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**OAK RIDGE
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LABORATORY**

MARTIN MARIETTA

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

J. J. McGowan
R. K. Nanstad
K. R. Thoms

Prepared for the
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MARTIN MARIETTA ENERGY SYSTEMS, INC.
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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

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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/m² (>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 INDEXK_{Ic} (ASTM E399)

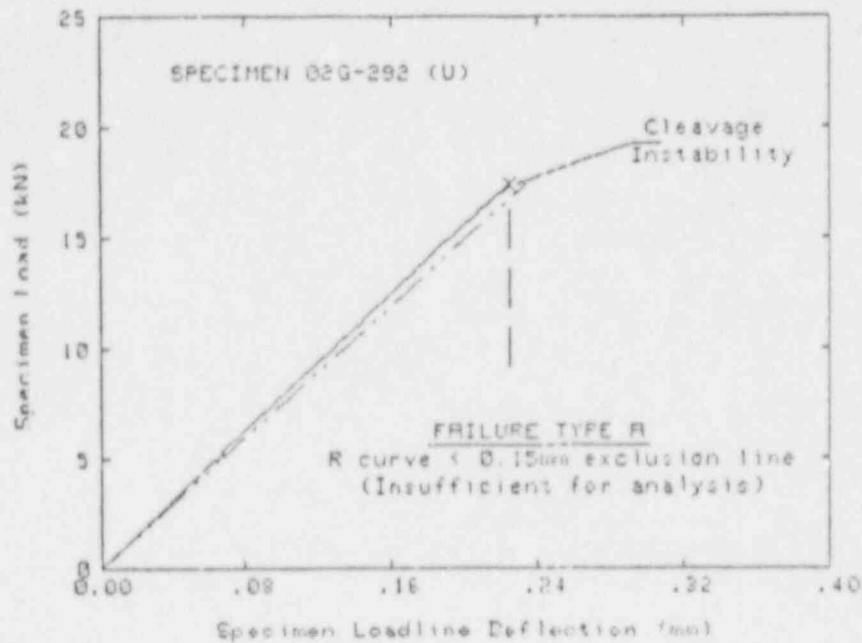
1. $K_{Ic} > \sigma_{ys} * \sqrt{a_0/2.5}$
2. $K_{Ic} > \sigma_{ys} * \sqrt{(B*B_N)^{0.5}/2.5}$
3. $P_{Max}/P_Q > 1.1$

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. $b_0 < 25 J_Q/\sigma_y$

Tentative J_I - R Curve Procedure

1. < 3 data points between $(\text{delta-a})=0$ and secant line
 $[J=4/3*\sigma_y*(\text{delta-a})]$
2. < 10 data points between secant line and $(\text{delta-a})_{max}$
 $[0.1*b_0]$
3. (delta-a) prediction error too large,
 $|(\text{delta-a})_{pred} - (\text{delta-a})_{meas}| >$
 $\text{MINIMUM } [0.15*(\text{delta-a})_{meas}, 0.15*(\text{delta-a})_{max}]$



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 * 212000 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

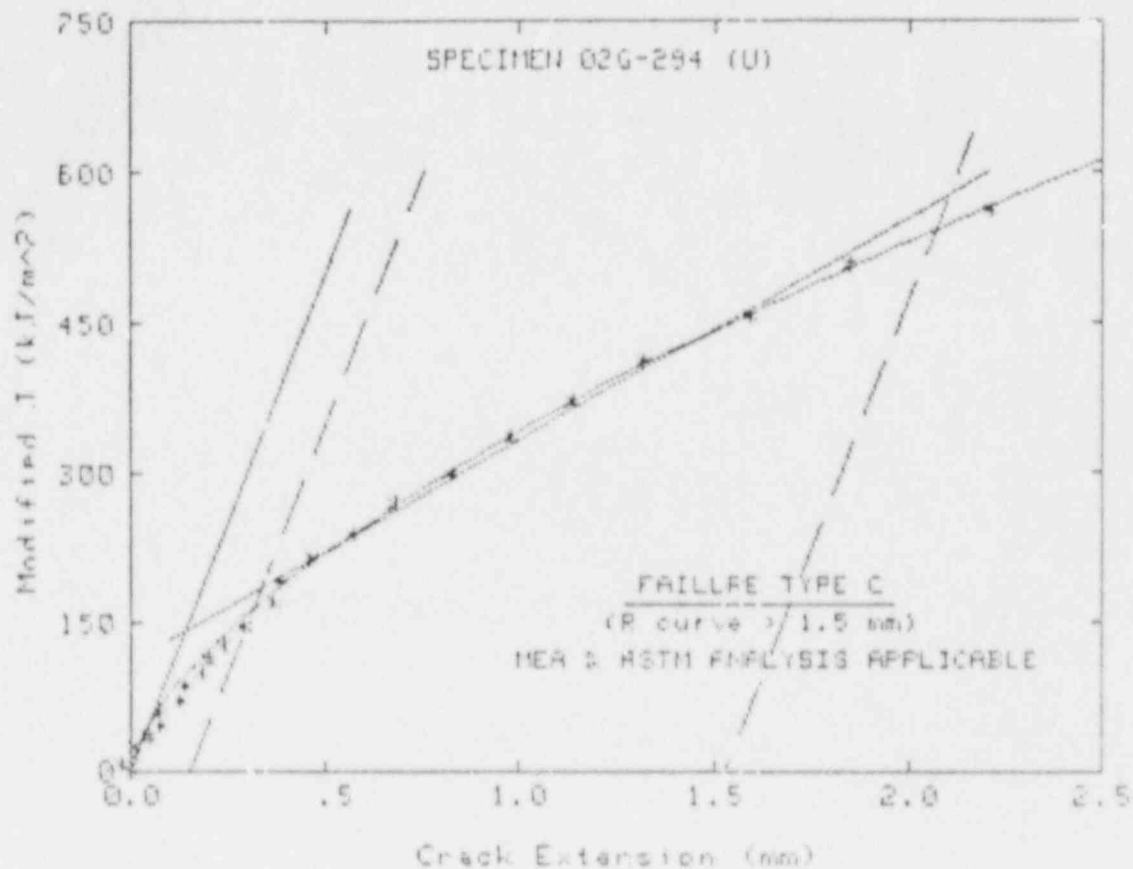
Failure Type R (J at instability = J_{ic})
 J_{ic} * 8.8 kJ/m²
 K_{Jc} (EJ_{ic})^{1/2} * 43.2 MPa √m √E
 K_{Jc} (Beta Corrected) * 42.1 MPa √m √E

ASTM E399-81 ANALYSIS

Modified K_{Jc} Equation; B = (EJ_{ic})^{1/2}
 Maximum Load P * 17.41 kN
 1% Secant Offset P_q * 17.41 kN
 K_{Jc} * 44.4 MPa √m
 Validity * VALID K_{Jc} value

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Ferlie-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = -2.46655535750E-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 = A500-B PLATE 02
 Test Temperature = 121 °C
 Percent Side Groove = 20 %
 Specimen Thickness = 25.4 mm
 Init crack length = 31.65 mm
 Final crack length = 40.6 mm
 Flow stress = 500.2 MPa
 Young's modulus = 200000 MPa

Init a/W = .623

Final a/W = .799

(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

J_{ic} = 164.3 kJ/m²
 K_{jc} = 181.4 $J (91-1)^{0.83}$
 Exponent n = .6362
 Coefficient C = 341.4 kJ/m²
 T (coverage) = 168

= 752.6 kJ/m²

LEAST SQUARE LINEAR LINE (ASTM) $J = H (\Delta a) + B$

J_{ic} = 141.6 kJ/m²
 K_{jc} = 168.4
 Intercept B = 110.2 kJ/m²
 T (ASTM) = 178

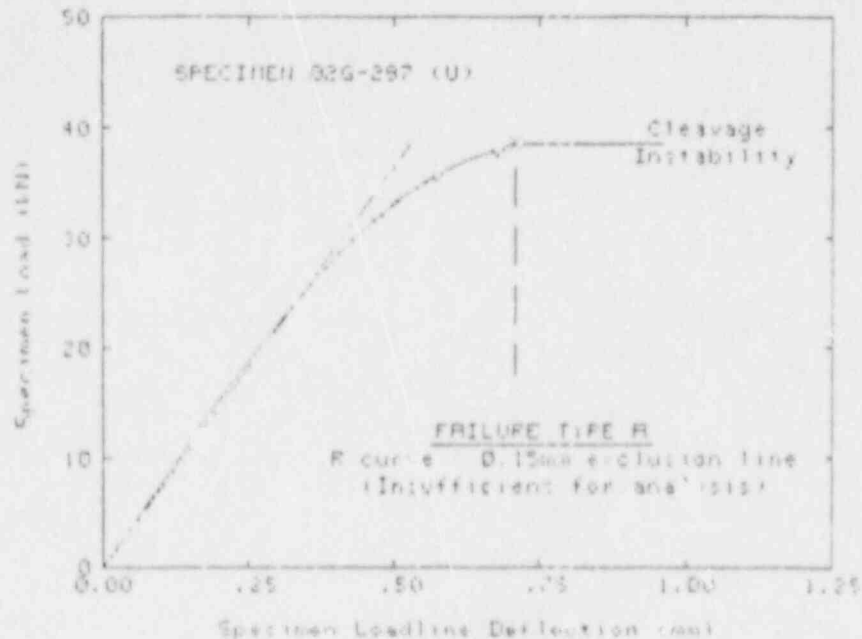
Slope H = 222003.2 kJ/m³

Validity (J_{ic}) = VALID

Validity (R-curve) = INVALID--3 (.3 vs .28)

J maximum allowed = 478.6 kJ/m² ($J_{max} = \text{Init} \times \text{Flow stress} / 20$)

Δa max. allowed = 1.91 mm ($\Delta a \text{ max} = 0.1 \times b_0$)



TEST SPECIMEN DATA

Material Type * A530-B PLATE 02
 Test Temperature * -5 °C
 Percent Side Groove * 0.5
 Specimen Thickness B * 25.4 mm
 Initial a-U * .619
 Init crack length a * 31.44 mm
 Flow stress * 573.4 MPa
 Yield stress * 496.1 MPa
 Young's modulus E * 207500 MPa (Estimated Value)

1-INTEGRAL ANALYSIS

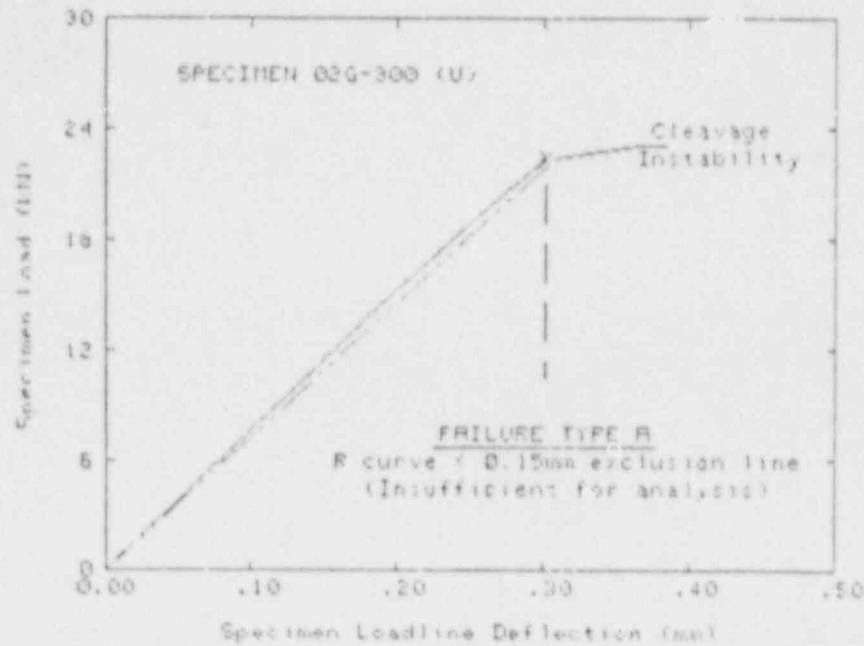
Failure Type W = 3 at instability = Jic
 Jic * 74.2 kJ/m²
 EJC(EJic)/.5 * 124.1 MPa · m W = W_{1,3}
 Kic (Beta Corrected) * 79.5 MPa · m W = W_{1,3}

ASTM E399-91 ANALYSIS

Modified Kic Equation: B = (BEJC)/.5
 P_{max} Load P * 33.63 kN
 5% Secant Offset P_Q * 23.55 kN
 Kic * 60.6 MPa · m
 Validity * INVALID=1, 2, 3

DATA CORRECTIONS USED FOR 1-INTEGRAL DATA

Finite-Strain OFFSET LOADS 0.16 OFFSET DEFLECTION * 5.44519194175E-04 m.
 Specimen rotation Load intercept elastic slope * 2.27142357141E-07 1/m
 Fitted elastic load range 2000 to 600 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type * A535-B PLATE 02
 Test Temperature * -95 °C
 Percent Side Groove * 0.5
 Specimen Thickness B * 25.4 mm
 Initial a/W * 0.23
 Init crack length a * 31.65 mm
 Flow stress * 671.5 MPa
 Yield stress * 592.9 MPa
 Young's modulus E * 210000 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

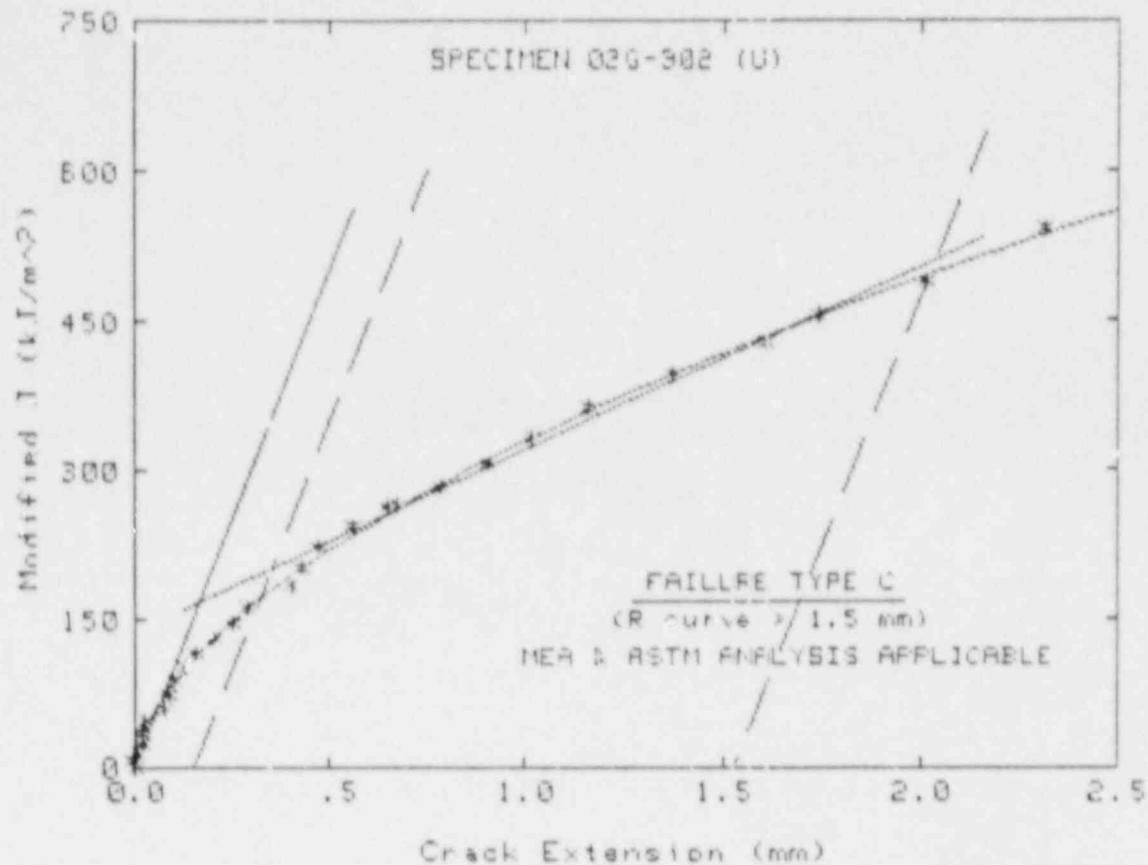
Failure Type A (J at instability) = J_{IC}
 J_{IC} * 15.6 kJ/m²
 K_{IC} = E'J_{IC}^{0.5} * 57.6 MPa√m (vs. 3)
 K_{IC} (Beta Corrected) * 55.6 MPa√m (vs. 3)

ASTM E199-01 ANALYSIS

Modified E' Equation: E' = (E/E')^{0.5}
 Maximum Load P * 22.44 lbf
 0.2% Secant Offset P_{0.2} * 22.44 lbf
 P_{IC} * 50.7 MPa√m
 Validity * VALID P_{IC} value

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Parabolic-corrected OFFSET LOADS 0.16 OFFSET DEFLECTION = 5.607992070710E-05 in.
 Specimen rotation Load intercept elastic slope = 2.57140557140E-08 lb
 Fitted elastic load range 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

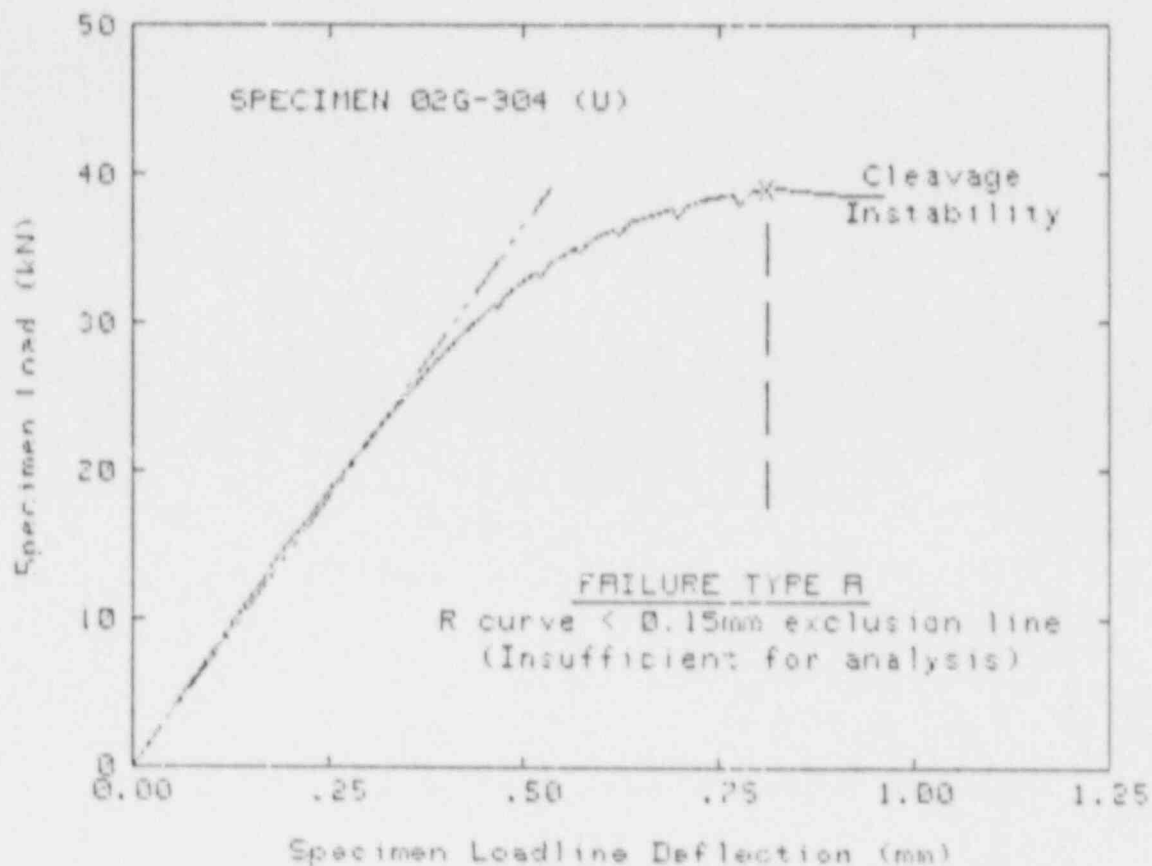
Material Type	= A533-B PLATE 02	
Test Temperature	= 121 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.41 mm	Init a/W = .618
Final crack length	= 41 mm	Final a/W = .807
Flow stress	= 500.2 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

J _{IC}	= 170.2 kJ/m ²	
K _{JC}	= 184.6	J (ΔJ/1=8.8) = 746.3 kJ/m ²
Exponent n	= .5825	
Coefficient C	= 328.9 kJ/m ²	
n (average)	= 149	

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

J _{IC}	= 167 kJ/m ²	
K _{JC}	= 182.9	Slope M = 183860.6 kJ/m ³
Intercept B	= 136.3 kJ/m ²	
n (ASTM)	= 147	
Validity (J _{IC})	= VALID	
Validity (R-curve)	= INVALID--3 (.52 vs .29)	
J maximum allowed	= 484.5 kJ/m ²	(J _{max} =B _{net} *Flow stress/20)
Δa max. allowed	= 1.94 mm	(Δa 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

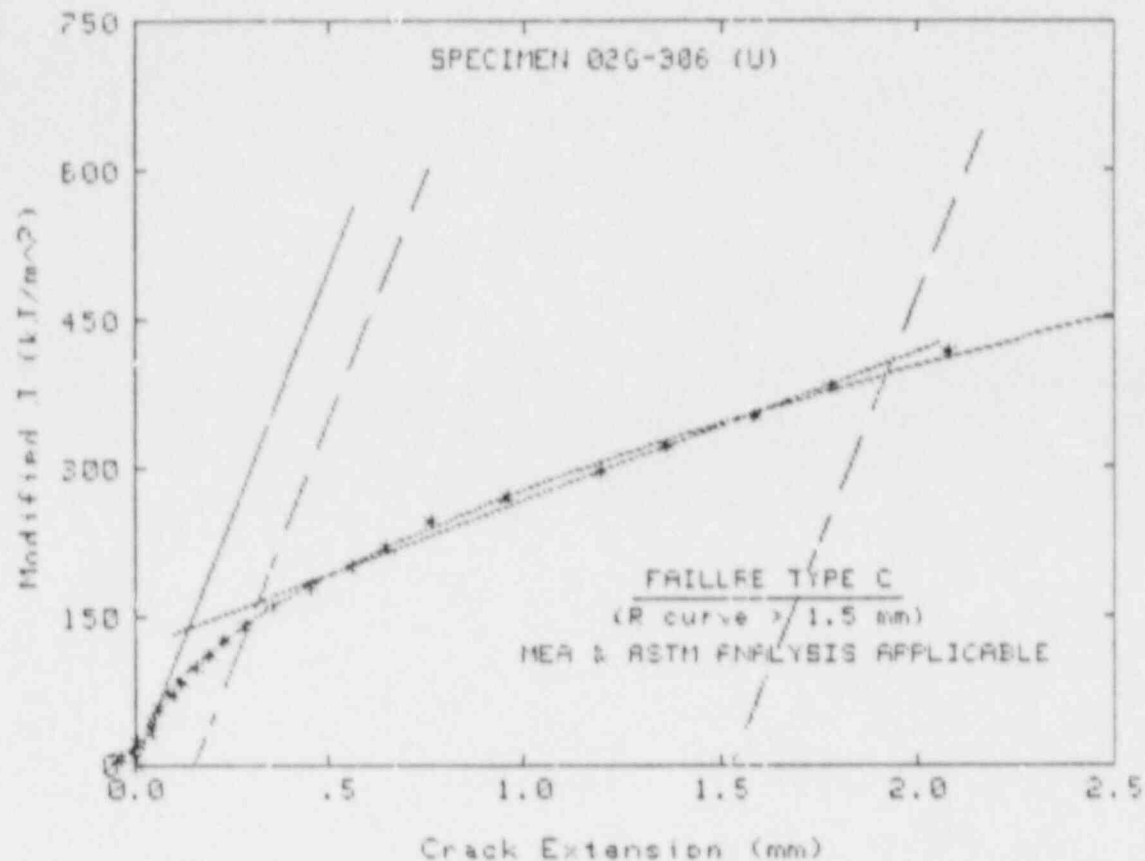
Failure Type A (J at instability = J_{ic})
 J_{ic} = 90.6 kJ/m²
 K_{Jc} = (EJ_{ic})^{0.5} = 137.2 MPa √m $\psi=0.3$
 K_{ic} (Beta Corrected) = 83.2 MPa √m $\psi=0.3$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{0.5}
 Maximum Load P = 39.01 kN
 5% Secant Offset P_Q = 22.9 kN
 K_{ic} = 59 MPa √m
 Validity = INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Berkle-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
 Final crack length = 41.84 mm
 Flow stress = 498.3 MPa
 Young's modulus = 195500 MPa

Init a/W = .62
 Final a/W = .823

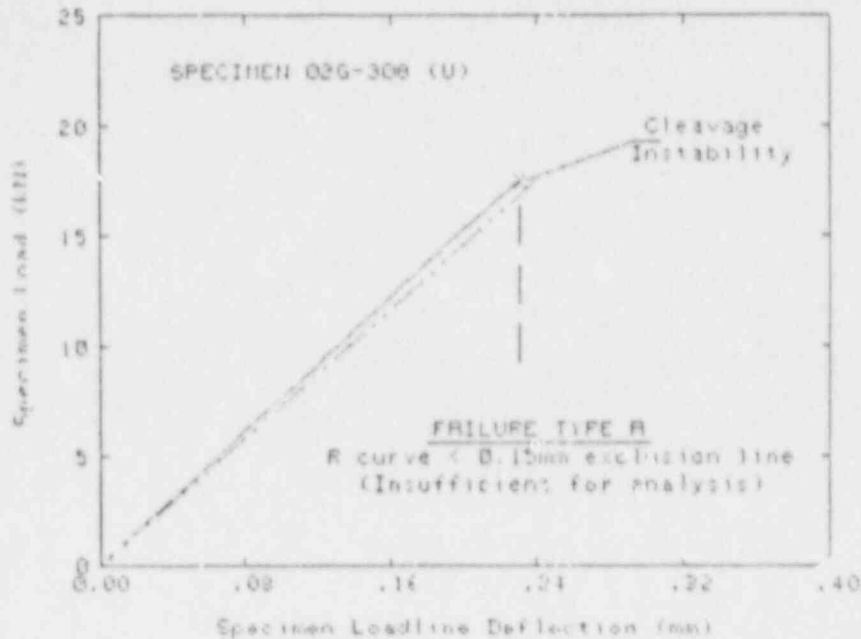
(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

J_{ic} = 145.1 kJ/m²
 K_{ic} = 168.4 J (0J/1=0.8) = 558.4 kJ/m²
 Exponent n = .5355
 Coefficient C = 277.4 kJ/m²
 I (average) = 117

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

J_{ic} = 139.8 kJ/m²
 K_{ic} = 165.3 Slope M = 149722.3 kJ/m³
 Intercept B = 118.7 kJ/m²
 I (ASTM) = 118
 Validity (J_{ic}) = VALID
 Validity (R-curve) = INVALID--3 (.48 vs .28)
 J maximum allowed = 479.7 kJ/m² (J_{max}=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 * .52
 Init crack length a * 31.48 mm
 Flow stress * 677.5 MPa
 Yield stress * 592.9 MPa
 Young's modulus E * 212000 MPa (Estimated Value)

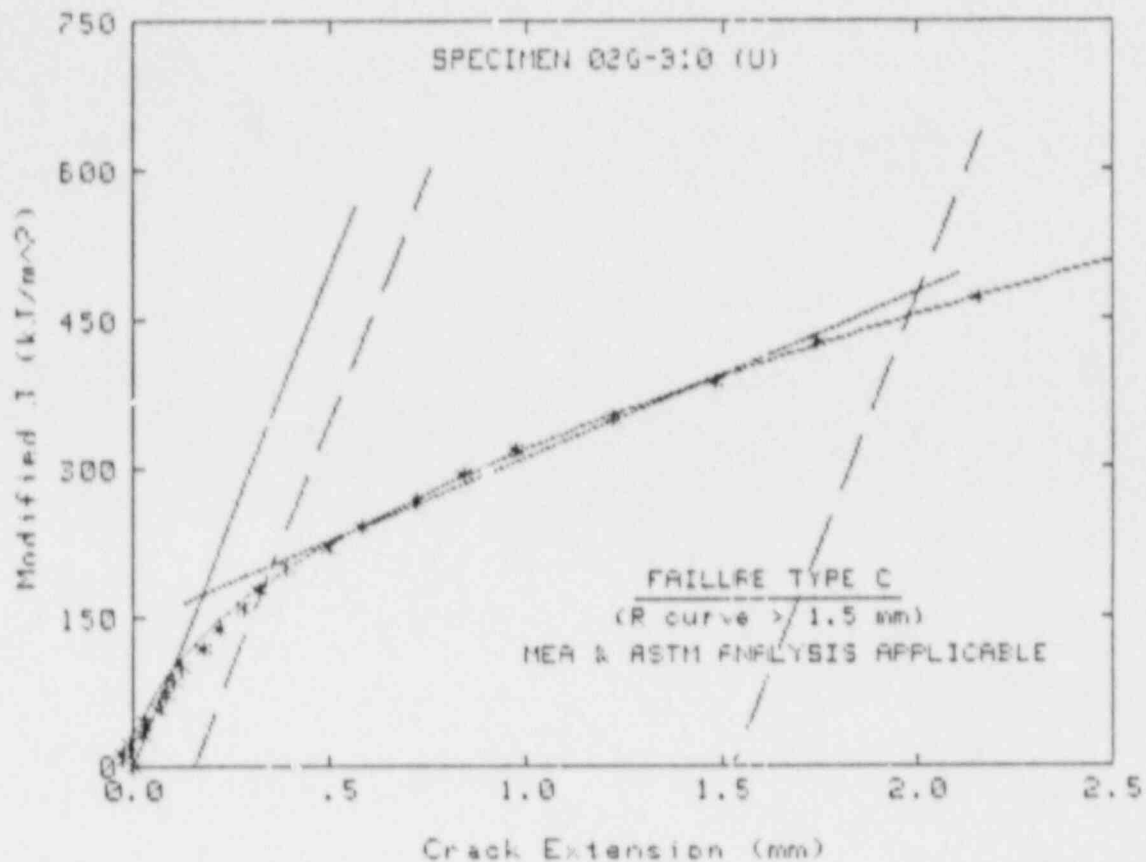
J-INTEGRAL ANALYSIS

Failure Type R (J at instability = J_{IC})
 J_{IC} * 9.14 J/m²
 E_{sec}=E/(1+.5) * 44.1 MPa/mm * 0.3
 E_{IC} (Beta Corrected) * 42.8 MPa/mm * 0.3
 ASTM E399-01 ANALYSIS

Modified sec Equation: E = (E_{IC})/.5
 Maximum Load P * 17.5 kN
 5% Secant Offset F_g * 17.5 kN
 E_{IC} * 45.2 MPa/mm
 Validity * VALID E_{IC} value

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Parish-Cortan OFFSET LOADS 0 lb OFFSET DEFLECTION = -5.69007047720E-04 mm.
 Specimen rotation Load intercept elastic slope = 4.32142857141E-07 lb
 Fitted elastic load range 2000 TO 600 Correction to J for crack x tension



TEST SPECIMEN DATA

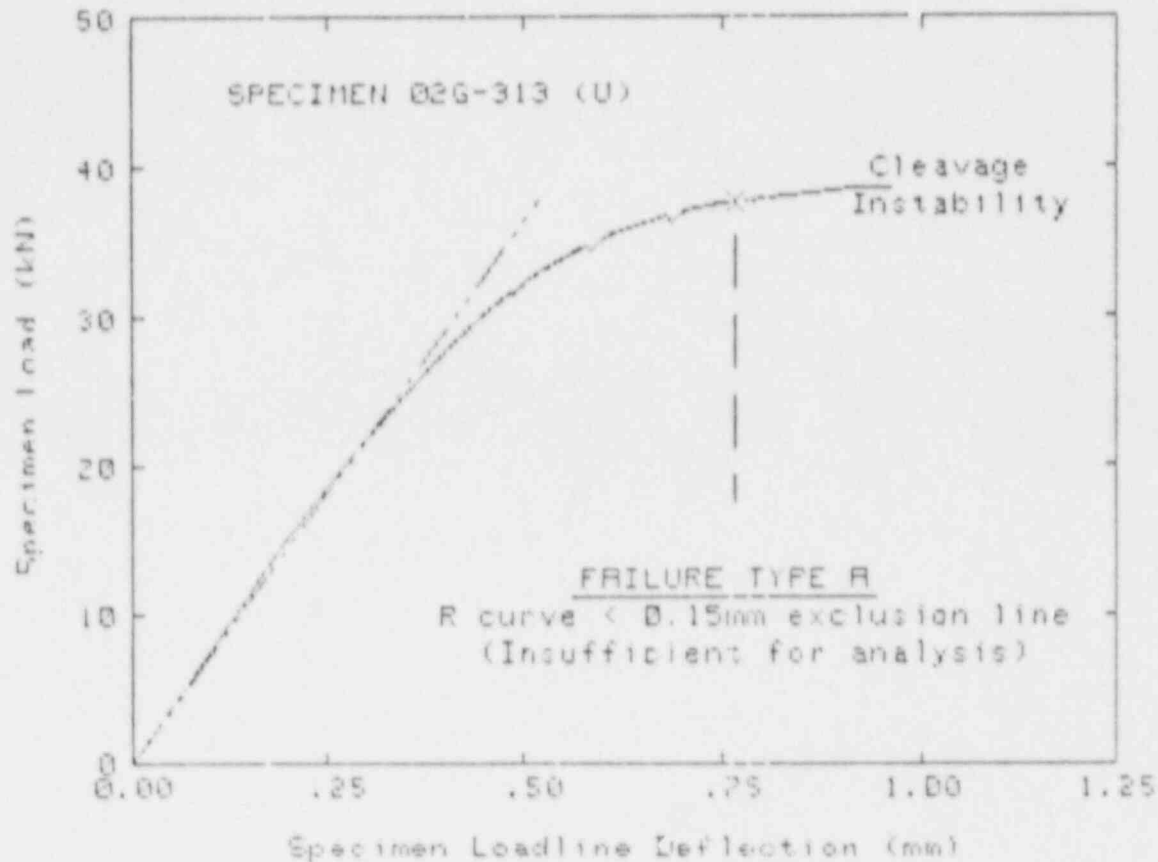
Material Type	= A533-B PLATE 02	
Test Temperature	= 121 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.62 mm	Init a/W = .622
Final crack length	= 37.62 mm	Final a/W = .74
Flow stress	= 500.2 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

J _{ic}	= 183.3 kJ/m ²	
K _{Jc}	= 191.6	J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 173.9 kJ/m ²	
K _{Jc}	= 186.6	Slope M = 166189.8 kJ/m ³
Intercept B	= 145 kJ/m ²	
T (ASTM)	= 133	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 479.5 kJ/m ²	(J _{max} = B _{net} + Flow stress/20)
Δa max. allowed	= 1.92 mm	(Δa max = 0.1 * b ₀)



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

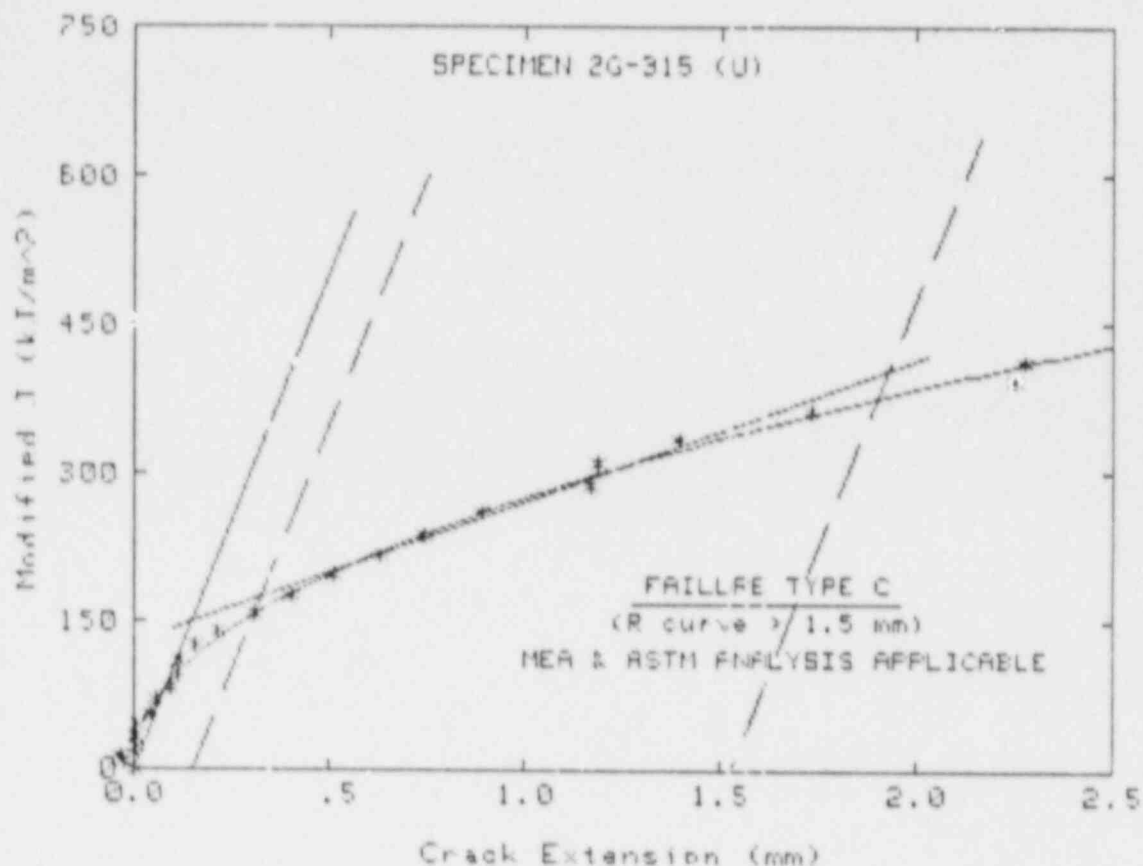
Failure Type R (J at instability = J_{ic})
 J_{ic} = 81.8 kJ/m²
 K_{Jc} = (E'J_{ic})^{0.5} = 130.3 MPa √m (U.S.)
 K_{Jc} (Beta Corrected) = 81.3 MPa √m (U.S.)

ASTM E399-81 ANALYSIS

Modified K_{Jc} Equation; B = (BB_n)^{0.5}
 Maximum Load P = 37.68 kN
 1% Secant Offset P_Q = 22.39 kN
 K_{Jc} = 57.6 MPa √m
 Validity = INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

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



TEST SPECIMEN DATA

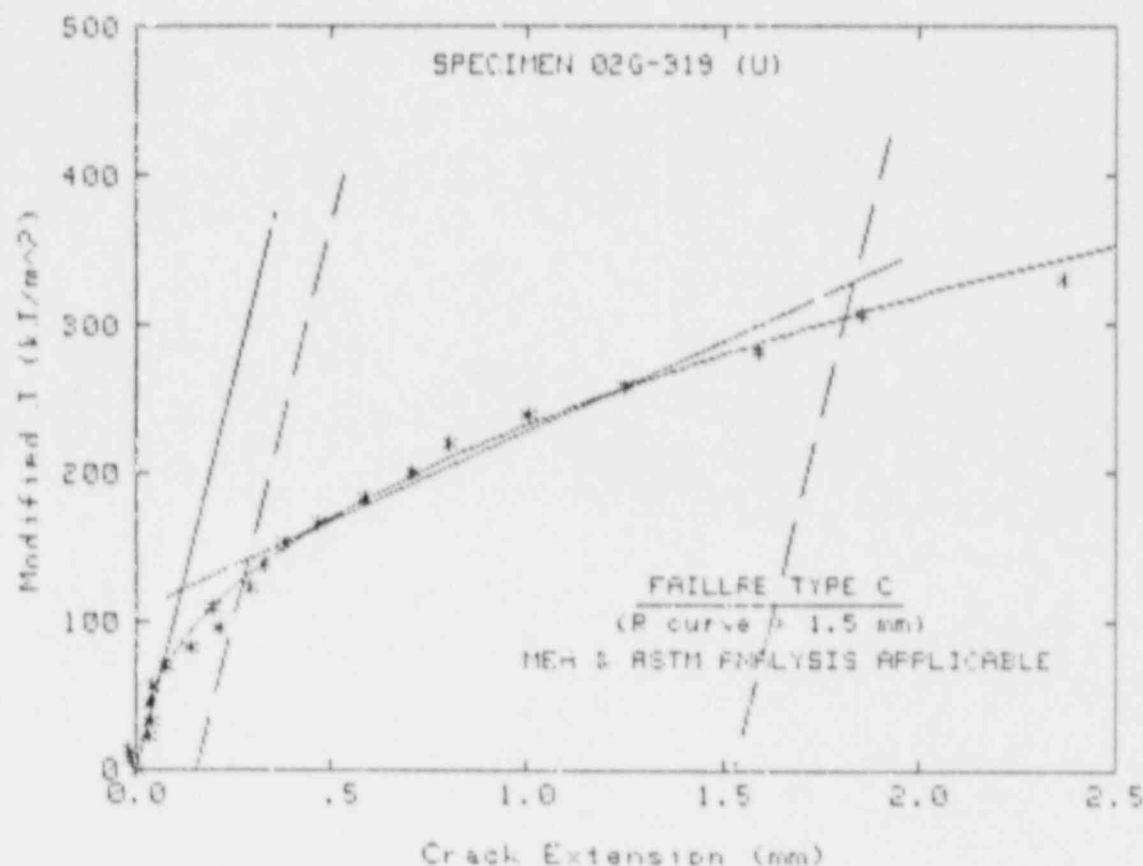
Material Type	= A533-B PLATE 02	
Test Temperature	= 204 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.66 mm	Init a/W = .623
Final crack length	= 42.06 mm	Final a/W = .827
Flow stress	= 498.3 MPa	
Young's modulus	= 195500 MPa	(Estimated Value)

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

J_{ic}	= 156.3 kJ/m²	
K_{jc}	= 174.8	$J (\theta J/I = 0.0) = 459 \text{ kJ/m}^2$
Exponent N	= .4825	
Coefficient C	= 275.4 kJ/m²	
I (average)	= 104	

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

J_{ic}	= 148.5 kJ/m²	
K_{jc}	= 170.4	Slope M = 143428.5 kJ/m³
Intercept B	= 127.1 kJ/m²	
I (ASTM)	= 113	
Validity (J_{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 476.6 kJ/m²	($J_{max} = I_{net} \times \text{Flow stress} / 20$)
Δa max. allowed	= 1.91 mm	($\Delta a_{max} = 0.1 \times b_0$)



TEST SPECIMEN DATA

Material Type = A533-B PLATE 02
 Test Temperature = 289 °C
 Percent Side Groove = 20 %
 Specimen Thickness = 25.4 mm
 Init crack length = 31.63 mm
 Final crack length = 40.36 mm
 Flow stress = 533.8 MPa
 Youngs modulus = 190800 MPa

Init a/W = .622Final a/W = .794

(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^N$ J_{ic} = 128.6 kJ/m²K_{Jc} = 156.6J (at J_{ic}) = 0.8= 431.1 kJ/m²

Exponent N = .4563

Coefficient C = 232.6 kJ/m²

1 (average) = 73

LEAST SQUARE LINEAR LINE (ASTM) $J = H (\Delta a) + B$ J_{ic} = 121.3 kJ/m²K_{Jc} = 152.1

Slope N

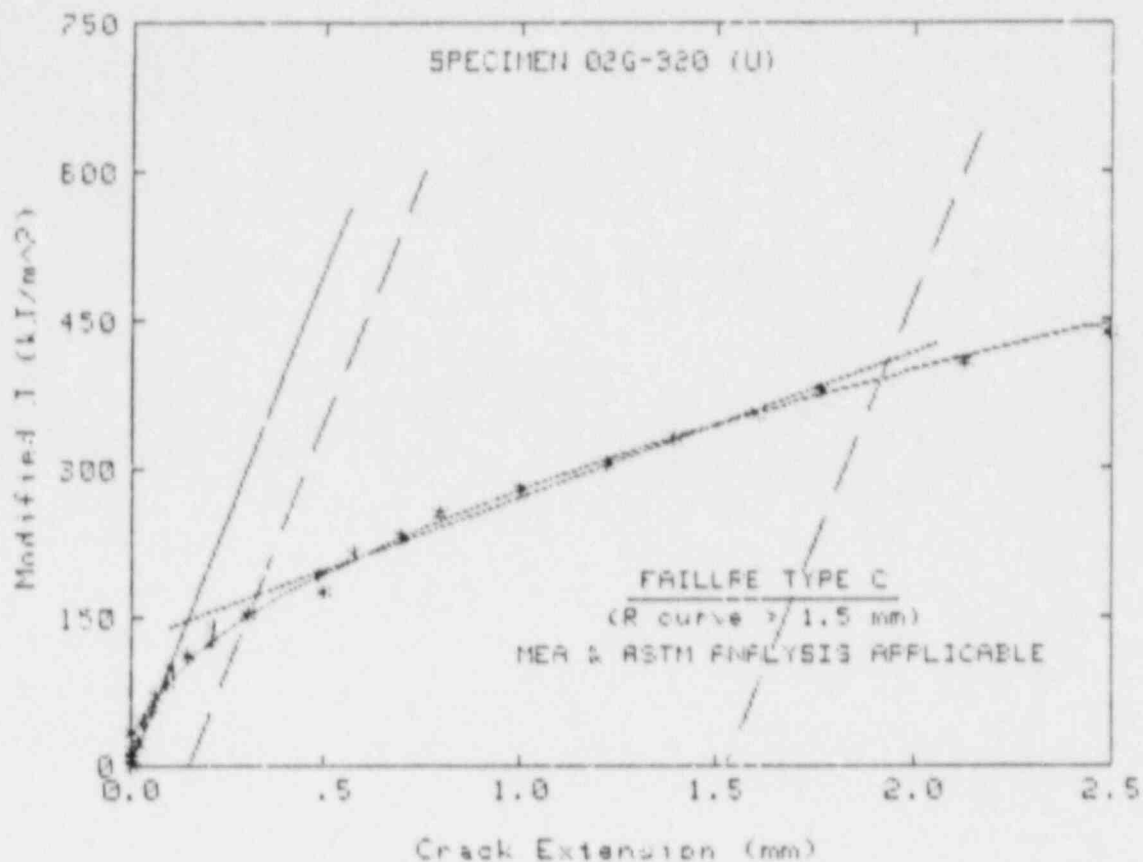
= 120602.1 kJ/m²Intercept B = 107.6 kJ/m²

1 (ASTM) = 81

Validity (J_{ic}) = VALID

Validity (R-curve) = INVALID--3 (.31 vs .28)

J maximum allowed = 511.4 kJ/m² (J_{max} = F_{net} * Flow stress / 20)Delta a max. allowed = 1.92 mm (Delta a max = 0.1 * b₀)



TEST SPECIMEN DATA

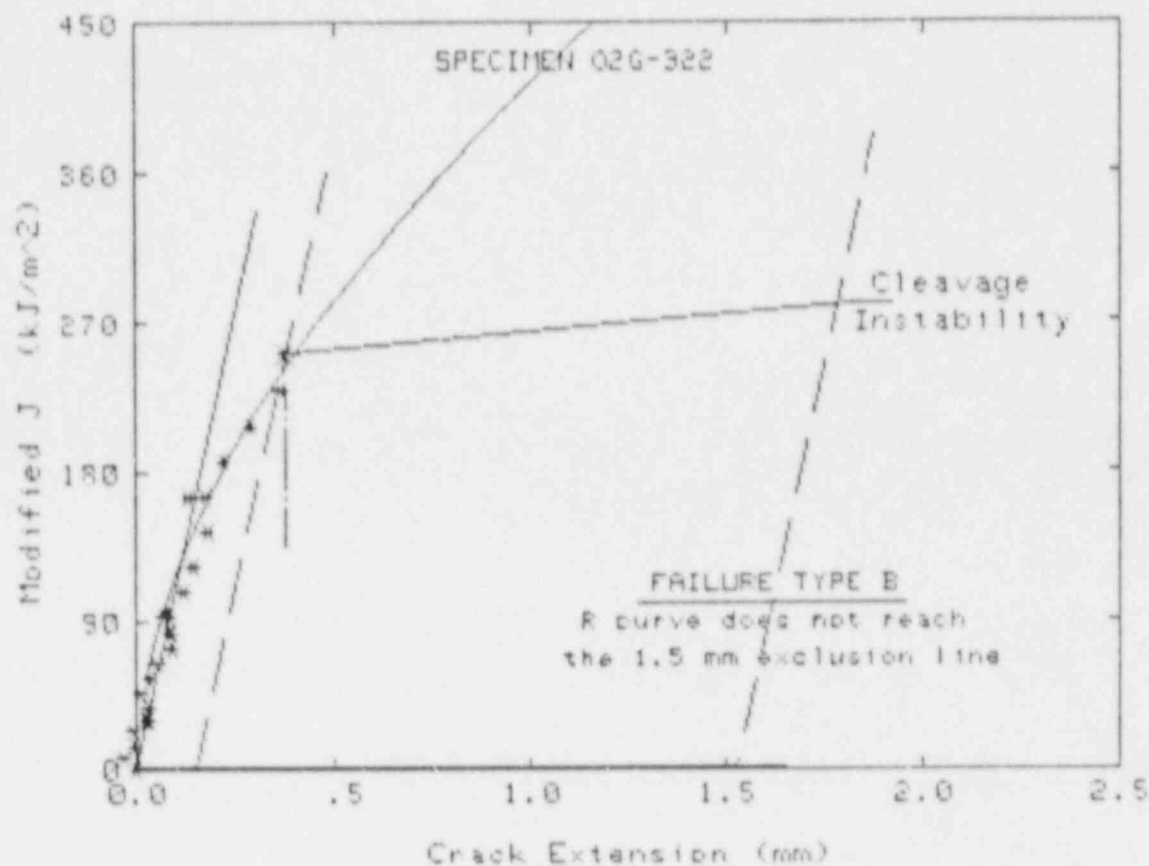
Material Type	= A533-B PLATE 02	
Test Temperature	= 204 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.65 mm	Init a/W = .623
Final crack length	= 42.61 mm	Final a/W = .838
Flow stress	= 498.3 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

J _{ic}	= 150.5 kJ/m ²	
K _{Jc}	= 171.5	J (ΔJ/I=0.8) = 535.6 kJ/m ²
Exponent n	= .517	
Coefficient C	= 278.8 kJ/m ²	
I (average)	= 113	

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

J _{ic}	= 147.3 kJ/m ²	
K _{Jc}	= 169.7	Slope M = 146270.1 kJ/m ³
Intercept B	= 125.7 kJ/m ²	
I (ASTM)	= 115	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= INVALID--3 (.5 vs .28)	
J maximum allowed	= 476.8 kJ/m ²	(J _{max} =B _{net} *Flow stress/20)
Δa max. allowed	= 1.91 mm	(Δa max = 0.1*b ₀)



TEST SPECIMEN DATA

Material Type = A533-B U2 REF
 Test Temperature = 22 °C
 Percent Side Groove = 20 %
 Specimen Thickness = 25.4 mm
 Init crack length = 31.61 mm
 Flow stress = 549.9 MPa
 Youngs modulus = 205900 MPa

Init a/W = .622

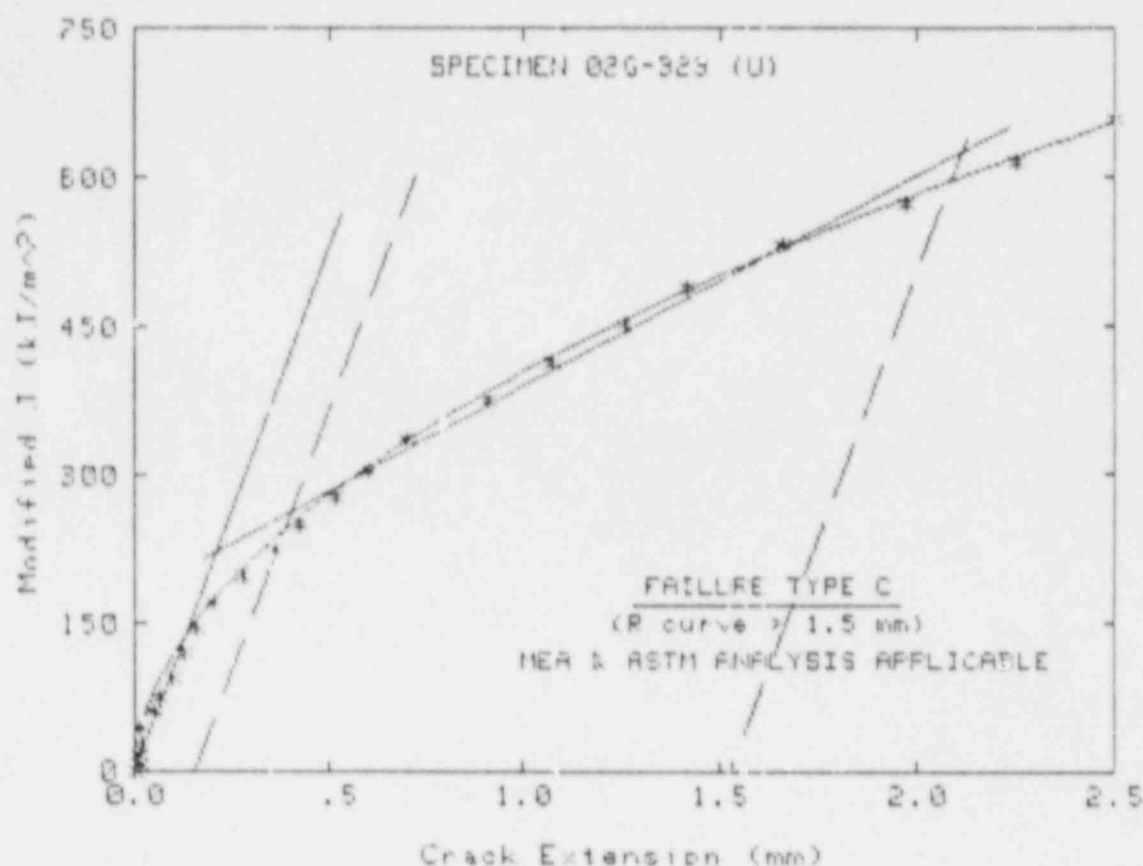
(Estimate U Value)

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

J_{ic} = 240.8 kJ/m²
 K_{ic} = 222.6 Exponent N = .5496
 Coefficient C = 414.9 kJ/m²

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

J_{ic} = 1.7 kJ/m²
 K_{ic} = 18.5 Slope M = 3.8 kJ/m^{3/2}
 Intercept B = 1.7 kJ/m²
 Validity (J_{ic}) = INVALID--a, b
 Validity (R-curve) = INVALID--2
 J maximum allowed = 527.3 kJ/m² (J_{max} = B_{net} + Flow stress/20)
 Delta a max. allowed = 1.92 mm (Delta a max = 0.1 * b_o)
 Poisson's Ratio (ν) = 0



TEST SPECIMEN DATA

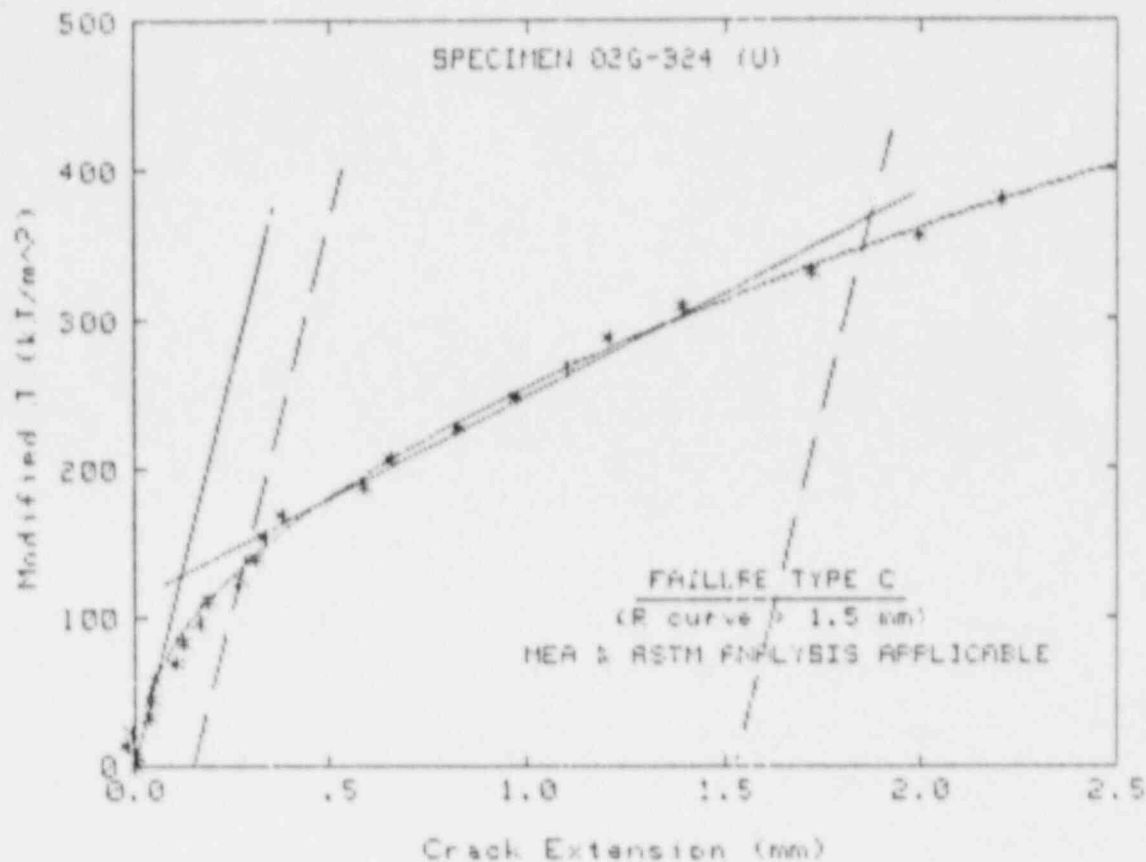
Material Type	= A533-B PLATE 02	
Test Temperature	= 50 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.46 mm	Init a/W = .615
Final crack length	= 40.37 mm	Final a/W = .794
Flow stress	= 531.1 MPa	
Youngs modulus	= 204400 MPa	(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

J _{IC}	= 243.2 kJ/m ²	
K _{IC}	= 222.9	J (θJ/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) $J = M (\Delta a) + B$

J _{IC}	= 221.7 kJ/m ²	
K _{IC}	= 212.8	Slope M = 211469.5 kJ/m ³
Intercept B	= 177.5 kJ/m ²	
T (ASTM)	= 153	
Validity (J _{IC})	= VALID	
Validity (R-curve)	= INVALID--3 (.53 vs .29)	
J maximum allowed	= 513.3 kJ/m ²	(J _{max} = E _{net} * Flow stress / 20)
Δa max. allowed	= 1.93 mm	(Δa max = 0.1 * b ₀)



TEST SPECIMEN DATA

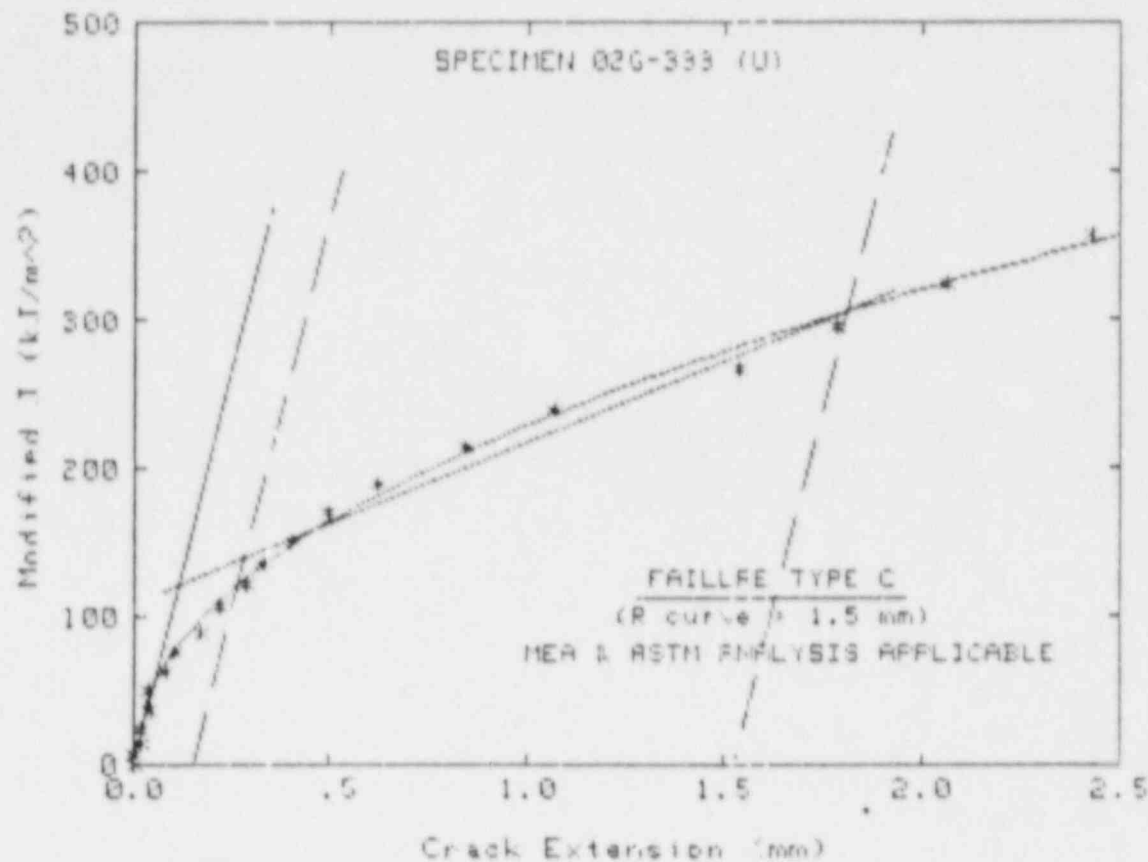
Material Type	= A533-B PLATE 02	
Test Temperature	= 288 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.62 mm	Init a/W = .622
Final crack length	= 40.12 mm	Final a/W = .789
Flow stress	= 533.8 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

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

J _{ic}	= 135.1 kJ/m ²	
K _{ic}	= 160.5	J (ΔJ/1=0.8) = 509.7 kJ/m ²
Exponent N	= .4994	
Coefficient C	= 255.6 kJ/m ²	
1 (average)	= 87	

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

J _{ic}	= 128 kJ/m ²	
K _{ic}	= 156.3	Slope M = 137844.6 kJ/m ³
Intercept B	= 111.5 kJ/m ²	
1 (ASTM)	= 92	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 511.5 kJ/m ²	(J _{max} = B _{net} * Flow stress / 20)
Δa max. allowed	= 1.92 mm	(Δa max = 0.1 * b ₀)



TEST SPECIMEN DATA

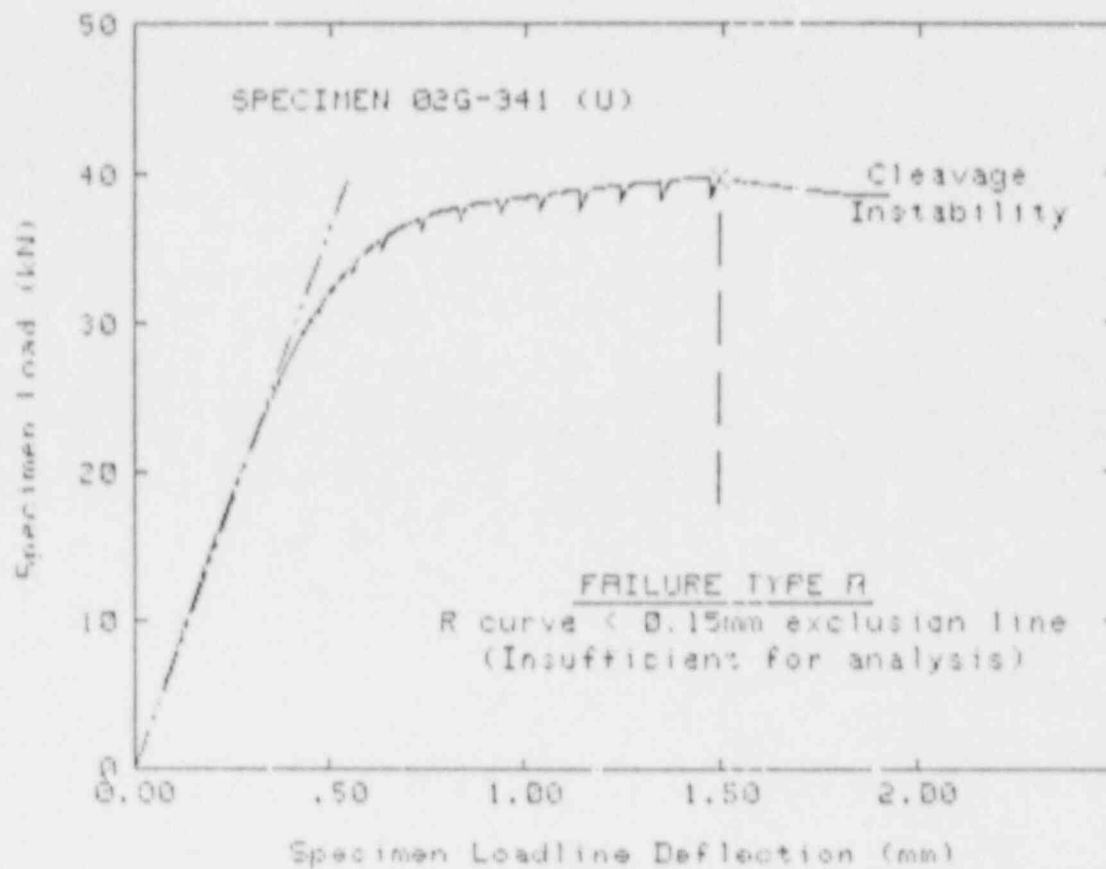
Material Type	= A533-B PLATE 02	
Test Temperature	= 288 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.81 mm	Init a/W = .626
Final crack length	= 37.65 mm	Final a/W = .741
Flow stress	= 533.8 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

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

J _{ic}	= 121.1 kJ/m ²	
K _{jc}	= 152	J (θJ/T=0.8) = 475.4 kJ/m ²
Exponent N	= .4816	
Coefficient C	= 229.2 kJ/m ²	
I (average)	= 76	

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

J _{ic}	= 121.6 kJ/m ²	
K _{jc}	= 152.3	Slope M = 108965.3 kJ/m ³
Intercept B	= 109.1 kJ/m ²	
I (ASTM)	= 73	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 506.5 kJ/m ²	(J _{max} = B _{net} * Flow stress / 20)
Δa max. allowed	= 1.9 mm	(Δa max = 0.1 * b ₀)



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

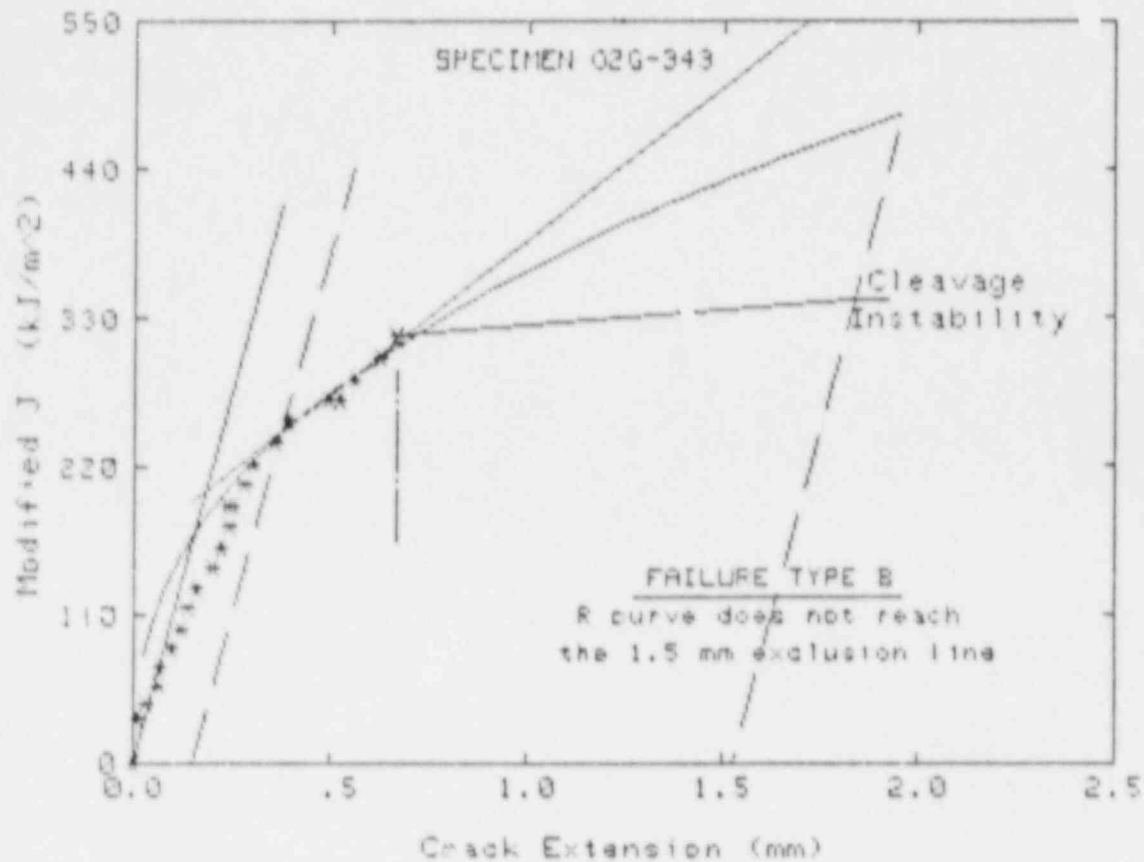
Failure Type R (J at instability = J_{ic})
 J_{ic} = 209.5 kJ/m²
 K_{Jc} = (EJ_{ic})^{0.5} = 207.8 MPa √m u=.3
 K_{ic} (Beta Corrected) = 96.1 MPa √m u=.3

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BBn)^{0.5}
 Maximum Load P = 39.61 kN
 5% Secant Offset P_Q = 22.27 kN
 K_{ic} = 58.3 MPa √m
 Validity = INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

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



TEST SPECIMEN DATA

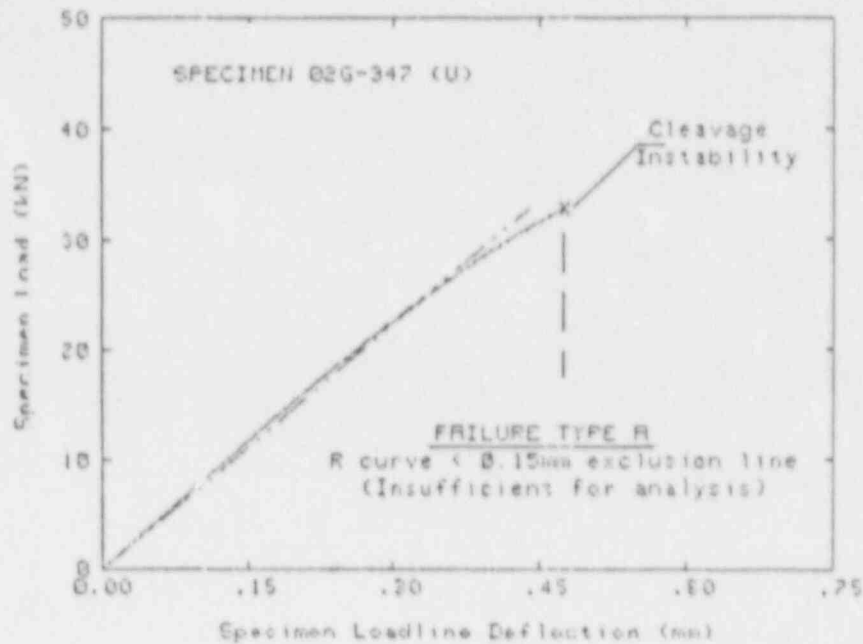
Material Type = A533-B 02 REF
 Test Temperature = 22 °C
 Percent Side Groove = 20 %
 Specimen Thickness = 25.4 mm
 Init crack length = 32.06 mm Init a/W = .631
 Flow stress = 549.9 MPa
 Youngs modulus = 205900 MPa (Estimated Value)

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

J_{ic} = 243.9 kJ/m²
 K_{Jc} = 224.1 Exponent N = .4113
 Coefficient C = 365.4 kJ/m²

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

J_{ic} = 200.9 kJ/m²
 K_{Jc} = 203.4 Slope M = 228766.2 kJ/m³
 Intercept B = 159.1 kJ/m²
 Validity (J_{ic}) = INVALID--b
 Validity (R-curve) = VALID
 J maximum allowed = 515 kJ/m² (J_{max} = B_{net} + Flow stress/20)
 Delta a max. allowed = 1.87 mm (Delta a max = 0.1 * b₀)
 Poisson's Ratio (ν) = 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 AND JIS

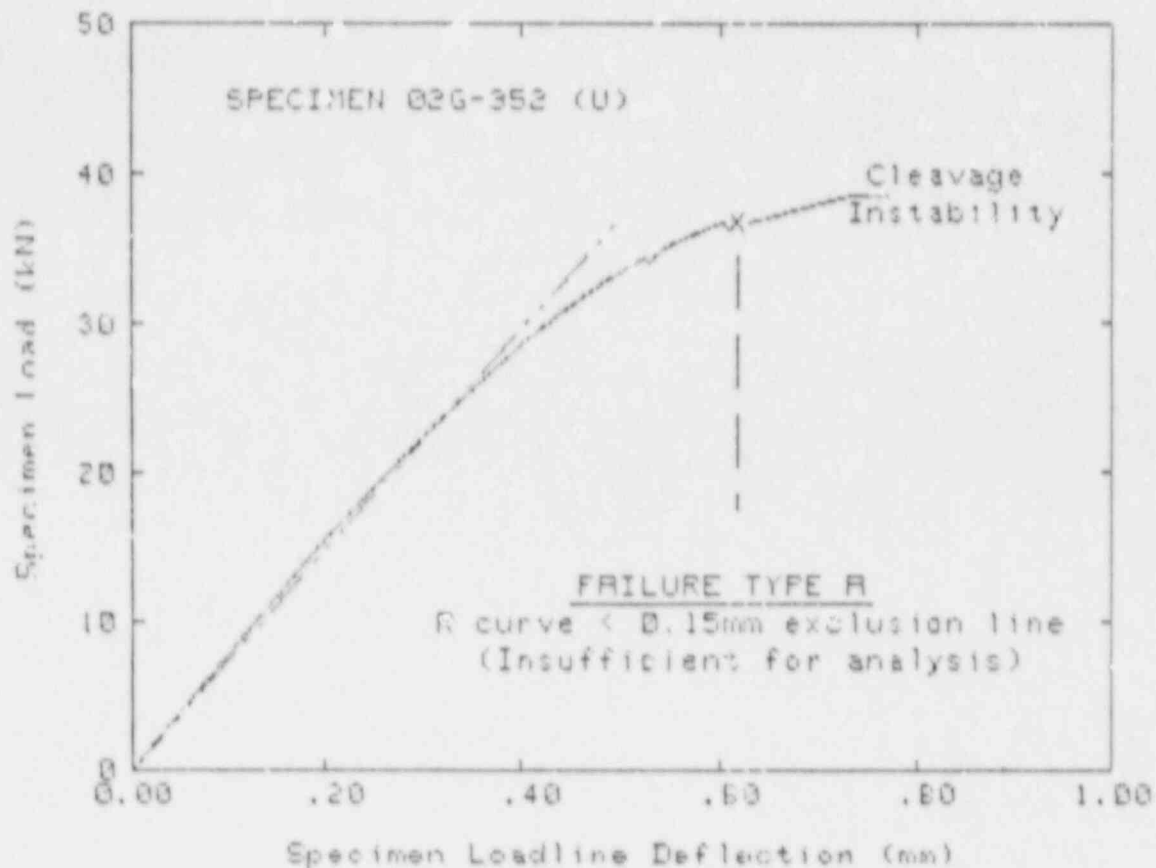
Failure Type R (J at instability = J_{IC})
 J_{IC} * 37.6 kJ/m²
 E_{IC}(E_{IC})^{1/5} * 60.8 MPa $\sqrt{m}$ $\sqrt{m}$
 E_{IC} (E_{IC})^{1/5} Corrected * 69.4 MPa $\sqrt{m}$ $\sqrt{m}$

ASTM E399-01 ANALYSIS

Modified Fit Equation: B * (E_{IC})^{1/5}
 Maximum Load P * 32.70 kN
 1% Secant Offset P_Q * 23.92 kN
 E_{IC} * 61.3 MPa $\sqrt{m}$
 Validity * INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Perlis-Corten OFFSET LOADS @ 1b OFFSET DEFLECTION = 1.74271021241E-04 mm.
 Specimen rotation Load intercept elastic slope = 2.5365553E-07 1b
 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 = J_{ic})

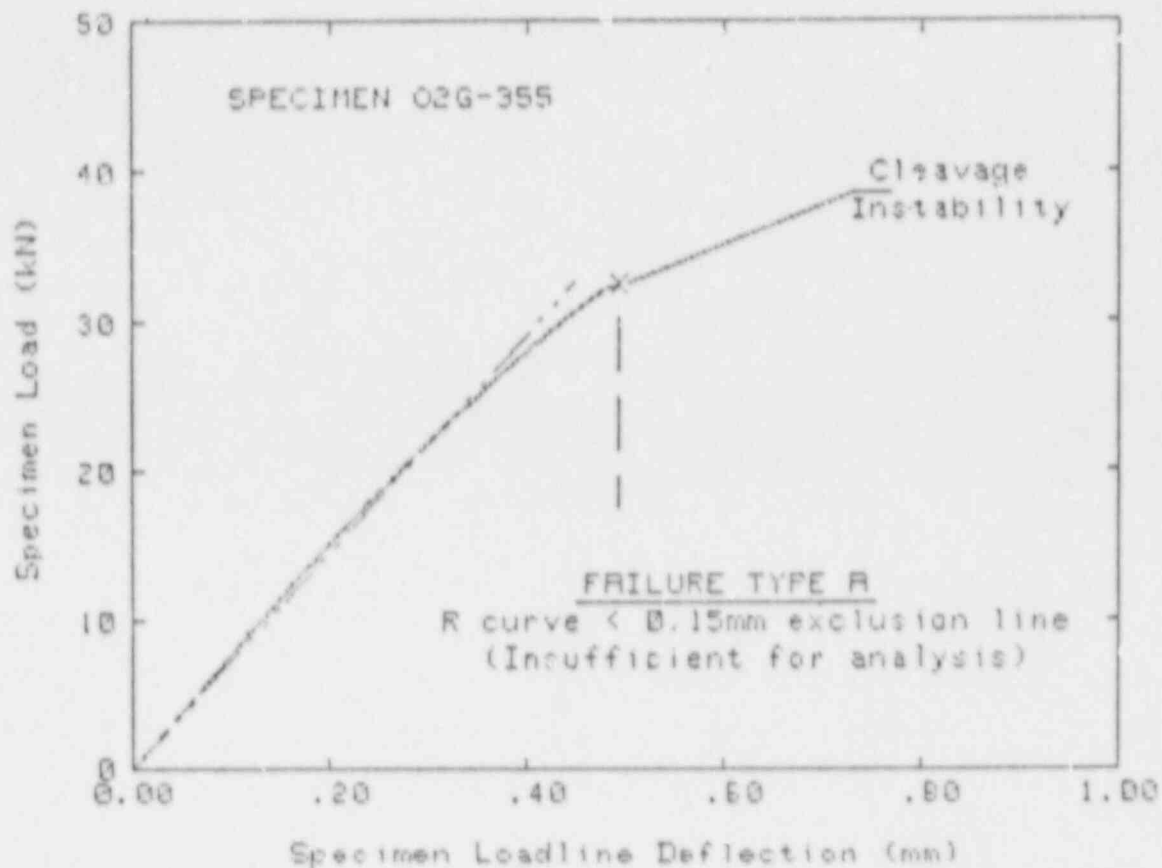
J_{ic} = 59.7 kJ/m²
 $K_{Jc} = (EJ_{ic})^{.5} = 91.6 \text{ MPa } \sqrt{\text{m}}$ $\nu=.3$
 $K_{ic} \text{ (Beta Corrected)} = 70.6 \text{ MPa } \sqrt{\text{m}}$ $\nu=.3$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation: $B = (BB_n)^{.5}$
 Maximum Load P = 36.8 kN
 1% Secant Offset P_Q = 23.14 kN
 $K_{ic} = 80.4 \text{ MPa } \sqrt{\text{m}}$
 Validity = INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Parkle-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	= 638.4 MPa	
Yield stress	= 529.4 MPa	
Youngs modulus E	= 209500 MPa	(Estimated Value)
Poisson's Ratio (ν)	= 0	

J-INTEGRAL ANALYSIS

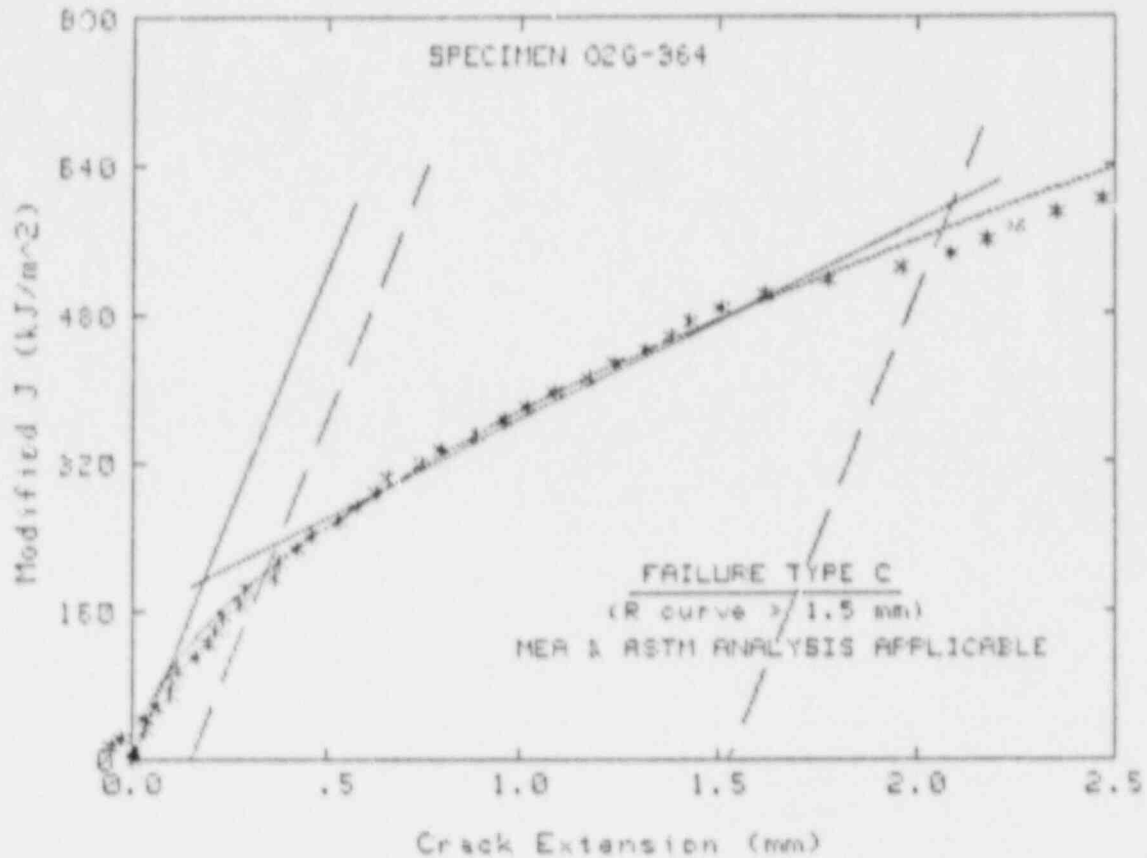
Failure Type A (J at instability = J _{ic})		
J _{ic}	= 39.3 kJ/m ²	
K _{ic} = (EJ _{ic} / (1-ν ²)) ^{0.5}	= 90.8 MPa √m	ν=.3
K _{ic} (Beta Corrected)	= 70.2 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B = (BEn) ^{0.5}	
Maximum Load P	= 32.5 kN
5% Secant Offset P _q	= 22.9 kN
K _{ic}	= 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

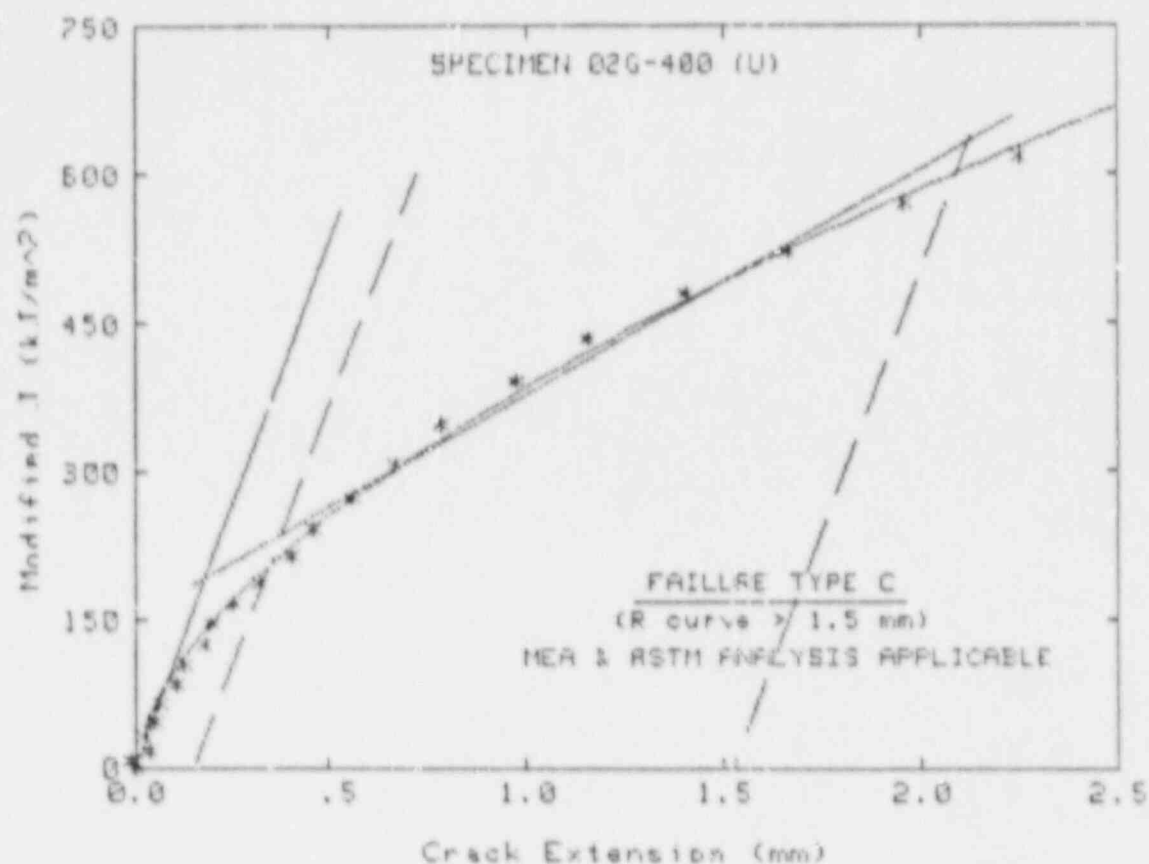
Material Type	= A533-B 02 REF	
Test Temperature	= 50 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 32.17 mm	Init a/W = .633
Final crack length	= 34.79 mm	Final a/W = .684
Flow stress	= 531.2 MPa	
Youngs modulus	= 204400 MPa	(Estimated Value)

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

J _{ic}	= 282.9 kJ/m ²
K _{ic}	= 283.6 MPa √m
J (9J/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) $J = M (\Delta a) + B$

J _{ic}	= 194.1 kJ/m ²	
K _{ic}	= 199.2 MPa √m	
Slope M	= 213000.5 kJ/m ³	
Intercept B	= 155.2 kJ/m ²	
T (ASTM)	= 154	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 494.4 kJ/m ²	(J _{max} =B _{net} +Flow stress/20)
Delta a max. allowed	= 1.86 mm	(Delta a max = 0.1*b _o)
Final Delta a	= 2.55 mm	
Poisson's Ratio (ν)	= 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
 Final crack length = 39.64 mm
 Flow stress = 531.1 MPa
 Youngs modulus = 204400 MPa

Init a/W = .615

Final a/W = .78

(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$ J_{IC} = 203.5 kJ/m²K_{JC} = 203.9 J (8J/T=8.8)

= 812.8 kJ/m²

Exponent n = .5995

Coefficient C = 385.8 kJ/m²

1 (average) = 160

LEAST SQUARE LINEAR LINE (ASTM) $J = M (\Delta a) + B$ J_{IC} = 192.2 kJ/m²K_{JC} = 198.2 Slope M

= 226743.4 kJ/m³

Intercept B = 151.2 kJ/m²

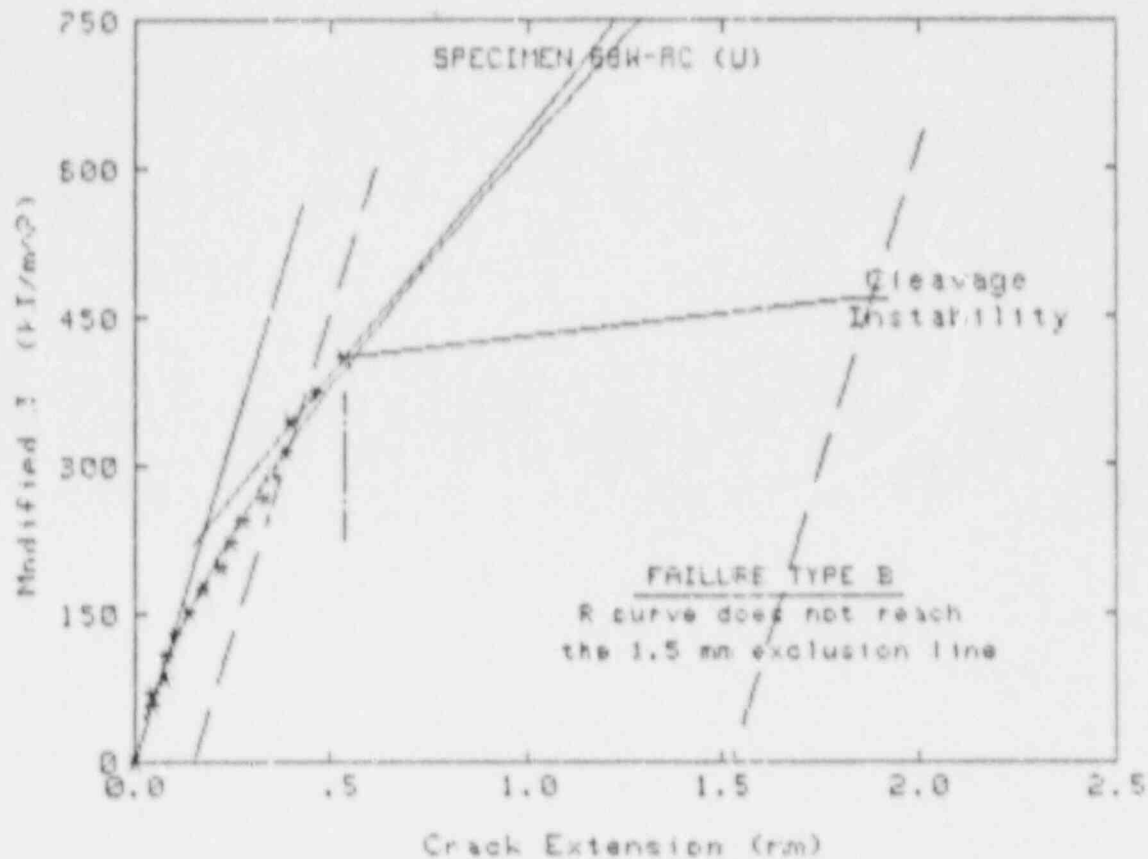
1 (ASTM) = 164

Validity (J_{IC}) = VALID

Validity (R-curve) = INVALID--3 (.46 vs .29)

J maximum allowed = 518.4 kJ/m² (J_{max}=F_{net}*Flow stress/20)

Delta a max. allowed = 1.95 mm (Delta a max = 0.1*bo)



TEST SPECIMEN DATA

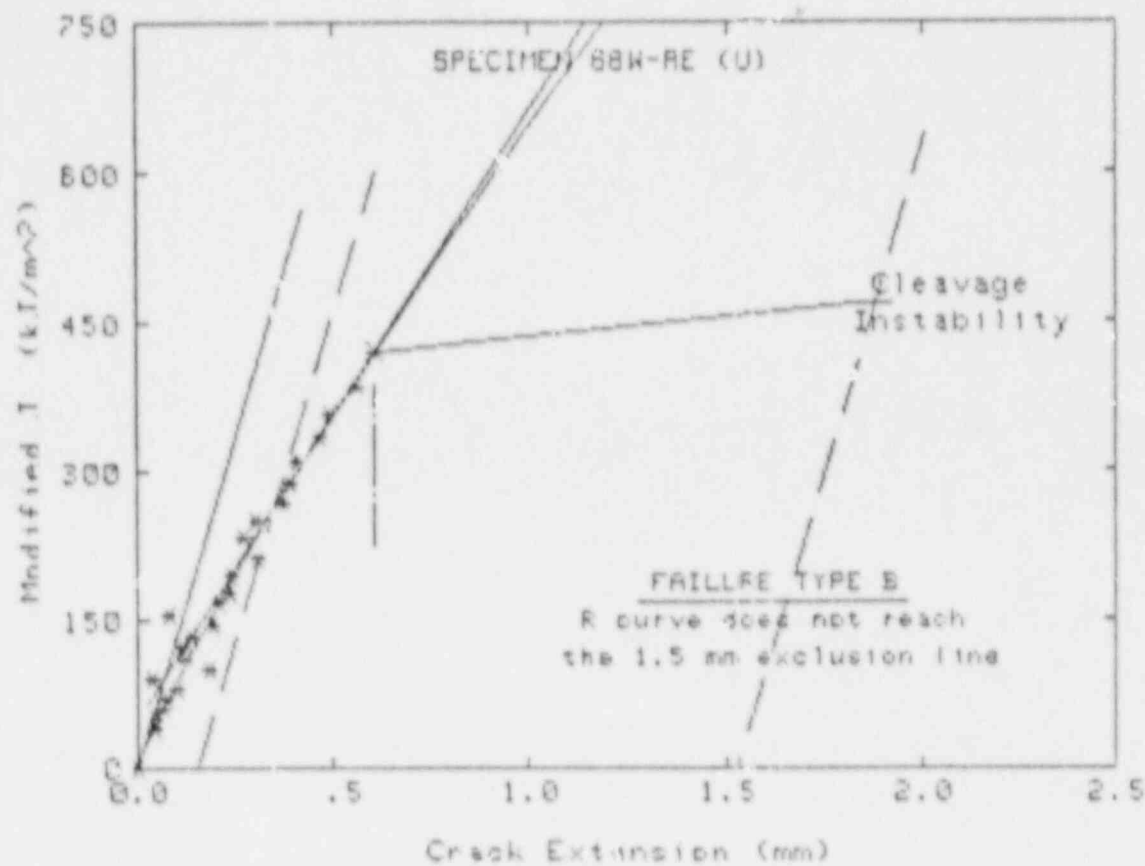
Material Type = A503-B HSST WELD
 Test Temperature = -30 °C
 Percent Side Groove = 0 %
 Specimen Thickness = 25.4 mm
 Init crack length = 30.33 mm Init a/W = .596
 Flow stress = 652.5 MPa
 Youngs modulus = 208900 MPa (Estimated Value)

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

J_{IC} = 324.9 kJ/m²
 K_{JC} = 260.5 Exponent N = .7192
 Coefficient C = 626.2 kJ/m²

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

J_{IC} = 234.6 kJ/m²
 K_{JC} = 221.4 Slope M = 494267.2 kJ/m³
 Intercept B = 145.7 kJ/m²
 Validity (J_{IC}) = INVALID--a, b
 Validity (R-curve) = INVALID--2
 J maximum allowed = 667.5 kJ/m² (J_{max} = J_{net} * Flow stress / 20)
 Delta a max. allowed = 2.05 mm (Delta a max = 0.1 * b₀)



TEST SPECIMEN DATA

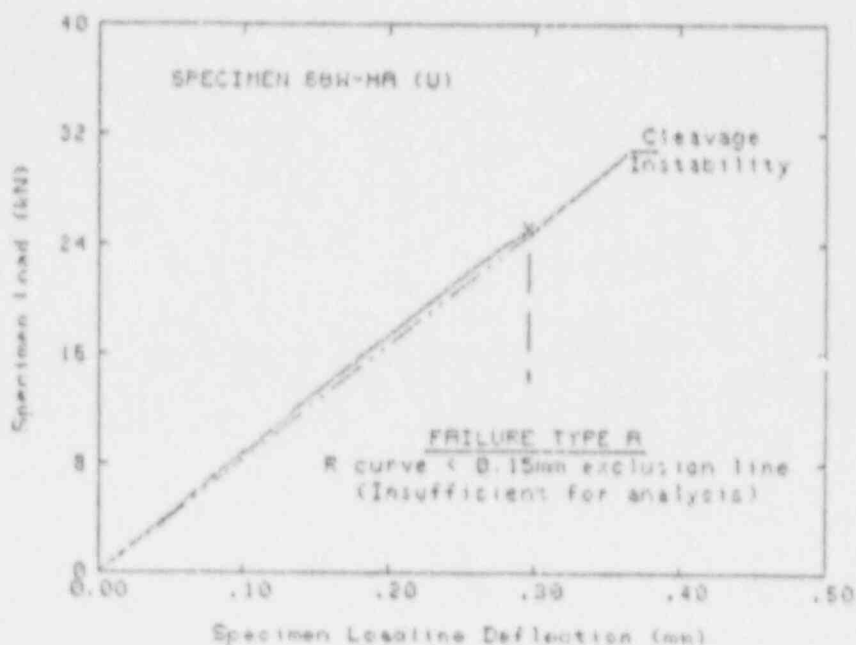
Material Type = A533-B HSST WELD
 Test Temperature = -40 °C
 Percent Side Groove = 0 %
 Specimen Thickness = 25.4 mm
 Init crack length = 30.52 mm Init a/W = .6
 Flow stress = 663.6 MPa
 Youngs modulus = 20950. MPa (Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

J_{ic} = 262.3 kJ/m²
 K_{Jc} = 234.4 Exponent n = .8619
 Coefficient C = 648.2 kJ/m²

LEAST SQUARE LINEAR LINE (ASTM) $J = H (\Delta a) + B$

J_{ic} = 93.6 kJ/m²
 K_{Jc} = 140 Slope H = 610763.2 kJ/m³
 Intercept B = 50.5 kJ/m²
 Validity (J_{ic}) = INVALID--b
 Validity (R-curve) = VALID
 J maximum allowed = 672.7 kJ/m² (J_{max} = Init * Flow stress / 20)
 Delta a max. allowed = 2.03 mm (Delta a max = 0.1 * b₀)



TEST SPECIMEN DATA

Material Type * A500-B MELT WELD
 Test Temperature * -120 C
 Percent Side Groove * 0 %
 Specimen Thickness B * 25.4 mm
 Initial a/H * .599
 Init crack length a * 20.42 mm
 Flow stress * 775.3 MPa
 Yield stress * 740.7 MPa
 Young's modulus E * 114100 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

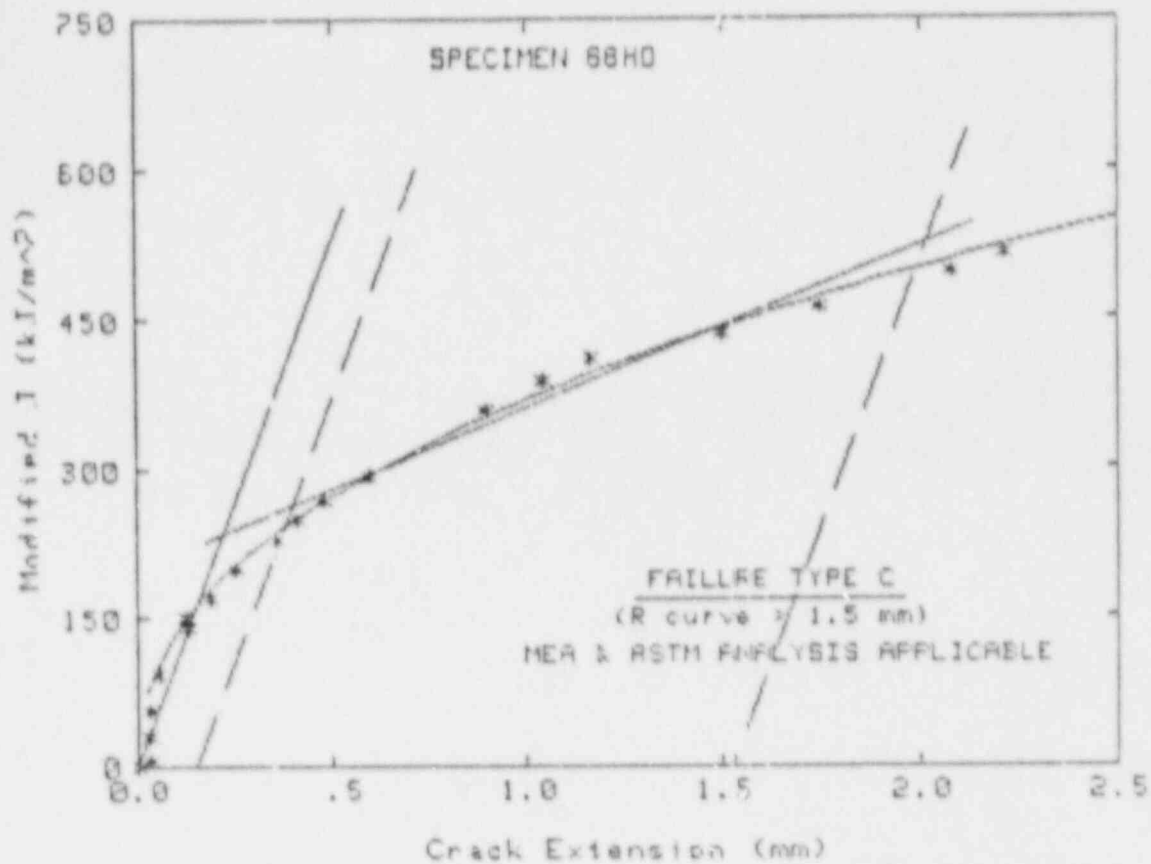
Failure Type R (J at instability = J_{IC})
 J_{IC} * 16.2 kJ/m²
 K_{IC} (EJ_{IC})^{1/2} * 55.9 MPa √m v_{9.3}
 K_{IC} (Beta Corrected) * 56.9 MPa √m v_{9.3}

ASTM E399-01 ANALYSIS

Modified K_{IC} Equation: E * (2Bb)^{1/2}
 Maximum Load P * 25.16 kN
 1% Secant Offset P_Q * 25.16 kN
 K_{IC} * 55.2 MPa √m
 Validity * VALID K_{IC} value

INSTRUMENT CORRECTIONS USED FOR J-INTEGRAL DATA

Parikh-Corten OFFSET LOADS 0 TO 10 OFFSET DEFLECTION = 4.12591047190E-05 in.
 Specimen rotation Load intercept elastic slope = 2.47050021521E-07 lb
 Fitted elastic load range 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

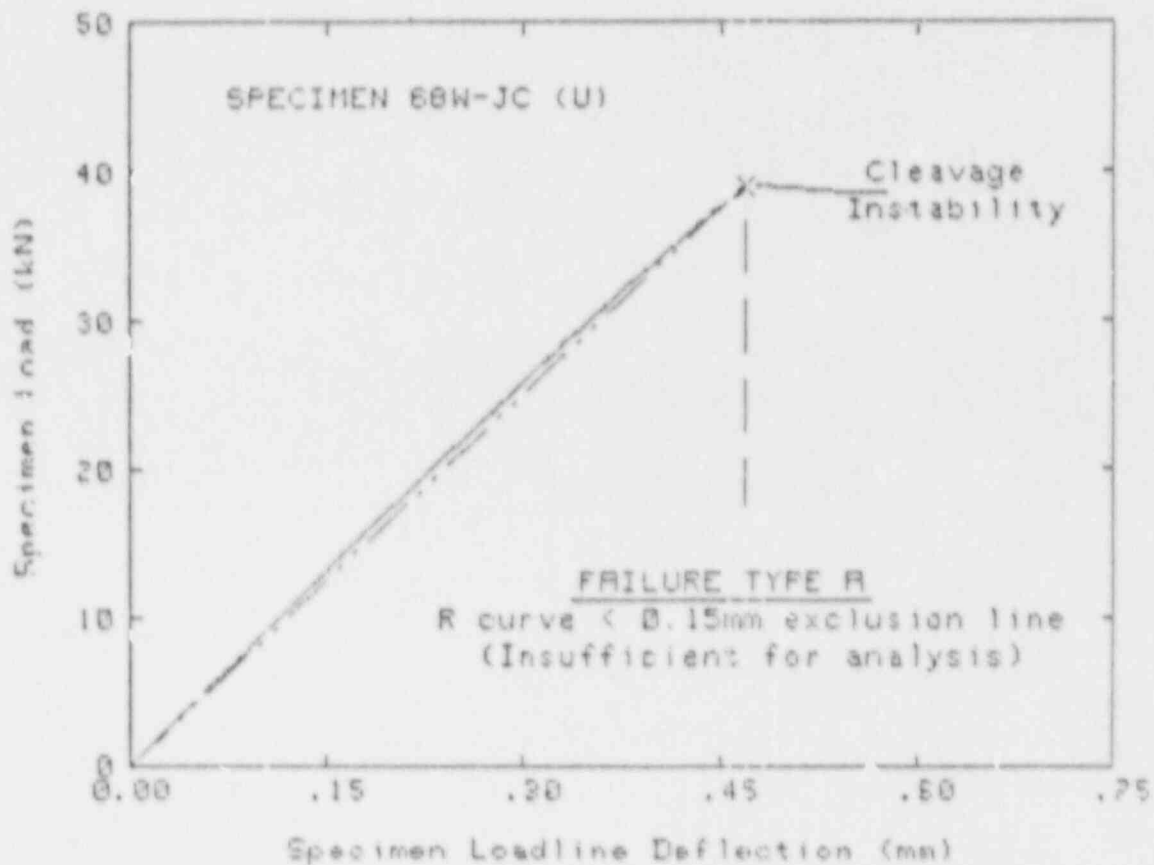
Material Type	= A533-B HSST WELD	
Test Temperature	= 288 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.81 mm	Init a/W = .606
Final crack length	= 34.88 mm	Final a/W = .686
Flow stress	= 533.4 MPa	
Youngs modulus	= 195800 MPa	(Estimated Value)

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

J _{ic}	= 242.3 kJ/m ²	
K _{jc}	= 217.8	$J (\theta J/1=0.8) = 575.9 \text{ kJ/m}^2$
Exponent N	= .4366	
Coefficient C	= 369.8 kJ/m ²	
1 (average)	= 106	

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

J _{ic}	= 236.1 kJ/m ²	
K _{jc}	= 215	Slope M = 161519.1 kJ/m ³
Intercept B	= 200.3 kJ/m ²	
1 (ASTM)	= 111	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 532.6 kJ/m ²	(J _{max} = Init * Flow stress / 20)
Delta a max. allowed	= 2 mm	(Delta a max = 0.1 * b ₀)



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 R (J at instability = J_{ic})

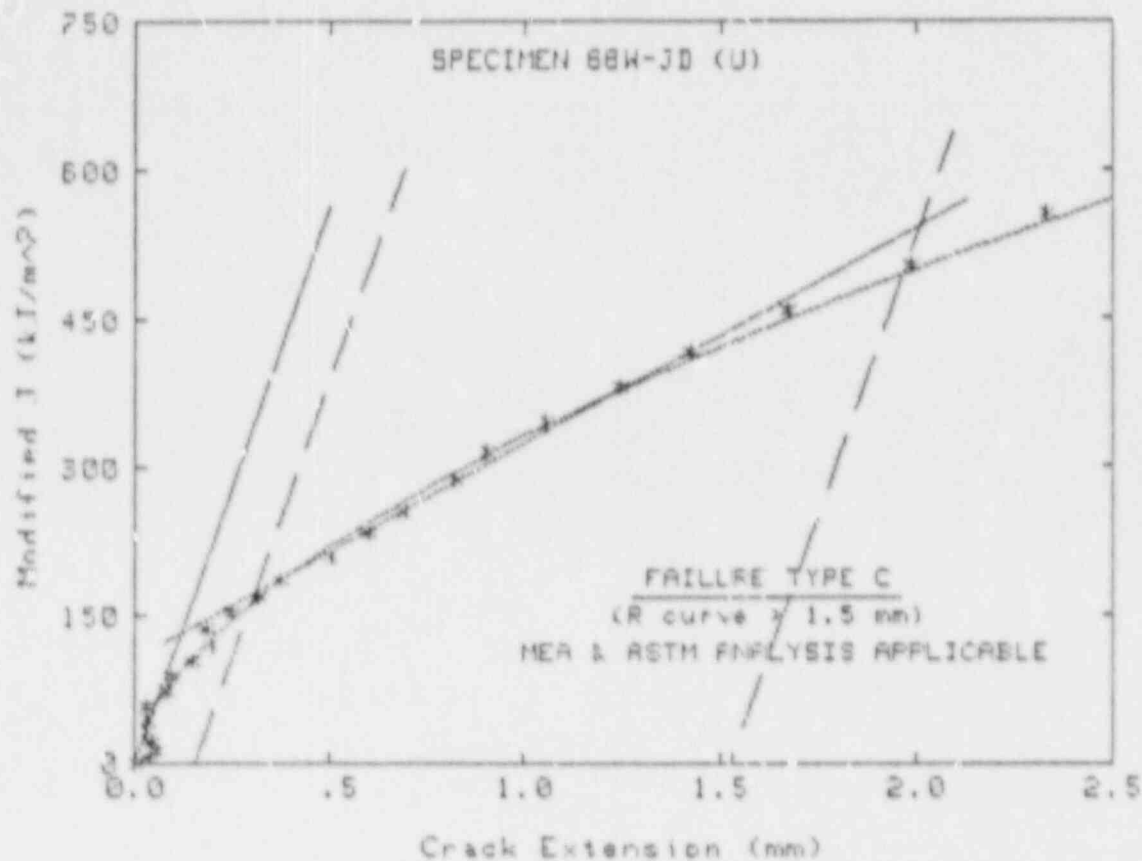
J _{ic}	= 48.2 kJ/m ²	
K _{Jc} =(EJ _{ic}) ^{0.5}	= 92.5 MPa √m	ν=.3
K _{ic} (Beta Corrected)	= 79.6 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation:	B = (E _{Sn}) ^{-0.5}
Maximum Load P	= 39.01 kN
5% Secant Offset P _Q	= 36.17 kN
K _{ic}	= 90.1 MPa √m
Validity	= INVALID--1, 2

