-DWG 87-7981



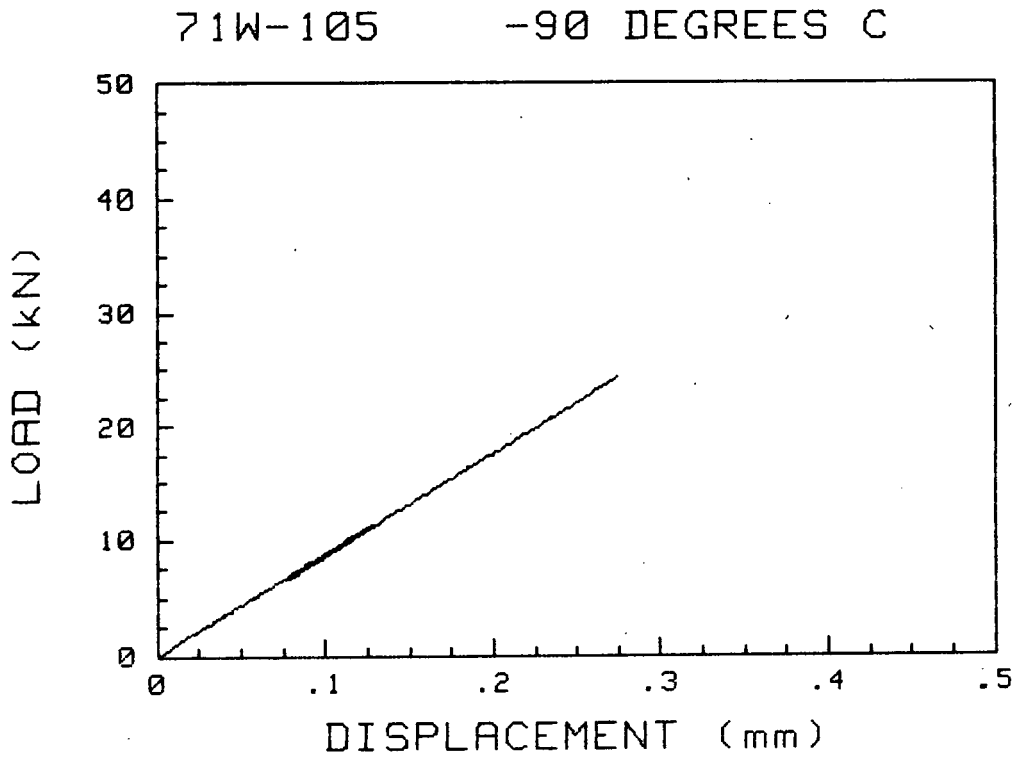
SPECIMEN ID= 71W-105
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -90 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.7 mm a/W)i= .547
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 656 MPa
FLOW STRENGTH= 690 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

SPECIMEN CLEAVED AT KIc= 47.8 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 12.6 kJ/m^2	J-INTEGRAL= 12.6 kJ/m^2
KJc= 51.7 MPa SQR[m]	KJc= 51.7 MPa SQR[m]
K-beta-c= 50 MPa SQR[m]	K-beta-c= 50 MPa SQR[m]

YP1262

ORNL-DWG 87-7982

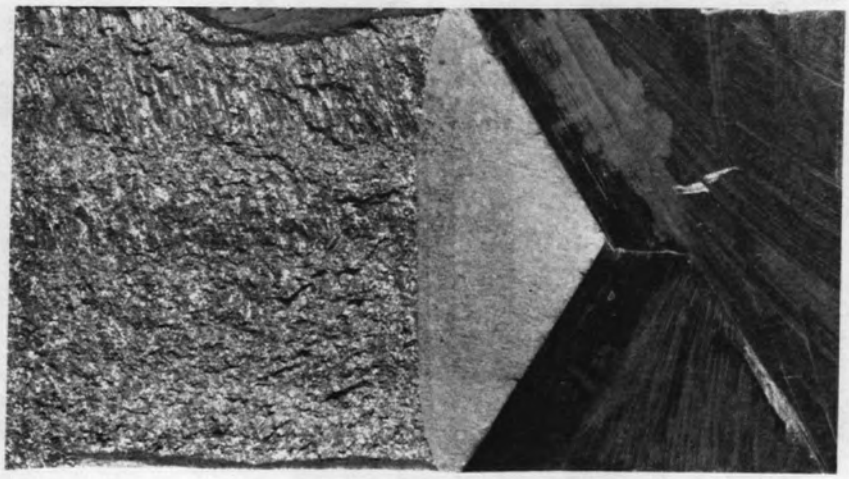


SPECIMEN ID= 71W107
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.6 mm a/W)i= .544
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 541 MPa
FLOW STRENGTH= 607 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

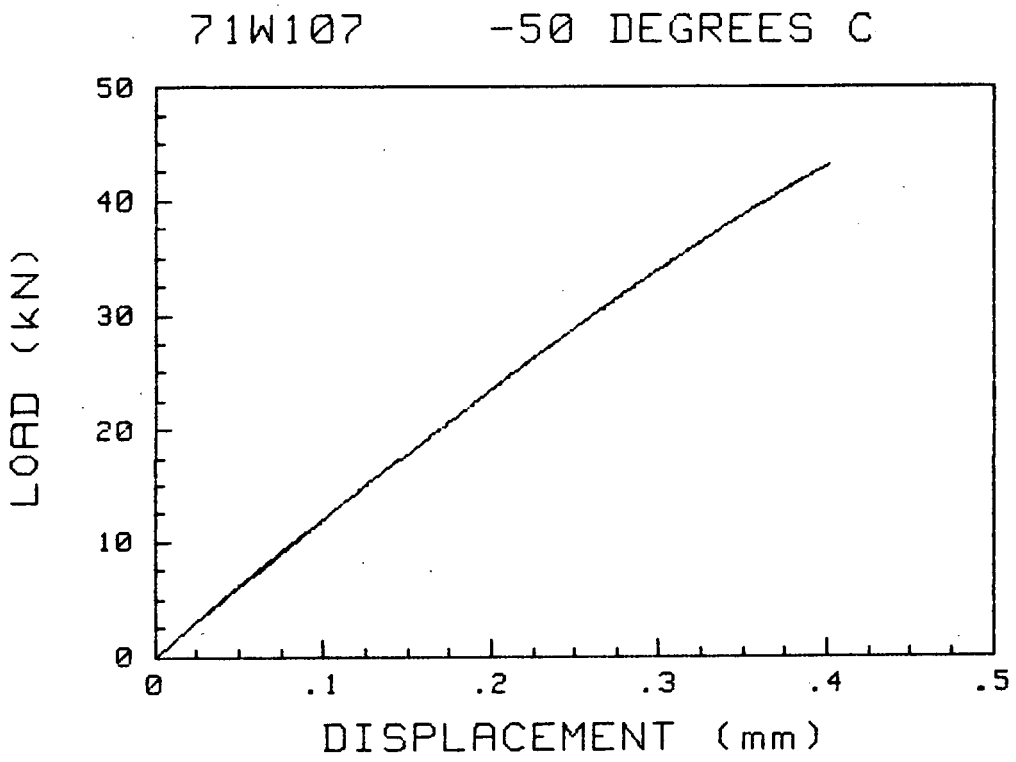
SPECIMEN CLEAVED AT K = 84.1 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 35.1 kJ/m^2	J-INTEGRAL= 35.1 kJ/m^2
KJc= 85.8 MPa SQR[m]	KJc= 85.8 MPa SQR[m]
K-beta-c= 68.6 MPa SQR[m]	K-beta-c= 68.6 MPa SQR[m]

YP1263



ORNL-DWG 87-7983



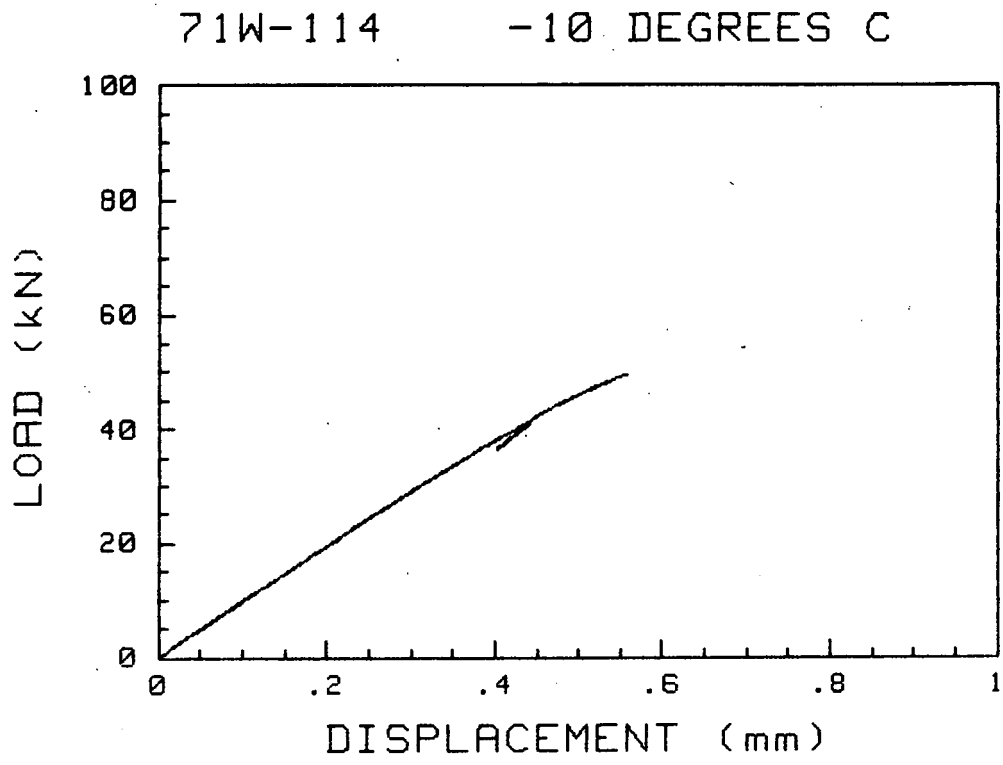
SPECIMEN ID= 71W-114
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -10 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 28.1 mm a/W)i= .553
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 502 MPa
FLOW STRENGTH= 567 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

SPECIMEN CLEAVED AT K = 99.5 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 58.8 kJ/m^2	J-INTEGRAL= 58.8 kJ/m^2
KJc= 110.6 MPa SQR[m]	KJc= 110.6 MPa SQR[m]
K-beta-c= 75.8 MPa SQR[m]	K-beta-c= 75.8 MPa SQR[m]

YP1264

ORNL-DWG 87-7984



SPECIMEN ID= 71W124
TEST TEMPERATURE= 50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 27.8 mm a/W)i= .549
MEASURED DUCTILE DELTA-A= 3.01 mm
YIELD STRENGTH= 457 MPa
FLOW STRENGTH= 521 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 228.4 kJ/m^2
KJ-MAX LOAD= 216.1 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 111.6 kJ/m^2
K-JIc= 151 MPa SQR[m]
POWER= .6774
COEFFICIENT= 280.2 kJ/m^2
T (AVERAGE)= 143

ASTM LINEAR PROCEDURE

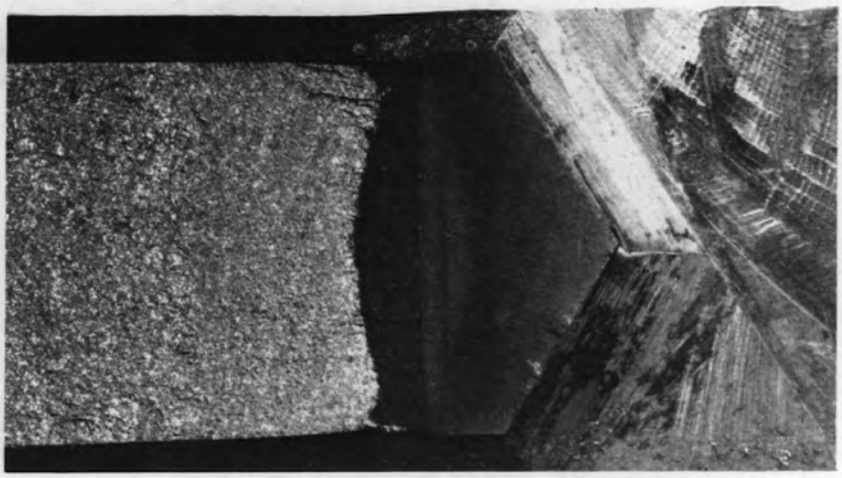
JIc= 99.2 kJ/m^2
K-JIc= 142.3 MPa SQR[m]
SLOPE= 191563 kJ/m^3
INTERCEPT= 80.9 kJ/m^2
T (ASTM)= 144
VALID, E813

JI-R CURVE CALCULATIONS

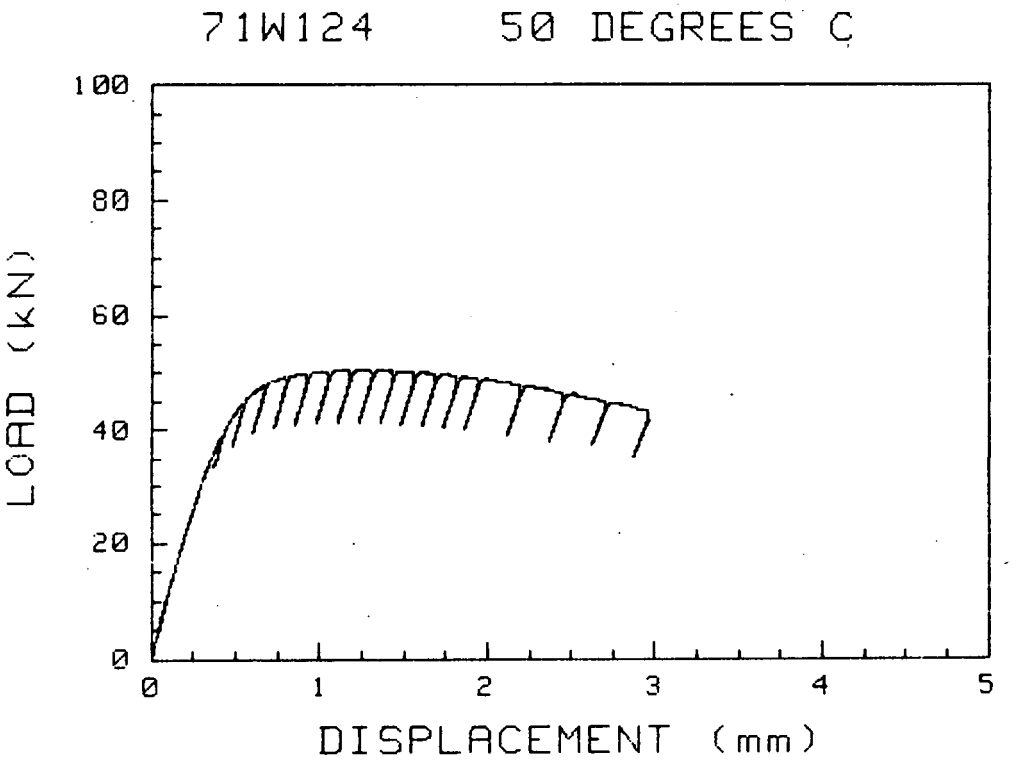
J (@J/T=8.8)= 763.7 kJ/m^2
POWER= .672
J-MAX ALLOWED= 529.8 kJ/m^2
RCURVE INVALID, 1 3

COEFFICIENT= 280.3 kJ/m^2
DELTA-A MAX ALLOWED= 2.29 mm

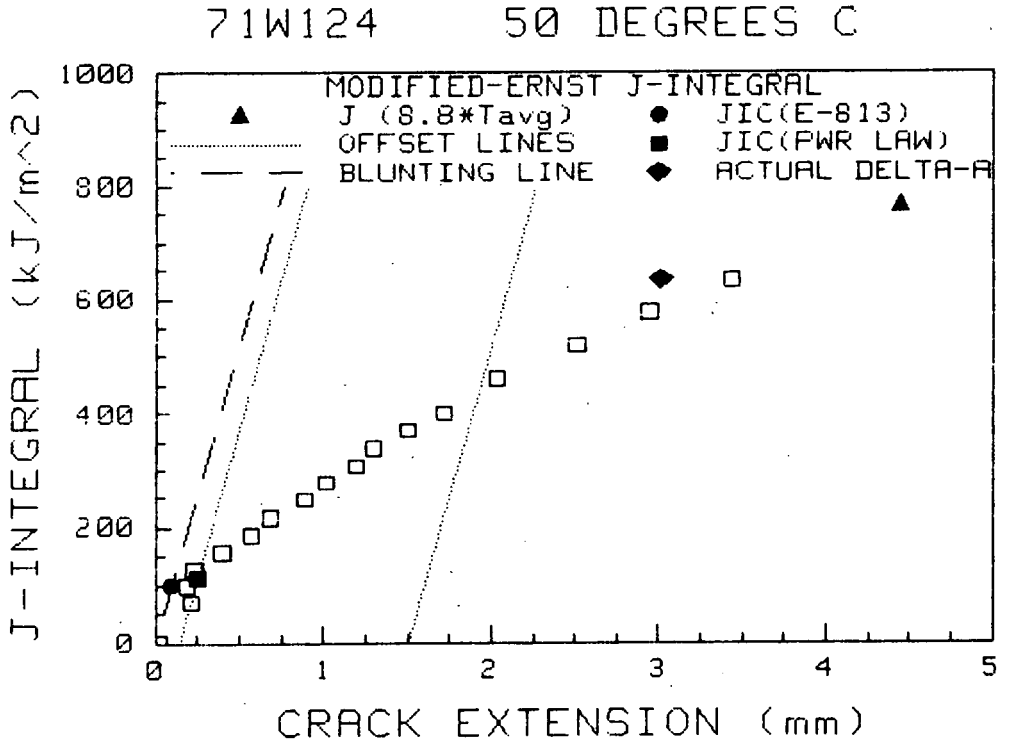
YP1291



ORNL-DWG 87-7985



ORNL-DWG 87-7986



SPECIMEN ID= 71W125
TEST TEMPERATURE= 204 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 28.1 mm a/W)i= .553
MEASURED DUCTILE DELTA-A= 3.19 mm
YIELD STRENGTH= 415 MPa
FLOW STRENGTH= 482 MPa
ESTIMATED YOUNG'S MODULUS= 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 158.4 kJ/m^2
KJ-MAX LOAD= 176 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 136.5 kJ/m^2
K-JIc= 163.4 MPa SQR[m]
POWER= .392
COEFFICIENT= 221.2 kJ/m^2
T (AVERAGE)= 76

ASTM LINEAR PROCEDURE

JIc= 122.1 kJ/m^2
K-JIc= 154.5 MPa SQR[m]
SLOPE= 106659 kJ/m^3
INTERCEPT= 108.6 kJ/m^2
T (ASTM)= 90
VALID, E813

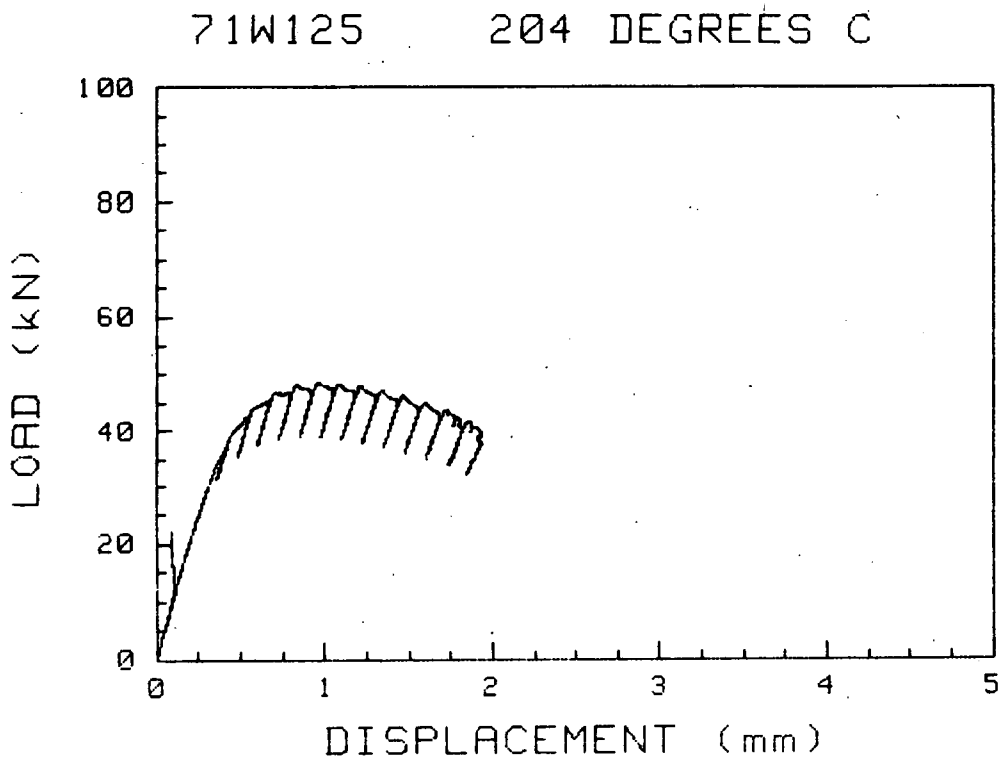
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 344.6 kJ/m^2
POWER= .4007
J-MAX ALLOWED= 489.4 kJ/m^2
RCURVE INVALID, 2

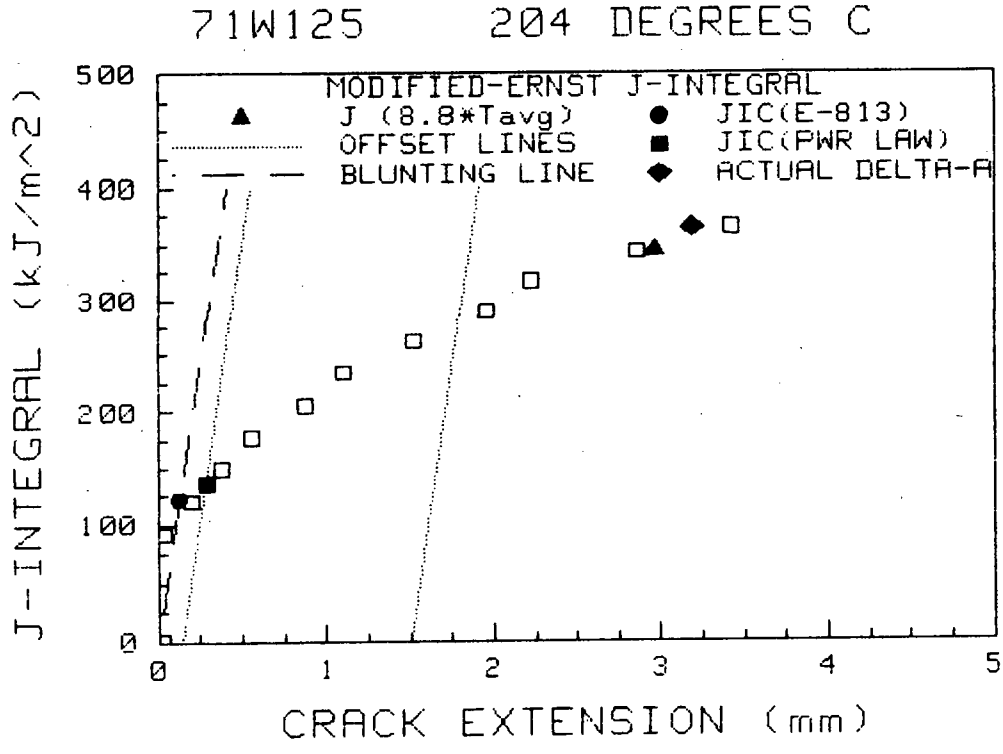
COEFFICIENT= 222.9 kJ/m^2
DELTA-A MAX ALLOWED= 2.27 mm

YP1290

ORNL-DWG 87-7987



ORNL-DWG 87-7988



SPECIMEN ID= 71W127
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 28 mm a/W)i= .553
MEASURED DUCTILE DELTA-A= 3.87 mm
YIELD STRENGTH= 438 MPa
FLOW STRENGTH= 508 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 155.1 kJ/m^2
KJ-MAX LOAD= 172 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 90.4 kJ/m^2
K-JIc= 131.3 MPa SQR[m]
POWER= .4268
COEFFICIENT= 166.6 kJ/m^2
T (AVERAGE)= 57

ASTM LINEAR PROCEDURE

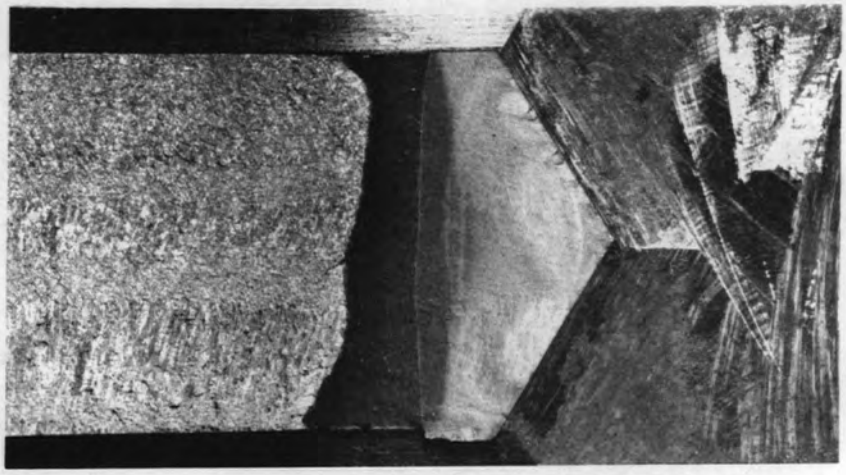
JIc= 86.9 kJ/m^2
K-JIc= 128.8 MPa SQR[m]
SLOPE= 82036 kJ/m^3
INTERCEPT= 79.9 kJ/m^2
T (ASTM)= 61
VALID, E813

JI-R CURVE CALCULATIONS

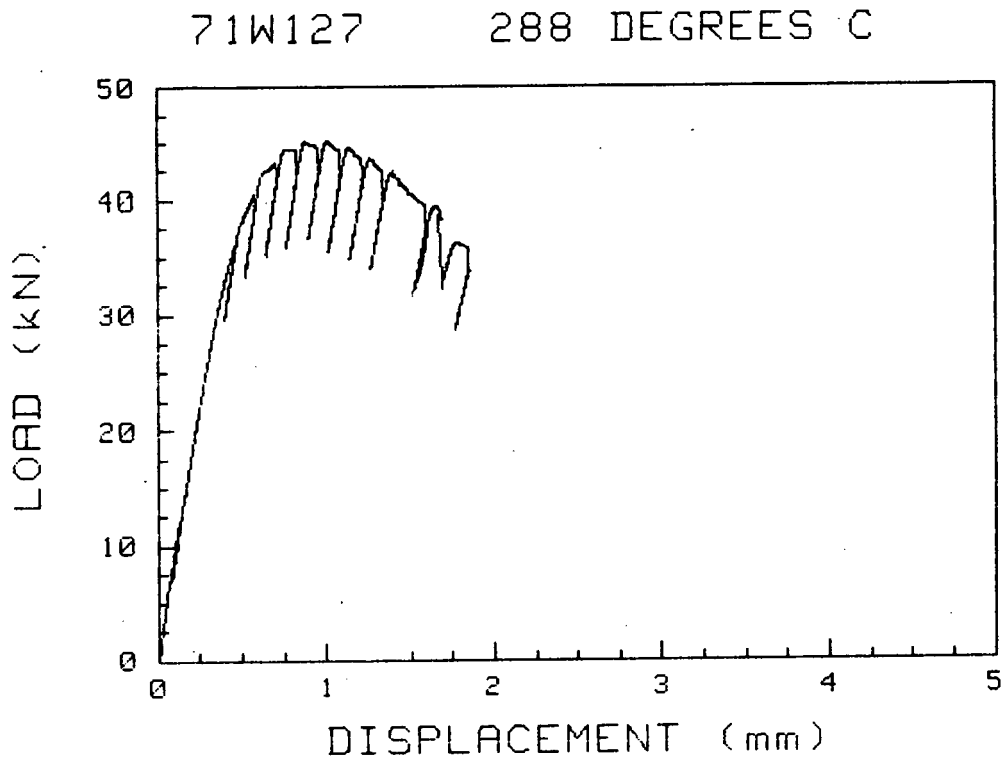
J (@J/T=8.8)= 247.5 kJ/m^2
POWER= .4014
J-MAX ALLOWED= 516.2 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 168.5 kJ/m^2
DELTA-A MAX ALLOWED= 2.26 mm

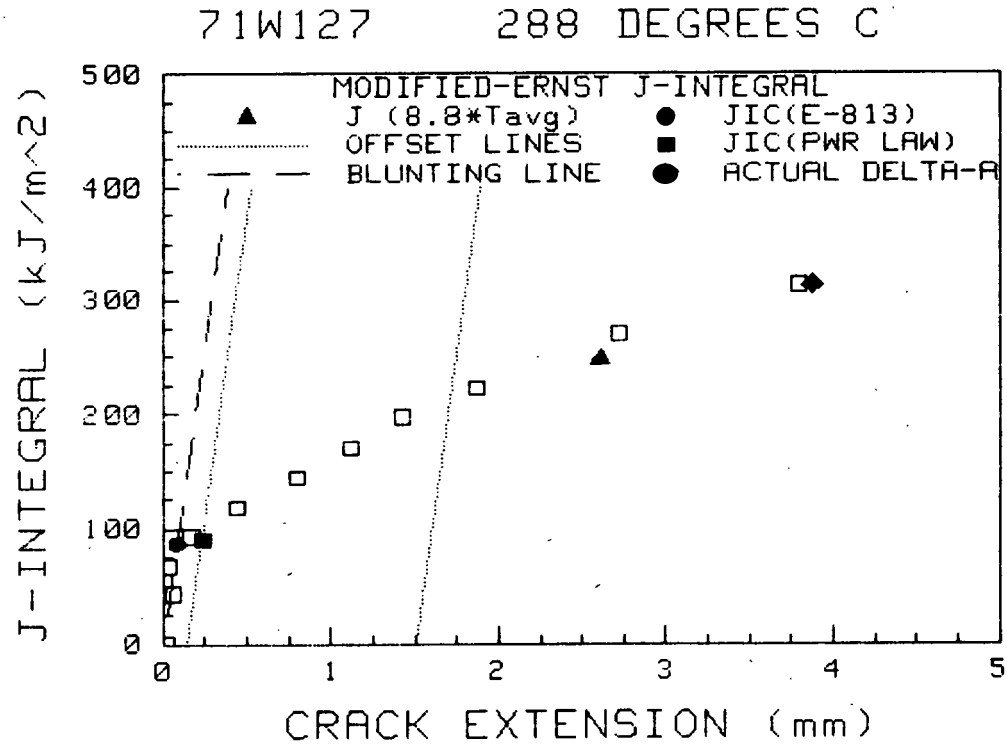
YP1289



ORNL-DWG 87-7989



ORNL-DWG 87-7990



SPECIMEN ID= 71W-130
TEST TEMPERATURE= 30 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.7 mm a/W)i= .547
MEASURED DUCTILE DELTA-A= 3.29 mm
YIELD STRENGTH= 470 MPa
FLOW STRENGTH= 535 MPa
ESTIMATED YOUNG'S MODULUS= 205 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 285.3 kJ/m^2
KJ-MAX LOAD= 242.1 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 131.5 kJ/m^2
K-JIc= 164.4 MPa SQR[m]
POWER= .7843
COEFFICIENT= 364.2 kJ/m^2
T (AVERAGE)= 201

ASTM LINEAR PROCEDURE

JIc= 128.8 kJ/m^2
K-JIc= 162.7 MPa SQR[m]
SLOPE= 258546 kJ/m^3
INTERCEPT= 97.7 kJ/m^2
T (ASTM)= 186
VALID, E813

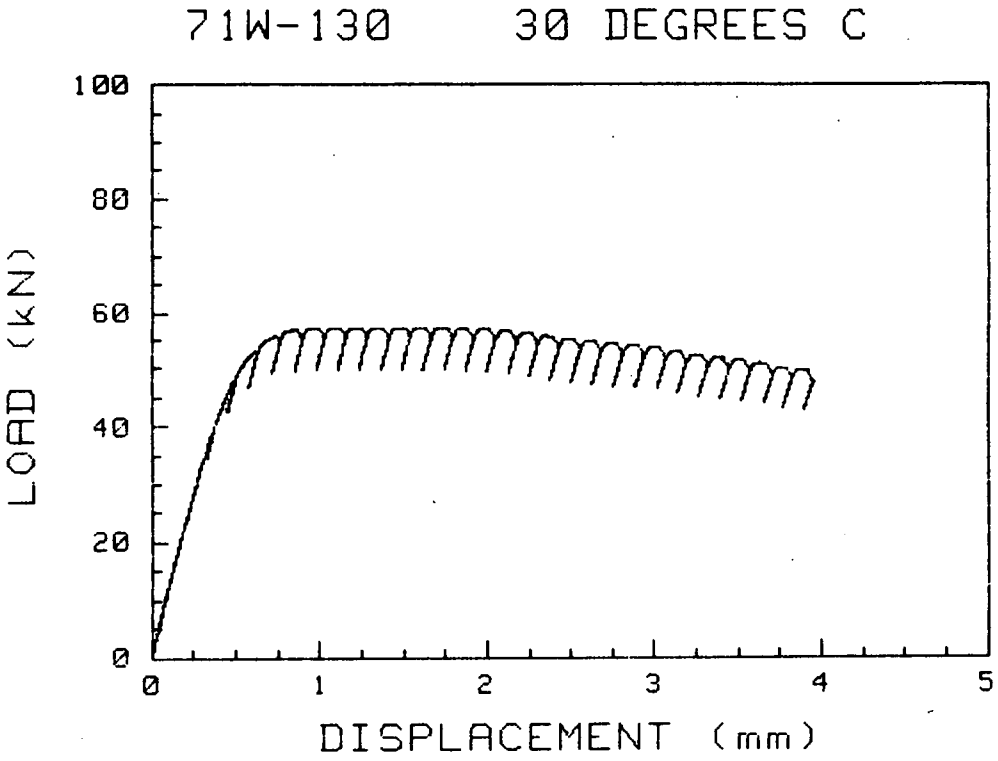
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 1019.9 kJ/m^2
POWER= .6956
J-MAX ALLOWED= 613.4 kJ/m^2
RCURVE INVALID, 3

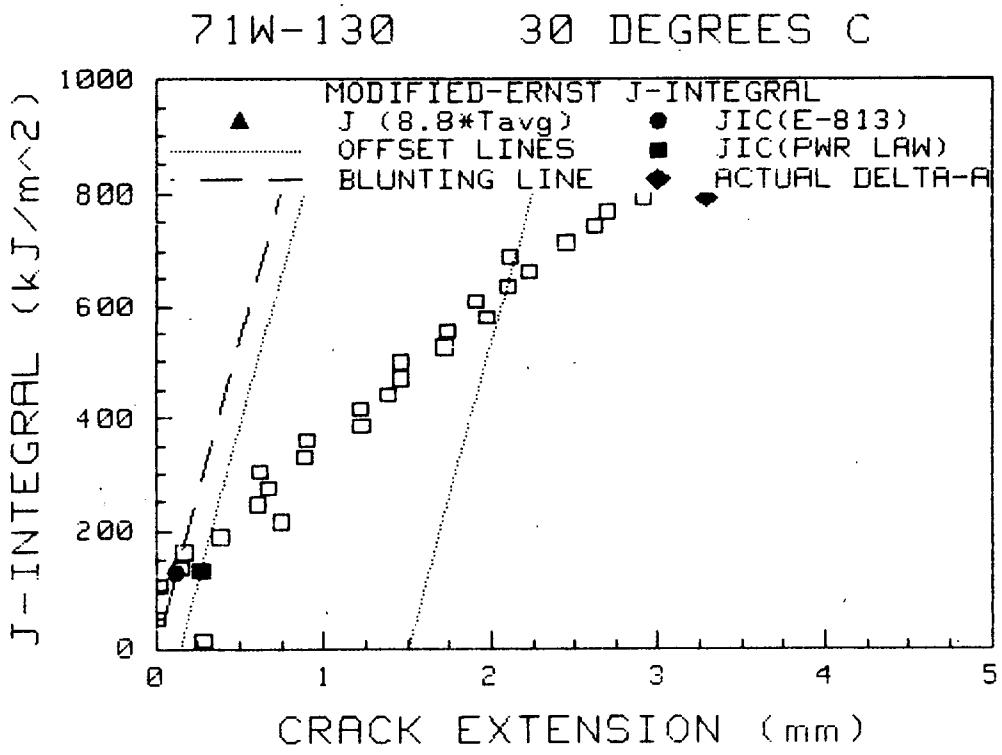
COEFFICIENT= 364.1 kJ/m^2
DELTA-A MAX ALLOWED= 2.29 mm

YP1288

ORNL-DWG 87-7991



ORNL-DWG 87-7992



SPECIMEN ID= 71W135
TEST TEMPERATURE= -10 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 28 mm a/W)i= .551
MEASURED DUCTILE DELTA-A= .45 mm
YIELD STRENGTH= 502 MPa
FLOW STRENGTH= 567 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

SPECIMEN CLEAVED AT K = 111.3 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 202.9 kJ/m^2
KJc= 205.3 MPa SQR[m]
K-beta-c= 99 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 202.2 kJ/m^2
KJc= 205 MPa SQR[m]
K-beta-c= 99 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 161.9 kJ/m^2
K-JIc= 183.4 MPa SQR[m]
POWER= .5616
COEFFICIENT= 322.9 kJ/m^2
T (AVERAGE)= 117

ASTM LINEAR PROCEDURE

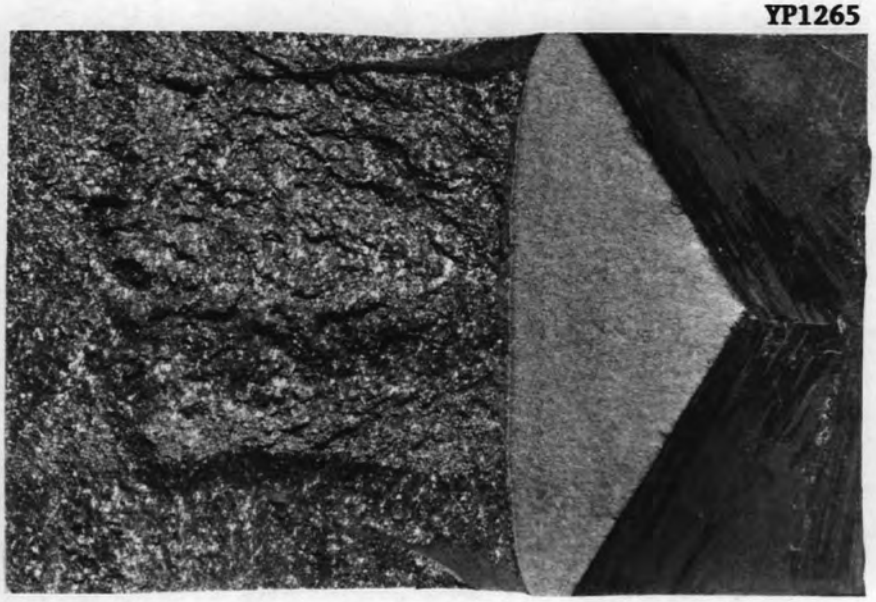
JIc= 0 kJ/m^2
K-JIc= 0 MPa SQR[m]
SLOPE= 0 kJ/m^3
INTERCEPT= 0 kJ/m^2
T (ASTM)= 0
INVALID, 1

JI-R CURVE CALCULATIONS

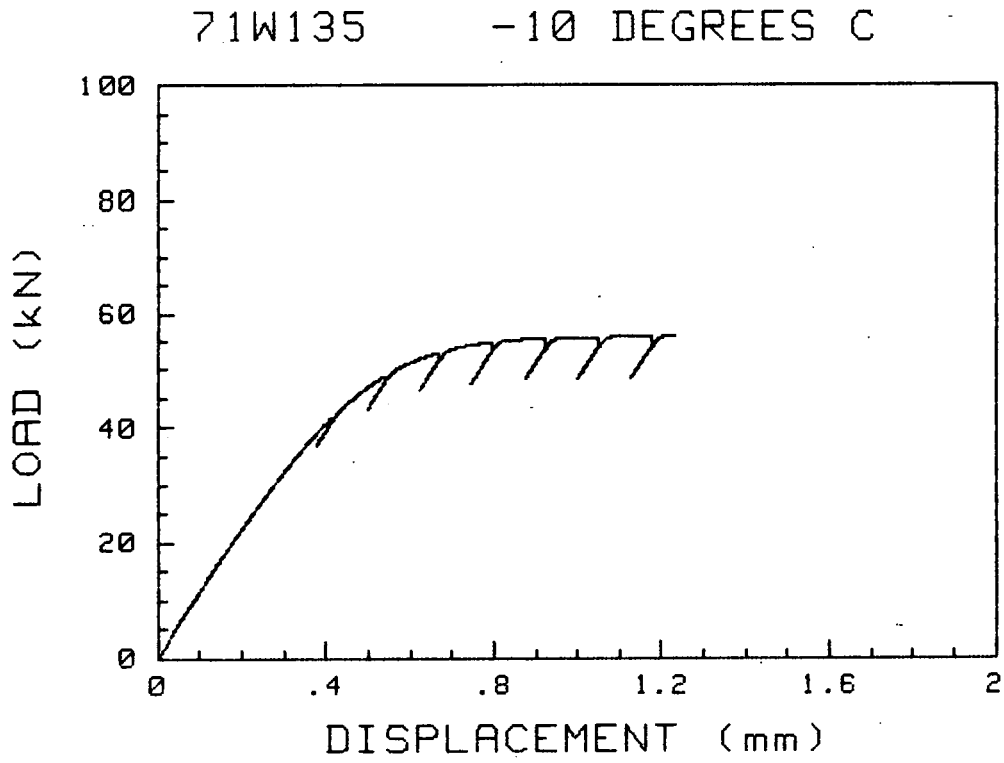
J (@J/T=8.8)= 328.9 kJ/m^2
POWER= .3544
J-MAX ALLOWED= 645.3 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 256.6 kJ/m^2
DELTA-A MAX ALLOWED= 2.27 mm

YP1265



ORNL-DWG 87-7993



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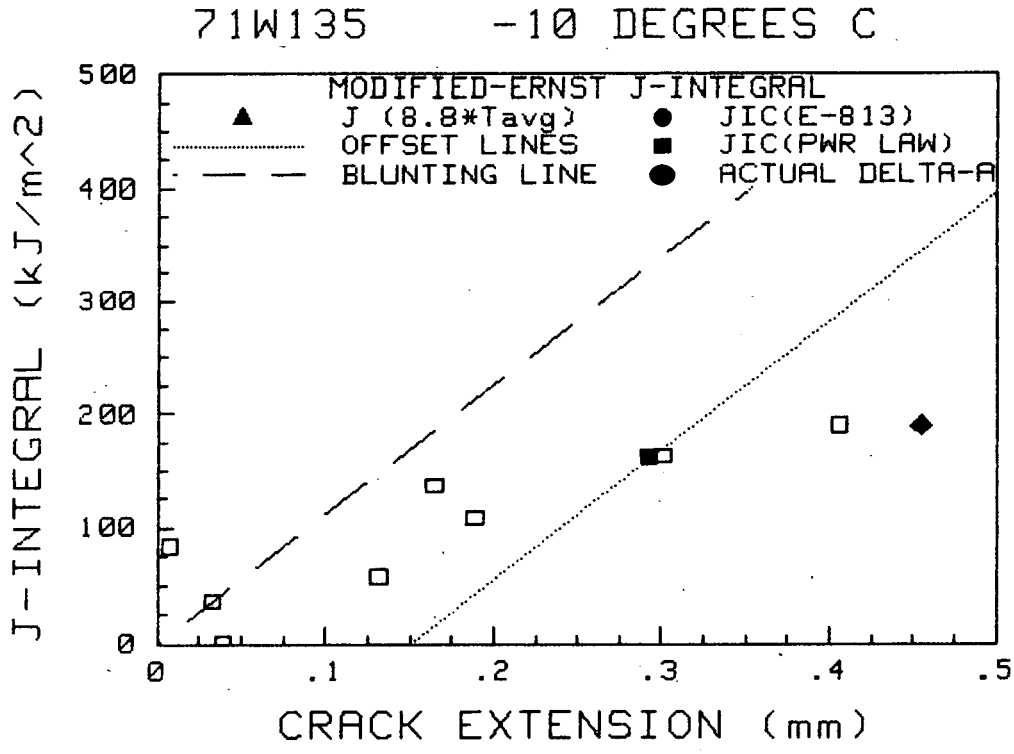

Appendix E

LOAD-DISPLACEMENT AND J-R CURVES, SUPPLIED BY MATERIALS ENGINEERING ASSOCIATES, FOR IRRADIATED MATERIAL

MEA IRRADIATED 1TCS DATA SHEETS
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E-222	02G287	E-270	69W146
E-223	02G331	E-271	69W148
E-224	02G332	E-272	69W157
E-225	02G335	E-273	69W159
E-226	02G342	E-274	69W166
E-227	02G345	E-275	70W104
E-228	02G348	E-276	70W111
E-229	02G349	E-277	70W112
E-230	02G354	E-278	70W113
E-231	02G356	E-279	70W115
E-232	02G358	E-280	70W119
E-233	02G360	E-281	70W125
E-234	02G368	E-282	70W128
E-235	02G379	E-283	70W129
E-236	02G375	E-284	70W130
E-237	02G402	E-285	70W131
E-238	02G403	E-286	70W132
E-239	02G411	E-287	70W133
E-240	02G412	E-288	70W137
E-241	02G413	E-289	70W138
E-242	02G416	E-290	70W142
E-243	02G419	E-291	70W145
E-244	02G423	E-292	71W110
E-245	68WAB	E-293	71W112
E-246	68WBA	E-294	71W115
E-247	68WBC	E-295	71W117
E-248	68WBD	E-296	71W120
E-249	68WCC	E-297	71W121
E-250	68WCD	E-298	71W128
E-251	68WEA	E-299	71W131
E-252	68WEC	E-300	71W138
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E-254	68WED	E-302	71W149
E-255	68WEE	E-303	71W150
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E-257	68WLA		
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MEA VALIDITY INDEX

K_{Ic} (ASTM E399)

1. $K_{Ic} > \sigma_{ys} * \sqrt{a_o/2.5}$

2. $K_{Ic} > \sigma_{ys} * \sqrt{(B*B_N)^{0.5}/2.5}$

3. $P_{Max}/P_Q > 1.1$

J_{Ic} (ASTM E813)

a. < 4 data points between 0.15 and 1.5 mm exclusion lines.

b. Data clustering problem.

c. Delta-a prediction error too large,
$|(\text{delta-a})_{pred} - (\text{delta-a})_{meas}| > 0.15\ (\text{delta-a})_{meas}$

d. $B_N < 25\ J_Q/\sigma_y$

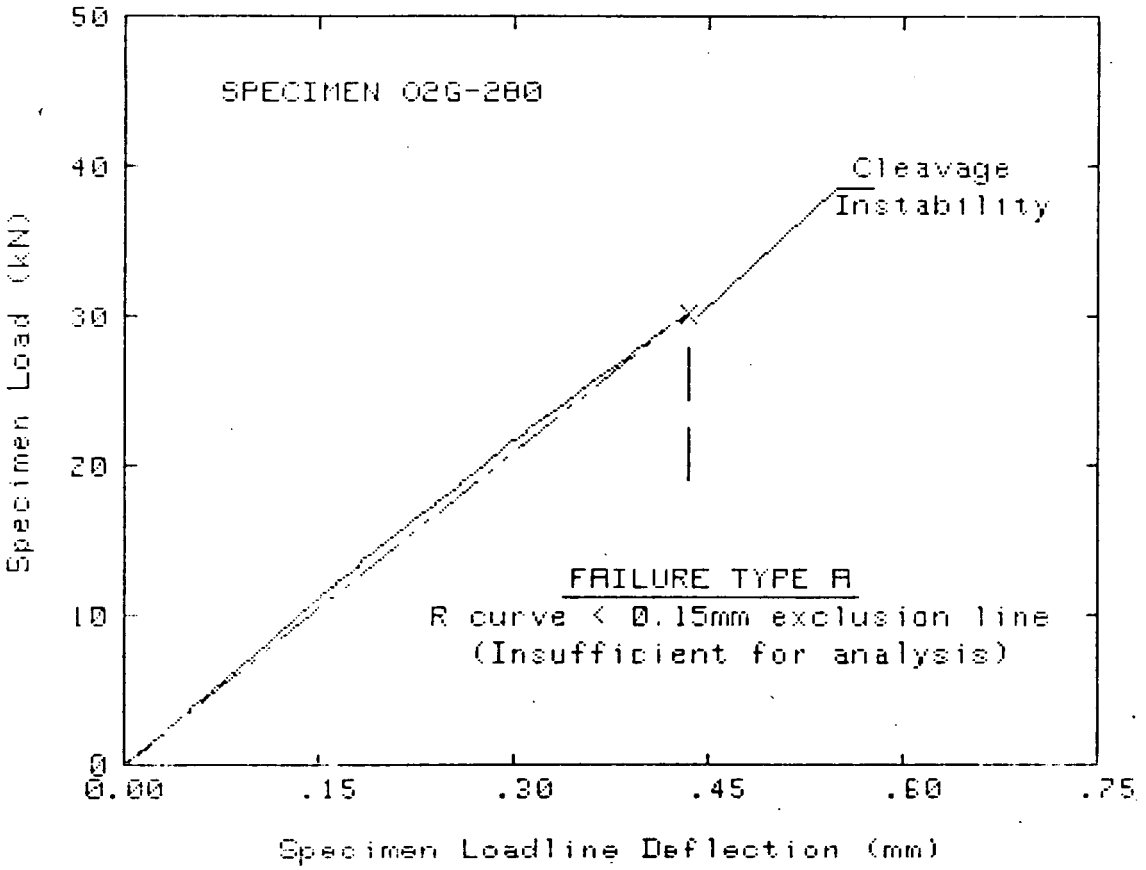
e. $b_o < 25\ J_Q/\sigma_y$

Tentative J_I - R Curve Procedure

1. < 3 data points between (delta-a)=0 and secant line [$J=4/3*\sigma_y*(\text{delta-a})$]

2. < 10 data points between secant line and $(\text{delta-a})_{max}$ [$0.1*b_o$]

3. (delta-a) prediction error too large,
$|(\text{delta-a})_{pred} - (\text{delta-a})_{meas}| >$
MINIMUM [$0.15*(\text{delta-a})_{meas}, 0.15*(\text{delta-a})_{max}$]



TEST SPECIMEN DATA

Material Type	= A533B Plate 02	
Test Temperature	= 25 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .621	
Init crack length a	= 31.52 mm	
Flow stress	= 686.3 MPa	
Yield stress	= 616.7 MPa	
Youngs modulus E	= 205800 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

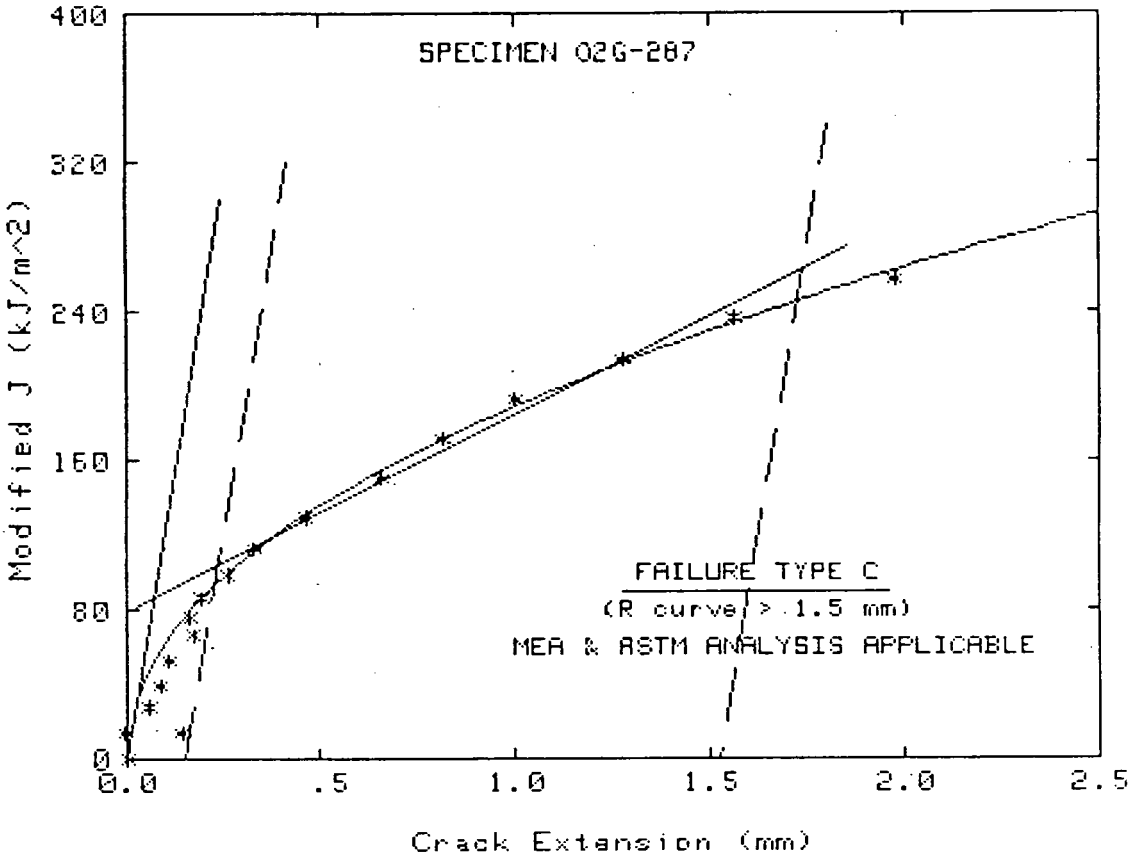
Jic	= 30.6 kJ/m^2	
Kjc=(EJic)^.5	= 79.3 MPa √m	ν=.3
Kic (Beta Corrected)	= 68.7 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 30.12 kN	
5% Secant Offset Pq	= 28.66 kN	
Kic	= 74.3 MPa √m	
Validity	= INVALID--1, 2	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

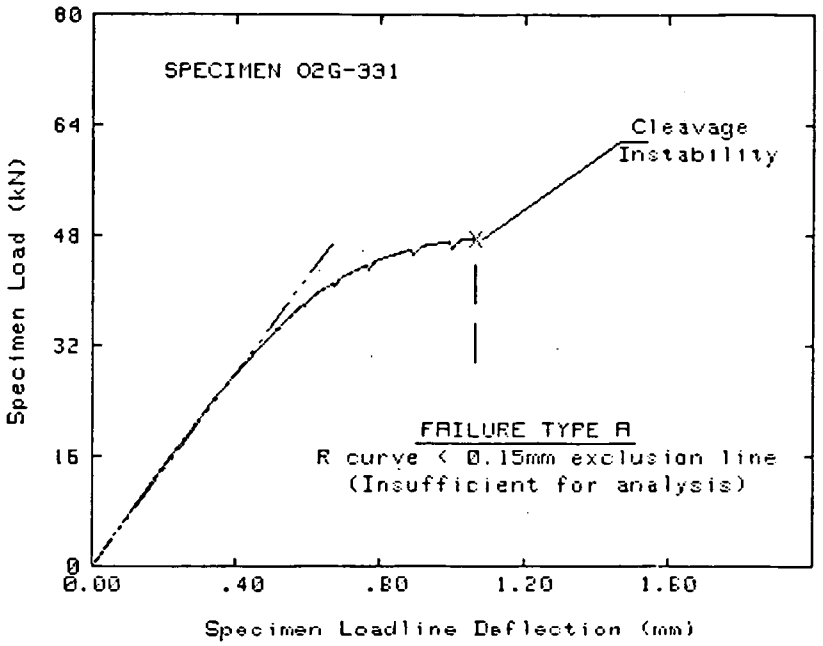
Material Type	= A533B 02 Plate	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.96 mm	Init a/W = .609
Final crack length	= 43.65 mm	Final a/W = .859
Flow stress	= 613.1 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 93.2 kJ/m^2
Kjc	= 133.3 MPa √m
J (@J/T=8.8)	= 288.5 kJ/m^2
Exponent N	= .4787
Coefficient C	= 188.9 kJ/m^2
T (average)	= 49

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 86.8 kJ/m^2	
Kjc	= 128.7 MPa √m	
Slope M	= 105633.9 kJ/m^3	
Intercept B	= 79.3 kJ/m^2	
T (ASTM)	= 54	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--1, 3 (.56 vs .29)	
J maximum allowed	= 607.7 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.98 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B HSST 02 Ref	
Test Temperature	= 80 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .62	
Init crack length a	= 31.47 mm	
Flow stress	= 656.4 MPa	
Yield stress	= 590.2 MPa	
Youngs modulus E.	= 202600 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 147.8 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 173.1 MPa \/m	v=.3
Kic (Beta Corrected)	= 101.6 MPa \/m	v=.3

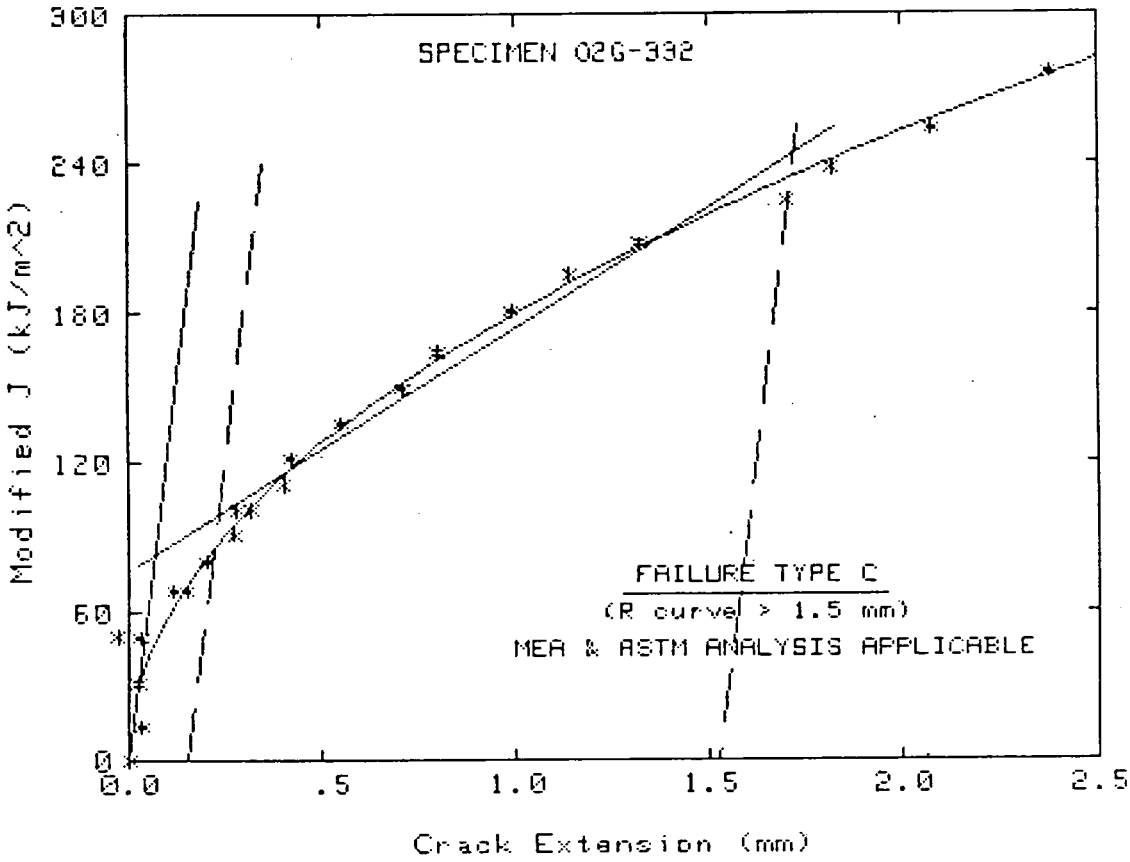
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 47.5 kN	
5% Secant Offset Pq	= 27.84 kN	
Kic	= 71.8 MPa \/m	
Validity	= INVALID--1, 2, 3	
K at Maximum Load	= 122.5 MPa \/m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 7.66567519757E-05 in.
Specimen rotation Load intercept elastic slope = .000004248 lb
Fitted elastic load range= 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

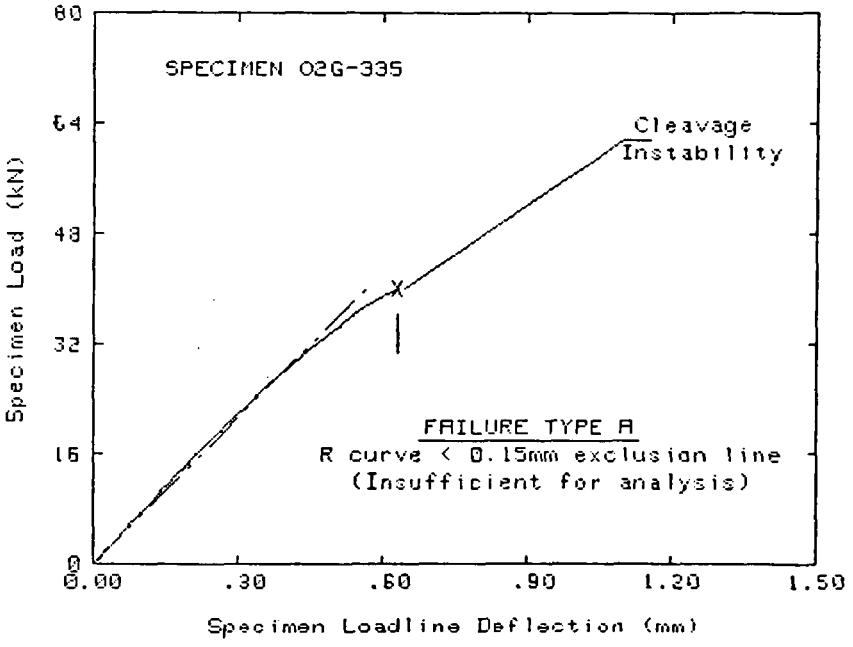
Material Type	= A533B 02 Plate	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.33 mm	Init a/W = .616
Final crack length	= 42.94 mm	Final a/W = .845
Flow stress	= 613.1 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 86 kJ/m^2
Kjc	= 128.1 MPa \/m
J (@J/T=8.8)	= 280.8 kJ/m^2
Exponent N	= .4905
Coefficient C	= 179.8 kJ/m^2
T (average)	= 48

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 83.3 kJ/m^2	
Kjc	= 126.1 MPa \/m	
Slope M	= 96953.4 kJ/m^3	
Intercept B	= 76.7 kJ/m^2	
T (ASTM)	= 49	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 596.4 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.95 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B HSST 02 Ref	
Test Temperature	= 80 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .617	
Init crack length a	= 31.33 mm	
Flow stress	= 656.4 MPa	
Yield stress	= 590.2 MPa	
Youngs modulus E	= 202600 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

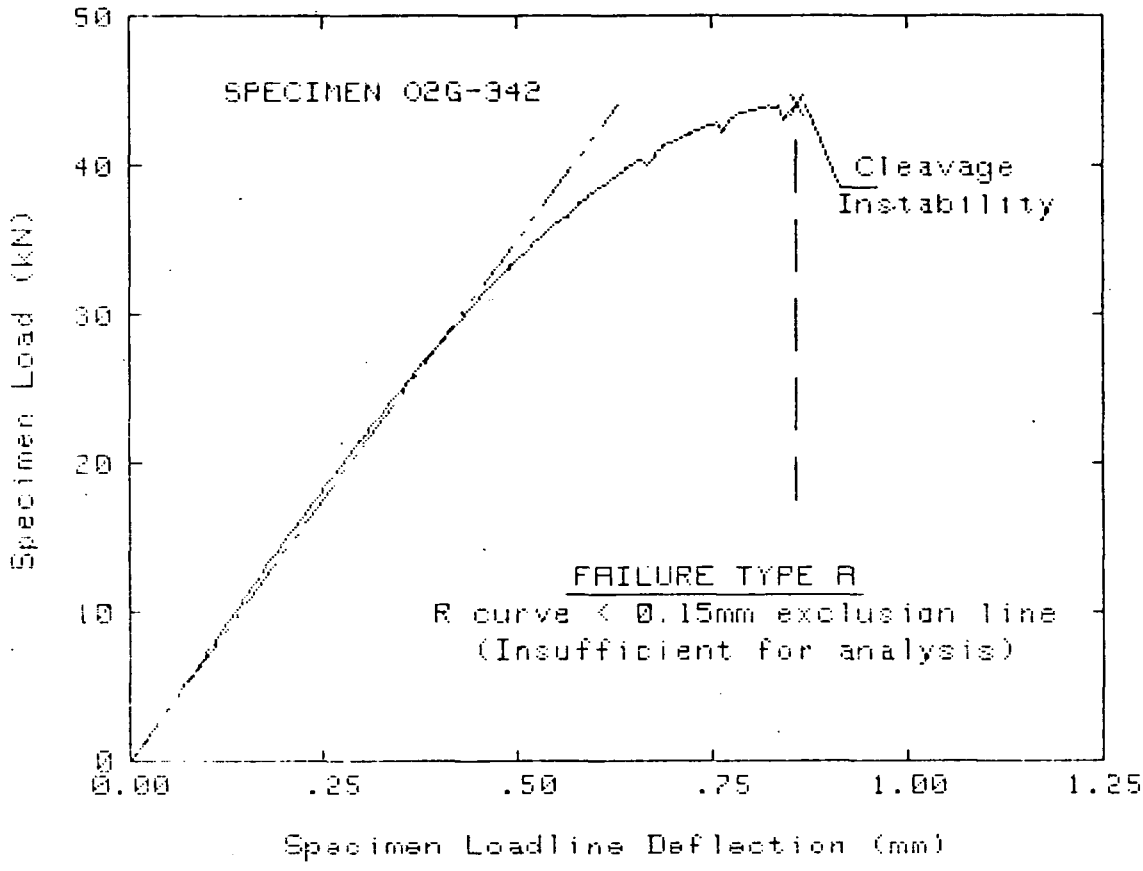
Jic	= 61.3 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 111.5 MPa \/m	v=.3
Kic (Beta Corrected)	= 82.5 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 40.1 kN	
5% Secant Offset Pq	= 27.76 kN	
Kic	= 70.8 MPa \/m	
Validity	= INVALID--1, 2, 3	
K at Maximum Load	= 102.3 MPa \/m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 3.93675884187E-05 in.
Specimen rotation Load intercept elastic slope = 1.33333333333E-07 lb
Fitted elastic load range= 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533B Plate 02	
Test Temperature	= 80 ° C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .615	
Init crack length a	= 31.24 mm	
Flow stress	= 656.4 MPa	
Yield stress	= 590.3 MPa	
Youngs modulus E	= 202600 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

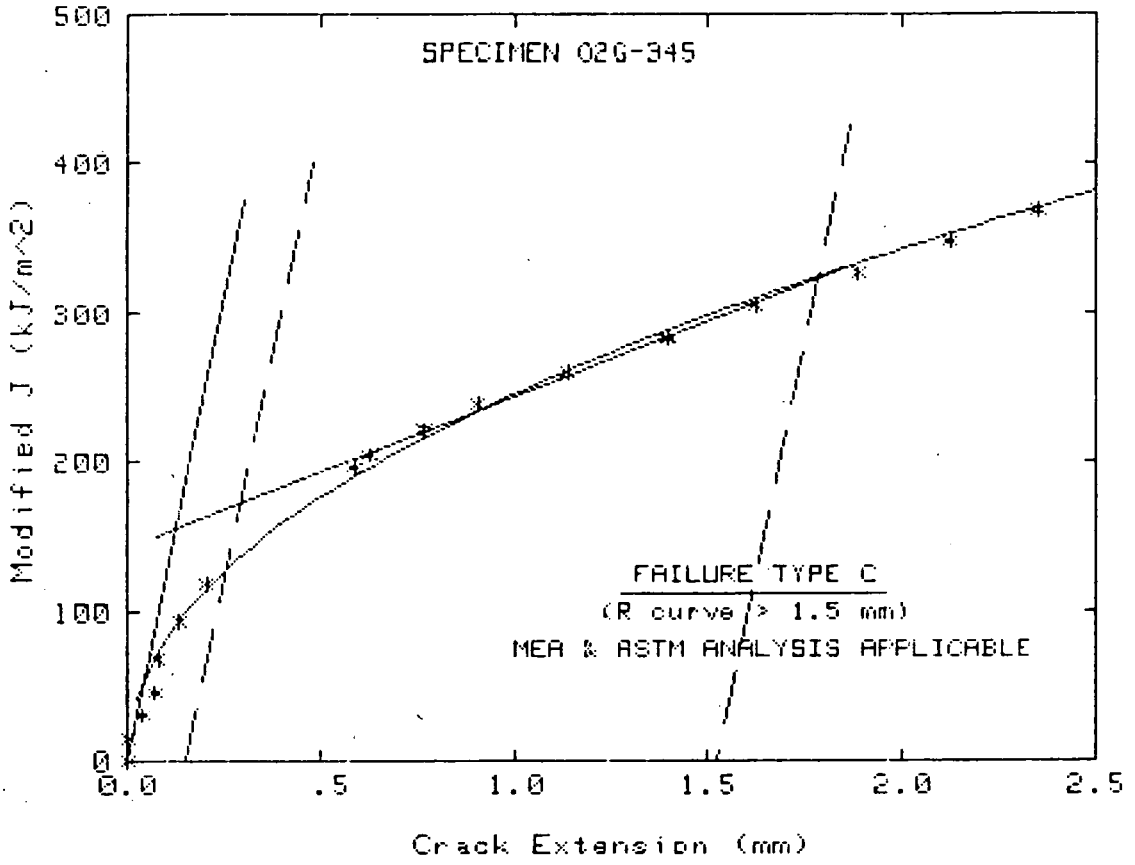
Jic	= 103.4 kJ/m^2	
Kjc=(EJic)^.5	= 144.8 MPa √m	v=.3
Kic (Beta Corrected)	= 93.8 MPa √m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 44.06 kN	
5% Secant Offset Pq	= 28.56 kN	
Kic	= 72.3 MPa √m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

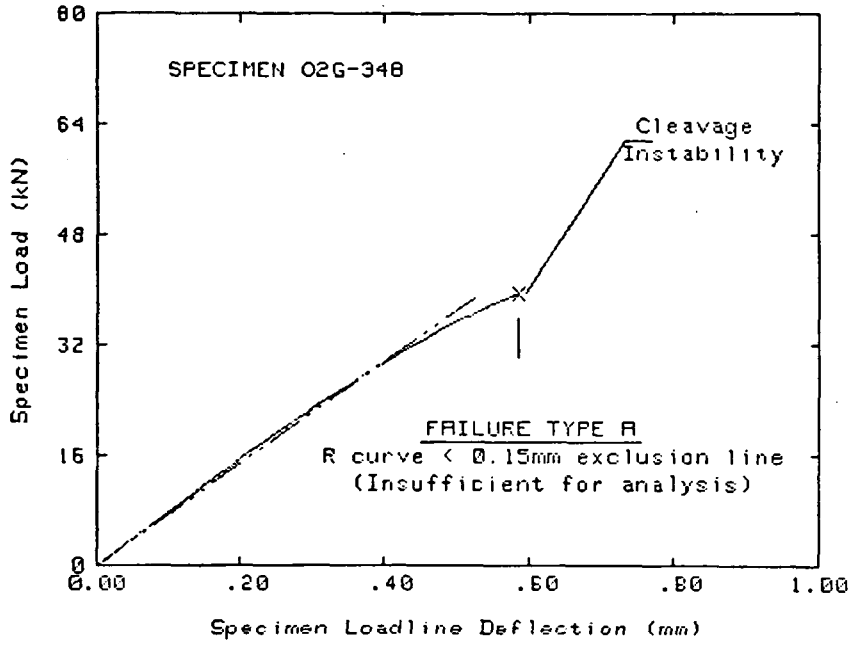
Material Type	= A533B PLATE 02	
Test Temperature	= 204 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.66 mm	Init a/W = .623
Final crack length	= 41.54 mm	Final a/W = .817
Flow stress	= 617.4 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 127.8 kJ/m^2
Kjc	= 158 MPa \/m
J (@J/T=8.8)	= 353.6 kJ/m^2
Exponent N	= .4798
Coefficient C	= 245.7 kJ/m^2
T (average)	= 63

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 154.6 kJ/m^2	
Kjc	= 173.8 MPa \/m	
Slope M	= 101752.7 kJ/m^3	
Intercept B	= 141.8 kJ/m^2	
T (ASTM)	= 52	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--1, 3 (.54 vs .28)	
J maximum allowed	= 590.4 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.91 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B HSST 02 Ref	
Test Temperature	= 50 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .618	
Init crack length a	= 31.41 mm	
Flow stress	= 670.2 MPa	
Yield stress	= 604 MPa	
Youngs modulus E	= 204400 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

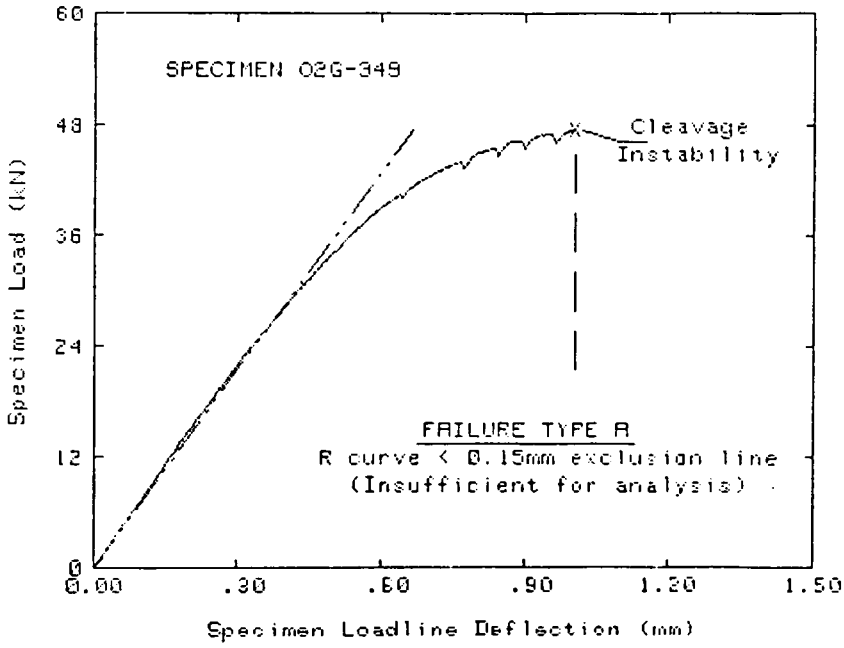
Jic	= 55.9 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 107 MPa √m	v=.3
Kic (Beta Corrected)	= 81.5 MPa √m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 39.5 kN	
5% Secant Offset Pq	= 28.95 kN	
Kic	= 74.3 MPa √m	
Validity	= INVALID--1, 2, 3	
K at Maximum Load	= 101.4 MPa √m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 1.46645116770E-04 in.
Specimen rotation Load intercept elastic slope =-.00000455 lb
Fitted elastic load range= 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533B Plate 02 (I)	
Test Temperature	= 80 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .626	
Init crack length a	= 31.81 mm	
Flow stress	= 656.5 MPa	
Yield stress	= 590.3 MPa	
Youngs modulus E	= 202600 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

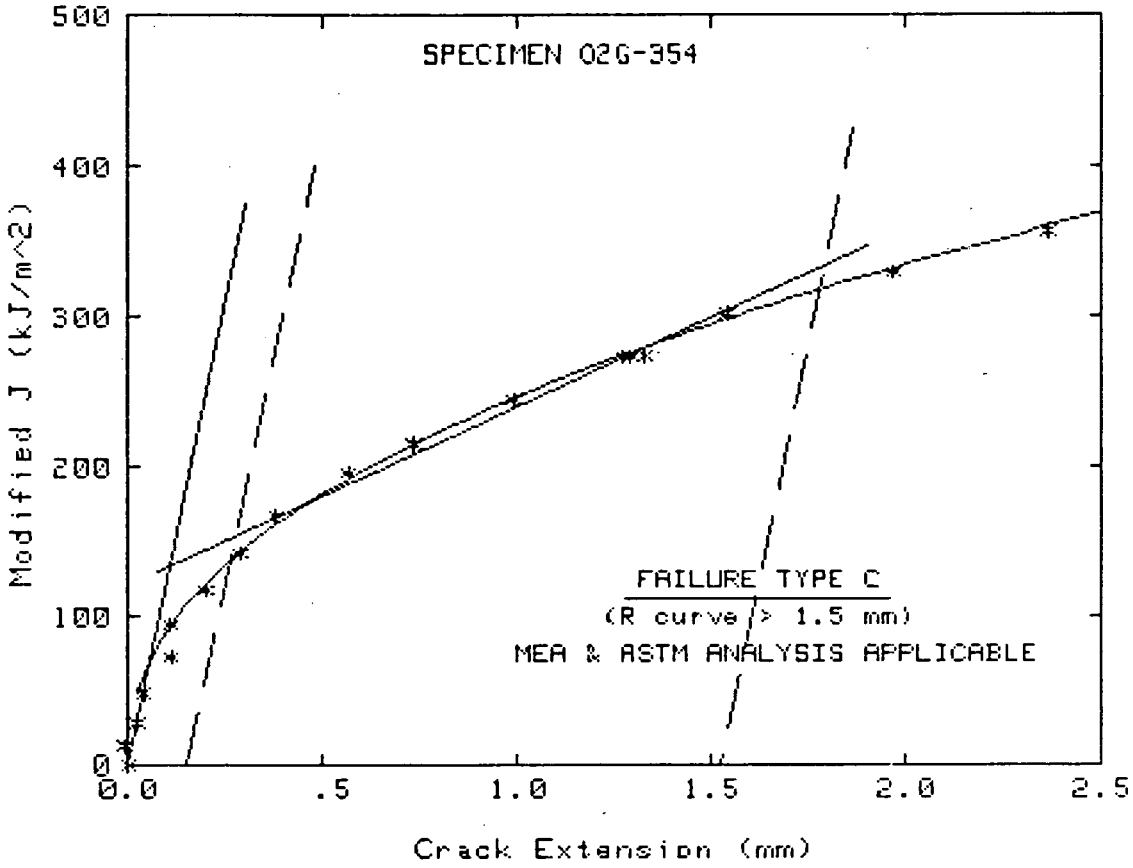
Jic	= 139.4 kJ/m^2	
Kjc=(EJic)^.5	= 168.1 MPa √m	ν=.3
Kic (Beta Corrected)	= 100.3 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 47.52 kN	
5% Secant Offset Pq	= 26.6 kN	
Kic	= 70.6 MPa √m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 1.264472387[illegible]E-04 in.
Specimen rotation Load intercept elastic slope =-3.462962962[illegible]E-07 lb
Fitted elastic load range= 3000 TO 500 Correction to J for crack extension



TEST SPECIMEN DATA

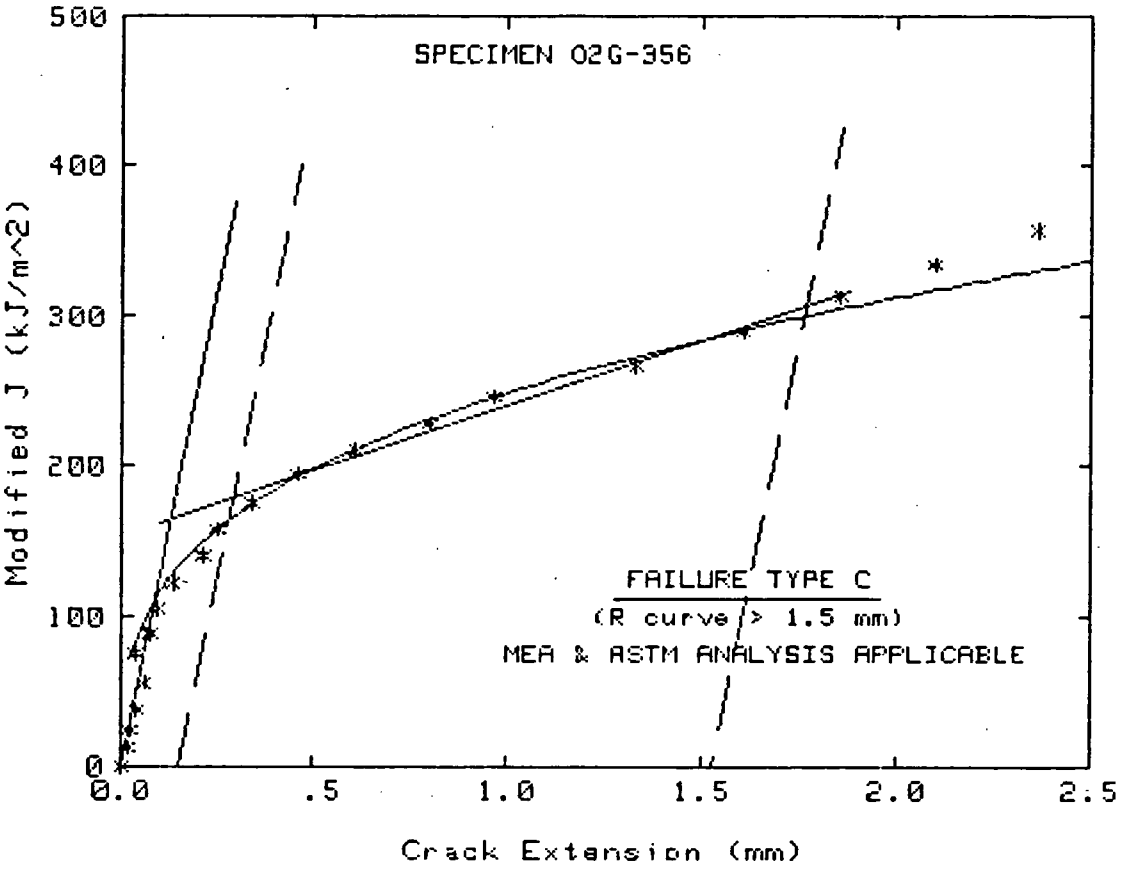
Material Type	= A533-B HSST 02 Ref	
Test Temperature	= 204 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.36 mm	Init a/W = .617
Final crack length	= 41.98 mm	Final a/W = .826
Flow stress	= 617.4 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 137.2 kJ/m^2
Kjc	= 163.8 MPa \/m
J (@J/T=8.8)	= 318.7 kJ/m^2
Exponent N	= .4397
Coefficient C	= 246.5 kJ/m^2
T (average)	= 58

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 134.3 kJ/m^2	
Kjc	= 162 MPa \/m	
Slope M	= 118561.1 kJ/m^3	
Intercept B	= 121.4 kJ/m^2	
T (ASTM)	= 61	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--3 (.87 vs .29)	
J maximum allowed	= 599.8 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.94 mm	(Delta a max = 0.1*bo)
Final Delta a	= 9.75 mm	
Poisson's Ratio (v)	= 0	



TEST SPECIMEN DATA

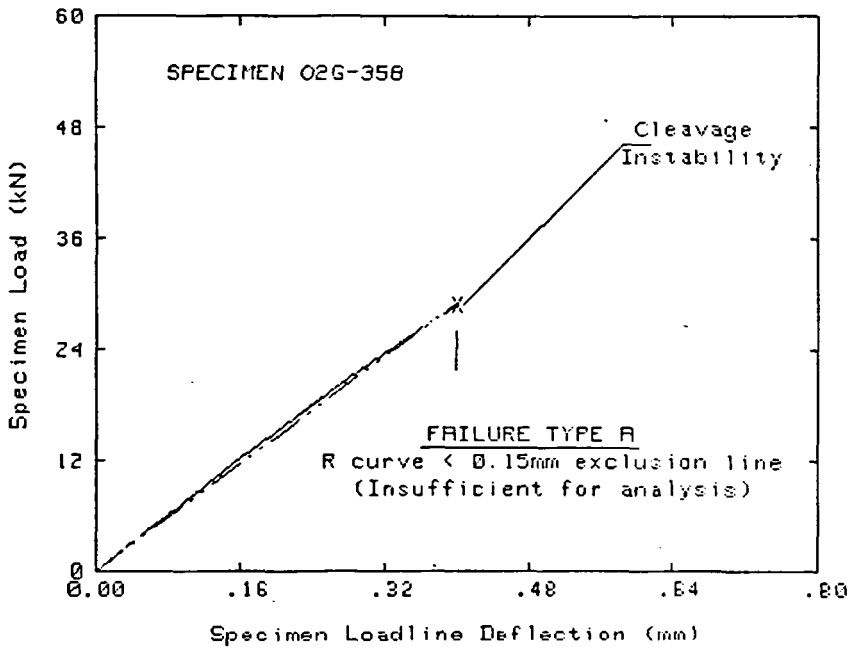
Material Type	= A533B PLATE 02	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.6 mm	Init a/W = .622
Final crack length	= 40.61 mm	Final a/W = .799
Flow stress	= 639.2 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 163.1 kJ/m^2
Kjc	= 180.7 MPa \/m
J (@J/T=8.8)	= 351.3 kJ/m^2
Exponent N	= .3314
Coefficient C	= 248.6 kJ/m^2
T (average)	= 43

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 165.2 kJ/m^2	
Kjc	= 181.9 MPa \/m	
Slope M	= 87303.3 kJ/m^3	
Intercept B	= 153.9 kJ/m^2	
T (ASTM)	= 43	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--3 (.56 vs .28)	
J maximum allowed	= 613.2 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.92 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B HSST 02 Ref	
Test Temperature	= 50 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .619	
Init crack length a	= 31.46 mm	
Flow stress	= 670.2 MPa	
Yield stress	= 604 MPa	
Youngs modulus E	= 204400 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

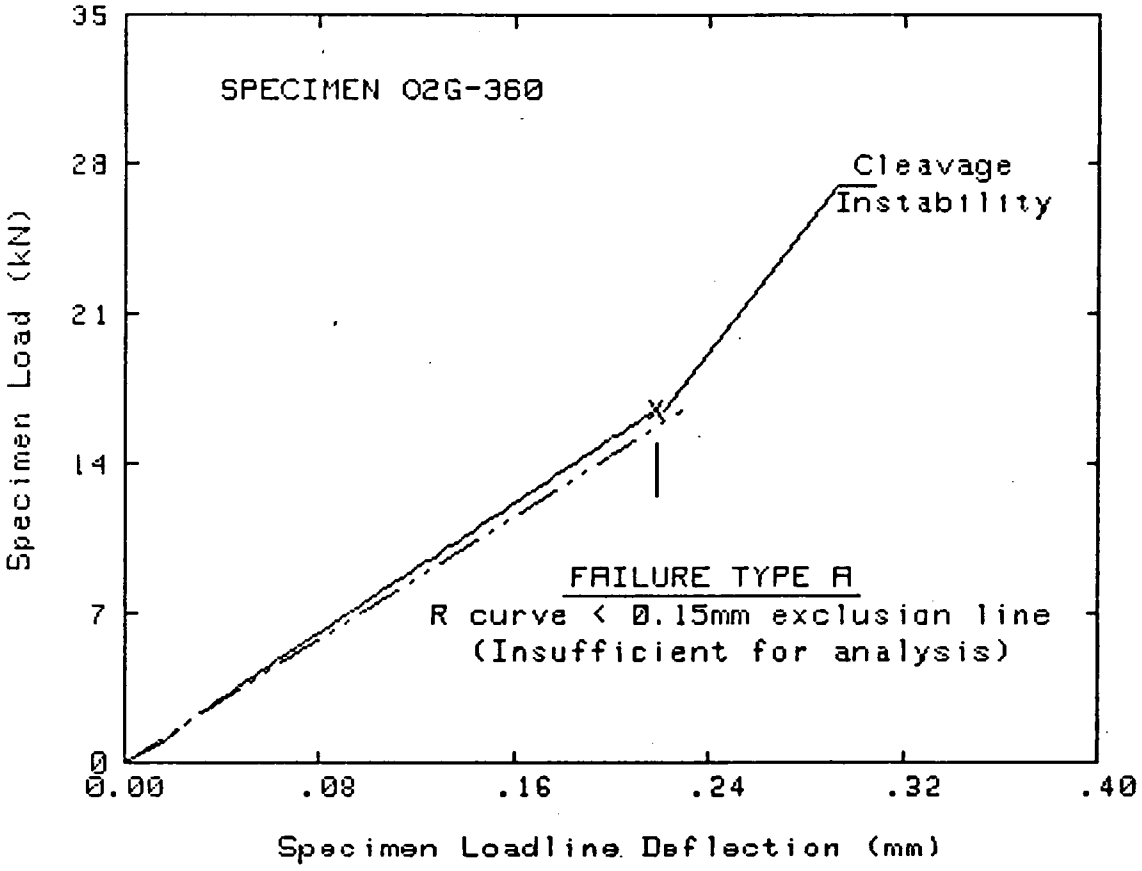
Jic	= 26.6 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 73.8 MPa √m	v=.3
Kic (Beta Corrected)	= 65 MPa √m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 28.8 kN	
5% Secant Offset Pq	= 28.22 kN	
Kic	= 72.7 MPa √m	
Validity	= INVALID--1, 2	
K at Maximum Load	= 74.2 MPa √m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 8.08109976833E-05 in.
Specimen rotation Load intercept elastic slope = 9.71818181818E-06 lb
Fitted elastic load range= 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533-B HSST 02 Ref	
Test Temperature	= -25 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .622	
Init crack length a	= 31.6 mm	
Flow stress	= 715.7 MPa	
Yield stress	= 643.3 MPa	
Youngs modulus E	= 208600 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

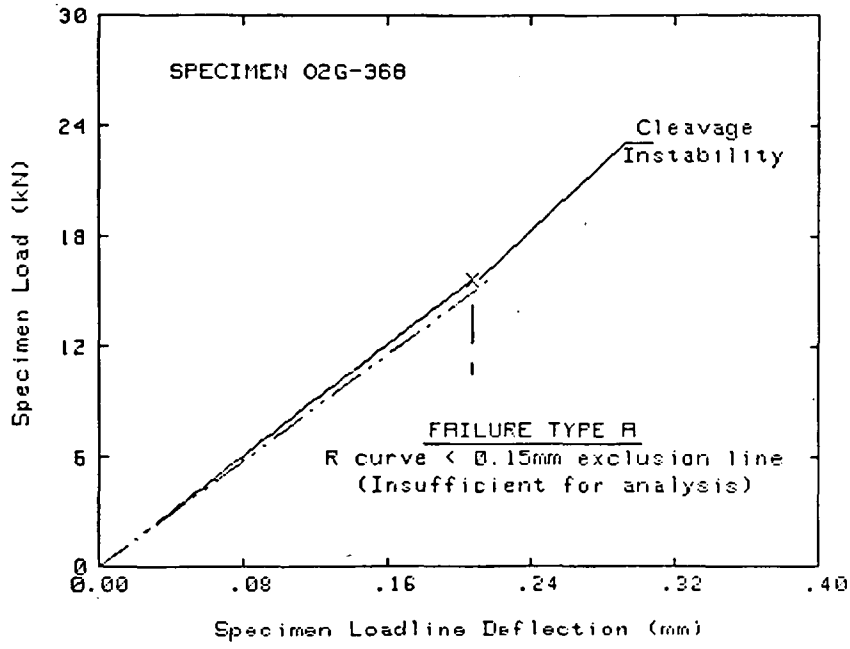
Jic	= 8.2 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 41.3 MPa √m	v=.3
Kic (Beta Corrected)	= 40.6 MPa √m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 16.5 kN	
5% Secant Offset Pq	= 16.53 kN	
Kic	= 43.1 MPa √m	
Validity	= VALID Kic value	
K at Maximum Load	= 43 MPa √m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533-B HSST 02 Ref	
Test Temperature	= -25 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .625	
Init crack length a	= 31.72 mm	
Flow stress	= 715.7 MPa	
Yield stress	= 643.3 MPa	
Youngs modulus E	= 208600 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 7.4 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 39.3 MPa \/m	v=.3
Kic (Beta Corrected)	= 38.8 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

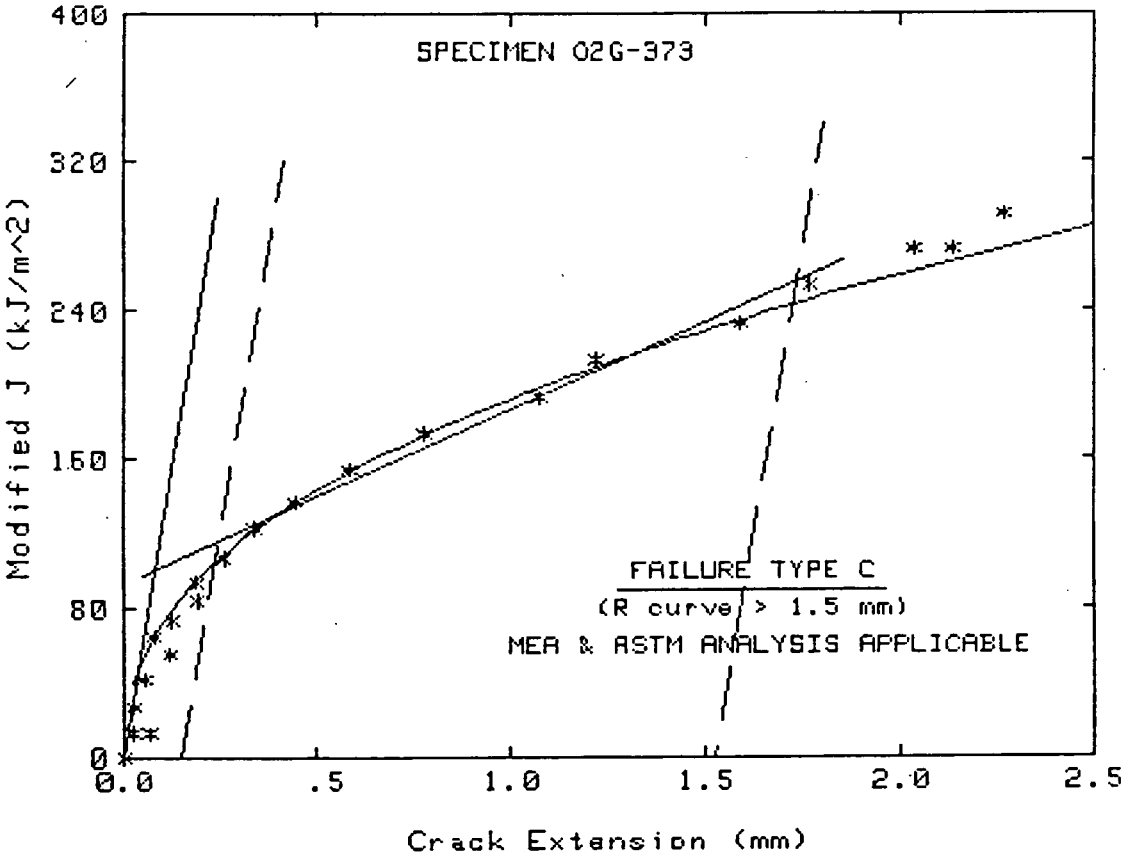
Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 15.7 kN	
5% Secant Offset Pq	= 15.67 kN	
Kic	= 41.3 MPa \/m	
Validity	= VALID Kic value	
K at Maximum Load	= 41.4 MPa \/m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 2.433630141[illegible]E-04 in.

Specimen rotation Load intercept elastic slope = 2.3384[illegible]E-06 lb

Fitted elastic load range= 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

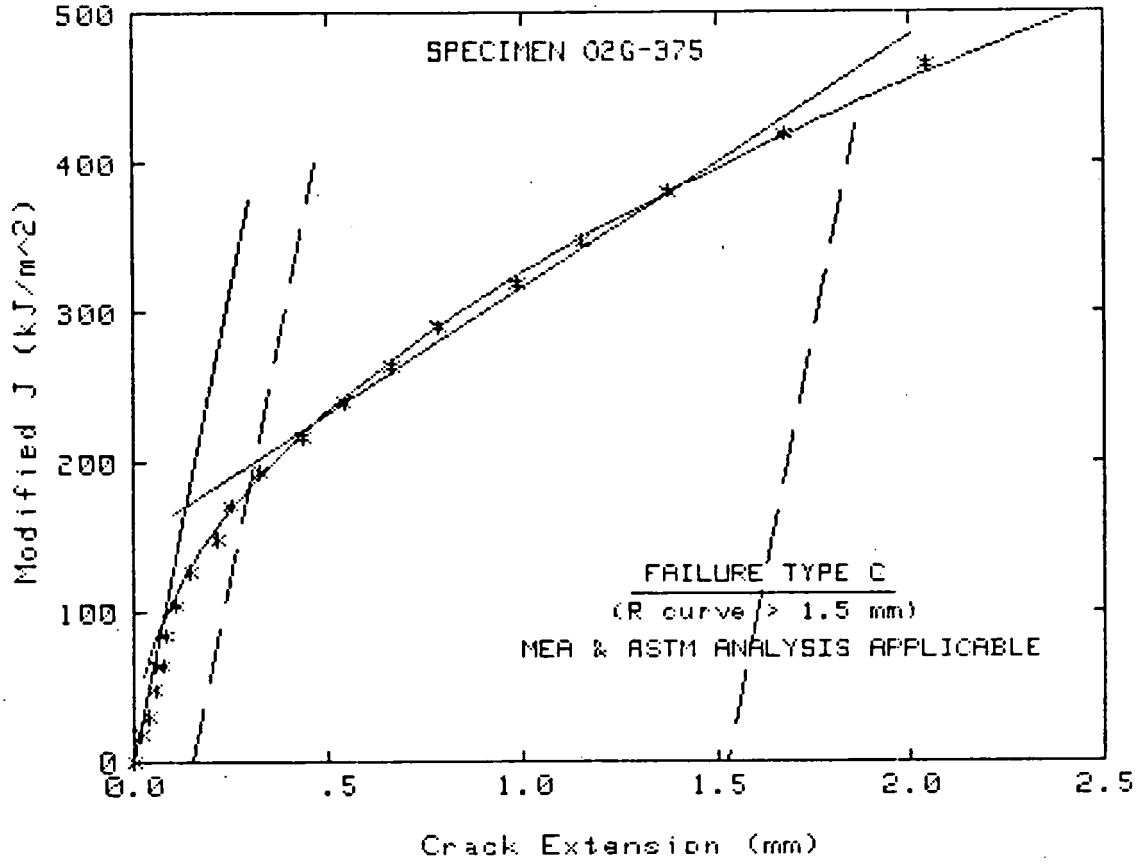
Material Type	= A533B 02 Plate	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.74 mm	Init a/W = .624
Final crack length	= 43.32 mm	Final a/W = .852
Flow stress	= 613.1 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 103.8 kJ/m^2
Kjc	= 140.7 MPa \/m
J (@J/T=8.8)	= 279.1 kJ/m^2
Exponent N	= .4287
Coefficient C	= 192.4 kJ/m^2
T (average)	= 45

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 100.9 kJ/m^2	
Kjc	= 138.7 MPa \/m	
Slope M	= 93565.2 kJ/m^3	
Intercept B	= 93.2 kJ/m^2	
T (ASTM)	= 48	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--1	
J maximum allowed	= 584 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.91 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

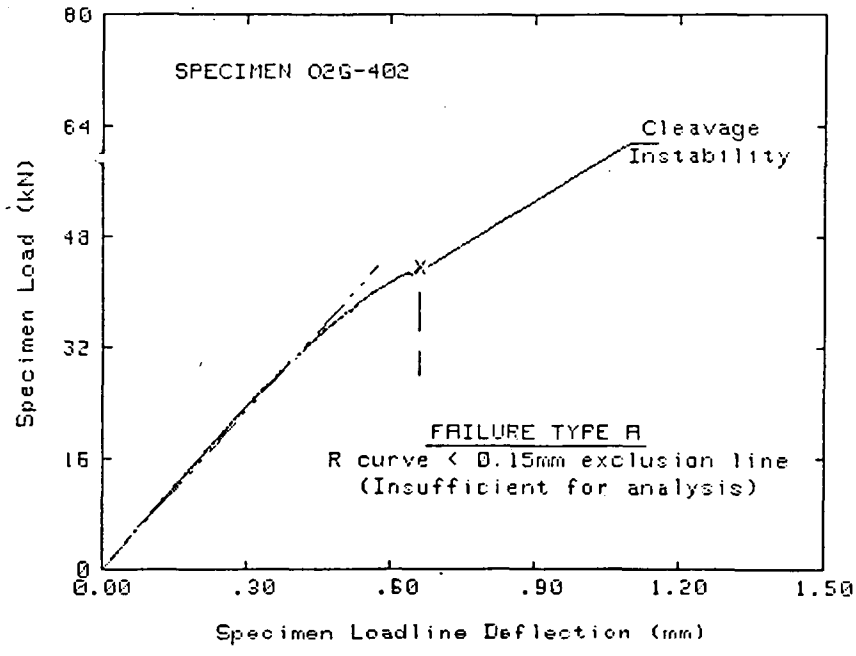
Material Type	= A533B PLATE 02	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.85 mm	Init a/W = .626
Final crack length	= 38.56 mm	Final a/W = .759
Flow stress	= 639.2 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 182 kJ/m^2
Kjc	= 191 MPa \/m
J (@J/T=8.8)	= 475.1 kJ/m^2
Exponent N	= .4784
Coefficient C	= 326.5 kJ/m^2
T (average)	= 77

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 171.1 kJ/m^2
Kjc	= 185.1 MPa \/m
Slope M	= 168236.9 kJ/m^3
Intercept B	= 148.5 kJ/m^2
T (ASTM)	= 83
Validity (Jic)	= VALID
Validity (R-curve)	= VALID
J maximum allowed	= 605.2 kJ/m^2 (Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.9 mm (Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B HSST 02 Ref	
Test Temperature	= 50 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .615	
Init crack length a	= 31.24 mm	
Flow stress	= 670.2 MPa	
Yield stress	= 604 MPa	
Youngs modulus E	= 204400 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

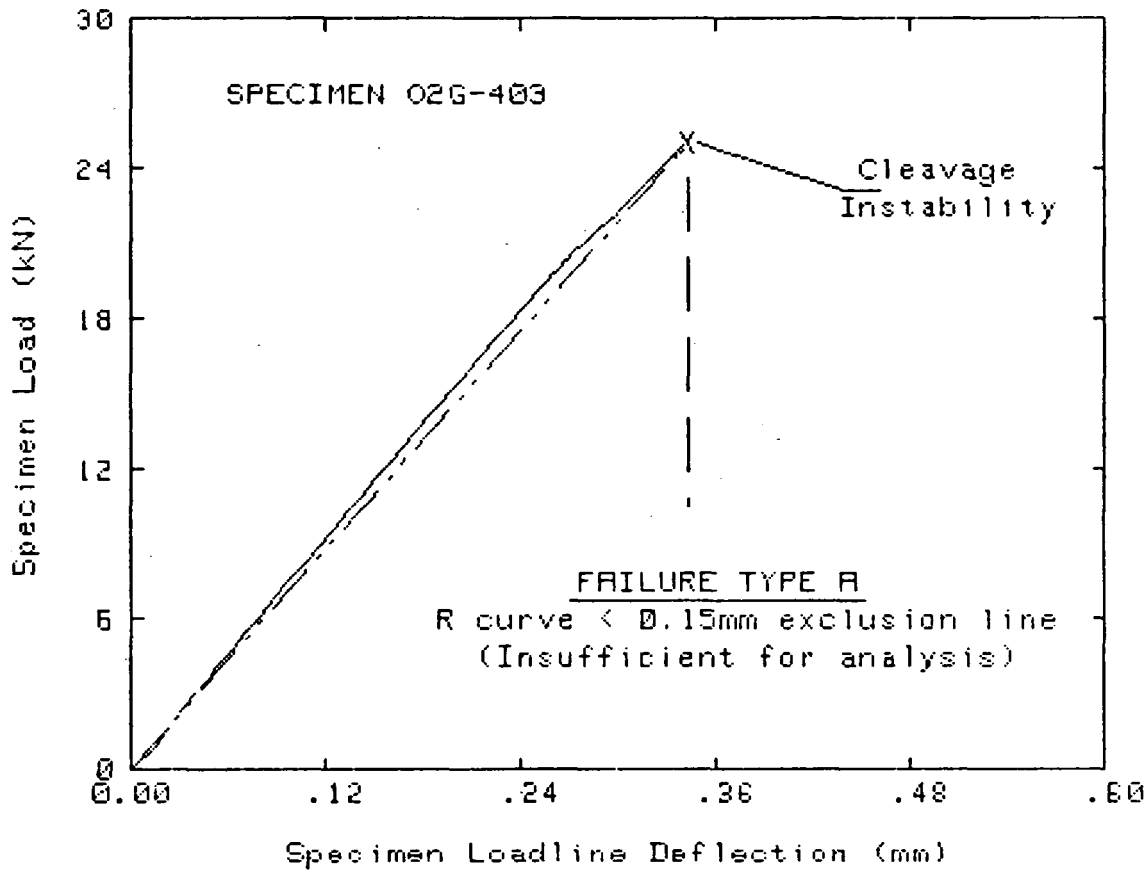
Jic	= 71.9 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 121.2 MPa \/m	v=.3
Kic (Beta Corrected)	= 87.1 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 43.7 kN	
5% Secant Offset Pq	= 31.25 kN	
Kic	= 79.1 MPa \/m	
Validity	= INVALID--1, 2, 3	
K at Maximum Load	= 110.7 MPa \/m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 1.501946958E-04 in.
Specimen rotation Load intercept elastic slope = .000004275 lb
Fitted elastic load range= 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533B Plate 02 (I)	
Test Temperature	= 0 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .608	
Init crack length a	= 30.89 mm	
Flow stress	= 702.5 MPa	(Estimated Value)
Yield stress	= 630 MPa	(Estimated Value)
Youngs modulus E	= 207200 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 19.4 kJ/m^2	
Kjc=(EJic)^.5	= 63.4 MPa √m	ν=.3
Kic (Beta Corrected)	= 58.7 MPa √m	ν=.3

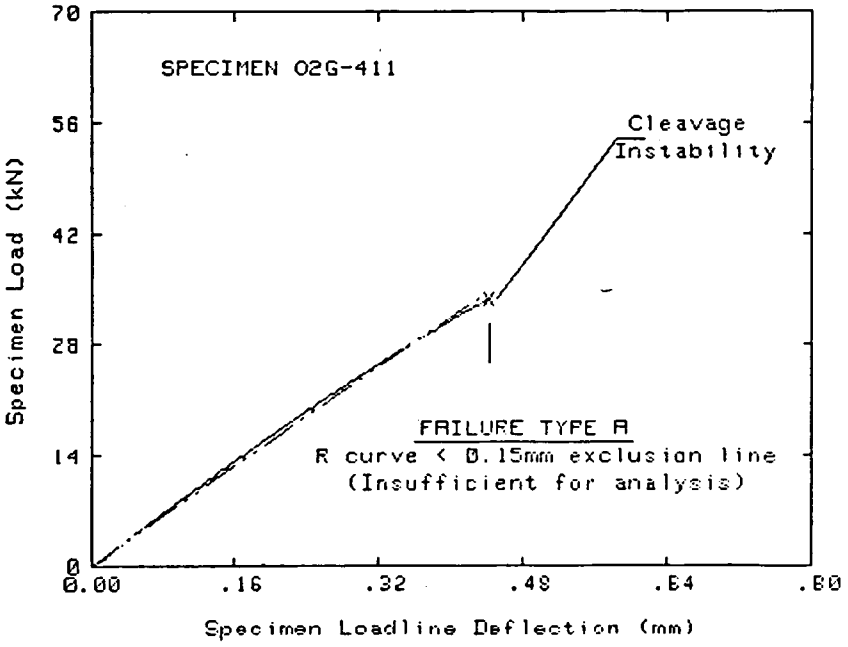
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 25.04 kN	
5% Secant Offset Pq	= 25.04 kN	
Kic	= 61.6 MPa √m	
Validity	= VALID Kic value	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533-B HSST 02 Ref	
Test Temperature	= 50 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .612	
Init crack length a	= 31.06 mm	
Flow stress	= 670.2 MPa	
Yield stress	= 604 MPa	
Youngs modulus E	= 204400 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 34.3 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 83.7 MPa \/m	v=.3
Kic (Beta Corrected)	= 70.6 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

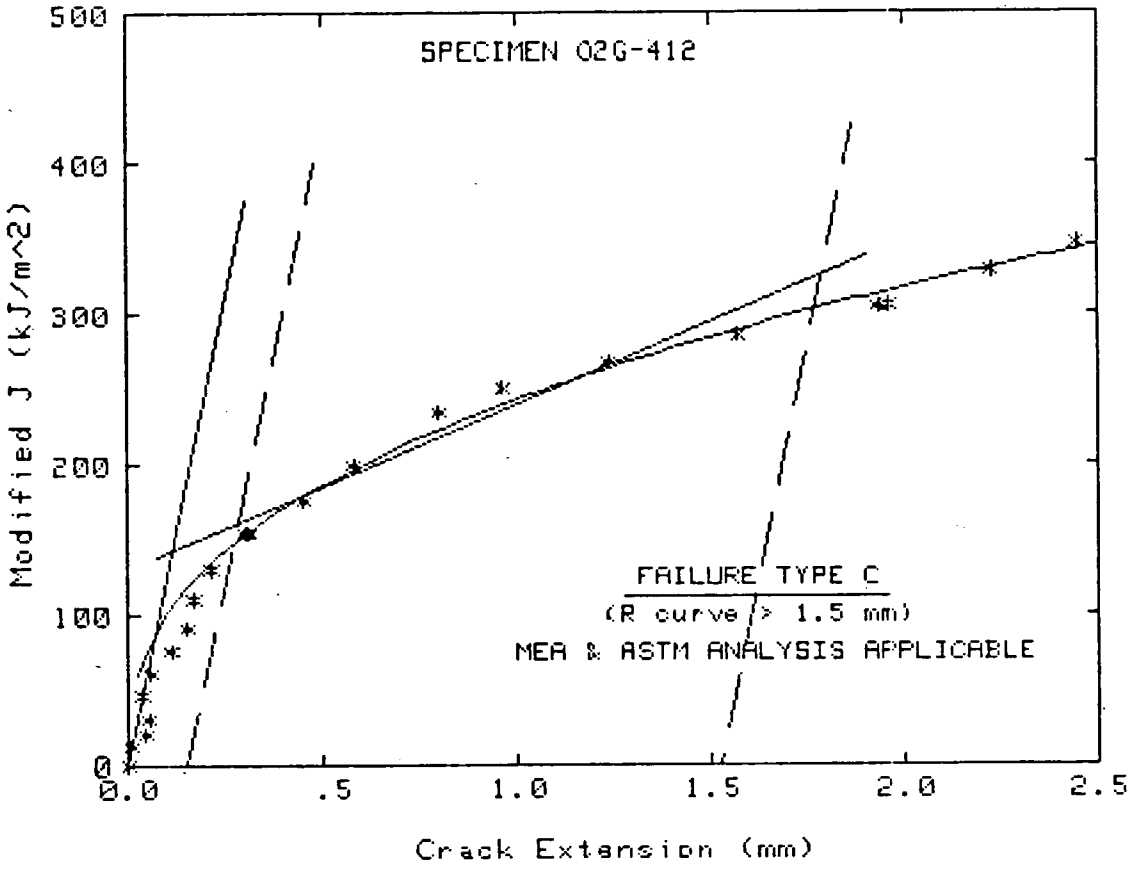
Maximum Load	P	= 33.8 kN
5% Secant Offset	Pq	= 29.28 kN
Kic		= 73.1 MPa \/m
Validity		= INVALID--1, 2, 3
K at Maximum Load		= 84.4 MPa \/m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 1.36307343724E-04 in.