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

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



TEST SPECIMEN DATA

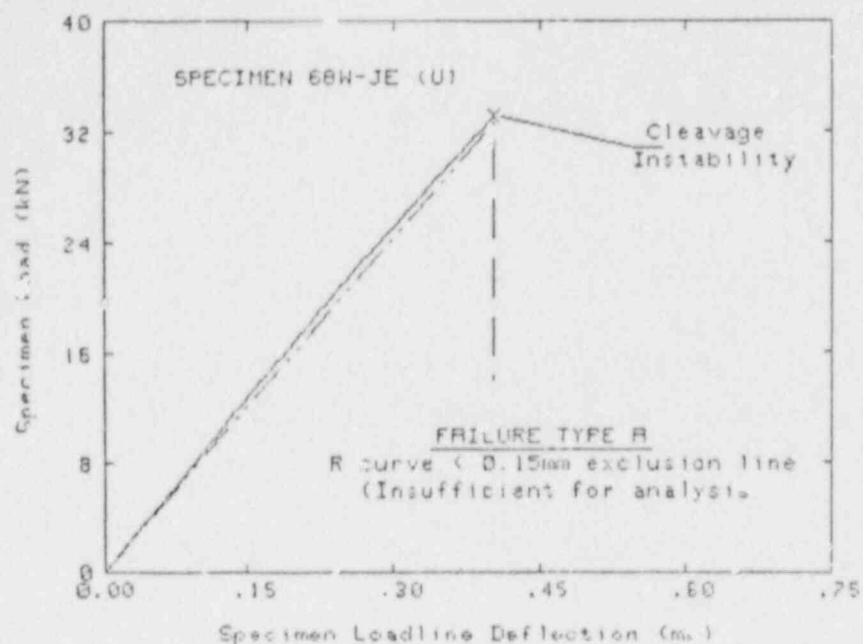
Material Type	= A533-B HSST WELD	
Test Temperature	= 288 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.72 mm	Init a/W = .604
Final crack length	= 37.81 mm	Final a/W = .744
Flow stress	= 561.4 MPa	
Young's modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

J _{ic}	= 161.3 kJ/m²	
K _{Jc}	= 175.4	J (θJ/T=0.8) = 651 kJ/m²
Exponent n	= .5914	
Coefficient C	= 331.3 kJ/m²	
T (average)	= 117	

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

J _{ic}	= 131.5 kJ/m²	
K _{Jc}	= 158.4	Slope M = 4.8 kJ/m³
Intercept B	= 106 kJ/m²	
T (ASTM)	= 132	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 563.4 kJ/m²	(J _{max} = B _{net} * Flow stress / 20)
Δa max. allowed	= 2.01 mm	(Δa max = 0.1 * b ₀)



TEST SPECIMEN DATA

Material Type = HSST WELD
 Test Temperature = -125 C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/H = .603
 Init crack length a = 30.63 mm
 Flow stress = 783.4 MPa
 Yield stress = 757.5 MPa
 Young's modulus E = 214000 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

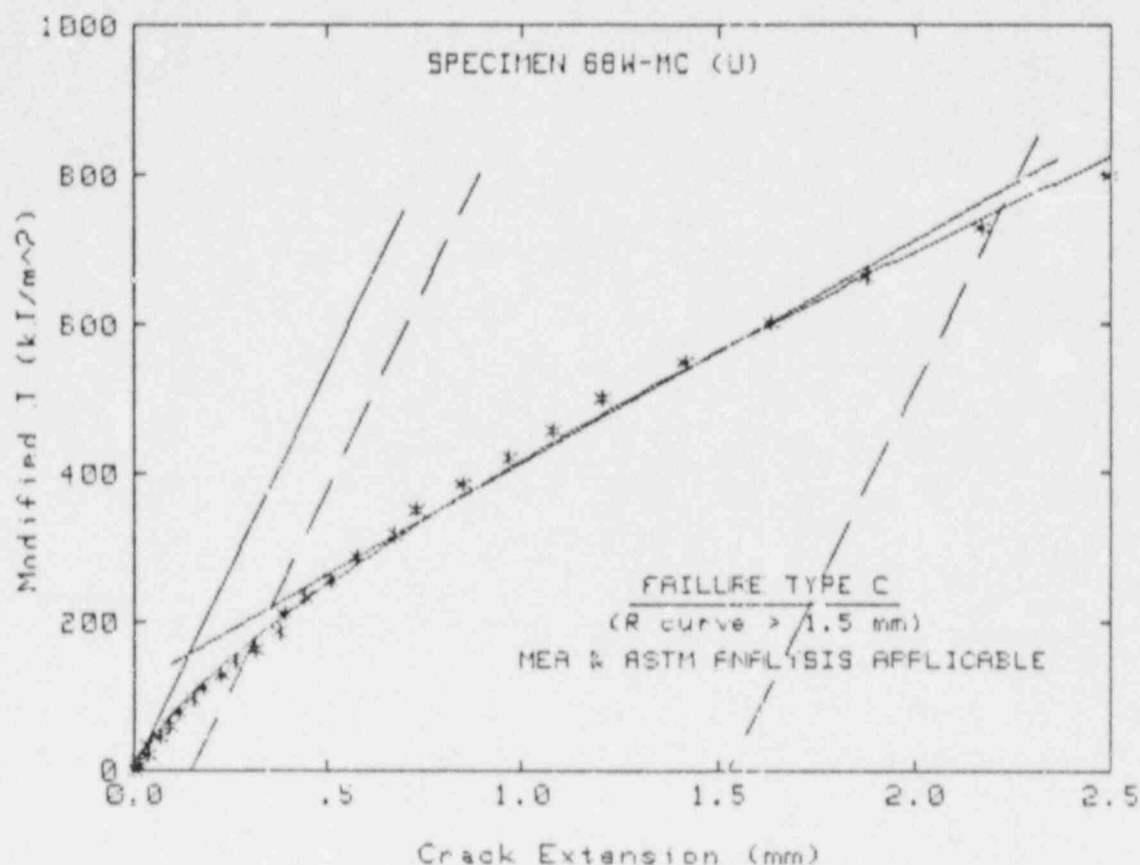
Failure Type A J at instability = J_{ic}
 J_{ic} = 29.4 kJ/m²
 $K_{Ic} = (E J_{ic})^{.5}$ = 79.4 MPa $\sqrt{m}$ $v=.3$
 K_{Ic} (Beta Corrected) = 72.9 MPa $\sqrt{m}$ $v=.3$

ASTM E399-81 ANALYSIS

Modified Kic Equation: $B = (E E_n)^{.5}$
 Maximum Load P = 33.15 kN
 1% Secant Offset P_Q = 33.14 kN
 K_{Ic} = 80 MPa $\sqrt{m}$
 Validity = VVALID=-2

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Perkle-Curtin OFFSET LOAD= 0 lb OFFSET REFLECTION = 6.43164005108E-05 in.
 Specimen rotation Load intercept elastic slope = .000000003 lb
 Fitted elastic load range= 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

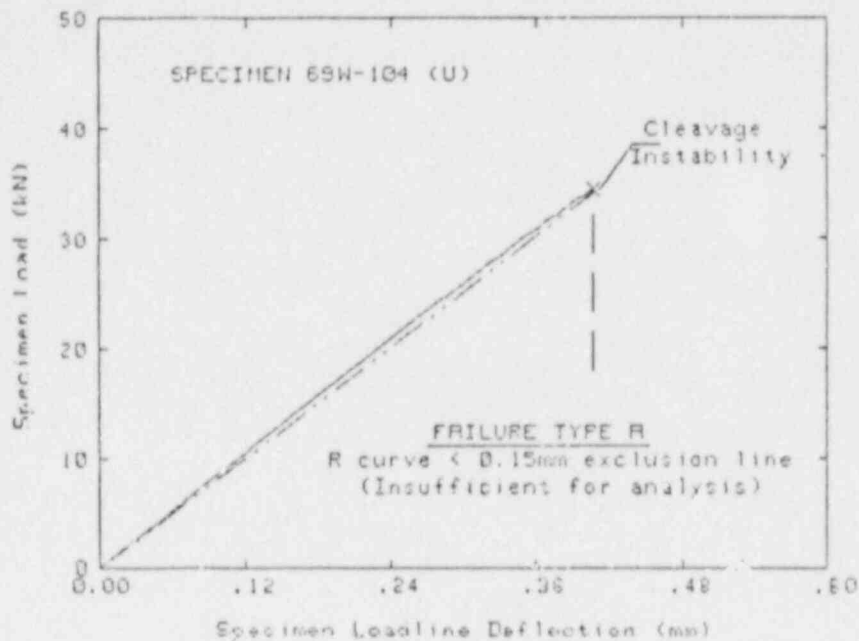
Material Type	= A533-B HSST WELD	
Test Temperature	= 121 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.82 mm	Init a/W = .606
Final crack length	= 36.83 mm	Final a/W = .764
Flow stress	= 542.3 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

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

J _{ic}	= 177.5 kJ/m ²	
K _{ic}	= 178.5	J (at J/T=8.0) = 1054.8 kJ/m ²
Exponent N	= .742	
Coefficient C	= 417.1 kJ/m ²	
T (average)	= 203	

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

J _{ic}	= 156.1 kJ/m ²	
K _{ic}	= 176.8	Slope M = 299157.5 kJ/m ³
Intercept B	= 113 kJ/m ²	
T (ASTM)	= 204	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= INVALID--1	
J maximum allowed	= 541.5 kJ/m ²	(J _{max} = E _{net} * Flow stress / 20)
Delta a max. allowed	= 2 mm	(Delta a max = 0.1 * b ₀)



TEST SPECIMEN DATA

Material Type = A500-B HSBT WELD
 Test Temperature = -60 C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .597
 Init crack length a = 30.04 mm
 Flow stress = 766 MPa
 Yield stress = 725.2 MPa
 Youngs modulus E = 210000 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

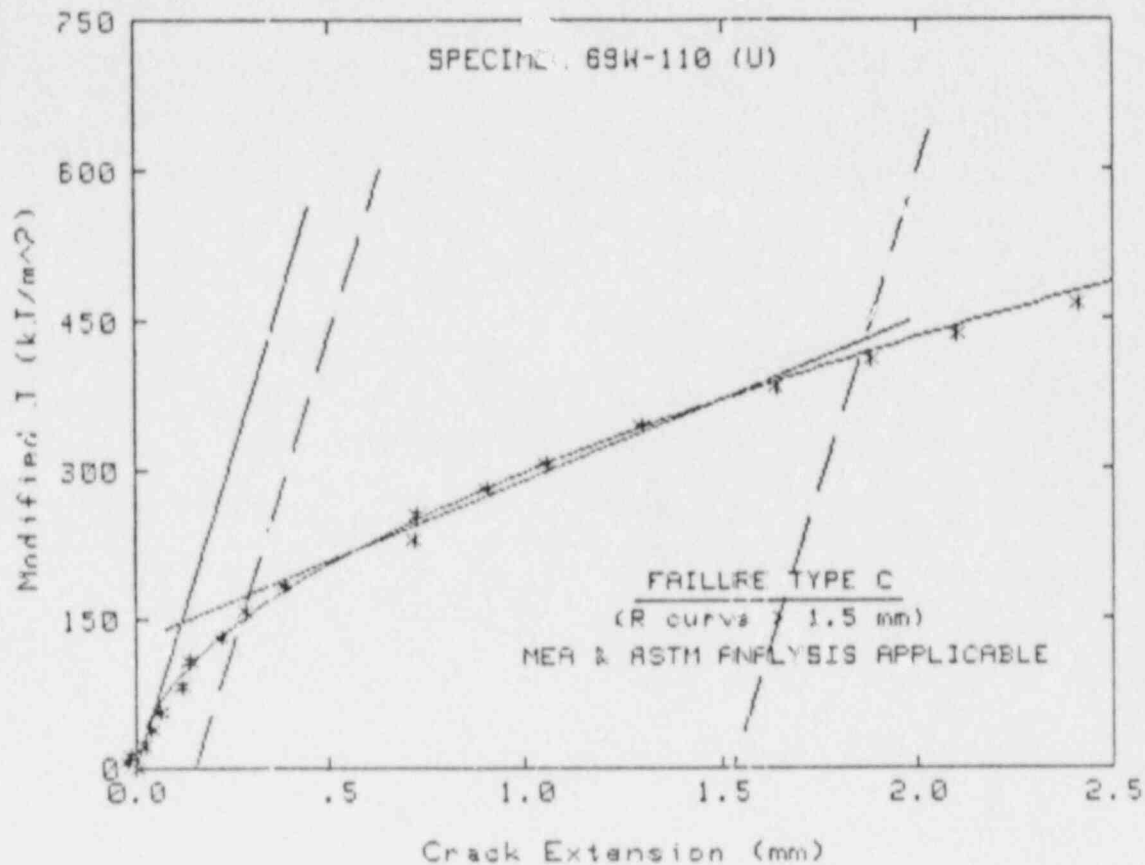
Failure Type R (J at instability = J_{ic})
 J_{ic} = 30.6 kJ/m²
 K_{JIC} = 60.3 MPa √m OK, 0
 K_{IC} (Beta Corrected) = 72.7 MPa √m OK, 0

ASTM E399-81 ANALYSIS

Modified K_{IC} Equation: $K = (E\sigma)^{1/2}$
 Maximum Load P = 34.53 kN
 5% Secant Offset P_Q = 34.53 kN
 K_{IC} = 81.4 MPa √m
 Validity = INVALID--1, 2

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Parkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = -6.01662003404E-05 in.
 Specimen rotation Load intercept elastic slope = -.000000209375 lb
 Fitted elastic load range 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

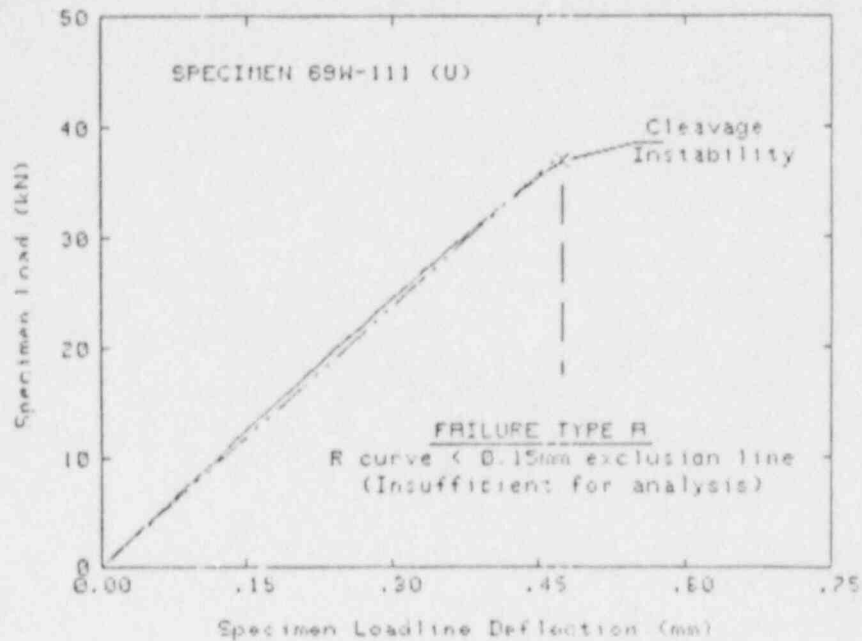
Material Type	= A533-B HSST WELD	
Test Temperature	= 121 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.64 mm	Init a/W = .603
Final crack length	= 40.62 mm	Final a/W = .799
Flow stress	= 630.3 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

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

J _{ic}	= 147.4 kJ/m ²	
K _{jc}	= 171.8	J (at 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) $J = M (\Delta a) + B$

J _{ic}	= 147.3 kJ/m ²	
K _{jc}	= 171.8	Slope M = 161876.3 kJ/m ³
Intercept B	= 128.4 kJ/m ²	
T (ASTM)	= 82	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 634.8 kJ/m ²	(J _{max} = B _{net} * Flow stress / 20)
Delta a max. allowed	= 2.02 mm	(Delta a max = 0.1 * b ₀)



TEST SPECIMEN DATA

Material Type = A500-B HSS T WELT
 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
 Young's modulus E = 207500 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

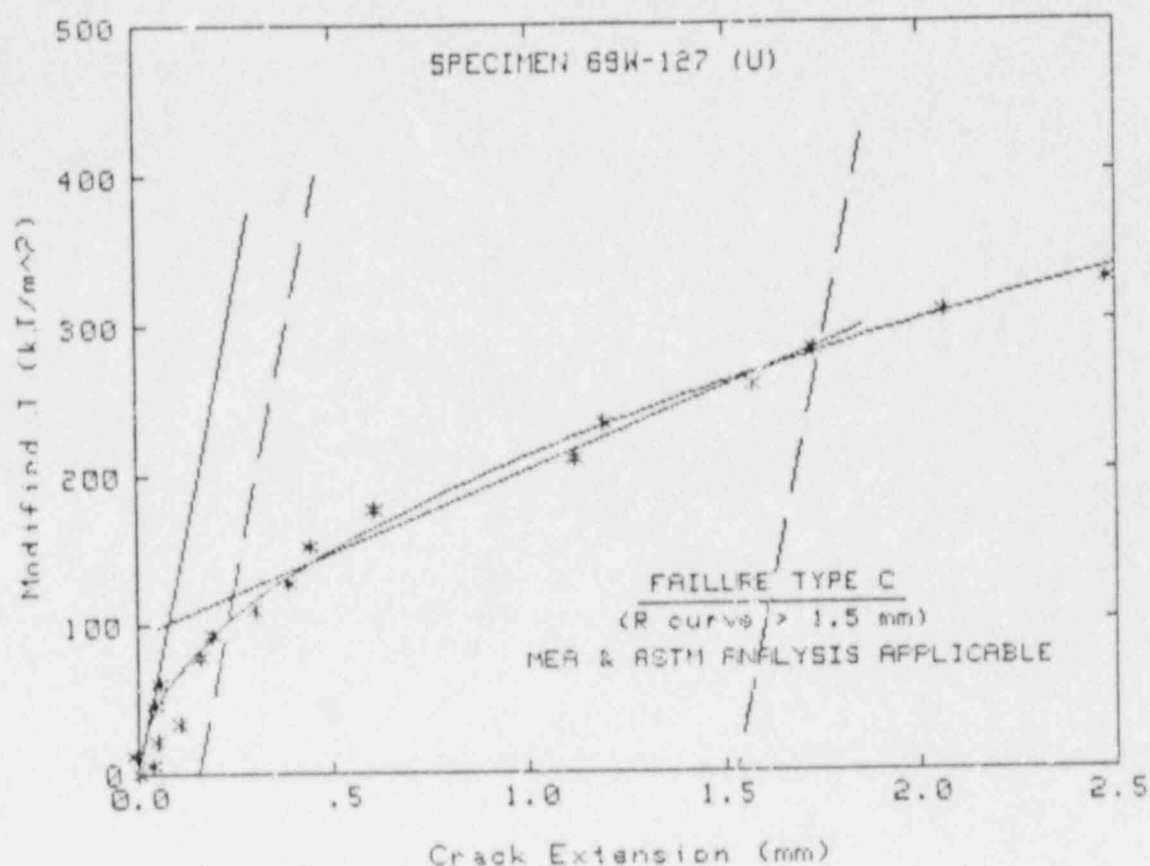
Failure Type R (J at instability = J_{ic})
 J_{ic} = 39.4 kJ/m²
 K_{Jc} = (EJ_{ic})^{0.5} = 90.5 MPa √m VR.3
 K_{ic} (Beta Corrected) = 76.8 MPa √m VR.2

ASTM E299-01 ANALYSIS

Modified K_{ic} Equation; B = (B_{min})^{0.5}
 Maximum Load P = 37.01 kN
 5% Secant Offset P_Q = 33.25 kN
 K_{ic} = 80.4 MPa √m
 Validity = INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Perkle-Corten OFFSET LOADS = 0 lb OFFSET REFLECTION = -2.46783175895E-04 in.
 Specimen Rotation Load intercept elastic slope = 6.12903225804E-05 lb
 Fitted elastic load range = 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

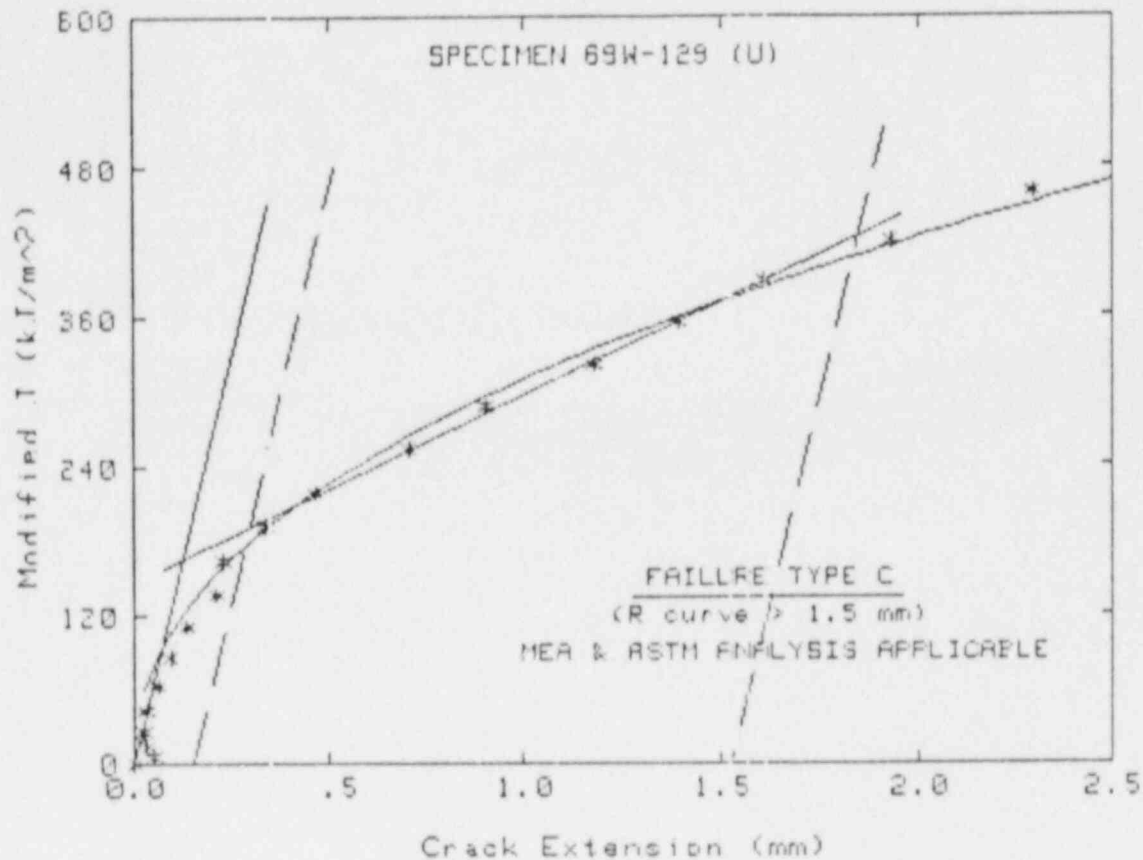
Material Type	= A533-B HSST WELD	
Test Temperature	= 288 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.57 mm	Init a/W = .601
Final crack length	= 41.07 mm	Final a/W = .808
Flow stress	= 650.7 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

J _{ic}	= 101.5 kJ/m ²	
K _{ic}	= 139.2	J (θJ/T=0.8) = 299.7 kJ/m ²
Exponent n	= .5029	
Coefficient C	= 212.4 kJ/m ²	
1 (average)	= 51	

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

J _{ic}	= 102 kJ/m ²	
K _{ic}	= 139.5	Slope M = 109743.2 kJ/m ³
Intercept B	= 93.4 kJ/m ²	
1 (ASTM)	= 49	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 657.6 kJ/m ²	(J _{max} = E _{net} * Flow stress / 20)
Δa max. allowed	= 2.02 mm	(Δa max = 0.1 * b ₀)



TEST SPECIMEN DATA

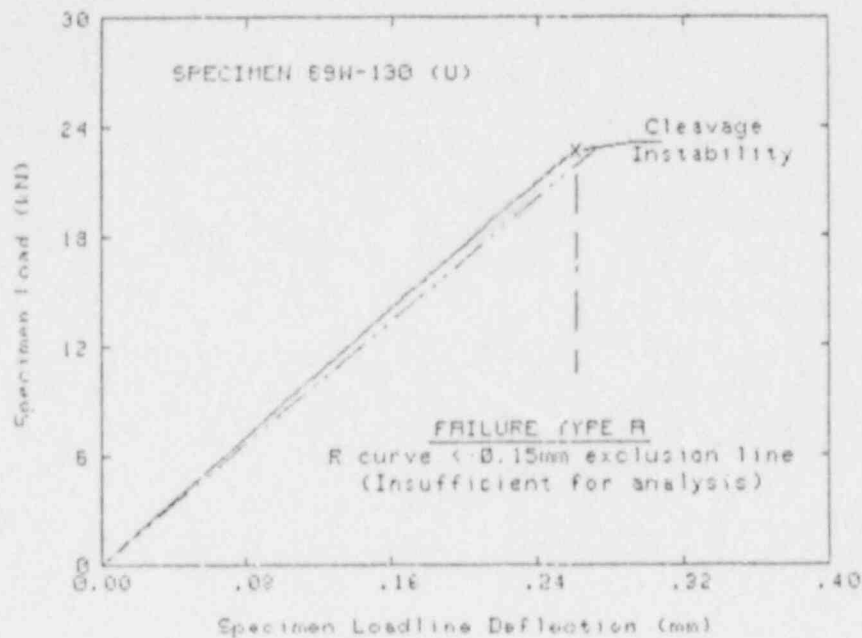
Material Type	=	A533-B HSST WELD	
Test Temperature	=	50 °C	
Percent Side Groove	=	20 %	
Specimen Thickness	=	25.4 mm	
Init crack length	=	30.72 mm	Init a/W = .604
Final crack length	=	41.53 mm	Final a/W = .817
Flow stress	=	664.1 MPa	
Youngs modulus	=	204400 MPa	(Estimated Value)

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

J _{ic}	=	176.4 kJ/m ²	
K _{jc}	=	189.8	J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	=	165.6 kJ/m ²	
K _{jc}	=	184	Slope M = 150592.3 kJ/m ³
Intercept B	=	146.8 kJ/m ²	
T (ASTM)	=	70	
Validity (J _{ic})	=	VALID	
Validity (R-curve)	=	INVALID--3 (.33 vs .3)	
J maximum allowed	=	666.4 kJ/m ²	(J _{max} = E _{net} * Flow stress / 20)
Delta a max. allowed	=	2.01 mm	(Delta a max = 0.1 * b ₀)



TEST SPECIMEN DATA

Material Type * A502-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

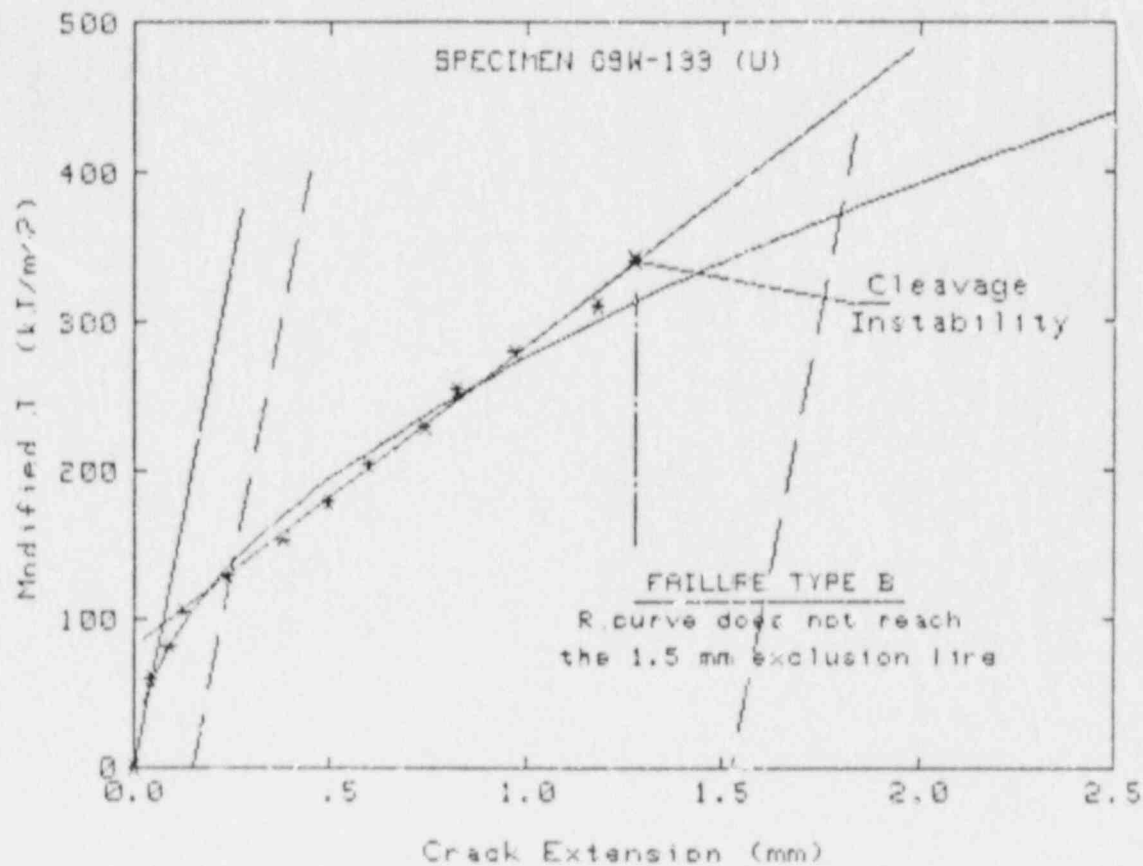
Failure Type R (J at instability = J_{ic})
 J_{ic} * 12.8 kJ/m²
 K_{Jc} (EJ_{ic})^{1/2} * 51.9 MPa √m v_{1.3}
 K_{ic} (Beta Corrected) * 50.6 MPa √m v_{1.3}

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B * (EIn)^{1/2}
 Maximum Load P * 22.72 kN
 1% Secant Offset P_Q * 22.72 kN
 K_{ic} * 54.1 MPa √m
 Validity * VALID K_{ic} value

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Parkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = -1.10744517044E-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

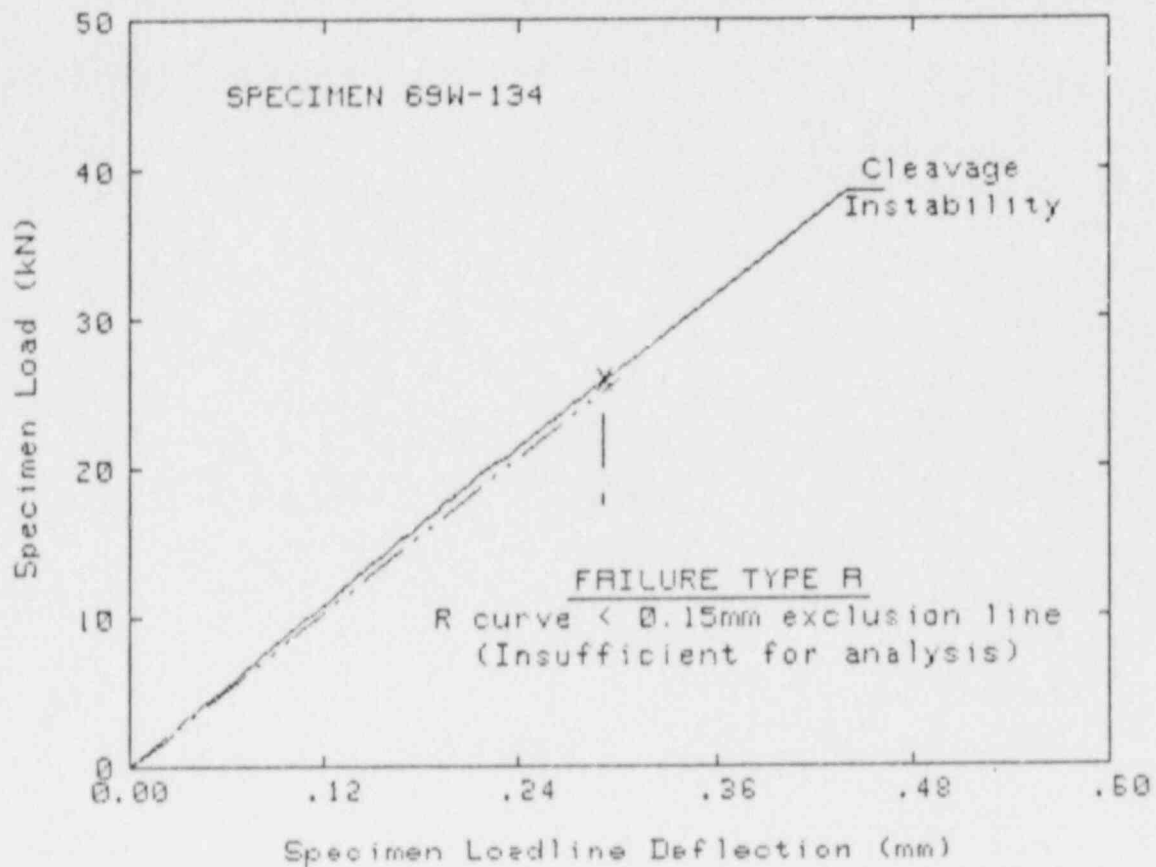
Material Type = A533-B HSST WELD
 Test Temperature = 23 °C
 Percent Side Groove = 0 %
 Specimen Thickness = 25.4 mm
 Init crack length = 29.93 mm Init a/W = .589
 Flow stress = 684.2 MPa
 Youngs modulus = 205900 MPa (Estimated Value)

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

J_{ic} = 138.3 kJ/m²
 K_{Jc} = 168.3 Exponent N = .5054
 Coefficient C = 276.8 kJ/m²

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

J_{ic} = 95.7 kJ/m²
 K_{Jc} = 140.4 Slope M = 202079.6 kJ/m³
 Intercept B = 81.5 kJ/m²
 Validity (J_{ic}) = VALID
 Validity (R-curve) = INVALID--1
 J maximum allowed = 713.4 kJ/m² (J_{max} = E_{net} * Flow stress / 20)
 Delta a max. allowed = 2.09 mm (Delta a max = 0.1 * b₀)



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 (ν) = 0

J-INTEGRAL ANALYSIS

Failure Type R (J at instability = J_{ic})

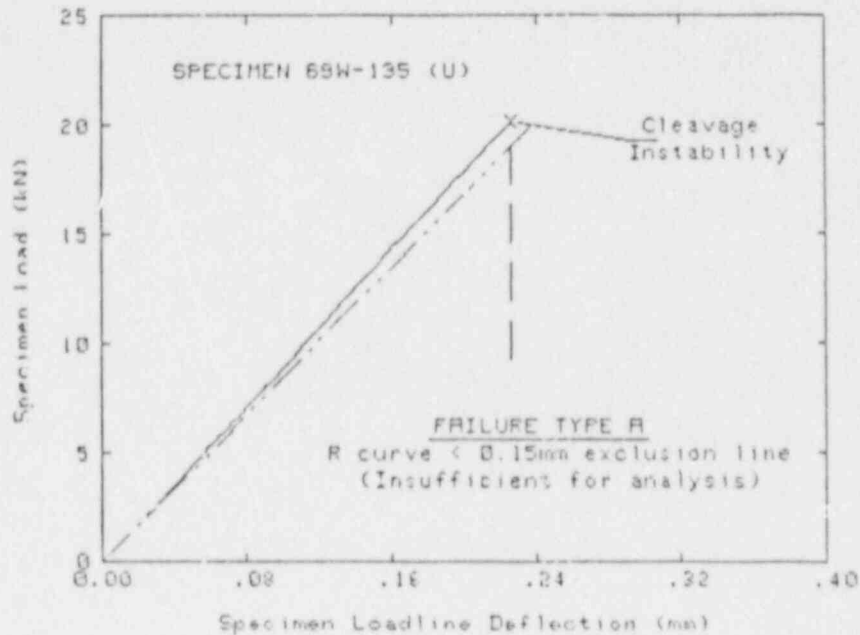
J_{ic} = 16.1 kJ/m²
 $K_{Jc} = (E J_{ic} / (1 - \nu^2))^{.5} = 58.6 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$
 $K_{ic} \text{ (Beta Corrected)} = 56.9 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$

ASTM E399-81 ANALYSIS

Modif. K_{ic} Equation; $B = (B B_n)^{.5}$
 Maximum Load P = 25.89 kN
 5% Secant Offset P_Q = 25.89 kN
 $K_{ic} = 60.1 \text{ MPa } \sqrt{\text{m}}$
 Validity = VALID K_{ic} value
 K at Maximum Load = 60.1 MPa $\sqrt{\text{m}}$

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 = A500-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 = 20.07 mm
 Flow stress = 618.1 MPa
 Yield stress = 778.6 MPa
 Youngs modulus E = 212900 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

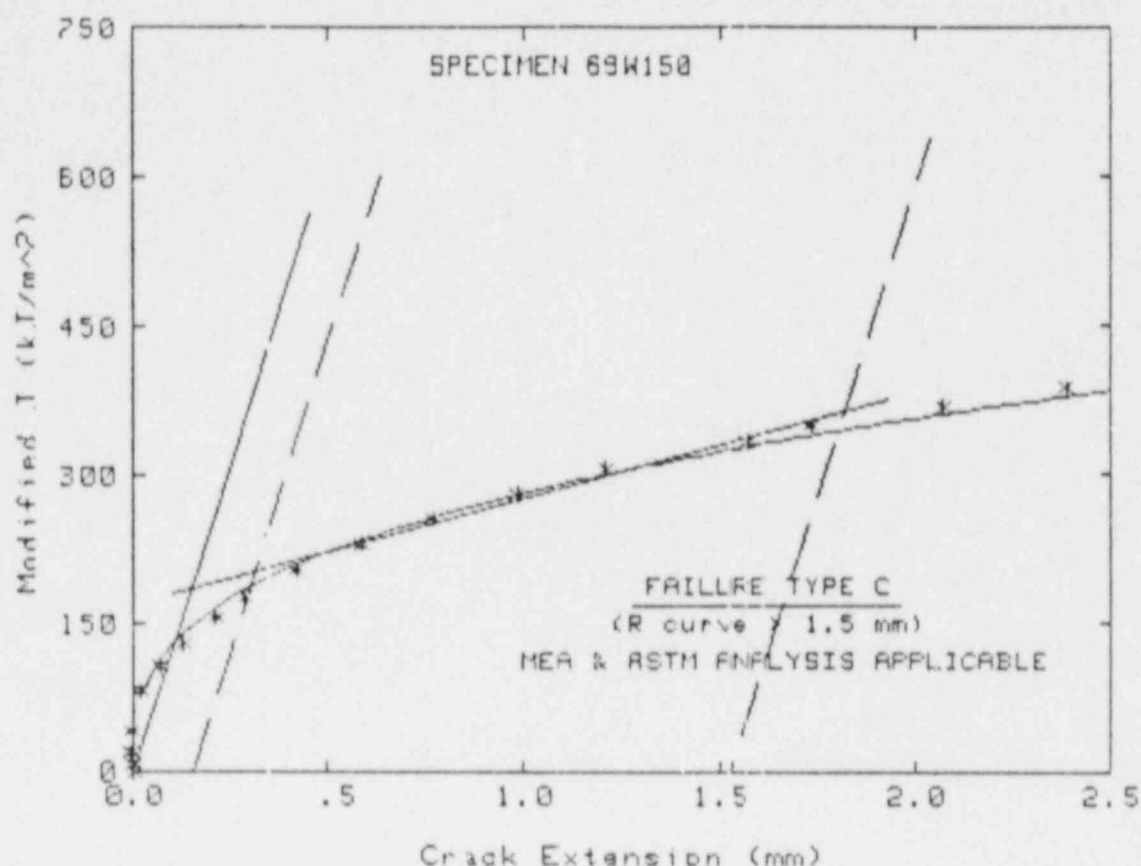
Failure Type A (J at Instability = J_{ic})
 J_{ic} = 9.6 kJ/m²
 K_{ic} = (E J_{ic})^{0.5} = 45.1 MPa √m
 K_{ic} (Beta Corrected) = 44.6 MPa √m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation: B = (E B₀)^{0.5}
 Maximum Load P = 20.14 kN
 5% Secant Offset P_Q = 20.14 kN
 K_{ic} = 46.6 MPa √m
 Validity = VALID K_{ic} value

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Parabolic-Corner OFFSET LOAD = 0 lb OFFSET DEFLECTION = 1.93167307555E-04 in.
 Specimen rotation Load intercept elastic slope = 2.20555555555E-07 lb
 Fitted elastic load range = 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type = A533-B HSS T WELD
 Test Temperature = 200 °C
 Percent Side Groove = 20 %
 Specimen Thickness = 25.4 mm
 Init crack length = 30.6 mm
 Final crack length = 35.29 mm
 Flow stress = 623 MPa
 Youngs modulus = 195800 MPa

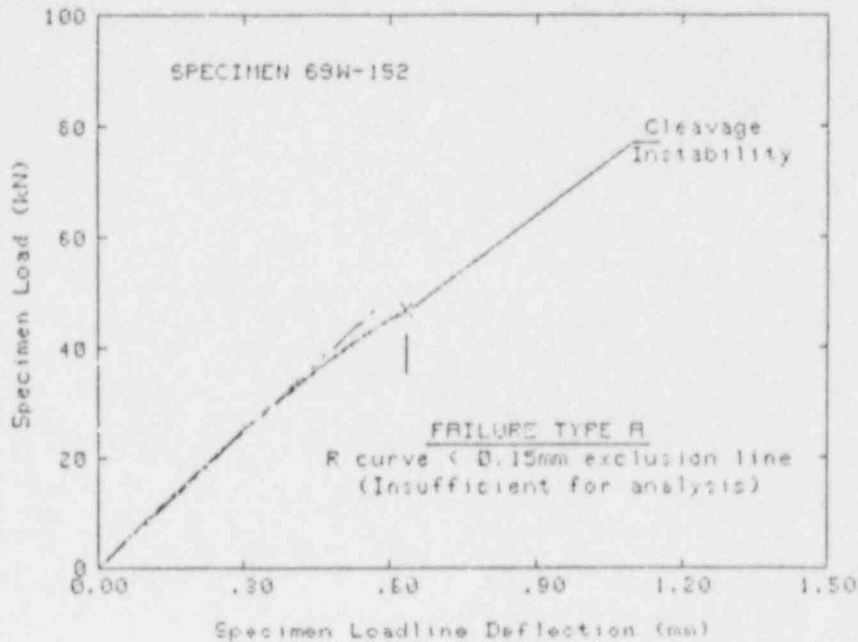
Init a/W = .602
 Final a/W = .694
 (Estimated Value)

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

J_{ic} = 187.6 kJ/m²
 K_{ic} = 191.6 $J^{1/0.3399}/I=0.8$ = 323.1 kJ/m²
 Exponent N = .3399
 Coefficient C = 281.4 kJ/m²
 I (average) = 50

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

J_{ic} = 184.3 kJ/m²
 K_{ic} = 190 Slope M = 107548.3 kJ/m³
 Intercept B = 168.4 kJ/m²
 I (ASTM) = 54
 Validity (J_{ic}) = VALID
 Validity (R-curve) = INVALID--2
 J maximum allowed = 628.8 kJ/m² (J_{max}=B_{net}*Flow stress/20)
 Delta a max. allowed = 2.82 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/H = .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 (ν) = 0

J-INTEGRAL ANALYSIS

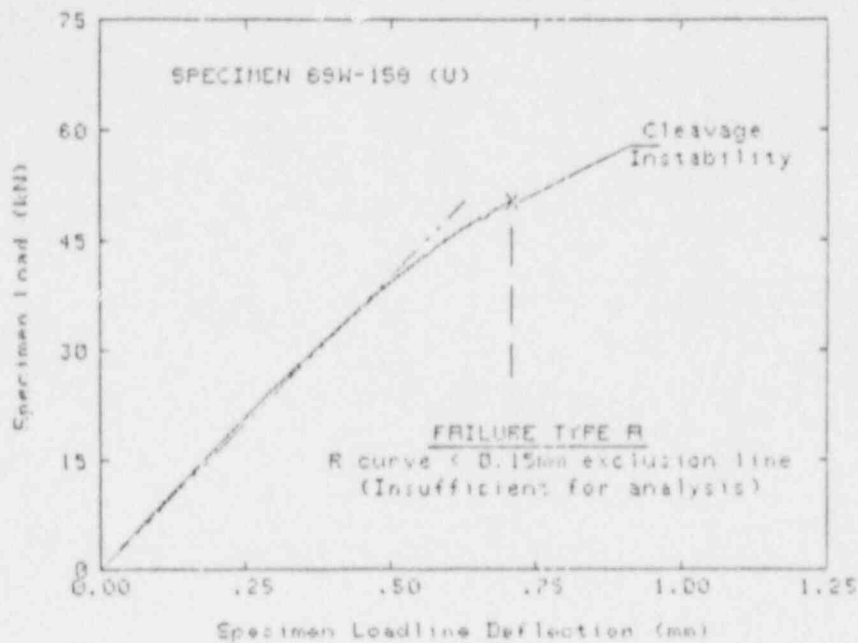
Failure Type A at instability = J_{ic}
 J_{ic} = 69.1 kJ/m²
 $K_{Jc} = (E J_{ic} / (1 - \nu^2))^{0.5} = 119.8 \text{ MPa } \sqrt{\text{m}}$ ν=0
 K_{Jc} (Beta Corrected) = 90.6 MPa $\sqrt{\text{m}}$ ν=0.3

ASTM E299-01 ANALYSIS

Modified K_{Jc} Equation: $B = (B_n)^{0.5}$
 Maximum Load P = 47 kN
 5% Secant Offset P_Q = 29.9 kN
 K_{Jc} = 71.7 MPa $\sqrt{\text{m}}$
 Validity = INVALID--2, 3
 P at Maximum Load = 112.7 MPa $\sqrt{\text{m}}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Hinkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 0.000607100216-04 in.
 Specimen rotation Load intercept elastic slope = 9.78571428571E-07 lb
 Fitted elastic load range= 2000 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type * A500-B HSSB WELT
 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
 Young's modulus E * 207500 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

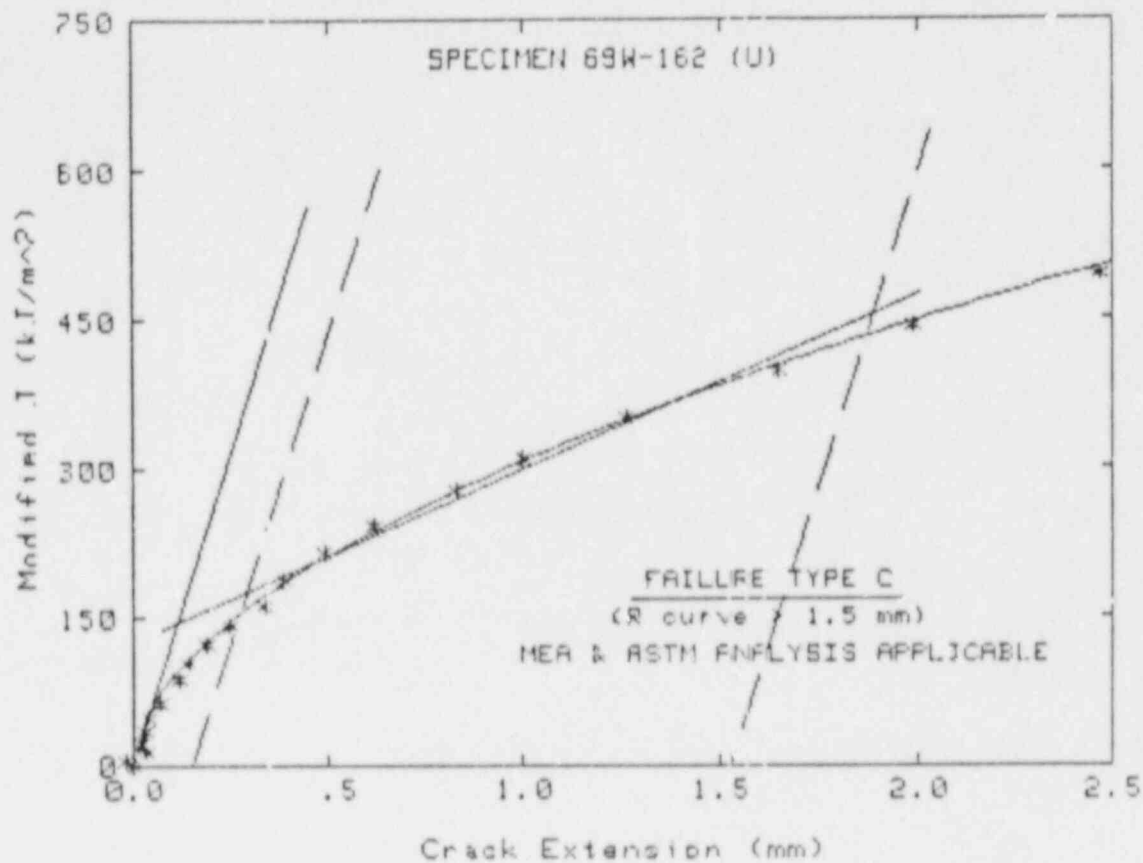
Failure Type R (J at instability = J_{ic})
 J_{ic} * 84.4 kJ/m²
 K_{Jic}=(EJ_{ic})^{0.5} * 102.4 MPa √m vx.3
 K_{ic} (Beta Corrected) * 95.5 MPa √m vx.3

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation: B * (B/B_{min})^{1.5}
 Maximum Load P * 50.33 kN
 1N Secant Offset P_Q * 34.69 kN
 K_{ic} * 82.8 MPa √m
 Validity * INVALID--1, 2, 5

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Tertiary-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

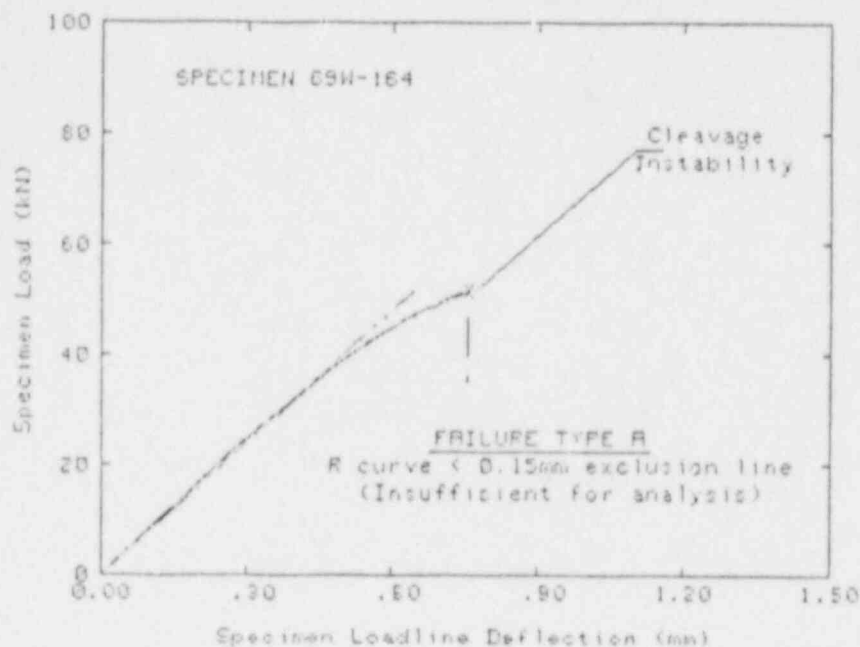
Material Type	= A533-B HSST WELD	
Test Temperature	= 121 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.42 mm	Init a/W = .598
Final crack length	= 40.14 mm	Final a/W = .79
Flow stress	= 630.3 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

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

J _{ic}	= 152.9 kJ/m ²	
K _{jc}	= 175	J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 144.2 kJ/m ²	
K _{jc}	= 169.9	Slope M = 175781.2 kJ/m ³
Intercept B	= 124.1 kJ/m ²	
T (ASTM)	= 89	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 639.9 kJ/m ²	(J _{max} = B _{net} * Flow stress / 20)
Delta a max. allowed	= 2.04 mm	(Delta a max = 0.1 * b ₀)



TEST SPECIMEN DATA

Material Type * A503-B 02 REF
 Test Temperature * 20 °C
 Percent Side Groove * 0 %
 Specimen Thickness B * 25.4 mm
 Initial a-W * 1.593
 Init crack length a * 30.12 mm
 Flow stress * 688 MPa
 Yield stress * 641.9 MPa
 Young's modulus E * 206100 MPa (Estimated Value)
 Poisson's Ratio (ν) * 0

J-INTEGRAL ANALYSIS

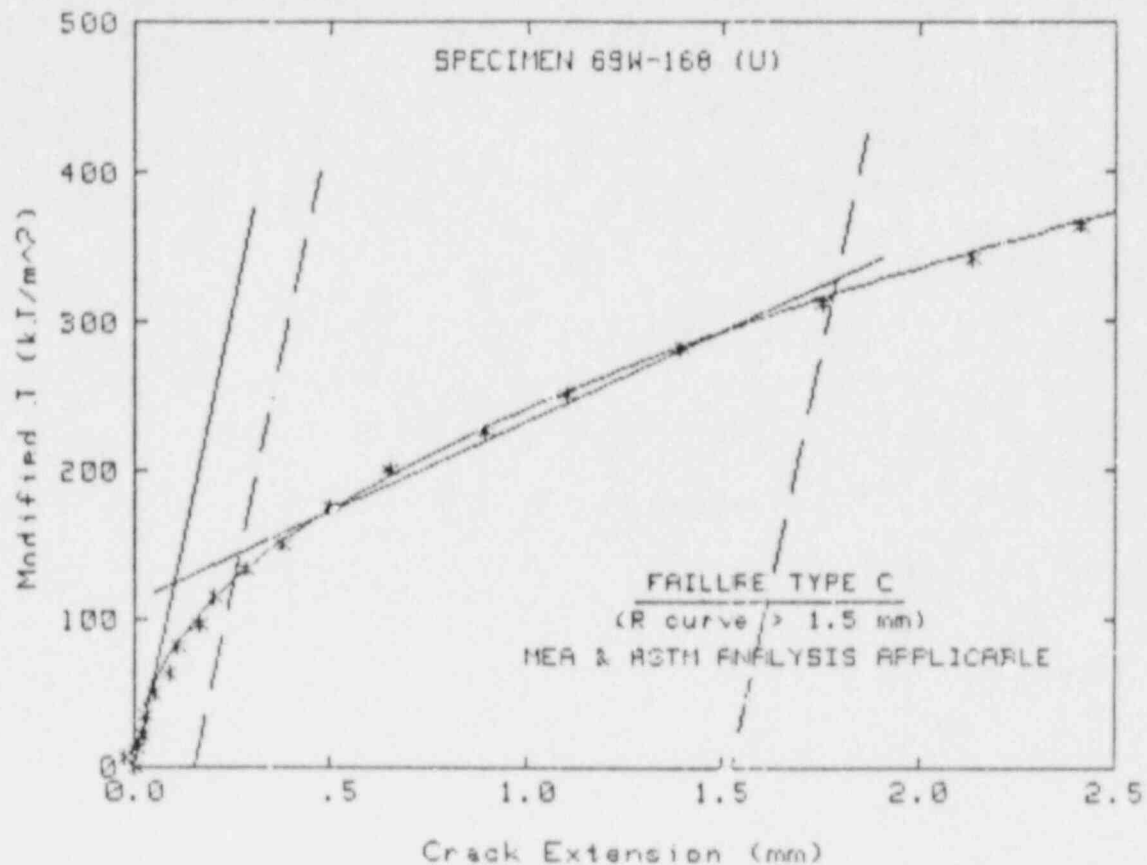
Failure Type A (J at instability = J_{ic})
 J_{ic} * 92.9 kJ/m²
 $K_{Jic} = (E J_{ic} / (1 - \nu^2))^{0.5}$ * 128.4 MPa $\sqrt{m}$ $\nu=0$
 K_{ic} (Beta Corrected) * 95.9 MPa $\sqrt{m}$ $\nu=0$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation: $E = (E S_n)^{0.5}$
 Maximum Load P * 51.45 kN
 5% Secant Offset P_Q * 34.21 kN
 K_{ic} * 79.4 MPa $\sqrt{m}$
 Validity * INVALID=-1, 2, 3
 K at Maximum Load * 115.4 MPa $\sqrt{m}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Herrick-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-3.10517098694E-04 in.
 Specimen rotation Load intercept elastic slope = 5.50620609455E-06 lb
 Fitted elastic load range= 3000 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

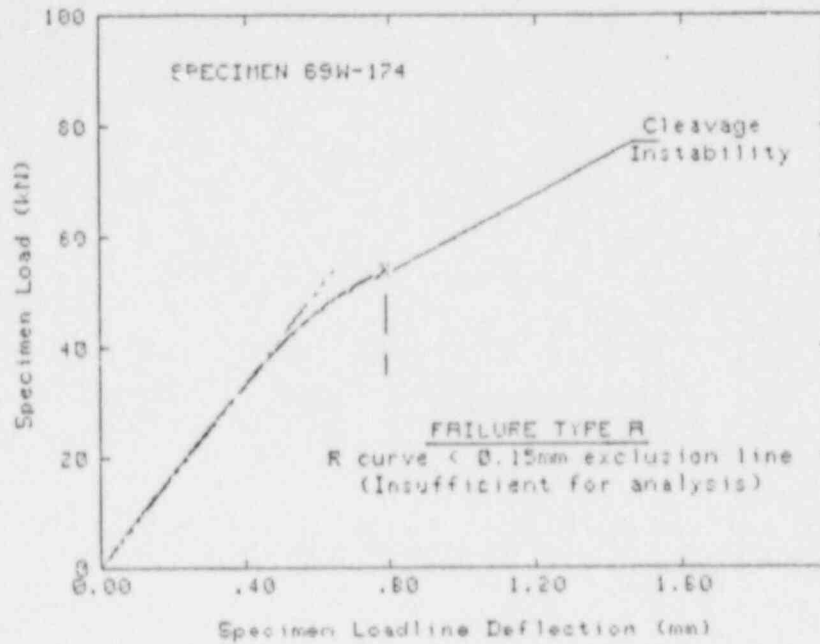
Material Type	A533-B HSST WELD	
Test Temperature	= 204 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.88 mm	Init a/W = .607
Final crack length	= 40.86 mm	Final a/W = .804
Flow stress	= 623 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

J _{ic}	= 126.1 kJ/m ²	
K _{ic}	= 157	J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 124 kJ/m ²	
K _{ic}	= 155.7	Slope M = 120457.5 kJ/m ³
Intercept B	= 112 kJ/m ²	
T (ASTM)	= 61	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 620.2 kJ/m ²	(J _{max} = B _{net} * Flow stress / 20)
Δa max. allowed	= 1.99 mm	(Δa max = 0.1 * b _o)



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 (ν) = 0

J-INTEGRAL ANALYSIS

Failure Type R (J at instability = J_{ic})

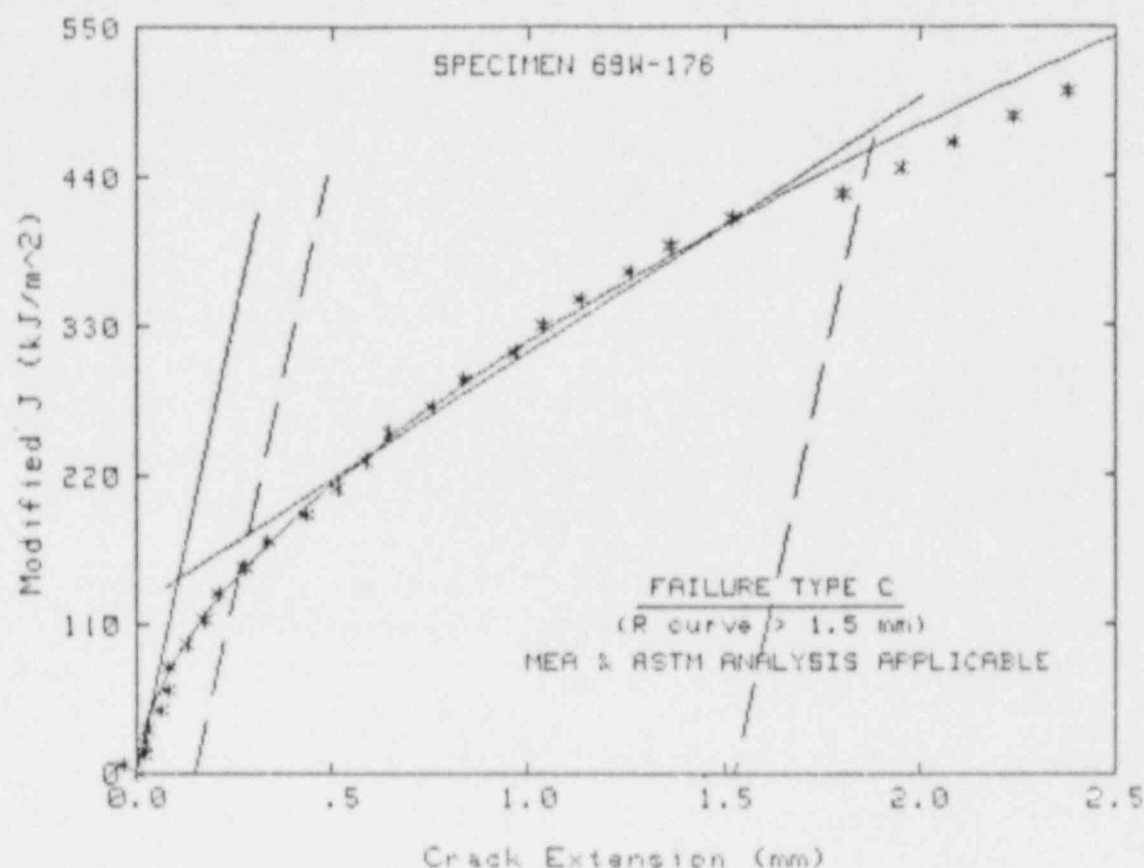
J_{ic} = 103.2 kJ/m²
 $K_{Jc} = (E J_{ic} / (1 - \nu^2))^{.5} = 142.4 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$
 $K_{Jc} \text{ (Beta Corrected)} = 97.6 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (E \sigma_y)^{.5}$
 Maximum Load P = 53.9 kN
 5% Secant Offset P_Q = 31.76 kN
 $K_{Jc} = 74.2 \text{ MPa } \sqrt{\text{m}}$
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 125.9 MPa $\sqrt{\text{m}}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Hertke-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = -4.5145595047E-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
 Final crack length = 41.9 mm
 Flow stress = 664 MPa
 Young's modulus = 204400 MPa

Init a/W = .608

Final a/W = .824

(Estimated Value)

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

J_{ic} = 147.1 kJ/m²
 K_{Jc} = 173.4 MPa √m
 J (@J/T=6.8) = 492.2 kJ/m²
 Exponent N = .5808
 Coefficient C = 319.3 kJ/m²
 T (average) = 87

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

J_{ic} = 144.7 kJ/m²
 K_{Jc} = 172 MPa √m
 Slope M = 187250.7 kJ/m³
 Intercept B = 124.3 kJ/m²
 T (ASTM) = 87

Validity (J_{ic}) = VAL'D

Validity (R-curve) = VALID

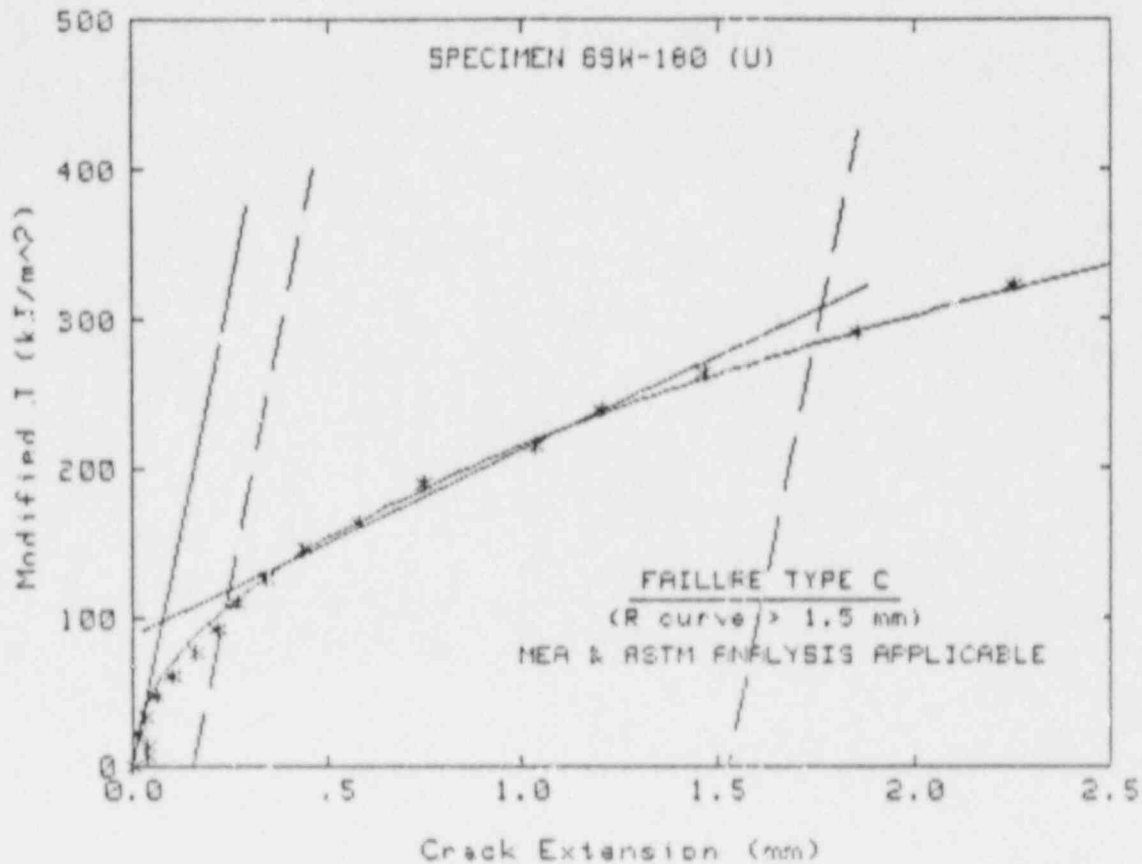
J maximum allowed = 660.6 kJ/m²(J_{max} = B_{net} * Flow stress / 20)

Delta a max. allowed = 1.92 mm

(Delta a max = 0.1 * b₀)

Final Delta a = 10.97 mm

Poisson's Ratio (ν) = 0



TEST SPECIMEN DATA

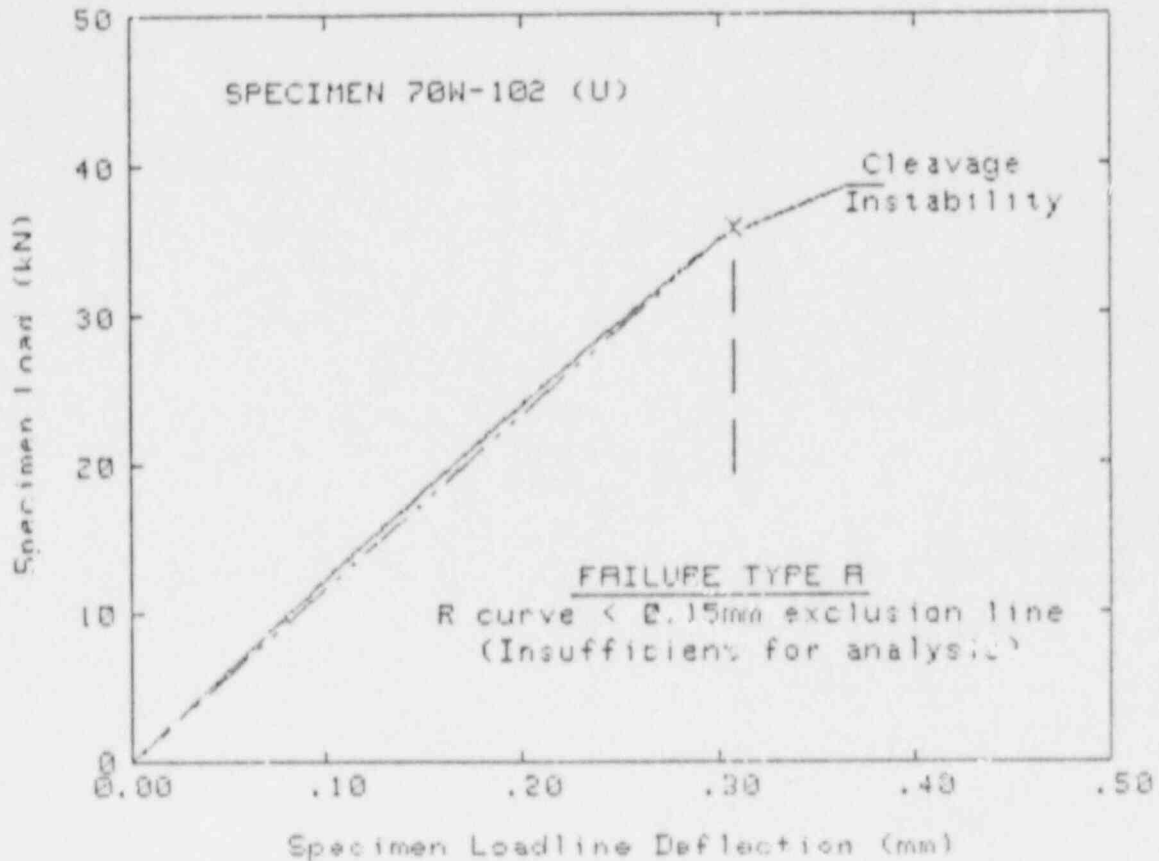
Material Type	= A533-B HSST WELD	
Test Temperature	= 288 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.76 mm	Init a/W = .605
Final crack length	= 41.56 mm	Final a/W = .818
Flow stress	= 650.7 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

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

J _{ic}	= 106.4 kJ/m ²	
K _{Jc}	= 142.4	J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 97.2 kJ/m ²	
K _{Jc}	= 136.2	Slope M = 124238 kJ/m ³
Intercept B	= 87.9 kJ/m ²	
T (ASTM)	= 56	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= INVALID--1	
J maximum allowed	= 651.4 kJ/m ²	(J _{max} = B _{net} * Flow stress / 20)
Δa max. allowed	= 2 mm	(Δa max = 0.1 * b ₀)



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

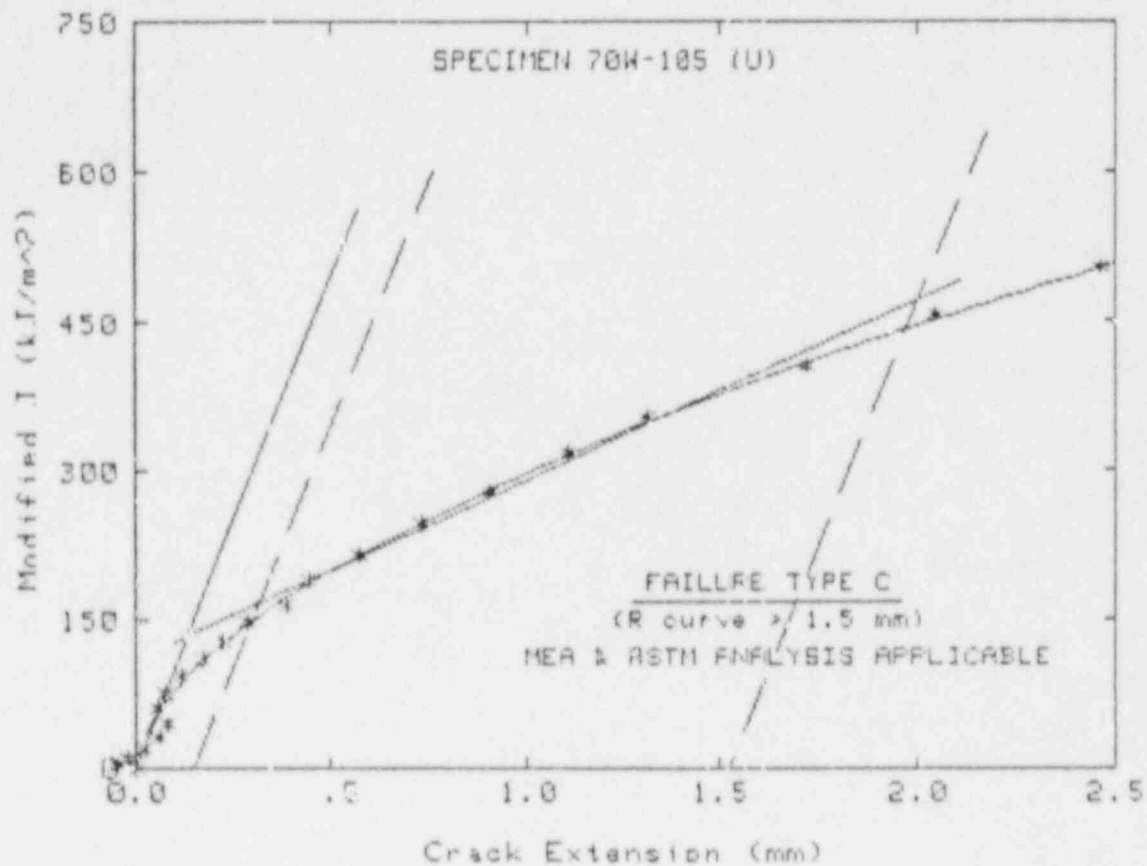
Failure Type A (J at instability = J _{ic})	
J _{ic}	= 21.4 kJ/m ²
K _{Jc} = (EJ _{ic} /(1-ν ²)) ^{0.5}	= 71 MPa √m ν=.3
K _{ic} (Beta Corrected)	= 65.5 MPa √m ν=.3

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation: B = (BB _n) ^{0.5}	
Maximum Load P	= 35.74 kN
5% Secant Offset P _q	= 33.99 kN
K _{ic}	= 66 MPa √m
Validity	= INVALID--1, 2

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Hinkle-Corten Correction
Correction for specimen rotation
Correction to J for crack extension



TEST SPECIMEN DATA

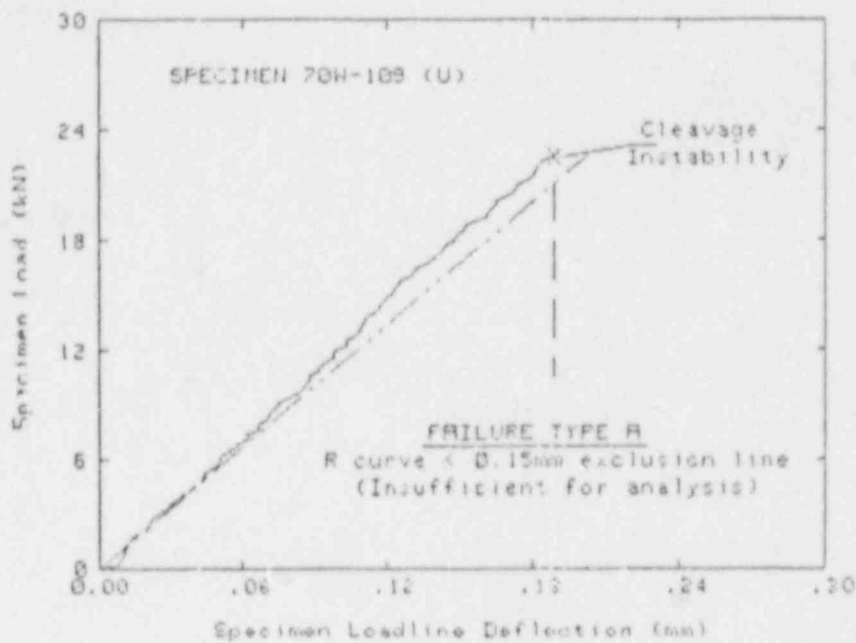
Material Type	= A533-B HSST WELD	
Test Temperature	= 121 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.8 mm	Init a/W = .547
Final crack length	= 38.39 mm	Final a/W = .755
Flow stress	= 494.2 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

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

J _{ic}	= 148.4 kJ/m ²	
K _{Jc}	= 172.4	$J (\theta J-1=8.8) = 684.5 \text{ kJ/m}^2$
Exponent N	= .5823	
Coefficient C	= 297.6 kJ/m ²	
T (average)	= 148	

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

J _{ic}	= 135.4 kJ/m ²	
K _{Jc}	= 164.7	Slope M = .797617 kJ/m ³
Intercept B	= 110.8 kJ/m ²	
T (ASTM)	= 148	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 501.8 kJ/m ²	(J _{max} = J _{ic} * Flow stress / 20)
Delta a max. allowed	= 2.3 mm	(Delta a max = 0.1 * b ₀)



TEST SPECIMEN DATA

Material Type * A500-B HSSB WELD
 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 * 210000 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

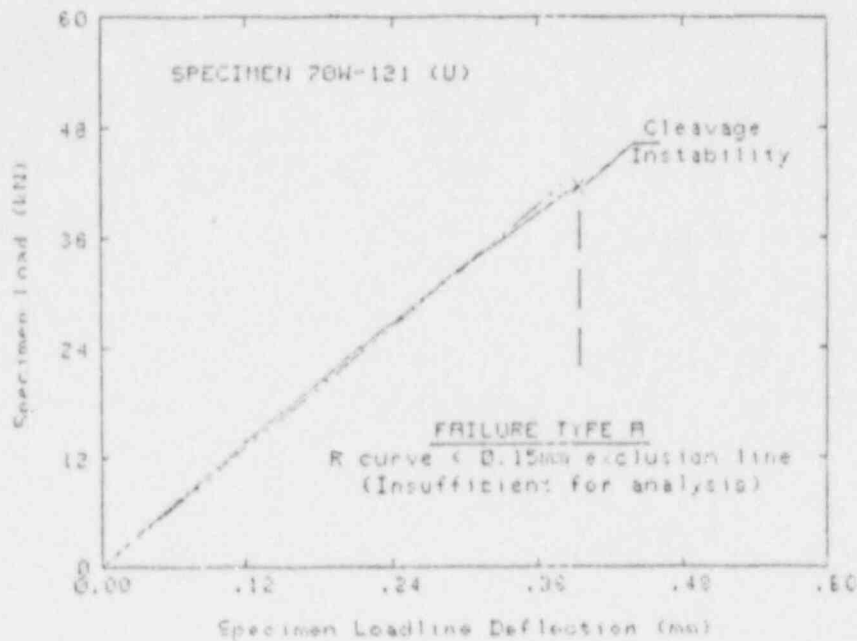
Failure Type A (J at instability * J_{IC})
 J_{IC} * 0.5 kJ-m²
 K_{JIC}(E_{JIC})^{0.5} * 42 MPa √m
 K_{IC} (Beta Corrected) * 41.2 MPa √m

ASTM E399-81 ANALYSIS

Modified K_{IC} Equation: E * (Bb)^{0.5}
 Maximum Load P * 22.53 kN
 1% Secant Offset P_Q * 22.53 kN
 K_{IC} * 44.1 MPa √m
 Validity * VALID K_{IC} value

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Parkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 6.60467E-03 in.
 Specimen rotation Load intercept elastic slope = 2.84782E-04 lb
 Fitted elastic load range = 2000 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

Material Type * A500-B HSSB WELI
 Test Temperature * -45 C
 Percent Side Groove * 0 %
 Specimen Thickness B * 25.4 mm
 Initial a/R * .546
 Init crack length a * 27.74 mm
 Flow stress * 626.0 MPa
 Yield stress * 565.7 MPa
 Young's Modulus E * 210900 MPa (Estimated Value)

J-INTEGRAL AND VSIS

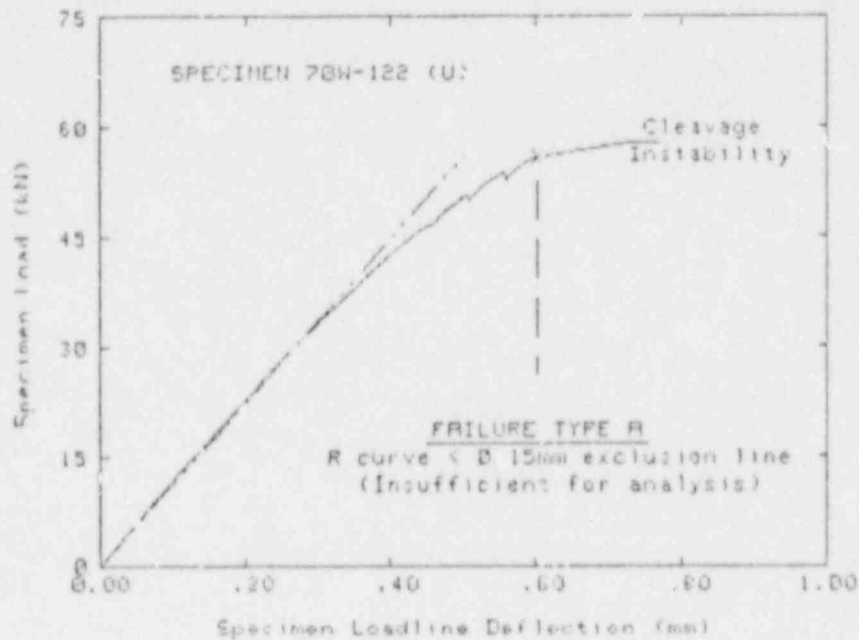
Failure Type A (J at instability = J_{ic})
 J_{ic} * 32.0 kJ/m²
 E_{peak}(E_{J_{ic}}) * .5 * 87.2 MPa $\sqrt{m}$ $\sqrt{m}$
 K_{ic} (Beta Corrected) * 68.6 MPa $\sqrt{m}$ $\sqrt{m}$

ASTM E169-01 ANALYSIS

Modified K_{ic} Equation: B * (E_{J_{ic}})^{1.5}
 Maximum Load P * 41.55 kN
 1% Secant Offset P_Q * 37.54 kN
 K_{ic} * 65.7 MPa $\sqrt{m}$
 Validity * INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Parallel-Correction OFFSET LOADS 0 TO OFFSET REFLECTION * -4.63764007671E-05 in.
 Specimen rotation Load intercept elastic slope * .00000036375 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 WITH YSIS

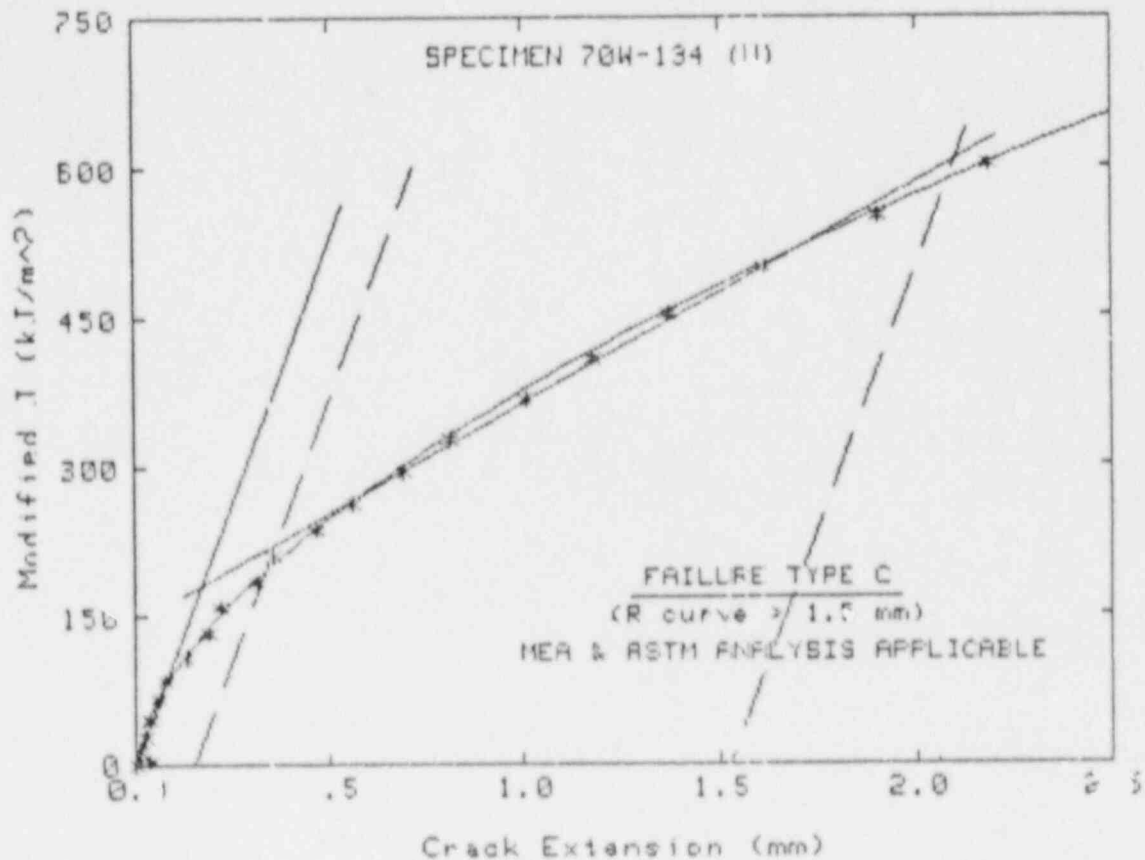
Failure Type A (J at instability = J_{ic})
 J_{ic} = 73 kJ/m²
 E_{sec}E_{ic}0.5 = 124.1 MPa $\sqrt{mm}$ $\sqrt{mm}$
 E_{ic} (Beta Corrected) = 65.2 MPa $\sqrt{mm}$ $\sqrt{mm}$

FSTH 2299-81 ANALYSIS

Fitted E_{ic} Equation: E = (E_{ic})^{0.5}
 Maximum Load P = 56.02 kN
 5% Secant Offset P_q = 31.23 kN
 E_{ic} = 61.6 MPa $\sqrt{mm}$
 Validity = INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Perkle-Corten OFFSET LOAD= 0 lb; OFFSET DEFLECTION = 3.4216737E-05 in.
 Specimen rotation Load intercept elastic slope = 1.9230769E-07 lb
 Fitted elastic load ranges 2000 TO 600 Correction to J for crack extension



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 = 27.88 mm
 Final crack length = 39.4 mm
 Flow stress = 526.2 MPa
 Youngs modulus = 204400 MPa

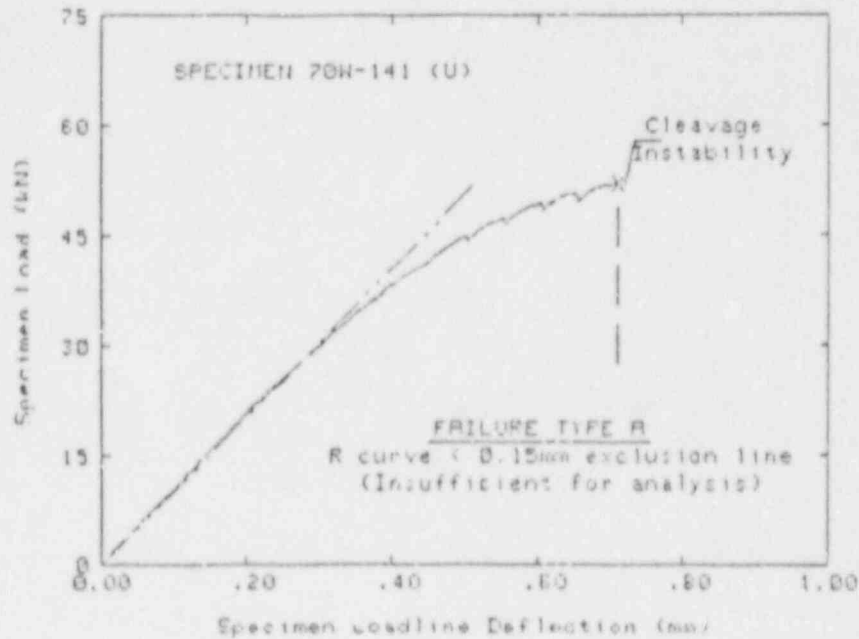
Init a/W = .548
 Final a/W = .775
 (Estimated Value)

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

Jic = 196.6 kJ/m²
 Kjc = 200.4 J (0J/T=0.8) = 852 kJ/m²
 Exponent N = .6015
 Coefficient C = 376.5 kJ/m²
 T (average) = 160

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

Jic = 180 kJ/m²
 Kjc = 191.8 Slope M = 220763.1 kJ/m³
 Intercept B = 142.2 kJ/m²
 T (ASTM) = 163
 Validity (Jic) = VALID
 Validity (R-curve) = INVALID--3 (.4 vs .34)
 J maximum allowed = 534.2 kJ/m² (Jmax=Bnet*Flow stress/20)
 Delta a max. allowed = 2.29 mm (Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type * A500-B HSS WELD
 Test Temperature * -35 C
 Percent Side Groove * 0 %
 Specimen Thickness B * 25.4 mm
 Initial a/W * .566
 Init crack length a * 28.77 mm
 Flow stress * 594.6 MPa
 Yield stress * 535 MPa
 Young's modulus E * 209200 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

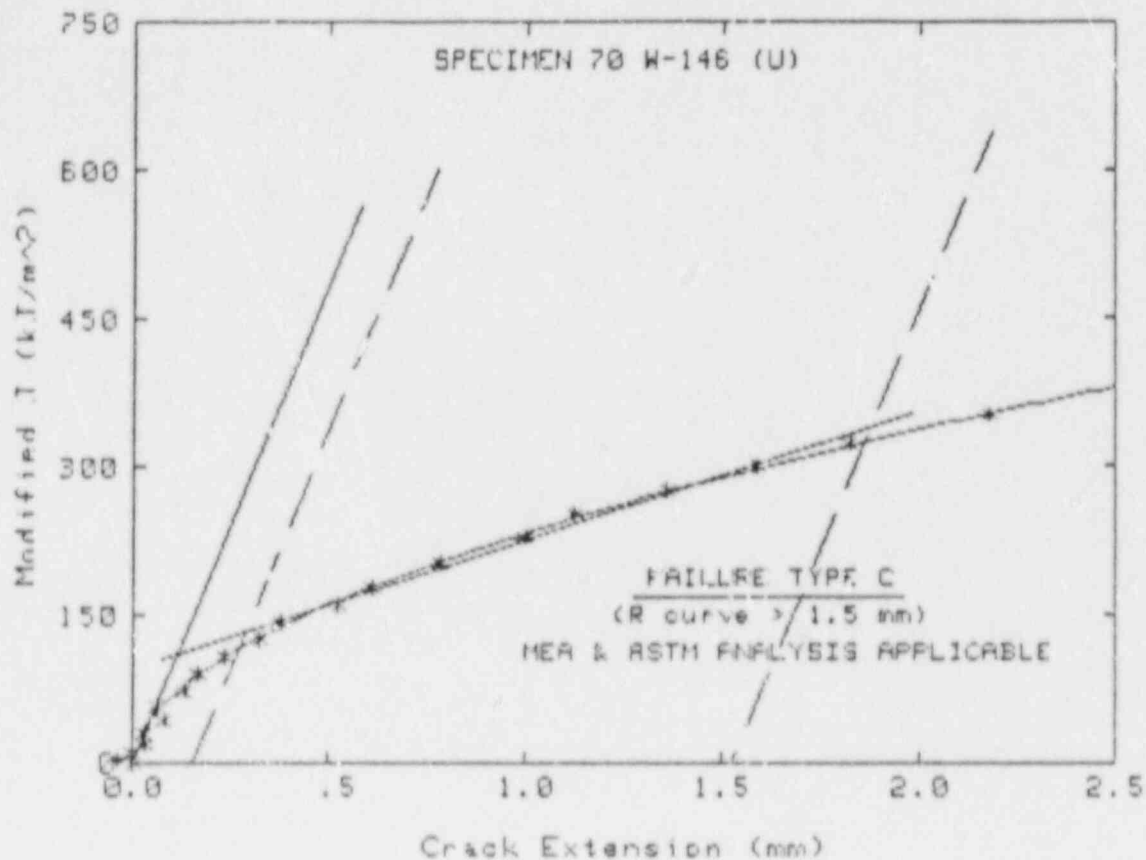
Failure Type A (J at instability = J_{ic})
 J_{ic} * 89.5 kJ/m²
 K_{JIC(EJIC)}*.5 * 156.9 MPa $\sqrt{mm}$ vs. 2
 K_{IC (Beta Corrected)} * 86.7 MPa $\sqrt{mm}$ vs. 2

ASTM E399-81 ANALYSIS

Modified K_{IC} Equation: B * (EEN)^{1.5}
 Maximum Load P * 50.11 kN
 1% Secant Offset P_Q * 20.49 kN
 K_{IC} * 59.9 MPa $\sqrt{mm}$
 Validity * INVALID=-1, 2, 2

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Perble-Corten OFFSET LOADS 0 10 OFFSET REFLECTION =1.89442043921E-04 mm.
 Specimen rotation Load intercept elastic slope = .0000001 lb
 Fitted elastic load range 2000 TO 600 Correction to 2 for crack extension



TEST SPECIMEN DATA

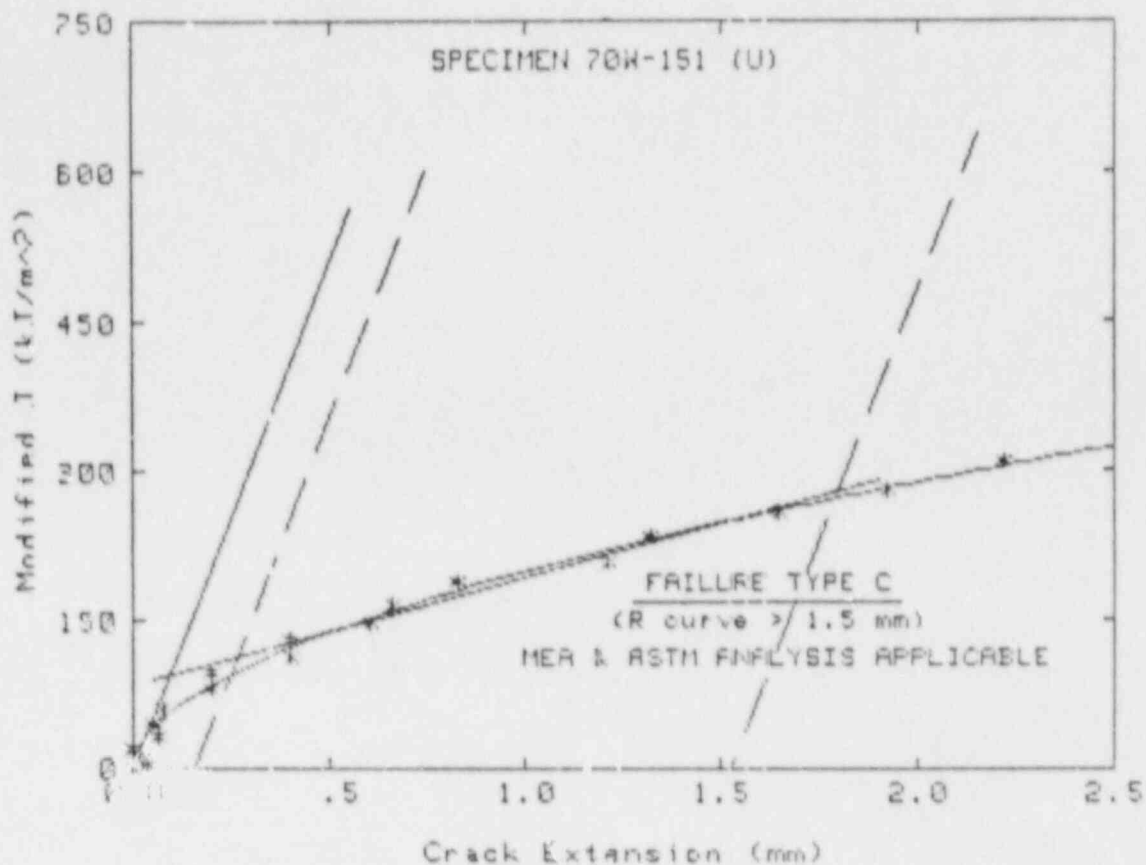
Material Type	= A533-B HSST WELD	
Test Temperature	= 204 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.86 mm	Init a/W = .548
Final crack length	= 37.81 mm	Final a/W = .744
Flow stress	= 485.5 MPa	
Youngs modulus	= 191500 MPa	(Estimated Value)

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

J _{ic}	= 115.6 kJ/m ²	
K _{jc}	= 150.3	J (θJ/T=8.8) = 480.1 kJ/m ²
Exponent N	= .5256	
Coefficient C	= 232.5 kJ/m ²	
T (average)	= 105	

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

J _{ic}	= 109.3 kJ/m ²	
K _{jc}	= 146.2	Slope M = 130597.6 kJ/m ³
Intercept B	= 94.6 kJ/m ²	
T (ASTM)	= 108	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 494 kJ/m ²	(J _{max} = J _{net} * Flow stress / 20)
Δa max, allowed	= 2.29 mm	(Δa max = 0.1 * b ₀)



TEST SPECIMEN DATA

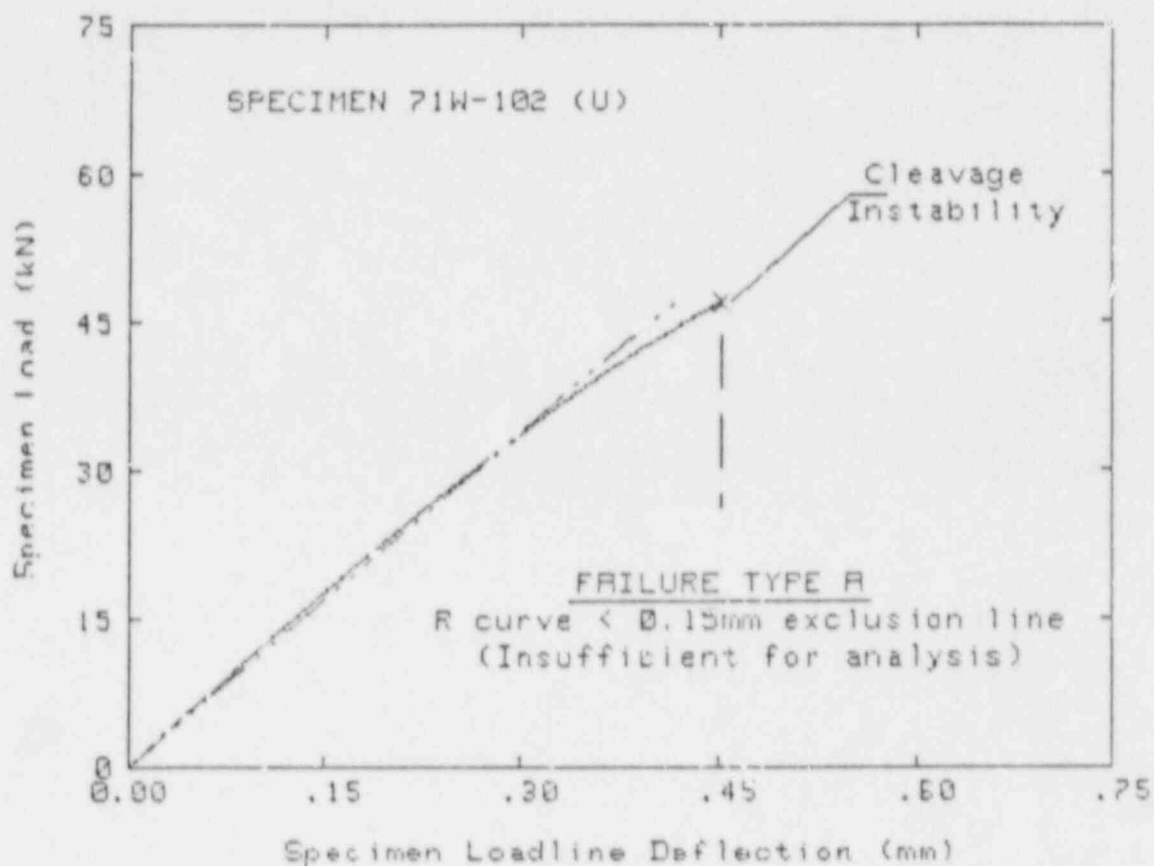
Material Type	= A533-B HSST WELD	
Test Temperature	= 288 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.05 mm	Init a/W = .552
Final crack length	= 38.07 mm	Final a/W = .749
Flow stress	= 511 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

J _{ic}	= 94.6 kJ/m ²	
K _{jc}	= 134.4	J (θJ/T=8.6) = 380.7 kJ/m ²
Exponent n	= .5299	
Coefficient C	= 199.4 kJ/m ²	
T (average)	= 80	

LAST SQUARE LINEAR LINE (ASTM) $J = M (\Delta a) + B$

J _{ic}	= 95.5 kJ/m ²	
K _{jc}	= 135	Slope M = 108126.5 kJ/m ³
Intercept B	= 85.4 kJ/m ²	
T (ASTM)	= 79	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 518.9 kJ/m ²	(J _{max} = B _{net} * Flow stress / 20)
Δa max. allowed	= 2.28 mm	(Δa max = 0.1 * b ₀)



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

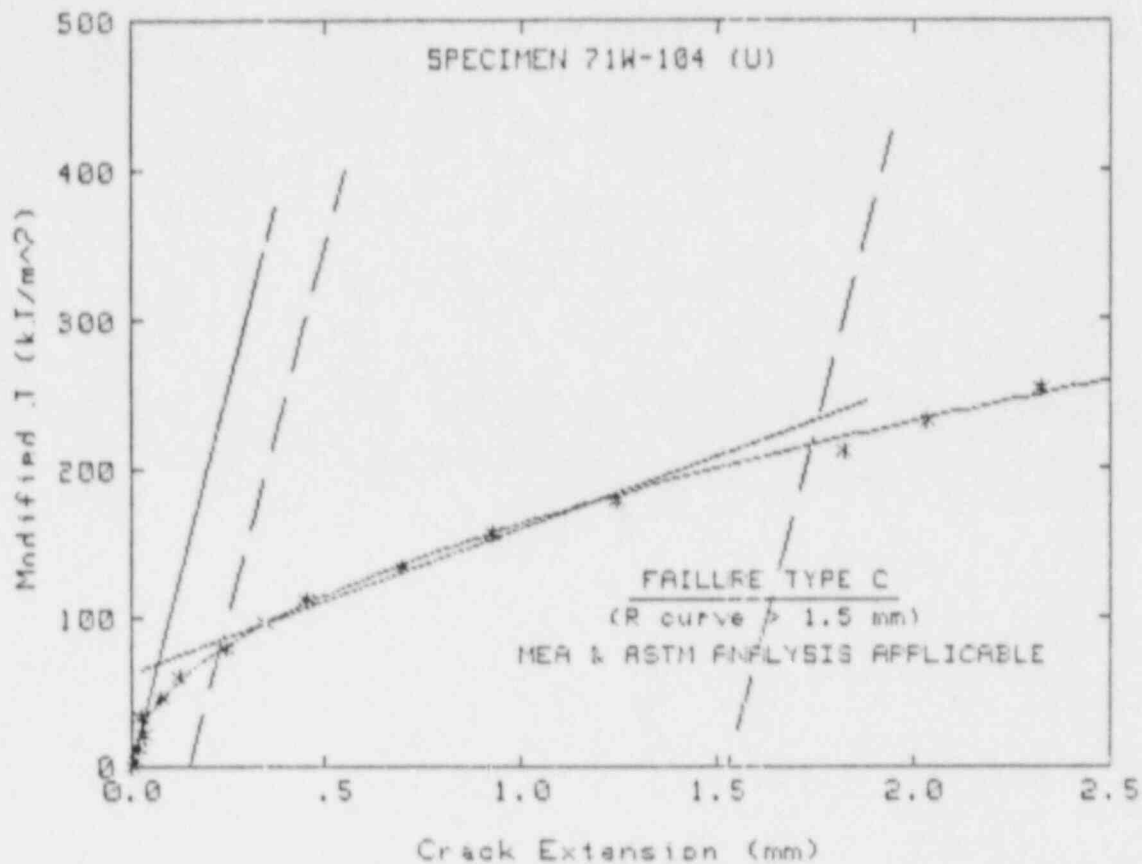
Failure Type A (J at instability = J _{ic})	
J _{ic}	= 43.4 kJ/m ²
K _{Jc} = (EJ _{ic}) ^{0.5}	= 95.5 MPa √m ν=.3
K _{ic} (Beta Corrected)	= 72.9 MPa √m ν=.3

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation, 2 = (BB _n) ^{0.5}	
Maximum Load P	= 46.96 kN
5% Secant Offset P _q	= 32.37 kN
K _{ic}	= 63.3 MPa √m
Validity	= INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Erkkle-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
 Final crack length = 38.82 mm
 Flow stress = 508.1 MPa
 Youngs modulus = 190800 MPa

Init a/W = .565

Final a/W = .764

(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

J_{ic} = 77.5 kJ/m²
 K_{Jc} = 121.6
 Exponent n = .5052
 Coefficient C = 163.2 kJ/m²
 T (average) = 65

J (ΔJ/T=8.8)

= 296.9 kJ/m²

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

J_{ic} = 69.9 kJ/m²
 K_{Jc} = 115.5
 Intercept B = 63.2 kJ/m²
 T (ASTM) = 72

Slope M

= 97110.3 kJ/m³

Validity (J_{ic}) = VALID

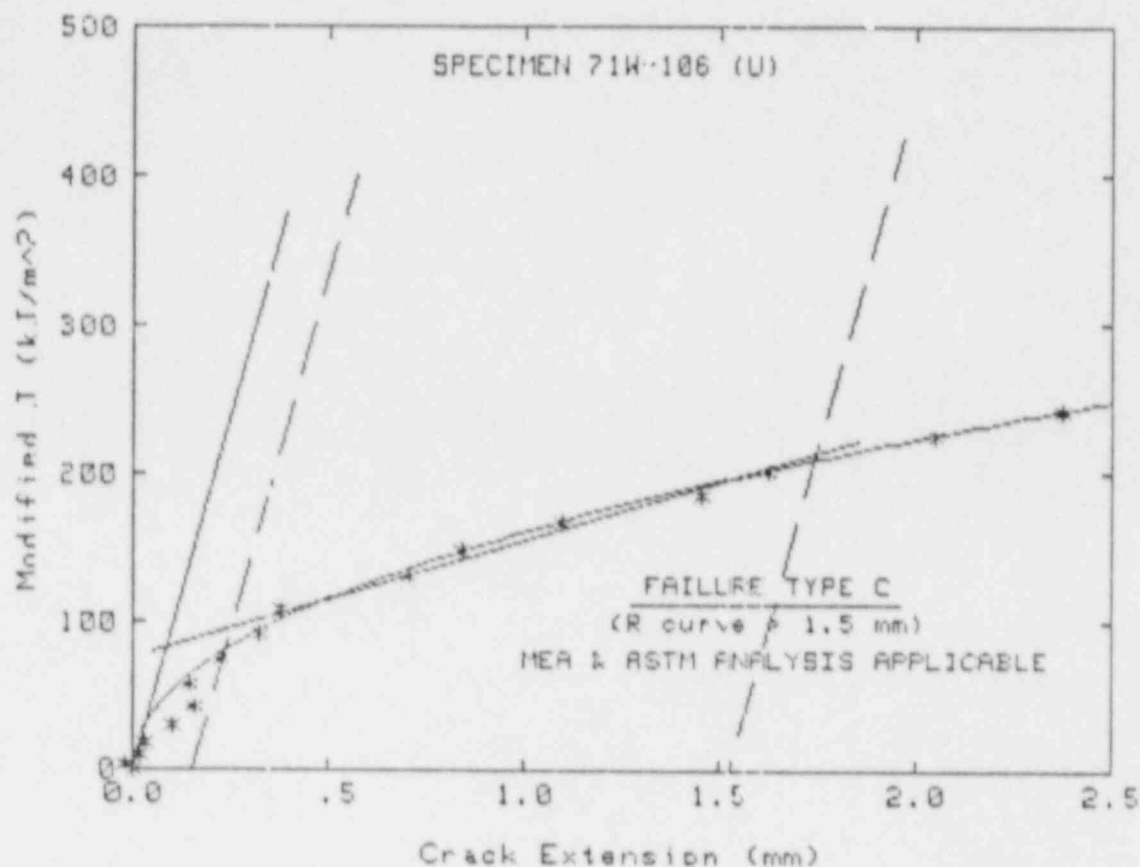
Validity (R-curve) = VALID

J maximum allowed = 515.8 kJ/m²

(J_{max} = E_{net} * Flow stress / 20)

Δa max. allowed = 2.21 mm

(Δa max = 9.1 * b₀)



TEST SPECIMEN DATA

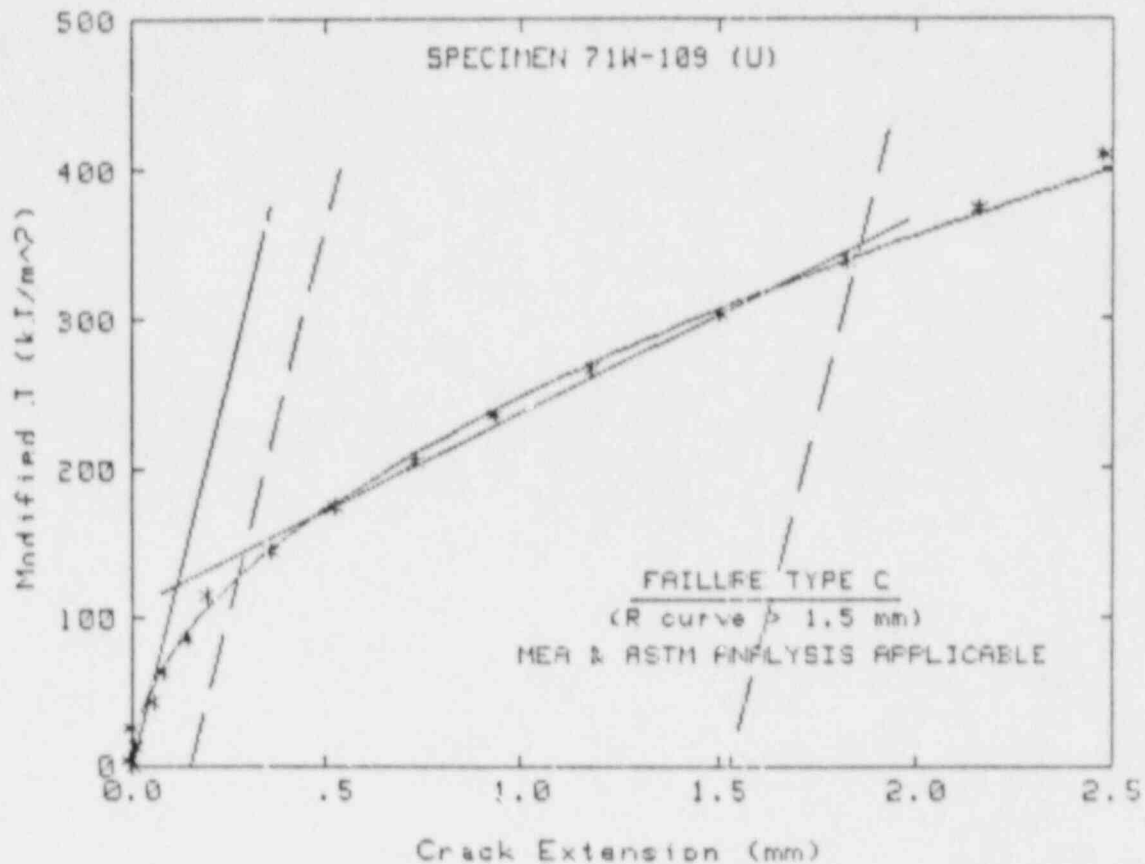
Material Type	= A503-B HSST WELD	
Test Temperature	= 204 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.64 mm	Init a/W = .544
Final crack length	= 38.12 mm	Final a/W = .75
Flow stress	= 482 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

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

Jic	= 81 kJ/m²		
Kjc	= 125.8	$J (\theta J/I=8.8)$	= 291.3 kJ/m²
Exponent N	= .4751		
Coefficient C	= 160.7 kJ/m²		
T (average)	= 68		

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

Jic	= 82.1 kJ/m²		
Kjc	= 136.7	Slope M	= 78632.3 kJ/m³
Intercept B	= 75.4 kJ/m²		
T (ASTM)	= 66		
Validity (Jic)	= VALID		
Validity (R-curve)	= INVALID--1		
J maximum allowed	= 489.3 kJ/m²	$(J_{max} = B_{net} \times \text{Flow stress} / 20)$	
Delta a max, allowed	= 2.32 mm	$(\Delta a_{max} = 0.1 \times b_0)$	



TEST SPECIMEN DATA

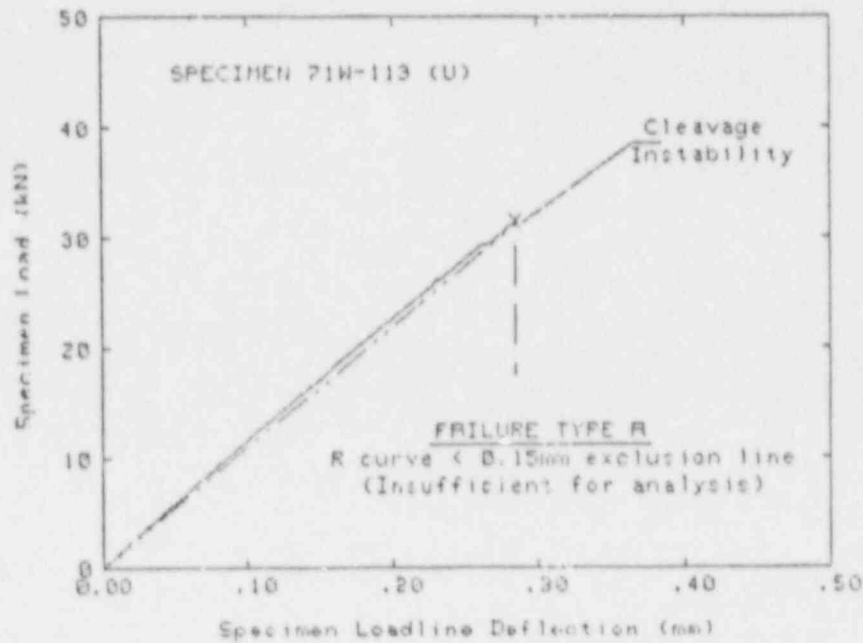
Material Type	= A533-B HSST WELD	
Test Temperature	= 50 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.58 mm	Init a/W = .562
Final crack length	= 40.54 mm	Final a/W = .798
Flow stress	= 521.4 MPa	
Youngs modulus	= 204400 MPa	(Estimated Value)

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

Jic	= 126.7 kJ/m ²	
Kjc	= 168.9	$J (\theta J/I=8.8) = 529.2 \text{ kJ/m}^2$
Exponent N	= .5195	
Coefficient C	= 248.2 kJ/m ²	
I (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	
I (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 * MSST 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 * 212000 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

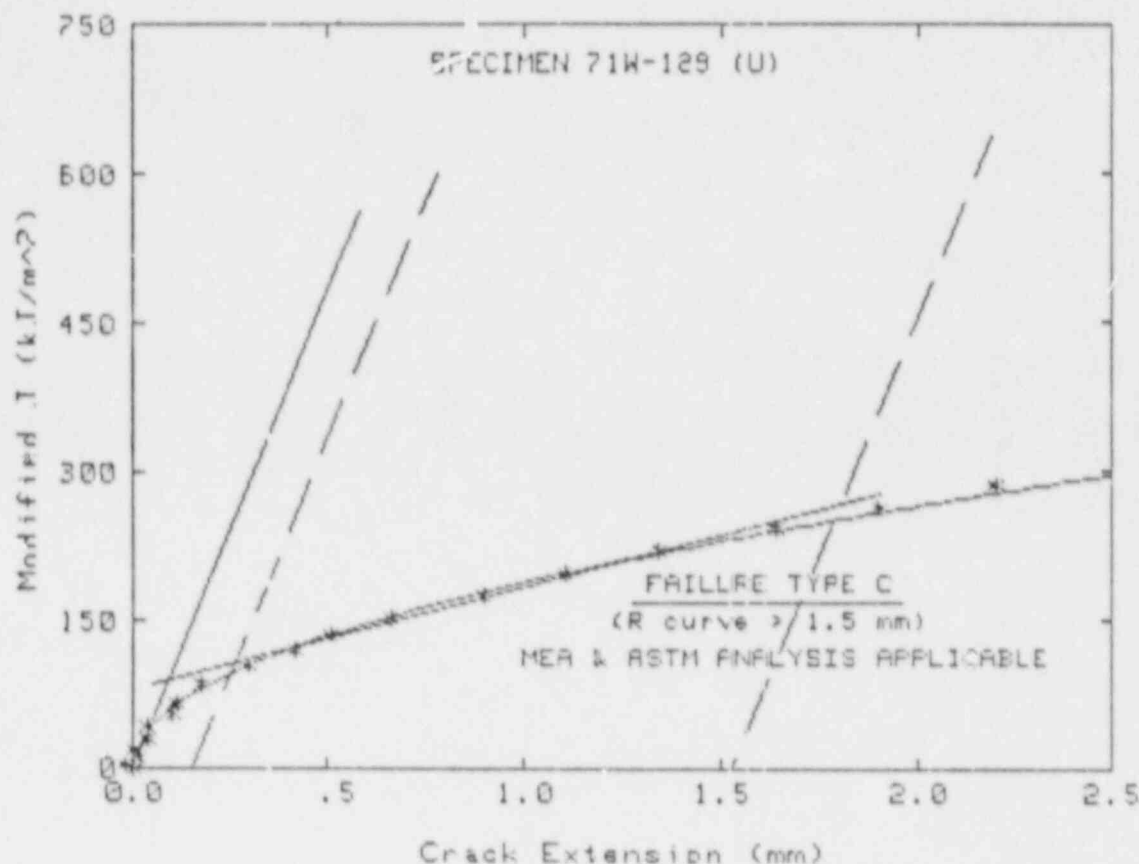
Failure Type R (J at instability = J_{ic})
 J_{ic} * 17.7 kJ/m²
 K_{JCH}(EJ_{ic})^{0.5} * 61.4 MPa √m OK,3
 K_{ic} (Beta Corrected) * 56.5 MPa √m OK,3

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation: B * (BIn)^{0.5}
 Maximum Load P * 31.46 kN
 1% Secant Offset P_Q * 31.46 kN
 K_{ic} * 62.1 MPa √m
 Validity * INVALID--2

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Perkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-7.972508221E-04 in.
 Specimen rotation Load intercept elastic slope =-1.5757575757E-07 lb
 Fitted elastic load range 2008 TO 600 Correction to J for crack extension



TEST SPECIMEN DATA

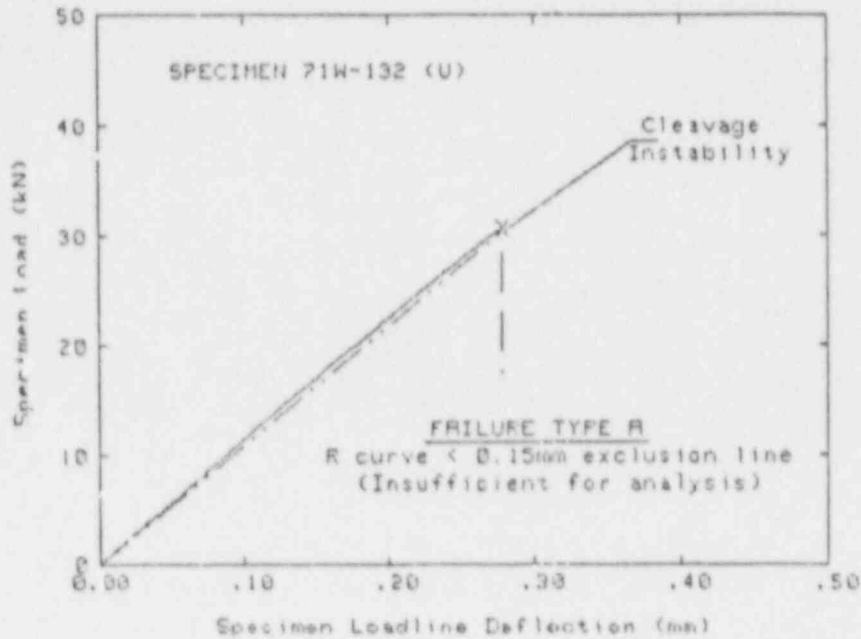
Material Type = A533-B HSST WELD
 Test Temperature = 204 °C
 Percent Side Groove = 20 %
 Specimen Thickness = 25.4 mm
 Init crack length = 28.23 mm
 Final crack length = 39.17 mm
 Flow stress = 482 MPa
 Youngs modulus = 195500 MPa
 Init a/W = .555
 Final a/W = .771
 (Estimated Value)

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

J_{ic} = 95.5 kJ/m²
 K_{jc} = 136.7 J (0J/1=8.8) = 355.5 kJ/m²
 Exponent N = .4925
 Coefficient C = 188.5 kJ/m²
 I (average) = 82

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

J_{ic} = 89.7 kJ/m²
 K_{jc} = 132.4 Slope M = 103315.7 kJ/m³
 Intercept B = 80 kJ/m²
 I (ASTM) = 87
 Validity (J_{ic}) = VALID
 Validity (R-curve) = VALID
 J maximum allowed = 489.3 kJ/m² (J_{max} = 2net + Flow stress/20)
 Delta a max. allowed = 2.26 mm (Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type	* A500-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

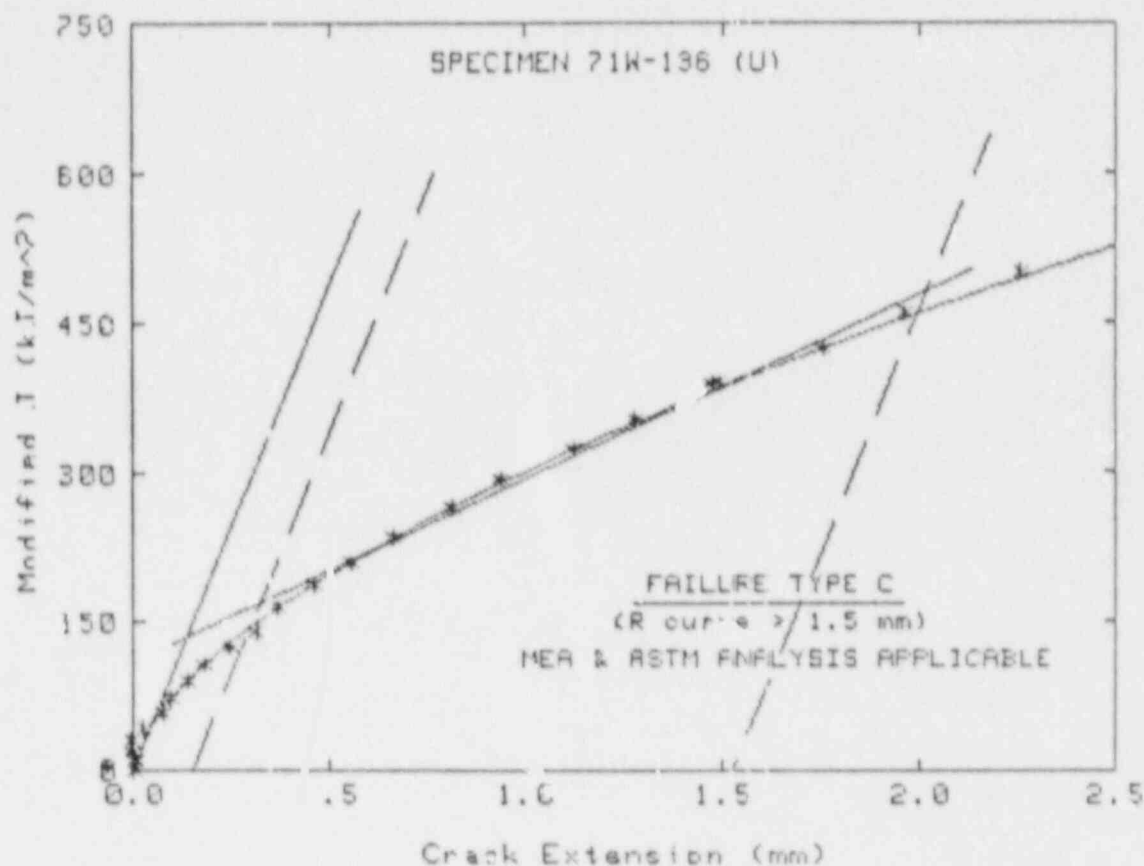
Failure Type A (J at instability = J _{ic})		
J _{ic}	* 16.8 kJ/m ²	
K _{Jc} =(EJ _{ic}) ^{0.5}	* 59.8 MPa √m	ν=.3
K _{ic} (Beta Corrected)	* 55.4 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B * (Eβn) ^{0.5}		
Maximum Load P	* 30.73 kN	
2% Secant Offset P _Q	* 30.73 kN	
K _{ic}	* 61.1 MPa √m	
Validity	* INVALID--2	

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Ferkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION =-2.57650067620E-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

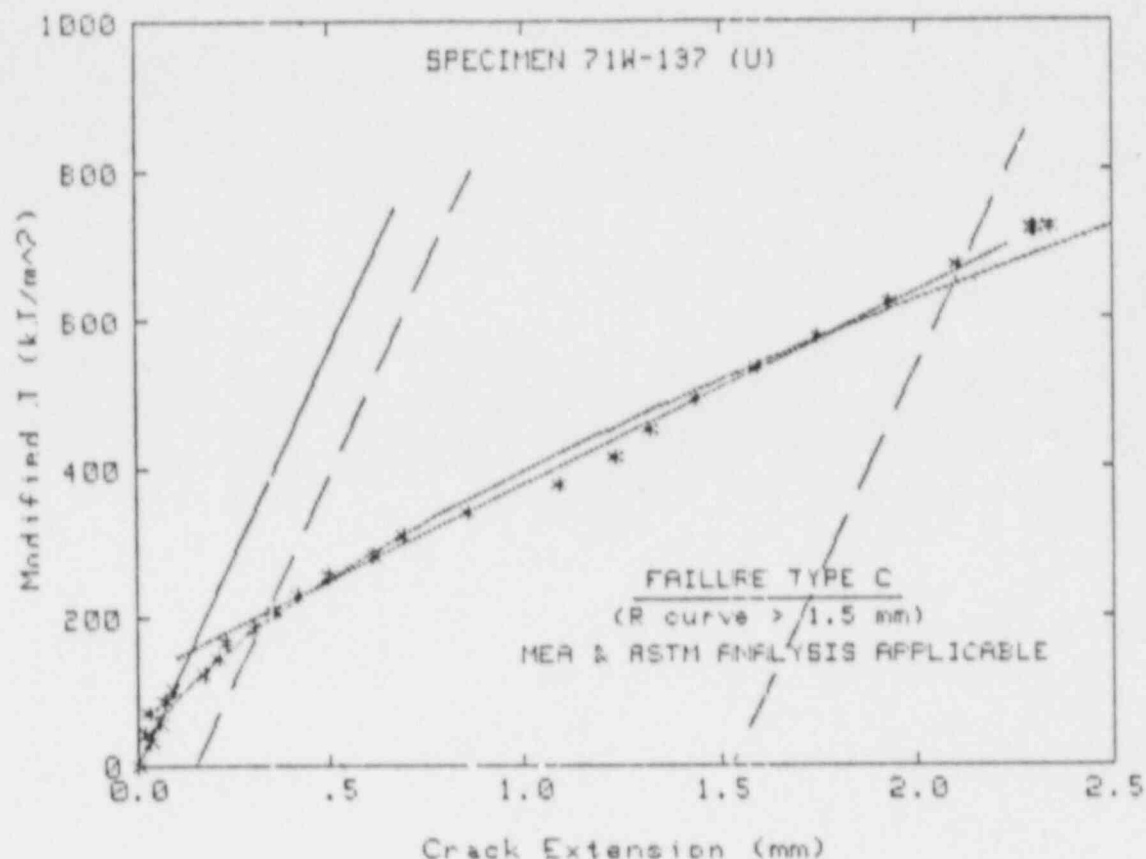
Material Type	= A533-B HSST WELD	
Test Temperature	= 121 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.16 mm	Init a/W = .554
Final crack length	= 40.1 mm	Final a/W = .789
Flow stress	= 489.2 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

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

J _{ic}	= 144.4 kJ/m ²	
K _{jc}	= 178.1	J (at J=8.8) = 750.6 kJ/m ²
Exponent N	= .6103	
Coefficient C	= 381 kJ/m ²	
T (average)	= 151	

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

J _{ic}	= 135.2 kJ/m ²	
K _{jc}	= 164.6	Slope M = 185096.9 kJ/m ³
Intercept B	= 109.6 kJ/m ²	
T (ASTM)	= 155	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 496.6 kJ/m ²	(J _{max} = B _{net} * Flow stress / 20)
Delta a max. allowed	= 2.26 mm	(Delta a max = 0.1 * b _o)



TEST SPECIMEN DATA

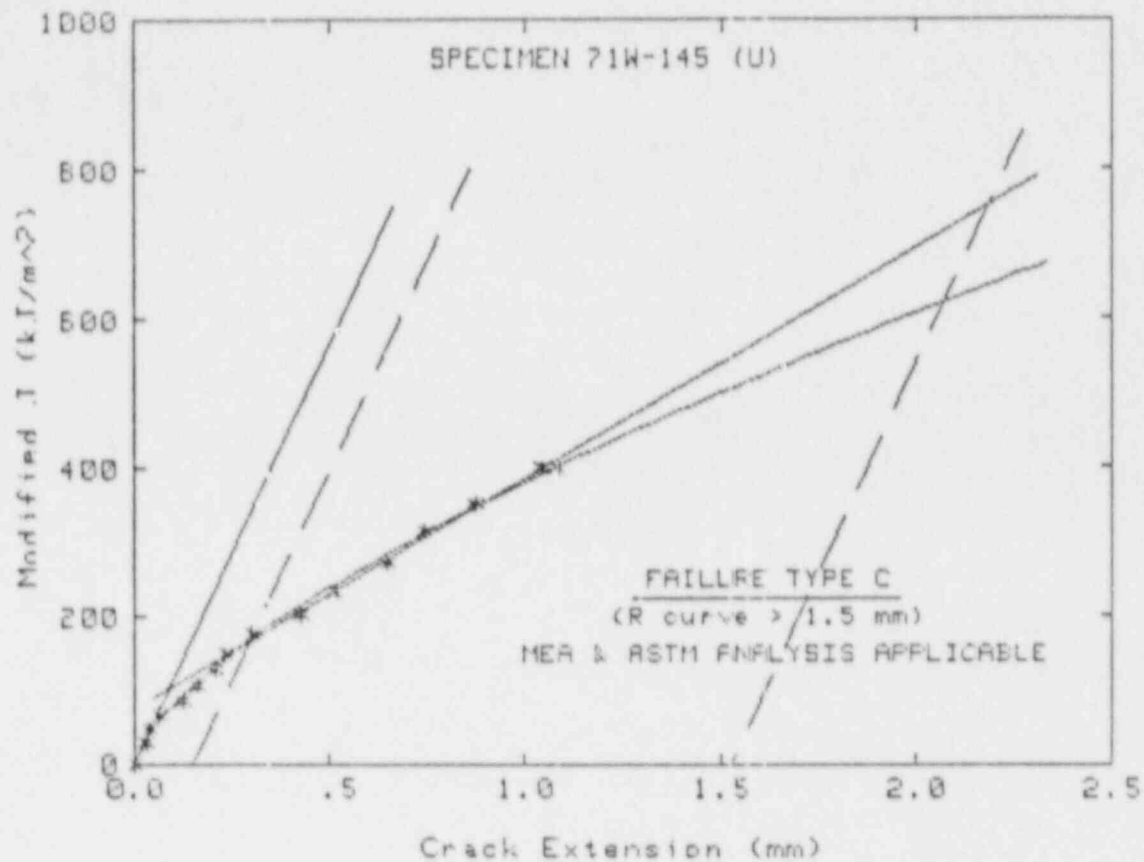
Material Type	= A533-B HSST WELD	
Test Temperature	= -5 °C	
Percent Side Groove	= 0 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.29 mm	Init a/W = .556
Final crack length	= 31.43 mm	Final a/W = .618
Flow stress	= 562.7 MPa	
Young's modulus	= 207500 MPa	(Estimated Value)

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

J _{ic}	= 188.3 kJ/m ²	
K _{ic}	= 197.7	J (θJ/I=8.8) = 0 kJ/m ²
Exponent N	= .6549	
Coefficient C	= 397.2 kJ/m ²	
I (average)	= 165	

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

J _{ic}	= 155.3 kJ/m ²	
K _{ic}	= 179.5	Slope M = 258532.2 kJ/m ³
Intercept	= 119.6 kJ/m ²	
I (ASTM)	= 170	
Validity (J _{ic})	= INVALID--c (.82 vs .47)	
Validity (R-curve)	= INVALID--3 (.82 vs .33)	
J maximum allowed	= 632.8 kJ/m ²	(J _{max} =B _{net} *Flow stress/20)
Delta a max. allowed	= 2.25 mm	(Delta a max = 0.1*b _o)



TEST SPECIMEN DATA

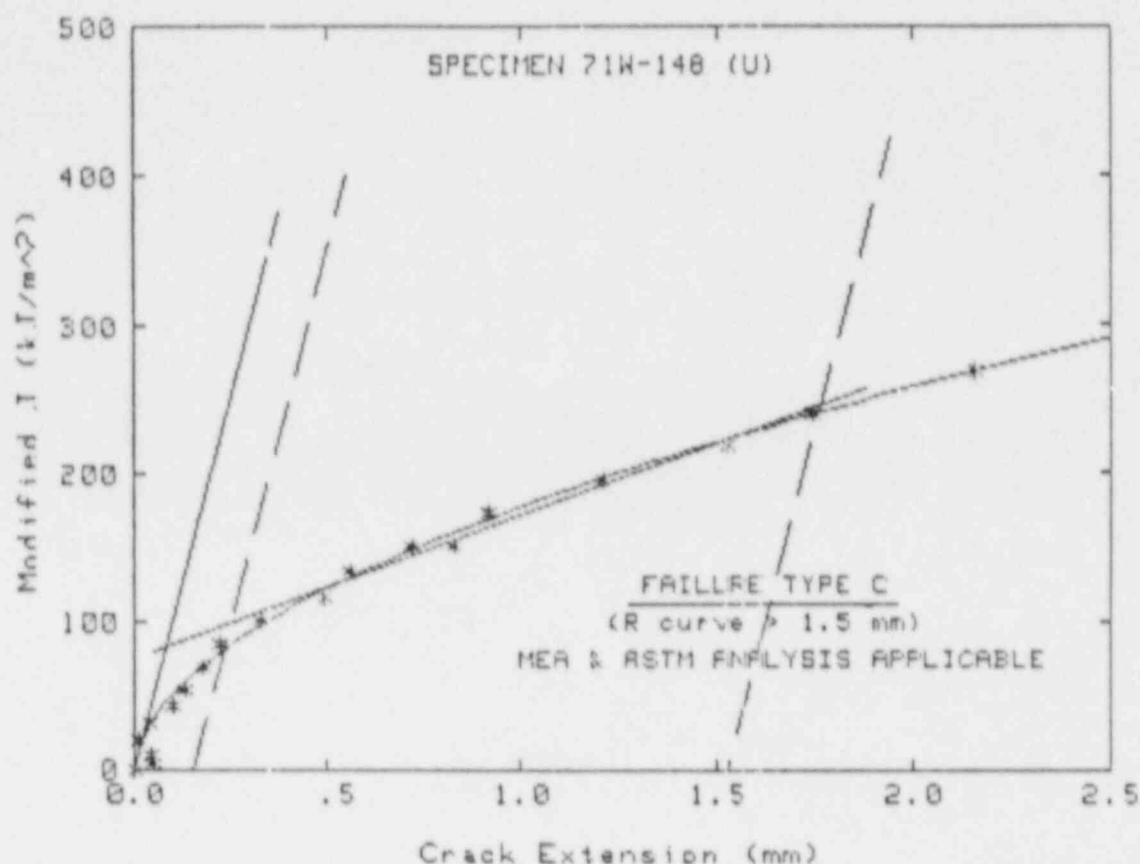
Material Type	= A533-B HSST WELD	
Test Temperature	= -10 °C	
Percent Side Groove	= 0 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.22 mm	Init a/W = .555
Final crack length	= 29.65 mm	Final a/W = .583
Flow stress	= 567.2 MPa	
Youngs modulus	= 207800 MPa	(Estimated Value)

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

J _{ic}	= 168.9 kJ/m ²	
K _{ic}	= 187.3	J (@J ₁ =8.8) = 0 kJ/m ²
Exponent N	= .676	
Coefficient C	= 379.9 kJ/m ²	
T (average)	= 162	

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

J _{ic}	= 101.7 kJ/m ²	
K _{ic}	= 145.3	Slope M = 310925.1 kJ/m ³
Intercept B	= 73.8 kJ/m ²	
T (ASTM)	= 201	
Validity (J _{ic})	= INVALID--b, c (.38 vs .21)	
Validity (R-curve)	= INVALID--3 (.38 vs .21)	
J maximum allowed	= 639.9 kJ/m ²	(J _{max} =E _{net} *Flow stress/20)
Delta a max. allowed	= 2.26 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

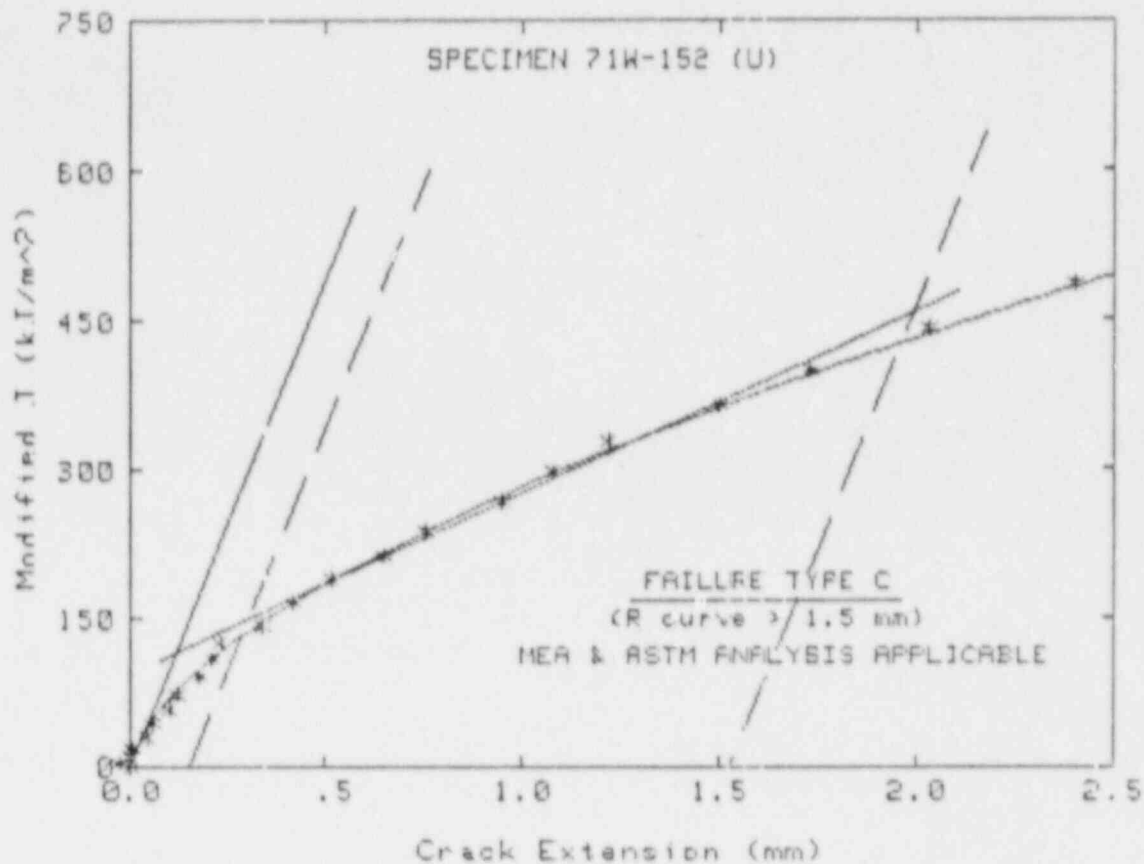
Material Type	= A533-B HSST WELD	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.71 mm	Init a/W = .545
Final crack length	= 38.76 mm	Final a/W = .763
Flow stress	= 508.1 MPa	
Youngs modulus	= 198800 MPa	(Estimated Value)

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

J _{ic}	= 81.1 kJ/m ²	
K _{jc}	= 124.4	J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 83.8 kJ/m ²	
K _{jc}	= 126.5	Slope M = 96099.6 kJ/m ³
Intercept B	= 75.9 kJ/m ²	
T (ASTM)	= 71	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= INVALID--1	
J maximum allowed	= 515.8 kJ/m ²	(J _{max} = E _{net} * Flow stress / 20)
Delta a max. allowed	= 2.31 mm	(Delta a max = 0.1 * b ₀)



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 $J = C (\Delta a)^n$

J _{IC}	= 131.6 kJ/m ²	
K _{JC}	= 162.4	J (a/W = 0.8) = 705.5 kJ/m ²
Exponent n	= .6111	
Coefficient C	= 282.2 kJ/m ²	
n (average)	= 143	

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

J _{IC}	= 114.4 kJ/m ²	
K _{JC}	= 151.4	Slope M = 183219 kJ/m ³
Intercept B	= 92.9 kJ/m ²	
n (ASTM)	= 153	
Validity (J _{IC})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 496.6 kJ/m ²	(J _{max} = B _{net} * Flow stress / 20)
Delta a max. allowed	= 2.27 mm	(Delta a max = 0.1 * b ₀)

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. $BW < 25 J_q/\sigma_y$
4. $b_o < 25 J_q/\sigma_y$
5. $dJ/da > \sigma_{flow}$
6. Delta-a prediction error too large,
 $|(\Delta a)_{pred} - (\Delta a)_{meas}| > 0.15 (\Delta a)_{meas}$

Tentative J_I - R Curve Procedure

1. < 3 data points between $(\Delta a)=0$ and secant line
 $[J=4/3\sigma_y(\Delta a)]$
2. < 10 data points between secant line and $(\Delta a)_{max}$
 $[0.1b_o]$
3. (Δa) prediction error too large,
 $|(\Delta a)_{pred} - (\Delta a)_{meas}| >$
 $\text{MINIMUM } [0.15(\Delta a)_{meas}, 0.15(\Delta a)_{max}]$

ORNL UNIRRADIATED 1TCS DATA SHEETS
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D-87	02G296	D-183	70W127
D-89	02G299	D-185	70W135
D-91	02G301	D-187	70W143
D-93	02G303	D-189	70W144
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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
 MEASURED DUCTILE DELTA-A= .05 mm
 YIELD STRENGTH= 593 MPa
 FLOW STRENGTH= 678 MPa
 ESTIMATED YOUNG'S MODULUS= 213 GPa

$a/W)i = .619$

SPECIMEN CLEAVED AT $K_{Ic} = 57.2 \text{ MPa SQR(m)}$ (VALID ASTM E399)

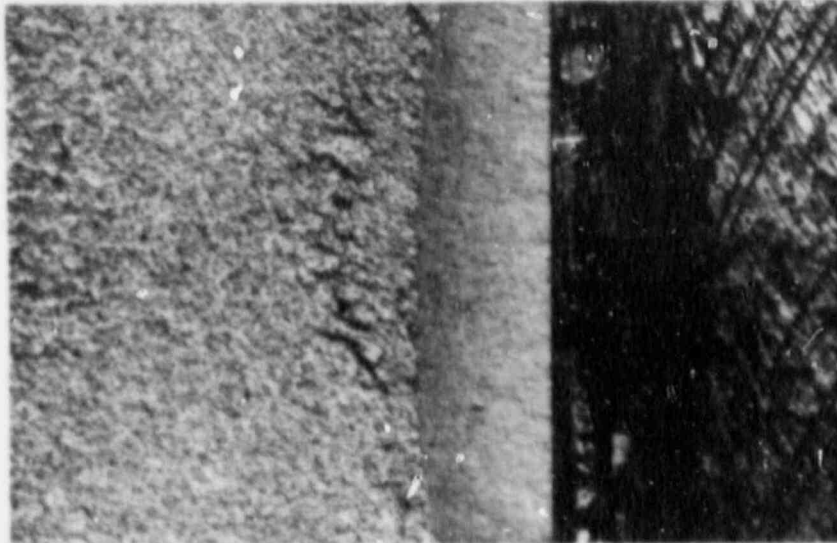
VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 13.3 kJ/m²
 $K_{Jc} = 53.2 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 50.4 \text{ MPa SQR(m)}$

VALUES AT CLEAVAGE LOAD

 J-INTEGRAL= 13.3 kJ/m²
 $K_{Jc} = 53.2 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 50.4 \text{ MPa SQR(m)}$

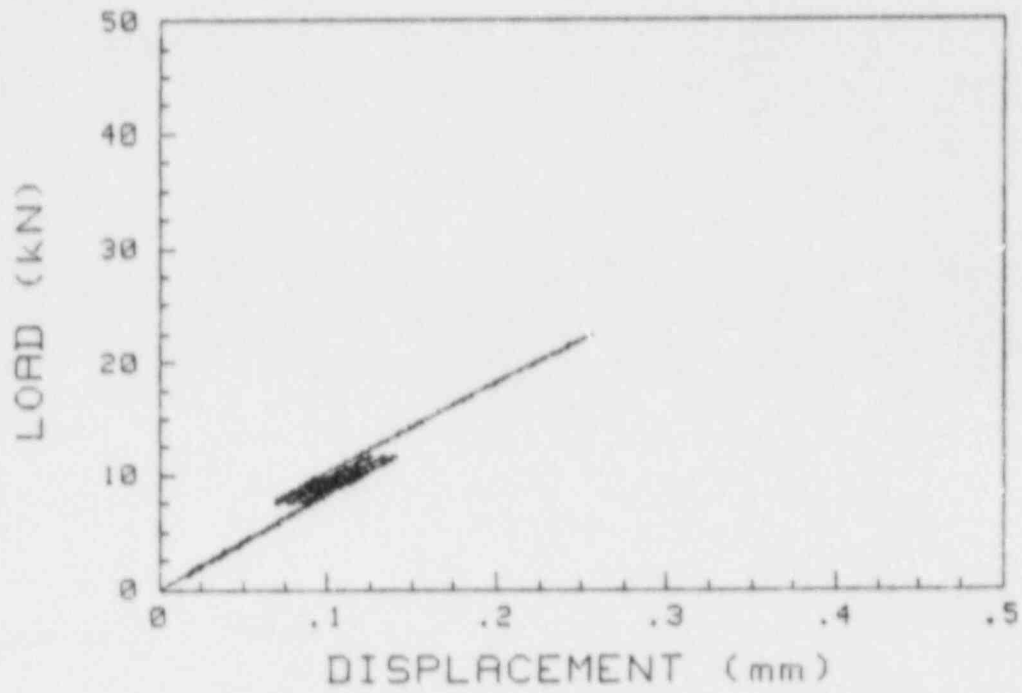
YP1247



ORNL-DWG 87-7893

02GA283

-95 DEGREES C



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 K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 248.6 kJ/m²
 $KJc = 226.2$ MPa SQR(m)
 $K-beta-c = 99.3$ MPa SQR(m)

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 381.1 kJ/m²
 $KJc = 280.1$ MPa SQR(m)
 $K-beta-c = 107.6$ MPa SQR(m)

POWER LAW PROCEDURE

$J_{Ic} = 153.6$ kJ/m²
 $K-J_{Ic} = 177.8$ MPa SQR(m)
 POWER= .7307
 COEFFICIENT= 379.7 kJ/m²
 T (AVERAGE)= 184

ASTM LINEAR PROCEDURE

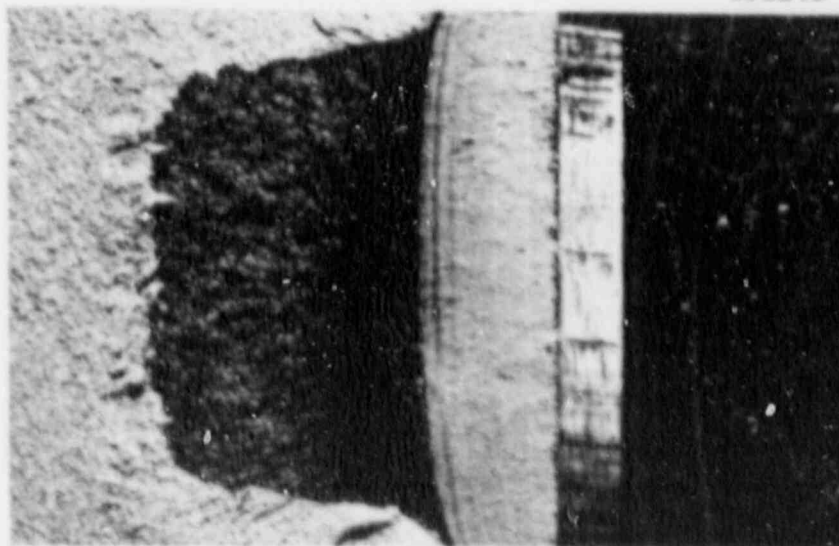
$J_{Ic} = 112.4$ kJ/m²
 $K-J_{Ic} = 152.1$ MPa SQR(m)
 SLOPE= 291420 kJ/m³
 INTERCEPT= 82.6 kJ/m²
 T (ASTM)= 198
 INVALID, 2

J1-R CURVE CALCULATIONS

$J (\Delta J/T=8.8) = 877.4$ kJ/m²
 POWER= .6473
 $J-MAX ALLOWED = 533.9$ kJ/m²

COEFFICIENT= 364.9 kJ/m²
 DELTA-A MAX ALLOWED= 1.94 mm
 VALID R-CURVE

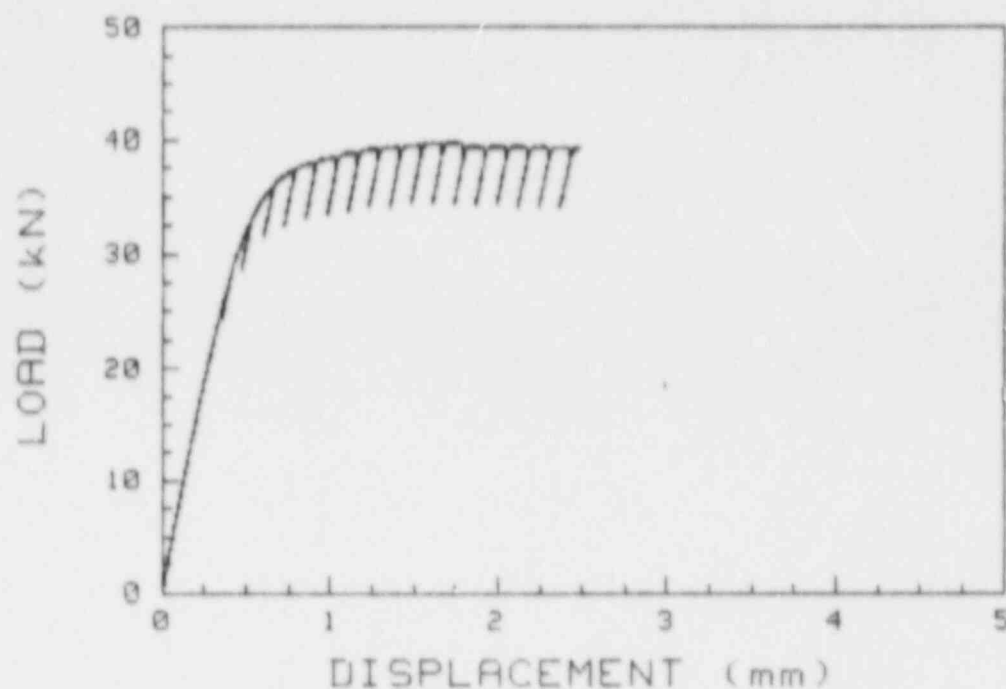
YP1248



ORNL-DWG 87-7894

02GA293

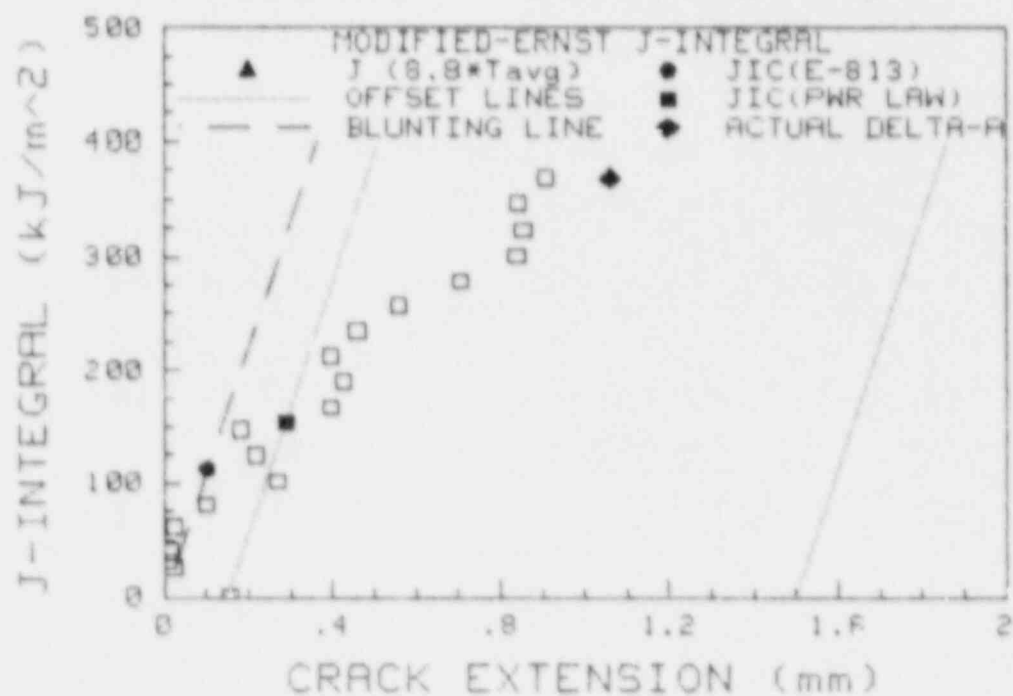
23 DEGREES C



ORNL-DWG 87-7895

02GA293

23 DEGREES C



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

$a/W_i = .617$

SPECIMEN CLEAVED AT $K = 69 \text{ MPa SQR}(m)$ (NOT VALID K_{Ic})

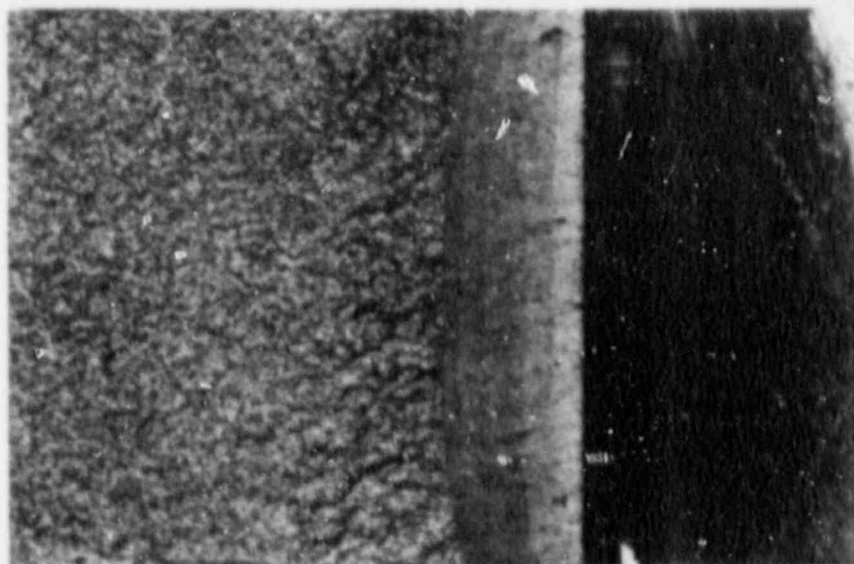
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 22.8 kJ/m²
KJc= 69.1 MPa SQR(m)
K-beta-c= 59.5 MPa SQR(m)

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 22.8 kJ/m²
KJc= 69.1 MPa SQR(m)
K-beta-c= 59.5 MPa SQR(m)

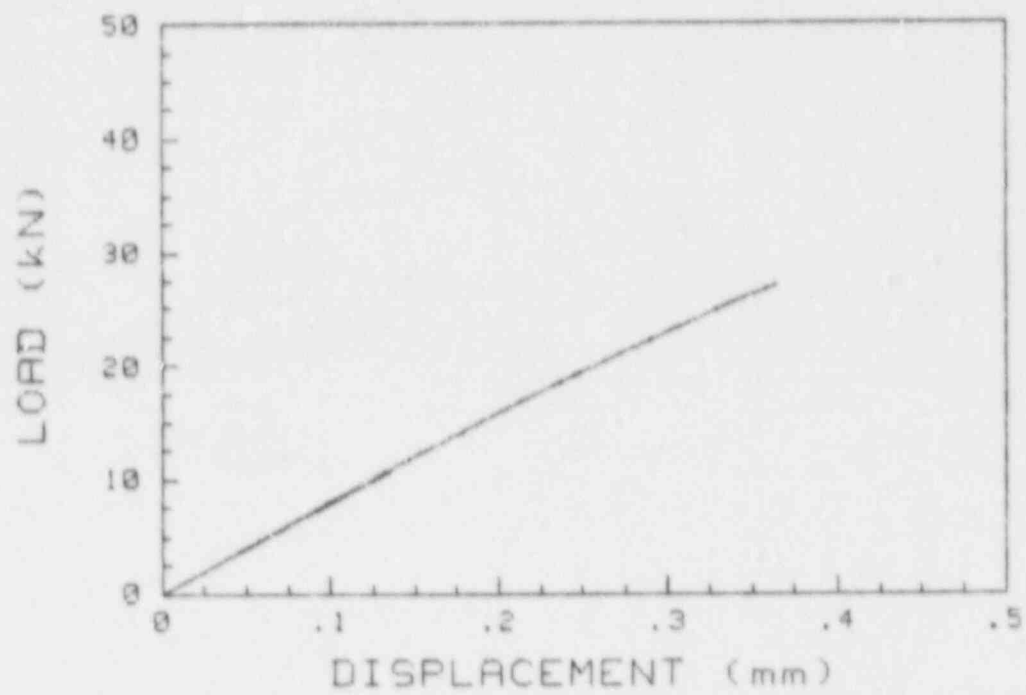
YP1246



ORNL-DWG 87-7896

02GA236

-40 DEGREES C



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/m²
 KJ-MAX LOAD= 232.9 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 213.9 kJ/m²
 K-JIc= 209.1 MPa SQR[m]
 POWER= .5363
 COEFFICIENT= 374.9 kJ/m²
 T (AVERAGE)= 140

ASTM LINEAR PROCEDURE

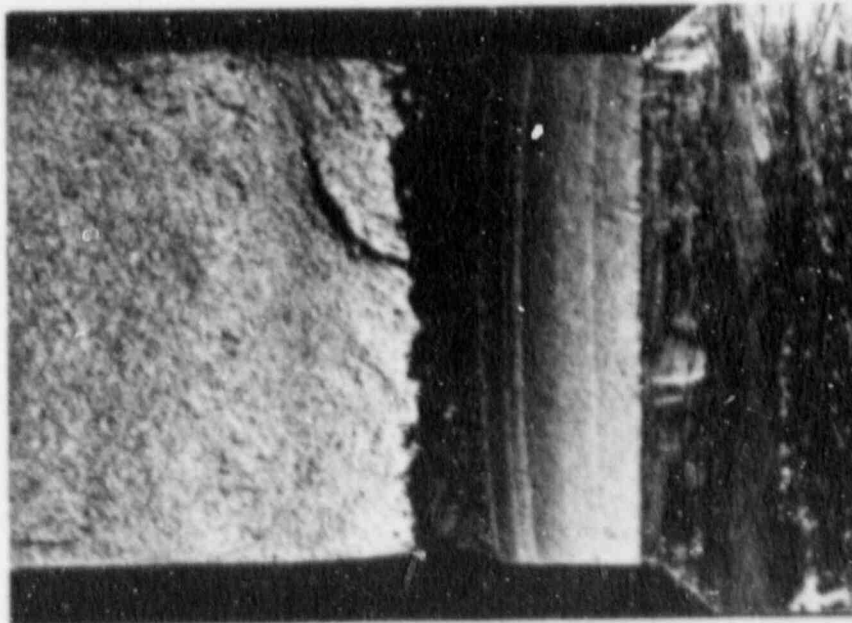
 JIc= 207.6 kJ/m²
 K-JIc= 206 MPa SQR[m]
 SLOPE= 194064 kJ/m³
 INTERCEPT= 169.7 kJ/m²
 T (ASTM)= 141
 VALID, E813

J1-R CURVE CALCULATIONS

 J (@J/T=8.8)= 663.8 kJ/m²
 POWER= .4978
 J-MAX ALLOWED= 513.2 kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 373.6 kJ/m²
 DELTA-A MAX ALLOWED= 1.93 mm

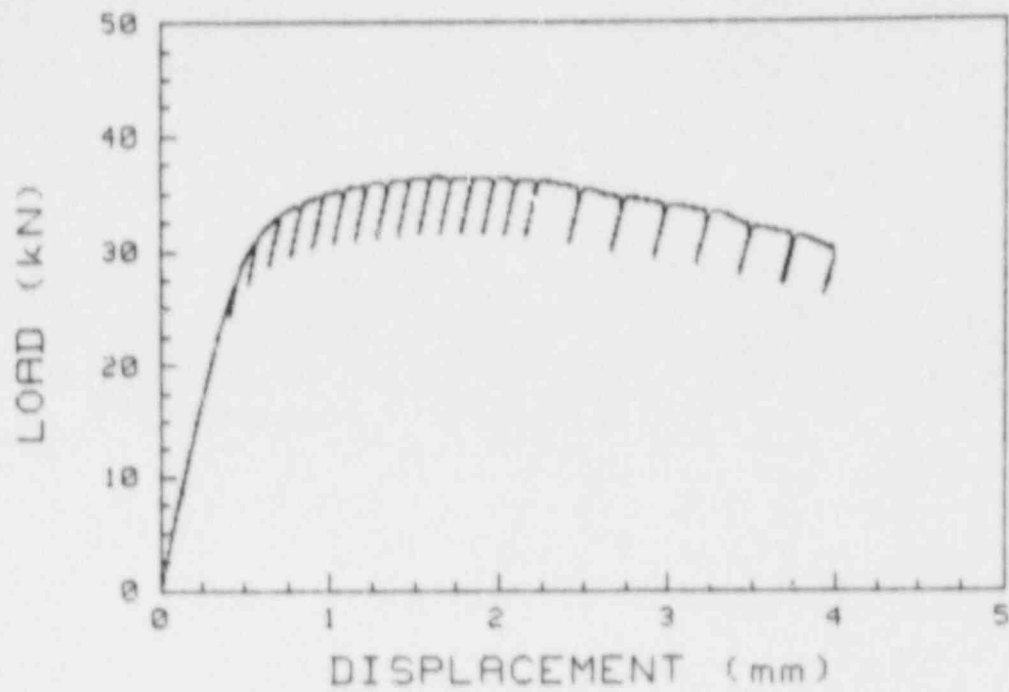
YP1245



ORNL-DWG 87-7897

02GA299

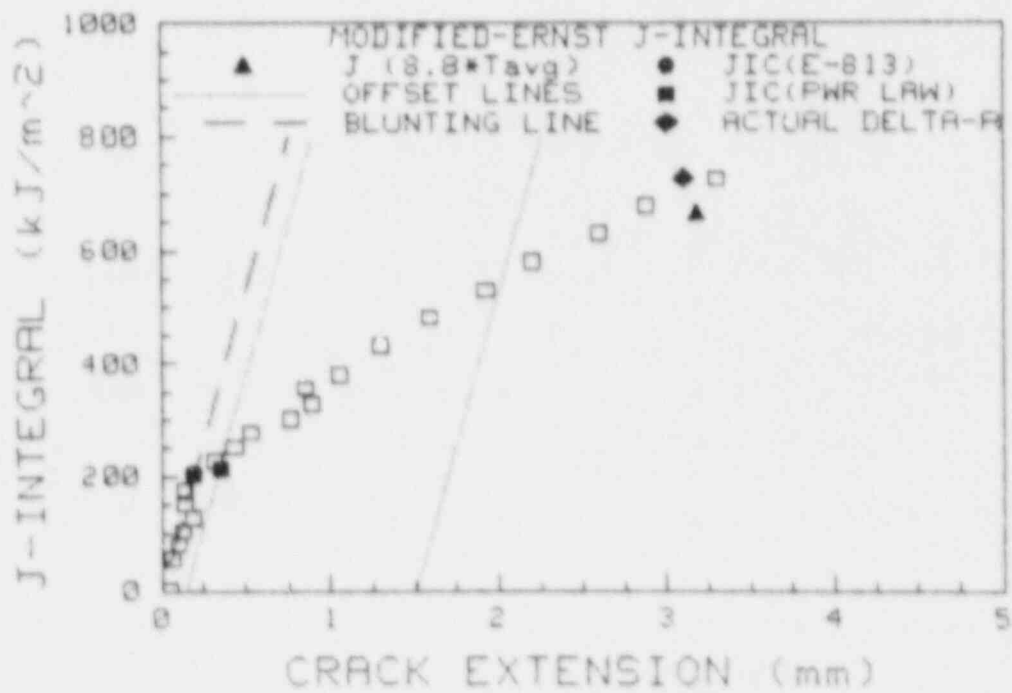
50 DEGREES C



ORNL-DWG 87-7898

02GA299

50 DEGREES C



SPECIMEN ID= 02GA301
 MATERIAL TYPE= A533B
 TEST TEMPERATURE= -40 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 31.6 mm $a/W)1 = .621$
 MEASURED DUCTILE DELTA-A= .05 mm
 YIELD STRENGTH= 529 MPa
 FLOW STRENGTH= 609 MPa
 ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT $K = 73.8 \text{ MPa SQR(m)}$ (NOT VALID K_{Ic})

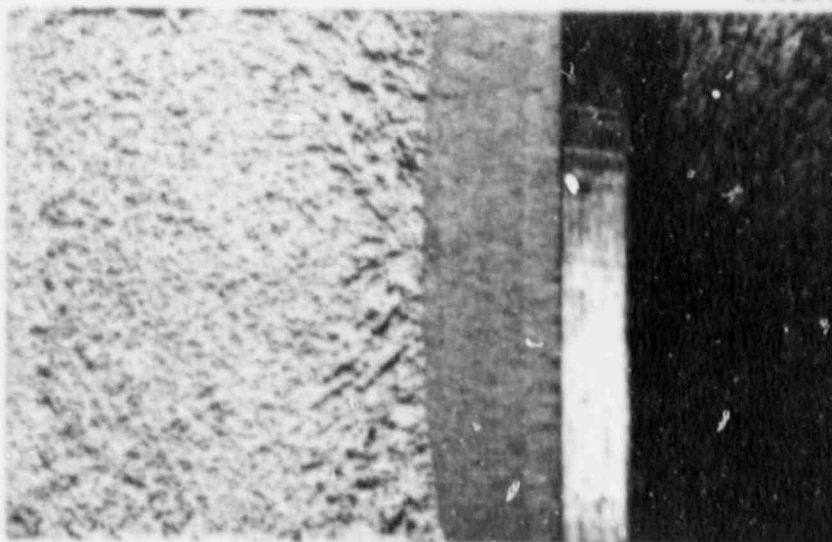
VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 26.6 kJ/m²
 $KJc = 74.6 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 62.6 \text{ MPa SQR(m)}$

VALUES AT CLEAVAGE LOAD

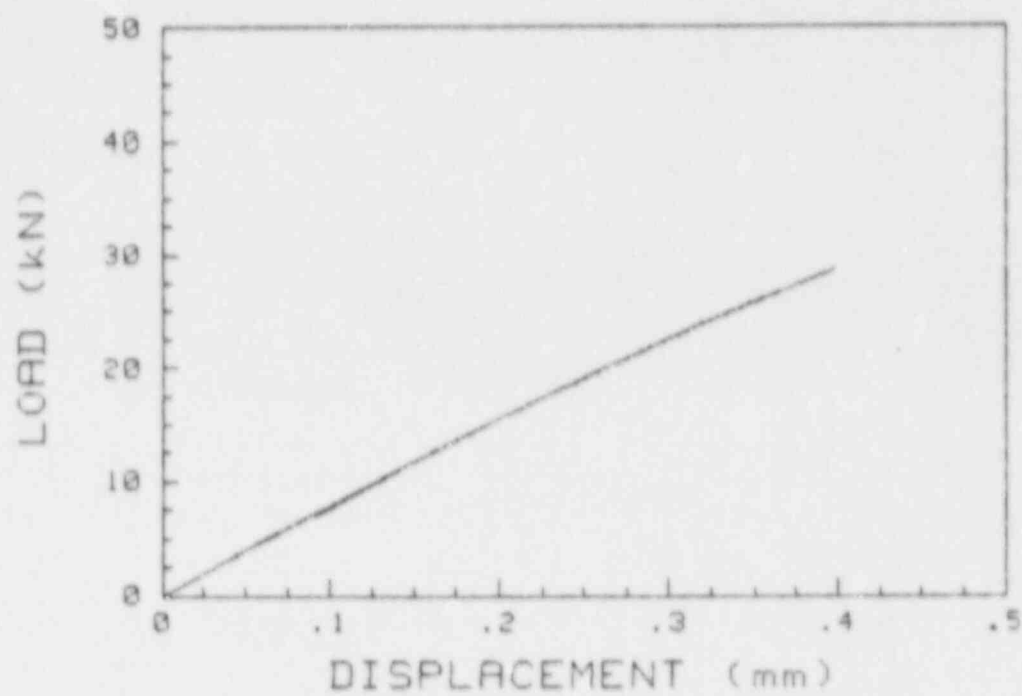
 J-INTEGRAL= 26.6 kJ/m²
 $KJc = 74.6 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 62.6 \text{ MPa SQR(m)}$

YP1244



02GA301

-40 DEGREES C



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/m²
 KJ-MAX LOAD= 216.1 MPa SQR(m)

POWER LAW PROCEDURE

J_{Ic}= 171 kJ/m²
 K-J_{Ic}= 185.1 MPa SQR(m)
 POWER= .5717
 COEFFICIENT= 327.5 kJ/m²
 T (AVERAGE)= 146

ASTM LINEAR PROCEDURE

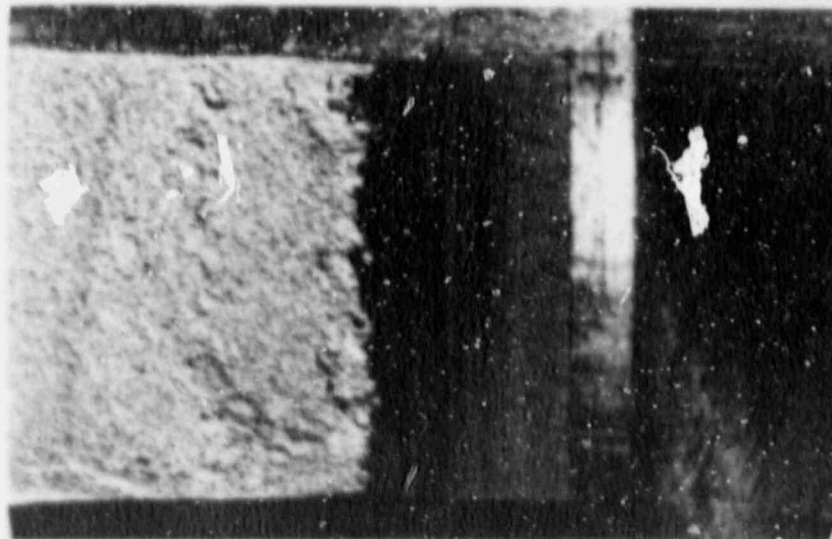
J_{Ic}= 177 kJ/m²
 K-J_{Ic}= 183.3 MPa SQR(m)
 SLOPE= 172848 kJ/m³
 INTERCEPT= 146.4 kJ/m²
 T (ASTM)= 138
 VALID, E813

JI-R CURVE CALCULATIONS

J (WJ/T=8.8)= 595.8 kJ/m²
 POWER= .4869
 J-MAX ALLOWED= 484.6 kJ/m²
 RCURVE INVALID, 1

COEFFICIENT= 327 kJ/m²
 DELTA-A MAX ALLOWED= 1.94 mm

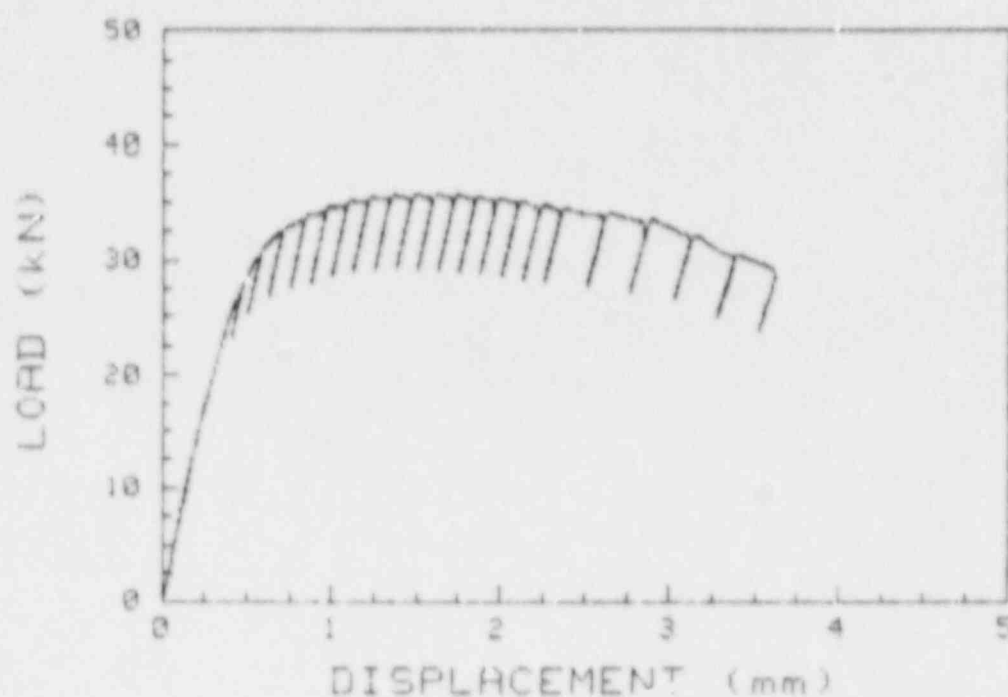
YP1213



ORNL-DWG 87-7900

02GA303

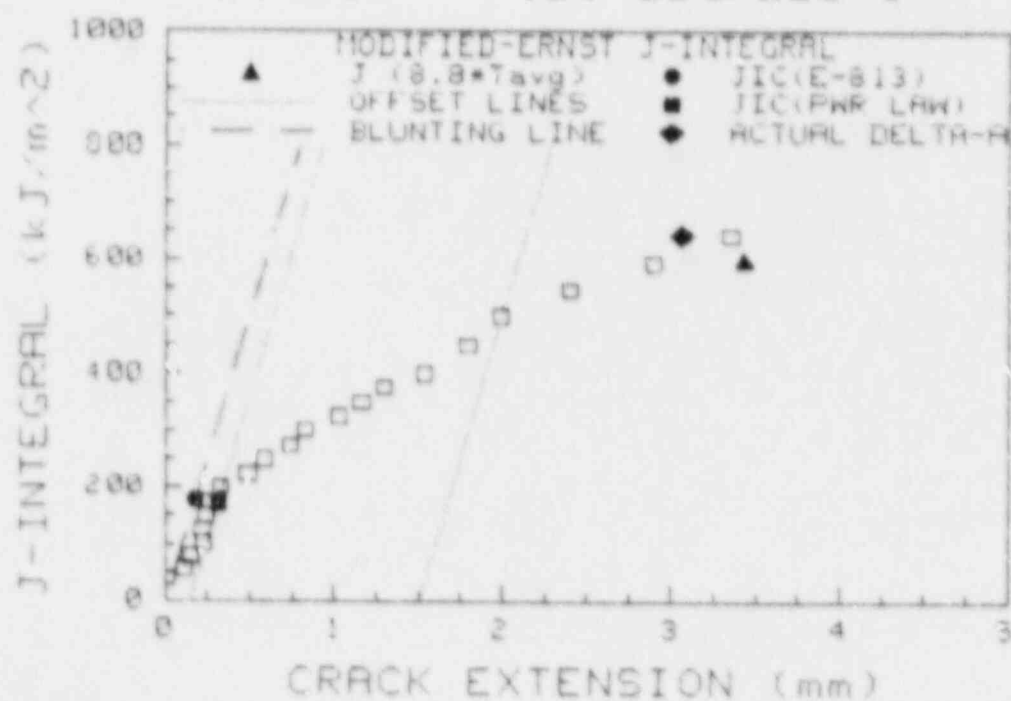
121 DEGREES C



ORNL-DWG 87-7901

02GA303

121 DEGREES C



SPECIMEN ID= 02GA309
 TEST TEMPERATURE 23 DEG C
 THICKNESS= 25.
 SIDE GROOVES=
 INITIAL CRACK 31.3 mm $a/W_i = .617$
 MEASURED DUCT $\Delta a = .56$ mm
 YIELD STRENGTH MPa
 FLOW STRENGTH MPa
 ESTIMATED YOUNG MODULUS= 206 GPa

SPECIMEN CLEAVED AT $K = 238.9$ MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 277 kJ/m²
 $K_{Jc} = 238.9$ MPa SQR[m]
 $K\text{-beta-c} = 101.4$ MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 277 kJ/m²
 $K_{Jc} = 238.9$ MPa SQR[m]
 $K\text{-beta-c} = 101.4$ MPa SQR[m]

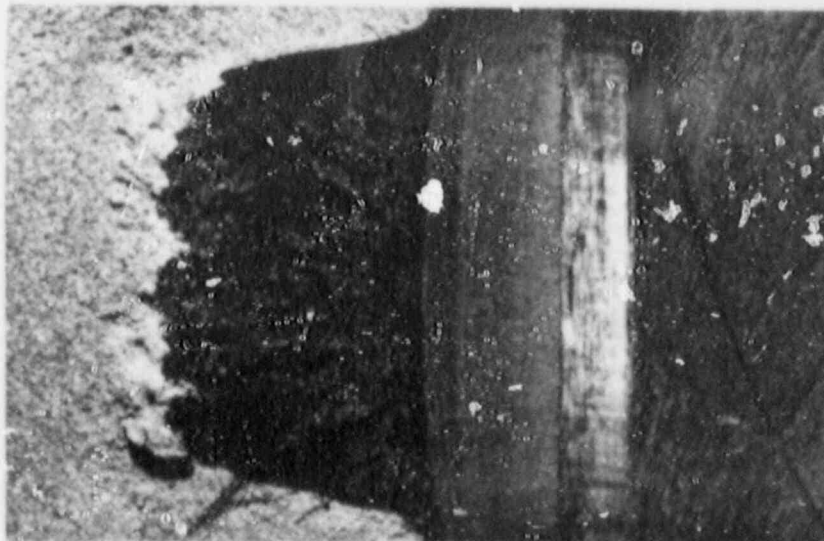
POWER LAW PROCEDURE

$J_{Ic} = 216.6$ kJ/m²
 $K\text{-}J_{Ic} = 211.2$ MPa SQR[m]
 POWER= .7556
 COEFFICIENT= 481.9 kJ/m²
 T (AVERAGE)= 235

ASTM LINEAR PROCEDURE

$J_{Ic} = 0$ kJ/m²
 $K\text{-}J_{Ic} = 0$ MPa SQR[m]
 SLOPE= 0 kJ/m³
 INTERCEPT= 0 kJ/m²
 T (ASTM)= 0
 INVALID, 1

YP1242



J1-R CURVE CALCULATIONS

 $J (8J/T=8.8) = 773.9 \text{ kJ/m}^2$
 POWER = .5503
 $J\text{-MAX ALLOWED} = 535 \text{ kJ/m}^2$
 RCURVE INVALID, 2

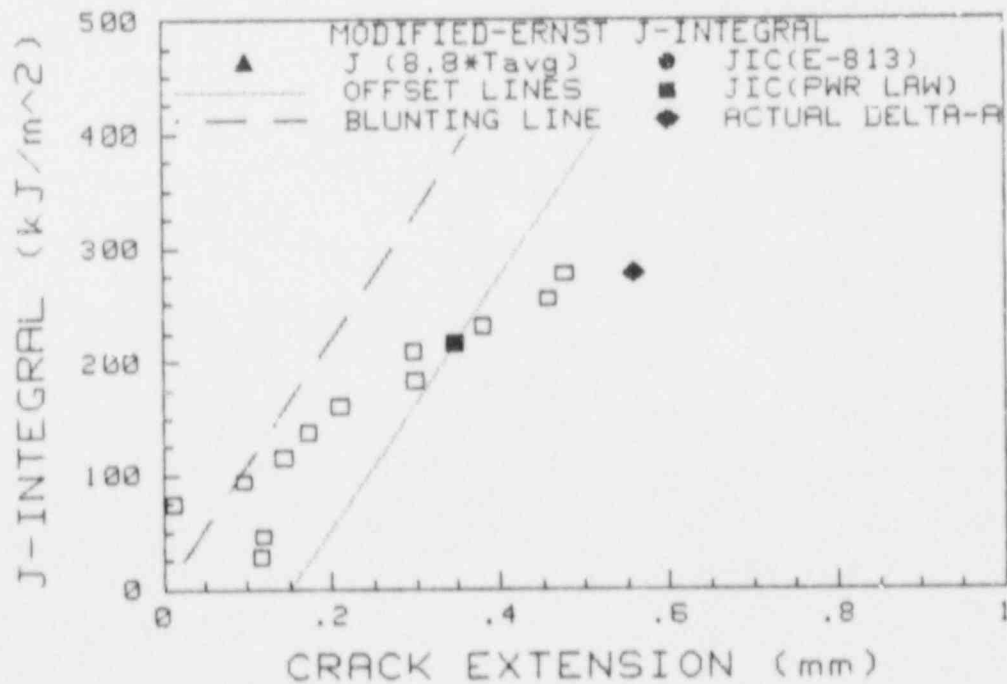
COEFFICIENT = 401.4 kJ/m^2
 $\Delta A \text{ MAX ALLOWED} = 1.95 \text{ mm}$

LOAD-DISPLACEMENT CURVE UNAVAILABLE

ORNL-DWG 87-7902

02GA309

23 DEGREES C



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
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 593 MPa
FLOW STRENGTH= 678 MPa
ESTIMATED YOUNG'S MODULUS= 213 GPa

$a/W)i = .612$

SPECIMEN CLEAVED AT $K_{Ic} = 41.8 \text{ MPa SQR[m]}$ (VALID ASTM E399)

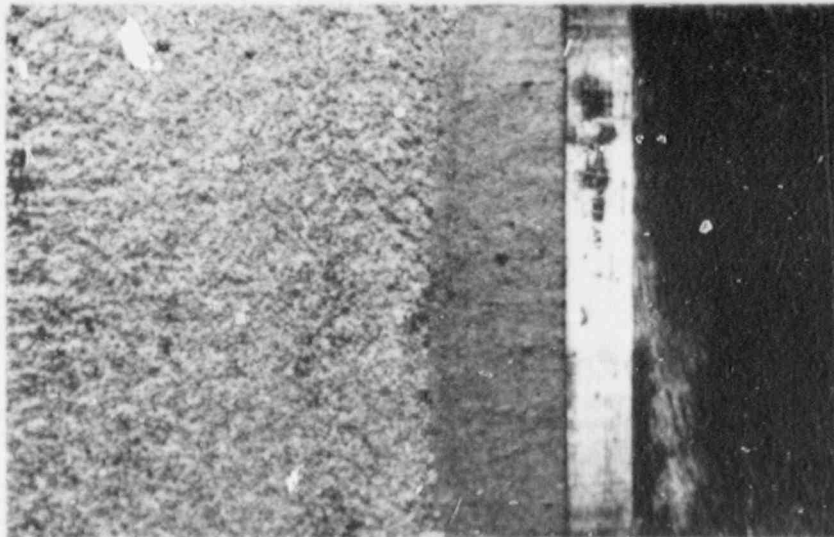
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 6.4 kJ/m²
KJc= 36.8 MPa SQR[m]
K-beta-c= 36.3 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 6.4 kJ/m²
KJc= 36.8 MPa SQR[m]
K-beta-c= 36.3 MPa SQR[m]

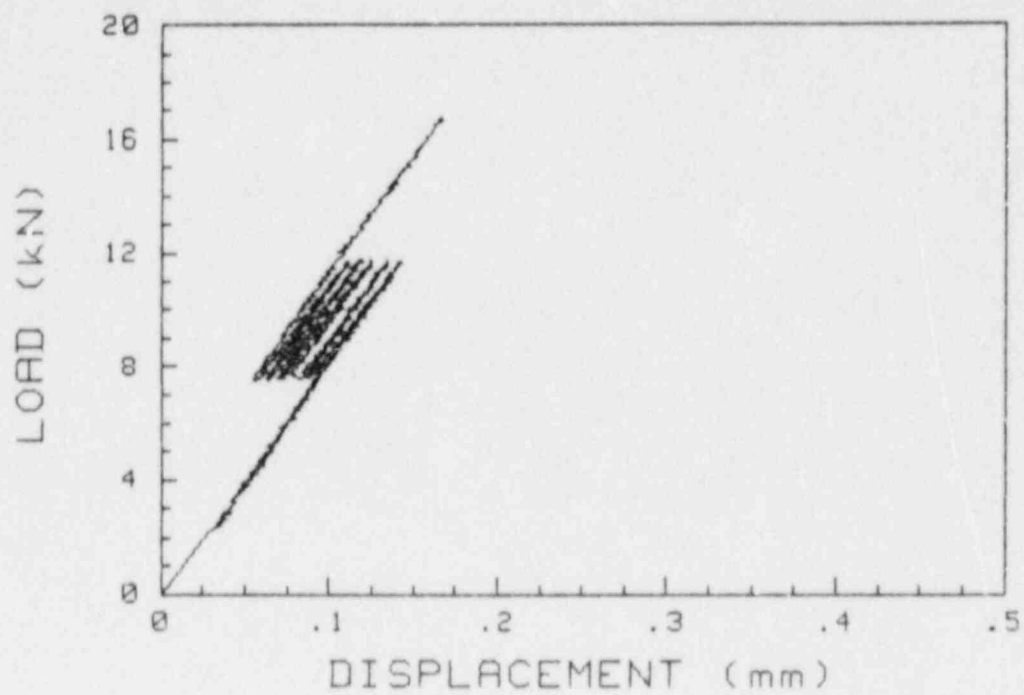
YP1211



ORNL-DWG 87-7903

02GA312

-95 DEGREES C



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/m²
 KJ-MAX LOAD= 220.3 MPa SQR[m]

POWER LAW PROCEDURE

J_{1c}= 199.3 kJ/m²
 K-J_{1c}= 197.4 MPa SQR[m]
 POWER= .3993
 COEFFICIENT= 703.1 kJ/m²
 T (AVERAGE)= 94

ASTM LINEAR PROCEDURE

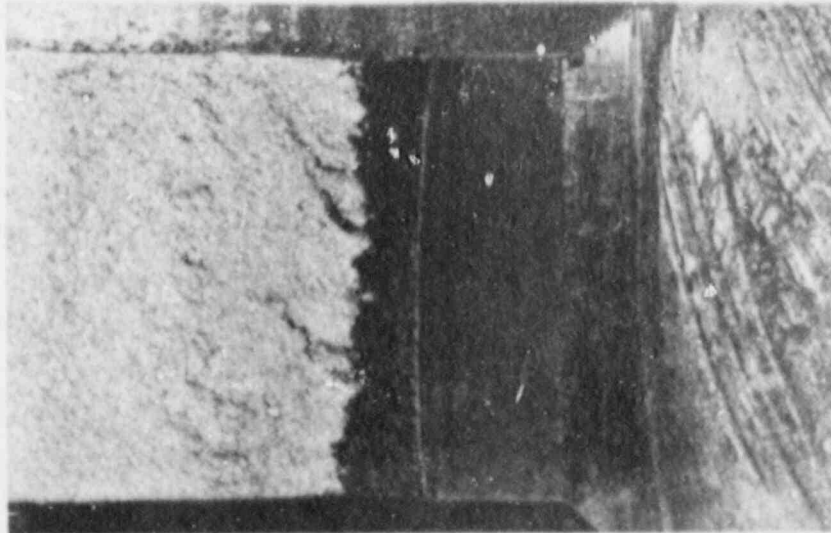
J_{1c}= 191.4 kJ/m²
 K-J_{1c}= 193.5 MPa SQR[m]
 SLOPE= 127287 kJ/m³
 INTERCEPT= 167 kJ/m²
 T (ASTM)= 100
 VALID, E813

JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 425.3 kJ/m²
 POWER= .3664
 J-MAX ALLOWED= 474.8 kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 302.3 kJ/m²
 DELTA-A MAX ALLOWED= 1.91 mm

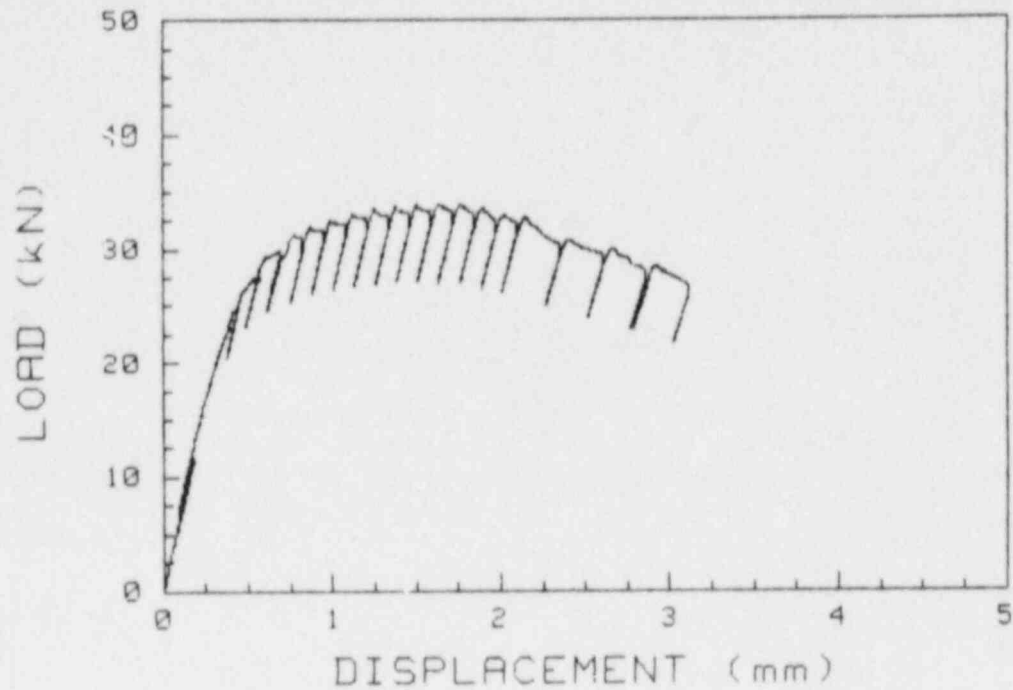
YP1240



ORNL-DWG 87-7904

02GA321

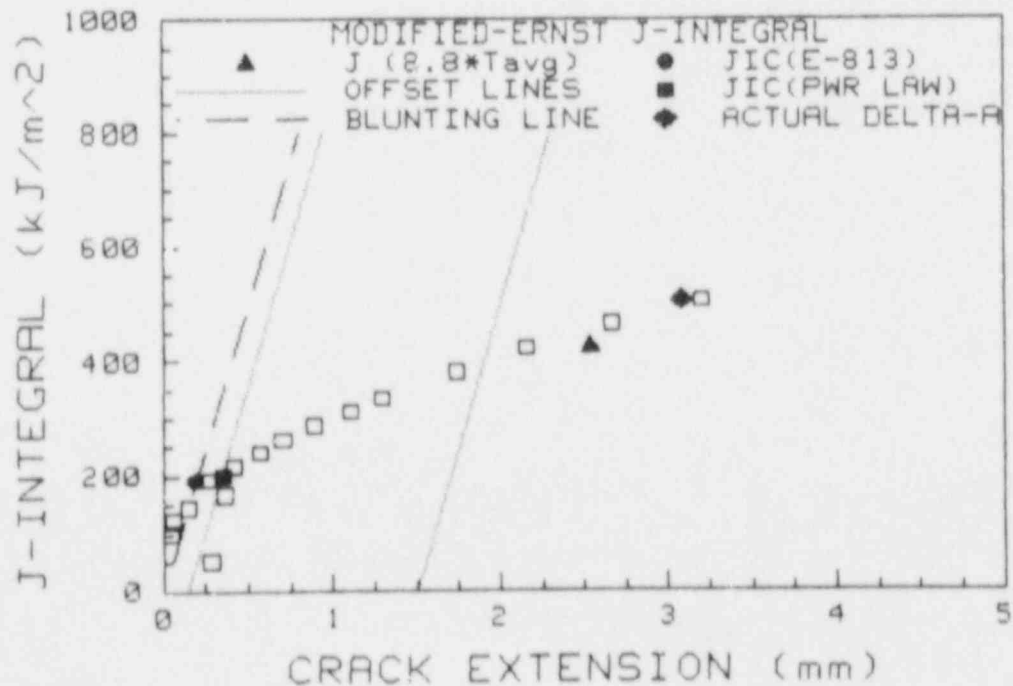
204 DEGREES C



ORNL-DWG 87-7905

02GA321

204 DEGREES C



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/m²
 KJ-MAX LOAD= 237.9 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 139.8 kJ/m²
 K-JIc= 167.3 MPa SQR[m]
 POWER= .5976
 COEFFICIENT= 293.1 kJ/m²
 T (AVERAGE)= 139

ASTM LINEAR PROCEDURE

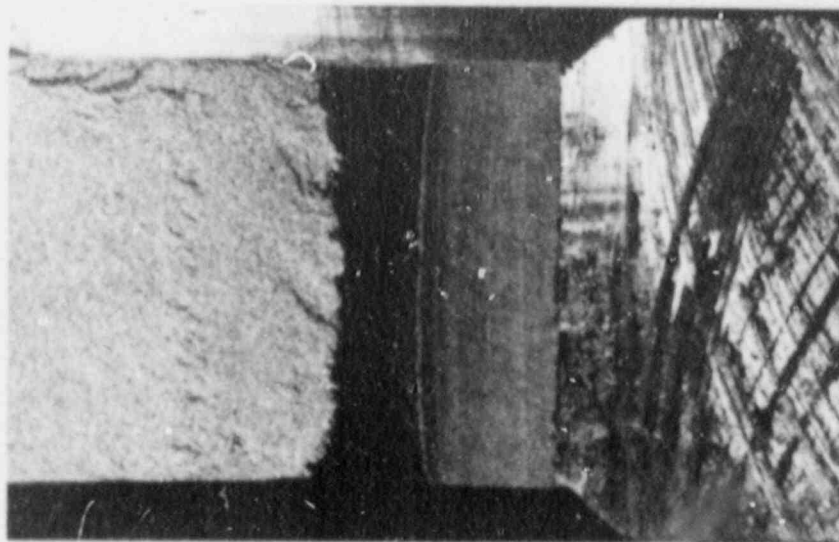
 JIc= 114.5 kJ/m²
 K-JIc= 151.5 MPa SQR[m]
 SLOPE= 195314 kJ/m³
 INTERCEPT= 92.2 kJ/m²
 T (ASTM)= 156
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 688 kJ/m²
 POWER= .5958
 J-MAX ALLOWED= 482.7 kJ/m²
 RCURVE INVALID, 1

COEFFICIENT= 292.8 kJ/m²
 DELTA-A MAX ALLOWED= 1.93 mm

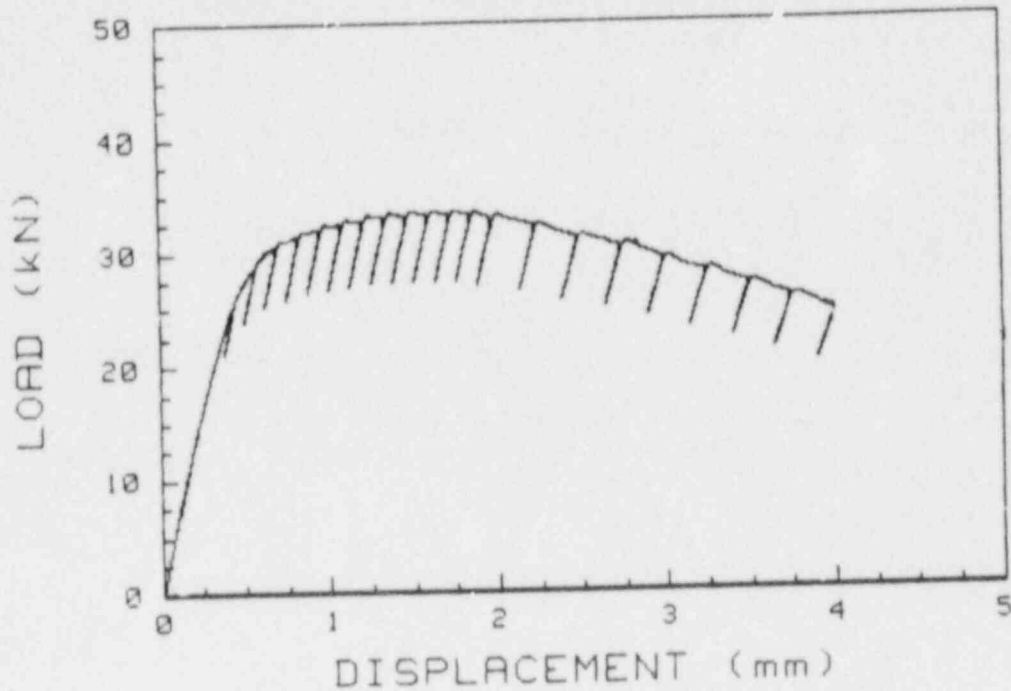
YP1239



ORNL-DWG 87-7906

02GA325

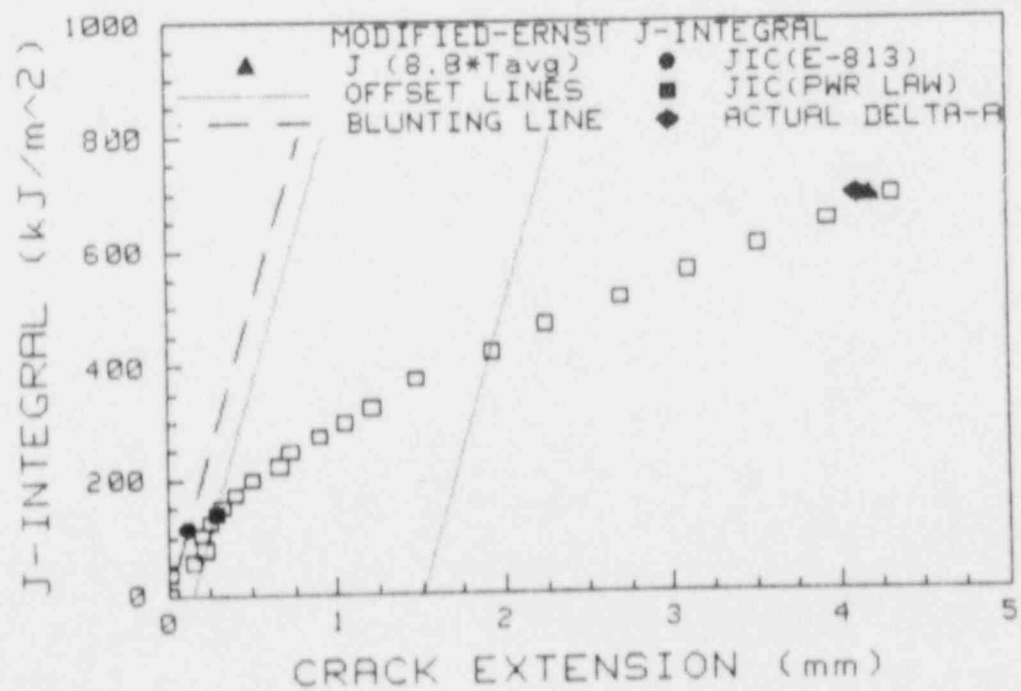
121 DEGREES C



ORNL-DWG 87-7907

02GA325

121 DEGREES C



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/m²
 KJ-MAX LOAD= 221.1 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 148.4 kJ/m²
 K-JIc= 170.3 MPa SQR[m]
 POWER= .4626
 COEFFICIENT= 259.4 kJ/m²
 T (AVERAGE)= 96

ASTM LINEAR PROCEDURE

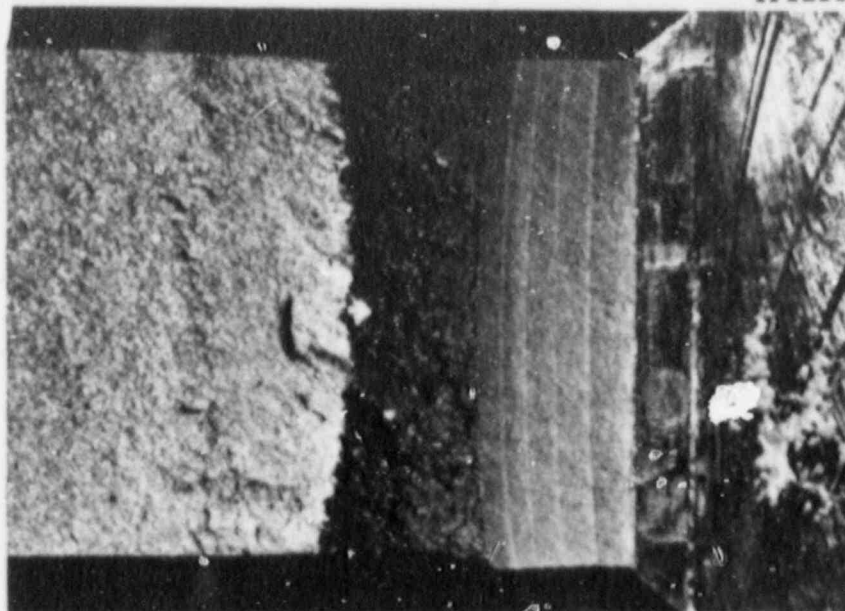
 JIc= 142.5 kJ/m²
 K-JIc= 166.9 MPa SQR[m]
 SLOPE= 126090 kJ/m³
 INTERCEPT= 124.4 kJ/m²
 T (ASTM)= 99
 VALID, E813

J1-R CURVE CALCULATIONS

 J (@J/T=8.8)= 439.1 kJ/m²
 POWER= .4576
 J-MAX ALLOWED= 478.1 kJ/m²

COEFFICIENT= 259 kJ/m²
 DELTA-A MAX ALLOWED= 1.92 mm
 VALID R-CURVE

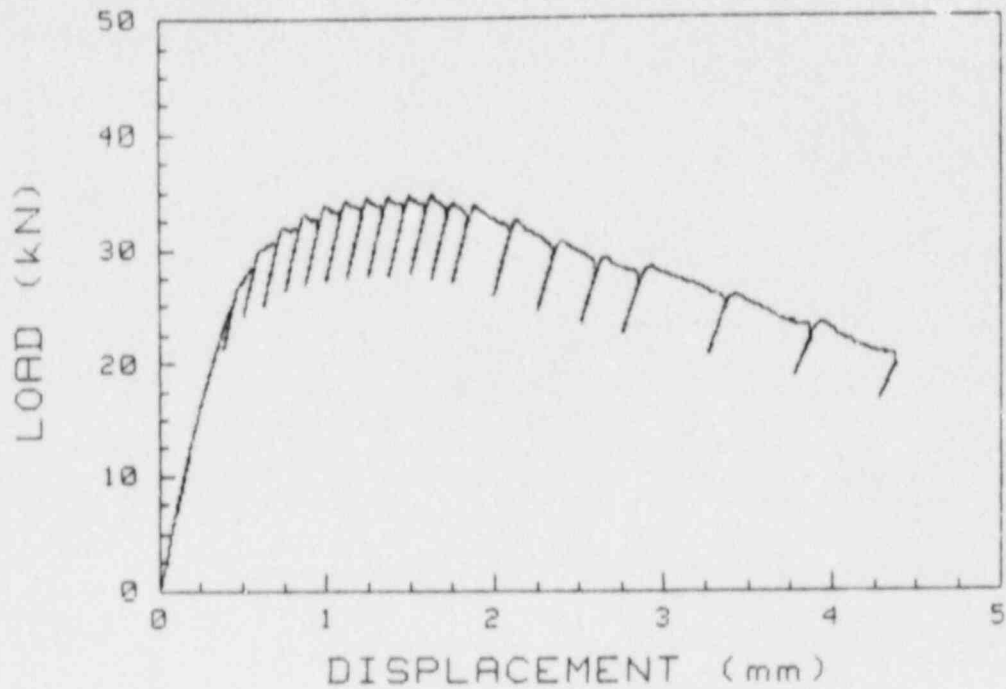
YP1238



ORNL-DWG 87-7908

02GA326

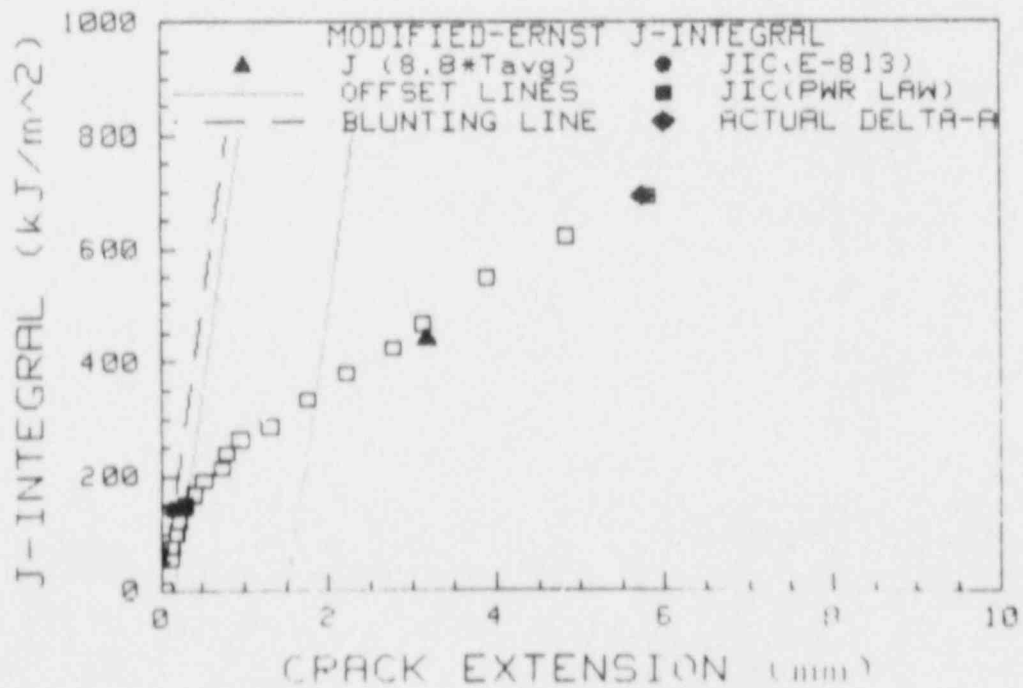
204 DEGREES C



ORNL-DWG 87-7909

02GA326

204 DEGREES C



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/m²
 KJ-MAX LOAD= 179.5 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 130.9 kJ/m²
 K-JIc= 158 MPa SQR[m]
 POWER= .455
 COEFFICIENT= 236.4 kJ/m²
 T (AVERAGE)= 75

ASTM LINEAR PROCEDURE

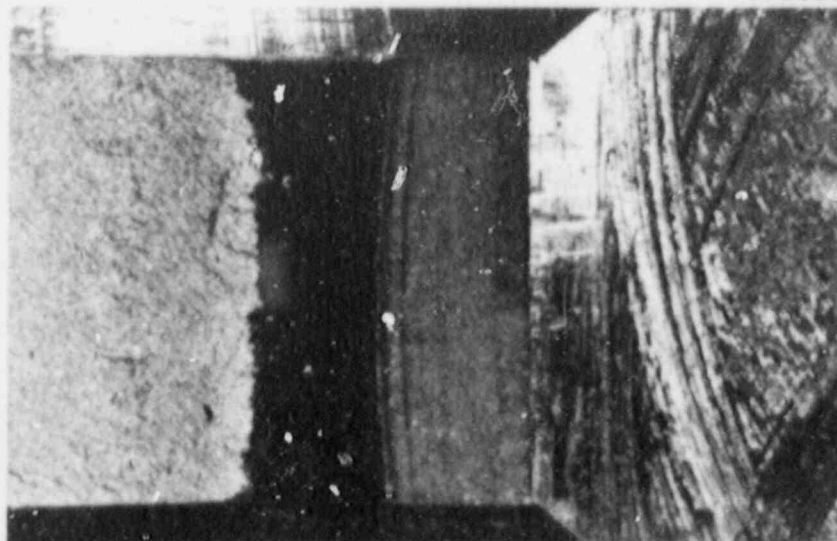
 JIc= 132.2 kJ/m²
 K-JIc= 158.8 MPa SQR[m]
 SLOPE= 109068 kJ/m³
 INTERCEPT= 118.7 kJ/m²
 T (ASTM)= 73
 VALID, E813

J1-R CURVE CALCULATIONS

 J (@J/T=8.8)= 337.8 kJ/m²
 POWER= .4083
 J-MAX ALLOWED= 500.8 kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 236.1 kJ/m²
 DELTA-A MAX ALLOWED= 1.88 mm

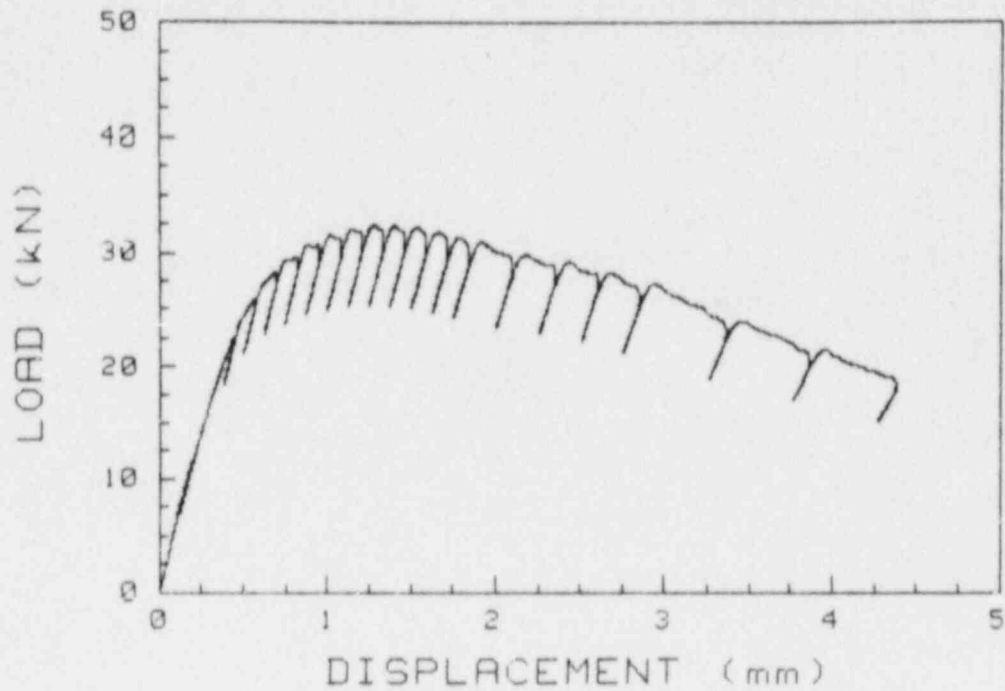
YP1237



ORNL-DWG 87-7910

02GA327

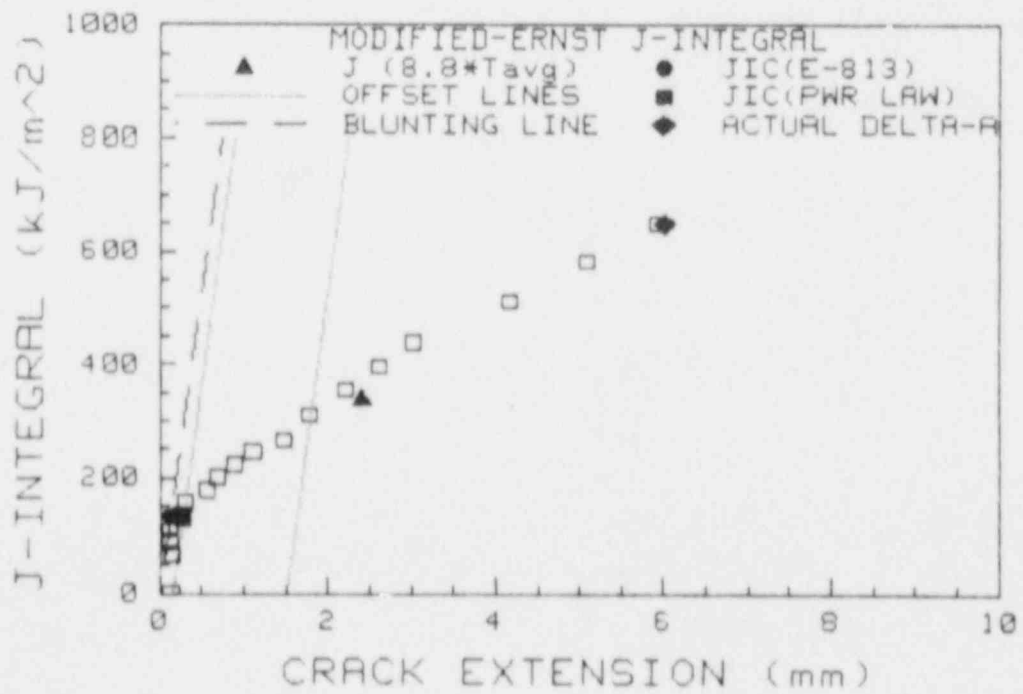
288 DEGREES C



ORNL-DWG 87-7911

02GA327

288 DEGREES C



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
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 574 MPa
FLOW STRENGTH= 657 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

$a/W)i = .622$

SPECIMEN CLEAVED AT $K_{Ic} = 50.3 \text{ MPa SQR[m]}$ (VALID ASTM E399)

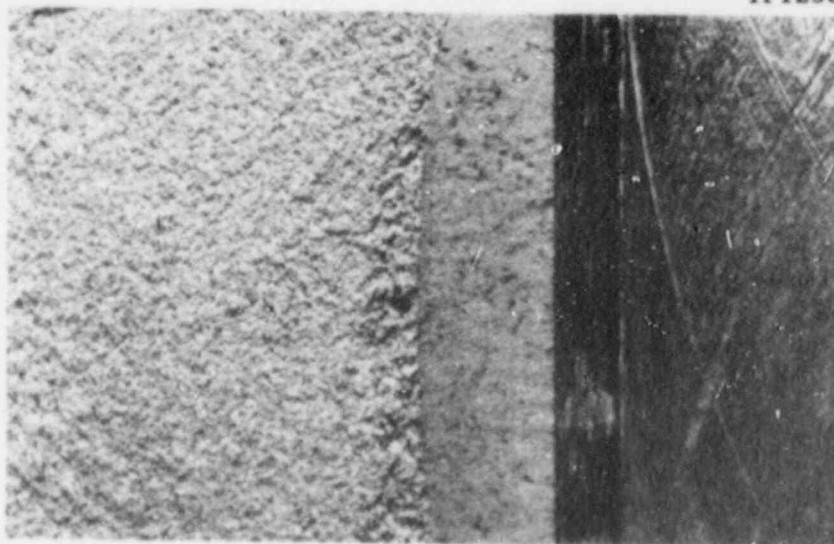
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 13.3 kJ/m²
 $KJc = 53.1 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 50.1 \text{ MPa SQR[m]}$

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 13.3 kJ/m²
 $KJc = 53.1 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 50.1 \text{ MPa SQR[m]}$

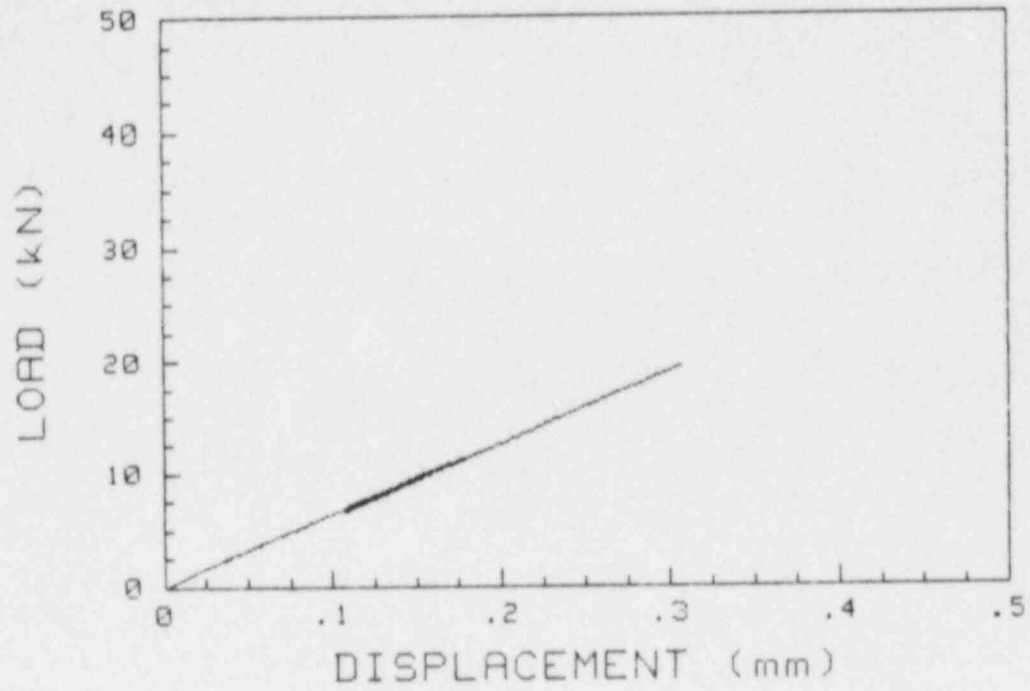
YP1236



ORNL-DWG 87-7912

02GA-350

-80 DEGREES C



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/m²
 KJ-MAX LOAD= 195.4 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 140.4 kJ/m²
 K-JIc= 163.7 MPa SQR[m]
 POWER= .5065
 COEFFICIENT= 266.8 kJ/m²
 T (AVERAGE)= 92

ASTM LINEAR PROCEDURE

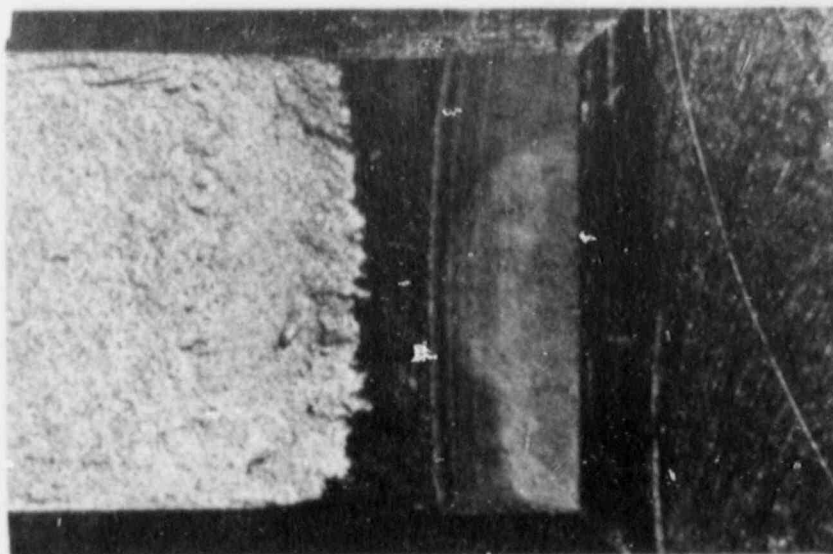
 JIc= 143.7 kJ/m²
 K-JIc= 165.6 MPa SQR[m]
 SLOPE= 133412 kJ/m³
 INTERCEPT= 125.7 kJ/m²
 T (ASTM)= 89
 VALID, E813

J1-R CURVE CALCULATIONS

 J (@J/T=8.8)= 414.3 kJ/m²
 POWER= .4526
 J-MAX ALLOWED= 507.7 kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 265.9 kJ/m²
 DELTA-A MAX ALLOWED= 1.9 mm