Specimen rotation Load intercept elastic slope =-.00000035 lb

Fitted elastic load range= 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

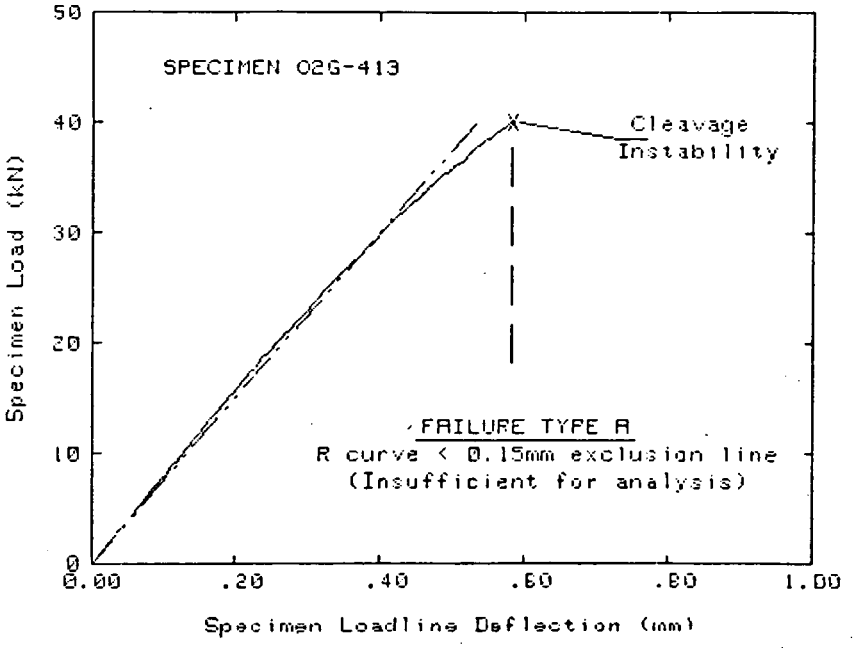
Material Type	= A533B Plate 02	
Test Temperature	= 204 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.09 mm	Init a/W = .612
Final crack length	= 40.92 mm	Final a/W = .805
Flow stress	= 617.4 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 147.5 kJ/m^2
Kjc	= 169.8 MPa √m
J (@J/T=8.8)	= 323.4 kJ/m^2
Exponent N	= .3836
Coefficient C	= 243.1 kJ/m^2
T (average)	= 50

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 143 kJ/m^2	
Kjc	= 167.2 MPa √m	
Slope M	= 109648.9 kJ/m^3	
Intercept B	= 130.3 kJ/m^2	
T (ASTM)	= 56	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 608 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.97 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533B Plate 02 (I)	
Test Temperature	= 80 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .6	
Init crack length a	= 30.48 mm	
Flow stress	= 656.5 MPa	
Yield stress	= 590.3 MPa	
Youngs modulus E	= 202600 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

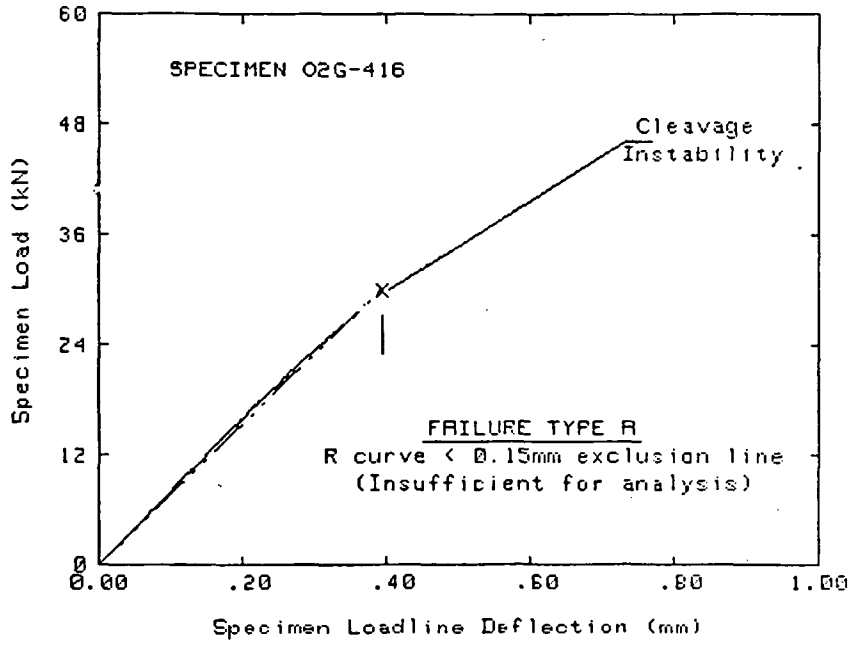
Jic	= 54.1 kJ/m^2	
Kjc=(EJic)^.5	= 104.7 MPa √m	ν=.3
Kic (Beta Corrected)	= 79.8 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 40.08 kN	
5% Secant Offset Pq	= 28.74 kN	
Kic	= 68.5 MPa √m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-4.18073596109E-05 in.
Specimen rotation Load intercept elastic slope =-.000000576 lb
Fitted elastic load range= 3000 TO 500 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533-B HSST 02 Ref	
Test Temperature	= 50 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .61	
Init crack length a	= 30.98 mm	
Flow stress	= 670.2 MPa	
Yield stress	= 604 MPa	
Youngs modulus E	= 204400 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 26.7 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 73.9 MPa \/m	v=.3
Kic (Beta Corrected)	= 65 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

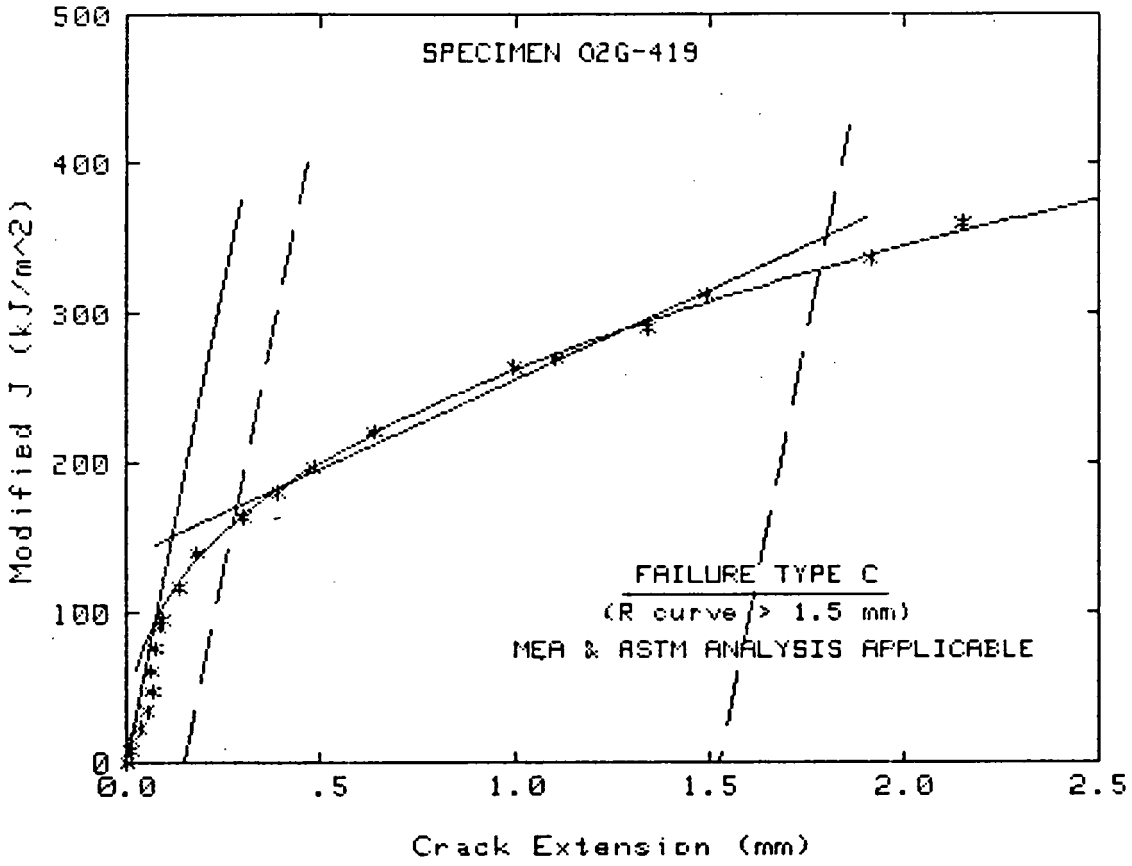
Maximum Load P	= 29.98 kN	
5% Secant Offset Pq	= 29.04 kN	
Kic	= 72 MPa \/m	
Validity	= INVALID--1, 2	
K at Maximum Load	= 74.3 MPa \/m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 4.5826888920 8E-05 in.

Specimen rotation Load intercept elastic slope = 1.4141666666 7E-05 lb

Fitted elastic load range= 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

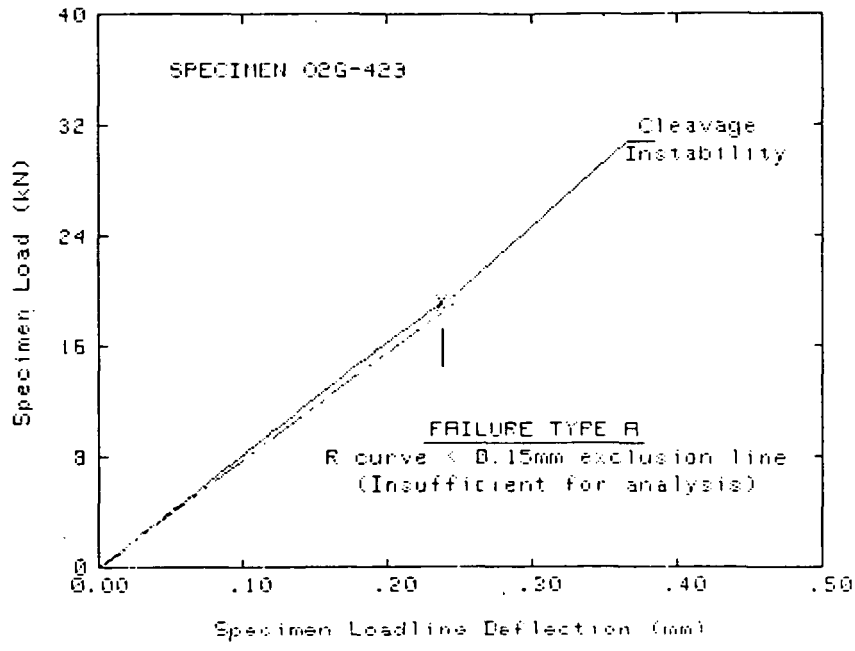
Material Type	= A533B Plate (HSST 02)	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.62 mm	Init a/W = .622
Final crack length	= 40.56 mm	Final a/W = .798
Flow stress	= 639.2 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 158.4 kJ/m^2
Kjc	= 178.1 MPa \/m
J (@J/T=8.8)	= 345.5 kJ/m^2
Exponent N	= .3927
Coefficient C	= 262.5 kJ/m^2
T (average)	= 53

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 150.6 kJ/m^2	
Kjc	= 173.7 MPa \/m	
Slope M	= 119773.4 kJ/m^3	
Intercept B	= 136.5 kJ/m^2	
T (ASTM)	= 59	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 612.6 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.92 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B HSST 02 Ref	
Test Temperature	= -25 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .61	
Init crack length a	= 31 mm	
Flow stress	= 715.7 MPa	
Yield stress	= 643.3 MPa	
Youngs modulus E	= 208600 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 10 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 45.8 MPa √m	v=.3
Kic (Beta Corrected)	= 44.7 MPa √m	v=.3

ASTM E399-81 ANALYSIS

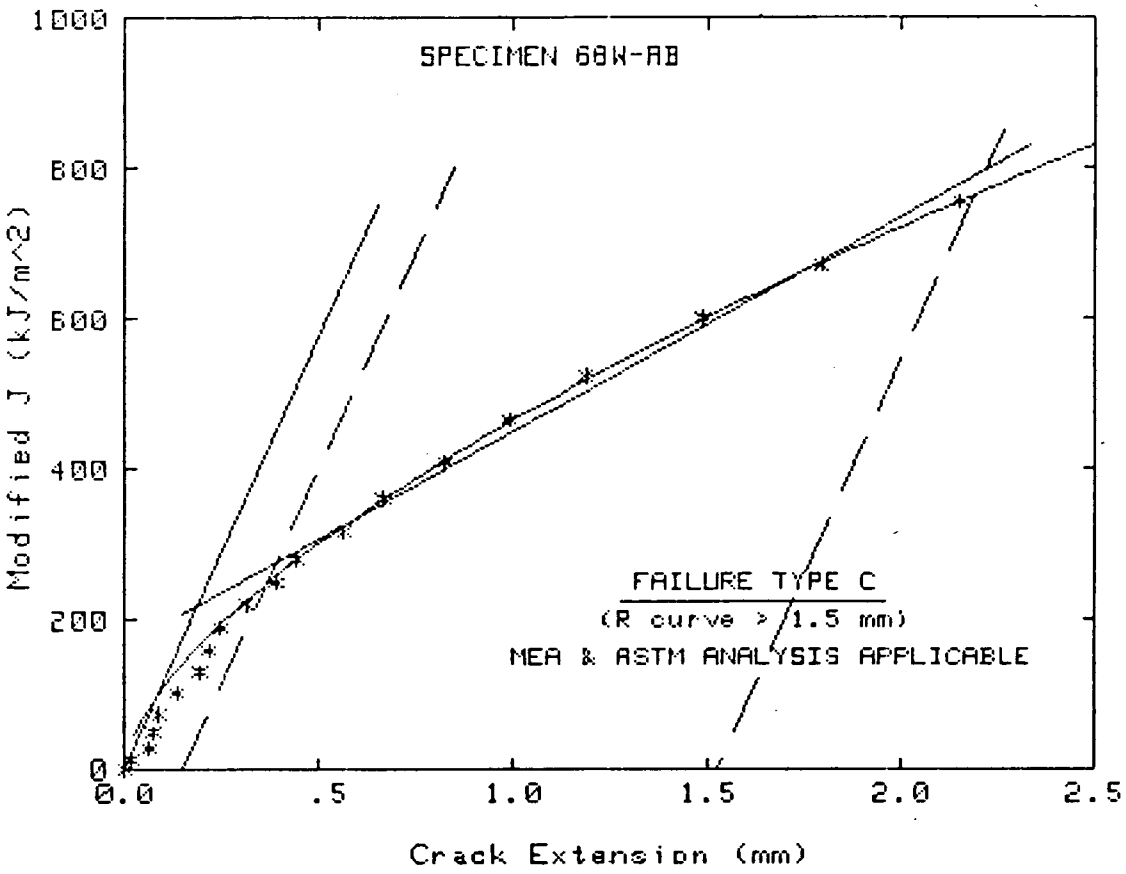
Modified Kic Equation:	B = (BBn)^.5	
Maximum Load P	= 19.1 kN	
5% Secant Offset Pq	= 19.1 kN	
Kic	= 47.5 MPa √m	
Validity	= VALID Kic value	
K at Maximum Load	= 47.4 MPa √m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merrile-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 1.969445039 73E-04 in.

Specimen rotation Load intercept elastic slope = 3.141666666667E-06 lb

Fitted elastic load range= 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

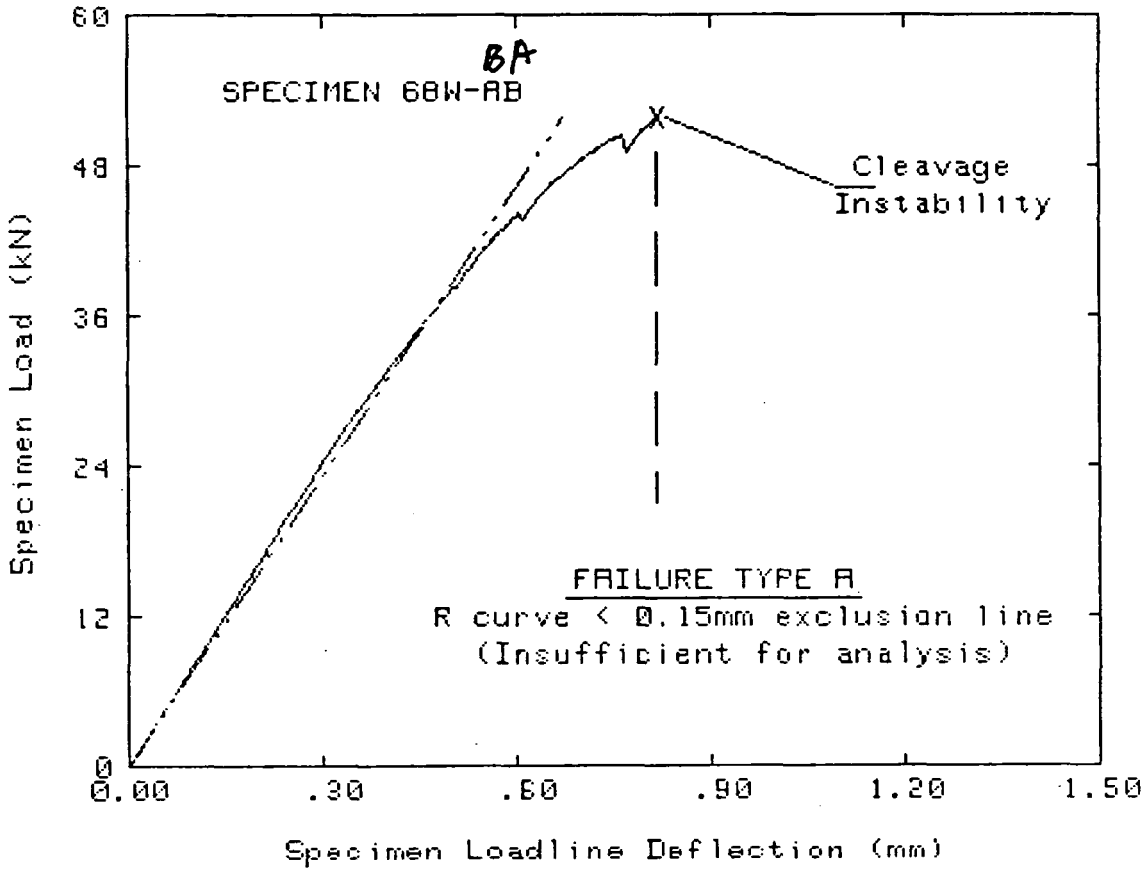
Material Type	= HSST S/A Weld	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.65 mm	Init a/W = .603
Final crack length	= 34.75 mm	Final a/W = .684
Flow stress	= 575.5 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 246.7 kJ/m^2
Kjc	= 222.3 MPa \/m
J (@J/T=8.8)	= 983.7 kJ/m^2
Exponent N	= .6326
Coefficient C	= 465.2 kJ/m^2
T (average)	= 168

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 217 kJ/m^2	
Kjc	= 208.5 MPa \/m	
Slope M	= 286325.8 kJ/m^3	
Intercept B	= 163 kJ/m^2	
T (ASTM)	= 173	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--1	
J maximum allowed	= 579.4 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.01 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -75 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .596	
Init crack length a	= 30.26 mm	
Flow stress	= 741 MPa	
Yield stress	= 726 MPa	
Youngs modulus E	= 211400 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 104.3 kJ/m^2	
Kjc=(EJic)^.5	= 148.5 MPa \/m	v=.3
Kic (Beta Corrected)	= 105.7 MPa \/m	v=.3

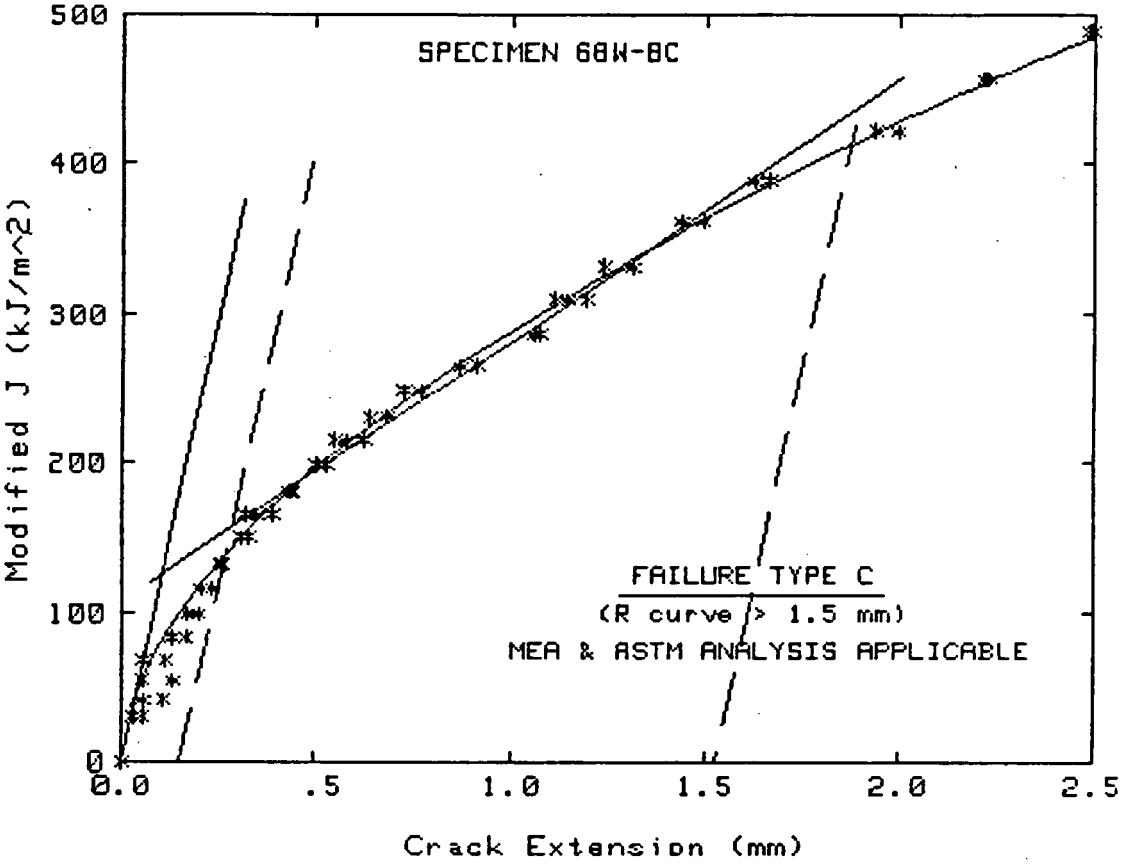
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 51.88 kN	
5% Secant Offset Pq	= 35.92 kN	
Kic	= 84.2 MPa \/m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

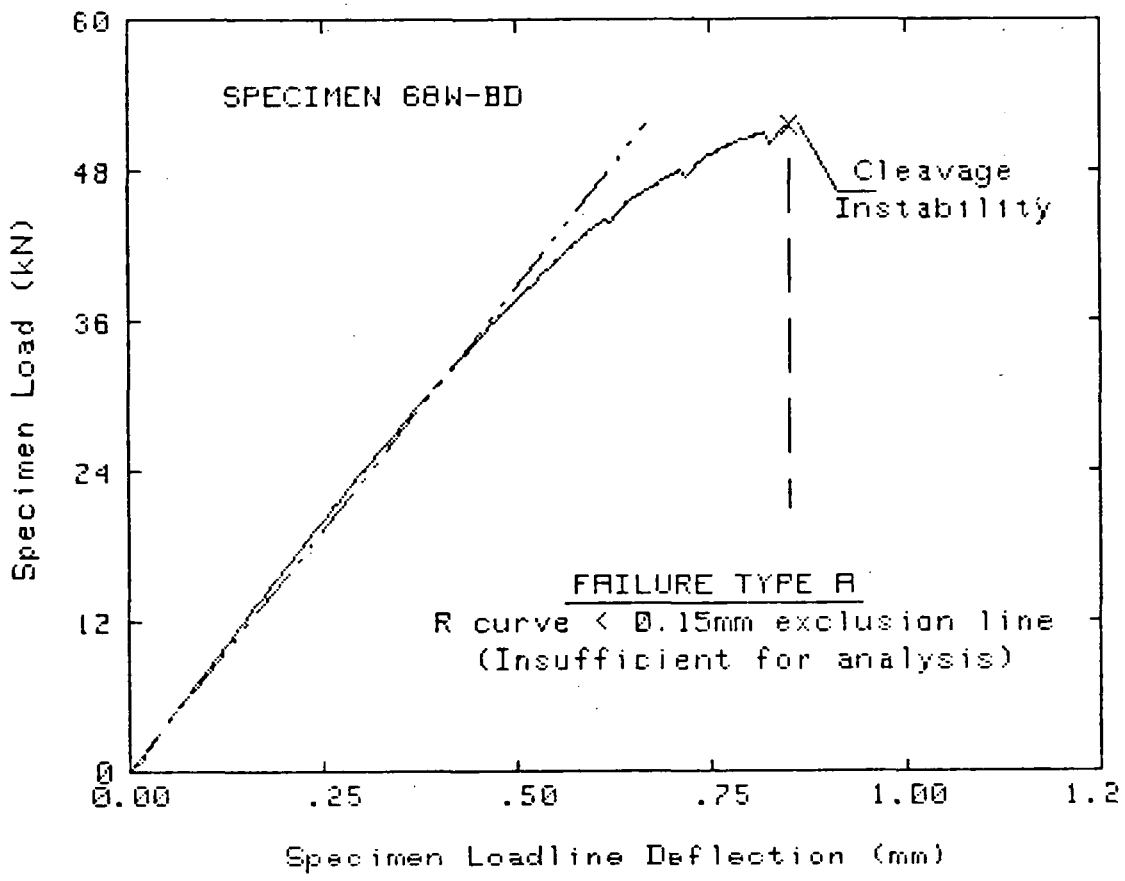
Material Type	= A533B HSST Weld	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.59 mm	Init a/W = .602
Final crack length	= 38.04 mm	Final a/W = .748
Flow stress	= 590.9 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 138 kJ/m^2
Kjc	= 162.3 MPa \/m
J (@J/T=8.8)	= 542.9 kJ/m^2
Exponent N	= .5642
Coefficient C	= 289.4 kJ/m^2
T (average)	= 90

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 125.8 kJ/m^2	
Kjc	= 154.9 MPa \/m	
Slope M	= 174822.2 kJ/m^3	
Intercept B	= 107.1 kJ/m^2	
T (ASTM)	= 96	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--3 (.62 vs .3)	
J maximum allowed	= 596.5 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.02 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -50 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .597	
Init crack length a	= 30.33 mm	
Flow stress	= 709 MPa	
Yield stress	= 691 MPa	
Youngs modulus E	= 210000 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

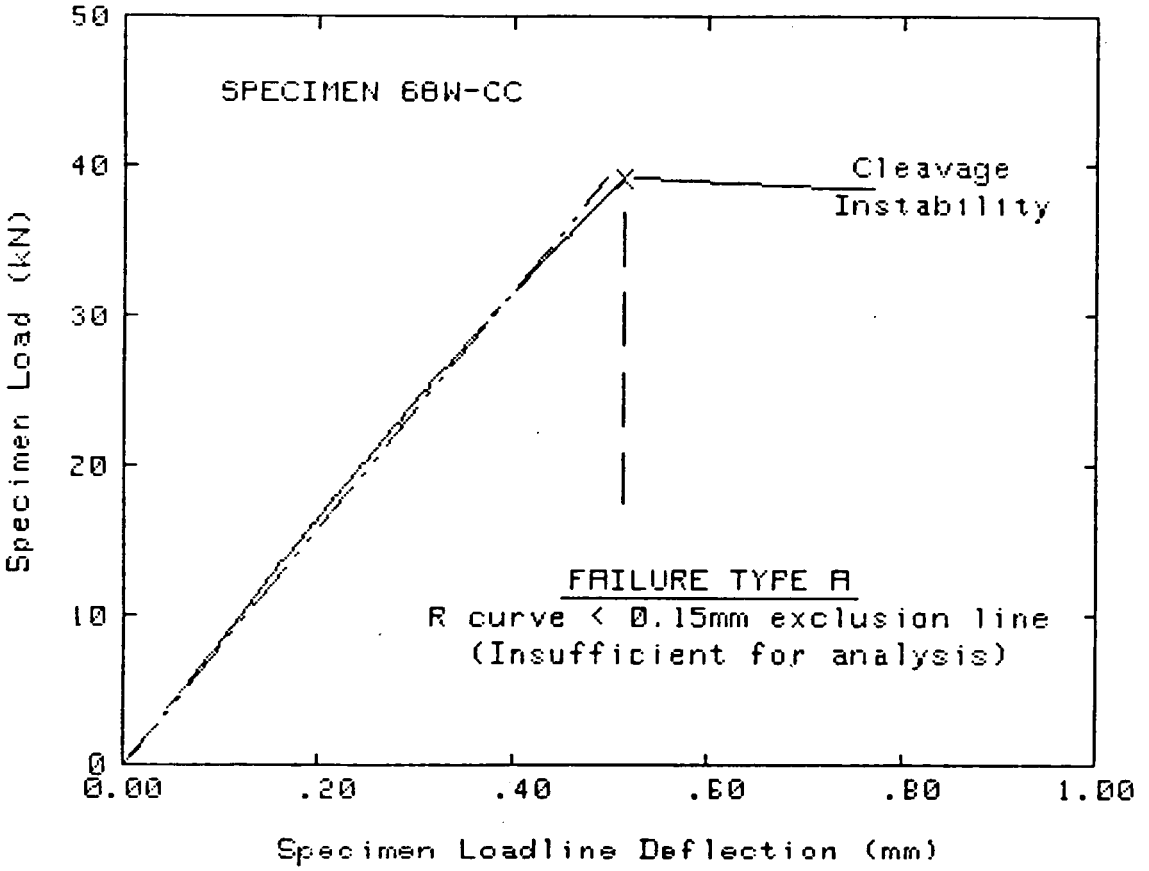
Jic	= 110.6 kJ/m^2	
Kjc=(EJic)^.5	= 152.4 MPa √m	ν=.3
Kic (Beta Corrected)	= 104.4 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 51.64 kN	
5% Secant Offset Pq	= 32.2 kN	
Kic	= 75.9 MPa √m	
Validity	= INVALID--2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -75 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .597	
Init crack length a	= 30.33 mm	
Flow stress	= 741 MPa	
Yield stress	= 726 MPa	
Youngs modulus E	= 211400 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

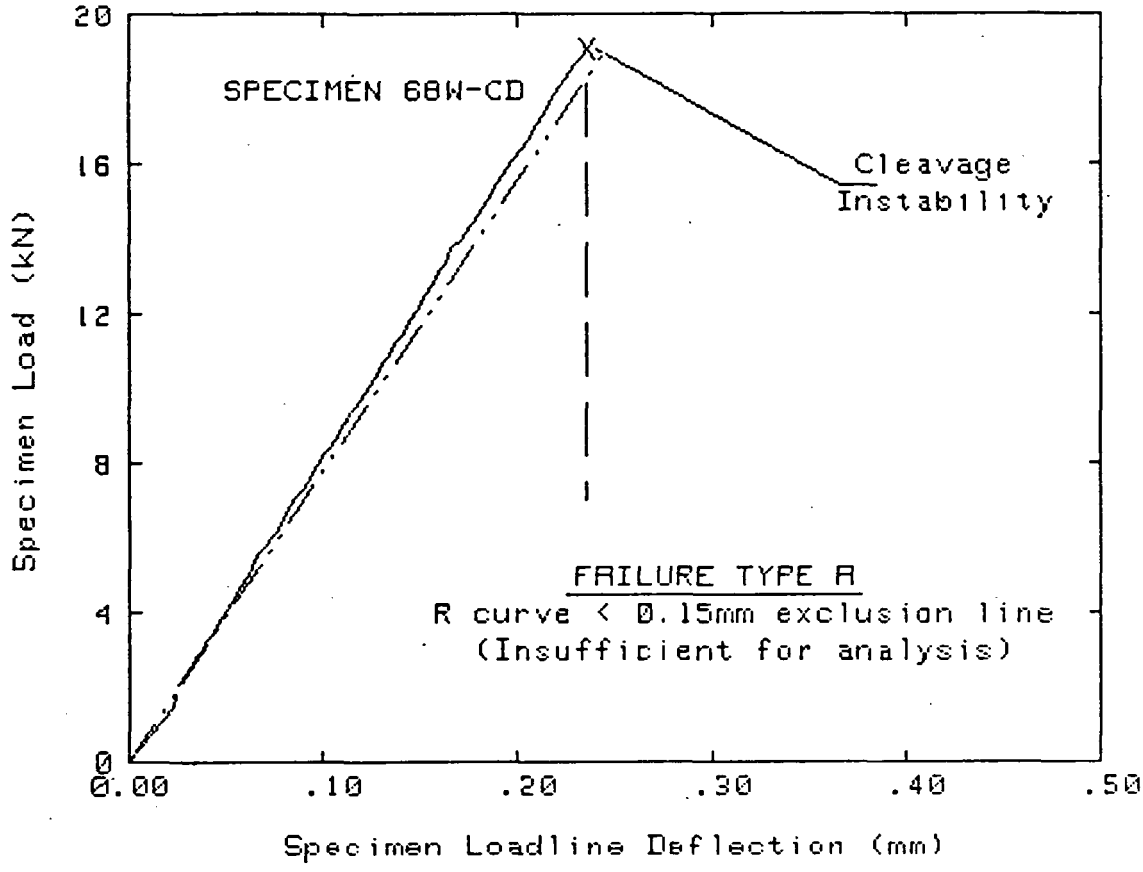
Jic	= 44.8 kJ/m^2	
Kjc=(EJic)^.5	= 97.3 MPa \/m	v=.3
Kic (Beta Corrected)	= 83.1 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 39.15 kN	
5% Secant Offset Pq	= 32.28 kN	
Kic	= 76.1 MPa \/m	
Validity	= INVALID--2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 2.52960950458E-04 in.
Specimen rotation Load intercept elastic slope = 5.73529411765E-07 lb
Fitted elastic load range=4000 TO 500 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -130 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .594	
Init crack length a	= 30.18 mm	
Flow stress	= 824.5 MPa	
Yield stress	= 817 MPa	
Youngs modulus E	= 214900 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 9.5 kJ/m^2	
Kjc=(EJic)^.5	= 45.3 MPa √m	ν=.3
Kic (Beta Corrected)	= 44.9 MPa √m	ν=.3

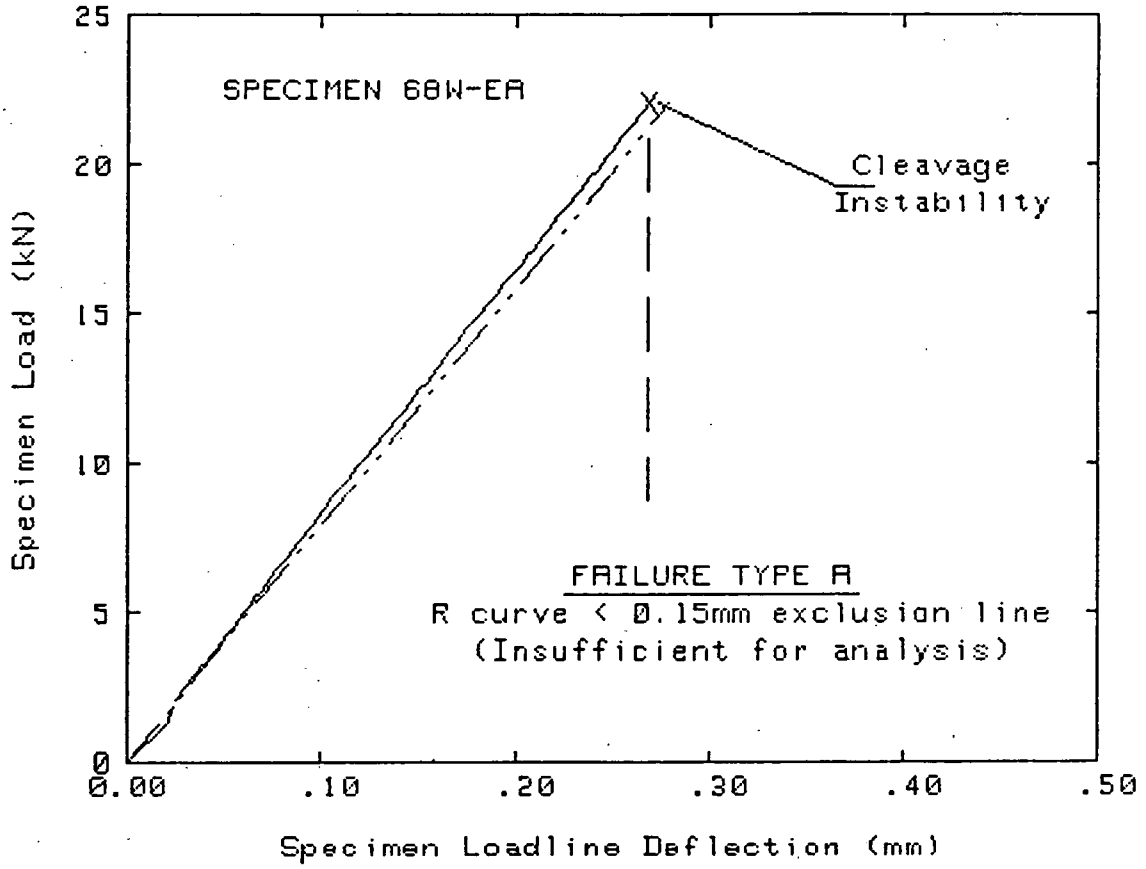
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 19.1 kN	
5% Secant Offset Pq	= 19.1 kN	
Kic	= 44.5 MPa √m	
Validity	= VALID Kic value	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 5.00325532684E-05 in.
Specimen rotation Load intercept elastic slope = 3.15789473684E-07 lb
Fitted elastic load range=3400 TO 500 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -130 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .605	
Init crack length a	= 30.73 mm	
Flow stress	= 824.5 MPa	
Yield stress	= 817 MPa	
Youngs modulus E	= 212300 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 12.9 kJ/m^2	
Kjc=(EJic)^.5	= 52.3 MPa \/m	v=.3
Kic (Beta Corrected)	= 51.4 MPa \/m	v=.3

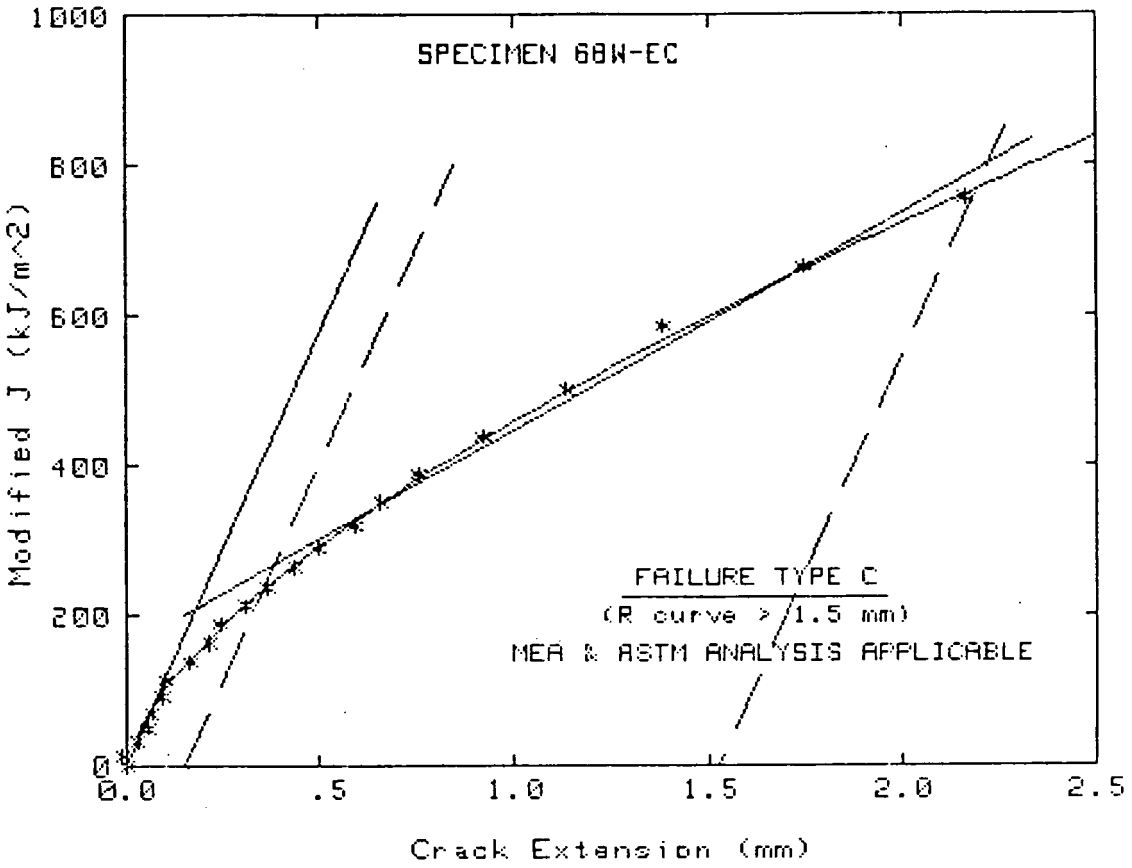
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load	P	= 22 kN
5% Secant Offset	Pq	= 22.03 kN
Kic		= 53.6 MPa \/m
Validity		= VALID Kic value

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

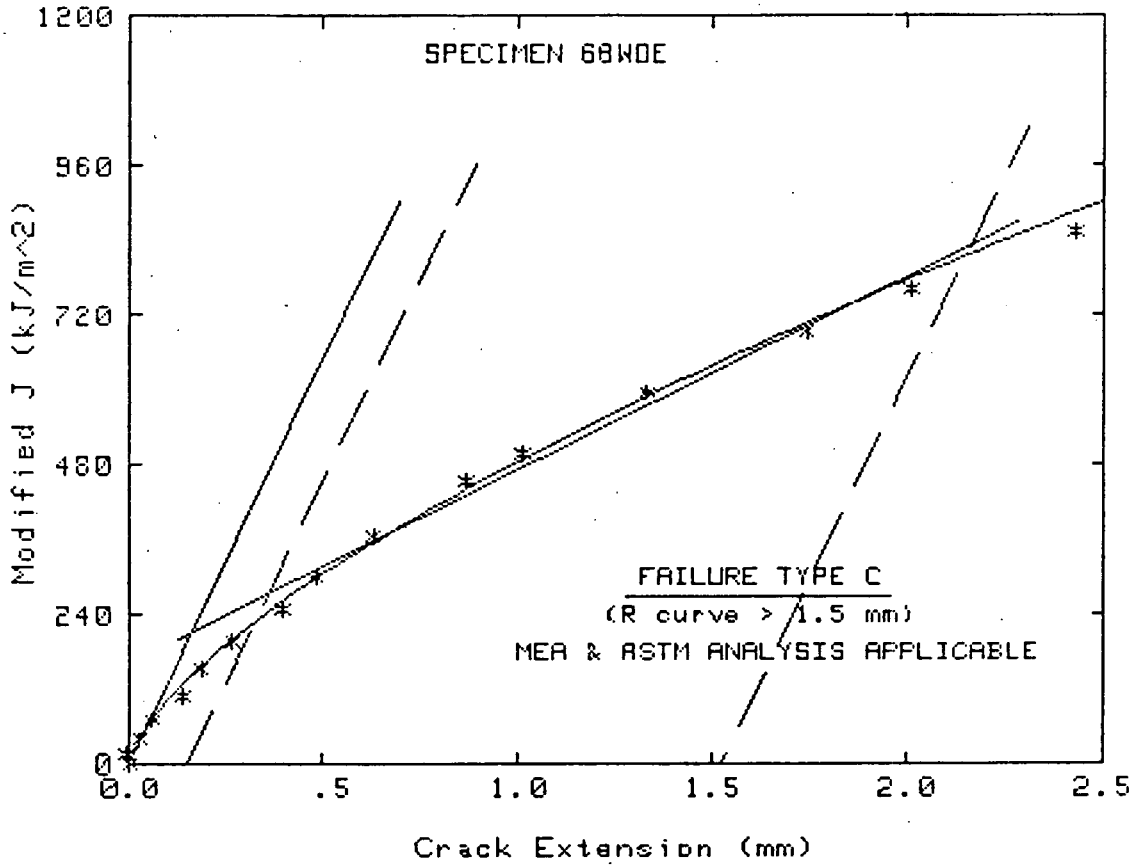
Material Type	= HSST S/A Weld	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.75 mm	Init a/W = .605
Final crack length	= 35.1 mm	Final a/W = .69
Flow stress	= 575.5 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 233.2 kJ/m^2
Kjc	= 216.1 MPa √m
J (@J/T=8.8)	= 990.1 kJ/m^2
Exponent N	= .6541
Coefficient C	= 459 kJ/m^2
T (average)	= 172

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 210.8 kJ/m^2	
Kjc	= 205.5 MPa √m	
Slope M	= 290056.7 kJ/m^3	
Intercept B	= 157.6 kJ/m^2	
T (ASTM)	= 176	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 576.5 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.01 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

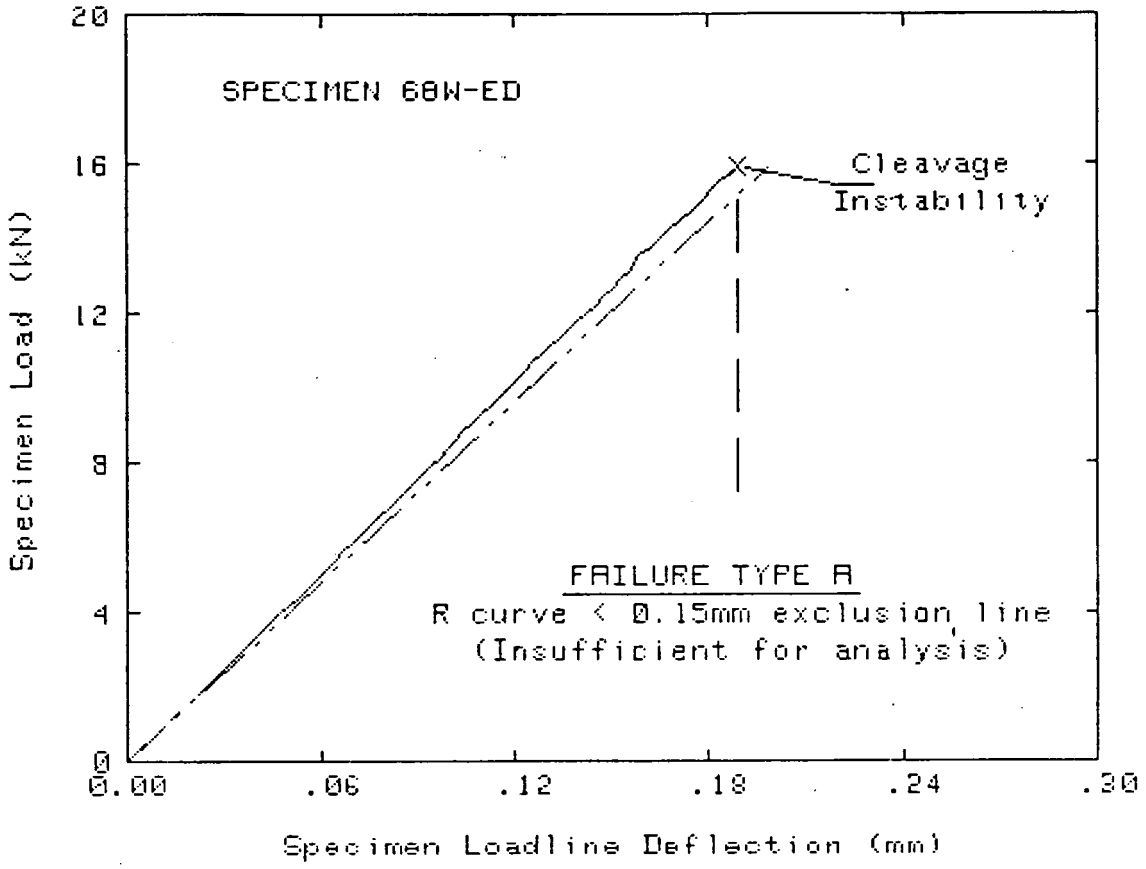
Material Type	= A533-B HS	
Test Temperature	= 25 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.01 mm	Init a/W = .61
Final crack length	= 34.91 mm	Final a/W = .687
Flow stress	= 650.2 MPa	
Youngs modulus	= 205800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 228.1 kJ/m^2
Kjc	= 216.7 MPa \/m
J (@J/T=8.8)	= 932.4 kJ/m^2
Exponent N	= .6764
Coefficient C	= 484.9 kJ/m^2
T (average)	= 153

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 210.7 kJ/m^2	
Kjc	= 208.3 MPa \/m	
Slope M	= 309715.3 kJ/m^3	
Intercept B	= 160.5 kJ/m^2	
T (ASTM)	= 151	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 642.8 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.98 mm	(Delta a max = 0.1*bo)
Final Delta a	= 4.03 mm	
Poisson's Ratio (v)	= 0	



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -130 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .603	
Init crack length a	= 30.65 mm	
Flow stress	= 824.5 MPa	
Yield stress	= 817 MPa	
Youngs modulus E	= 214900 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 6.5 kJ/m^2	
Kjc=(EJic)^.5	= 37.4 MPa √m	v=.3
Kic (Beta Corrected)	= 37.2 MPa √m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

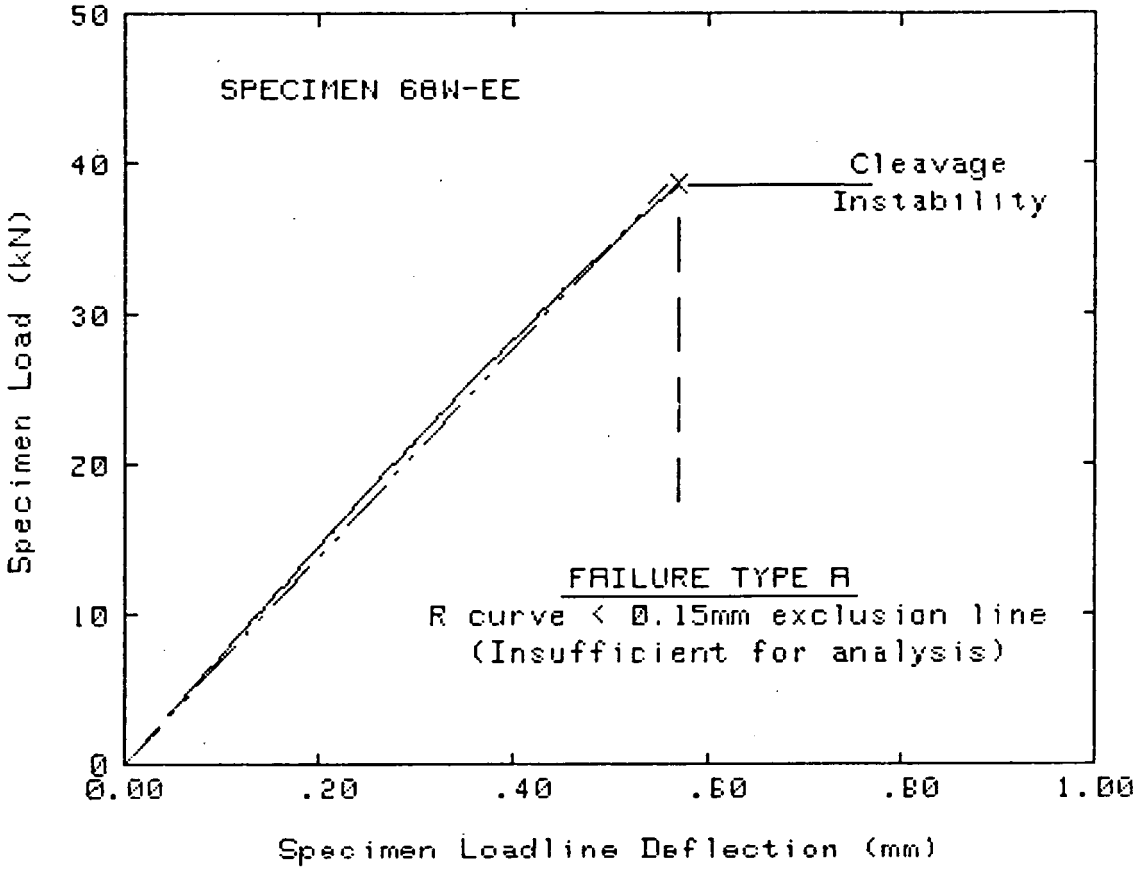
Maximum Load P	= 15.9 kN	
5% Secant Offset Pq	= 15.91 kN	
Kic	= 38.5 MPa √m	
Validity	= VALID Kic value	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 5.58354494761E-05 in.

Specimen rotation Load intercept elastic slope =-.000000375 lb

Fitted elastic load range=3400 TO 500 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -100 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .623	
Init crack length a	= 31.67 mm	
Flow stress	= 777 MPa	
Yield stress	= 765 MPa	
Youngs modulus E	= 212900 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

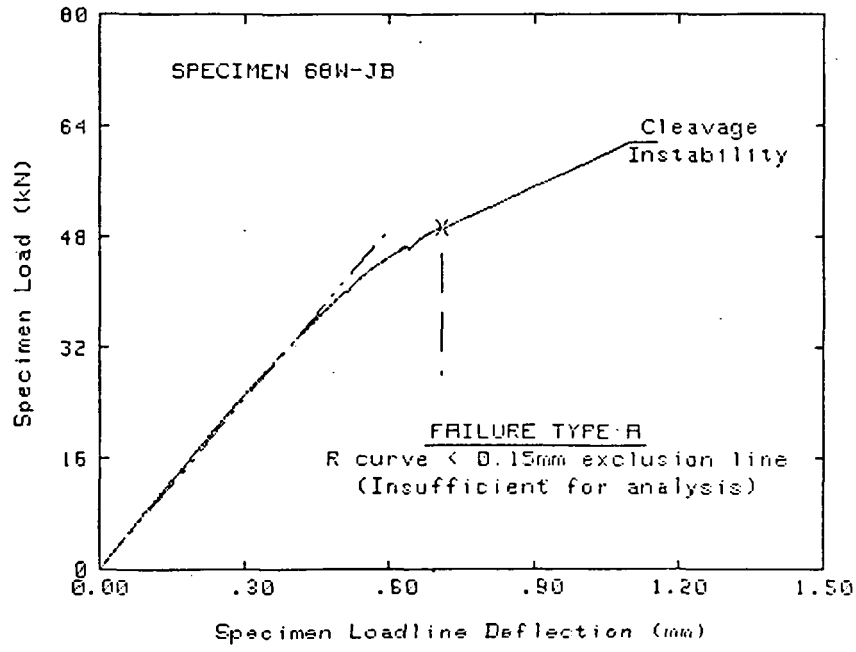
Jic	= 51.8 kJ/m^2	
Kjc=(EJic)^.5	= 105.1 MPa \/m	v=.3
Kic (Beta Corrected)	= 88.9 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 38.6 kN	
5% Secant Offset Pq	= 33.48 kN	
Kic	= 87.8 MPa \/m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 2.44533097686E-04 in.
Specimen rotation Load intercept elastic slope = 8.38709677419E-07 lb
Fitted elastic load range=3400 TO 500 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= -50 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .603	
Init crack length a	= 30.62 mm	
Flow stress	= 708.6 MPa	
Yield stress	= 604 MPa	
Youngs modulus E	= 210100 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

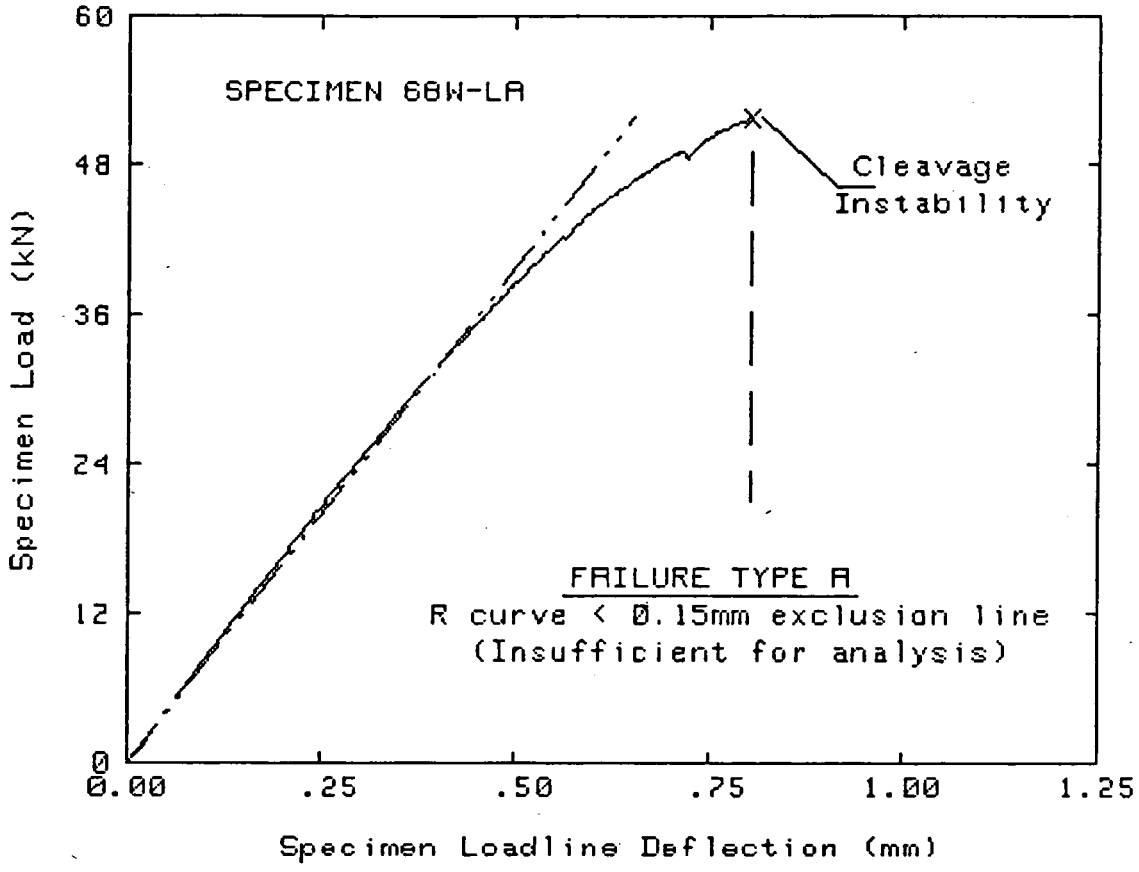
Jic	= 85.3 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 133.9 MPa \/m	v=.3
Kic (Beta Corrected)	= 91.5 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 49.4 kN	
5% Secant Offset Pq	= 31.74 kN	
Kic	= 76.5 MPa \/m	
Validity	= INVALID--1, 2, 3	
K at Maximum Load	= 119.1 MPa \/m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 1.3862506629E-04 in.
Specimen rotation Load intercept elastic slope = .0000083 lb
Fitted elastic load range= 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -50 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .611	
Init crack length a	= 31.04 mm	
Flow stress	= 709 MPa	
Yield stress	= 691 MPa	
Youngs modulus E	= 210000 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 105.8 kJ/m^2	
Kjc=(EJic)^.5	= 149.1 MPa \/m	v=.3
Kic (Beta Corrected)	= 103.3 MPa \/m	v=.3

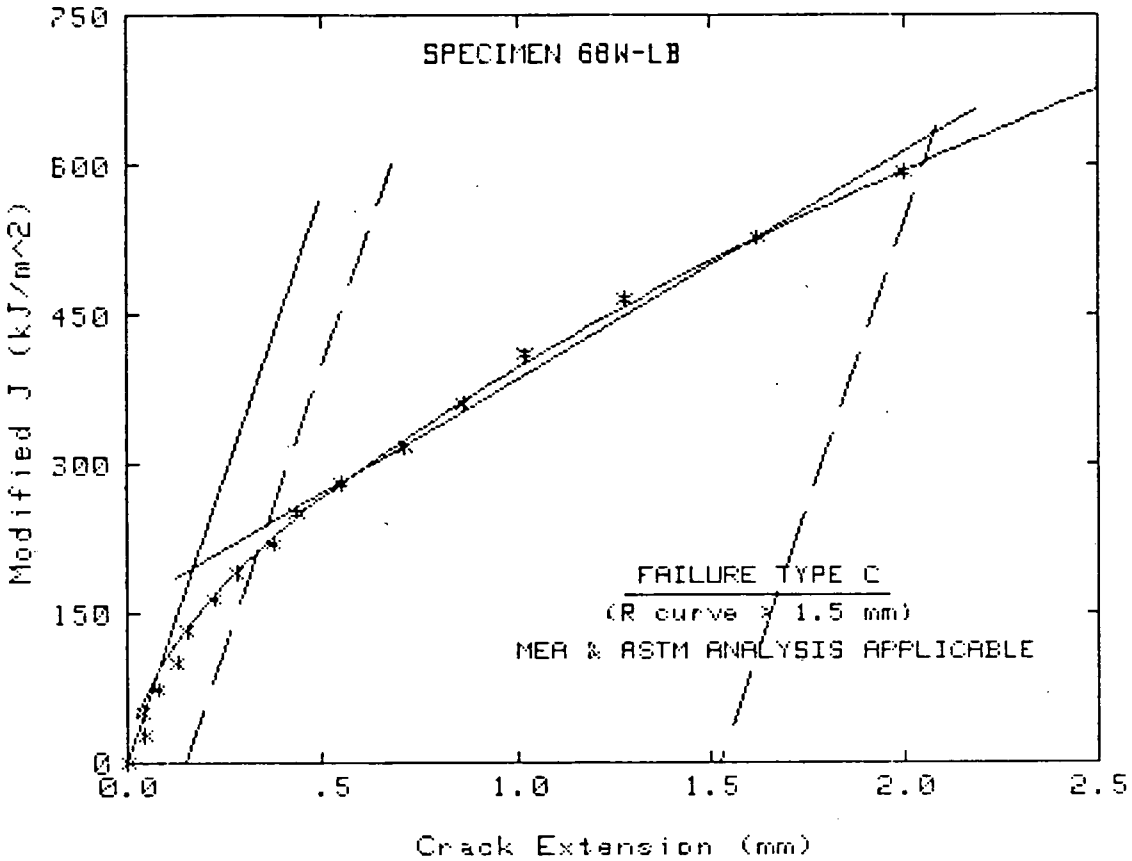
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 51.8 kN	
5% Secant Offset Pq	= 32.61 kN	
Kic	= 81.3 MPa \/m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 2.60699548054E-04 in.
Specimen rotation Load intercept elastic slope = 2.67857142857E-07 lb
Fitted elastic load range=3400 TO 500 Correction to J for crack extension



TEST SPECIMEN DATA

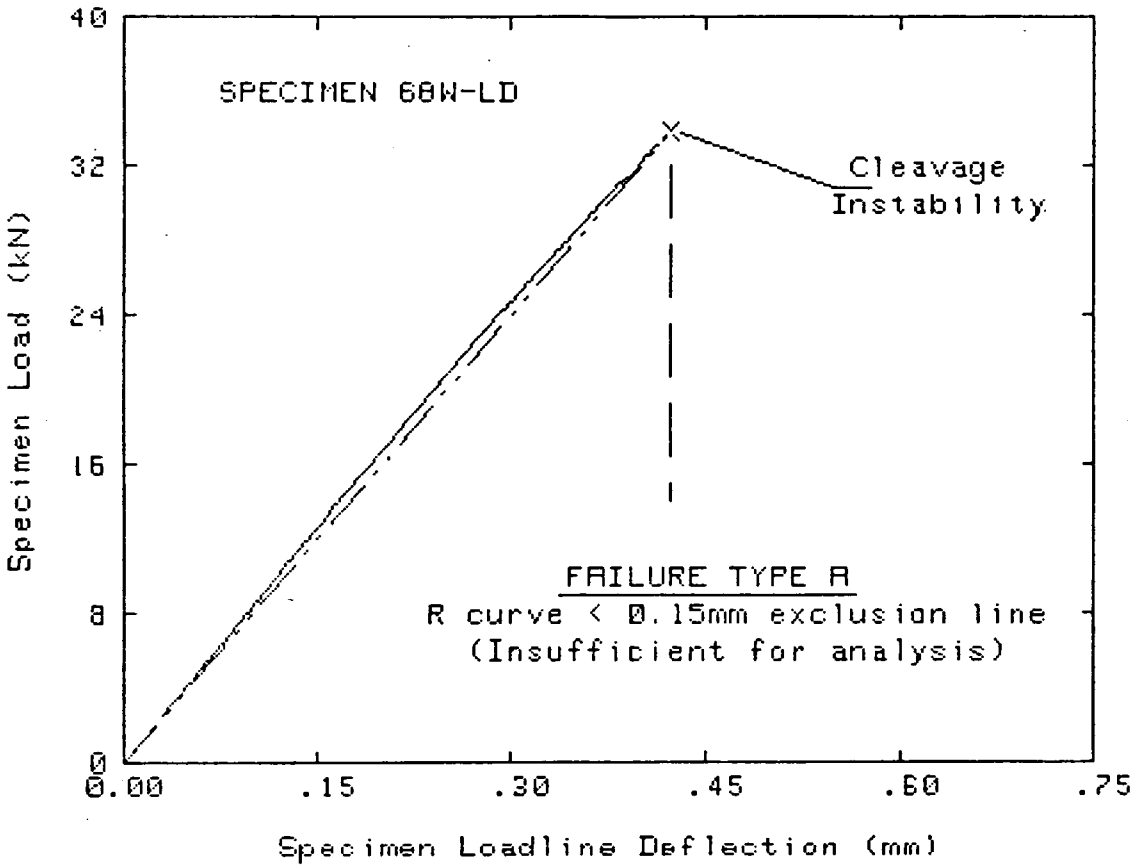
Material Type	= HSST-S/A WELD	
Test Temperature	= 204 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.76 mm	Init a/W = .605
Final crack length	= 36.02 mm	Final a/W = .709
Flow stress	= 571.8 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 211.3 kJ/m^2
Kjc	= 203.2 MPa √m
J (@J/T=8.8)	= 738.5 kJ/m^2
Exponent N	= .5809
Coefficient C	= 397.2 kJ/m^2
T (average)	= 133

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 194.4 kJ/m^2
Kjc	= 195 MPa √m
Slope M	= 229436.7 kJ/m^3
Intercept B	= 155.4 kJ/m^2
T (ASTM)	= 137
Validity (Jic)	= VALID
Validity (R-curve)	= VALID
J maximum allowed	= 572.5 kJ/m^2 (Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2 mm (Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -75 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .596	
Init crack length a	= 30.26 mm	
Flow stress	= 741 MPa	
Yield stress	= 726 MPa	
Youngs modulus E	= 211500 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

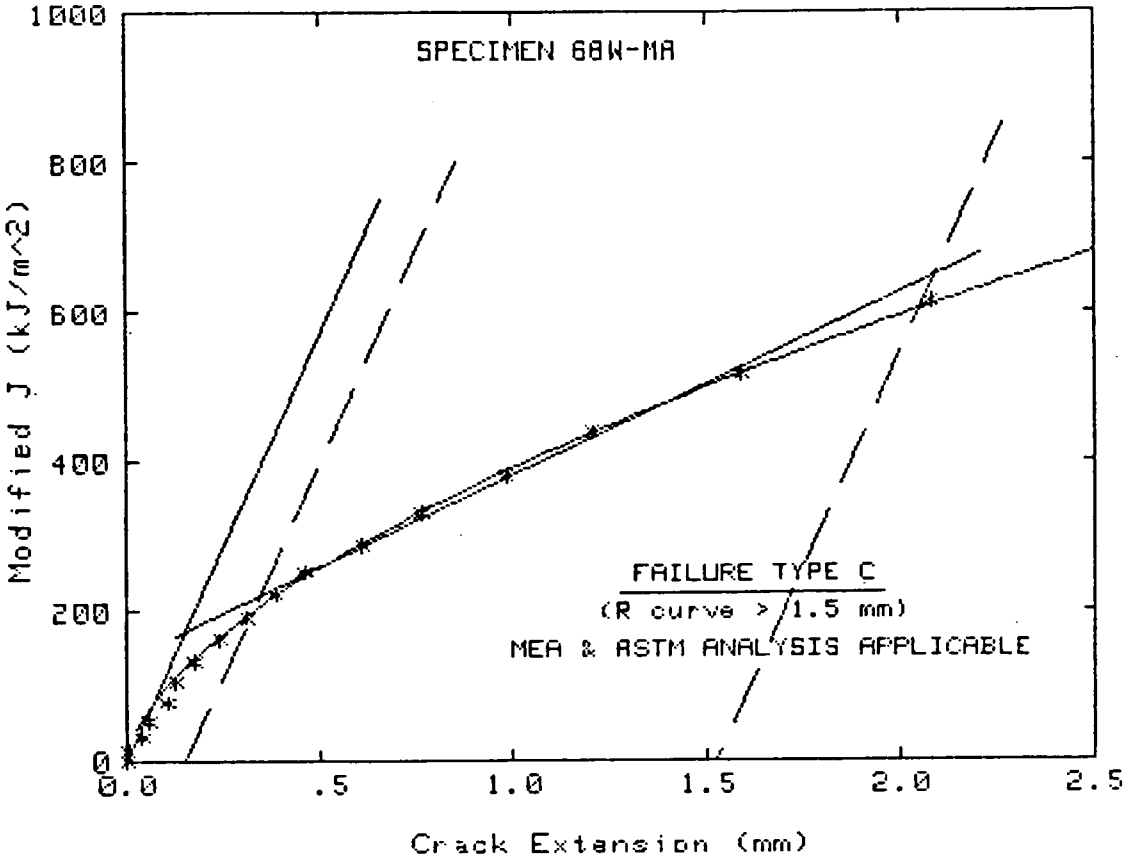
Jic	= 31.3 kJ/m^2	
Kjc=(EJic)^.5	= 81.4 MPa √m	ν=.3
Kic (Beta Corrected)	= 73.4 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 33.85 kN	
5% Secant Offset Pq	= 33.85 kN	
Kic	= 79.4 MPa √m	
Validity	= INVALID--2	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 3.45210187928E-04 in.
Specimen rotation Load intercept elastic slope = 2.64705882353E-07 lb
Fitted elastic load range=4000 TO 500 Correction to J for crack extension



TEST SPECIMEN DATA

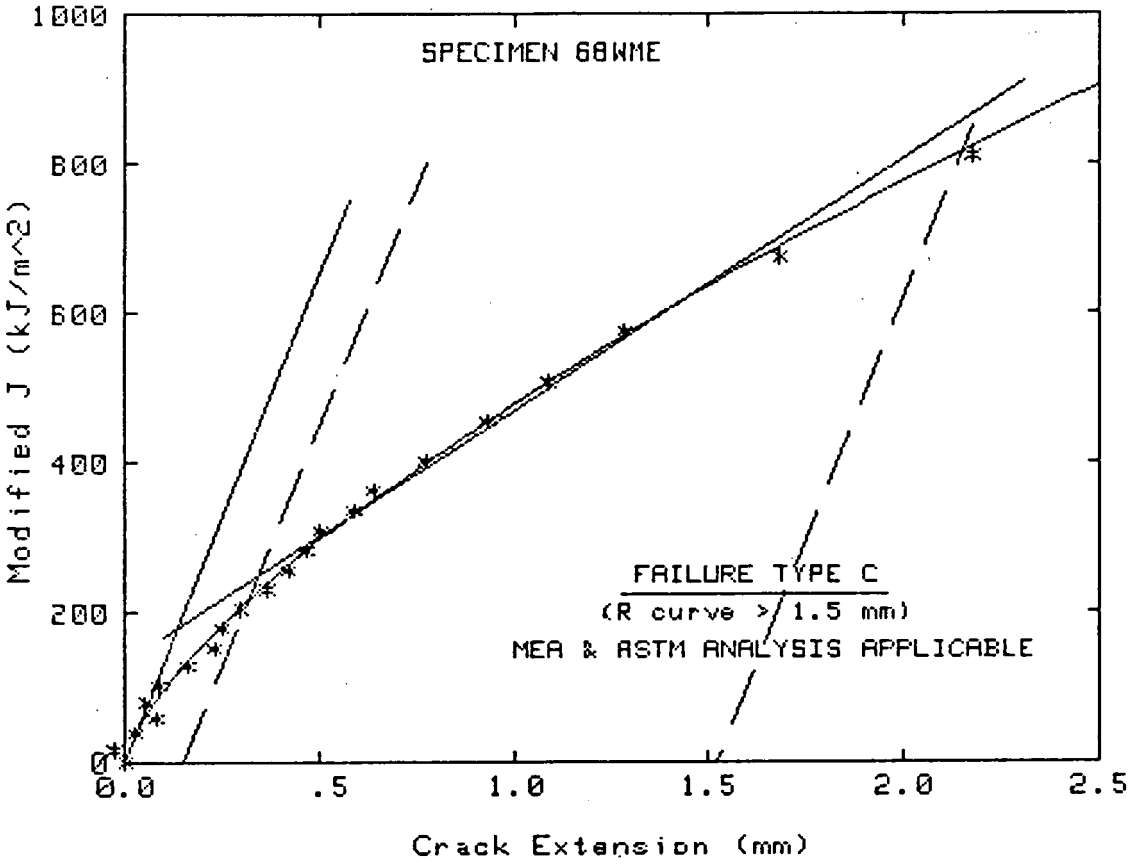
Material Type	= HSST S/A Weld	
Test Temperature	= 204 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.62 mm	Init a/W = .602
Final crack length	= 36.18 mm	Final a/W = .712
Flow stress	= 571.8 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 199.9 kJ/m^2
Kjc	= 197.7 MPa √m
J (@J/T=8.8)	= 0 kJ/m^2
Exponent N	= .6018
Coefficient C	= 391.4 kJ/m^2
T (average)	= 136

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 175.1 kJ/m^2	
Kjc	= 185 MPa √m	
Slope M	= 244415.3 kJ/m^3	
Intercept B	= 137.7 kJ/m^2	
T (ASTM)	= 146	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 576.5 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.02 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

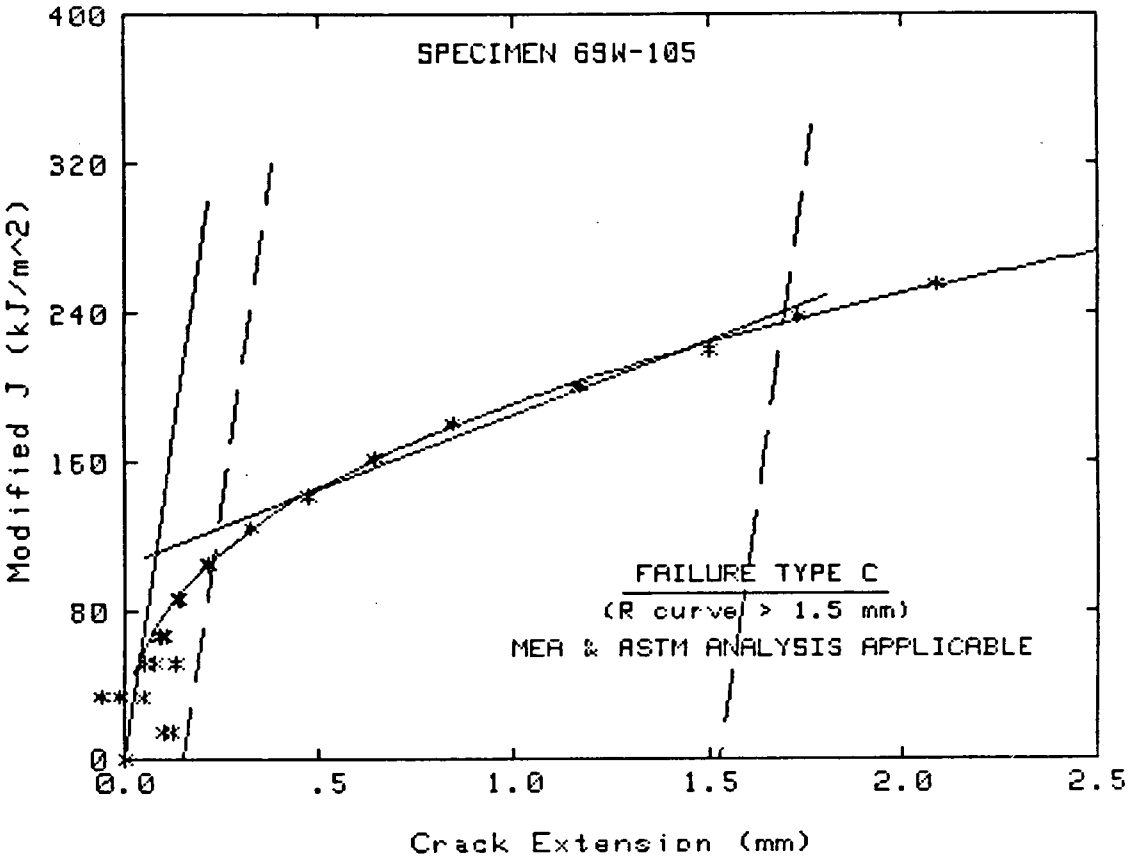
Material Type	= A533-B HS	
Test Temperature	= 25 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.85 mm	Init a/W = .607
Final crack length	= 34.89 mm	Final a/W = .686
Flow stress	= 650.2 MPa	
Youngs modulus	= 205800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 217 kJ/m^2
Kjc	= 211.3 MPa \/m
J (@J/T=8.8)	= 981.6 kJ/m^2
Exponent N	= .6942
Coefficient C	= 479.2 kJ/m^2
T (average)	= 156

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 178.1 kJ/m^2
Kjc	= 191.4 MPa \/m
Slope M	= 336803.2 kJ/m^3
Intercept B	= 131.9 kJ/m^2
T (ASTM)	= 164
Validity (Jic)	= VALID
Validity (R-curve)	= VALID
J maximum allowed	= 648.1 kJ/m^2 (Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2 mm (Delta a max = 0.1*bo)
Final Delta a	= 3.99 mm
Poisson's Ratio (v)	= 0



TEST SPECIMEN DATA

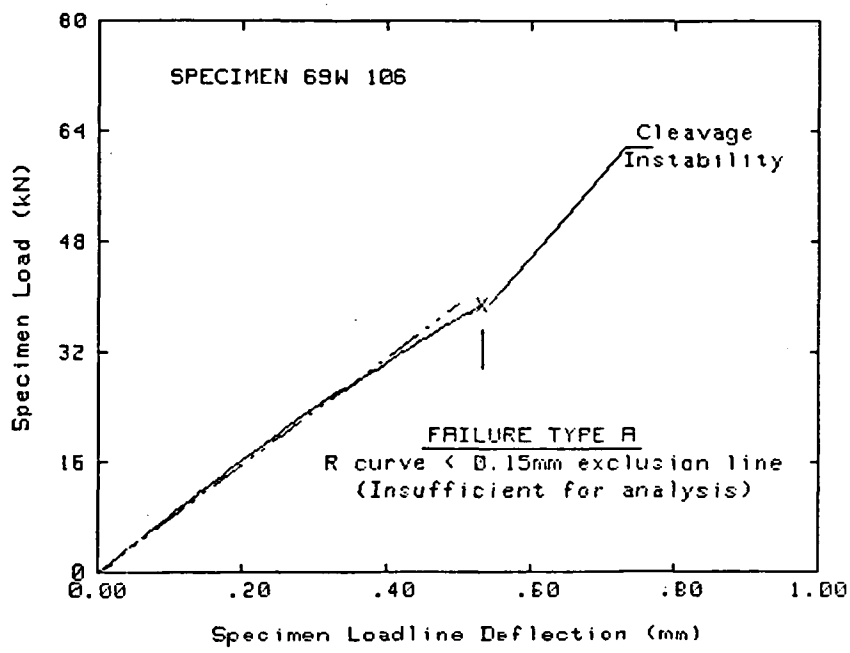
Material Type	= A533B Weld	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.78 mm	Init a/W = .606
Final crack length	= 42.56 mm	Final a/W = .837
Flow stress	= 704.5 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 108.3 kJ/m^2
Kjc	= 143.7 MPa \/m
J (@J/T=8.8)	= 212.1 kJ/m^2
Exponent N	= .3873
Coefficient C	= 191.5 kJ/m^2
T (average)	= 31

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 112.1 kJ/m^2
Kjc	= 146.2 MPa \/m
Slope M	= 80107 kJ/m^3
Intercept B	= 105.7 kJ/m^2
T (ASTM)	= 31
Validity (Jic)	= VALID
Validity (R-curve)	= VALID
J maximum allowed	= 704.5 kJ/m^2 (Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2 mm (Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= 10 C	
Percent Side Groove	= 20 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .61	
Init crack length a	= 30.98 mm	
Flow stress	= 759.8 MPa	
Yield stress	= 723.9 MPa	
Youngs modulus E	= 206600 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 60.2 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 111.6 MPa \/m	v=.3
Kic (Beta Corrected)	= 86.1 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

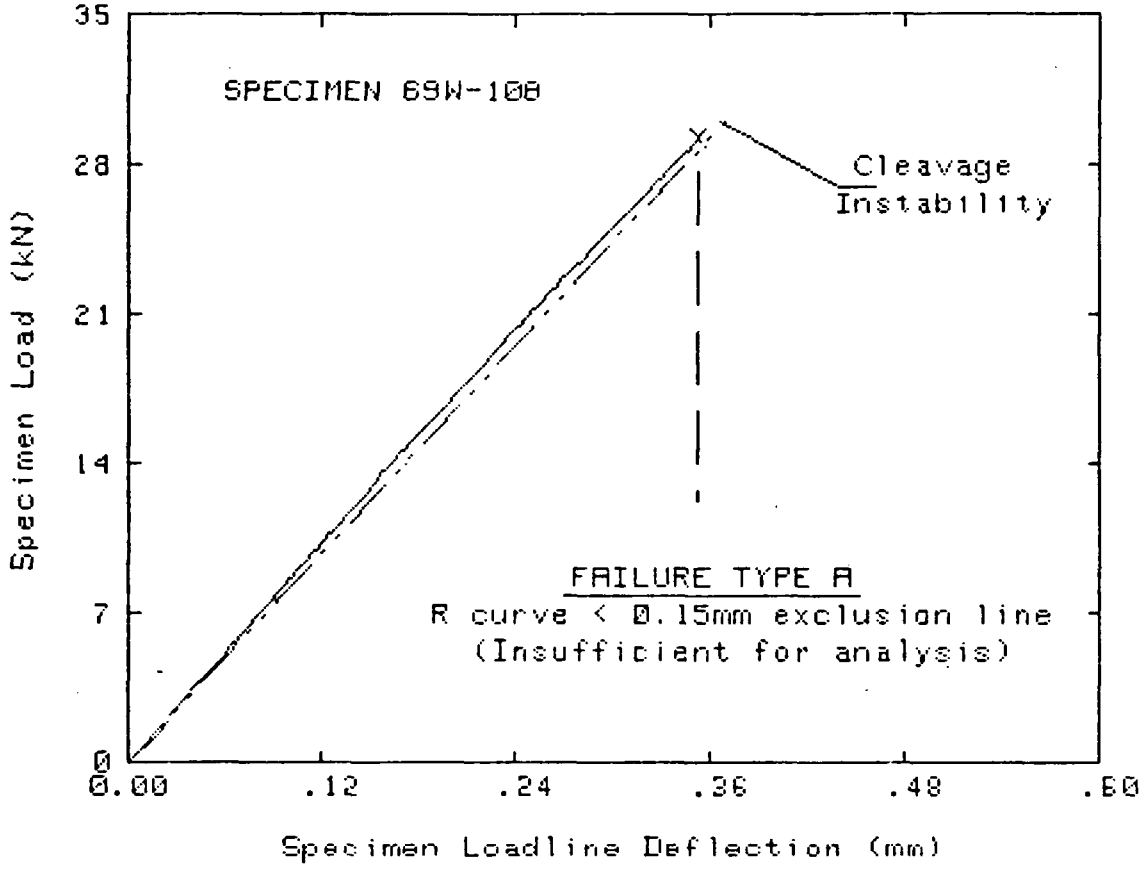
Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 38.9 kN	
5% Secant Offset Pq	= 26.77 kN	
Kic	= 74.2 MPa \/m	
Validity	= INVALID--2, 3	
K at Maximum Load	= 107.8 MPa \/m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 1.09375973717E-04 in.