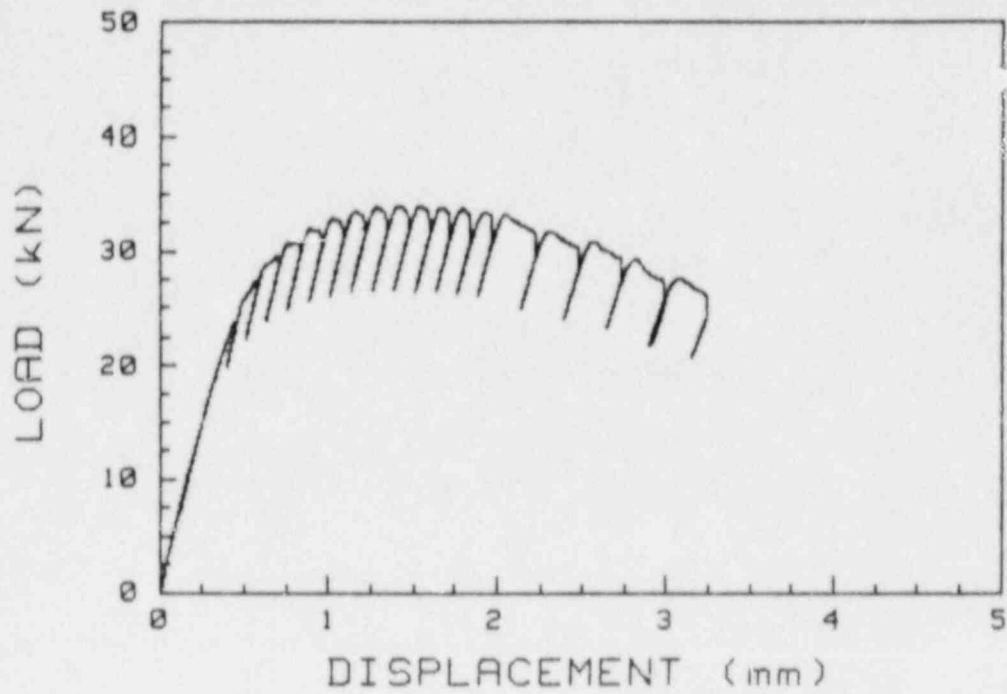
YP1306



ORNL-DWG 87-7913

02GA357

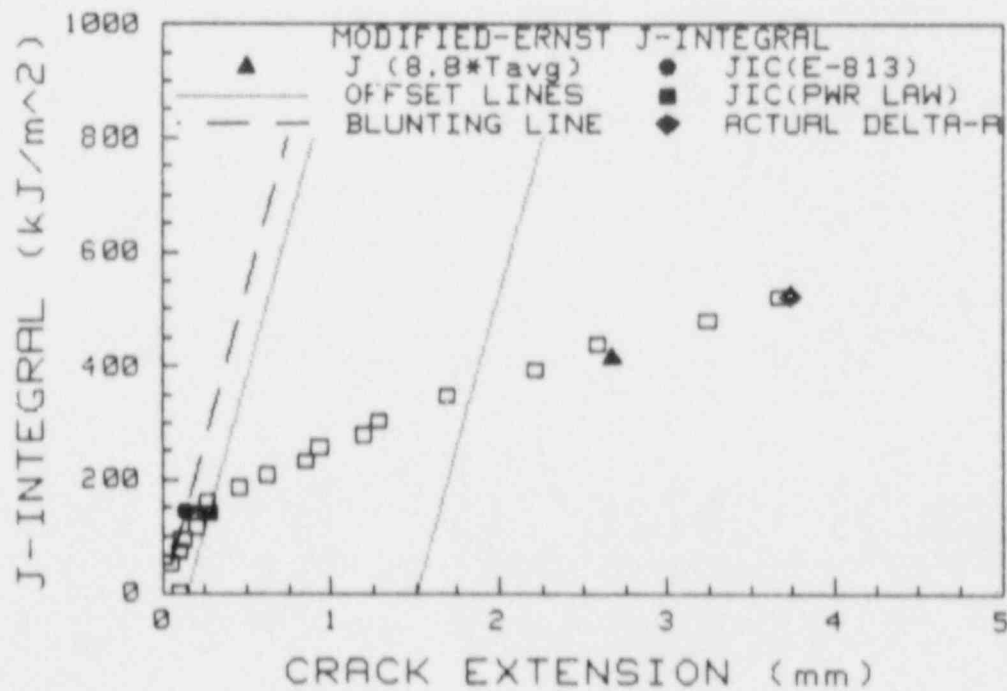
288 DEGREES C



ORNL-DWG 87-7914

02GA357

288 DEGREES C



SPECIMEN ID= 02GA361
MATERIAL TYPE= A533B
TEST TEMPERATURE= -40 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 31.5 mm $a/W)_1 = .62$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 529 MPa
FLOW STRENGTH= 609 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT $K = 69.7 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

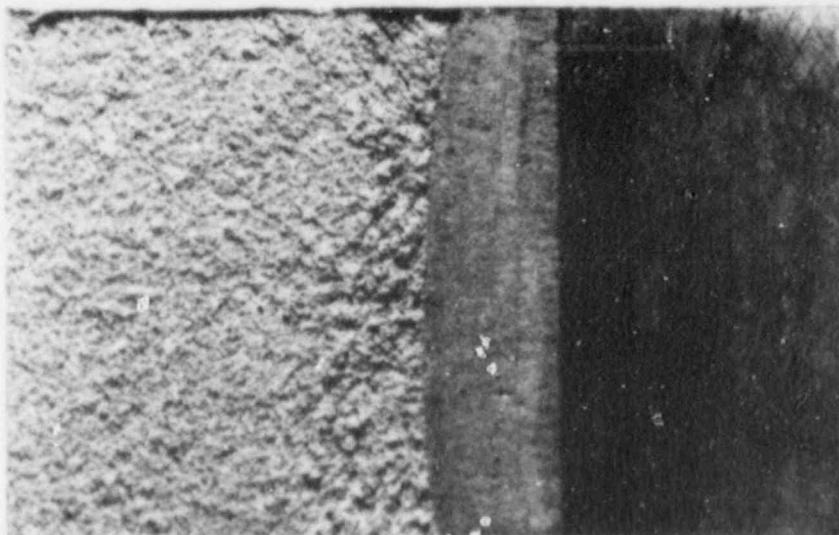
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 23.6 kJ/m²
KJc= 70.3 MPa SQR[m]
K-beta-c= 60.2 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 23.6 kJ/m²
KJc= 70.3 MPa SQR[m]
K-beta-c= 60.2 MPa SQR[m]

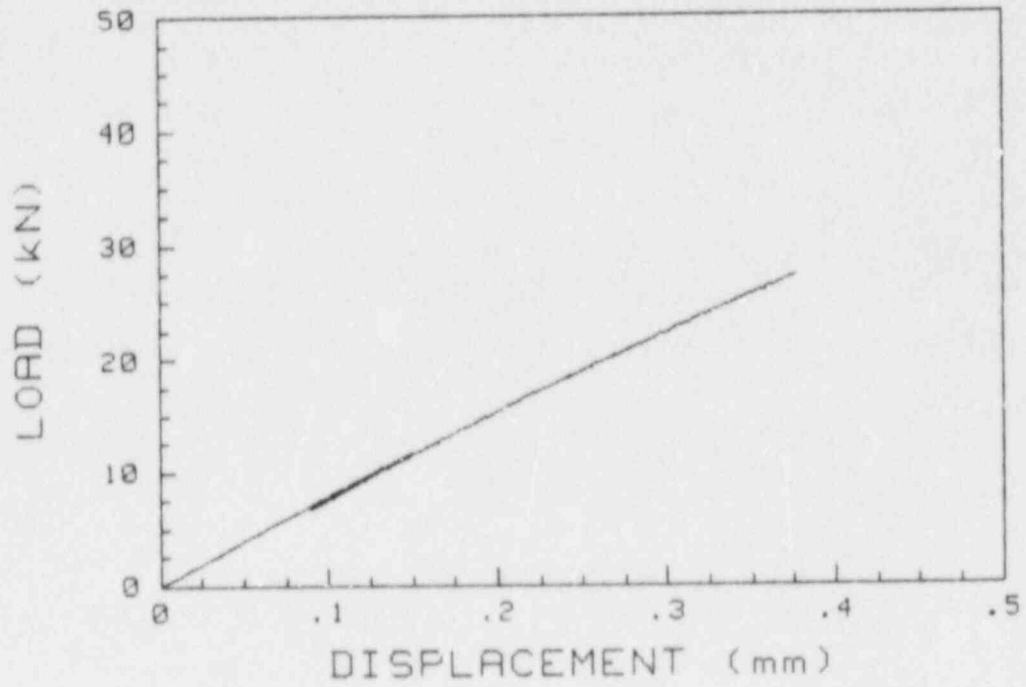
YP1235



ORNL-DWG 87-7915

Ø2GA361

-40 DEGREES C



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 $K = 98.6 \text{ MPa SQR(m)}$ (NOT VALID K_{Ic})

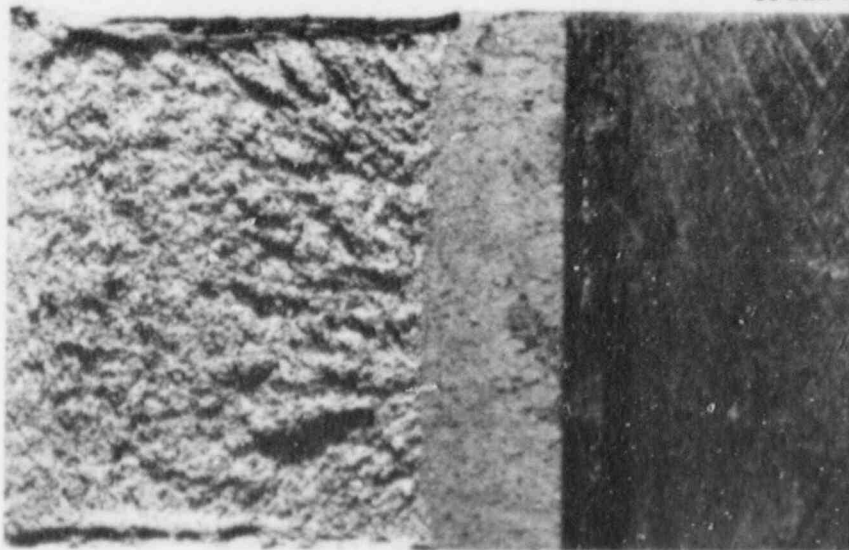
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 80.7 kJ/m²
KJc= 129.3 MPa SQR(m)
K-beta-c= 80.7 MPa SQR(m)

VALUES AT CLEAVAGE LOAD

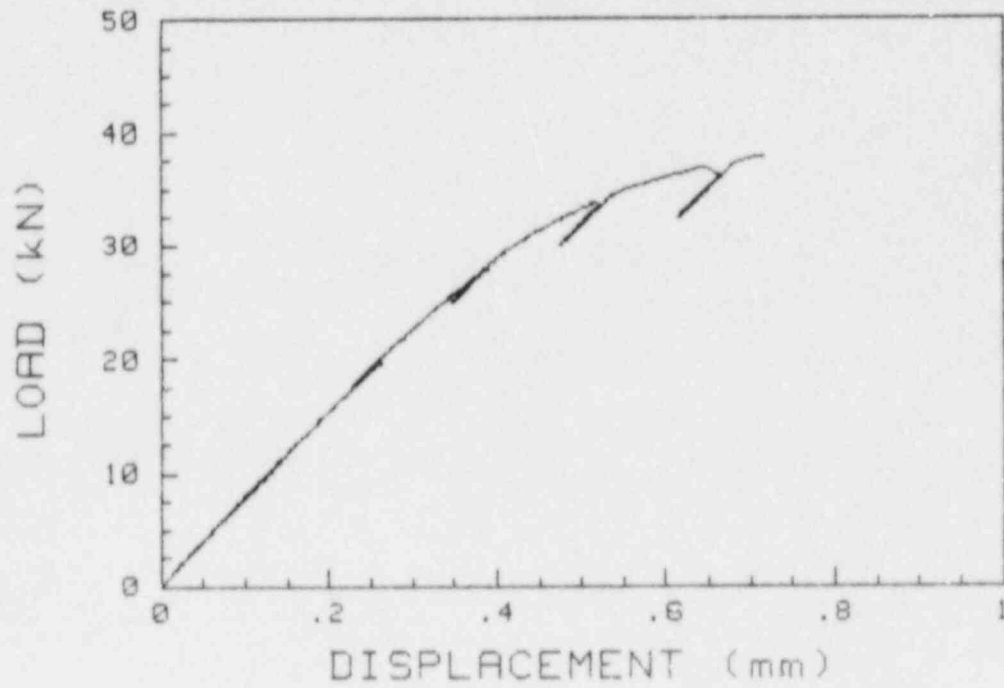
J-INTEGRAL= 75.1 kJ/m²
KJc= 124.7 MPa SQR(m)
K-beta-c= 79.4 MPa SQR(m)

YP1234



02GA-367

0 DEGREES C



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/m²
 KJ-MAX LOAD= 303.8 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 164.3 kJ/m²
 K-JIc= 183.5 MPa SQR[m]
 POWER= .8396
 COEFFICIENT= 448.1 kJ/m²
 T (AVERAGE)= 258

ASTM LINEAR PROCEDURE

 JIc= 102.4 kJ/m²
 K-JIc= 144.9 MPa SQR[m]
 SLOPE= 375940 kJ/m³
 INTERCEPT= 66.6 kJ/m²
 T (ASTM)= 267
 INVALID, 6

JI-R CURVE CALCULATIONS

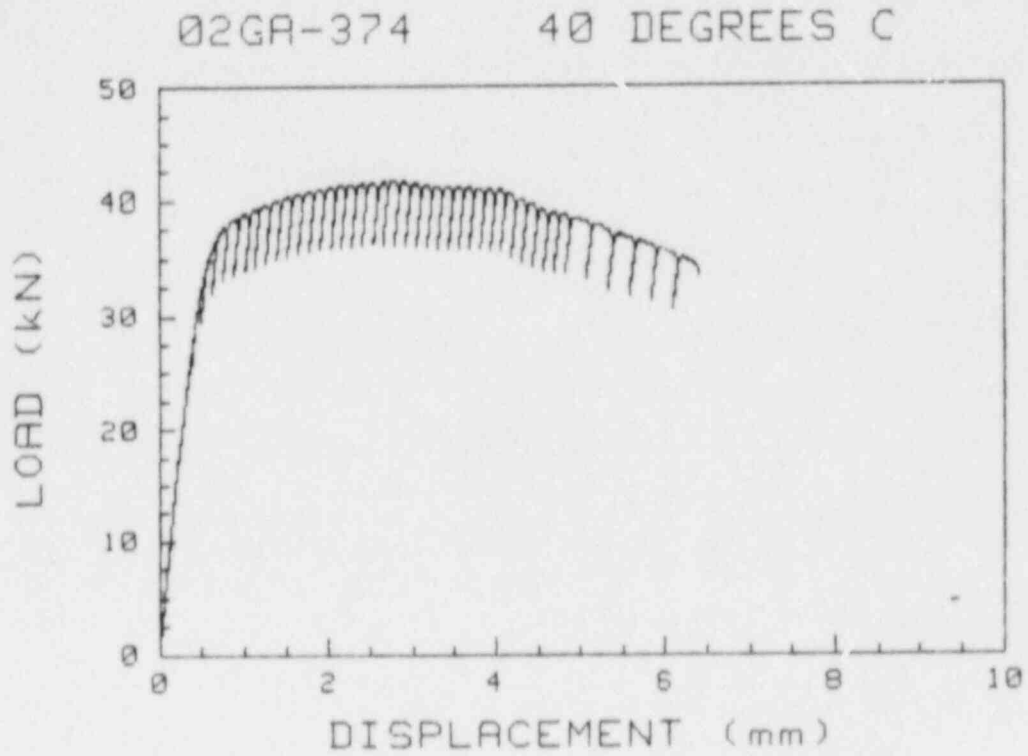
 J (@J/T=8.8)= 1774.2 kJ/m²
 POWER= .836
 J-MAX ALLOWED= 516.1 kJ/m²
 RCURVE INVALID, 3

COEFFICIENT= 446.1 kJ/m²
 DELTA-A MAX ALLOWED= 1.92 mm

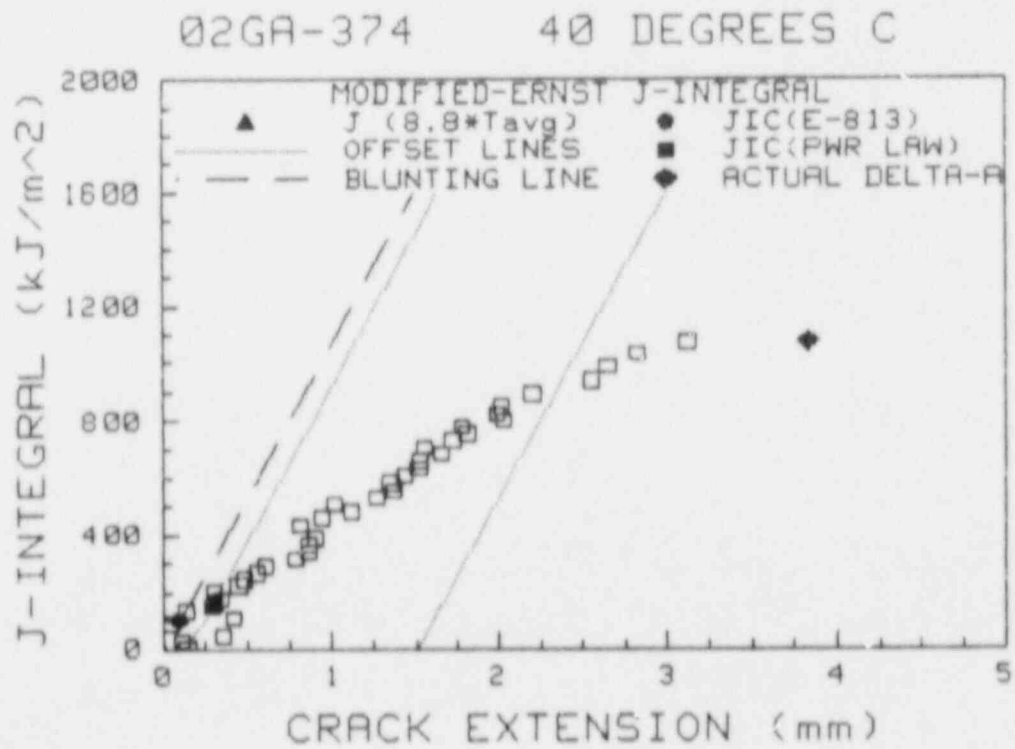
YP1233



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
MEASURED DUCTILE DELTA-A= .07 mm
YIELD STRENGTH= 496 MPa
FLOW STRENGTH= 574 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

$a/W)i = .612$

SPECIMEN CLEAVED AT $K = 101.1 \text{ MPa SQR[m]}$ (NOT VALID KIc)

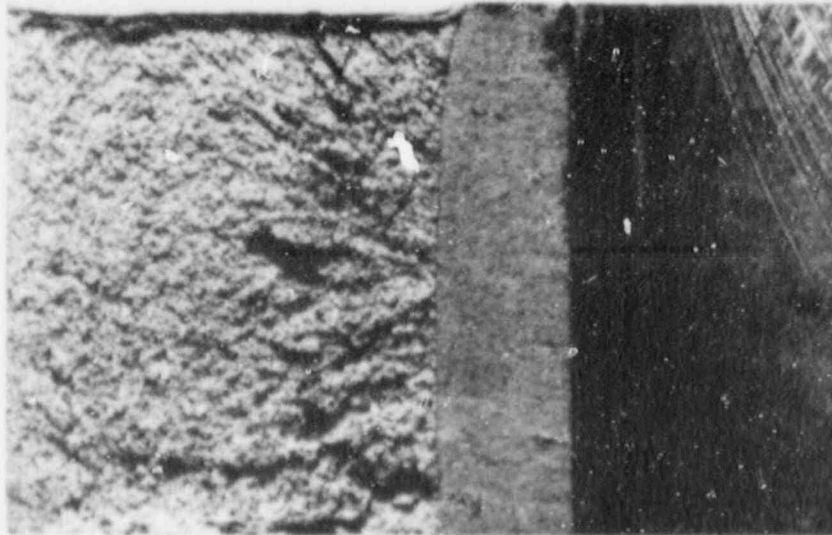
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 74.3 kJ/m²
KJc= 124.2 MPa SQR[m]
K-beta-c= 79.6 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 74.3 kJ/m²
KJc= 124.2 MPa SQR[m]
K-beta-c= 79.6 MPa SQR[m]

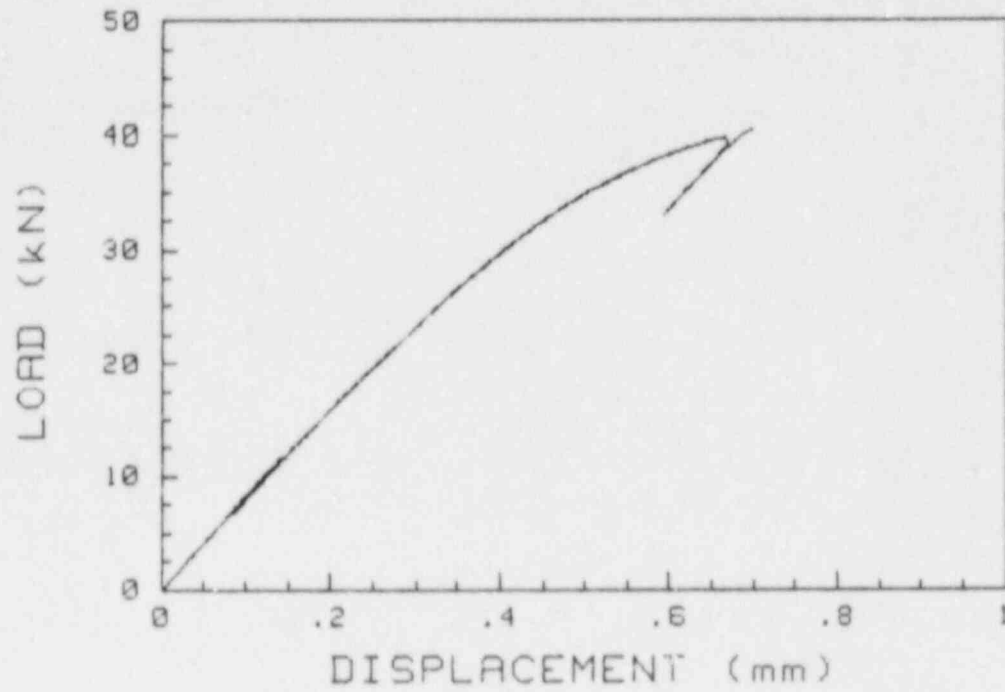
YP1232



ORNL-DWG 87-7919

02GA405

-5 DEGREES C



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 K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 207.5 kJ/m²
 K_{Ic} = 206.6 MPa SQR[m]
 K_{beta-c} = 89.5 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 206.9 kJ/m²
 K_{Ic} = 206.4 MPa SQR[m]
 K_{beta-c} = 89.4 MPa SQR[m]

POWER LAW PROCEDURE

J_{Ic} = 152.7 kJ/m²
 $K-J_{Ic}$ = 177.3 MPa SQR[m]
 POWER= .8108
 COEFFICIENT= 417.8 kJ/m²
 T (AVERAGE)= 225

ASTM LINEAR PROCEDURE

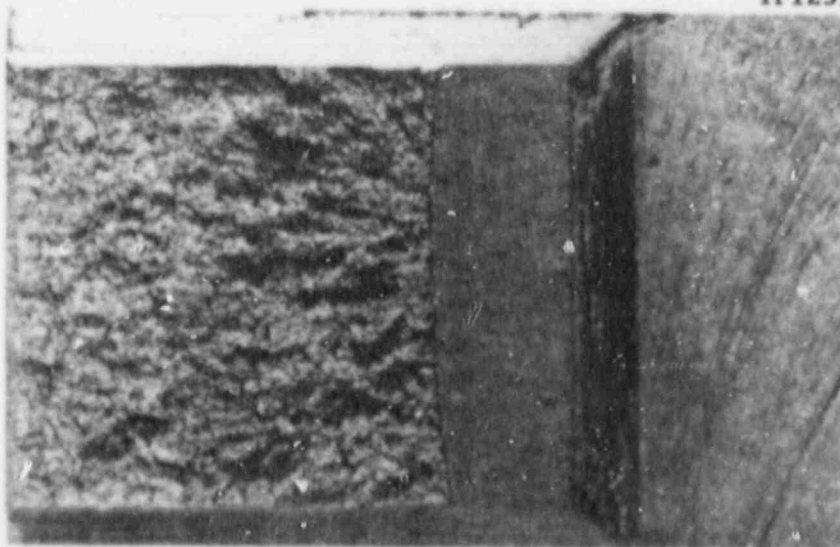
J_{Ic} = 0 kJ/m²
 $K-J_{Ic}$ = 0 MPa SQR[m]
 SLOPE= kJ/m³
 INTERCEPT= 0 kJ/m²
 T (ASTM)= 0
 INVALID, 1 6

J1-R CURVE CALCULATIONS

$J (@J/T=8.8)$ = 728.8 kJ/m²
 POWER= .6093
 J -MAX ALLOWED= 545.5 kJ/m²
 RCURVE INVALID, 1 2 3

COEFFICIENT= 330.6 kJ/m²
 DELTA-A MAX ALLOWED= 1.99 mm

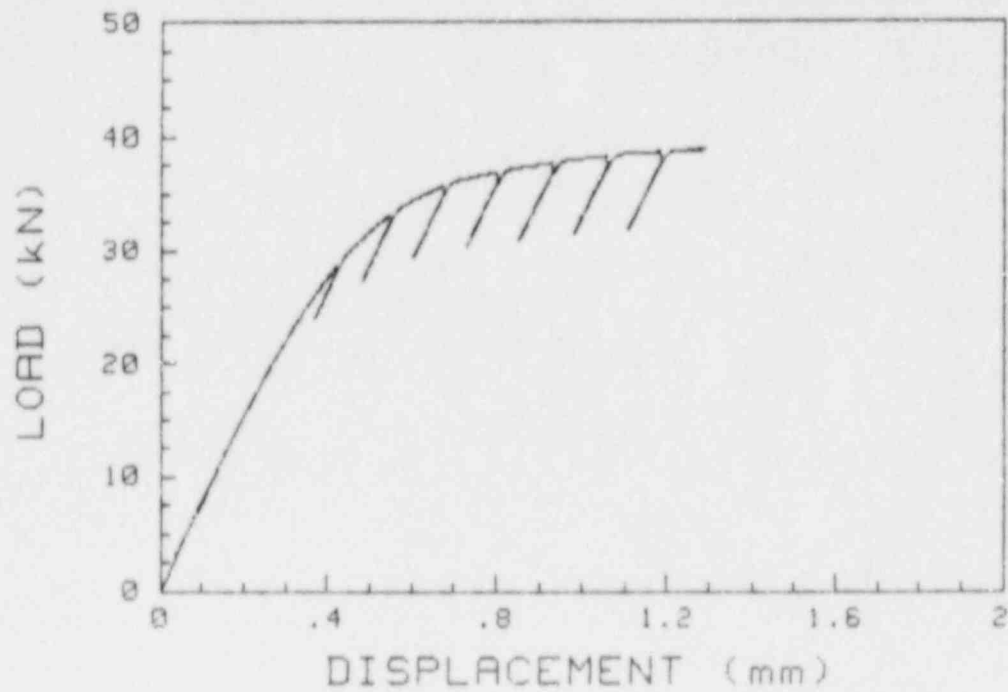
YP1231



ORNL-DWG 87-7920

02GA408

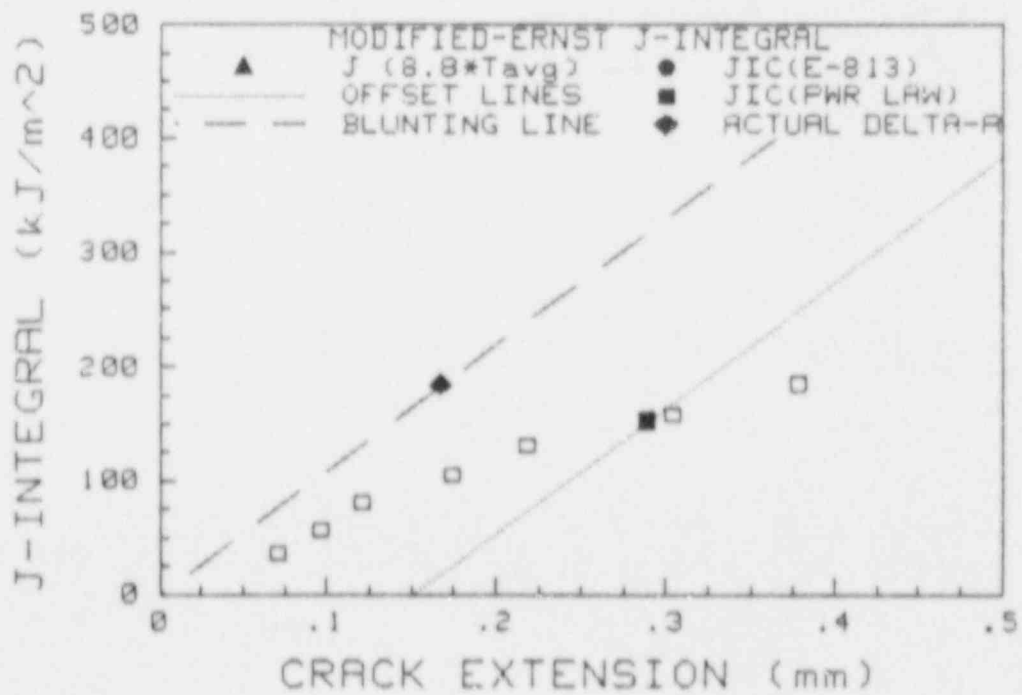
24 DEGREES C



ORNL-DWG 87-7921

02GA408

24 DEGREES C



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/m²
 KJ-MAX LOAD= 263.5 MPa SQR(m)

POWER LAW PROCEDURE

 JIc= 177.5 kJ/m²
 K-JIc= 190.5 MPa SQR(m)
 POWER= .6771
 COEFFICIENT= 386.4 kJ/m²
 T (AVERAGE)= 183

ASTM LINEAR PROCEDURE

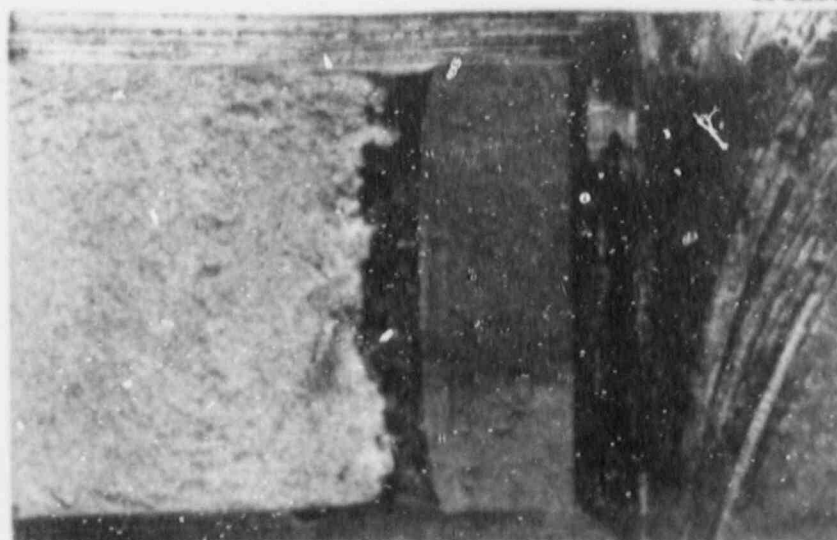
 JIc= 118.8 kJ/m²
 K-JIc= 155.8 MPa SQR(m)
 SLOPE= 271806 kJ/m³
 INTERCEPT= 88.4 kJ/m²
 T (ASTM)= 197
 INVALID, 6

J!-R CURVE CALCULATIONS

 J (@J/T=8.8)= 1194 kJ/m²
 POWER= .7361
 J-MAX ALLOWED= 503.6 kJ/m²
 RCURVE INVALID, 1 3

COEFFICIENT= 382.7 kJ/m²
 DELTA-A MAX ALLOWED= 1.9 mm

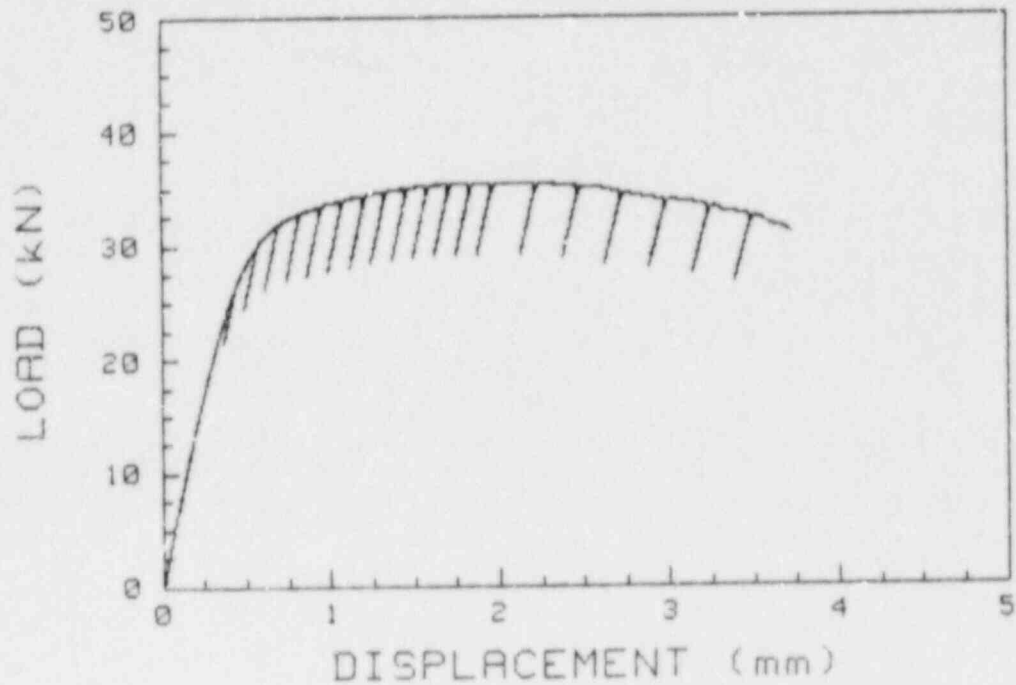
YP1230



ORNL-DWG 87-7922

02GA410

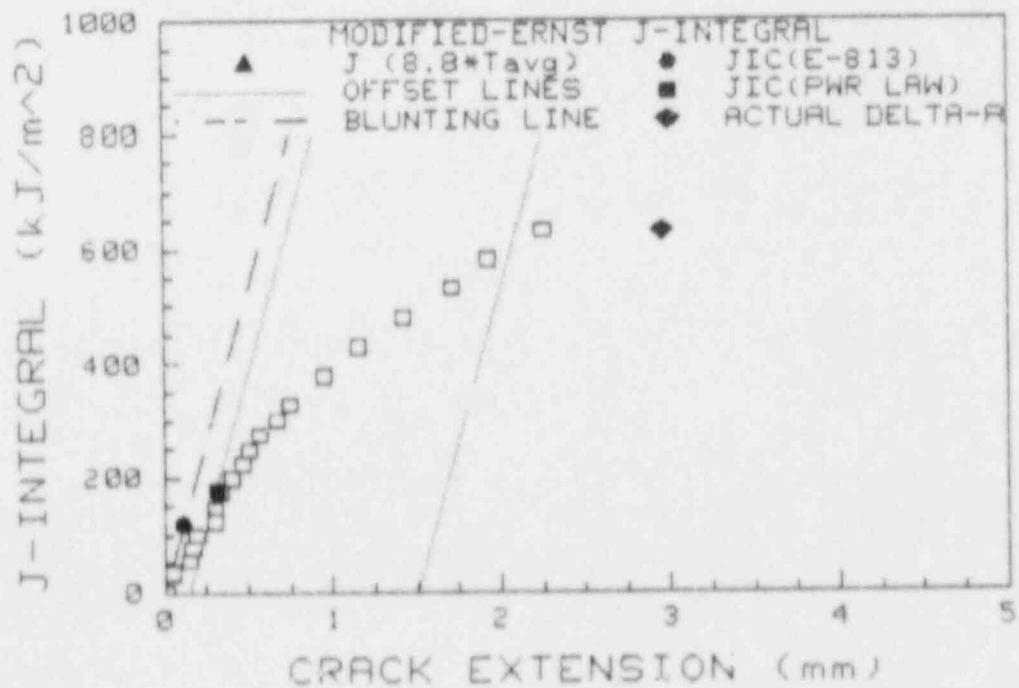
50 DEGREES C



ORNL-DWG 87-7923

02GA410

50 DEGREES C



SPECIMEN ID= 02GA415
 MATERIAL TYPE= A533-B-1
 TEST TEMPERATURE= -100 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 31.7 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 $K_{Ic} = 44 \text{ MPa SQR}(m)$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

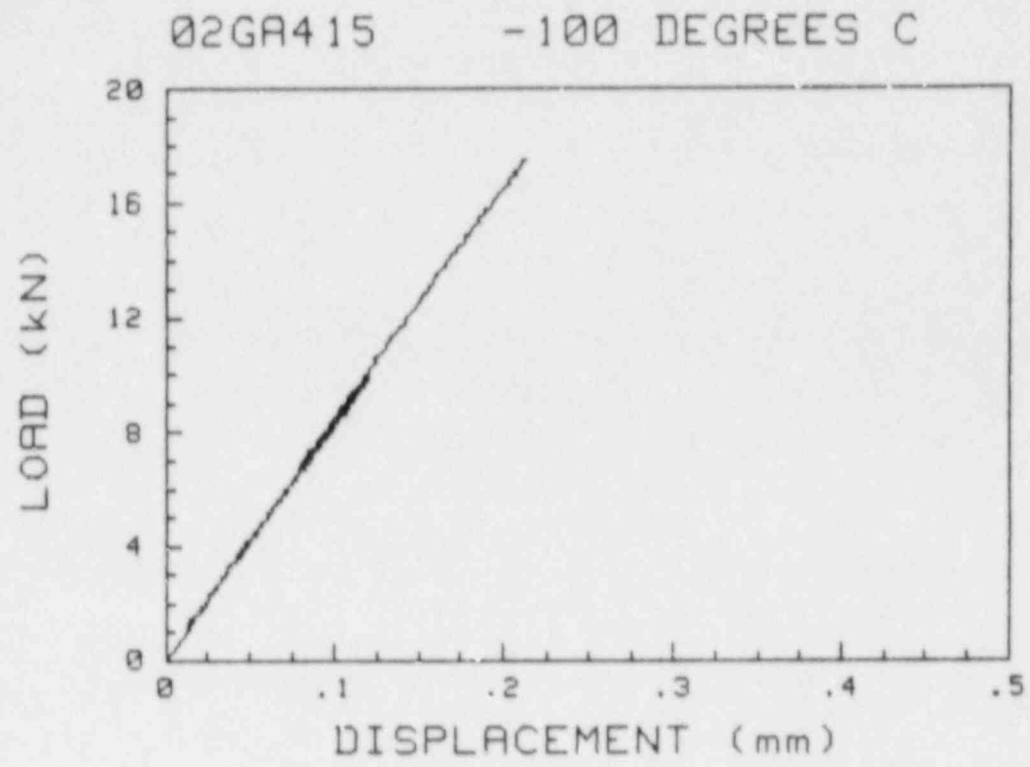
 J-INTEGRAL= 8.3 kJ/m²
 KJc= 41.9 MPa SQR(m)
 K-beta-c= 41 MPa SQR(m)

VALUES AT CLEAVAGE LOAD

 J-INTEGRAL= 8.3 kJ/m²
 KJc= 41.9 MPa SQR(m)
 K-beta-c= 41 MPa SQR(m)

YP1227





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

$a/W)_1 = .606$

SPECIMEN CLEAVED AT $K = 99.7 \text{ MPa SQR(m)}$ (NOT VALID K_{Ic})

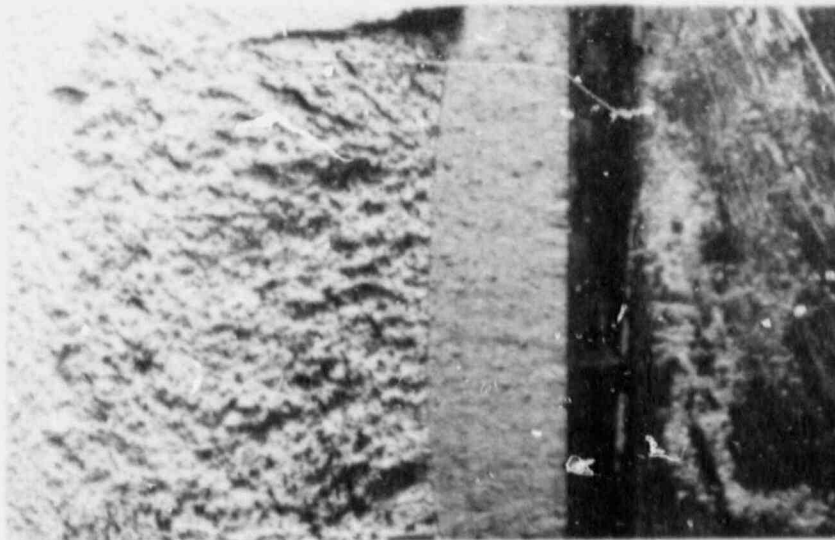
VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 73.5 kJ/m^2
 $KJc = 123.4 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 79 \text{ MPa SQR(m)}$

VALUES AT CLEAVAGE LOAD

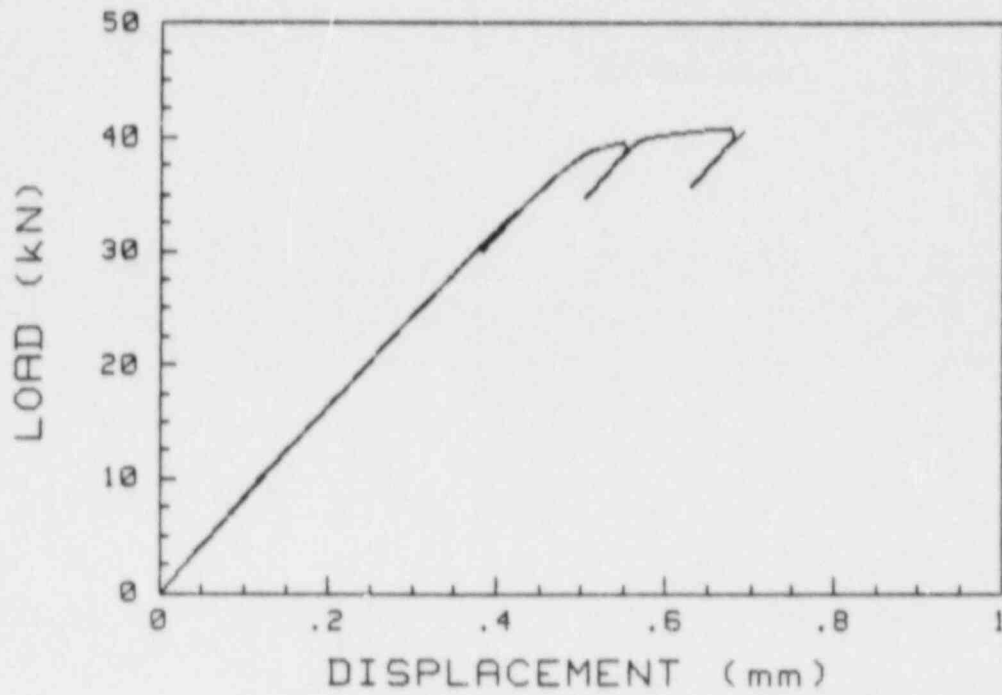
 J-INTEGRAL= 75.9 kJ/m^2
 $KJc = 125.4 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 79.6 \text{ MPa SQR(m)}$

YP1228



02GA417

0 DEGREES C



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/m²
 KJ-MAX LOAD= 257.9 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 229.1 kJ/m²
 K-JIc= 209.1 MPa SQR[m]
 POWER= .5528
 COEFFICIENT= 406.8 kJ/m²
 T (AVERAGE)= 130

ASTM LINEAR PROCEDURE

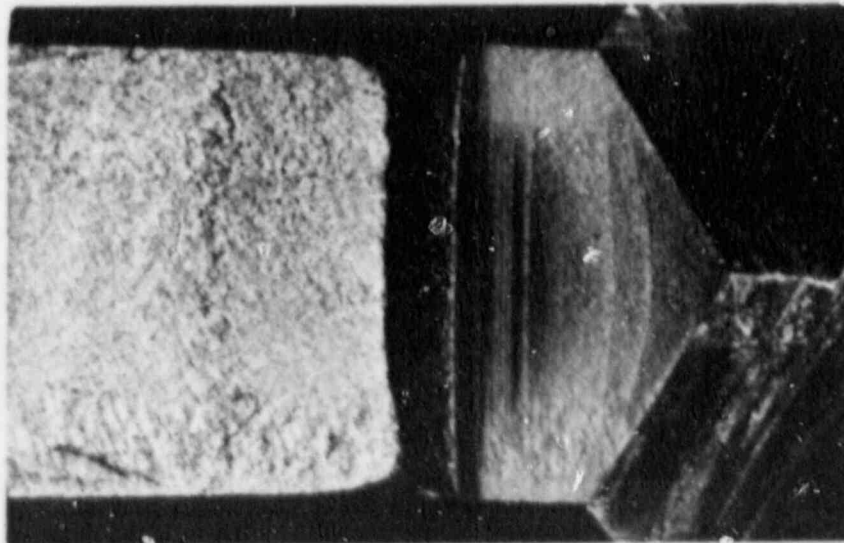
 JIc= 206.8 kJ/m²
 K-JIc= 198.6 MPa SQR[m]
 SLOPE= 227436 kJ/m³
 INTERCEPT= 164.9 kJ/m²
 T (ASTM)= 138
 VALID, E813

J1-R CURVE CALCULATIONS

 J (@J/T=8.8)= 769.8 kJ/m²
 POWER= .5725
 J-MAX ALLOWED= 570.6 kJ/m²
 VALID R-CURVE

COEFFICIENT= 406.7 kJ/m²
 DELTA-A MAX ALLOWED= 2.04 mm

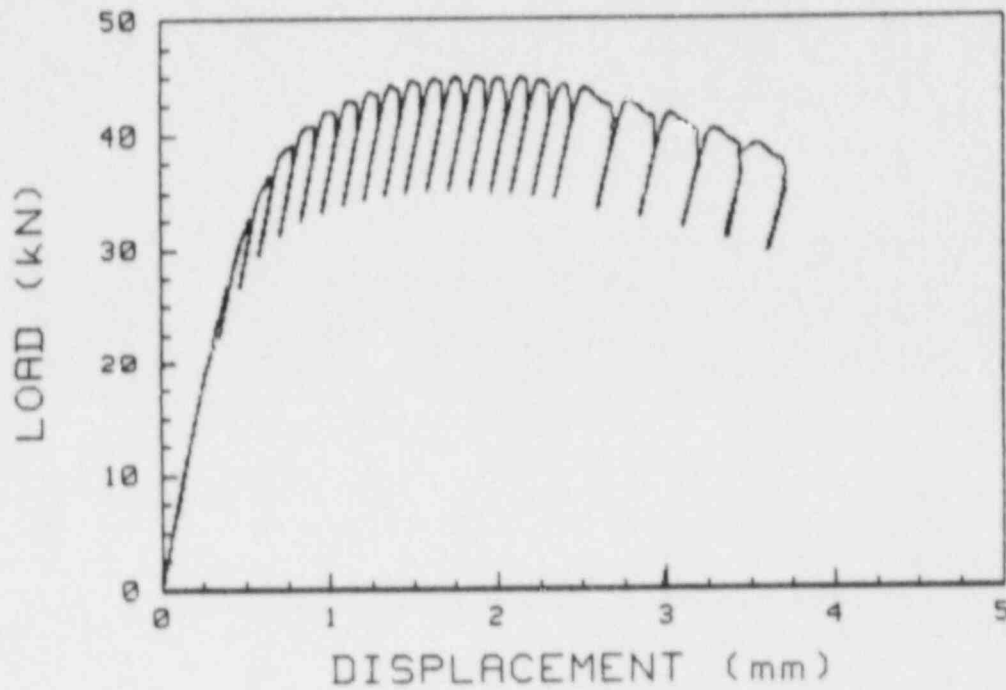
YP1226



ORNL-DWG 87-7926

68WAA

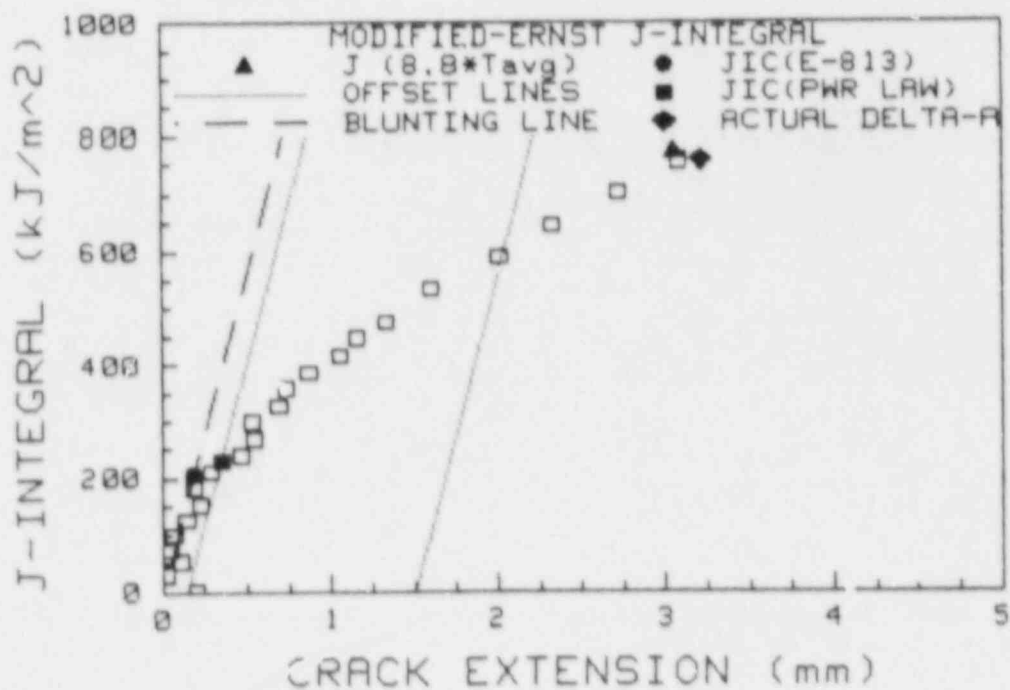
288 DEGREES C



ORNL-DWG 87-7927

68WAA

288 DEGREES C



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

$a/W_i = .601$

SPECIMEN CLEAVED AT $K_{Ic} = 59.5 \text{ MPa SQR[m]}$ (VALID ASTM E399)

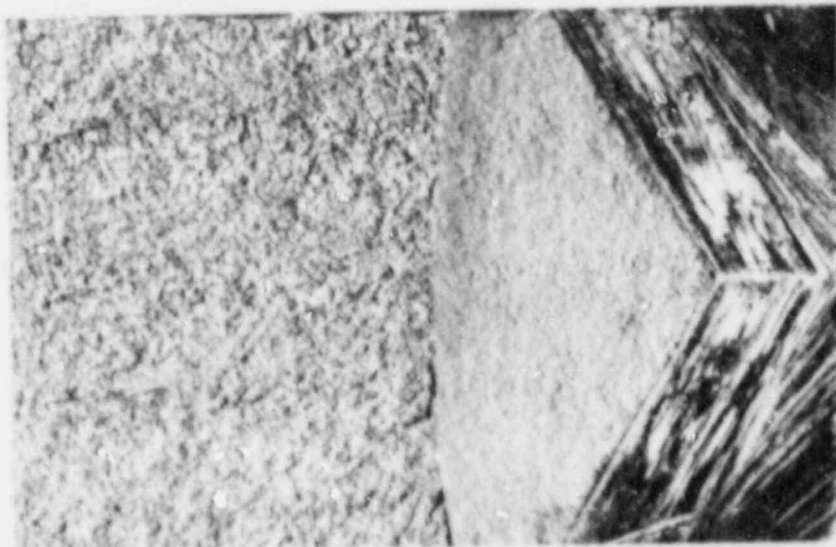
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 16.2 kJ/m²
KJc= 58.6 MPa SQR[m]
K-beta-c= 55.9 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

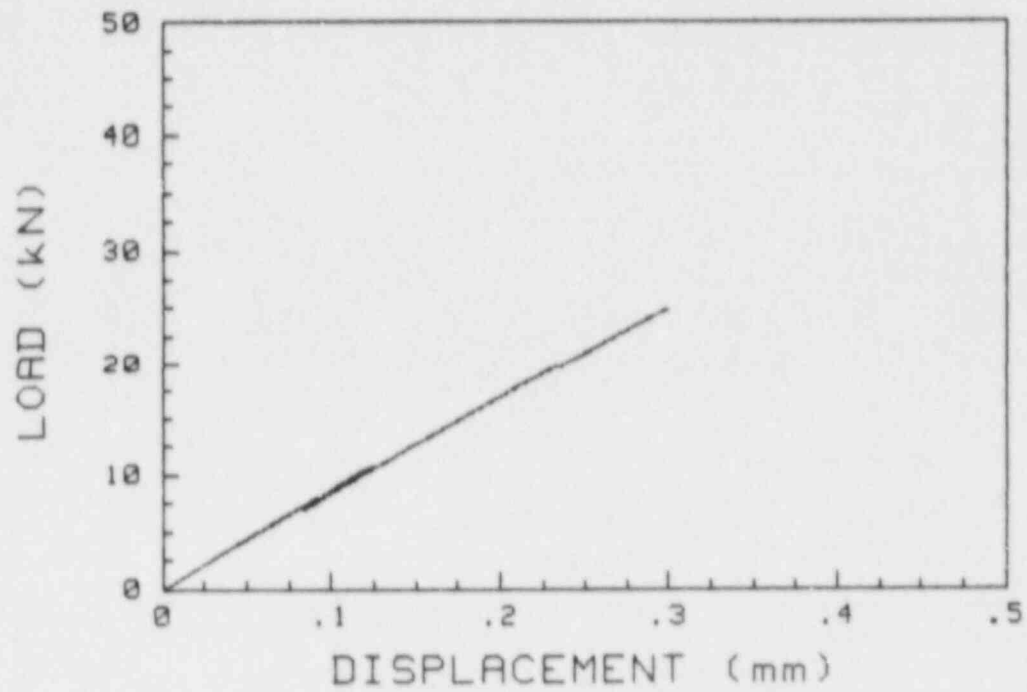
J-INTEGRAL= 16.2 kJ/m²
KJc= 58.6 MPa SQR[m]
K-beta-c= 55.9 MPa SQR[m]

YP1225



68WCB

-80 DEGREES C



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 $K = 120.8 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

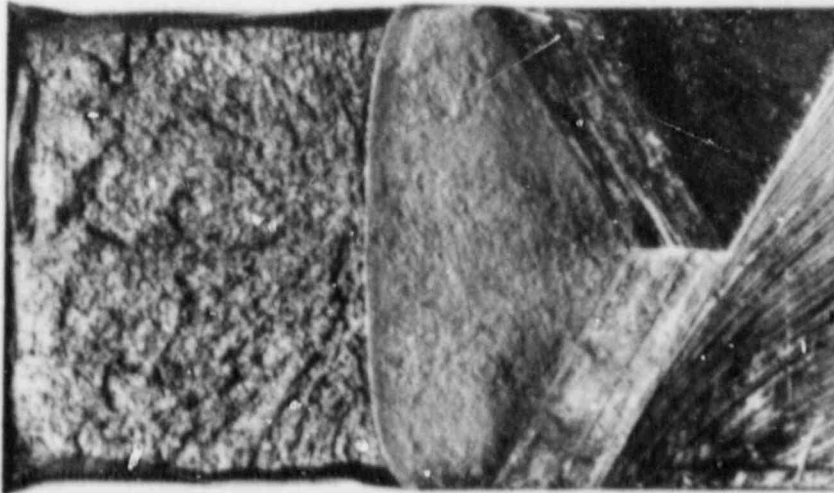
VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 213.5 kJ/m^2
 $KJc = 211.2 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 113.1 \text{ MPa SQR[m]}$

VALUES AT CLEAVAGE LOAD

 J-INTEGRAL= 215.7 kJ/m^2
 $KJc = 212.3 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 113.3 \text{ MPa SQR[m]}$

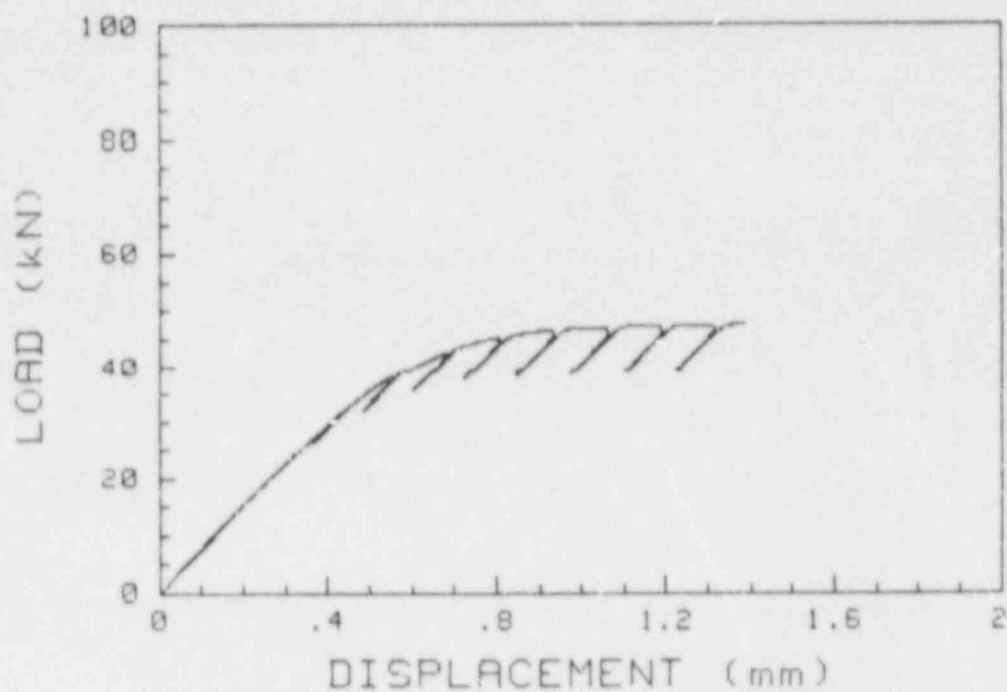
YP1224



ORNL-DWG 87-7929

68WDD

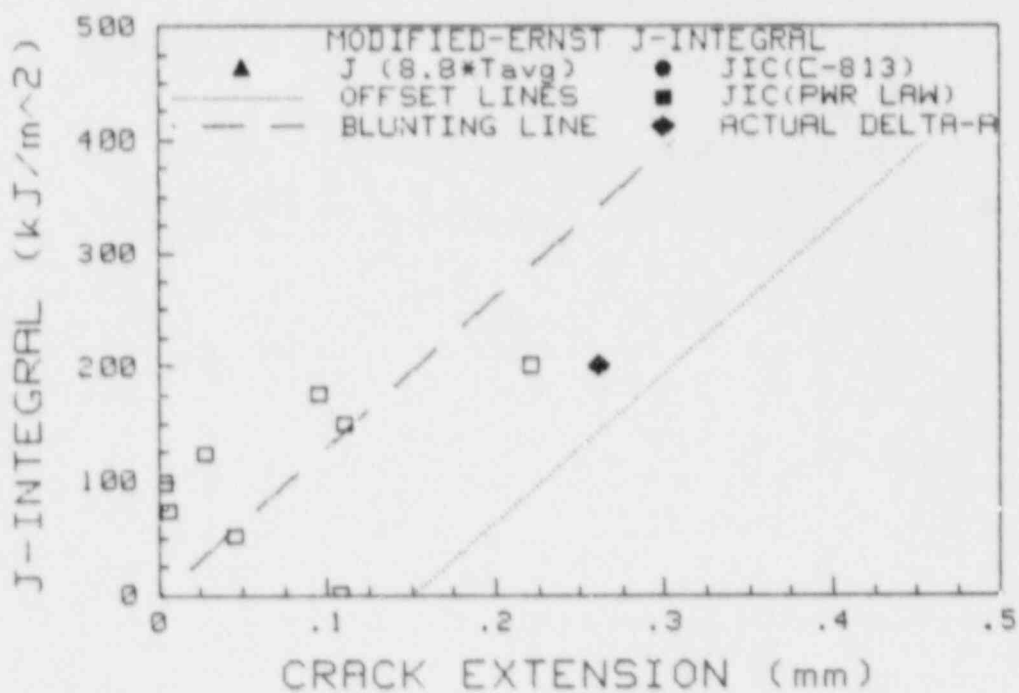
-30 DEGREES C



ORNL-DWG 87-7930

68WDD

-30 DEGREES C



SPECIMEN ID= 68WEB
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -135 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.3 mm $a/W)1 = .597$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 276 MPa
FLOW STRENGTH= 800 MPa
ESTIMATED YOUNG'S MODULUS= 215 GPa

SPECIMEN CLEAVED AT $K_{Ic} = 40.2 \text{ MPa SQR[m]}$ (VALID ASTM E399)

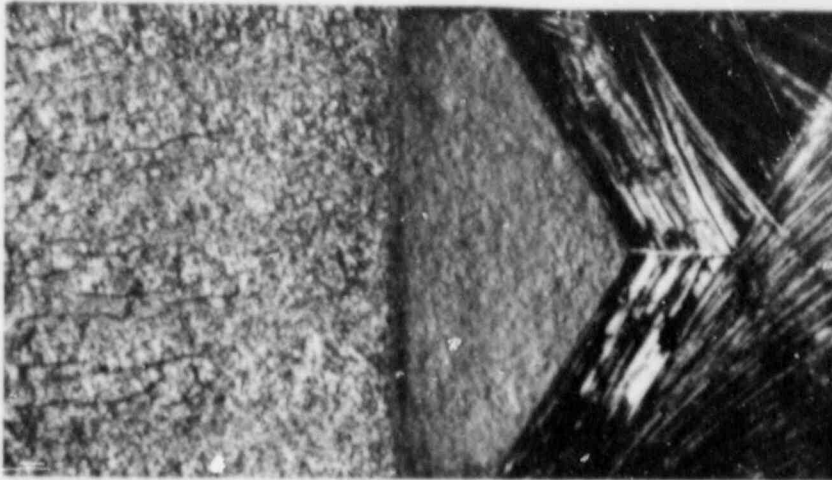
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 7.6 kJ/m²
KJc= 40.4 MPa SQR[m]
K-beta-c= 40 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 7.6 kJ/m²
KJc= 40.4 MPa SQR[m]
K-beta-c= 40 MPa SQR[m]

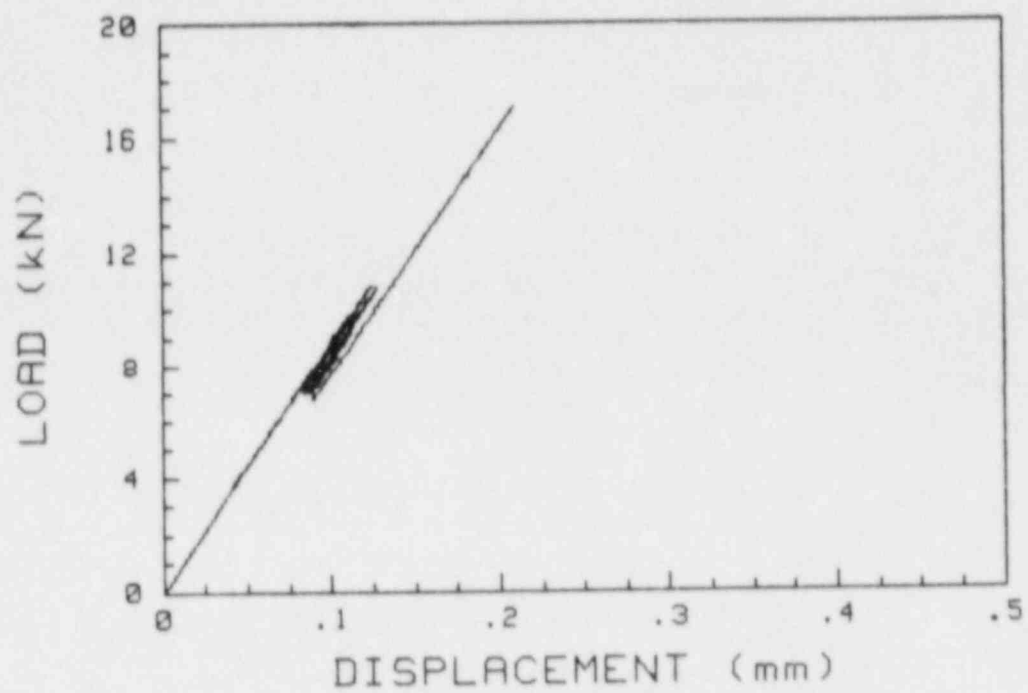
YP1223



ORNL-DWG 87-7931

68WEB

-135 DEGREES C



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/m²
 KJ-MAX LOAD= 266.8 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 243.1 kJ/m²
 K-JIc= 220.6 MPa SQR[m]
 POWER= .6496
 COEFFICIENT= 460.5 kJ/m²
 T (AVERAGE)= 191

ASTM LINEAR PROCEDURE

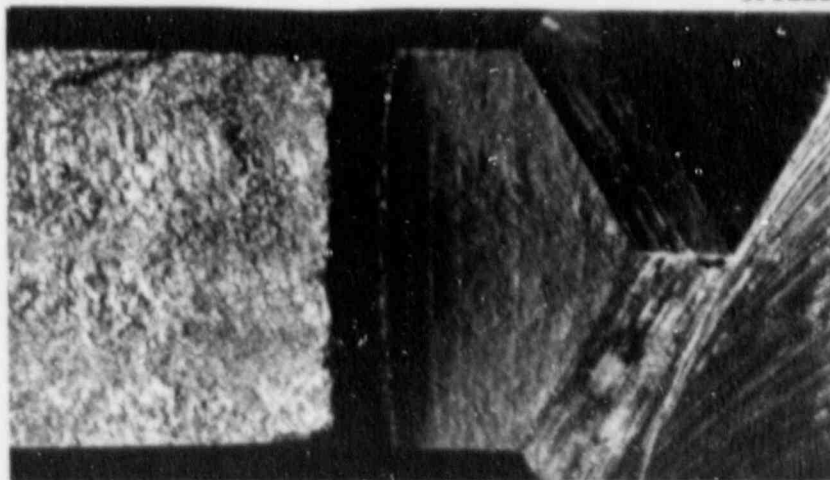
 JIc= 203.3 kJ/m²
 K-JIc= 201.8 MPa SQR[m]
 SLOPE= 299044 kJ/m³
 INTERCEPT= 147.2 kJ/m²
 T (ASTM)= 204
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 1070.5 kJ/m²
 POWER= .6363
 J-MAX ALLOWED= 541.3 kJ/m²
 VALID R-CURVE

COEFFICIENT= 457 kJ/m²
 DELTA-A MAX ALLOWED= 2 mm

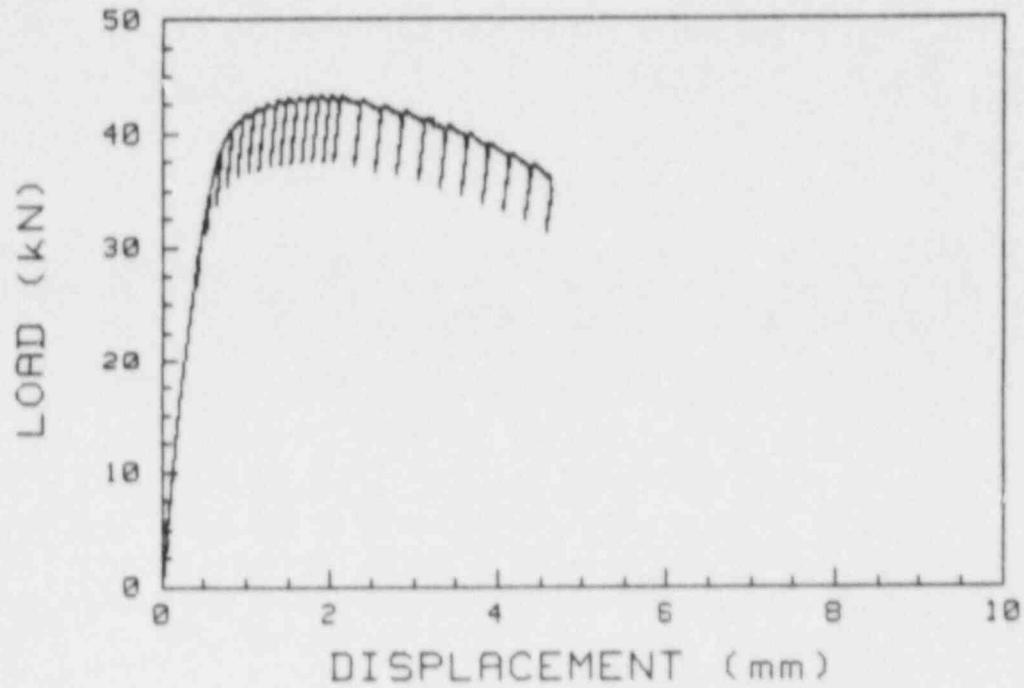
YP1222



ORNL-DWG 87-7932

68WHB

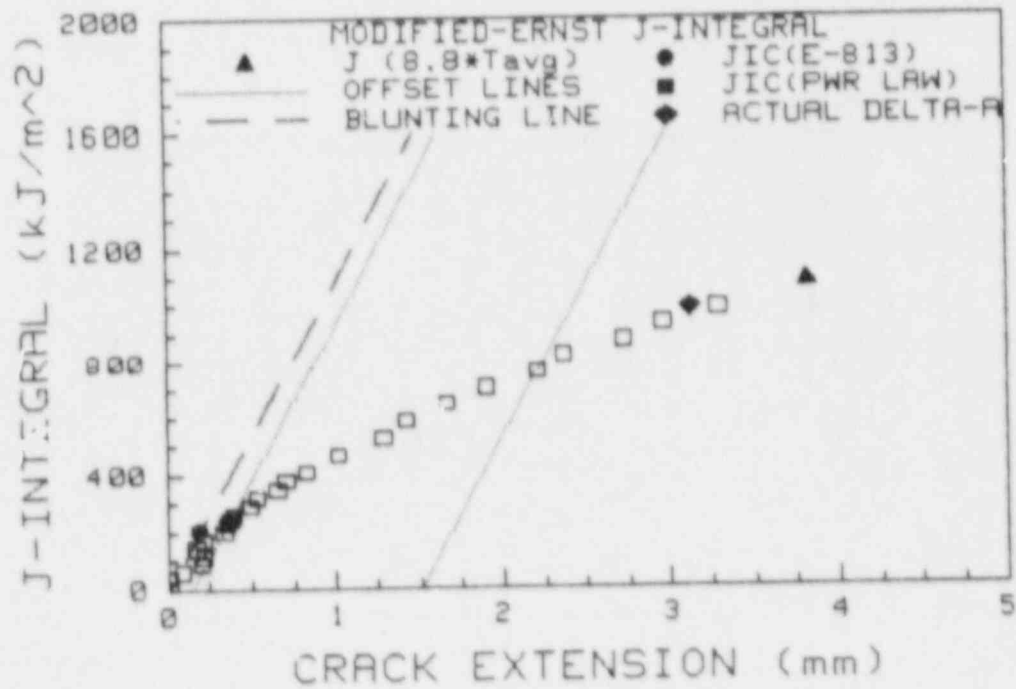
121 DEGREES C



ORNL-DWG 87-7933

68WHB

121 DEGREES C



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/m²
 KJ-MAX LOAD= 295.2 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 223.5 kJ/m²
 K-JIc= 214.5 MPa SQR[m]
 POWER= .7398
 COEFFICIENT= 500.6 kJ/m²
 T (AVERAGE)= 202

ASTM LINEAR PROCEDURE

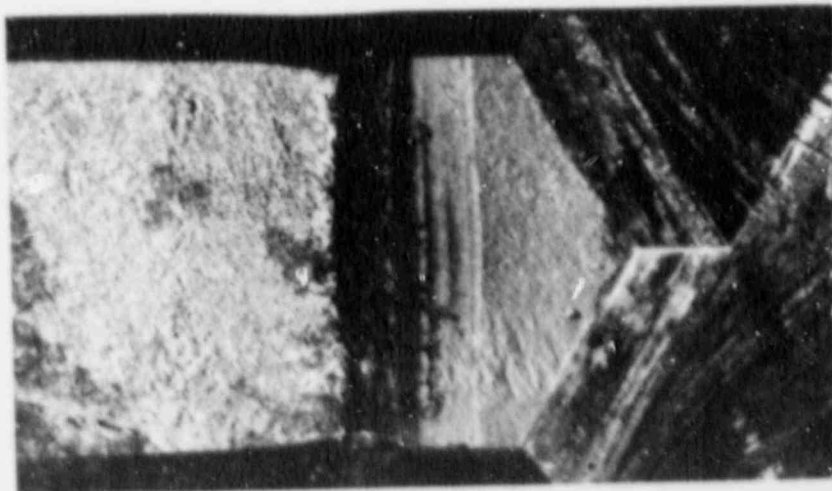
 JIc= 160.9 kJ/m²
 K-JIc= 182 MPa SQR[m]
 SLOPE= 383755 kJ/m³
 INTERCEPT= 109.4 kJ/m²
 T (ASTM)= 219
 VALID, E813

J1-R CURVE CALCULATIONS

 J (@J/T=8.8)= 1321.3 kJ/m²
 POWER= .7421
 J-MAX ALLOWED= 602.1 kJ/m²
 RCURVE INVALID, 3

COEFFICIENT= 497.1 kJ/m²
 DELTA-A MAX ALLOWED= 2.01 mm

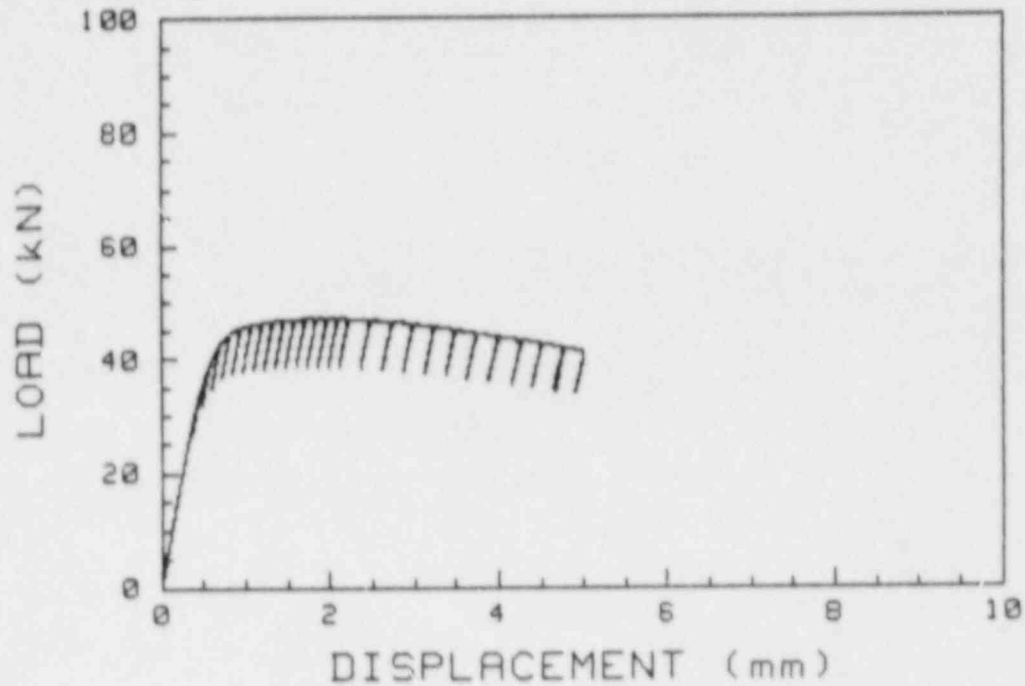
YP1221



ORNL-DWG 87-7934

68WKA

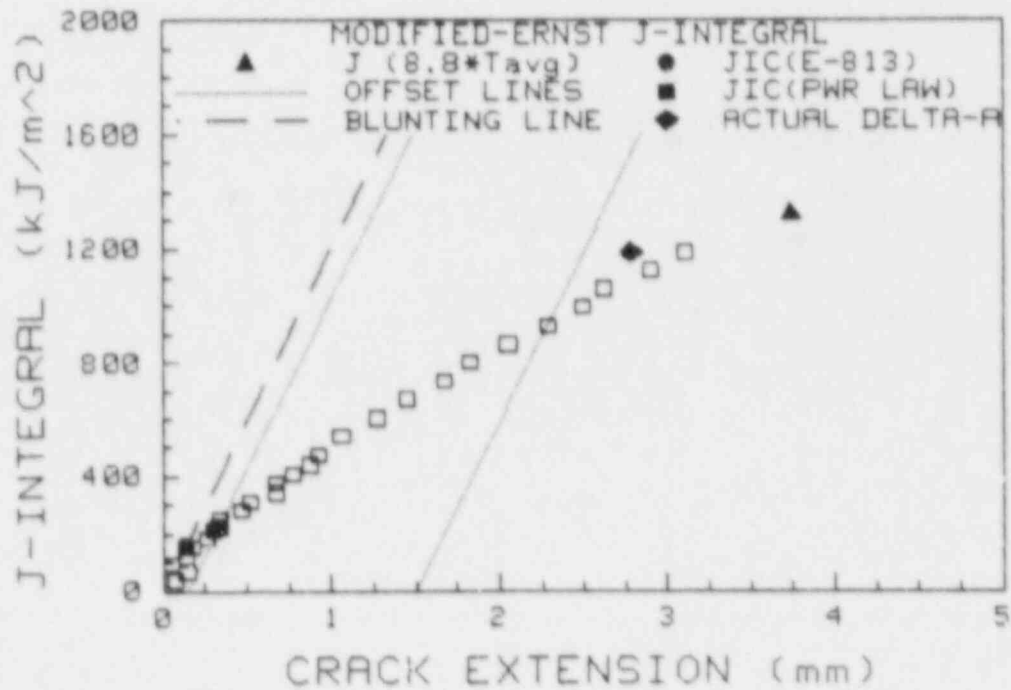
23 DEGREES C



ORNL-DWG 87-7935

68WKA

23 DEGREES C



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 K_{Ic})

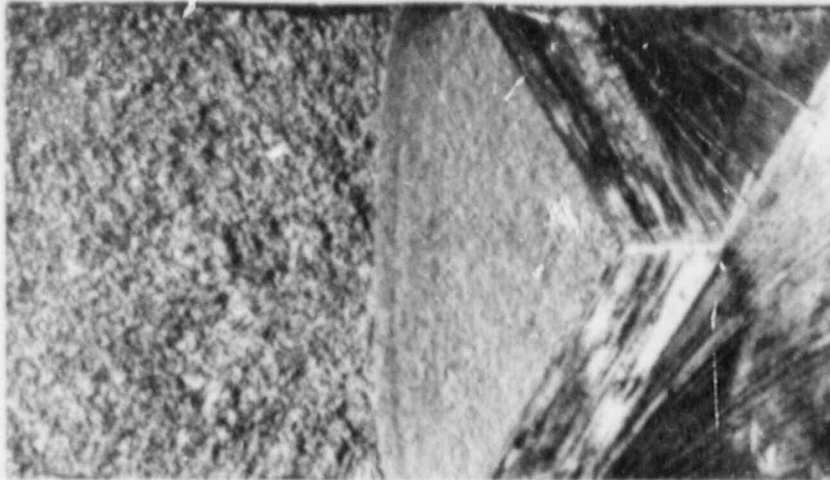
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 71.3 kJ/m²
KJc= 122.9 MPa SQR[m]
K-beta-c= 93 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

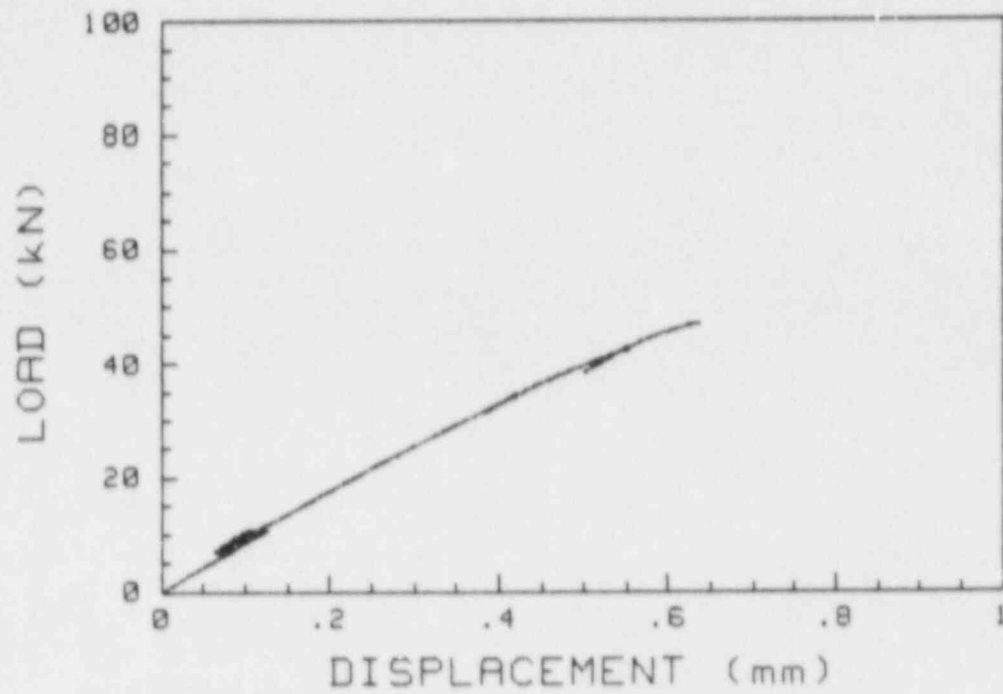
J-INTEGRAL= 71.3 kJ/m²
KJc= 122.9 MPa SQR[m]
K-beta-c= 93 MPa SQR[m]

YP1220



68WKD

-80 DEGREES C



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 $K_{Ic} = 42.6 \text{ MPa SQR[m]}$ (VALID ASTM E399)

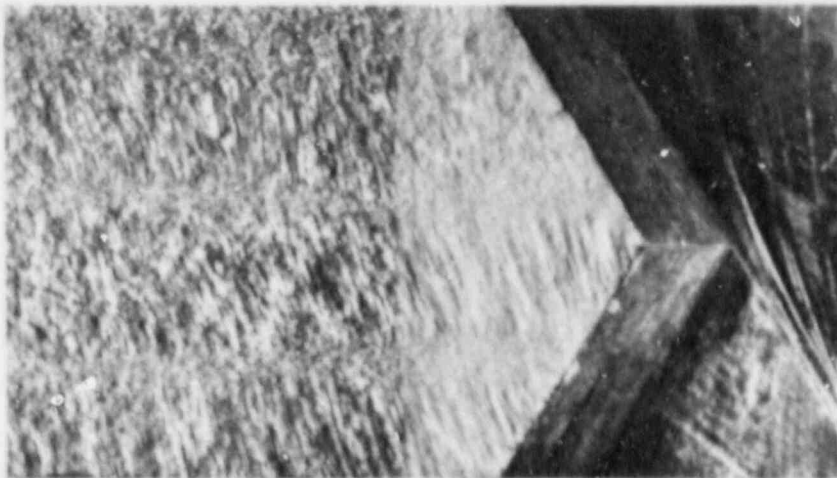
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 9.9 kJ/m²
KJc= 45.9 MPa SQR[m]
K-beta-c= 45.3 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 9.9 kJ/m²
KJc= 45.9 MPa SQR[m]
K-beta-c= 45.3 MPa SQR[m]

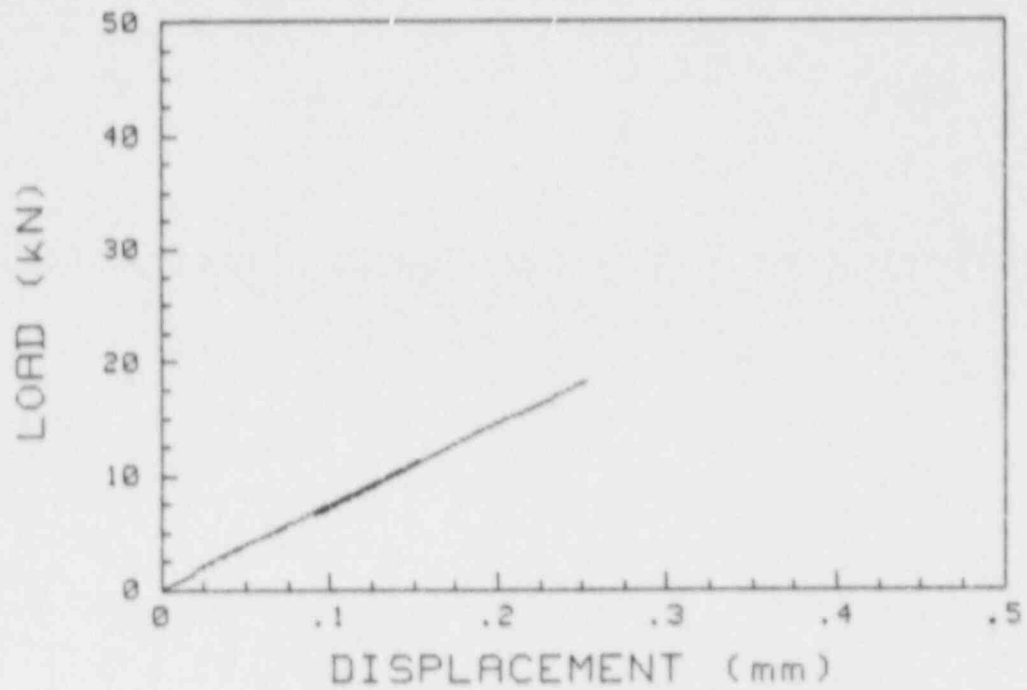
YP1219



ORNL-DWG 87-7937

69W-103

-100 DEGREES C



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

$a/W)i = .597$

SPECIMEN CLEAVED AT $K_{Ic} = 40.7 \text{ MPa SQR}[m]$ (VALID ASTM E399)

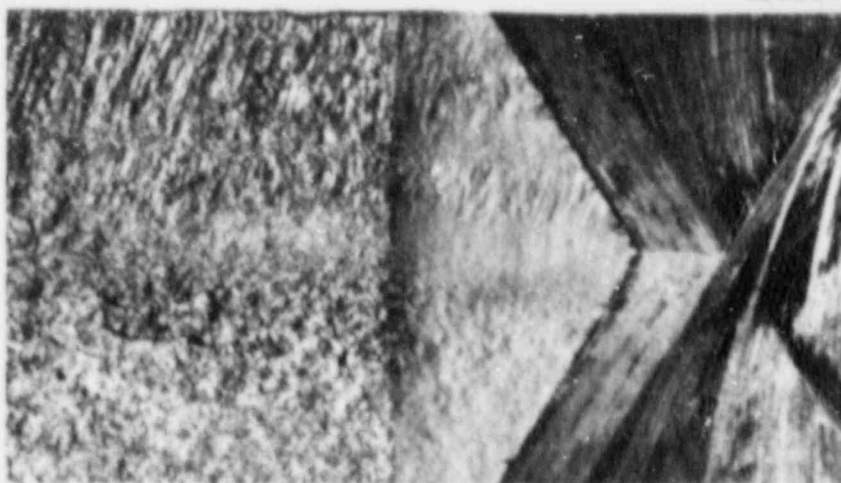
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 7.8 kJ/m²
KJc= 40.8 MPa SQR[m]
K-beta-c= 40.5 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

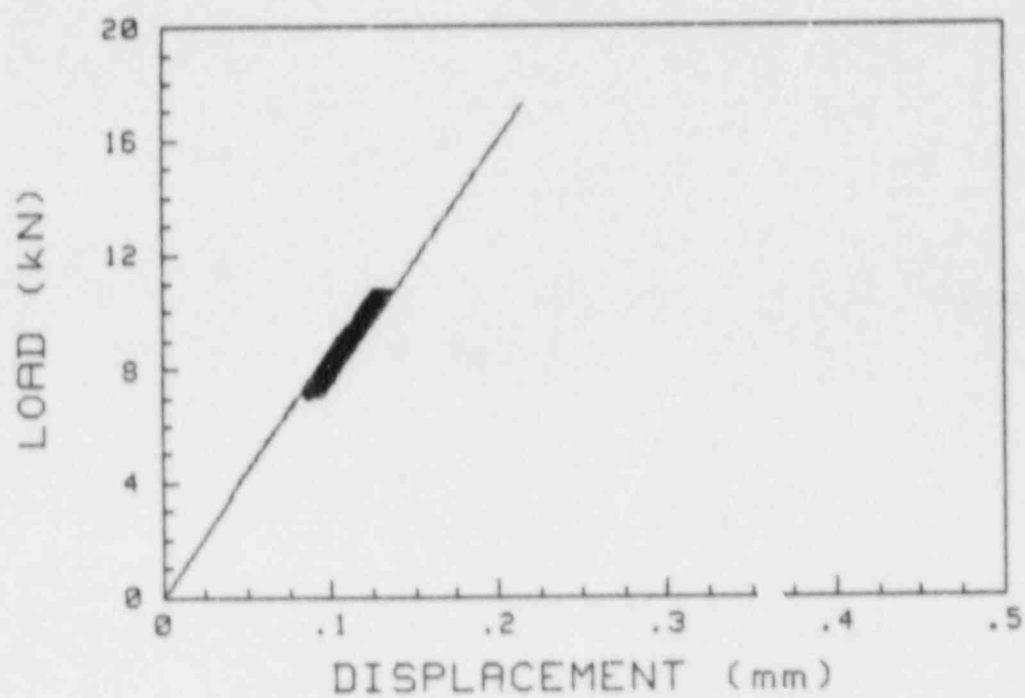
J-INTEGRAL= 7.8 kJ/m²
KJc= 40.8 MPa SQR[m]
K-beta-c= 40.5 MPa SQR[m]

YP1218



69W109

-100 DEGREES C



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/m²
 KJ-MAX LOAD= 215.4 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 164.6 kJ/m²
 K-JIc= 181.6 MPa SQR[m]
 POWER= .5155
 COEFFICIENT= 317 kJ/m²
 T (AVERAGE)= 84

ASTM LINEAR PROCEDURE

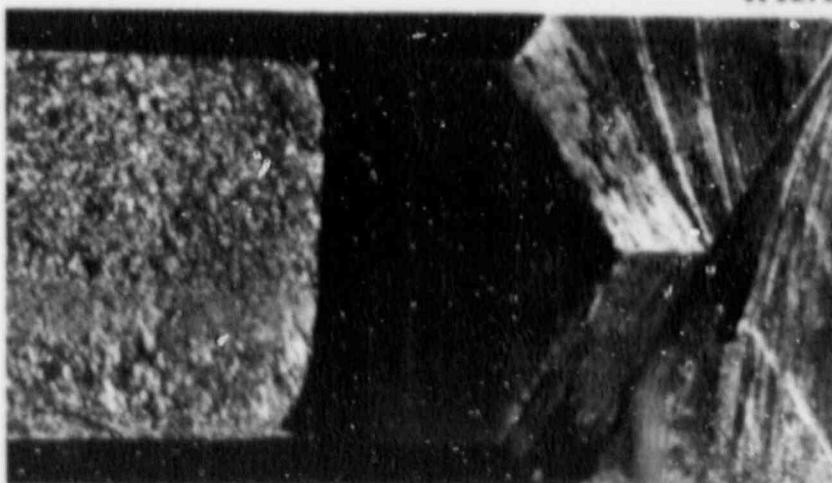
 JIc= 146.4 kJ/m²
 K-JIc= 171.2 MPa SQR[m]
 SLOPE= 184777 kJ/m³
 INTERCEPT= 124.9 kJ/m²
 T (ASTM)= 93
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 460.6 kJ/m²
 POWER= .4875
 J-MAX ALLOWED= 640.6 kJ/m²
 RCURVE INVALID, 2 3

COEFFICIENT= 316.3 kJ/m²
 DELTA-A MAX ALLOWED= 2.04 mm

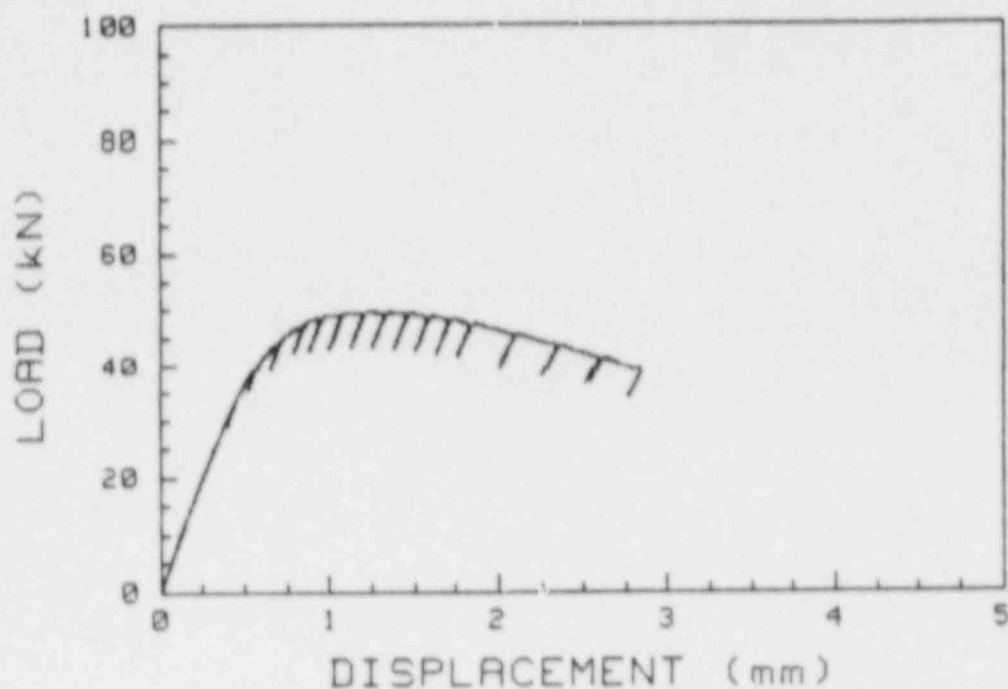
YP1276



ORNL-DWG 87-7939

69W117

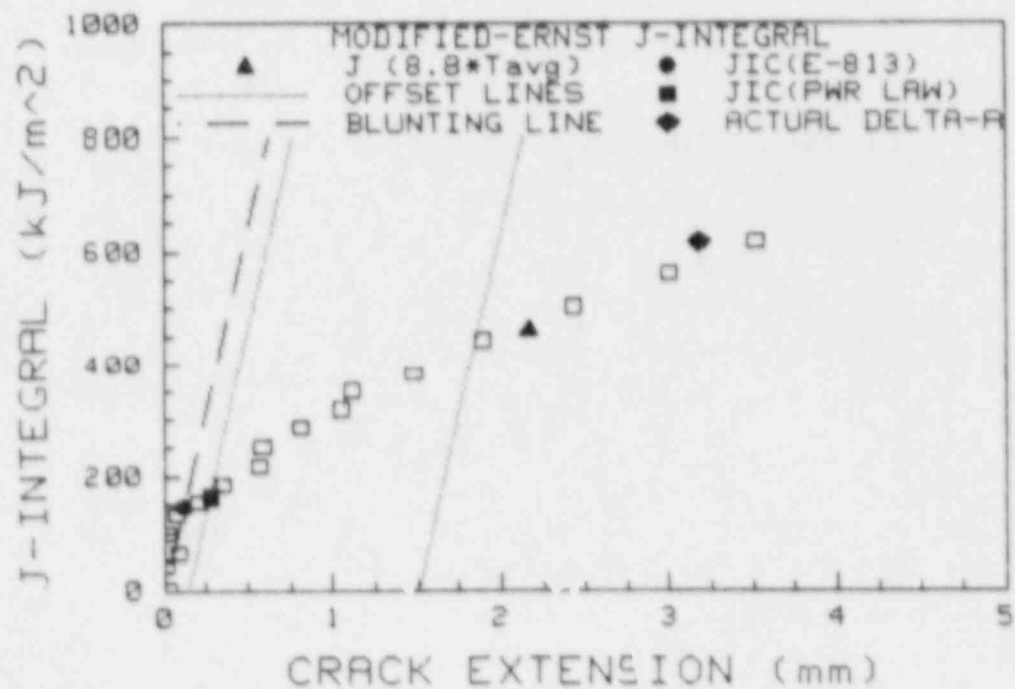
121 DEGREES C



ORNL-DWG 87-7940

69W117

121 DEGREES C



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
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 680 MPa
FLOW STRENGTH= 722 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

$a/W)_i = .605$

SPECIMEN CLEAVED AT $K = 104.5 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

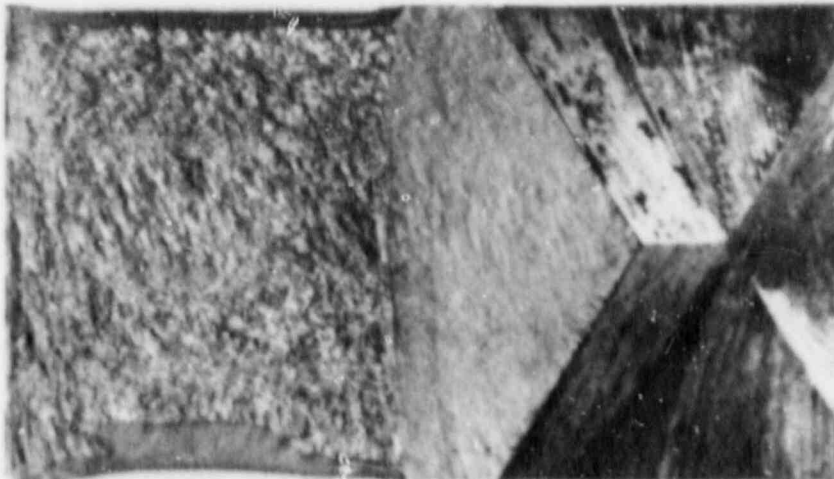
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 58.3 kJ/m²
KJc= 110.2 MPa SQR[m]
K-beta-c= 87.4 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 58.3 kJ/m²
KJc= 110.2 MPa SQR[m]
K-beta-c= 87.4 MPa SQR[m]

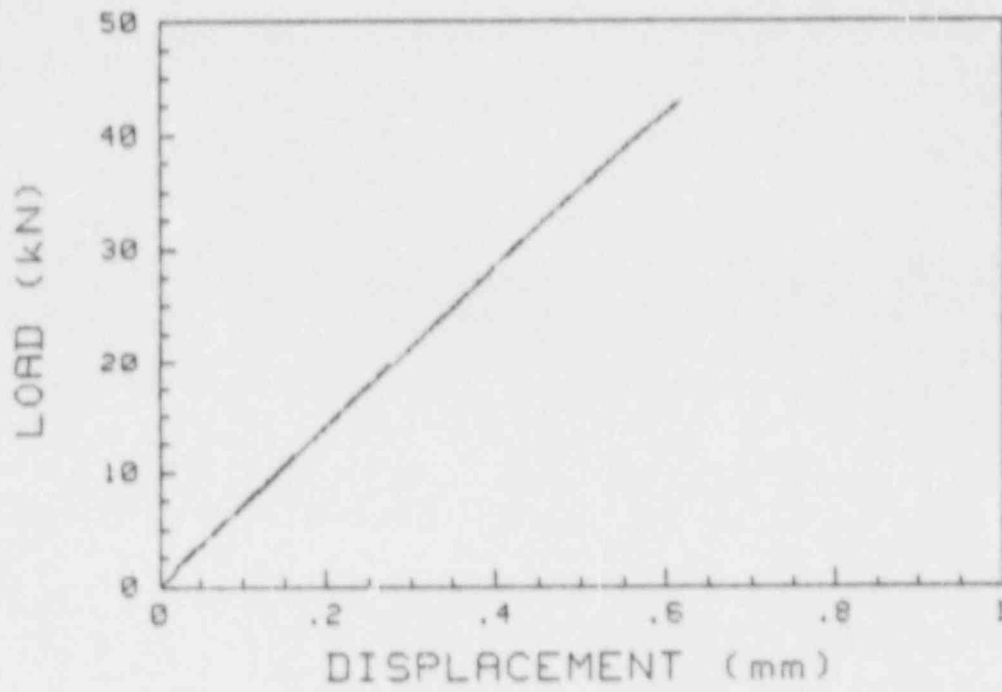
YP1277



ORNL-DWG 87-7941

69W-124

-20 DEGREES C



SPECIMEN ID= 69U125
 TEST TEMPERATURE= 50 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 20 %
 INITIAL CRACK LENGTH= 30 mm $a/W)_1 = .591$
 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/m²
 KJ-MAX LOAD= 209.8 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 160.4 kJ/m²
 K-JIc= 181.1 MPa SQR[m]
 POWER= .5106
 COEFFICIENT= 312.6 kJ/m²
 T (AVERAGE)= 76

ASTM LINEAR PROCEDURE

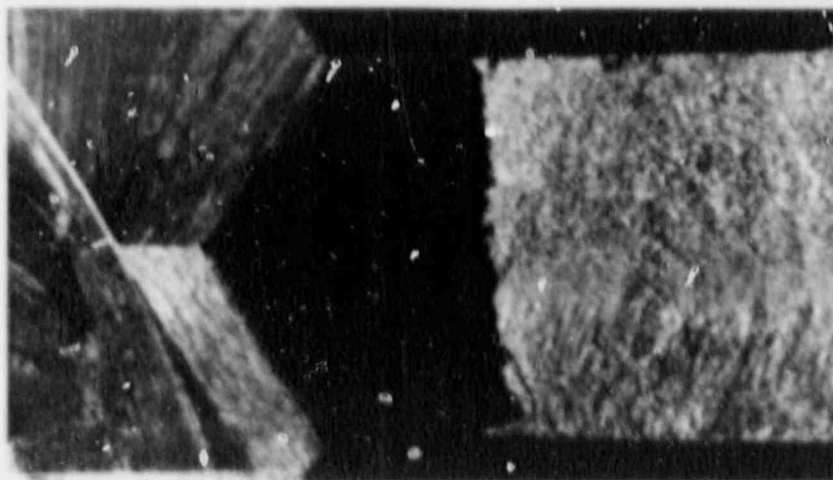
 JIc= 149.8 kJ/m²
 K-JIc= 174.9 MPa SQR[m]
 SLOPE= 172774 kJ/m²
 INTERCEPT= 130.3 kJ/m²
 T (ASTM)= 80
 INVALID, 6

J1-R CURVE CALCULATIONS

 J (@J/T=8.8)= 454.2 kJ/m²
 POWER= .5102
 J-MAX ALLOWED= 675 kJ/m²
 RCURVE INVALID, 1 3

COEFFICIENT= 312.6 kJ/m²
 DELTA-A MAX ALLOWED= 2.08 mm

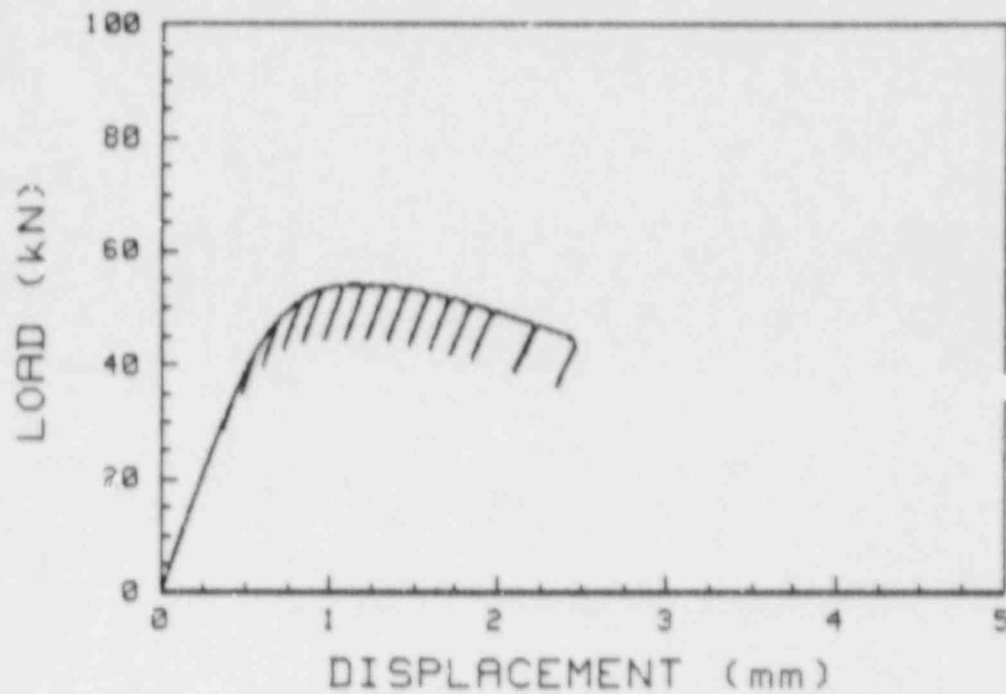
YP1278



ORNL-DWG 87-7942

69W125

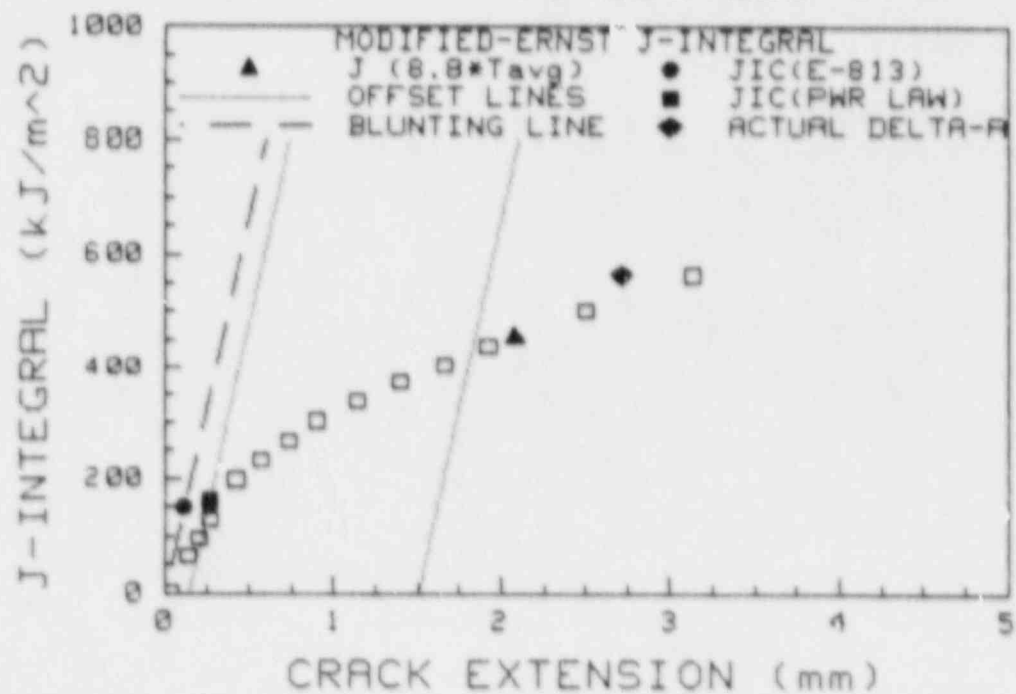
50 DEGREES C



ORNL-DWG 87-7943

69W125

50 DEGREES C



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

$a/W)_1 = .599$

SPECIMEN CLEAVED AT $K = 95.1 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

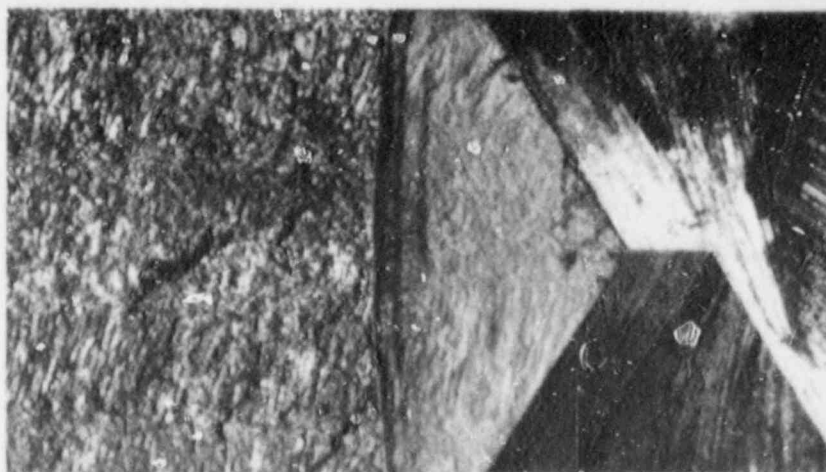
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 44.4 kJ/m²
KJc= 95.9 MPa SQR[m]
K-beta-c= 79.7 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 44.4 kJ/m²
KJc= 95.9 MPa SQR[m]
K-beta-c= 79.7 MPa SQR[m]