Specimen rotation Load intercept elastic slope = .0000032 lb

Fitted elastic load range= 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld (I)	
Test Temperature	= 0 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .598	
Init crack length a	= 30.38 mm	
Flow stress	= 768 MPa	
Yield stress	= 730 MPa	
Youngs modulus E	= 207200 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 22.4 kJ/m^2	
Kjc=(EJic)^.5	= 68.1 MPa √m	ν=.3
Kic (Beta Corrected)	= 64.1 MPa √m	ν=.3

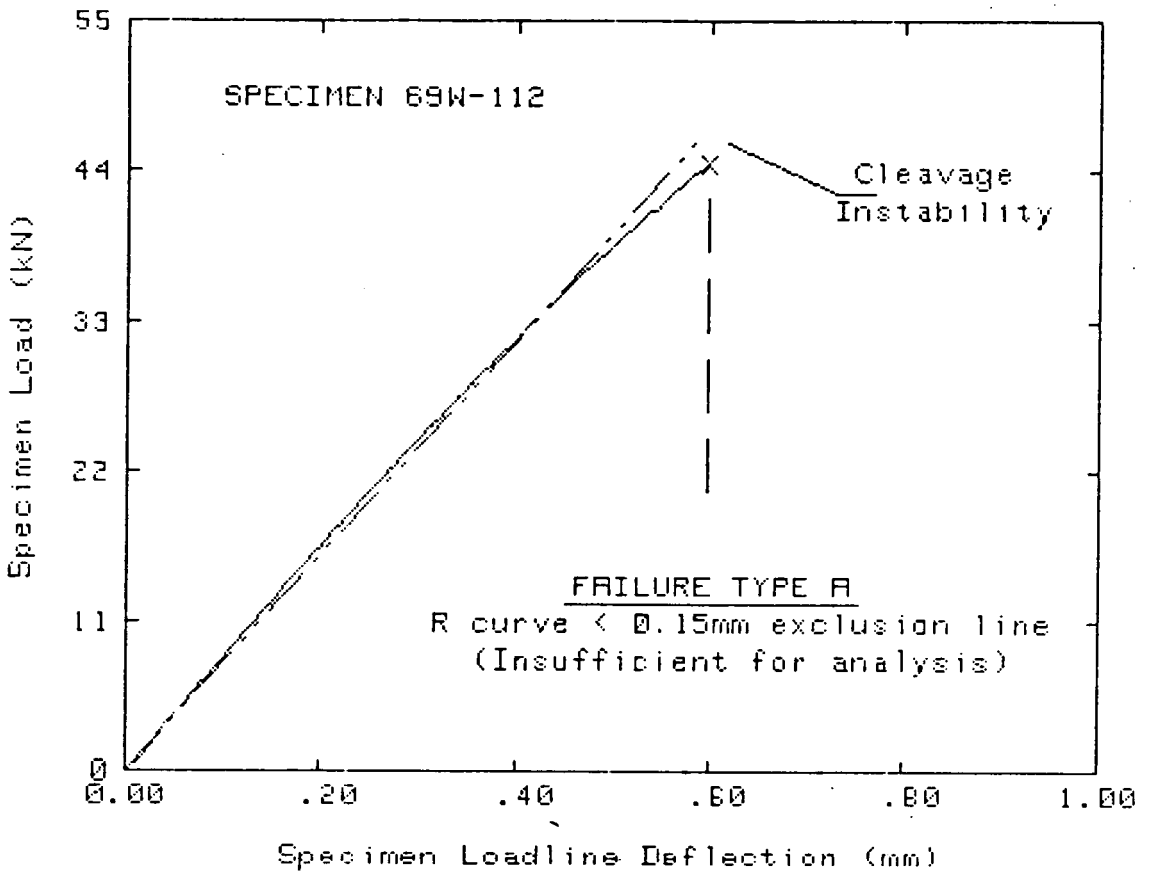
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 30 kN	
5% Secant Offset Pq	= 29.24 kN	
Kic	= 69.2 MPa √m	
Validity	= VALID Kic value	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld (I)	
Test Temperature	= 40 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .618	
Init crack length a	= 31.41 mm	
Flow stress	= 744.6 MPa	
Yield stress	= 708.2 MPa	
Youngs modulus E	= 204900 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 63.1 kJ/m^2	
Kjc=(EJic)^.5	= 113.7 MPa √m	ν=.3
Kic (Beta Corrected)	= 90.5 MPa √m	ν=.3

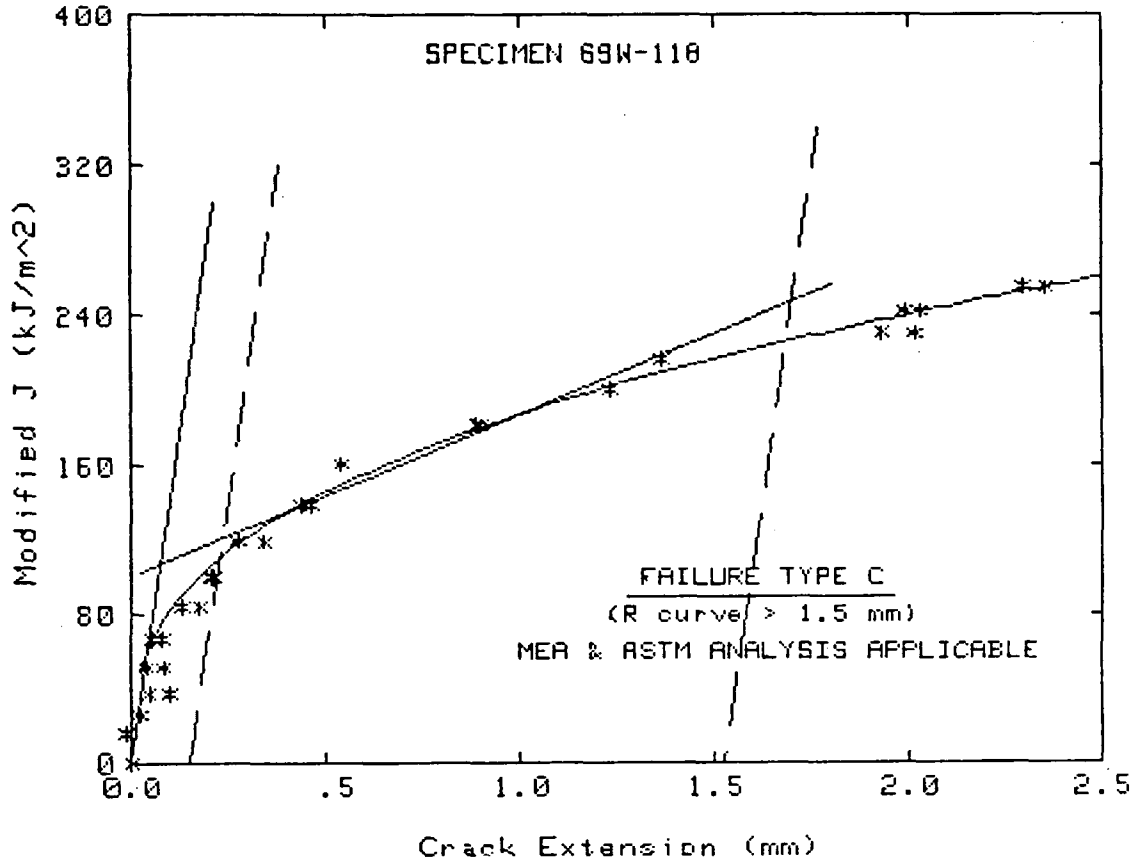
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 46 kN	
5% Secant Offset Pq	= 34.41 kN	
Kic	= 88.3 MPa √m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

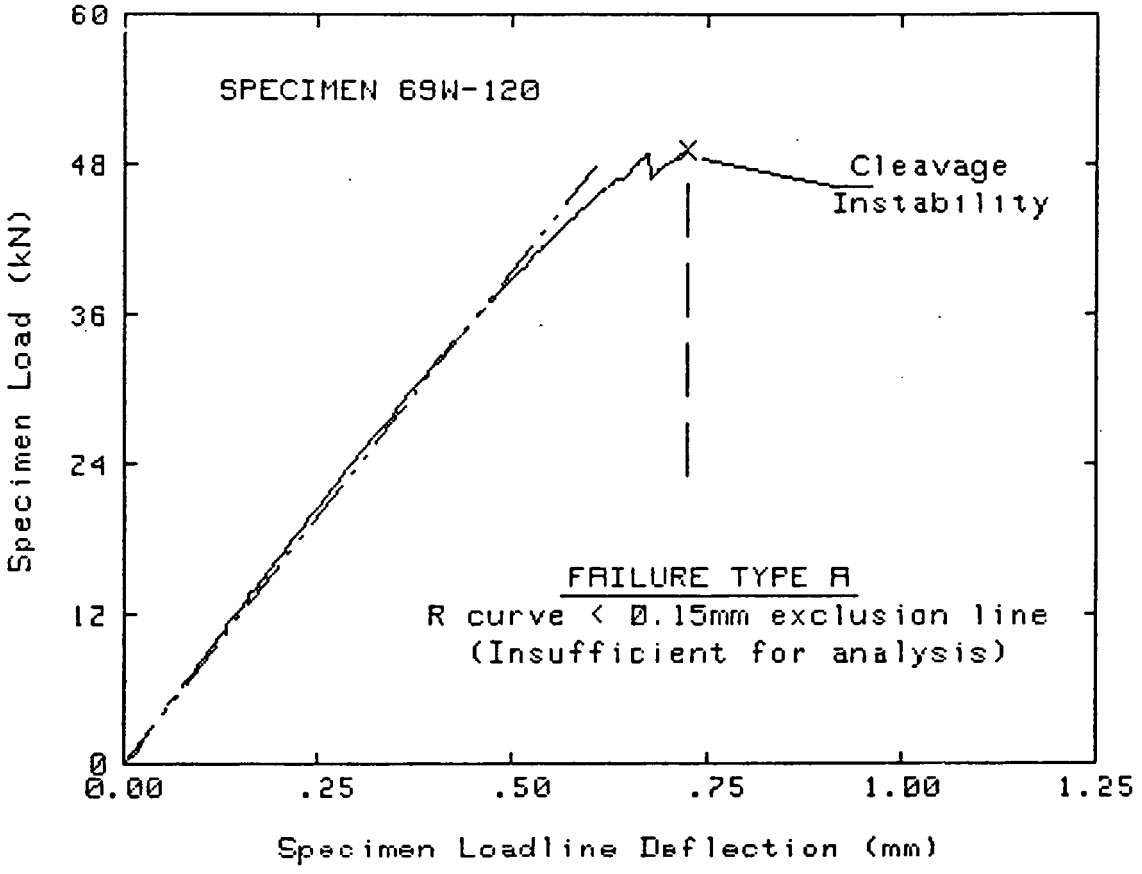
Material Type	= A533B Weld	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.23 mm	Init a/W = .555
Final crack length	= 41.81 mm	Final a/W = .823
Flow stress	= 704.5 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 110.5 kJ/m^2
Kjc	= 145.2 MPa \/m
J (@J/T=8.8)	= 199.9 kJ/m^2
Exponent N	= .3597
Coefficient C	= 187.3 kJ/m^2
T (average)	= 29

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 106.6 kJ/m^2	
Kjc	= 142.6 MPa \/m	
Slope M	= 86534.9 kJ/m^3	
Intercept B	= 100.1 kJ/m^2	
T (ASTM)	= 33	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--3 (1.66 vs .33)	
J maximum allowed	= 715.2 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.26 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= 50 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .6	
Init crack length a	= 30.48 mm	
Flow stress	= 739.4 MPa	
Yield stress	= 703.3 MPa	
Youngs modulus E	= 204300 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 86.5 kJ/m^2	
Kjc=(EJic)^.5	= 133 MPa √m	ν=.3
Kic (Beta Corrected)	= 98.3 MPa √m	ν=.3

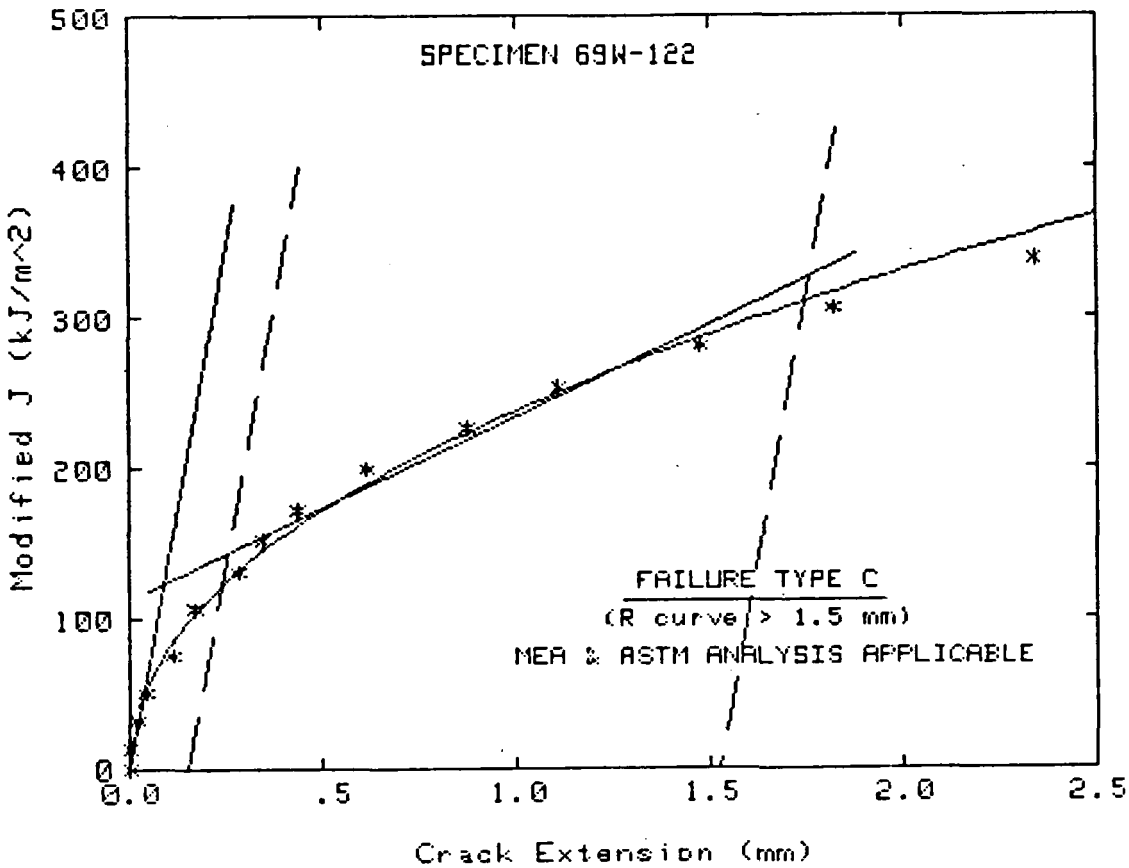
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 48.5 kN	
5% Secant Offset Pq	= 34.67 kN	
Kic	= 82.7 MPa √m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 2.38168298016E-05 in.
Specimen rotation Load intercept elastic slope =-2.85714285714E-07 lb
Fitted elastic load range=3400 TO 500 Correction to J for crack extension



TEST SPECIMEN DATA

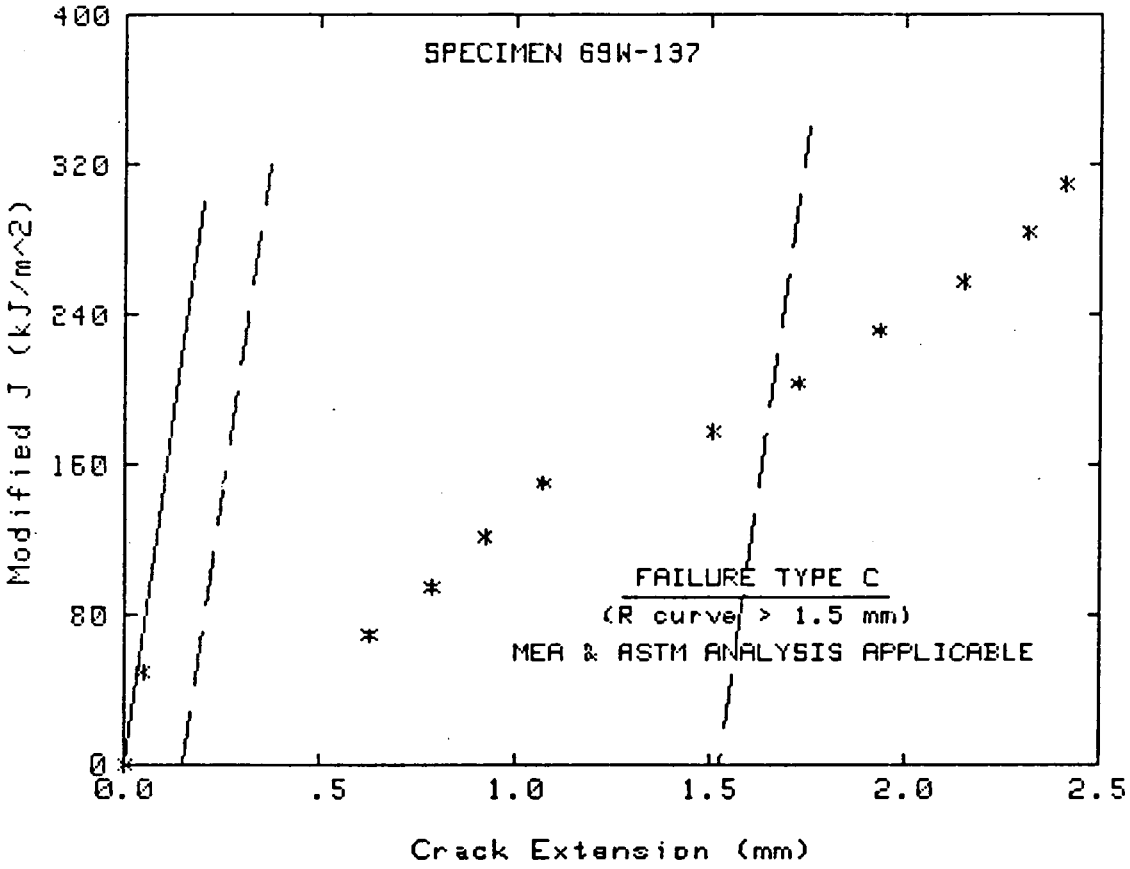
Material Type	= HSST S/A Weld	
Test Temperature	= 204 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.23 mm	Init a/W = .595
Final crack length	= 41.91 mm	Final a/W = .825
Flow stress	= 697.8 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 121.5 kJ/m^2
Kjc	= 154.1 MPa \/m
J (@J/T=8.8)	= 282.4 kJ/m^2
Exponent N	= .4723
Coefficient C	= 238.7 kJ/m^2
T (average)	= 48

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 123.7 kJ/m^2	
Kjc	= 155.5 MPa \/m	
Slope M	= 121962.9 kJ/m^3	
Intercept B	= 112.9 kJ/m^2	
T (ASTM)	= 49	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 708.5 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.06 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

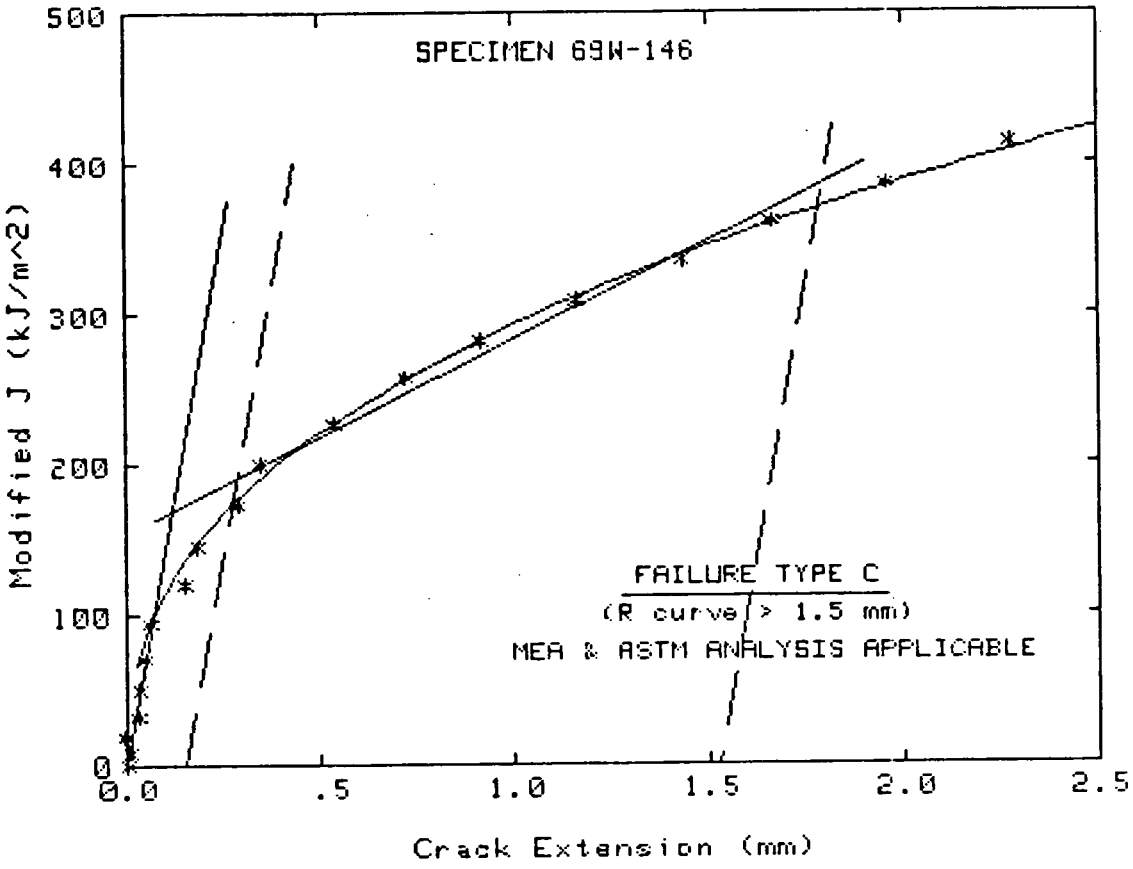
Material Type	= A533-B HSST WELD	
Test Temperature	= 50 C	
Percent Side Groove	= 0 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.24 mm	Init a/W = .595
Final crack length	= 34.14 mm	Final a/W = .672
Flow stress	= 739.5 MPa	
Youngs modulus	= 204400 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 69.2 kJ/m^2
Kjc	= 119 MPa \/m
J (@J/T=8.8)	= 496.1 kJ/m^2
Exponent N	= .4272
Coefficient C	= 137.9 kJ/m^2
T (average)	= 25

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= .2 kJ/m^2
Kjc	= 6.8 MPa \/m
Slope M	= 124470.1 kJ/m^3
Intercept B	= .2 kJ/m^2
T (ASTM)	= 47
Validity (Jic)	= INVALID--b, c (1.11 vs .58)
Validity (R-curve)	= INVALID--1,2, 3 (1.11 vs .3)
J maximum allowed	= 759.7 kJ/m^2 (Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.06 mm (Delta a max = 0.1*bo)
Final Delta a	= 5.02 mm
Poisson's Ratio (v)	= 0



TEST SPECIMEN DATA

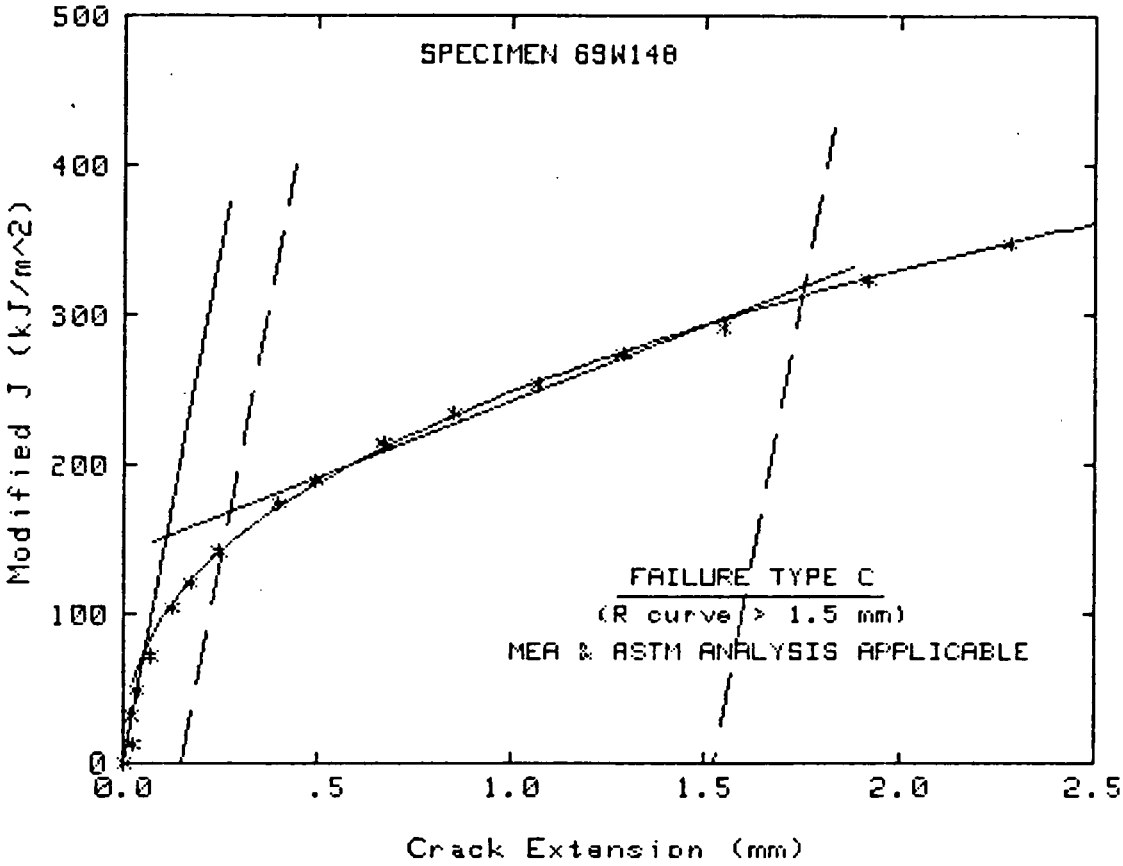
Material Type	= HSST S/A Weld (I)	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.37 mm	Init a/W = .597
Final crack length	= 39.61 mm	Final a/W = .779
Flow stress	= 711.6 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 173.4 kJ/m^2
Kjc	= 186.4 MPa √m
J (@J/T=8.8)	= 346.4 kJ/m^2
Exponent N	= .4051
Coefficient C	= 292.8 kJ/m^2
T (average)	= 49

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 169.3 kJ/m^2	
Kjc	= 184.1 MPa √m	
Slope M	= 129546.8 kJ/m^3	
Intercept B	= 153.9 kJ/m^2	
T (ASTM)	= 51	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 722.5 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.04 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

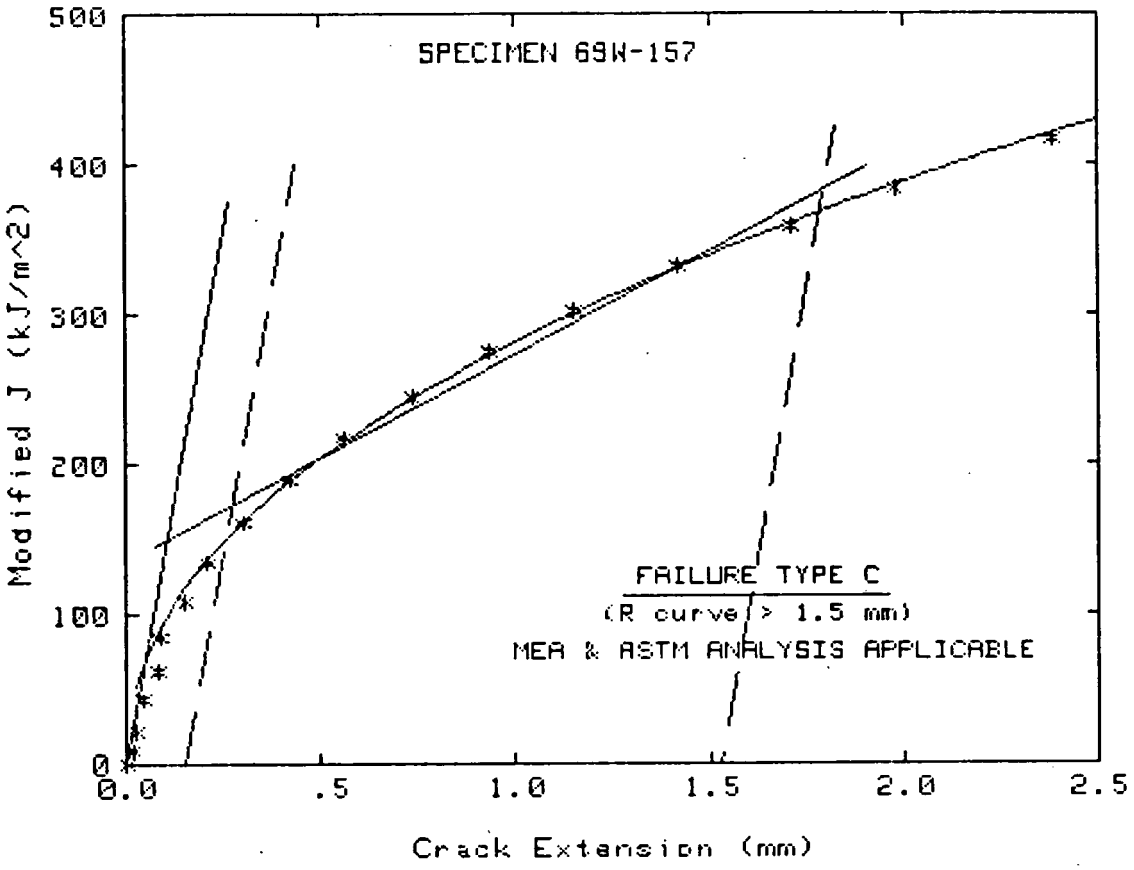
Material Type	= HSST S/A WELD	
Test Temperature	= 204 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.05 mm	Init a/W = .611
Final crack length	= 41.86 mm	Final a/W = .824
Flow stress	= 697.8 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 142.6 kJ/m^2
Kjc	= 167 MPa \/m
J (@J/T=8.8)	= 290.5 kJ/m^2
Exponent N	= .4073
Coefficient C	= 249 kJ/m^2
T (average)	= 43

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 152.7 kJ/m^2	
Kjc	= 172.8 MPa \/m	
Slope M	= 101685.8 kJ/m^3	
Intercept B	= 141.6 kJ/m^2	
T (ASTM)	= 41	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--3 (.43 vs .29)	
J maximum allowed	= 688.6 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 1.98 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

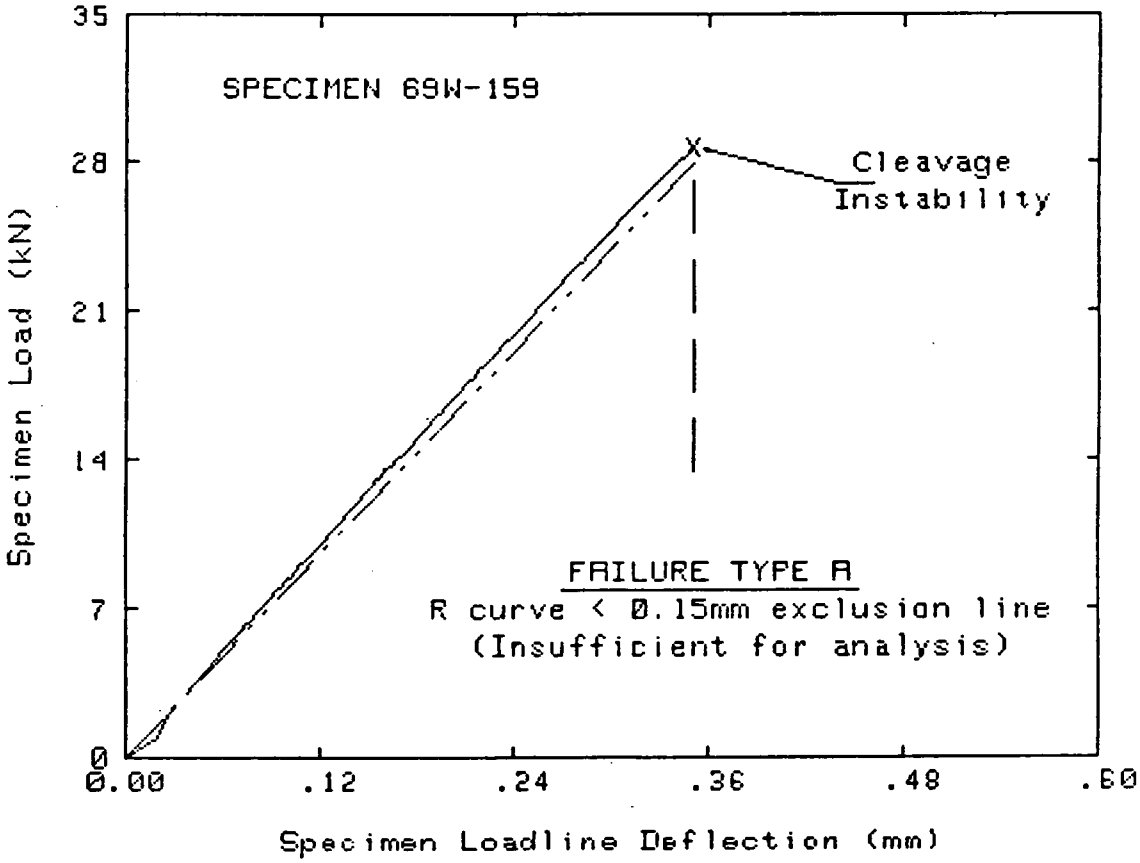
Material Type	= HSST S/A Weld (I)	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.16 mm	Init a/W = .593
Final crack length	= 40.5 mm	Final a/W = .797
Flow stress	= 711.6 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 150.3 kJ/m^2
Kjc	= 173.5 MPa \/m
J (@J/T=8.8)	= 349.6 kJ/m^2
Exponent N	= .4634
Coefficient C	= 281.6 kJ/m^2
T (average)	= 54

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 149.3 kJ/m^2	
Kjc	= 172.9 MPa \/m	
Slope M	= 139007.6 kJ/m^3	
Intercept B	= 134.7 kJ/m^2	
T (ASTM)	= 55	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--1	
J maximum allowed	= 722.5 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.06 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -35 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .589	
Init crack length a	= 29.9 mm	
Flow stress	= 803.8 MPa	
Yield stress	= 773.5 MPa	
Youngs modulus E	= 209100 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

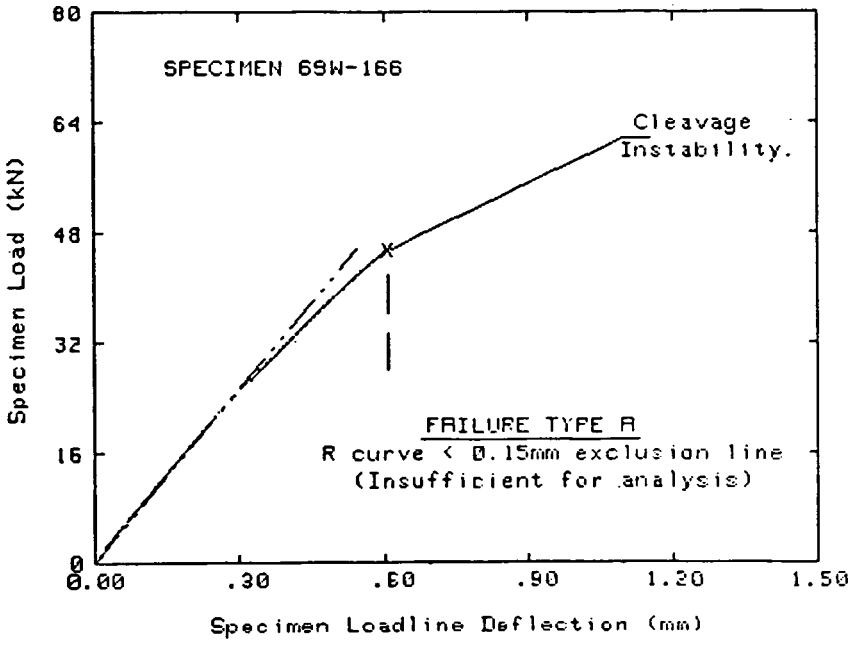
Jic	= 21.3 kJ/m^2	
Kjc=(EJic)^.5	= 66.7 MPa √m	ν=.3
Kic (Beta Corrected)	= 63.6 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 28.66 kN	
5% Secant Offset Pq	= 28.66 kN	
Kic	= 65.4 MPa √m	
Validity	= VALID Kic value	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 1.88728740736E-05 in.
Specimen rotation Load intercept elastic slope = 1.81818181818E-07 lb
Fitted elastic load range=3400 TO 500 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= 10 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .594	
Init crack length a	= 30.19 mm	
Flow stress	= 739.5 MPa	
Yield stress	= 723.9 MPa	
Youngs modulus E	= 206600 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 62.3 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 113.5 MPa \/m	v=.3
Kic (Beta Corrected)	= 91.3 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

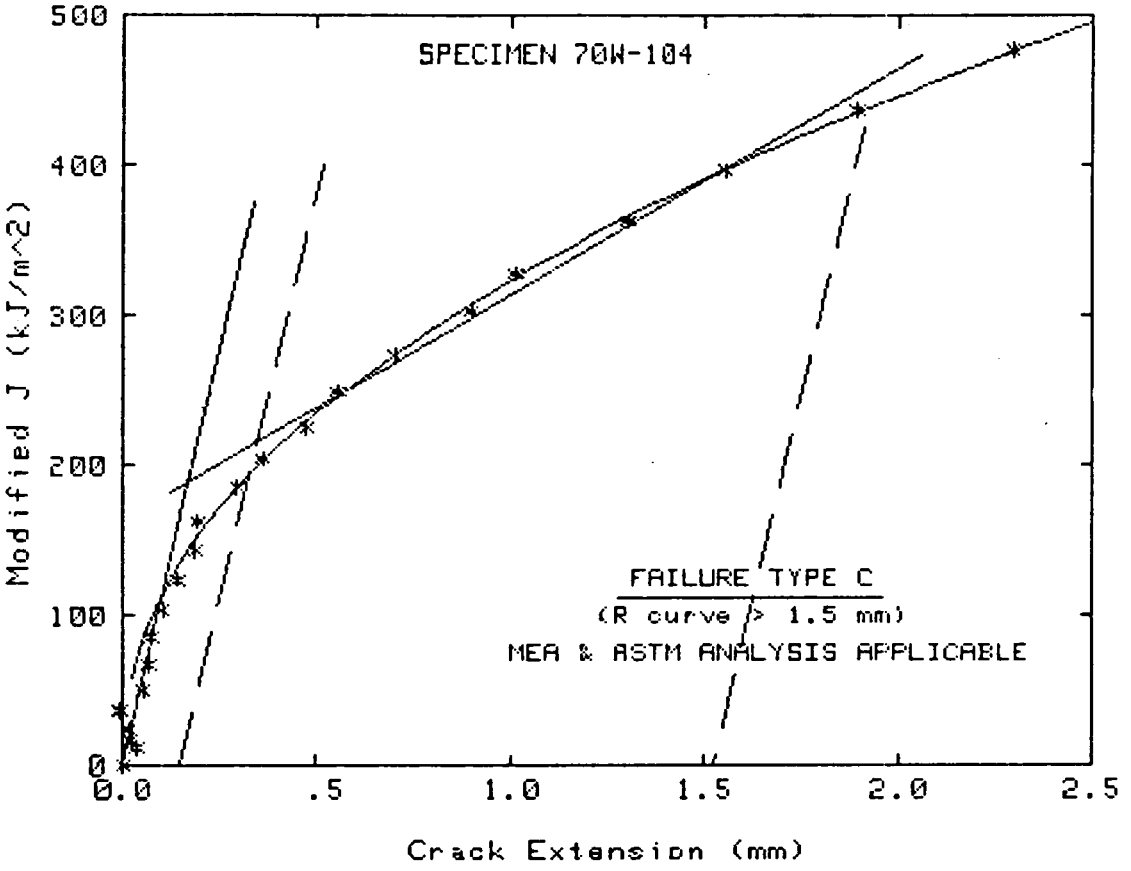
Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 45.6 kN	
5% Secant Offset Pq	= 25.35 kN	
Kic	= 59.1 MPa \/m	
Validity	= INVALID--3	
K at Maximum Load	= 106.3 MPa \/m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 5.3589921119 6E-06 in.

Specimen rotation Load intercept elastic slope = 2.02727272727E-06 lb

Fitted elastic load range= 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

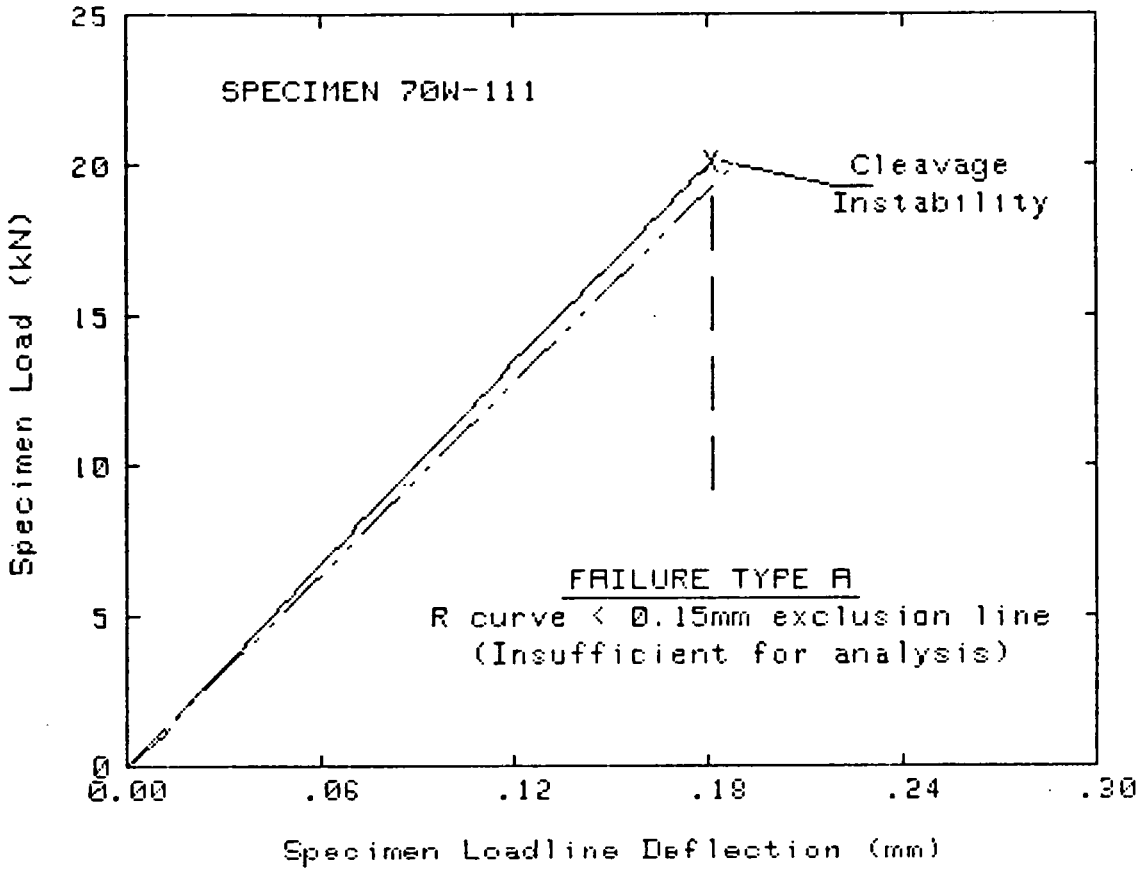
Material Type	= HSST S/A Weld (I)	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.51 mm	Init a/W = .541
Final crack length	= 37.57 mm	Final a/W = .739
Flow stress	= 549.8 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 193 kJ/m^2
Kjc	= 196.6 MPa \/m
J (@J/T=8.8)	= 537.9 kJ/m^2
Exponent N	= .4639
Coefficient C	= 323.7 kJ/m^2
T (average)	= 98

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 187.9 kJ/m^2	
Kjc	= 194 MPa \/m	
Slope M	= 151318.7 kJ/m^3	
Intercept B	= 162 kJ/m^2	
T (ASTM)	= 100	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--3 (.37 vs .34)	
J maximum allowed	= 558.2 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.33 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld (I)	
Test Temperature	= -125 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .544	
Init crack length a	= 27.61 mm	
Flow stress	= 748.8 MPa	(Estimated Value)
Yield stress	= 682.5 MPa	(Estimated Value)
Youngs modulus E	= 215000 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

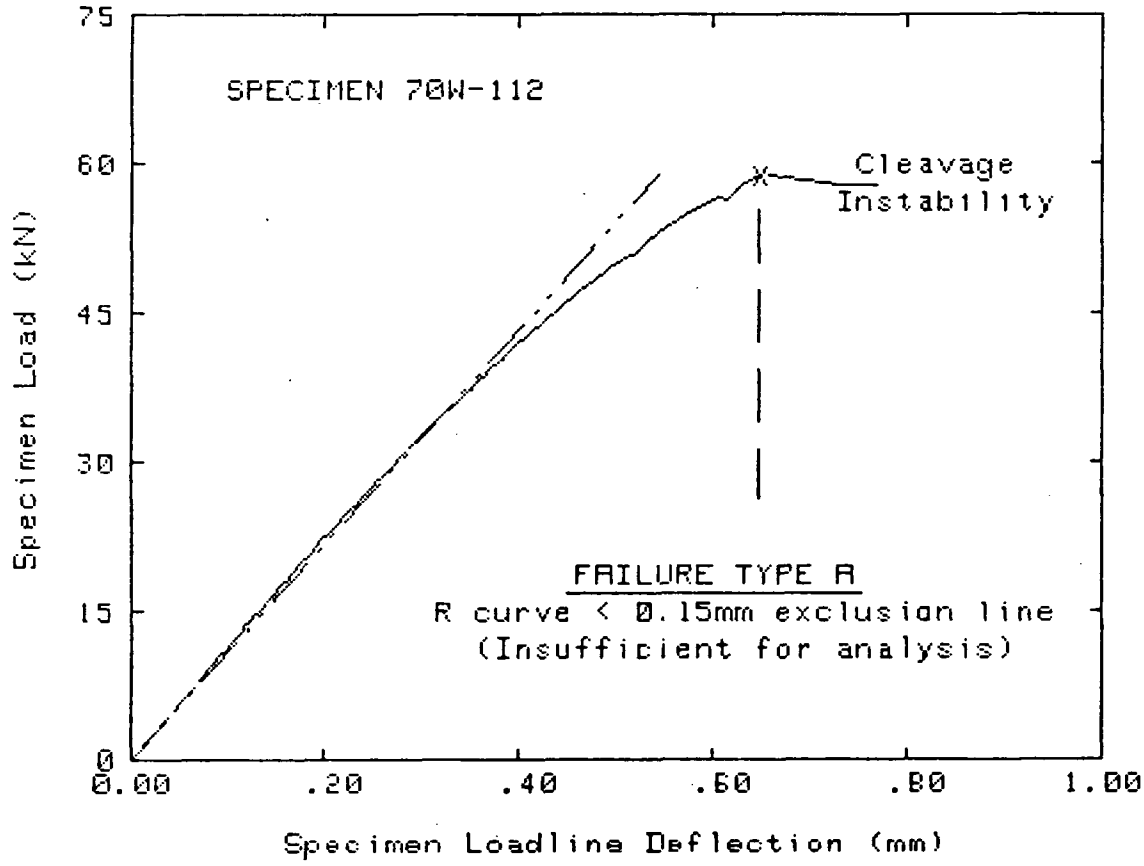
Jic	= 7 kJ/m^2	
Kjc=(EJic)^.5	= 38.7 MPa √m	ν=.3
Kic (Beta Corrected)	= 38.3 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5
Maximum Load P	= 20.12 kN
5% Secant Offset Pq	= 20.11 kN
Kic	= 39 MPa √m
Validity	= VALID Kic value

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -25 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .548	
Init crack length a	= 27.86 mm	
Flow stress	= 630 MPa	
Yield stress	= 570 MPa	
Youngs modulus E	= 208600 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 82.6 kJ/m^2	
Kjc=(EJic)^.5	= 131.3 MPa \/m	v=.3
Kic (Beta Corrected)	= 87.9 MPa \/m	v=.3

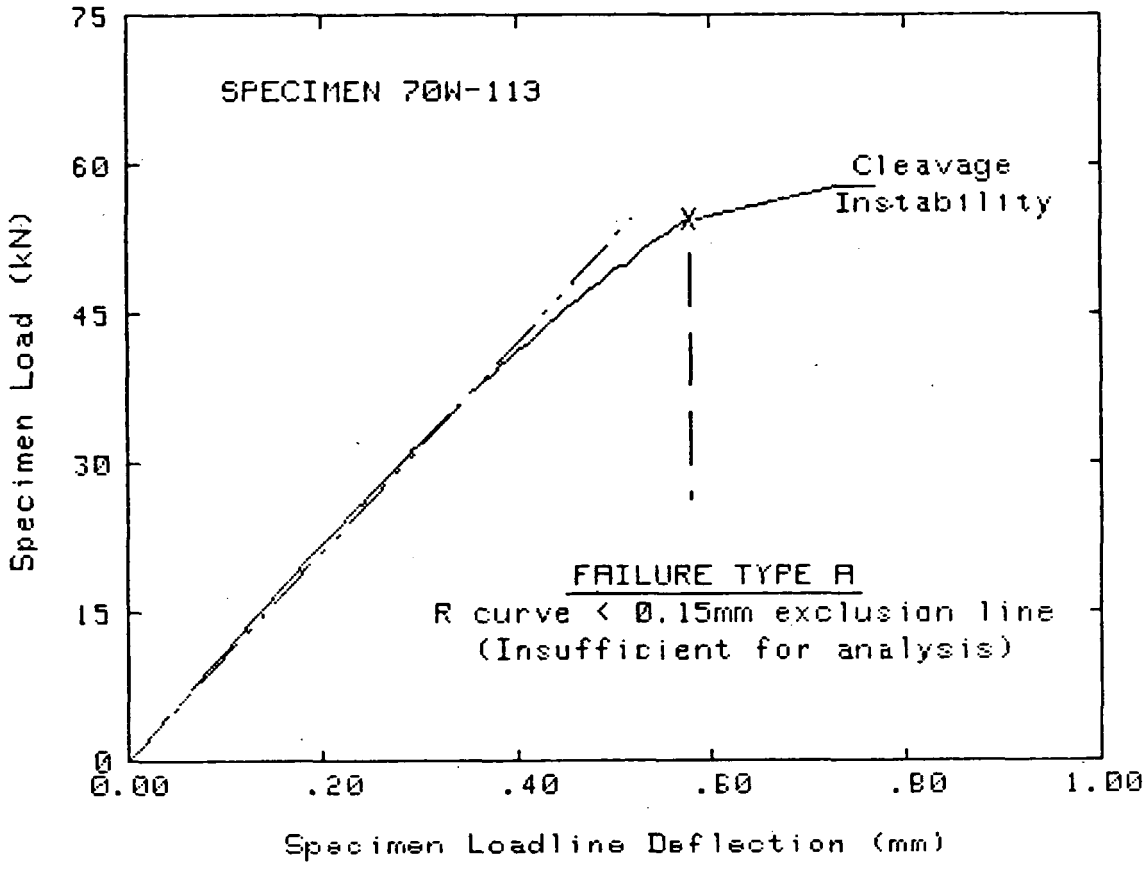
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 58.75 kN	
5% Secant Offset Pq	= 34.97 kN	
Kic	= 69 MPa \/m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -25 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .544	
Init crack length a	= 27.65 mm	
Flow stress	= 630 MPa	
Yield stress	= 570 MPa	
Youngs modulus E	= 208600 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

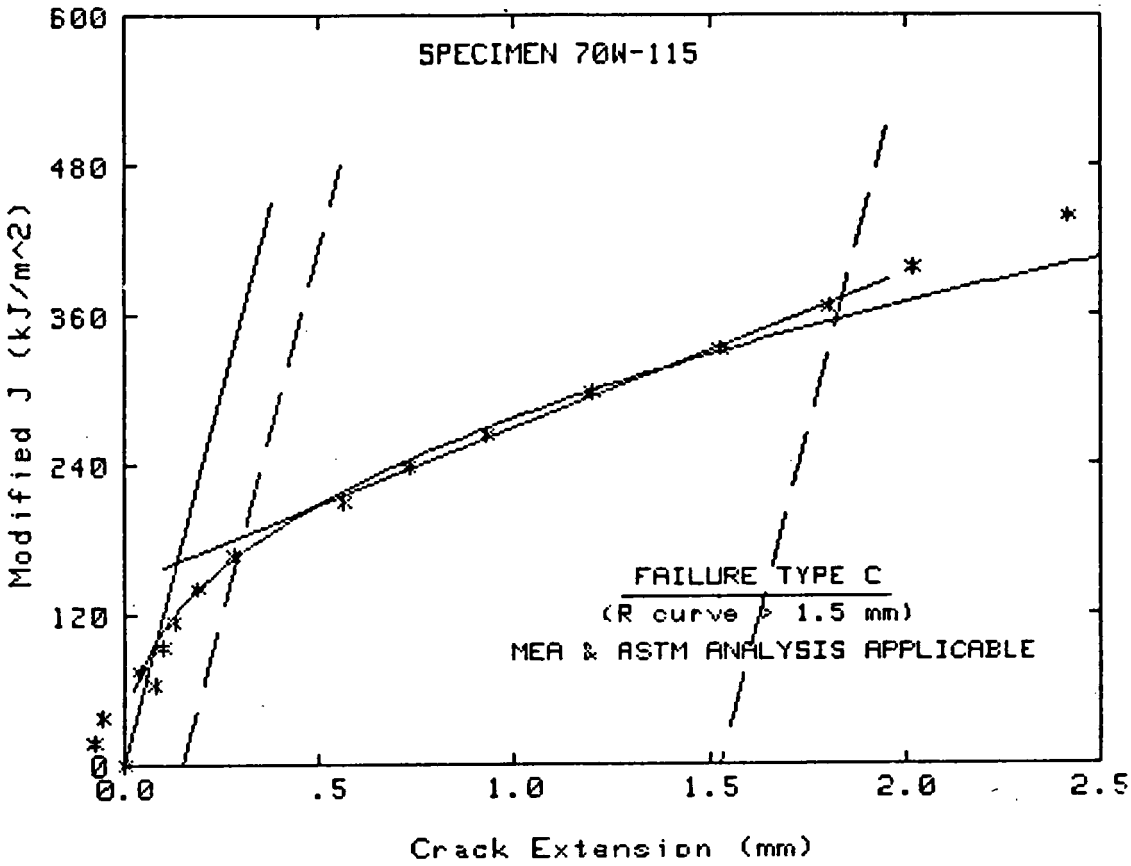
Jic	= 65.5 kJ/m^2	
Kjc=(EJic)^.5	= 117 MPa √m	ν=.3
Kic (Beta Corrected)	= 83.1 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 54.59 kN	
5% Secant Offset Pq	= 36.45 kN	
Kic	= 71 MPa √m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

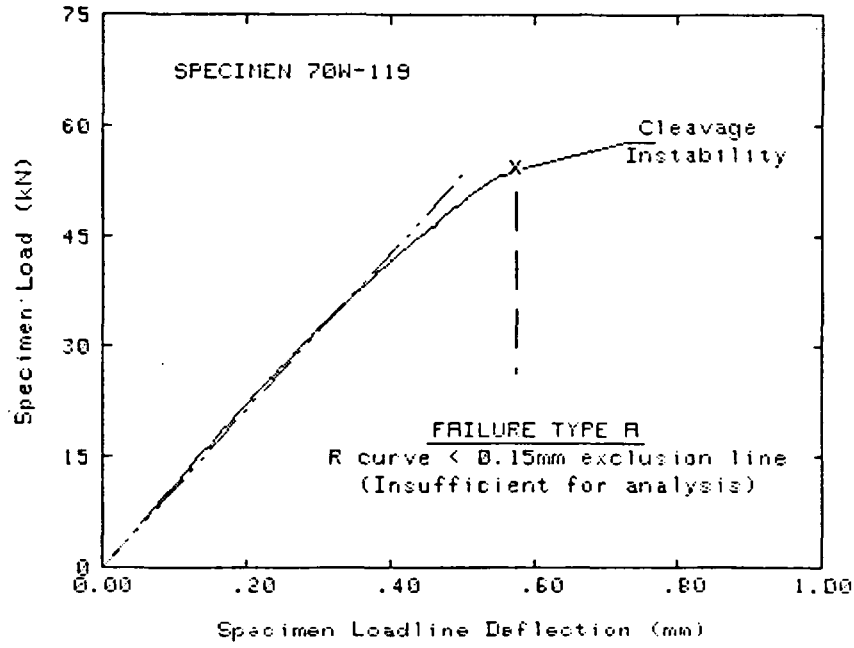
Material Type	= A533-B HSST WELD	
Test Temperature	= 30 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.22 mm	Init a/W = .555
Final crack length	= 39.79 mm	Final a/W = .783
Flow stress	= 599.8 MPa	
Youngs modulus	= 205500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 166.6 kJ/m^2
Kjc	= 185 MPa \/m
J (@J/T=8.8)	= 442.5 kJ/m^2
Exponent N	= .4144
Coefficient C	= 277.7 kJ/m^2
T (average)	= 68

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 163 kJ/m^2	
Kjc	= 183 MPa \/m	
Slope M	= 123868.6 kJ/m^3	
Intercept B	= 146.2 kJ/m^2	
T (ASTM)	= 71	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--2	
J maximum allowed	= 609 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.26 mm	(Delta a max = 0.1*bo)
Final Delta a	= 11.34 mm	
Poisson's Ratio (v)	= 0	



TEST SPECIMEN DATA

Material Type	= HSST S/A WELD	
Test Temperature	= -15 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .549	
Init crack length a	= 27.9 mm	
Flow stress	= 621 MPa	
Yield stress	= 561 MPa	
Youngs modulus E	= 208000 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

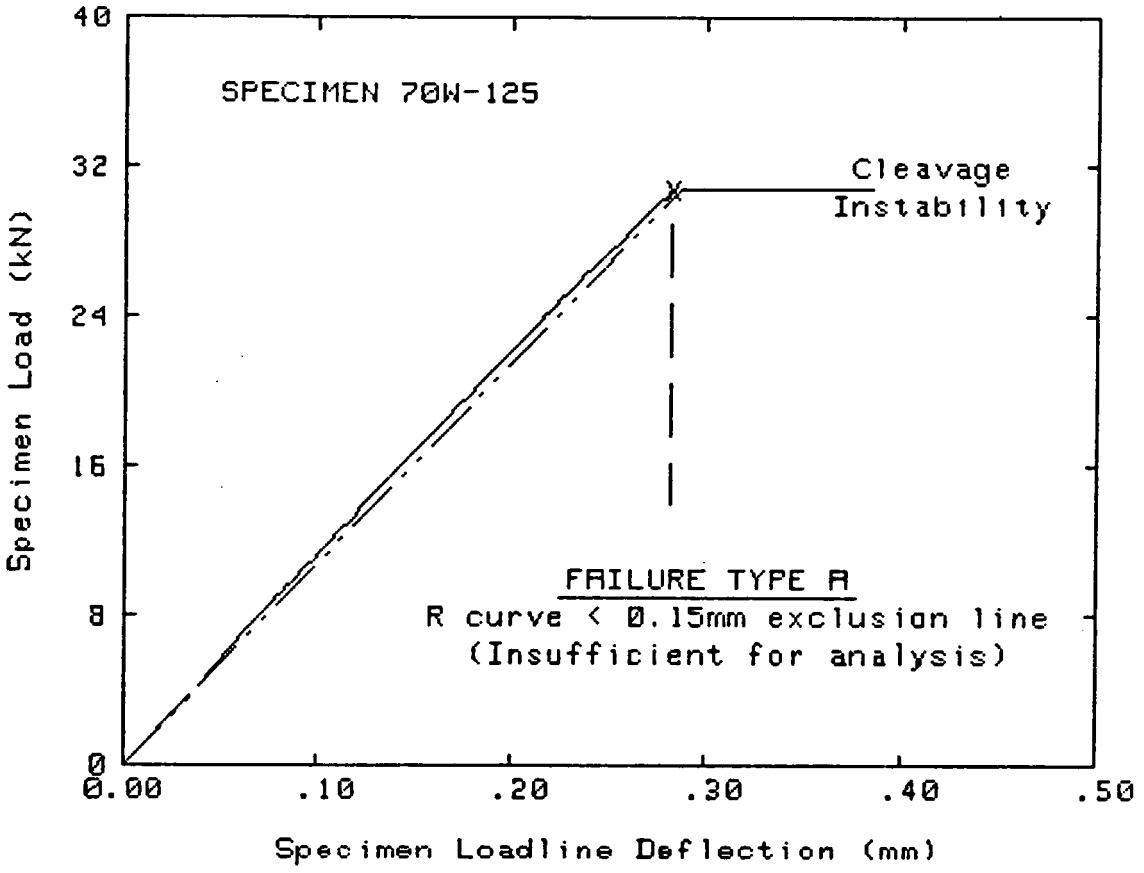
Jic	= 65.9 kJ/m^2	
Kjc=(EJic)^.5	= 117.1 MPa √m	v=.3
Kic (Beta Corrected)	= 82.5 MPa √m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 54.42 kN	
5% Secant Offset Pq	= 35.28 kN	
Kic	= 69.9 MPa √m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 2.85783397559E-05 in.
Specimen rotation Load intercept elastic slope = 5.49019607843E-07 lb
Fitted elastic load range= 4000 TO 400 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -95 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .54	
Init crack length a	= 27.41 mm	
Flow stress	= 708 MPa	
Yield stress	= 644 MPa	
Youngs modulus E	= 212600 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

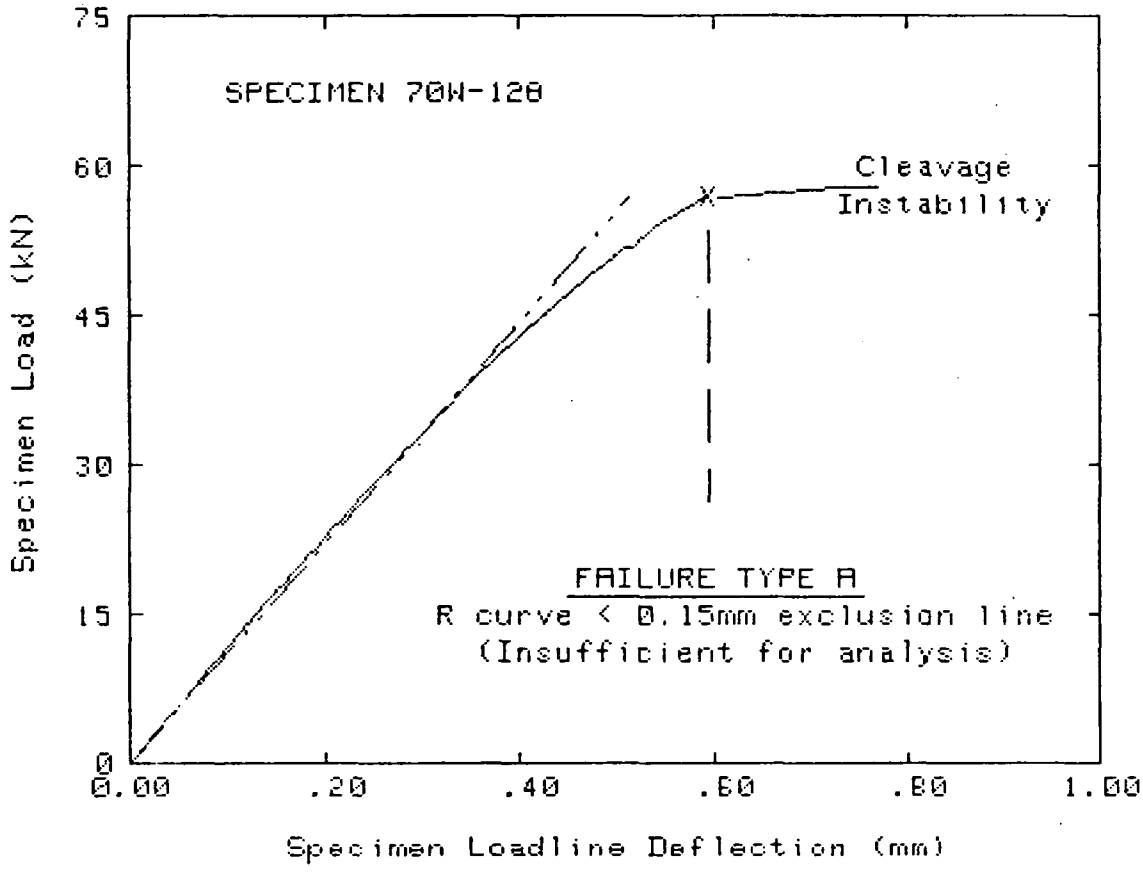
Jic	= 16.7 kJ/m^2	
Kjc=(EJic)^.5	= 59.6 MPa √m	ν=.3
Kic (Beta Corrected)	= 56.2 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation:	B = (BBn)^.5	
Maximum Load P	= 30.8 kN	
5% Secant Offset Pq	= 30.82 kN	
Kic	= 59 MPa √m	
Validity	= INVALID--1, 2	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 1.19871079685E-04 in.
Specimen rotation Load intercept elastic slope =-7.56097560976E-08 lb
Fitted elastic load range=3400 TO 500 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -25 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .542	
Init crack length a	= 27.51 mm	
Flow stress	= 630 MPa	
Yield stress	= 570 MPa	
Youngs modulus E	= 208600 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 71 kJ/m^2	
Kjc=(EJic)^.5	= 121.7 MPa \/m	v=.3
Kic (Beta Corrected)	= 84.8 MPa \/m	v=.3

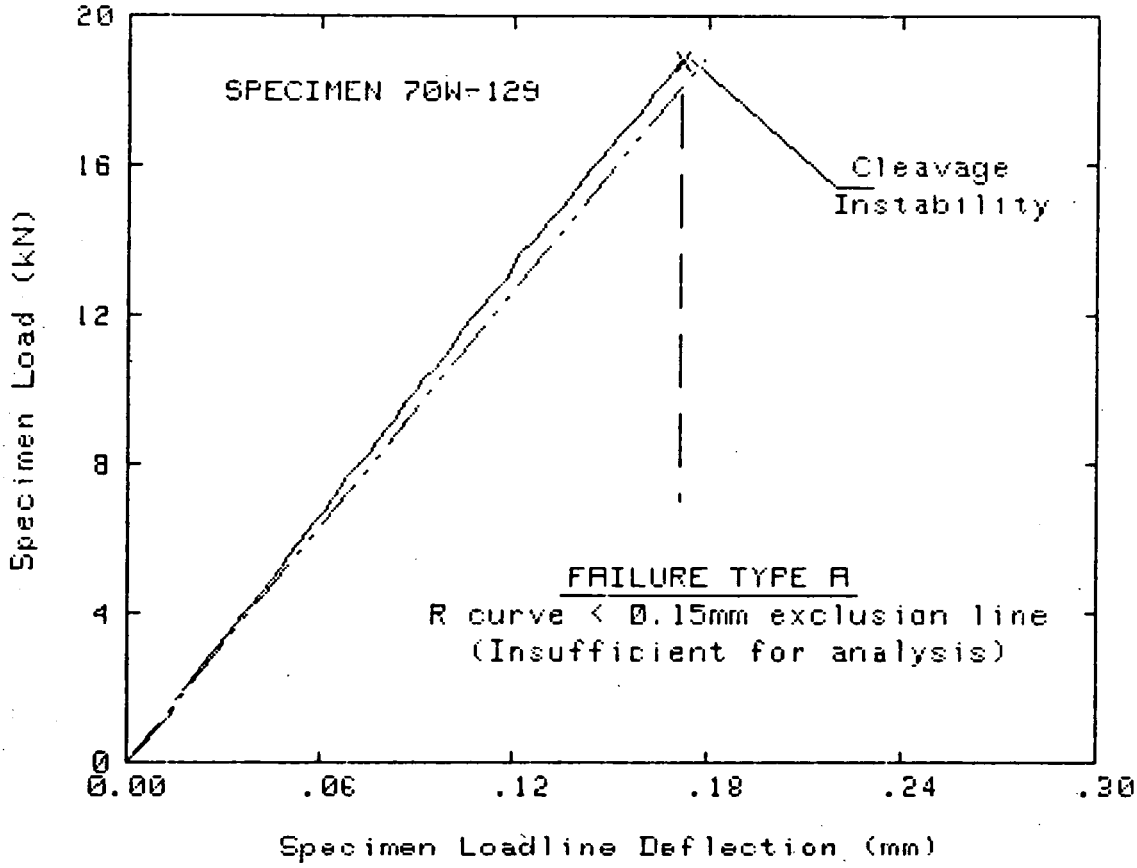
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 56.92 kN	
5% Secant Offset Pq	= 34.21 kN	
Kic	= 66 MPa \/m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld (I)	
Test Temperature	= -125 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .55	
Init crack length a	= 27.94 mm	
Flow stress	= 748.8 MPa	(Estimated Value)
Yield stress	= 682.5 MPa	(Estimated Value)
Youngs modulus E	= 214400 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

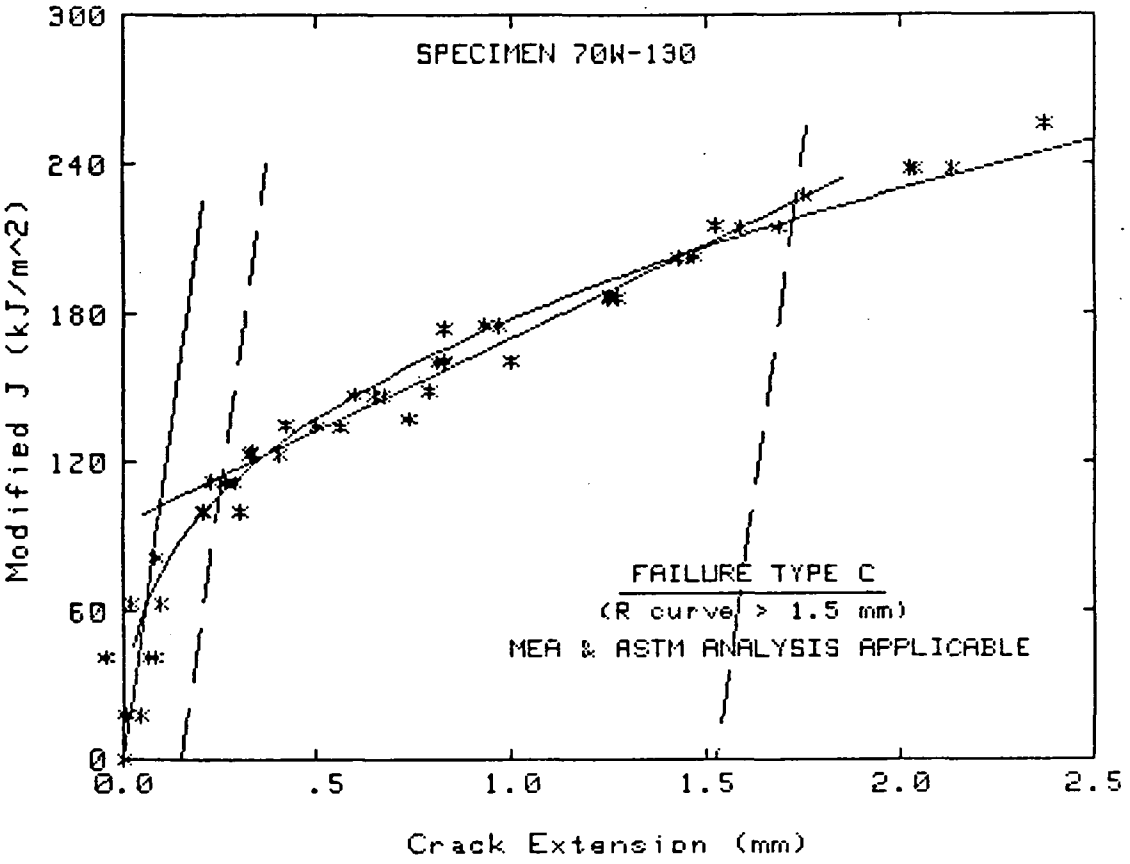
Jic	= 6.3 kJ/m^2	
Kjc=(EJic)^.5	= 36.8 MPa √m	ν=.3
Kic (Beta Corrected)	= 36.4 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 18.82 kN	
5% Secant Offset Pq	= 18.82 kN	
Kic	= 37.3 MPa √m	
Validity	= VALID Kic value	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

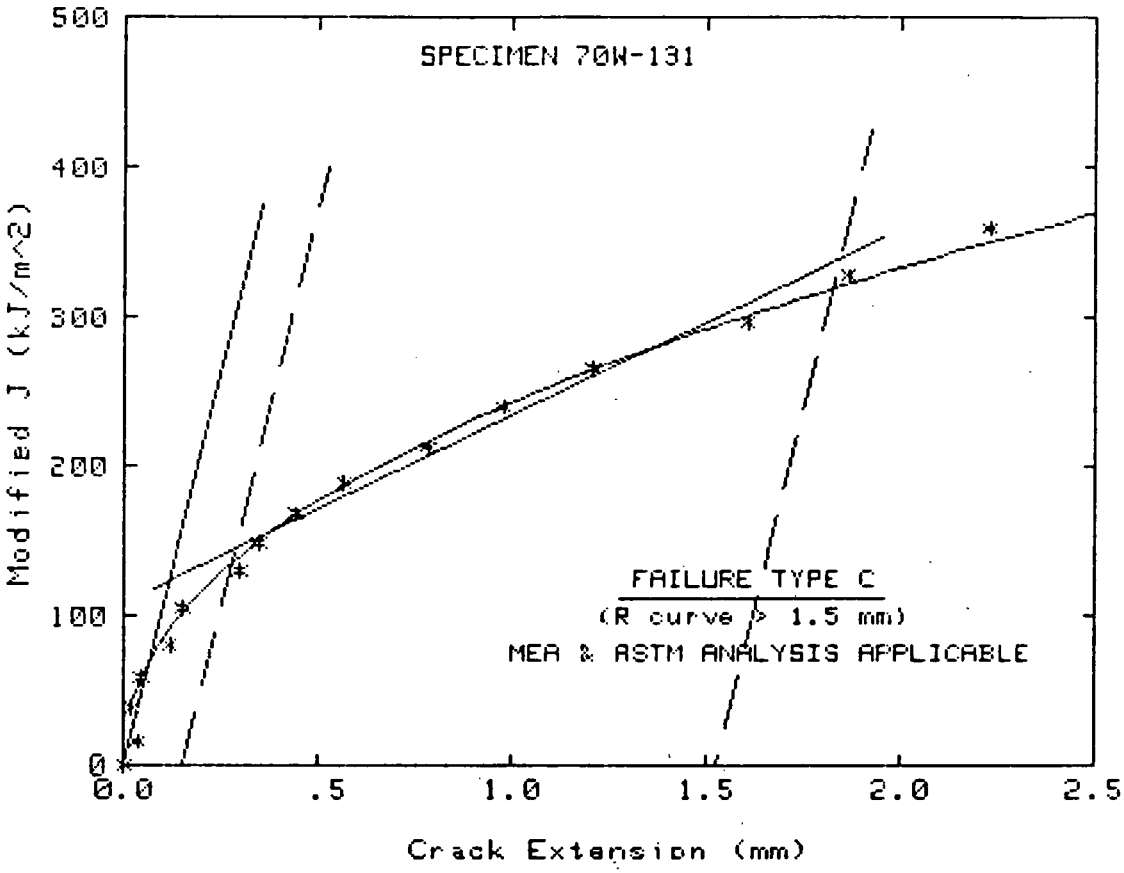
Material Type	= A533B Weld	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.7 mm	Init a/W = .566
Final crack length	= 39.79 mm	Final a/W = .783
Flow stress	= 542.6 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 106.7 kJ/m^2
Kjc	= 142.7 MPa \/m
J (@J/T=8.8)	= 287.8 kJ/m^2
Exponent N	= .3696
Coefficient C	= 177.9 kJ/m^2
T (average)	= 46

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 102.6 kJ/m^2	
Kjc	= 139.9 MPa \/m	
Slope M	= 74780.9 kJ/m^3	
Intercept B	= 95.6 kJ/m^2	
T (ASTM)	= 48	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--3 (.37 vs .33)	
J maximum allowed	= 550.9 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.21 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

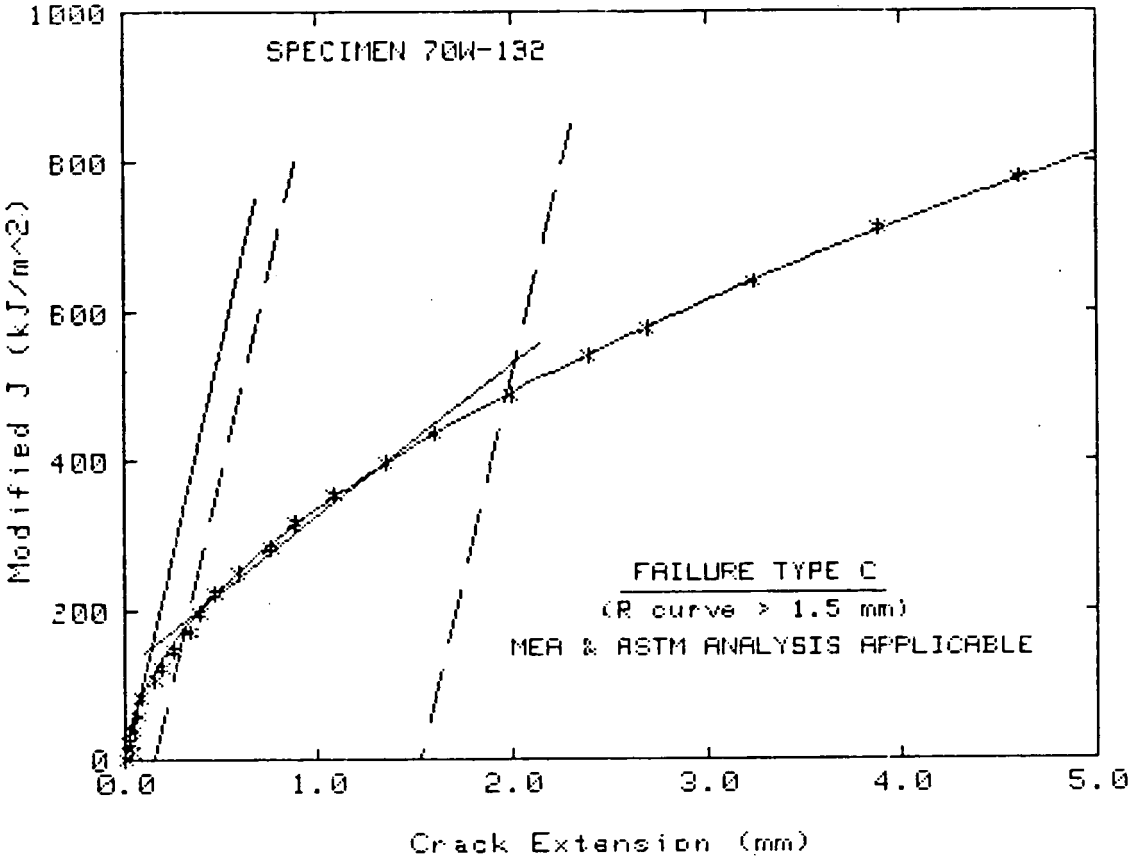
Material Type	= HSST S/A Weld (I)	
Test Temperature	= 204 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.28 mm	Init a/W = .556
Final crack length	= 39.8 mm	Final a/W = .783
Flow stress	= 535.3 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 135.4 kJ/m^2
Kjc	= 162.7 MPa \/m
J (@J/T=8.8)	= 412 kJ/m^2
Exponent N	= .457
Coefficient C	= 242.7 kJ/m^2
T (average)	= 78

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 123.9 kJ/m^2	
Kjc	= 155.6 MPa \/m	
Slope M	= 124574.7 kJ/m^3	
Intercept B	= 109.5 kJ/m^2	
T (ASTM)	= 85	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--1, 3 (.58 vs .33)	
J maximum allowed	= 543.5 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.25 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

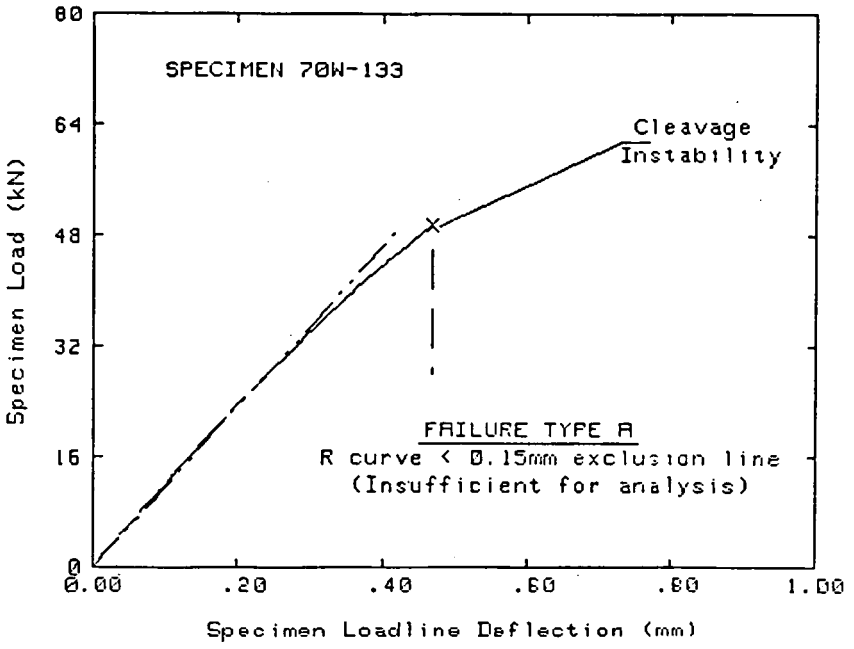
Material Type	= HSST S/A Weld (I)	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.72 mm	Init a/W = .545
Final crack length	= 36.28 mm	Final a/W = .714
Flow stress	= 549.8 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

J (@J/T=8.8)	= 633.4 kJ/m^2
Jic	= 178.5 kJ/m^2
Kjc	= 189.1 MPa √m
Exponent N	= .5478
Coefficient C	= 336.2 kJ/m^2
T (average)	= 120

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 151.4 kJ/m^2	
Kjc	= 174.1 MPa √m	
Slope M	= 204363.5 kJ/m^3	
Intercept B	= 123.2 kJ/m^2	
T (ASTM)	= 136	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 558.2 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.31 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= -50 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .55	
Init crack length a	= 27.91 mm	
Flow stress	= 655.3 MPa	
Yield stress	= 572.3 MPa	
Youngs modulus E	= 210100 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 47.6 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 100.1 MPa √m	v=.3
Kic (Beta Corrected)	= 76.7 MPa √m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

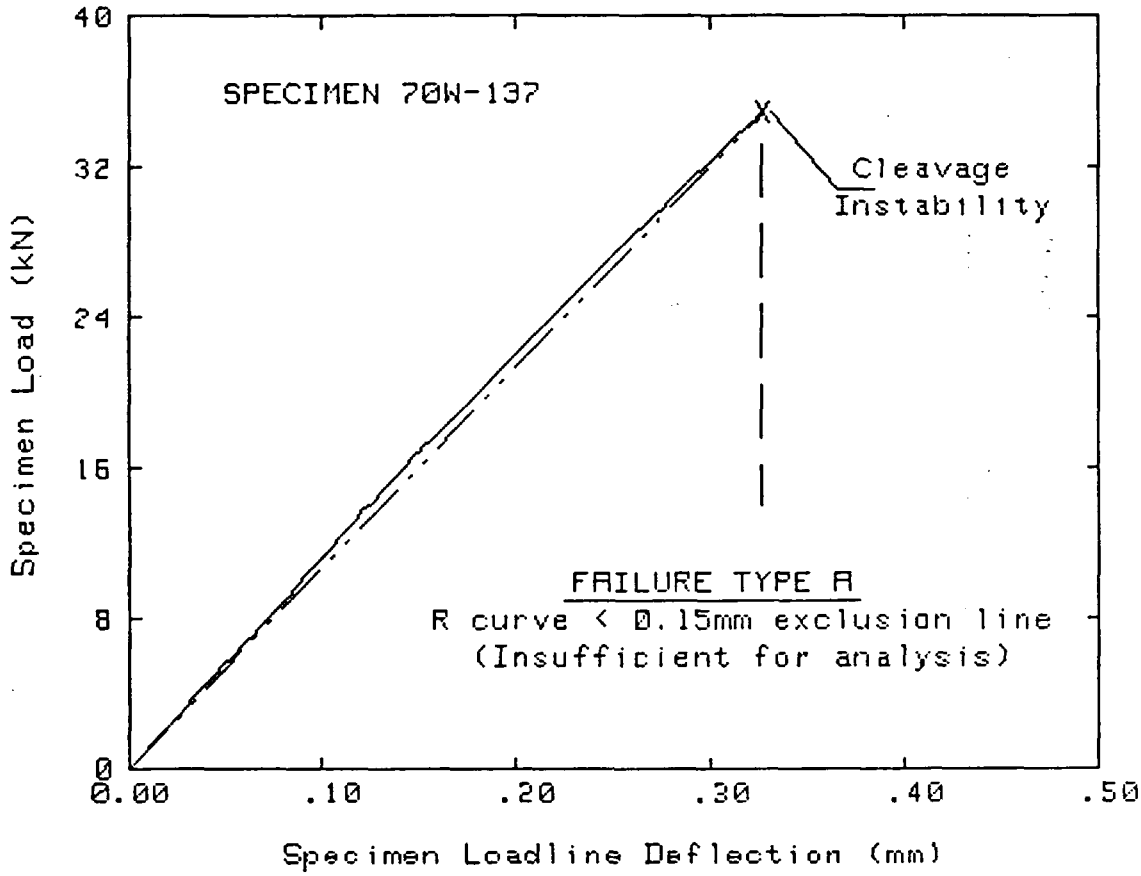
Maximum Load P	= 49.5 kN	
5% Secant Offset Pq	= 27.66 kN	
Kic	= 54.8 MPa √m	
Validity	= INVALID--3	
K at Maximum Load	= 98.1 MPa √m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 1.04616173941E-04 in.

Specimen rotation Load intercept elastic slope =-.0000040875 lb

Fitted elastic load range= 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -75 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .548	
Init crack length a	= 27.86 mm	
Flow stress	= 683.5 MPa	
Yield stress	= 621 MPa	
Youngs modulus E	= 211500 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

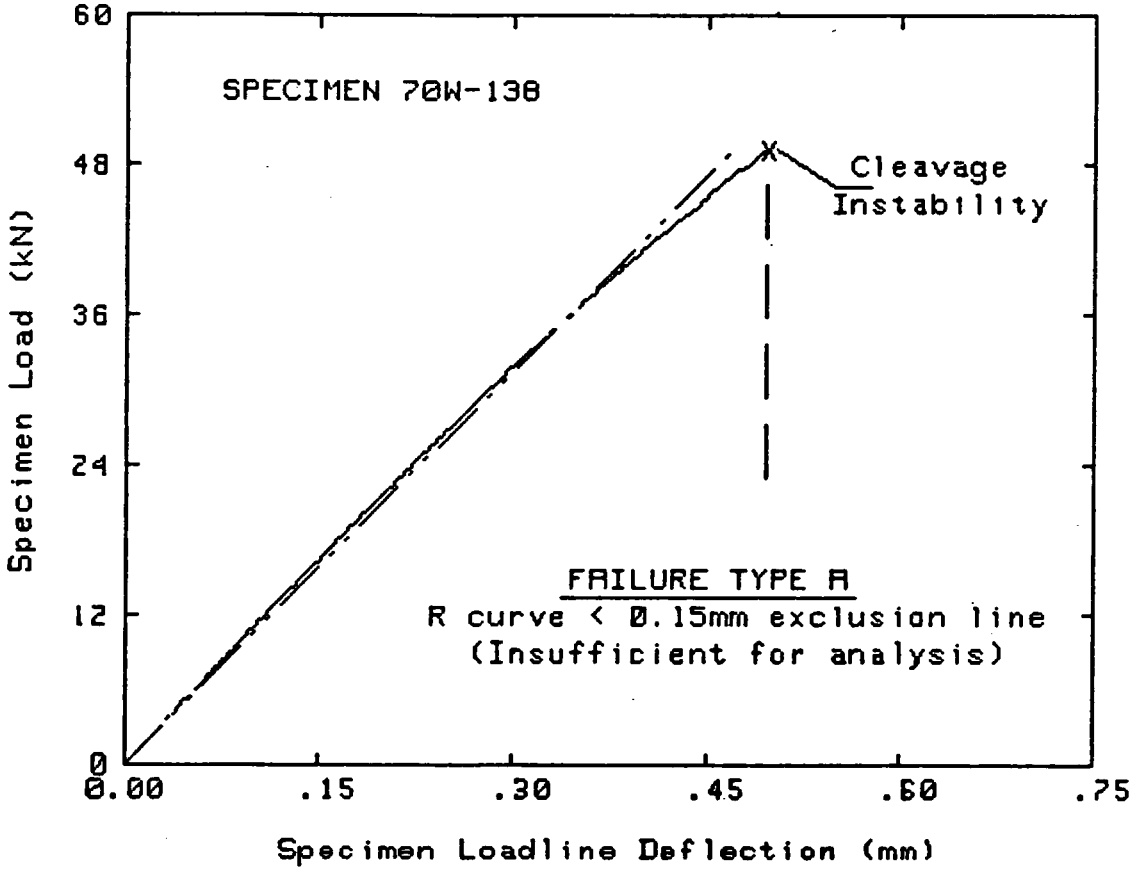
Jic	= 22.5 kJ/m^2	
Kjc=(EJic)^.5	= 69.1 MPa \/m	v=.3
Kic (Beta Corrected)	= 62.5 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 35 kN	
5% Secant Offset Pq	= 35 kN	
Kic	= 69.1 MPa \/m	
Validity	= INVALID--1, 2	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -50 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .551	
Init crack length a	= 27.99 mm	
Flow stress	= 655.5 MPa	
Yield stress	= 594 MPa	
Youngs modulus E	= 210000 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

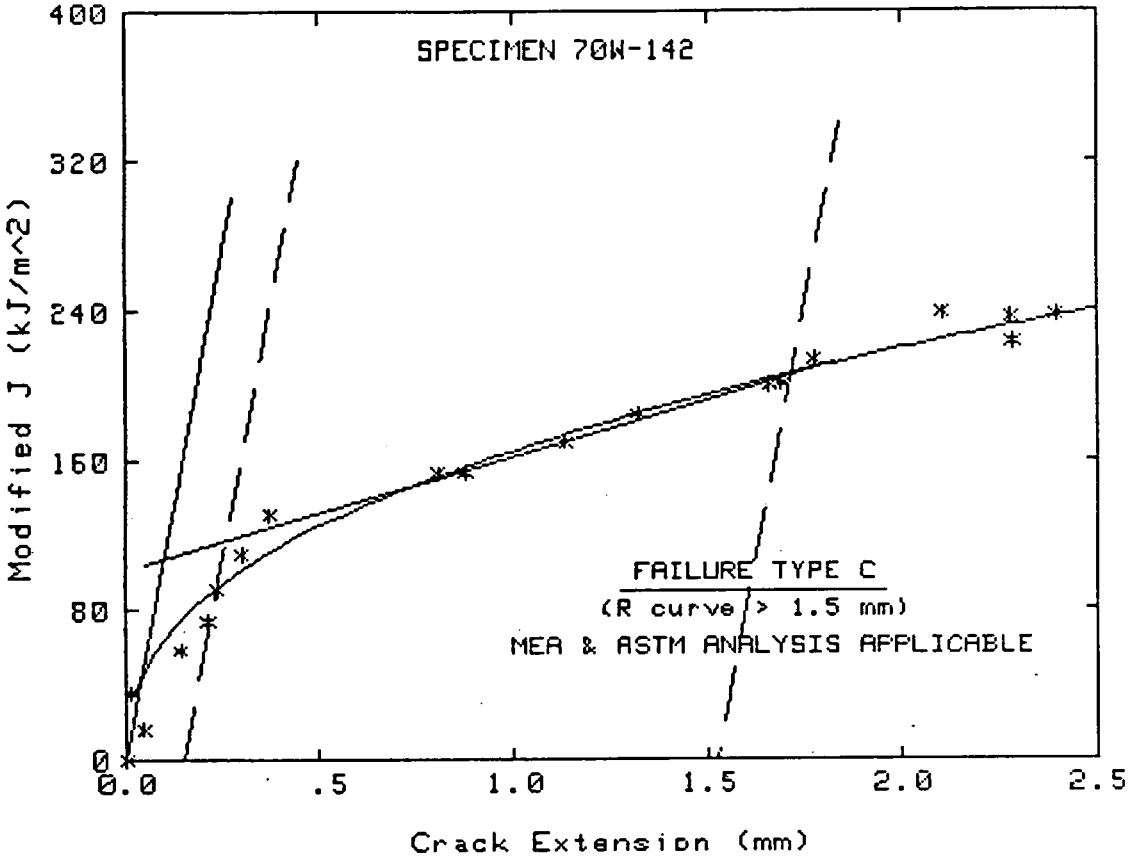
Jic	= 49.8 kJ/m^2	
Kjc=(EJic)^.5	= 102.3 MPa \/m	ν=.3
Kic (Beta Corrected)	= 79 MPa \/m	ν=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 49.2 kN	
5% Secant Offset Pq	= 36.45 kN	
Kic	= 72.6 MPa \/m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 1.11268570869E-04 in.
Specimen rotation Load intercept elastic slope =-3.38095238095E-07 lb
Fitted elastic load range=3400 TO 500 Correction to J for crack extension



TEST SPECIMEN DATA

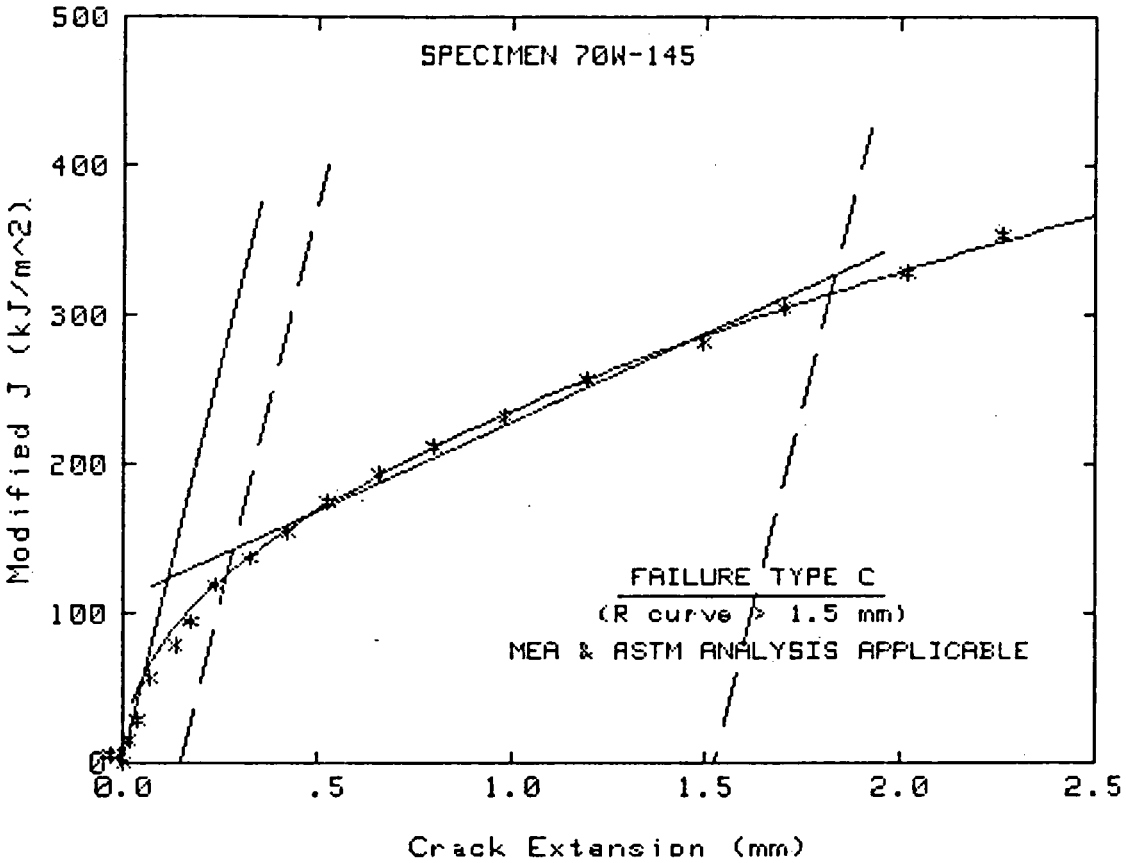
Material Type	= A533B Weld	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.94 mm	Init a/W = .55
Final crack length	= 39.84 mm	Final a/W = .784
Flow stress	= 542.6 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 91.5 kJ/m^2
Kjc	= 132.1 MPa \/m
J (@J/T=8.8)	= 249 kJ/m^2
Exponent N	= .4102
Coefficient C	= 165.2 kJ/m^2
T (average)	= 48

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 106.7 kJ/m^2	
Kjc	= 142.7 MPa \/m	
Slope M	= 60966.1 kJ/m^3	
Intercept B	= 100.7 kJ/m^2	
T (ASTM)	= 40	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--1, 3 (.72 vs .34)	
J maximum allowed	= 550.9 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.29 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

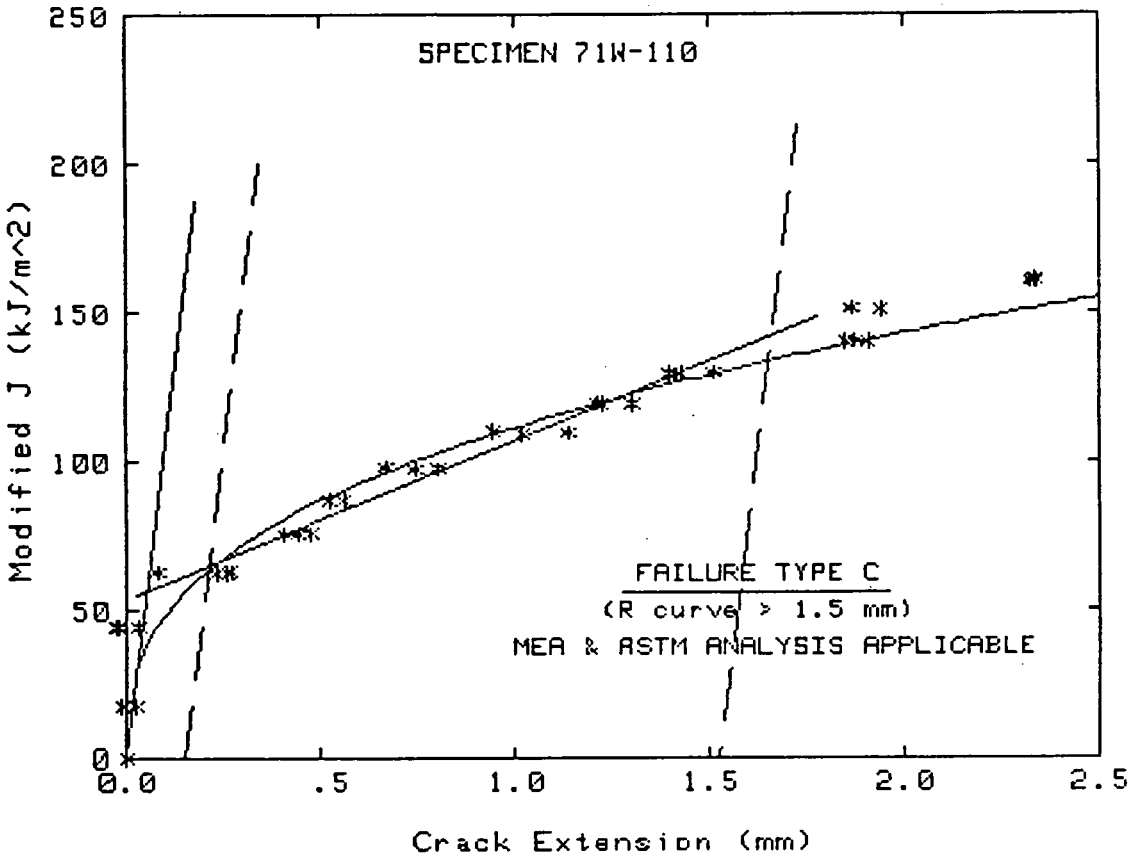
Material Type	= HSST S/A Weld (I)	
Test Temperature	= 204 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.07 mm	Init a/W = .552
Final crack length	= 39.62 mm	Final a/W = .779
Flow stress	= 535.3 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 126 kJ/m^2
Kjc	= 157 MPa \/m
J (@J/T=8.8)	= 410.9 kJ/m^2
Exponent N	= .4797
Coefficient C	= 236.1 kJ/m^2
T (average)	= 80

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 124.1 kJ/m^2	
Kjc	= 155.7 MPa \/m	
Slope M	= 118205.8 kJ/m^3	
Intercept B	= 110.4 kJ/m^2	
T (ASTM)	= 81	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 543.5 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.27 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

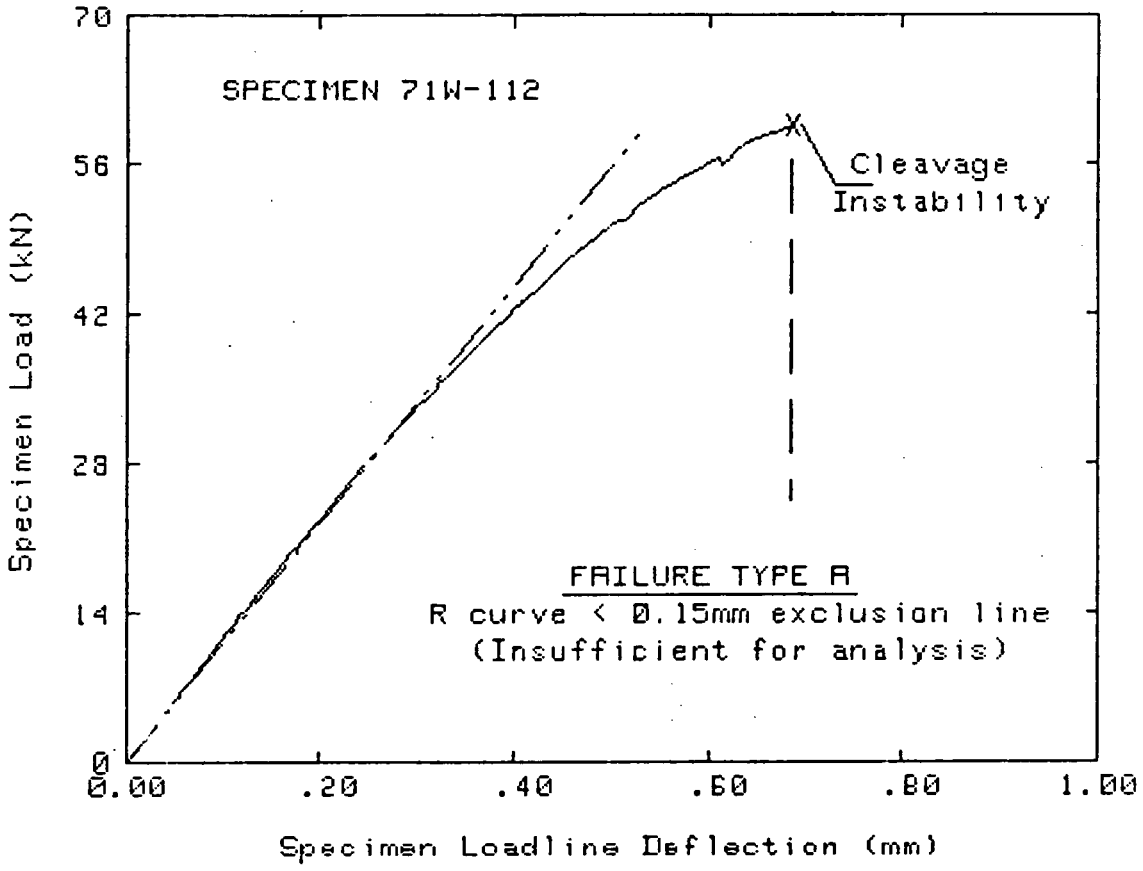
Material Type	= A533B HSST Weld	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.17 mm	Init a/W = .554
Final crack length	= 40.27 mm	Final a/W = .792
Flow stress	= 532.6 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 63.7 kJ/m^2
Kjc	= 110.3 MPa \/m
J (@J/T=8.8)	= 169 kJ/m^2
Exponent N	= .3606
Coefficient C	= 111.4 kJ/m^2
T (average)	= 31

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 56.4 kJ/m^2	
Kjc	= 103.7 MPa \/m	
Slope M	= 53607.5 kJ/m^3	
Intercept B	= 53.6 kJ/m^2	
T (ASTM)	= 36	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 540.8 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.26 mm	(Delta a max = 0.1*bo)
Final Delta a	= 11.81 mm	
Poisson's Ratio (v)	= 0	



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld (I)	
Test Temperature	= 0 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .548	
Init crack length a	= 27.83 mm	
Flow stress	= 615.5 MPa	
Yield stress	= 558 MPa	
Youngs modulus E	= 207200 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 91.8 kJ/m^2	
Kjc=(EJic)^.5	= 138 MPa √m	ν=.3
Kic (Beta Corrected)	= 89 MPa √m	ν=.3

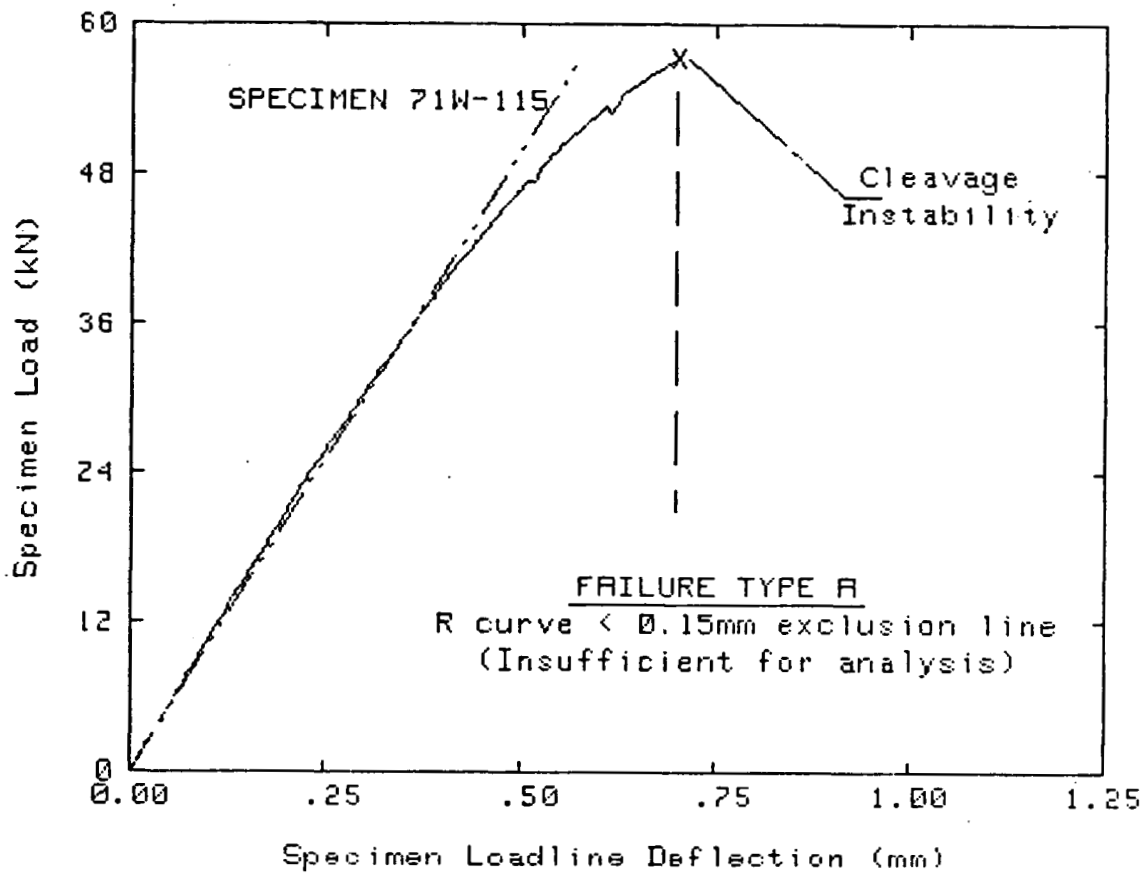
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 59.58 kN	
5% Secant Offset Pq	= 31.06 kN	
Kic	= 61.2 MPa √m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld (I)	
Test Temperature	= 0 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .545	
Init crack length a	= 27.7 mm	
Flow stress	= 615.5 MPa	
Yield stress	= 558 MPa	
Youngs modulus E	= 207200 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 88 kJ/m^2	
Kjc=(EJic)^.5	= 135.1 MPa \/m	v=.3
Kic (Beta Corrected)	= 88.1 MPa \/m	v=.3

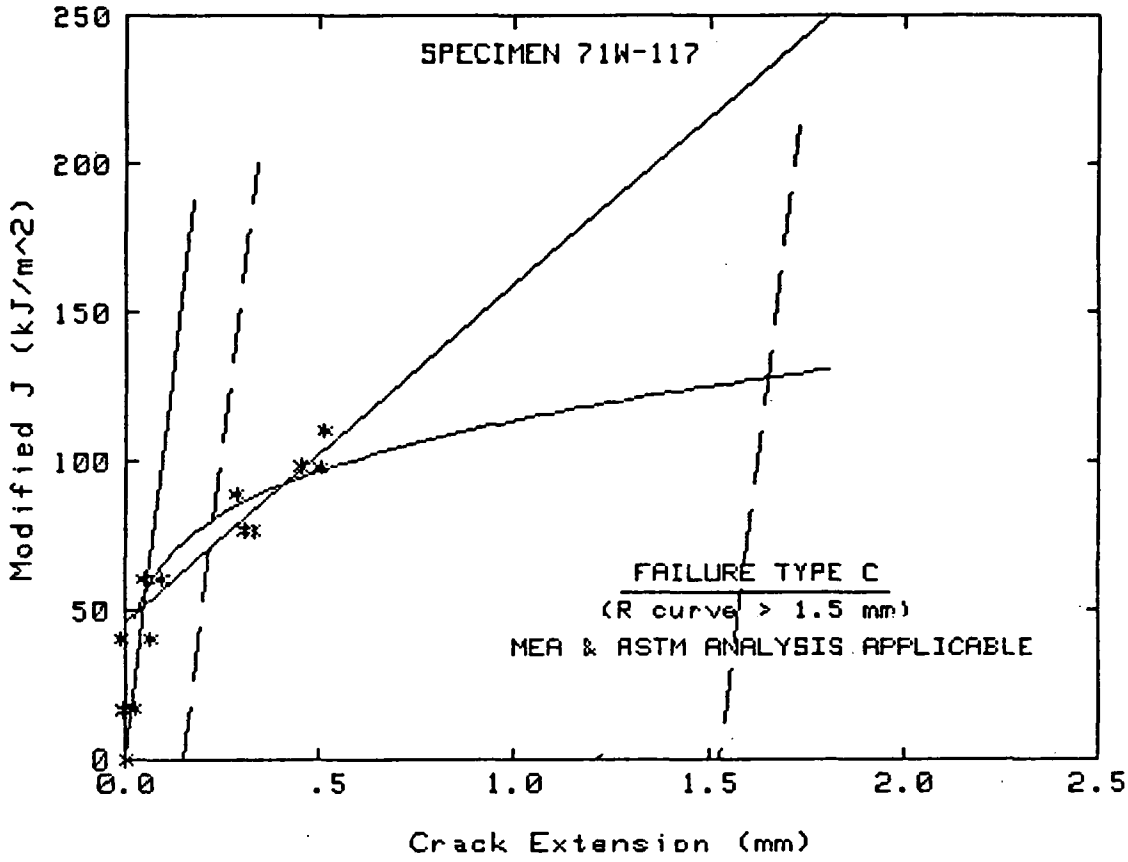
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 57.32 kN	
5% Secant Offset Pq	= 35.11 kN	
Kic	= 68.6 MPa \/m	
Validity	= INVALID--1, 2, 3	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

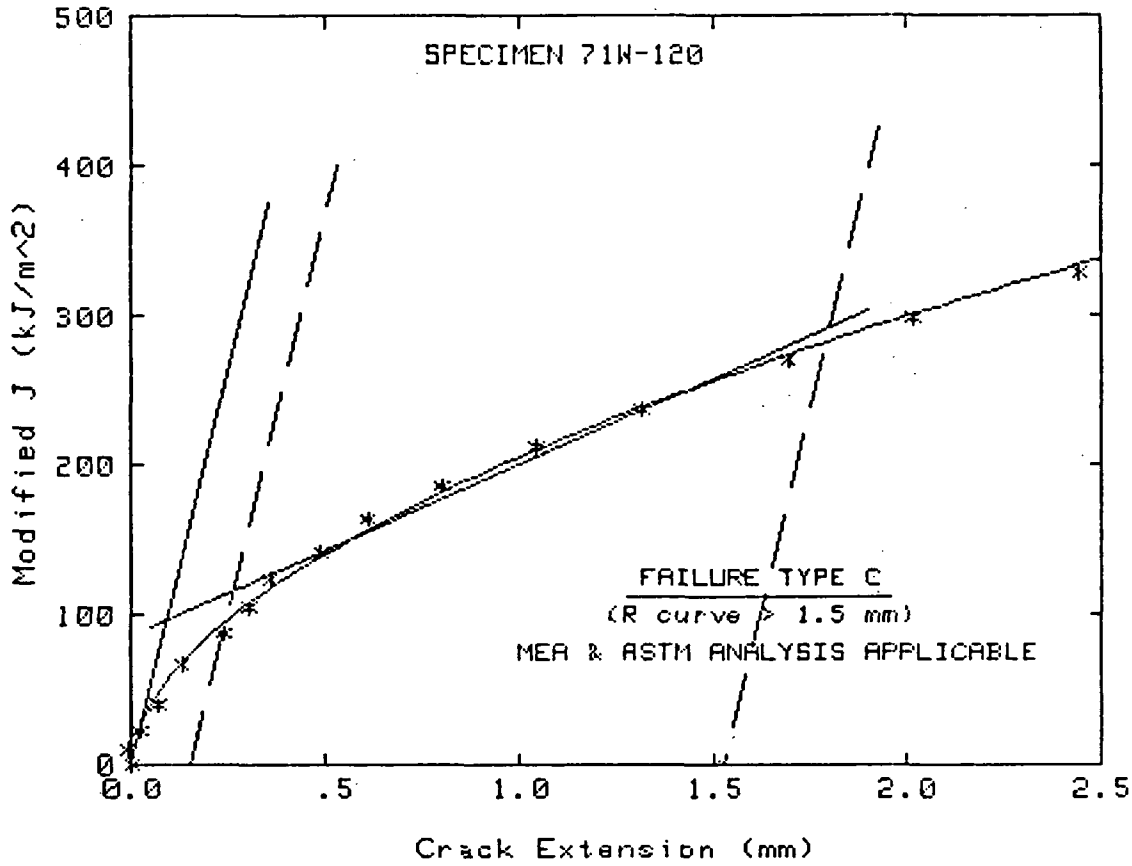
Material Type	= A533B 02 Plate	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28 mm	Init a/W = .551
Final crack length	= 28.85 mm	Final a/W = .568
Flow stress	= 532.6 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 80.2 kJ/m^2
Kjc	= 123.7 MPa \/m
J (@J/T=8.8)	= 0 kJ/m^2
Exponent N	= .2377
Coefficient C	= 114 kJ/m^2
T (average)	= 21

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 51.8 kJ/m^2	
Kjc	= 99.4 MPa \/m	
Slope M	= 113429.9 kJ/m^3	
Intercept B	= 46.3 kJ/m^2	
T (ASTM)	= 76	
Validity (Jic)	= INVALID--b, c (.33 vs .12)	
Validity (R-curve)	= INVALID--2, 3 (.33 vs .12)	
J maximum allowed	= 540.8 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.28 mm	(Delta a max = 0.1*bo)
Final Delta a	= .51 mm	
Poisson's Ratio (v)	= 0	



TEST SPECIMEN DATA

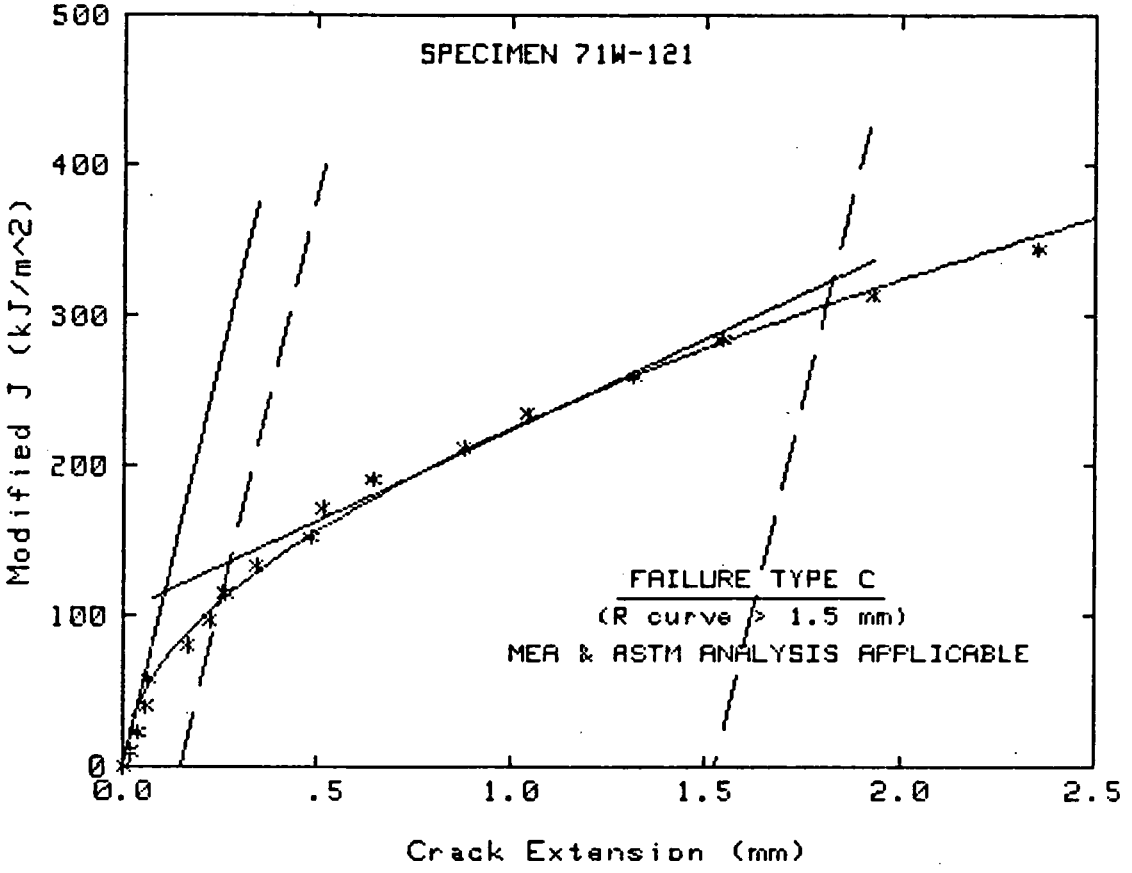
Material Type	= HSST S/A Weld (I)	
Test Temperature	= 204 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.58 mm	Init a/W = .562
Final crack length	= 41.26 mm	Final a/W = .812
Flow stress	= 527 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 95.3 kJ/m^2
Kjc	= 136.5 MPa \/m
J (@J/T=8.8)	= 374.3 kJ/m^2
Exponent N	= .5426
Coefficient C	= 205.4 kJ/m^2
T (average)	= 82