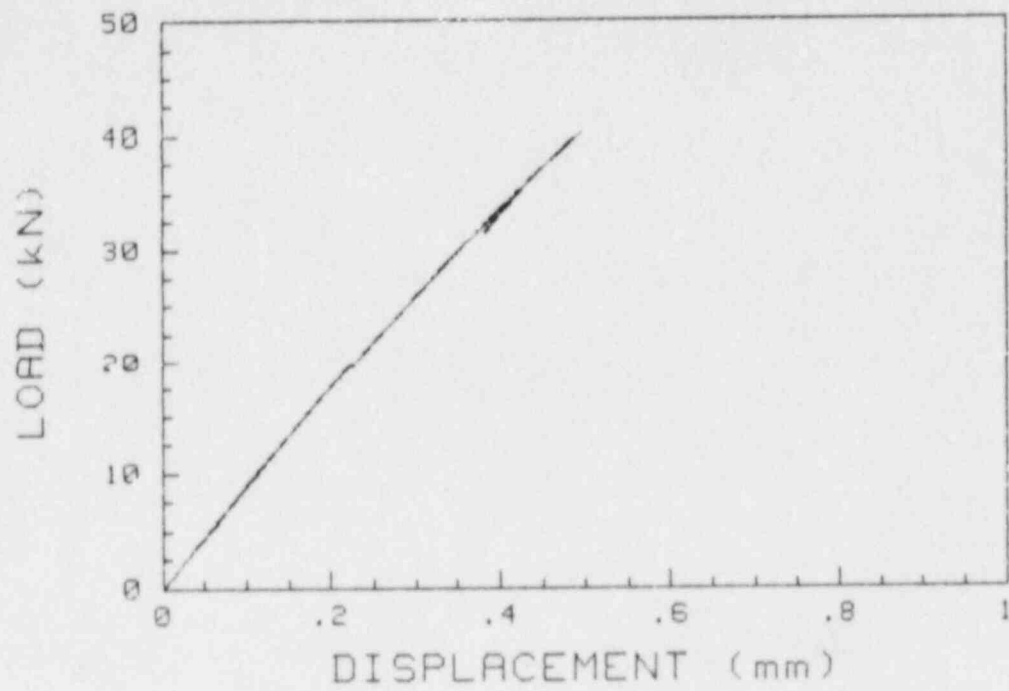
YP1279



ORNL-DWG 87-7944

69W128

-5 DEGREES C



SPECIMEN ID= 69W-132
 TEST TEMPERATURE= 24 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 30 mm $a/W)_1 = .592$
 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 K_{Ic})

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 183.2 kJ/m²
 K_{Jc} = 194.2 MPa SQR[m]
 K_{beta-c} = 111.8 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

 J-INTEGRAL= 253.6 kJ/m²
 K_{Jc} = 228.5 MPa SQR[m]
 K_{beta-c} = 119.7 MPa SQR[m]

POWER LAW PROCEDURE

 J_{Ic} = 89.2 kJ/m²
 $K-J_{Ic}$ = 135.5 MPa SQR[m]
 POWER= .717
 COEFFICIENT= 268.3 kJ/m²
 T (AVERAGE)= 87

ASTM LINEAR PROCEDURE

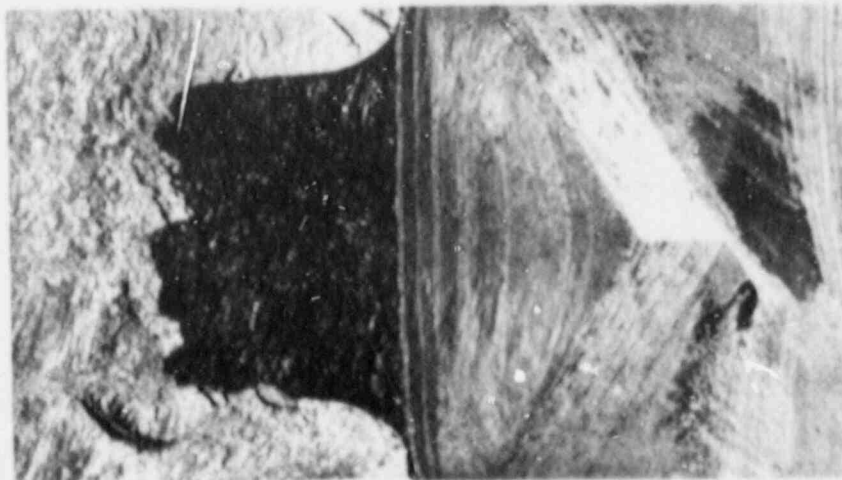
 J_{Ic} = 49.3 kJ/m²
 $K-J_{Ic}$ = 100.8 MPa SQR[m]
 SLOPE= 235704 kJ/m³
 INTERCEPT= 40.8 kJ/m²
 T (ASTM)= 104
 INVALID, 2 6

J1-R CURVE CALCULATIONS

 $J (@J/T=8.8)$ = 532 kJ/m²
 POWER= .7017
 J -MAX ALLOWED= 706.5 kJ/m²
 RCURVE INVALID, 2 3

COEFFICIENT= 264.1 kJ/m²
 DELTA-A MAX ALLOWED= 2.06 mm

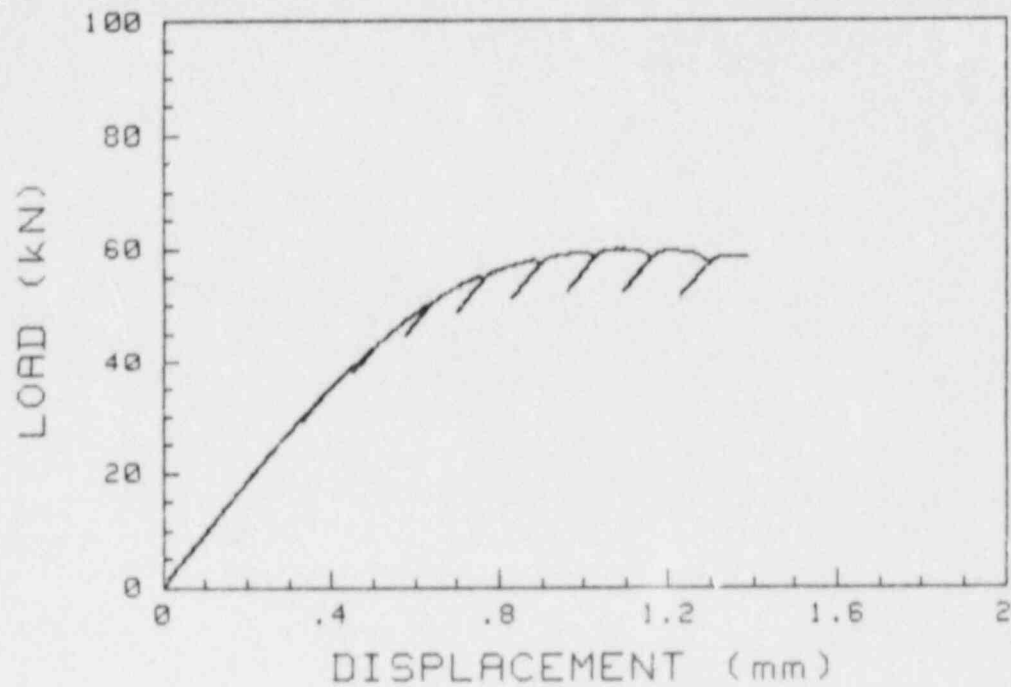
YP1280



ORNL-DWG 87-7945

69W-132

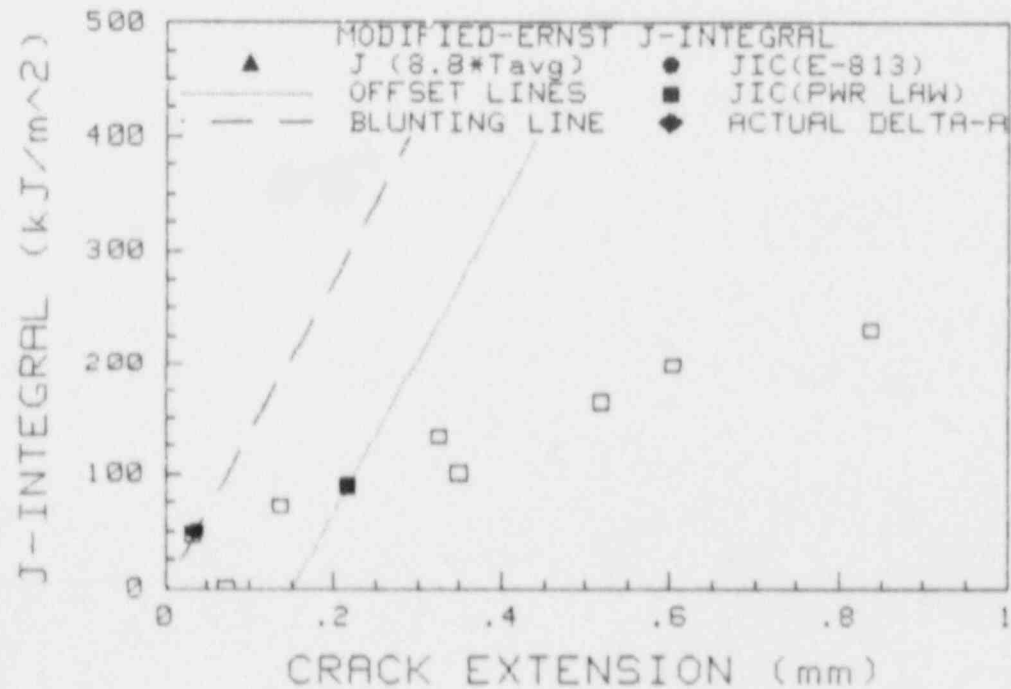
24 DEGREES C



ORNL-DWG 87-7946

69W-132

24 DEGREES C



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 $K_{Ic} = 60.8 \text{ MPa SQR[m]}$ (VALID ASTM E399)

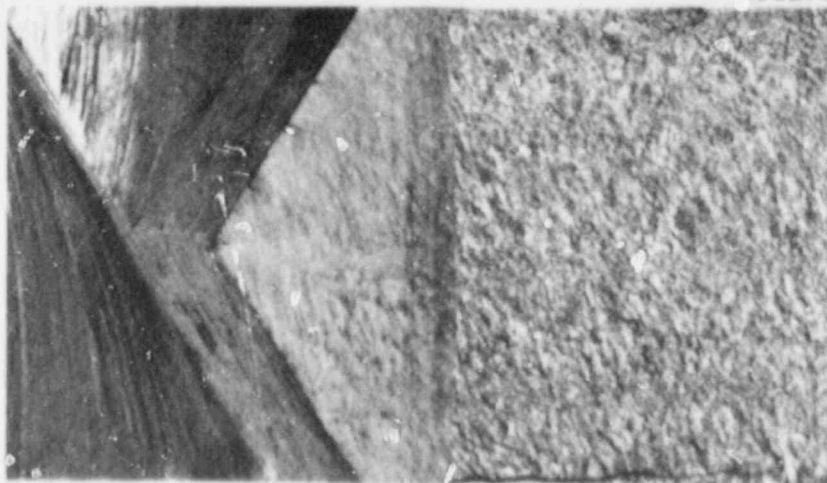
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 16.2 kJ/m²
KJc= 58.4 MPa SQR[m]
K-beta-c= 56.2 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 16.2 kJ/m²
KJc= 58.4 MPa SQR[m]
K-beta-c= 56.2 MPa SQR[m]

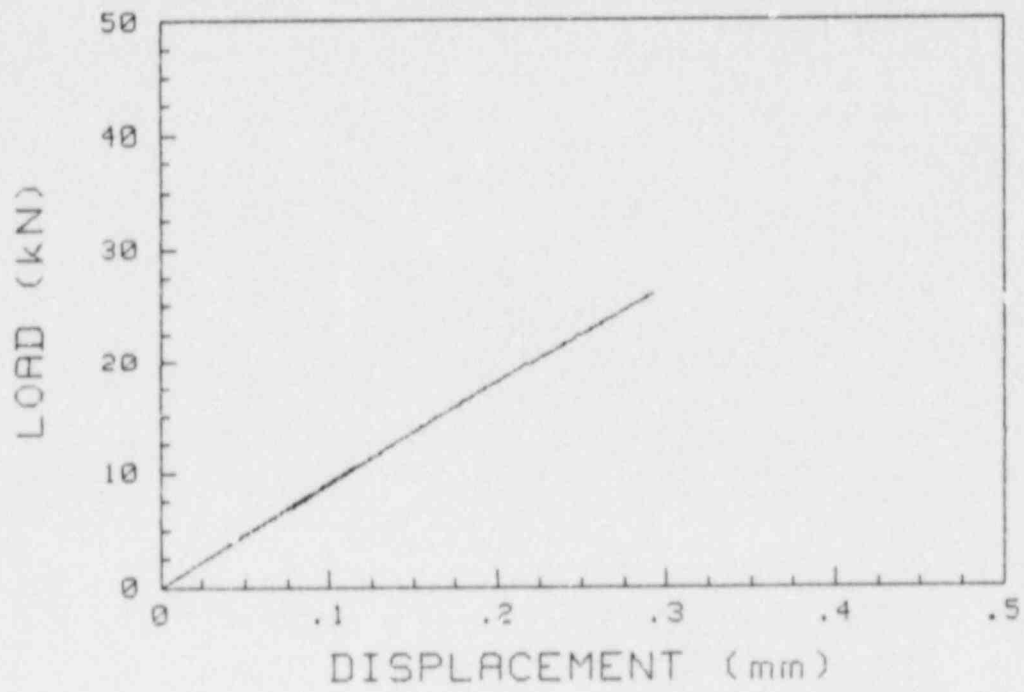
YP1270



ORNL-DWG 87-7947

69W136

-60 DEGREES C



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 $K_{Ic} = 68.4 \text{ MPa SQR}(m)$ (VALID ASTM E399)

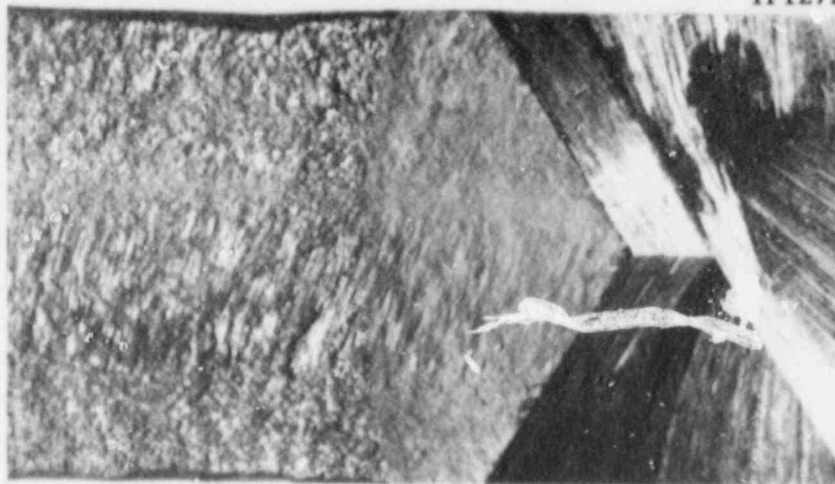
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 21.1 kJ/m²
KJc= 66.6 MPa SQR(m)
K-beta-c= 62.9 MPa SQR(m)

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 21.1 kJ/m²
KJc= 66.6 MPa SQR(m)
K-beta-c= 62.9 MPa SQR(m)

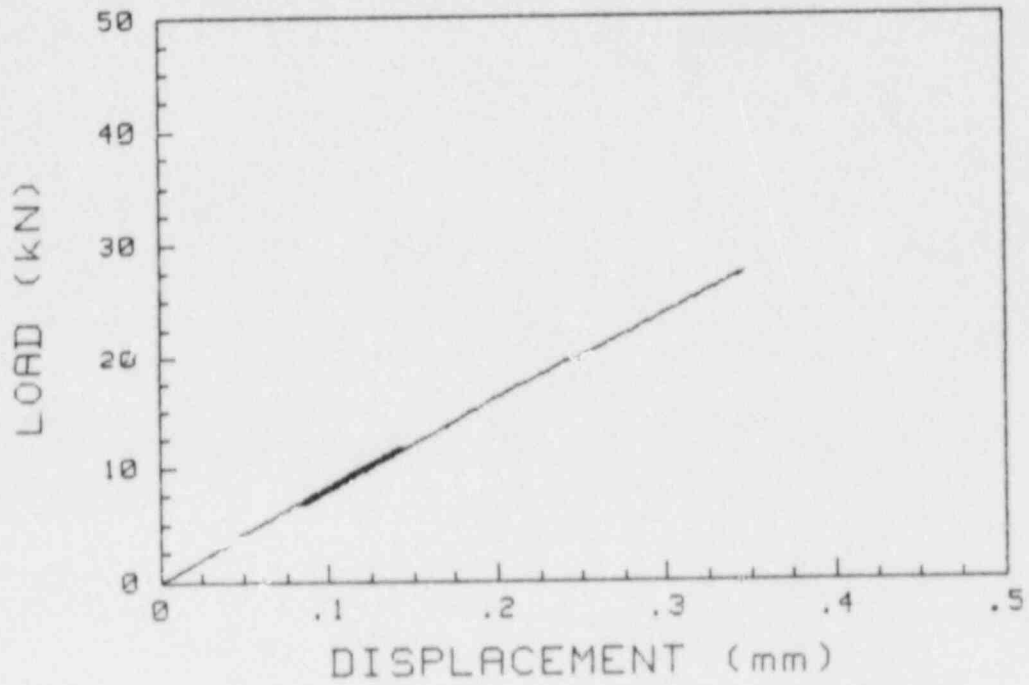
YP1272



ORNL-DWG 87-7948

69W138

-60 DEGREES C



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

$a/W)_i = .587$

SPECIMEN CLEAVED AT $K_{Ic} = 55.8 \text{ MPa SQR[m]}$ (VALID ASTM E399)

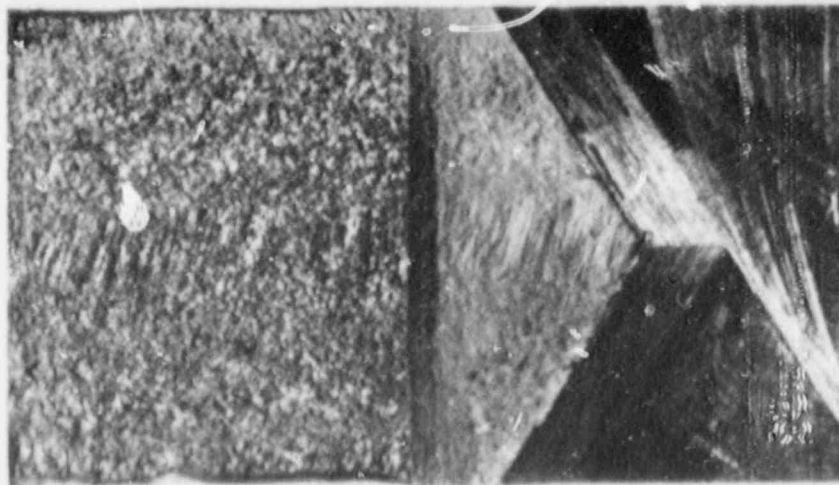
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 12.3 kJ/m²
KJc= 50.8 MPa SQR[m]
K-beta-c= 49.6 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 12.3 kJ/m²
KJc= 50.8 MPa SQR[m]
K-beta-c= 49.6 MPa SQR[m]

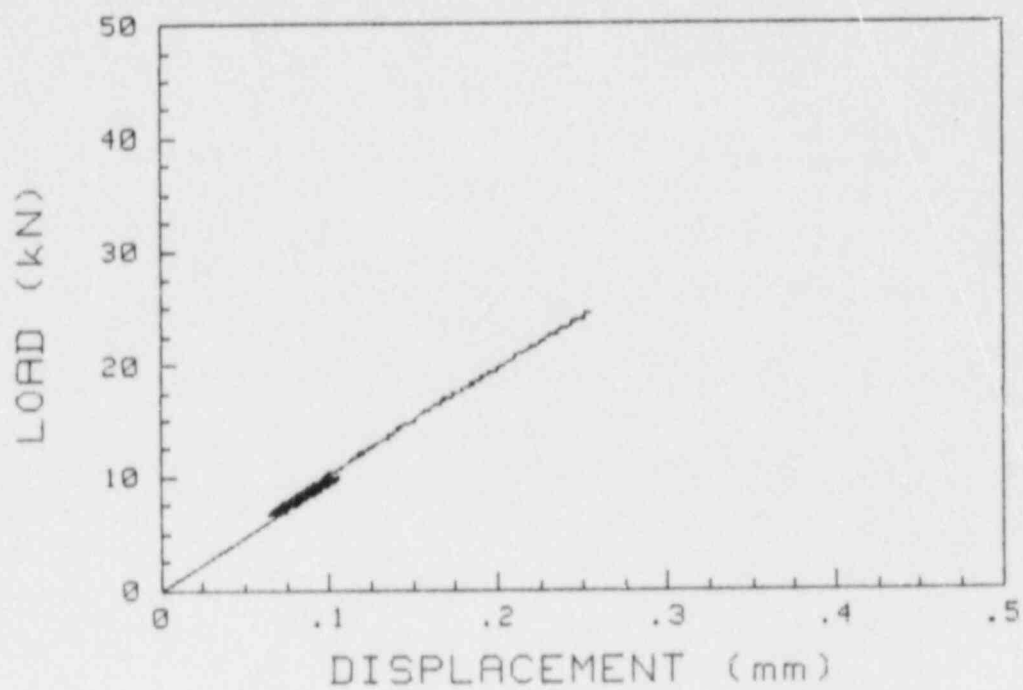
YP1273



ORNL-DWG 87-7949

69W140

-60 DEGREES C



SPECIMEN ID= 69W141
 TEST TEMPERATURE= 121 DEG C
 THICKNESS 25.4 mm
 SIDE GROOVES= 20 %
 INITIAL CRACK LENGTH= 30.2 mm $a/W)_1 = .595$
 MEASURED DUCTILE DELTA-A= 3.2 mm
 Y ELD STRENGTH= 580 MPa
 FLOW STRENGTH= 630 MPa
 ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 219.6 kJ/m²
 KJ-MAX LOAD= 209.7 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 178.8 kJ/m²
 K-JIc= 189.3 MPa SQR[m]
 POWER= .4954
 COEFFICIENT= 329.2 kJ/m²
 T (AVERAGE)= 83

ASTM LINEAR PROCEDURE

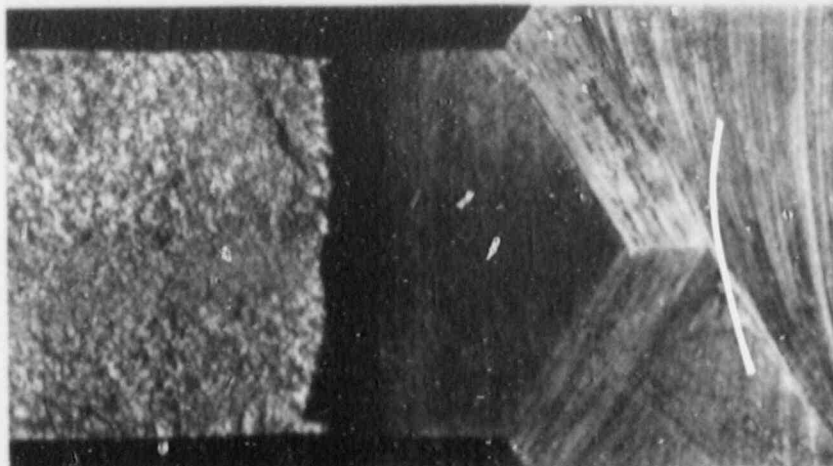
 JIc= 164 kJ/m²
 K-JIc= 181.3 MPa SQR[m]
 SLOPE= 174908 kJ/m³
 INTERCEPT= 141.3 kJ/m²
 T (ASTM)= 88
 VALID, E813

Ji-R CURVE CALCULATIONS

 J (@J/T=8.8)= 466.5 kJ/m²
 POWER= .4727
 J-MAX ALLOWED= 640.6 kJ/m²
 RCURVE INVALID, 3

COEFFICIENT= 328.7 kJ/m²
 DELTA-A MAX ALLOWED= 2.06 mm

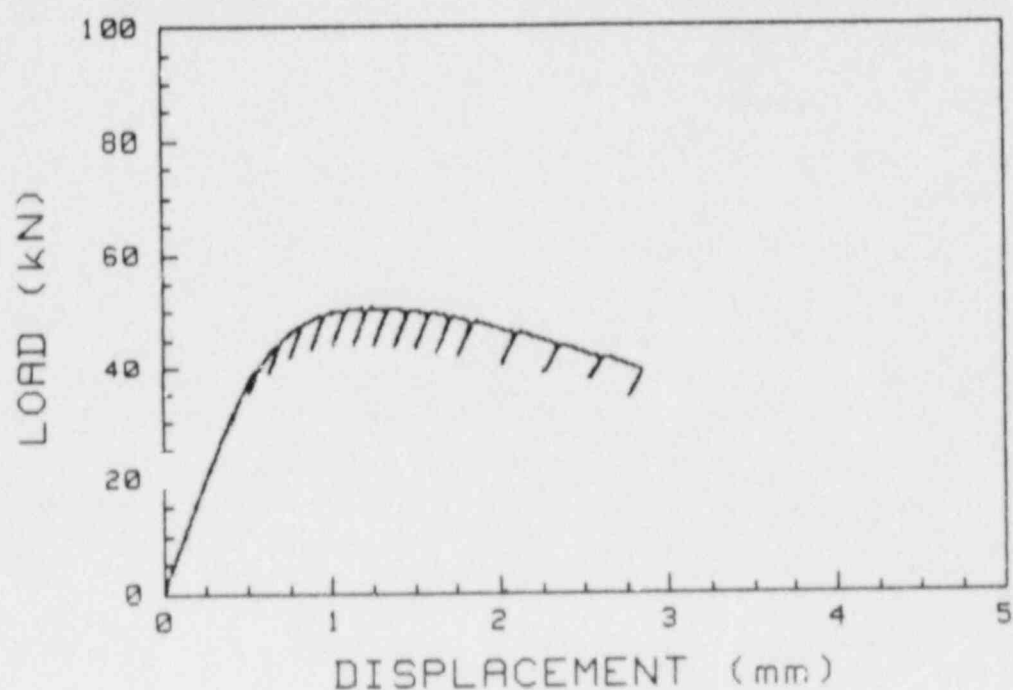
YP1274



ORNL-DWG 87-7950

69W141

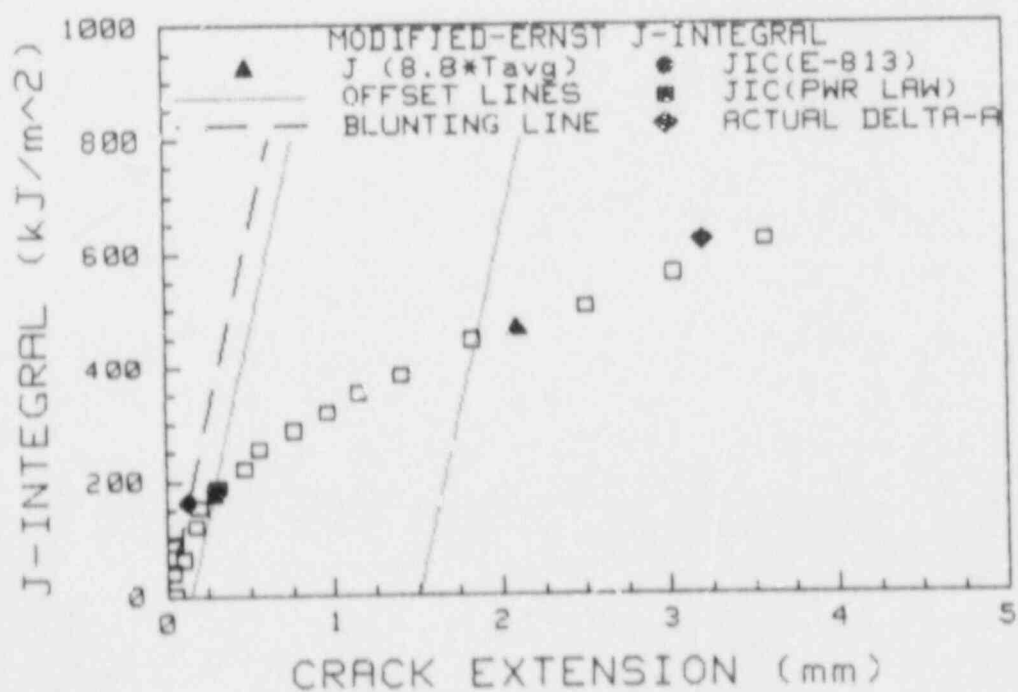
121 DEGREES C



ORNL-DWG 87-7951

69W141

121 DEGREES C



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/m²
 KJ-MAX LOAD= 209.9 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 137.7 kJ/m²
 K-JIc= 164.1 MPa SQR[m]
 POWER= .475
 COEFFICIENT= 260.9 kJ/m²
 T (AVERAGE)= 65

ASTM LINEAR PROCEDURE

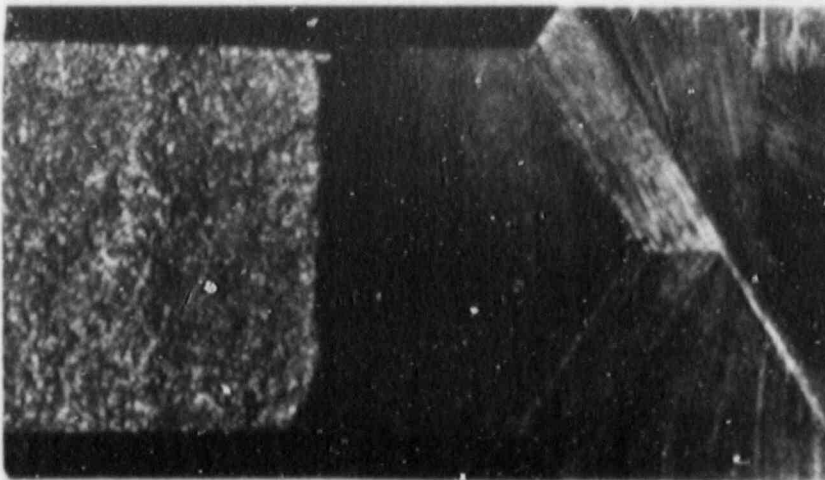
 JIc= 104.5 kJ/m²
 K-JIc= 143 MPa SQR[m]
 SLOPE= 150078 kJ/m³
 INTERCEPT= 91.9 kJ/m²
 T (ASTM)= 76
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 369.3 kJ/m²
 POWER= .4986
 J-MAX ALLOWED= 626.9 kJ/m²
 RCURVE INVALID, 2 3

COEFFICIENT= 248.7 kJ/m²
 DELTA-1 MAX ALLOWED= 2.01 mm

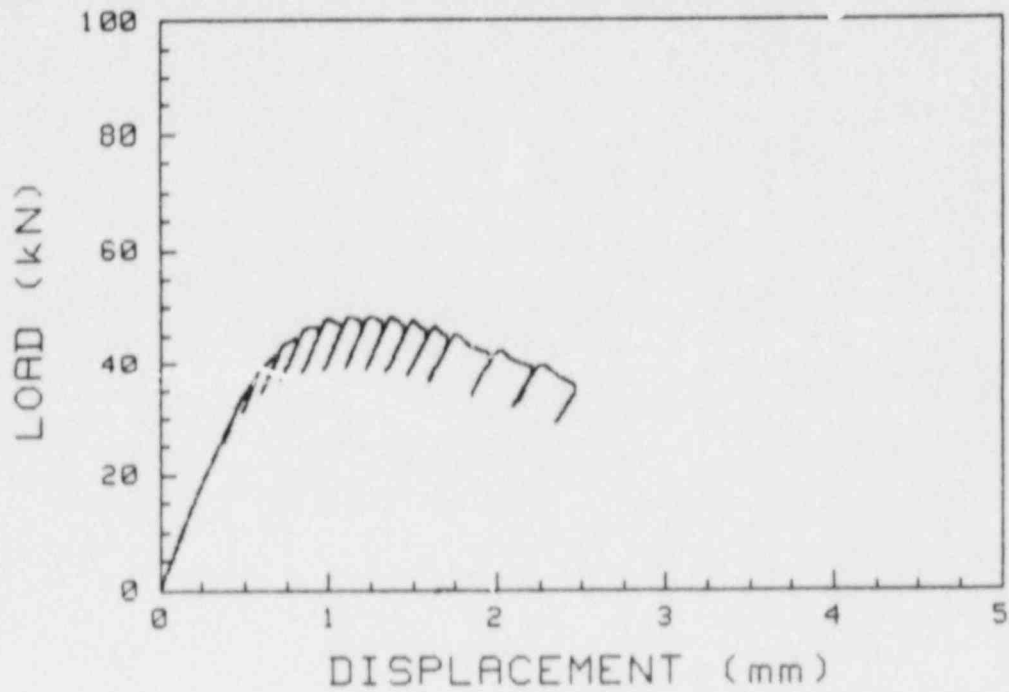
YP1275



ORNL-DWG 87-7952

69W145

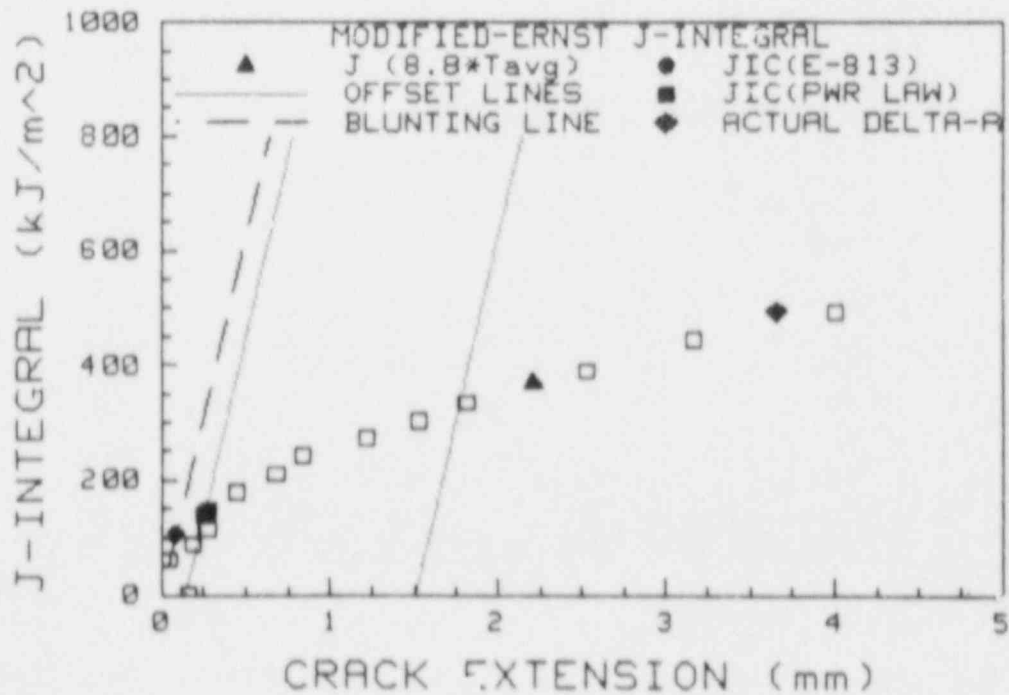
204 DEGREES C



ORNL-DWG 87-7953

69W145

204 DEGREES C



SPECIMEN ID= 69W151
 MATERIAL TYPE= A533BW
 TEST TEMPERATURE= 20 °C
 THICKNESS= 2 mm

SIDE GROU

INITIAL CRACK LENGTH= 4 mm

MEASURED DUCTILITY DELT

YIELD STRENGTH= 542 MPa

FLOW STRENGTH= 686 MPa

ESTIMATED YOUNG'S MODULUS

SPECIMEN CLEAVED AT $K_{IC} = 121 \text{ MPa SQR(m)}$ (NOT VALID K_{IC})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 118.2 kJ/m²

KJc= 156.1 MPa SQR(m)

K-beta-c= 101.6 MPa SQR.

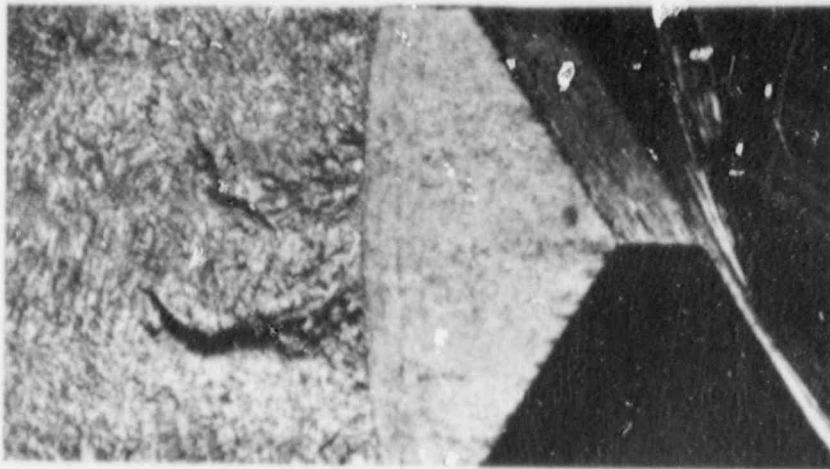
VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 118.4 kJ/m²

KJc= 156.2 MPa SQR(m)

K-beta-c= 101.6 MPa SQR(m)

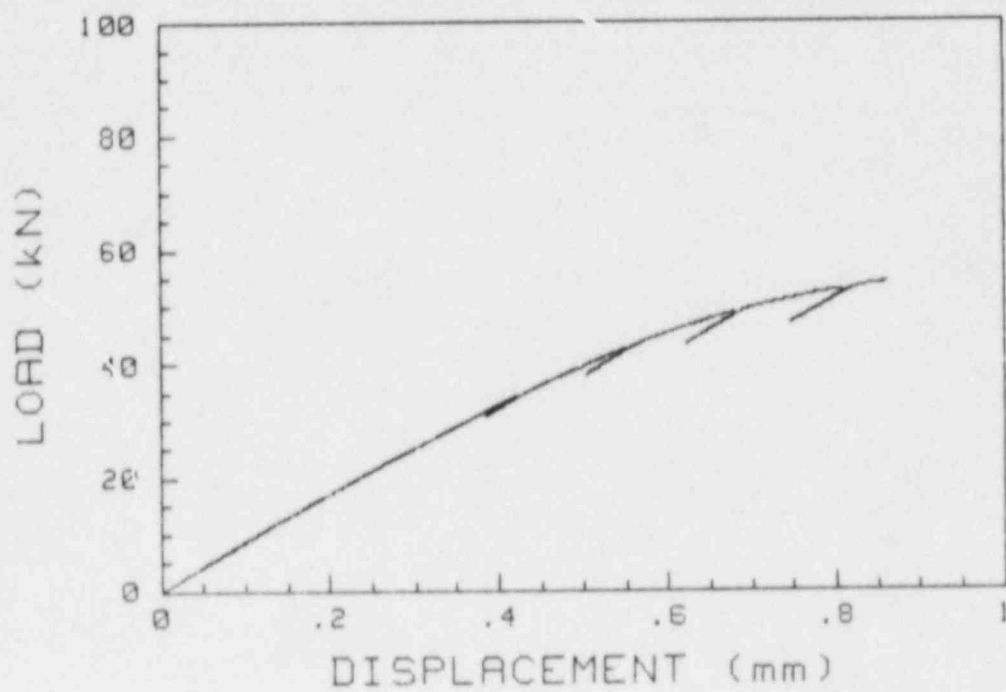
YP1271



ORNL-DWG 87-7954

69W151

20 DEGREES C



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/m²
 KJ-MAX LOAD= 203.3 MPa SQR[m]

POWER LAW PROCEDURE

J_{Ic}= 123.2 kJ/m²
 K-J_{Ic}= 153.3 MPa SQR[m]
 POWER= .4538
 COEFFICIENT= 233.4 kJ/m²
 T (AVERAGE)= 51

ASTM LINEAR PROCEDURE

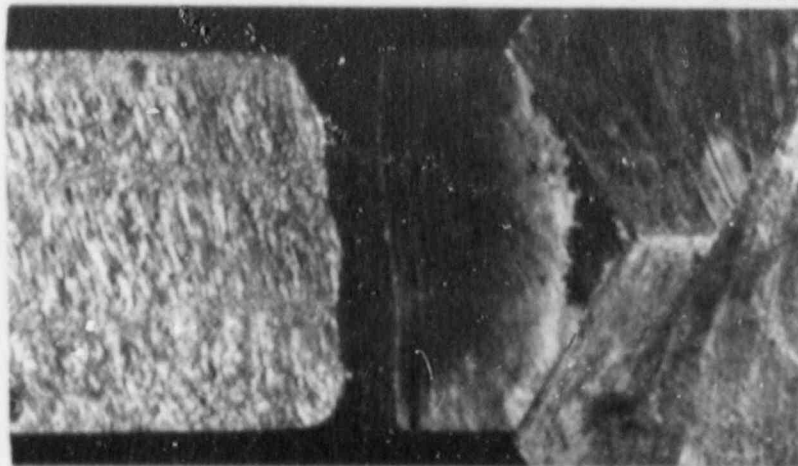
J_{Ic}= 112.5 kJ/m²
 K-J_{Ic}= 146.5 MPa SQR[m]
 SLOPE= 123281 kJ/m³
 INTERCEPT= 101.8 kJ/m²
 T (ASTM)= 56
 VALID, E813

JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 302.6 kJ/m²
 POWER= .4506
 J-MAX ALLOWED= 661 kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 233 kJ/m²
 DELTA-A MAX ALLOWED= 2.04 mm

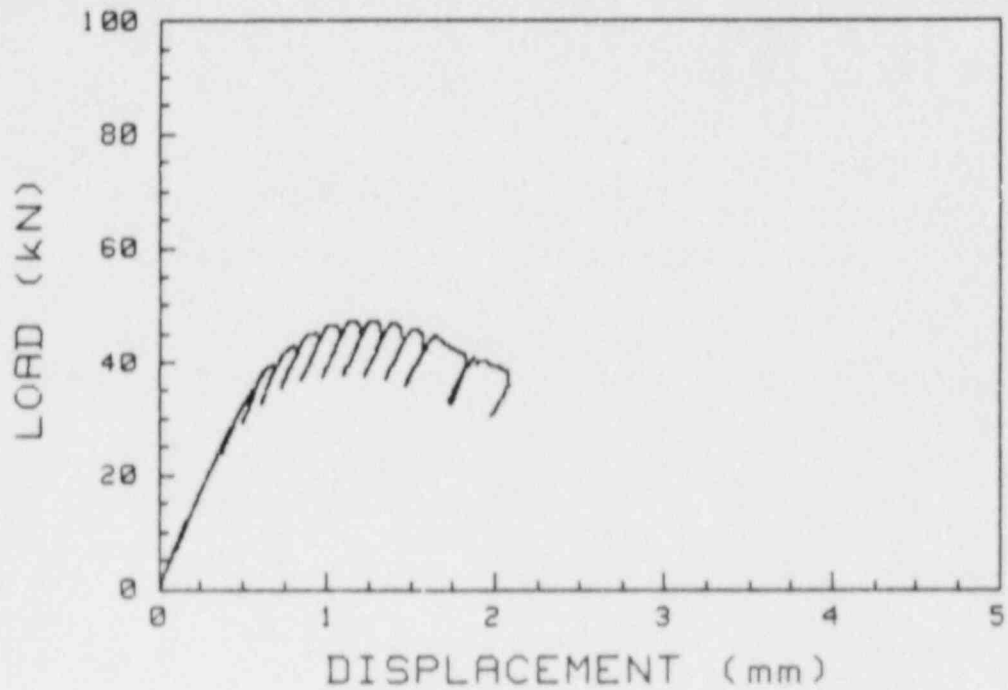
YP1268



ORNL-DWG 87-7955

69W154

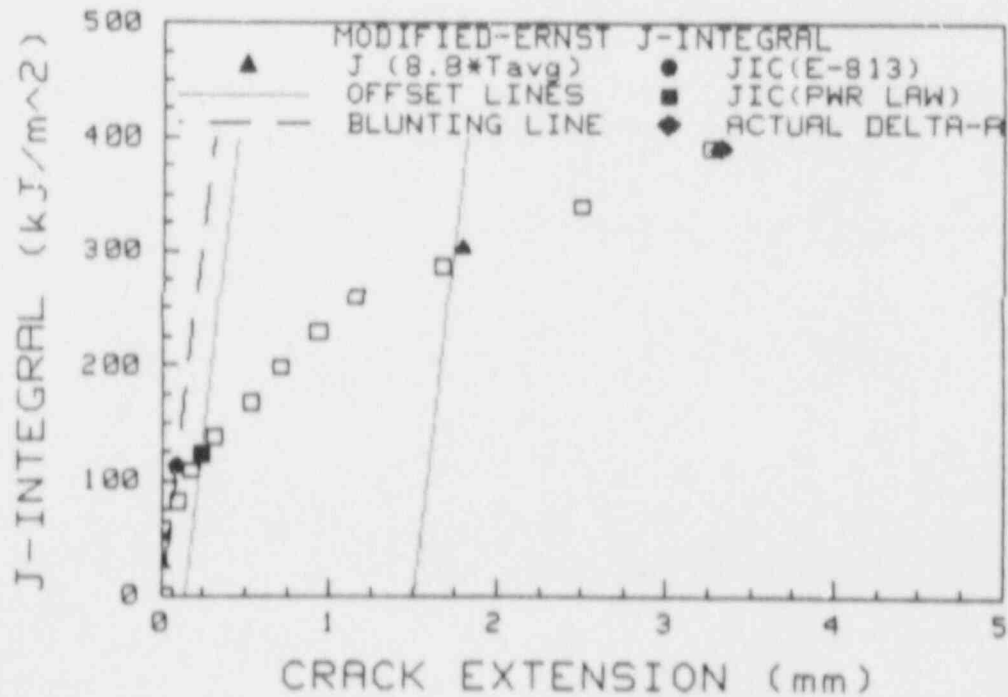
288 DEGREES C



ORNL-DWG 87-7956

69W154

288 DEGREES C



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/m²
 KJ-MAX LOAD= 207.7 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 147 kJ/m²
 K-JIc= 167.5 MPa SQR[m]
 POWER= .4186
 COEFFICIENT= 257.1 kJ/m²
 T (AVERAGE)= 51

ASTM LINEAR PROCEDURE

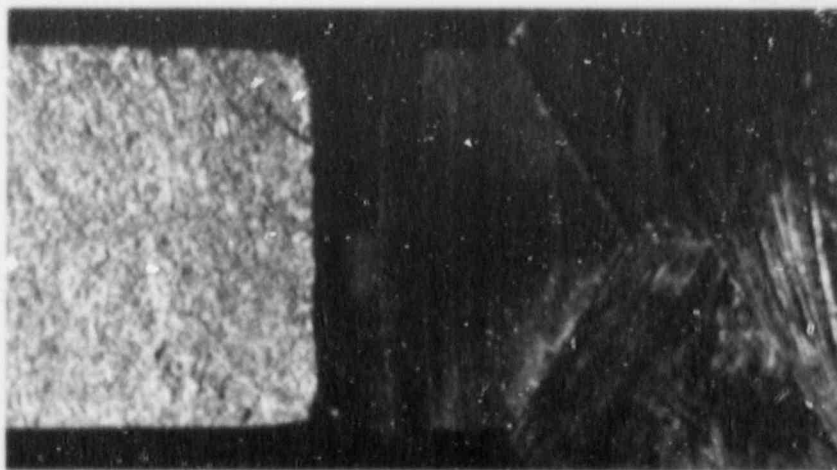
 JIc= 140.2 kJ/m²
 K-JIc= 163.6 MPa SQR[m]
 SLOPE= 123937 kJ/m³
 INTERCEPT= 126.8 kJ/m²
 T (ASTM)= 56
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 301.6 kJ/m²
 POWER= .3867
 J-MAX ALLOWED= 661.6 kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 255.7 kJ/m²
 DELTA-A MAX ALLOWED= 2.04 mm

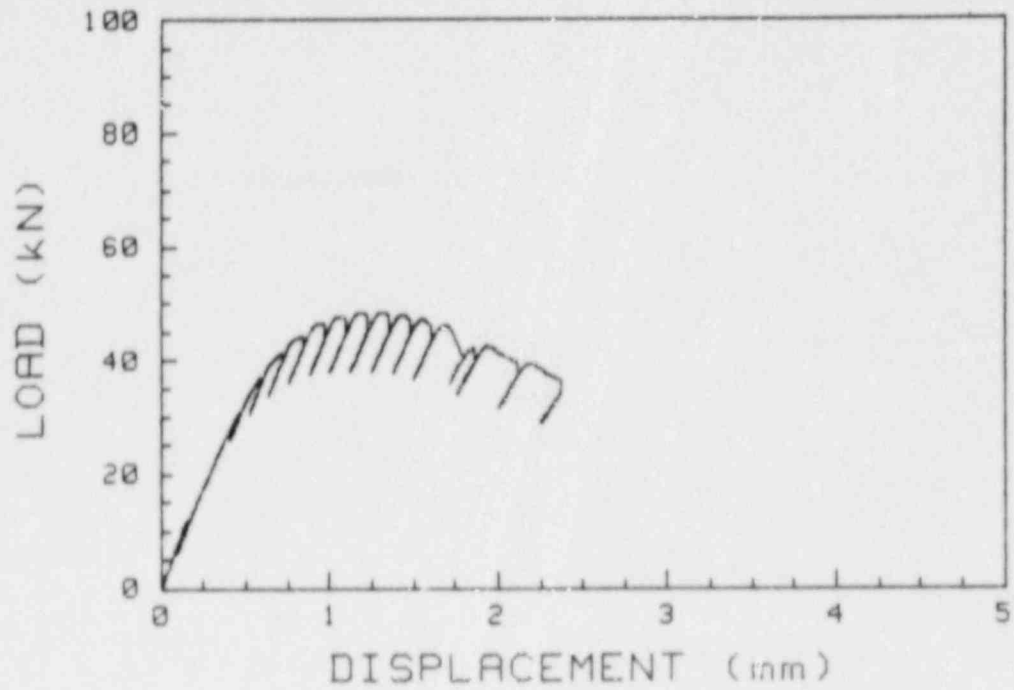
YP1269



ORNL-DWG 87-7957

69W161

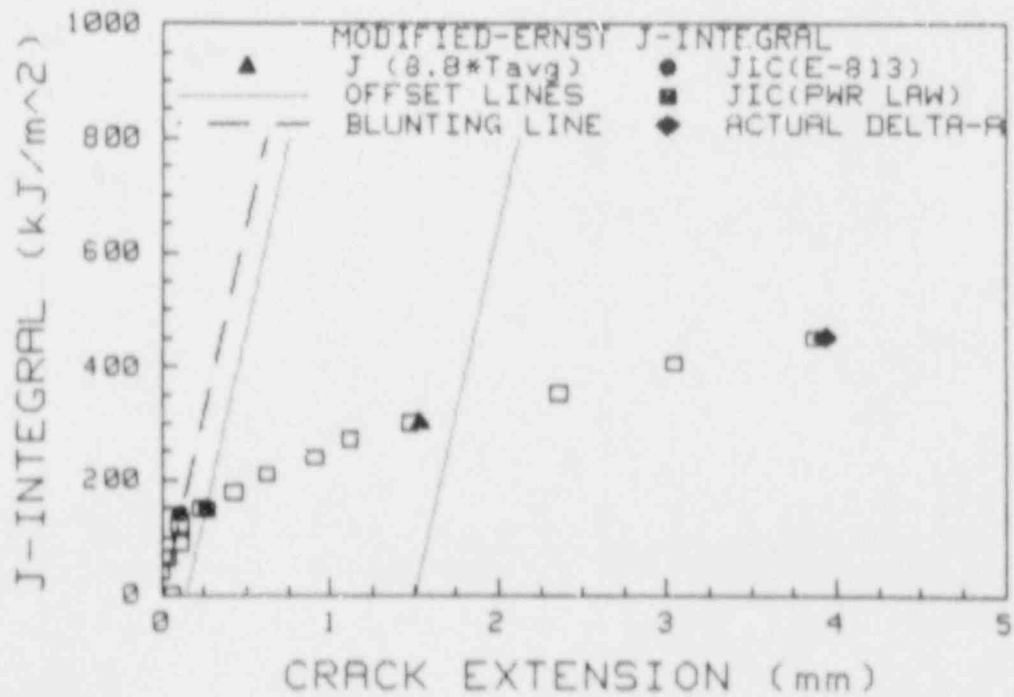
288 DEGREES C



ORNL-DWG 87-7958

69W161

288 DEGREES C



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

$a/W)i = .605$

SPECIMEN CLEAVED AT $K = 95.8 \text{ MPa SQR[m]}$ (NOT VALID KIc)

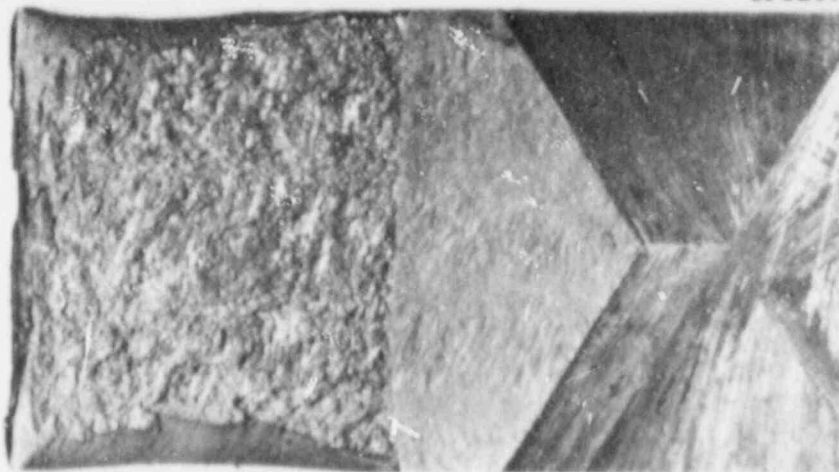
VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 44 kJ/m²
 $KJc = 95.5 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 79.5 \text{ MPa SQR[m]}$

VALUES AT CLEAVAGE LOAD

 J-INTEGRAL= 44 kJ/m²
 $KJc = 95.5 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 79.5 \text{ MPa SQR[m]}$

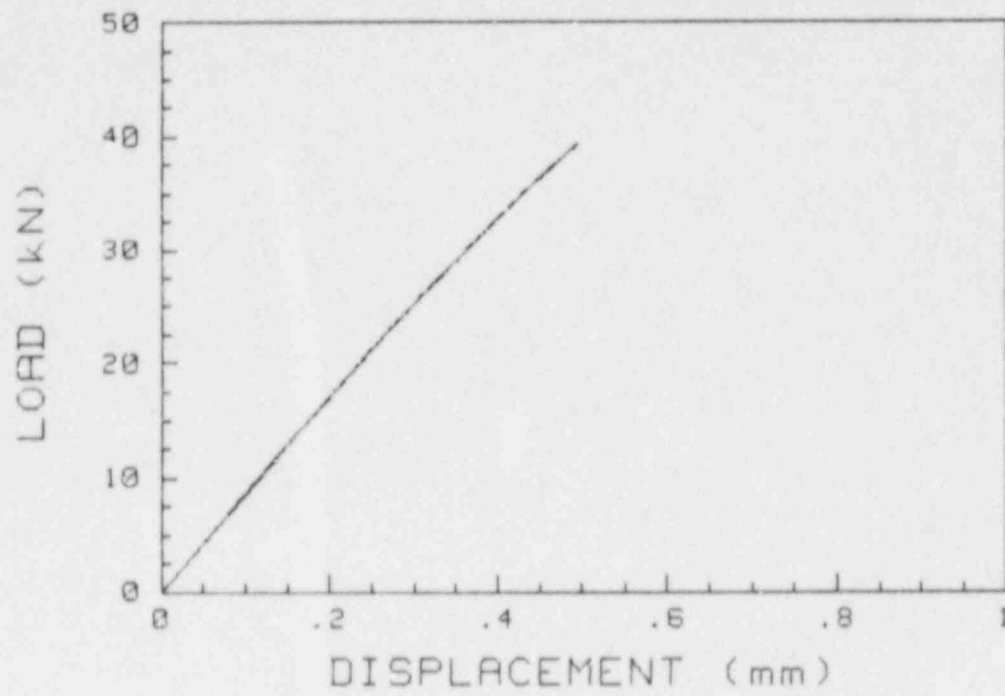
YP1267



ORNL-DWG 87-7959

69W170

-5 DEGREES C



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

$a/W)i = .599$

SPECIMEN CLEAVED AT $K = 133.7 \text{ MPa SQR[m]}$ (NOT VALID KIc)

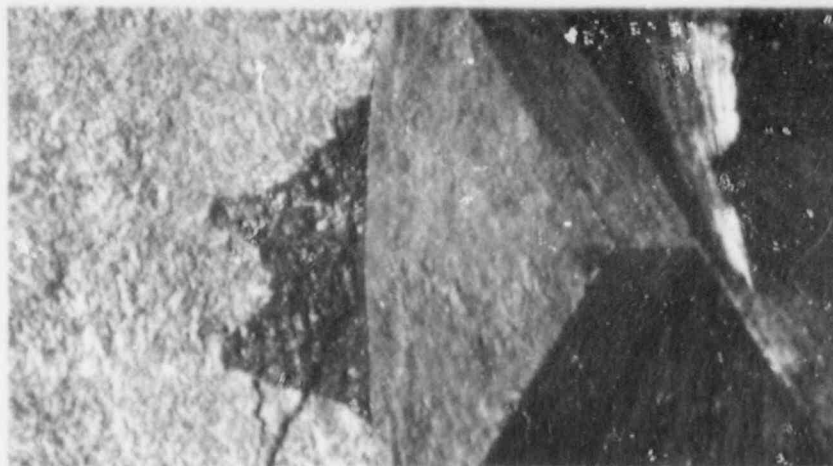
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 134 kJ/m^2
KJc= 166.1 MPa SQR[m]
K-beta-c= 104.2 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 136.3 kJ/m^2
KJc= 167.5 MPa SQR[m]
K-beta-c= 104.6 MPa SQR[m]

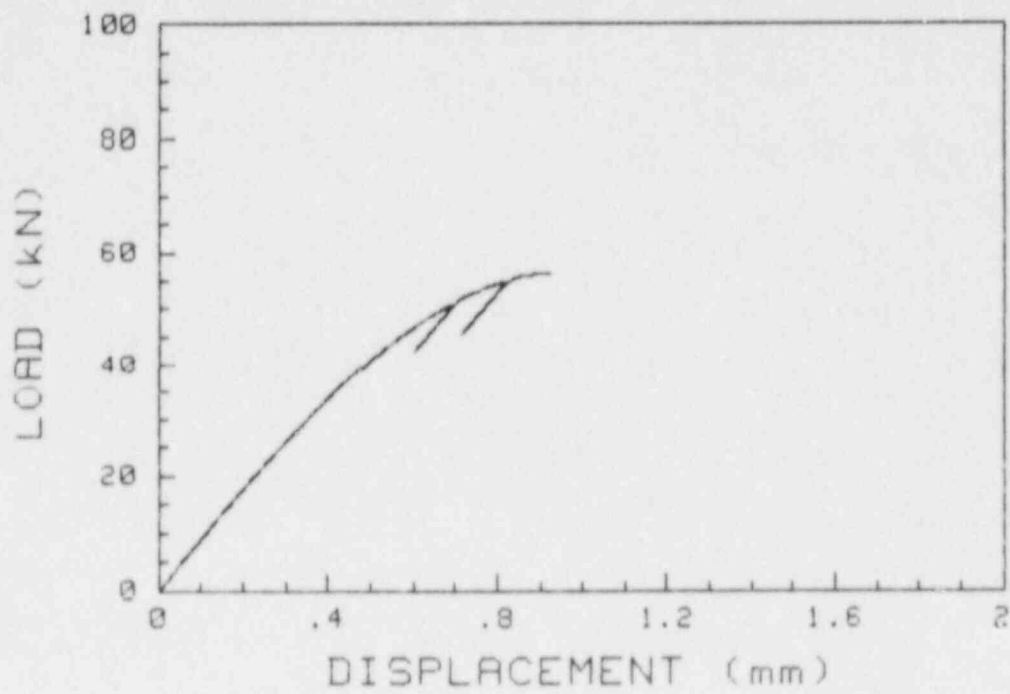
YP1266



ORNL-DWG 87-7960

69W175

24 DEGREES C



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

$a/W)_1 = .55$

SPECIMEN CLEAVED AT $K_{Ic} = 35.9 \text{ MPa SQR[m]}$ (VALID ASTM E399)

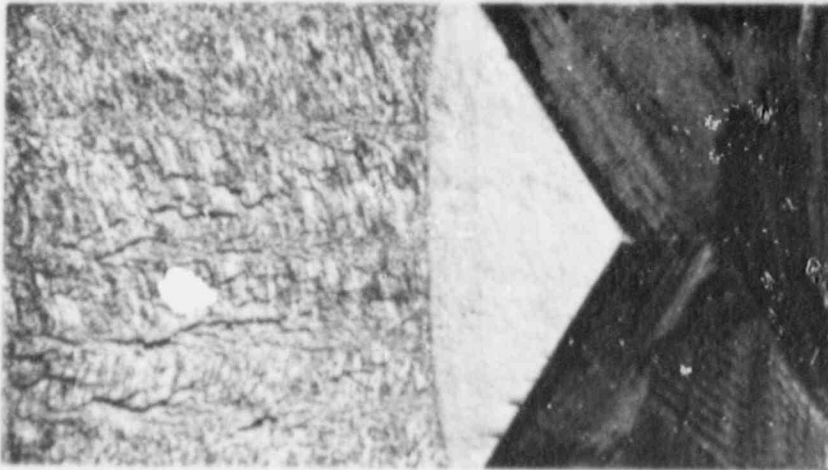
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 5.5 kJ/m²
KJc= 34.2 MPa SQR[m]
K-beta-c= 34 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 5.5 kJ/m²
KJc= 34.2 MPa SQR[m]
K-beta-c= 34 MPa SQR[m]

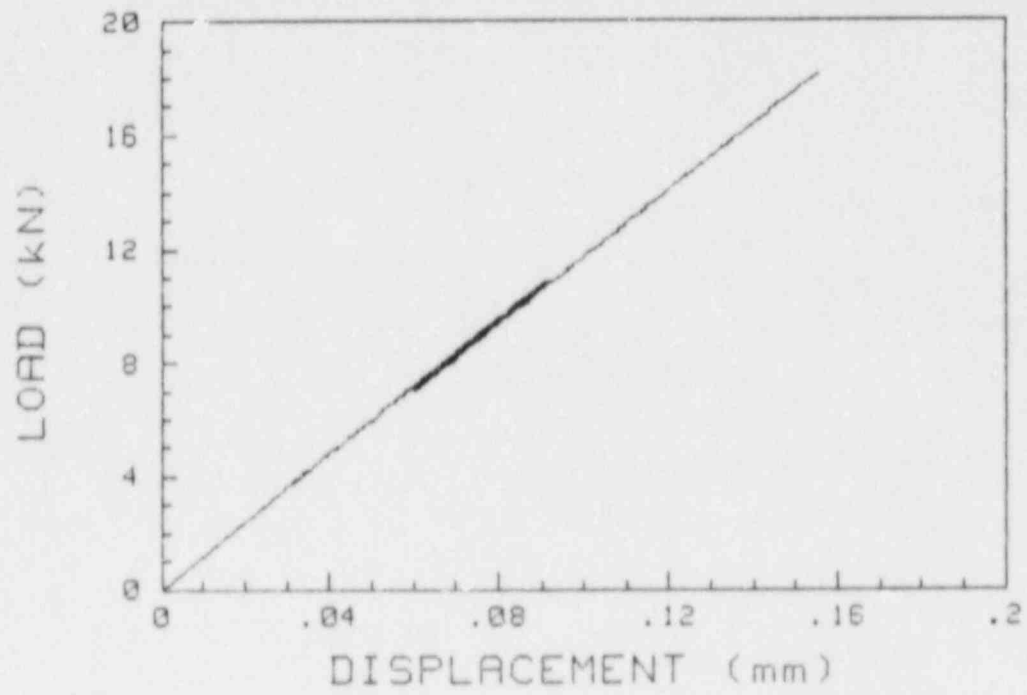
YP1257



ORNL-DWG 87-7961

70W103

-135 DEGREES C



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/m²
 KJ-MAX LOAD= 195.3 MPa SQR[m]

POWER LAW PROCEDURE

J_{1c}= 164 kJ/m²
 K-J_{1c}= 181.3 MPa SQR[m]
 POWER= .5312
 COEFFICIENT= 302.5 kJ/m²
 T (AVERAGE)= 130

ASTM LINEAR PROCEDURE

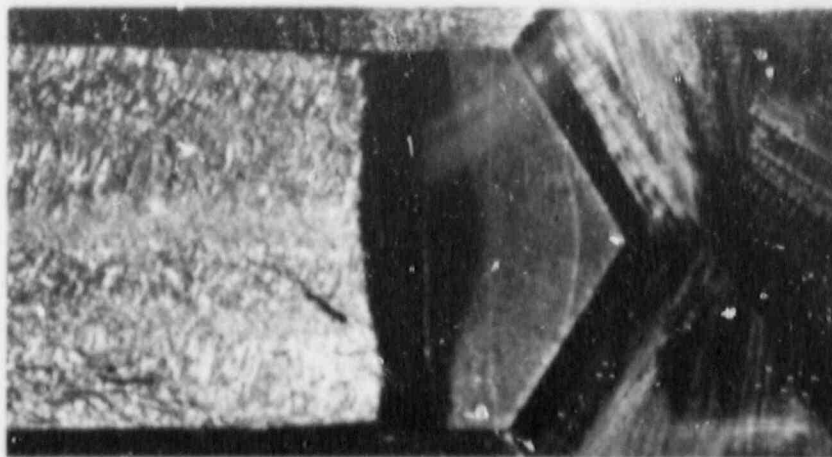
J_{1c}= 147.6 kJ/m²
 K-J_{1c}= 171.9 MPa SQR[m]
 SLOPE= 171413 kJ/m³
 INTERCEPT= 122 kJ/m²
 T (ASTM)= 140
 VALID, E013

J1-R CURVE CALCULATIONS

J (@J/T=8.8)= 617.4 kJ/m²
 POWER= .5299
 J-MAX ALLOWED= 502.5 kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 303.5 kJ/m²
 DELTA-A MAX ALLOWED= 2.27 mm

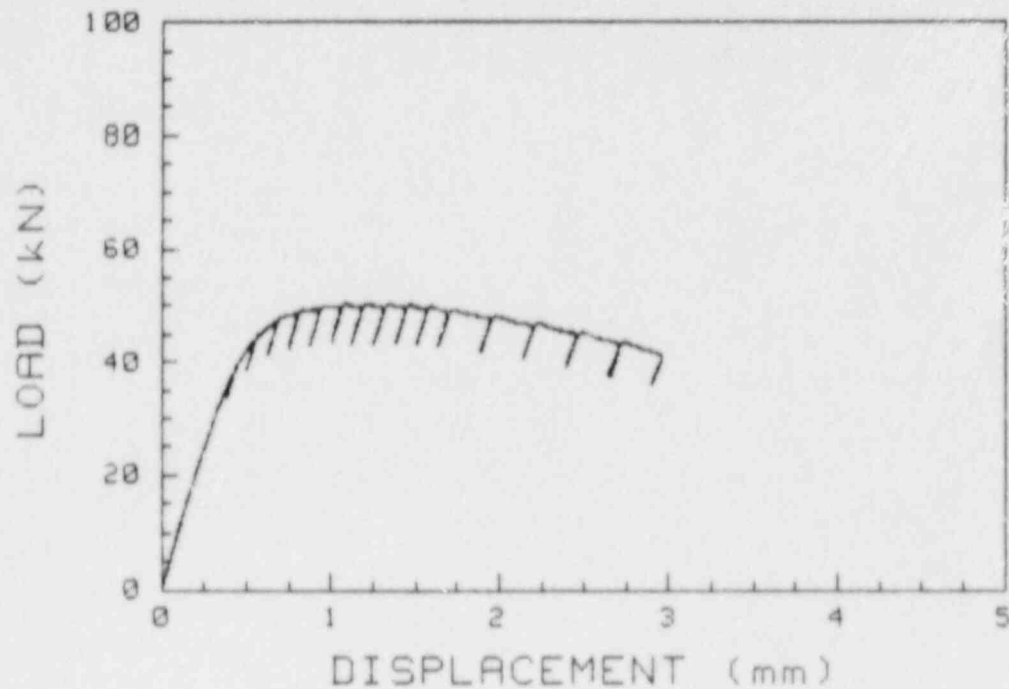
YP1250



ORNL-DWG 87-7962

70W114

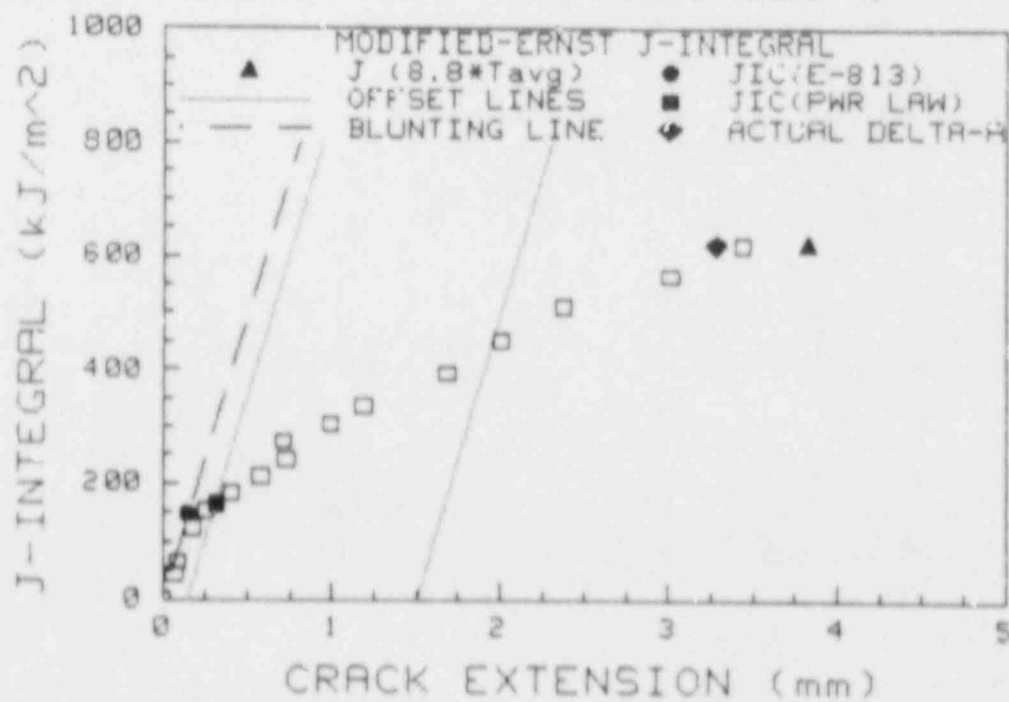
121 DEGREES C



ORNL-DWG 87-7963

70W114

121 DEGREES C



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/m²
 KJ-MAX LOAD= 189.9 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 125.8 kJ/m²
 K-JIc= 154.9 MPa SQR[m]
 POWER= .4664
 COEFFICIENT= 230.5 kJ/m²
 T (AVERAGE)= 81

ASTM LINEAR PROCEDURE

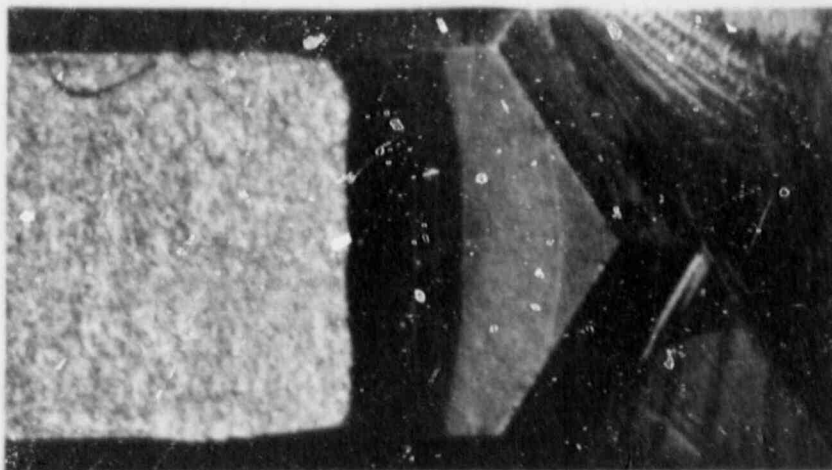
 JIc= 115 kJ/m²
 K-JIc= 148.2 MPa SQR[m]
 SLOPE= 121180 kJ/m³
 INTERCEPT= 101.4 kJ/m²
 T (ASTM)= 88
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 398.7 kJ/m²
 POWER= .4833
 J-MAX ALLOWED= 519.4 kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 230.6 kJ/m²
 DELTA-A MAX ALLOWED= 2.27 mm

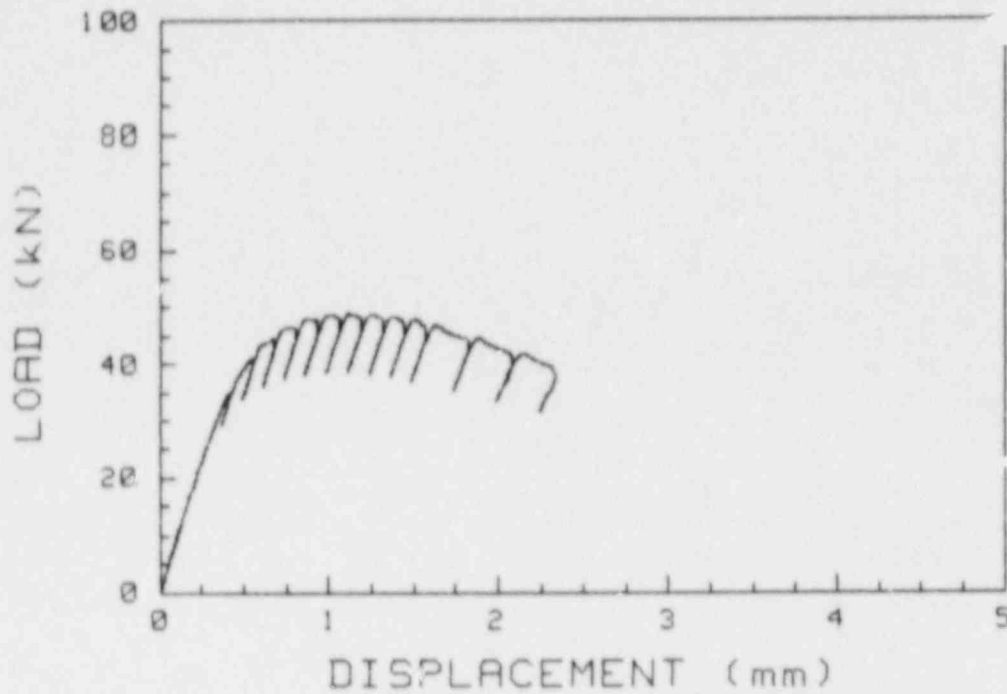
YP1249



ORNL-DWG 87-7964

70W116

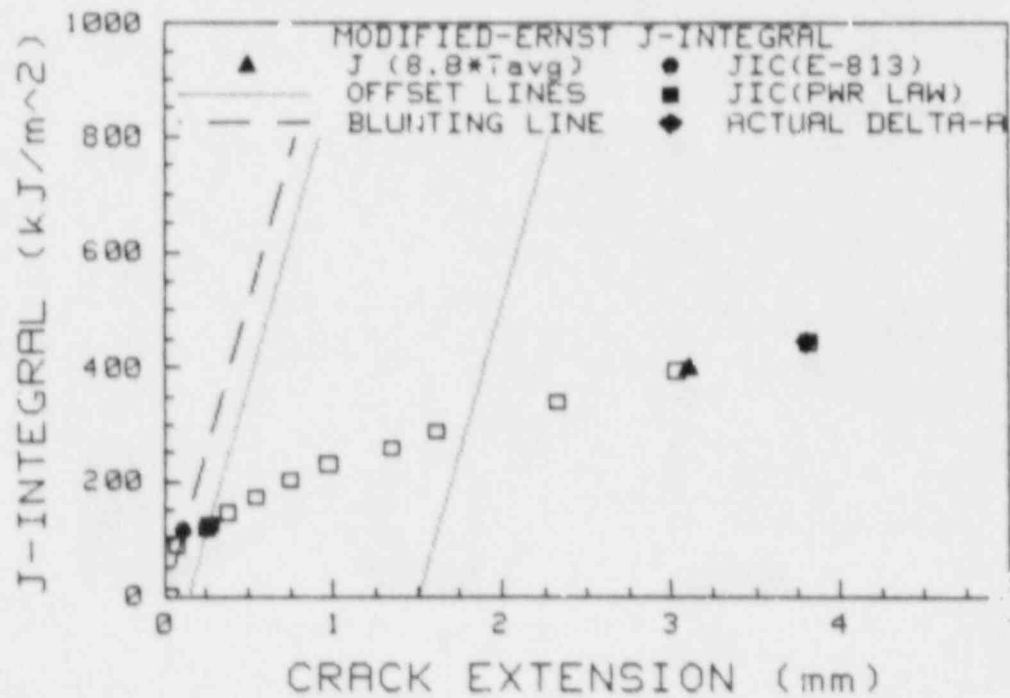
288 DEGREES C



ORNL-DWG 87-7965

70W116

288 DEGREES C



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 $K = 101.8 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

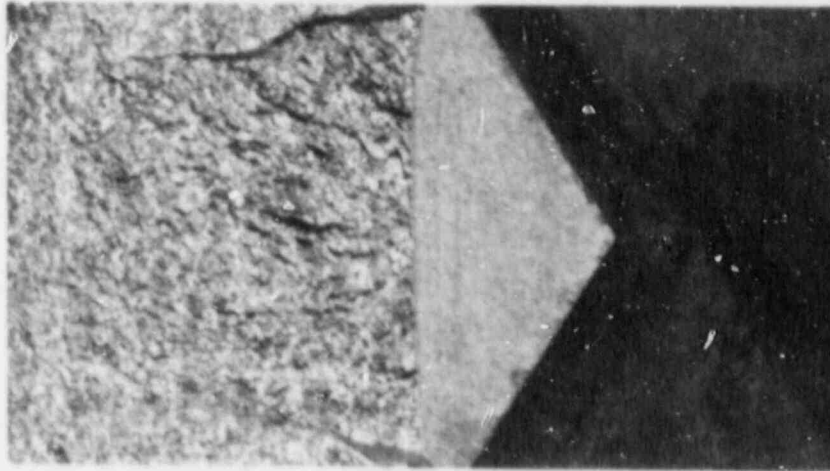
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 59.3 kJ/m²
KJc= 111.4 MPa SQR[m]
K-beta-c= 79 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 59.3 kJ/m²
KJc= 111.4 MPa SQR[m]
K-beta-c= 79 MPa SQR[m]

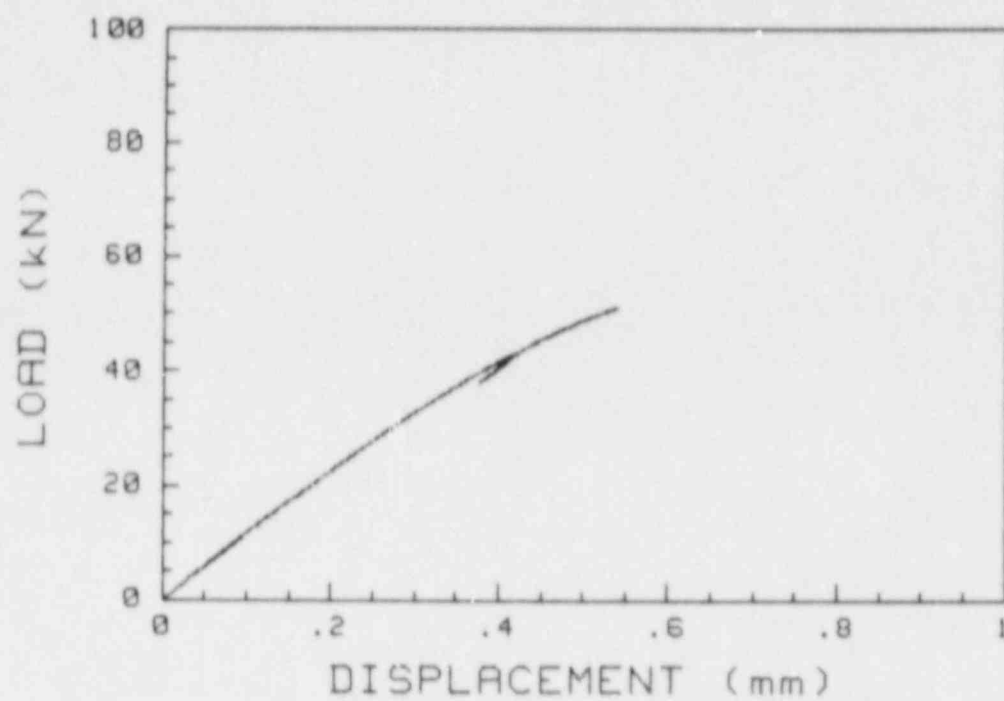
YP1258



ORNL-DWG 87-7966

70W120

-40 DEGREES C



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

$a/W_i = .549$

SPECIMEN CLEAVED AT $K_{Ic} = 47.3 \text{ MPa SQR[m]}$ (VALID ASTM E399)

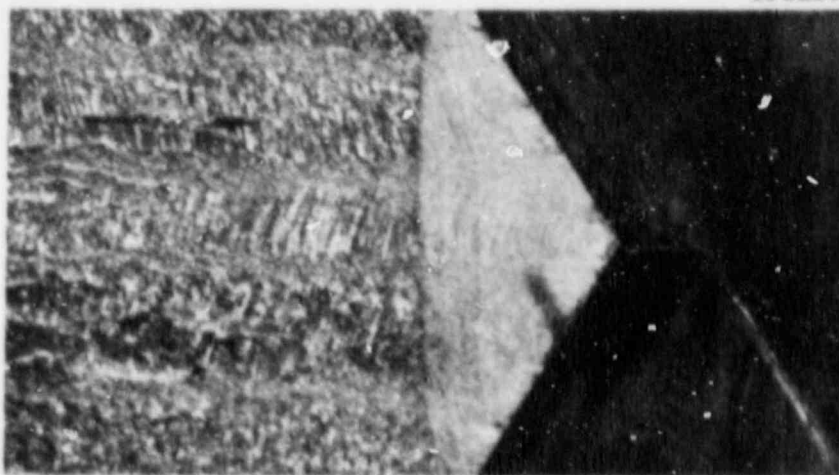
VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 10 kJ/m²
 $K_{Jc} = 46.4 \text{ MPa SQR[m]}$
 $K_{\beta-c} = 45.3 \text{ MPa SQR[m]}$

VALUES AT CLEAVAGE LOAD

 J-INTEGRAL= 10 kJ/m²
 $K_{Jc} = 46.4 \text{ MPa SQR[m]}$
 $K_{\beta-c} = 45.3 \text{ MPa SQR[m]}$

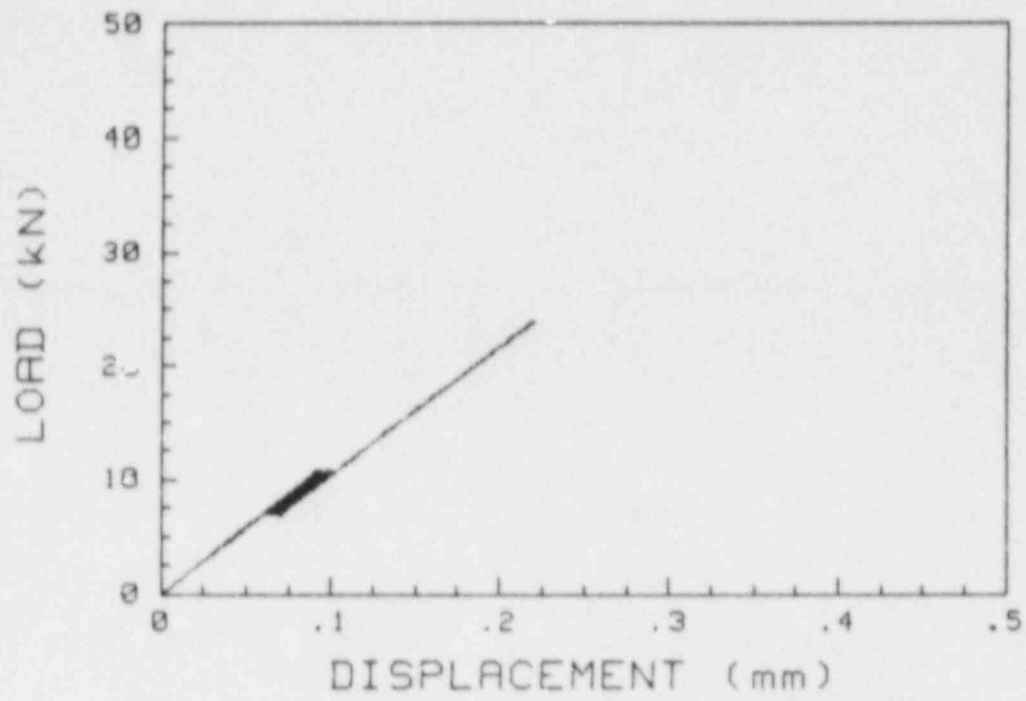
YP1259



ORNL-DWG 87-7967

70W127

-135 DEGREES C



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/m²
 KJ-MAX LOAD= 211.9 MPa SQR(m)

POWER LAW PROCEDURE

J_{Ic}= 155.5 kJ/m²
 K-J_{Ic}= 176.5 MPa SQR(m)
 POWER= .5925
 COEFFICIENT= 312.9 kJ/m²
 T (AVERAGE)= 149

ASTM LINEAR PROCEDURE

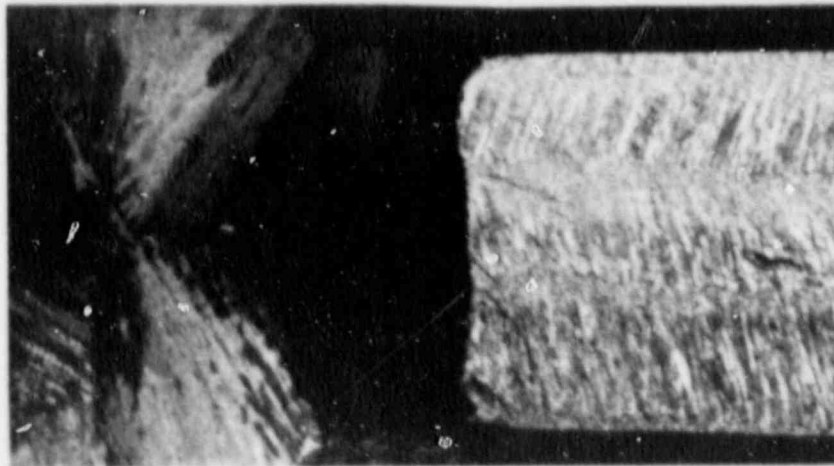
J_{Ic}= 131.6 kJ/m²
 K-J_{Ic}= 162.4 MPa SQR(m)
 SLOPE= 194013 kJ/m³
 INTERCEPT= 105.8 kJ/m²
 T (ASTM)= 159
 VALID, E813

J_I-R CURVE CALCULATIONS

J (QJ/T=8.8)= 751.5 kJ/m²
 POWER= .6021
 J-MAX ALLOWED= 502.5 kJ/m²
 VALID R-CURVE

COEFFICIENT= 310.4 kJ/m²
 DELTA-A MAX ALLOWED= 2.29 mm

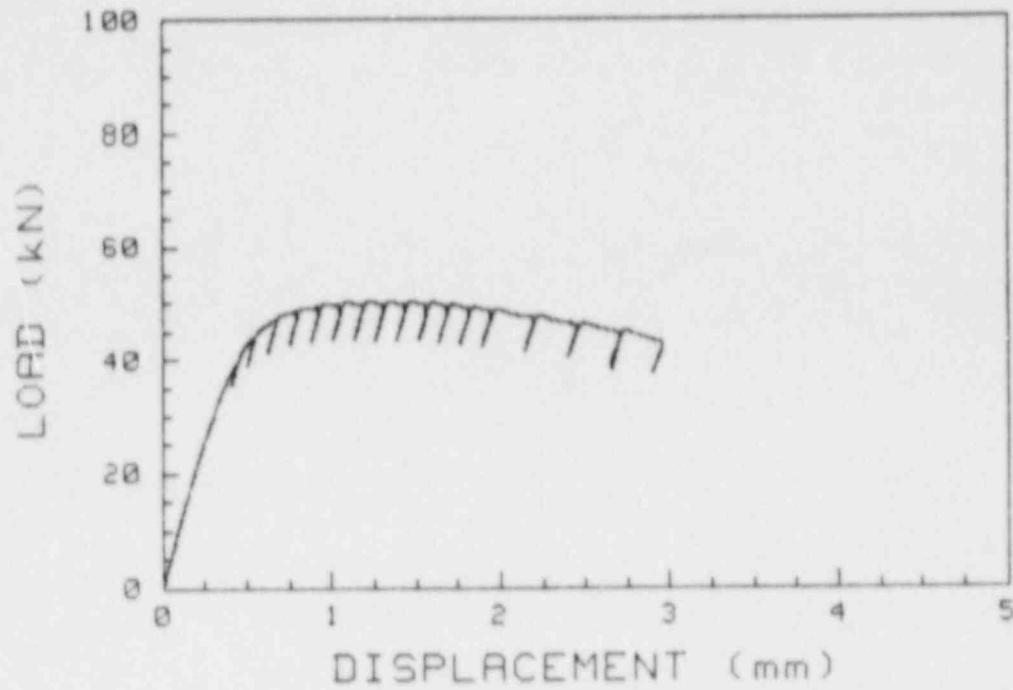
YP1251



ORNL-DWG 87-7968

70W135

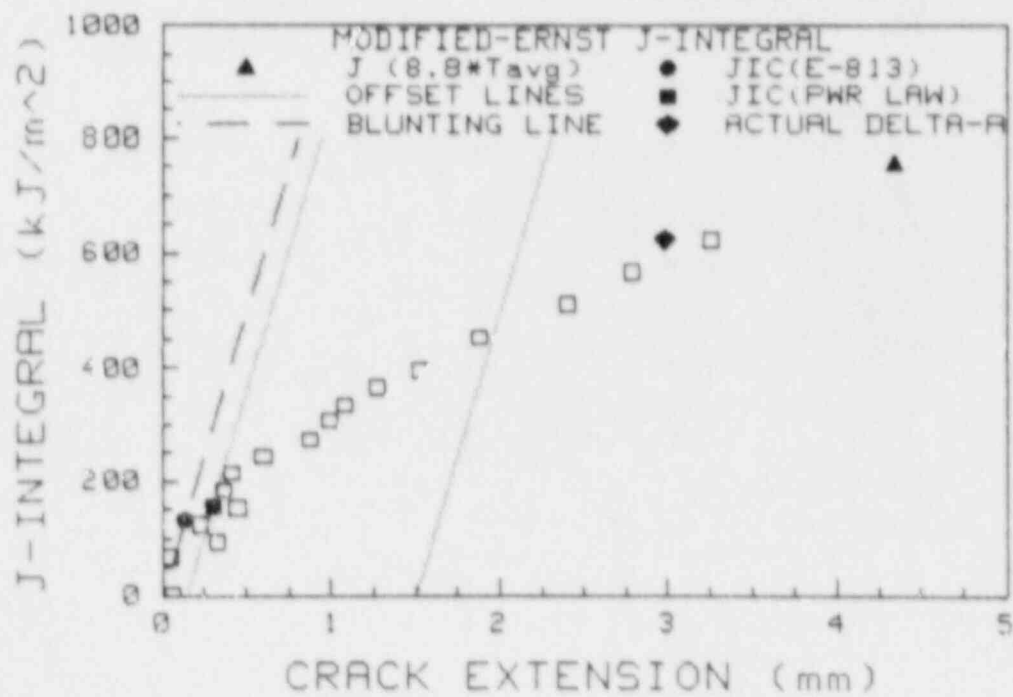
121 DEGREES C



ORNL-DWG 87-7969

70W135

121 DEGREES C



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 $K = 103.1 \text{ MPa SQR(m)}$ (NOT VALID KIc)

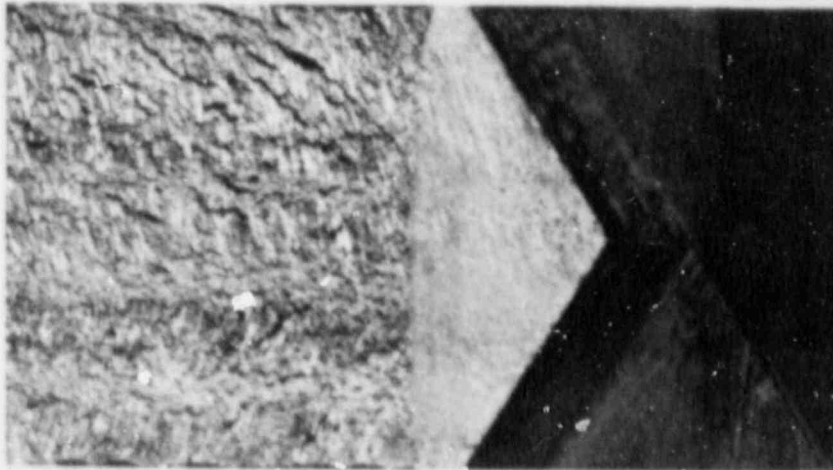
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 58.1 kJ/m²
KJc= 110.7 MPa SQR(m)
K-beta-c= 80.5 MPa SQR(m)

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 58.1 kJ/m²
KJc= 110.7 MPa SQR(m)
K-beta-c= 80.5 MPa SQR(m)

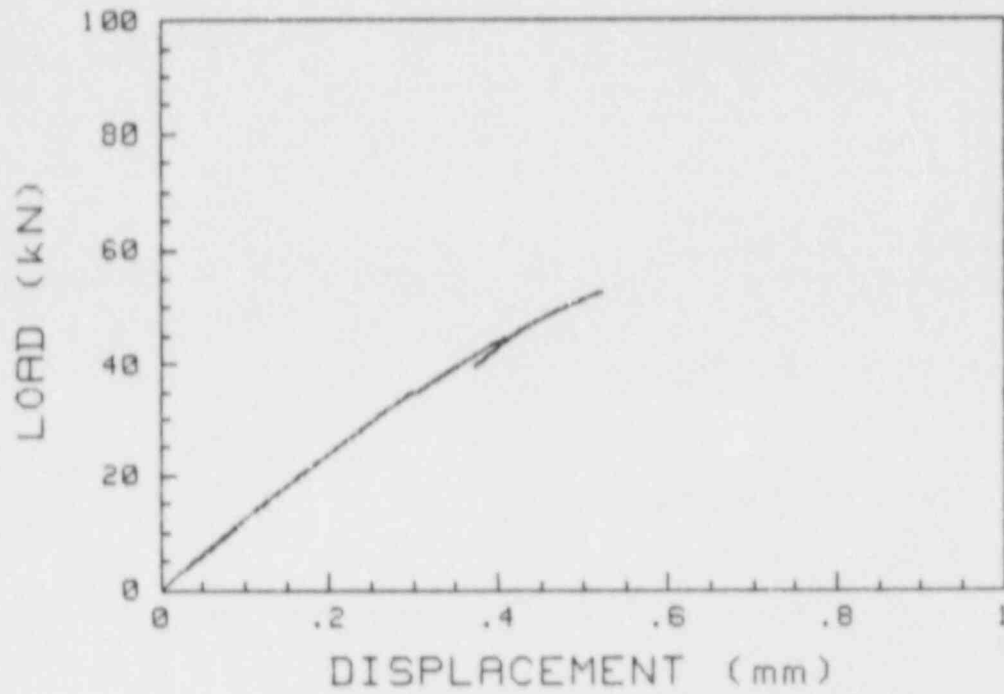
YP1260



ORNL-DWG 87-7970

70W143

-65 DEGREES C



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/m²
 KJ-MAX LOAD= 176.4 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 132.1 kJ/m²
 K-JIc= 160.7 MPa SQR[m]
 POWER= .5724
 COEFFICIENT= 270.6 kJ/m²
 T (AVERAGE)= 128

ASTM LINEAR PROCEDURE

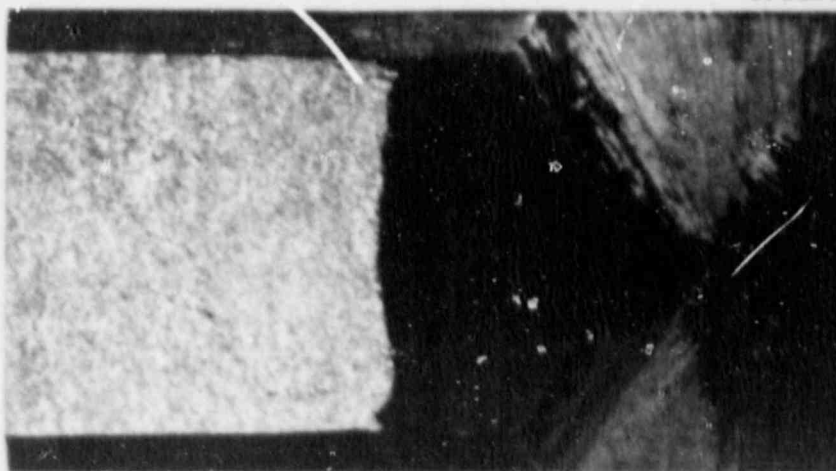
 JIc= 118.4 kJ/m²
 K-JIc= 152.2 MPa SQR[m]
 SLOPE= 161461 kJ/m³
 INTERCEPT= 98.8 kJ/m²
 T (ASTM)= 133
 VALID, E813

J1-R CURVE CALCULATIONS

 J (@J/T=8.8)= 566.3 kJ/m²
 POWER= .5415
 J-MAX ALLOWED= 494.7 kJ/m²
 RCURVE INVALID, 1

COEFFICIENT= 269.7 kJ/m²
 DELTA-A MAX ALLOWED= 2.27 mm

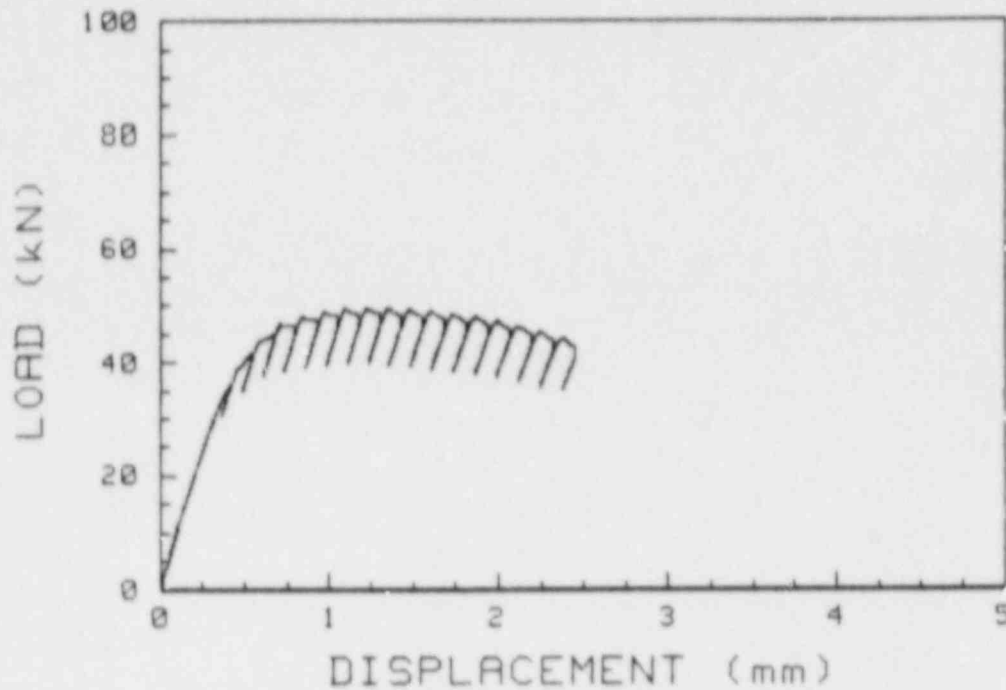
YP1252



ORNL-DWG 87-7971

70W144

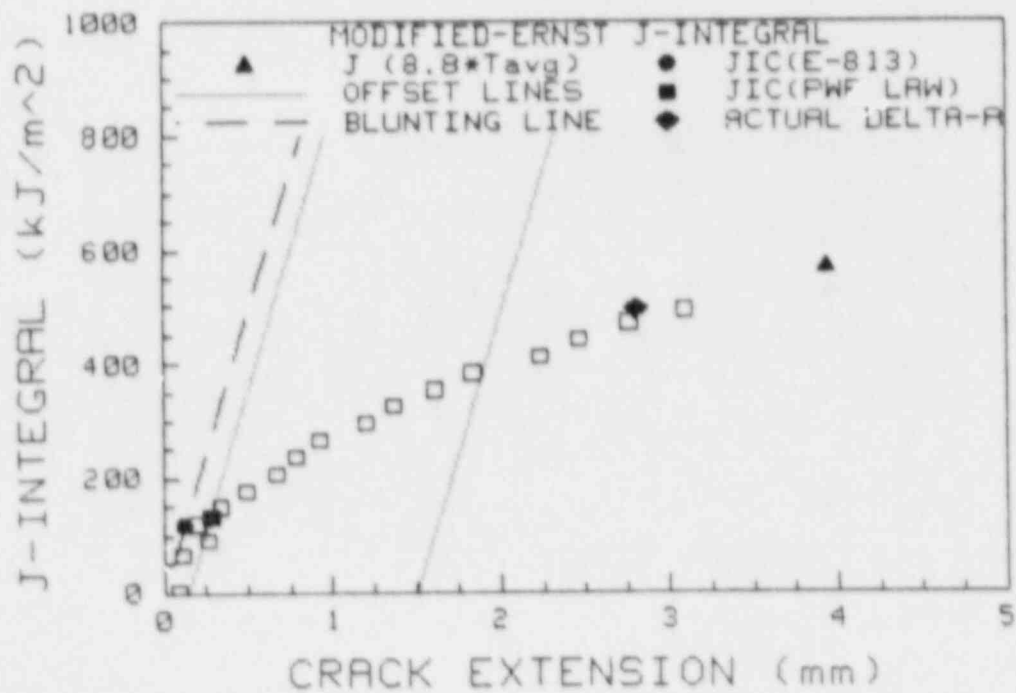
204 DEGREES C



ORNL-DWG 87-7972

70W144

204 DEGREES C



SPECIMEN ID= 79W147
 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/m²
 KJ-MAX LOAD= 205.9 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 137.6 kJ/m²
 K-JIc= 164 MPa SQR[m]
 POWER= .4989
 COEFFICIENT= 254.6 kJ/m²
 T (AVERAGE)= 106

ASTM LINEAR PROCEDURE

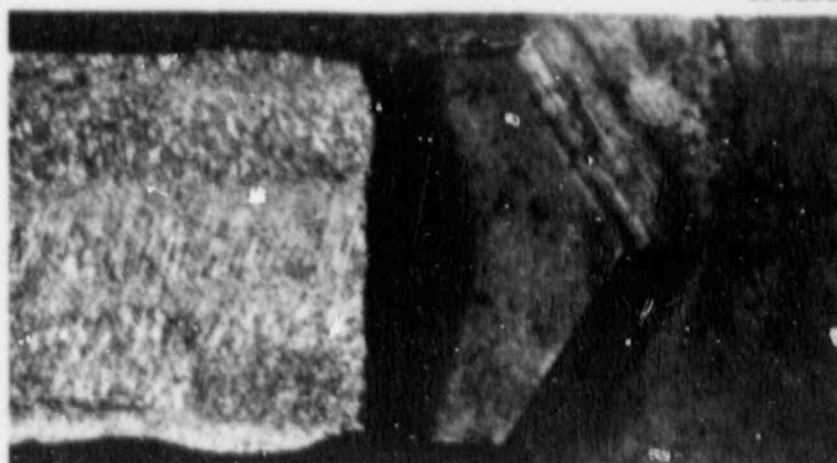
 JIc= 128.8 kJ/m²
 K-JIc= 158.7 MPa SQR[m]
 SLOPE= 133223 kJ/m³
 INTERCEPT= 111.2 kJ/m²
 T (ASTM)= 110
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 445 kJ/m²
 POWER= .4565
 J-MAX ALLOWED= 494.2 kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 257.4 kJ/m²
 DELTA-A MAX ALLOWED= 2.27 mm

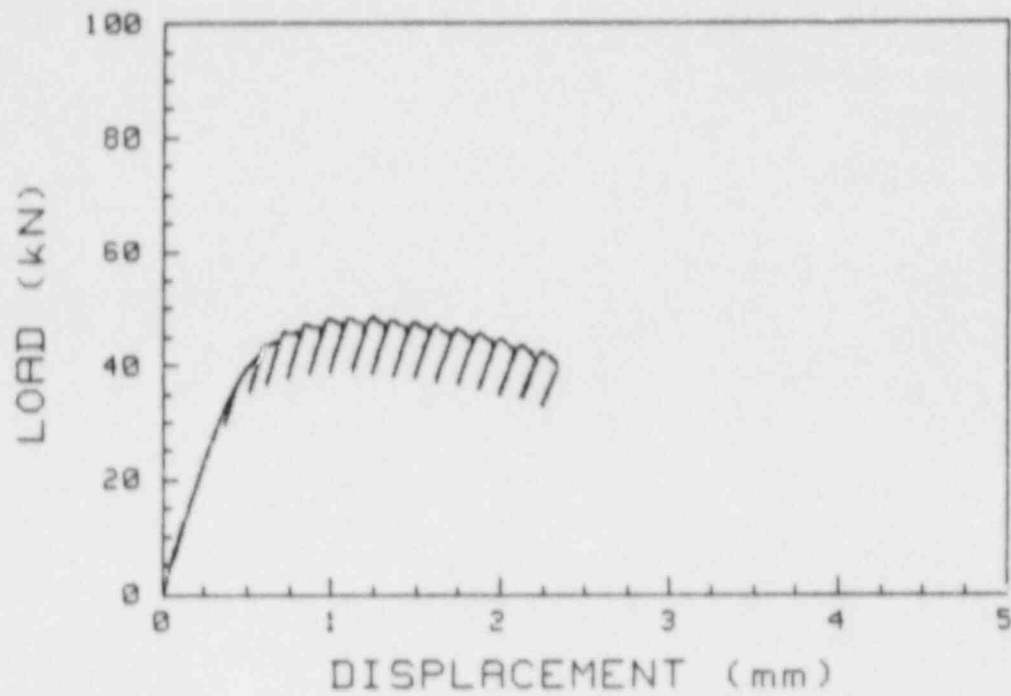
YP1253



ORNL-DWG 87-7973

70W147

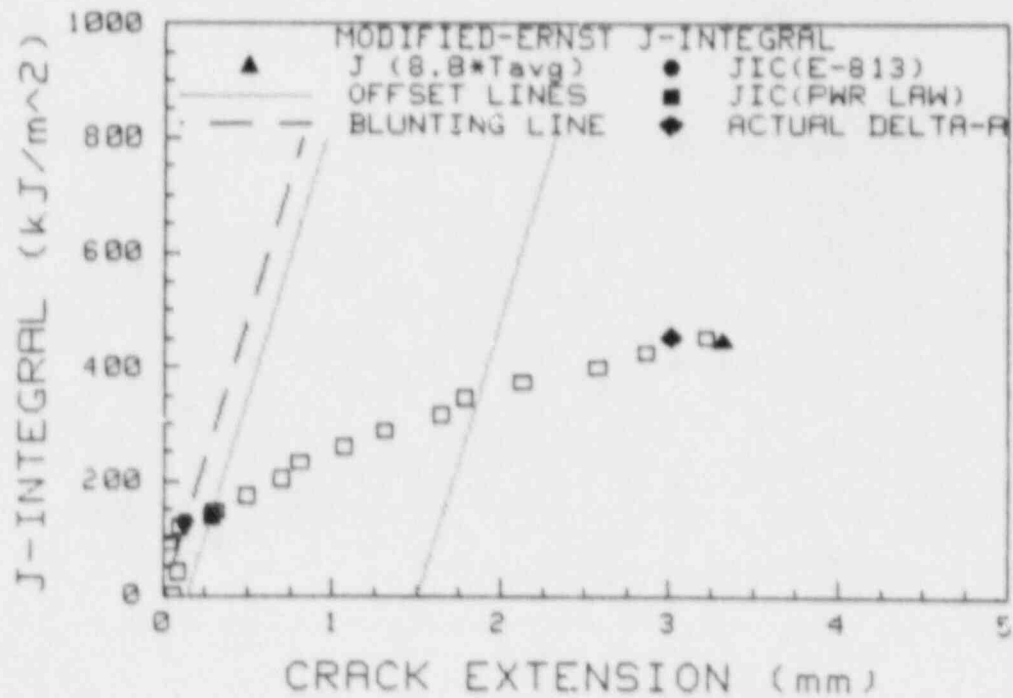
204 DEGREES C



ORNL-DWG 87-7974

70W147

204 DEGREES C



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

$a/W)_1 = .546$

SPECIMEN CLEAVED AT $K = 101.3 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

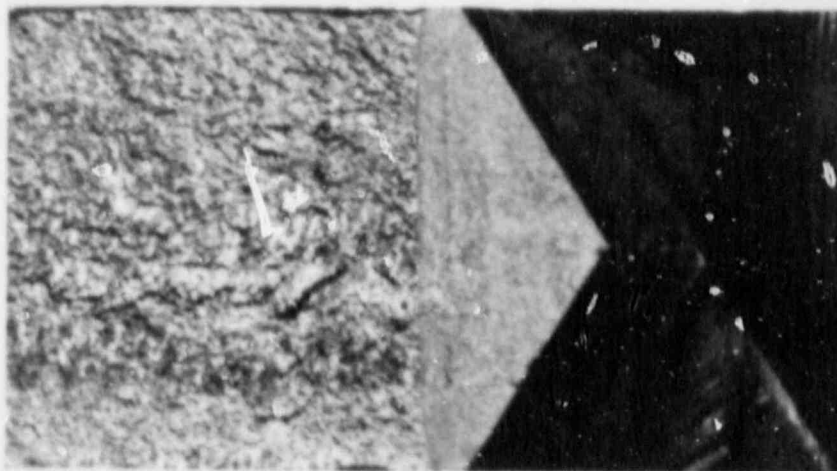
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 56 kJ/m²
KJc= 108.7 MPa SQR[m]
K-beta-c= 79.8 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 56 kJ/m²
KJc= 108.7 MPa SQR[m]
K-beta-c= 79.8 MPa SQR[m]

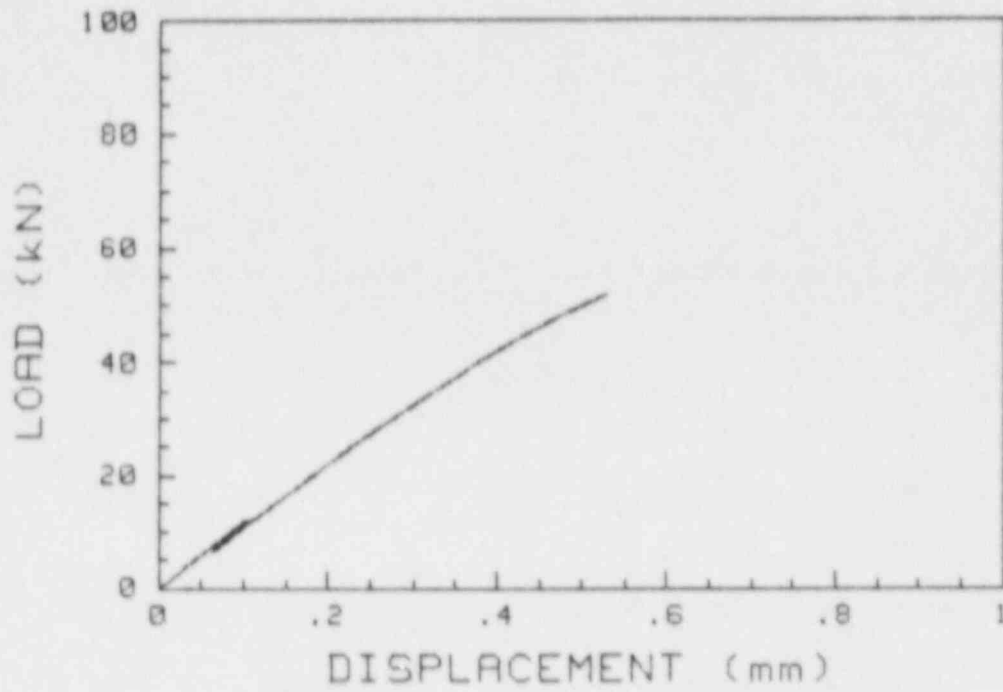
YP1261



ORNL-DWG 87-7975

70W149

-65 DEGREES C



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/m²
 KJ-MAX LOAD= 228.3 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 151.3 kJ/m²
 K-JIc= 175.8 MPa SQR[m]
 POWER= .675
 COEFFICIENT= 345.8 kJ/m²
 T (AVERAGE)= 169

ASTM LINEAR PROCEDURE

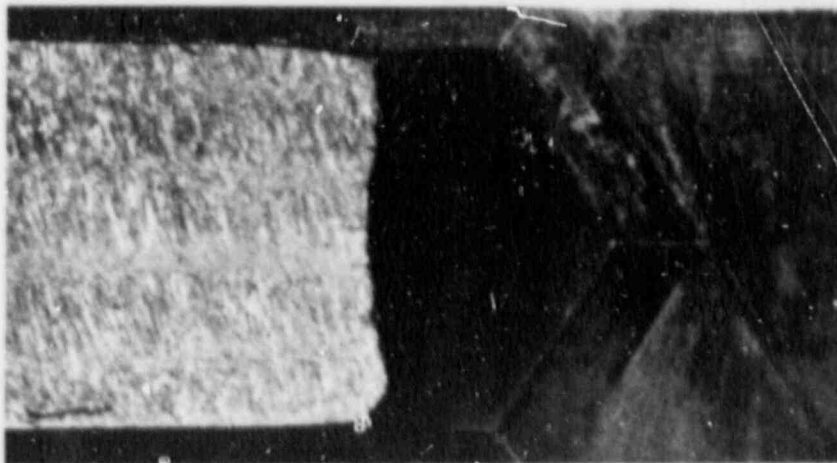
 JIc= 107.5 kJ/m²
 K-JIc= 148.2 MPa SQR[m]
 SLOPE= 254126 kJ/m³
 INTERCEPT= 81.5 kJ/m²
 T (ASTM)= 188
 VALID, E813

J1-R CURVE CALCULATIONS

 J (@J/T=8.8)= 925.4 kJ/m²
 POWER= .671
 J-MAX ALLOWED= 534.6 kJ/m²
 RCURVE INVALID, 3

COEFFICIENT= 344.6 kJ/m²
 DELTA-A MAX ALLOWED= 2.32 mm

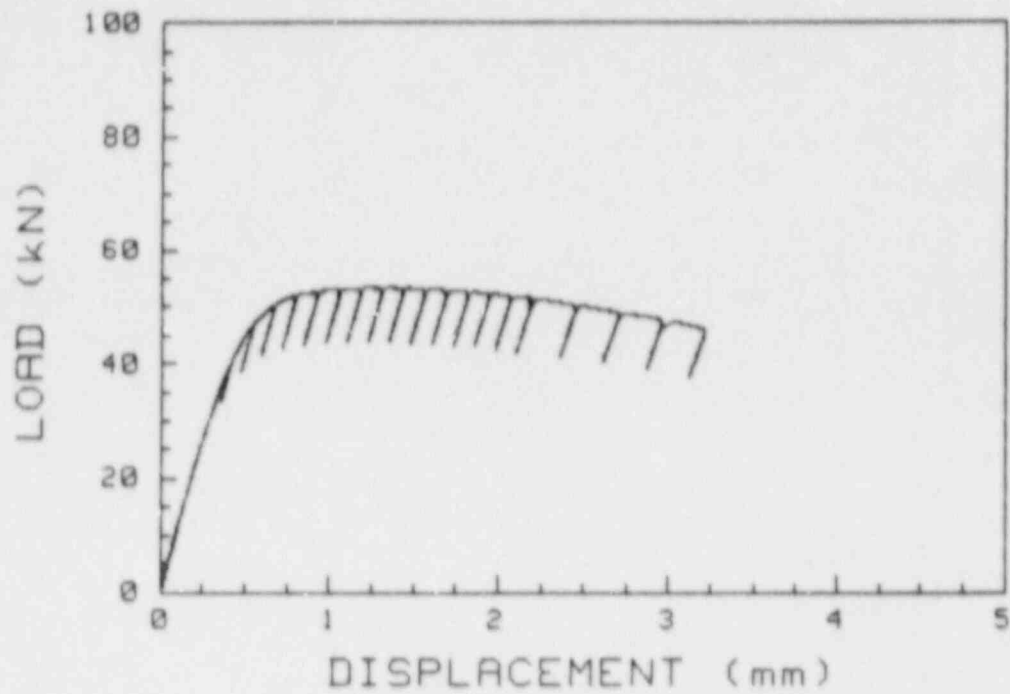
YP1254



ORNL-DWG 87-7976

70W150

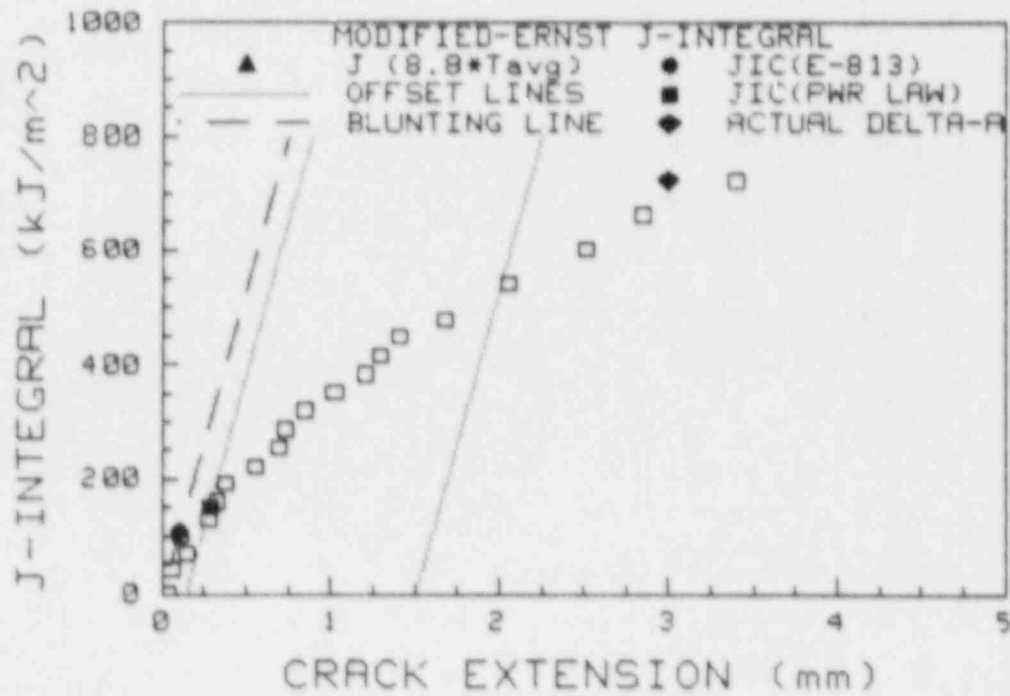
50 DEGREES C



ORNL-DWG 87-7977

70W150

50 DEGREES C



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/m²
 KJ-MAX LOAD= 187.7 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 122.1 kJ/m²
 K-JIc= 152.7 MPa SQR[m]
 POWER= .5059
 COEFFICIENT= 237.1 kJ/m²
 T (AVERAGE)= 90

ASTM LINEAR PROCEDURE

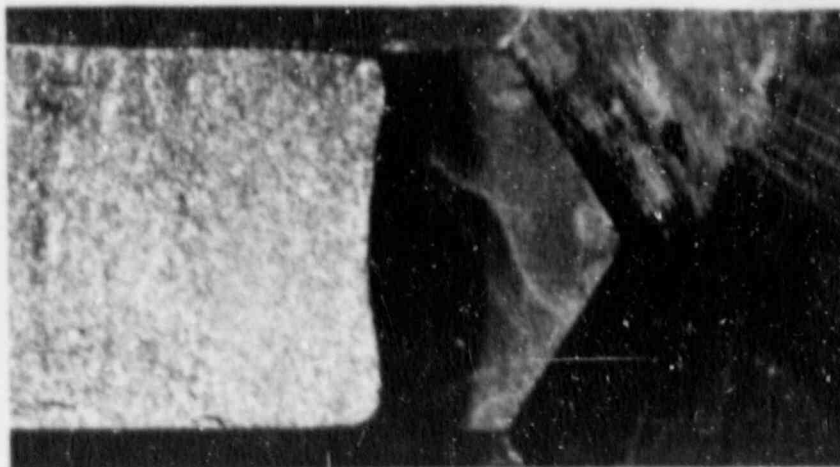
 JIc= 114.6 kJ/m²
 K-JIc= 147.8 MPa SQR[m]
 SLOPE= 127306 kJ/m³
 INTERCEPT= 100.3 kJ/m²
 T (ASTM)= 93
 VALID, E813

J1-R CURVE CALCULATIONS

 J (BJ/T=8.8)= 403.9 kJ/m²
 POWER= .4776
 J-MAX ALLOWED= 519.6 kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 236.4 kJ/m²
 DELTA-A MAX ALLOWED= 2.31 mm

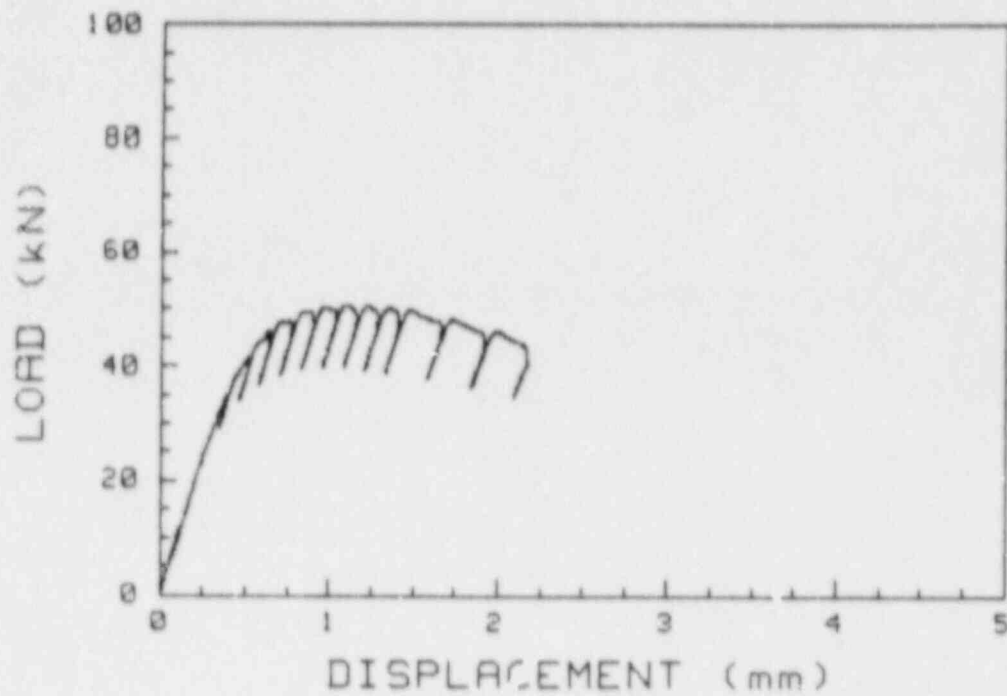
YP1255



ORNL-DWG 87-7978

70W152

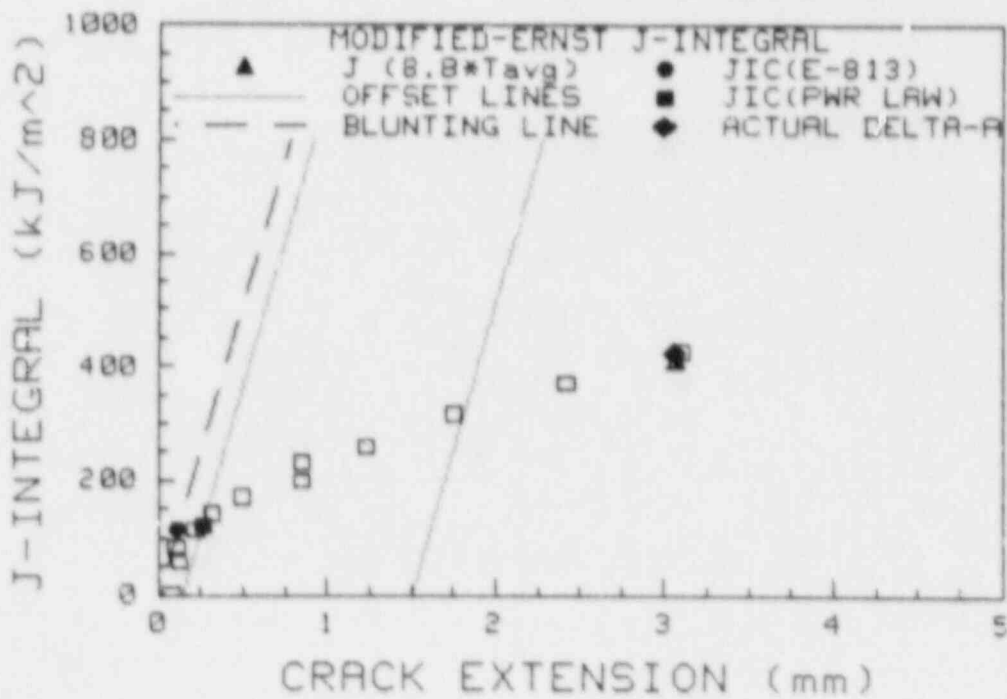
288 DEGREES C



ORNL-DWG 87-7979

70W152

288 DEGREES C



SPECIMEN ID= 71W103
 TEST TEMPERATURE= 121 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 20 %
 INITIAL CRACK LENGTH= 28.2 mm $a/W)_1 = .556$
 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/m²
 KJ-MAX LOAD= 194.1 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 125.9 kJ/m²
 K-JIc= 158.8 MPa SQR[m]
 POWER= .5307
 COEFFICIENT= 248 kJ/m²
 T (AVERAGE)= 112

ASTM LINEAR PROCEDURE

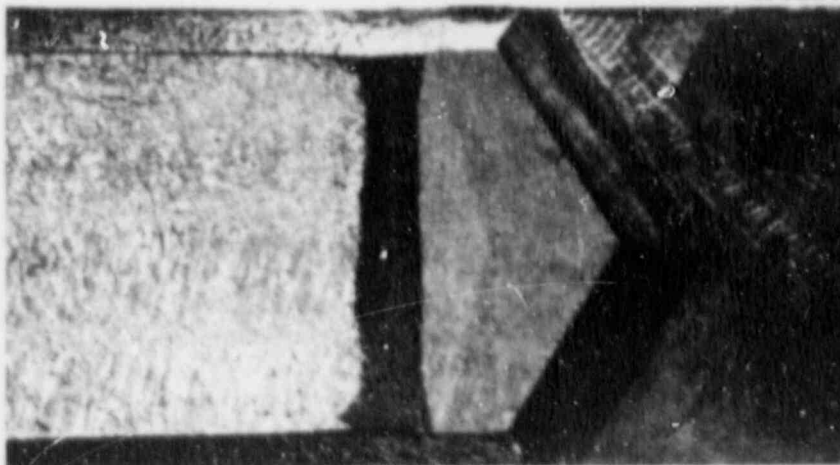
 JIc= 130.8 kJ/m²
 K-JIc= 161.9 MPa SQR[m]
 SLOPE= 125341 kJ/m³
 INTERCEPT= 114.1 kJ/m²
 T (ASTM)= 105
 VALID, E813

J1-R CURVE CALCULATIONS

 J (@J/T=8.8)= 424.8 kJ/m²
 POWER= .4516
 J-MAX ALLOWED= 497.1 kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 246.9 kJ/m²
 DELTA-A MAX ALLOWED= 2.25 mm

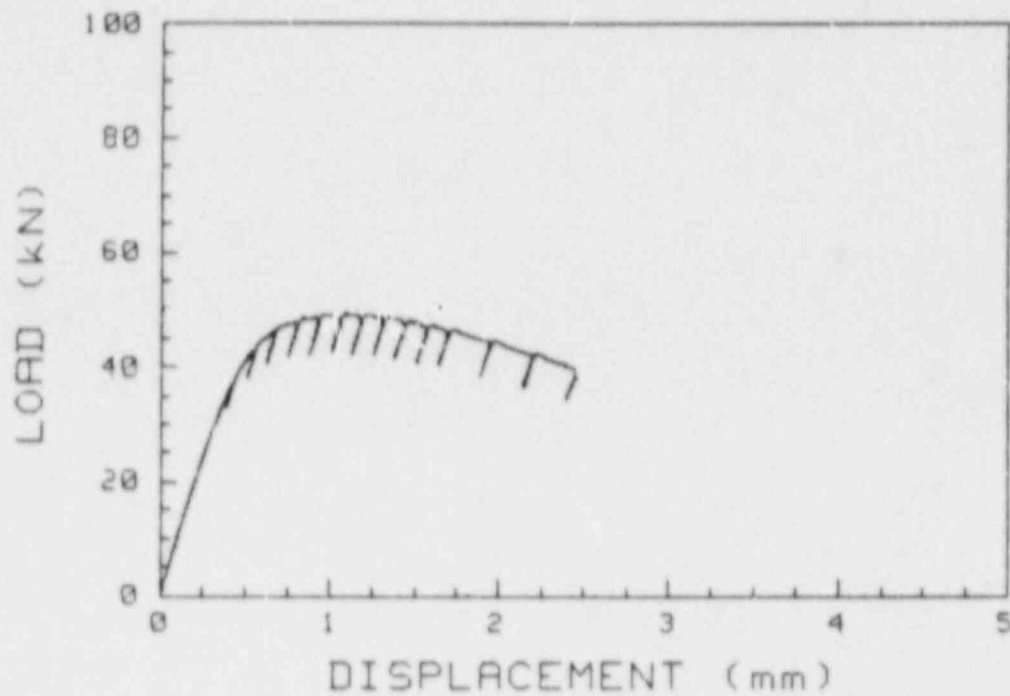
YP1256



ORNL-DWG 87-7980

71W103

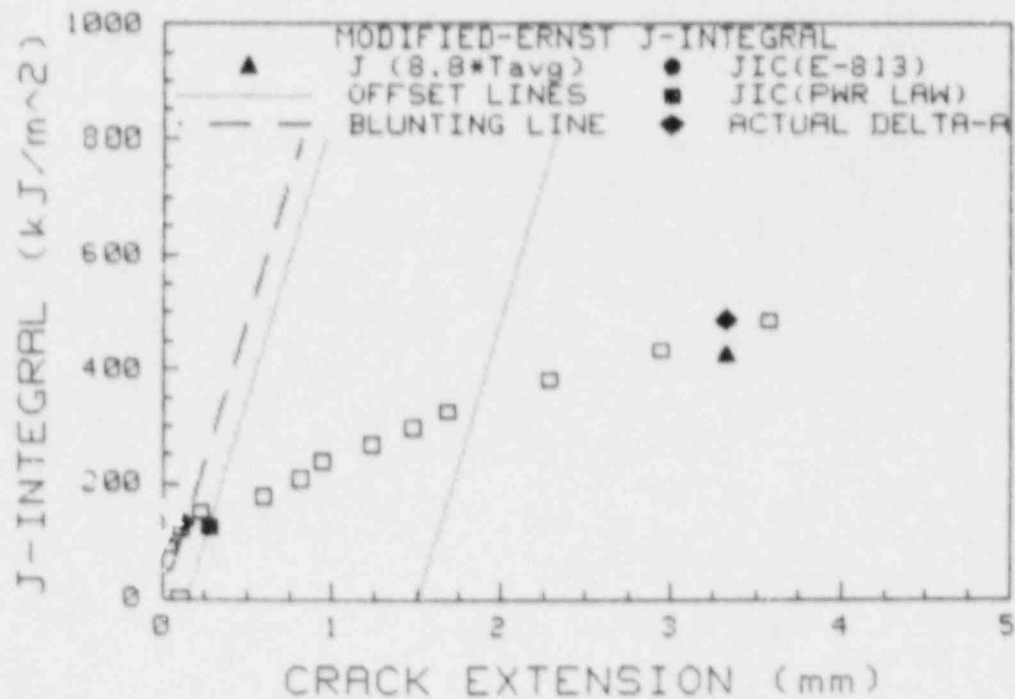
121 DEGREES C



ORNL-DWG 87-7981

71W103

121 DEGREES C



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 $K_{Ic} = 47.8 \text{ MPa SQR(m)}$ (VALID ASTM E399)

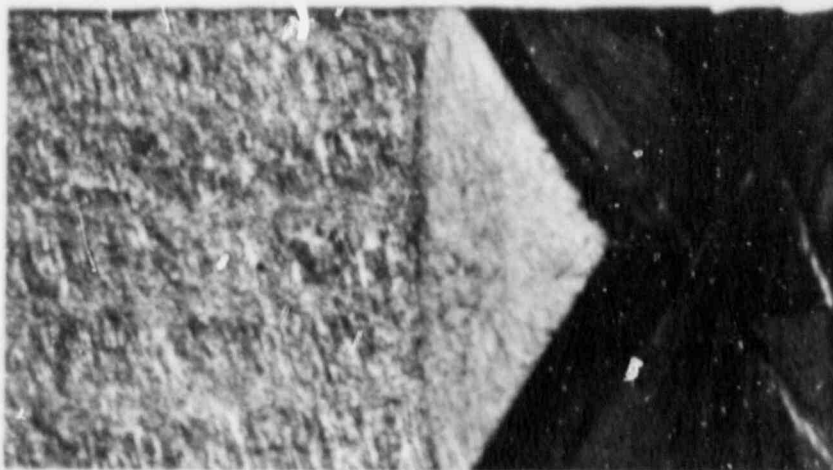
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 12.6 kJ/m²
KJc= 51.7 MPa SQR(m)
K-beta-c= 50 MPa SQR(m)

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 12.6 kJ/m²
KJc= 51.7 MPa SQR(m)
K-beta-c= 50 MPa SQR(m)

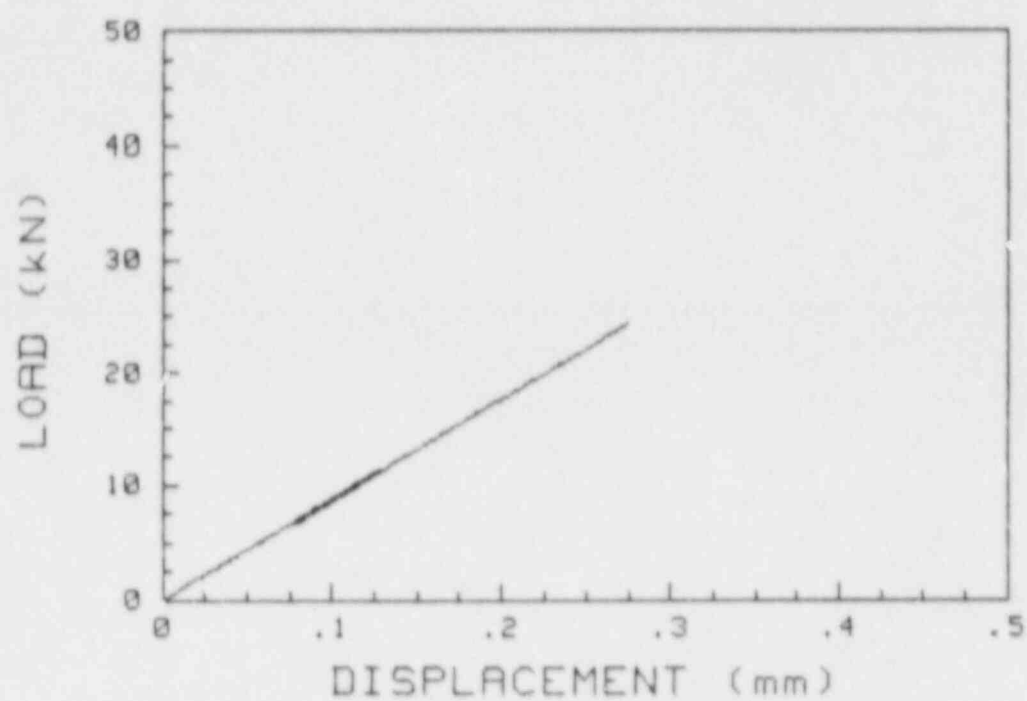
YP1262



ORNL-DWG 87-7982

71W-105

-90 DEGREES C



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

SPECIMEN CLEAVED AT $K = 84.1 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

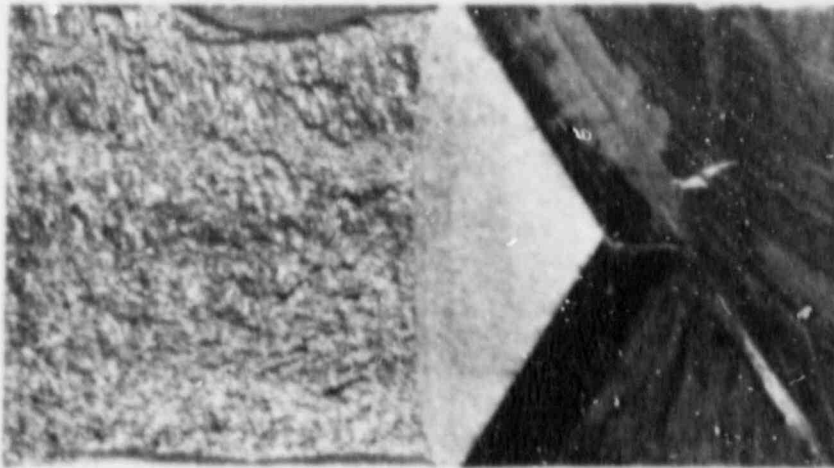
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 35.1 kJ/m²
KJc= 85.8 MPa SQR[m]
K-beta-c= 68.6 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 35.1 kJ/m²
KJc= 85.8 MPa SQR[m]
K-beta-c= 68.6 MPa SQR[m]

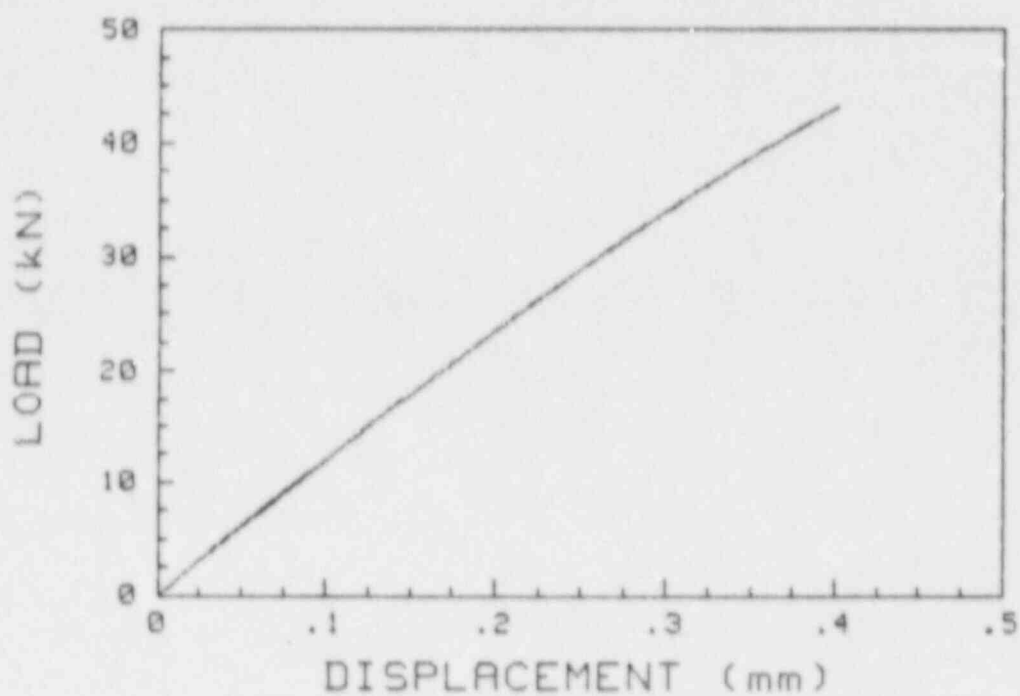
YP1263



ORNL-DWG 87-7983

71W107

-50 DEGREES C



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 $K = 99.5 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

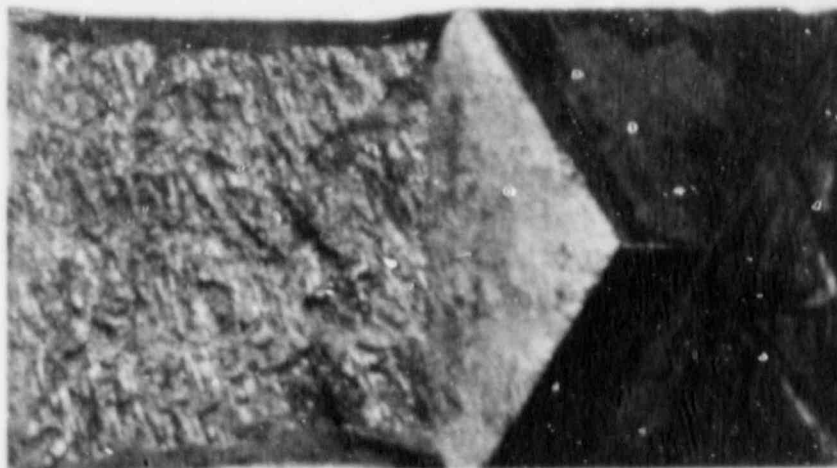
VALUES AT MAXIMUM LOAD

J-INTEGRAL= 58.8 kJ/m²
KJc= 110.6 MPa SQR[m]
K-beta-c= 75.8 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 58.8 kJ/m²
KJc= 110.6 MPa SQR[m]
K-beta-c= 75.8 MPa SQR[m]

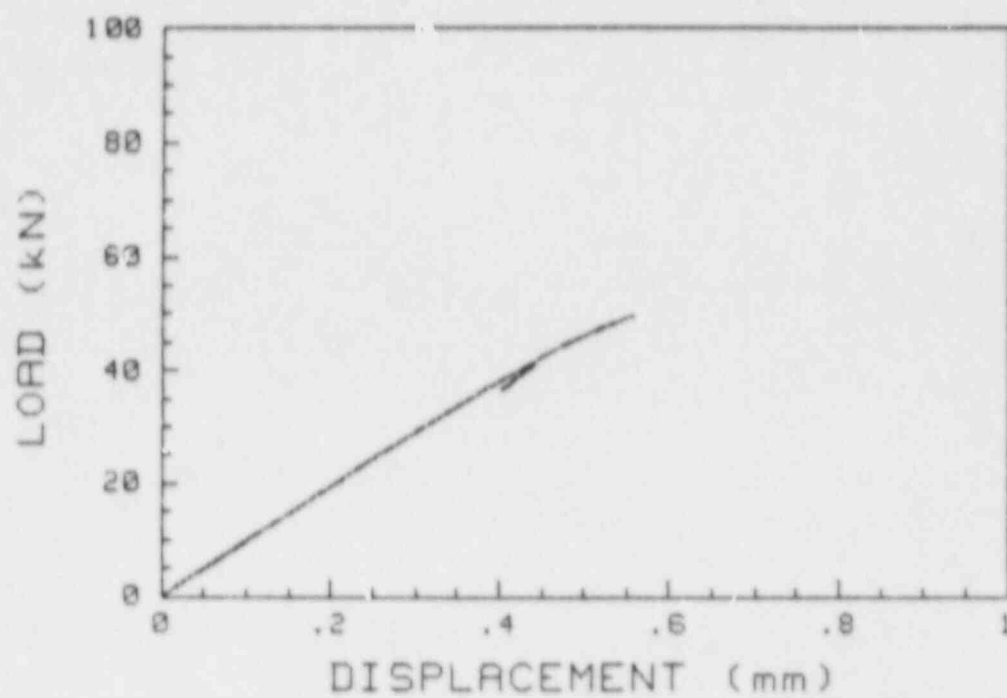
YP1264



ORNL-DWG 87-7984

71W-114

-10 DEGREES C



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/m²
 KJ-MAX LOAD= 216.1 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 111.6 kJ/m²
 K-JIc= 151 MPa SQR[m]
 POWER= .6774
 COEFFICIENT= 280.2 kJ/m²
 T (AVERAGE)= 143

ASTM LINEAR PROCEDURE

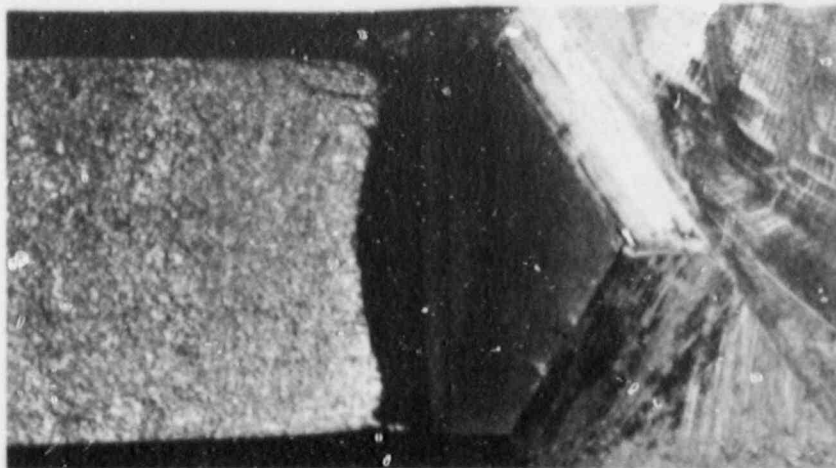
 JIc= 99.2 kJ/m²
 K-JIc= 142.3 MPa SQR[m]
 SLOPE= 191563 kJ/m³
 INTERCEPT= 80.9 kJ/m²
 T (ASTM)= 144
 VALID, E813

J1-R CURVE CALCULATIONS

 J (@J/T=8.8)= 763.7 kJ/m²
 POWER= .675
 J-MAX ALLOWED= 529.8 kJ/m²
 RCURVE INVALID, 1 3

COEFFICIENT= 280.3 kJ/m²
 DELTA-A MAX ALLOWED= 2.29 mm

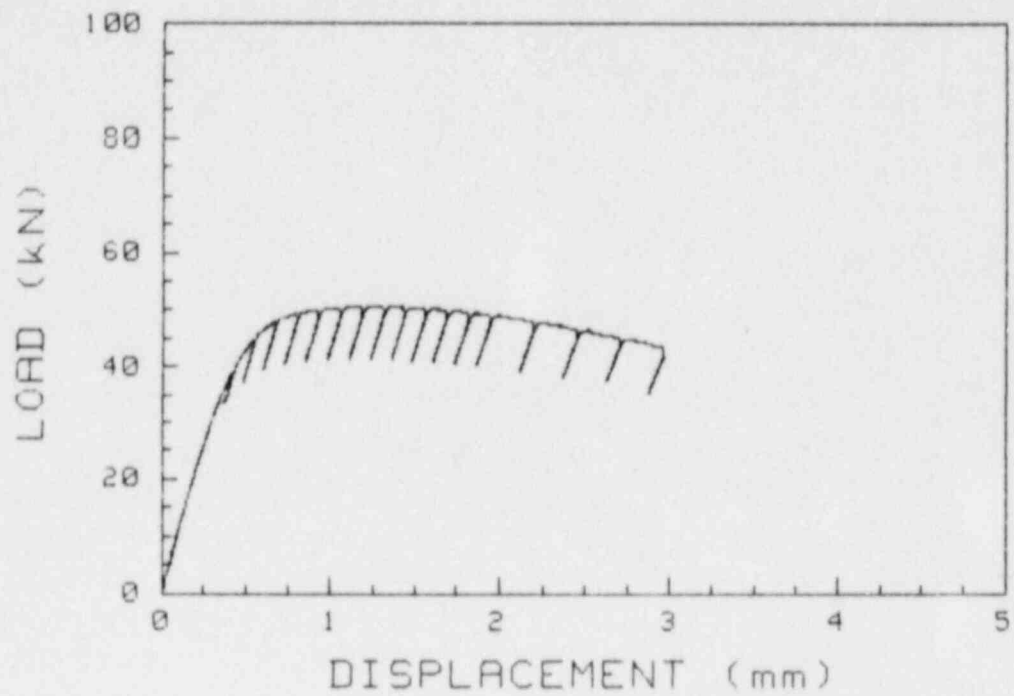
YP1291



ORNL-DWG 87-7985

71W124

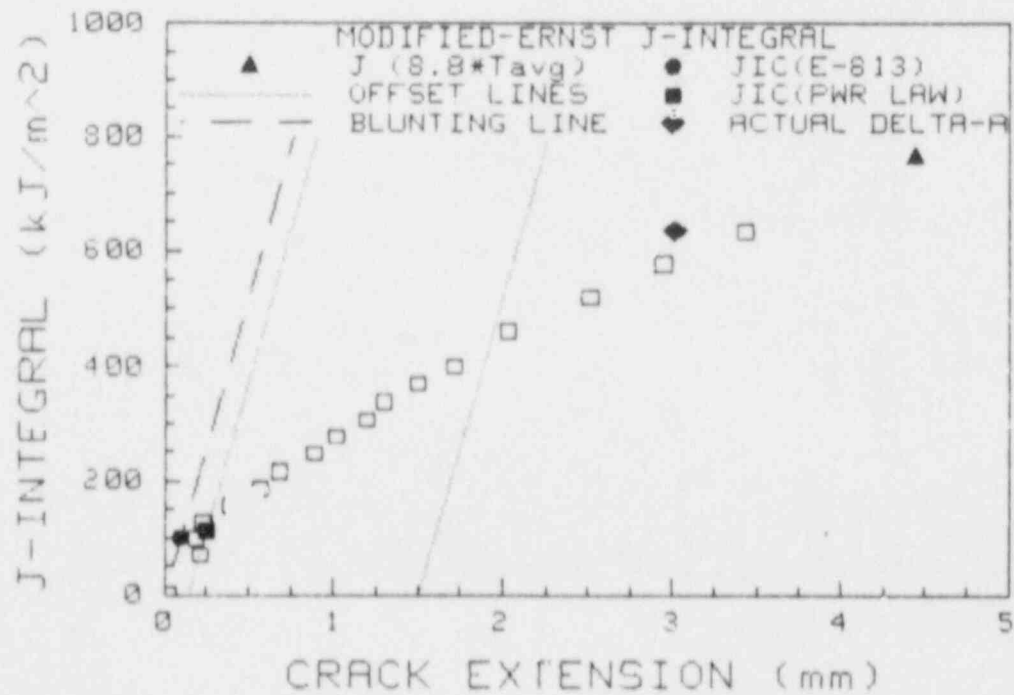
50 DEGREES C



ORNL-DWG 87-7986

71W124

50 DEGREES C



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/m²
 KJ-MAX LOAD= 176 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 135.5 kJ/m²
 K-JIc= 163.4 MPa SQR[m]
 POWER= .392
 COEFFICIENT= 221.2 kJ/m²
 T (AVERAGE)= 76

ASTM LINEAR PROCEDURE

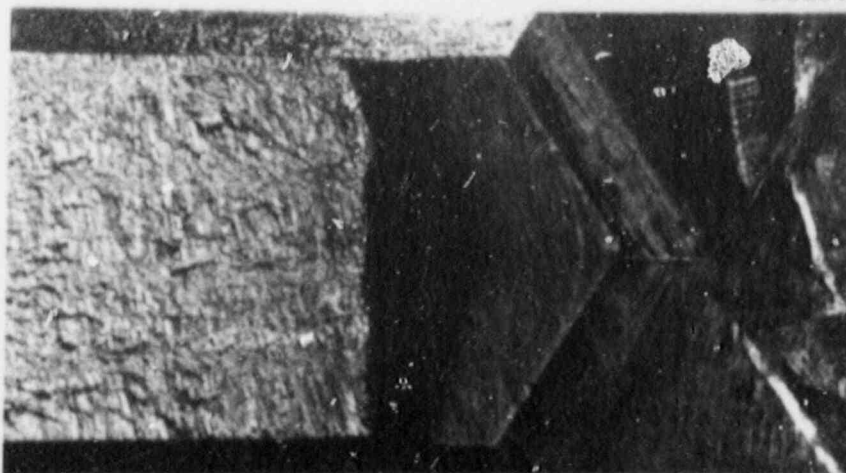
 JIc= 122.1 kJ/m²
 K-JIc= 154.5 MPa SQR[m]
 SLOPE= 106659 kJ/m³
 INTERCEPT= 108.6 kJ/m²
 T (ASTM)= 90
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 344.6 kJ/m²
 POWER= .4007
 J-MAX ALLOWED= 489.4 kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 222.9 kJ/m²
 DELTA-A MAX ALLOWED= 2.27 mm

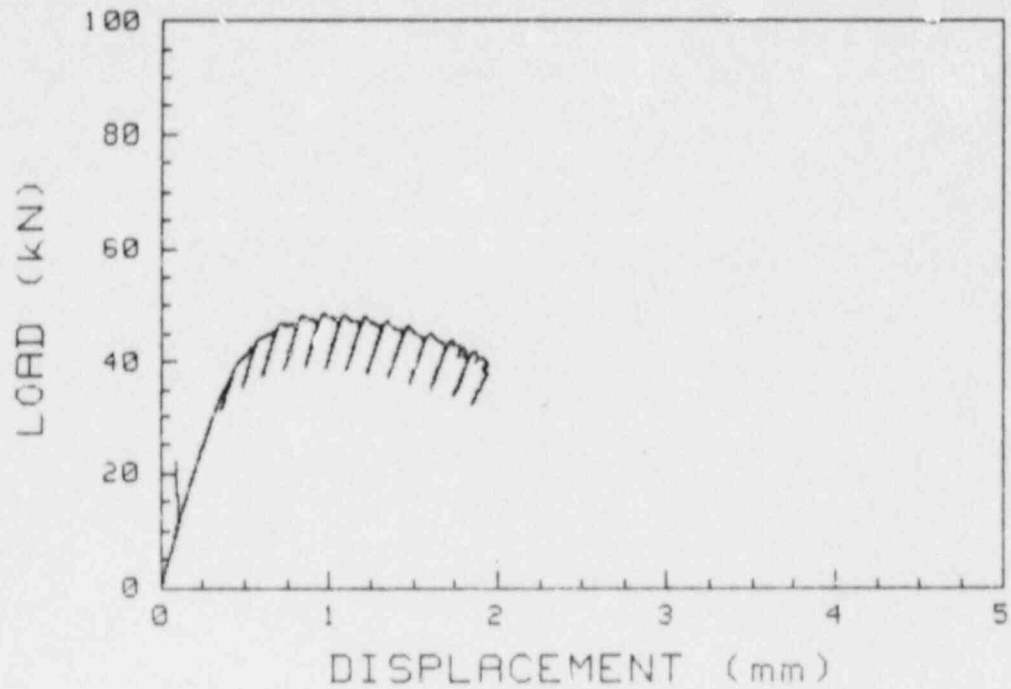
YP1290



ORNL-DWG 87-7987

71W125

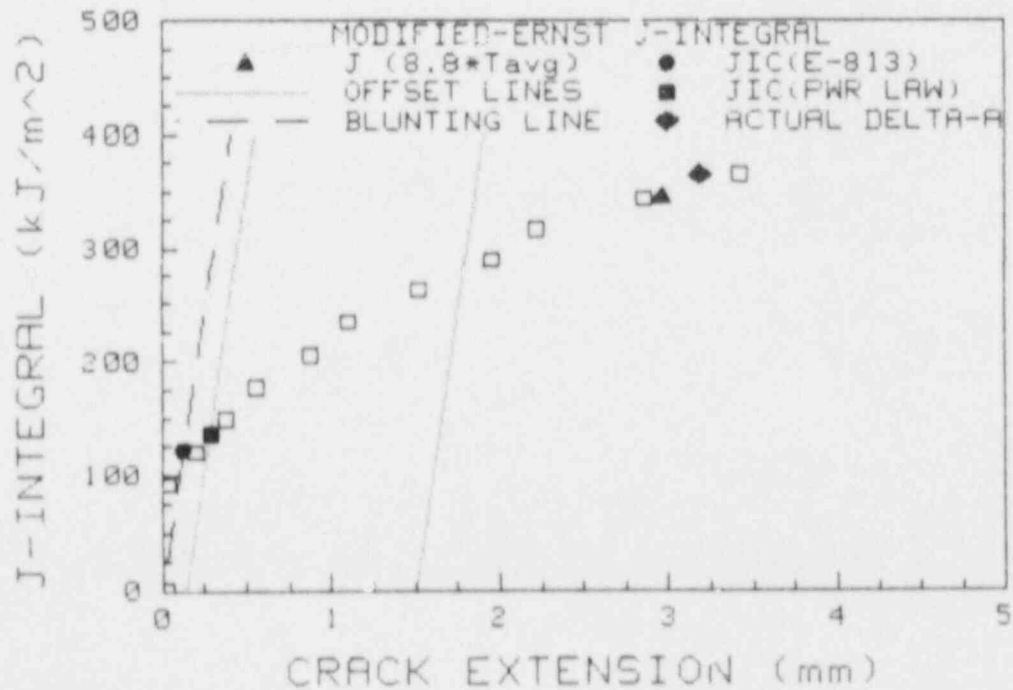
204 DEGREES C



ORNL-DWG 87-7988

71W125

204 DEGREES C



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/m²
 KJ-MAX LOAD= 172 MPa SQR[m]

POWER LAW PROCEDURE

 J_{Ic}= 90.4 kJ/m²
 K-J_{Ic}= 131.3 MPa SQR[m]
 POWER= .4268
 COEFFICIENT= 166.6 kJ/m²
 T (AVERAGE)= 57

ASTM LINEAR PROCEDURE

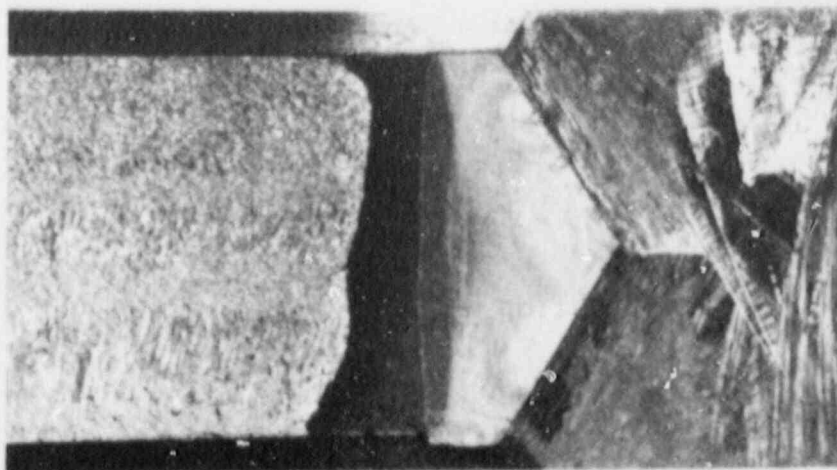
 J_{Ic}= 96.9 kJ/m²
 K-J_{Ic}= 128.8 MPa SQR[m]
 SLOPE= 82036 kJ/m³
 INTERCEPT= 79.9 kJ/m²
 T (ASTM)= 61
 VALID, E813

J1-R CURVE CALCULATIONS

 J (@J/T=8.8)= 247.5 kJ/m²
 POWER= .4014
 J-MAX ALLOWED= 516.2 kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 168.5 kJ/m²
 DELTA-A MAX ALLOWED= 2.26 mm

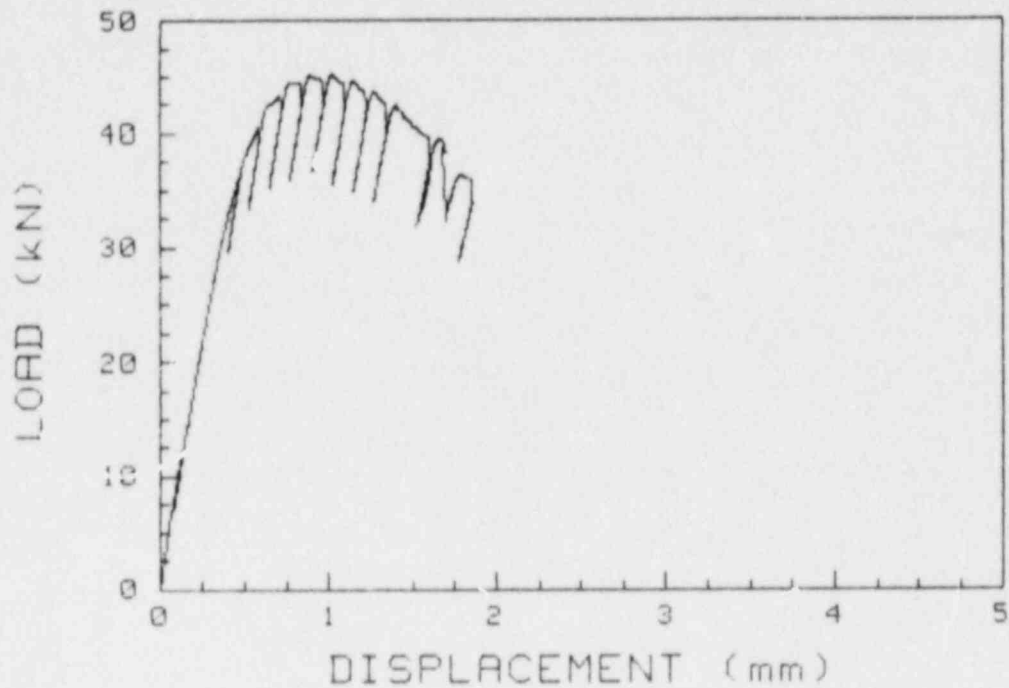
YP1289



ORNL-DWG 87-7989

71W127

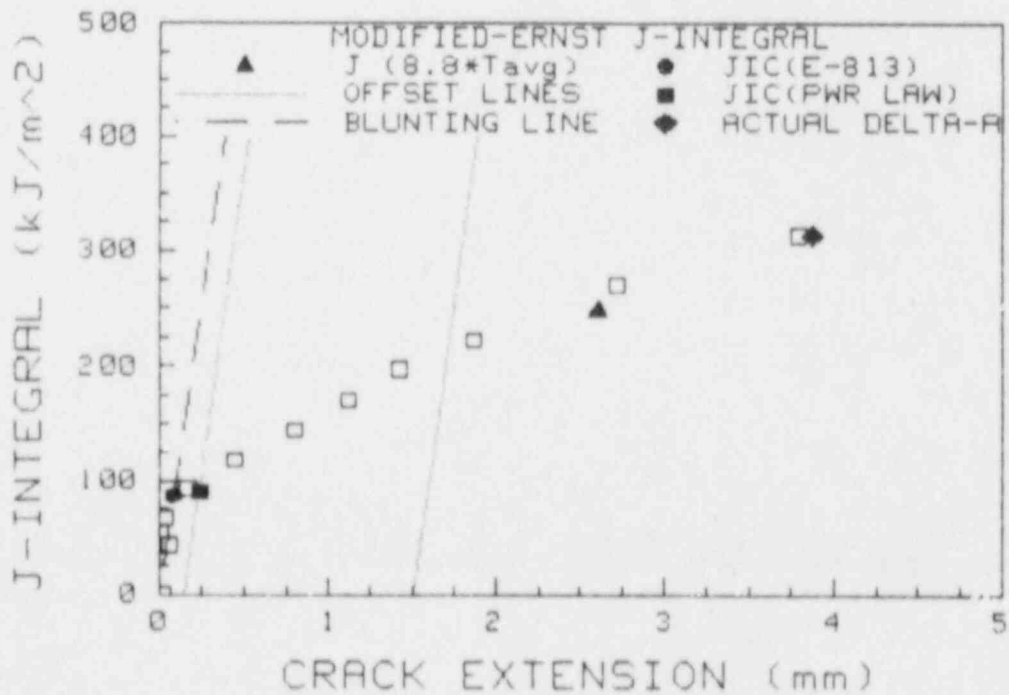
288 DEGREES C



ORNL-DWG 87-7990

71W127

288 DEGREES C



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/m²
 KJ-MAX LOAD= 242.1 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 131.5 kJ/m²
 K-JIc= 164.4 MPa SQR[m]
 POWER= .7843
 COEFFICIENT= 364.2 kJ/m²
 T (AVERAGE)= 201

ASTM LINEAR PROCEDURE

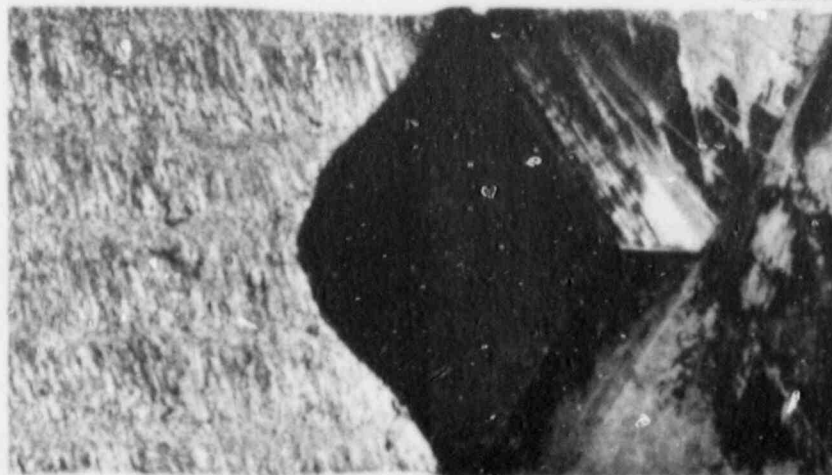
 JIc= 128.8 kJ/m²
 K-JIc= 162.7 MPa SQR[m]
 SLOPE= 258546 kJ/m³
 INTERCEPT= 97.7 kJ/m²
 T (ASTM)= 186
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 1019.9 kJ/m²
 POWER= .6956
 J-MAX ALLOWED= 613.4 kJ/m²
 RCURVE INVALID, 3

COEFFICIENT= 364.1 kJ/m²
 DELTA-A MAX ALLOWED= 2.29 mm

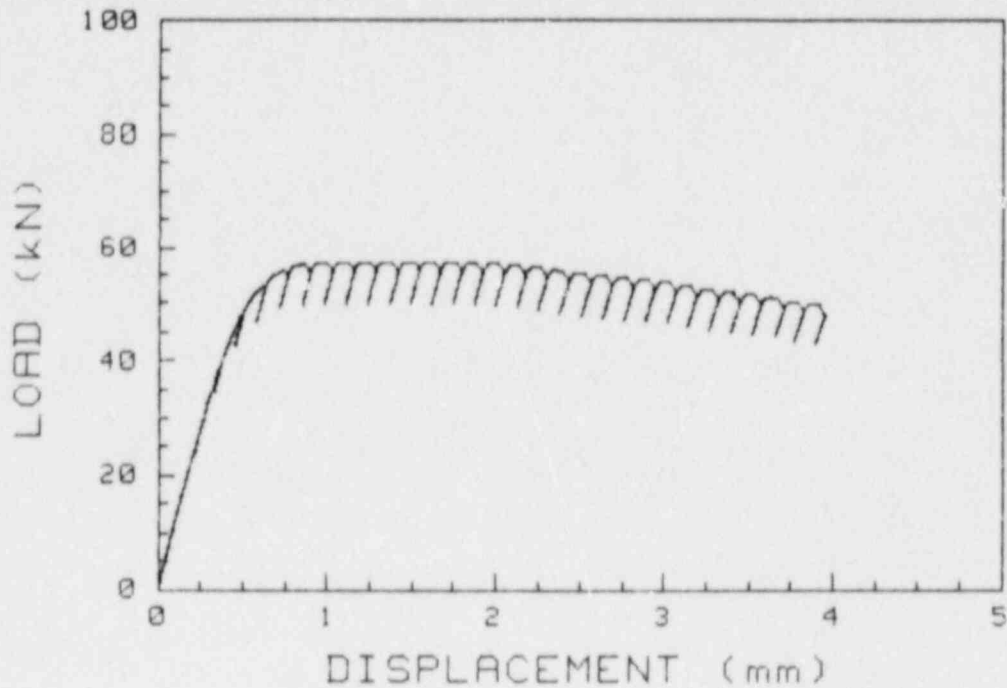
YP1288



ORNL-DWG 87-7991

71W-130

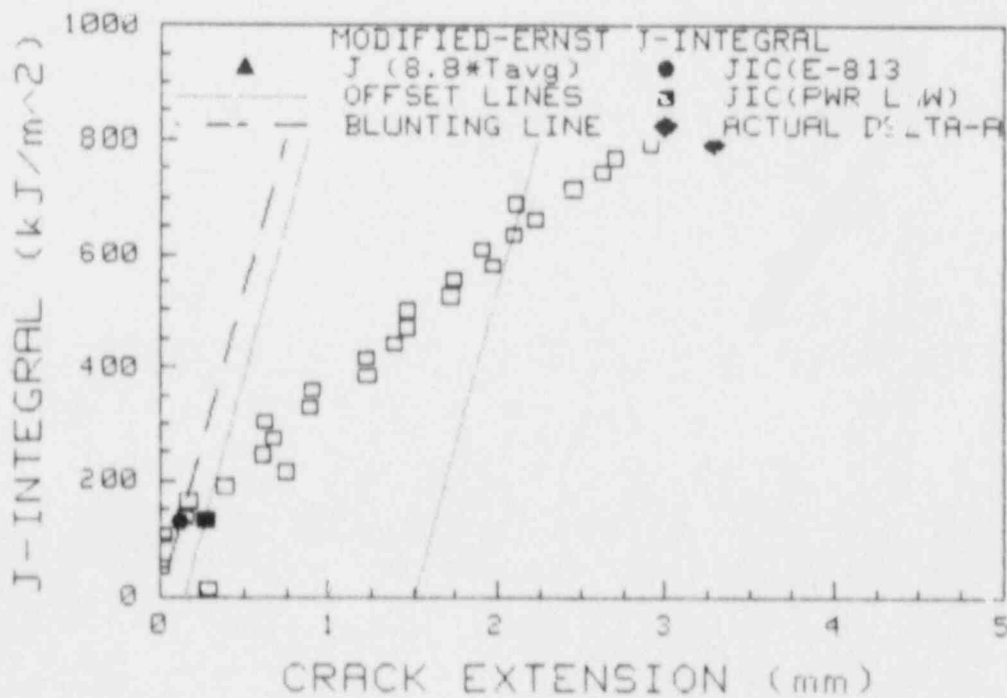
30 DEGREES C



ORNL-DWG 87-7992

71W-130

30 DEGREES C



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 K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 202.9 kJ/m²
 $K_{Jc} = 205.3$ MPa SQR[m]
 $K\text{-beta-c} = 99$ MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 202.2 kJ/m²
 $K_{Jc} = 205$ MPa SQR[m]
 $K\text{-beta-c} = 99$ MPa SQR[m]

POWER LAW PROCEDURE

$J_{Ic} = 161.9$ kJ/m²
 $K\text{-}J_{Ic} = 183.4$ MPa SQR[m]
 POWER= .5616
 COEFFICIENT= 322.9 kJ/m²
 T (AVERAGE)= 117

ASTM LINEAR PROCEDURE

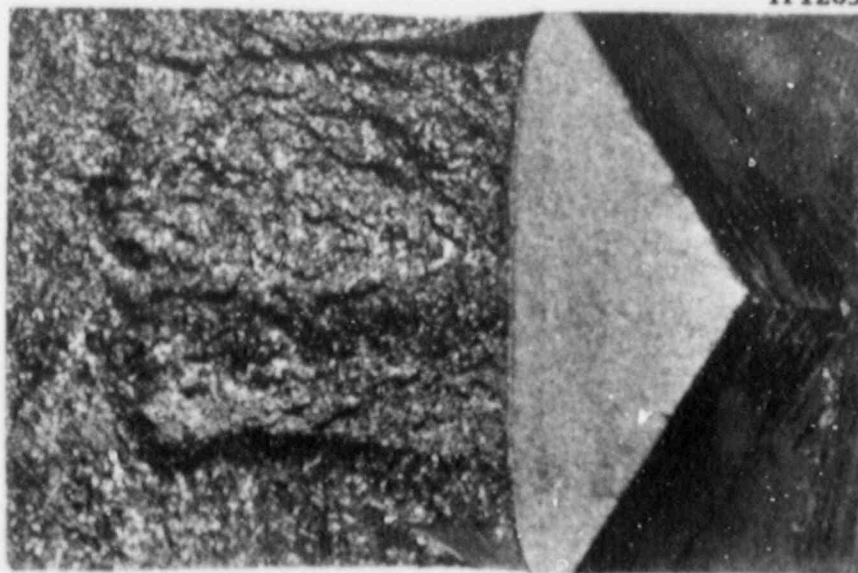
$J_{Ic} = 0$ kJ/m²
 $K\text{-}J_{Ic} = 0$ MPa SQR[m]
 SLOPE= 0 kJ/m³
 INTERCEPT= 0 kJ/m²
 T (ASTM)= 0
 INVALID, 1

J1-R CURVE CALCULATIONS

$J (@J/T=8.8) = 328.9$ kJ/m²
 POWER= .3544
 $J\text{-MAX ALLOWED} = 645.3$ kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 256.6 kJ/m²
 DELTA-A MAX ALLOWED= 2.27 mm

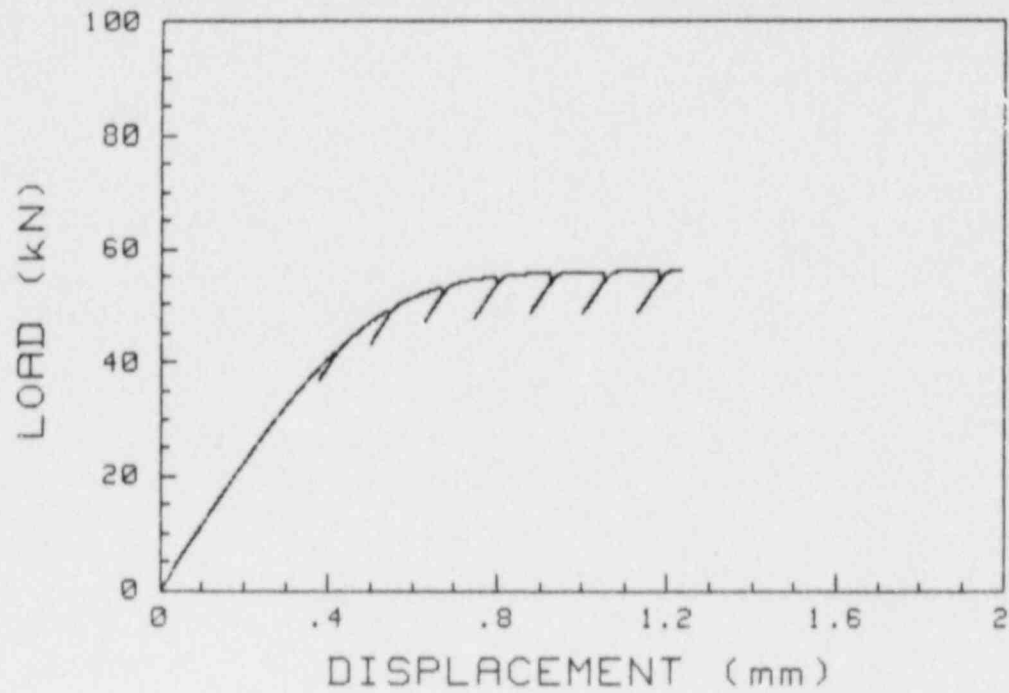
YP1265



ORNL-DWG 87-7993

71W135

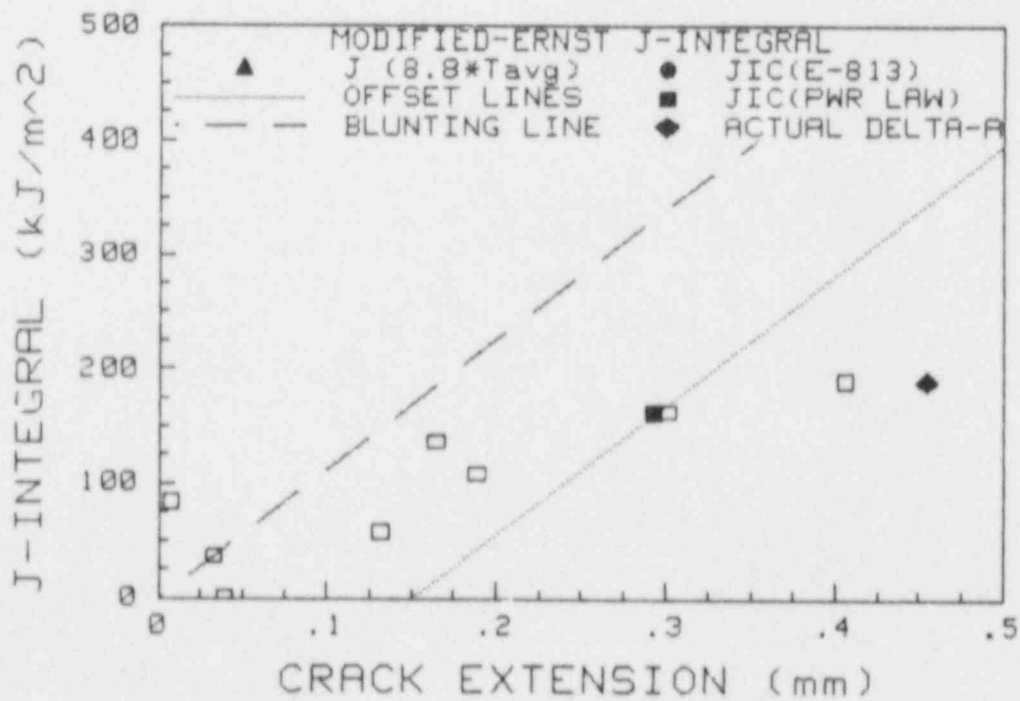
-10 DEGREES C



ORNL-DWG 87-7994

71W135

-10 DEGREES C



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
E-253	68WDE	E-301	71W139
E-254	68WED	E-302	71W149
E-255	68WEE	E-303	71W150
E-256	68WJB	E-304	71W151
E-257	68WLA		
E-258	68WLP		
E-259	68WLD		
E-260	68WMA		
E-261	68WME		
F-262	69W105		
E-263	69W106		
E-264	69W108		
E-265	69W112		
E-266	69W116		
E-267	69W120		
E-268	69W122		

MEA VALIDITY INDEXK_{Ic} (ASTM E399)

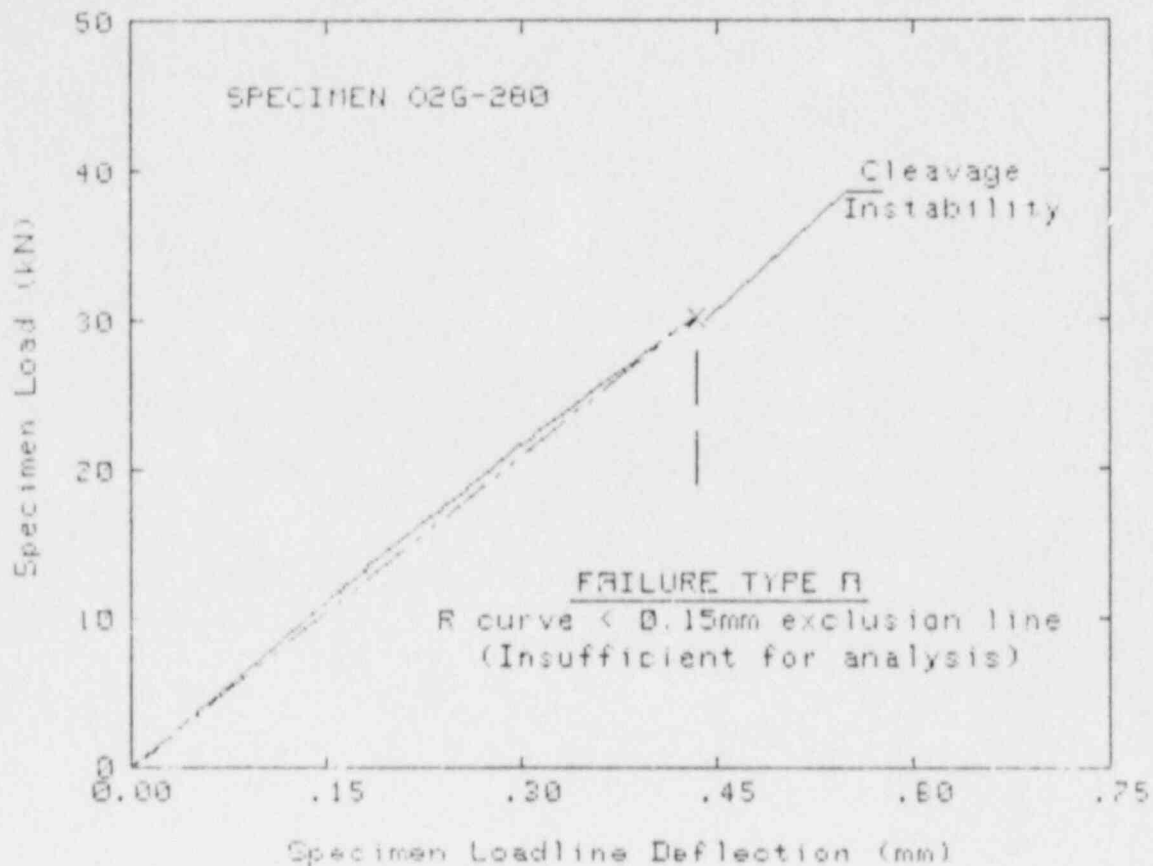
1. $K_{Ic} > \sigma_{ys} * \sqrt{a_0/2.5}$
2. $K_{Ic} > \sigma_{ys} * \sqrt{(B*B_N)^{0.5}/2.5}$
3. $P_{Max}/P_Q > 1.1$

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,
 $|(\Delta a)_{pred} - (\Delta a)_{meas}| > 0.15 (\Delta a)_{meas}$
- d. $B_N < 25 J_Q/\sigma_y$
- e. $b_0 < 25 J_Q/\sigma_y$

Tentative J_I - R Curve Procedure

1. < 3 data points between $(\Delta a)=0$ and secant line
 $[J=4/3*\sigma_y*(\Delta a)]$
2. < 10 data points between secant line and $(\Delta a)_{max}$
 $[0.1*b_0]$
3. (Δa) prediction error too large,
 $|(\Delta a)_{pred} - (\Delta a)_{meas}| >$
 $\text{MINIMUM } [0.15*(\Delta a)_{meas}, 0.15*(\Delta a)_{max}]$



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 = J_{ic})

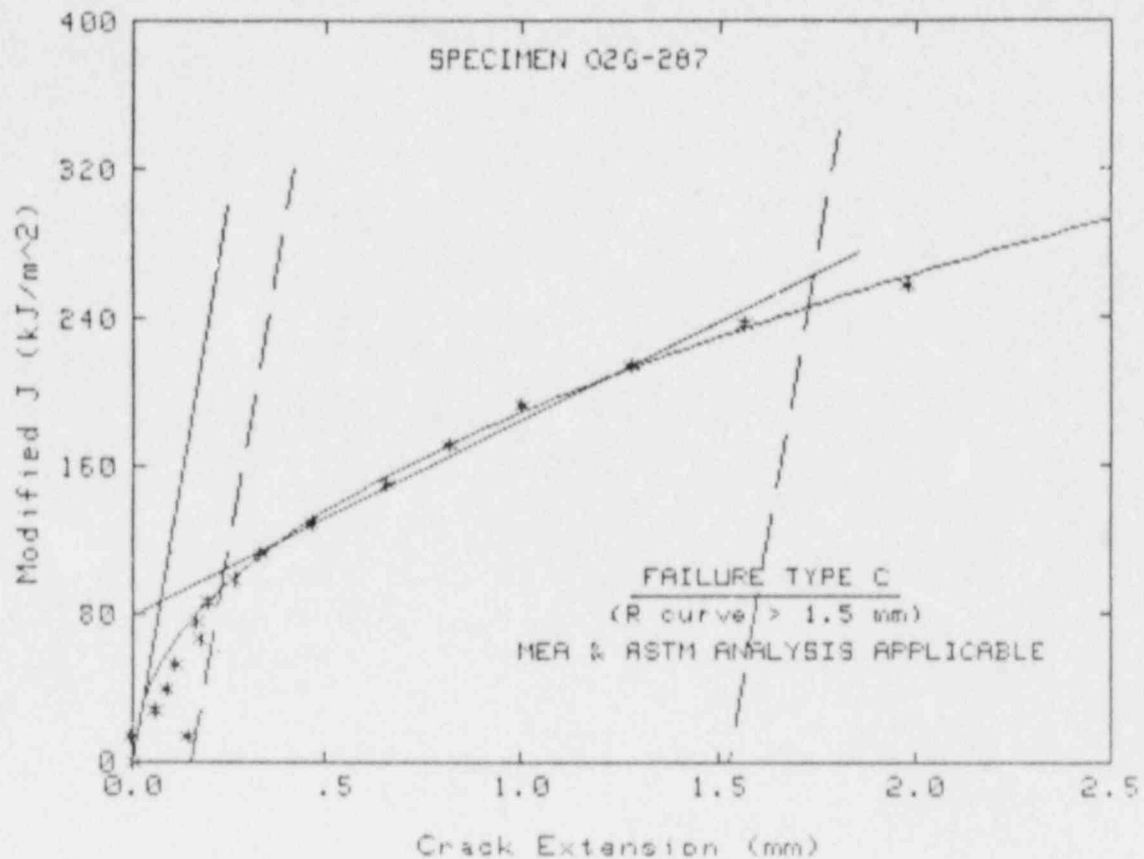
J_{ic} = 30.6 kJ/m²
 $K_{Jc} = (EJ_{ic})^{.5} = 79.3 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$
 $K_{ic} \text{ (Beta Corrected)} = 68.7 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation: $B = (BB_n)^{.5}$
 Maximum Load P = 30.12 kN
 5% Secant Offset P_q = 28.66 kN
 $K_{ic} = 74.3 \text{ MPa } \sqrt{\text{m}}$
 Validity = INVALID--1, 2

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Herrick-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
 Final crack length = 43.65 mm
 Flow stress = 613.1 MPa
 Youngs modulus = 190000 MPa

Init a/W = .609

Final a/W = .859

(Estimated Value)

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

Jic = 93.2 kJ/m²
 Kjc = 133.3 MPa √m
 J (θJ/T=8.8) = 288.5 kJ/m²
 Exponent N = .4787
 Coefficient C = 188.9 kJ/m²
 T (average) = 49

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

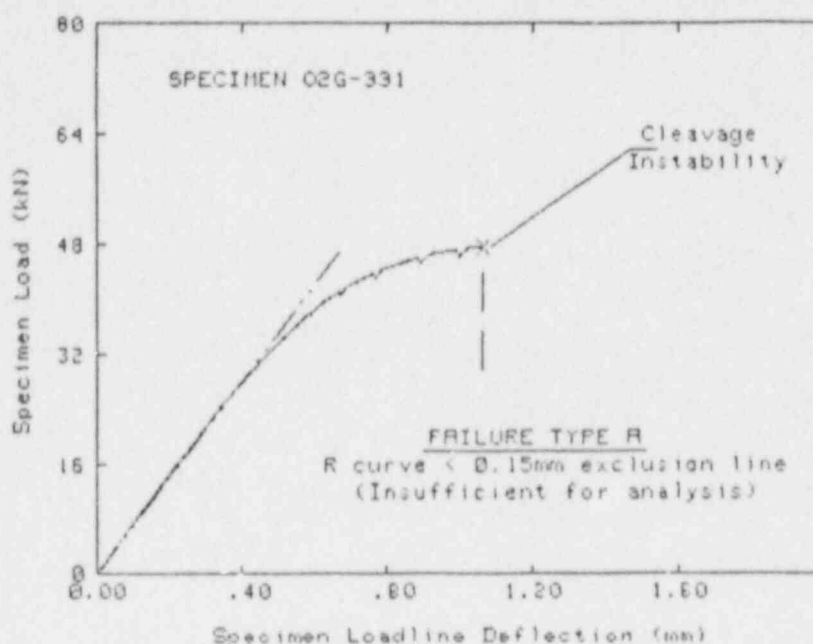
Jic = 86.8 kJ/m²
 Kjc = 128.7 MPa √m
 Slope M = 105633.9 kJ/m³
 Intercept B = 79.3 kJ/m²
 T (ASTM) = 54

Validity (Jic) = VALID

Validity (R-curve) = INVALID--1, 3 (.56 vs .29)

J maximum allowed = 607.7 kJ/m² (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
 Young's modulus E = 202600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

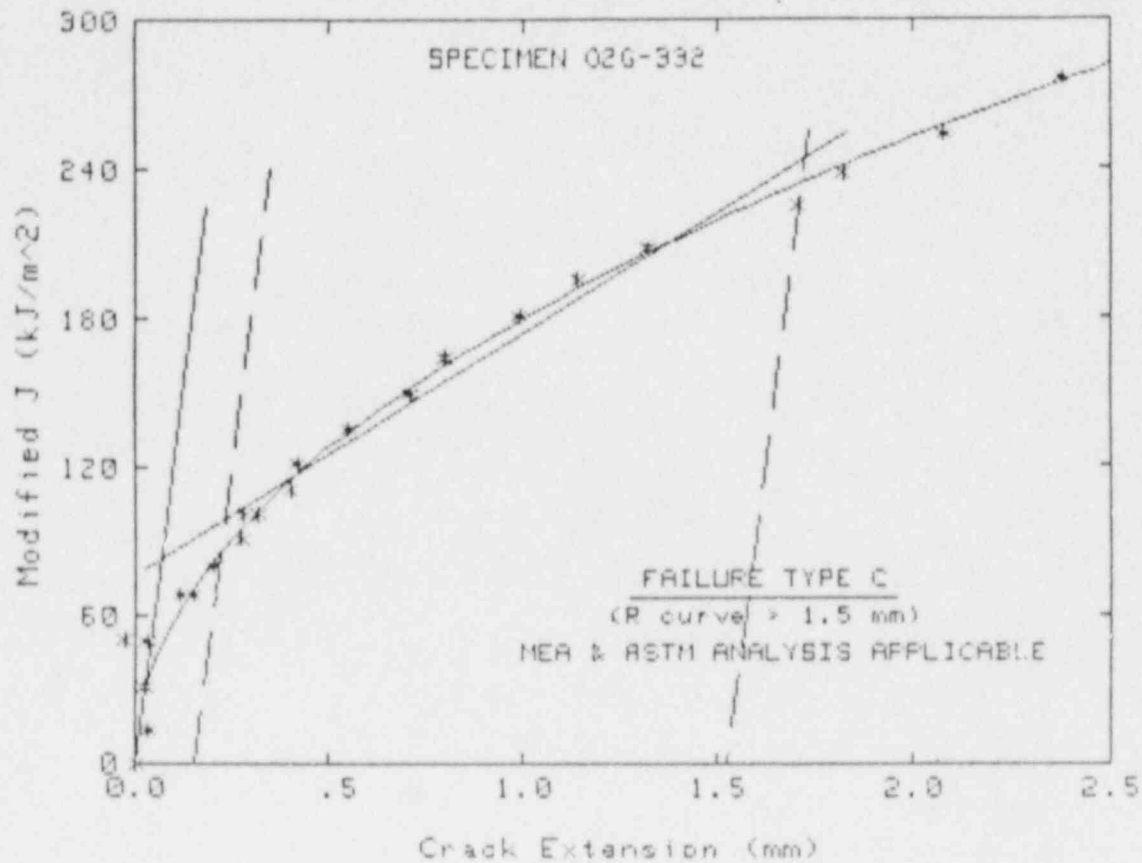
Failure Type R (J at instability = J_{ic})
 J_{ic} = 147.8 kJ/m²
 K_{Jc} = (E J_{ic} / (1 - ν²))^{0.5} = 173.1 MPa √m ν = .3
 K_{ic} (Beta Corrected) = 101.6 MPa √m ν = .3

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation: B = (BB_n)^{0.5}
 Maximum Load P = 47.5 kN
 5% Secant Offset P_Q = 27.84 kN
 K_{ic} = 71.8 MPa √m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 122.5 MPa √m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Hinkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 7.66567519751E-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

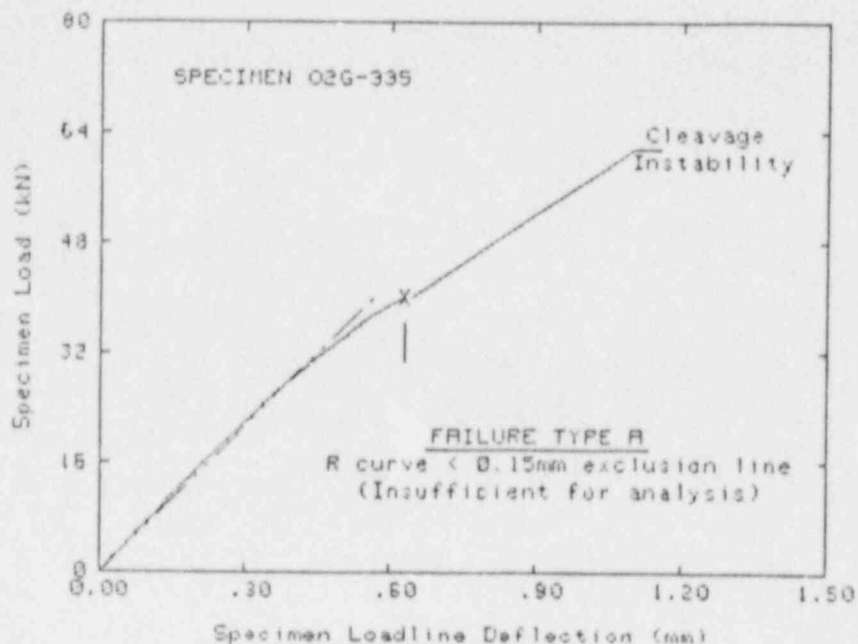
Material Type	= A533B 02 Plate	
Test Temperature	= 288 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.33 mm	Init a/W = .616
Final crack length	= 42.94 mm	Final a/W = .845
Flow stress	= 613.1 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

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

Jic	= 86 kJ/m ²
Kjc	= 128.1 MPa √m
J (@J/T=8.8)	= 288.8 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
 Young's modulus E = 202600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J_{IC})

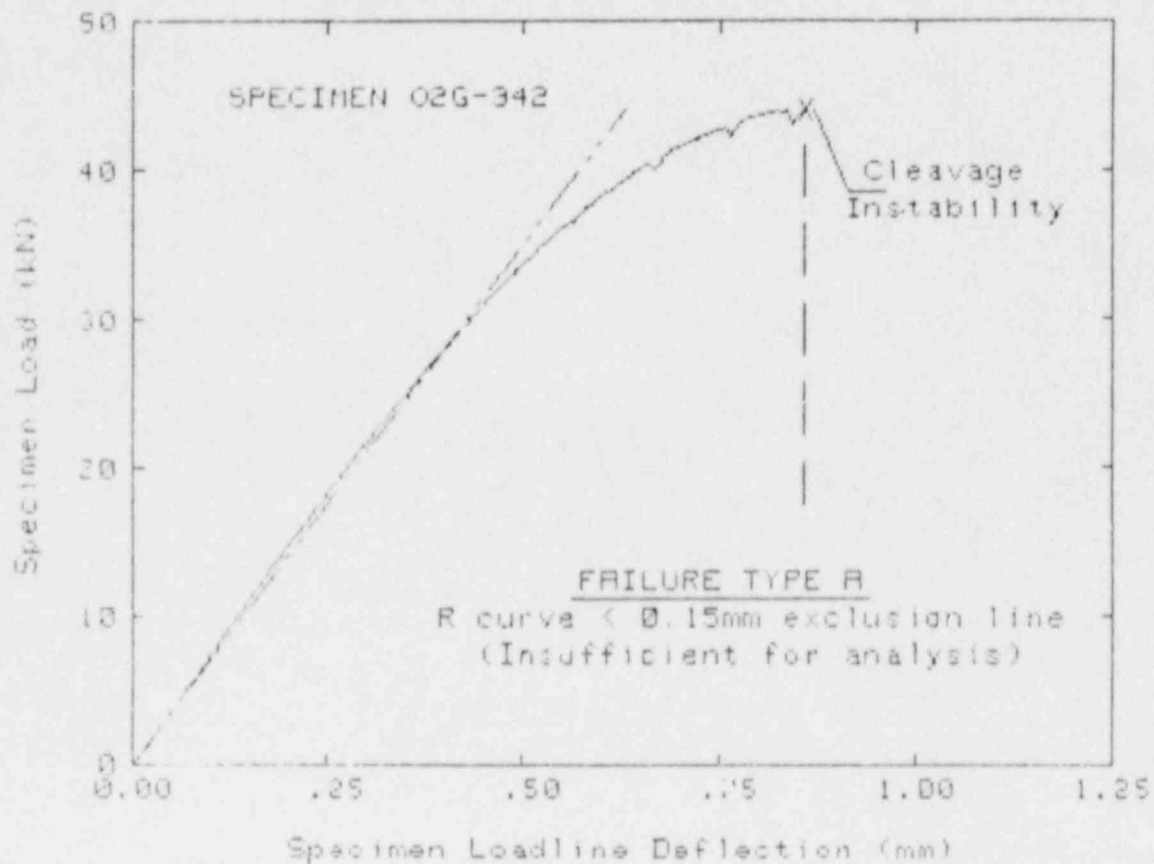
J_{IC} = 61.3 kJ/m²
 $K_{Jc} = (E J_{IC} / (1 - \nu^2))^{.5} = 111.5 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$
 $K_{Ic} \text{ (Beta Corrected)} = 82.5 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$

ASTM E399-81 ANALYSIS

Modified K_{IC} Equation; $B = (B B_n)^{.5}$
 Maximum Load P = 40.1 kN
 5% Secant Offset P_Q = 27.76 kN
 $K_{Ic} = 70.9 \text{ MPa } \sqrt{\text{m}}$
 Validity = INVALID--1, 2, 3
 $K \text{ at Maximum Load} = 102.3 \text{ MPa } \sqrt{\text{m}}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Hertz-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 3.00675364137E-05 in.
 Specimen rotation Load intercept elastic slope = 1.00000000000E-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 = J_{ic})

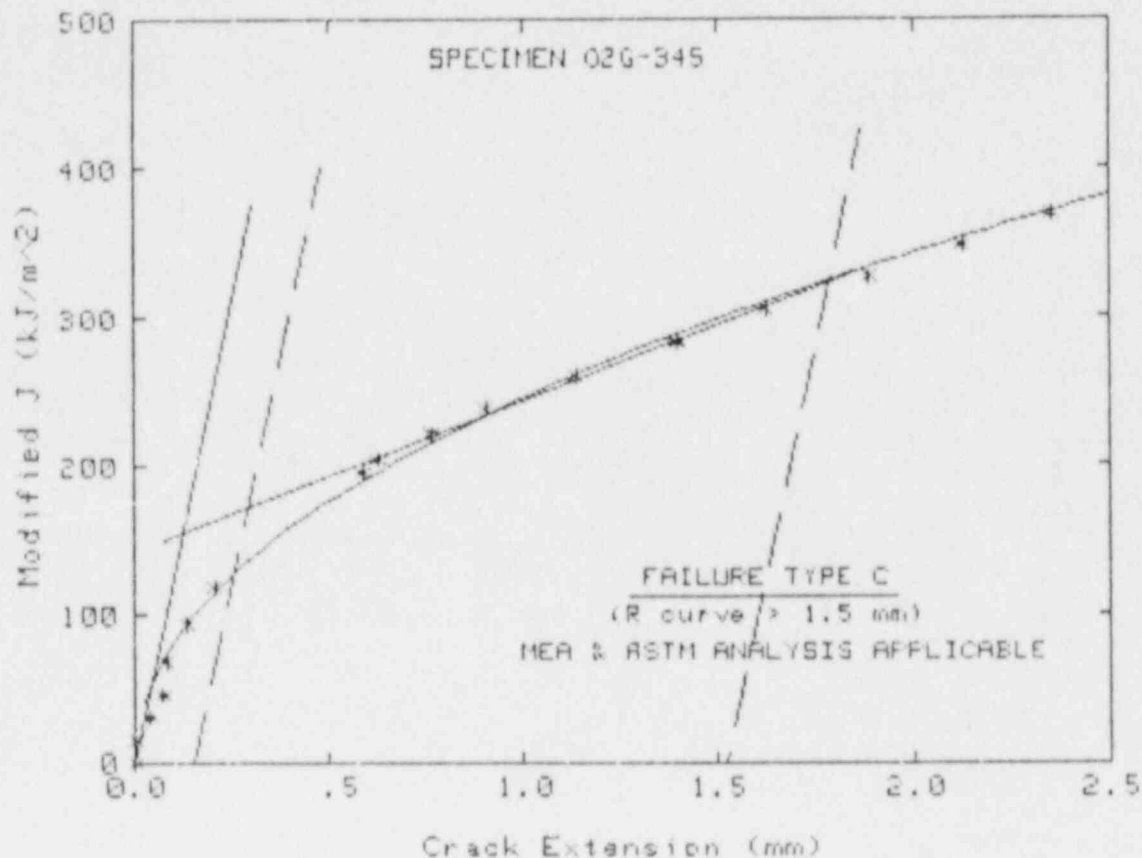
J_{ic} = 103.4 kJ/m²
 K_{Jc} = (EJ_{ic})^{0.5} = 144.8 MPa √m ν=.3
 K_{ic} (Beta Corrected) = 93.8 MPa √m ν=.3

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{0.5}
 Maximum Load P = 44.06 kN
 5% Secant Offset P_Q = 28.56 kN
 K_{ic} = 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

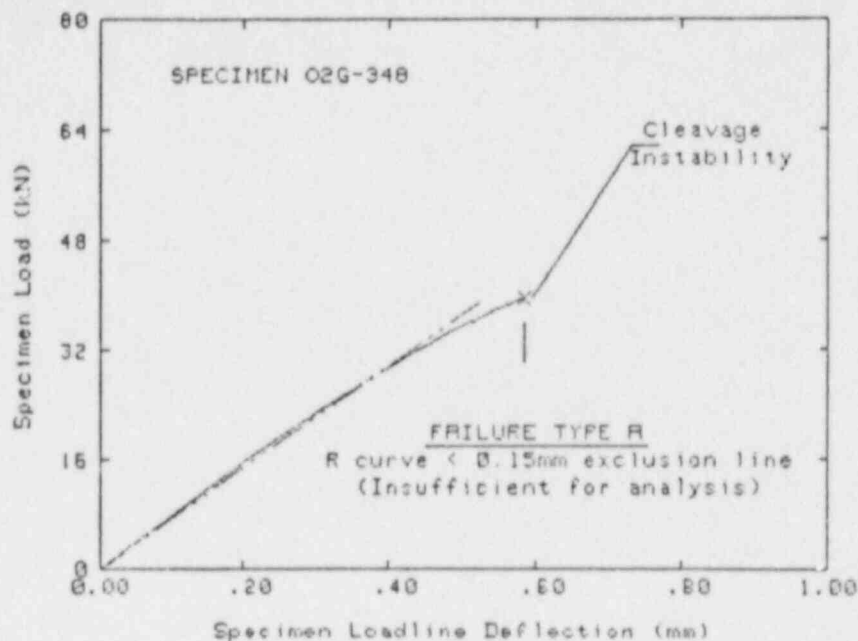
Material Type	= A533B PLATE 02	
Test Temperature	= 204 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.66 mm	Init a/W = .623
Final crack length	= 41.54 mm	Final a/W = .817
Flow stress	= 617.4 MPa	
Young's modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

J _{ic}	= 127.8 kJ/m ²
K _{jc}	= 158 MPa √m
J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 154.6 kJ/m ²
K _{jc}	= 173.8 MPa √m
Slope M	= 101752.7 kJ/m ³
Intercept B	= 141.8 kJ/m ²
T (ASTM)	= 52°
Validity (J _{ic})	= VALID
Validity (R-curve)	= INVALID--1, 3 (.54 vs .28)
J maximum allowed	= 590.4 kJ/m ² (J _{max} =B _{net} +Flow stress/20)
Delta a max. allowed	= 1.91 mm (Delta a max = 0.1*bc)



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
 Young's modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

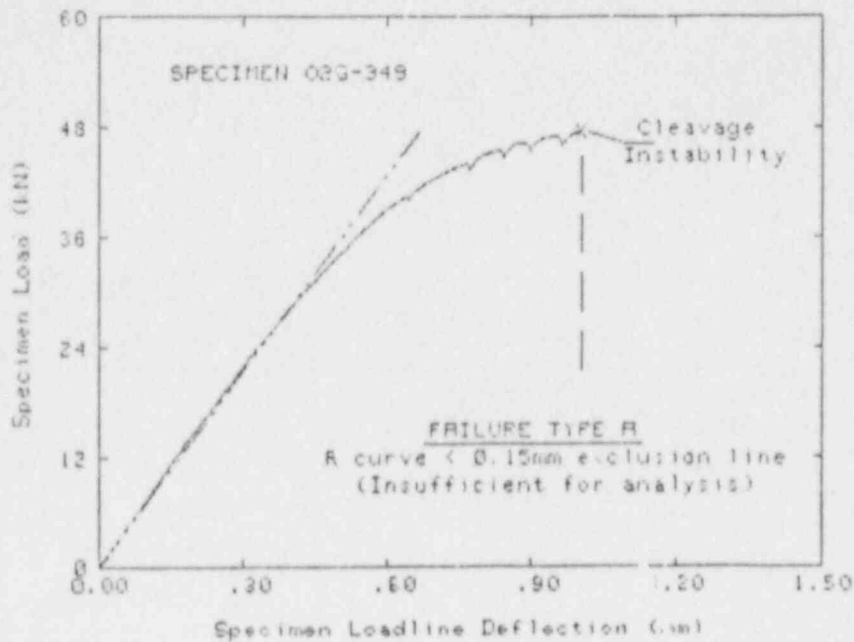
Failure Type R (J at instability = J_{ic})
 J_{ic} = 55.9 kJ/m²
 $K_{Jc} = (E J_{ic} / (1 - \nu^2))^{.5} = 107 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$
 $K_{ic} \text{ (Beta Corrected)} = 81.5 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$

ASTM E399-91 ANALYSIS

Modified K_{ic} Equation; $B = (B_n)^{.5}$
 Maximum Load P = 39.5 kN
 5% Secant Offset P_Q = 28.95 kN
 K_{ic} = 74.3 MPa $\sqrt{\text{m}}$
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 101.4 MPa $\sqrt{\text{m}}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Herrle-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 (1)
 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

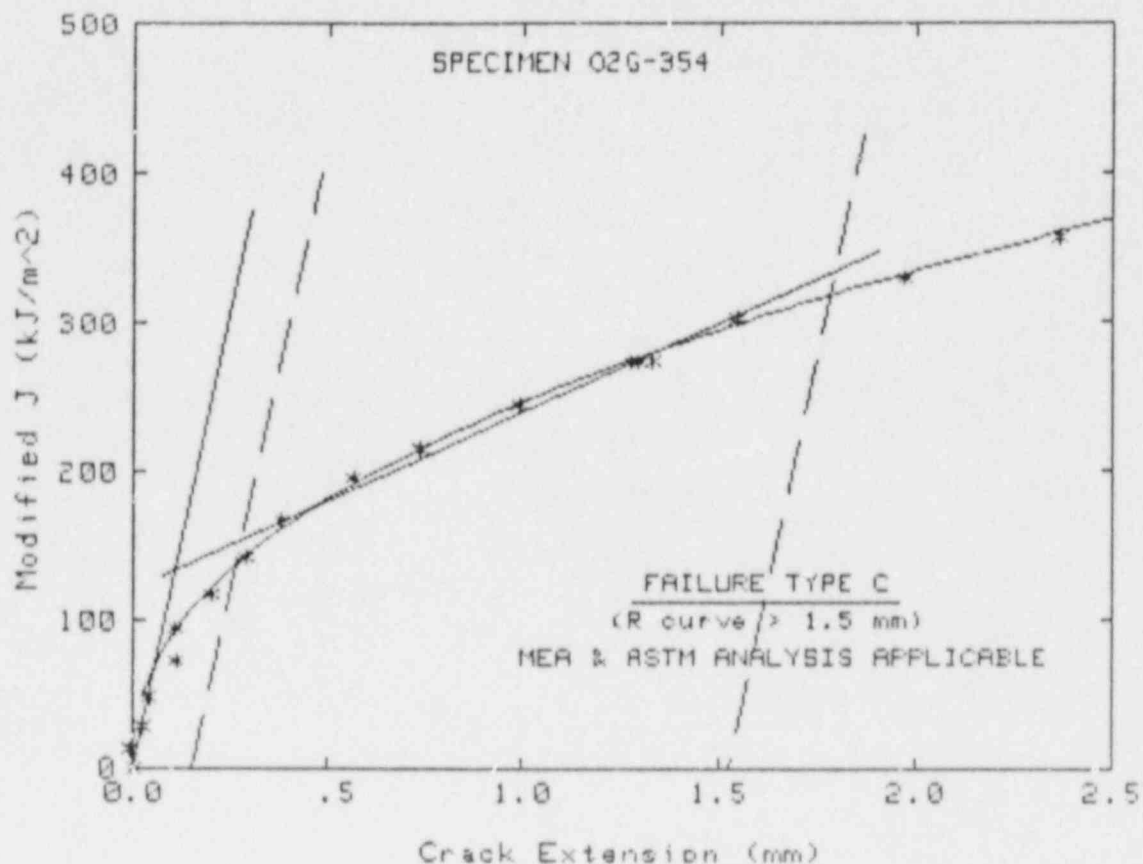
Failure type R (J at instability = J_{ic})
 J_{ic} = 109.4 kJ/m²
 K_{ic} = (E J_{ic})^{0.5} = 168.1 MPa √m vx.3
 K_{ic} (Beta Corrected) = 100.3 MPa √m vx.3

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation: B = (E E₀)^{0.5}
 Maximum Load P = 47.52 kN
 5% Secant Offset P_Q = 26.6 kN
 K_{ic} = 70.6 MPa √m
 Validity = INVALID=1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Hertz-Corten OFFSET LOADS = 0 lb OFFSET DEFLECTION = 1.26447200741E-04 in.
 Specimen rotation Load intercept elastic slope = 3.4629627423E-07 lb
 Fitted elastic load range= 3000 TO 500 Correction to J for crack extension



TEST SPECIMEN DATA

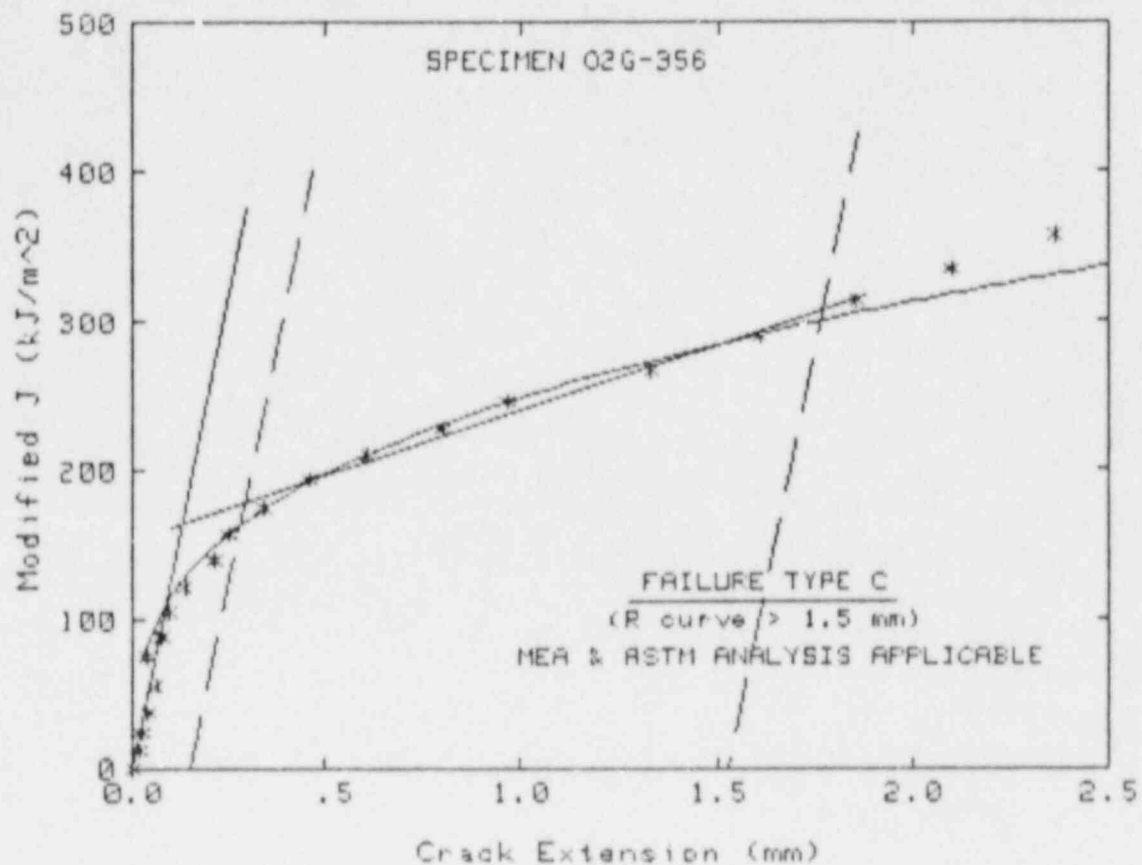
Material Type	= A533-B HSST 02 Ref	
Test Temperature	= 204 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.36 mm	Init a/W = .617
Final crack length	= 41.98 mm	Final a/W = .826
Flow stress	= 617.4 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

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

J _{ic}	= 137.2 kJ/m ²
K _{Jc}	= 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) $J = M (\Delta a) + B$

J _{ic}	= 134.3 kJ/m ²
K _{Jc}	= 162 MPa √m
Slope M	= 118561.1 kJ/m ³
Intercept B	= 121.4 kJ/m ²
T (ASTM)	= 61
Validity (J _{ic})	= VALID
Validity (R-curve)	= INVALID--3 (.87 vs .29)
J maximum allowed	= 599.8 kJ/m ² (J _{max} =B _{net} *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 (ν)	= 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
 Final crack length = 40.61 mm
 Flow stress = 639.2 MPa
 Youngs modulus = 200300 MPa

Init a/W = .622
 Final a/W = .799

(Estimated Value)

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

Jic = 163.1 kJ/m²
 Kjc = 180.7 MPa √m
 J (θJ/T=8.8) = 351.3 kJ/m²
 Exponent N = .3314
 Coefficient C = 248.6 kJ/m²
 T (average) = 43

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

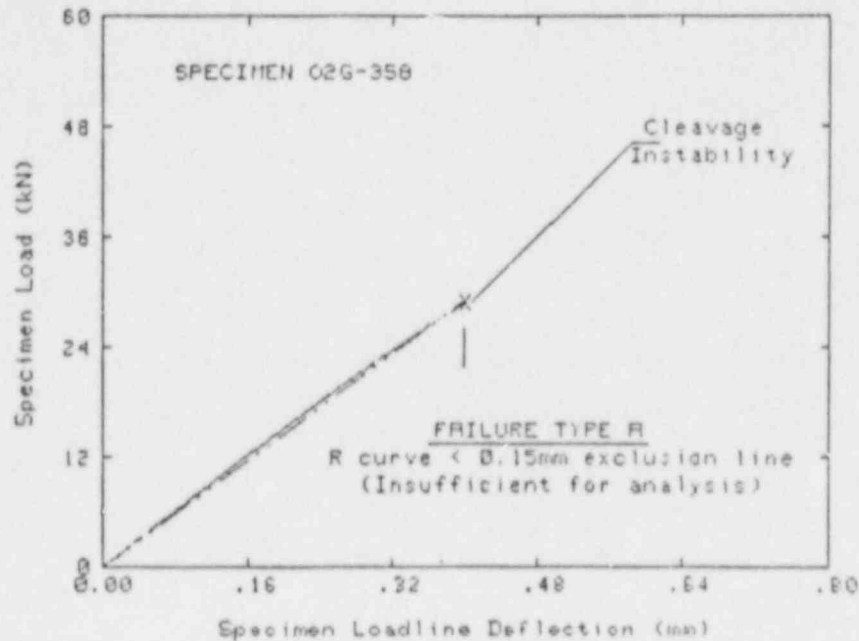
Jic = 165.2 kJ/m²
 Kjc = 181.9 MPa √m
 Slope M = 87303.3 kJ/m³
 Intercept B = 153.9 kJ/m²
 T (ASTM) = 43

Validity (Jic) = VALID

Validity (R-curve) = INVALID--3 (.56 vs .28)

J maximum allowed = 613.2 kJ/m² (Jmax=Bnet*Flow stress/20)

Delta a max. allowed = 1.92 mm (Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type * A503-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

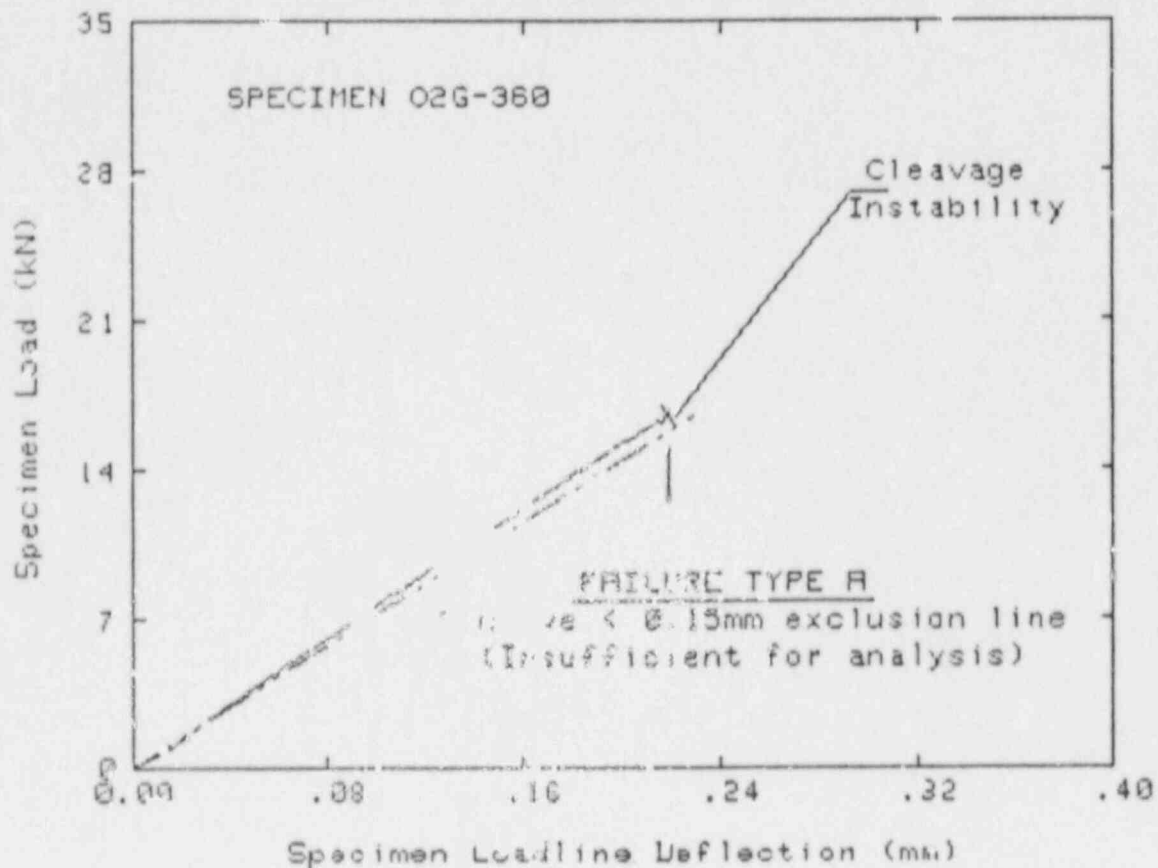
Failure Type A (J at instability = J_{ic})
 J_{ic} * 26.6 kJ/m²
 $K_{Jic} = (E J_{ic} / (1 - v^2))^{.5}$ * 73.8 MPa $\sqrt{m}$ v=.3
 K_{ic} (Beta Corrected) * 65 MPa $\sqrt{m}$ v=.3

ASTM E399-S1 ANALYSIS

Modified K_{ic} Equation; B * (BBn)^{.5}
 Maximum Load P * 28.8 kN
 5% Secant Offset P_Q * 20.22 kN
 K_{ic} * 72.7 MPa $\sqrt{m}$
 Validity * INVALID--1, 2
 K at Maximum Load * 74.2 MPa $\sqrt{m}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Hinkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 8.06109976001E-05 in.
 Specimen rotation Load intercept elastic slope = 9.7181218181E-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	= 21.0 mm
Flow stress	= 715.7 MPa
Yield stress	= 643.3 MPa
Young's modulus E	= 208600 MPa (Estimated Value)
Poisson's Ratio (ν)	= 0

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J_{ic})