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 95.7 kJ/m^2
Kjc	= 136.8 MPa \/m
Slope M	= 114956 kJ/m^3
Intercept B	= 85.2 kJ/m^2
T (ASTM)	= 81
Validity (Jic)	= VALID
Validity (R-curve)	= INVALID--1, 3 (.51 vs .33)
J maximum allowed	= 535 kJ/m^2 (Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.22 mm (Delta a max = 0.1*bo)



TEST SPECIMEN DATA

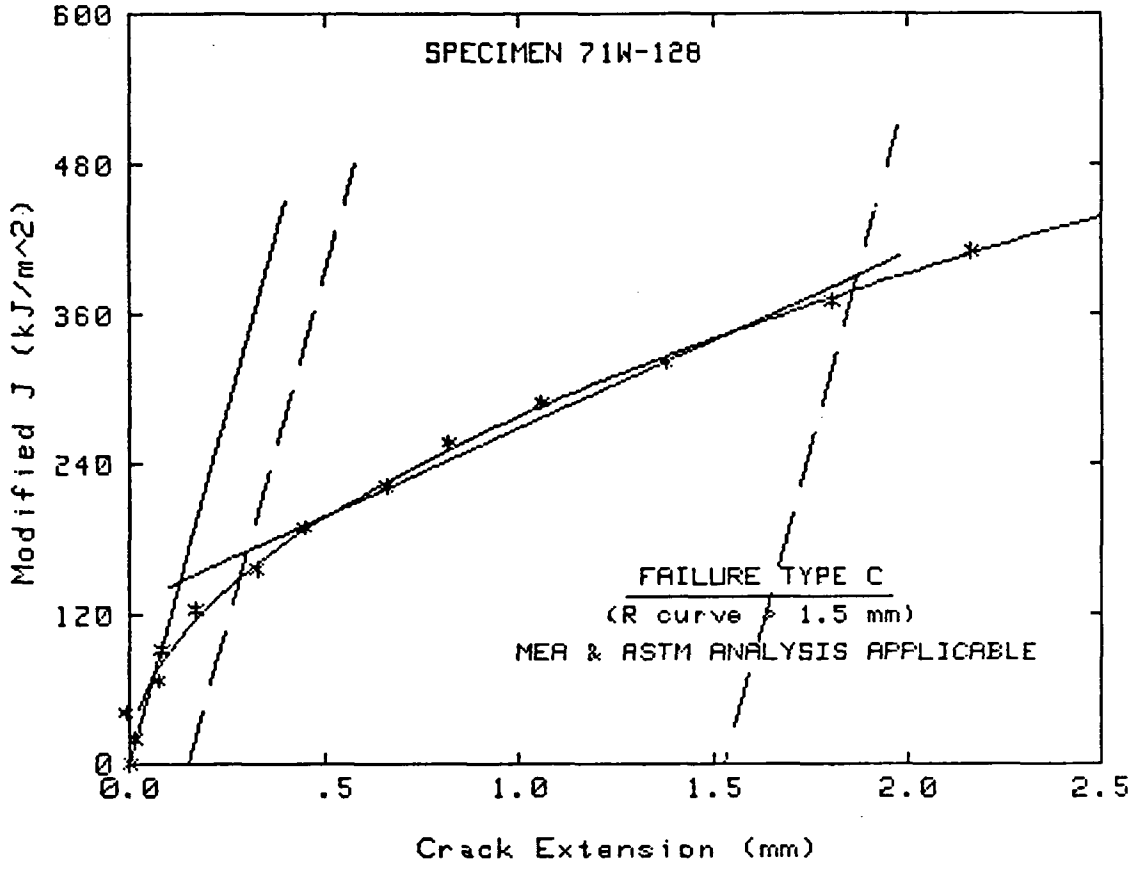
Material Type	= HSST S/A Weld (I)	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.81 mm	Init a/W = .547
Final crack length	= 39.14 mm	Final a/W = .77
Flow stress	= 545.5 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 109.4 kJ/m^2
Kjc	= 148 MPa \/m
J (@J/T=8.8)	= 383 kJ/m^2
Exponent N	= .5253
Coefficient C	= 225.3 kJ/m^2
T (average)	= 83

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 115 kJ/m^2
Kjc	= 151.8 MPa \/m
Slope M	= 121637.2 kJ/m^3
Intercept B	= 102.2 kJ/m^2
T (ASTM)	= 82
Validity (Jic)	= VALID
Validity (R-curve)	= INVALID--1
J maximum allowed	= 553.8 kJ/m^2 (Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.3 mm (Delta a max = 0.1*bo)



TEST SPECIMEN DATA

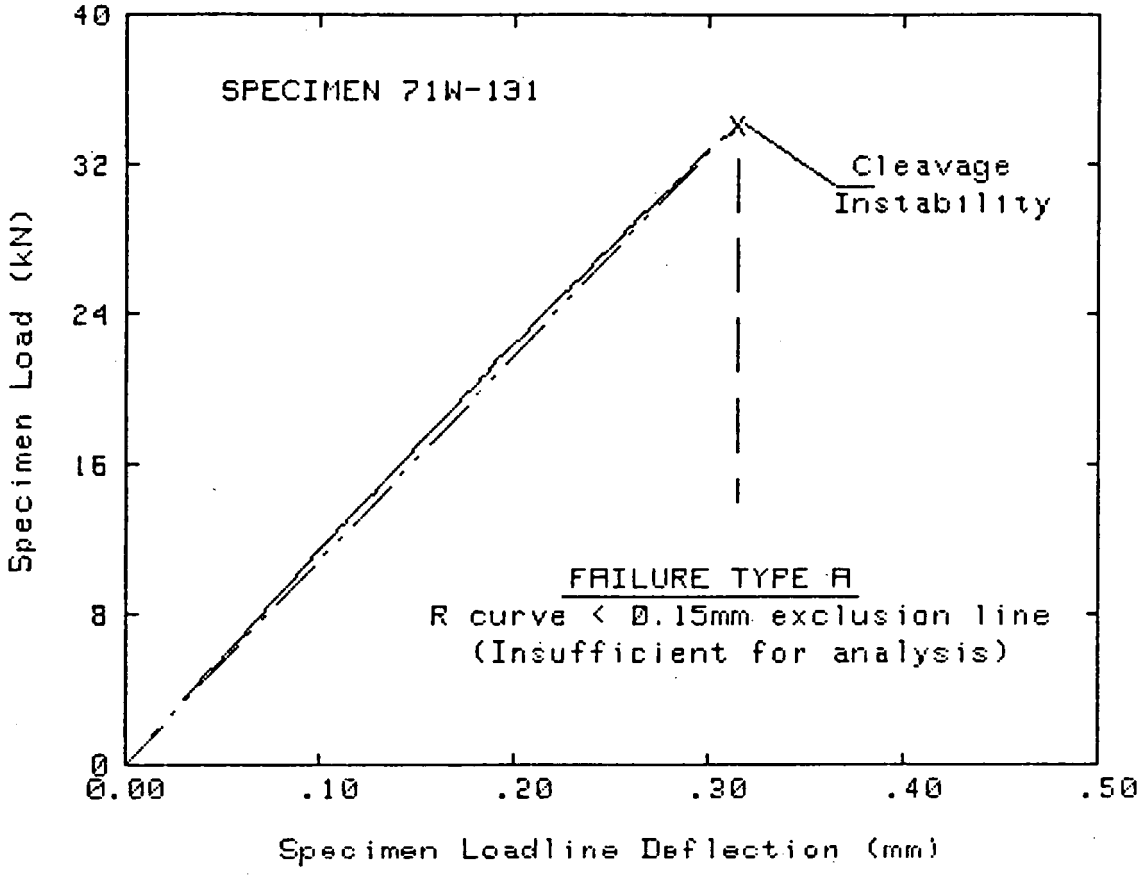
Material Type	= A533-B HSST WELD	
Test Temperature	= 50 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.21 mm	Init a/W = .555
Final crack length	= 38.74 mm	Final a/W = .762
Flow stress	= 569.5 MPa	
Youngs modulus	= 204400 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 148.7 kJ/m^2
Kjc	= 174.3 MPa \/m
J (@J/T=8.8)	= 478.2 kJ/m^2
Exponent N	= .4963
Coefficient C	= 278.3 kJ/m^2
T (average)	= 88

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 145.7 kJ/m^2	
Kjc	= 172.5 MPa \/m	
Slope M	= 141057.5 kJ/m^3	
Intercept B	= 127.6 kJ/m^2	
T (ASTM)	= 89	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--2	
J maximum allowed	= 578.2 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.26 mm	(Delta a max = 0.1*bo)
Final Delta a	= 10.38 mm	
Poisson's Ratio (v)	= 0	



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld (I)	
Test Temperature	= -50 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .553	
Init crack length a	= 28.09 mm	
Flow stress	= 649.2 MPa	(Estimated Value)
Yield stress	= 587 MPa	(Estimated Value)
Youngs modulus E	= 210100 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 21.4 kJ/m^2	
Kjc=(EJic)^.5	= 67.1 MPa \/m	v=.3
Kic (Beta Corrected)	= 60.2 MPa \/m	v=.3

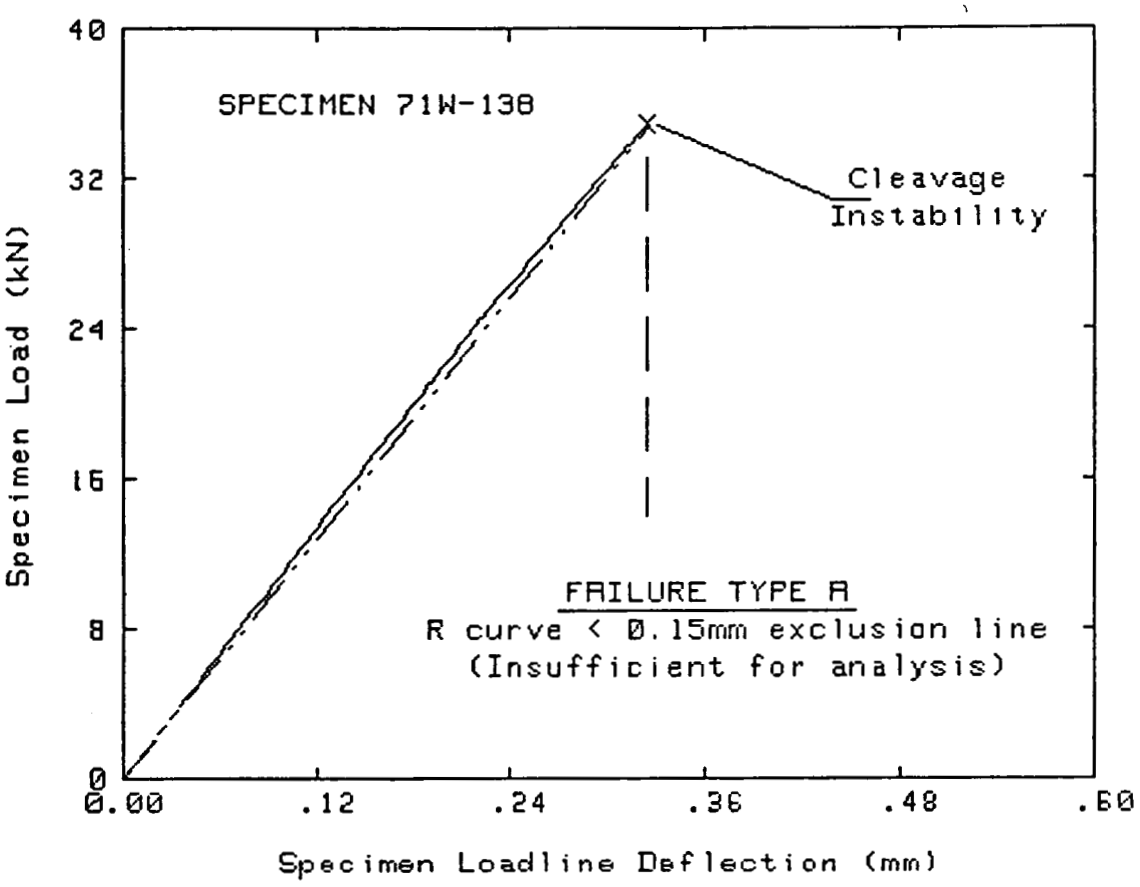
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 34.14 kN	
5% Secant Offset Pq	= 33.66 kN	
Kic	= 67.5 MPa \/m	
Validity	= INVALID--1, 2	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld	
Test Temperature	= -70 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .548	
Init crack length a	= 27.84 mm	
Flow stress	= 672.5 MPa	
Yield stress	= 609 MPa	
Youngs modulus E	= 211100 MPa	(Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 22.2 kJ/m^2	
Kjc=(EJic)^.5	= 68.6 MPa √m	ν=.3
Kic (Beta Corrected)	= 61.8 MPa √m	ν=.3

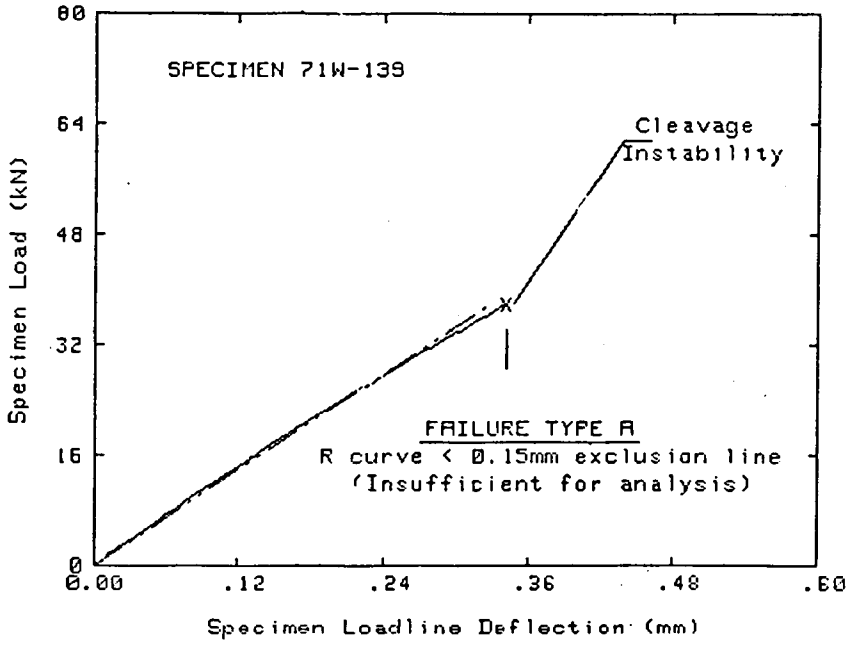
ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^.5

Maximum Load P	= 34.9 kN	
5% Secant Offset Pq	= 34.91 kN	
Kic	= 68.8 MPa √m	
Validity	= INVALID--1, 2	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-1.99267238415E-05 in.
Specimen rotation Load intercept elastic slope =-1.82926829268E-07 lb
Fitted elastic load range=3400 TO 500 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= -30 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .55	
Init crack length a	= 27.95 mm	
Flow stress	= 635 MPa	
Yield stress	= 577.8 MPa	
Youngs modulus E	= 208900 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 25.9 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 73.6 MPa \/m	v=.3
Kic (Beta Corrected)	= 63.9 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

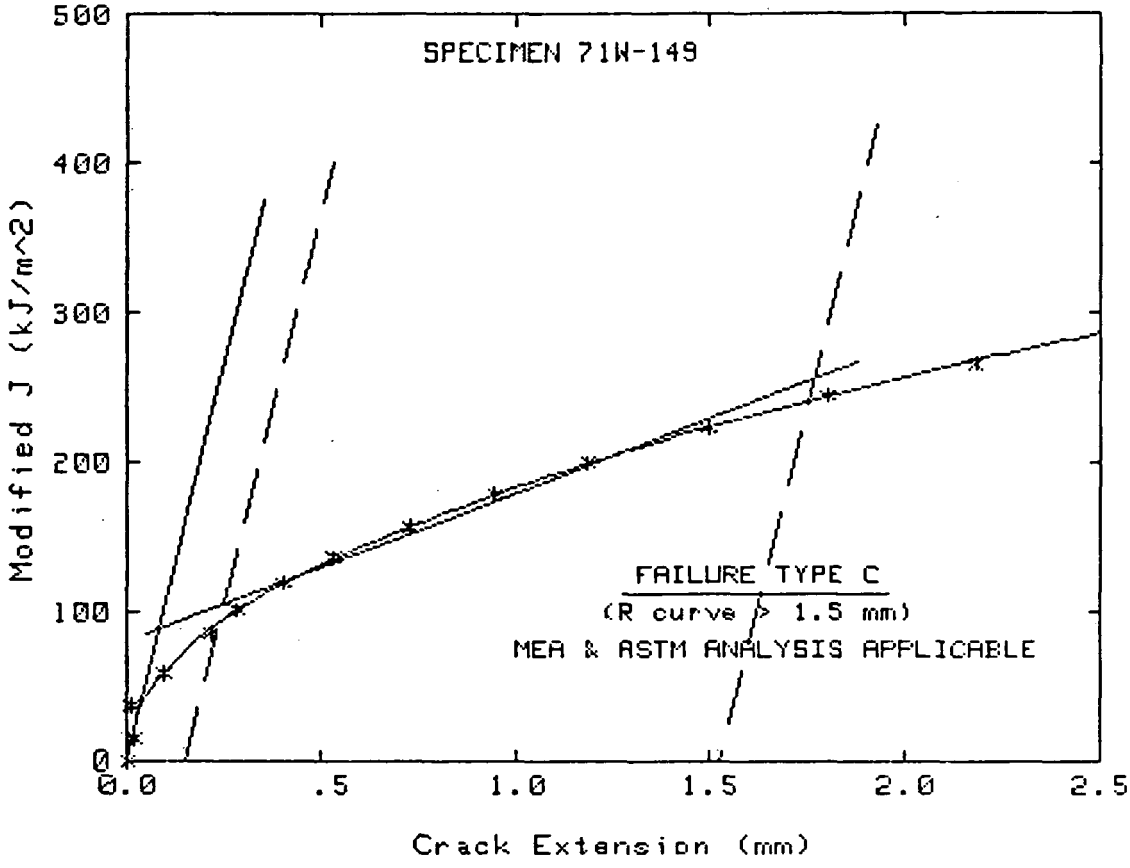
Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 37.8 kN	
5% Secant Offset Pq	= 27.02 kN	
Kic	= 53.7 MPa \/m	
Validity	= INVALID--3	
K at Maximum Load	= 75.1 MPa \/m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 6.7018514886 5E-05 in.

Specimen rotation Load intercept elastic slope =-.000000325 lb

Fitted elastic load range= 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

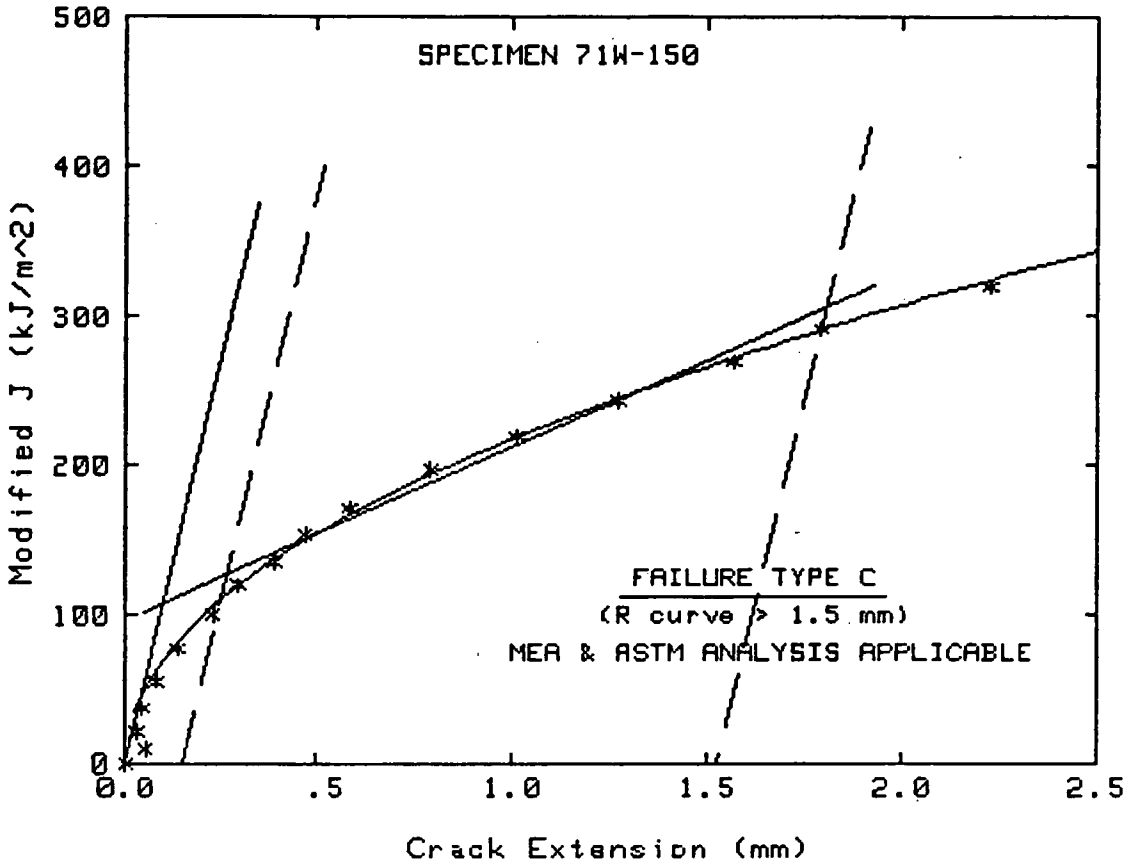
Material Type	= HSST S/A Weld (I)	
Test Temperature	= 204 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.99 mm	Init a/W = .55
Final crack length	= 41.12 mm	Final a/W = .809
Flow stress	= 527 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 92 kJ/m^2
Kjc	= 134.1 MPa \/m
J (@J/T=8.8)	= 305.6 kJ/m^2
Exponent N	= .4844
Coefficient C	= 183.7 kJ/m^2
T (average)	= 66

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 89 kJ/m^2	
Kjc	= 131.9 MPa \/m	
Slope M	= 98998.8 kJ/m^3	
Intercept B	= 80.6 kJ/m^2	
T (ASTM)	= 70	
Validity (Jic)	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 535 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.28 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

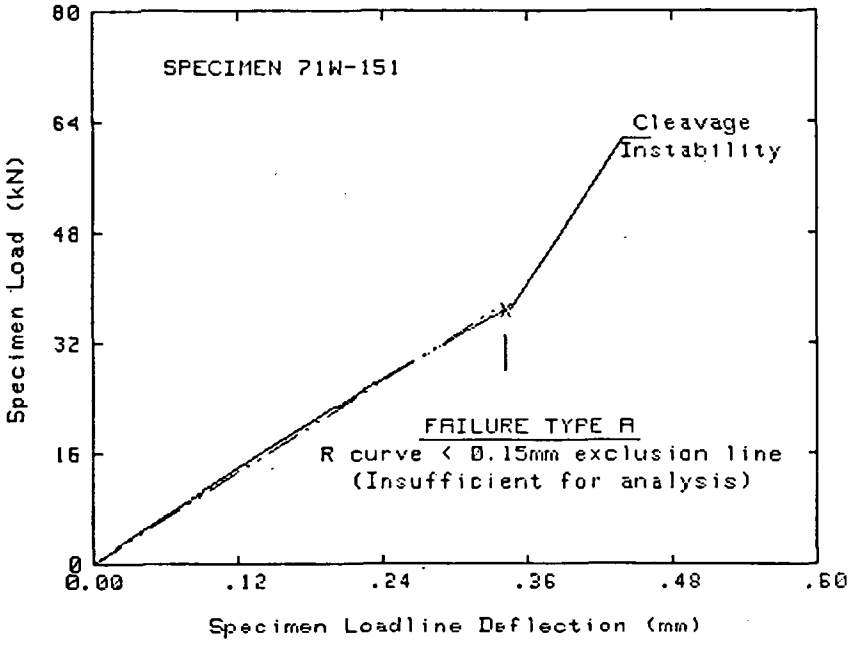
Material Type	= HSST S/A Weld (I)	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.74 mm	Init a/W = .546
Final crack length	= 39.75 mm	Final a/W = .782
Flow stress	= 545.5 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA J = C (Delta a) ^ N

Jic	= 109.9 kJ/m^2	
Kjc	= 155.5 MPa \/m	Kic (Beta) = 92.7 MPa \/m
J (@J/T=8.8)	= 365 kJ/m^2	
Exponent N	= .4972	
Coefficient C	= 217.6 kJ/m^2	
T (average)	= 76	

LEAST SQUARE LINEAR LINE (ASTM) J = M (Delta a) + B

Jic	= 107.4 kJ/m^2	
Kjc	= 153.7 MPa \/m	Kic (Beta) = 92.3 MPa \/m
Slope M	= 116347.5 kJ/m^3	
Intercept B	= 95.9 kJ/m^2	
T (ASTM)	= 78	
Validity (Jic)	= VALID	
Validity (R-curve)	= INVALID--1	
J maximum allowed	= 553.8 kJ/m^2	(Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 2.31 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	= A533-B HSST WELD	
Test Temperature	= -30 C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 25.4 mm	
Initial a/W	= .553	
Init crack length a	= 28.07 mm	
Flow stress	= 635 MPa	
Yield stress	= 577.8 MPa	
Youngs modulus E	= 208900 MPa	(Estimated Value)
Poisson's Ratio (v)	= 0	

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = Jic)

Jic	= 25.3 kJ/m^2	
Kjc=(EJic/(1-v^2))^.5	= 72.8 MPa \/m	v=.3
Kic (Beta Corrected)	= 63.4 MPa \/m	v=.3

ASTM E399-81 ANALYSIS

Modified Kic Equation;	B = (BBn)^.5	
Maximum Load P	= 36.8 kN	
5% Secant Offset Pq	= 30.77 kN	
Kic	= 61.6 MPa \/m	
Validity	= INVALID--1, 2, 3	
K at Maximum Load	= 73.7 MPa \/m	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 7.86537495457E-06 in.
Specimen rotation Load intercept elastic slope = .0000036125 lb
Fitted elastic load range= 2500 TO 2000 Correction to J for crack extension

Appendix F

LOAD-DISPLACEMENT AND J-R CURVES AND PHOTOGRAPHS, SUPPLIED BY OAK RIDGE NATIONAL LABORATORY, FOR IRRADIATED MATERIAL

ORNL VALIDITY INDEX

J_{Ic} (ASTM E813)

1. < 4 data points between 0.15 and 1.5 mm exclusion lines.

2. Data clustering problem.

3. $B_N < 25\ J_Q/\sigma_y$

4. $b_o < 25\ J_Q/\sigma_y$

5. $dJ/da > \sigma_{flow}$

6. Delta-a prediction error too large,
   $|(\text{delta-a})_{pred} - (\text{delta-a})_{meas}| > 0.15\ (\text{delta-a})_{meas}$

Tentative J_I - R Curve Procedure

1. < 3 data points between (delta-a)=0 and secant line [$J=4/3*\sigma_y*(\text{delta-a})$]

2. < 10 data points between secant line and $(\text{delta-a})_{max}$ [$0.1*b_o$]

3. (delta-a) prediction error too large,
   $|(\text{delta-a})_{pred} - (\text{delta-a})_{meas}| >$
   MINIMUM [$0.15*(\text{delta-a})_{meas}, 0.15*(\text{delta-a})_{max}$]

ORNL IRRADIATED 1TCS DATA SHEETS
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F-315	02G298	F-411	70W107
F-317	02G316	F-413	70W108
F-319	02G328	F-415	70W110
F-321	02G329	F-417	70W117
F-323	02G338	F-419	70W118
F-325	02G340	F-421	70W123
F-327	02G344	F-423	70W124
F-329	02G353	F-425	70W126
F-331	02G362	F-427	70W136
F-333	02G363	F-429	70W139
F-335	02G365	F-431	70W140
F-337	02G401	F-433	70W148
F-339	02G404	F-435	71W101
F-341	02G406	F-437	71W108
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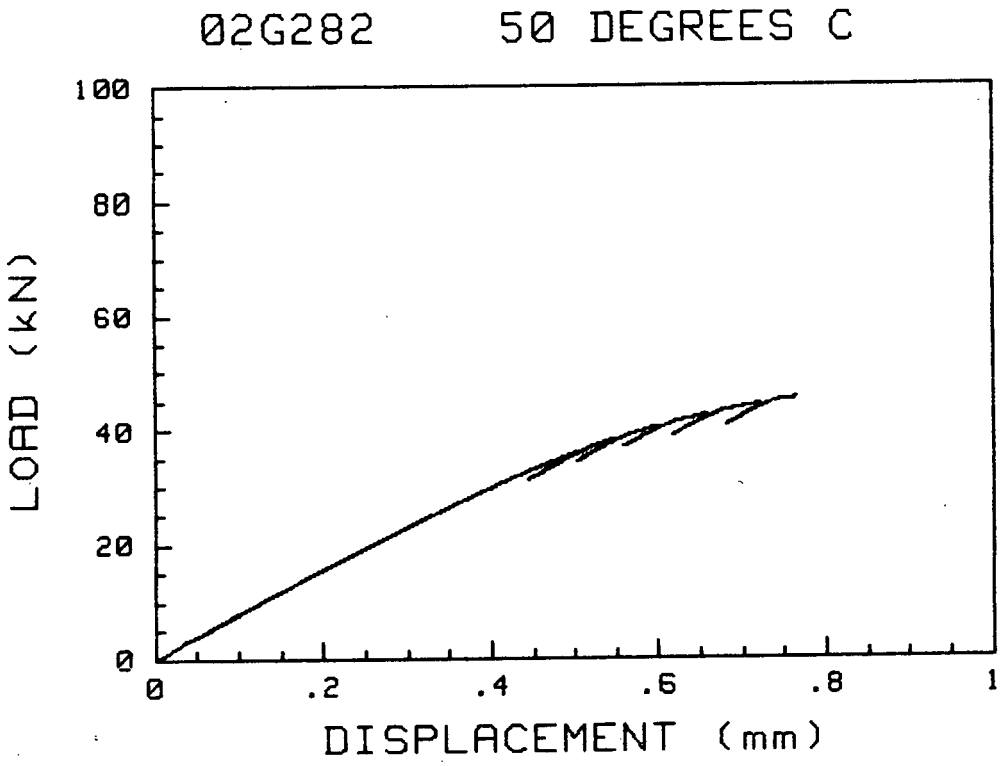
F-351	68WAD	F-447	71W123
F-353	68WBB	F-449	71W126
F-355	68WCE	F-451	71W133
F-357	68WDA	F-453	71W134
F-359	68WDC	F-455	71W140
F-361	68WHC	F-457	71W141
F-363	68WKB	F-459	71W142
F-365	68WKC	F-461	71W143
F-367	68WKE	F-463	71W144
F-369	68WLC	F-465	71W146
F-371	68WMB	F-467	71W147
F-373	68WMD		
F-375	69W102		
F-377	69W113		
F-379	69W114		
F-381	69W116		
F-383	69W119		
F-385	69W121		
F-387	69W126		
F-389	69W142		
F-391	69W143		
F-393	69W144		
F-395	69W149		
F-397	69W153		
F-399	69W160		
F-401	69W165		
F-403	69W167		

SPECIMEN ID= 02G282
MATERIAL TYPE= A533
TEST TEMPERATURE= 50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.6 mm a/W)i= .618
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 604 MPa
FLOW STRENGTH= 672 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN CLEAVED AT K = 116.5 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 90.7 kJ/m^2	J-INTEGRAL= 90.3 kJ/m^2
KJc= 136.1 MPa SQR[m]	KJc= 135.9 MPa SQR[m]
K-beta-c= 92.2 MPa SQR[m]	K-beta-c= 92.2 MPa SQR[m]

ORNL-DWG 87-7995



SPECIMEN ID= 02GA285
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 31.9 mm a/W)i= .626
MEASURED DUCTILE DELTA-A= 3.54 mm
YIELD STRENGTH= 573 MPa
FLOW STRENGTH= 639 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 204.1 kJ/m^2
KJ-MAX LOAD= 202.2 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 156.7 kJ/m^2
K-JIc= 177.2 MPa SQR[m]
POWER= .4336
COEFFICIENT= 275.4 kJ/m^2
T (AVERAGE)= 61

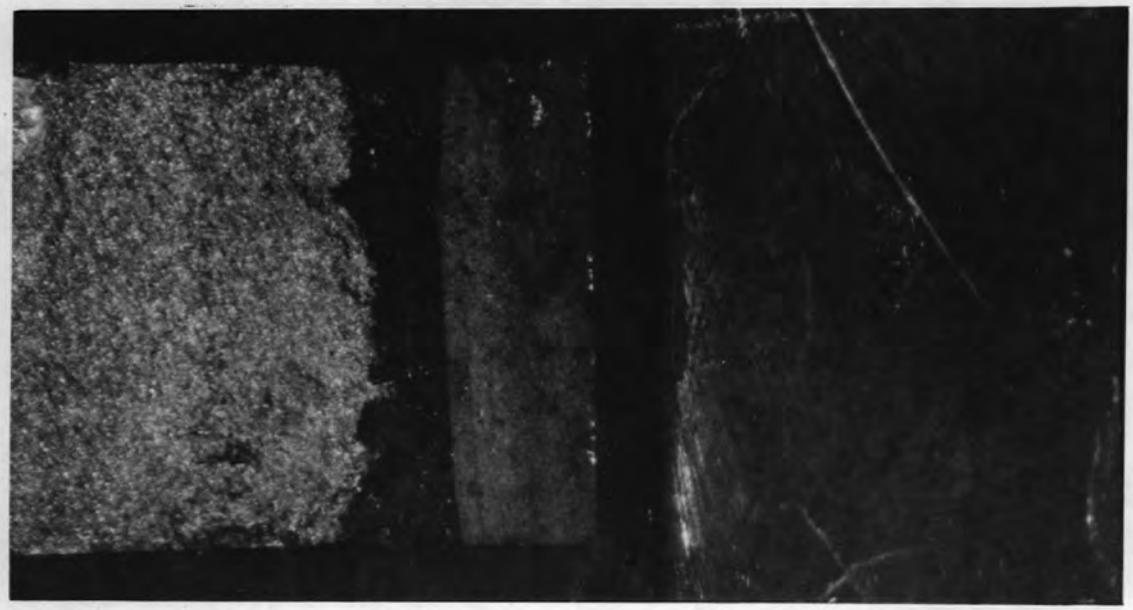
ASTM LINEAR PROCEDURE

JIc= 141.6 kJ/m^2
K-JIc= 168.4 MPa SQR[m]
SLOPE= 139549 kJ/m^3
INTERCEPT= 126.2 kJ/m^2
T (ASTM)= 68
VALID, E813

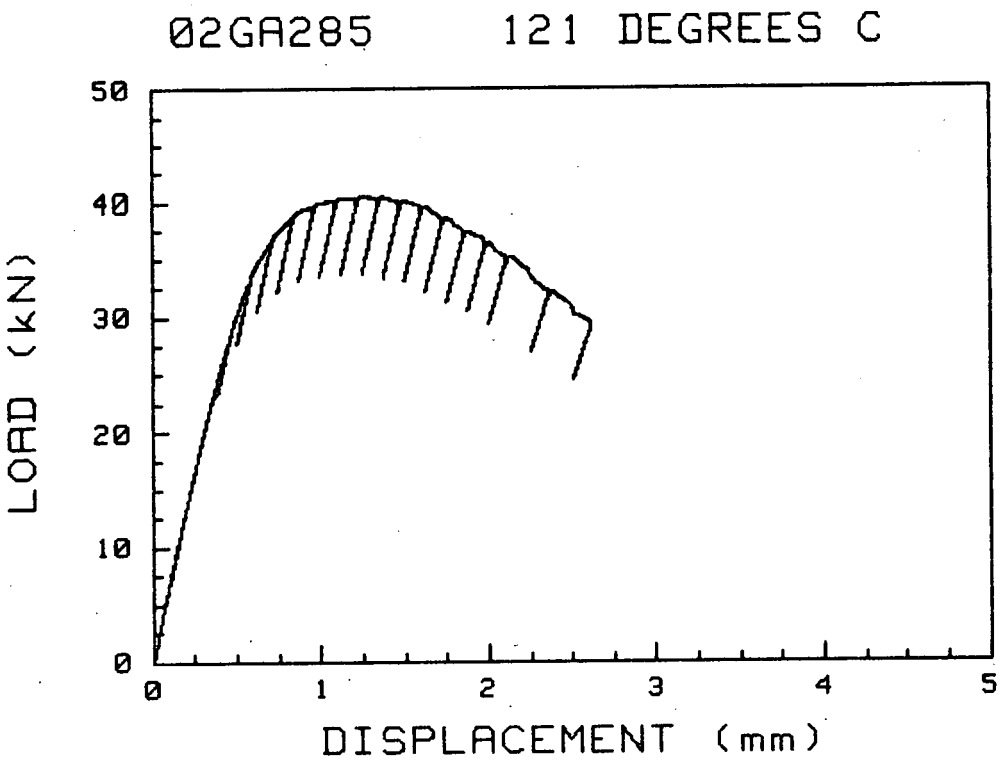
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 376.5 kJ/m^2
POWER= .4614
J-MAX ALLOWED= 609.4 kJ/m^2
RCURVE INVALID, 1 3

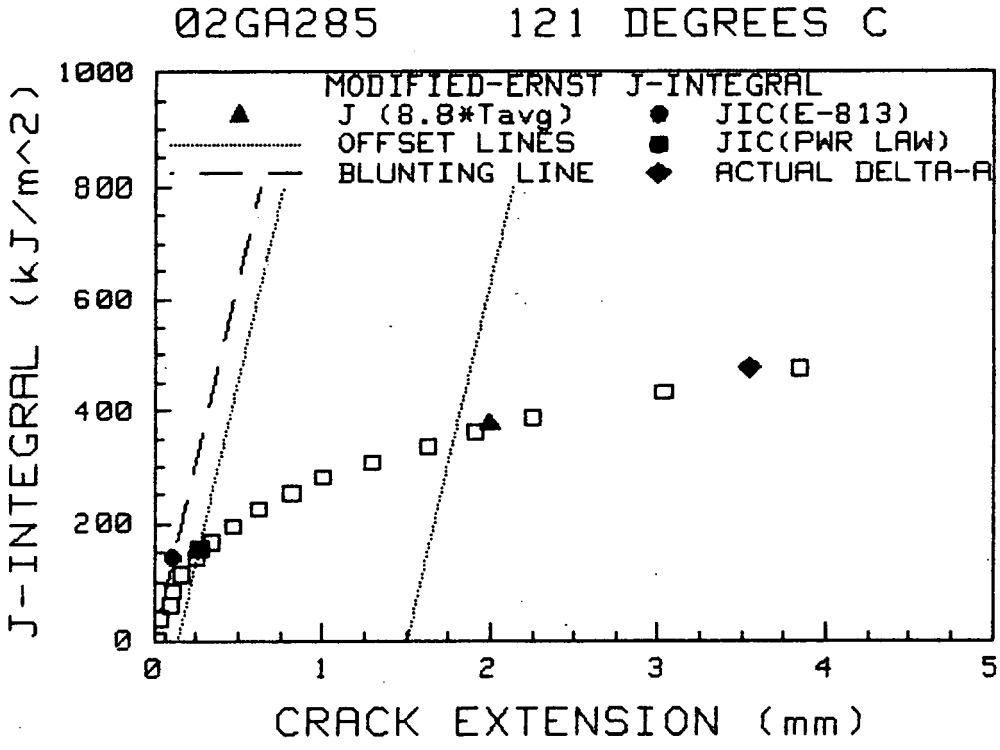
COEFFICIENT= 274 kJ/m^2
DELTA-A MAX ALLOWED= 1.91 mm



ORNL-DWG 87-7996



ORNL-DWG 87-7997

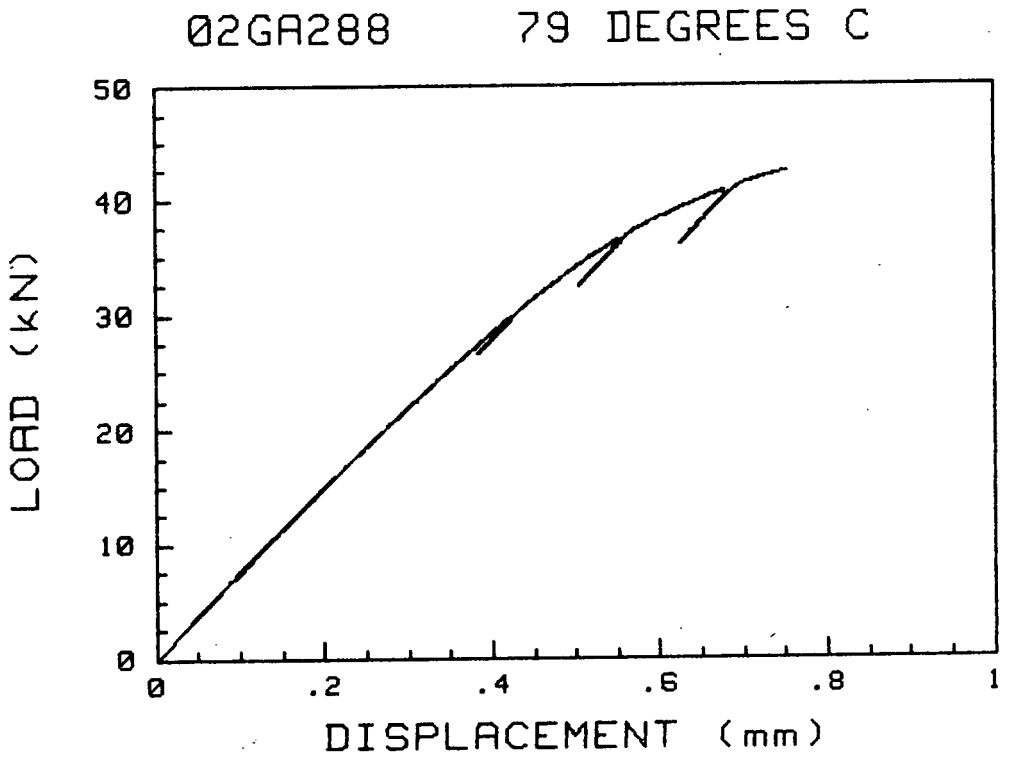


SPECIMEN ID= 02GA288
MATERIAL TYPE= A533B
TEST TEMPERATURE= 79 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.9 mm a/W)i= .624
MEASURED DUCTILE DELTA-A= .12 mm
YIELD STRENGTH= 591 MPa
FLOW STRENGTH= 657 MPa
ESTIMATED YOUNG'S MODULUS= 203 GPa

SPECIMEN CLEAVED AT K = 111.3 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 84.9 kJ/m^2	J-INTEGRAL= 84.7 kJ/m^2
KJc= 131.2 MPa SQR[m]	KJc= 131.1 MPa SQR[m]
K-beta-c= 89.6 MPa SQR[m]	K-beta-c= 89.5 MPa SQR[m]

ORNL-DWG 87-7998



SPECIMEN ID= 02GA298
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 31.8 mm a/W)i= .623
MEASURED DUCTILE DELTA-A= 4.5 mm
YIELD STRENGTH= 573 MPa
FLOW STRENGTH= 639 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 209.1 kJ/m^2
KJ-MAX LOAD= 204.6 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 159.6 kJ/m^2
K-JIc= 178.8 MPa SQR[m]
POWER= .3918
COEFFICIENT= 264.7 kJ/m^2
T (AVERAGE)= 54

ASTM LINEAR PROCEDURE

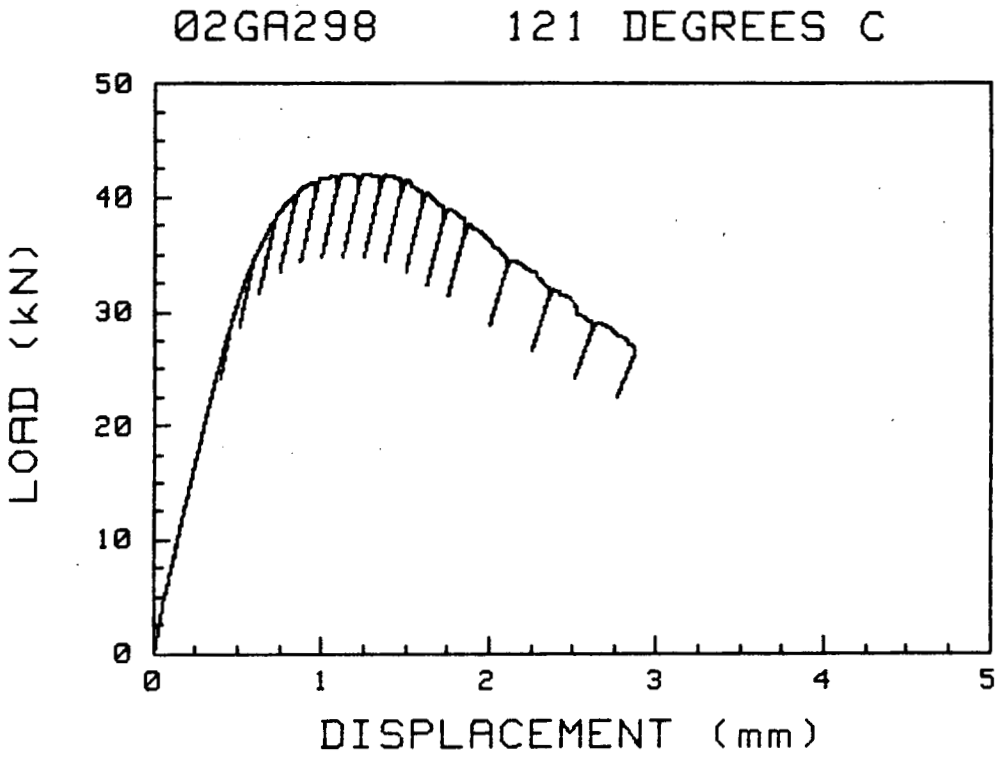
JIc= 146.3 kJ/m^2
K-JIc= 171.2 MPa SQR[m]
SLOPE= 123731 kJ/m^3
INTERCEPT= 132.2 kJ/m^2
T (ASTM)= 61
VALID, E813

JI-R CURVE CALCULATIONS

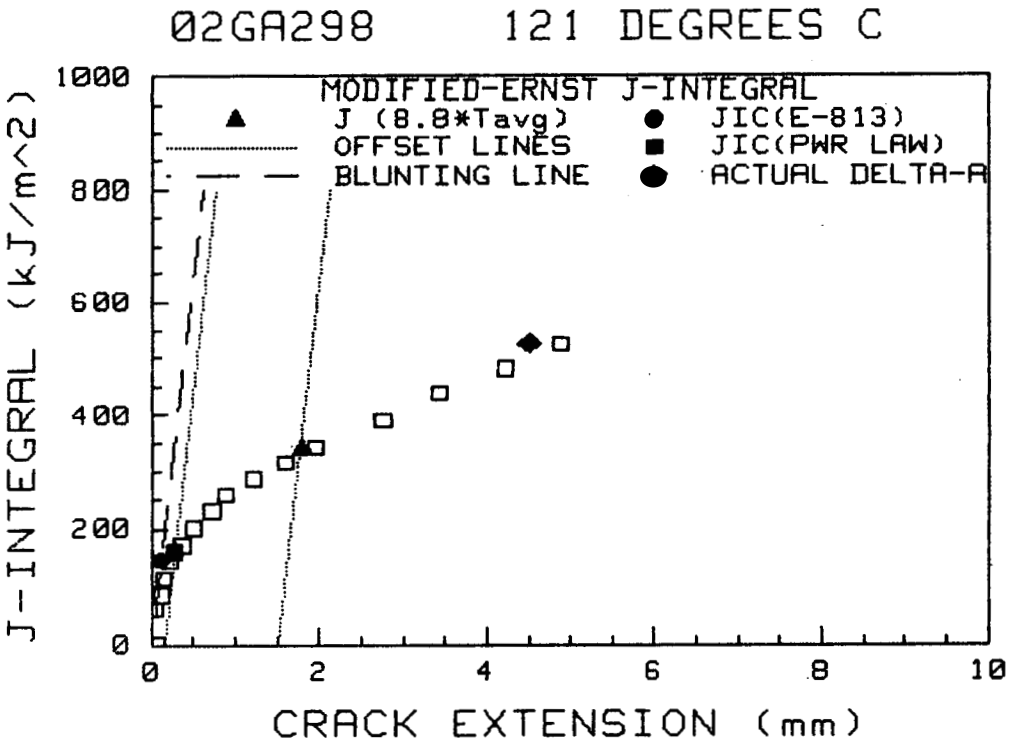
J (@J/T=8.8)= 337.8 kJ/m^2
POWER= .4162
J-MAX ALLOWED= 614.3 kJ/m^2
RCURVE INVALID, 2 3

COEFFICIENT= 264.7 kJ/m^2
DELTA-A MAX ALLOWED= 1.92 mm

ORNL-DWG 87-7999



ORNL-DWG 87-8001

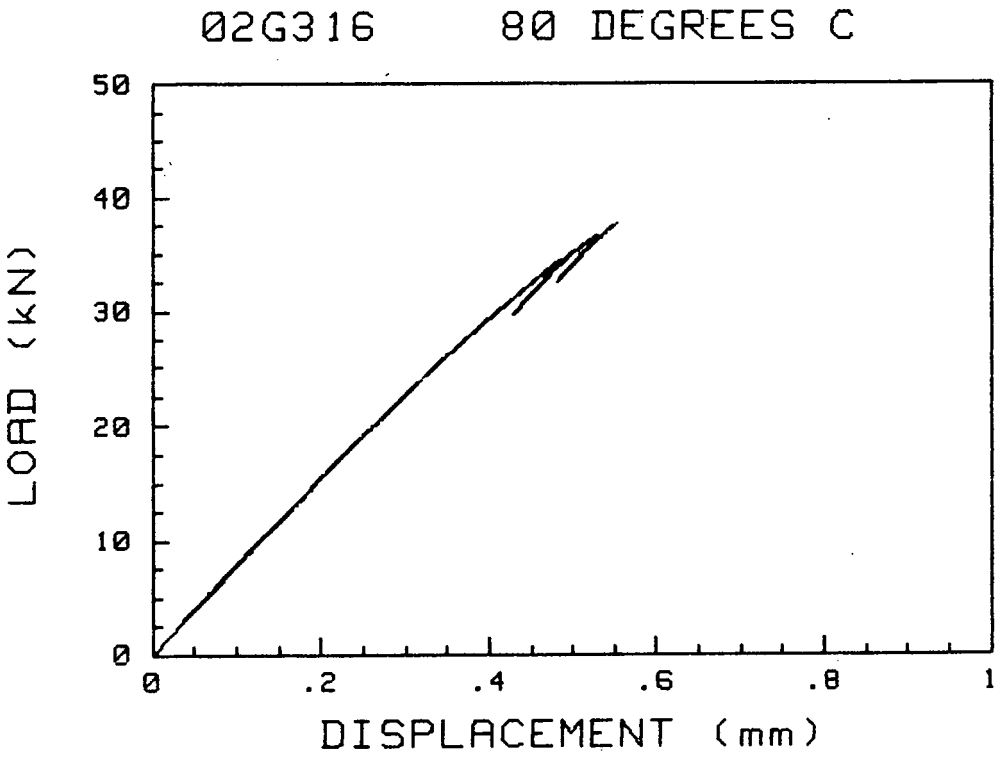


SPECIMEN ID= 02G316
MATERIAL TYPE= A533
TEST TEMPERATURE= 80 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.6 mm a/W)i= .619
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 590 MPa
FLOW STRENGTH= 656 MPa
ESTIMATED YOUNG'S MODULUS= 203 GPa

SPECIMEN CLEAVED AT K = 96.9 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 50.2 kJ/m^2	J-INTEGRAL= 50.1 kJ/m^2
KJc= 100.9 MPa SQR[m]	KJc= 100.7 MPa SQR[m]
K-beta-c= 78.2 MPa SQR[m]	K-beta-c= 78.1 MPa SQR[m]

ORNL-DWG 87-8002



SPECIMEN ID= 02G328
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 31.2 mm a/W)i= .613
MEASURED DUCTILE DELTA-A= 4.5 mm
YIELD STRENGTH= 526 MPa
FLOW STRENGTH= 613 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 192.4 kJ/m^2
KJ-MAX LOAD= 191.6 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 162.4 kJ/m^2
K-JIc= 176 MPa SQR[m]
POWER= .3464
COEFFICIENT= 251.7 kJ/m^2
T (AVERAGE)= 47

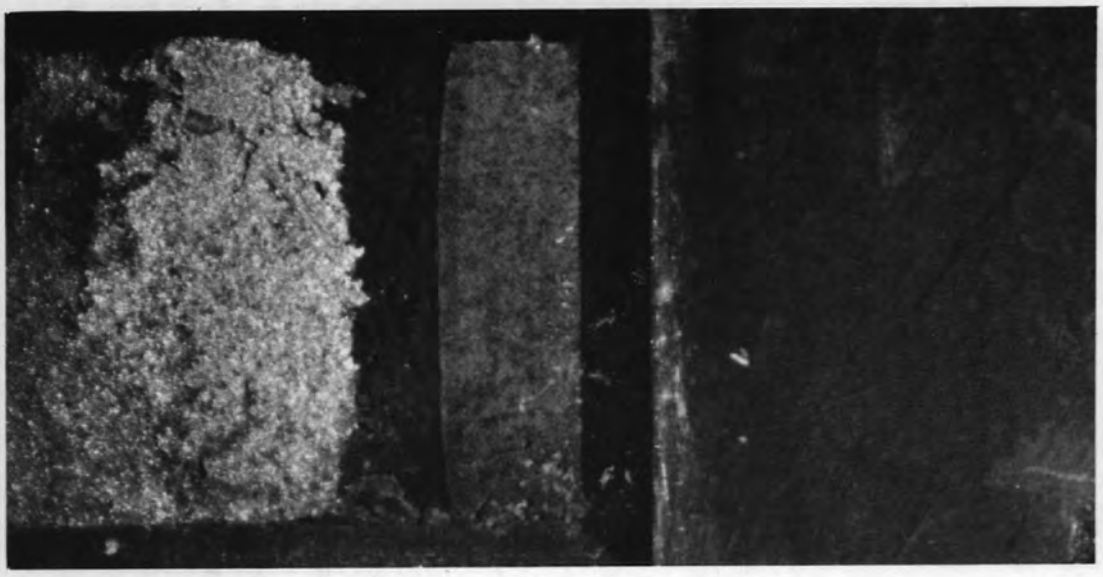
ASTM LINEAR PROCEDURE

JIc= 157 kJ/m^2
K-JIc= 173.1 MPa SQR[m]
SLOPE= 100182 kJ/m^3
INTERCEPT= 144.1 kJ/m^2
T (ASTM)= 51
VALID, E813

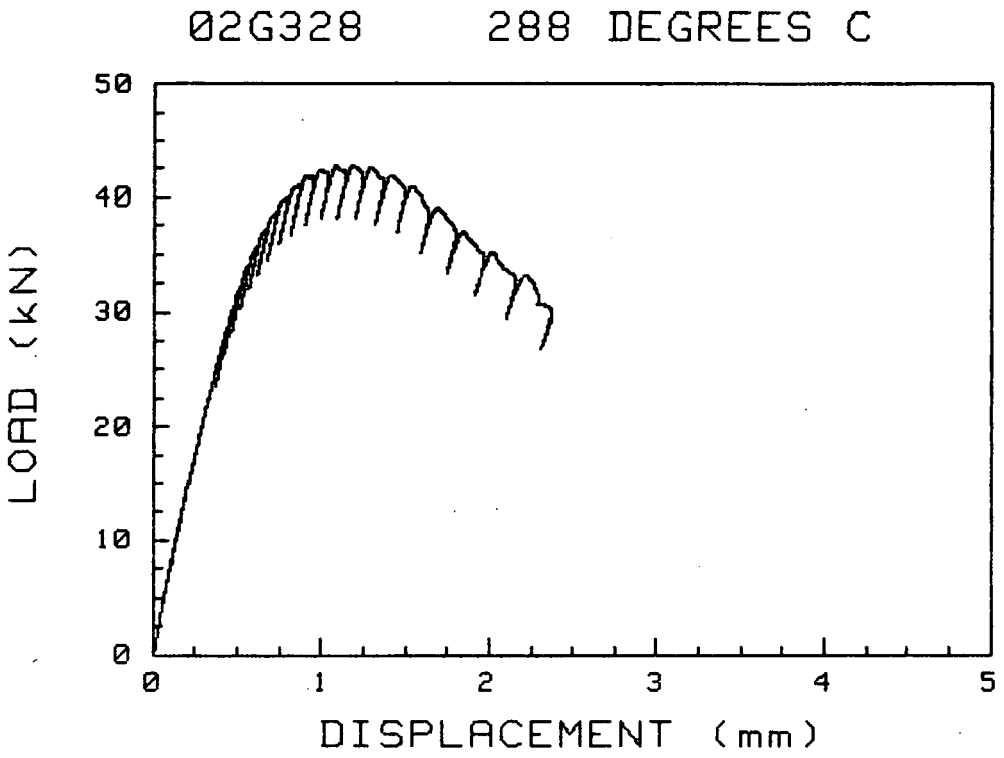
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 282.6 kJ/m^2
POWER= .3256
J-MAX ALLOWED= 605 kJ/m^2
RCURVE INVALID, 2 3

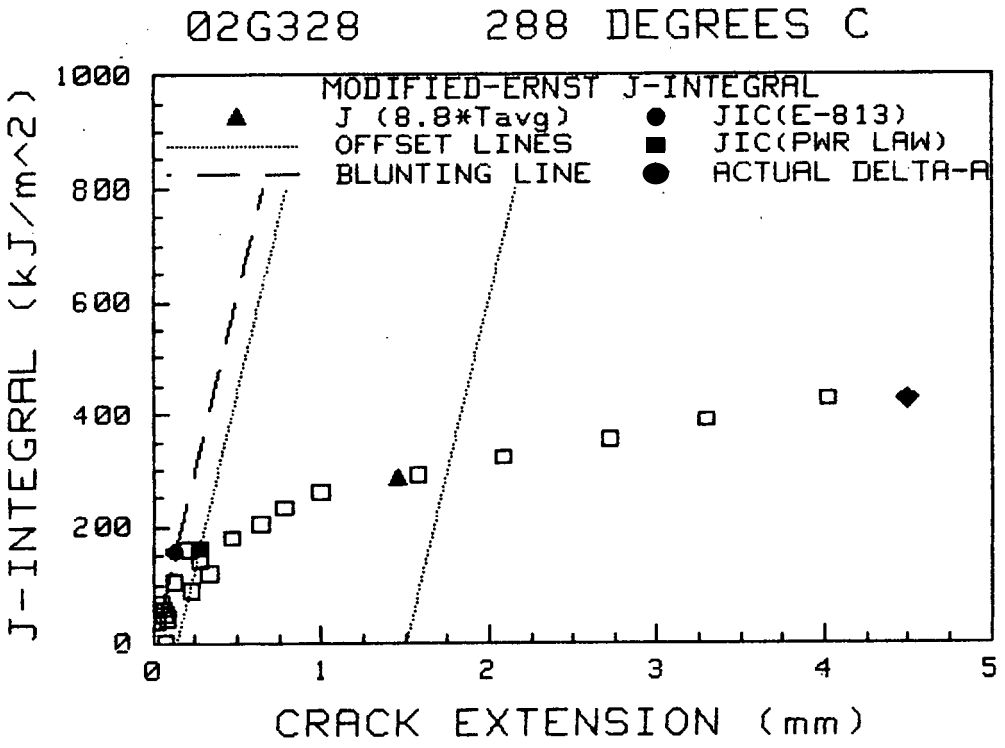
COEFFICIENT= 250.2 kJ/m^2
DELTA-A MAX ALLOWED= 1.97 mm



ORNL-DWG 87-8003



ORNL-DWG 87-8004



SPECIMEN ID= 02G329
TEST TEMPERATURE= 80 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.2 mm a/W)i= .612
MEASURED DUCTILE DELTA-A= .51 mm
YIELD STRENGTH= 590 MPa
FLOW STRENGTH= 656 MPa
ESTIMATED YOUNG'S MODULUS= 203 GPa

SPECIMEN CLEAVED AT K = 121.2 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 157 kJ/m^2
KJc= 178.4 MPa SQR[m]
K-beta-c= 102.9 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 161.1 kJ/m^2
KJc= 180.7 MPa SQR[m]
K-beta-c= 103.5 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 150.4 kJ/m^2
K-JIc= 174.5 MPa SQR[m]
POWER= .5613
COEFFICIENT= 317.1 kJ/m^2
T (AVERAGE)= 85

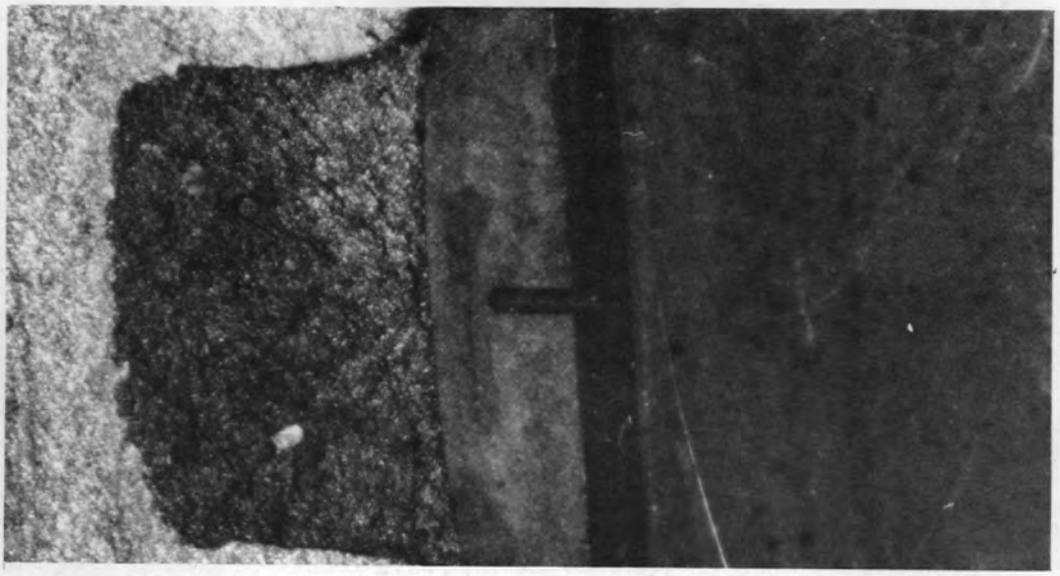
ASTM LINEAR PROCEDURE

JIc= 0 kJ/m^2
K-JIc= 0 MPa SQR[m]
SLOPE= 0 kJ/m^3
INTERCEPT= 0 kJ/m^2
T (ASTM)= 0
INVALID, 1 6

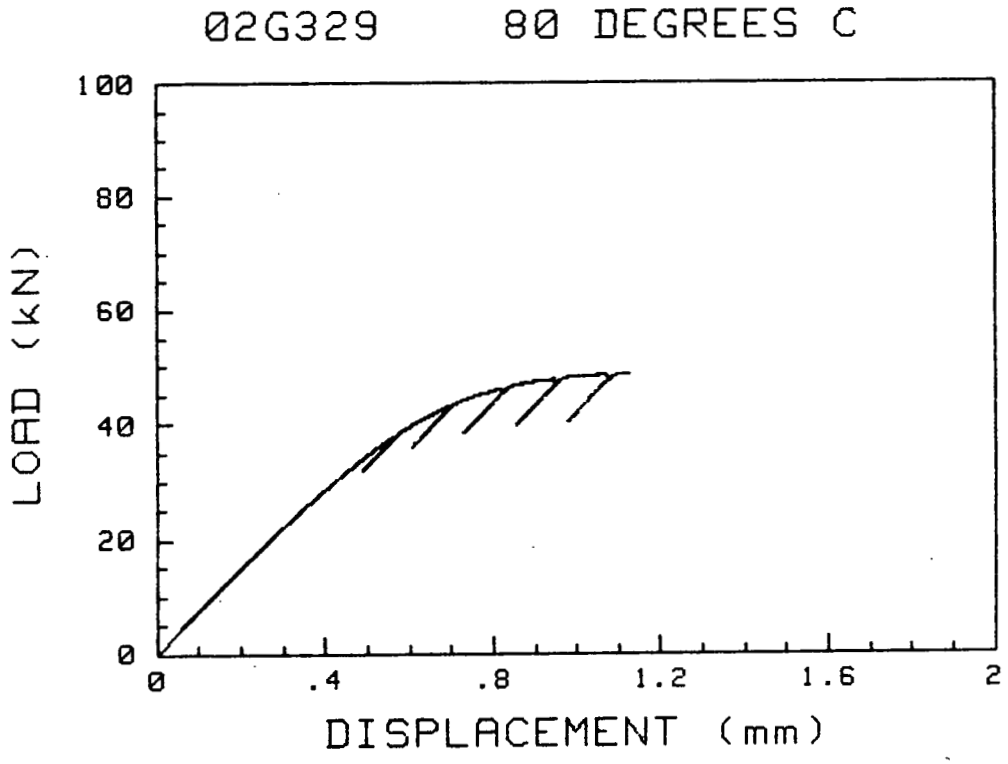
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 0 kJ/m^2
POWER= 0
J-MAX ALLOWED= 650.3 kJ/m^2
RCURVE INVALID, 2 3

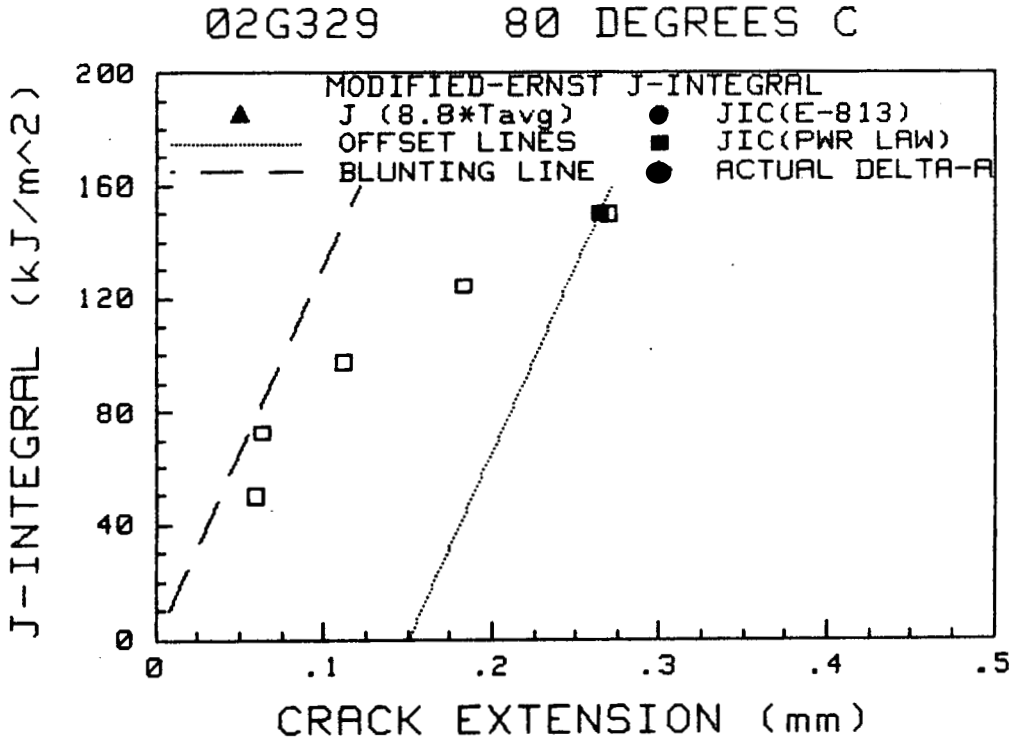
COEFFICIENT= 0 kJ/m^2
DELTA-A MAX ALLOWED= 1.98 mm



ORNL-DWG 87-8005



ORNL-DWG 87-8006



SPECIMEN ID= 02GA338
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 31.7 mm a/W)i= .622
MEASURED DUCTILE DELTA-A= 1.91 mm
YIELD STRENGTH= 526 MPa
FLOW STRENGTH= 613 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 196.7 kJ/m^2
KJ-MAX LOAD= 193.7 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 139.5 kJ/m^2
K-JIc= 163.2 MPa SQR[m]
POWER= .3854
COEFFICIENT= 233.2 kJ/m^2
T (AVERAGE)= 49

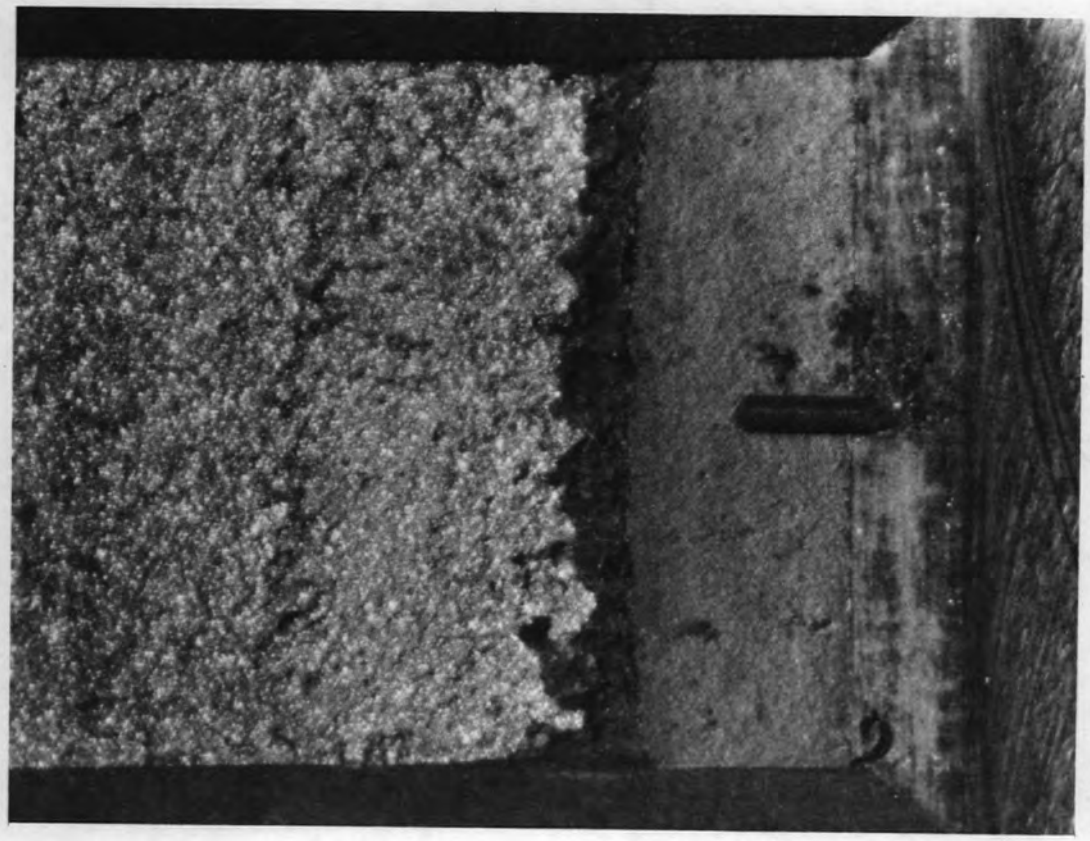
ASTM LINEAR PROCEDURE

JIc= 116.8 kJ/m^2
K-JIc= 149.3 MPa SQR[m]
SLOPE= 121740 kJ/m^3
INTERCEPT= 105.2 kJ/m^2
T (ASTM)= 62
VALID, E813

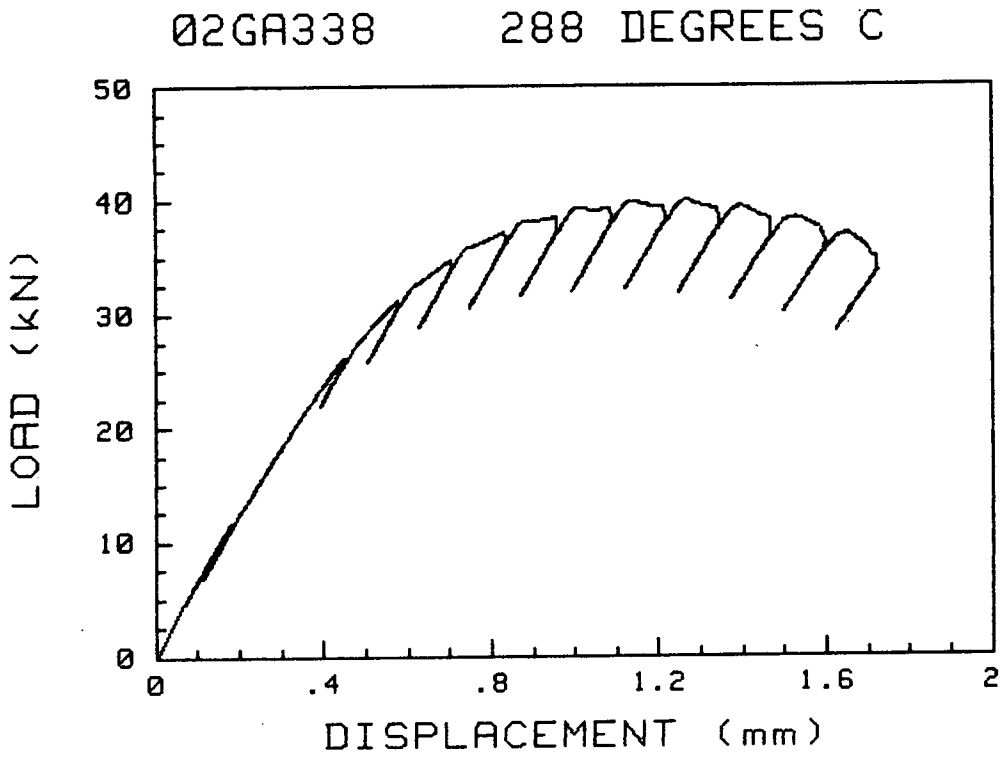
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 299.6 kJ/m^2
POWER= .4119
J-MAX ALLOWED= 591.3 kJ/m^2
RCURVE INVALID, 2

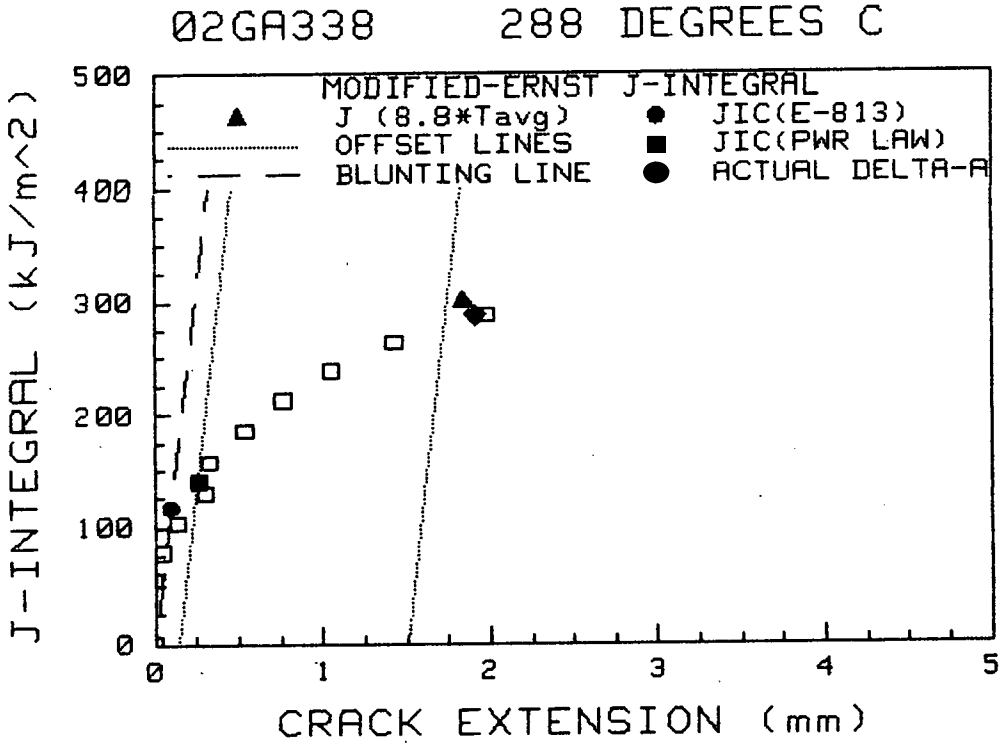
COEFFICIENT= 233.1 kJ/m^2
DELTA-A MAX ALLOWED= 1.93 mm



ORNL-DWG 87-8007



ORNL-DWG 87-8008



SPECIMEN ID= 02GA340
TEST TEMPERATURE= 204 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 31.8 mm a/W)i= .622
MEASURED DUCTILE DELTA-A= 2.99 mm
YIELD STRENGTH= 545 MPa
FLOW STRENGTH= 617 MPa
ESTIMATED YOUNG'S MODULUS= 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 177.1 kJ/m^2
KJ-MAX LOAD= 186.1 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 125.2 kJ/m^2
K-JIc= 156.5 MPa SQR[m]
POWER= .4775
COEFFICIENT= 242.1 kJ/m^2
T (AVERAGE)= 62

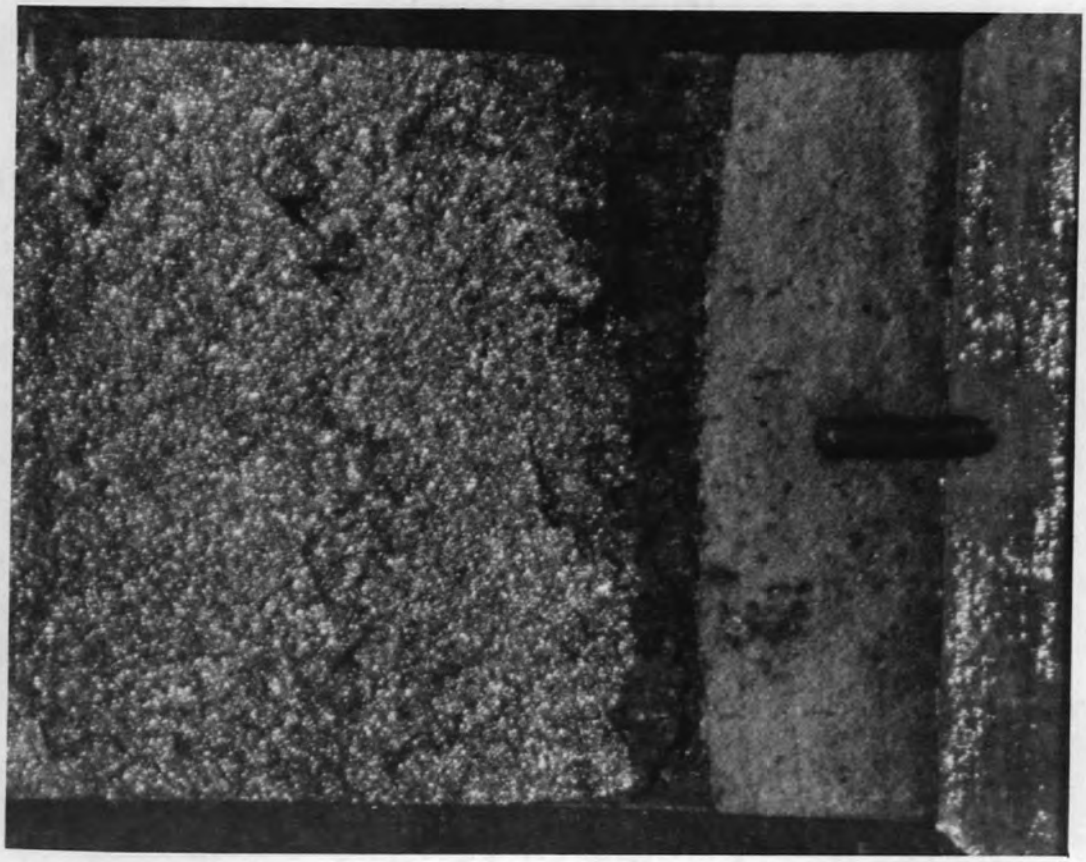
ASTM LINEAR PROCEDURE

JIc= 118.8 kJ/m^2
K-JIc= 152.4 MPa SQR[m]
SLOPE= 126681 kJ/m^3
INTERCEPT= 106.6 kJ/m^2
T (ASTM)= 65
INVALID, 6

JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 310.2 kJ/m^2
POWER= .4079
J-MAX ALLOWED= 596.3 kJ/m^2
RCURVE INVALID, 2 3

COEFFICIENT= 241.8 kJ/m^2
DELTA-A MAX ALLOWED= 1.93 mm



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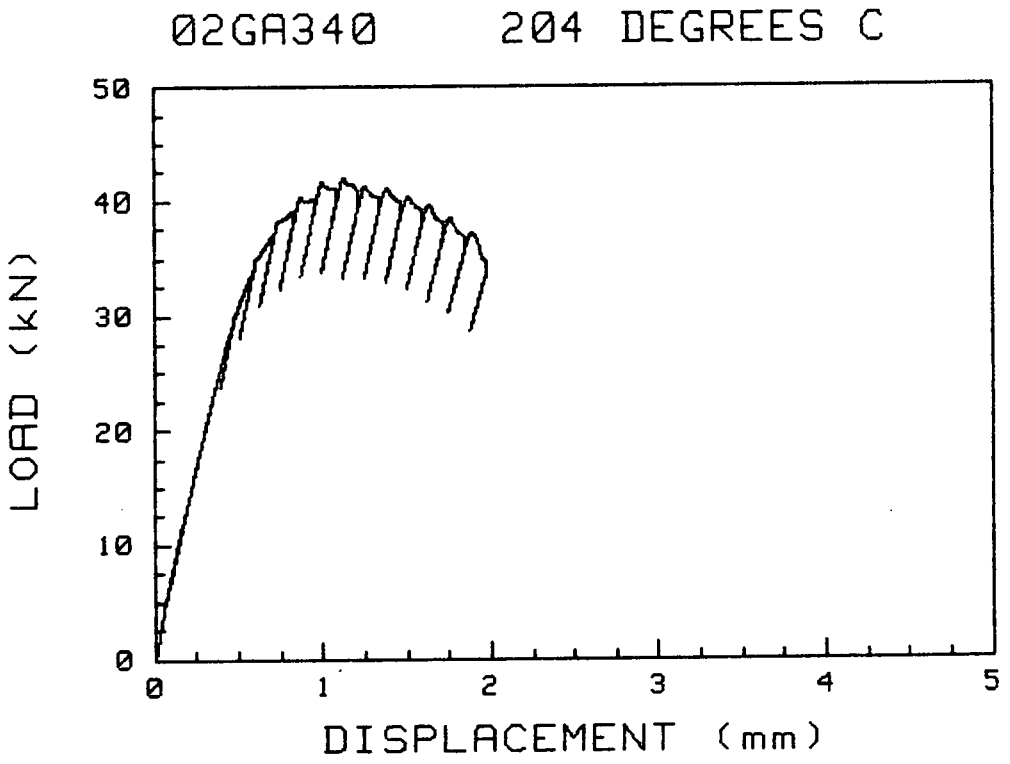
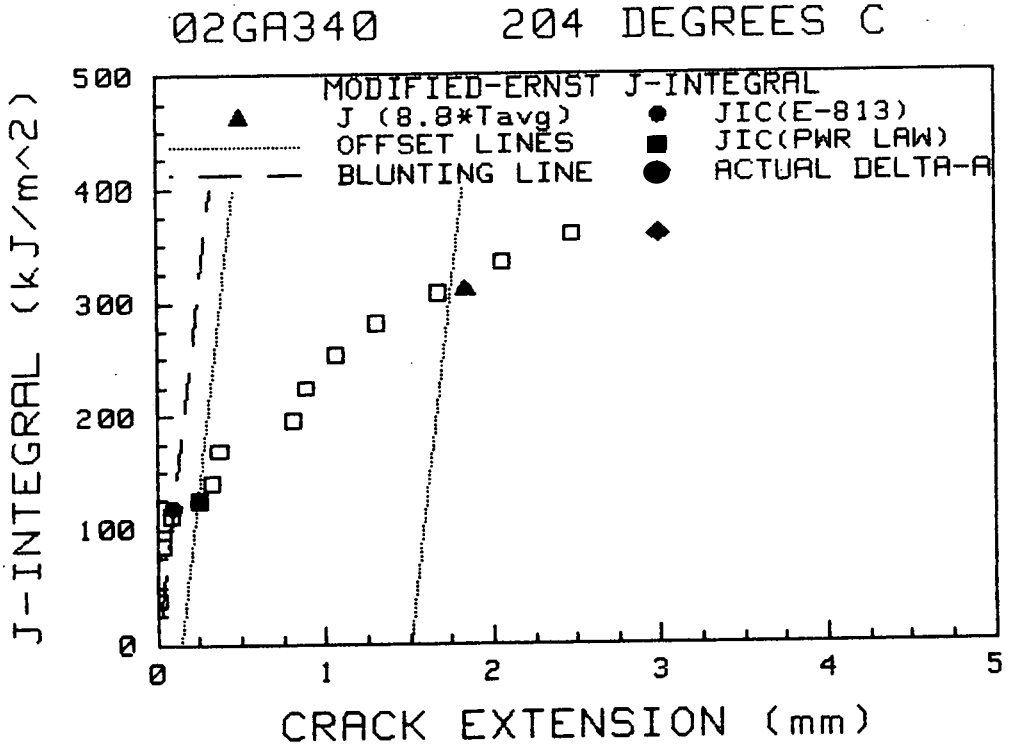


ORNL-DWG 87-8010



SPECIMEN ID= 02G344
TEST TEMPERATURE= 80 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31 mm a/W)i= .607
MEASURED DUCTILE DELTA-A= .25 mm
YIELD STRENGTH= 590 MPa
FLOW STRENGTH= 656 MPa
ESTIMATED YOUNG'S MODULUS= 203 GPa

SPECIMEN CLEAVED AT K = 115.1 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 151.2 kJ/m^2
KJc= 175.1 MPa SQR[m]
K-beta-c= 102.1 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 152 kJ/m^2
KJc= 175.5 MPa SQR[m]
K-beta-c= 102.2 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 140.8 kJ/m^2
K-JIc= 168.9 MPa SQR[m]
POWER= .8626
COEFFICIENT= 454.2 kJ/m^2
T (AVERAGE)= 181

ASTM LINEAR PROCEDURE

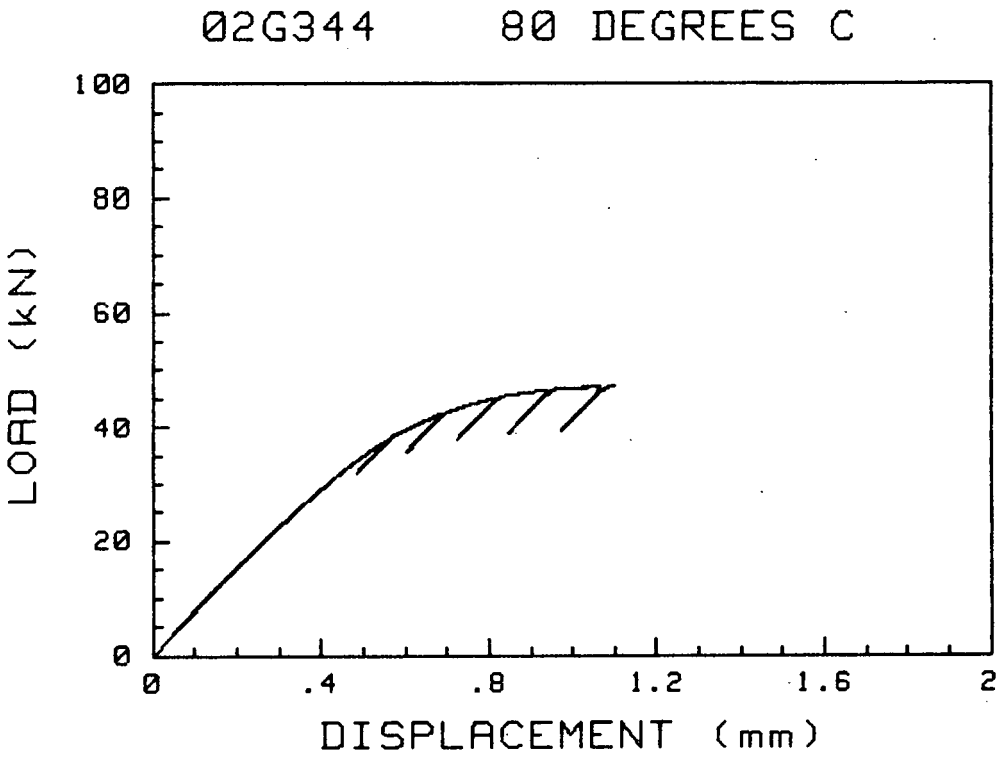
JIc= 0 kJ/m^2
K-JIc= 0 MPa SQR[m]
SLOPE= kJ/m^3
INTERCEPT= 0 kJ/m^2
T (ASTM)= 0
INVALID, 1

JI-R CURVE CALCULATIONS

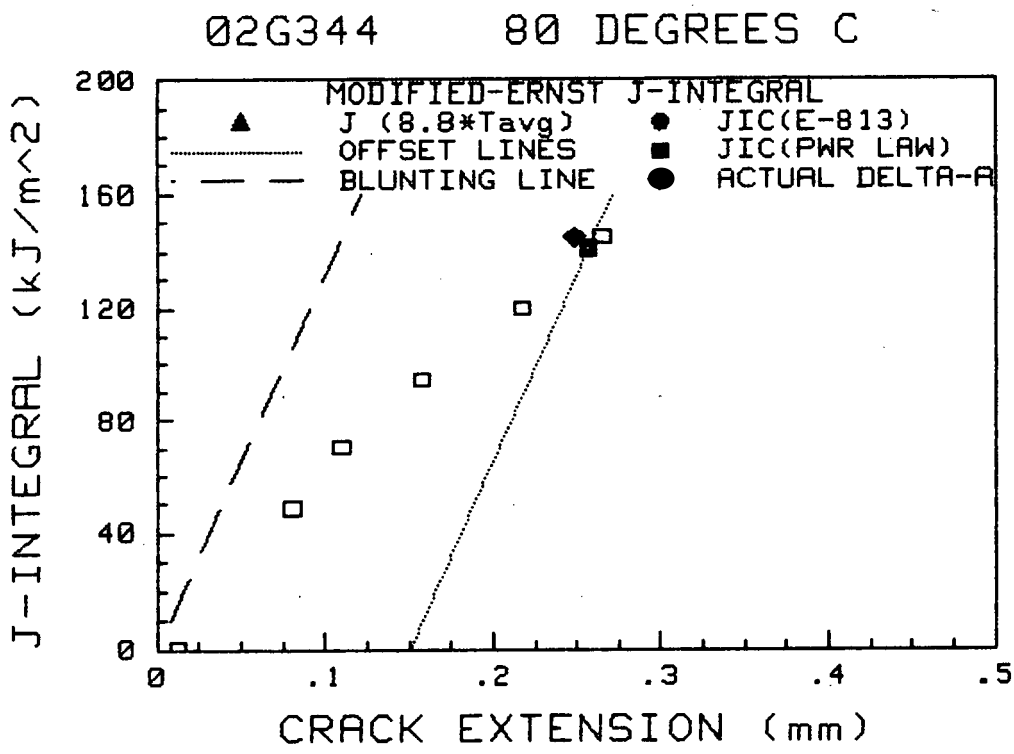
J (@J/T=8.8)= 0 kJ/m^2
POWER= 0
J-MAX ALLOWED= 658.6 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 0 kJ/m^2
DELTA-A MAX ALLOWED= 2.01 mm

ORNL-DWG 87-8011



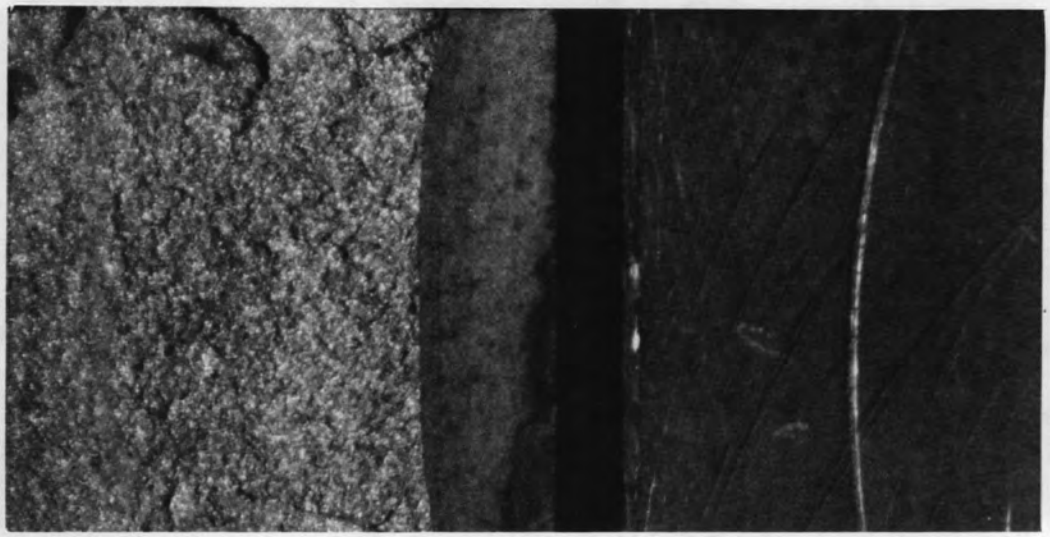
ORNL-DWG 87-8012



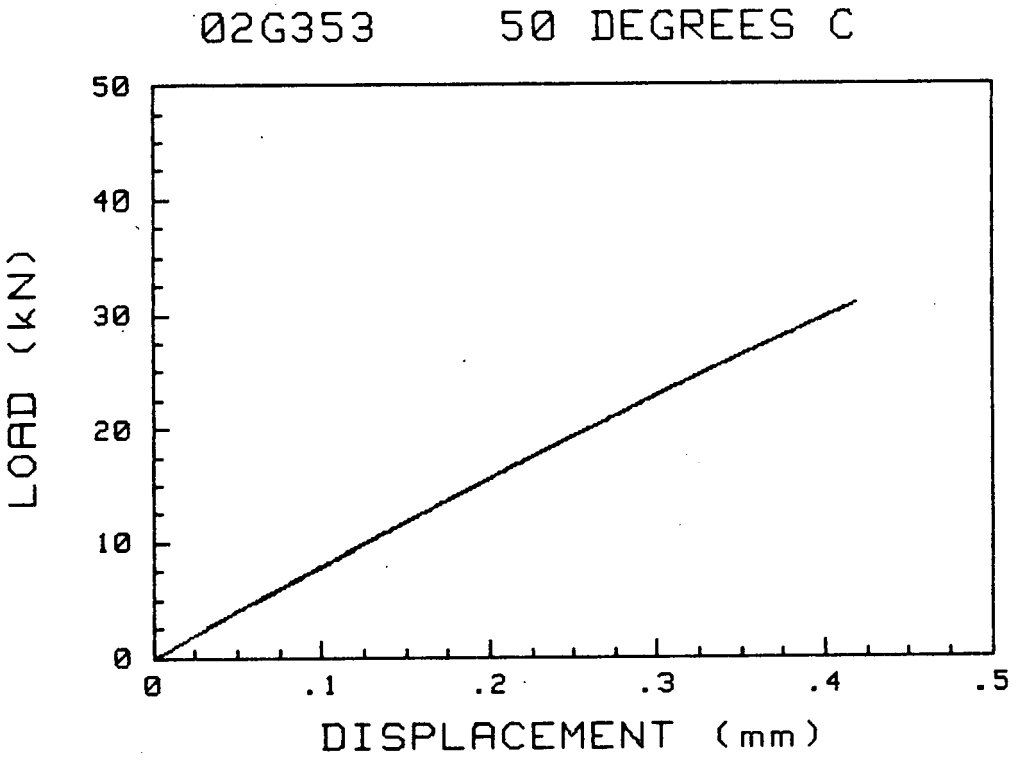
SPECIMEN ID= 02G353
MATERIAL TYPE= A533
TEST TEMPERATURE= 50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.5 mm a/W)i= .618
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 604 MPa
FLOW STRENGTH= 672 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN CLEAVED AT K = 78.9 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 29.8 kJ/m^2	J-INTEGRAL= 29.8 kJ/m^2
KJc= 78 MPa SQR[m]	KJc= 78 MPa SQR[m]
K-beta-c= 67.5 MPa SQR[m]	K-beta-c= 67.5 MPa SQR[m]



ORNL-DWG 87-8013



SPECIMEN ID= 02G362
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 31.7 mm a/W)i= .622
MEASURED DUCTILE DELTA-A= 4.3 mm
YIELD STRENGTH= 573 MPa
FLOW STRENGTH= 639 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 192.2 kJ/m^2
KJ-MAX LOAD= 196.2 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 148.7 kJ/m^2
K-JIc= 172.6 MPa SQR[m]
POWER= .3731
COEFFICIENT= 243.6 kJ/m^2
T (AVERAGE)= 48

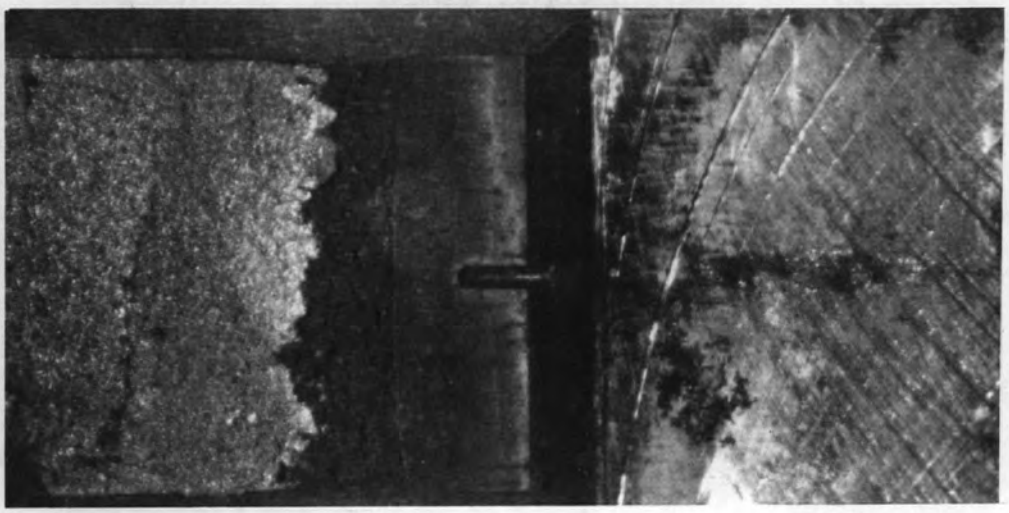
ASTM LINEAR PROCEDURE

JIc= 146.3 kJ/m^2
K-JIc= 171.2 MPa SQR[m]
SLOPE= 99999 kJ/m^3
INTERCEPT= 134.8 kJ/m^2
T (ASTM)= 49
VALID, E813

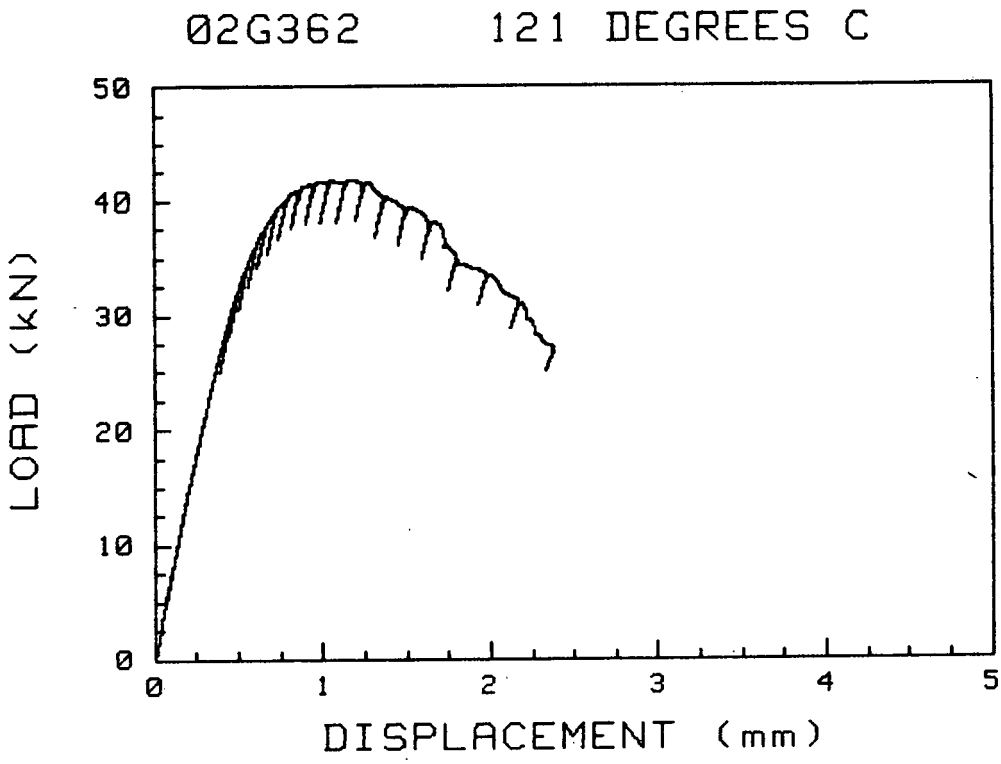
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 246.2 kJ/m^2
POWER= .2567
J-MAX ALLOWED= 617.5 kJ/m^2
RCURVE INVALID, 2

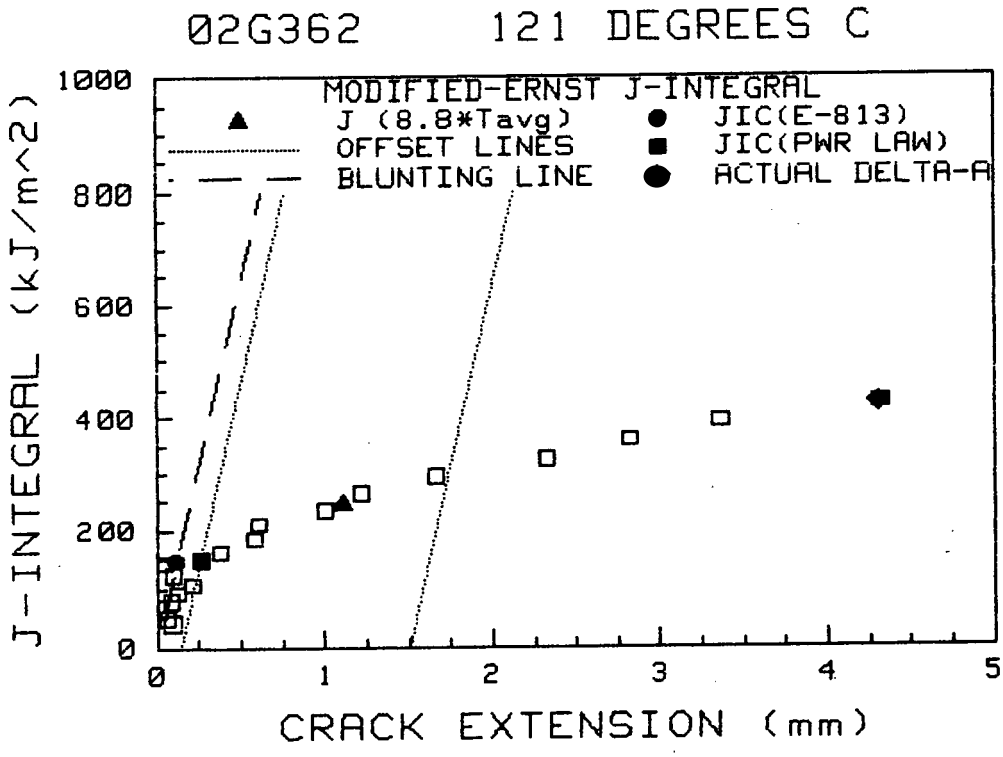
COEFFICIENT= 239.9 kJ/m^2
DELTA-A MAX ALLOWED= 1.93 mm



ORNL-DWG 87-8014



ORNL-DWG 87-8015



SPECIMEN ID= 02GA363
TEST TEMPERATURE= 204 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 31.8 mm a/W)i= .623
MEASURED DUCTILE DELTA-A= 2.2 mm
YIELD STRENGTH= 545 MPa
FLOW STRENGTH= 617 MPa
ESTIMATED YOUNG'S MODULUS= 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 175.8 kJ/m^2
KJ-MAX LOAD= 185.4 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 129.2 kJ/m^2
K-JIc= 159 MPa SQR[m]
POWER= .4543
COEFFICIENT= 240.6 kJ/m^2
T (AVERAGE)= 59