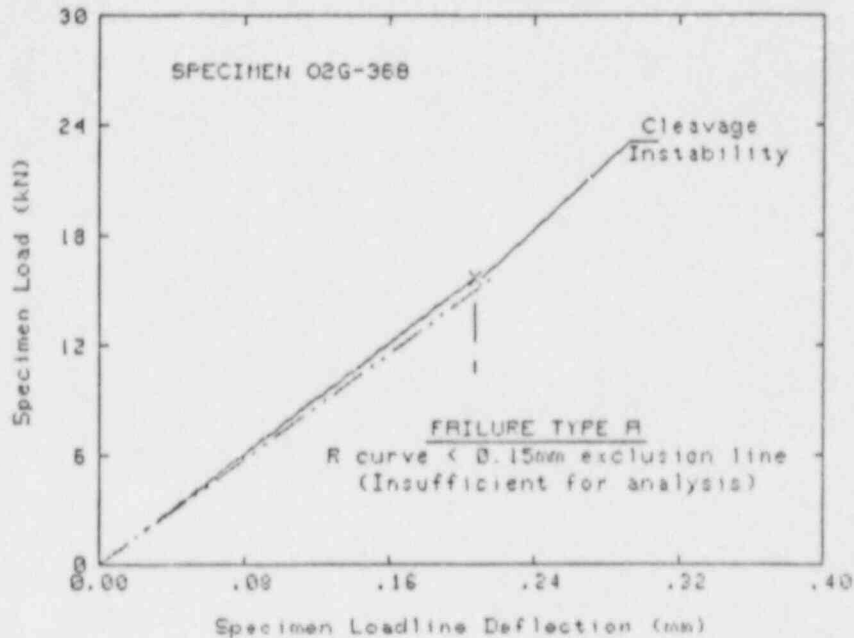
J _{ic}	= 8.7 kJ/m ²	
K _{Jc} = (EJ _{ic} / (1-ν ²)) ^{0.5}	= 41.3 MPa √m	ν=.3
K _{ic} (Beta Corrected)	= 40.6 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation;	R = (BBn) ^{0.5}
Maximum Load P	= 16.5 kN
5% Secant Offset P _q	= 16.53 kN
K _{ic}	= 43.1 MPa √m
Validity	= VALID K _{ic} 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 = A532-B HST 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 (ν) = 0

J-INTEGRAL ANALYSIS

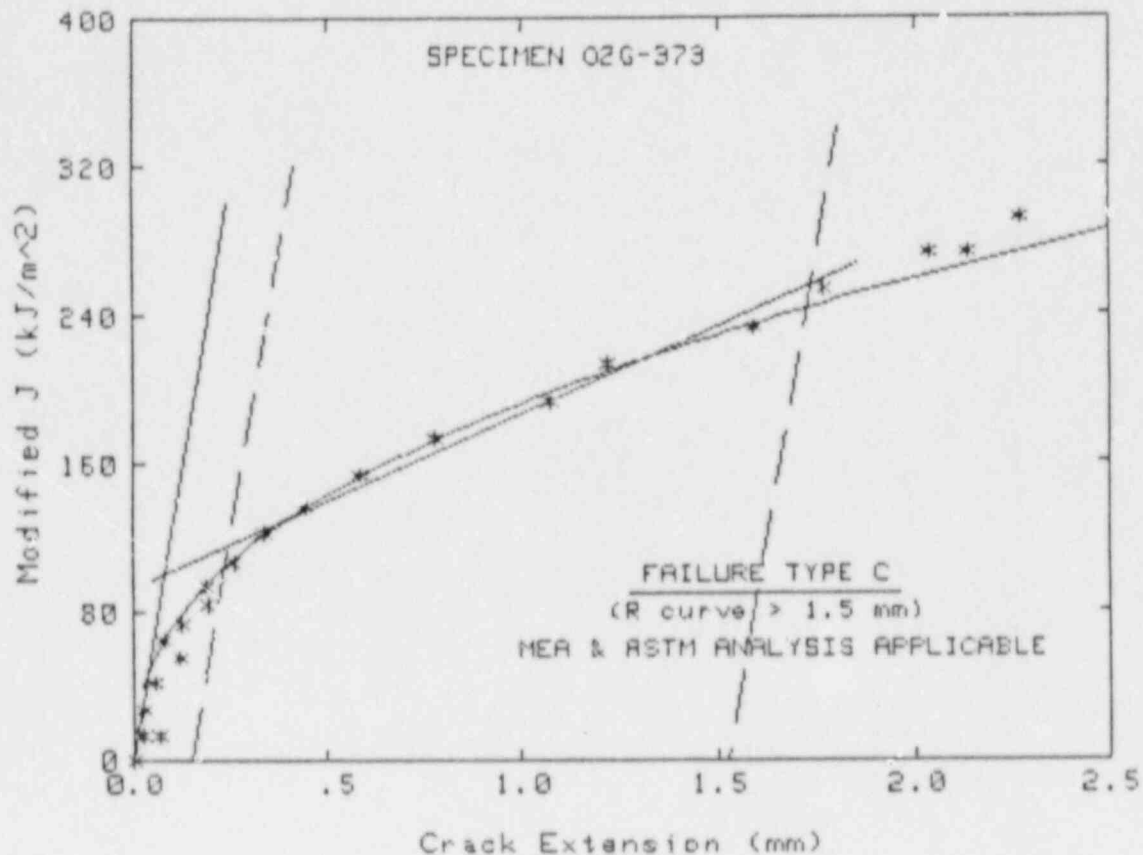
Failure Type A (J at instability = J_{ic})
 J_{ic} = 7.4 kJ/m²
 $K_{Jic} = (E J_{ic} / (1 - \nu^2))^{.5} = 39.3 \text{ MPa } \sqrt{\text{m}}$ ν=.3
 K_{ic} (Beta Corrected) = 38.8 MPa $\sqrt{\text{m}}$ ν=.3

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (B B_n)^{.5}$
 Maximum Load P = 15.7 kN
 5% Secant Offset P_Q = 15.67 kN
 K_{ic} = 41.3 MPa $\sqrt{\text{m}}$
 Validity = VALID K_{ic} value
 K at Maximum Load = 41.4 MPa $\sqrt{\text{m}}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Hinkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 2.402610141E-04 in.
 Specimen notation Load intercept elastic slope = 2.3084115004E+06 lb
 Fitted elastic load range= 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

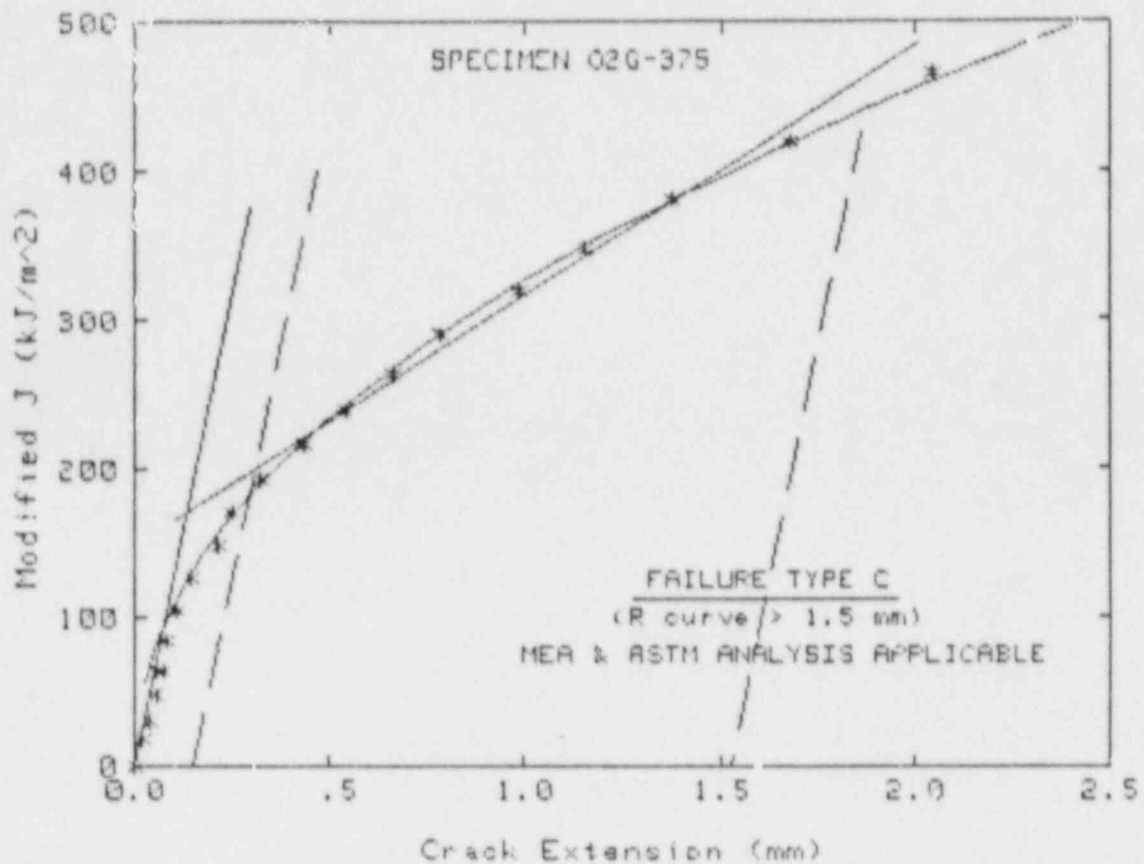
Material Type	= A533B 02 Plate	
Test Temperature	= 288 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.74 mm	Init a/W = .624
Final crack length	= 43.32 mm	Final a/W = .852
Flow stress	= 613.1 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

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

J _{ic}	= 103.8 kJ/m ²
K _{Jc}	= 140.7 MPa √m
J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 100.9 kJ/m ²
K _{Jc}	= 138.7 MPa √m
Slope M	= 93565.2 kJ/m ³
Intercept B	= 93.2 kJ/m ²
T (ASTM)	= 48
Validity (J _{ic})	= VALID
Validity (R-curve)	= INVALID--1
J maximum allowed	= 584 kJ/m ² (J _{max} = B _{net} * Flow stress / 20)
Delta a max. allowed	= 1.91 mm (Δa max = 0.1 * b 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 = 31.85 mm
 Final crack length = 38.56 mm
 Flow stress = 639.2 MPa
 Youngs modulus = 200300 MPa

Init a/W = .626

Final a/W = .759

(Estimated Value)

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

J_{ic} = 182 kJ/m²
 K_{Jc} = 191 MPa √m
 J (@J/T=0.8) = 475.1 kJ/m²
 Exponent N = .4784
 Coefficient C = 326.5 kJ/m²
 T (average) = 77

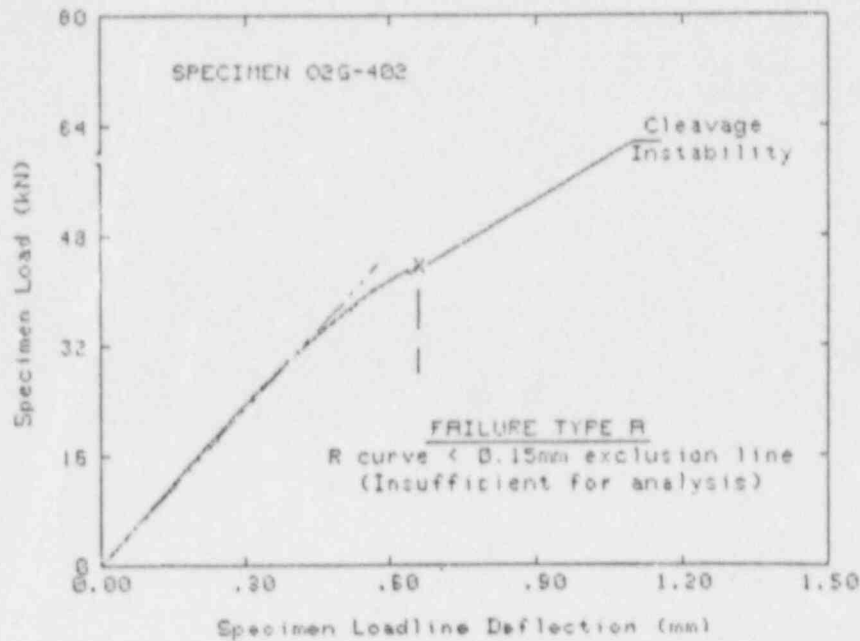
LEAST SQUARE LINEAR LINE (ASTM) $J = M (\Delta a) + B$

J_{ic} = 171.1 kJ/m²
 K_{Jc} = 185.1 MPa √m
 Slope M = 168236.9 kJ/m³
 Intercept B = 148.5 kJ/m²
 T (ASTM) = 83

Validity (J_{ic}) = VALID

Validity (R-curve) = VALID

J maximum allowed = 605.2 kJ/m² (J_{max} = B_{net} * Flow stress / 20)Delta a max. allowed = 1.9 mm (Delta a max = 0.1 * b₀)



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

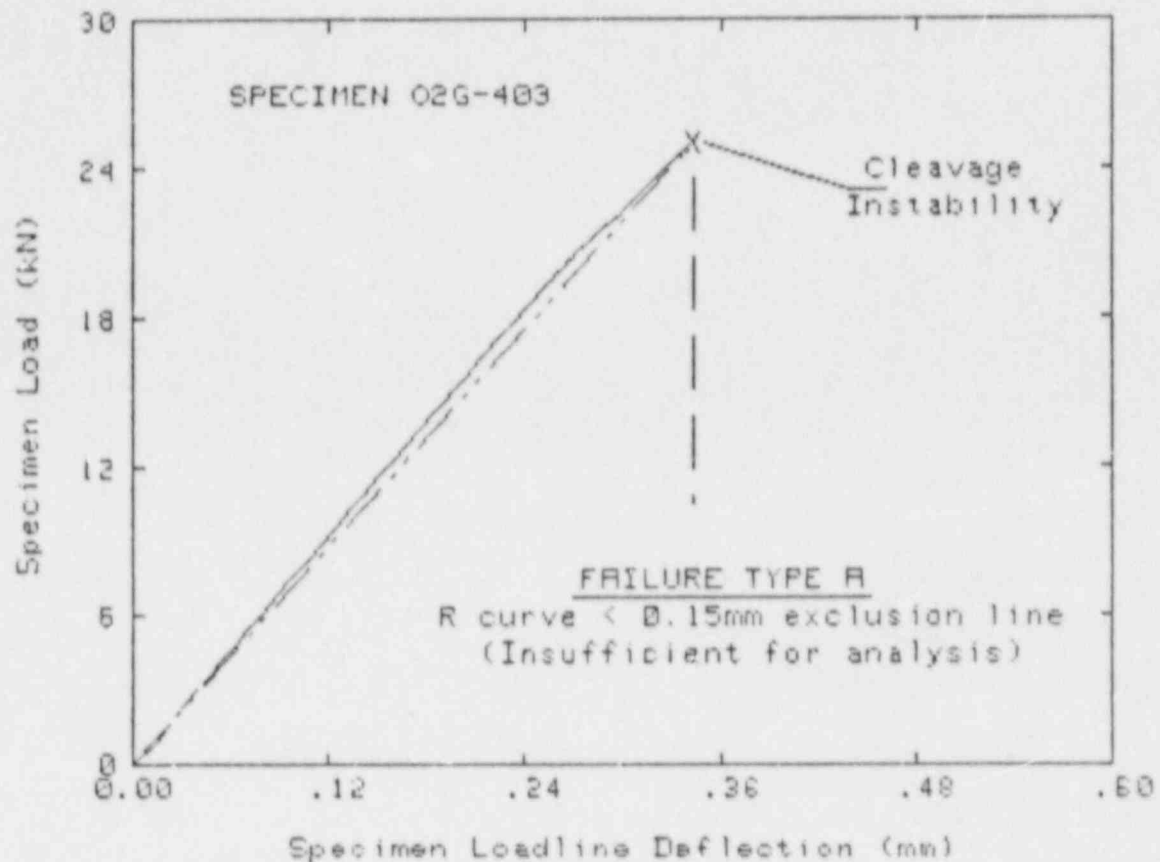
Failure Type R (J at instability = J_{ic})
 J_{ic} = 71.9 kJ/m²
 K_{Jc} (EJ_{ic}/(1-v²))^{0.5} = 121.2 MPa √m v=.3
 K_{ic} (P_{1a} Corrected) = 87.1 MPa √m v=.3

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation: B = (EEn)^{0.5}
 Maximum Load P = 43.7 kN
 5% Secant Offset P_q = 31.25 kN
 K_{ic} = 79.1 MPa √m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 110.7 MPa √m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Herkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 1.50194695321E-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 = J_{ic})

J _{ic}	= 19.4 kJ/m ²	
K _{Jc} = (EJ _{ic}) ^{.5}	= 63.4 MPa √m	ν=.3
K _{ic} (Beta Corrected)	= 58.7 MPa √m	ν=.3

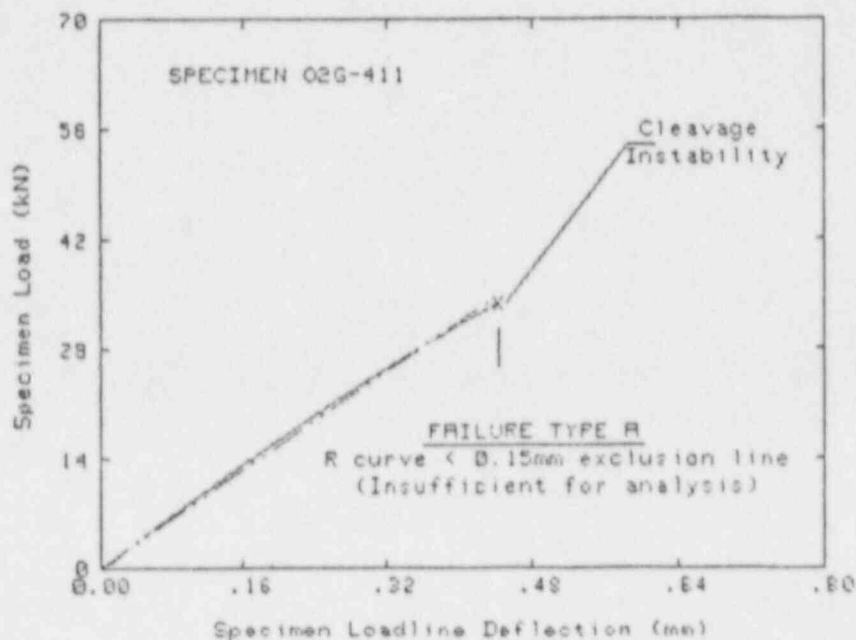
ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{.5}

Maximum Load P	= 25.04 kN
5% Secant Offset P _q	= 25.04 kN
K _{ic}	= 61.6 MPa √m
Validity	= VALID k _{ic} value

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Herkle-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 (ν) = 0

J-INTEGRAL ANALYSIS

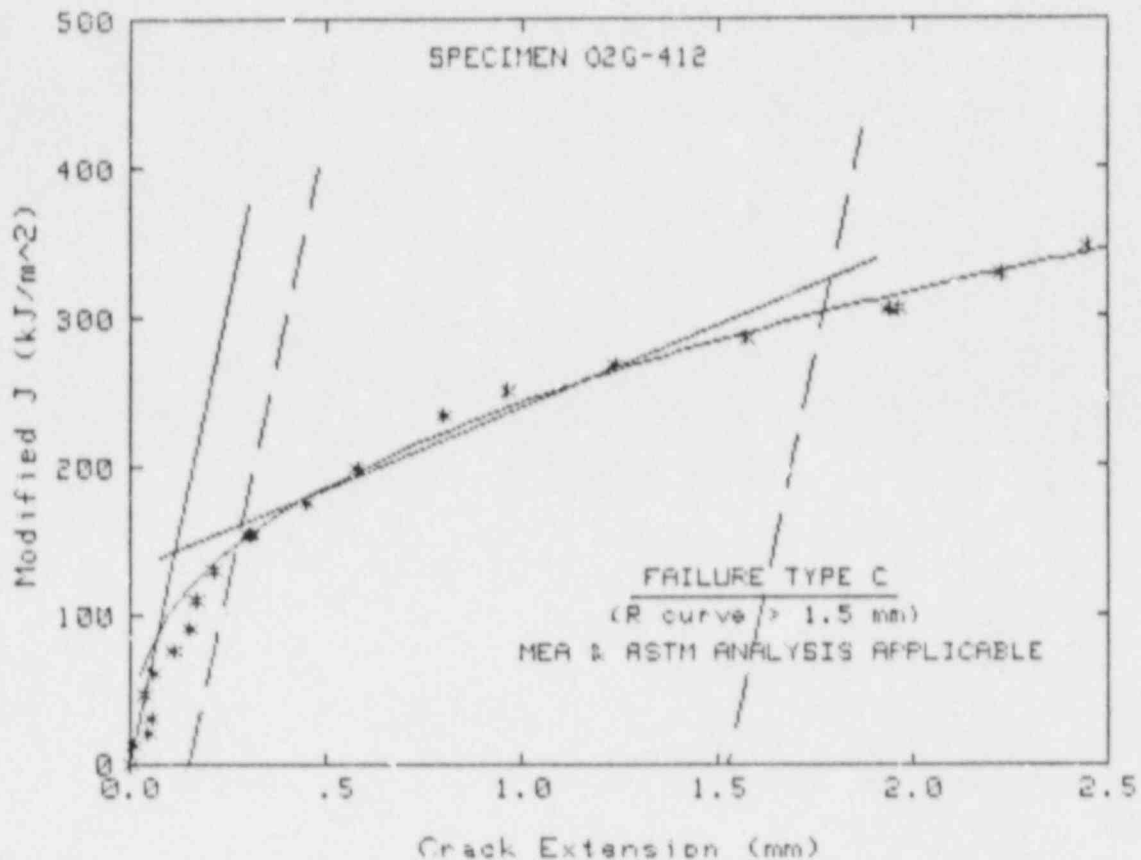
Failure Type A (J at instability = J_{ic})
 J_{ic} = 34.3 kJ/m²
 $K_{Jc} = (E'J_{ic} / (1-\nu^2))^{.5} = 80.7 \text{ MPa } \sqrt{\text{m}}$ vs. 3
 $K_{ic} \text{ (Beta Corrected)} = 70.6 \text{ MPa } \sqrt{\text{m}}$ vs. 3

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (BB_n)^{.5}$
 Maximum Load P = 33.8 kN
 5% Secant Offset P_Q = 29.28 kN
 K_{ic} = 73.1 MPa $\sqrt{\text{m}}$
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 84.4 MPa $\sqrt{\text{m}}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Herkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 1.36307343724E-04 in.
 Specimen rotation Load intercept elastic slope = -.00000035 lb
 Fitted elastic load range = 2500 T: 2000 Correction to J for crack extension



TEST SPECIMEN DATA

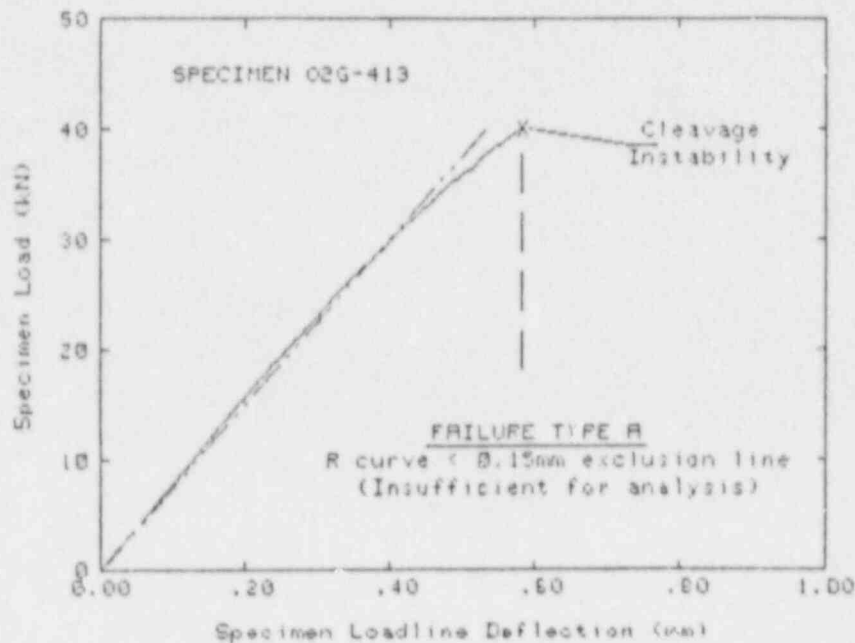
Material Type	= A533B Plate 02	
Test Temperature	= 204 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.89 mm	Init a/W = .612
Final crack length	= 40.92 mm	Final a/W = .805
Flow stress	= 617.4 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

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

Jic	= 147.5 kJ/m ²
Kjc	= 169.8 MPa $\sqrt{m}$
J ($\theta J/T=8.6$)	= 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 $\sqrt{m}$
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 ($J_{max} = B_{net} + \text{Flow stress}/20$)
Delta a max. allowed	= 1.97 mm ($\Delta a_{max} = 0.1 \cdot b_0$)



TEST SPECIMEN DATA

Material Type = A# 13b Plate 02 (1)
 Test Temperature = 60 °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

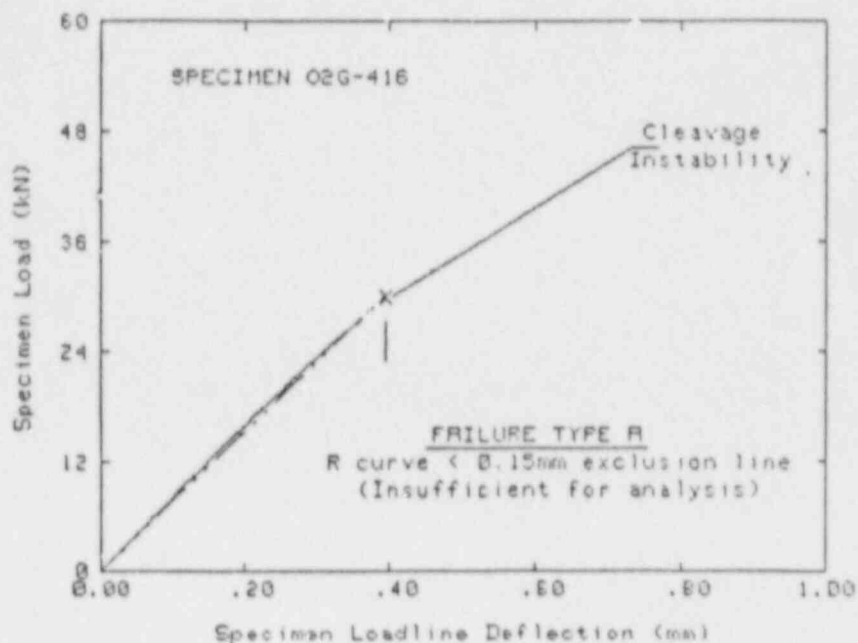
Failure Type A (J at instability = J_{ic})
 J_{ic} = 54.1 kJ/m²
 K_{Jc} = (EJ_{ic})^{0.5} = 104.7 MPa √m u=.3
 K_{ic} (Beta Corrected) = 79.8 MPa √m u=.3

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BBn)^{0.5}
 Maximum Load P = 40.08 kN
 5% Secant Offset P_Q = 28.74 kN
 K_{ic} = 68.5 MPa √m
 Validity = INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Herkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = -4.15078596109E-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 * A333-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
 Young's modulus E * 204400 MPa (Estimated Value)
 Poisson's Ratio (v) * 0

J-INTEGRAL ANALYSIS

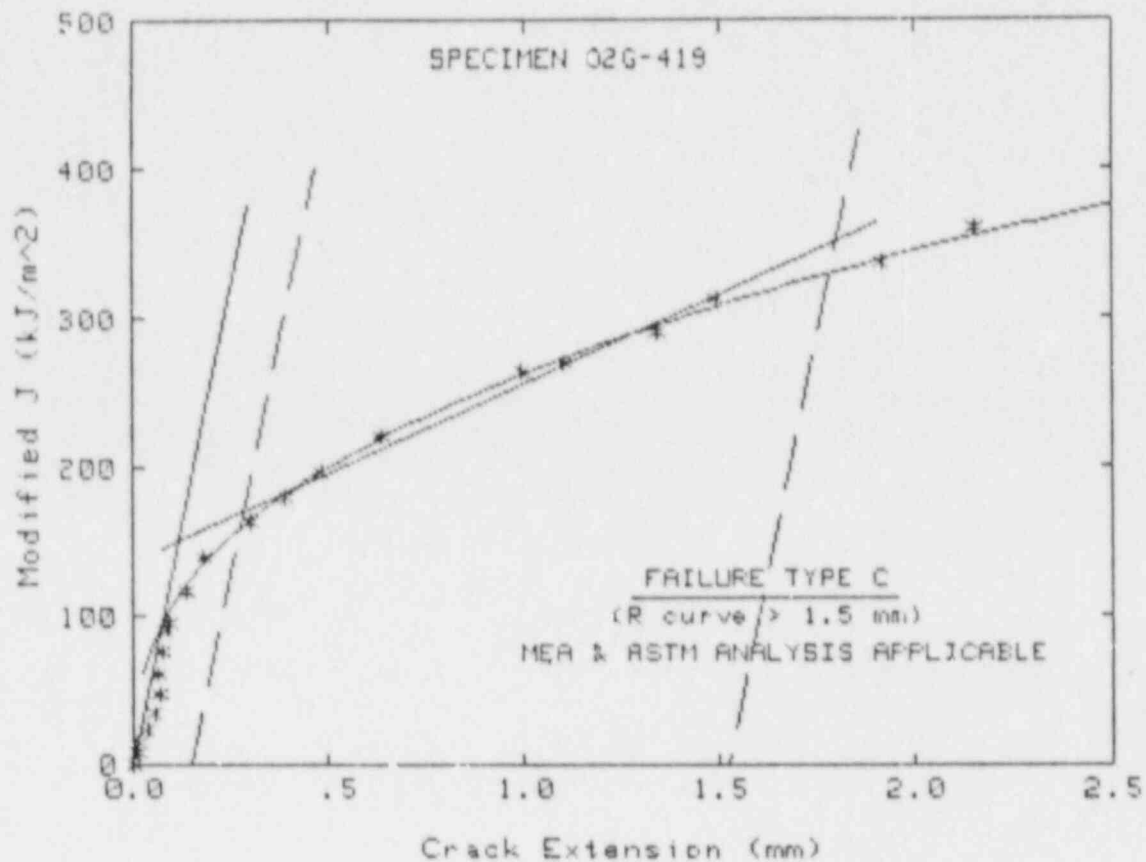
Failure Type A (J at instability = J_{ic})
 J_{ic} * 26.7 kJ/m²
 K_{Jc} = (E J_{ic} / (1 - v²))^{0.5} * 73.9 MPa √m v_u.3
 K_{ic} (Beta Corrected) * 65 MPa √m v_u.3

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation: B * (B_{min})^{1.5}
 Maximum Load P * 29.98 kN
 5% Secant Offset P_Q * 29.04 kN
 K_{ic} * 72 MPa √m
 Validity * INVALID-1, 2
 K at Maximum Load * 74.3 MPa √m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Hinkle-Corten OFFSET LOAD = 0 lb. OFFSET DEFLECTION = 4.58263399200E-05 in.
 Specimen rotation Load intercept elastic slope = 1.41416666667E-05 lb
 Fitted elastic load range = 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

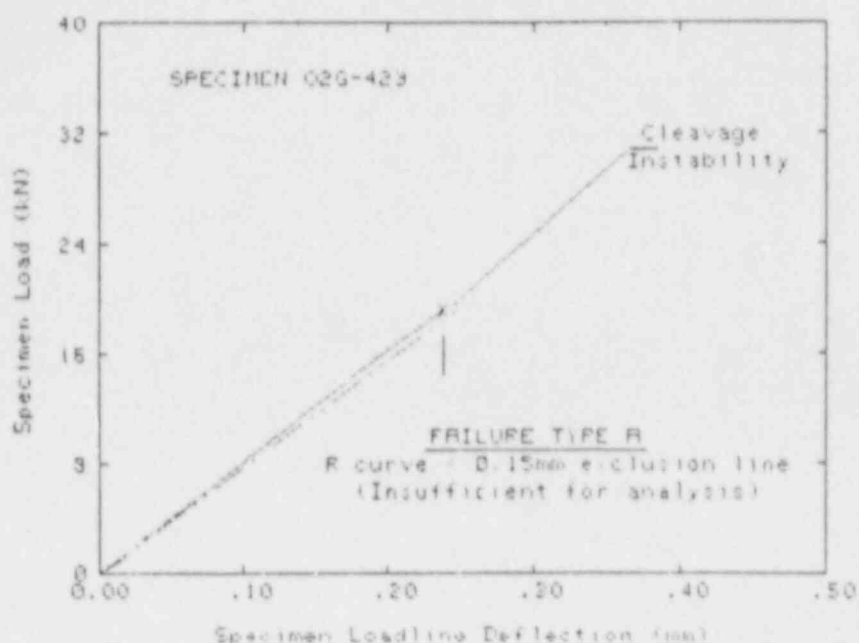
Material Type	= A533B Plate (HSST 02)	
Test Temperature	= 121 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 31.62 mm	Init a/W = .622
Final crack length	= 48.56 mm	Final a/W = .798
Flow stress	= 639.2 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

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

J _{ic}	= 158.4 kJ/m ²
K _{jc}	= 178.1 MPa √m
J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 150.6 kJ/m ²	
K _{jc}	= 173.7 MPa √m	
Slope M	= 119773.4 kJ/m ³	
Intercept B	= 136.5 kJ/m ²	
T (ASTM)	= 59	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 612.6 kJ/m ²	(J _{max} = B _{net} * Flow stress / 20)
Delta a max. allowed	= 1.92 mm	(Delta a max = 0.1 * b _o)



TEST SPECIMEN DATA

Material Type = A500-B HIST 02 Per
 Test Temperature = -25 °C
 Percent Side Groove = 0.1
 Specimen Thickness B = 25.4 mm
 Initial a/W = .61
 Init crack length a = 31 mm
 Flow stress = 715.7 MPa
 Yield stress = 640.3 MPa
 Young's modulus E = 205000 MPa (Estimated Value)
 Poisson's Ratio ν = 0

J-INTEGRAL ANALYSIS

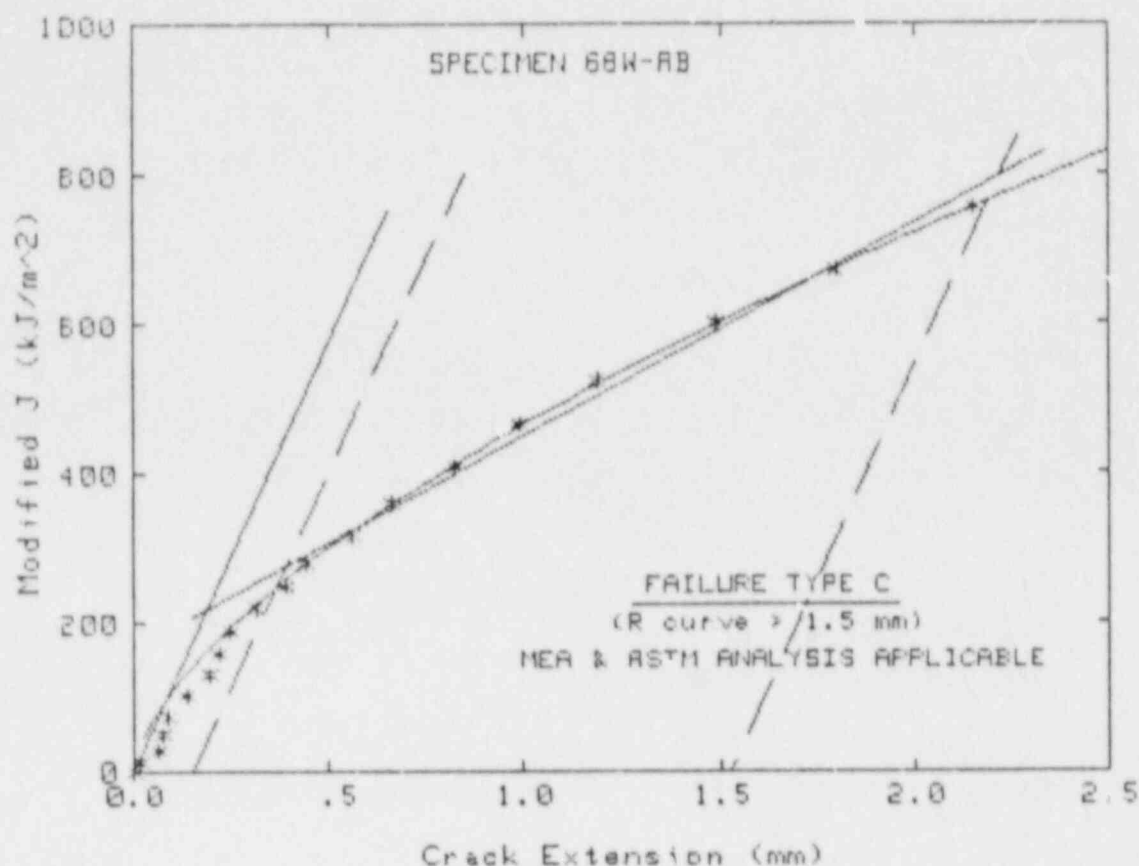
Failure Type R - J at instability = J_{ic}
 J_{ic} = 10.13 kJ/m²
 $K_{Jc} = (E' J_{ic} / (1 - \nu^2))^{1/2} = 45.8 \text{ MPa} \sqrt{\text{m}}$ (ok, 2)
 $K_{Jc} \text{ (Beta Corrected)} = 44.7 \text{ MPa} \sqrt{\text{m}}$ (ok, 3)

ASTM E399-81 ANALYSIS

Modified K_{Jc} Equation: $B = (SEB) \sqrt{.5}$
 Maximum Load P = 19.1 lbf
 5% Secant Offset P_Q = 19.1 lbf
 K_{Jc} = 47.5 MPa $\sqrt{\text{m}}$
 Validity = VALID K_{Jc} value
 K at Maximum Load = 47.4 MPa $\sqrt{\text{m}}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Hertel-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 1.96944502975E-04 in.
 Specimen rotation Load intercept elastic slope = 7.14166666667E-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
 Final crack length = 34.75 mm
 Flow stress = 575.5 MPa
 Youngs modulus = 200300 MPa

Init a/W = .603

Final a/W = .684

(Estimated Value)

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

J_{ic} = 246.7 kJ/m²
 K_{ic} = 222.3 MPa √m
 J (@J/T=8.8) = 983.7 kJ/m²
 Exponent N = .6326
 Coefficient C = 465.2 kJ/m²
 T (average) = 168

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

J_{ic} = 217 kJ/m²
 K_{ic} = 208.5 MPa √m
 Slope M = 286325.8 kJ/m³
 Intercept B = 163 kJ/m²
 T (ASTM) = 173

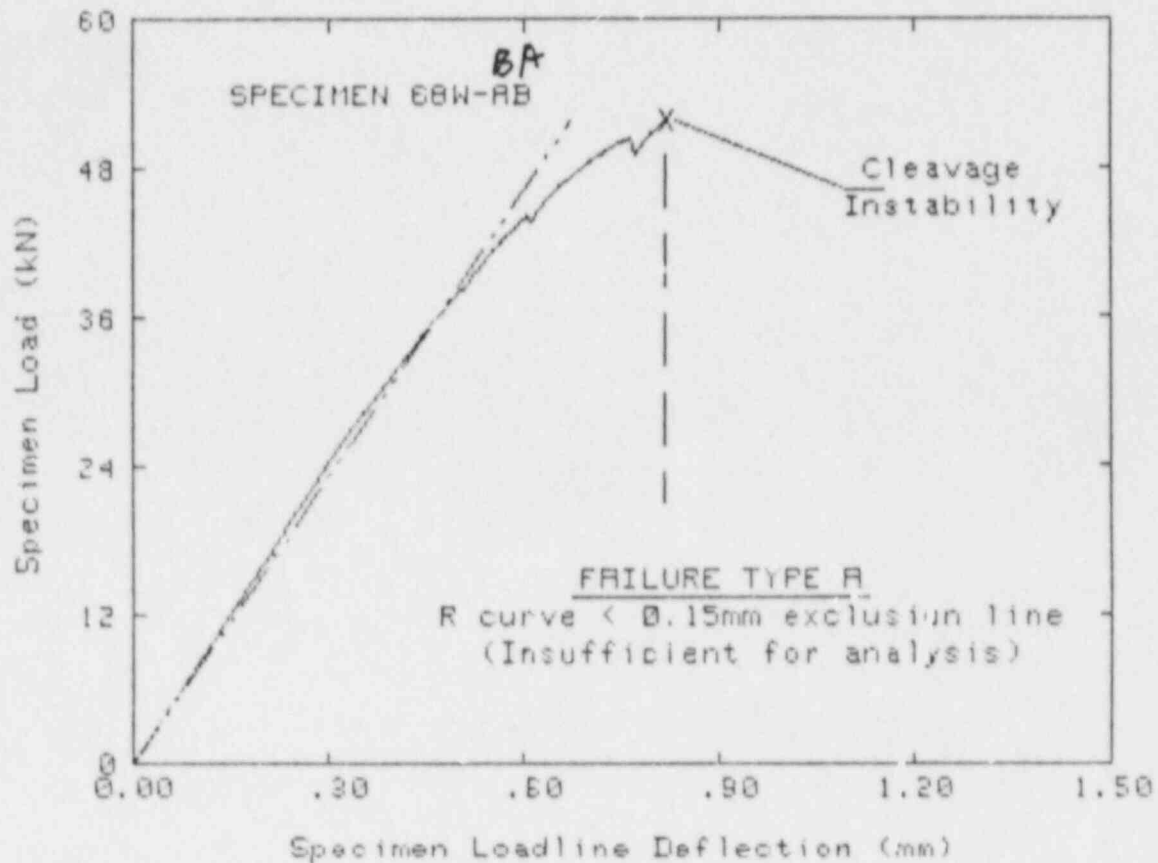
Validity (J_{ic}) = VALID

Validity (R-curve) = INVALID--1

J maximum allowed = 579.4 kJ/m²(J_{max} = B_{net} * Flow stress / 20)

Delta a max. allowed = 2.01 mm

(Delta a max = 0.1 * b₀)



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 = J_{ic})

J _{ic}	=	104.3 kJ/m ²	
K _{Jc} =(EJ _{ic}) ^{0.5}	=	148.5 MPa √m	ν=.3
K _{ic} (Beta Corrected)	=	105.7 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

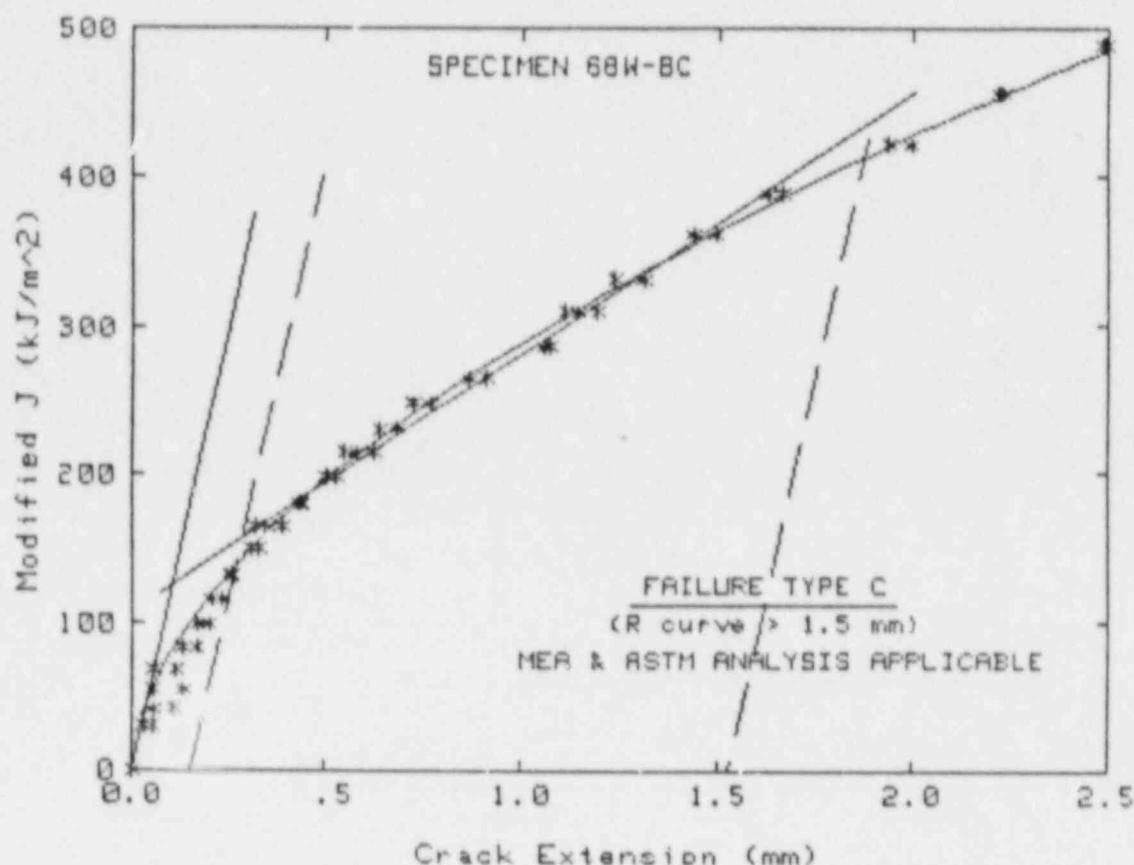
Modified K _{ic} Equation; B	=	(BB _n) ^{0.5}
Maximum Load P	=	51.88 kN
5% Secant Offset P _q	=	35.92 kN
K _{ic}	=	84.2 MPa √m
Validity	=	INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Herkle-Corten correction

Correction for specimen rotation

Correction to J for crack extension



TEST SPECIMEN DATA

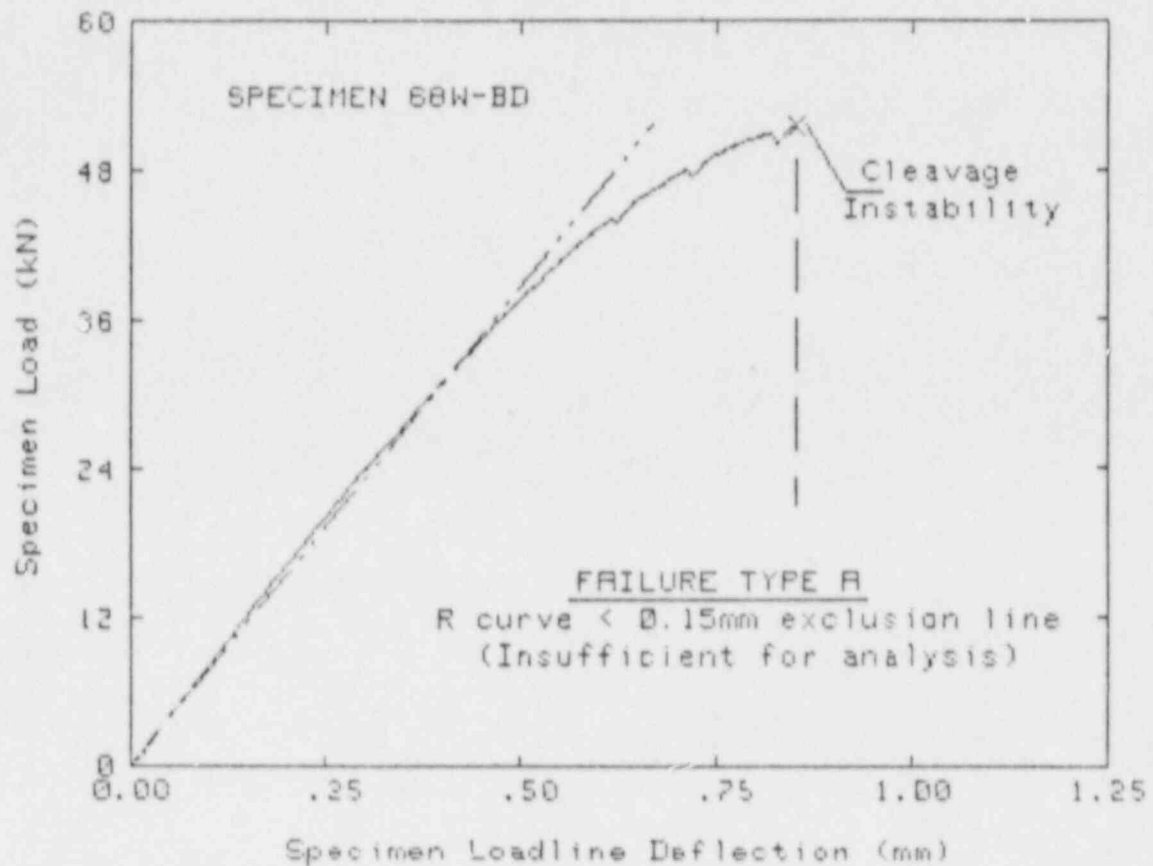
Material Type	= A533B HSST Weld	
Test Temperature	= 288 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.59 mm	Init a/W = .602
Final crack length	= 38.04 mm	Final a/W = .748
Flow stress	= 590.9 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

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

J _{ic}	= 138 kJ/m ²
K _{Jc}	= 162.3 MPa √m
J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 125.8 kJ/m ²
K _{Jc}	= 154.9 MPa √m
Slope M	= 174822.2 kJ/m ³
Intercept B	= 107.1 kJ/m ²
T (ASTM)	= 96
Validity (J _{ic})	= VALID
Validity (R-curve)	= INVALID--3 (.62 vs .3)
J maximum allowed	= 596.5 kJ/m ² (J _{max} =J _{net} *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 R (J at instability = J_{ic})

J _{ic}	=	110.6 kJ/m ²	
K _{ic} =(EJ _{ic}) ^{0.5}	=	152.4 MPa √m	ν=.3
K _{ic} (Beta Corrected)	=	104.4 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

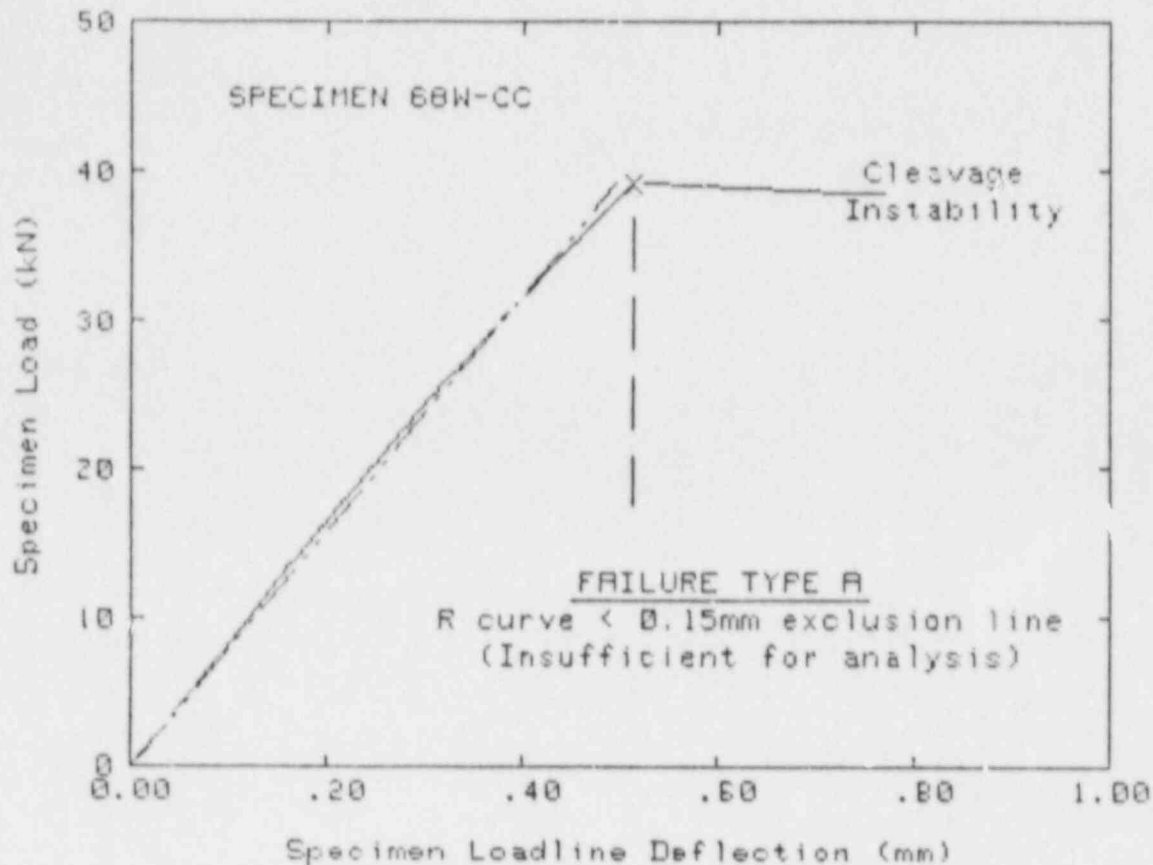
Modified K _{ic} Equation; B	=	(B ₀ n) ^{0.5}
Maximum Load P	=	51.64 kN
5% Secant Offset P _q	=	32.2 kN
K _{ic}	=	75.9 MPa √m
Validity	=	INVALID--2, 3

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 = J_{ic})

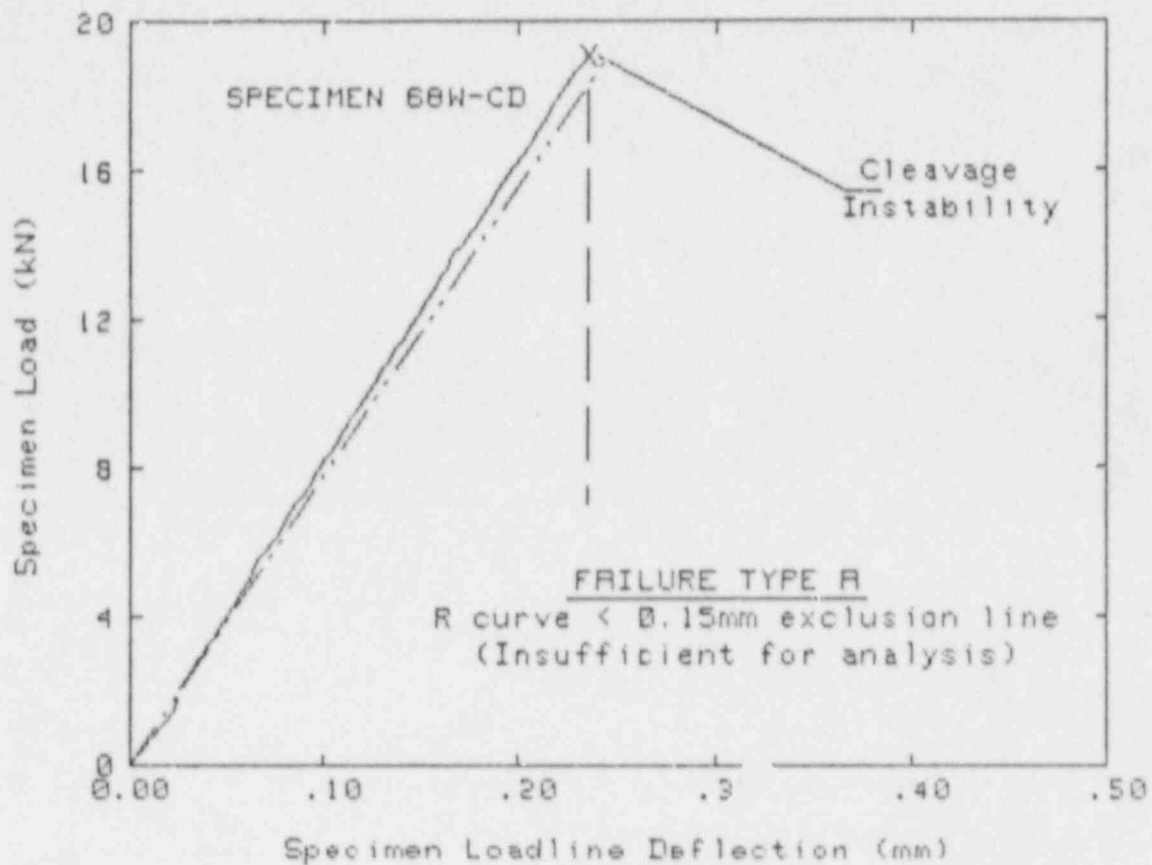
J_{ic} = 44.8 kJ/m²
 $K_{Jc} = (EJ_{ic})^{.5} = 97.3 \text{ MPa } \sqrt{\text{m}}$ $\nu=.3$
 $K_{ic} \text{ (Beta Corrected)} = 83.1 \text{ MPa } \sqrt{\text{m}}$ $\nu=.3$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (BB_n)^{.5}$
 Maximum load P = 39.15 kN
 5% Secant Offset P_q = 32.28 kN
 $K_{ic} = 76.1 \text{ MPa } \sqrt{\text{m}}$
 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 = J_{ic})

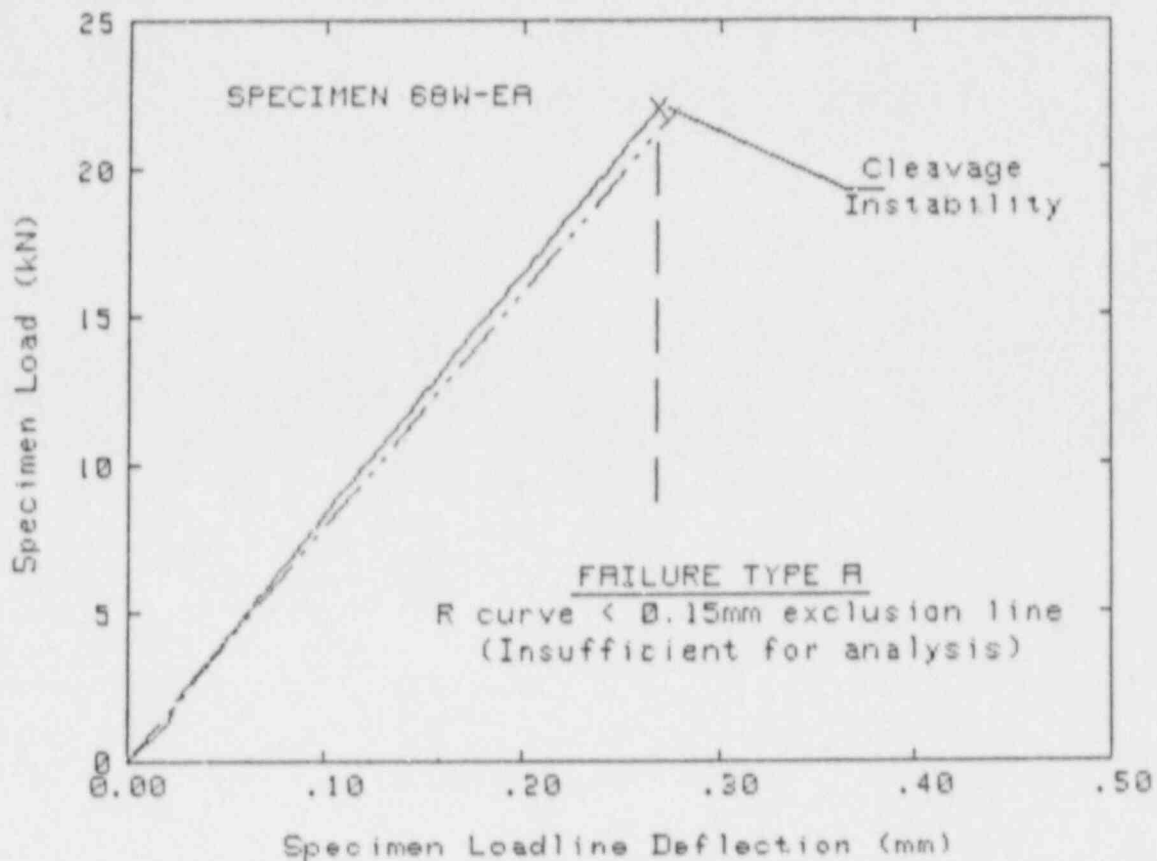
J_{ic} = 9.5 kJ/m²
 $K_{Jc} = (EJ_{ic})^{.5} = 45.3 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$
 $K_{ic} \text{ (Beta Corrected)} = 44.9 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (BB_n)^{.5}$
 Maximum Load P = 19.1 kN
 5% Secant Offset P_q = 19.1 kN
 $K_{ic} = 44.5 \text{ MPa } \sqrt{\text{m}}$
 Validity = VALID K_{ic} 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	= HSCT 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 = J_{ic})

J _{ic}	= 12.9 kJ/m ²	
K _{Jc} =(EJ _{ic}) ^{.5}	= 52.3 MPa √m	ν=.3
K _{ic} (Beta Corrected)	= 51.4 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

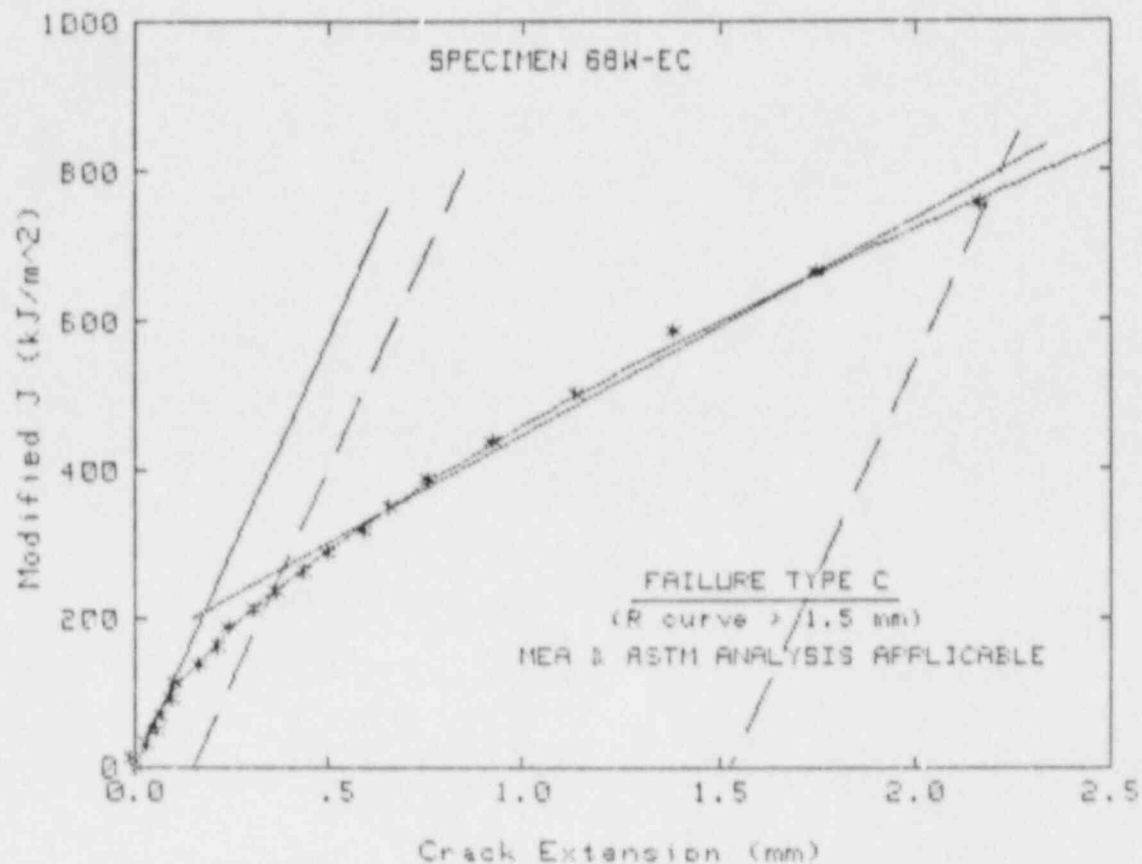
Modified K _{ic} Equation;	B = (BB _n) ^{.5}
Maximum Load P	= 22 kN
5% Secant Offset P _q	= 22.03 kN
K _{ic}	= 53.6 MPa √m
Validity	= VALID K _{ic} value

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
 Final crack length = 35.1 mm
 Flow stress = 575.5 MPa
 Youngs modulus = 200300 MPa

Init a/W = .605
 Final a/W = .69

(Estimated Value)

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

J_{ic} = 233.2 kJ/m²
 K_{Jc} = 216.1 MPa √m
 J (at J/T=8.8) = 990.1 kJ/m²
 Exponent N = .6541
 Coefficient C = 459 kJ/m²
 T (average) = 172

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

J_{ic} = 210.8 kJ/m²
 K_{Jc} = 205.5 MPa √m
 Slope M = 290056.7 kJ/m³
 Intercept B = 157.6 kJ/m²
 T (ASTM) = 176

Validity (J_{ic}) = VALID

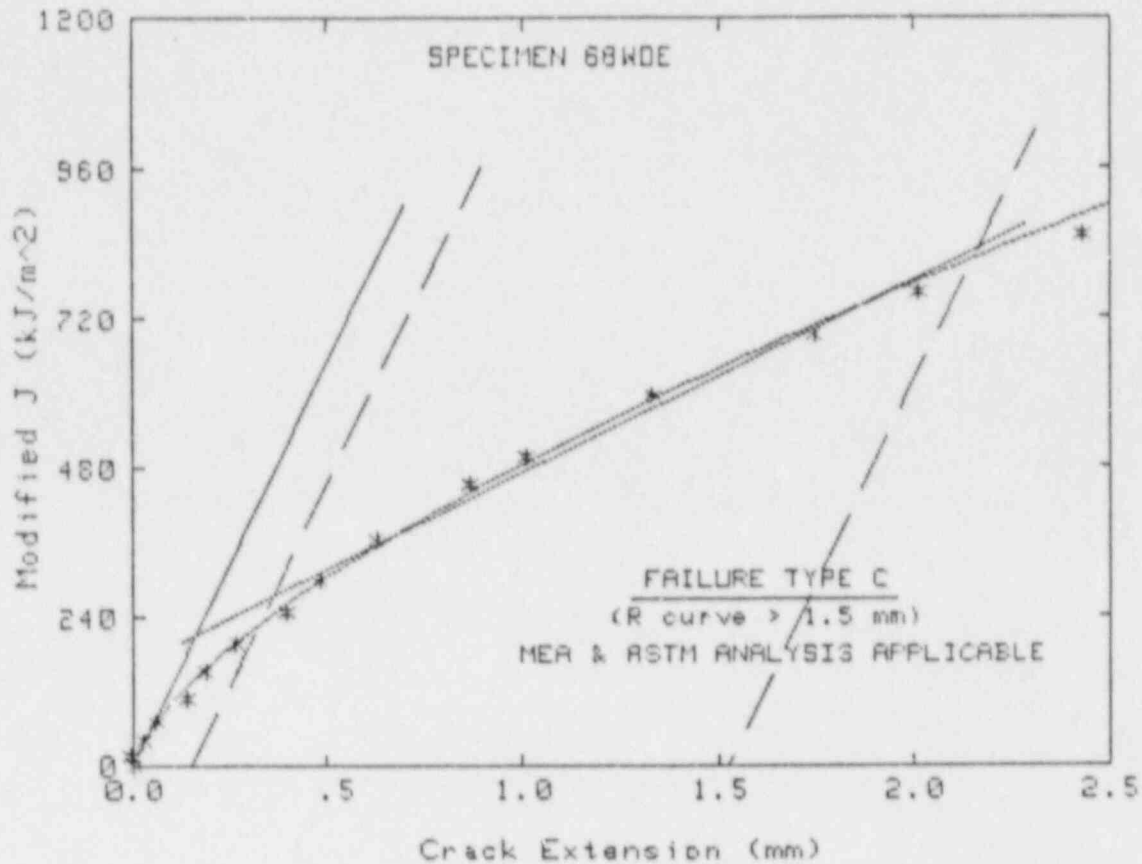
Validity (R-curve) = VALID

J maximum allowed = 576.5 kJ/m²

(J_{max} = B_{net} * Flow stress / 20)

Delta a max. allowed = 2.01 mm

(Delta a max = 0.1 * b₀)



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
 Final crack length = 34.91 mm
 Flow stress = 650.2 MPa
 Youngs modulus = 205800 MPa

Init a/W = .61
 Final a/W = .687

(Estimated Value)

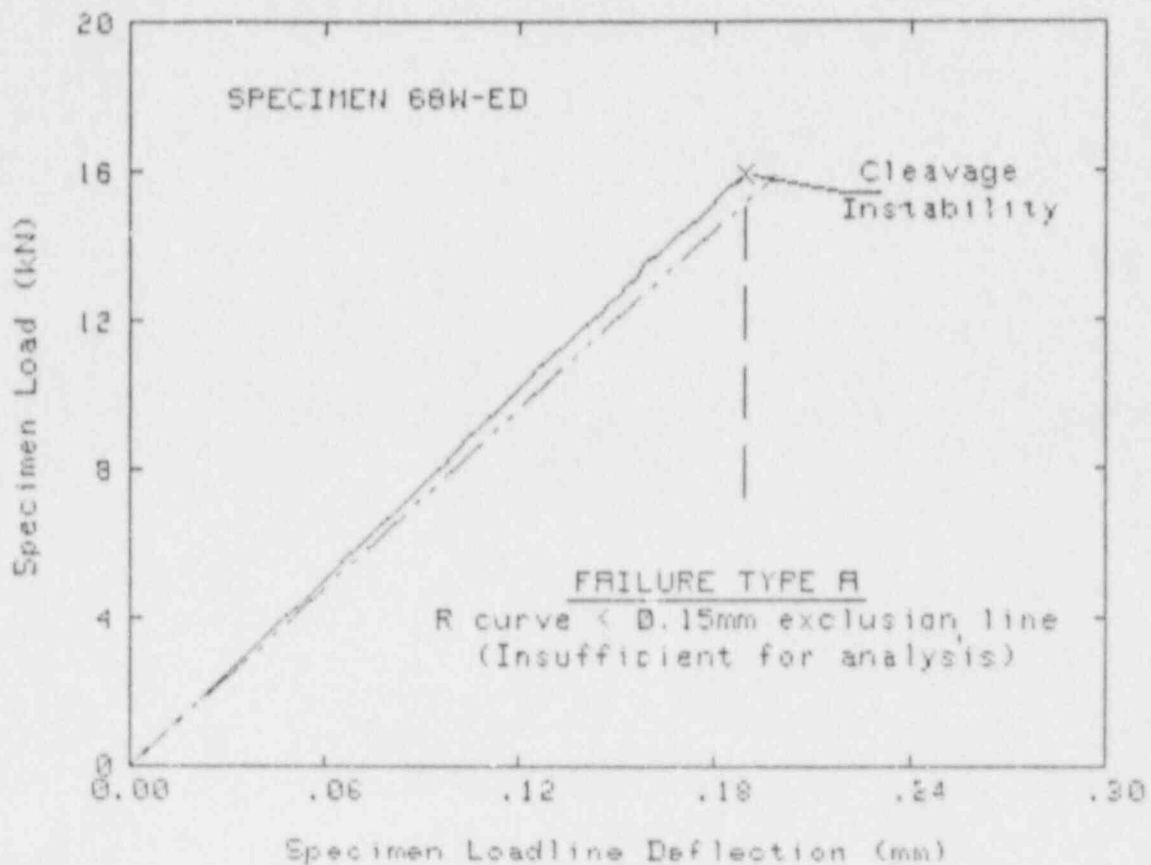
POWER LAW DATA $J = C (\Delta a)^N$

J_{ic} = 228.1 kJ/m²
 K_{ic} = 216.7 MPa √m
 J (@J/T=8.8) = 932.4 kJ/m²
 Exponent N = .6764
 Coefficient C = 484.9 kJ/m²
 T (average) = 153

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

J_{ic} = 210.7 kJ/m²
 K_{ic} = 208.3 MPa √m
 Slope M = 309715.3 kJ/m³
 Intercept B = 160.5 kJ/m²
 T (ASTM) = 151

Validity (J_{ic}) = VALID
 Validity (R-curve) = VALID
 J maximum allowed = 642.8 kJ/m² (J_{max} = B_{net} * Flow stress / 20)
 Delta a max. allowed = 1.98 mm (Delta a max = 0.1 * b_o)
 Final Delta a = 4.03 mm
 Poisson's Ratio (ν) = 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 = J_{ic})

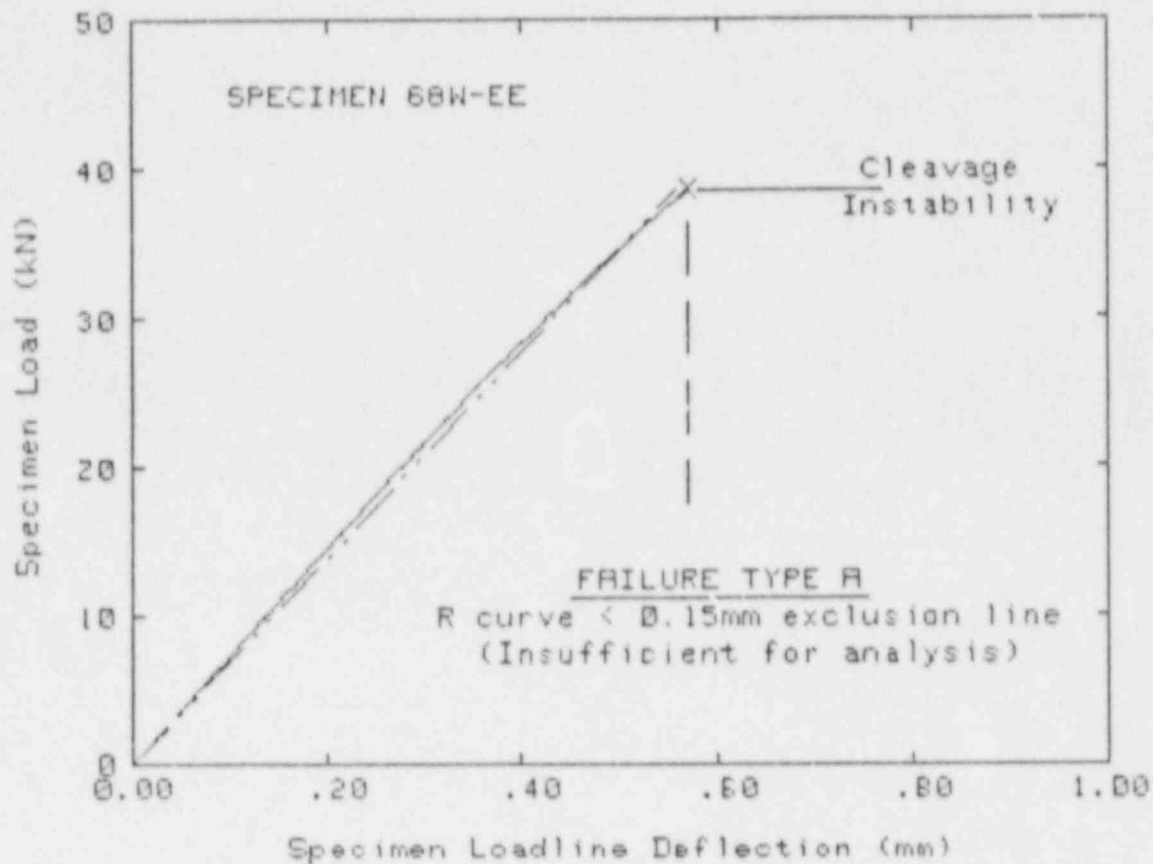
J _{ic}	= 6.5 kJ/m ²	
K _{Jc} =(EJ _{ic}) ^{0.5}	= 37.4 MPa √m	ν=.3
K _{ic} (Beta Corrected)	= 37.2 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation;	B = (BB _n) ^{-1.5}
Maximum Load P	= 15.9 kN
5% Secant Offset P _Q	= 15.91 kN
K _{ic}	= 39.5 MPa √m
Validity	= VALID K _{ic} value

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD= 0 lb OFFSET DEFLECTION = 5.58354494761E-05 in.
 Specimen notation 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 = J_{ic})

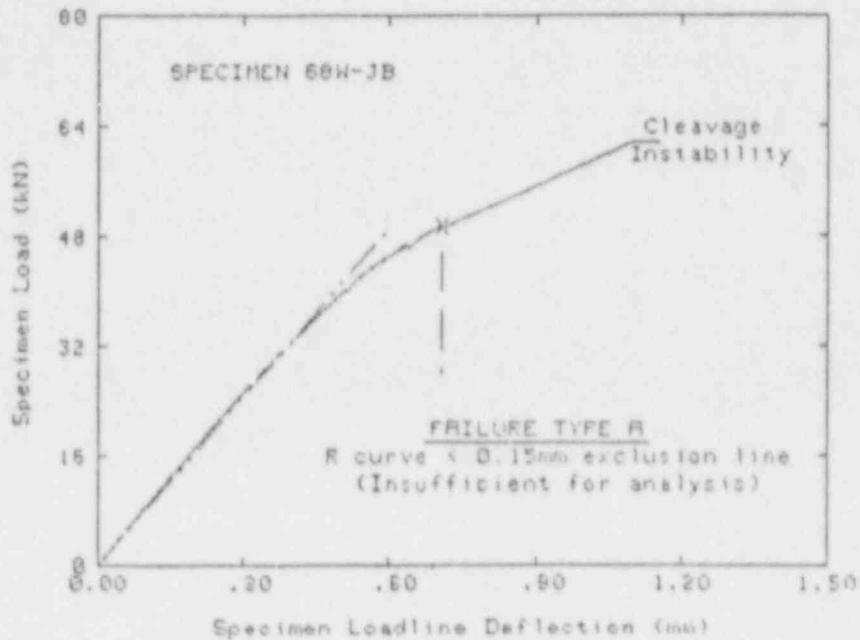
J_{ic} = 51.8 kJ/m²
 $K_{Jc} = (EJ_{ic})^{.5} = 105.1 \text{ MPa } \sqrt{\text{m}}$ $\nu=.3$
 $K_{ic} \text{ (Beta Corrected)} = 88.9 \text{ MPa } \sqrt{\text{m}}$ $\nu=.3$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (BB_n)^{.5}$
 Maximum Load P = 38.0 kN
 5% Secant Offset P_q = 33.48 kN
 $K_{ic} = 87.8 \text{ MPa } \sqrt{\text{m}}$
 Validity = INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Nerleke-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 = A500-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 = 770.6 MPa
 Yield stress = 604 MPa
 Youngs modulus E = 210100 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

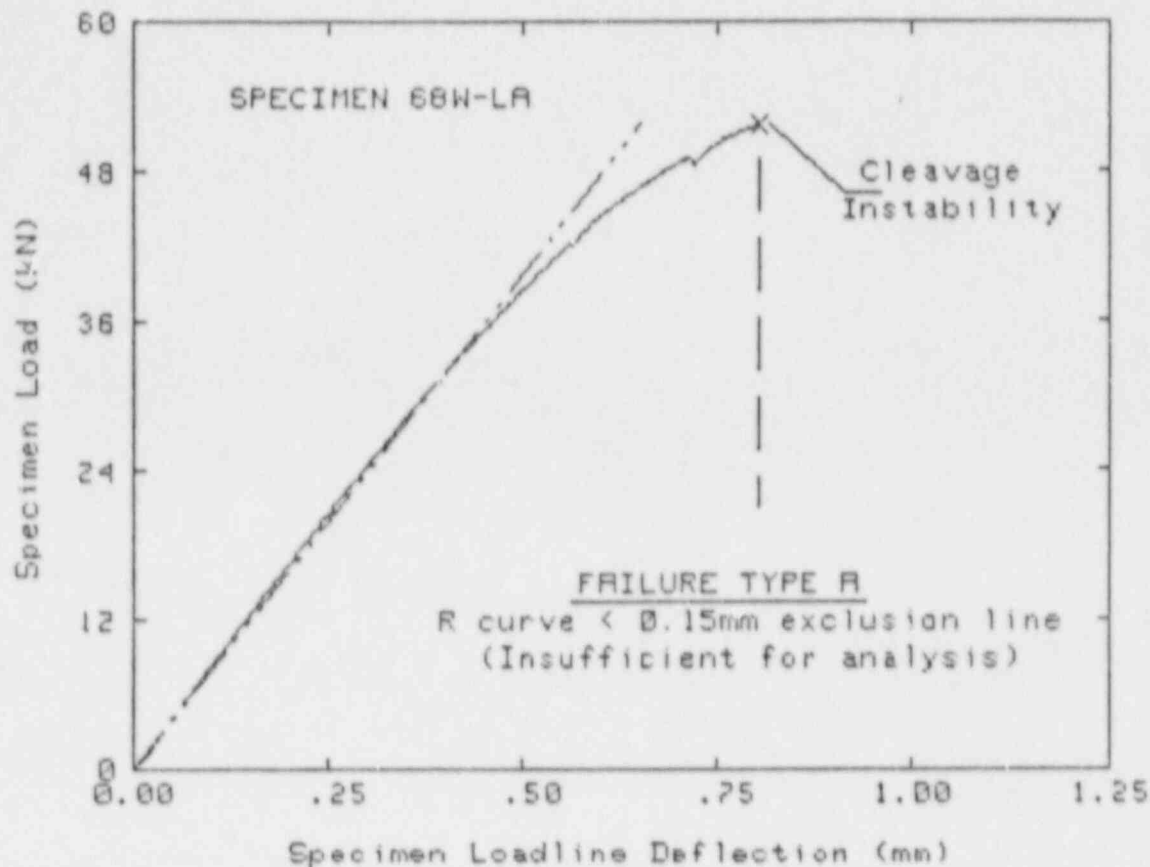
Failure Type R (J at instability = J_{ic})
 J_{ic} = 85.3 kJ/m²
 $K_{Jc} = (E'J_{ic} / (1 - \nu^2))^{0.5} = 100.9 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$
 K_{ic} (Beta Corrected) = 91.5 MPa $\sqrt{\text{m}}$ $\nu = .3$

ASTM E299-81 ANALYSIS

Modified K_{ic} Equation: $B = (E' E_n)^{0.5}$
 Maximum Load P = 49.4 kN
 5% Secant Offset P_Q = 31.74 kN
 K_{ic} = 76.5 MPa $\sqrt{\text{m}}$
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 119.1 MPa $\sqrt{\text{m}}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Hertz-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 1.256250400025E-04 in.
 Specimen rotation Load intercept elastic slope = .0000000 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 = J_{ic})

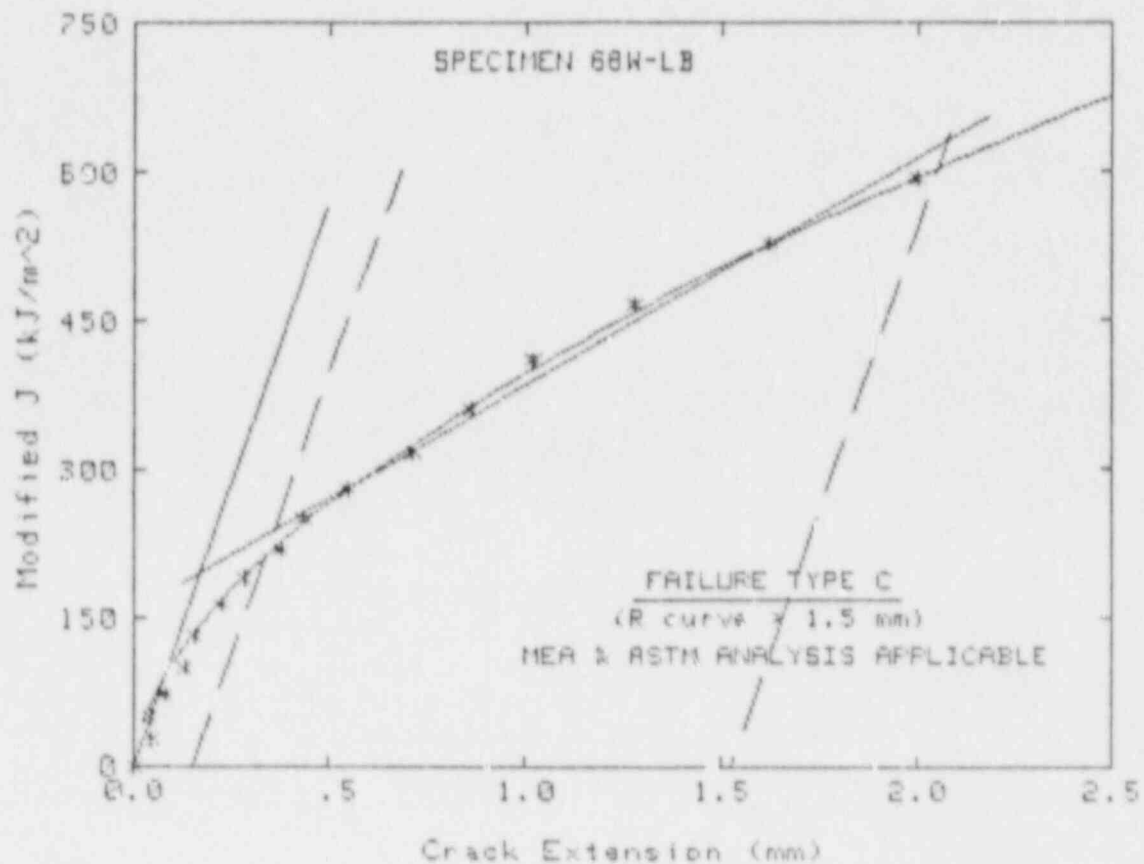
J_{ic} = 105.8 kJ/m²
 $K_{Jc} = (EJ_{ic})^{.5} = 149.1 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$
 $K_{ic} \text{ (Beta Corrected)} = 103.3 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (BB_n)^{.5}$
 Maximum Load P = 51.8 kN
 5% Secant Offset P_q = 32.61 kN
 $K_{ic} = 81.3 \text{ MPa } \sqrt{\text{m}}$
 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

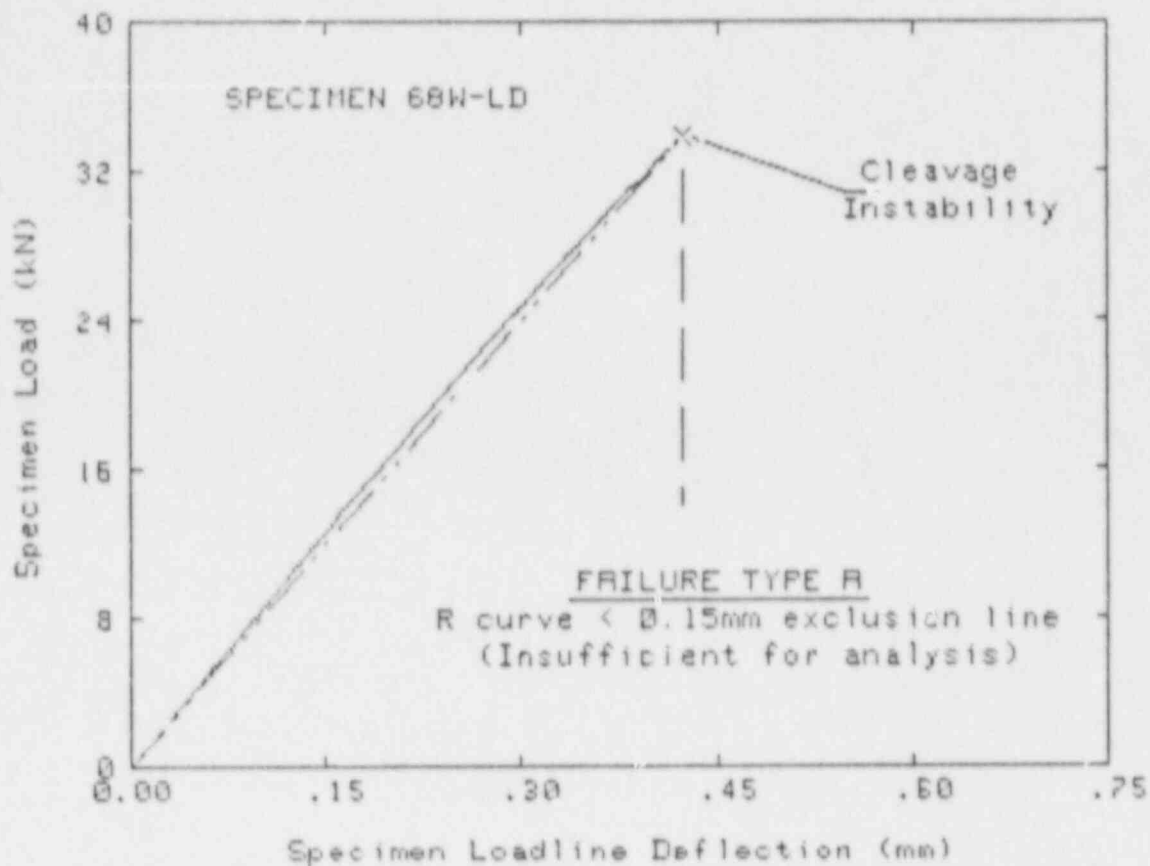
Material Type	= HSST-S/R WELD	
Test Temperature	= 204 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.76 mm	Init a/W = .605
Final crack length	= 36.02 mm	Final a/W = .709
Flow stress	= 571.8 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

Jic	= 211.3 kJ/m ²
Kjc	= 203.2 MPa √m
J (θJ/T=0.8)	= 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/P 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 = J_{ic})

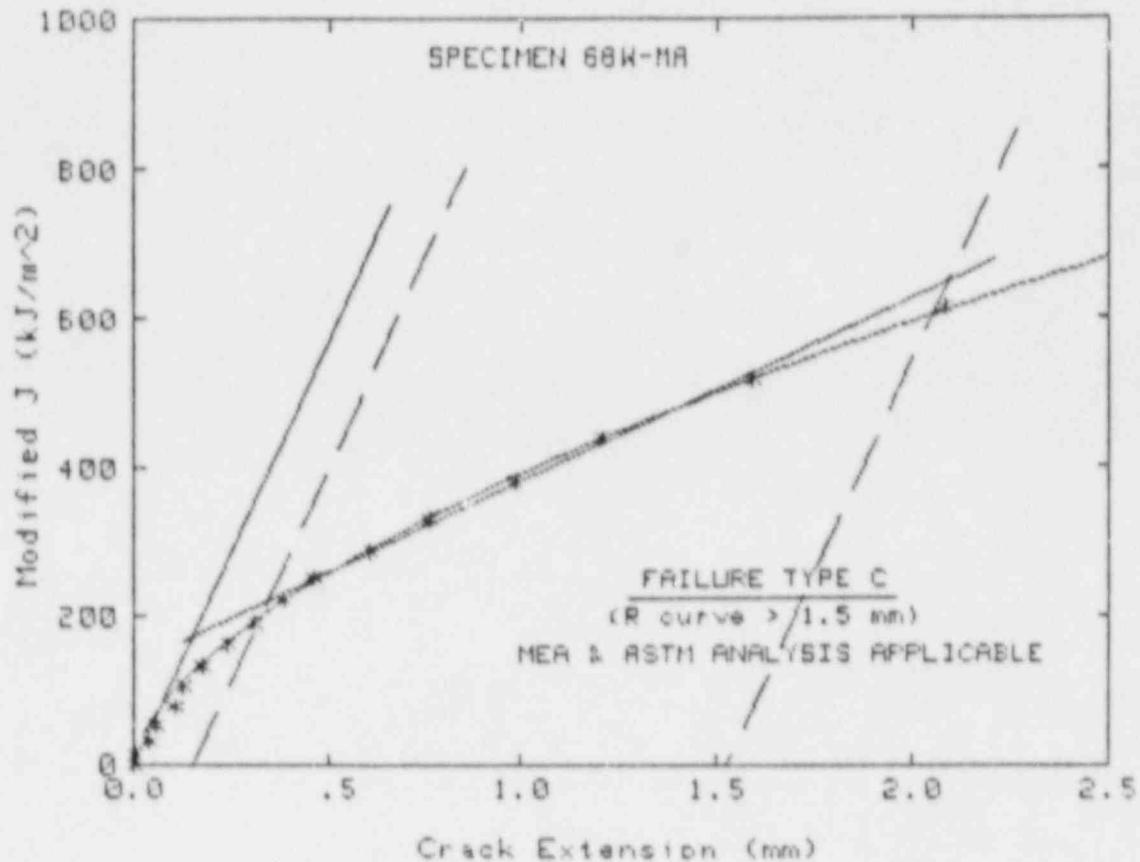
J_{ic} = 31.3 kJ/m²
 $K_{Jc} = (EJ_{ic})^{.5} = 81.4 \text{ MPa } \sqrt{\text{m}}$ $\nu=.3$
 $K_{ic} \text{ (Beta Corrected)} = 73.4 \text{ MPa } \sqrt{\text{m}}$ $\nu=.3$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (BB_n)^{.5}$
 Maximum Load P = 33.85 kN
 5% Secant Offset P_q = 33.85 kN
 $K_{ic} = 79.4 \text{ MPa } \sqrt{\text{m}}$
 Validity = INVALID--2

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Hinkle-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

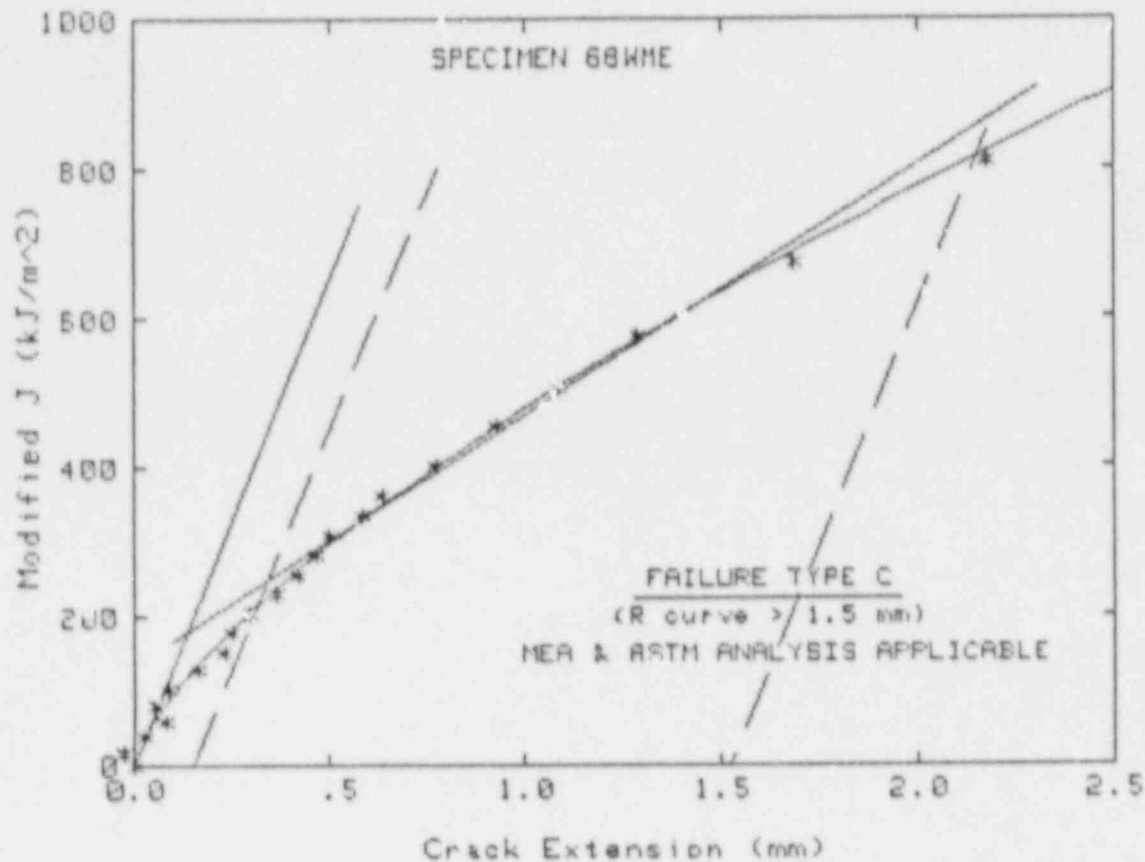
Material Type	= HSST S/A Weld	
Test Temperature	= 204 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.62 mm	Init a/W = .602
Final crack length	= 36.18 mm	Final a/W = .712
Flow stress	= 571.8 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

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

J _{ic}	= 199.9 kJ/m ²
K _{jc}	= 197.7 MPa √m
J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 175.1 kJ/m ²	
K _{jc}	= 185 MPa √m	
Slope M	= 244415.3 kJ/m ³	
Intercept B	= 137.7 kJ/m ²	
T (ASTM)	= 146	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 576.5 kJ/m ²	(J _{max} = B _{net} * Flow stress / 20)
Delta a max. allowed	= 2.02 mm	(Delta a max = 0.1 * b ₀)



TEST SPECIMEN DATA

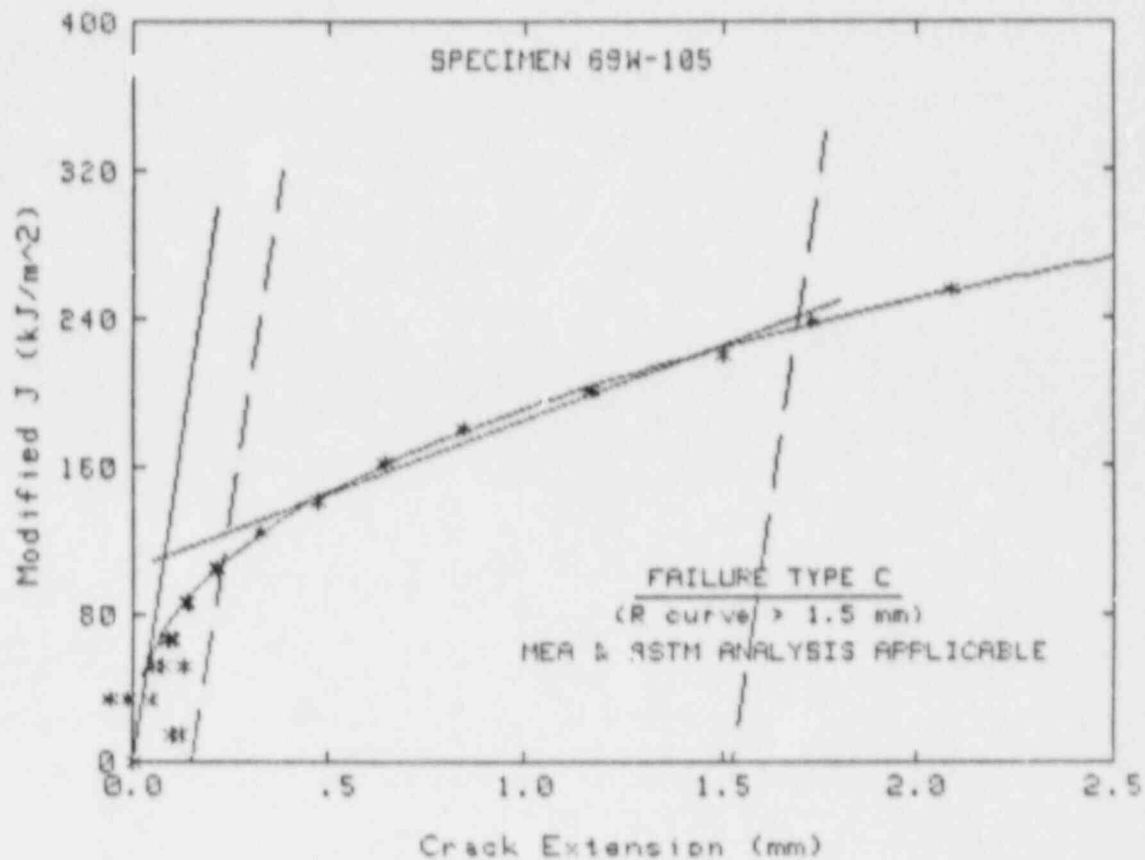
Material Type	= A533-B HS	
Test Temperature	= 25 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.85 mm	Init a/W = .607
Final crack length	= 34.89 mm	Final a/W = .686
Flow stress	= 650.2 MPa	
Youngs modulus	= 205800 MPa	(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

Jic	= 217 kJ/m ²
Kjc	= 211.3 MPa $\sqrt{m}$
J (0J/T=0.8)	= 991.6 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	= 176.1 kJ/m ²
Kjc	= 191.1 MPa $\sqrt{m}$
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

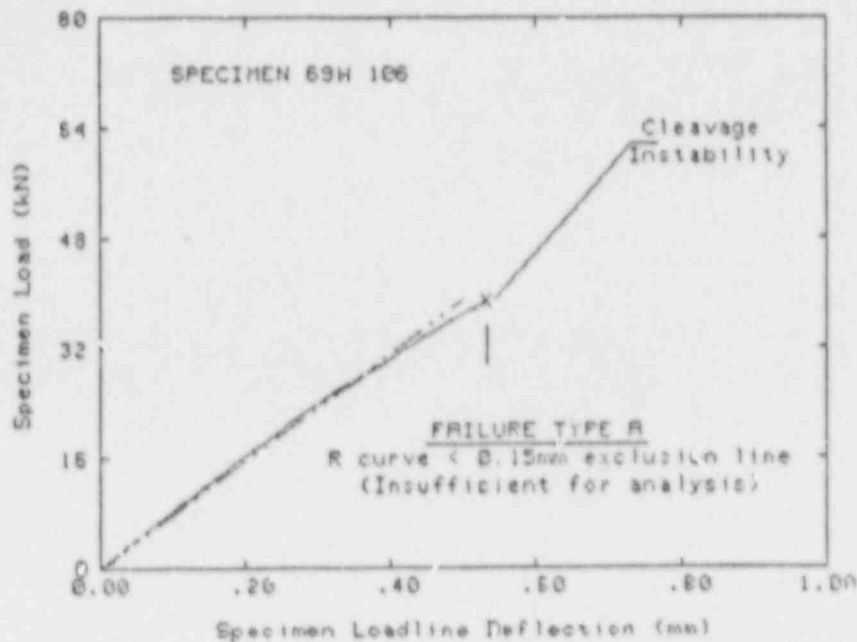
Material Type	= A533B Weld	
Test Temperature	= 288 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.78 mm	Init a/W = .606
Final crack length	= 42.56 mm	Final a/W = .837
Flow stress	= 704.5 MPa	
Youngs modulus	= 190000 MPa	(Estimated Value)

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

J _{ic}	= 108.3 kJ/m ²
K _{ic}	= 143.7 MPa √m
J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 112.1 kJ/m ²
K _{ic}	= 146.2 MPa √m
Slope M	= 80107 kJ/m ³
Intercept B	= 105.7 kJ/m ²
T (ASTM)	= 31
Validity (J _{ic})	= VALID
Validity (R-curve)	= VALID
J maximum allowed	= 704.5 kJ/m ² (J _{max} =B _{net} *Flow stress/20)
Delta a max. allowed	= 2 mm (Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type * A533-B MSST 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
 Young's modulus E * 206600 N/mm² (Estimated Value)
 Poisson's Ratio (ν) * 0

J-INTEGRAL ANALYSIS

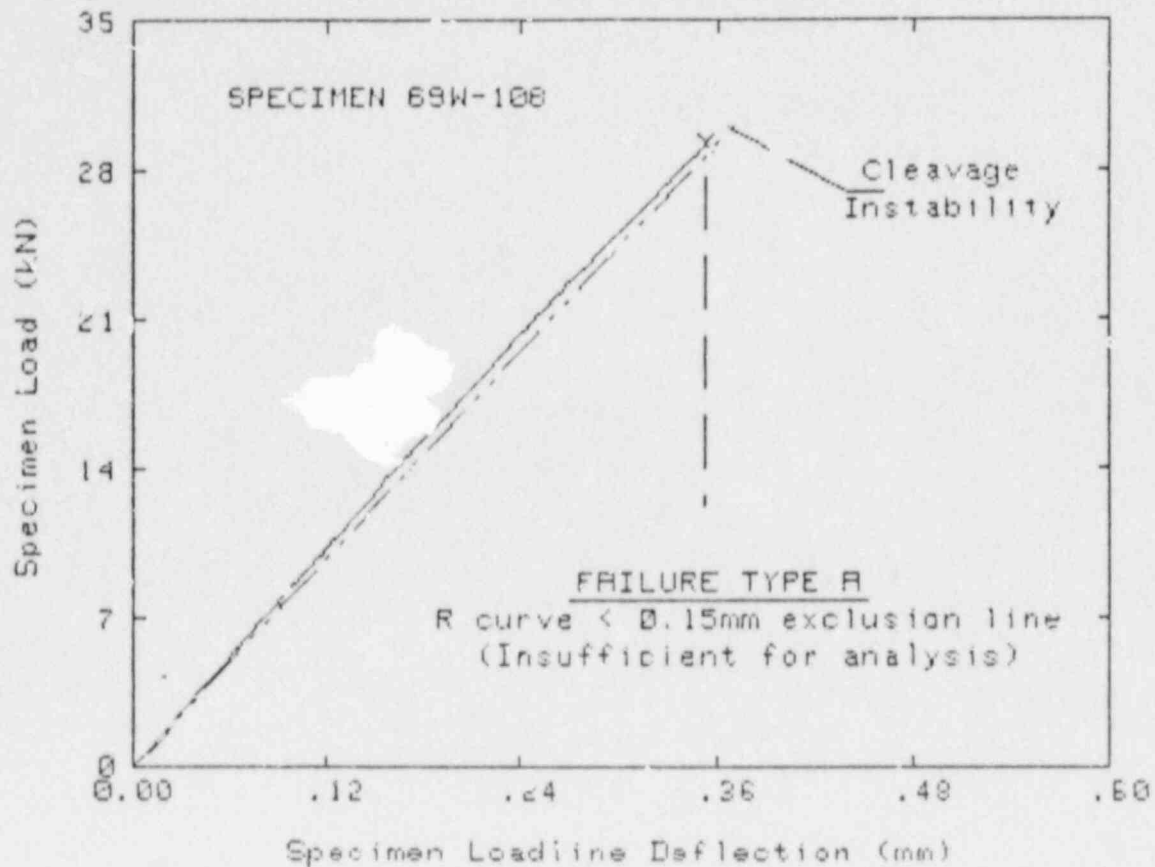
Failure Type A (J at instability = J_{ic})
 J_{ic} * 60.2 kJ/m²
 K_{Jic} = (E J_{ic} / (1 - ν²))^{0.5} * 111.6 MPa √m ν=0
 K_{ic} (Beta Corrected) * 86.1 MPa √m ν=0

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation: B = (B_{min})^{0.5}
 Maximum Load P * 30.9 kN
 5% Secant Offset P_Q * 26.77 kN
 K_{ic} * 74.2 MPa √m
 Validity * INVALID--2, 3
 K at Maximum Load * 107.8 MPa √m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Hinkle-Cortish OFFSET LOAD = 0 lb OFFSET DEFLECTION = 1.0937e-070717E-04 in.
 Specimen rotation Load intercept elastic slope = .000032 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	=	38.38 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 = J_{ic})

J _{ic}	=	22.4 kJ/m ²
K _{Jc} =(EJ _{ic}) ^{.5}	=	68.1 MPa √m ν=.3
K _{ic} (Beta Corrected)	=	64.1 MPa √m ν=.3

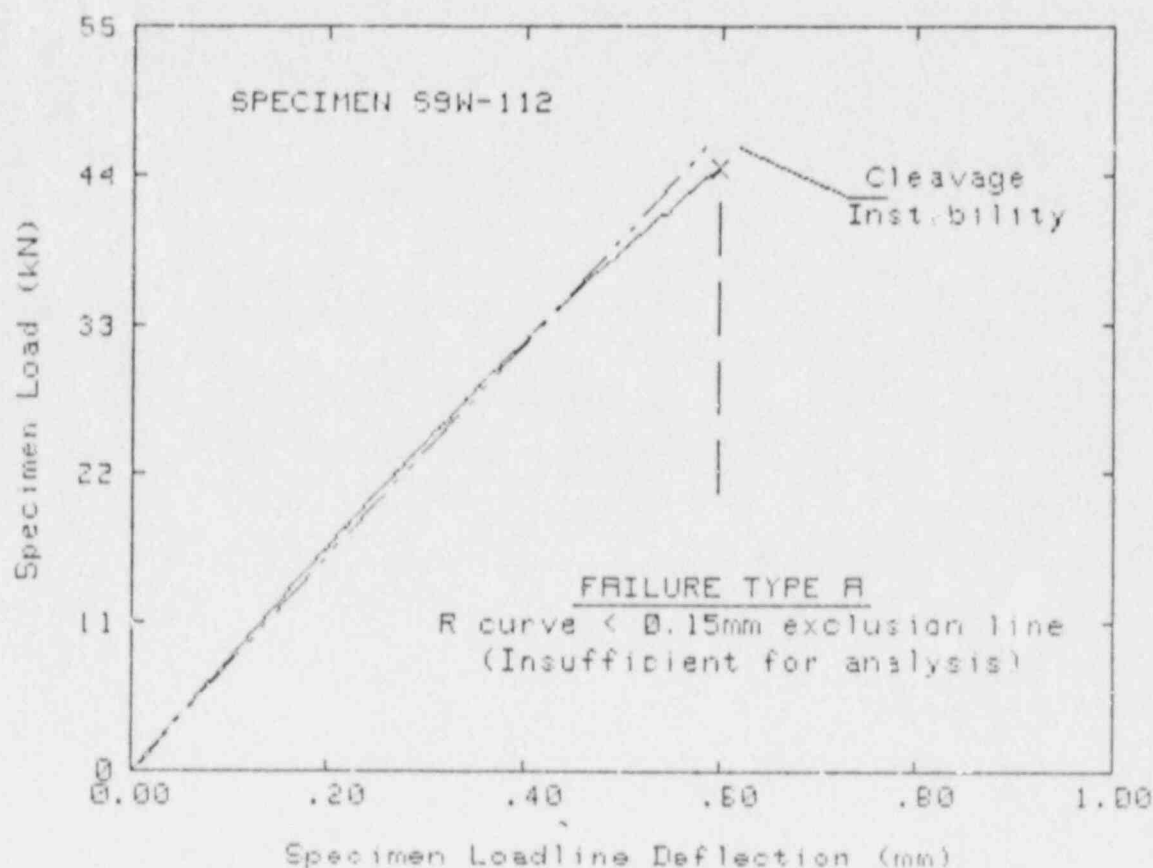
ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{.5}

Maximum Load P	=	30 kN
5% Secant Offset P _Q	=	29.24 kN
K _{ic}	=	69.2 MPa √
Validity	=	VALID K _{ic} value

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

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



TEST SPECIMEN DATA

Material Type	= HSST S/F Weld (1)
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 = J_{ic})

J _{ic}	= 63.1 kJ/m ²	
K _{Jc} =(EJ _{ic}) ^{.5}	= 113.7 MPa √m	ν=.3
K _{ic} (Beta Corrected)	= 90.5 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