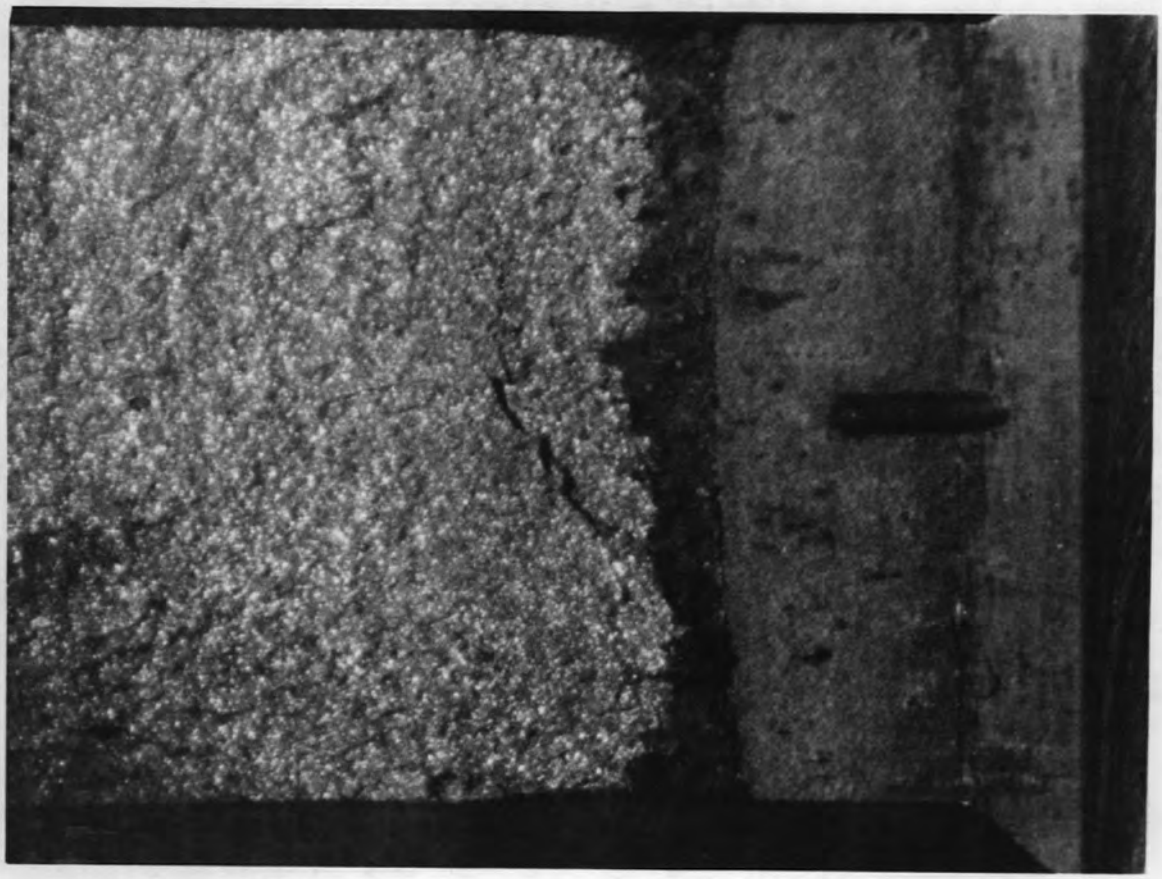
ASTM LINEAR PROCEDURE

JIc= 128.5 kJ/m^2
K-JIc= 158.5 MPa SQR[m]
SLOPE= 116277 kJ/m^3
INTERCEPT= 116.4 kJ/m^2
T (ASTM)= 60
VALID, E813

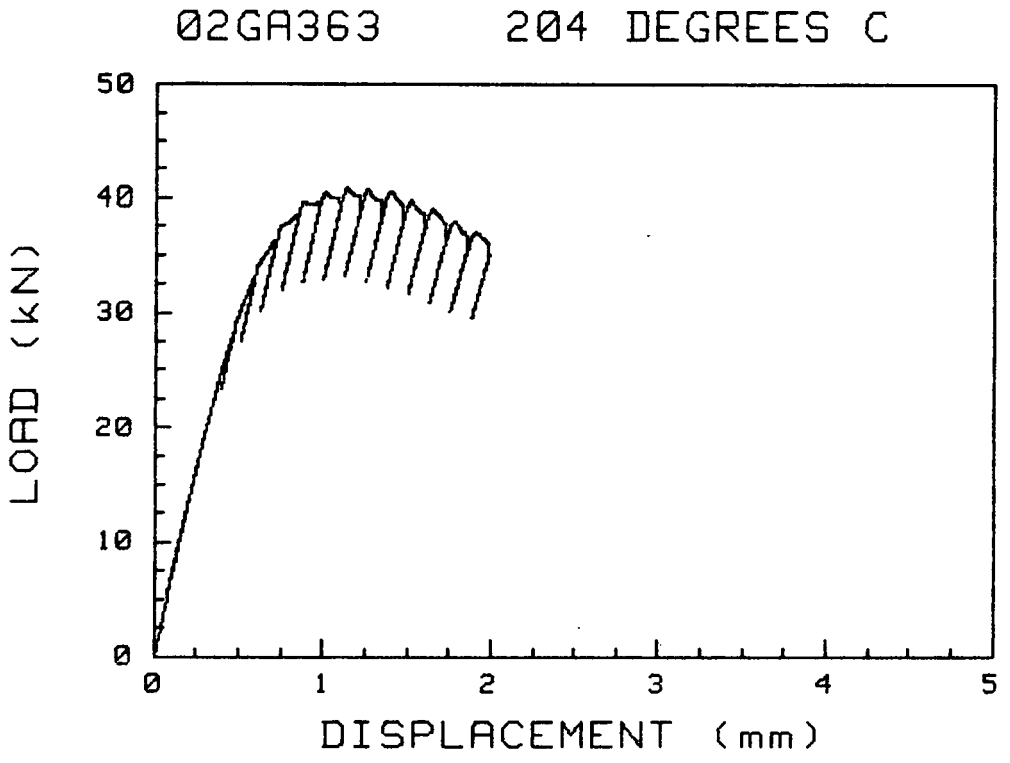
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 309.4 kJ/m^2
POWER= .4119
J-MAX ALLOWED= 593 kJ/m^2
RCURVE INVALID, 2

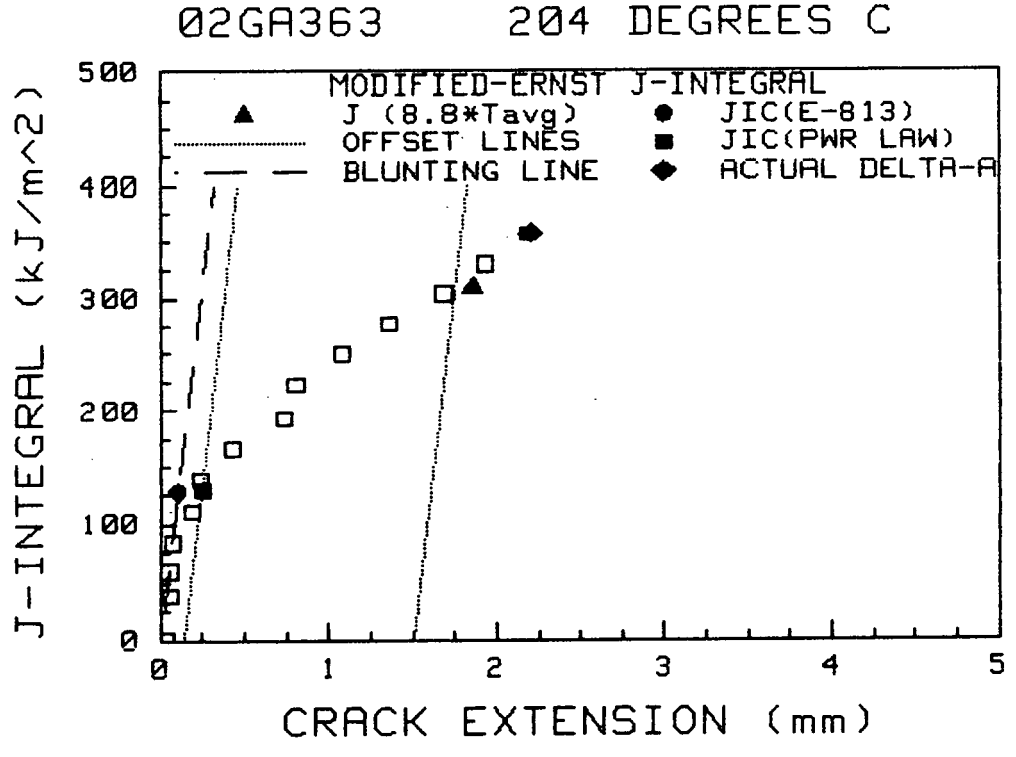
COEFFICIENT= 239.6 kJ/m^2
DELTA-A MAX ALLOWED= 1.92 mm



ORNL-DWG 87-8016



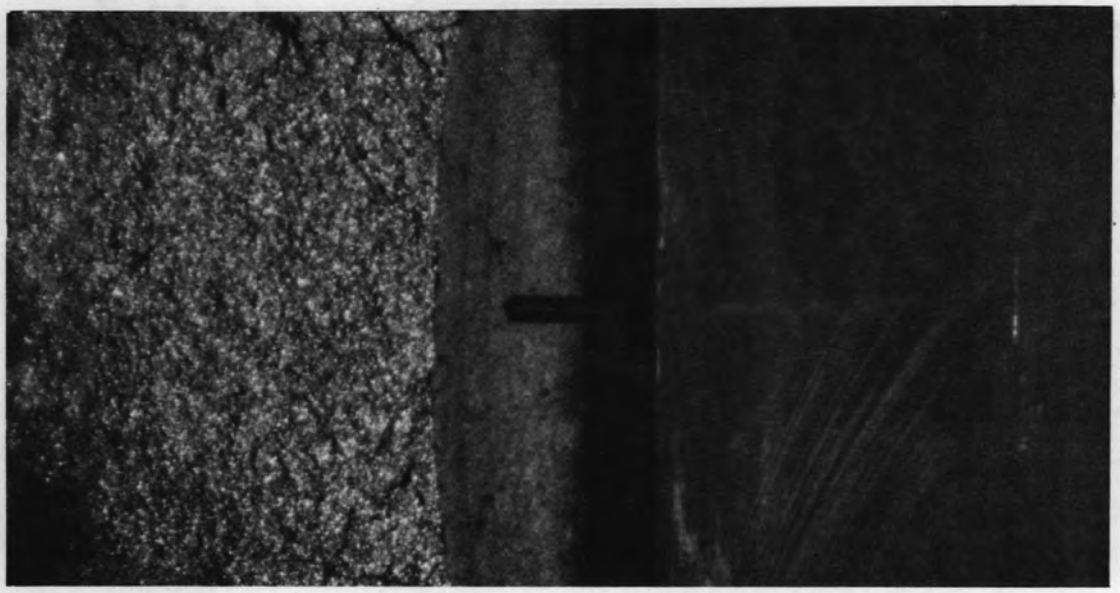
ORNL-DWG 87-8017



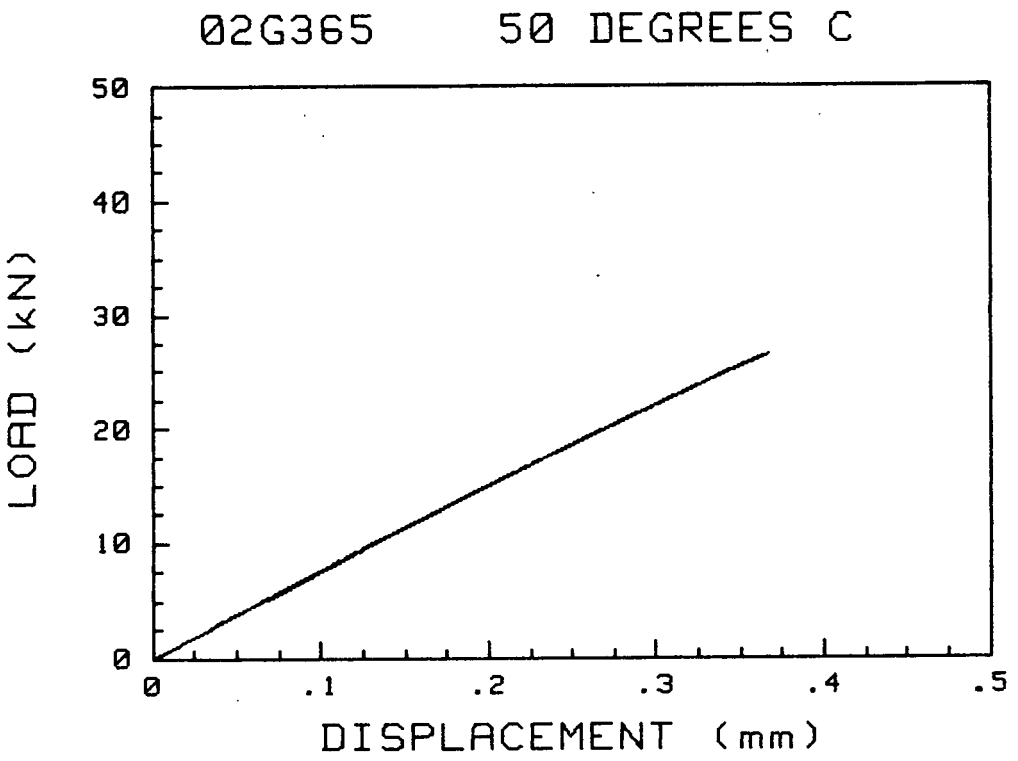
SPECIMEN ID= 02G365
MATERIAL TYPE= A533
TEST TEMPERATURE= 50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.8 mm a/W)i= .624
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 604 MPa
FLOW STRENGTH= 672 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN CLEAVED AT K = 69.4 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 22.5 kJ/m^2	J-INTEGRAL= 22.5 kJ/m^2
KJc= 67.8 MPa SQR[m]	KJc= 67.8 MPa SQR[m]
K-beta-c= 61.2 MPa SQR[m]	K-beta-c= 61.2 MPa SQR[m]



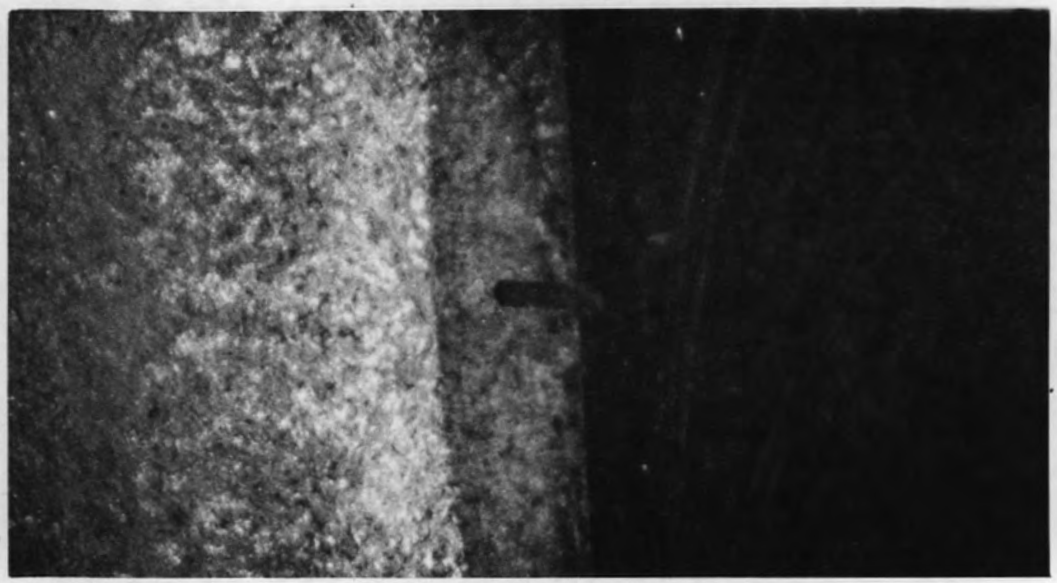
ORNL-DWG 87-8018



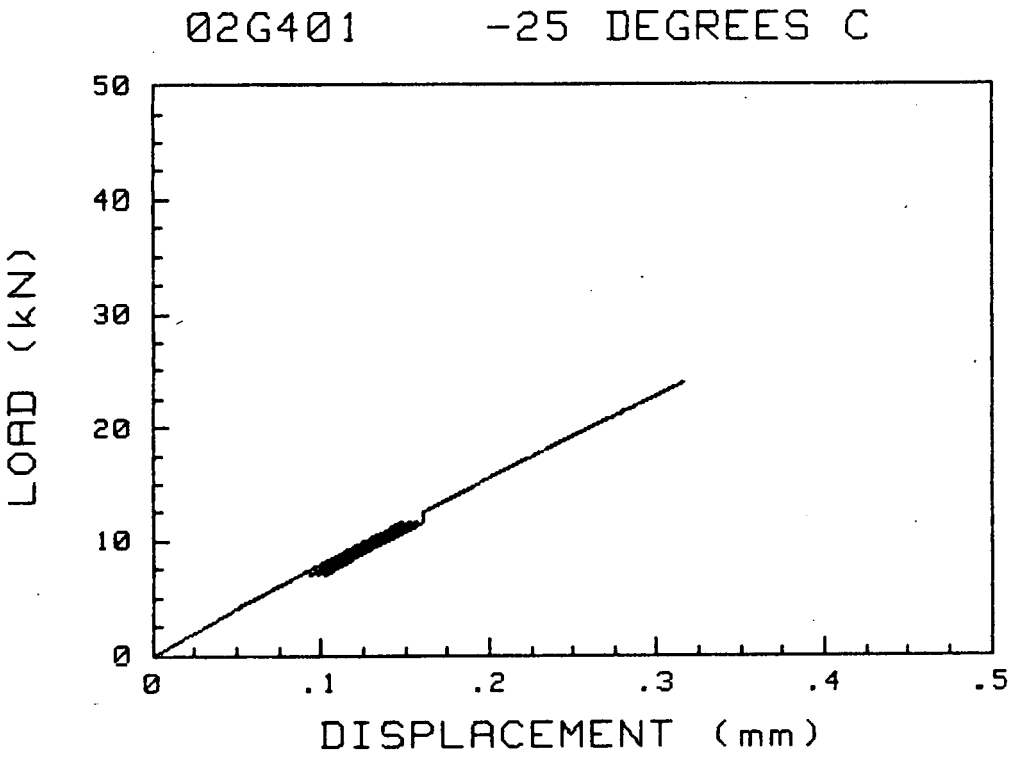
SPECIMEN ID= 02G401
MATERIAL TYPE= A533B1
TEST TEMPERATURE= -25 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31 mm a/W)i= .609
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 647 MPa
FLOW STRENGTH= 717 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT KIc= 58.9 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 16.6 kJ/m^2	J-INTEGRAL= 16.6 kJ/m^2
KJc= 58.8 MPa SQR[m]	KJc= 58.8 MPa SQR[m]
K-beta-c= 55.6 MPa SQR[m]	K-beta-c= 55.6 MPa SQR[m]



ORNL-DWG 87-8019

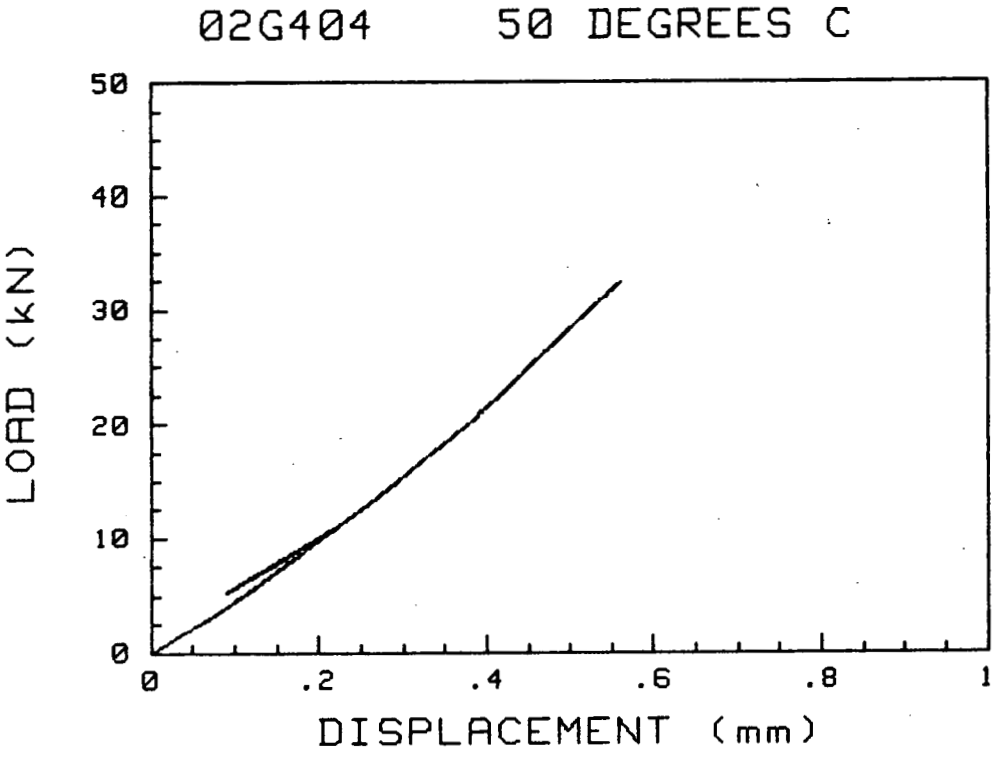


SPECIMEN ID= 02G404
MATERIAL TYPE= A533
TEST TEMPERATURE= 50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.1 mm a/W)i= .609
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 604 MPa
FLOW STRENGTH= 672 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN CLEAVED AT K = 79.9 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 36.7 kJ/m^2	J-INTEGRAL= 36.7 kJ/m^2
KJc= 86.6 MPa SQR[m]	KJc= 86.6 MPa SQR[m]
K-beta-c= 72.1 MPa SQR[m]	K-beta-c= 72.1 MPa SQR[m]

ORNL-DWG 87-8020

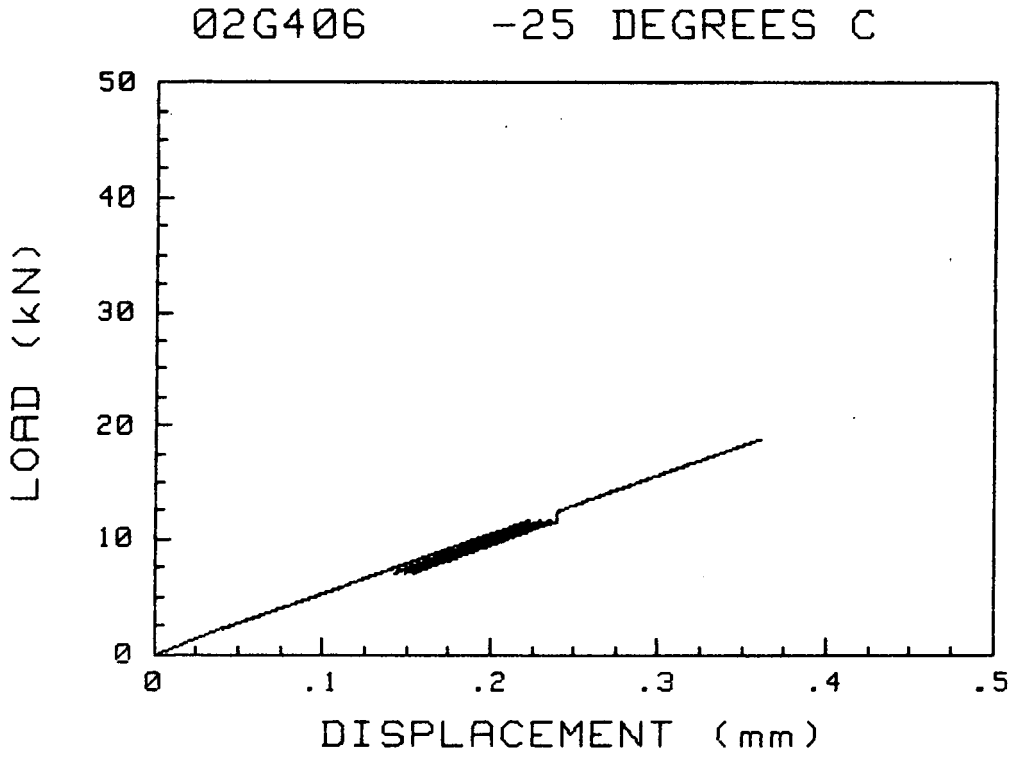


SPECIMEN ID= 02G406
MATERIAL TYPE= A533B
TEST TEMPERATURE= -25 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.7 mm a/W)i= .602
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 647 MPa
FLOW STRENGTH= 717 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT KIc= 45.1 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 14.3 kJ/m^2	J-INTEGRAL= 14.3 kJ/m^2
KJc= 54.6 MPa SQR[m]	KJc= 54.6 MPa SQR[m]
K-beta-c= 52.2 MPa SQR[m]	K-beta-c= 52.2 MPa SQR[m]

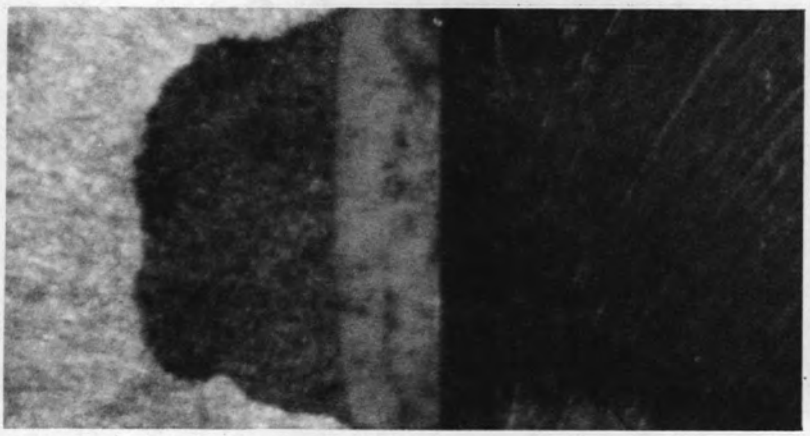
ORNL-DWG 87-8021



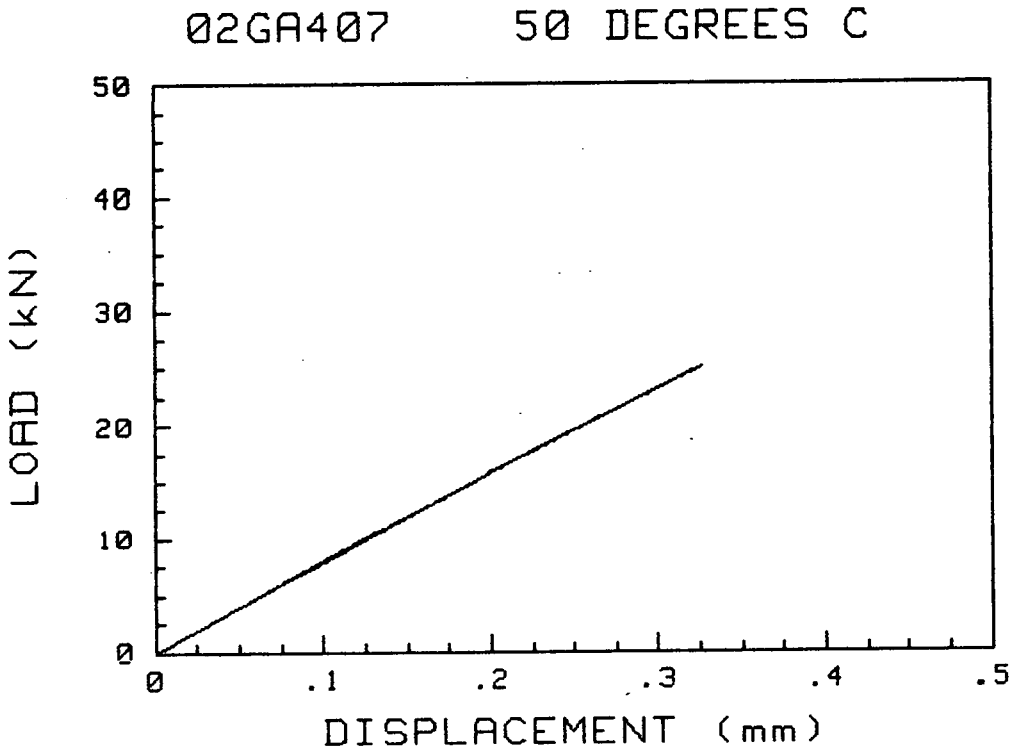
SPECIMEN ID= 02GA407
MATERIAL TYPE= A533B
TEST TEMPERATURE= 50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.1 mm a/W)i= .611
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 604 MPa
FLOW STRENGTH= 672 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN CLEAVED AT K = 62.3 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 18.3 kJ/m^2	J-INTEGRAL= 18.3 kJ/m^2
KJc= 61.1 MPa SQR[m]	KJc= 61.1 MPa SQR[m]
K-beta-c= 56.6 MPa SQR[m]	K-beta-c= 56.6 MPa SQR[m]



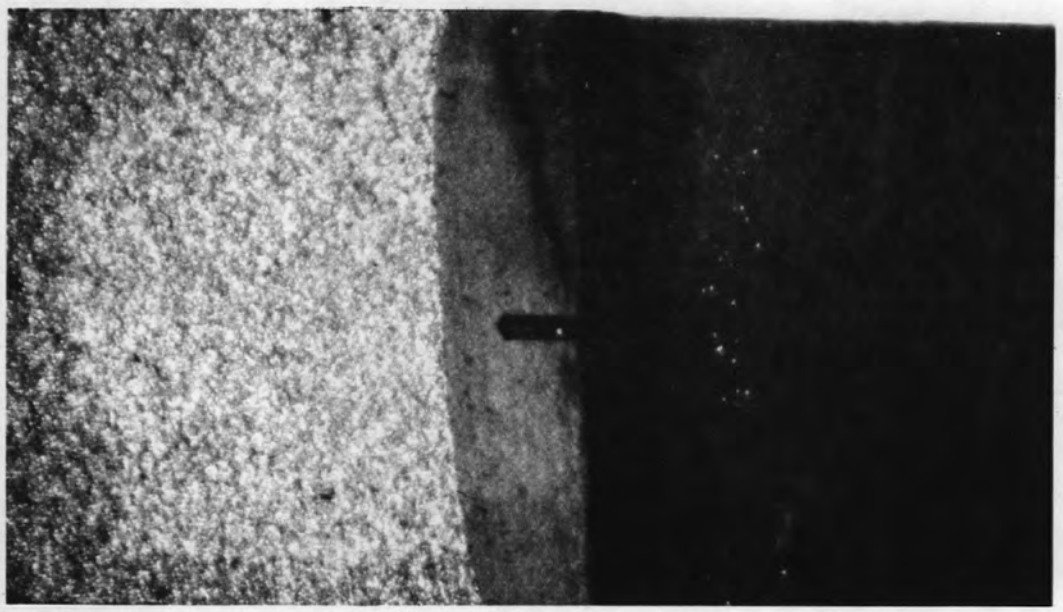
ORNL-DWG 87-8022



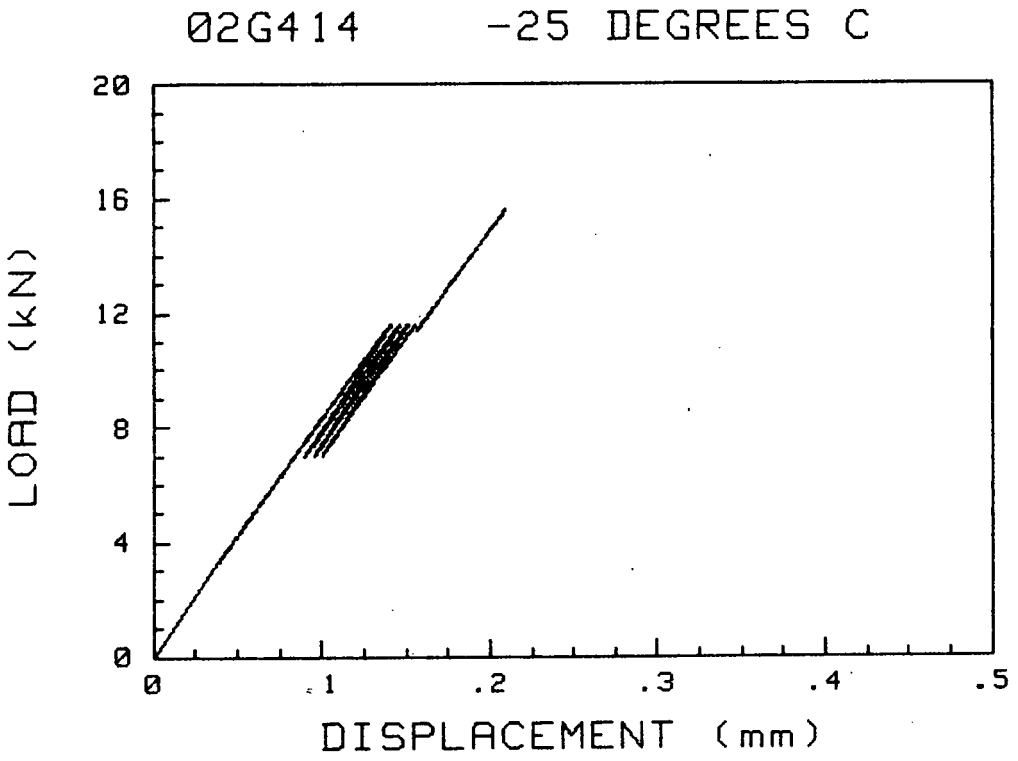
SPECIMEN ID= 02G414
MATERIAL TYPE= A533B1
TEST TEMPERATURE= -25 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.2 mm a/W)i= .592
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 647 MPa
FLOW STRENGTH= 717 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT Klc= 36 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 6.9 kJ/m^2	J-INTEGRAL= 6.9 kJ/m^2
KJc= 38 MPa SQR[m]	KJc= 38 MPa SQR[m]
K-beta-c= 37.5 MPa SQR[m]	K-beta-c= 37.5 MPa SQR[m]



ORNL-DWG 87-8023



SPECIMEN ID= 02G421
TEST TEMPERATURE= 80 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.7 mm a/W)i= .603
MEASURED DUCTILE DELTA-A= .44 mm
YIELD STRENGTH= 590 MPa
FLOW STRENGTH= 656 MPa
ESTIMATED YOUNG'S MODULUS= 203 GPa

SPECIMEN CLEAVED AT K = 118.4 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 138.1 kJ/m^2
KJc= 167.3 MPa SQR[m]
K-beta-c= 100.1 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 198.8 kJ/m^2
KJc= 200.7 MPa SQR[m]
K-beta-c= 108.1 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 151.4 kJ/m^2
K-JIc= 175.2 MPa SQR[m]
POWER= .353
COEFFICIENT= 241.9 kJ/m^2
T (AVERAGE)= 43

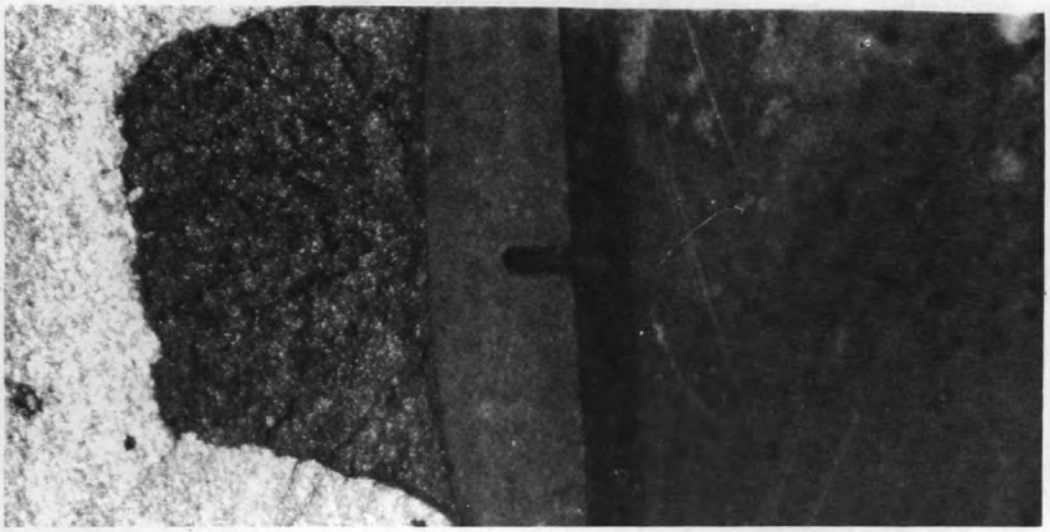
ASTM LINEAR PROCEDURE

JIc= 0 kJ/m^2
K-JIc= 0 MPa SQR[m]
SLOPE= kJ/m^3
INTERCEPT= 0 kJ/m^2
T (ASTM)= 0
INVALID, 1

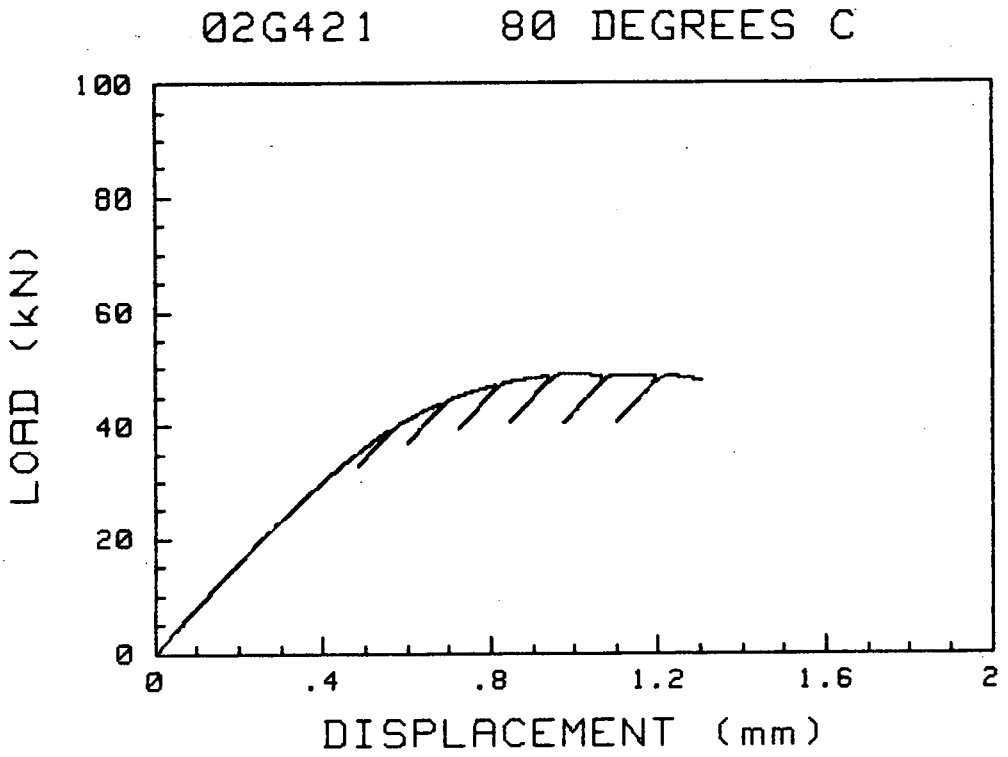
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 236.7 kJ/m^2
POWER= .2921
J-MAX ALLOWED= 662.8 kJ/m^2
RCURVE INVALID, 2

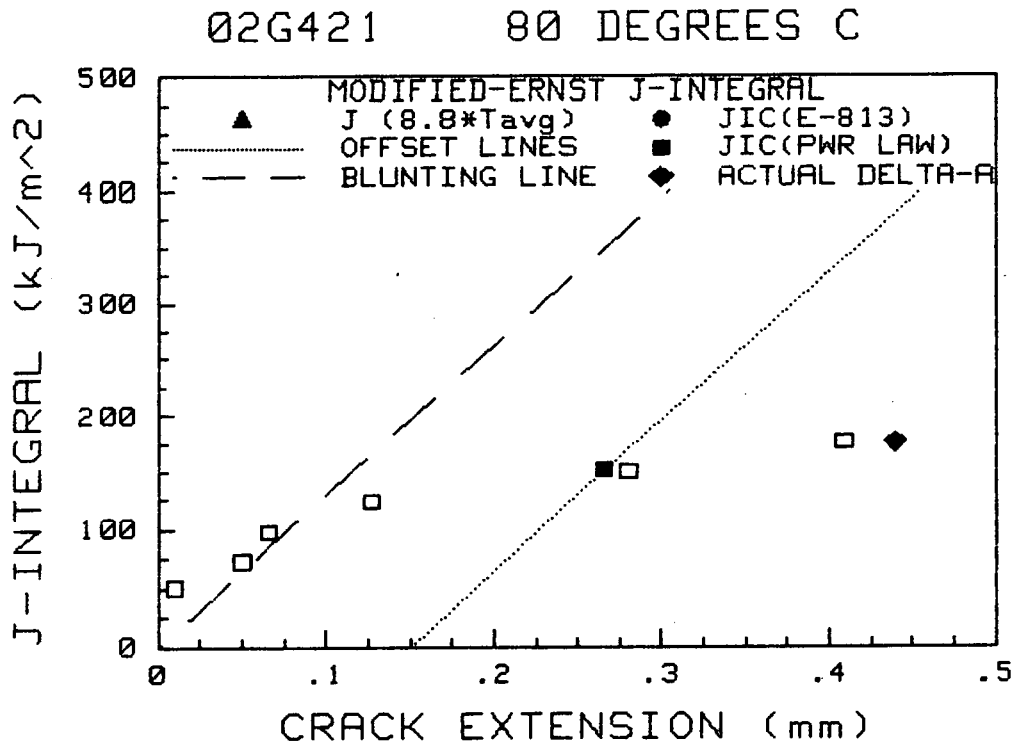
COEFFICIENT= 223.9 kJ/m^2
DELTA-A MAX ALLOWED= 2.02 mm



ORNL-DWG 87-8024



ORNL-DWG 87-8025



SPECIMEN ID= 02G422
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.9 mm a/W)i= .607
MEASURED DUCTILE DELTA-A= 4.73 mm
YIELD STRENGTH= 526 MPa
FLOW STRENGTH= 613 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 195.5 kJ/m^2
KJ-MAX LOAD= 193.1 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 154.4 kJ/m^2
K-JIc= 171.6 MPa SQR[m]
POWER= .3786
COEFFICIENT= 251.4 kJ/m^2
T (AVERAGE)= 51

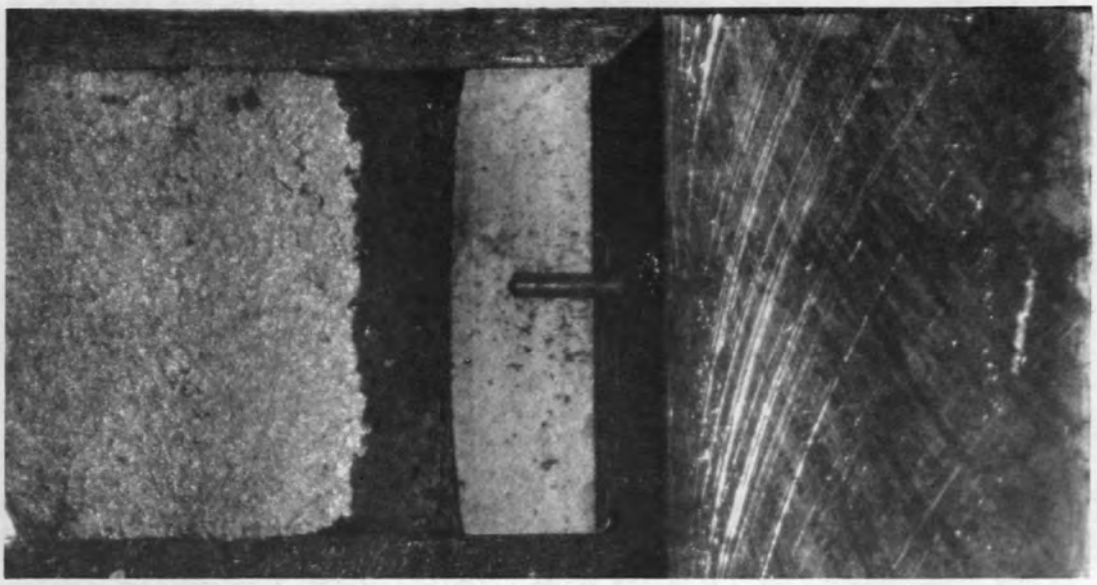
ASTM LINEAR PROCEDURE

JIc= 153.8 kJ/m^2
K-JIc= 171.3 MPa SQR[m]
SLOPE= 103020 kJ/m^3
INTERCEPT= 140.9 kJ/m^2
T (ASTM)= 52
VALID, E813

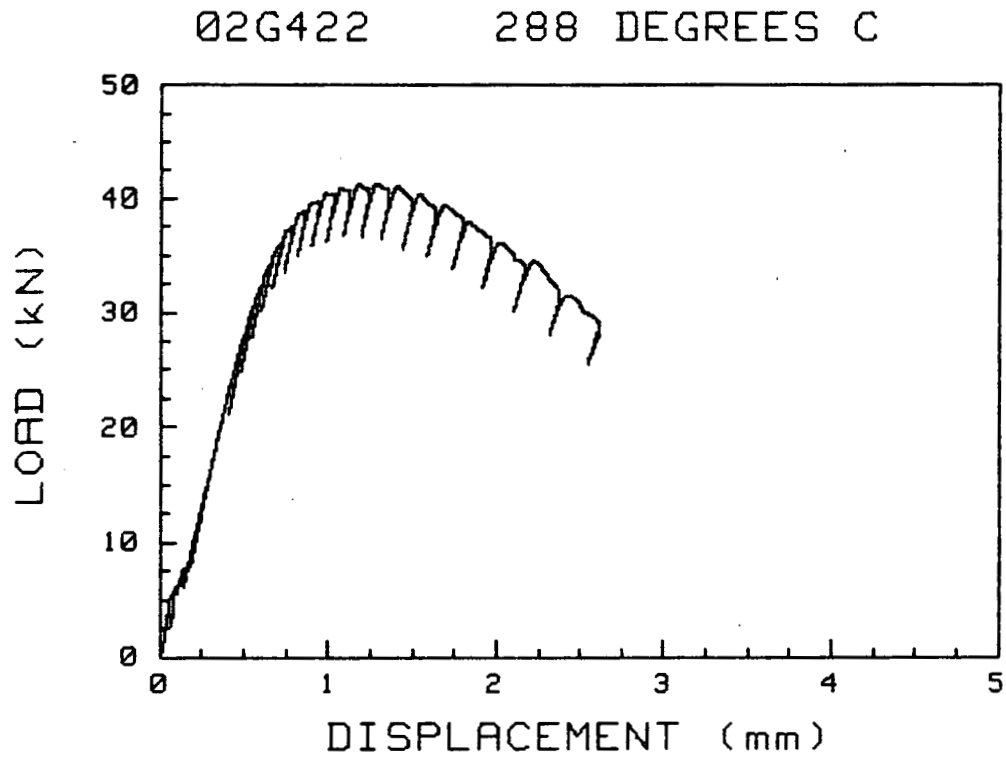
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 293.9 kJ/m^2
POWER= .3509
J-MAX ALLOWED= 614.4 kJ/m^2
RCURVE INVALID, 2 3

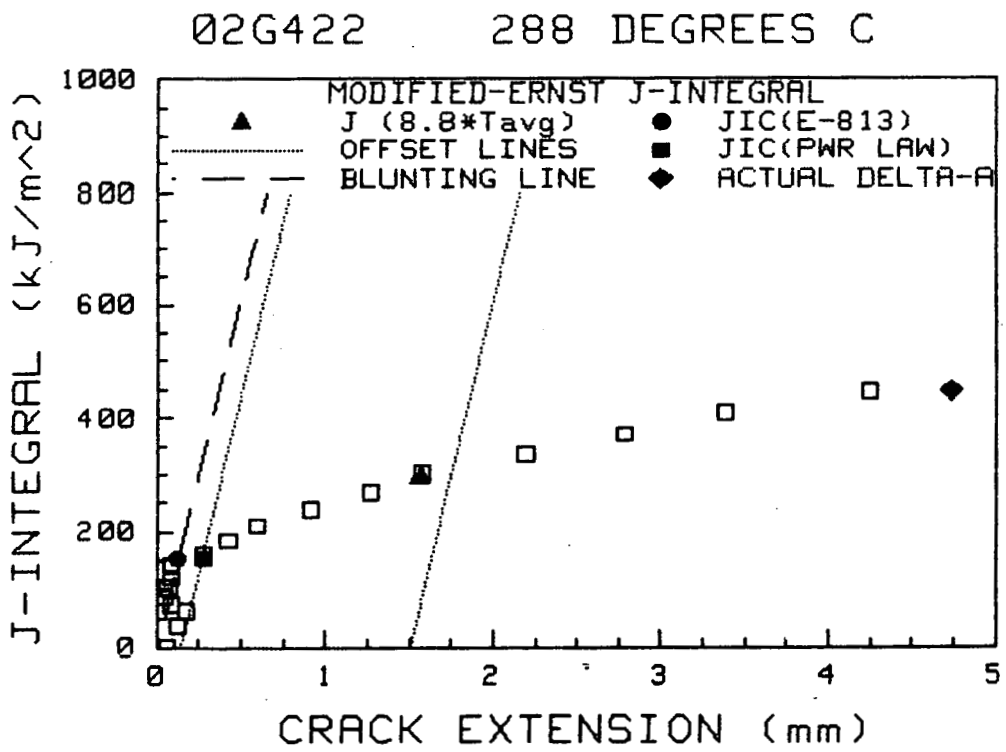
COEFFICIENT= 251 kJ/m^2
DELTA-A MAX ALLOWED= 2 mm



ORNL-DWG 87-8026



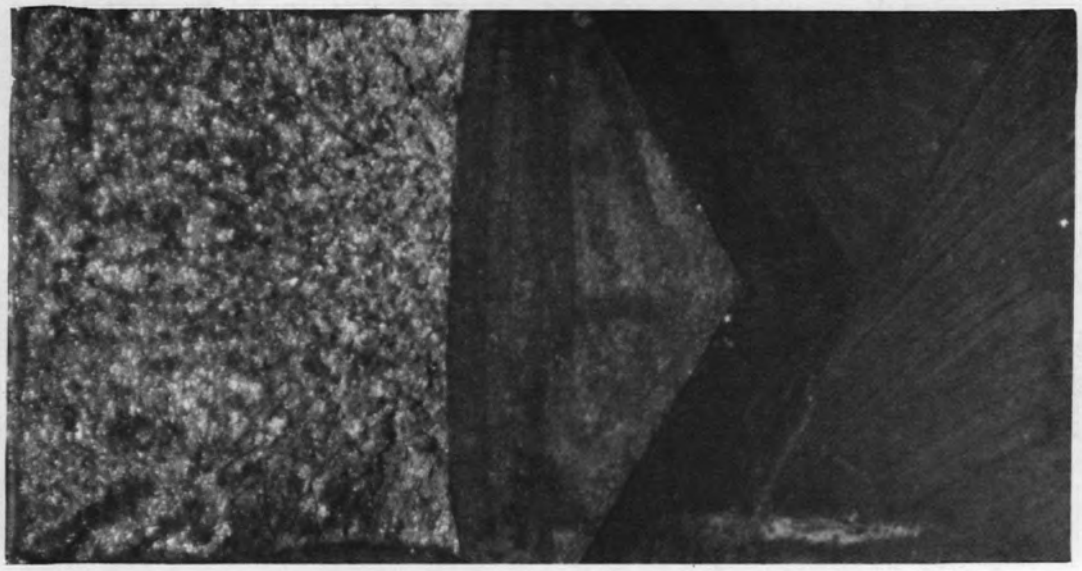
ORNL-DWG 87-8027



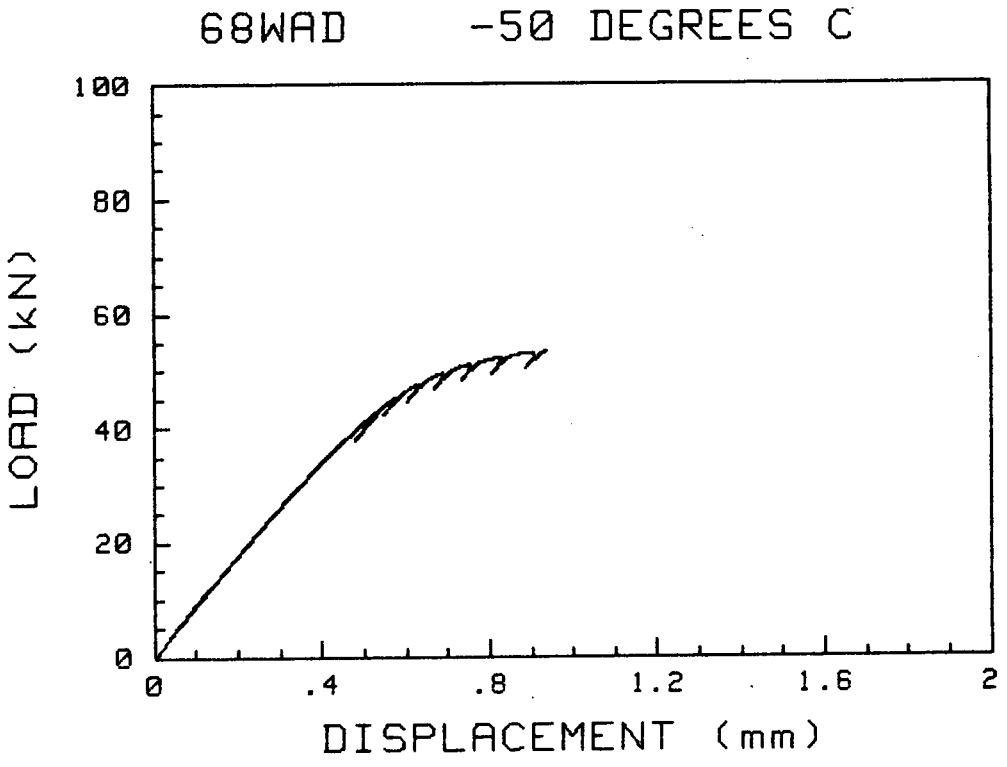
SPECIMEN ID= 68WAD
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.9 mm a/W)i= .608
MEASURED DUCTILE DELTA-A= .25 mm
YIELD STRENGTH= 727 MPa
FLOW STRENGTH= 727 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

SPECIMEN CLEAVED AT K = 131.3 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 140.3 kJ/m^2	J-INTEGRAL= 140.4 kJ/m^2
KJc= 171.7 MPa SQR[m]	KJc= 171.7 MPa SQR[m]
K-beta-c= 113.5 MPa SQR[m]	K-beta-c= 113.5 MPa SQR[m]



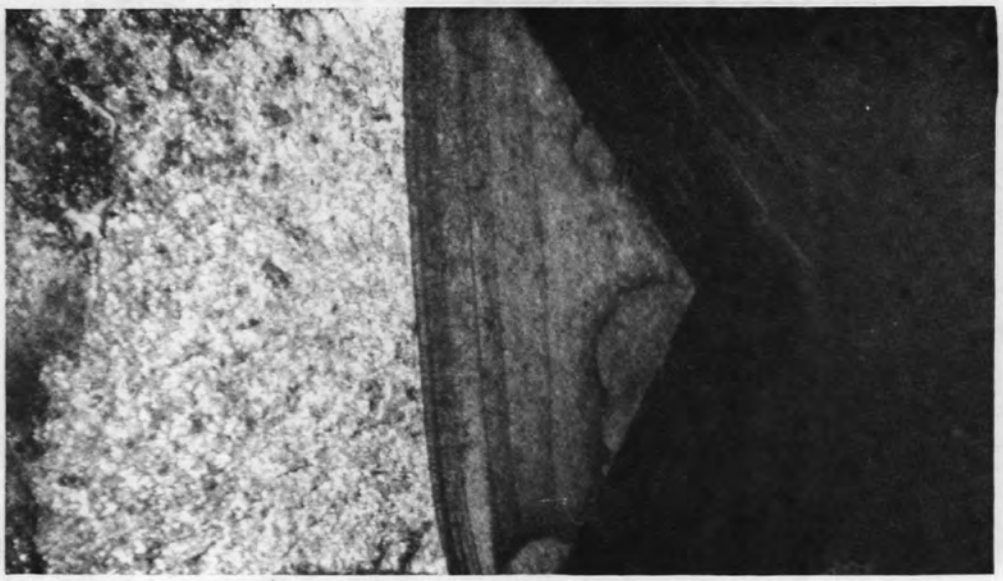
ORNL-DWG 87-8028



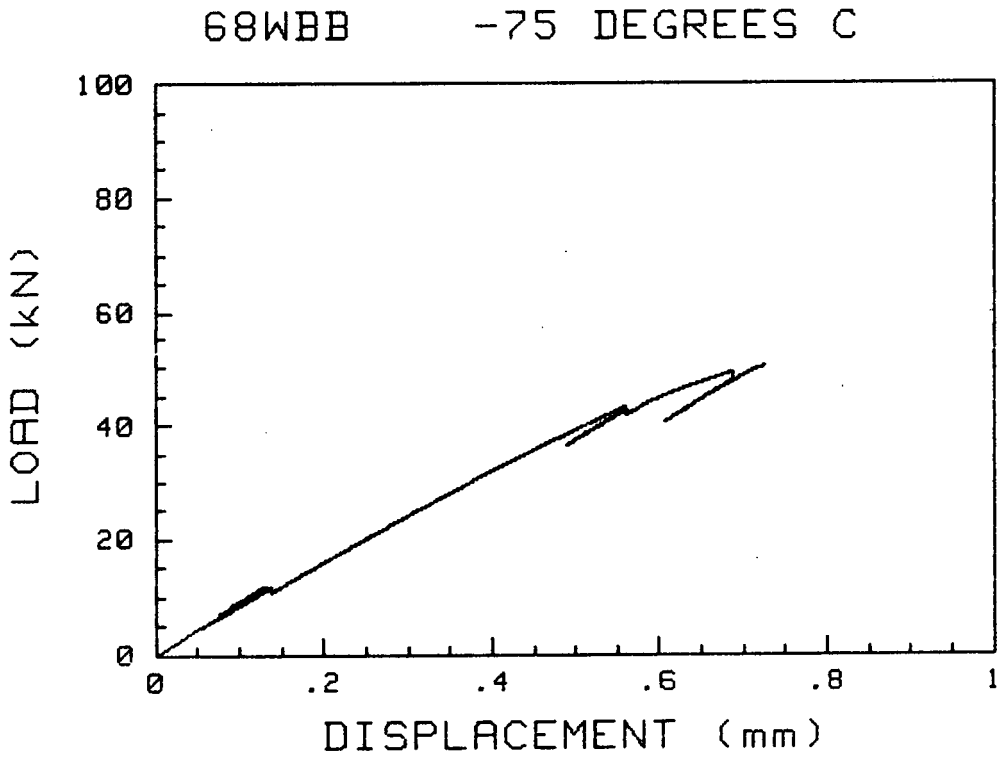
SPECIMEN ID= 68WBB
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -75 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.1 mm a/W)i= .593
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 757 MPa
FLOW STRENGTH= 757 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

SPECIMEN CLEAVED AT K = 116.1 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 84.3 kJ/m^2	J-INTEGRAL= 84.9 kJ/m^2
KJc= 133.6 MPa SQR[m]	KJc= 134 MPa SQR[m]
K-beta-c= 102 MPa SQR[m]	K-beta-c= 102.2 MPa SQR[m]



ORNL-DWG 87-8029



SPECIMEN ID= 68WCE
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.3 mm a/W)i= .606
MEASURED DUCTILE DELTA-A= 2.08 mm
YIELD STRENGTH= 548 MPa
FLOW STRENGTH= 593 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE. J-MAX LOAD= 295.6 kJ/m^2
KJ-MAX LOAD= 237.5 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 144.4 kJ/m^2
K-JIc= 166 MPa SQR[m]
POWER= .6841
COEFFICIENT= 352 kJ/m^2
T (AVERAGE)= 130

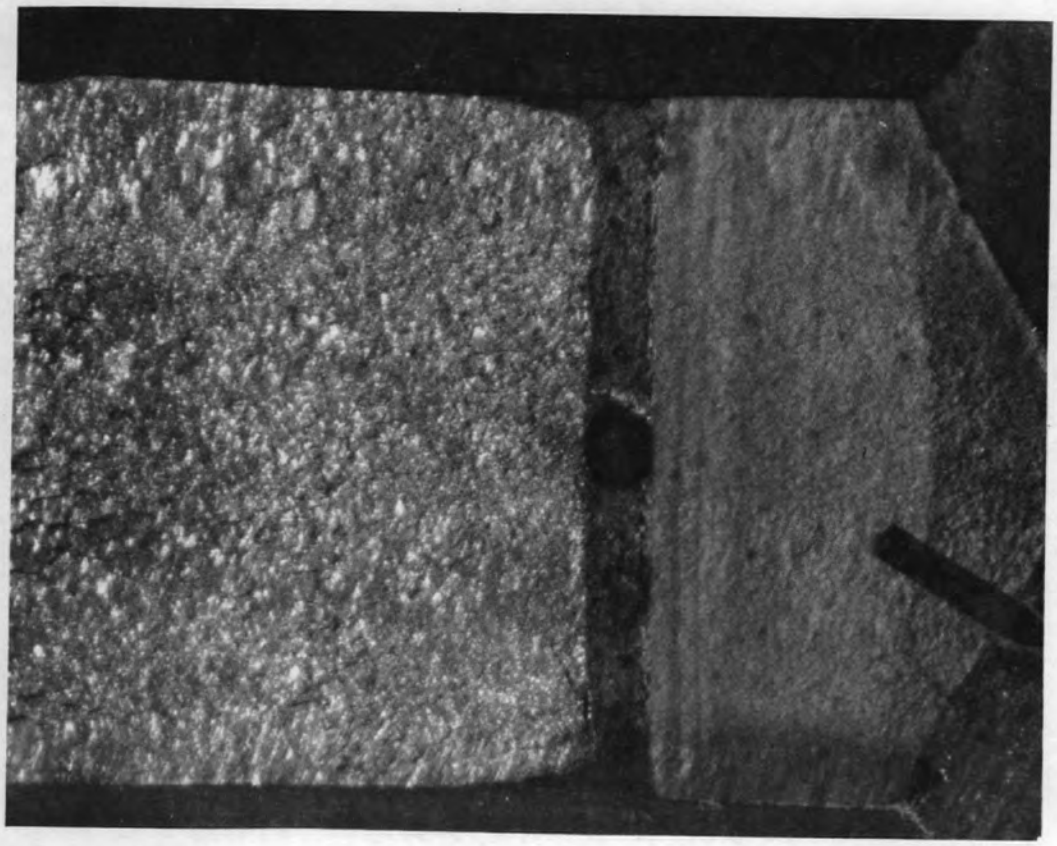
ASTM LINEAR PROCEDURE

JIc= 113.4 kJ/m^2
K-JIc= 147.1 MPa SQR[m]
SLOPE= 250748 kJ/m^3
INTERCEPT= 89.4 kJ/m^2
T (ASTM)= 136
VALID. E813

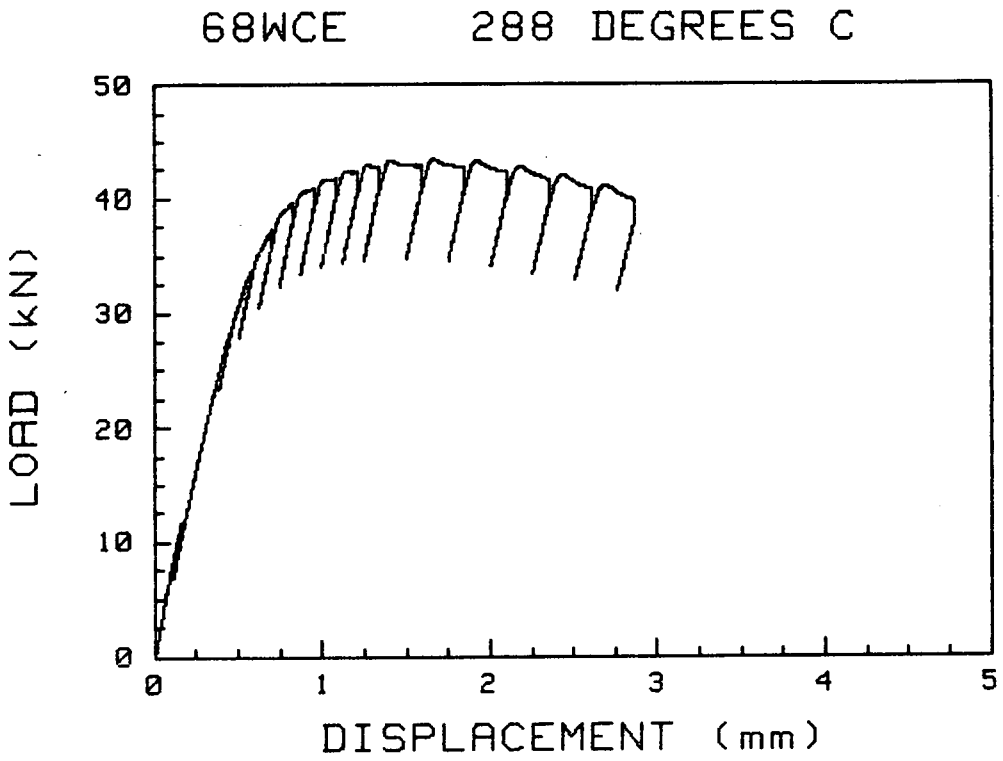
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 778.6 kJ/m^2
POWER= .6777
J-MAX ALLOWED= 592.4 kJ/m^2
VALID R-CURVE

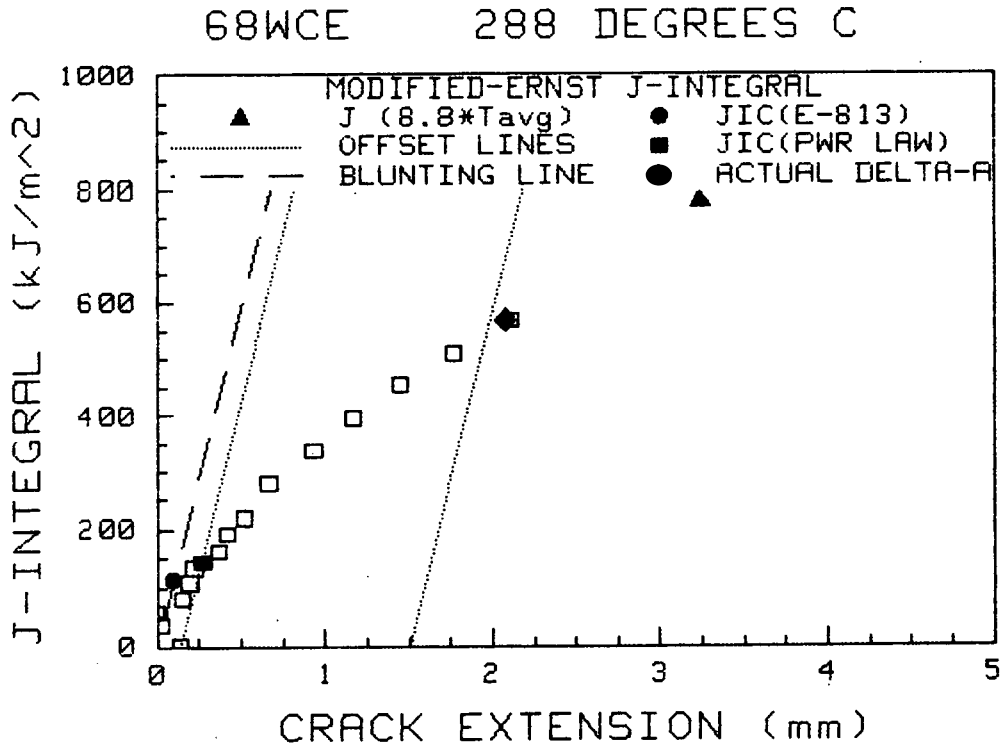
COEFFICIENT= 351.2 kJ/m^2
DELTA-A MAX ALLOWED= 2 mm



ORNL-DWG 87-8030



ORNL-DWG 87-8031



SPECIMEN ID= 68WDA
TEST TEMPERATURE= 204 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.4 mm a/W)i= .6
MEASURED DUCTILE DELTA-A= 2.47 mm
YIELD STRENGTH= 533 MPa
FLOW STRENGTH= 572 MPa
ESTIMATED YOUNG'S MODULUS= 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 275.1 kJ/m^2
KJ-MAX LOAD= 231.9 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 173.5 kJ/m^2
K-JIc= 184.2 MPa SQR[m]
POWER= .6523
COEFFICIENT= 379.2 kJ/m^2
T (AVERAGE)= 145

ASTM LINEAR PROCEDURE

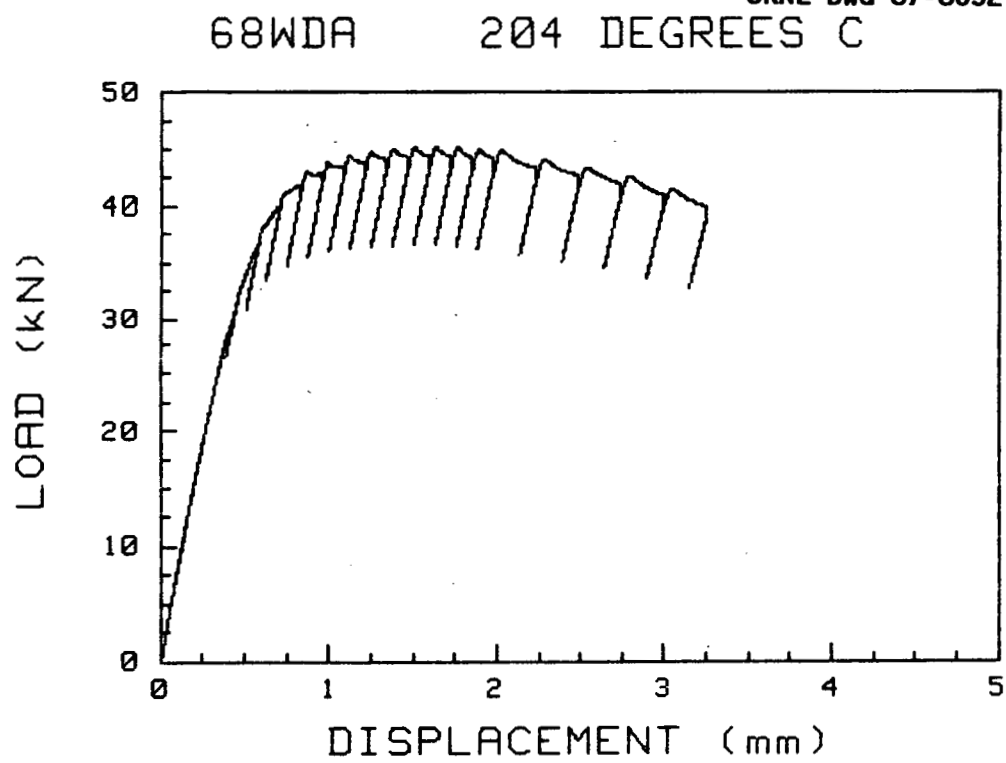
JIc= 137.9 kJ/m^2
K-JIc= 164.2 MPa SQR[m]
SLOPE= 261042 kJ/m^3
INTERCEPT= 106.4 kJ/m^2
T (ASTM)= 156
VALID, E813

JI-R CURVE CALCULATIONS

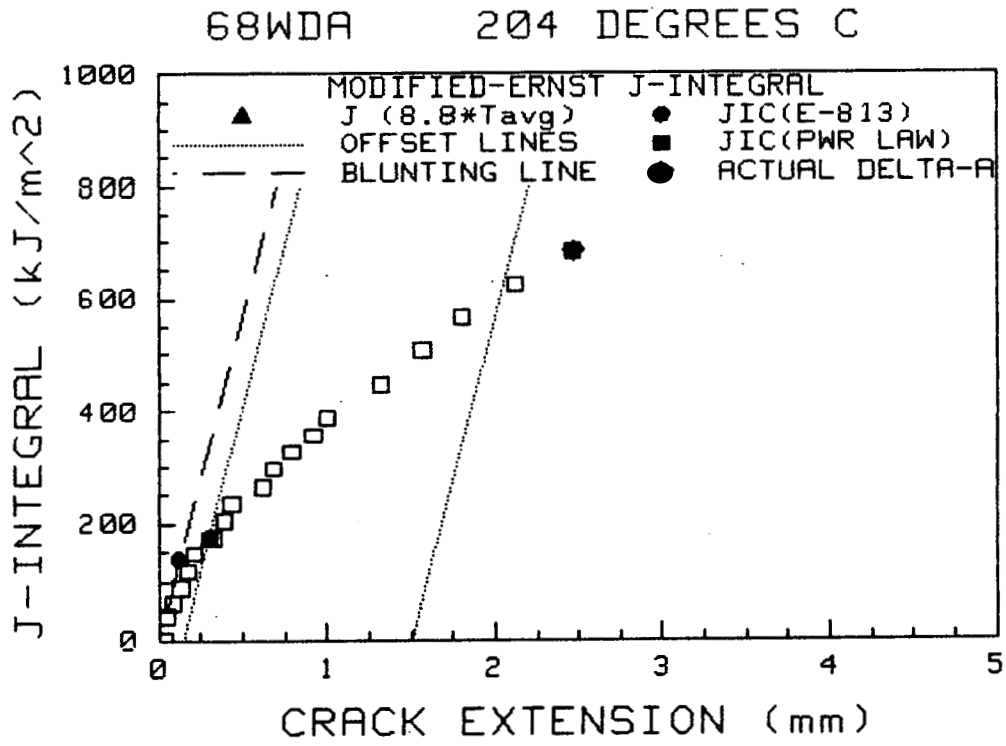
J (@J/T=8.8)= 839.5 kJ/m^2
POWER= .6485
J-MAX ALLOWED= 580.9 kJ/m^2
RCURVE INVALID, 1

COEFFICIENT= 378.7 kJ/m^2
DELTA-A MAX ALLOWED= 2.03 mm

ORNL-DWG 87-8032



ORNL-DWG 87-8033



SPECIMEN ID= 68WDC
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.5 mm a/W)i= .601
MEASURED DUCTILE DELTA-A= 2.81 mm
YIELD STRENGTH= 538 MPa
FLOW STRENGTH= 575 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 313.1 kJ/m^2
KJ-MAX LOAD= 250.4 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 163.8 kJ/m^2
K-JIc= 181.1 MPa SQR[m]
POWER= .7302
COEFFICIENT= 402.1 kJ/m^2
T (AVERAGE)= 173

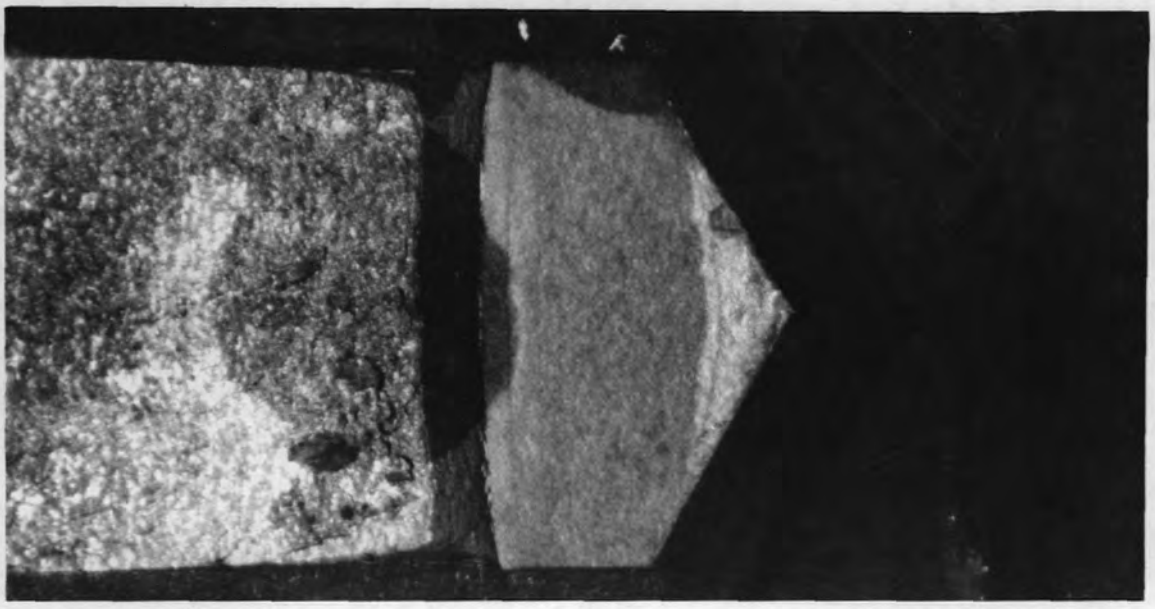
ASTM LINEAR PROCEDURE

JIc= 131.2 kJ/m^2
K-JIc= 162.1 MPa SQR[m]
SLOPE= 292740 kJ/m^3
INTERCEPT= 97.8 kJ/m^2
T (ASTM)= 177
VALID, E813

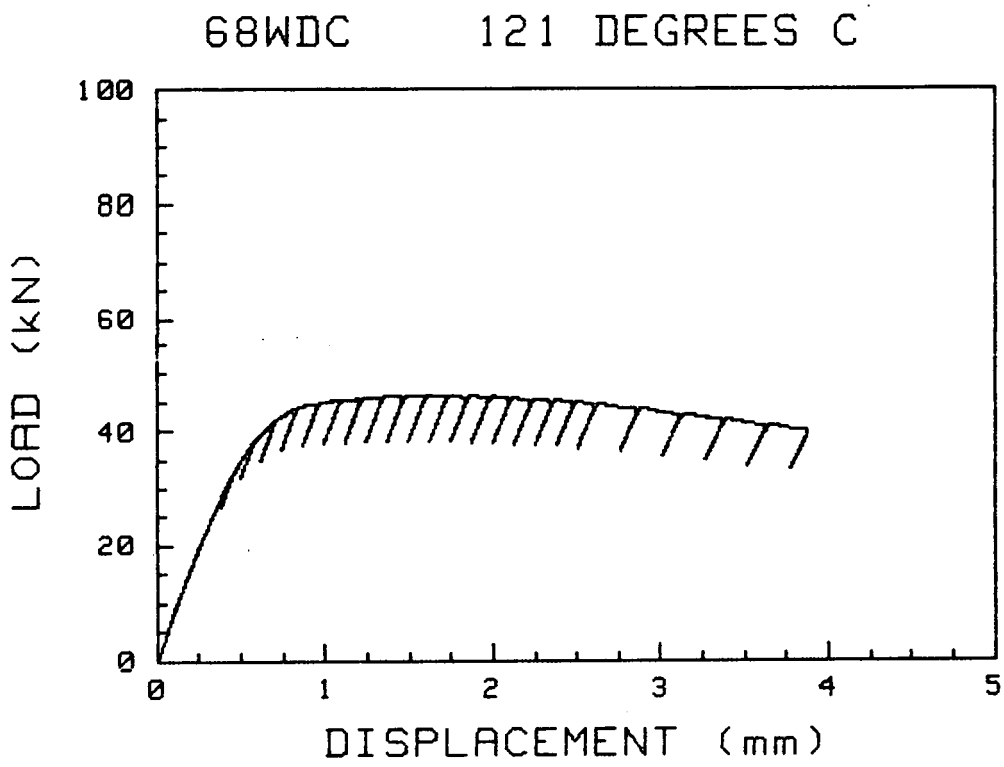
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 1090 kJ/m^2
POWER= .7321
J-MAX ALLOWED= 583.3 kJ/m^2
RCURVE INVALID, 2

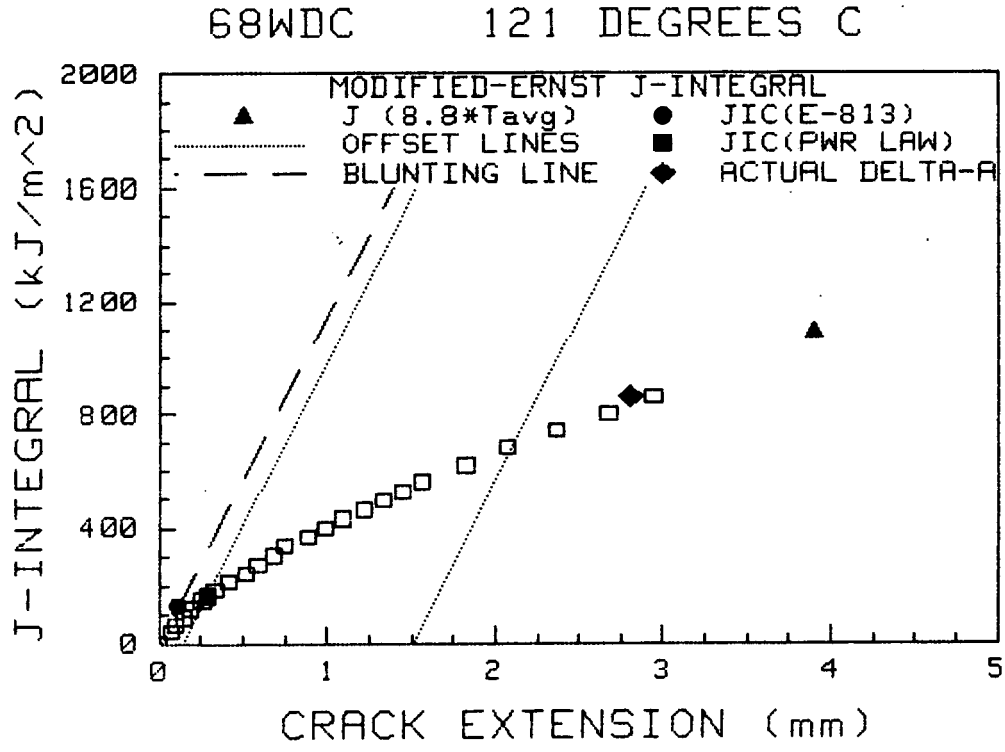
COEFFICIENT= 402.7 kJ/m^2
DELTA-A MAX ALLOWED= 2.03 mm



ORNL-DWG 87-8034



ORNL-DWG 87-8035

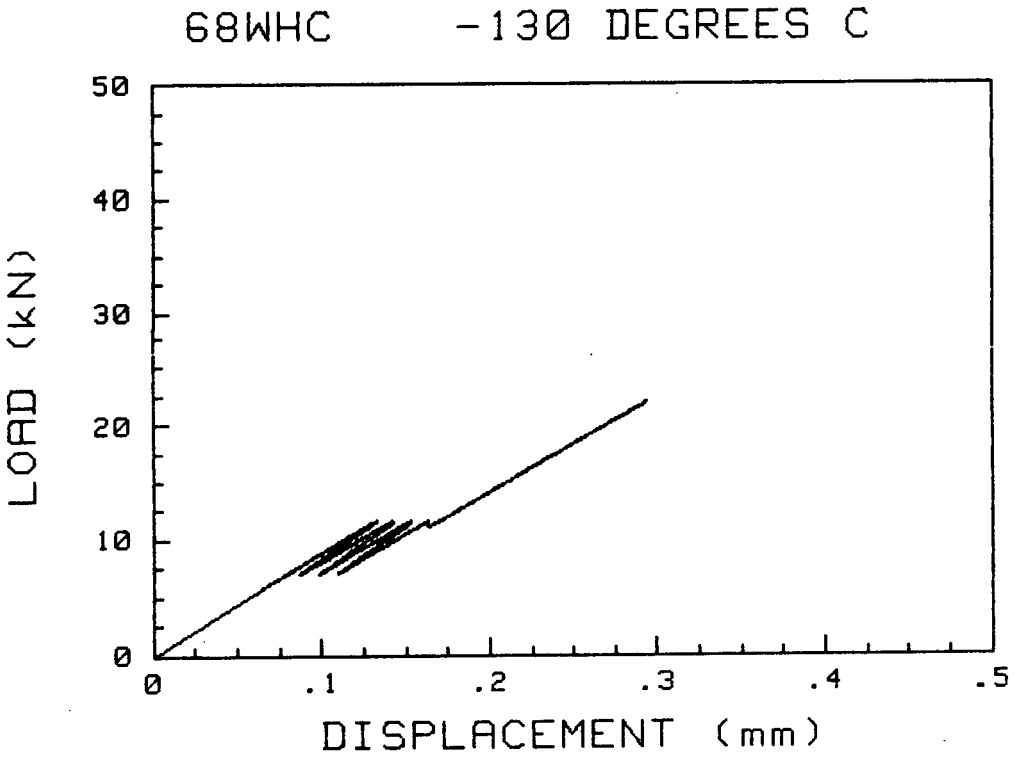


SPECIMEN ID= 68WHC
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -130 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.5 mm a/W)i= .601
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 833 MPa
FLOW STRENGTH= 833 MPa
ESTIMATED YOUNG'S MODULUS= 215 GPa

SPECIMEN CLEAVED AT KIc= 52.5 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 13.5 kJ/m^2	J-INTEGRAL= 13.5 kJ/m^2
KJc= 53.9 MPa SQR[m]	KJc= 53.9 MPa SQR[m]
K-beta-c= 52.9 MPa SQR[m]	K-beta-c= 52.9 MPa SQR[m]

ORNL-DWG 87-8036



SPECIMEN ID= 68WKB
TEST TEMPERATURE= 204 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.5 mm a/W)i= .602
MEASURED DUCTILE DELTA-A= 2.28 mm
YIELD STRENGTH= 533 MPa
FLOW STRENGTH= 572 MPa
ESTIMATED YOUNG'S MODULUS= 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 278 kJ/m^2
KJ-MAX LOAD= 233.1 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 144.7 kJ/m^2
K-JIc= 168.2 MPa SQR[m]
POWER= .6506
COEFFICIENT= 333.9 kJ/m^2
T (AVERAGE)= 129

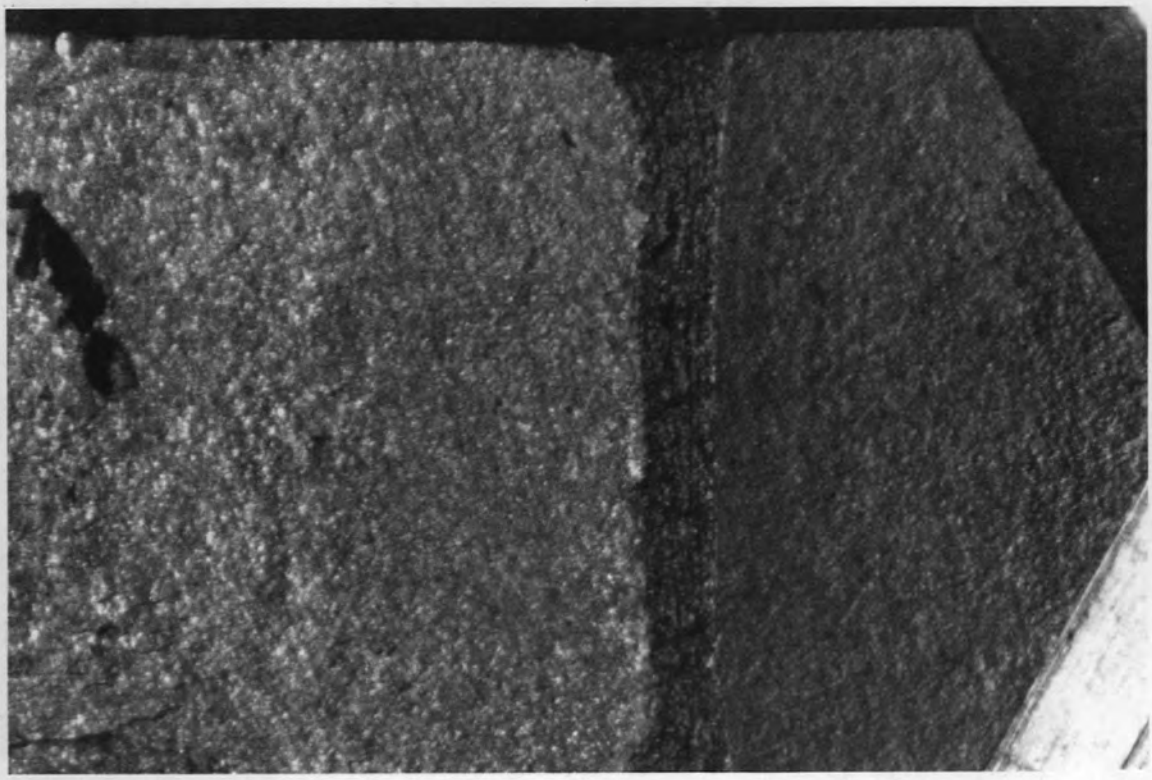
ASTM LINEAR PROCEDURE

JIc= 122.3 kJ/m^2
K-JIc= 154.7 MPa SQR[m]
SLOPE= 227311 kJ/m^3
INTERCEPT= 98 kJ/m^2
T (ASTM)= 136
VALID, E813

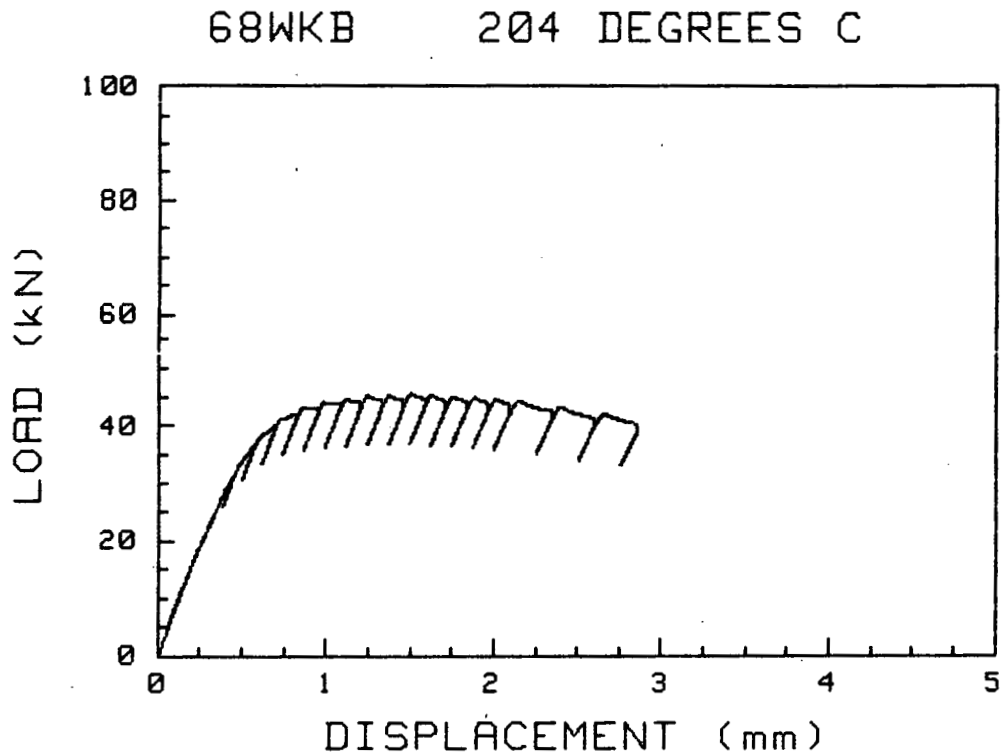
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 730.4 kJ/m^2
POWER= .6433
J-MAX ALLOWED= 577.6 kJ/m^2
RCURVE INVALID, 1

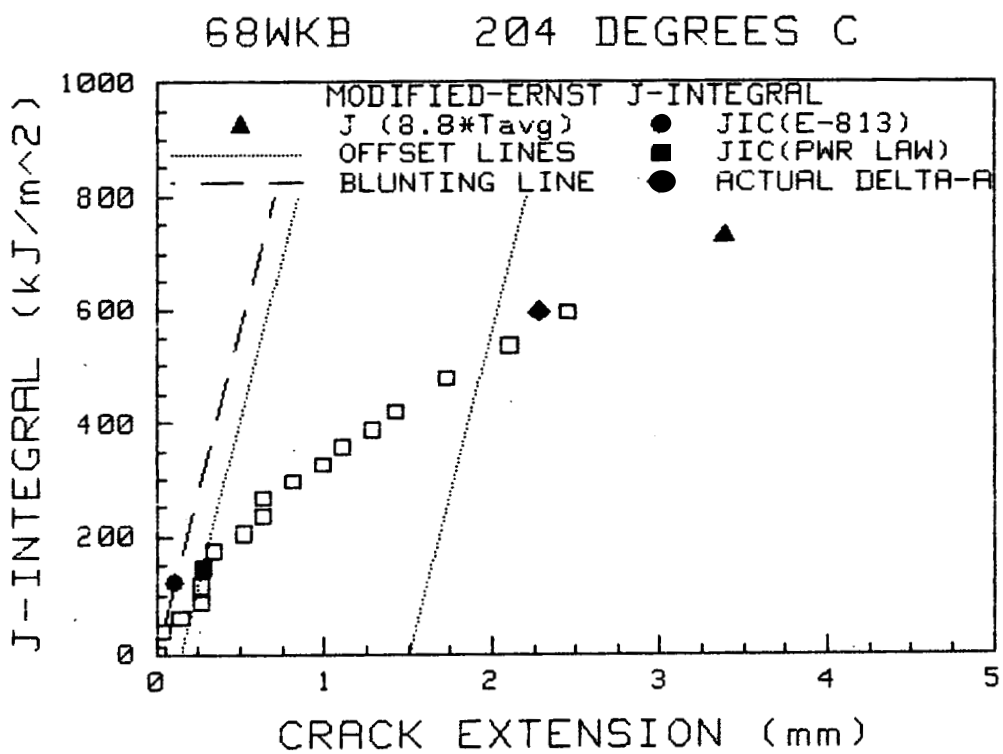
COEFFICIENT= 333.2 kJ/m^2
DELTA-A MAX ALLOWED= 2.02 mm



ORNL-DWG 87-8037



ORNL-DWG 87-8038



SPECIMEN ID= 68WKC
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.3 mm a/W)i= .598
MEASURED DUCTILE DELTA-A= 2.31 mm
YIELD STRENGTH= 548 MPa
FLOW STRENGTH= 593 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 306.5 kJ/m^2
KJ-MAX LOAD= 241.8 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 180 kJ/m^2
K-JIc= 185.3 MPa SQR[m]
POWER= .5888
COEFFICIENT= 364.5 kJ/m^2
T (AVERAGE)= 115

ASTM LINEAR PROCEDURE

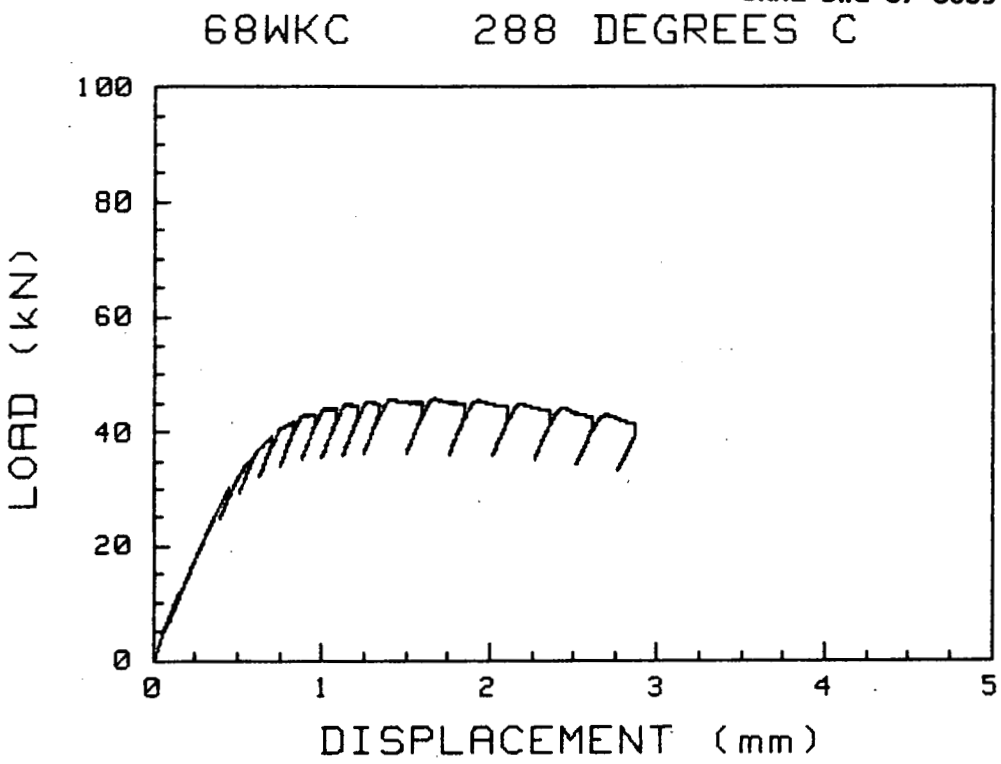
JIc= 164.1 kJ/m^2
K-JIc= 176.9 MPa SQR[m]
SLOPE= 218095 kJ/m^3
INTERCEPT= 133.9 kJ/m^2
T (ASTM)= 118
VALID, E813

JI-R CURVE CALCULATIONS

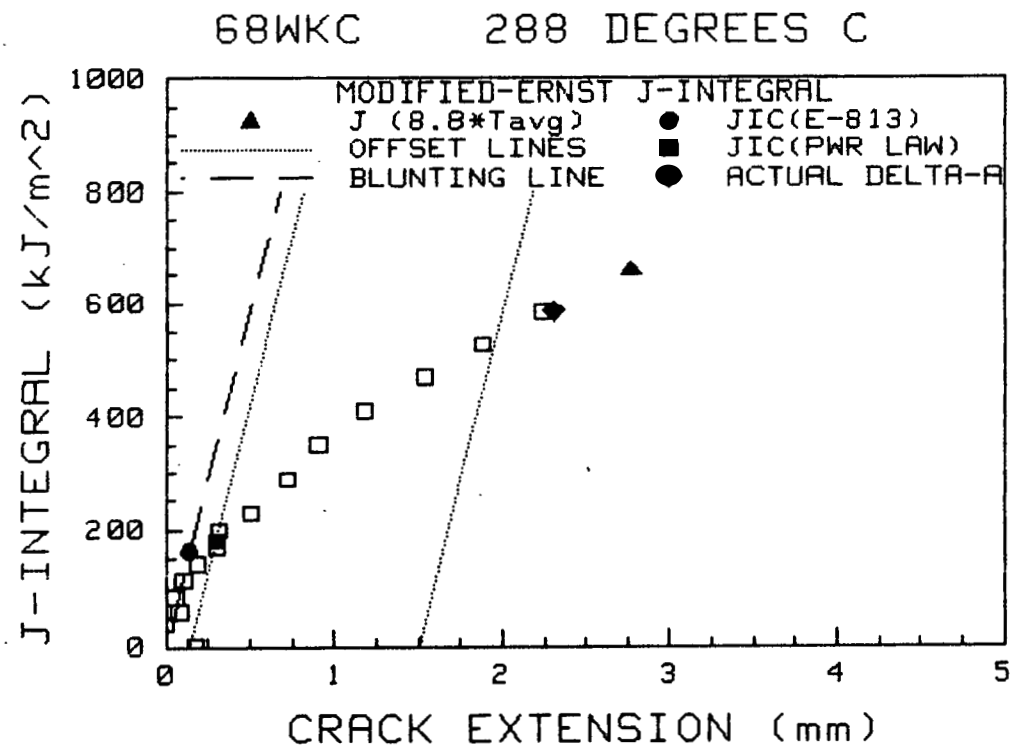
J (@J/T=8.8)= 657.4 kJ/m^2
POWER= .5801
J-MAX ALLOWED= 602.4 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 364 kJ/m^2
DELTA-A MAX ALLOWED= 2.04 mm

ORNL-DWG 87-8039



ORNL-DWG 87-8040



SPECIMEN ID= 68WKE
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.6 mm a/W)i= .601
MEASURED DUCTILE DELTA-A= 2.62 mm
YIELD STRENGTH= 538 MPa
FLOW STRENGTH= 575 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 342.3 kJ/m^2
KJ-MAX LOAD= 261.8 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 196.8 kJ/m^2
K-JIc= 198.6 MPa SQR[m]
POWER= .6466
COEFFICIENT= 410.4 kJ/m^2
T (AVERAGE)= 155

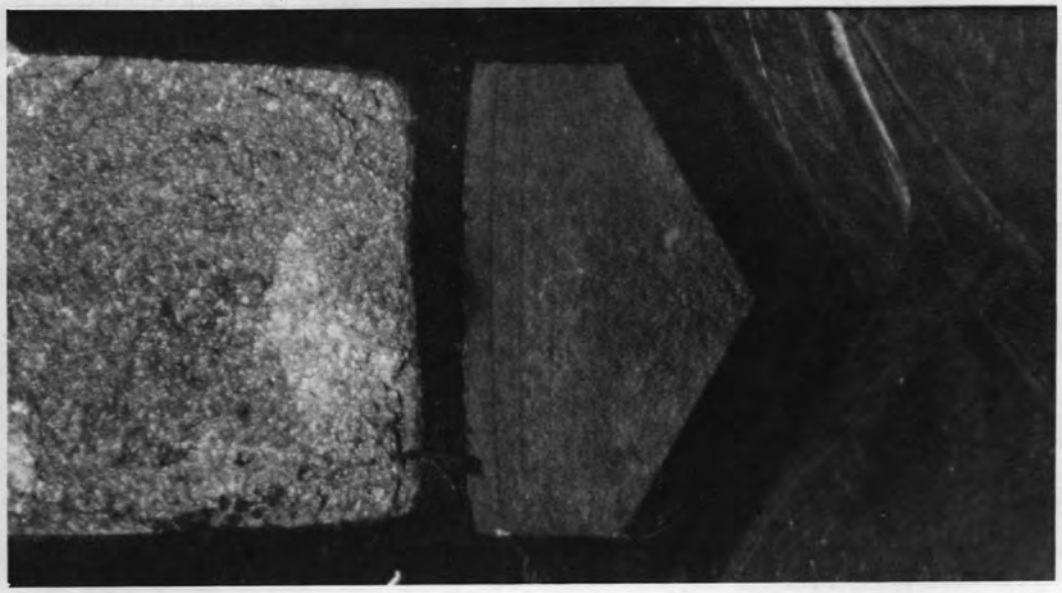
ASTM LINEAR PROCEDURE

JIc= 172.6 kJ/m^2
K-JIc= 185.9 MPa SQR[m]
SLOPE= 263609 kJ/m^3
INTERCEPT= 133.1 kJ/m^2
T (ASTM)= 159
VALID, E813

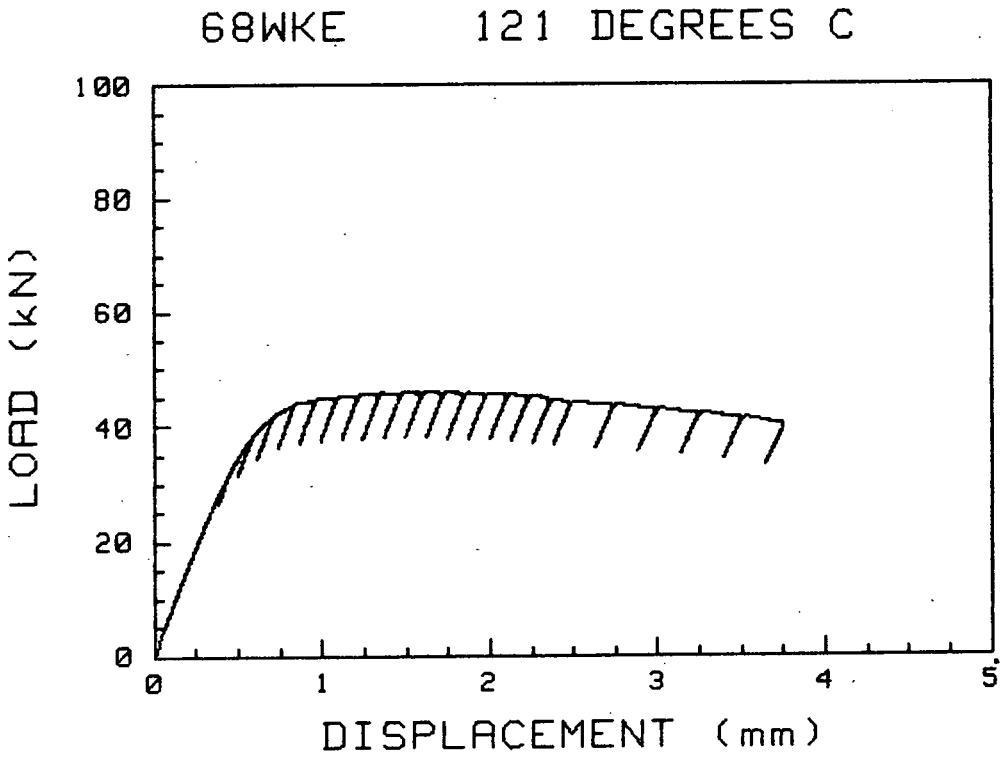
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 903.8 kJ/m^2
POWER= .643
J-MAX ALLOWED= 583.1 kJ/m^2
VALID R-CURVE

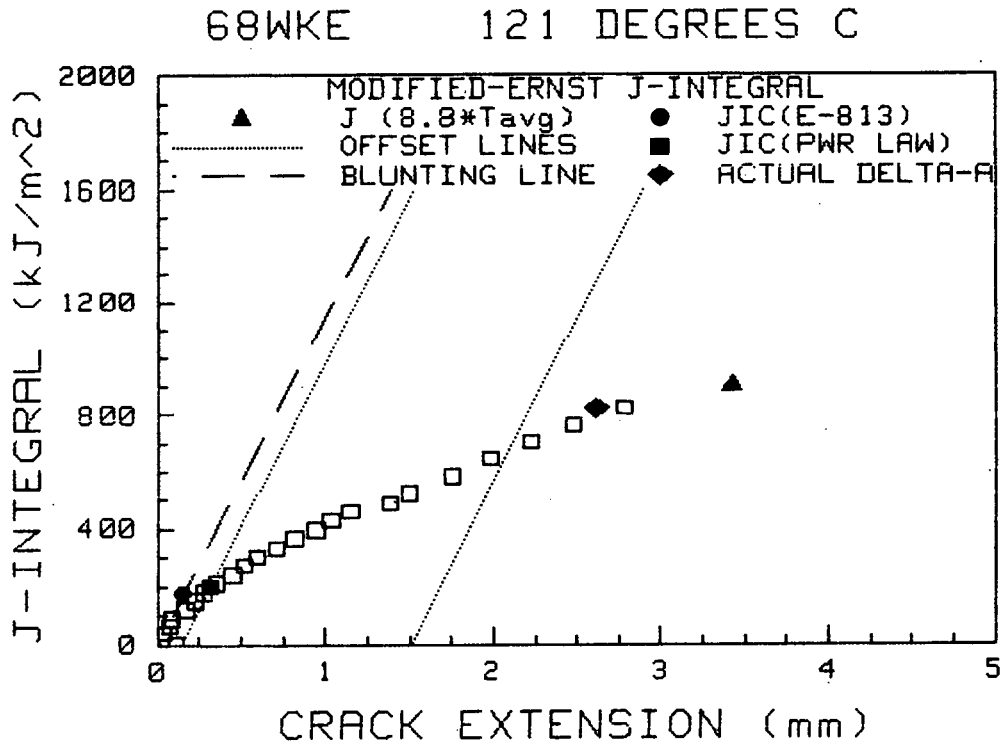
COEFFICIENT= 409.8 kJ/m^2
DELTA-A MAX ALLOWED= 2.03 mm



ORNL-DWG 87-8041



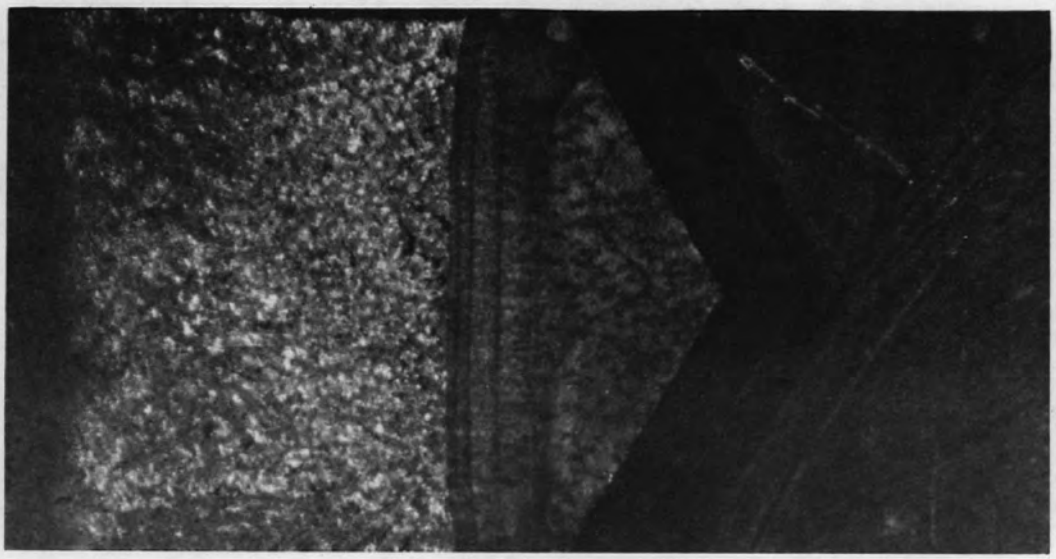
ORNL-DWG 87-8042



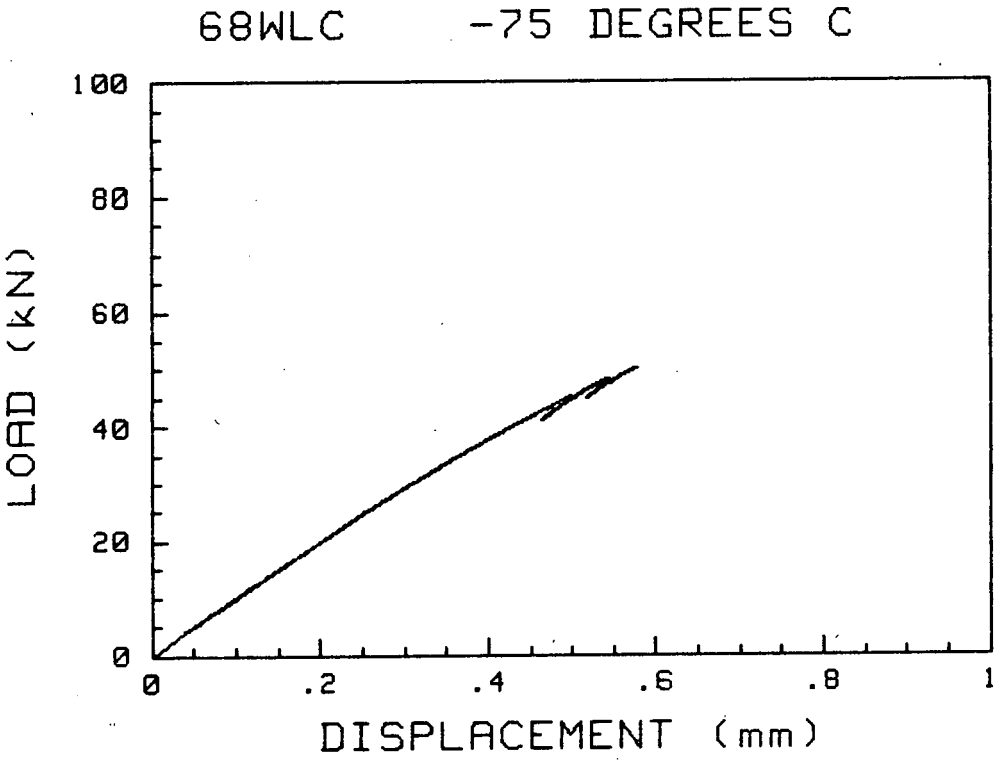
SPECIMEN ID= 68WLC
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -75 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.3 mm a/W)i= .597
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 757 MPa
FLOW STRENGTH= 757 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

SPECIMEN CLEAVED AT K = 118.2 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 67.9 kJ/m^2	J-INTEGRAL= 67.7 kJ/m^2
KJc= 119.8 MPa SQR[m]	KJc= 119.6 MPa SQR[m]
K-beta-c= 96 MPa SQR[m]	K-beta-c= 95.9 MPa SQR[m]



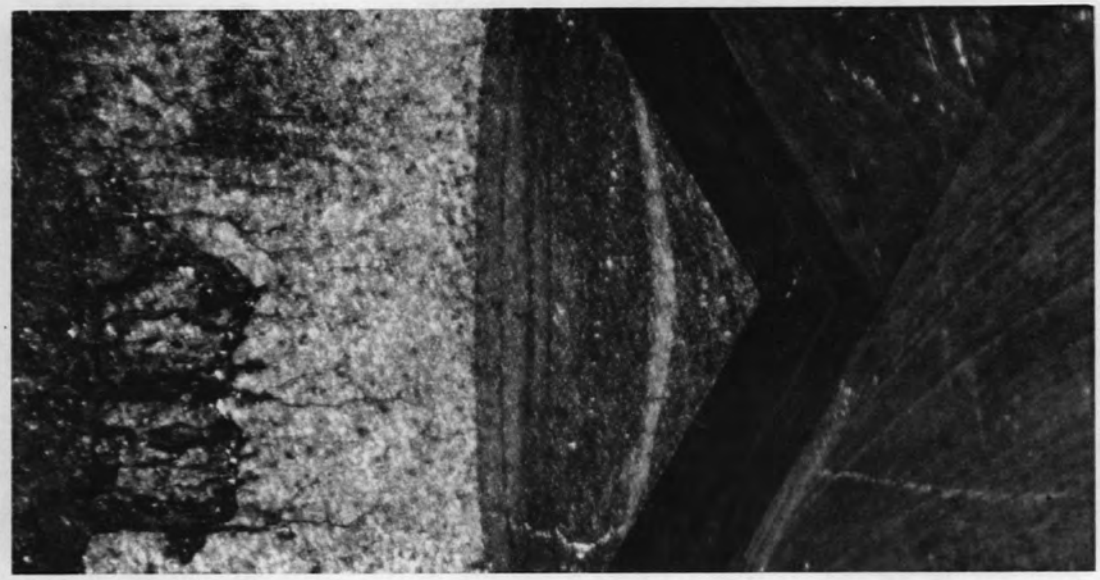
ORNL-DWG 87-8043



SPECIMEN ID= 68WMB
TEST TEMPERATURE= -130 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.4 mm a/W)i= .598
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 833 MPa
FLOW STRENGTH= 833 MPa
ESTIMATED YOUNG'S MODULUS= 215 GPa

SPECIMEN CLEAVED AT KIc= 37.4 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 6.5 kJ/m^2	J-INTEGRAL= 6.5 kJ/m^2
KJc= 37.4 MPa SQR[m]	KJc= 37.4 MPa SQR[m]
K-beta-c= 37.2 MPa SQR[m]	K-beta-c= 37.2 MPa SQR[m]



LOAD-DISPLACEMENT AND J-R CURVES UNAVAILABLE

SPECIMEN ID= 68WMD
TEST TEMPERATURE= 32 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.8 mm a/W)i= .606
MEASURED DUCTILE DELTA-A= 6.75 mm
YIELD STRENGTH= 569 MPa
FLOW STRENGTH= 610 MPa
ESTIMATED YOUNG'S MODULUS= 205 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 346.7 kJ/m^2
KJ-MAX LOAD= 266.8 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 206.4 kJ/m^2
K-JIc= 205.9 MPa SQR[m]
POWER= .6942
COEFFICIENT= 456 kJ/m^2
T (AVERAGE)= 168

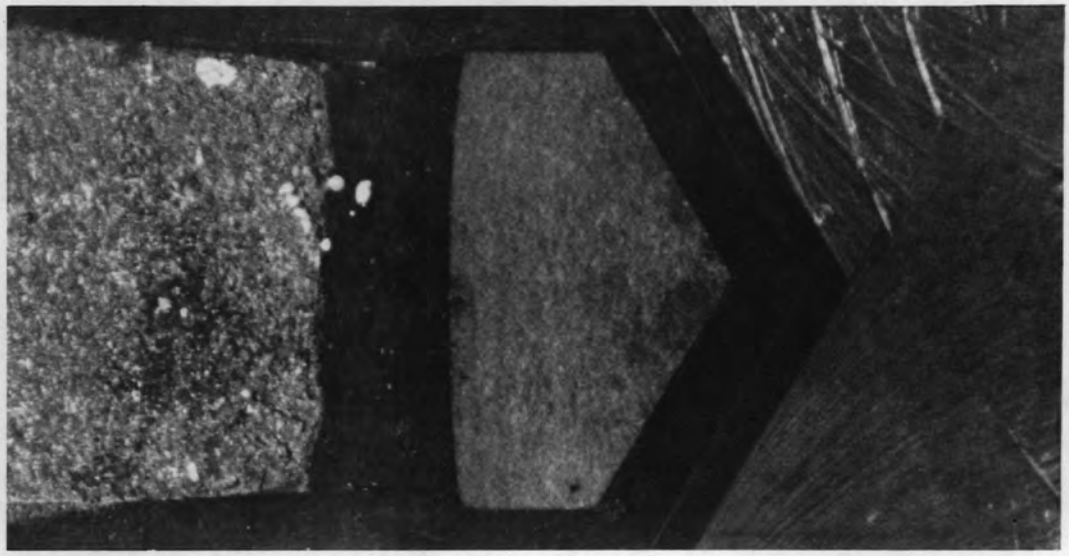
ASTM LINEAR PROCEDURE

JIc= 178.3 kJ/m^2
K-JIc= 191.3 MPa SQR[m]
SLOPE= 310973 kJ/m^3
INTERCEPT= 132.8 kJ/m^2
T (ASTM)= 172
VALID, E813

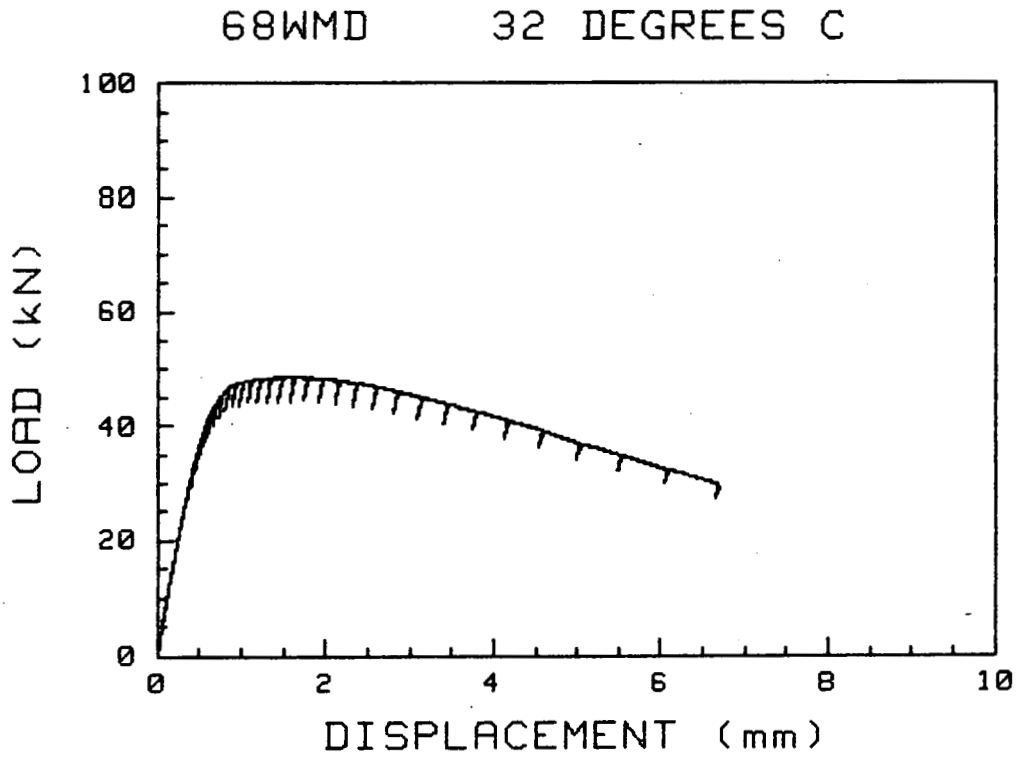
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 1113.1 kJ/m^2
POWER= .7141
J-MAX ALLOWED= 611 kJ/m^2
RCURVE INVALID, 3

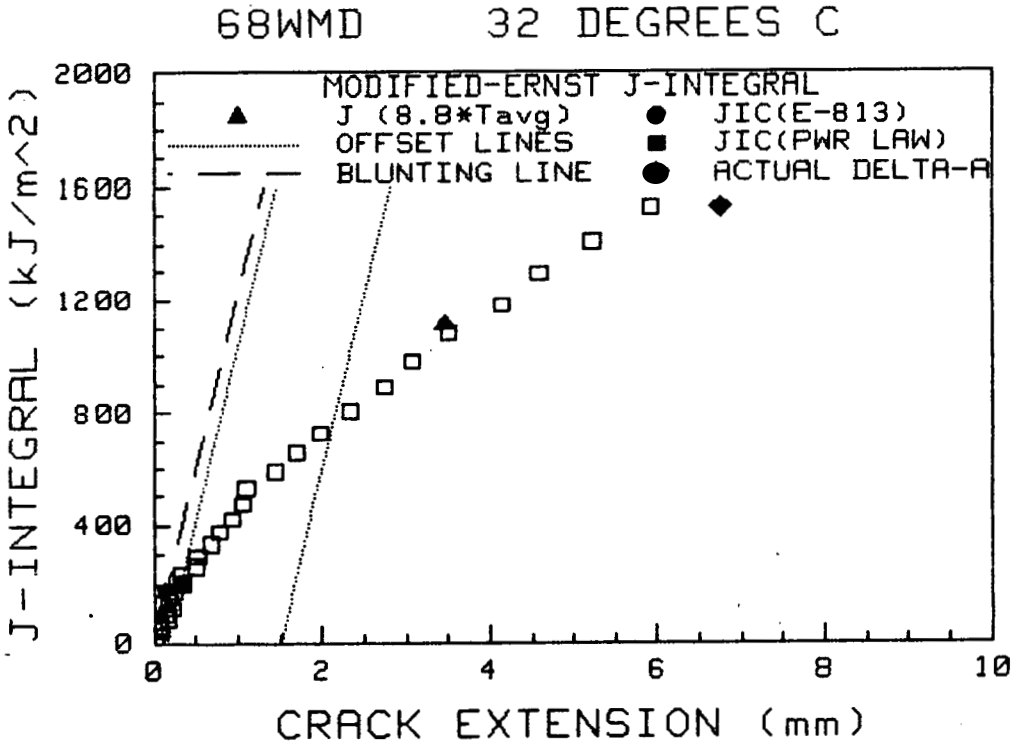
COEFFICIENT= 458.1 kJ/m^2
DELTA-A MAX ALLOWED= 2 mm



ORNL-DWG 87-8044



ORNL-DWG 87-8045



SPECIMEN ID= 69W102
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.6 mm a/W)i= .603
MEASURED DUCTILE DELTA-A= 3.43 mm
YIELD STRENGTH= 675 MPa
FLOW STRENGTH= 712 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 204.3 kJ/m^2
KJ-MAX LOAD= 202.3 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 150.1 kJ/m^2
K-JIc= 173.4 MPa SQR[m]
POWER= .4034
COEFFICIENT= 260.3 kJ/m^2
T (AVERAGE)= 44

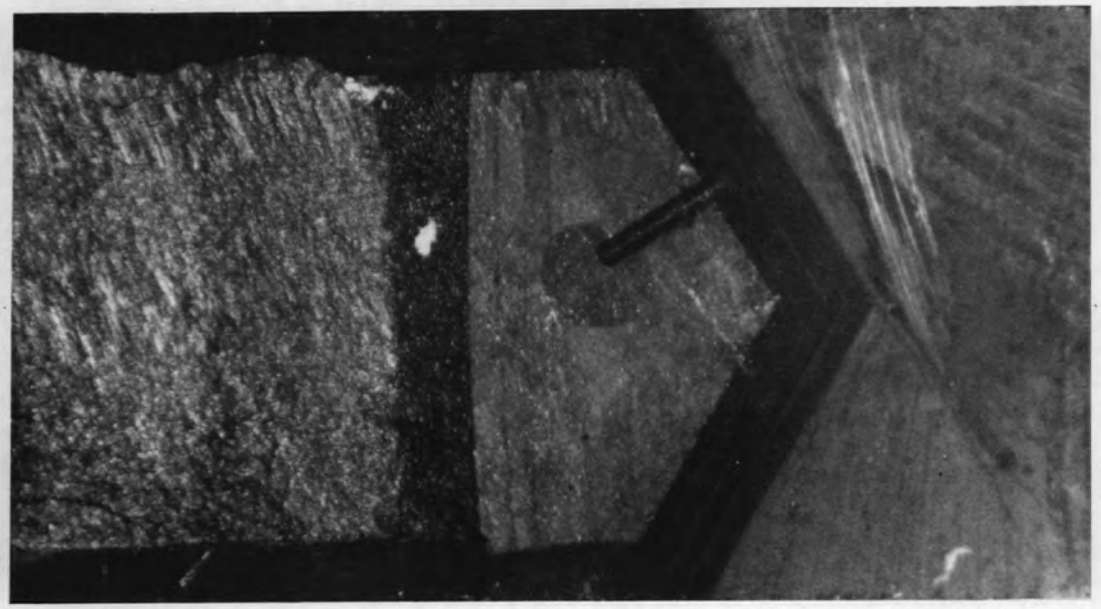
ASTM LINEAR PROCEDURE

JIc= 133.4 kJ/m^2
K-JIc= 163.4 MPa SQR[m]
SLOPE= 134114 kJ/m^3
INTERCEPT= 120.8 kJ/m^2
T (ASTM)= 53
VALID, E813

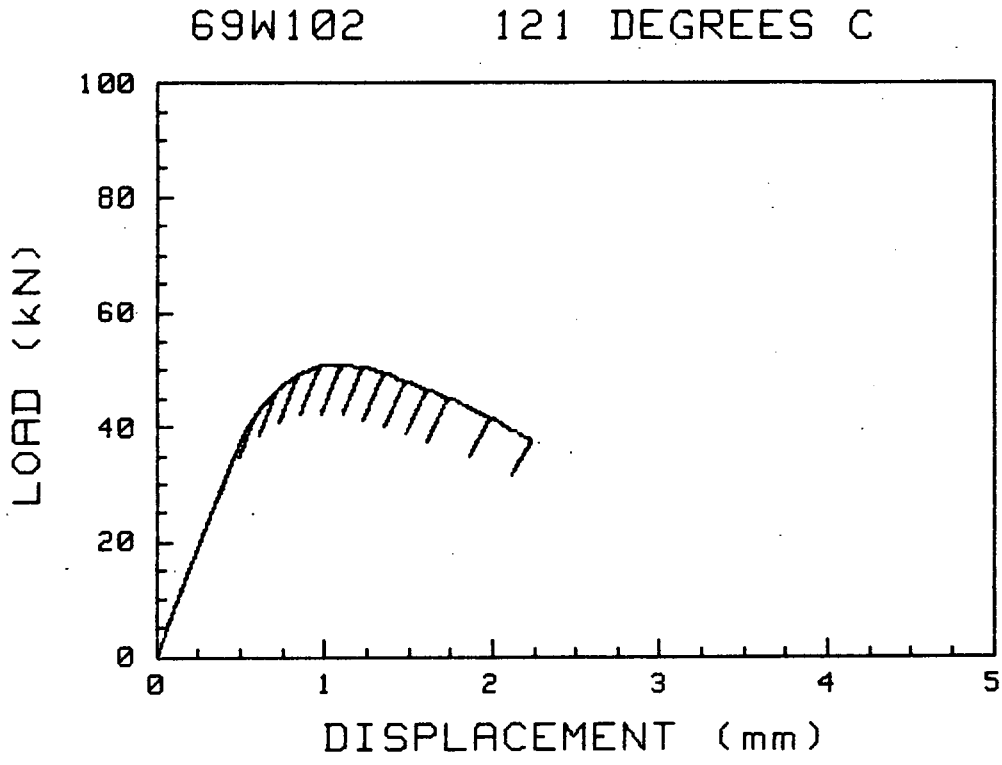
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 296.7 kJ/m^2
POWER= .4009
J-MAX ALLOWED= 717 kJ/m^2
RCURVE INVALID, 1 2

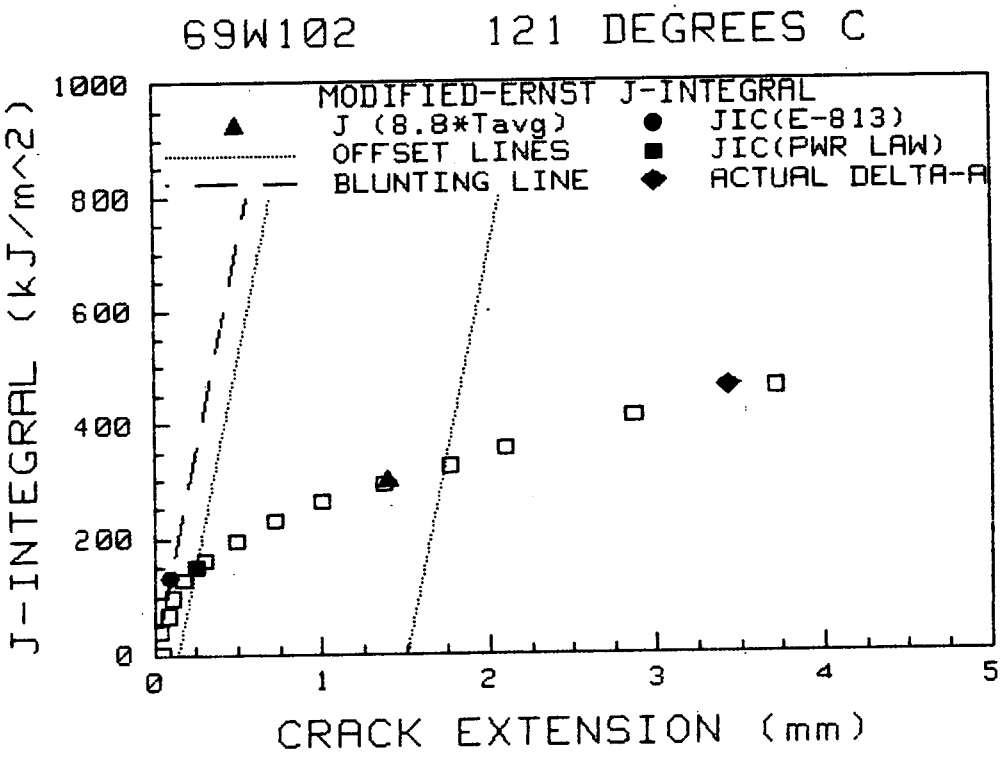
COEFFICIENT= 259.6 kJ/m^2
DELTA-A MAX ALLOWED= 2.02 mm



ORNL-DWG 87-8046



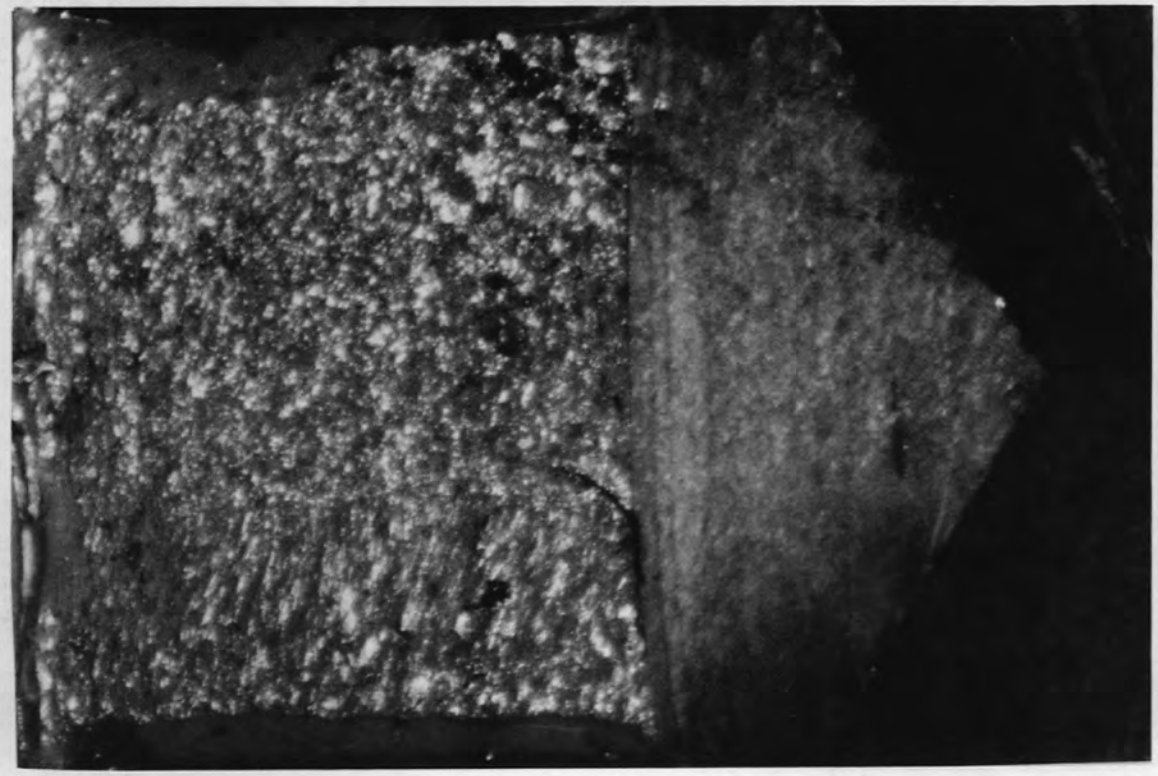
ORNL-DWG 87-8047



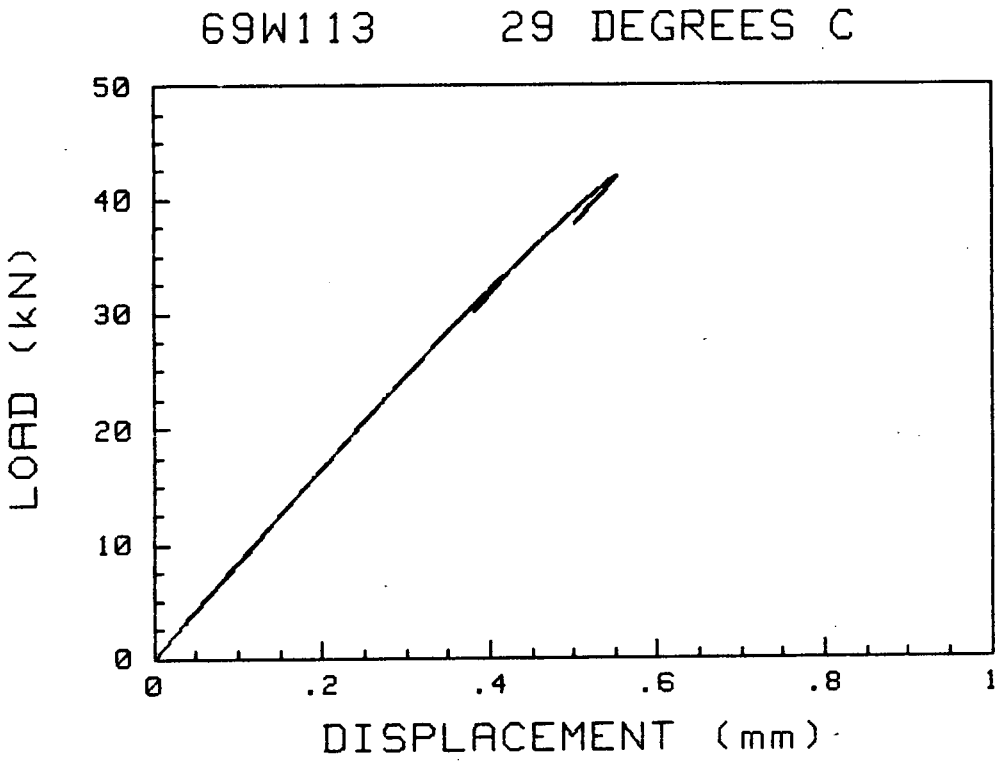
SPECIMEN ID= 69W113
MATERIAL TYPE= A533BW
TEST TEMPERATURE= 29 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.3 mm a/W)i= .617
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 714 MPa
FLOW STRENGTH= 751 MPa
ESTIMATED YOUNG'S MODULUS= 206 GPa

SPECIMEN CLEAVED AT K = 106.3 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 54.3 kJ/m^2	J-INTEGRAL= 54.3 kJ/m^2
KJc= 105.7 MPa SQR[m]	KJc= 105.7 MPa SQR[m]
K-beta-c= 87 MPa SQR[m]	K-beta-c= 87 MPa SQR[m]



ORNL-DWG 87-8048

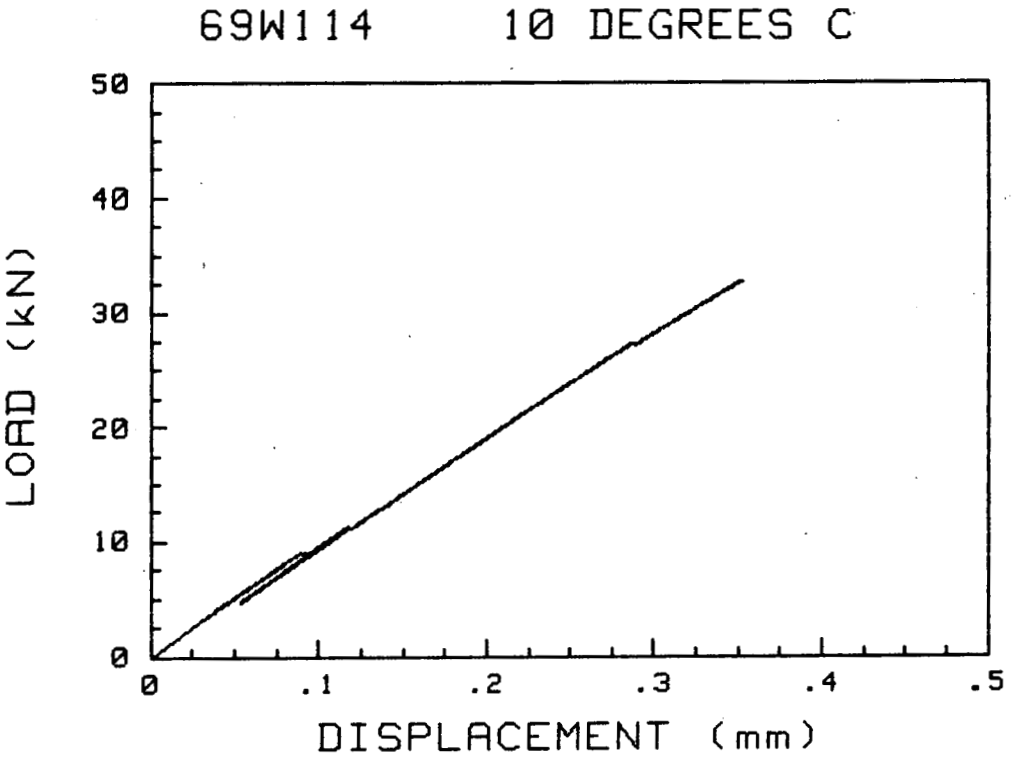


SPECIMEN ID= 69W114
MATERIAL TYPE= A533BW
TEST TEMPERATURE= 10 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.4 mm a/W)i= .598
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 739 MPa
FLOW STRENGTH= 768 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

SPECIMEN CLEAVED AT K = 77.3 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 25 kJ/m^2	J-INTEGRAL= 25 kJ/m^2
KJc= 71.9 MPa SQR[m]	KJc= 71.9 MPa SQR[m]
K-beta-c= 67.1 MPa SQR[m]	K-beta-c= 67.1 MPa SQR[m]

ORNL-DWG 87-8049



SPECIMEN ID= 69W116
TEST TEMPERATURE= 52 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 29.4 mm a/W)i= .58
MEASURED DUCTILE DELTA-A= .89 mm
YIELD STRENGTH= 702 MPa
FLOW STRENGTH= 738 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 171.6 kJ/m^2
KJ-MAX LOAD= 187.2 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 103.2 kJ/m^2
K-JIc= 145.2 MPa SQR[m]
POWER= .5673
COEFFICIENT= 243.7 kJ/m^2
T (AVERAGE)= 55

ASTM LINEAR PROCEDURE

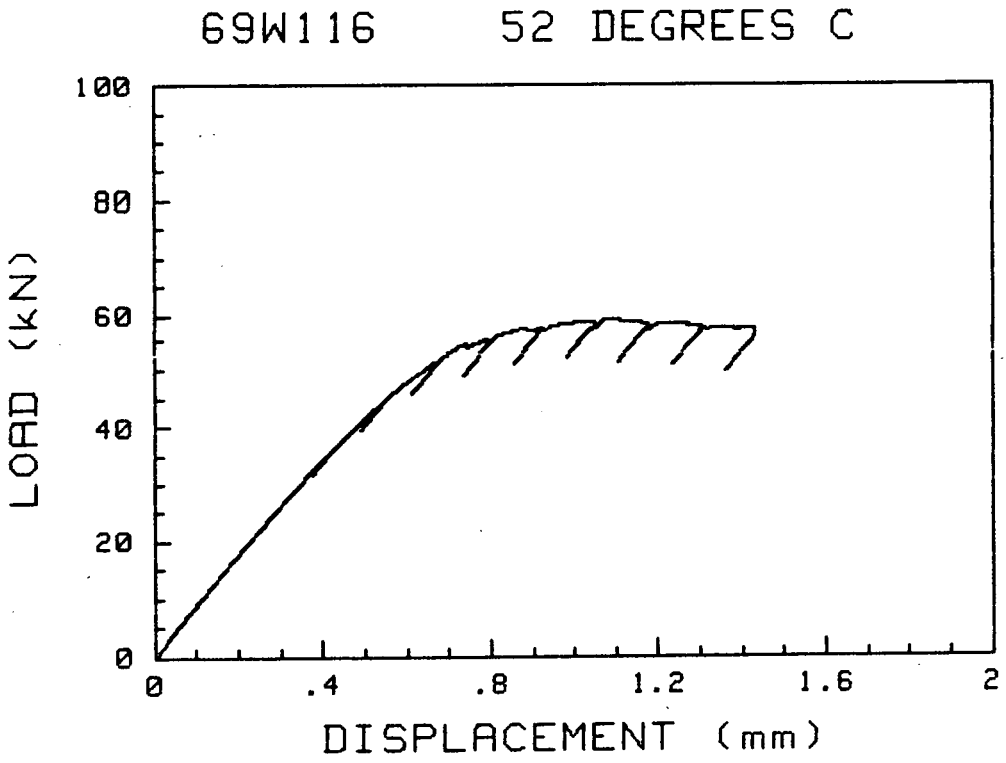
JIc= 75.2 kJ/m^2
K-JIc= 123.9 MPa SQR[m]
SLOPE= 182326 kJ/m^3
INTERCEPT= 65.9 kJ/m^2
T (ASTM)= 68
INVALID, 6

JI-R CURVE CALCULATIONS

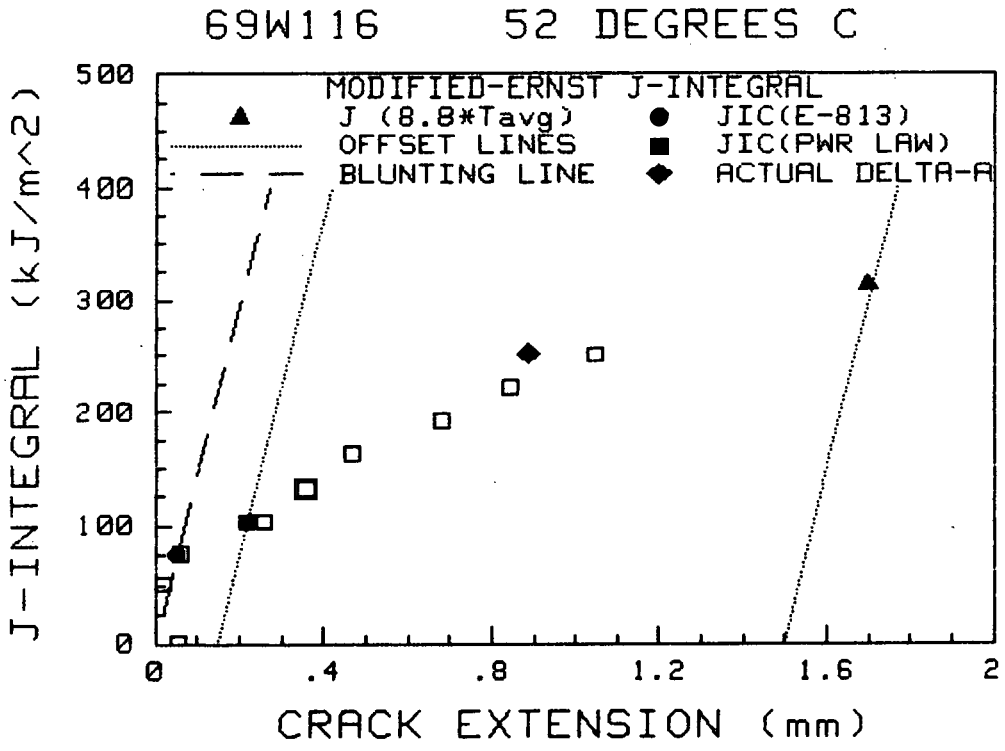
J (@J/T=8.8)= 312.9 kJ/m^2
POWER= .5153
J-MAX ALLOWED= 786.9 kJ/m^2
RCURVE INVALID, 2 3

COEFFICIENT= 238.2 kJ/m^2
DELTA-A MAX ALLOWED= 2.13 mm

ORNL-DWG 87-8050



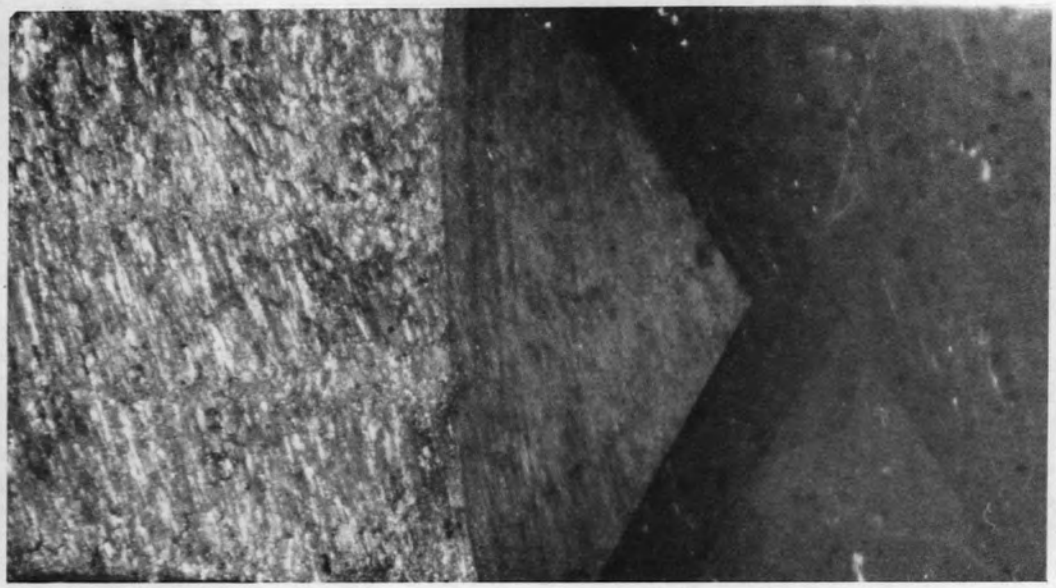
ORNL-DWG 87-8051



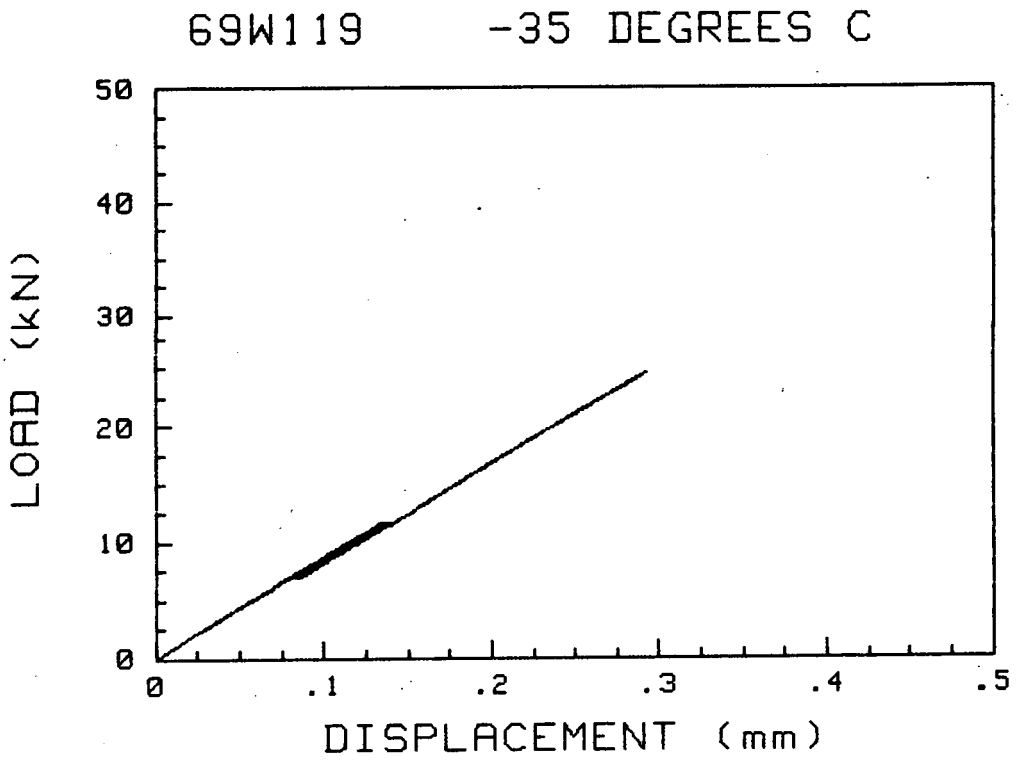
SPECIMEN ID= 69W119
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -35 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.1 mm a/W)i= .593
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 784 MPa
FLOW STRENGTH= 812 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT KIc= 56.9 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 15.2 kJ/m^2	J-INTEGRAL= 15.2 kJ/m^2
KJc= 56.4 MPa SQR[m]	KJc= 56.4 MPa SQR[m]
K-beta-c= 55 MPa SQR[m]	K-beta-c= 55 MPa SQR[m]



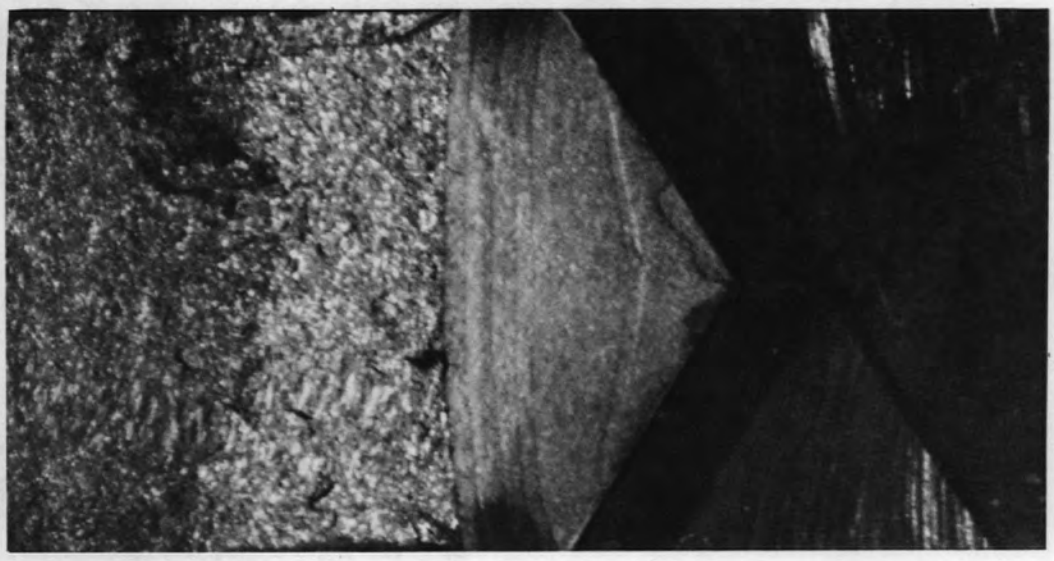
ORNL-DWG 87-8052



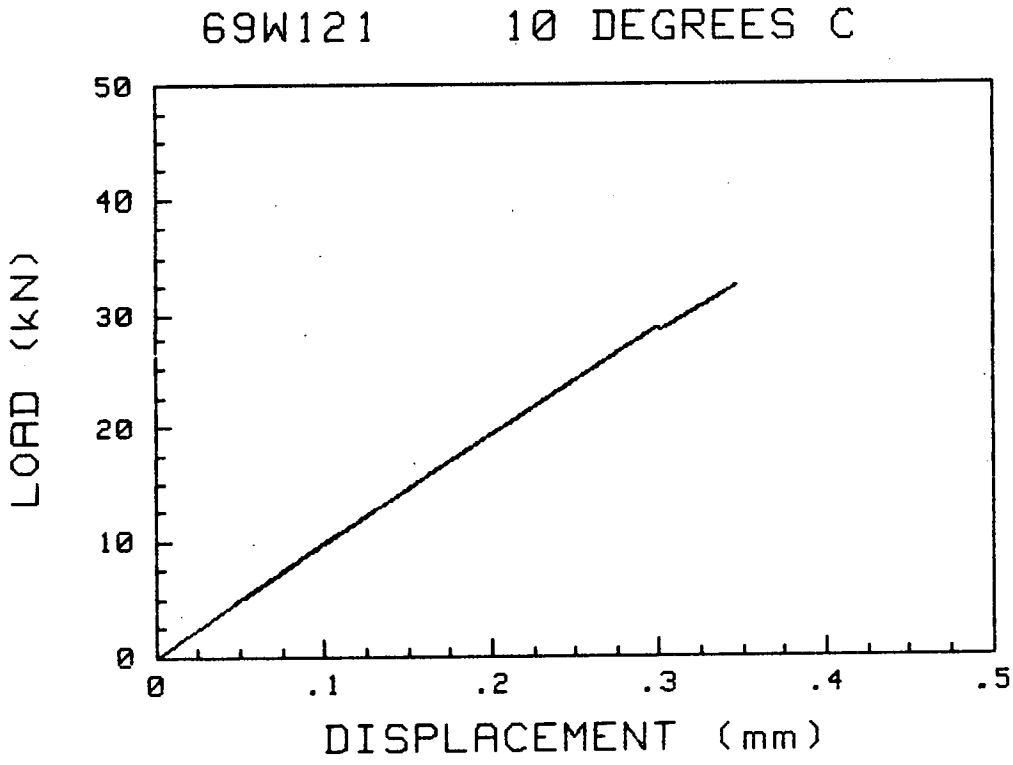
SPECIMEN ID= 69W121
MATERIAL TYPE= A533BW
TEST TEMPERATURE= 10 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.6 mm a/W)i= .603
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 739 MPa
FLOW STRENGTH= 768 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

SPECIMEN CLEAVED AT K = 78.3 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 24.7 kJ/m^2	J-INTEGRAL= 24.7 kJ/m^2
KJc= 71.4 MPa SQR[m]	KJc= 71.4 MPa SQR[m]
K-beta-c= 66.7 MPa SQR[m]	K-beta-c= 66.7 MPa SQR[m]



ORNL-DWG 87-8053



SPECIMEN ID= 69W126
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.3 mm a/W)i= .597
MEASURED DUCTILE DELTA-A= 3.15 mm
YIELD STRENGTH= 675 MPa
FLOW STRENGTH= 712 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 206 kJ/m^2
KJ-MAX LOAD= 203.1 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 124.3 kJ/m^2
K-JIc= 157.8 MPa SQR[m]
POWER= .4793
COEFFICIENT= 247.6 kJ/m^2
T (AVERAGE)= 50

ASTM LINEAR PROCEDURE

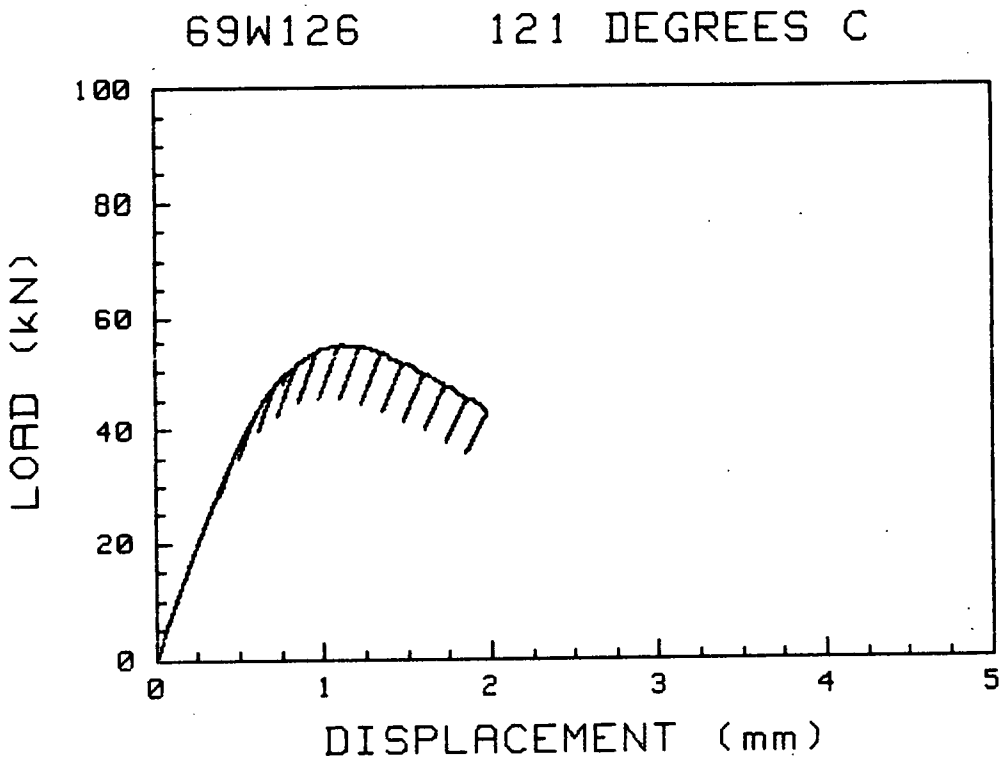
JIc= 105 kJ/m^2
K-JIc= 145 MPa SQR[m]
SLOPE= 144801 kJ/m^3
INTERCEPT= 94.4 kJ/m^2
T (ASTM)= 57
VALID, E813

JI-R CURVE CALCULATIONS

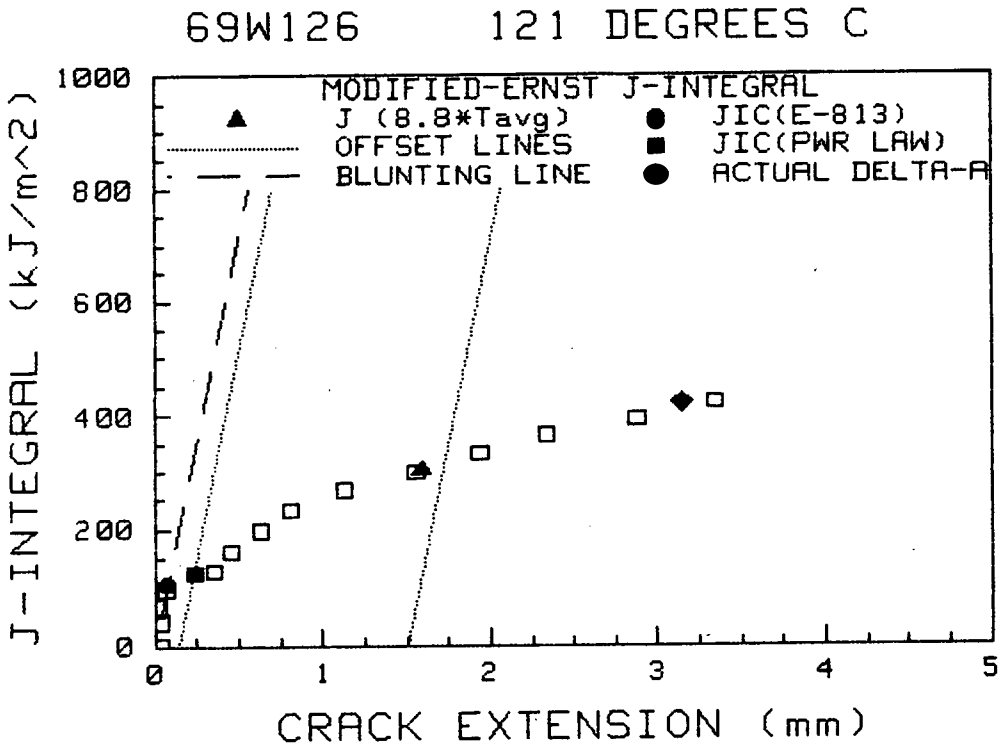
J (@J/T=8.8)= 303.1 kJ/m^2
POWER= .4567
J-MAX ALLOWED= 724.4 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 245.2 kJ/m^2
DELTA-A MAX ALLOWED= 2.05 mm

ORNL-DWG 87-8054



ORNL-DWG 87-8055

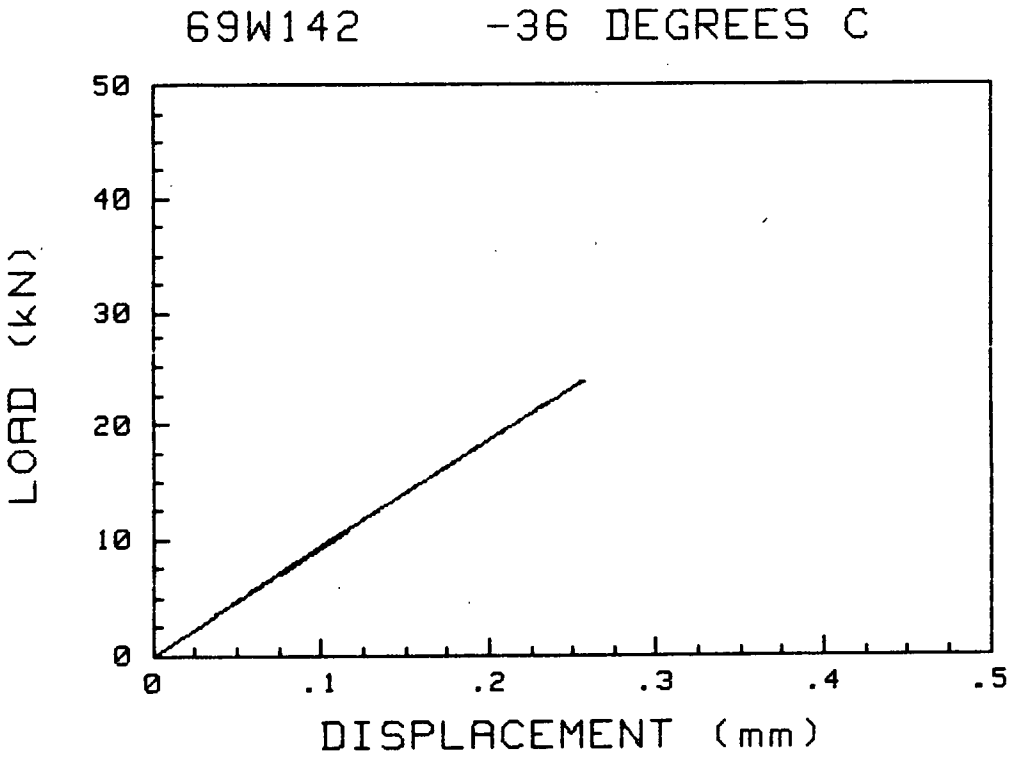


SPECIMEN ID= 69W142
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -36 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.1 mm a/W)i= .594
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 785 MPa
FLOW STRENGTH= 813 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT KIc= 55 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 12.9 kJ/m^2	J-INTEGRAL= 12.9 kJ/m^2
KJc= 52 MPa SQR[m]	KJc= 52 MPa SQR[m]
K-beta-c= 51.1 MPa SQR[m]	K-beta-c= 51.1 MPa SQR[m]

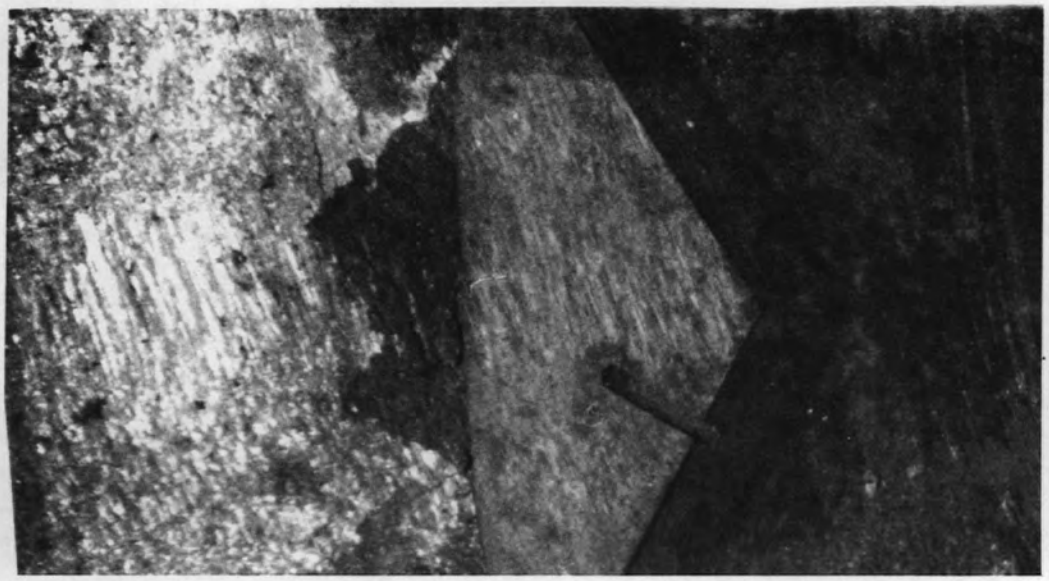
ORNL-DWG 87-8056



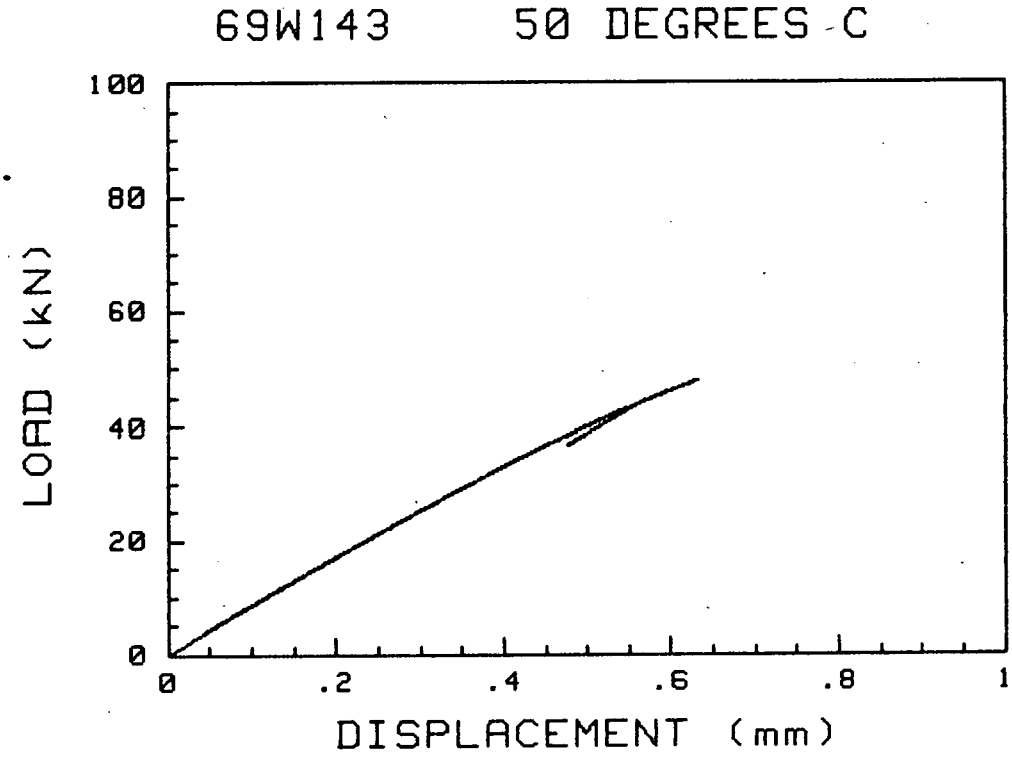
SPECIMEN ID= 69W143
MATERIAL TYPE= A533BW
TEST TEMPERATURE= 50 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.3 mm a/W)i= .597
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 703 MPa
FLOW STRENGTH= 739 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN CLEAVED AT K = 112.6 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 68.5 kJ/m^2	J-INTEGRAL= 68.5 kJ/m^2
KJc= 118.3 MPa SQR[m]	KJc= 118.3 MPa SQR[m]
K-beta-c= 92.3 MPa SQR[m]	K-beta-c= 92.3 MPa SQR[m]



ORNL-DWG 87-8057



SPECIMEN ID= 69W144
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.9 mm a/W)i= .608
MEASURED DUCTILE DELTA-A= 2.17 mm
YIELD STRENGTH= 653 MPa
FLOW STRENGTH= 704 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

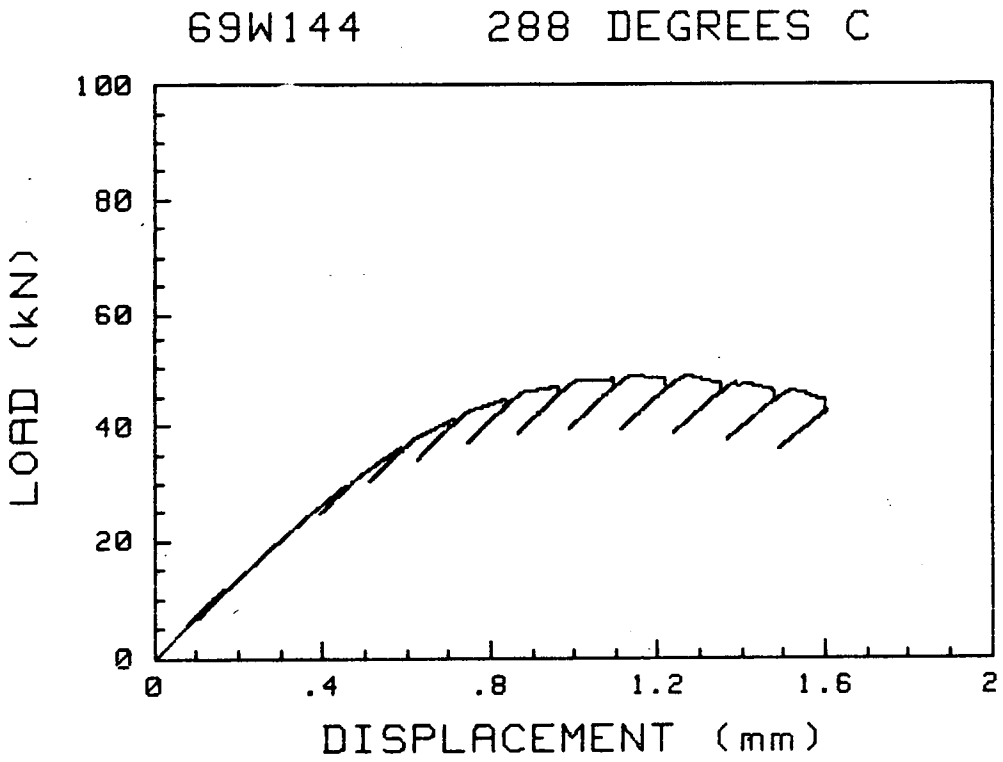
SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 190.9 kJ/m^2
KJ-MAX LOAD= 190.9 MPa SQR[m]

POWER LAW PROCEDURE	ASTM LINEAR PROCEDURE
JIc= 118.8 kJ/m^2	JIc= 97.6 kJ/m^2
K-JIc= 150.6 MPa SQR[m]	K-JIc= 136.4 MPa SQR[m]
POWER= .4537	SLOPE= 131858 kJ/m^3
COEFFICIENT= 229.5 kJ/m^2	INTERCEPT= 88.4 kJ/m^2
T (AVERAGE)= 43	T (ASTM)= 51
	VALID, E813

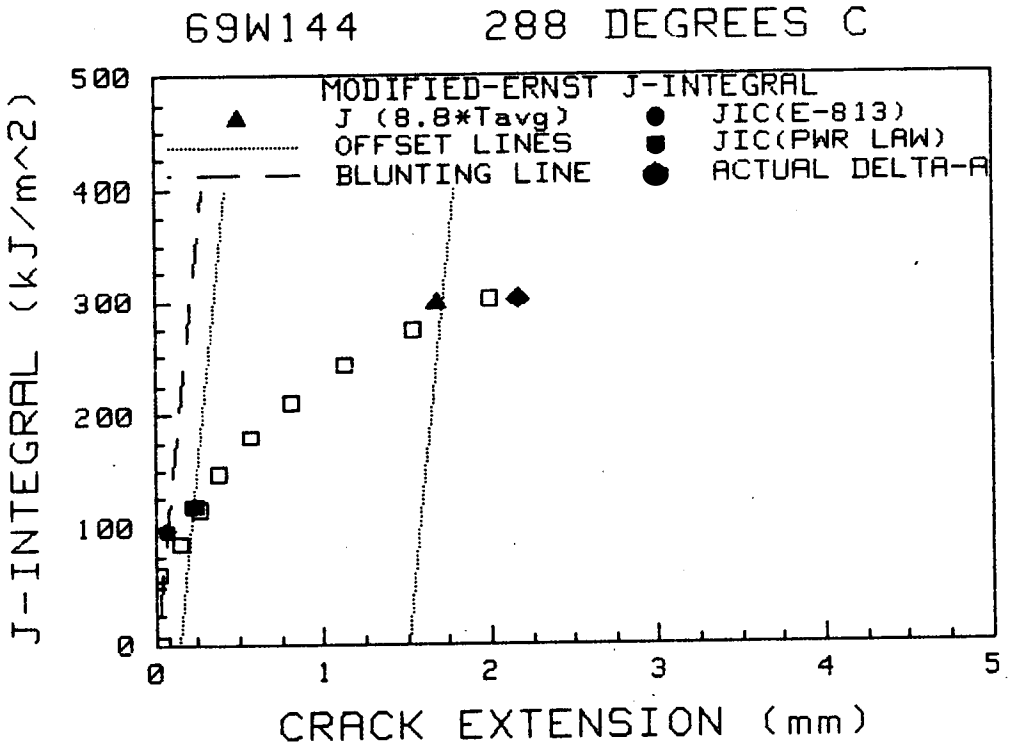
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 297.4 kJ/m^2	
POWER= .4973	COEFFICIENT= 229.6 kJ/m^2
J-MAX ALLOWED= 701.9 kJ/m^2	DELTA-A MAX ALLOWED= 1.99 mm
RCURVE INVALID, 2	

ORNL-DWG 87-8058



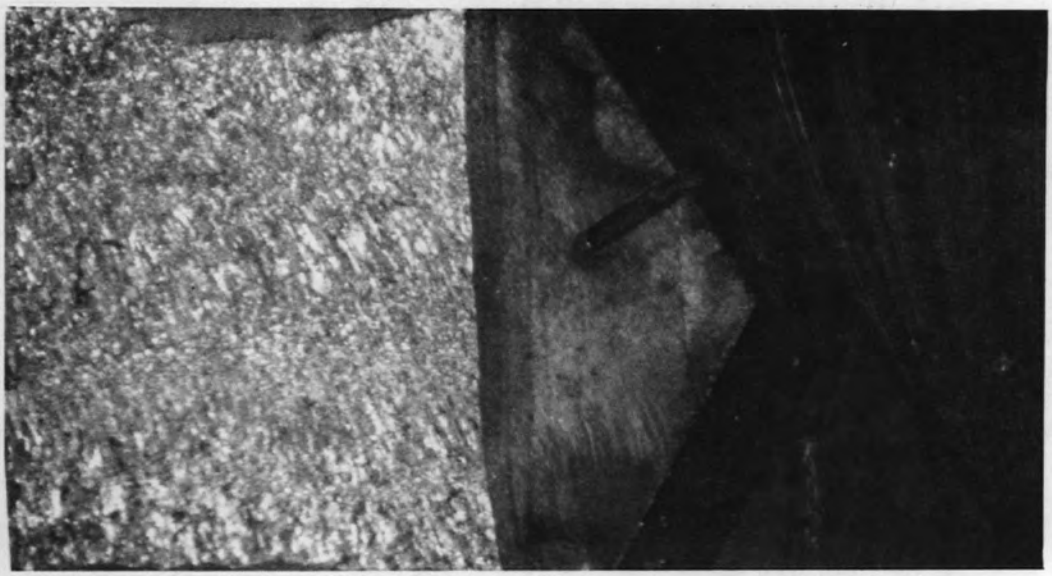
ORNL-DWG 87-8059



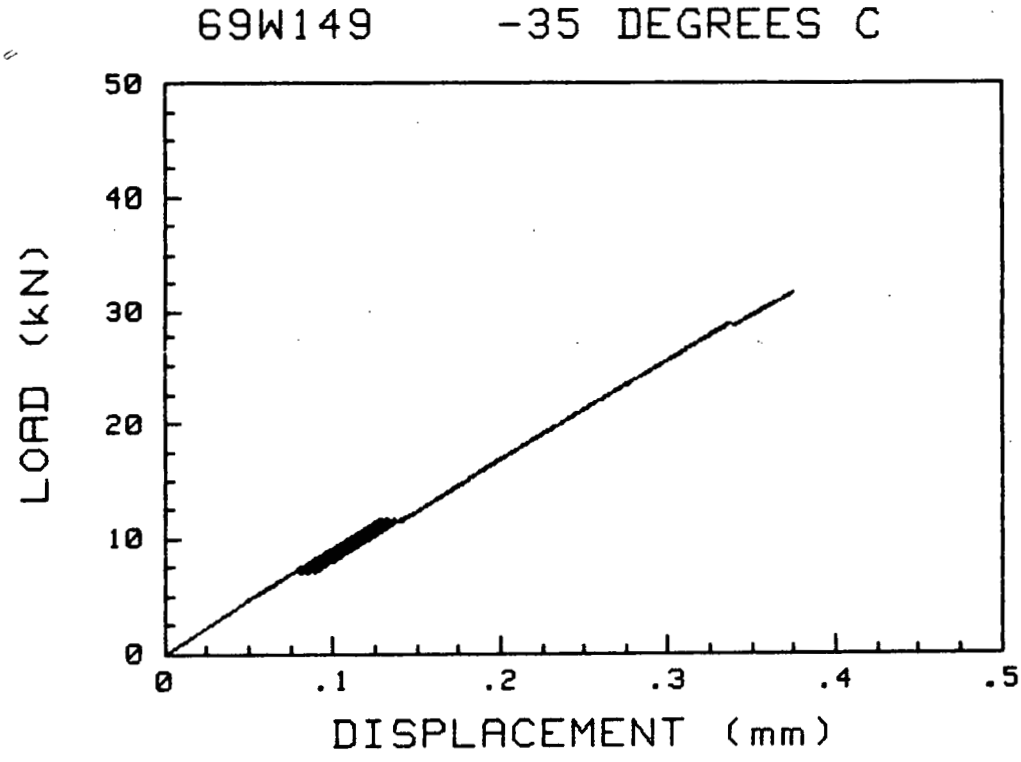
SPECIMEN ID= 69W149
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -35 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 29.5 mm a/W)i= .581
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 784 MPa
FLOW STRENGTH= 812 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT KIc= 69.8 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 24.1 kJ/m^2	J-INTEGRAL= 24.1 kJ/m^2
KJc= 71.1 MPa SQR[m]	KJc= 71.1 MPa SQR[m]
K-beta-c= 67.2 MPa SQR[m]	K-beta-c= 67.2 MPa SQR[m]



ORNL-DWG 87-8060



SPECIMEN ID= 69W153
TEST TEMPERATURE= 204 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.8 mm a/W)i= .606
MEASURED DUCTILE DELTA-A= 2.26 mm
YIELD STRENGTH= 656 MPa
FLOW STRENGTH= 698 MPa
ESTIMATED YOUNG'S MODULUS= 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 195.8 kJ/m^2
KJ-MAX LOAD= 195.7 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 156.8 kJ/m^2
K-JIc= 175.1 MPa SQR[m]
POWER= .4002
COEFFICIENT= 267.9 kJ/m^2
T (AVERAGE)= 46

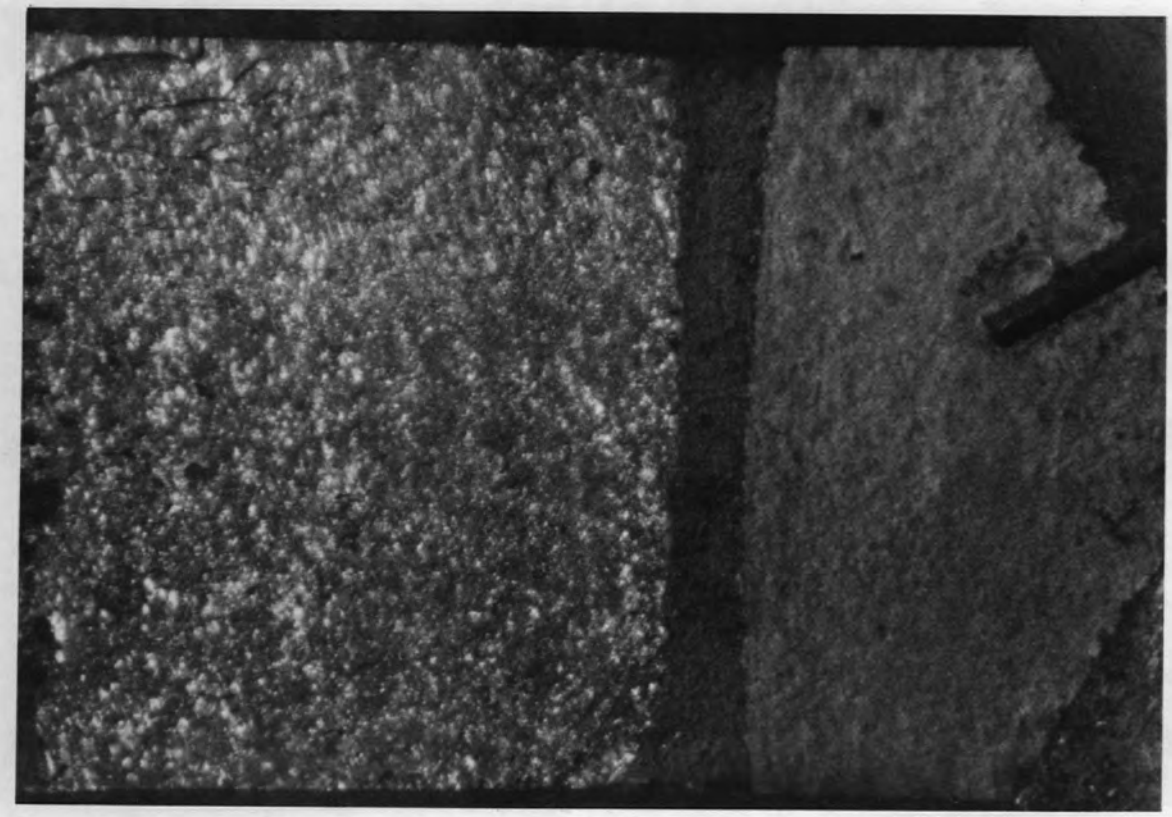
ASTM LINEAR PROCEDURE

JIc= 134.4 kJ/m^2
K-JIc= 162.1 MPa SQR[m]
SLOPE= 138378 kJ/m^3
INTERCEPT= 121.1 kJ/m^2
T (ASTM)= 56
VALID, E813

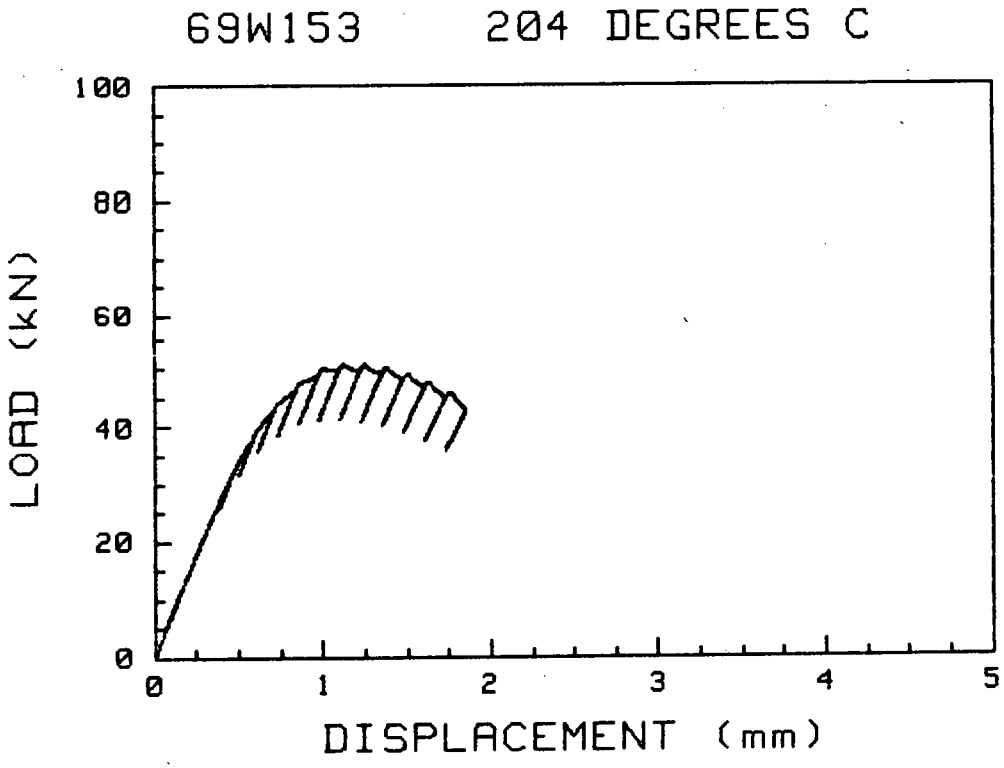
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 296.2 kJ/m^2
POWER= .3772
J-MAX ALLOWED= 698.2 kJ/m^2
RCURVE INVALID, 2

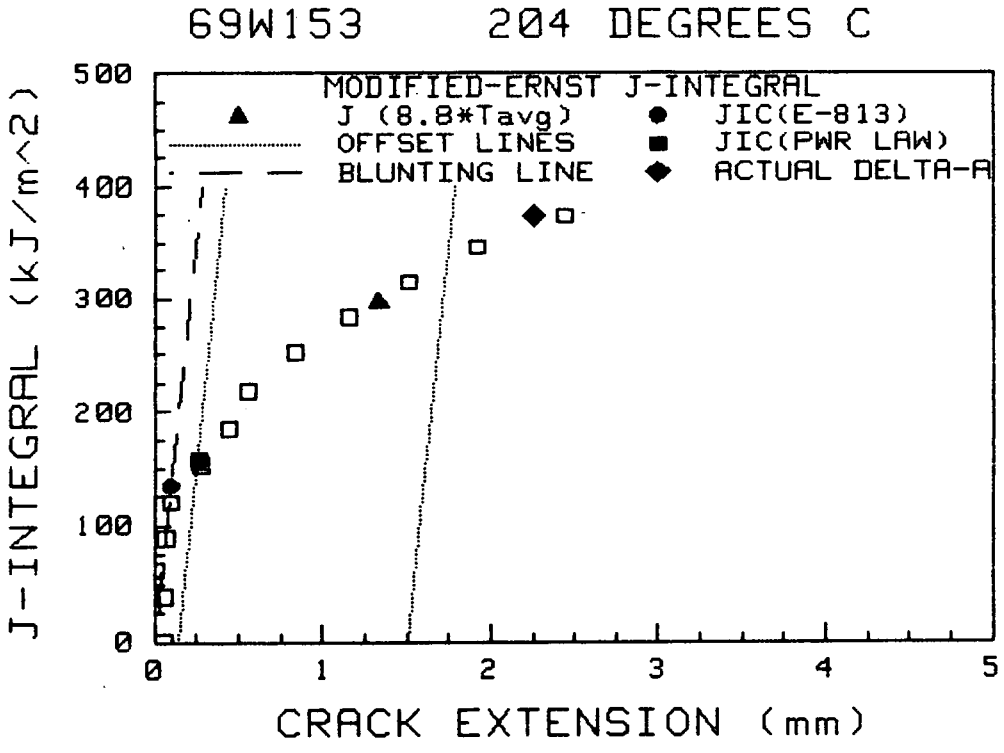
COEFFICIENT= 265.8 kJ/m^2
DELTA-A MAX ALLOWED= 2 mm



ORNL-DWG 87-8061



ORNL-DWG 87-8062



SPECIMEN ID= 69W160
TEST TEMPERATURE= 204 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.5 mm a/W)i= .602
MEASURED DUCTILE DELTA-A= 2.08 mm
YIELD STRENGTH= 656 MPa
FLOW STRENGTH= 698 MPa
ESTIMATED YOUNG'S MODULUS= 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 194.9 kJ/m^2
KJ-MAX LOAD= 195.2 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 125.9 kJ/m^2
K-JIc= 156.9 MPa SQR[m]
POWER= .4538
COEFFICIENT= 240.5 kJ/m^2
T (AVERAGE)= 47

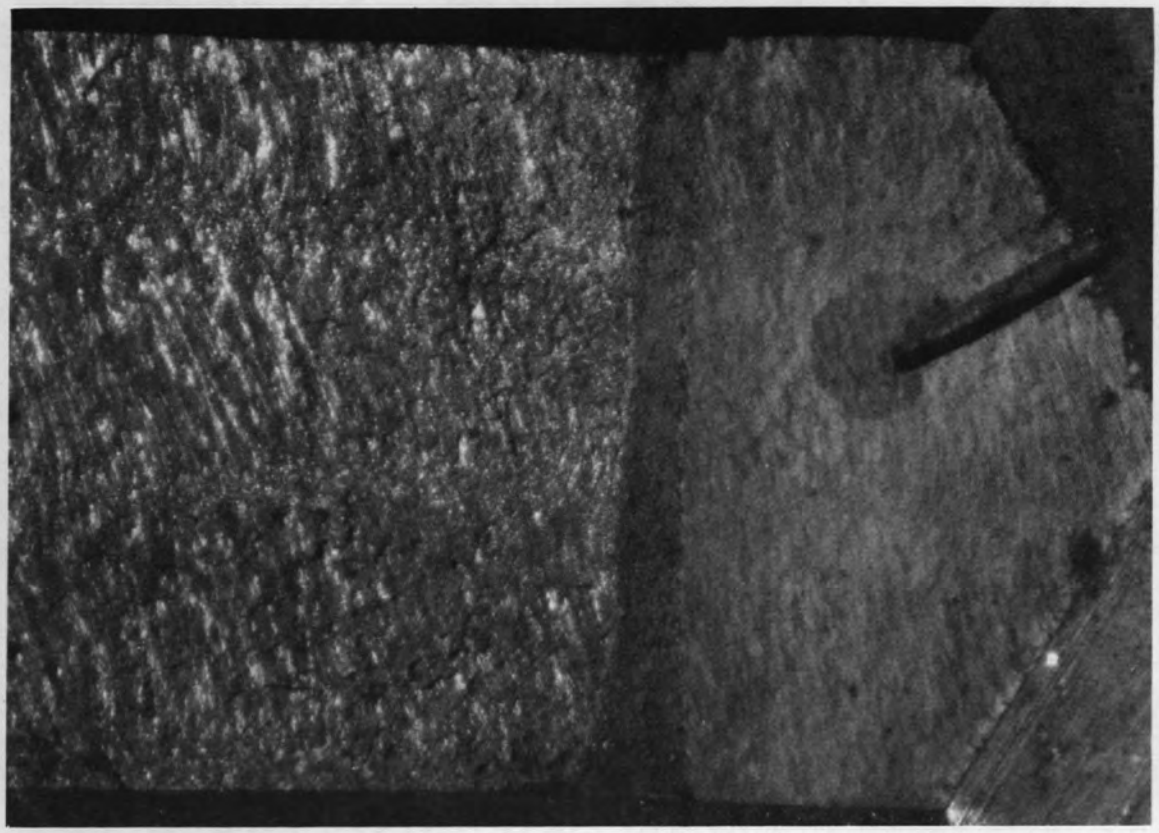
ASTM LINEAR PROCEDURE

JIc= 112.8 kJ/m^2
K-JIc= 148.5 MPa SQR[m]
SLOPE= 134035 kJ/m^3
INTERCEPT= 102 kJ/m^2
T (ASTM)= 54
VALID, E813

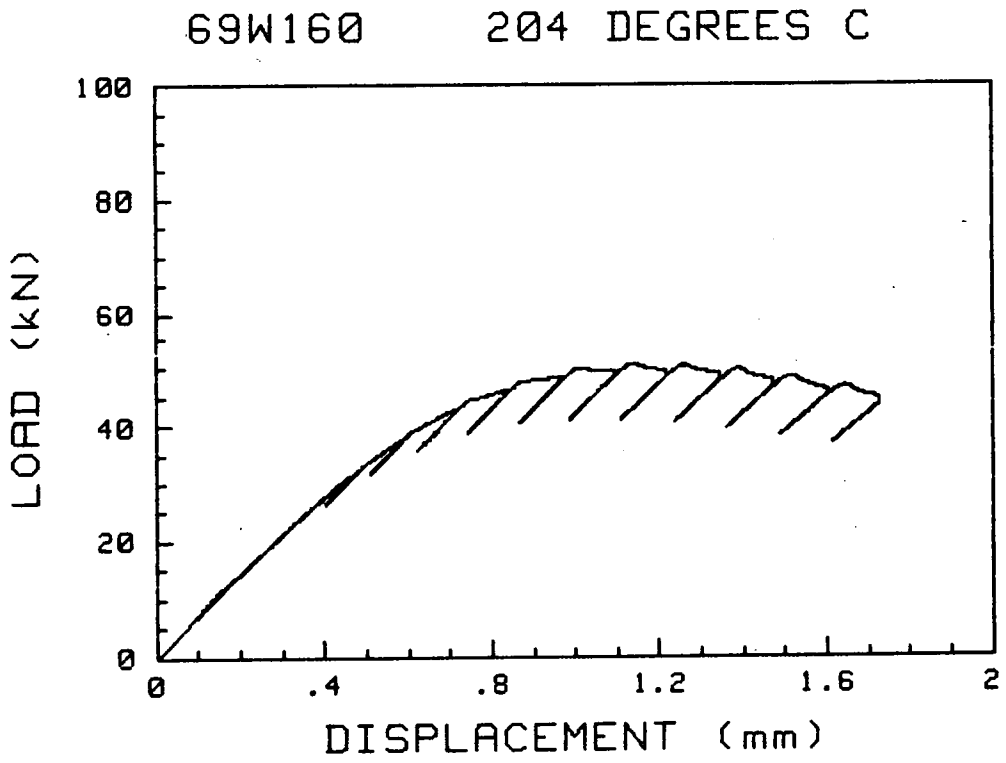
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 298.1 kJ/m^2
POWER= .4537
J-MAX ALLOWED= 705.7 kJ/m^2
RCURVE INVALID, 2

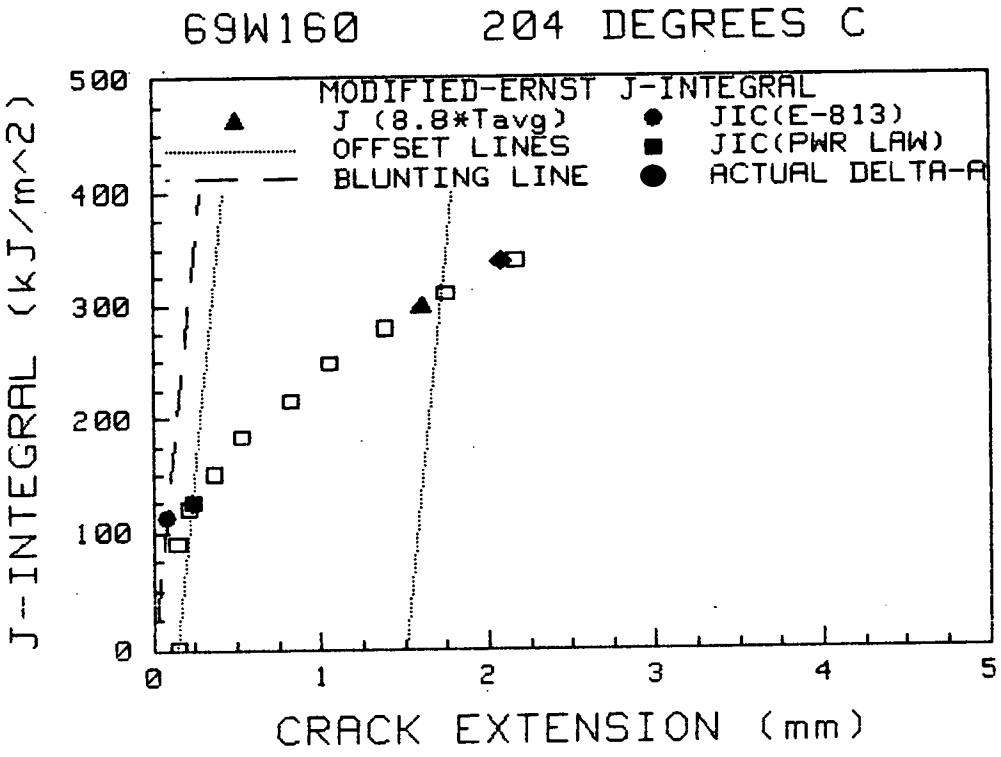
COEFFICIENT= 240.6 kJ/m^2
DELTA-A MAX ALLOWED= 2.02 mm



ORNL-DWG 87-8063



ORNL-DWG 87-8064



SPECIMEN ID= 69W165
TEST TEMPERATURE= 50 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.1 mm a/W)i= .592
MEASURED DUCTILE DELTA-A= 2.26 mm
YIELD STRENGTH= 703 MPa
FLOW STRENGTH= 739 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 191.2 kJ/m^2
KJ-MAX LOAD= 197.7 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 94.1 kJ/m^2
K-JIc= 138.7 MPa SQR[m]
POWER= .6252
COEFFICIENT= 247 kJ/m^2
T (AVERAGE)= 61

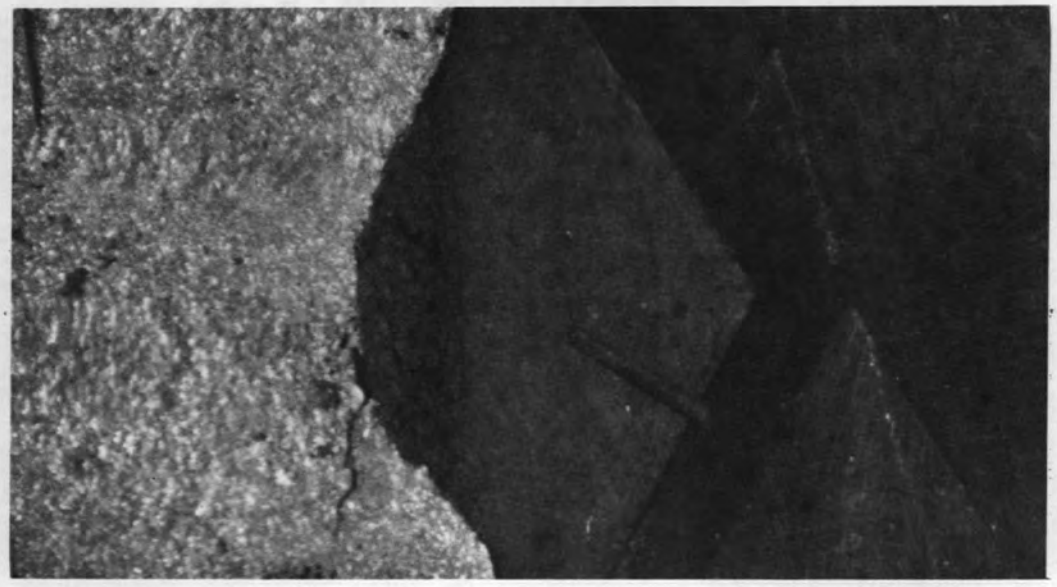
ASTM LINEAR PROCEDURE

JIc= 74.5 kJ/m^2
K-JIc= 123.4 MPa SQR[m]
SLOPE= 174054 kJ/m^3
INTERCEPT= 65.7 kJ/m^2
T (ASTM)= 65
VALID, E813

JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 411.6 kJ/m^2
POWER= .6547
J-MAX ALLOWED= 767.3 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 249.1 kJ/m^2
DELTA-A MAX ALLOWED= 2.08 mm



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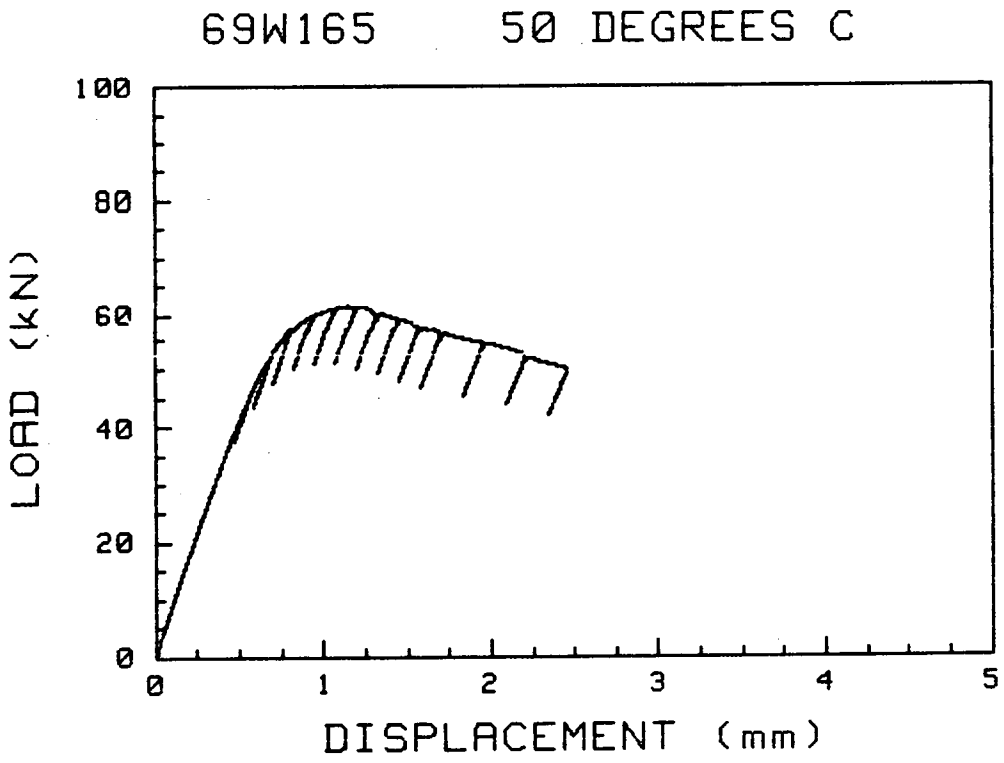
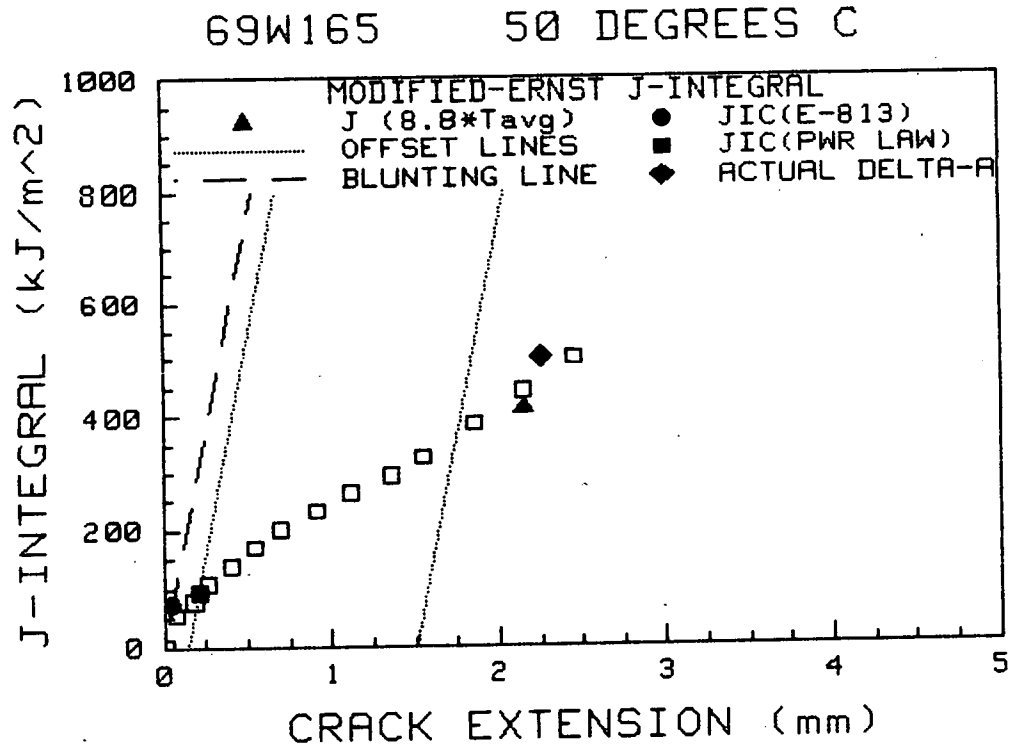


ORNL-DWG 87-8066



SPECIMEN ID= 69W167
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 30.6 mm a/W)i= .602
MEASURED DUCTILE DELTA-A= 2 mm
YIELD STRENGTH= 653 MPa
FLOW STRENGTH= 704 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 190.6 kJ/m^2
KJ-MAX LOAD= 190.7 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 148 kJ/m^2
K-JIc= 168 MPa SQR[m]
POWER= .3378
COEFFICIENT= 234.8 kJ/m^2
T (AVERAGE)= 33

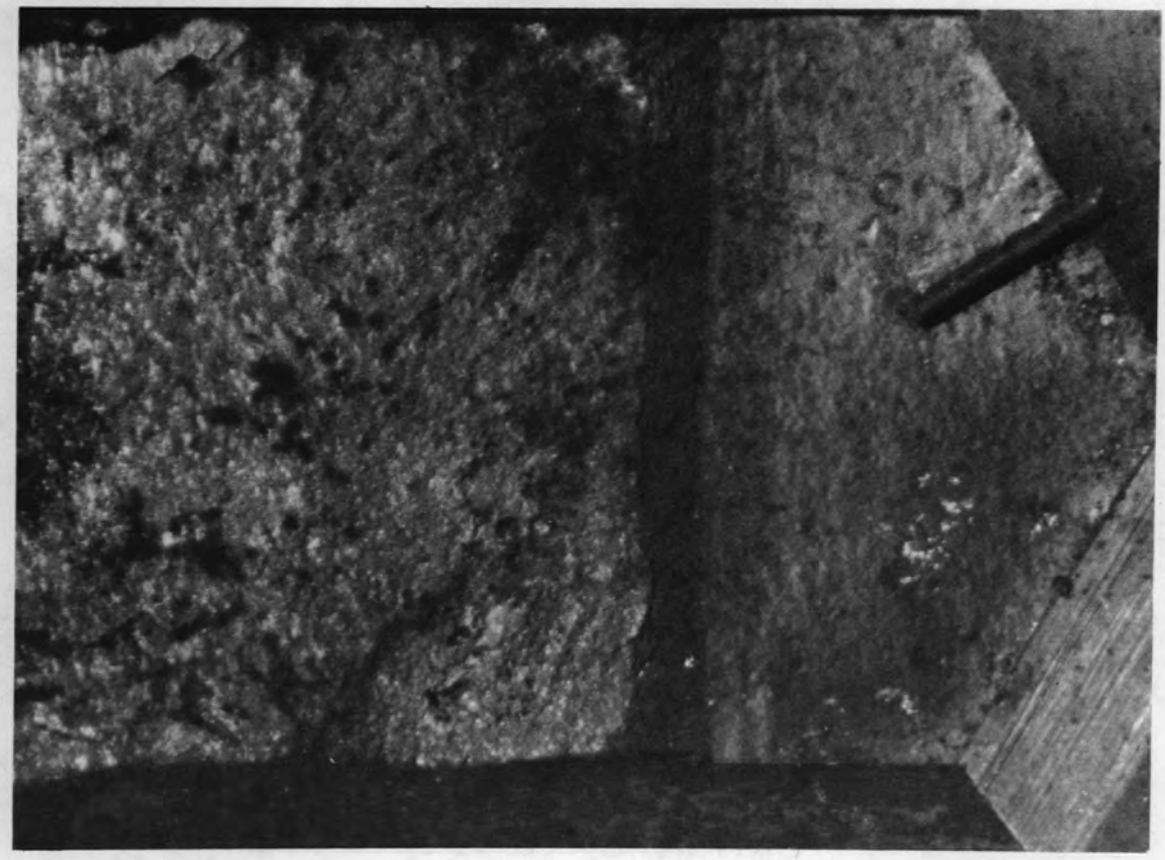
ASTM LINEAR PROCEDURE

JIc= 132 kJ/m^2
K-JIc= 158.7 MPa SQR[m]
SLOPE= 104737 kJ/m^3
INTERCEPT= 122.2 kJ/m^2
T (ASTM)= 40
VALID, E813

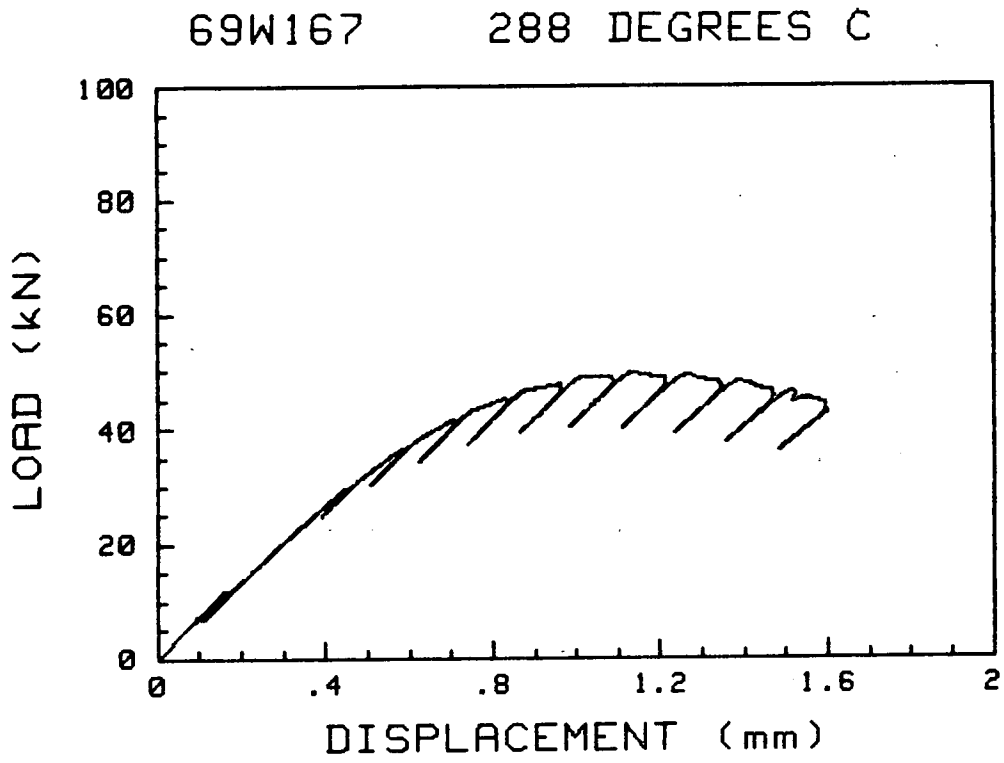
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 238.1 kJ/m^2
POWER= .303
J-MAX ALLOWED= 712.1 kJ/m^2
RCURVE INVALID, 2

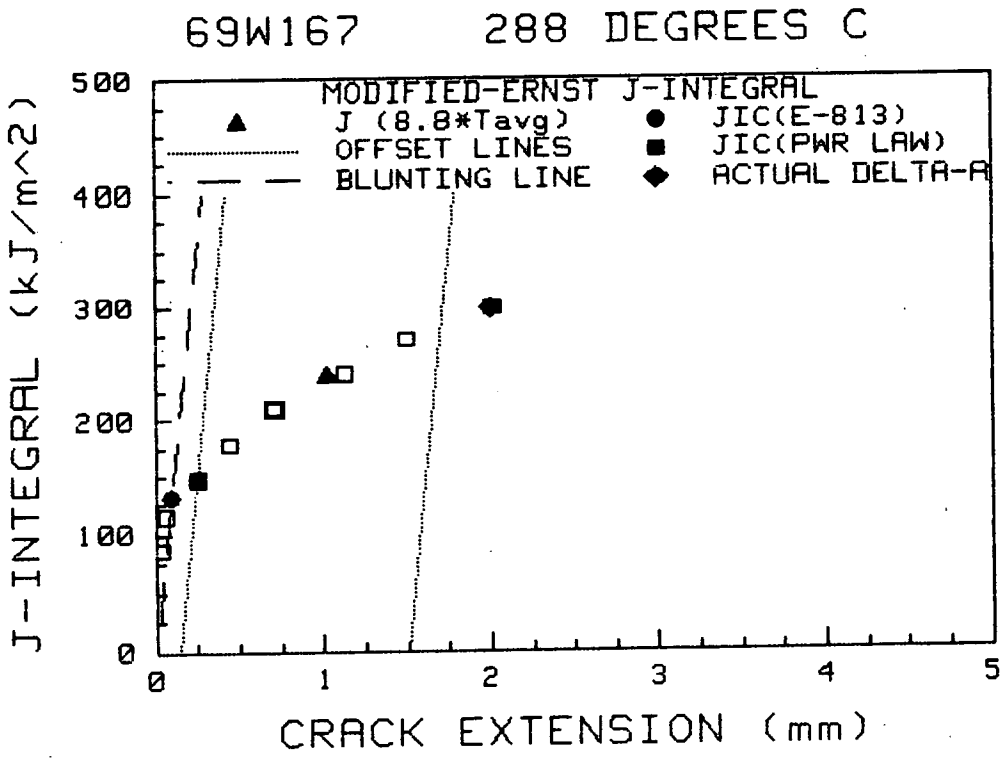
COEFFICIENT= 236.3 kJ/m^2
DELTA-A MAX ALLOWED= 2.02 mm



ORNL-DWG 87-8067



ORNL-DWG 87-8068



SPECIMEN ID= 69W172
TEST TEMPERATURE= 50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 29 mm a/W)i= .572
MEASURED DUCTILE DELTA-A= .64 mm
YIELD STRENGTH= 703 MPa
FLOW STRENGTH= 739 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN CLEAVED AT K = 128.7 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 183.2 kJ/m^2
KJc= 193.5 MPa SQR[m]
K-beta-c= 117.7 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 186.4 kJ/m^2
KJc= 195.2 MPa SQR[m]
K-beta-c= 118.2 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 141.2 kJ/m^2
K-JIc= 169.9 MPa SQR[m]
POWER= .5859
COEFFICIENT= 321.6 kJ/m^2
T (AVERAGE)= 73

ASTM LINEAR PROCEDURE

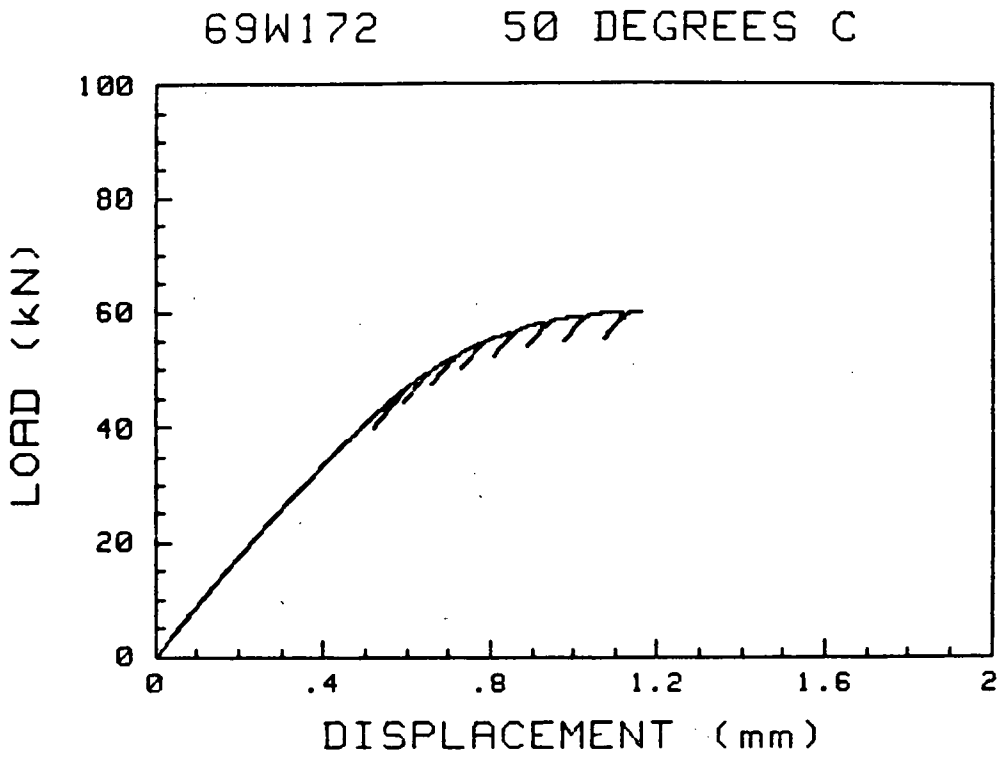
JIc= 0 kJ/m^2
K-JIc= 0 MPa SQR[m]
SLOPE= 0 kJ/m^3
INTERCEPT= 0 kJ/m^2
T (ASTM)= 0
INVALID, 1 6

JI-R CURVE CALCULATIONS

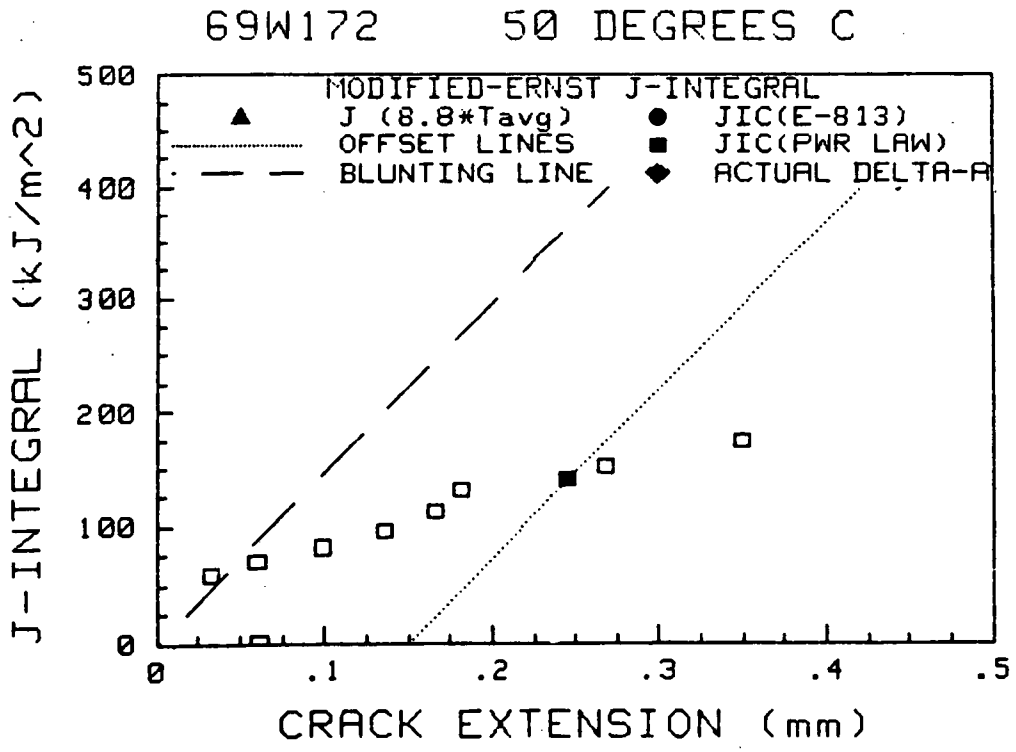
J (@J/T=8.8)= 318.7 kJ/m^2
POWER= .4342
J-MAX ALLOWED= 803 kJ/m^2
RCURVE INVALID, 2 3

COEFFICIENT= 273.1 kJ/m^2
DELTA-A MAX ALLOWED= 2.17 mm

ORNL-DWG 87-8069



ORNL-DWG 87-8070

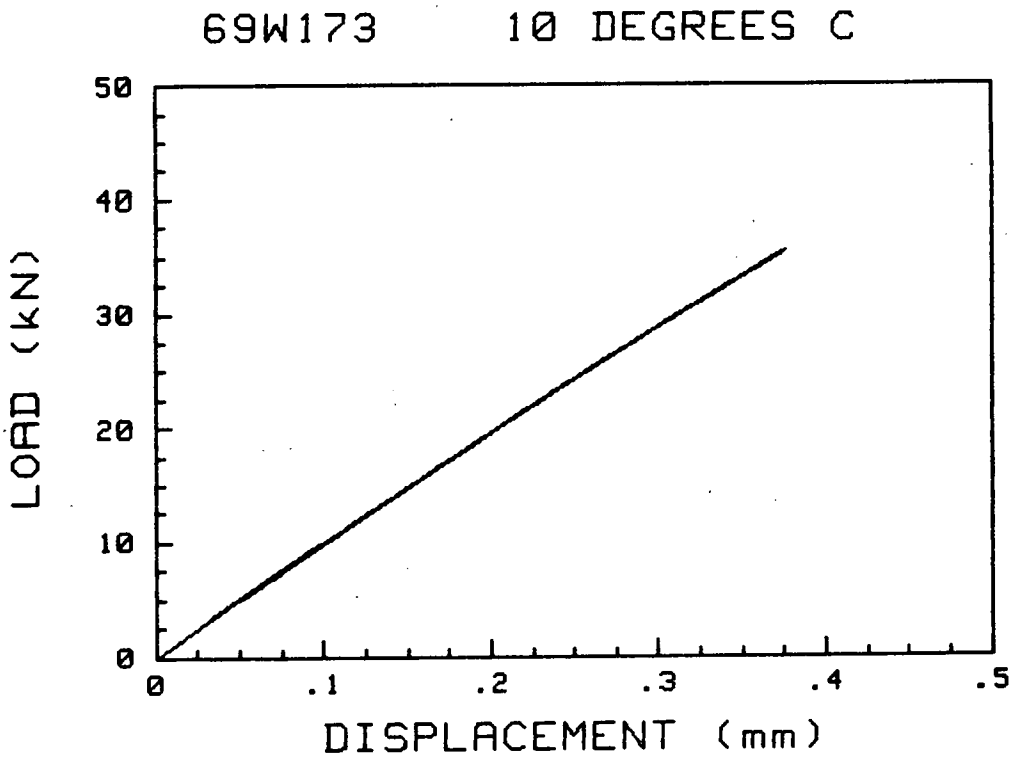


SPECIMEN ID= 69W173
MATERIAL TYPE= A533BW
TEST TEMPERATURE= 10 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.7 mm a/W)i= .604
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 739 MPa
FLOW STRENGTH= 768 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

SPECIMEN CLEAVED AT K = 85.9 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 29.5 kJ/m^2	J-INTEGRAL= 29.5 kJ/m^2
KJc= 78.1 MPa SQR[m]	KJc= 78.1 MPa SQR[m]
K-beta-c= 71.6 MPa SQR[m]	K-beta-c= 71.6 MPa SQR[m]

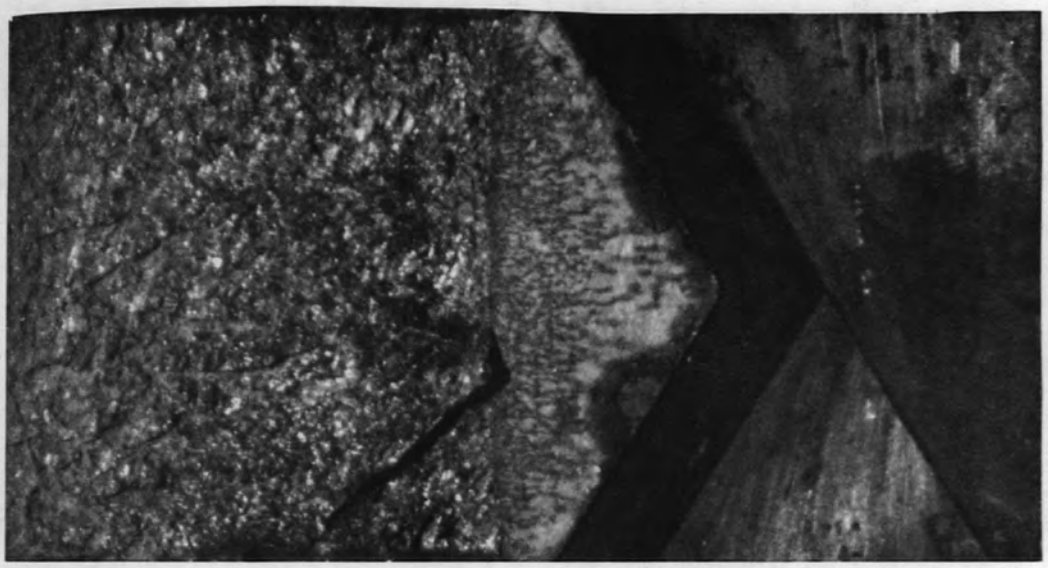
ORNL-DWG 87-8071



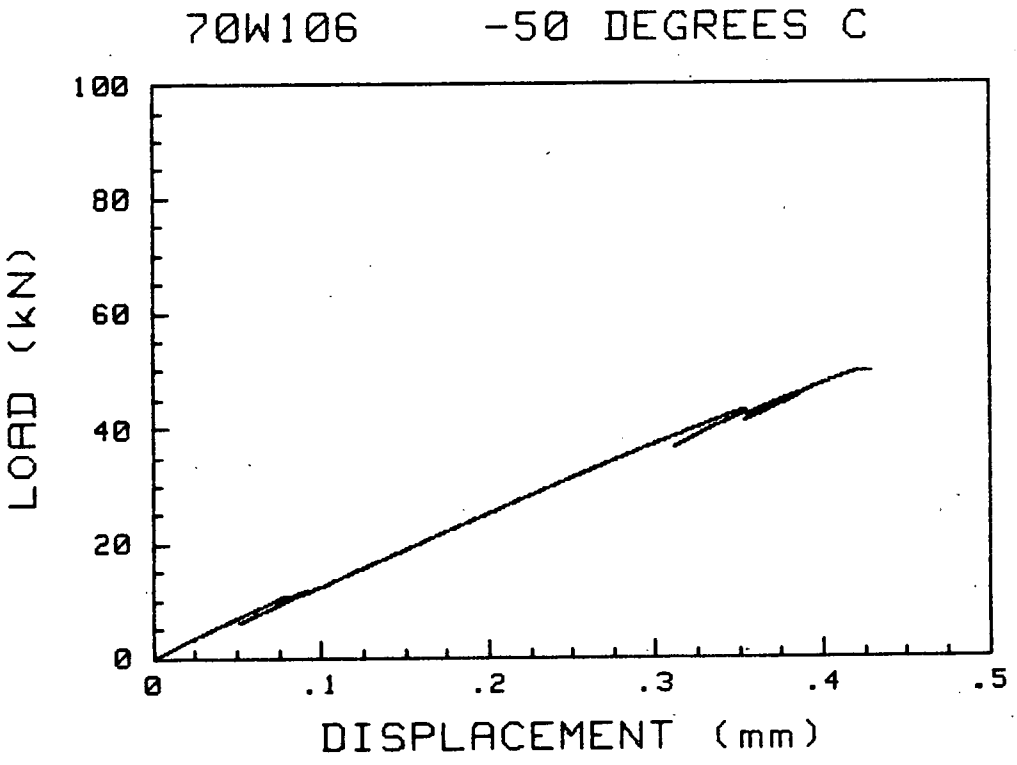
SPECIMEN ID= 70W106
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.7 mm a/W)i= .544
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 603 MPa
FLOW STRENGTH= 660 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

SPECIMEN CLEAVED AT K = 96.8 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 39.6 kJ/m^2	J-INTEGRAL= 42.7 kJ/m^2
KJc= 91.2 MPa SQR[m]	KJc= 94.7 MPa SQR[m]
K-beta-c= 74.4 MPa SQR[m]	K-beta-c= 76.1 MPa SQR[m]



ORNL-DWG 87-8072



SPECIMEN ID= 70W107
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 27.9 mm a/W)i= .549
MEASURED DUCTILE DELTA-A= 2.05 mm
YIELD STRENGTH= 469 MPa
FLOW STRENGTH= 543 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 163 kJ/m^2
KJ-MAX LOAD= 176.3 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 113.1 kJ/m^2
K-JIc= 146.9 MPa SQR[m]
POWER= .3772
COEFFICIENT= 189.6 kJ/m^2
T (AVERAGE)= 50

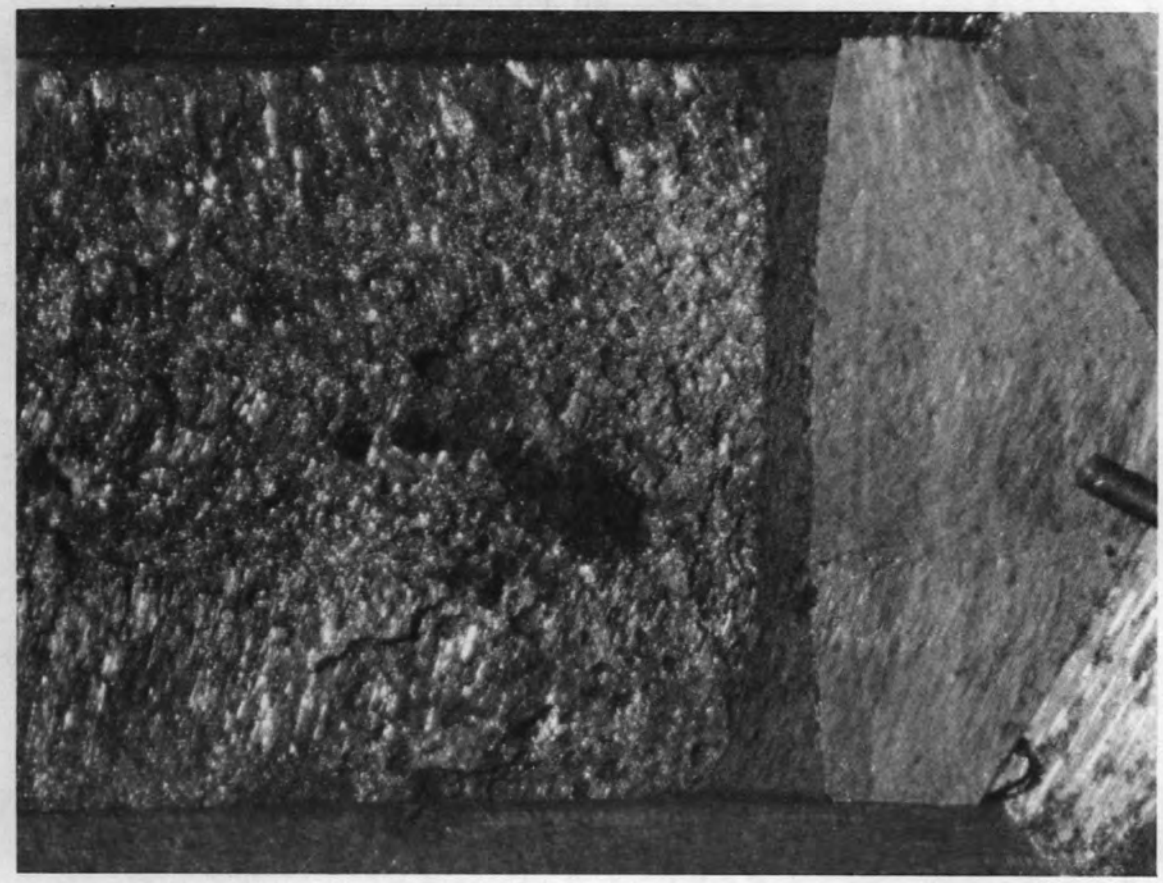
ASTM LINEAR PROCEDURE

JIc= 97 kJ/m^2
K-JIc= 136 MPa SQR[m]
SLOPE= 97489 kJ/m^3
INTERCEPT= 88.3 kJ/m^2
T (ASTM)= 63
INVALID, 6

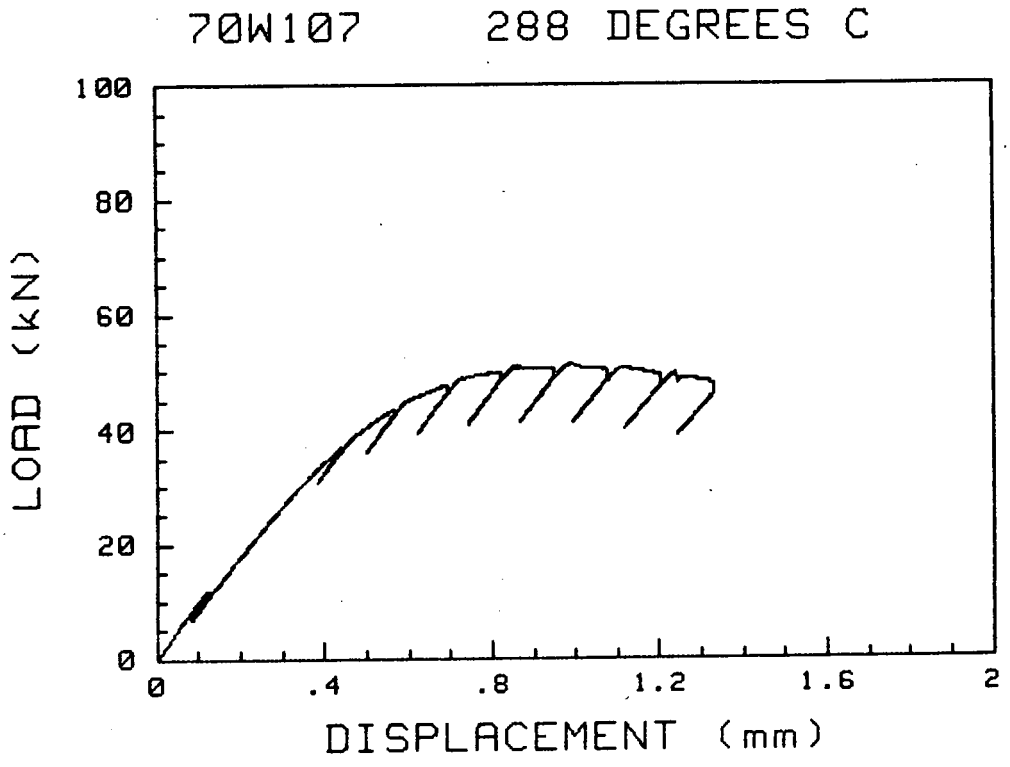
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 251.4 kJ/m^2
POWER= .3727
J-MAX ALLOWED= 551.3 kJ/m^2
RCURVE INVALID, 2 3

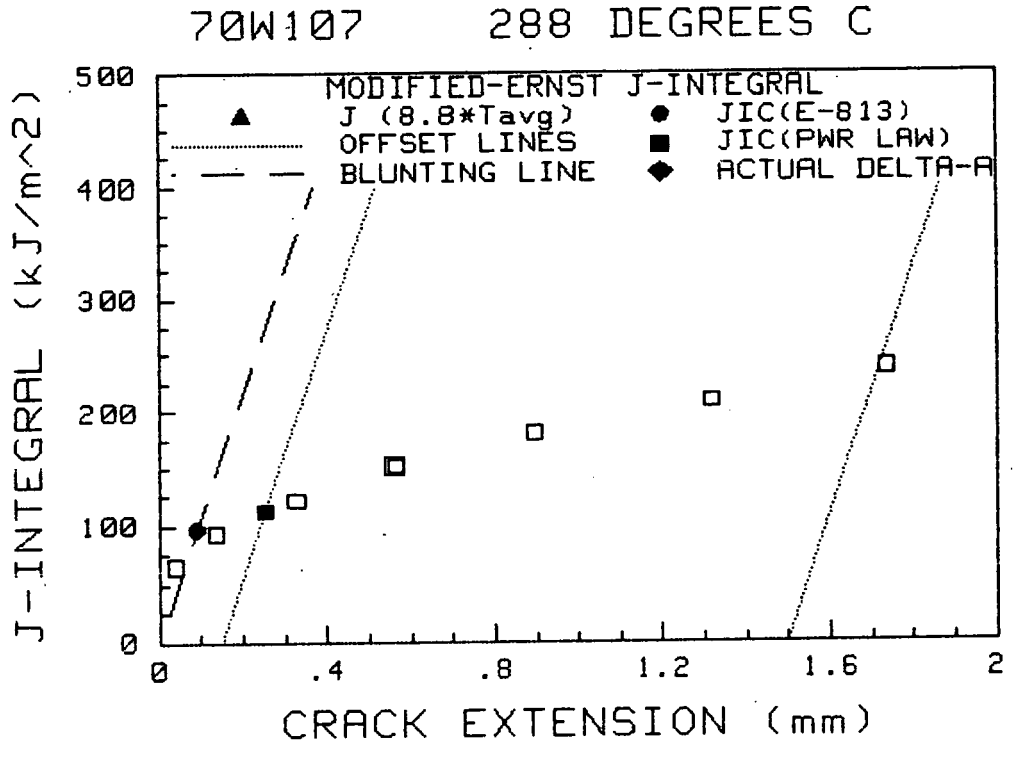
COEFFICIENT= 189.8 kJ/m^2
DELTA-A MAX ALLOWED= 2.29 mm



ORNL-DWG 87-8073



ORNL-DWG 87-8074



SPECIMEN ID= 70W108
TEST TEMPERATURE= 204 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 28 mm a/W)i= .551
MEASURED DUCTILE DELTA-A= 2.05 mm
YIELD STRENGTH= 477 MPa
FLOW STRENGTH= 535 MPa
ESTIMATED YOUNG'S MODULUS= 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 196.5 kJ/m^2
KJ-MAX LOAD= 196 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 132.9 kJ/m^2
K-JIc= 161.2 MPa SQR[m]
POWER= .4716
COEFFICIENT= 244.6 kJ/m^2
T (AVERAGE)= 81

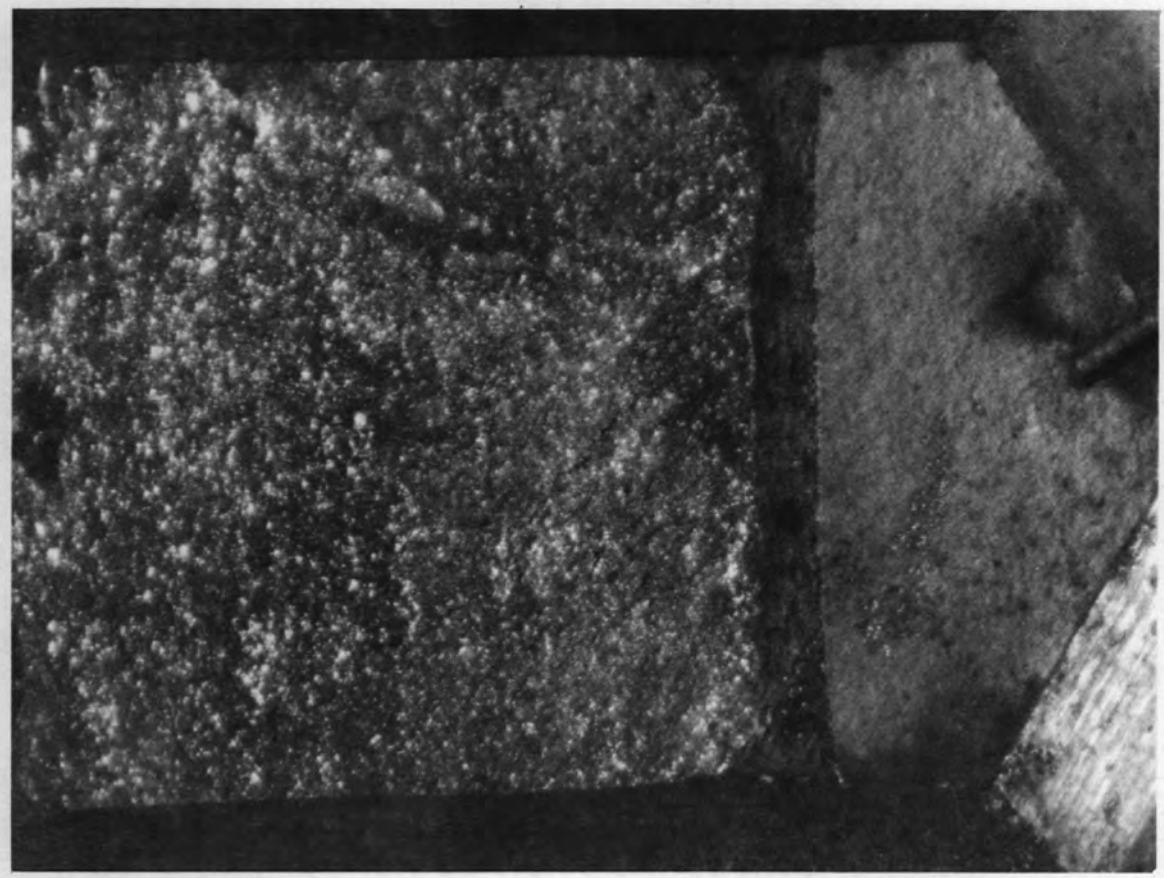
ASTM LINEAR PROCEDURE

JIc= 124.7 kJ/m^2
K-JIc= 156.1 MPa SQR[m]
SLOPE= 125840 kJ/m^3
INTERCEPT= 110 kJ/m^2
T (ASTM)= 86
VALID, E813

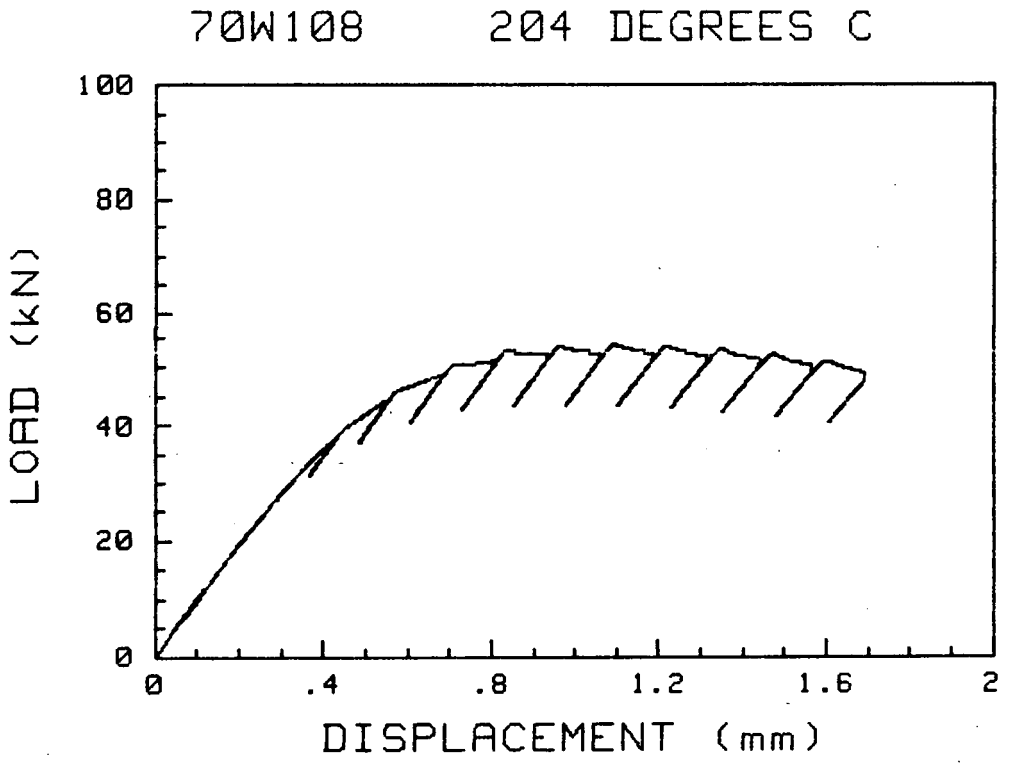
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 384 kJ/m^2
POWER= .4507
J-MAX ALLOWED= 543.9 kJ/m^2
RCURVE INVALID, 2

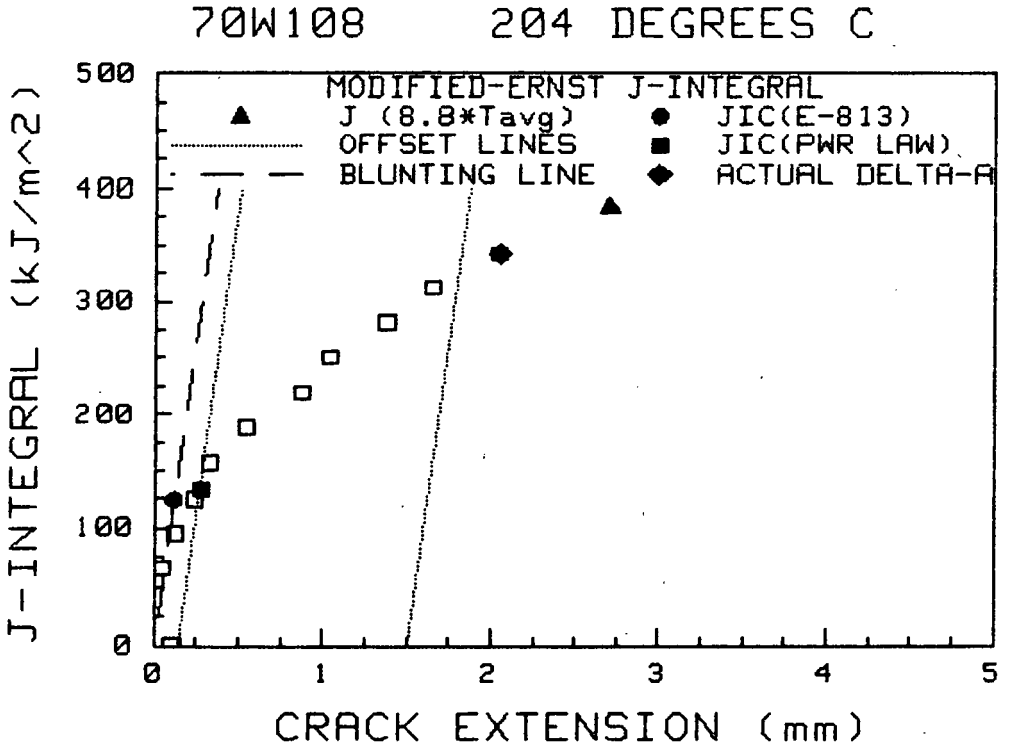
COEFFICIENT= 245.1 kJ/m^2
DELTA-A MAX ALLOWED= 2.28 mm



ORNL-DWG 87-8075



ORNL-DWG 87-8076



SPECIMEN ID= 70W110
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 28 mm a/W)i= .551
MEASURED DUCTILE DELTA-A= 4.35 mm
YIELD STRENGTH= 497 MPa
FLOW STRENGTH= 550 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 204.8 kJ/m^2
KJ-MAX LOAD= 202.5 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 115 kJ/m^2
K-JIc= 151.8 MPa SQR[m]
POWER= .5992
COEFFICIENT= 261.1 kJ/m^2
T (AVERAGE)= 106

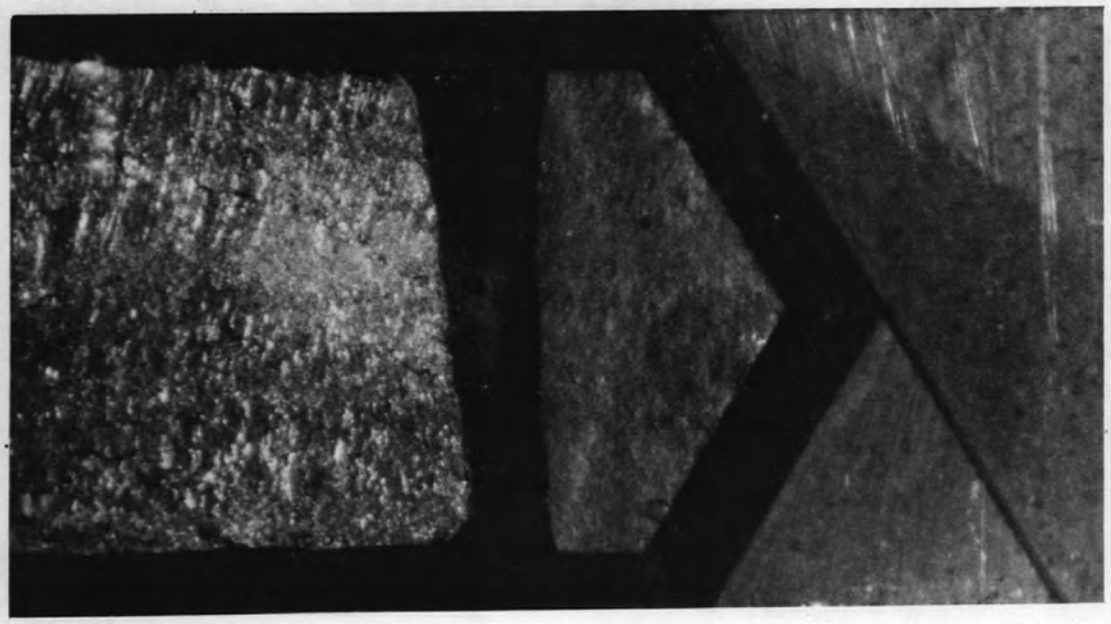
ASTM LINEAR PROCEDURE

JIc= 96.3 kJ/m^2
K-JIc= 138.9 MPa SQR[m]
SLOPE= 169933 kJ/m^3
INTERCEPT= 81.4 kJ/m^2
T (ASTM)= 113
VALID, E813

JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 571.4 kJ/m^2
POWER= .6168
J-MAX ALLOWED= 558.6 kJ/m^2
RCURVE INVALID, 1

COEFFICIENT= 259.4 kJ/m^2
DELTA-A MAX ALLOWED= 2.28 mm



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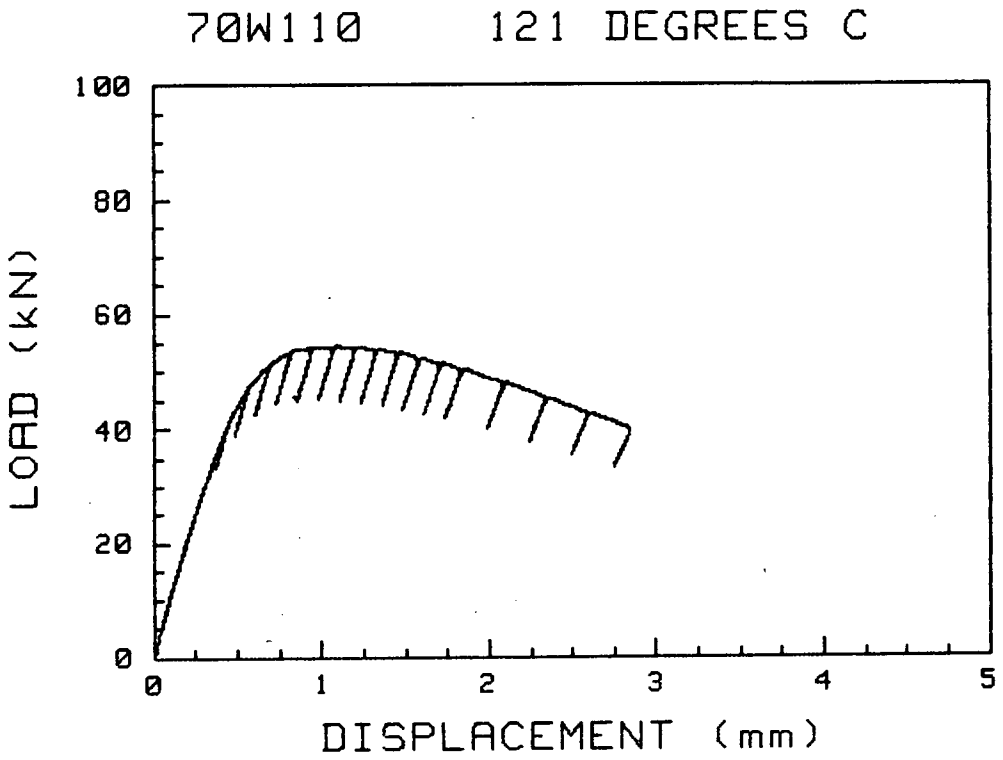
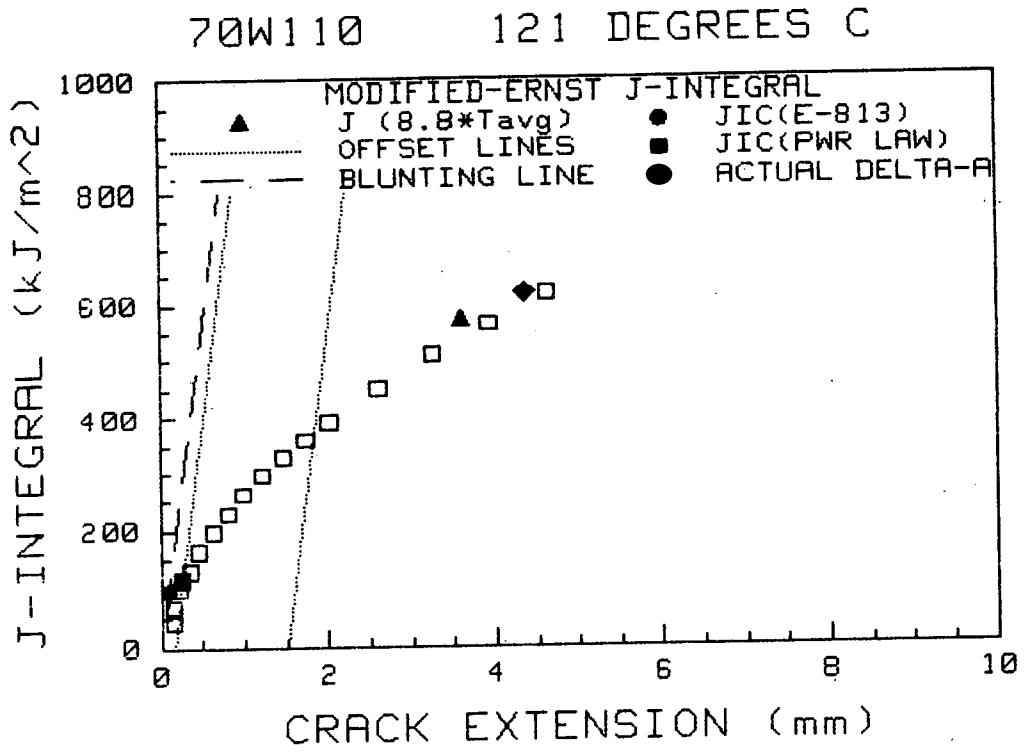


ORNL-DWG 87-8078



SPECIMEN ID= 70W117
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 28 mm a/W)i= .551
MEASURED DUCTILE DELTA-A= 1.83 mm
YIELD STRENGTH= 469 MPa
FLOW STRENGTH= 543 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 164.8 kJ/m^2
KJ-MAX LOAD= 177.3 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 123.4 kJ/m^2
K-JIc= 153.4 MPa SQR[m]
POWER= .4106
COEFFICIENT= 213.3 kJ/m^2
T (AVERAGE)= 60

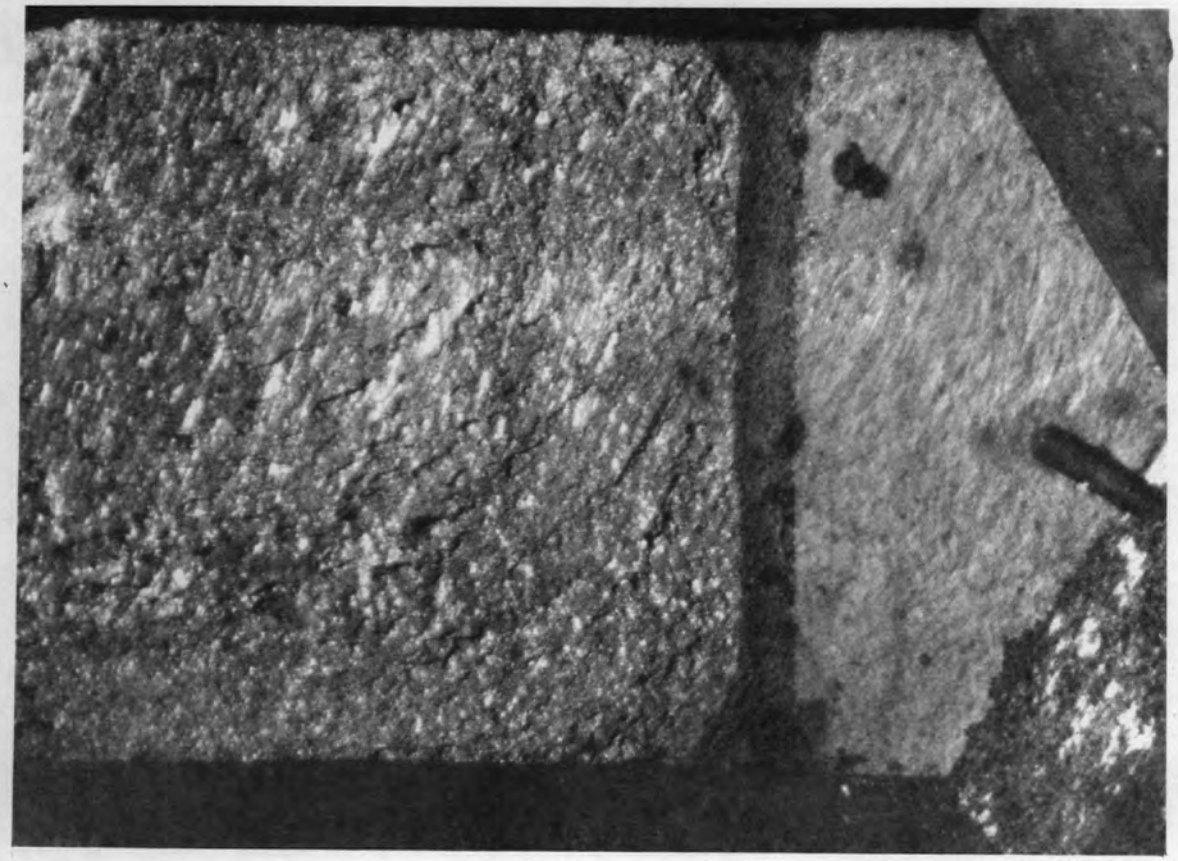
ASTM LINEAR PROCEDURE

JIc= 105 kJ/m^2
K-JIc= 141.5 MPa SQR[m]
SLOPE= 110431 kJ/m^3
INTERCEPT= 94.3 kJ/m^2
T (ASTM)= 72
VALID, E813

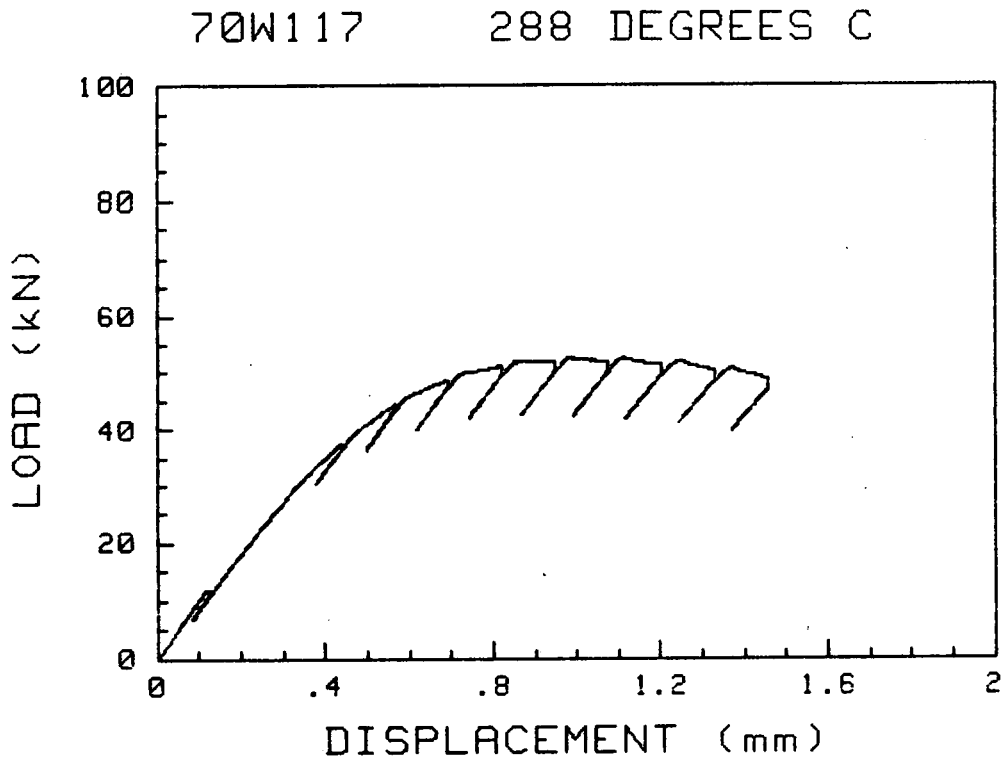
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 287.4 kJ/m^2
POWER= .3875
J-MAX ALLOWED= 551.3 kJ/m^2
RCURVE INVALID, 2

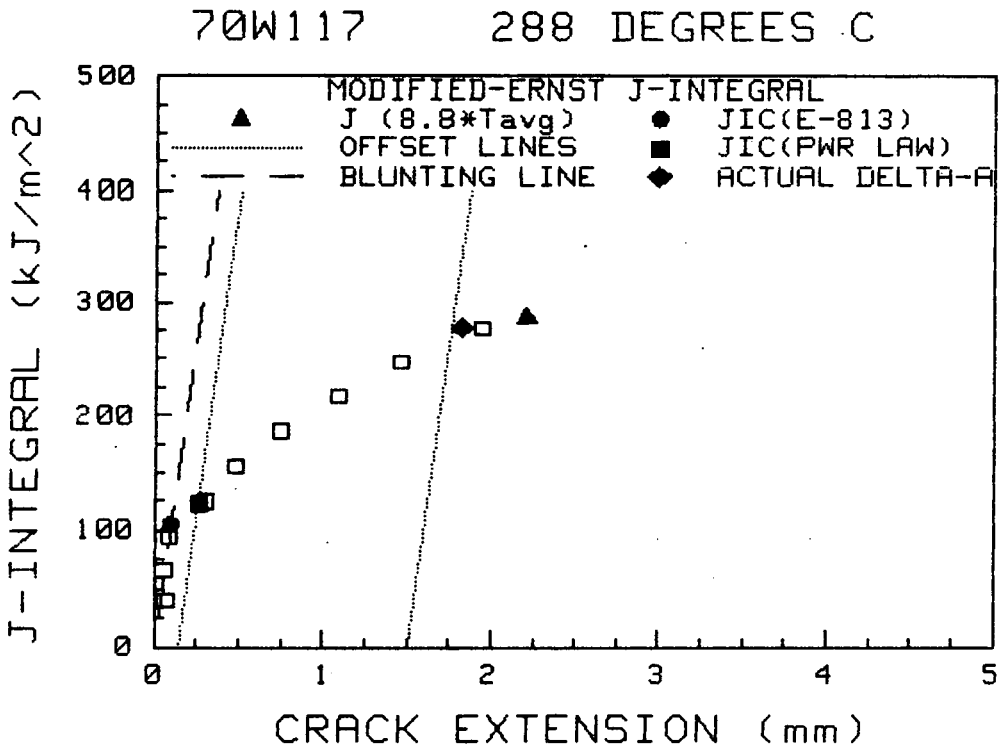
COEFFICIENT= 211.4 kJ/m^2
DELTA-A MAX ALLOWED= 2.28 mm



ORNL-DWG 87-8079



ORNL-DWG 87-8080



SPECIMEN ID= 70W118
TEST TEMPERATURE= 204 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 28.2 mm a/W)i= .556
MEASURED DUCTILE DELTA-A= 2.5 mm
YIELD STRENGTH= 477 MPa
FLOW STRENGTH= 535 MPa
ESTIMATED YOUNG'S MODULUS= 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 169.5 kJ/m^2
KJ-MAX LOAD= 182 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 141.5 kJ/m^2
K-JIc= 166.4 MPa SQR[m]
POWER= .4312
COEFFICIENT= 244.2 kJ/m^2
T (AVERAGE)= 74

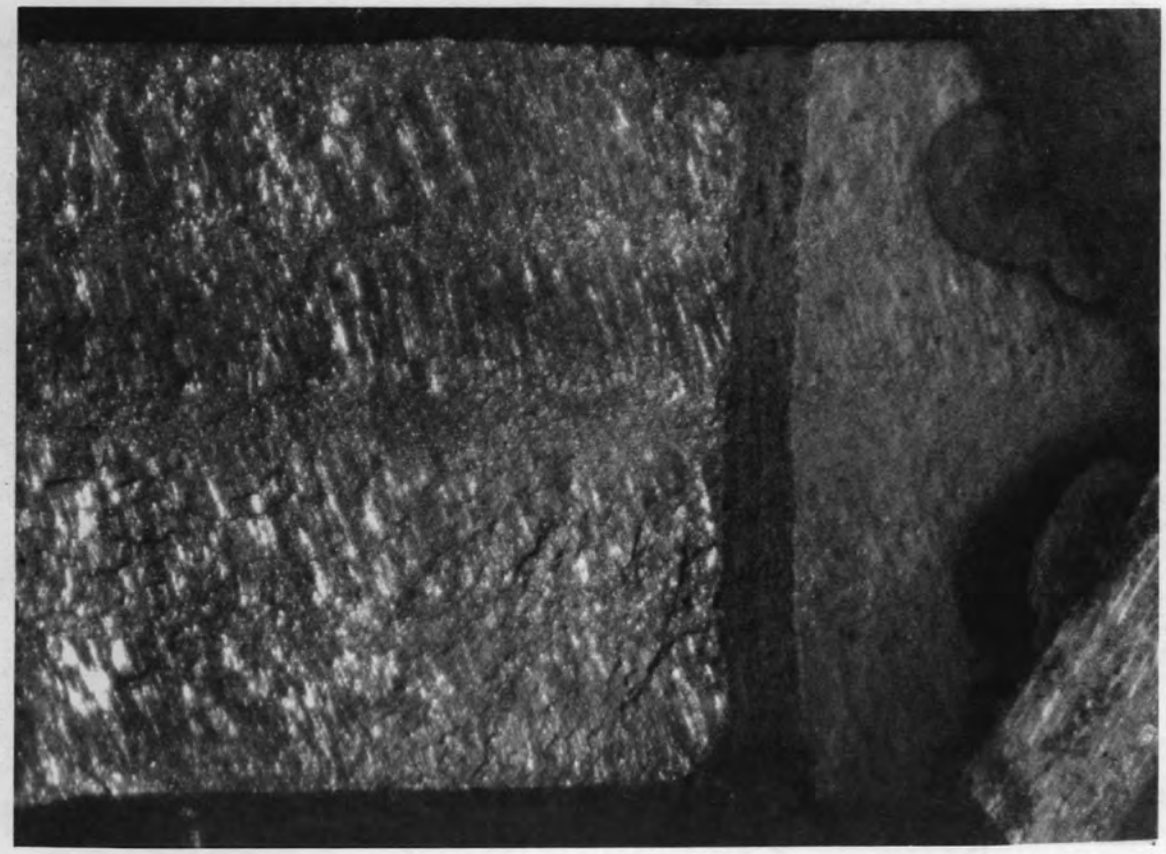
ASTM LINEAR PROCEDURE

JIc= 132.5 kJ/m^2
K-JIc= 160.9 MPa SQR[m]
SLOPE= 116006 kJ/m^3
INTERCEPT= 118.1 kJ/m^2
T (ASTM)= 79
VALID, E813

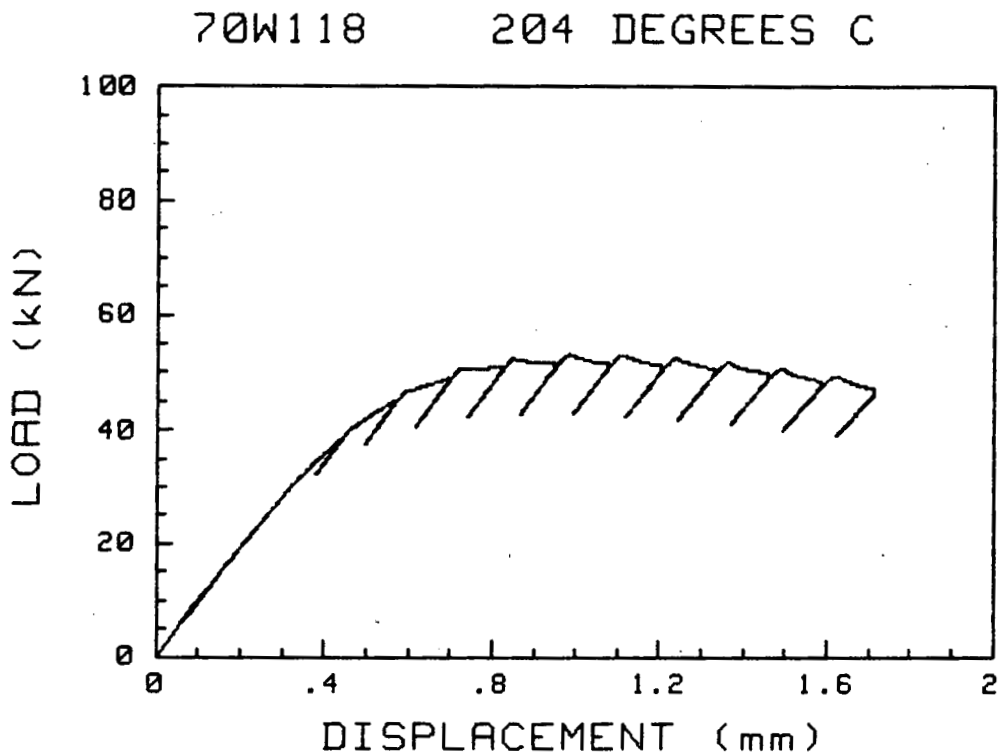
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 371.5 kJ/m^2
POWER= .4345
J-MAX ALLOWED= 543.9 kJ/m^2
RCURVE INVALID, 1 3

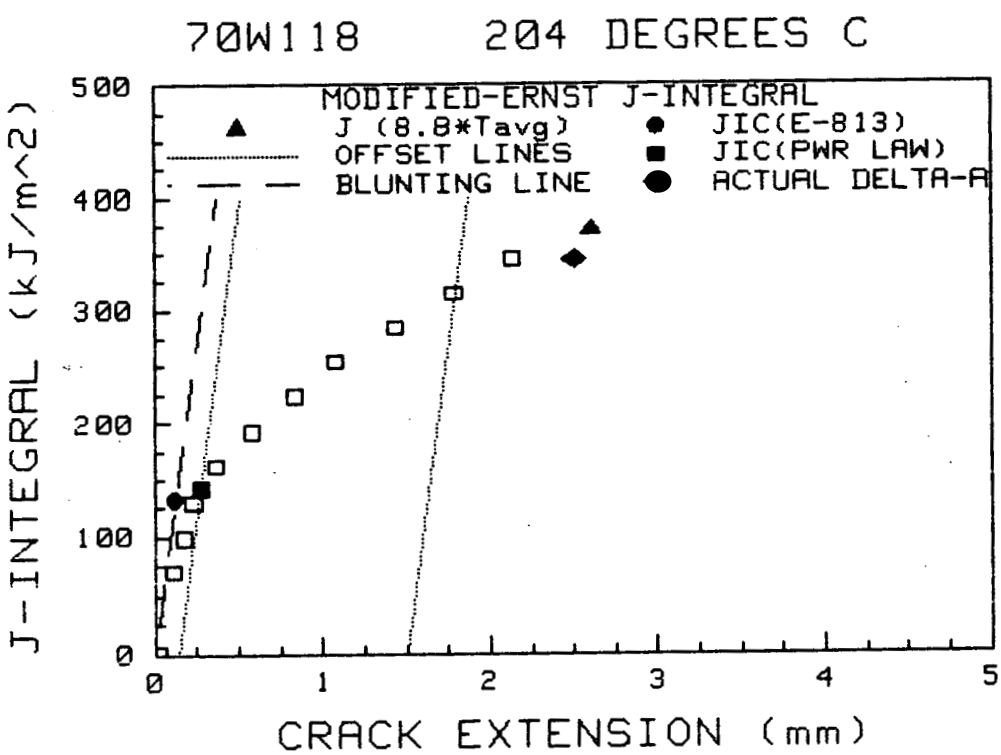
COEFFICIENT= 244.9 kJ/m^2
DELTA-A MAX ALLOWED= 2.26 mm



ORNL-DWG 87-8081



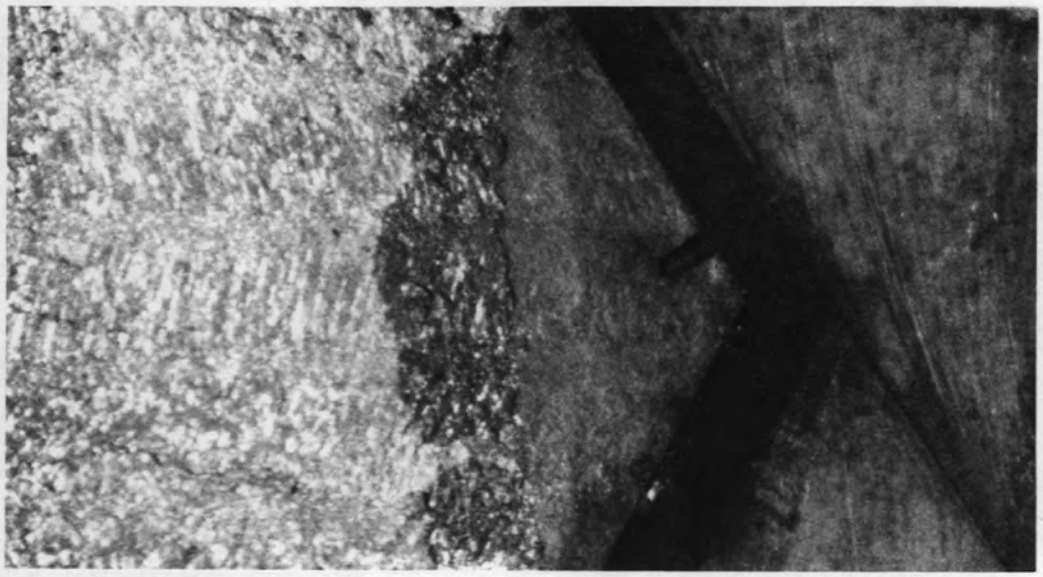
ORNL-DWG 87-8082



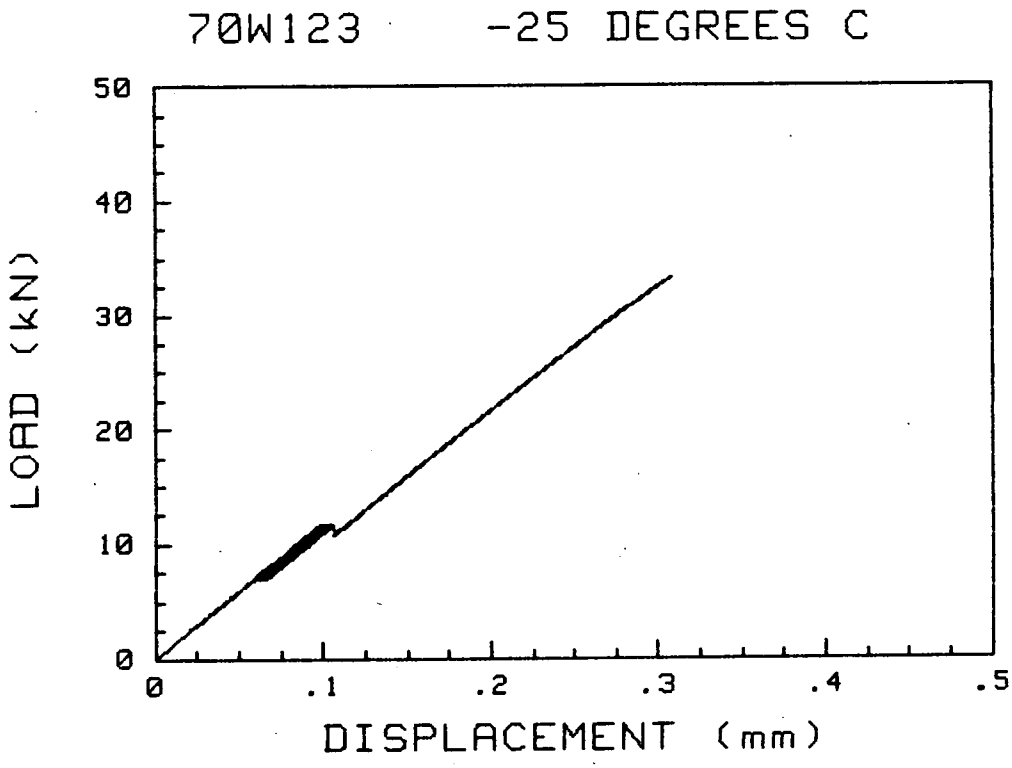
SPECIMEN ID= 70W123
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -25 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.4 mm a/W)i= .538
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 579 MPa
FLOW STRENGTH= 634 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT K = 63.5 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 19.3 kJ/m^2	J-INTEGRAL= 19.3 kJ/m^2
KJc= 63.4 MPa SQR[m]	KJc= 63.4 MPa SQR[m]
K-beta-c= 57.6 MPa SQR[m]	K-beta-c= 57.6 MPa SQR[m]



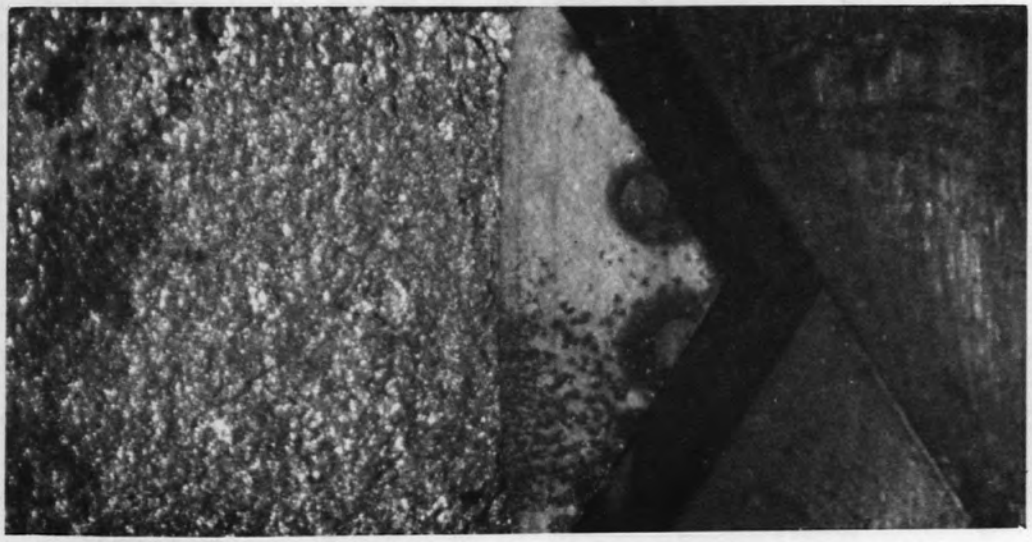
ORNL-DWG 87-8083



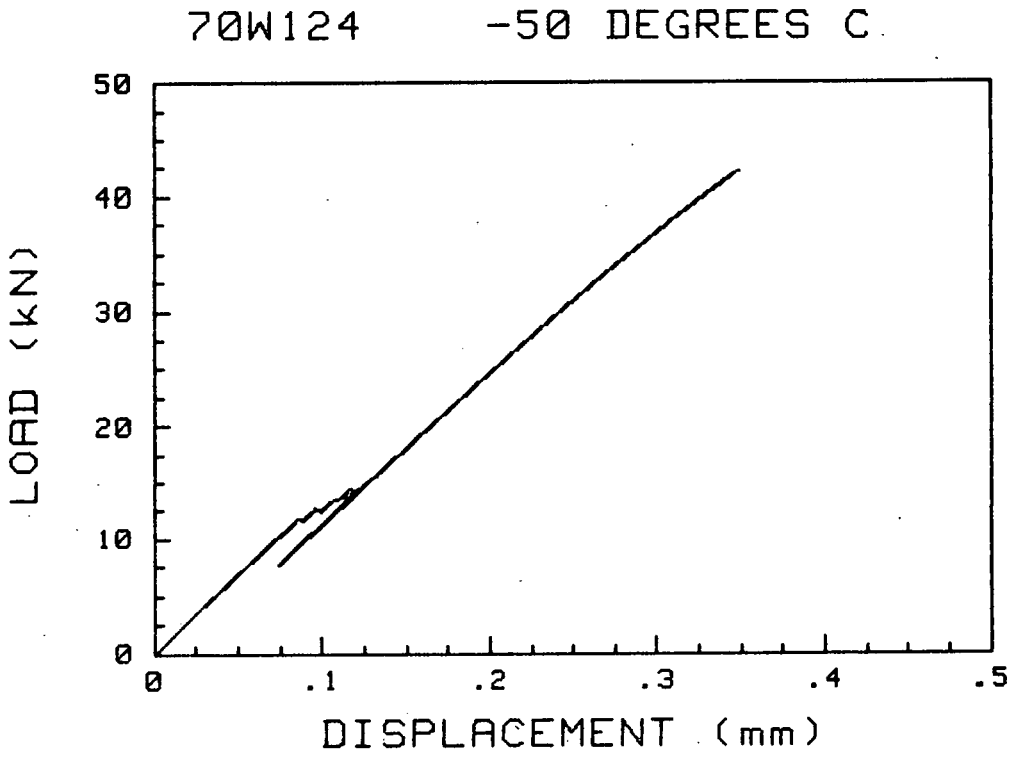
SPECIMEN ID= 70W124
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.6 mm a/W)i= .543
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 603 MPa
FLOW STRENGTH= 660 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

SPECIMEN CLEAVED AT K = 82 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 28.4 kJ/m^2	J-INTEGRAL= 28.4 kJ/m^2
KJc= 77.2 MPa SQR[m]	KJc= 77.2 MPa SQR[m]
K-beta-c= 66.9 MPa SQR[m]	K-beta-c= 66.9 MPa SQR[m]



ORNL-DWG 87-8084

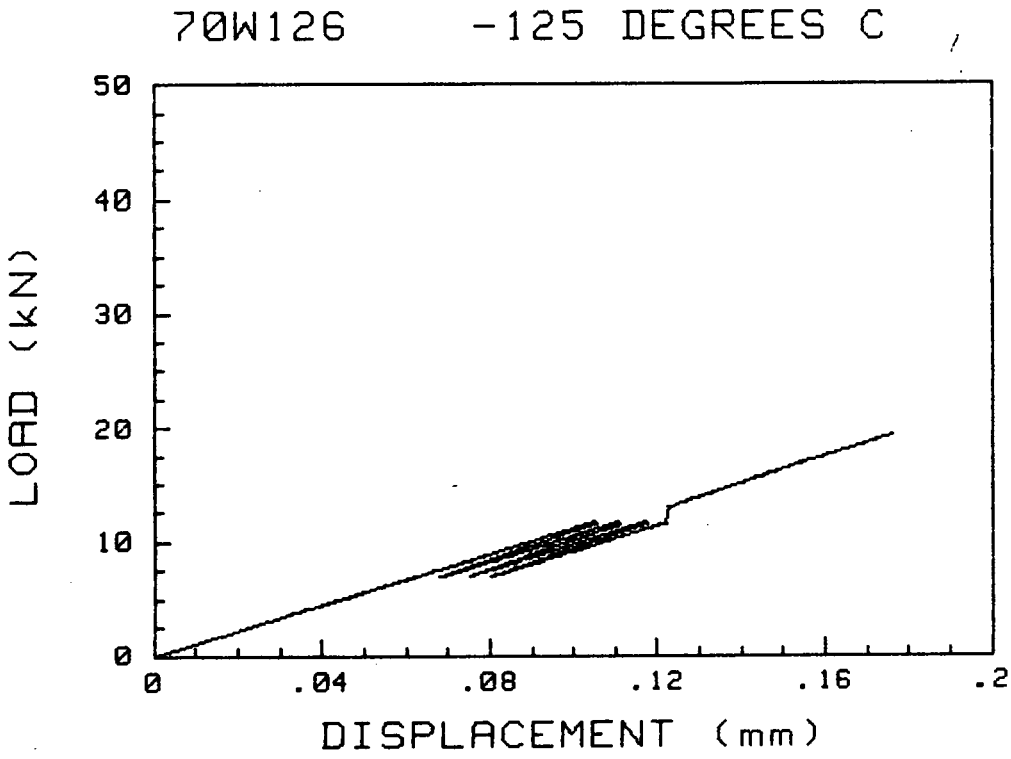


SPECIMEN ID= 70W126
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -125 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.8 mm a/W)i= .546
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 691 MPa
FLOW STRENGTH= 753 MPa
ESTIMATED YOUNG'S MODULUS= 214 GPa

SPECIMEN CLEAVED AT KIc= 37.9 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 6.2 kJ/m^2	J-INTEGRAL= 6.2 kJ/m^2
KJc= 36.4 MPa SQR[m]	KJc= 36.4 MPa SQR[m]
K-beta-c= 36.1 MPa SQR[m]	K-beta-c= 36.1 MPa SQR[m]

ORNL-DWG 87-8085



SPECIMEN ID= 70W136
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 27.7 mm a/W)i= .544
MEASURED DUCTILE DELTA-A= 5.27 mm
YIELD STRENGTH= 497 MPa
FLOW STRENGTH= 550 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 238.4 kJ/m^2
KJ-MAX LOAD= 218.5 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 140 kJ/m^2
K-JIc= 167.5 MPa SQR[m]
POWER= .5878
COEFFICIENT= 297.6 kJ/m^2
T (AVERAGE)= 116

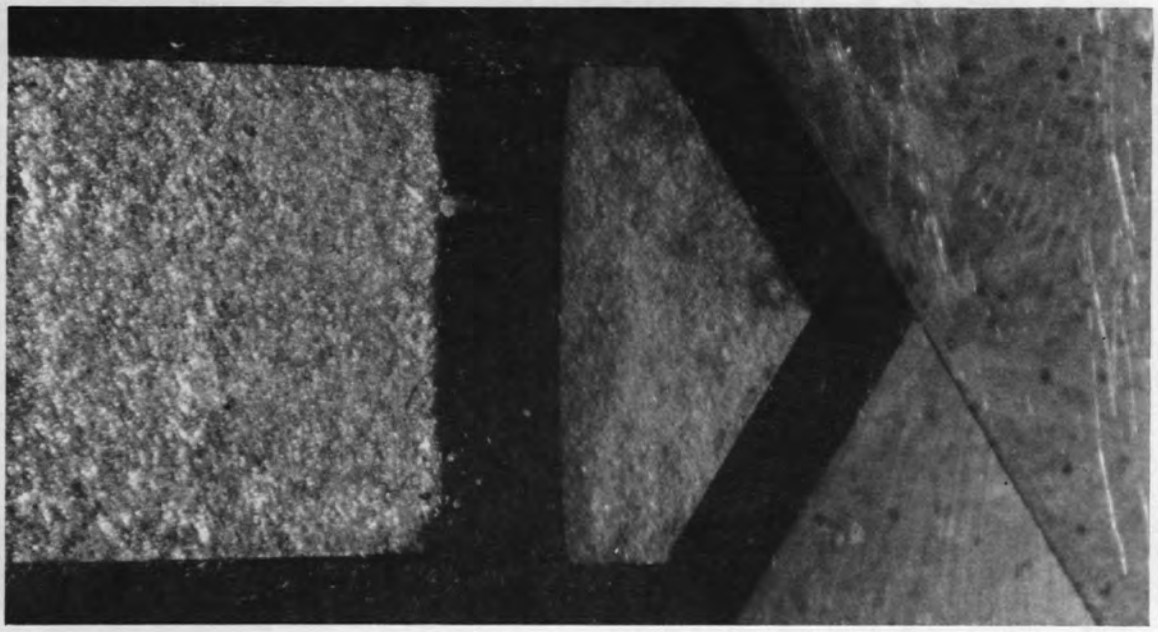
ASTM LINEAR PROCEDURE

JIc= 126 kJ/m^2
K-JIc= 158.9 MPa SQR[m]
SLOPE= 181248 kJ/m^3
INTERCEPT= 105.3 kJ/m^2
T (ASTM)= 120
VALID, E813

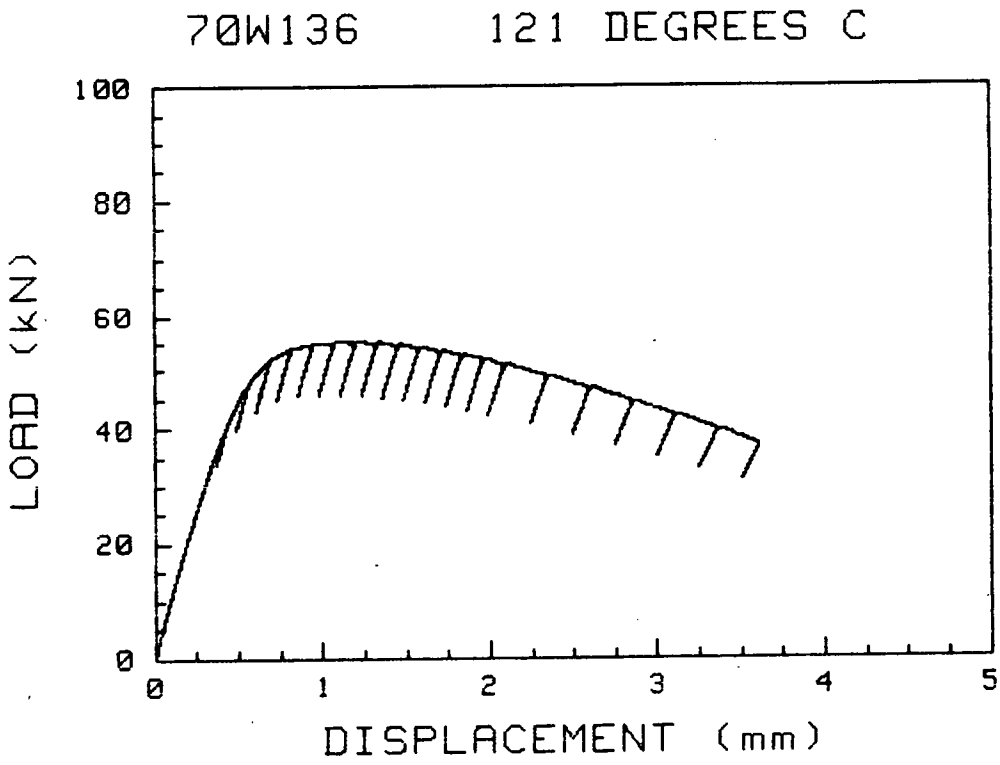
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 610.1 kJ/m^2
POWER= .5856
J-MAX ALLOWED= 558.6 kJ/m^2
VALID R-CURVE

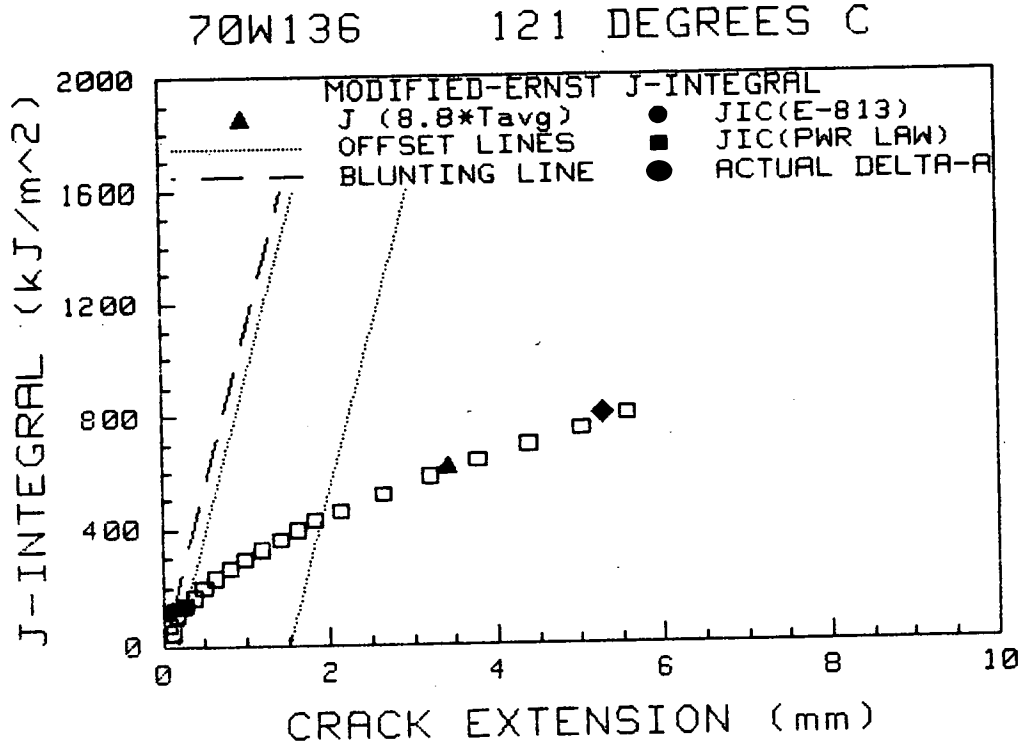
COEFFICIENT= 297.2 kJ/m^2
DELTA-A MAX ALLOWED= 2.31 mm



ORNL-DWG 87-8086



ORNL-DWG 87-8087



SPECIMEN ID= 70W139
TEST TEMPERATURE= 32 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 27.8 mm a/W)i= .547
MEASURED DUCTILE DELTA-A= 8.66 mm
YIELD STRENGTH= 533 MPa
FLOW STRENGTH= 590 MPa
ESTIMATED YOUNG'S MODULUS= 205 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 157.1 kJ/m^2
KJ-MAX LOAD= 179.6 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 136.7 kJ/m^2
K-JIc= 167.6 MPa SQR[m]
POWER= .5089
COEFFICIENT= 268.3 kJ/m^2
T (AVERAGE)= 83

ASTM LINEAR PROCEDURE

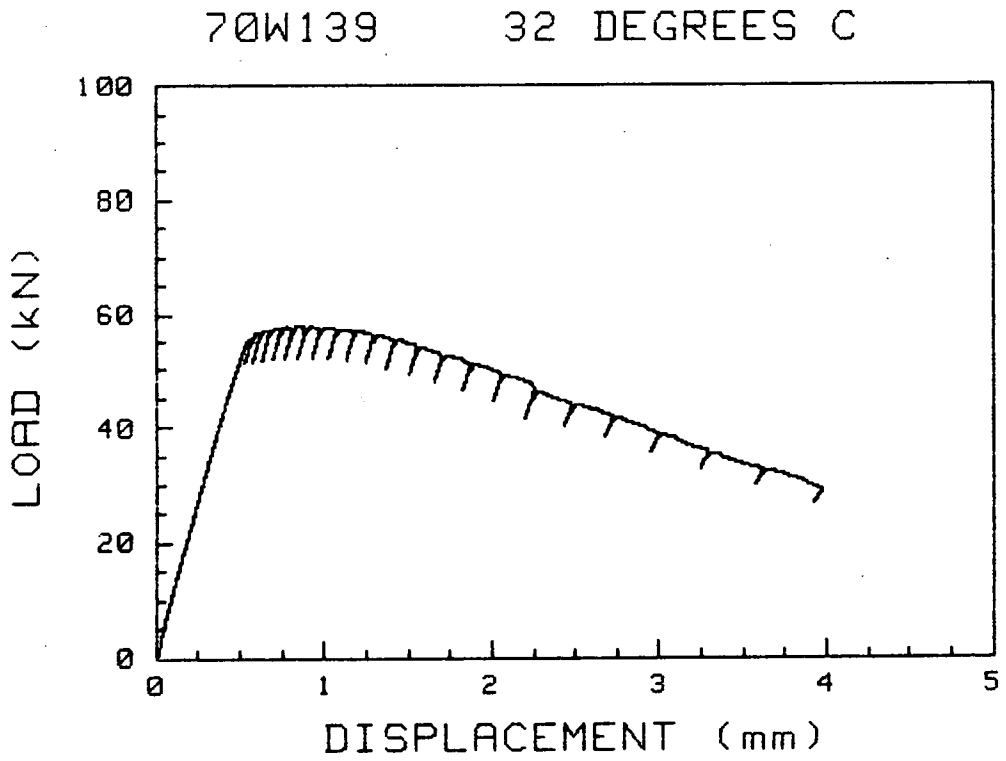
JIc= 121.9 kJ/m^2
K-JIc= 158.2 MPa SQR[m]
SLOPE= 153250 kJ/m^3
INTERCEPT= 106.1 kJ/m^2
T (ASTM)= 90
VALID, E813

JI-R CURVE CALCULATIONS

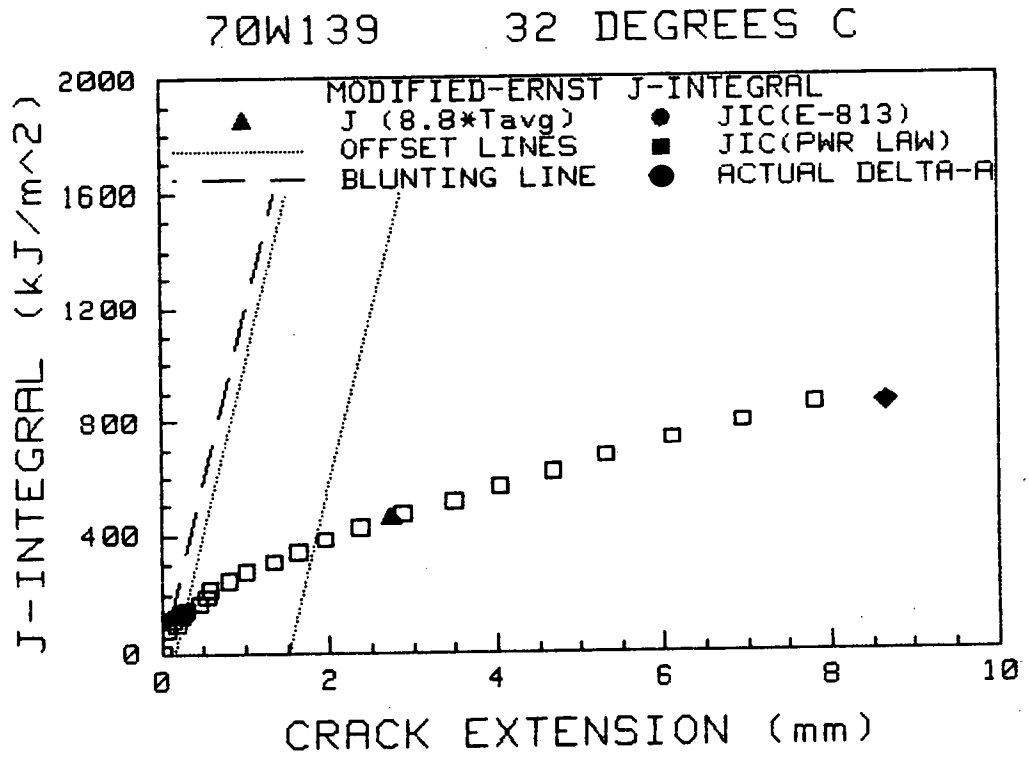
J (@J/T=8.8)= 456.4 kJ/m^2
POWER= .5277
J-MAX ALLOWED= 599.9 kJ/m^2
RCURVE INVALID, 3

COEFFICIENT= 268.3 kJ/m^2
DELTA-A MAX ALLOWED= 2.3 mm

ORNL-DWG 87-8088



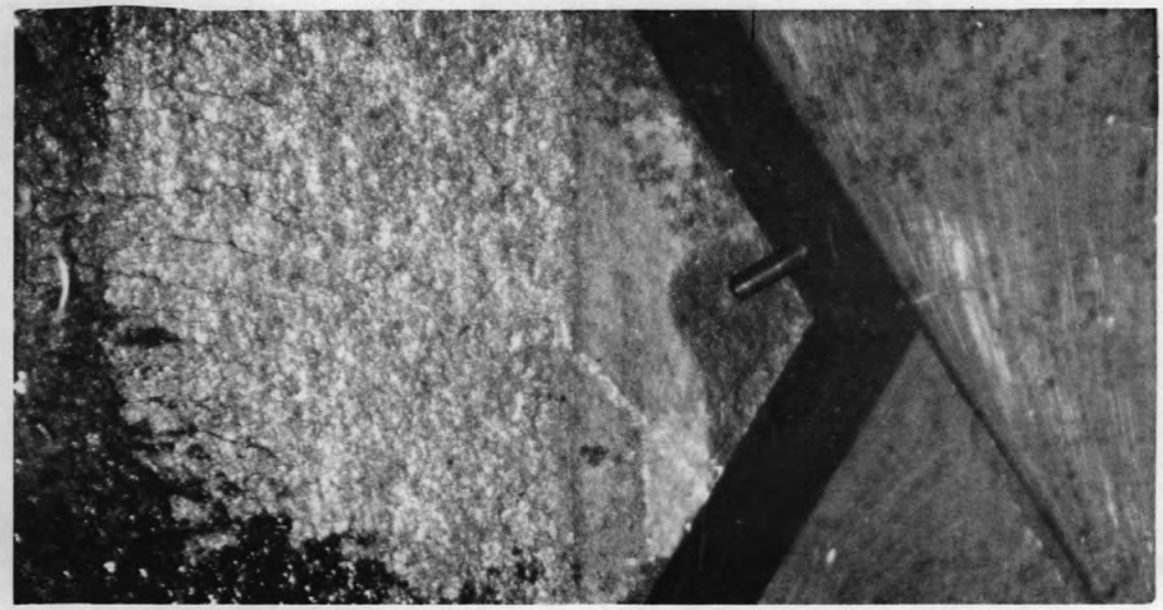
ORNL-DWG 87-8089



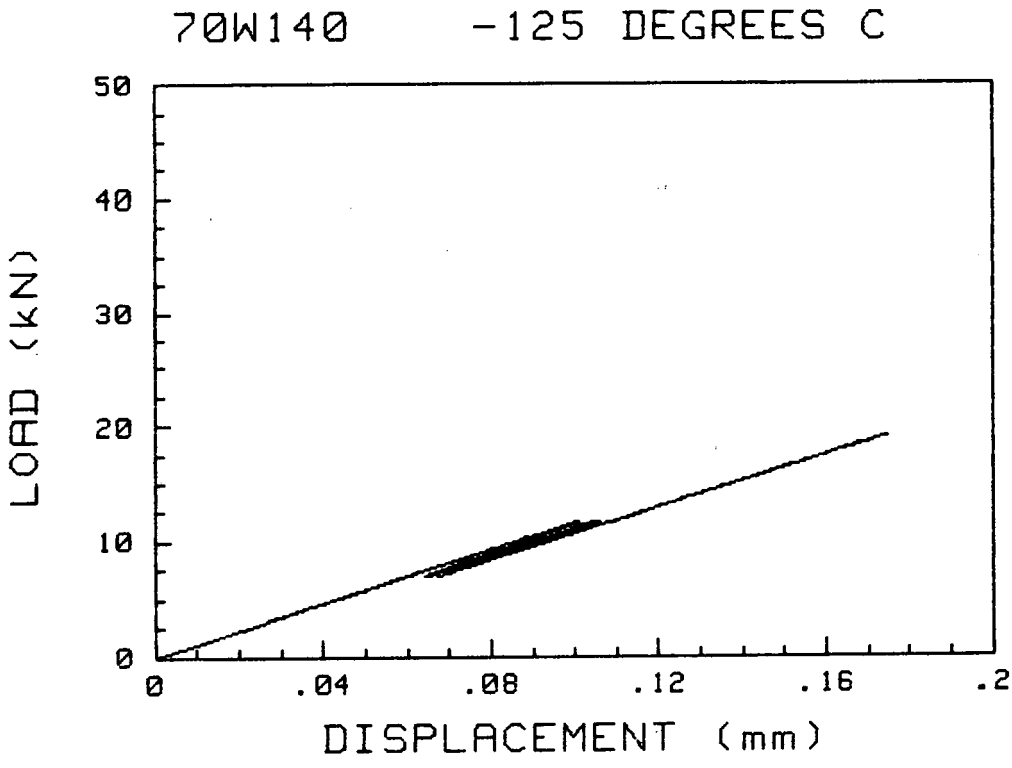
SPECIMEN ID= 70W140
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -125 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.5 mm a/W)i= .541
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 691 MPa
FLOW STRENGTH= 753 MPa
ESTIMATED YOUNG'S MODULUS= 214 GPa

SPECIMEN CLEAVED AT KIc= 36.9 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 6.3 kJ/m^2	J-INTEGRAL= 6.3 kJ/m^2
KJc= 36.7 MPa SQR[m]	KJc= 36.7 MPa SQR[m]
K-beta-c= 36.4 MPa SQR[m]	K-beta-c= 36.4 MPa SQR[m]



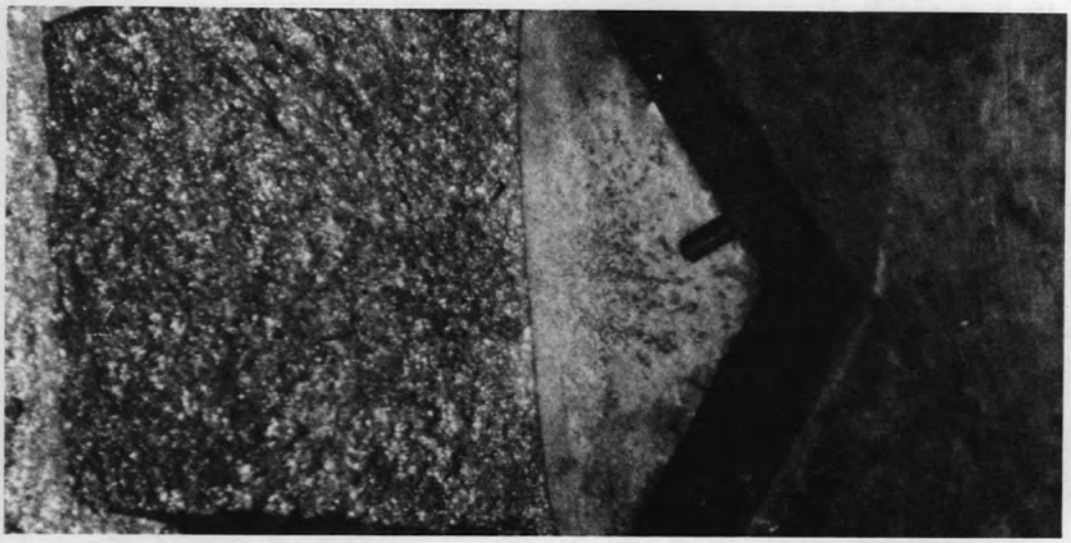
ORNL-DWG 87-8090



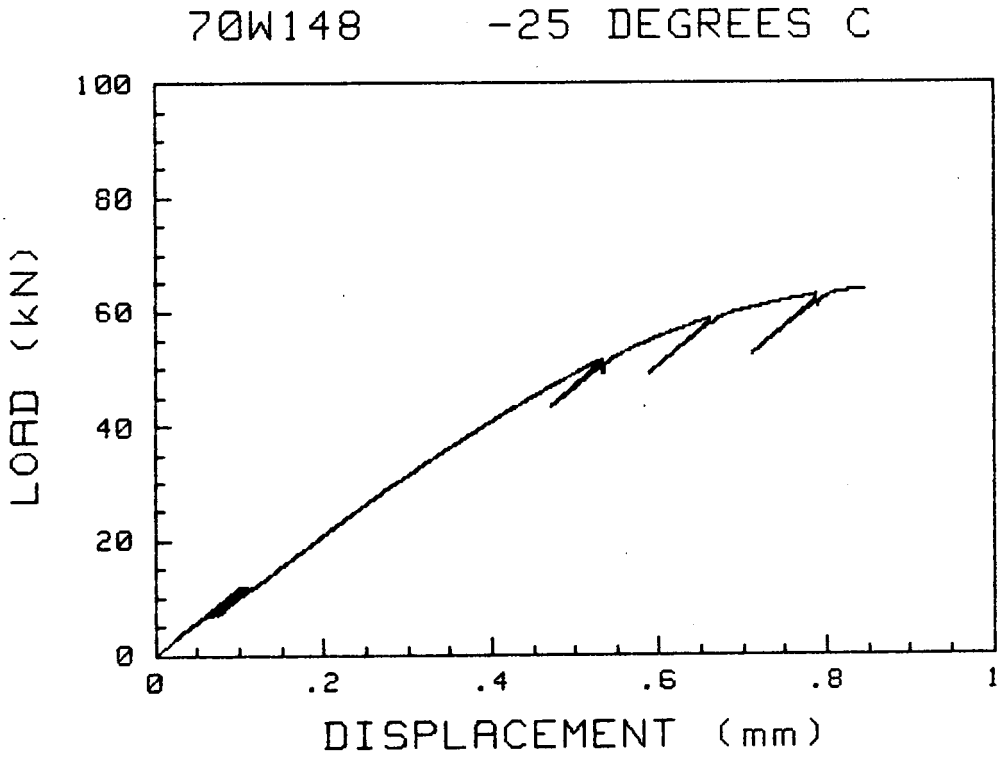
SPECIMEN ID= 70W148
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -25 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.4 mm a/W)i= .538
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 579 MPa
FLOW STRENGTH= 634 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT K = 121.6 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 124.6 kJ/m^2	J-INTEGRAL= 123.3 kJ/m^2
KJc= 161.2 MPa SQR[m]	KJc= 160.4 MPa SQR[m]
K-beta-c= 97.4 MPa SQR[m]	K-beta-c= 97.2 MPa SQR[m]



ORNL-DWG 87-8091



SPECIMEN ID= 71W101
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 28.2 mm a/W)i= .555
MEASURED DUCTILE DELTA-A= 2.94 mm
YIELD STRENGTH= 492 MPa
FLOW STRENGTH= 546 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 165.7 kJ/m^2
KJ-MAX LOAD= 182.2 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 102.3 kJ/m^2
K-JIc= 143.1 MPa SQR[m]
POWER= .5005
COEFFICIENT= 207.3 kJ/m^2
T (AVERAGE)= 74

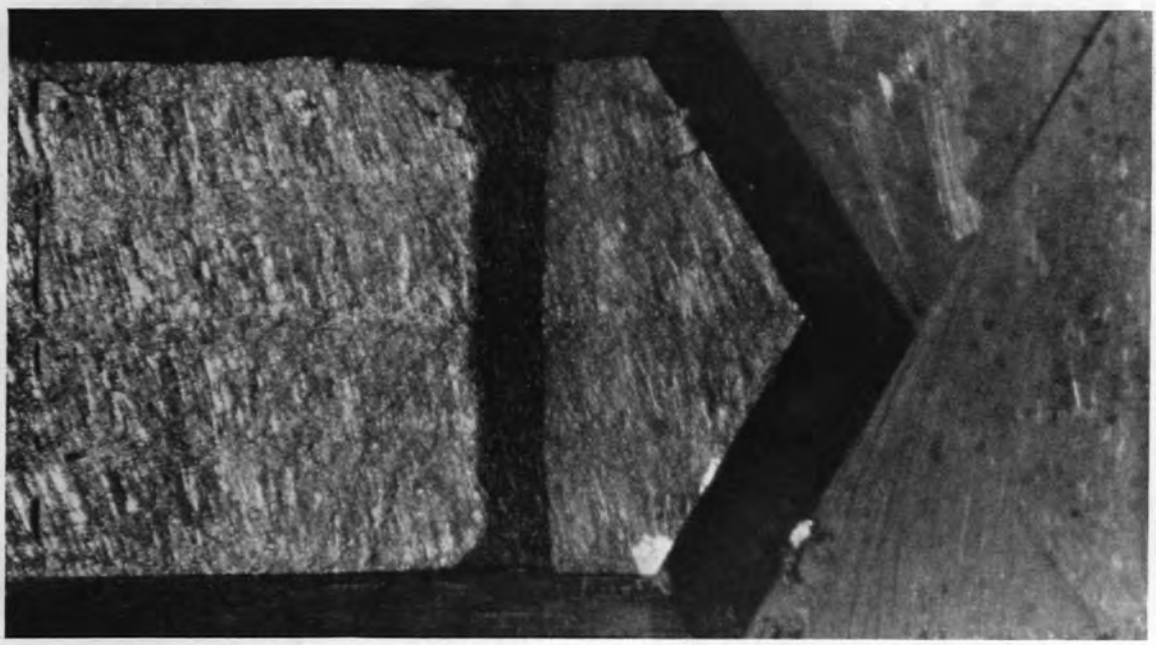
ASTM LINEAR PROCEDURE

JIc= 79.5 kJ/m^2
K-JIc= 126.2 MPa SQR[m]
SLOPE= 126247 kJ/m^3
INTERCEPT= 70.3 kJ/m^2
T (ASTM)= 85
VALID, E813

JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 357.5 kJ/m^2
POWER= .5131
J-MAX ALLOWED= 554.2 kJ/m^2
RCURVE INVALID, 1 2 3

COEFFICIENT= 202.1 kJ/m^2
DELTA-A MAX ALLOWED= 2.26 mm



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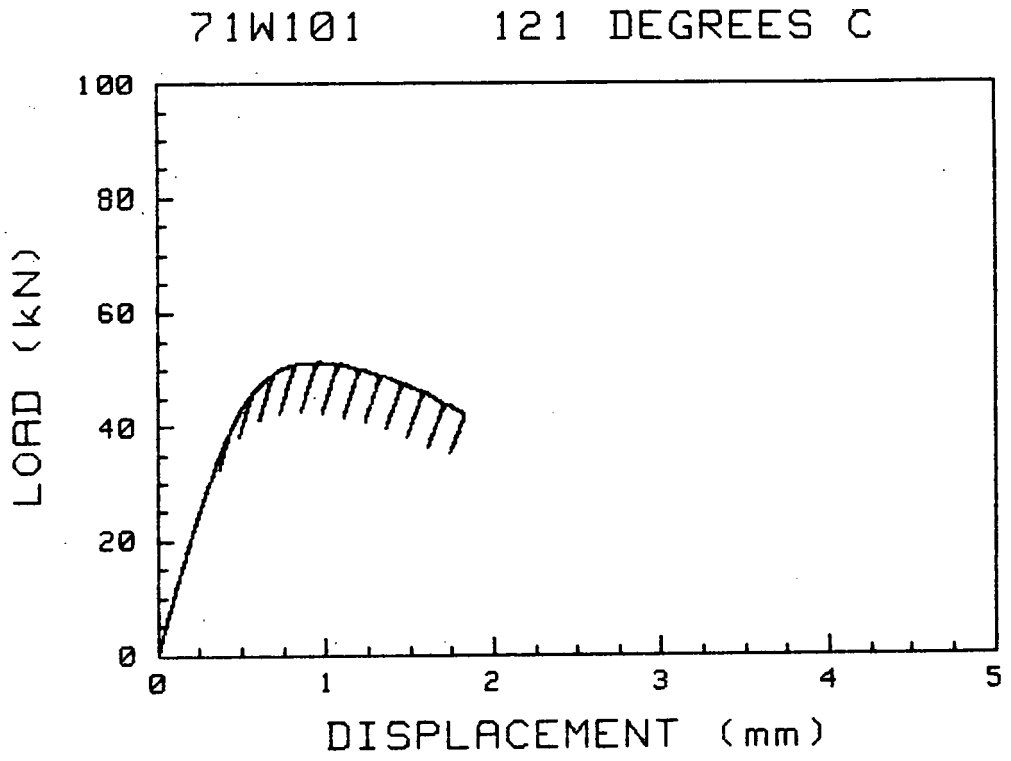
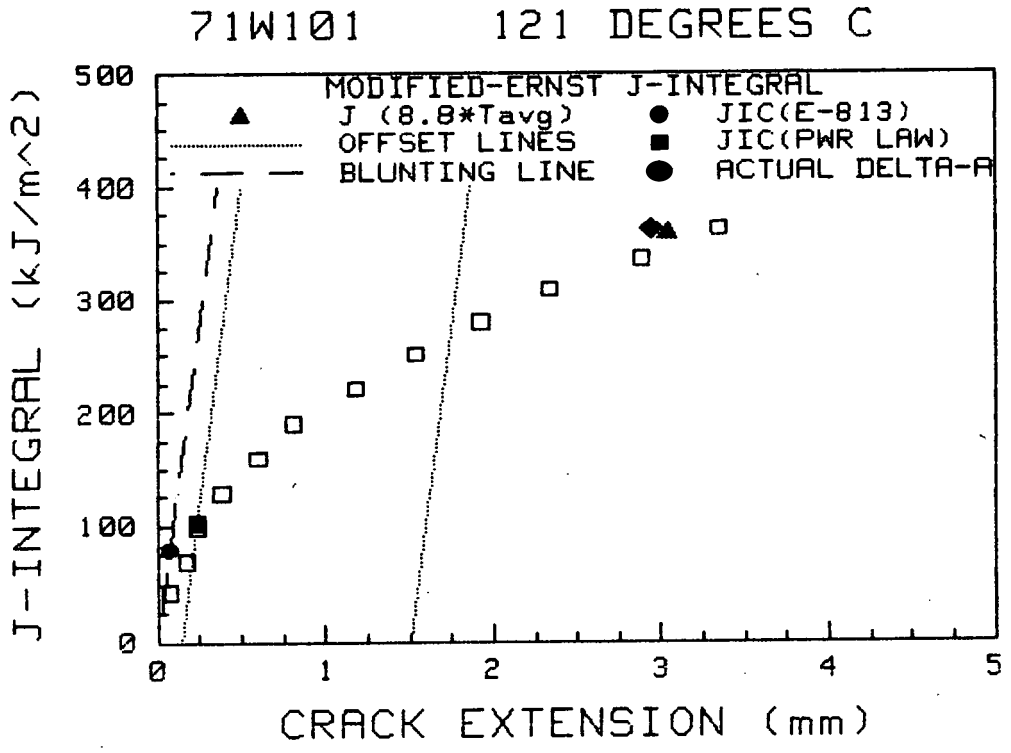


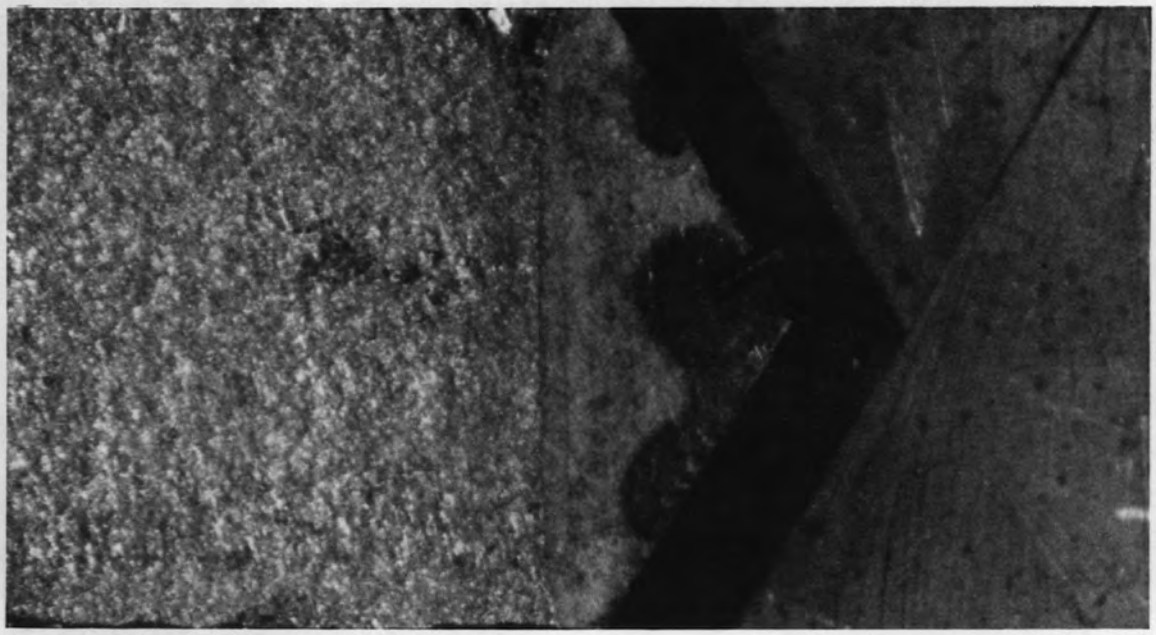
ORNL-DWG 87-8093



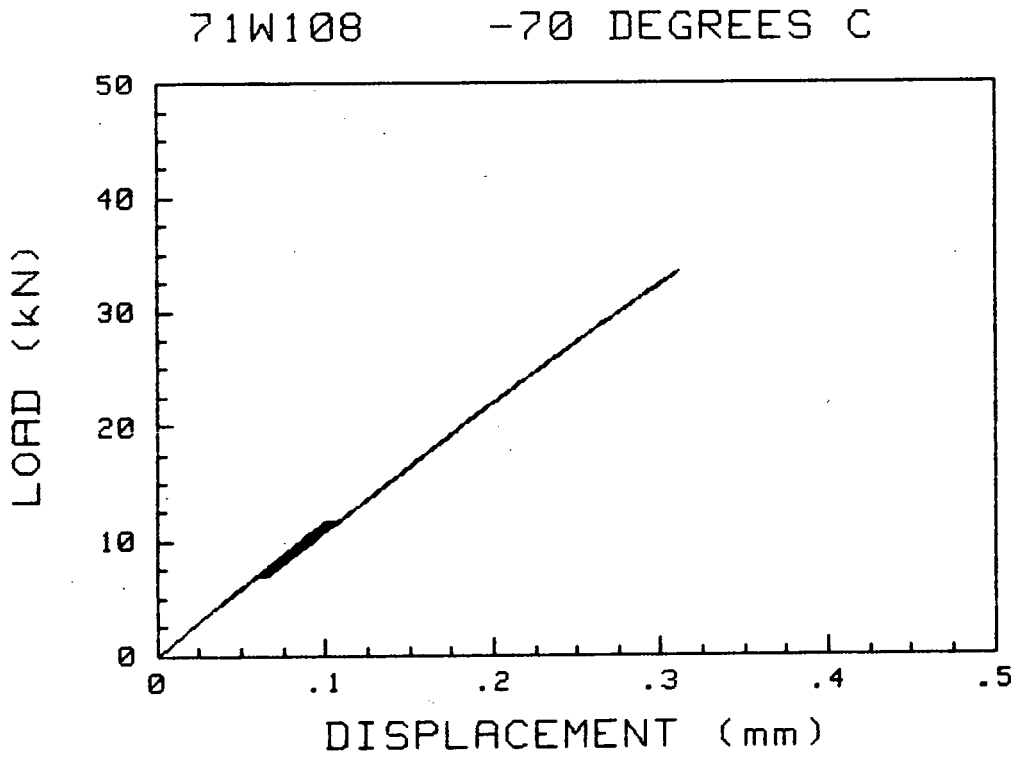
SPECIMEN ID= 71W108
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -70 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.7 mm a/W)i= .544
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 622 MPa
FLOW STRENGTH= 679 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

SPECIMEN CLEAVED AT K = 65.1 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 20.1 kJ/m^2	J-INTEGRAL= 20.1 kJ/m^2
KJc= 65.2 MPa SQR[m]	KJc= 65.2 MPa SQR[m]
K-beta-c= 59.9 MPa SQR[m]	K-beta-c= 59.9 MPa SQR[m]



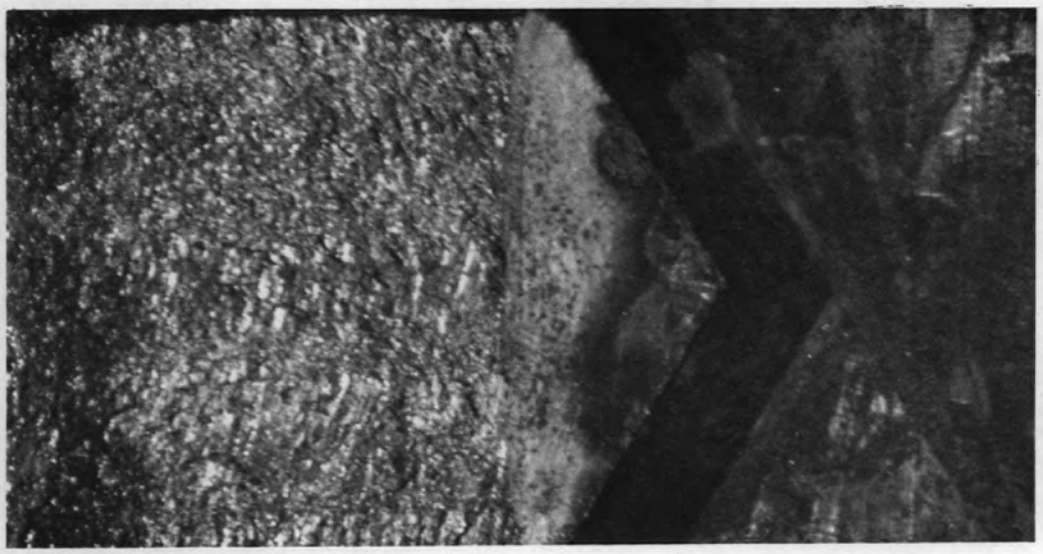
ORNL-DWG 87-8094



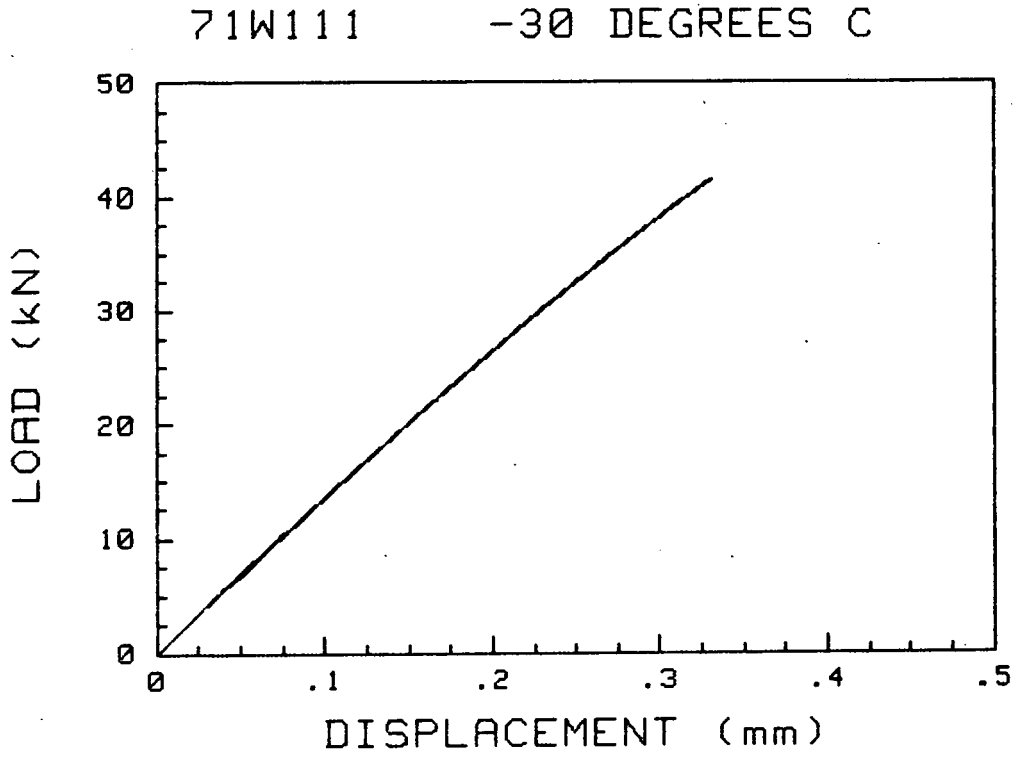
SPECIMEN ID= 71W111
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -30 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.5 mm a/W)i= .542
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 579 MPa
FLOW STRENGTH= 635 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT K = 80.3 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 27.1 kJ/m^2	J-INTEGRAL= 27.1 kJ/m^2
KJc= 75.3 MPa SQR[m]	KJc= 75.3 MPa SQR[m]
K-beta-c= 65 MPa SQR[m]	K-beta-c= 65 MPa SQR[m]



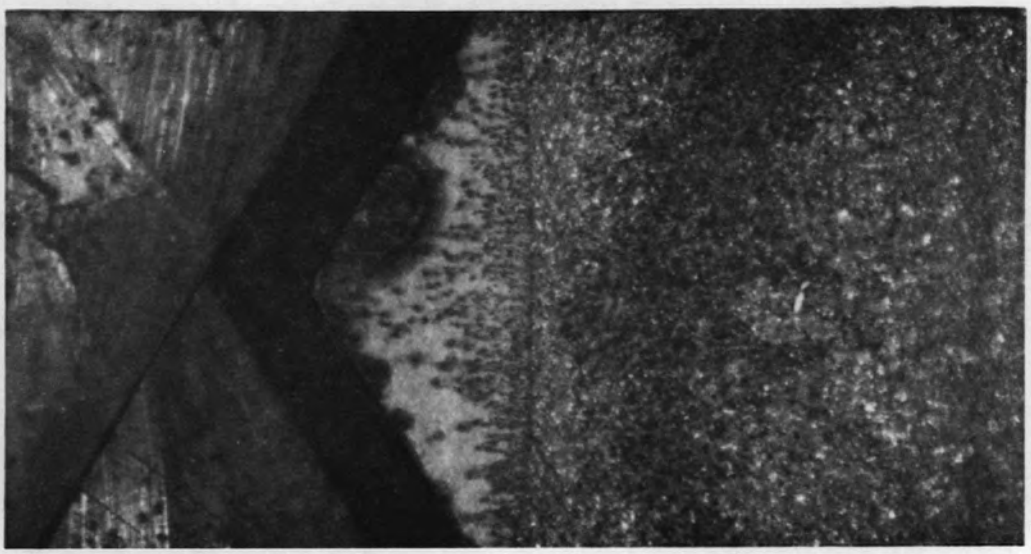
ORNL-DWG 87-8095



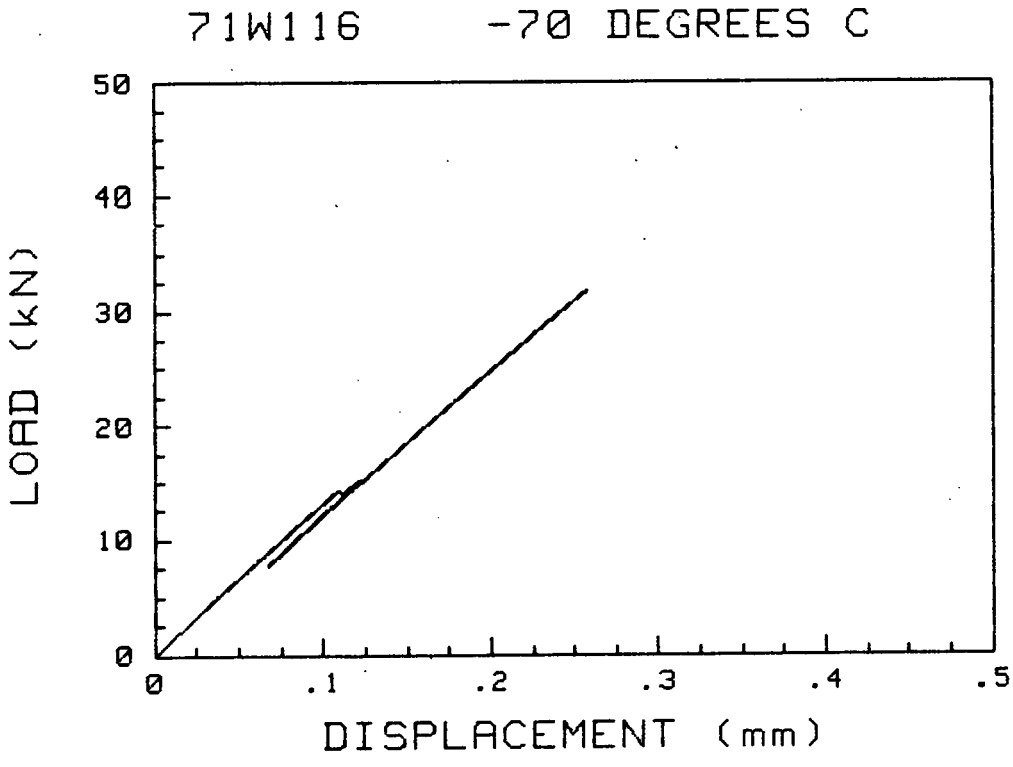
SPECIMEN ID= 71W116
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -70 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.7 mm a/W)i= .544
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 622 MPa
FLOW STRENGTH= 679 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

SPECIMEN CLEAVED AT KIc= 61.9 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 15.7 kJ/m^2	J-INTEGRAL= 15.7 kJ/m^2
KJc= 57.6 MPa SQR[m]	KJc= 57.6 MPa SQR[m]
K-beta-c= 54.2 MPa SQR[m]	K-beta-c= 54.2 MPa SQR[m]



ORNL-DWG 87-8096



SPECIMEN ID= 71W119
TEST TEMPERATURE= 204 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 27.8 mm a/W)i= .546
MEASURED DUCTILE DELTA-A= 2.34 mm
YIELD STRENGTH= 470 MPa
FLOW STRENGTH= 527 MPa
ESTIMATED YOUNG'S MODULUS= 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 160.2 kJ/m^2
KJ-MAX LOAD= 177 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 106.5 kJ/m^2
K-JIc= 144.3 MPa SQR[m]
POWER= .4144
COEFFICIENT= 188.9 kJ/m^2
T (AVERAGE)= 59

ASTM LINEAR PROCEDURE

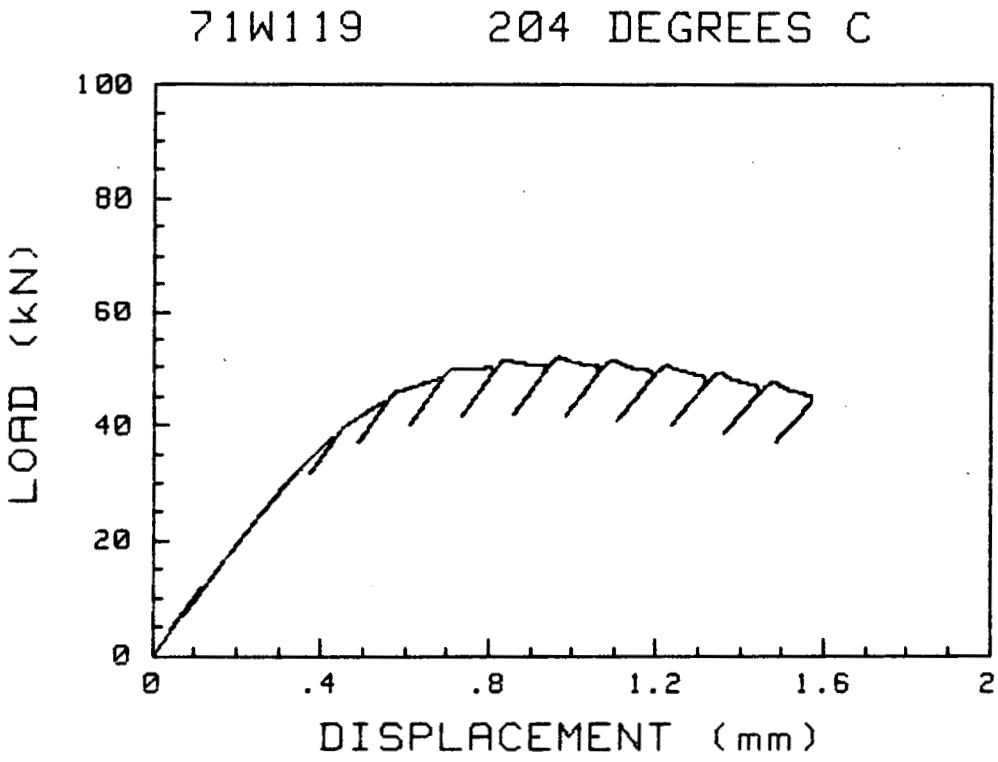
JIc= 114.1 kJ/m^2
K-JIc= 149.4 MPa SQR[m]
SLOPE= 77975 kJ/m^3
INTERCEPT= 105.7 kJ/m^2
T (ASTM)= 55
VALID, E813

JI-R CURVE CALCULATIONS

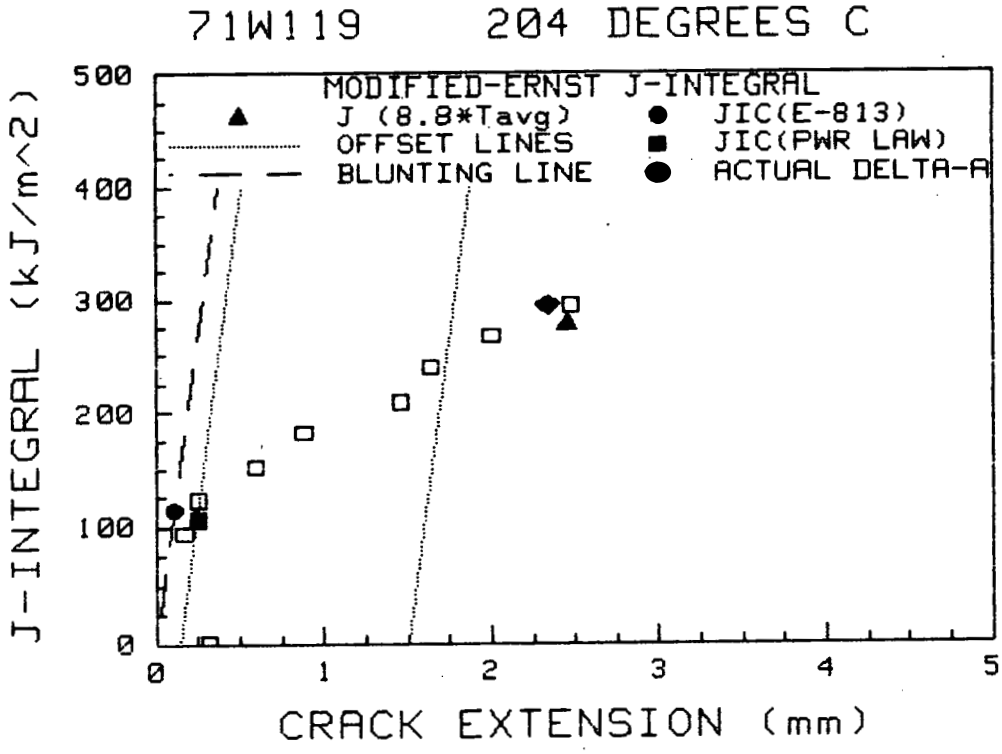
J (@J/T=8.8)= 276.9 kJ/m^2
POWER= .3963
J-MAX ALLOWED= 535.4 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 193.9 kJ/m^2
DELTA-A MAX ALLOWED= 2.3 mm

ORNL-DWG 87-8097



ORNL-DWG 87-8098

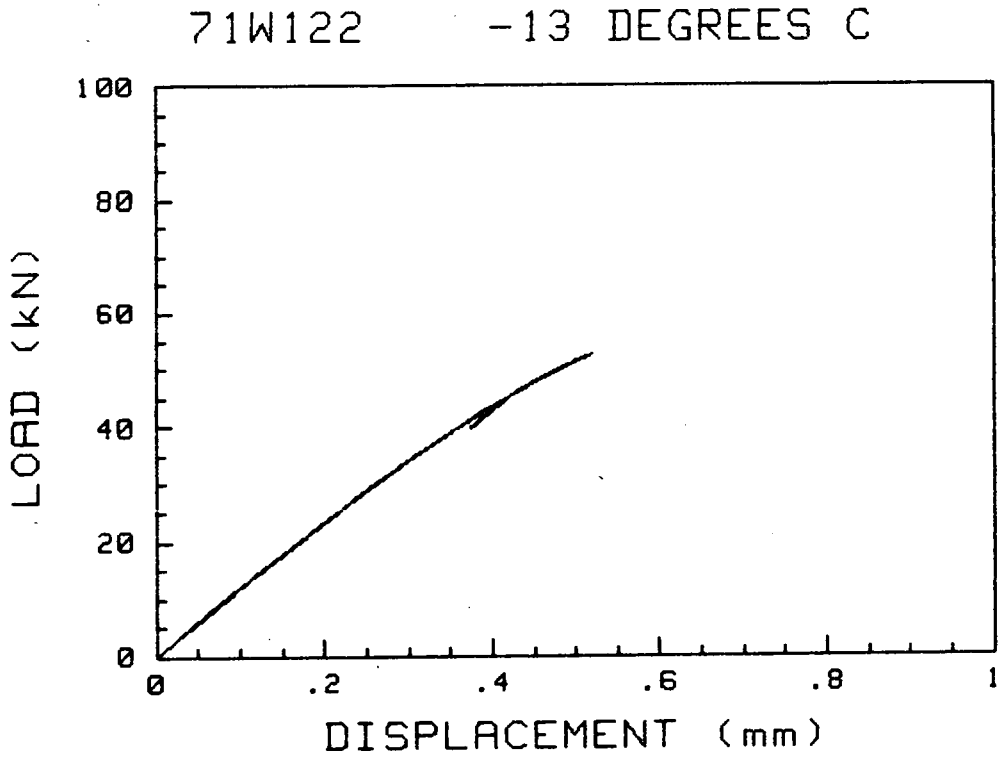


SPECIMEN ID= 71W122
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -13 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.7 mm a/W)i= .546
MEASURED DUCTILE DELTA-A= .09 mm
YIELD STRENGTH= 563 MPa
FLOW STRENGTH= 619 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

SPECIMEN CLEAVED AT K = 103.2 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 57.4 kJ/m^2	J-INTEGRAL= 57.4 kJ/m^2
KJc= 109.3 MPa SQR[m]	KJc= 109.3 MPa SQR[m]
K-beta-c= 79.8 MPa SQR[m]	K-beta-c= 79.8 MPa SQR[m]

ORNL-DWG 87-8099



SPECIMEN ID= 71W123
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 28 mm a/W)i= .552
MEASURED DUCTILE DELTA-A= 2.16 mm
YIELD STRENGTH= 465 MPa
FLOW STRENGTH= 533 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 156.9 kJ/m^2
KJ-MAX LOAD= 173 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 105.9 kJ/m^2
K-JIc= 142.2 MPa SQR[m]
POWER= .3802
COEFFICIENT= 179.6 kJ/m^2
T (AVERAGE)= 50

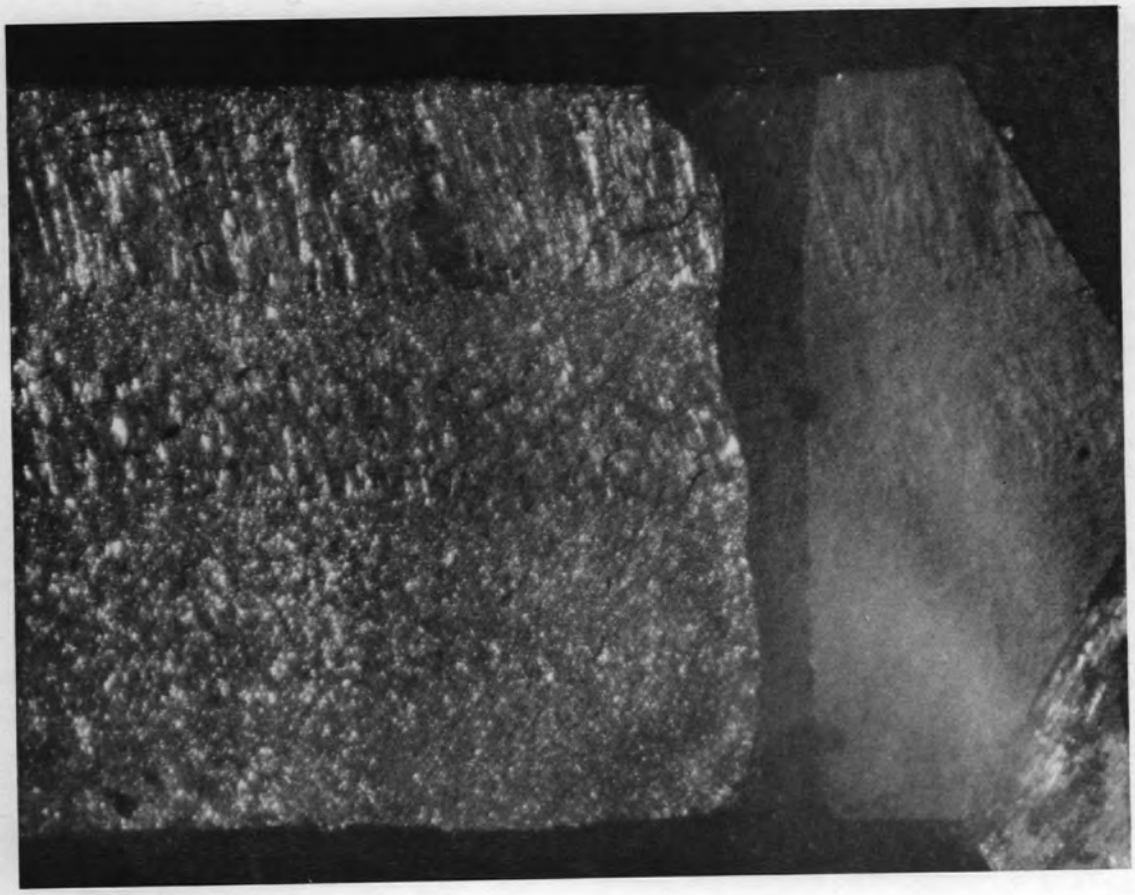
ASTM LINEAR PROCEDURE

JIc= 97 kJ/m^2
K-JIc= 136.1 MPa SQR[m]
SLOPE= 80665 kJ/m^3
INTERCEPT= 89.7 kJ/m^2
T (ASTM)= 54
VALID, E813

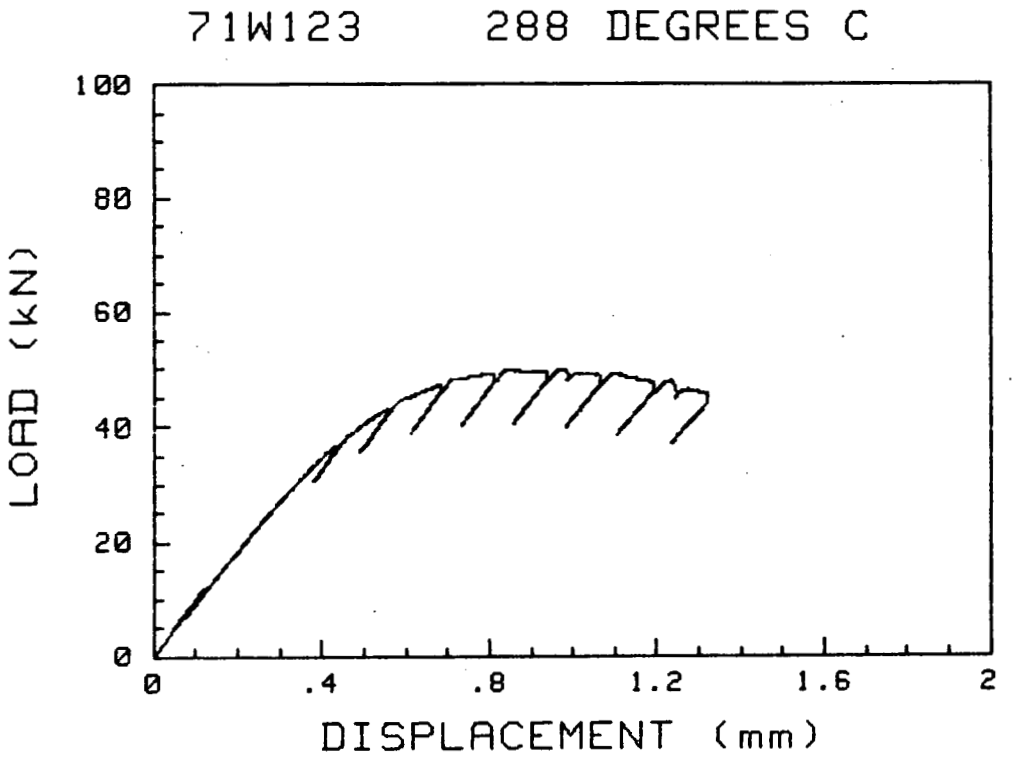
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 222.4 kJ/m^2
POWER= .3299
J-MAX ALLOWED= 541.1 kJ/m^2
RCURVE INVALID, 2

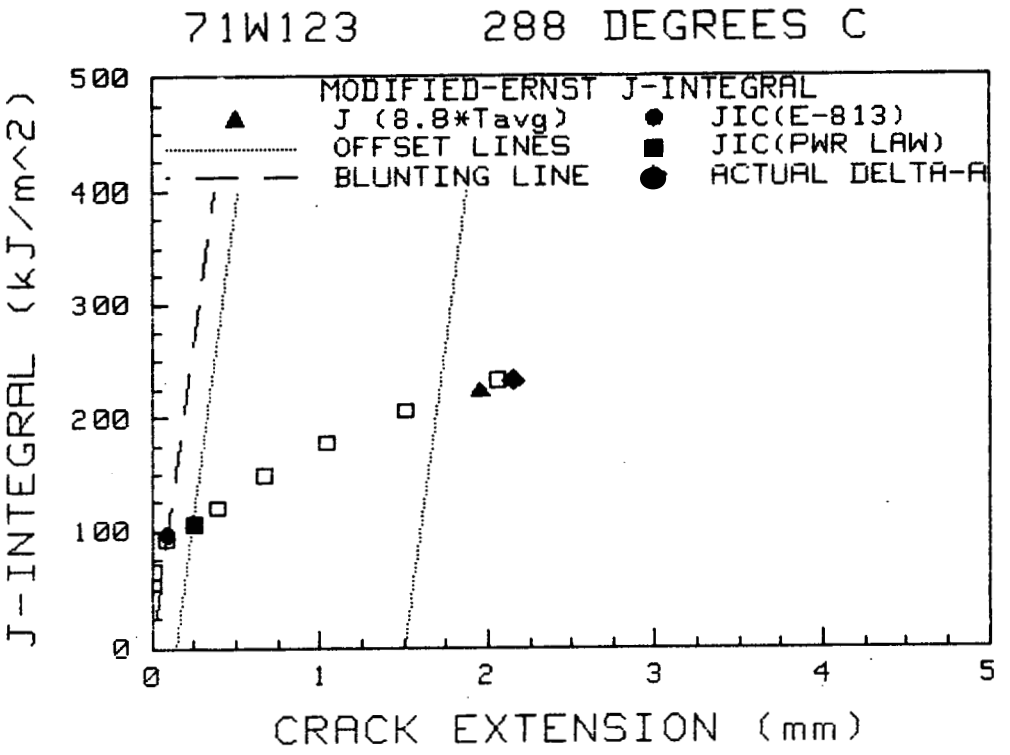
COEFFICIENT= 178.3 kJ/m^2
DELTA-A MAX ALLOWED= 2.28 mm



ORNL-DWG 87-8100



ORNL-DWG 87-8101



SPECIMEN ID= 71W126
TEST TEMPERATURE= 204 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 28 mm a/W)i= .551
MEASURED DUCTILE DELTA-A= 2.26 mm
YIELD STRENGTH= 470 MPa
FLOW STRENGTH= 527 MPa
ESTIMATED YOUNG'S MODULUS= 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 164.7 kJ/m^2
KJ-MAX LOAD= 179.5 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 118.2 kJ/m^2
K-JIc= 152.1 MPa SQR[m]
POWER= .3562
COEFFICIENT= 190.5 kJ/m^2
T (AVERAGE)= 52

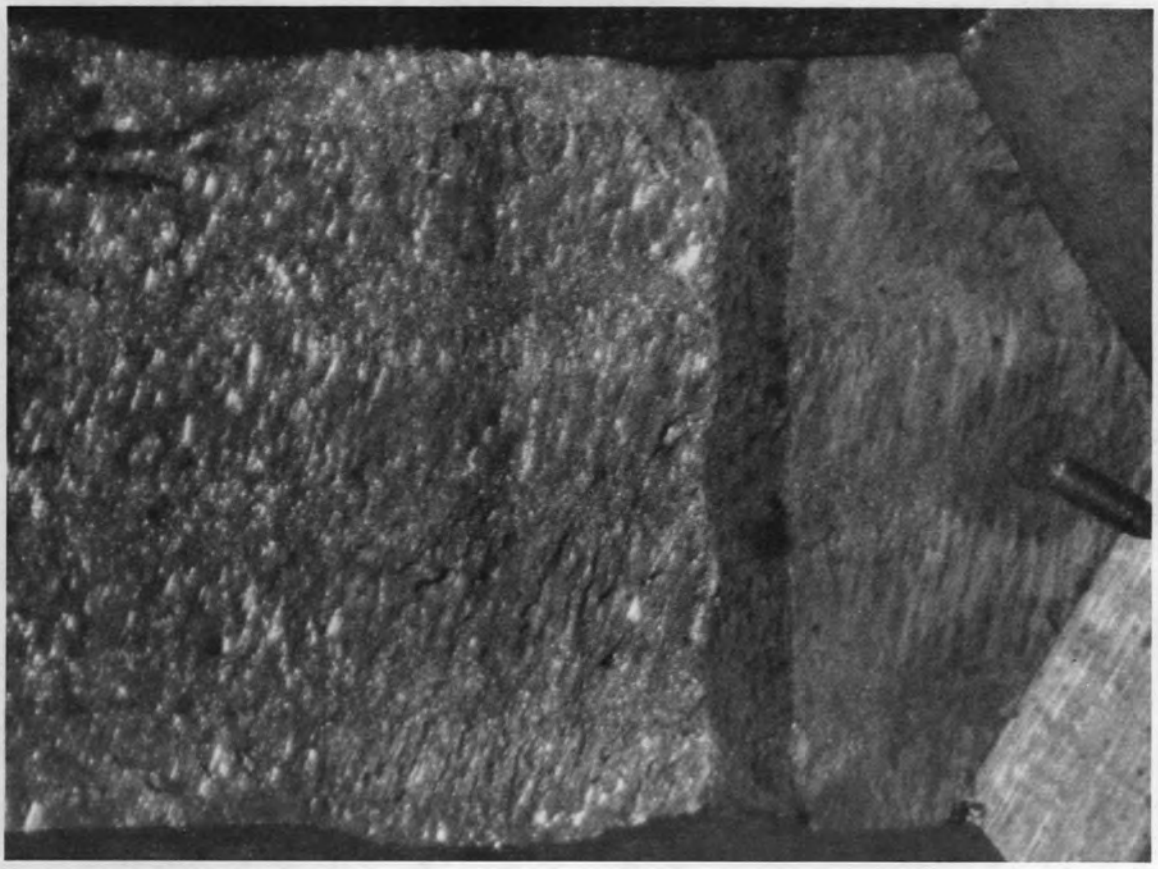
ASTM LINEAR PROCEDURE

JIc= 102.9 kJ/m^2
K-JIc= 141.8 MPa SQR[m]
SLOPE= 92797 kJ/m^3
INTERCEPT= 93.8 kJ/m^2
T (ASTM)= 65
VALID, E813

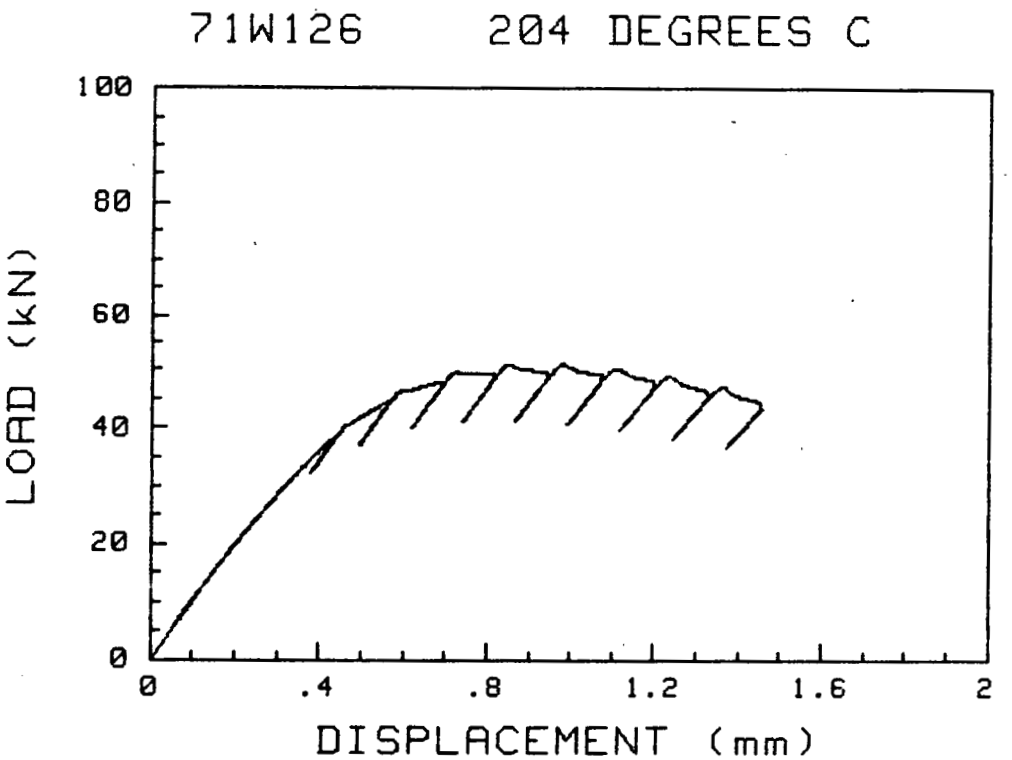
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 265.2 kJ/m^2
POWER= .3763
J-MAX ALLOWED= 535.4 kJ/m^2
RCURVE INVALID, 2

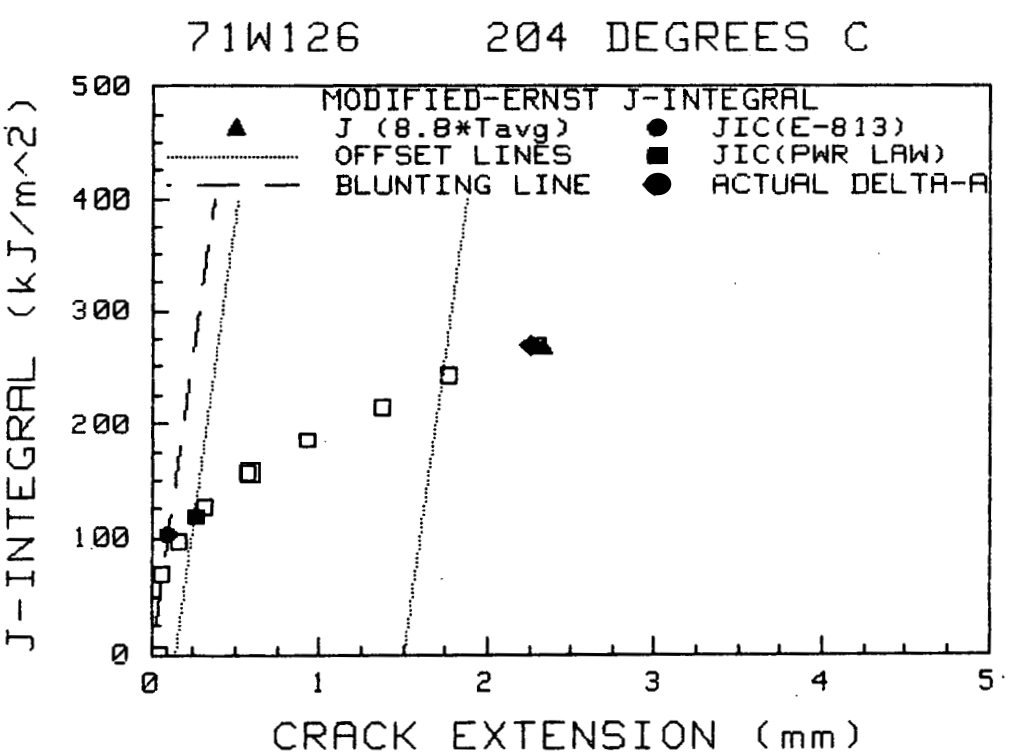
COEFFICIENT= 192.9 kJ/m^2
DELTA-A MAX ALLOWED= 2.28 mm



ORNL-DWG 87-8102



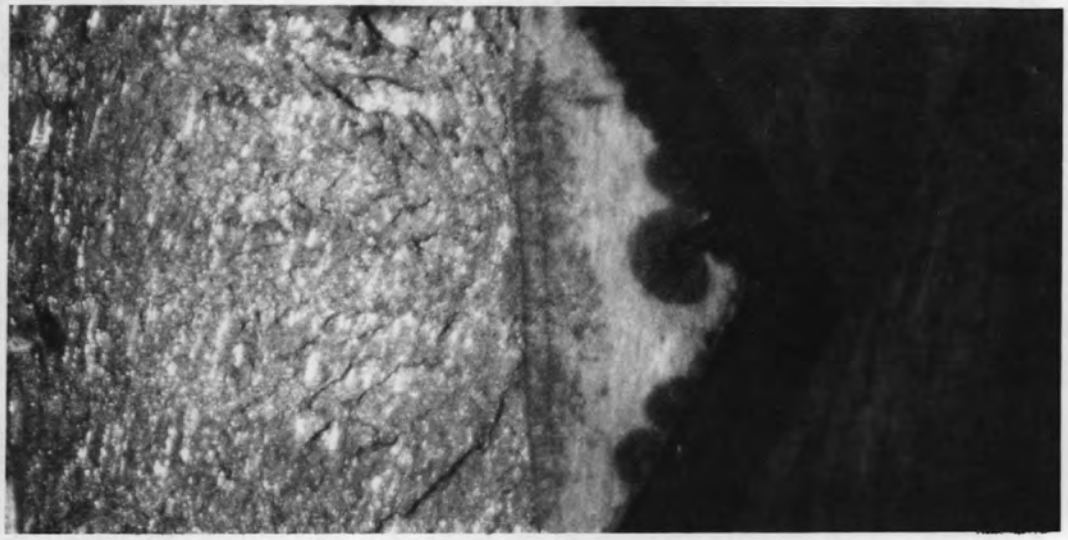
ORNL-DWG 87-8103



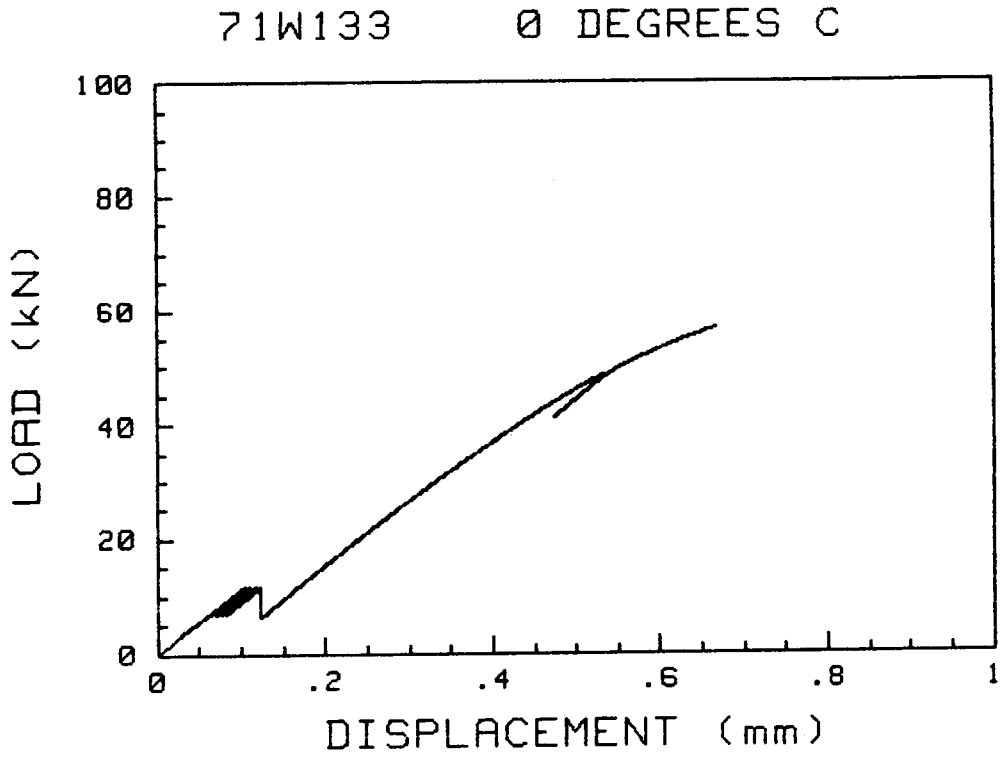
SPECIMEN ID= 71W133
MATERIAL TYPE= A533BW
TEST TEMPERATURE= 0 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.3 mm a/W)i= .537
MEASURED DUCTILE DELTA-A= .16 mm
YIELD STRENGTH= 552 MPa
FLOW STRENGTH= 608 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

SPECIMEN CLEAVED AT K = 108.1 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 74.5 kJ/m^2	J-INTEGRAL= 74.5 kJ/m^2
KJc= 124.3 MPa SQR[m]	KJc= 124.3 MPa SQR[m]
K-beta-c= 84.2 MPa SQR[m]	K-beta-c= 84.2 MPa SQR[m]



ORNL-DWG 87-8104



SPECIMEN ID= 71W134
TEST TEMPERATURE= 121 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 27.4 mm a/W)i= .539
MEASURED DUCTILE DELTA-A= 2.3 mm
YIELD STRENGTH= 492 MPa
FLOW STRENGTH= 546 MPa
ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 167.4 kJ/m^2
KJ-MAX LOAD= 183.1 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 122.3 kJ/m^2
K-JIc= 156.5 MPa SQR[m]
POWER= .4516
COEFFICIENT= 223.9 kJ/m^2
T (AVERAGE)= 71

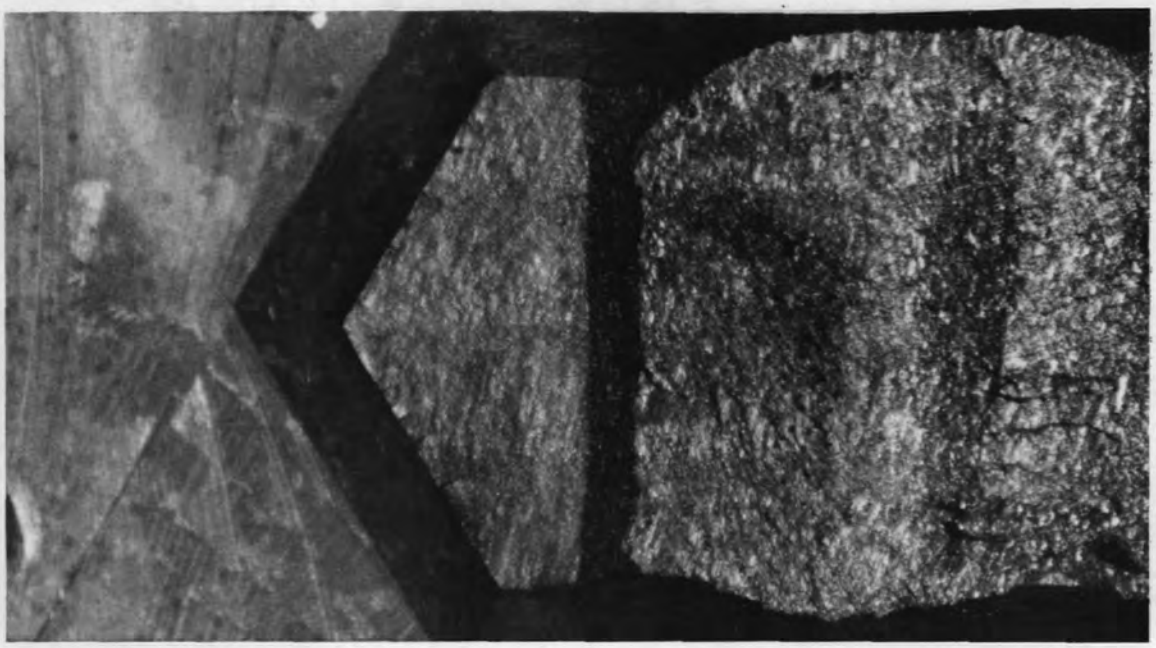
ASTM LINEAR PROCEDURE

JIc= 108.7 kJ/m^2
K-JIc= 147.6 MPa SQR[m]
SLOPE= 117231 kJ/m^3
INTERCEPT= 97 kJ/m^2
T (ASTM)= 79
VALID, E813

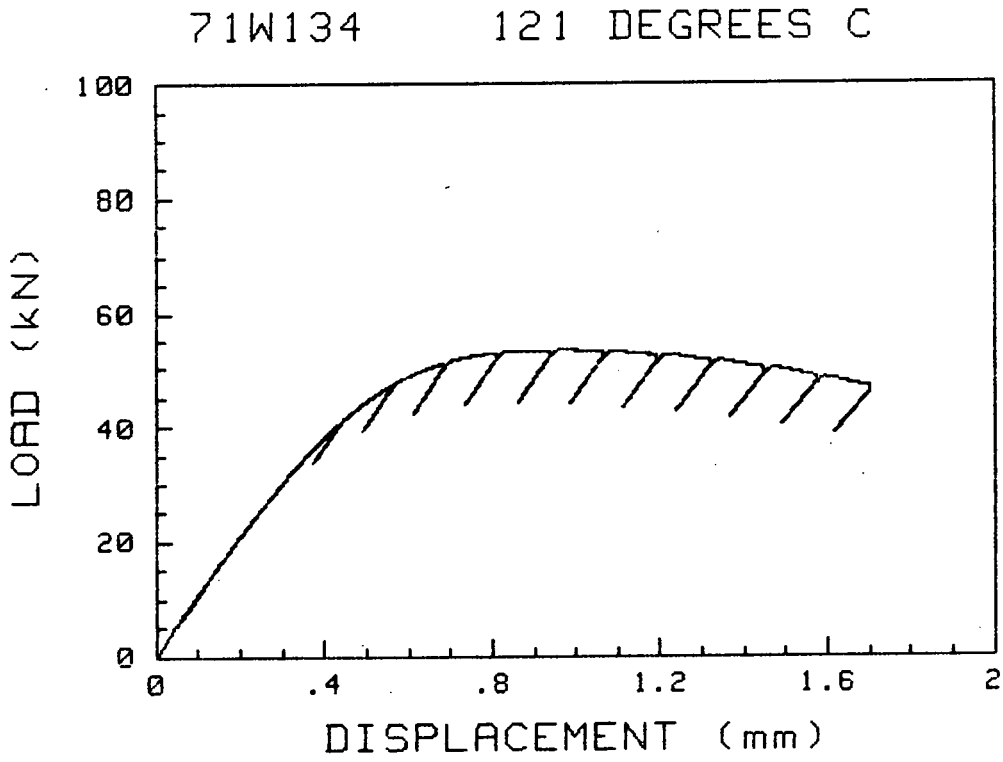
JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 335.1 kJ/m^2
POWER= .4303
J-MAX ALLOWED= 554.2 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 224.1 kJ/m^2
DELTA-A MAX ALLOWED= 2.34 mm



ORNL-DWG 87-8105



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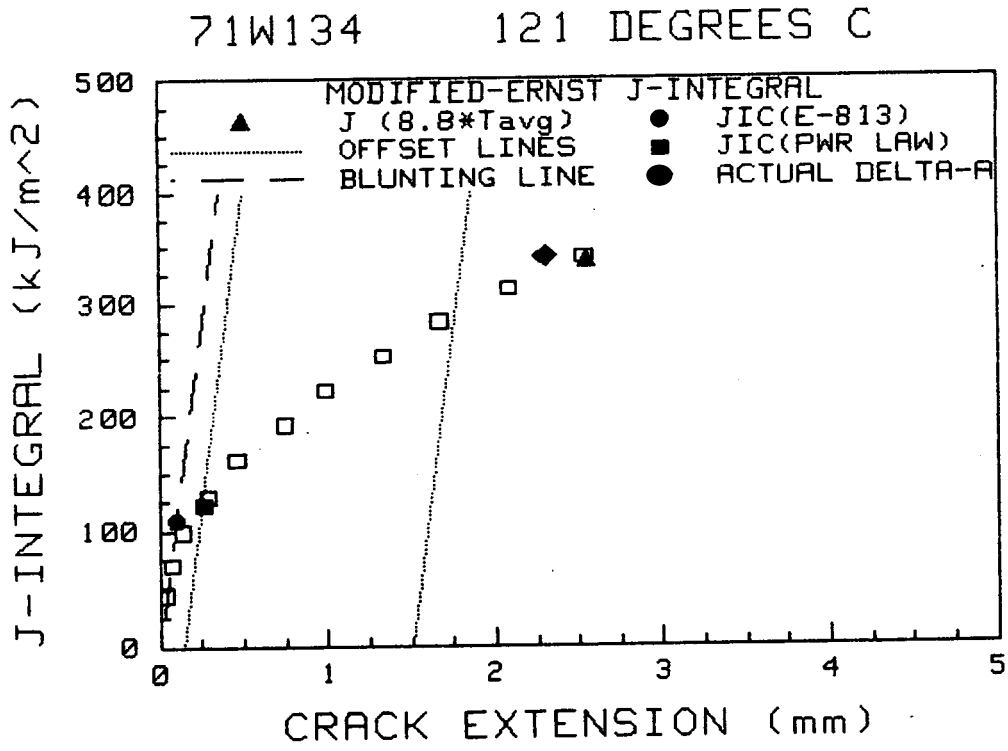


SPECIMEN ID= 71W140
TEST TEMPERATURE= 16 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 28.1 mm a/W)i= .553
MEASURED DUCTILE DELTA-A= .71 mm
YIELD STRENGTH= 547 MPa
FLOW STRENGTH= 603 MPa
ESTIMATED YOUNG'S MODULUS= 206 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 139.7 kJ/m^2
KJ-MAX LOAD= 169.7 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 154.9 kJ/m^2
K-JIc= 178.7 MPa SQR[m]
POWER= .4434
COEFFICIENT= 273 kJ/m^2
T (AVERAGE)= 71

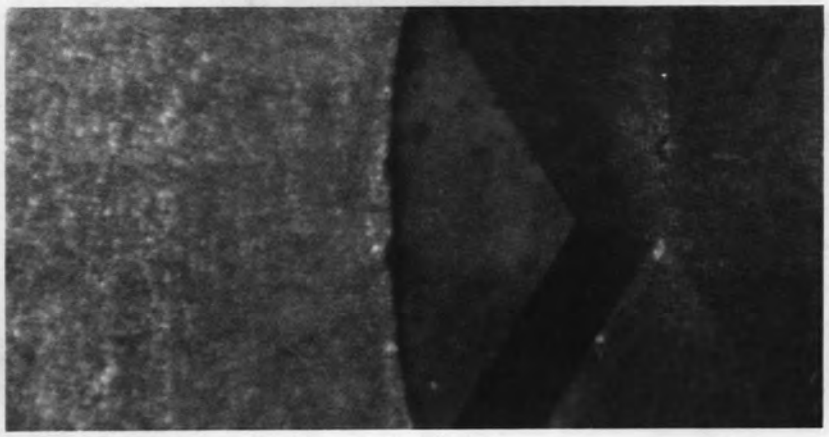
ASTM LINEAR PROCEDURE

JIc= 0 kJ/m^2
K-JIc= 0 MPa SQR[m]
SLOPE= 0 kJ/m^3
INTERCEPT= 0 kJ/m^2
T (ASTM)= 0
INVALID, 1 6

JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 0 kJ/m^2
POWER= 0
J-MAX ALLOWED= 684.2 kJ/m^2
RCURVE INVALID, 2 3

COEFFICIENT= 0 kJ/m^2
DELTA-A MAX ALLOWED= 2.27 mm



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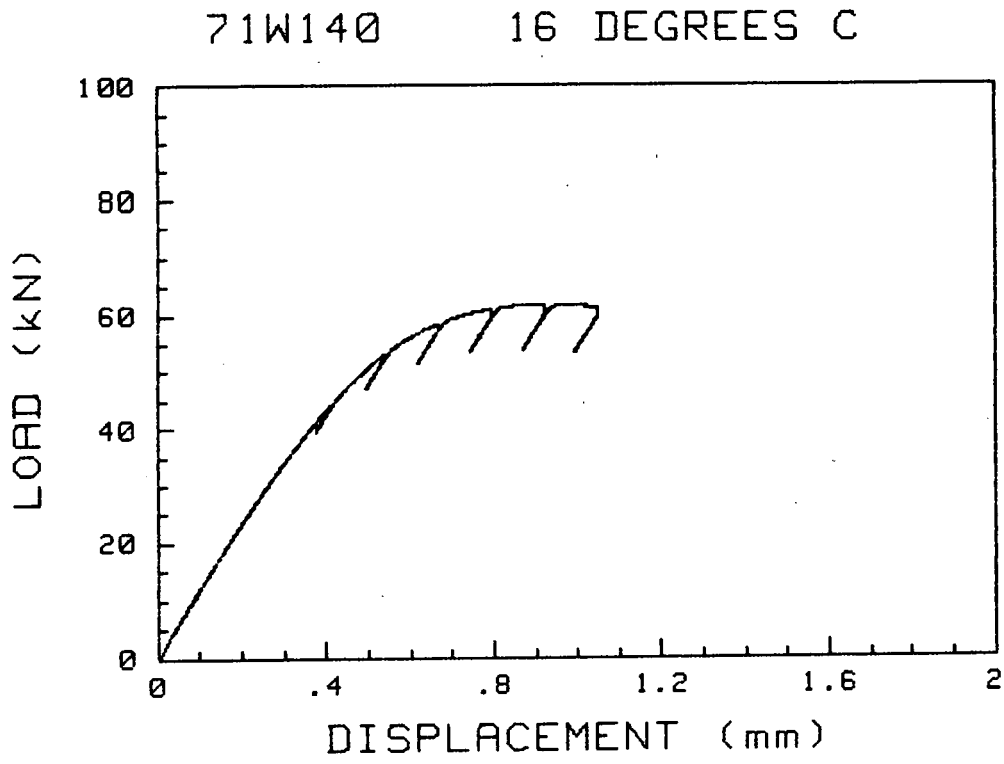

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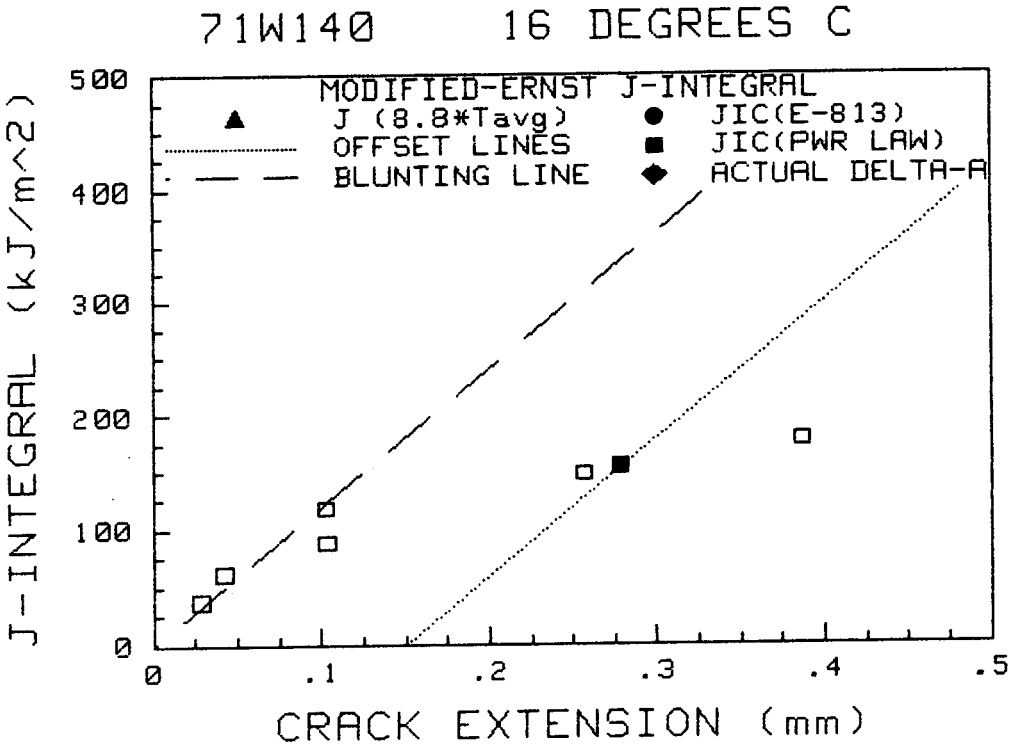
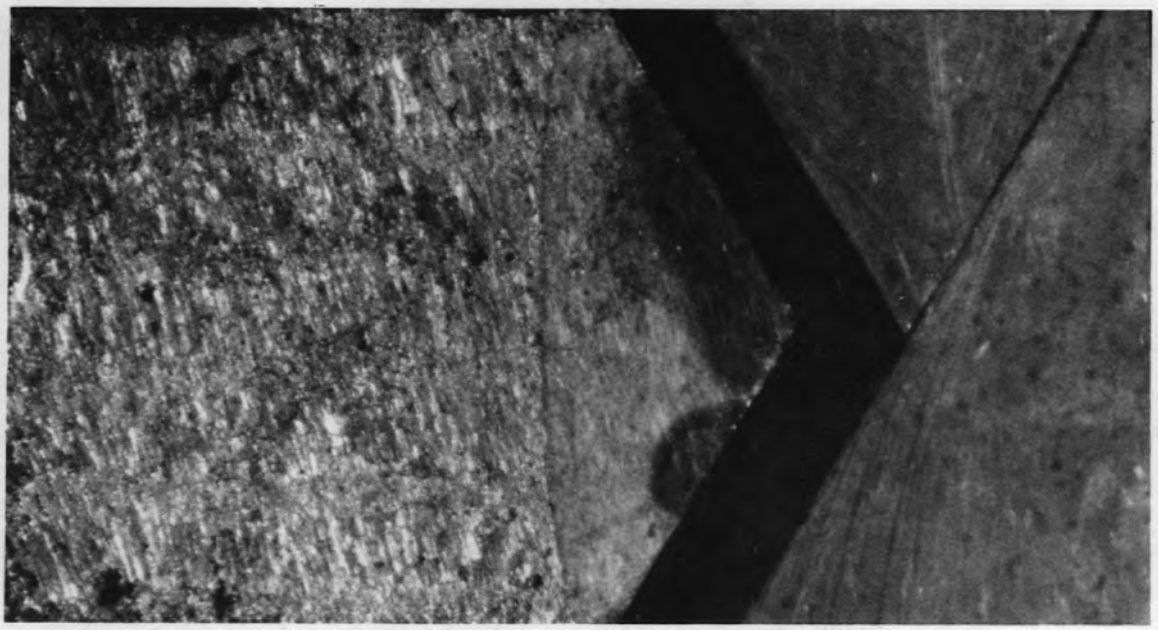


SPECIMEN ID= 71W141
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -70 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.9 mm a/W)i= .548
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 622 MPa
FLOW STRENGTH= 679 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

SPECIMEN CLEAVED AT K = 68.2 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 21.7 kJ/m^2	J-INTEGRAL= 21.7 kJ/m^2
KJc= 67.7 MPa SQR[m]	KJc= 67.7 MPa SQR[m]
K-beta-c= 61.6 MPa SQR[m]	K-beta-c= 61.6 MPa SQR[m]



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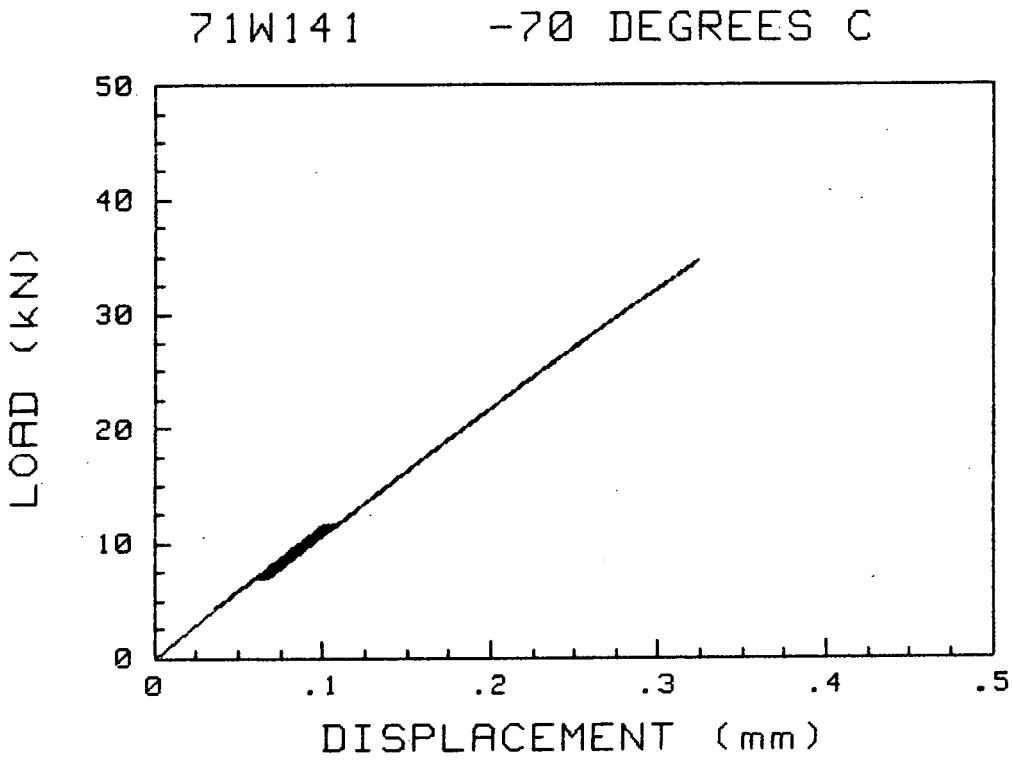


SPECIMEN ID= 71W142
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -30 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.7 mm a/W)i= .546
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 579 MPa
FLOW STRENGTH= 635 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

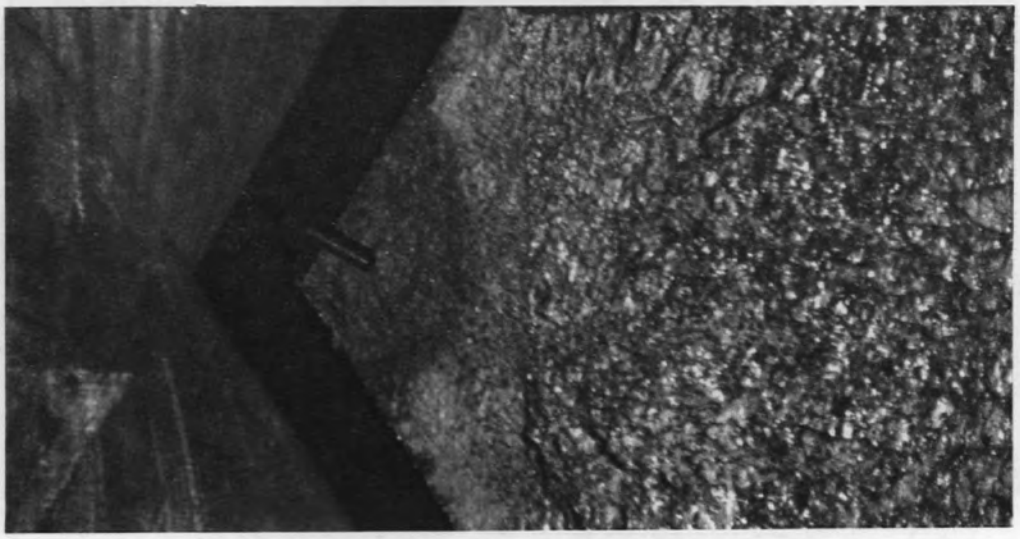
SPECIMEN CLEAVED AT K = 98.9 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 46.8 kJ/m^2
KJc= 98.8 MPa SQR[m]
K-beta-c= 76.6 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 46.6 kJ/m^2
KJc= 98.7 MPa SQR[m]
K-beta-c= 76.5 MPa SQR[m]



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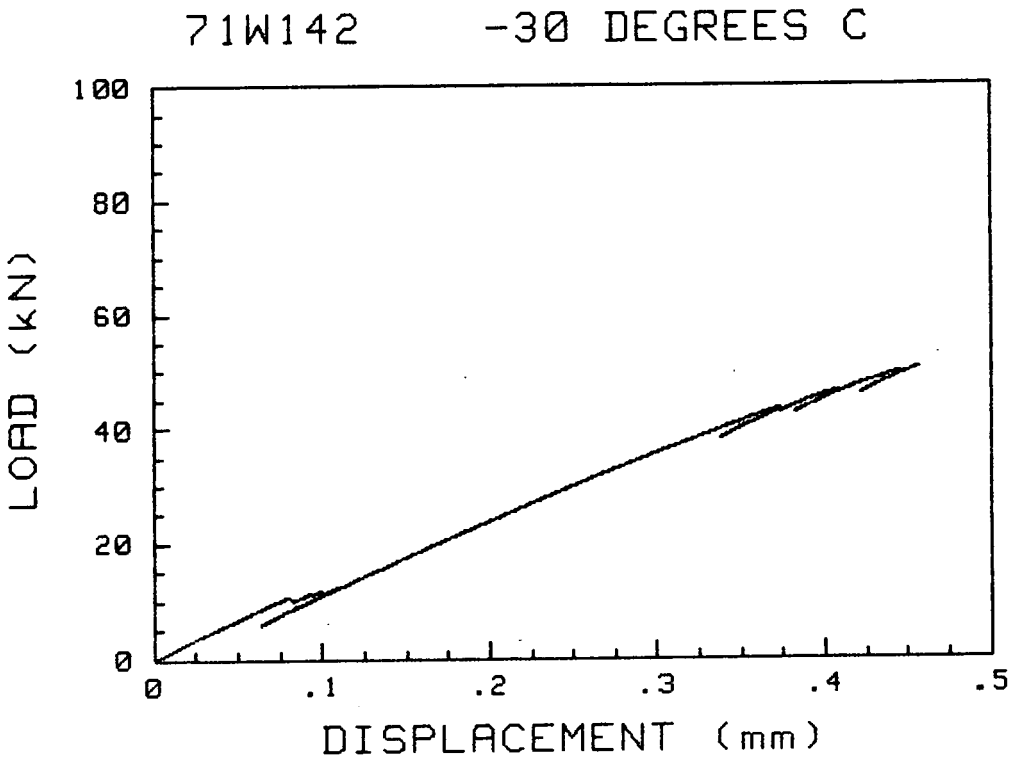
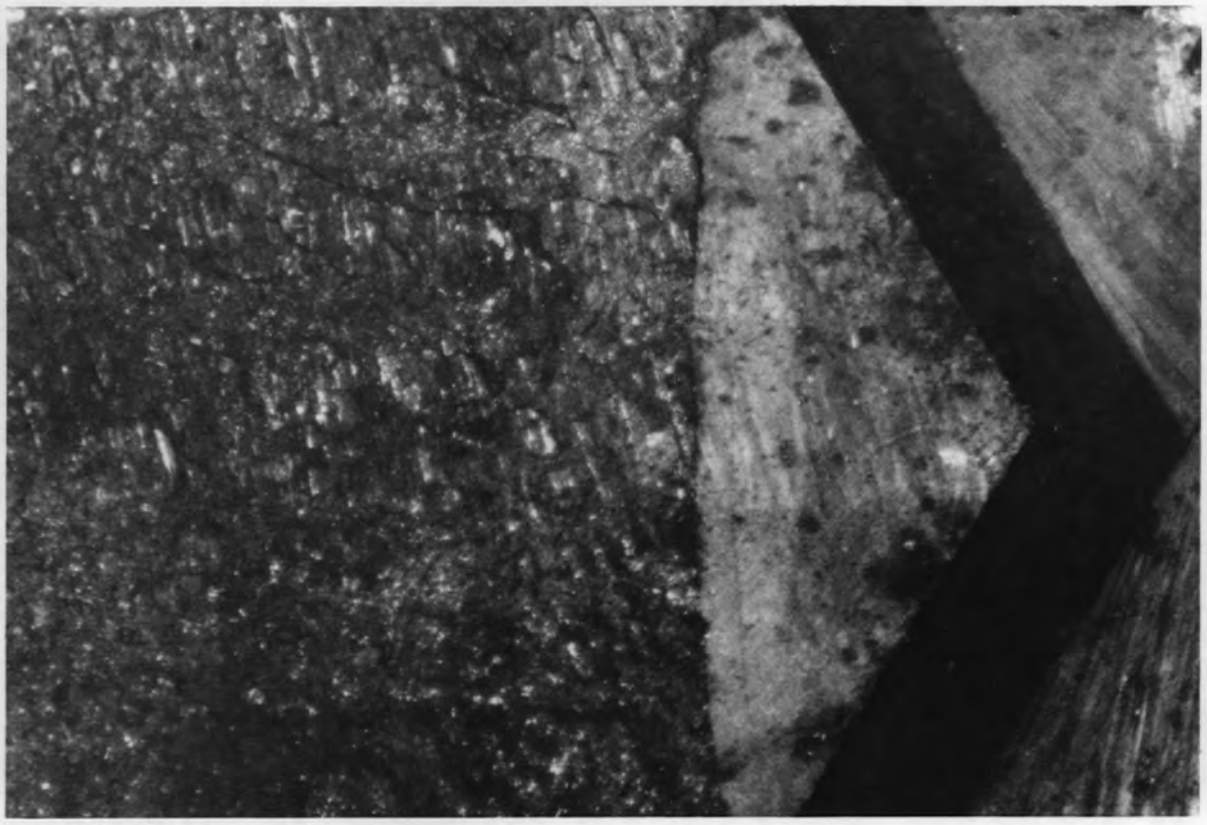


SPECIMEN ID= 71W143
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -73 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.8 mm a/W)i= .548
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 566 MPa
FLOW STRENGTH= 653 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

SPECIMEN CLEAVED AT KIc= 36.6 MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 5.6 kJ/m^2	J-INTEGRAL= 5.6 kJ/m^2
KJc= 34.3 MPa SQR[m]	KJc= 34.3 MPa SQR[m]
K-beta-c= 33.8 MPa SQR[m]	K-beta-c= 33.8 MPa SQR[m]



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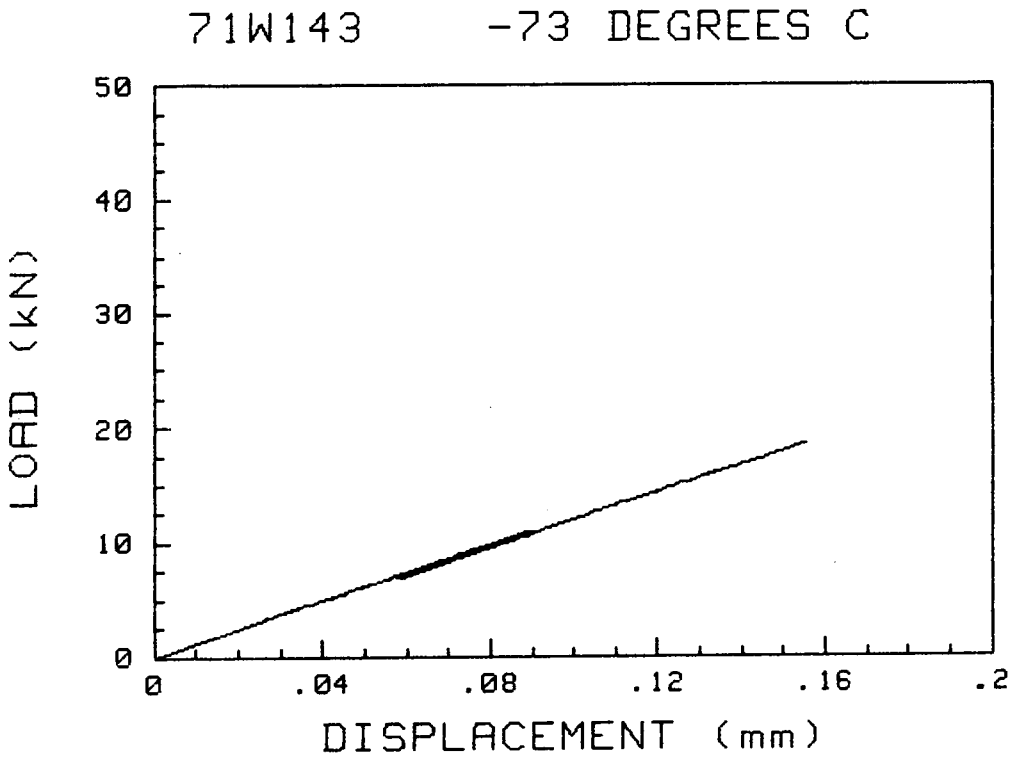
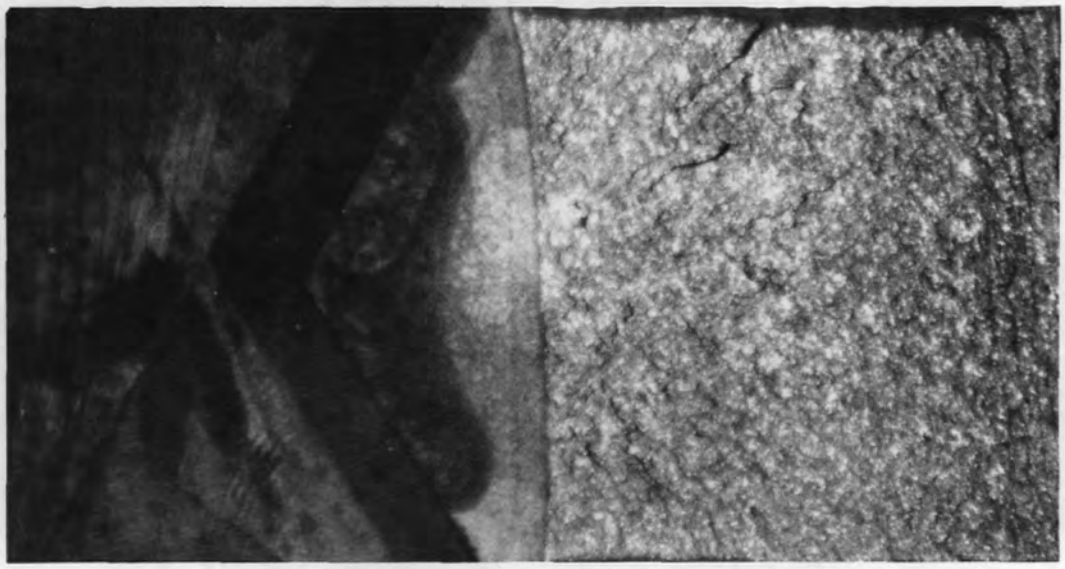


SPECIMEN ID= 71W144
MATERIAL TYPE= A533BW
TEST TEMPERATURE= 0 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.4 mm a/W)i= .54
MEASURED DUCTILE DELTA-A= .18 mm
YIELD STRENGTH= 552 MPa
FLOW STRENGTH= 608 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

SPECIMEN CLEAVED AT K = 117 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD	VALUES AT CLEAVAGE LOAD
J-INTEGRAL= 123.6 kJ/m^2	J-INTEGRAL= 125.1 kJ/m^2
KJc= 160 MPa SQR[m]	KJc= 161 MPa SQR[m]
K-beta-c= 94.5 MPa SQR[m]	K-beta-c= 94.8 MPa SQR[m]



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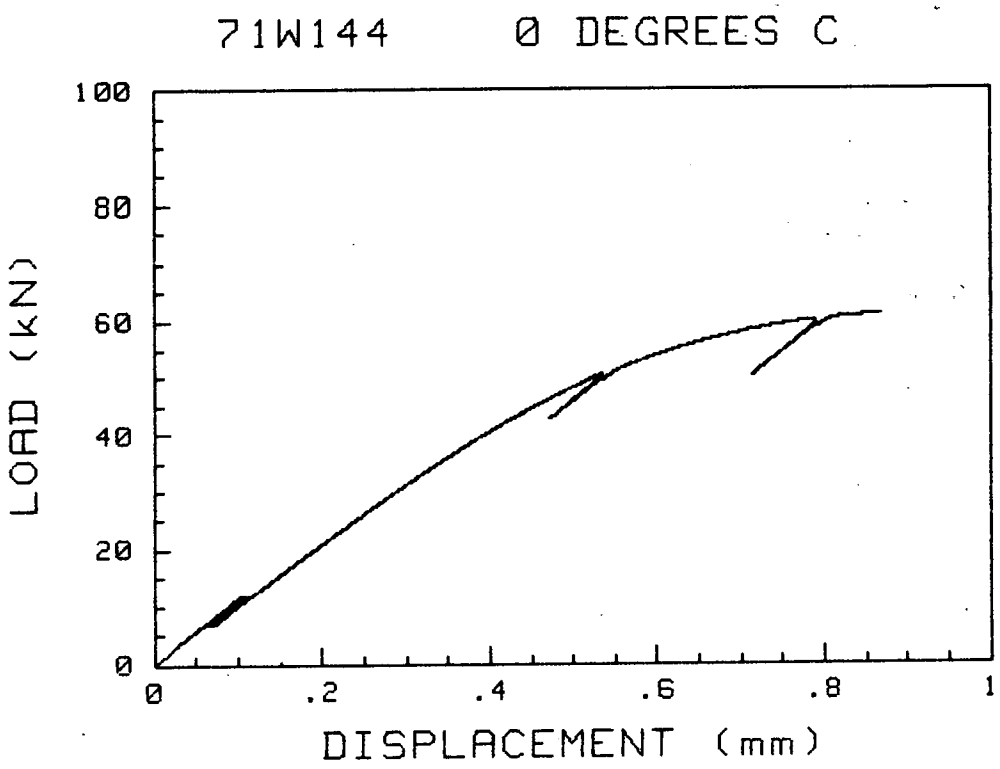


SPECIMEN ID= 71W146
TEST TEMPERATURE= 50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 26.5 mm a/W)i= .522
MEASURED DUCTILE DELTA-A= 1.45 mm
YIELD STRENGTH= 526 MPa
FLOW STRENGTH= 580 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN CLEAVED AT K = 103.3 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 155.9 kJ/m^2
KJc= 178.5 MPa SQR[m]
K-beta-c= 90.2 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 243.7 kJ/m^2
KJc= 223.2 MPa SQR[m]
K-beta-c= 98.4 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 97 kJ/m^2
K-JIc= 140.8 MPa SQR[m]
POWER= .5022
COEFFICIENT= 201.4 kJ/m^2
T (AVERAGE)= 65

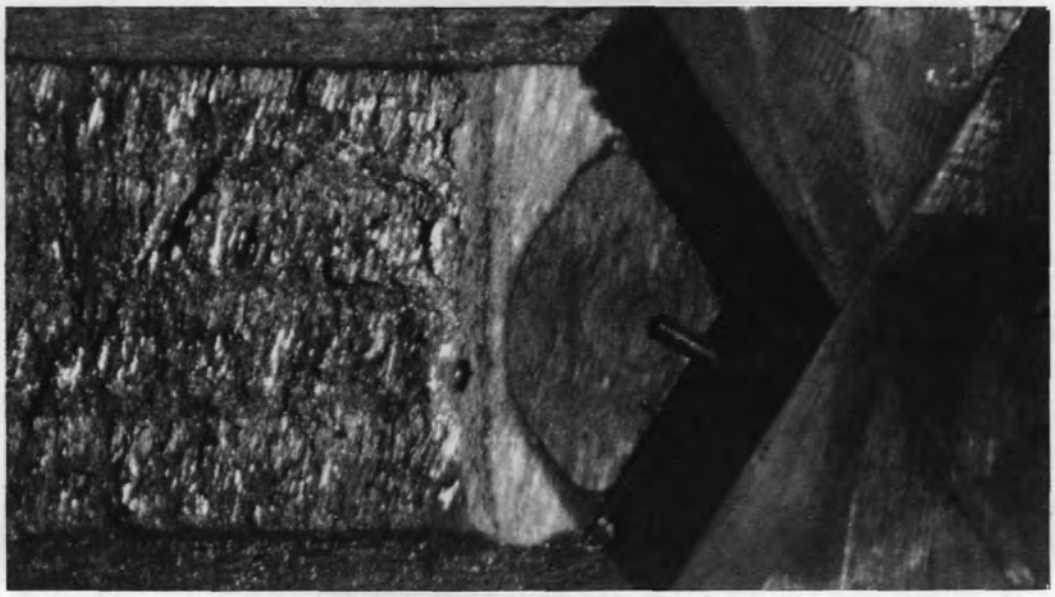
ASTM LINEAR PROCEDURE

JIc= 74.7 kJ/m^2
K-JIc= 123.5 MPa SQR[m]
SLOPE= 127794 kJ/m^3
INTERCEPT= 66.5 kJ/m^2
T (ASTM)= 78
VALID, E813

JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 341 kJ/m^2
POWER= .5238
J-MAX ALLOWED= 589.7 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 199 kJ/m^2
DELTA-A MAX ALLOWED= 2.43 mm



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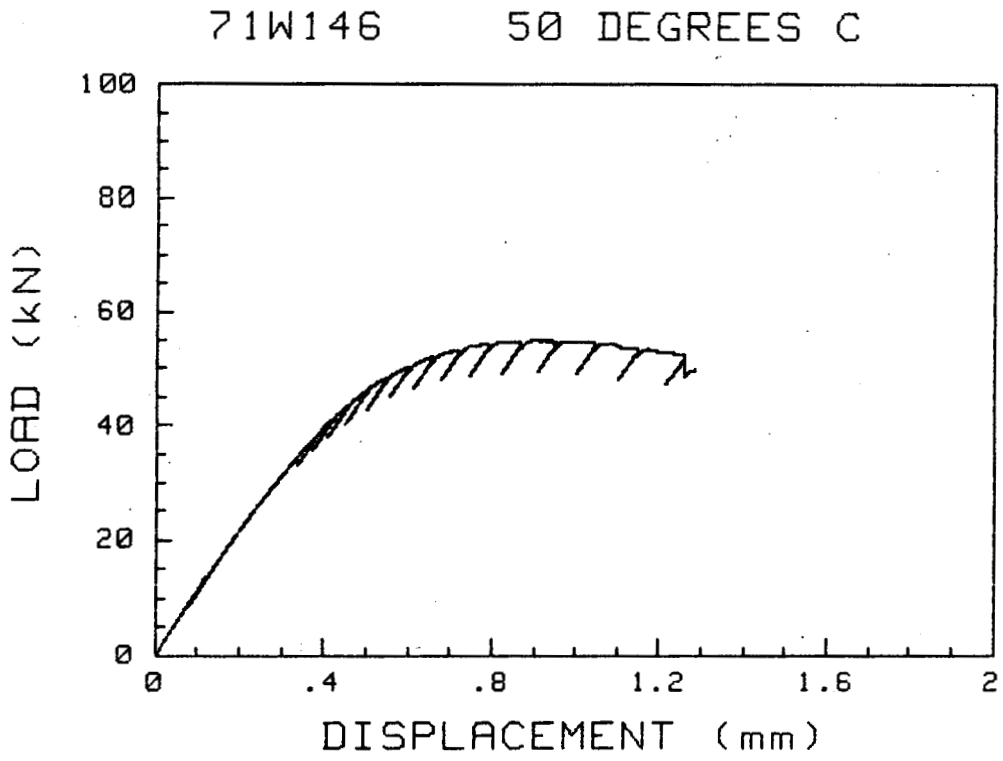

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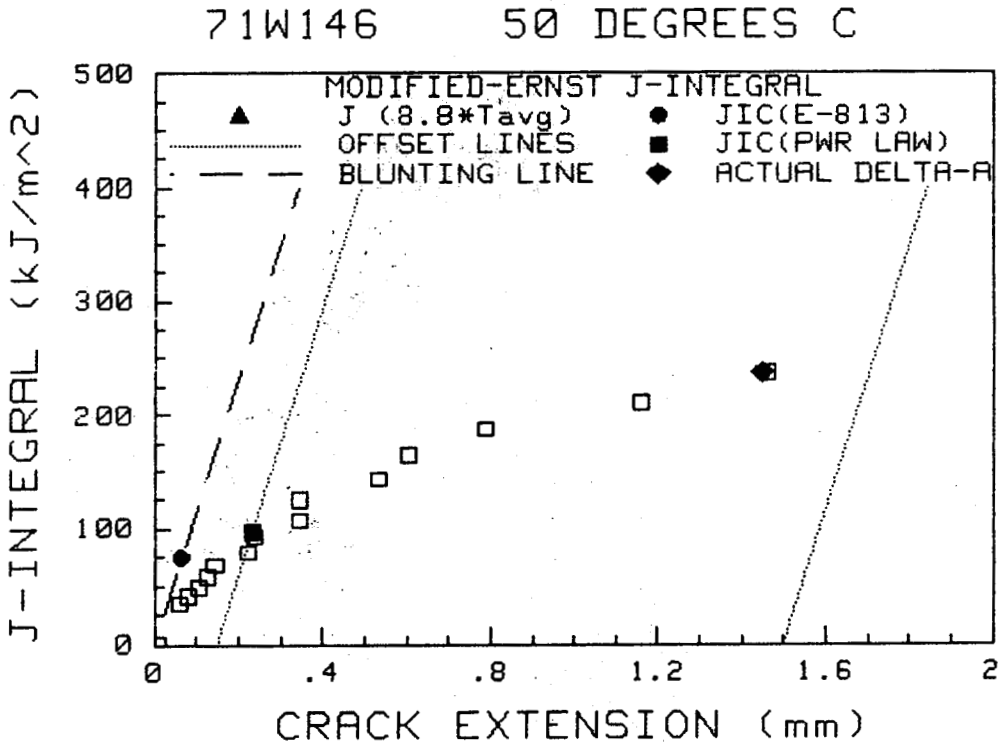


SPECIMEN ID= 71W147
TEST TEMPERATURE= 288 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 20 %
INITIAL CRACK LENGTH= 27.8 mm a/W)i= .547
MEASURED DUCTILE DELTA-A= 2.31 mm
YIELD STRENGTH= 465 MPa
FLOW STRENGTH= 533 MPa
ESTIMATED YOUNG'S MODULUS= 191 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 155.8 kJ/m^2
KJ-MAX LOAD= 172.4 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 104.1 kJ/m^2
K-JIc= 141 MPa SQR[m]
POWER= .3704
COEFFICIENT= 174.6 kJ/m^2
T (AVERAGE)= 47

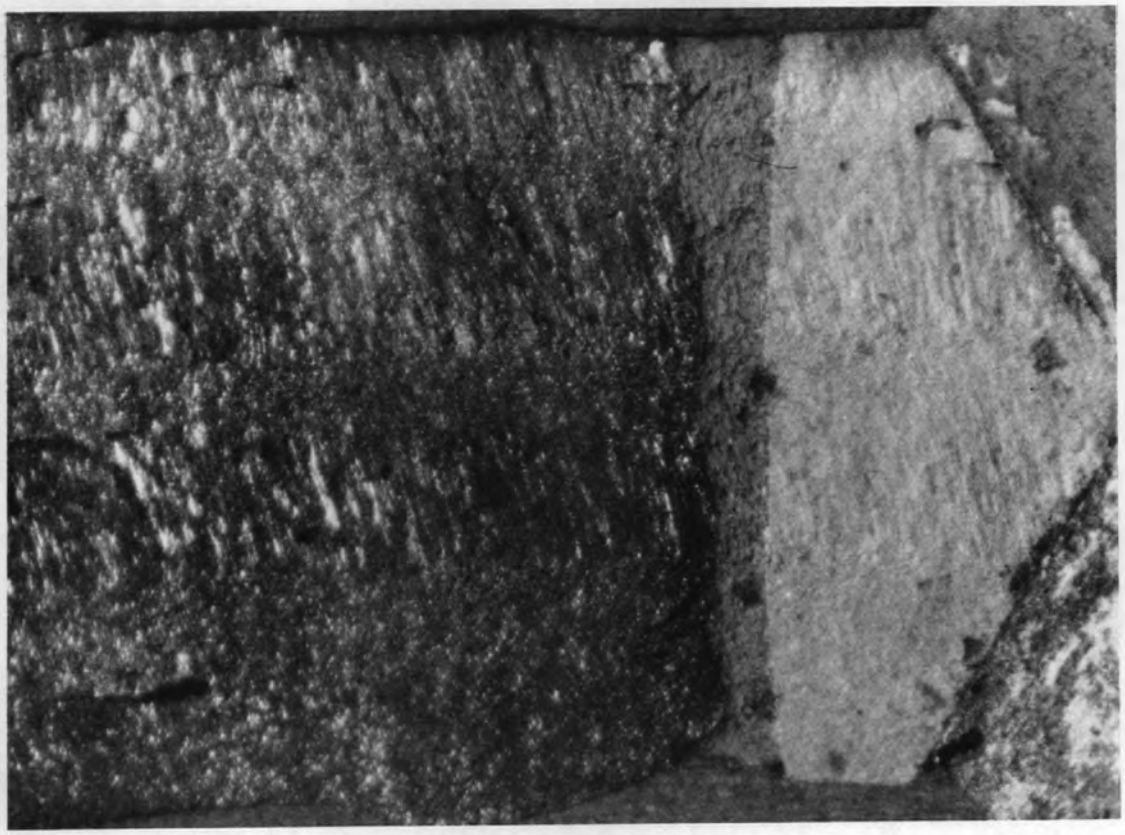
ASTM LINEAR PROCEDURE

JIc= 95.9 kJ/m^2
K-JIc= 135.2 MPa SQR[m]
SLOPE= 80652 kJ/m^3
INTERCEPT= 88.6 kJ/m^2
T (ASTM)= 54
VALID, E813

JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 234.1 kJ/m^2
POWER= .3676
J-MAX ALLOWED= 541.1 kJ/m^2
RCURVE INVALID, 2

COEFFICIENT= 175.9 kJ/m^2
DELTA-A MAX ALLOWED= 2.3 mm



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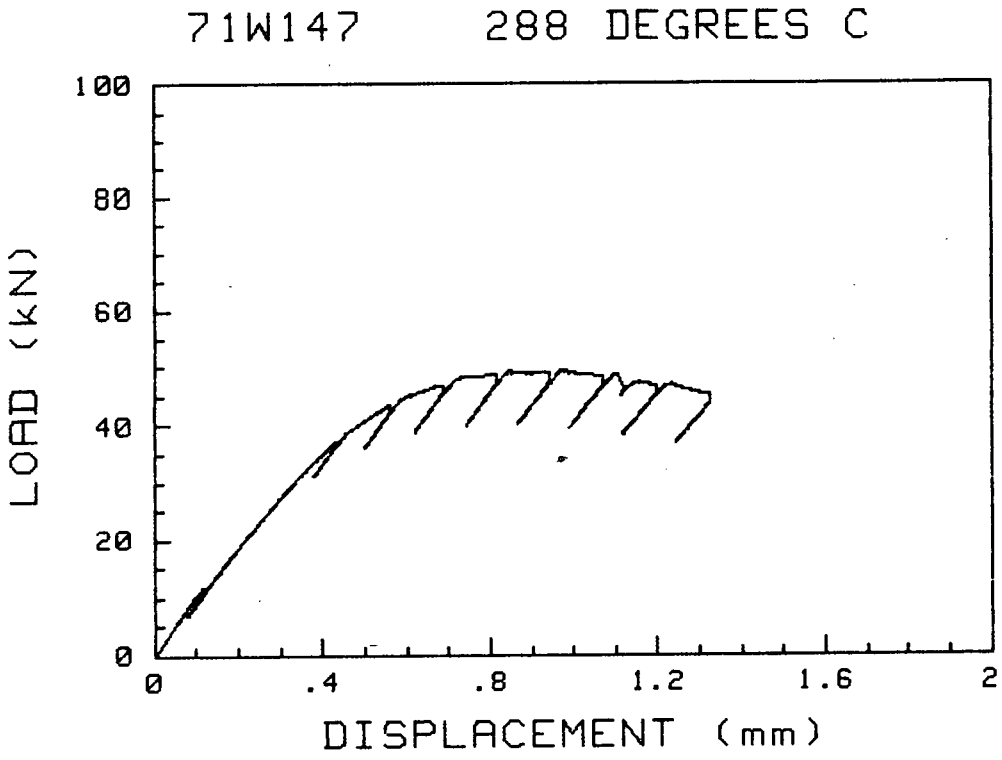

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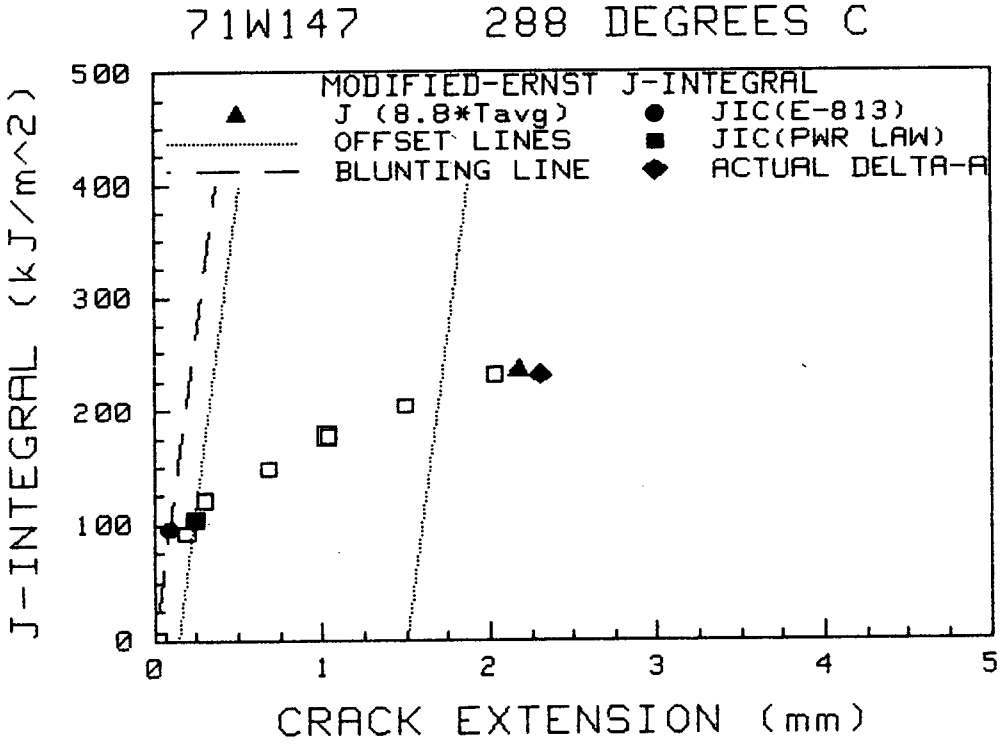

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13. ABSTRACT (200 words or less)

Studies of the effects of neutron irradiation on fracture toughness properties of steels have generally included a minimum number of tests for each material condition. The present study attempts to apply statistical analyses, with multiple testing at selected temperatures, to assess the accuracy and reliability of the results. Fracture toughness test specimens were irradiated in the Bulk Shielding Reactor at Oak Ridge National Laboratory at 288°C to target neutron fluences of 2×10^{23} neutrons/m^2 (>1 MeV). The materials were ASTM A533 grade B class 1 plate (HSST Plate 02) and four submerged-arc welds representing the current fabrication practice for nuclear pressure vessels. Both unirradiated and irradiated specimens were tested by two separate laboratories, and multiple tests were conducted at selected temperatures. Statistical analyses permitted the determination of material and test variability and an interlabo-ratory comparison. Behavior in both the transition and ductile-shelf regions was studied. The results demonstrated the relatively low radiation sensitivity of low copper/nickel welds and the qualitative agreement between Charpy impact and fracture toughness observations of toughness degradation.

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