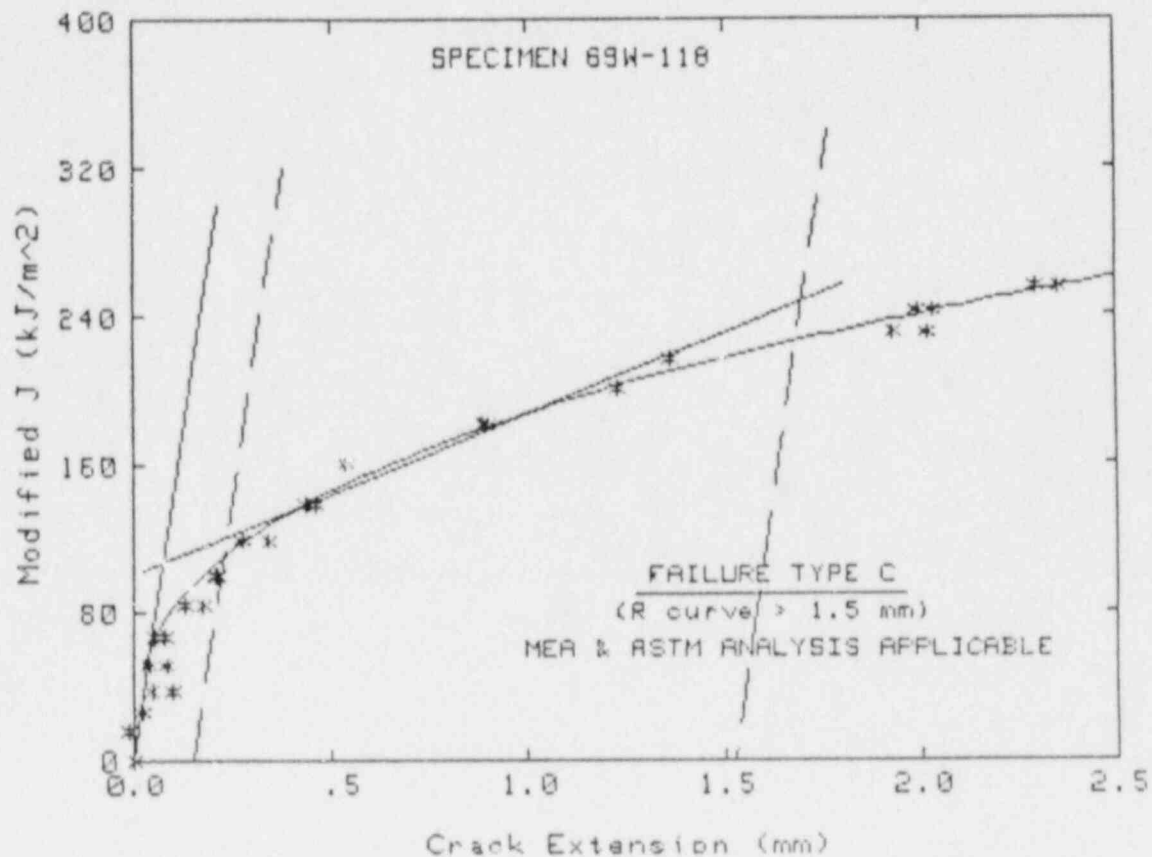
Modified K _{ic} Equation; B	= (BB _n) ^{.5}
Maximum Load P	= 46 kN
5% Secant Offset P _q	= 34.41 kN
K _{ic}	= 88.3 MPa √m
Validity	= INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Herkle-Corten correction

Correction for specimen rotation

Correction to J for crack extension



TEST SPECIMEN DATA

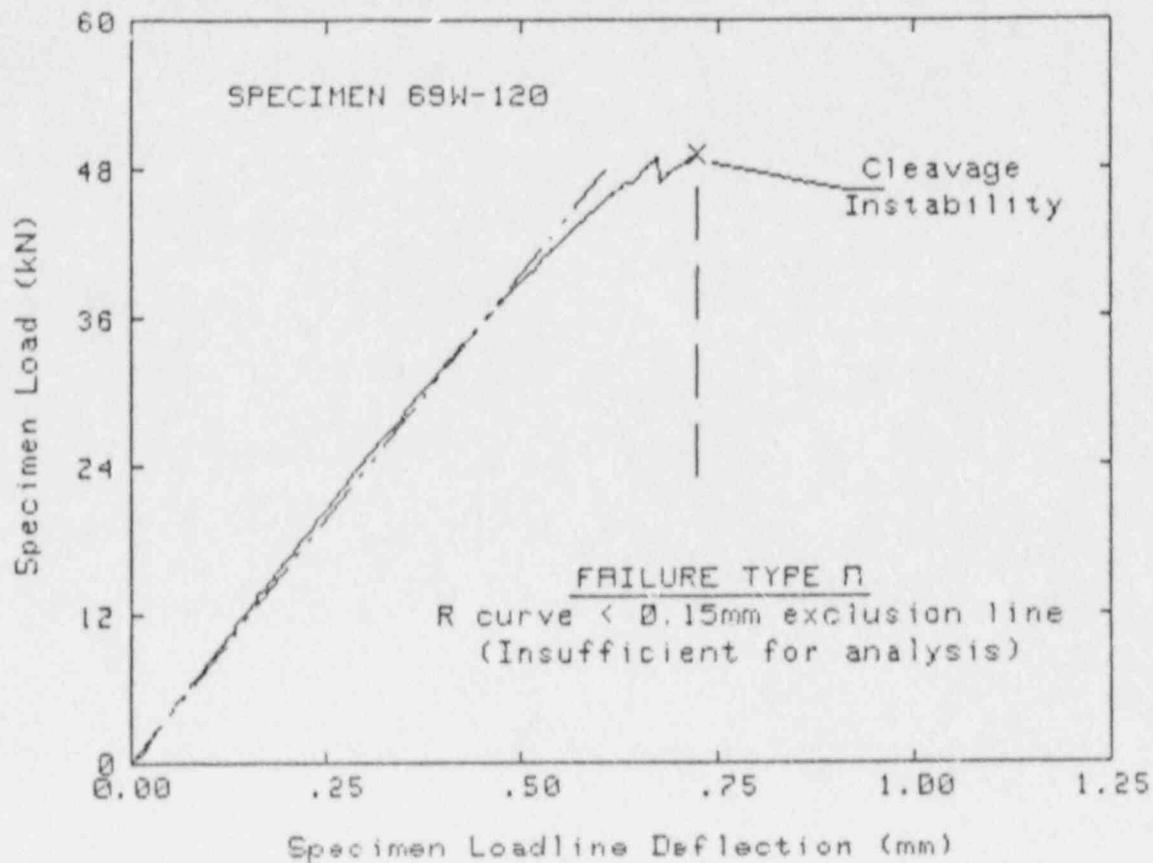
Material Type	= A533B Weld	
Test Temperature	= 288 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.23 mm	Init a/W = .555
Final crack length	= 41.81 mm	Final a/W = .823
Flow stress	= 704.5 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

Jic	= 110.5 kJ/m ²
Kjc	= 145.2 MPa √m
J (θJ/T=8.8)	= 199.9 kJ/m ²
Exponent n	= .3597
Coefficient C	= 187.3 kJ/m ²
average)	= 29

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

	= 106.6 kJ/m ²
	= 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 = J_{ic})

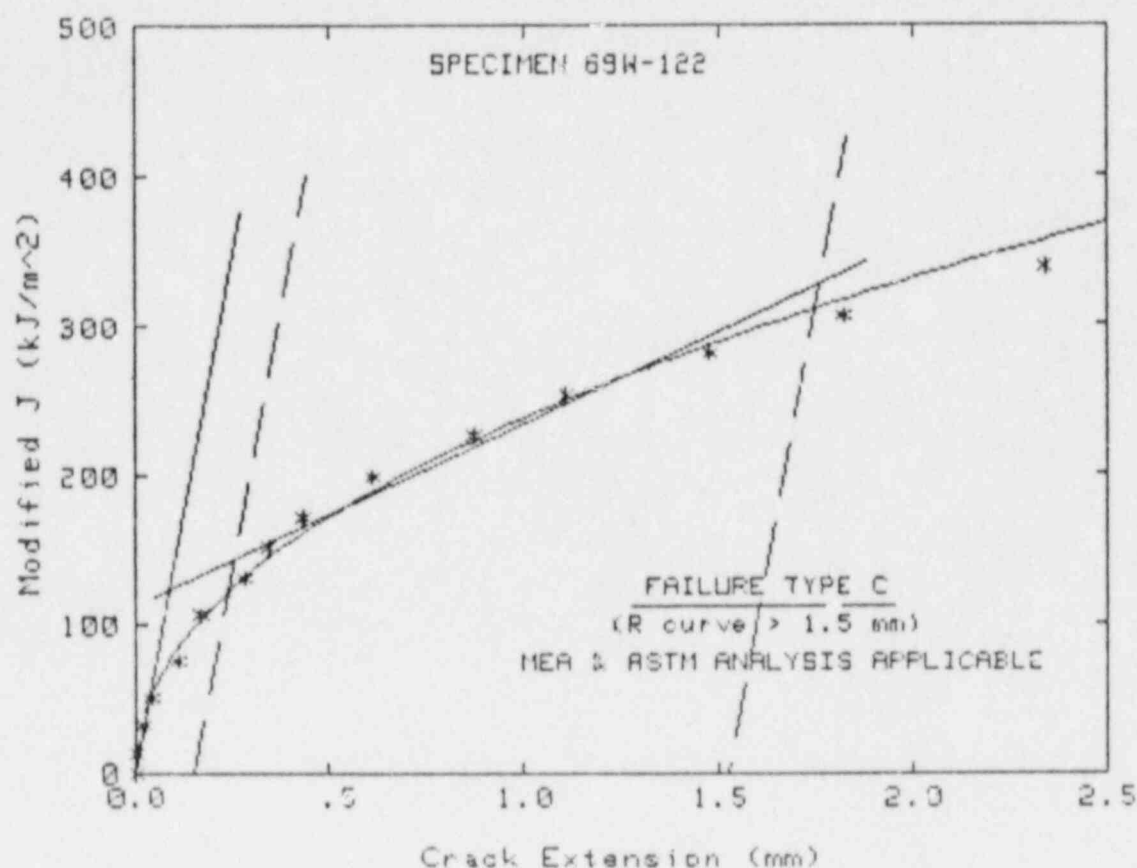
J_{ic} = 86.5 kJ/m²
 $K_{Jc} = (EJ_{ic})^{.5} = 133 \text{ MPa } \sqrt{\text{m}}$ $\nu=.3$
 $K_{ic} \text{ (Beta Corrected)} = 98.3 \text{ MPa } \sqrt{\text{m}}$ $\nu=.3$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (BB_n)^{.5}$
 Maximum Load P = 48.5 kN
 5% Secant Offset P_q = 34.67 kN
 $K_{ic} = 82.7 \text{ MPa } \sqrt{\text{m}}$
 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

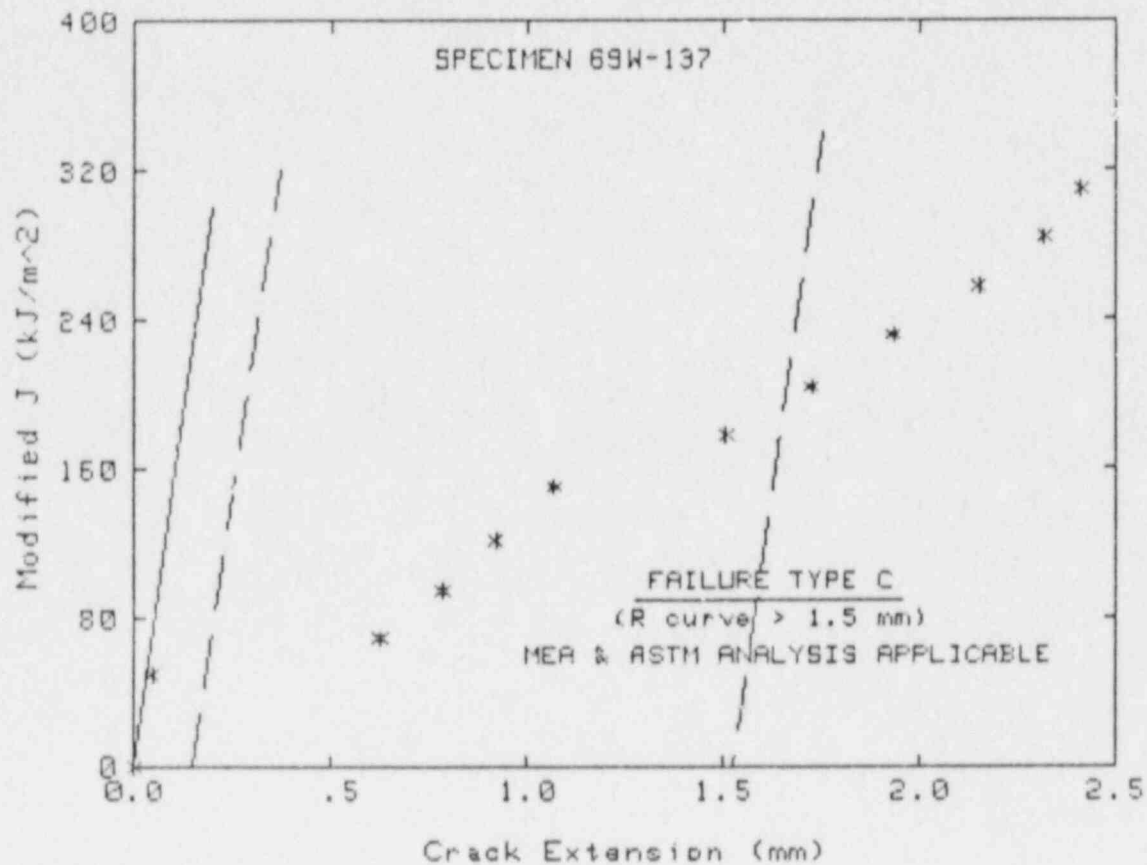
Material Type	= HSST S/A Weld	
Test Temperature	= 204 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.23 mm	Init a/W = .595
Final crack length	= 41.91 mm	Final a/W = .825
Flow stress	= 697.8 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

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	= 2.9 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

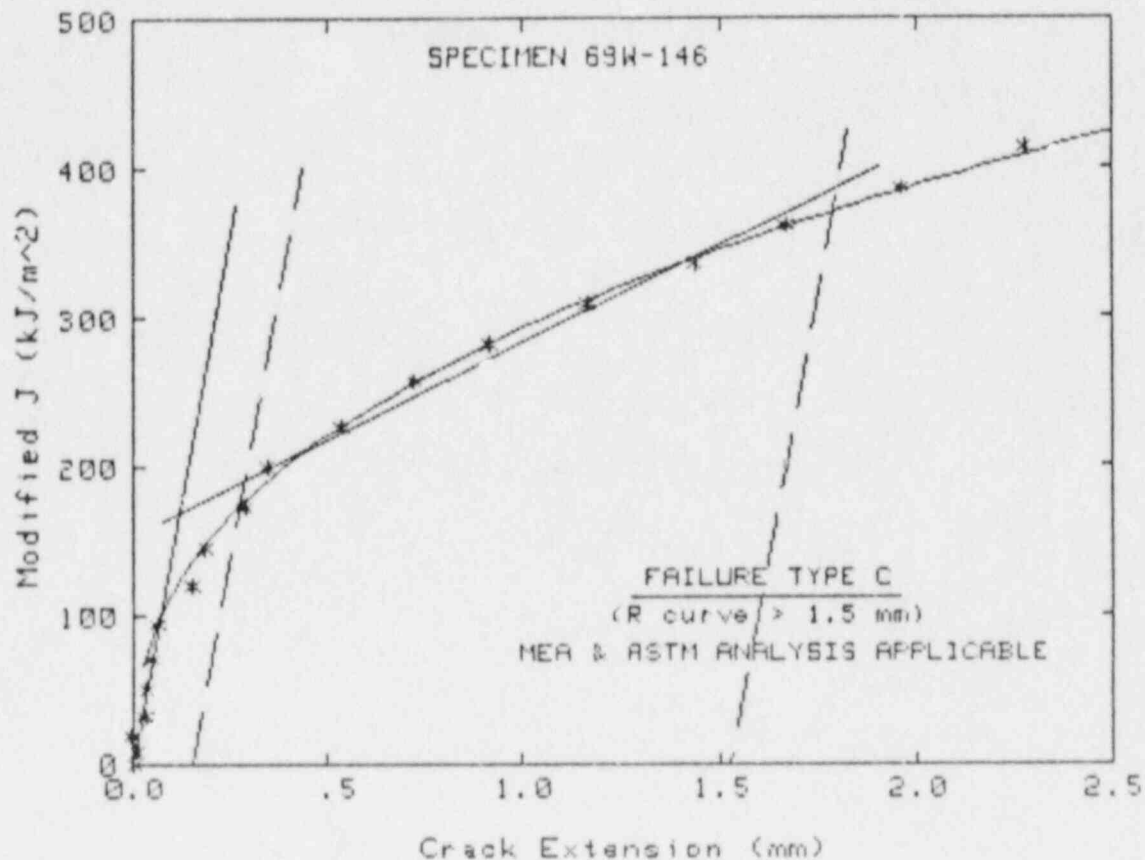
Material Type	= A533-B HSST WELD	
Test Temperature	= 50 C	
Percent Side Groove	= 0 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.24 mm	Init a/W = .595
Final crack length	= 34.14 mm	Final a/W = .612
Flow stress	= 739.5 MPa	
Youngs modulus	= 204400 MPa	(Estimated Value)

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

Jic	= 69.2 kJ/m ²
Kjc	= 119 MPa $\sqrt{m}$
J (0J/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 $\sqrt{m}$
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

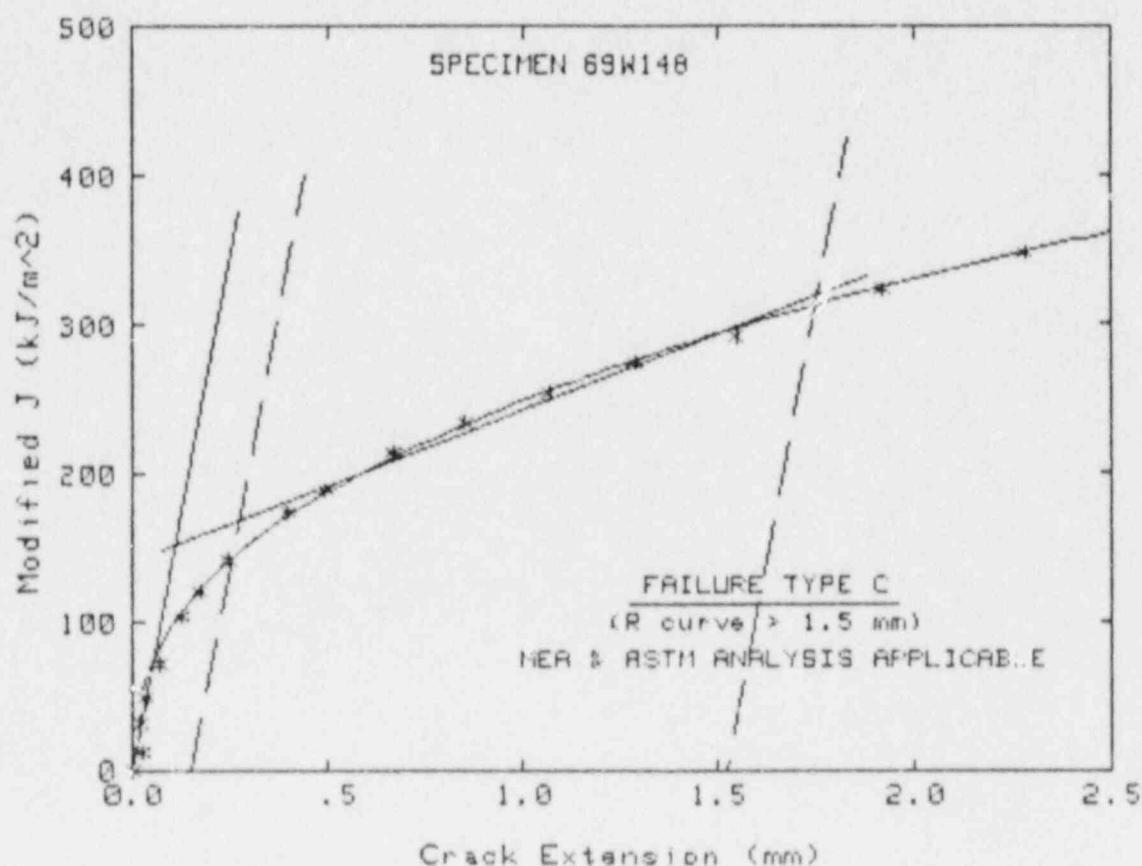
Material Type	= HSST S/A Weld (1)	
Test Temperature	= 121 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 38.37 mm	Init a/W = .597
Final crack length	= 39.61 mm	Final a/W = .779
Flow stress	= 711.6 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

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

J _{ic}	= 173.4 kJ/m ²
K _{ic}	= 186.4 MPa √m
J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 169.3 kJ/m ²	
K _{ic}	= 184.1 MPa √m	
Slope M	= 129546.8 kJ/m ³	
Intercept B	= 153.9 kJ/m ²	
T (ASTM)	= 51	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= VALID	
J maximum allowed	= 722.5 kJ/m ²	(J _{max} = B _{net} * Flow stress / 20)
Δa max. allowed	= 2.04 mm	(Δa max = 0.1 * b ₀)



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 = 31.85 mm
 Final crack length = 41.86 mm
 Flow stress = 697.8 MPa
 Youngs modulus = 195500 MPa

Init a/W = .611

Final a/W = .824

(Estimated Value)

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

Jic = 142.6 kJ/m²
 Kjc = 167 MPa √m
 J (θJ/T=8.8) = 290.5 kJ/m²
 Exponent N = .4873
 Coefficient C = 249 kJ/m²
 T (average) = 43

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

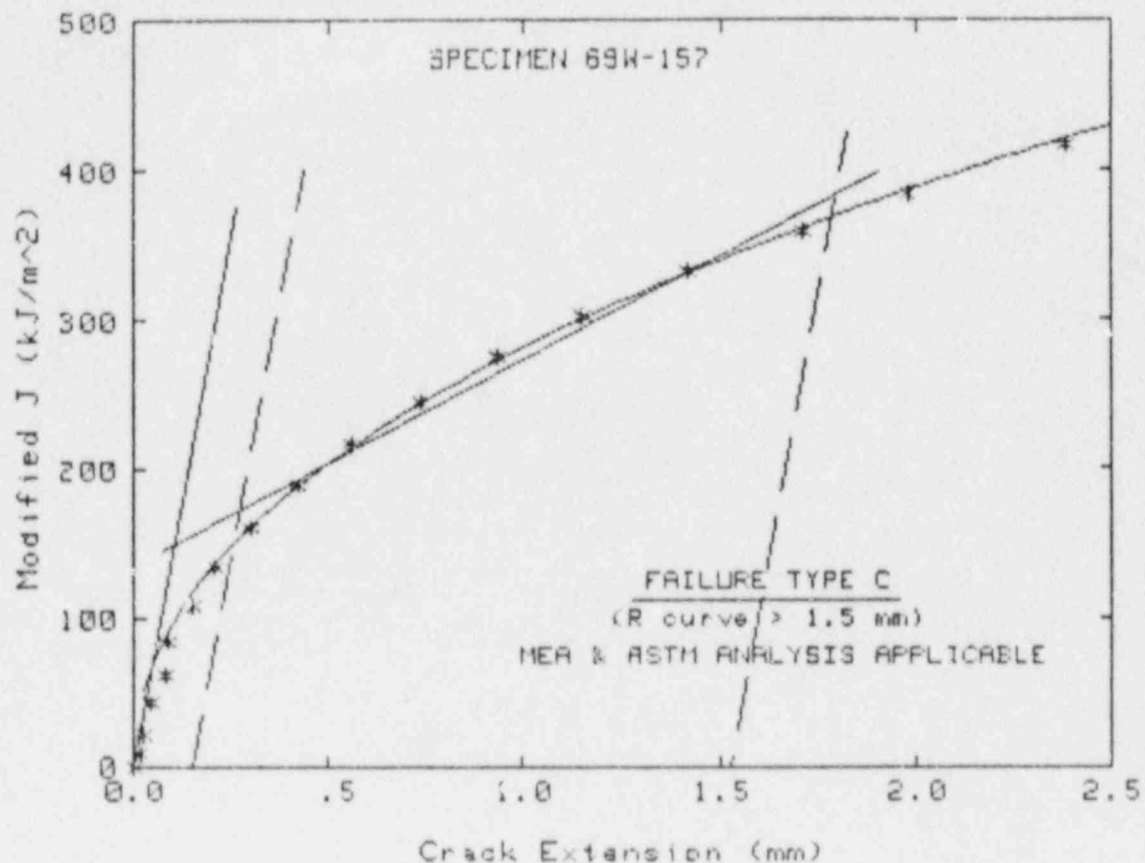
Jic = 152.7 kJ/m²
 Kjc = 172.8 MPa √m
 Slope M = 101685.8 kJ/m³
 Intercept B = 141.6 kJ/m²
 T (ASTM) = 41

Validity (Jic) = VALID

Validity (R-curve) = INVALID--3 (.43 vs .29)

J maximum allowed = 688.6 kJ/m² (Jmax=Bnet*Flow stress/20)

Delta a max. allowed = 1.98 mm (Delta a max = 0.1*bo)



TEST SPECIMEN DATA

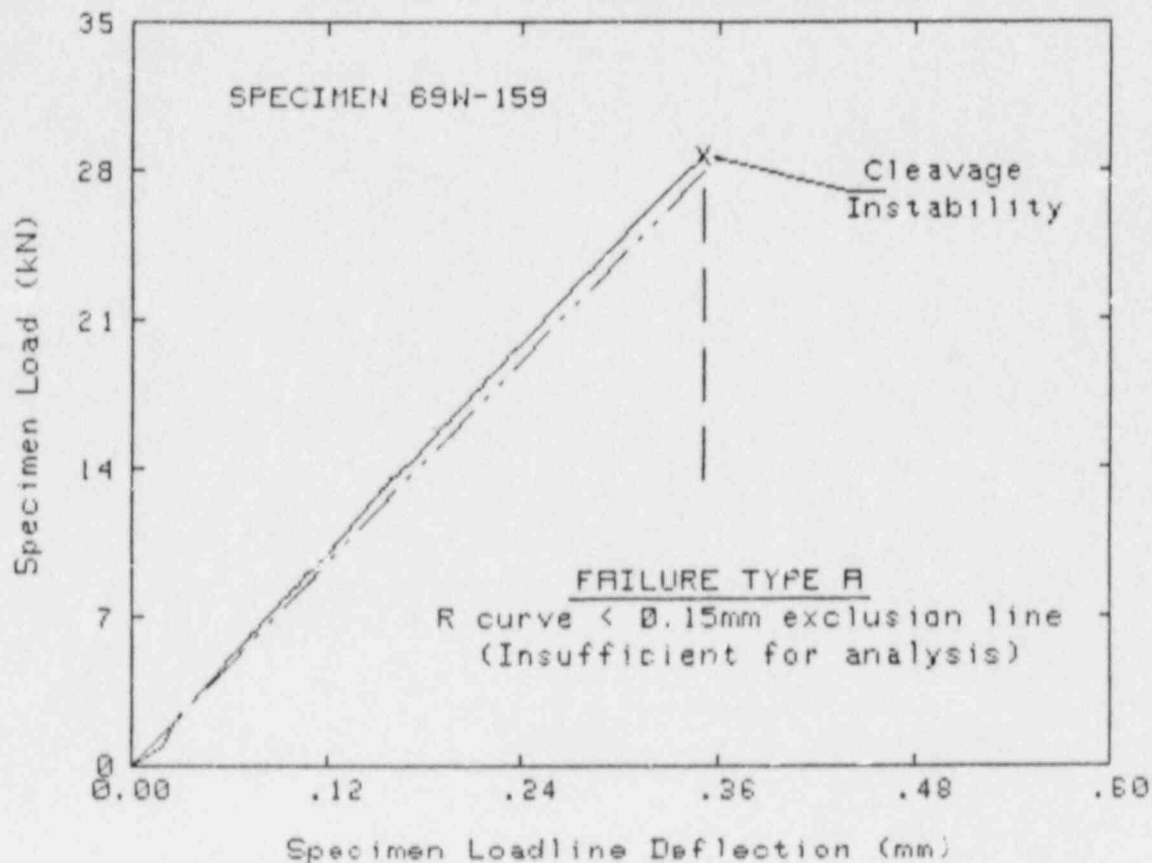
Material Type	= HSST S/A Weld (I)	
Test Temperature	= 121 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 30.16 mm	Init a/W = .593
Final crack length	= 40.5 mm	Final a/W = .797
Flow stress	= 711.6 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

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

J _{ic}	= 150.3 kJ/m ²
K _{ic}	= 173.5 MPa √m
J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 149.3 kJ/m ²	
K _{ic}	= 172.9 MPa √m	
Slope M	= 139007.6 kJ/m ³	
Intercept B	= 134.7 kJ/m ²	
T (ASTM)	= 55	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= INVALID--1	
J maximum allowed	= 722.5 kJ/m ²	(J _{max} =B _{net} *Flow stress/20)
Δa max. allowed	= 2.06 mm	(Δa 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 = J_{ic})

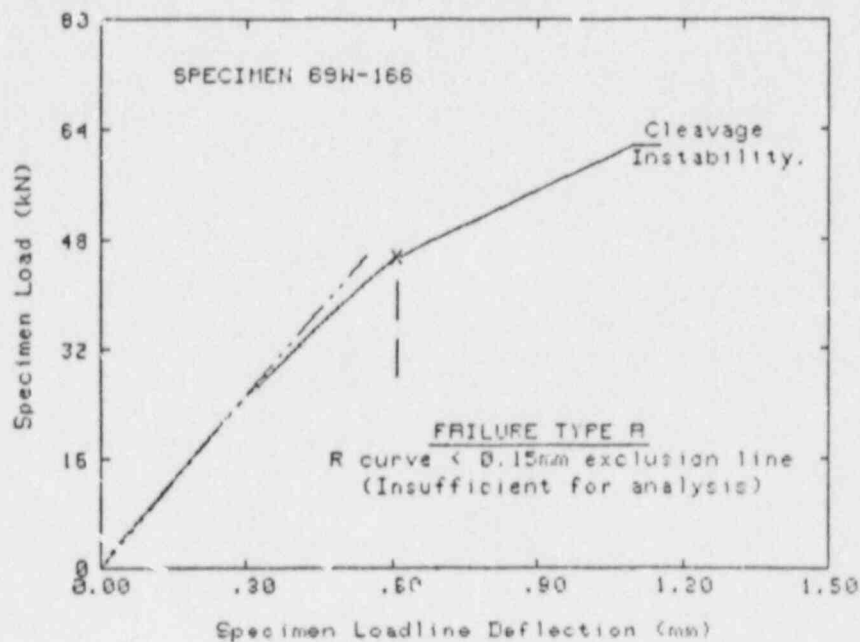
J_{ic} = 21.3 kJ/m²
 $K_{Jc} = (E J_{ic})^{.5} = 66.7 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$
 $K_{ic} \text{ (Beta Corrected)} = 63.6 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$

CTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (BB_n)^{.5}$
 Maximum Load P = 28.66 kN
 5% Secant Offset P_q = 28.66 kN
 $K_{ic} = 65.4 \text{ MPa } \sqrt{\text{m}}$
 Validity = VALID K_{ic} value

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Herkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 1.887287407355E-05 in.
 Specimen rotation Load intercept elastic slope = 1.818181818E-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

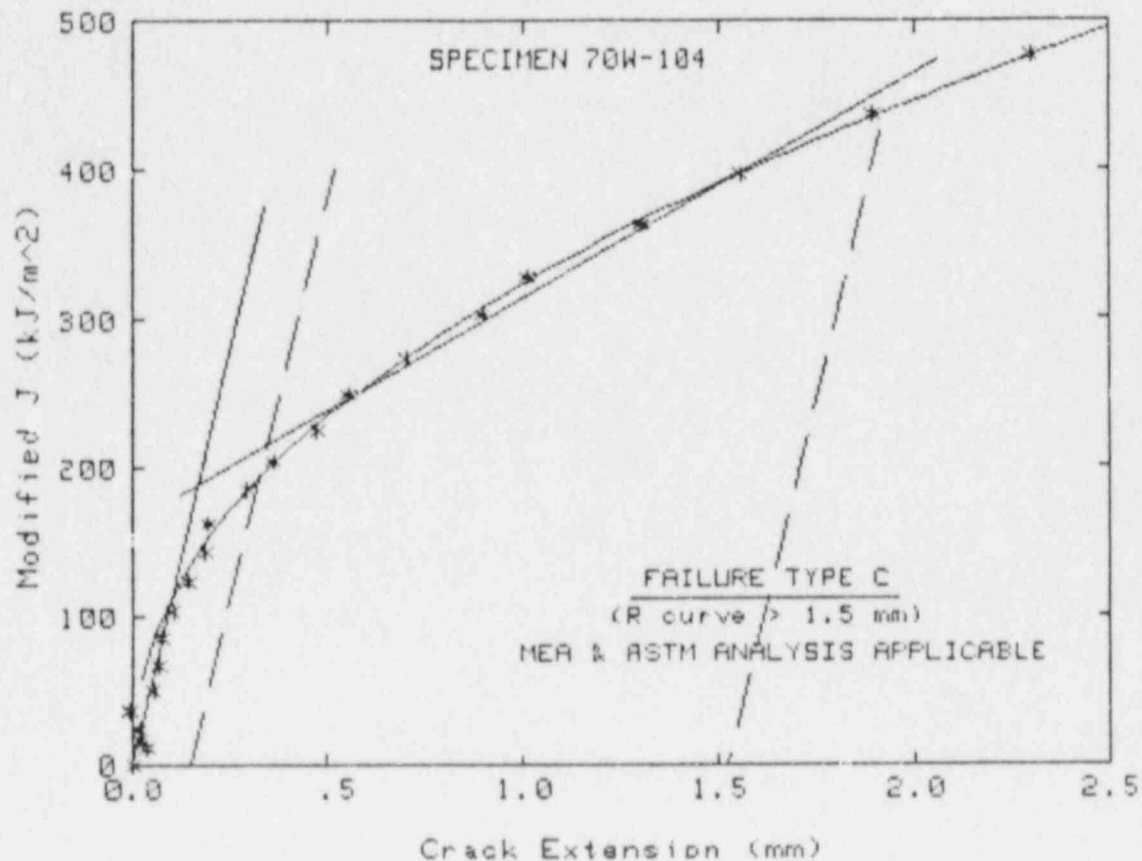
Failure Type A (J at instability = J_{ic})
 J_{ic} = 62.3 kJ/m²
 K_{Jc} = (EJ_{ic}/(1-v²))^{0.5} = 113.5 MPa √m v=.3
 K_{ic} (Beta Corrected) = 91.3 MPa √m v=.3

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB₀)^{0.5}
 Maximum Load P = 45.6 kN
 5% Secant Offset P_Q = 25.35 kN
 K_{ic} = 59.1 MPa √m
 Validity = INVALID--3
 K at Maximum Load = 106.3 MPa √m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Hinkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 5.35899211174E-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

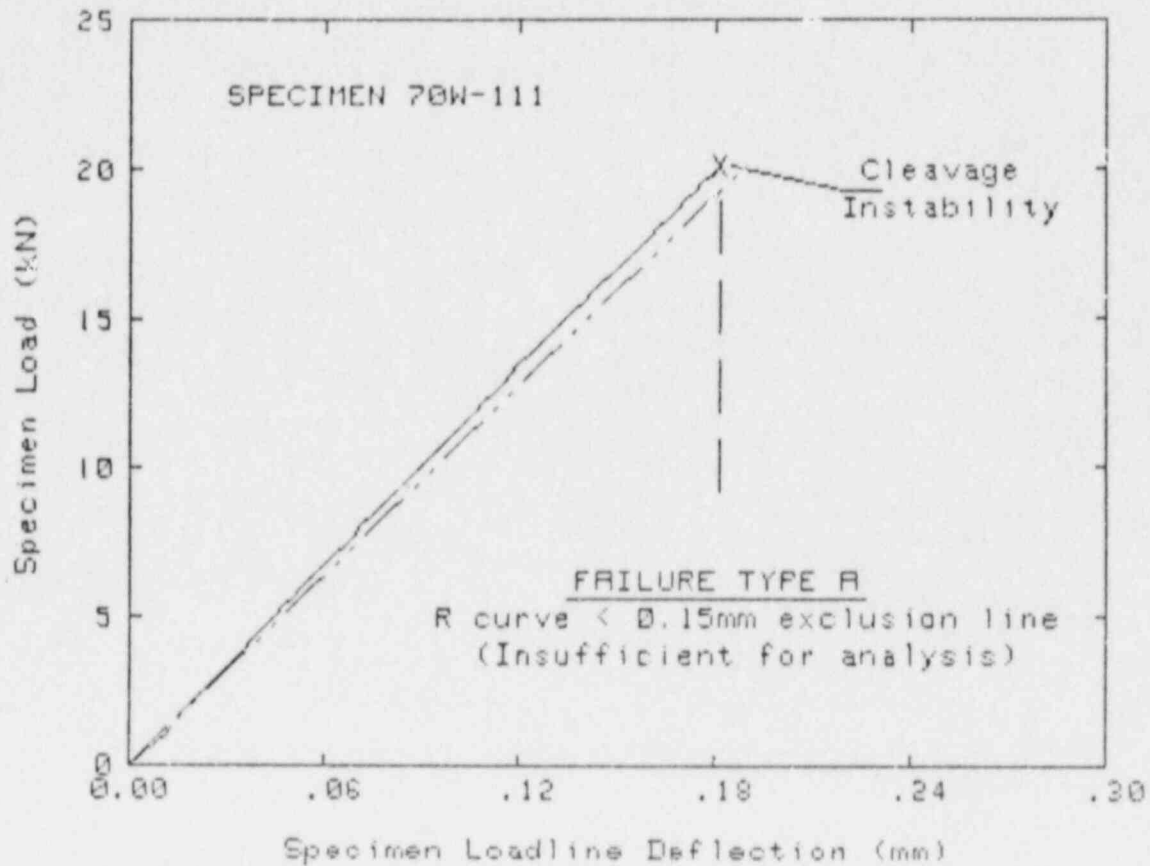
Material Type	= HSST S/A Weld (I)	
Test Temperature	= 121 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.51 mm	Init a/W = .541
Final crack length	= 37.57 mm	Final a/W = .739
Flow stress	= 549.8 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

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

J _{ic}	= 193 kJ/m ²
K _{Jc}	= 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) $J = M (\Delta a) + B$

J _{ic}	= 187.9 kJ/m ²
K _{Jc}	= 194 MPa √m
Slope M	= 151318.7 kJ/m ³
Intercept B	= 162 kJ/m ²
T (ASTM)	= 100
Validity (J _{ic})	= VALID
Validity (R-curve)	= INVALID--3 (.37 vs .34)
J maximum allowed	= 558.2 kJ/m ² (J _{max} =B _{net} *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 = J_{ic})

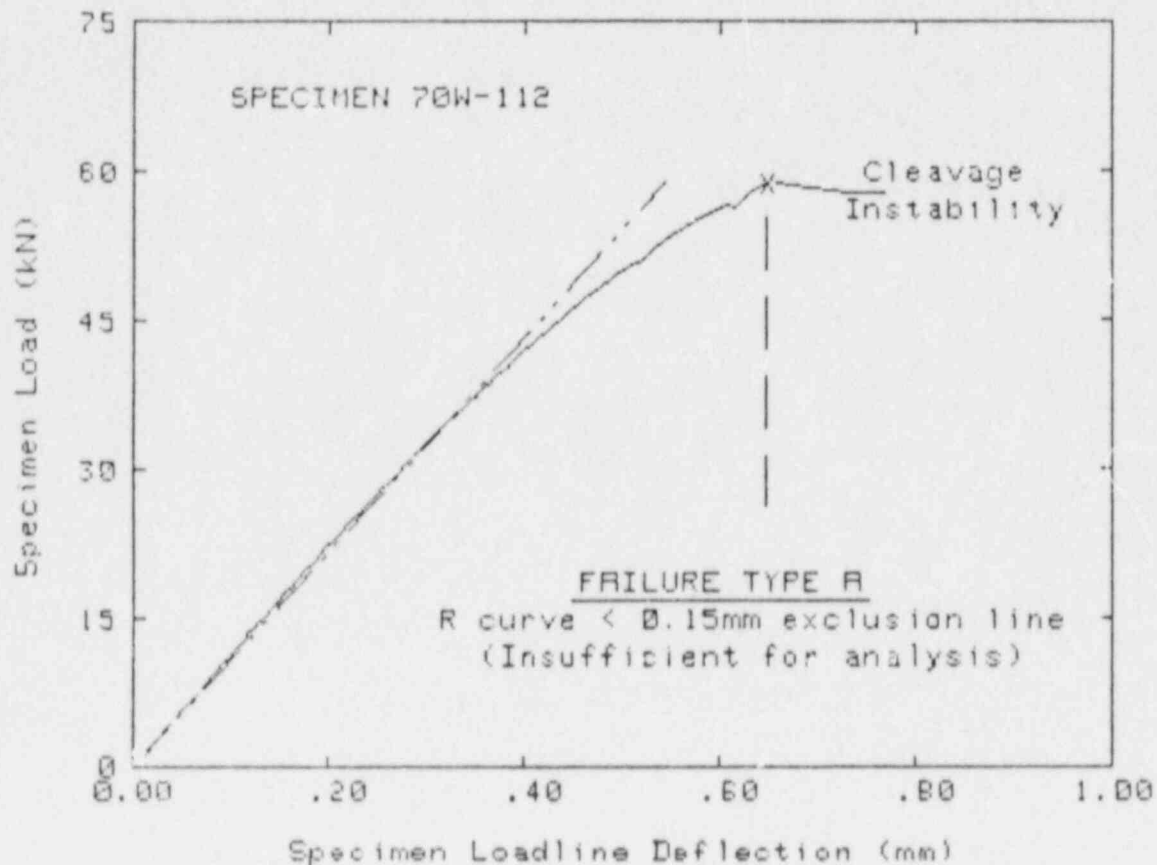
J _{ic}	= 7 kJ/m ²	
K _{Jc} =(EJ _{ic}) ^{0.5}	= 38.7 MPa √m	ν=.3
K _{ic} (Beta Corrected)	= 38.3 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation;	B = (BB _n) ^{0.5}
Maximum Load P	= 20.12 kN
5% Secant Offset P _q	= 20.11 kN
K _{ic}	= 39 MPa √m
Validity	= VALID K _{ic} value

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Herkle-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 = J_{ic})

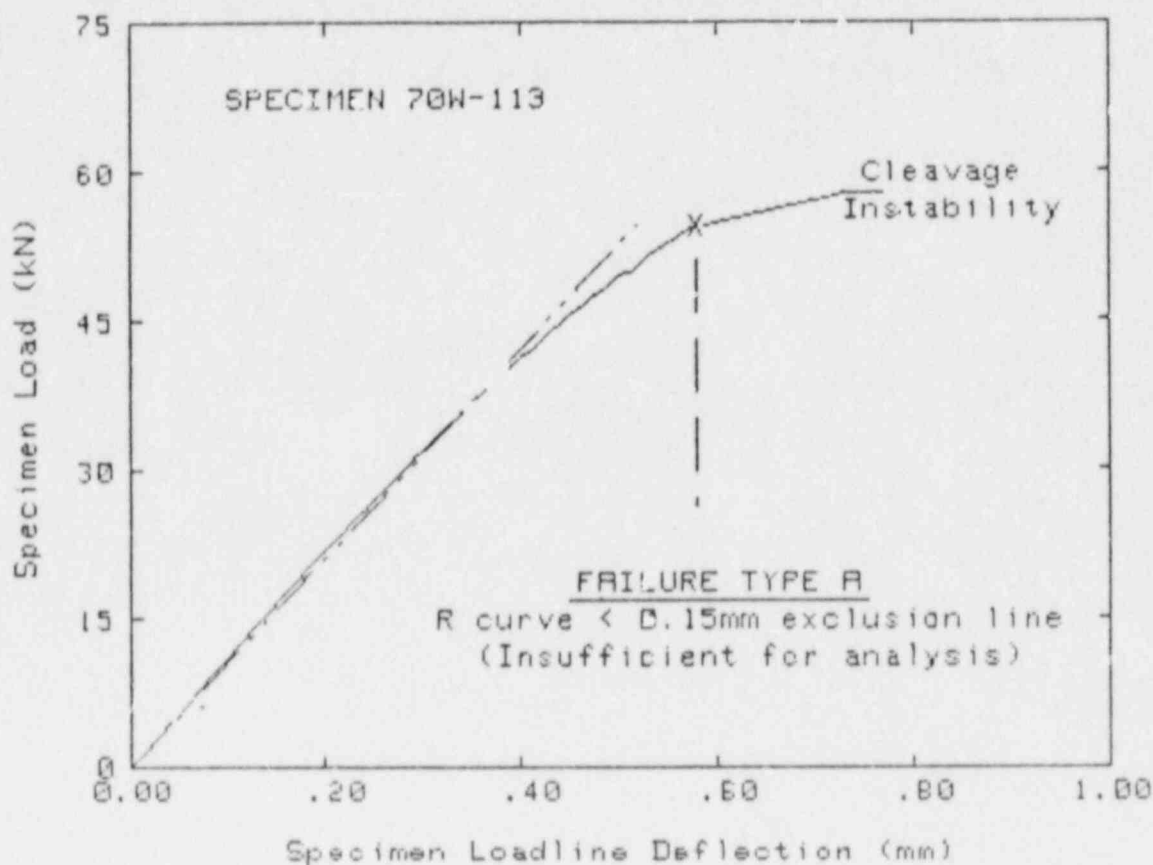
J _{ic}	= 82.6 kJ/m ²	
K _{ic} =(EJ _{ic}) ^{.5}	= 131.3 MPa √m	ν=.3
K _{ic} (Beta Corrected)	= 87.9 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B	= (BB _n) ^{.5}
Maximum Load P	= 58.75 kN
5% Secant Offset P _q	= 34.97 kN
K _{ic}	= 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

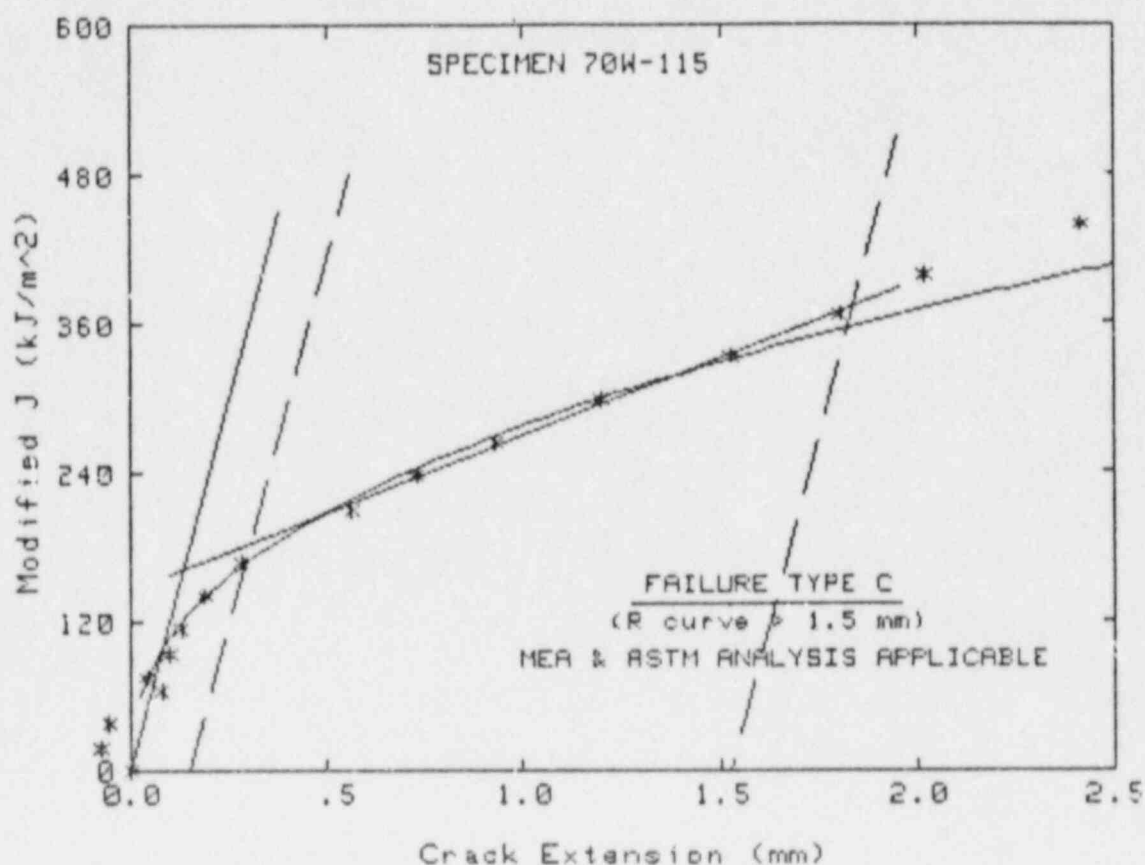
Failure Type A (J at instability = J _{ic})		
J _{ic}	= 65.5 kJ/m ²	
K _{Jic} = (EJ _{ic}) ^{.5}	= 117 MPa √m	ν=.3
K _{ic} (Beta Corrected)	= 83.1 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B = (BB _n) ^{.5}	
Maximum Load P	= 54.59 kN
5% Secant Offset P _q	= 36.45 kN
K _{ic}	= 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

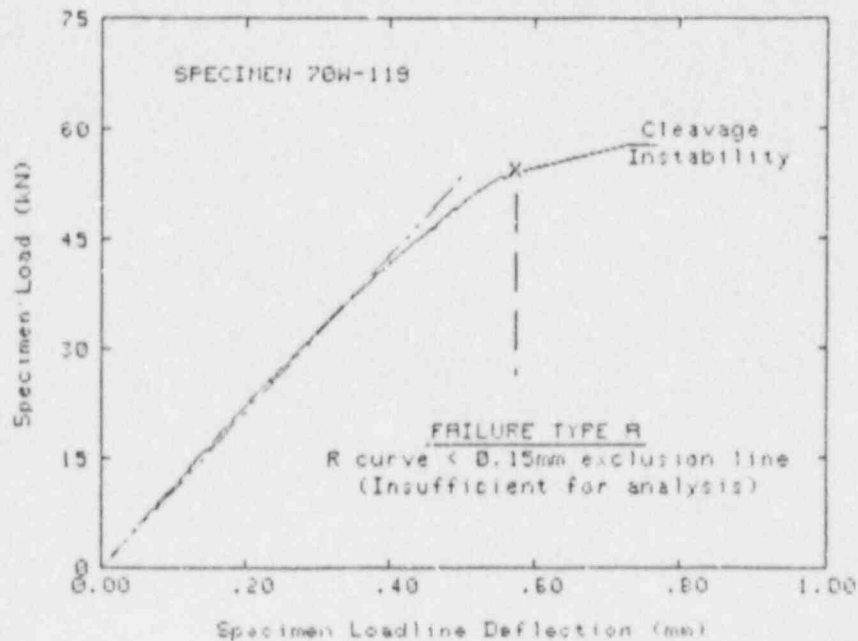
Material Type	= A533-B HSST WELD	
Test Temperature	= 30 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.22 mm	Init a/W = .555
Final crack length	= 39.79 mm	Final a/W = .783
Flow stress	= 599.8 MPa	
Youngs modulus	= 205500 MPa	(Estimated Value)

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

Jic	= 166.6 kJ/m ²
Kjc	= 185 MPa $\sqrt{m}$
J (0J/T=0.8)	= 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 $\sqrt{m}$
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
 Young's modulus E = 208000 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J_{ic})

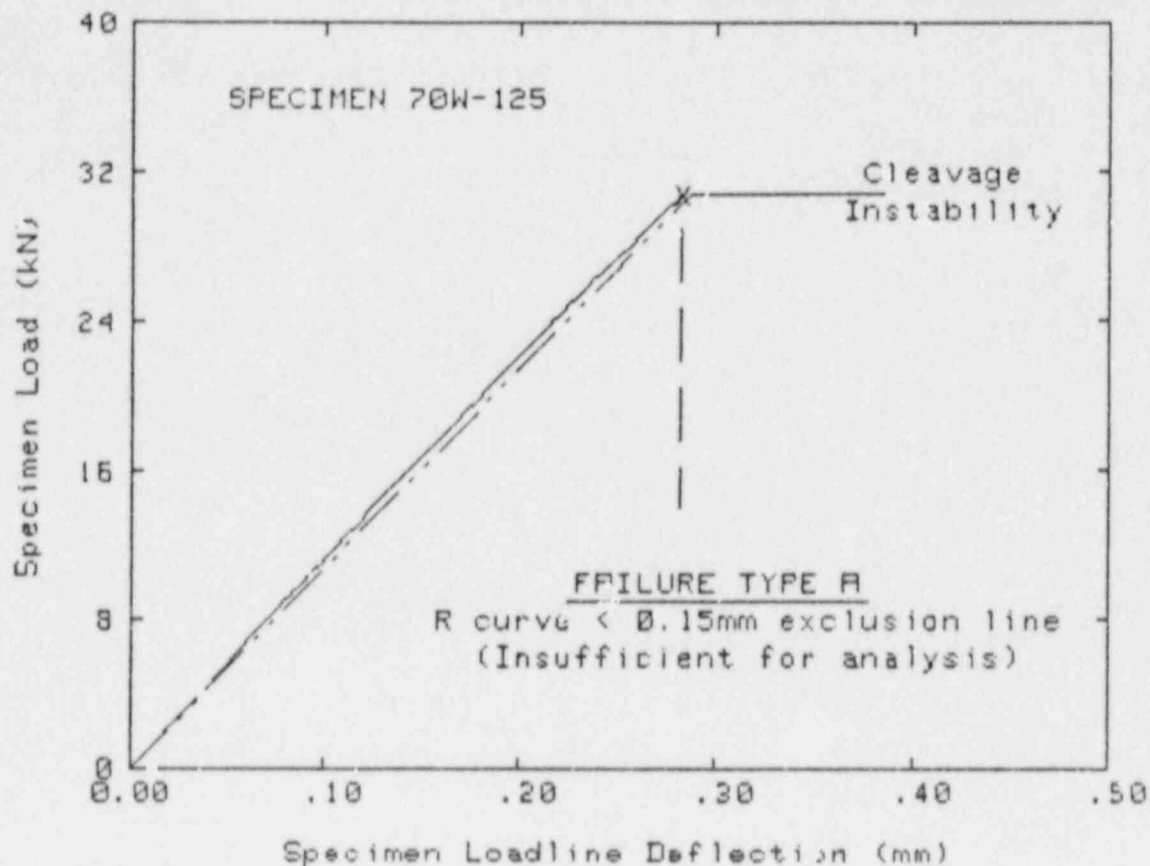
J_{ic} = 65.9 kJ/m²
 K_{Jic}(E_{Jic})^{1/2} = 117.1 MPa √m
 K_{Jic} (Beta Corrected) = 82.5 MPa √m

ASTM E399-91 ANALYSIS

Modified K_{Jic} Equation: B = (B_{min})^{1/2}
 Maximum Load P = 54.42 kN
 5% Secant Offset P_Q = 35.28 kN
 K_{Jic} = 69.9 MPa √m
 Validity = INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Hertz-Correction OFFSET LOAD = 0 lb OFFSET DEFLECTION = 2.85783397559E-05 in.
 Specimen notation 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	= 700 MPa
Yield stress	= 644 MPa
Youngs modulus E	= 212600 MPa (Estimated Value)

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J_{ic})

J _{ic}	= 16.7 kJ/m ²	
K _{Jc} = (EJ _{ic}) ^{.5}	= 59.6 MPa √m	ν=.3
K _{ic} (Beta Corrected)	= 56.2 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation: B = (BB_n)^{.5}

Maximum Load P = 30.8 kN

5% Secant Offset P_q = 30.82 kN

K_{ic} = 59 MPa √m

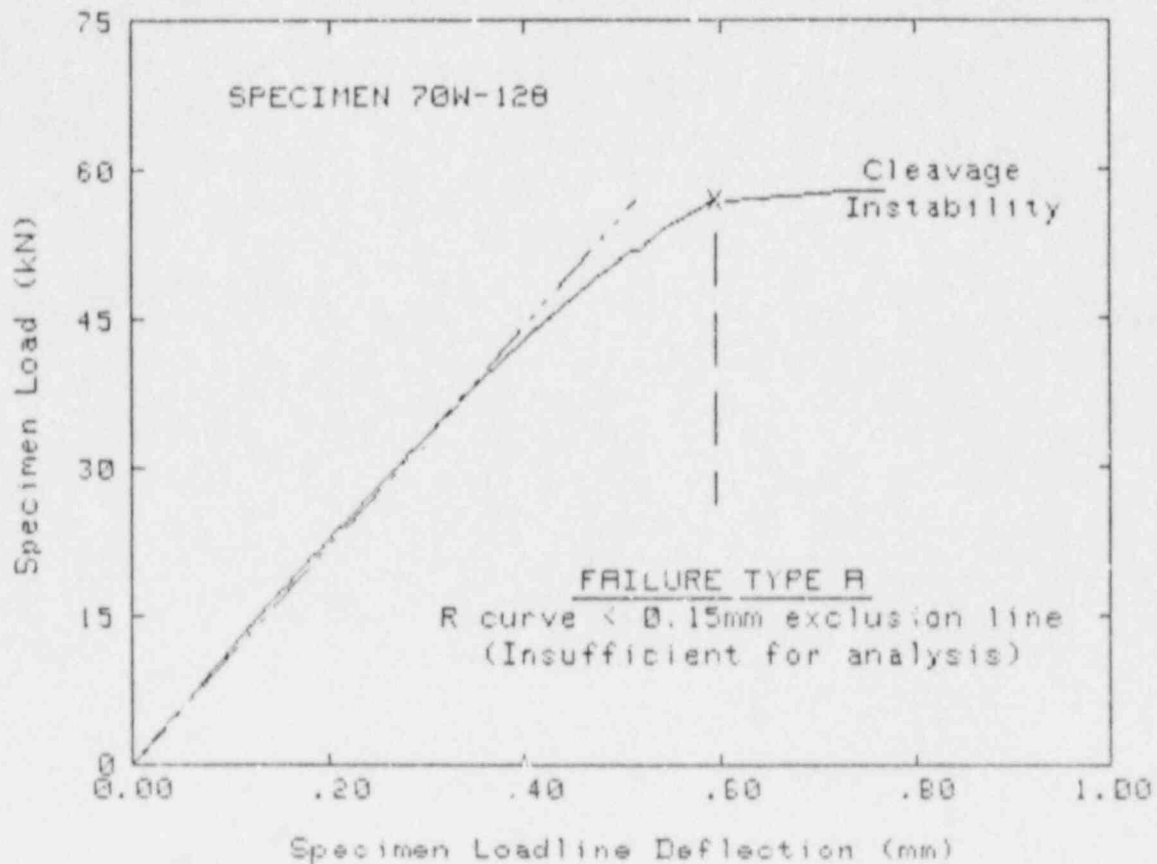
Validity = INVALID--1, 2

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 = J_{ic})

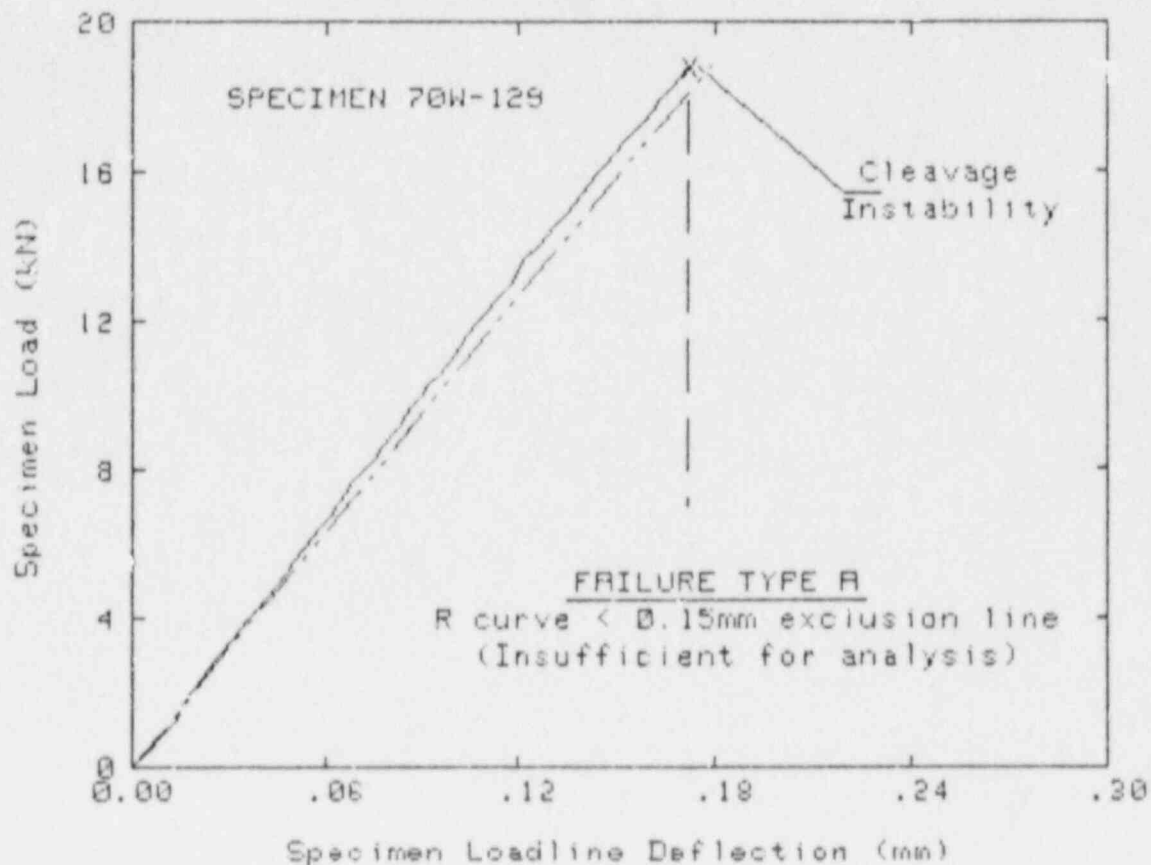
J _{ic}	=	71 kJ/m ²
K _{Jc} =(EJ _{ic}) ^{0.5}	=	121.7 MPa √m ν=.3
K _{ic} (Beta Corrected)	=	84.8 MPa √m ν=.3

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B	=	(B _{2n}) ^{0.5}
Maximum Load P	=	56.92 kN
5% Secant Offset P _q	=	34.21 kN
K _{ic}	=	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 (1)	
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	= 749.8 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 = J_{ic})

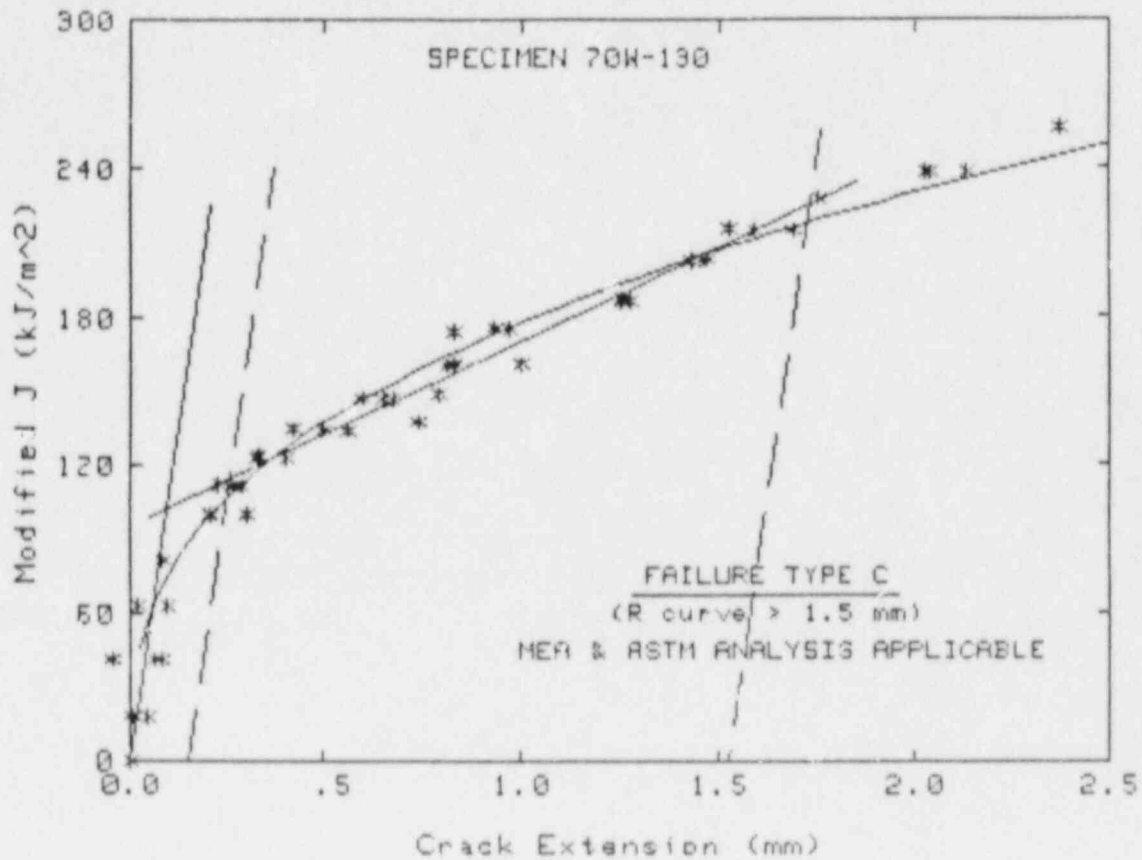
J _{ic}	= 6.3 kJ/m ²	
K _{Jc} = (EJ _{ic}) ^{0.5}	= 36.8 MPa √m	ν = .3
K _{ic} (Beta Corrected)	= 36.4 MPa √m	ν = .3

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation;	B = (BB _n) ^{0.5}
Maximum Load P	= 18.82 kN
5% Secant Offset P _q	= 18.82 kN
K _{ic}	= 37.3 MPa √m
Validity	= VALID K _{ic} value

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

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



TEST SPECIMEN DATA

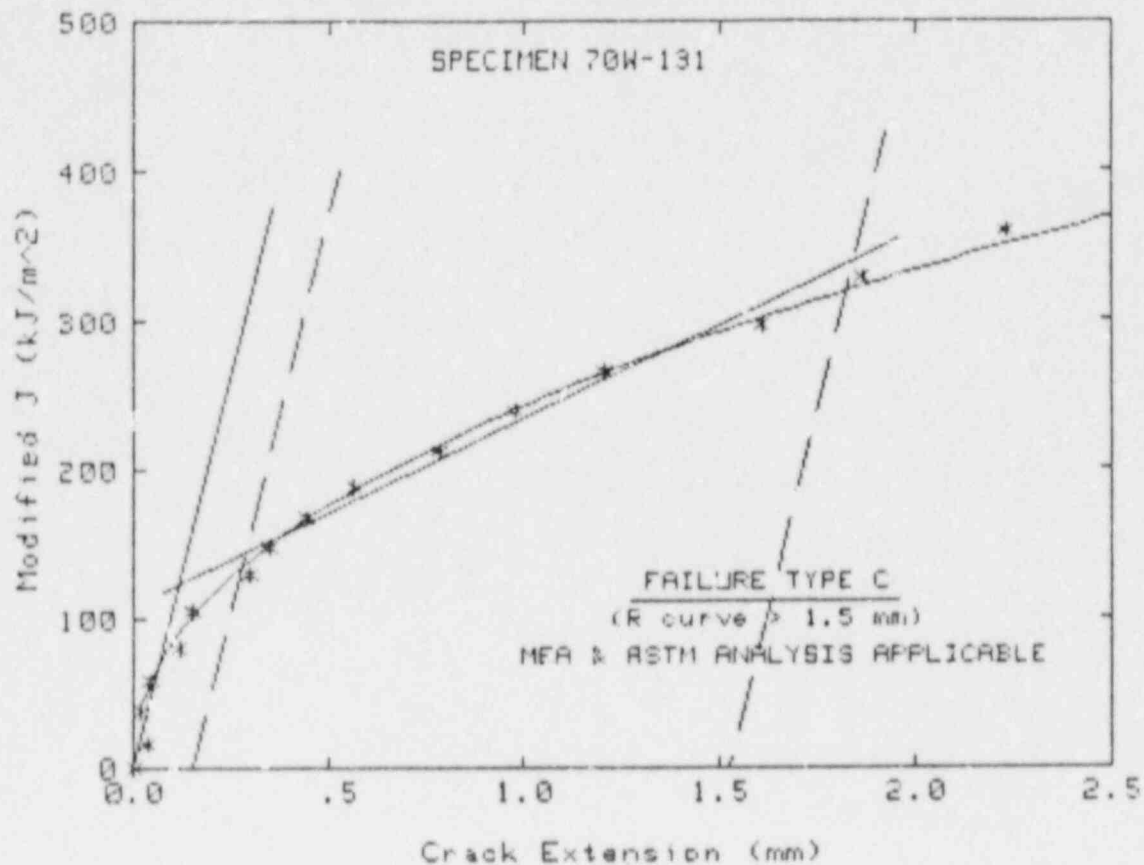
Material Type	= A533B Weld	
Test Temperature	= 288 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 26.7 mm	Init a/W = .566
Final crack length	= 39.79 mm	Final a/W = .783
Flow stress	= 542.6 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^H$

J _{ic}	= 106.7 kJ/m ²
K _{jc}	= 142.7 MPa √m
J (@J/T=8.8)	= 287.3 kJ/m ²
Exponent H	= .3696
Coefficient C	= 177.9 kJ/m ²
T (average)	= 46

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

J _{ic}	= 102.6 kJ/m ²
K _{jc}	= 139.9 MPa √m
Slope M	= 74780.9 kJ/m ³
Intercept B	= 95.6 kJ/m ²
T (ASTM)	= 48
Validity (J _{ic})	= VAL.D
Validity (R-curve)	= INVALID--3 (.37 vs .33)
J maximum allowed	= 550.9 kJ/m ² (J _{max} =E _{net} *Flow stress/20)
Delta a max. allowed	= 2.21 mm (Delta a max = 0.1*bo)



TEST SPECIMEN DATA

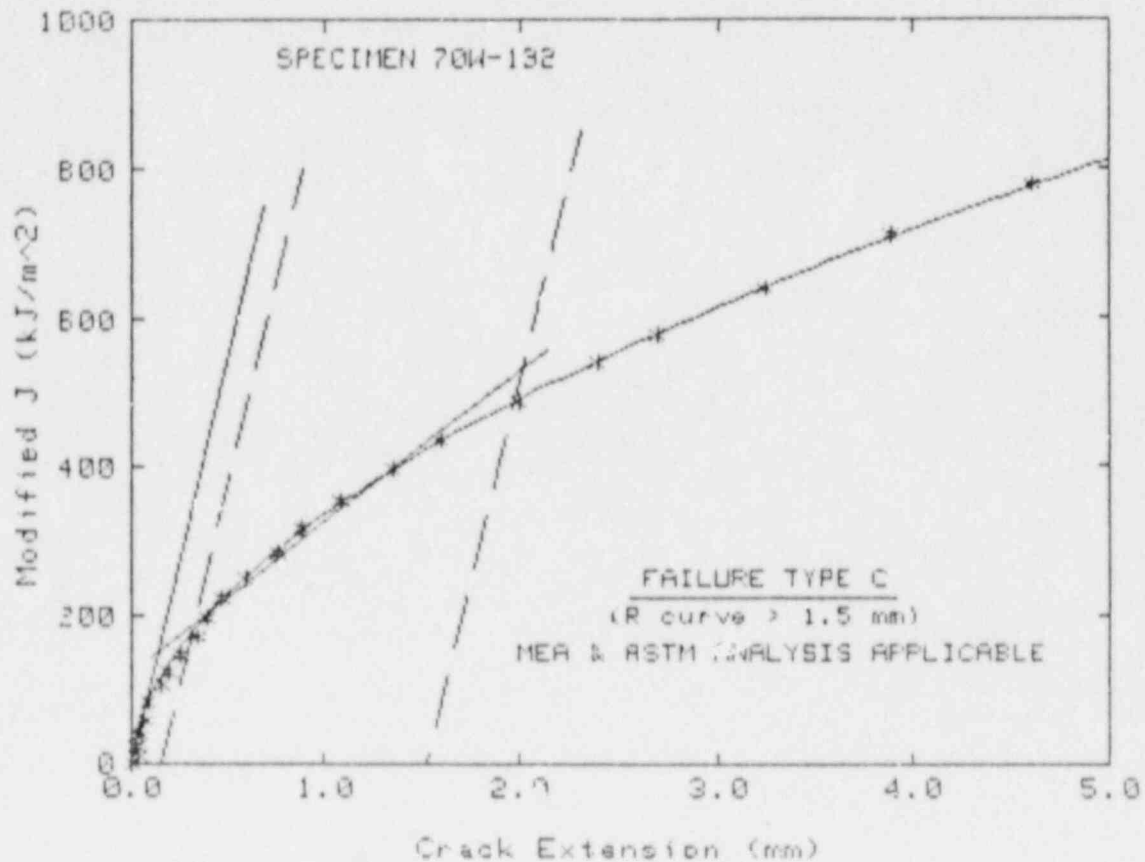
Material Type	= HSST S/A Weld (I)	
Test Temperature	= 204 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.28 mm	Init a/W = .556
Final crack length	= 39.8 mm	Final a/W = .783
Flow stress	= 535.3 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

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

J _{ic}	= 135.4 kJ/m ²
K _{jc}	= 162.7 MPa √m
J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 123.9 kJ/m ²
K _{jc}	= 155.6 MPa √m
Slope M	= 124574.7 kJ/m ³
Intercept B	= 109.5 kJ/m ²
T (ASTM)	= 85
Validity (J _{ic})	= VALID
Validity (R-curve)	= INVALID--1, 3 (.58 vs .33)
J maximum allowed	= 543.5 kJ/m ² (J _{max} =B _{net} *Flow stress/20)
Delta a max. allowed	= 2.25 mm (Delta a max = 0.1*bo)



TEST SPECIMEN DATA

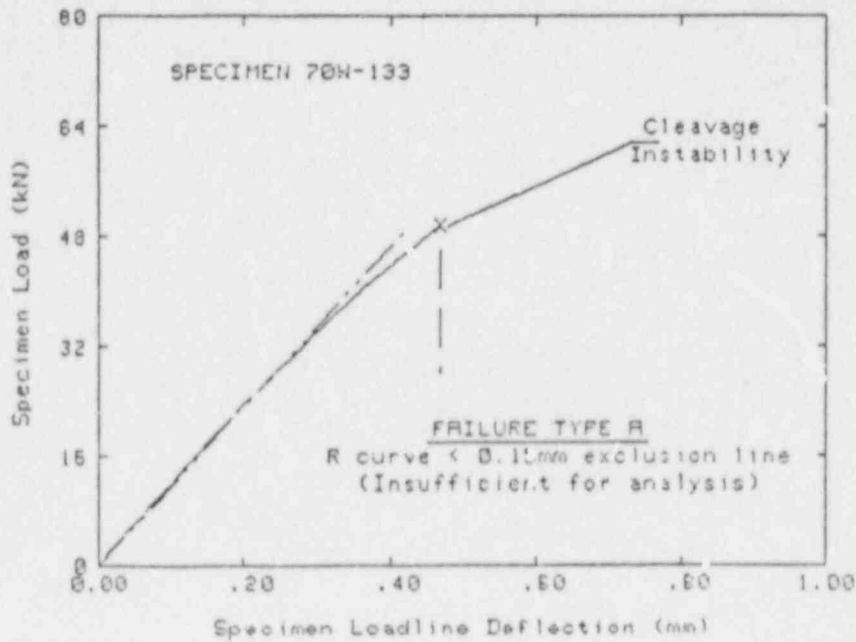
Material Type	= HSST S/A Weld (1)	
Test Temperature	= 121 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.72 mm	Init a/W = .545
Final crack length	= 36.28 mm	Final a/W = .714
Flow stress	= 549.8 MPa	
Youngs modulus	= 200300 MPa	(Estimated Value)

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

J ($\theta J/T=8.8$)	= 633.4 kJ/m ²
J_{ic}	= 178.5 kJ/m ²
K_{Jc}	= 189.1 MPa $\sqrt{m}$
Exponent N	= .5478
Coefficient C	= 336.2 kJ/m ²
T (average)	= 120

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

J_{ic}	= 151.4 kJ/m ²
K_{Jc}	= 174.1 MPa $\sqrt{m}$
Slope M	= 204363.5 kJ/m ³
Intercept B	= 123.2 kJ/m ²
T (ASTM)	= 136
Validity (J_{ic})	= VALID
Validity (R-curve)	= VALID
J maximum allowed	= 558.2 kJ/m ² ($J_{max} = B_{net} * \text{Flow stress} / 20$)
Δa max. allowed	= 2.31 mm ($\Delta a_{max} = 0.1 * b_0$)



TEST SPECIMEN DATA

Material Type = A503-B HSST WELD
 Test Temperature = -50 C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = 1.55
 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

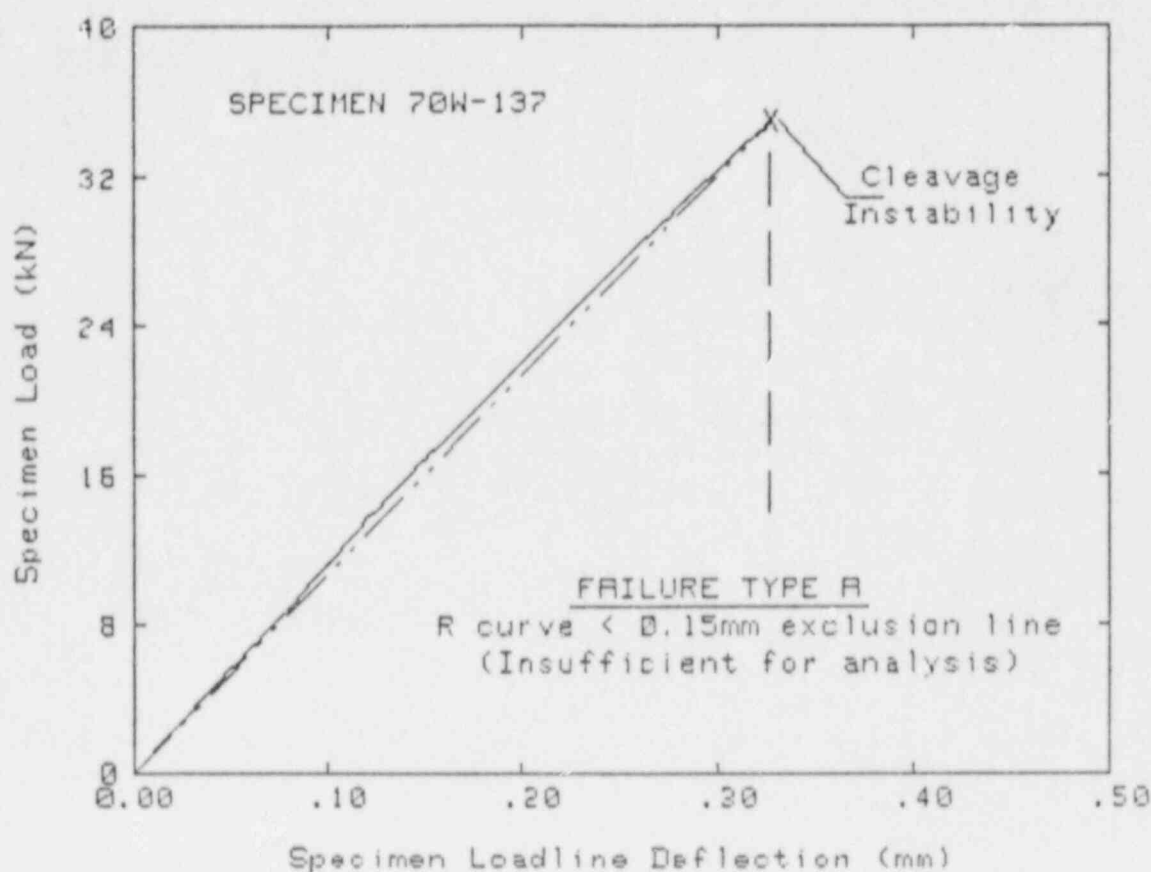
Failure Type A (J at instability = J_{ic})
 J_{ic} = 47.6 kJ/m²
 $K_{Jic} = (E J_{ic} / (1 - v^2))^{1/2} = 100.1 \text{ MPa } \sqrt{\text{m}}$ v=.3
 $K_{ic} \text{ (Beta Corrected)} = 76.7 \text{ MPa } \sqrt{\text{m}}$ v=.3

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (B_{fn})^{1.5}
 Maximum Load P = 49.5 kN
 5% Secant Offset P_Q = 27.66 kN
 K_{ic} = 54.8 MPa $\sqrt{\text{m}}$
 Validity = INVALID--3
 K at Maximum Load = 98.1 MPa $\sqrt{\text{m}}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Herkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 1.04616173941E-04 in.
 Specimen rotation Load intercept elastic slope = -1.0000040875 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 = J_{ic})

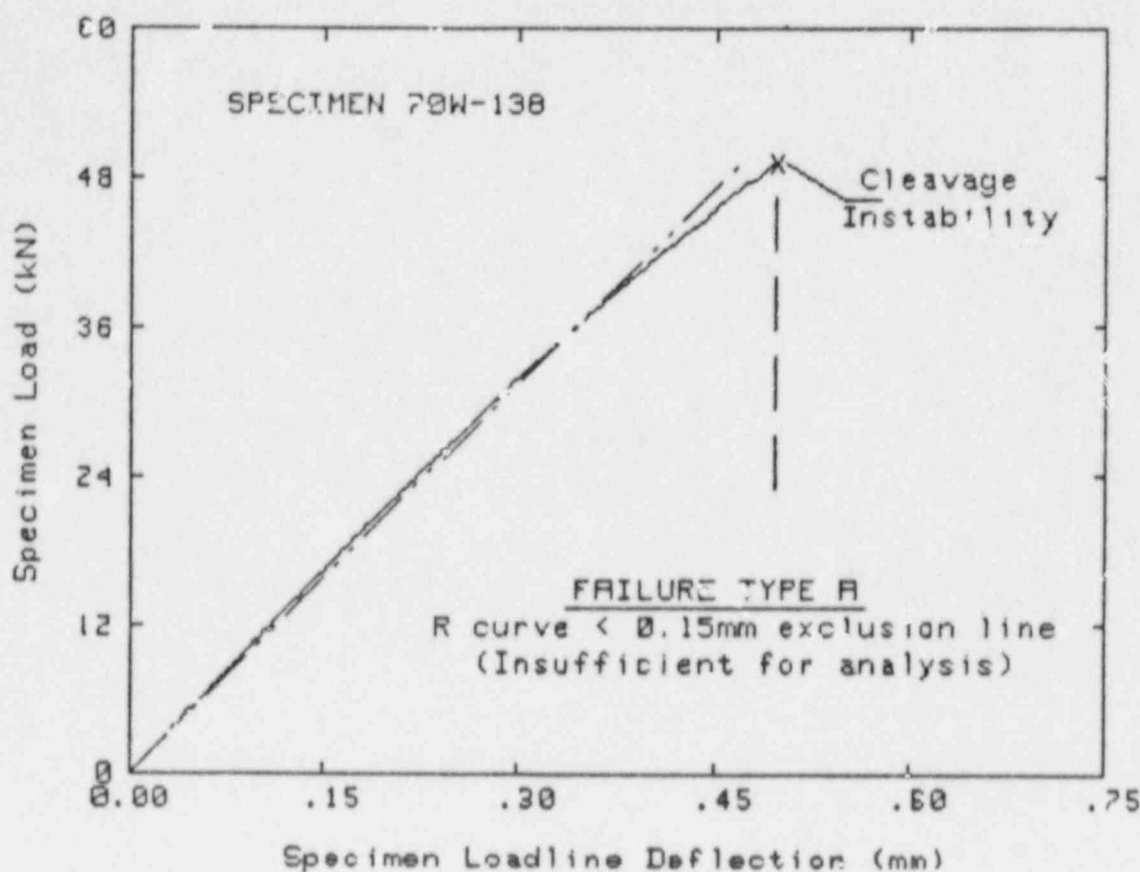
J _{ic}	= 22.5 kJ/m ²	
K _{Jc} = (EJ _{ic}) ^{.5}	= 69.1 MPa √m	ν=.3
K _{ic} (Beta Corrected)	= 62.5 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B	= (BB _n) ^{.5}
Maximum Load P	= 35 kN
5% Secant Offset P _q	= 35 kN
K _{ic}	= 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

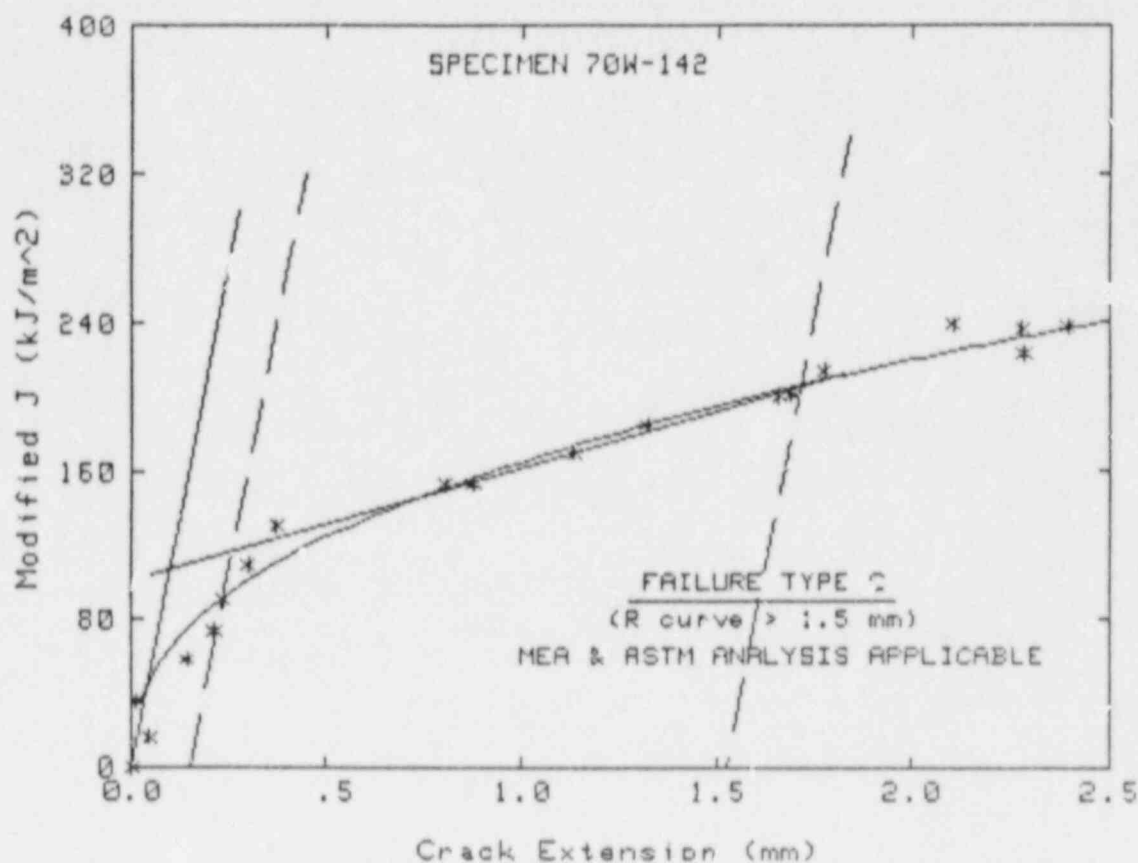
Failure Type A (J at instability = J _{ic})	
J _{ic}	= 49.8 kJ/m ²
K _{Jc} =(EJ _{ic}) ^{.5}	= 102.3 MPa √m ν=.3
K _{ic} (Beta Corrected)	= 79 MPa √m ν=.3

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B = (BB _n) ^{.5}	
Maximum Load P	= 49.2 kN
5% Secant Offset P _q	= 36.45 kN
K _{ic}	= 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

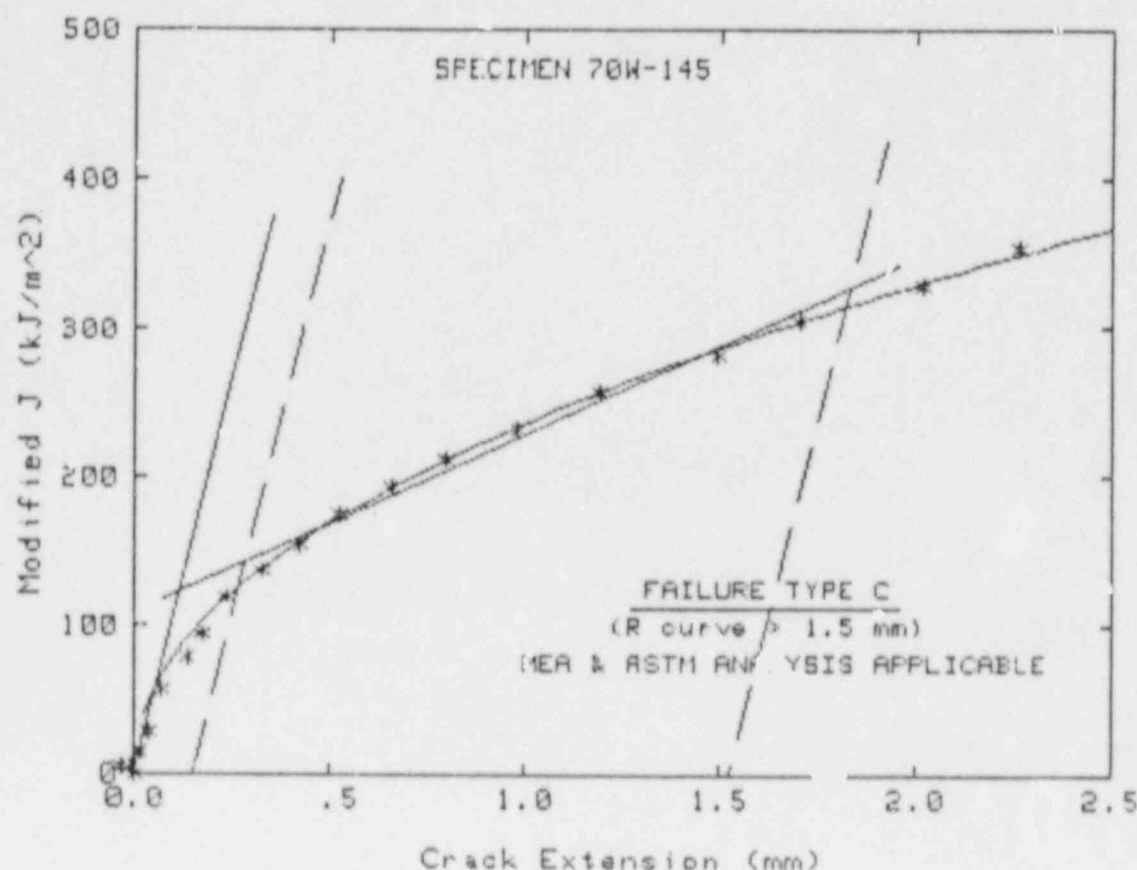
Material Type	= A533B Weld	
Test Temperature	= 288 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.94 mm	Init a/W = .55
Final crack length	= 39.84 mm	Final a/W = .784
Flow stress	= 542.6 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

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

J _{ic}	= 91.5 kJ/m ²
K _{jc}	= 132.1 MPa √m
J (θJ/T=8.8)	= 249 kJ/m ²
Exponent N	= .4182
Coefficient C	= 165.2 kJ/m ²
T (average)	= 48

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

J _{ic}	= 106.7 kJ/m ²
K _{jc}	= 142.7 MPa √m
Slope M	= 60966.1 kJ/m ³
Intercept B	= 100.7 kJ/m ²
T (ASTM)	= 40
Validity (J _{ic})	= VALID
Validity (R-curve)	= INVALID--1, 3 (.72 vs .34)
J maximum allowed	= 550.9 kJ/m ² (J _{max} =E _{net} *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	= 28.87 mm
Final crack length	= 39.62 mm
Flow stress	= 535.3 MPa
Youngs modulus	= 195500 MPa
POWER LAW DATA	$J = C (\Delta a)^N$

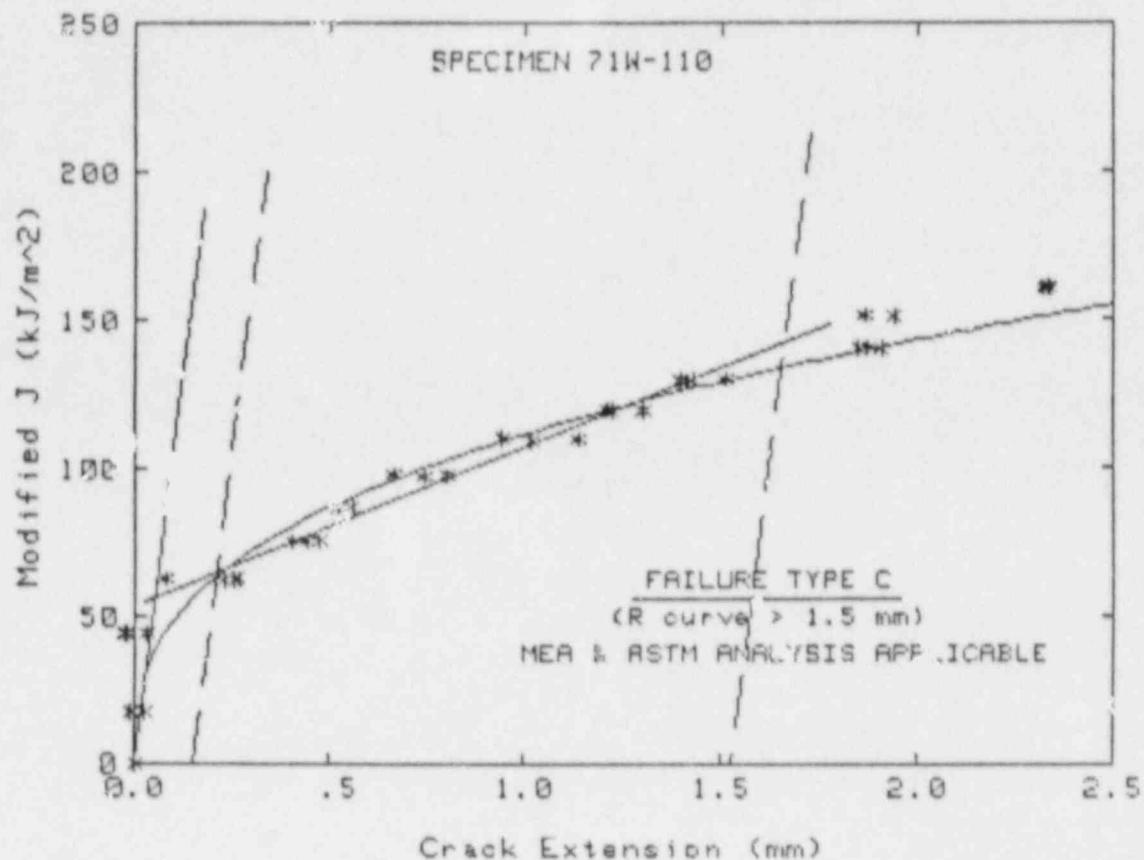
Init $a/W = .502$
Final $a/W = .779$

(Estimate of J_{max})

J_{ic}	= 126 kJ/m ²
K_{Jc}	= 157 MPa $\sqrt{m}$
$J (\theta J/T=8.8)$	= 410.9 kJ/m ²
Exponent N	= .4797
Coefficient C	= 236.1 kJ/m ²
T (average)	= 80

LEAST SQUARE LINEAR LINE (ASTM) $J = u (\Delta a) + B$

J_{ic}	= 124.1 kJ/m ²
K_{Jc}	= 155.7 MPa $\sqrt{m}$
Slope M	= 118205.8 kJ/m ³
Intercept B	= 110.4 kJ/m ²
T (ASTM)	= 81
Validity (J_{ic})	= VALID
Validity (R-curve)	= VALID
J maximum allowed	= 543.5 kJ/m ² ($J_{max} = B_{net} * \text{Flow stress} / 20$)
Delta a max. allowed	= 2.27 mm ($\Delta a_{max} = 0.1 * b_0$)



TEST SPECIMEN DATA

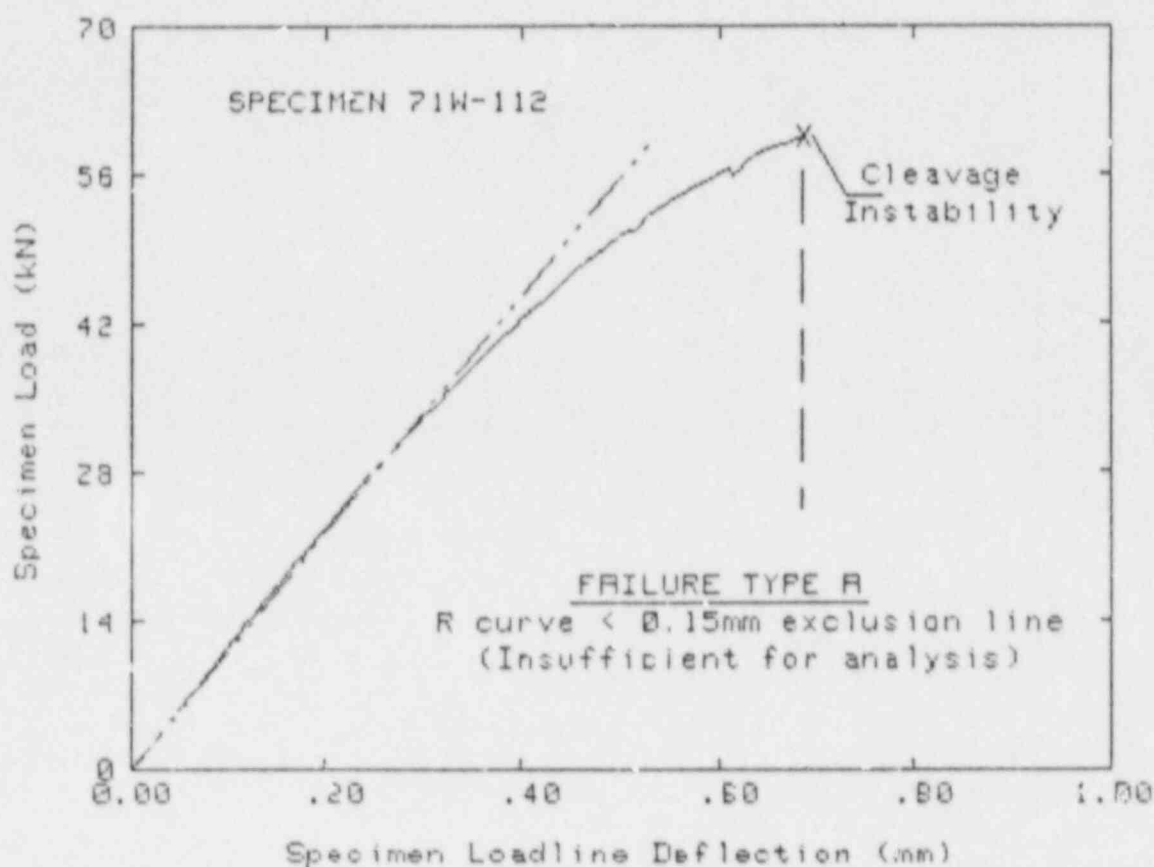
Material Type	= A533B HSST Weld	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.17 mm	Init a/W = .554
Final crack length	= 40.27 mm	Final a/W = .792
Flow stress	= 532.6 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

J _{IC}	= 63.7 kJ/m ²
K _{JC}	= 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 LINE (ASTM) $J = M (\Delta a)^3 + B$

J _{IC}	= 56.4 kJ/m ²
K _{JC}	= 103.1 MPa √m
Slope M	= 1.17 kJ/m ² / m ³
Intercept B	= 22.7 kJ/m ²
T (ASTM)	= 22.7
Validity (J _{IC})	= 56.4 kJ/m ²
Validity (R-curve)	= 201.1 kJ/m ²
Maximum allowed	= 57.1 kJ/m ² (J _{max} = B _{net} * Flow stress / 20)
Delta a max allowed	= 2.1 mm (Delta a max = 0.1 * b _o)
Final J	= 11.6 kJ/m ²
Poisson's Ratio (ν)	= 0



TEST SPECIMEN DATA

Material Type = HSST S/A Weld (1)
 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 = J_{ic})

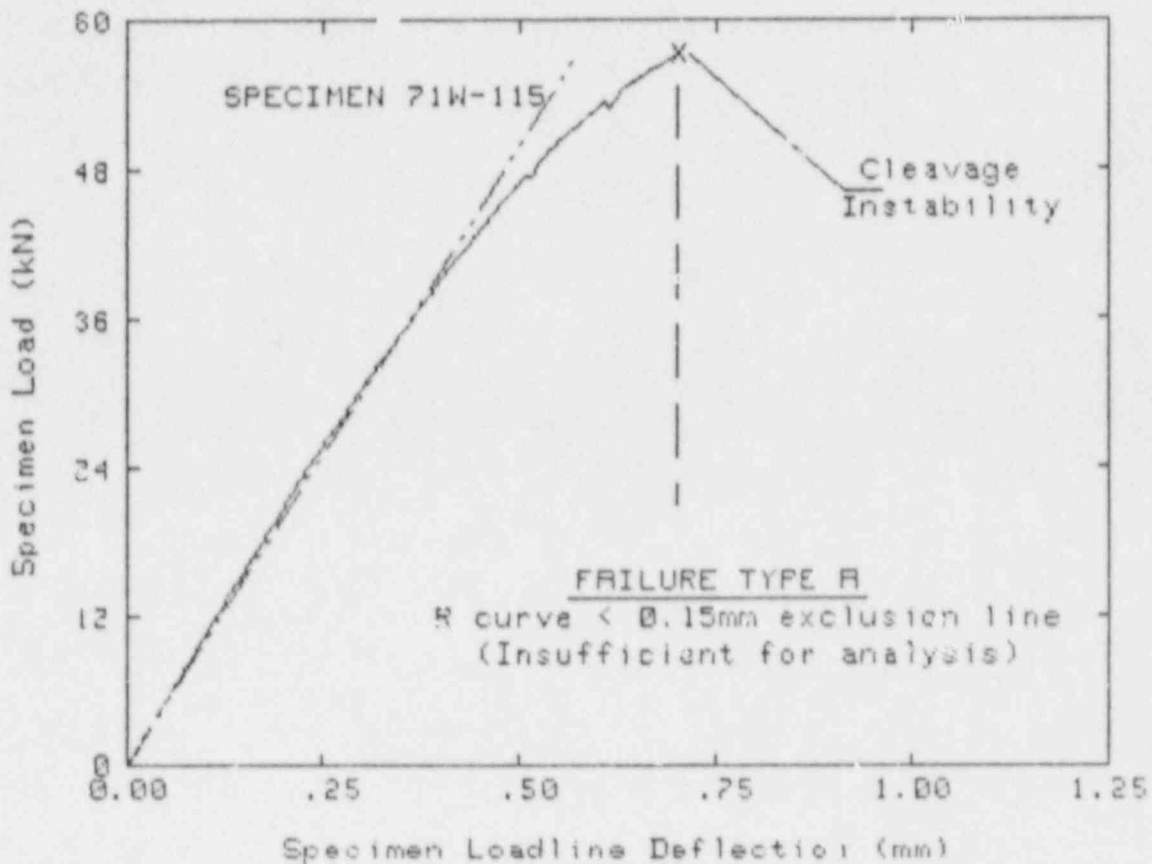
J_{ic} = 91.8 kJ/m²
 $K_{Jc} = (EJ_{ic})^{.5} = 138 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$
 $K_{ic} \text{ (Beta Corrected)} = 89 \text{ MPa } \sqrt{\text{m}}$ $\nu = .3$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (DBn)^{.5}$
 Maximum Load P = 59.58 kN
 5% Secant Offset P_q = 31.06 kN
 $K_{ic} = 61.2 \text{ MPa } \sqrt{\text{m}}$
 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 R (J at instability = J_{ic})

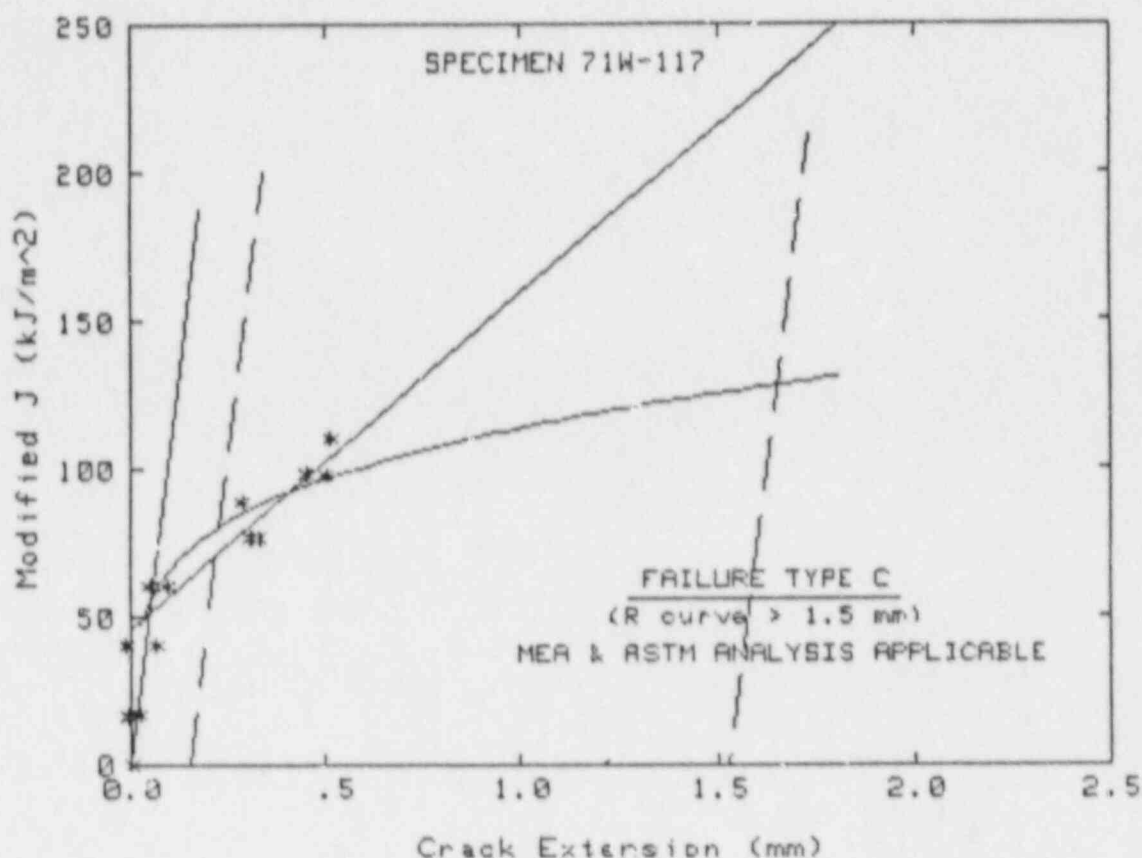
J_{ic} = 88 kJ/m²
 $K_{Jc} = (EJ_{ic})^{.5} = 135.1 \text{ MPa} \sqrt{\text{m}}$ $\nu=.3$
 $K_{ic} \text{ (Beta Corrected)} = 10.1 \text{ MPa} \sqrt{\text{m}}$ $\nu=.3$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation: $B = (B B_n)^{.5}$
 Maximum Load P = 57.32 kN
 5% Secant Offset P_q = 35.11 kN
 $K_{ic} = 68.6 \text{ MPa} \sqrt{\text{m}}$
 Validity = INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

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



TEAR SPECIMEN DATA

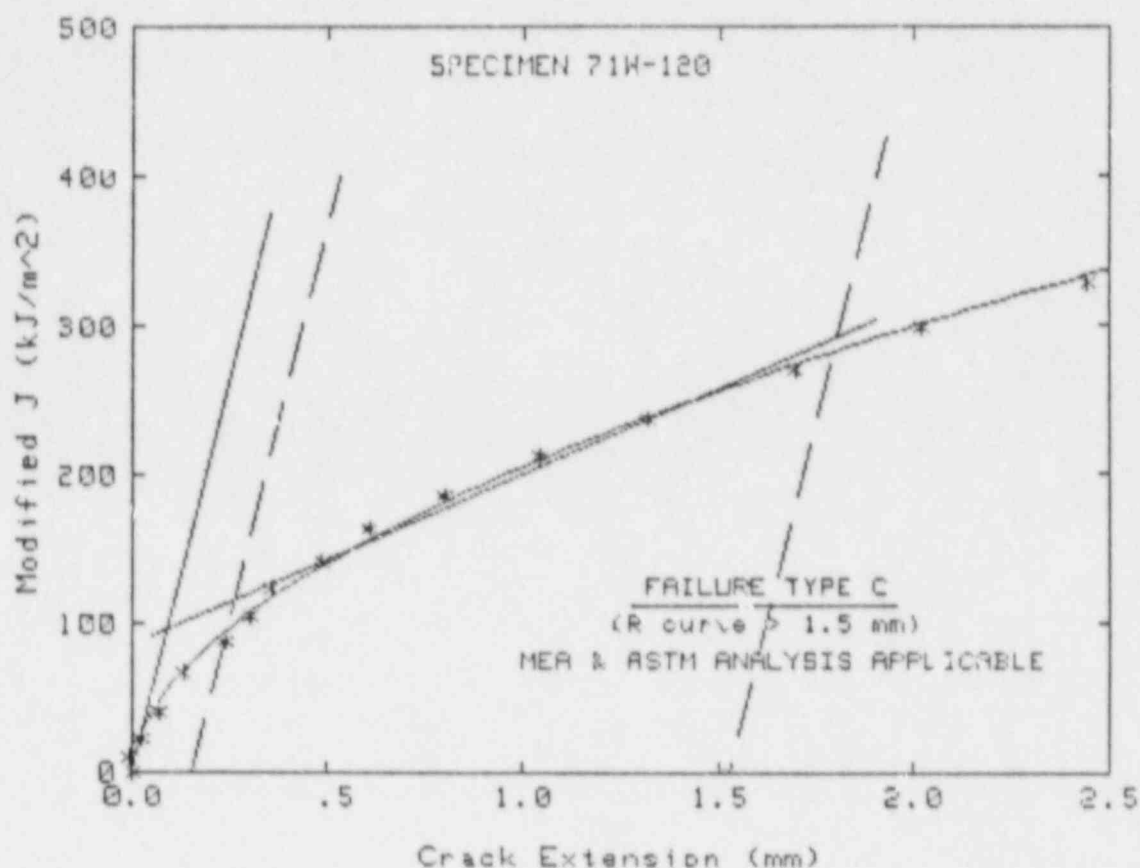
Material Type	= A533B 02 Plate	
Test Temperature	= 288 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28 mm	Init a/W = .551
Final crack length	= 28.85 mm	Final a/W = .568
Flow stress	= 532.6 MPa	
Youngs modulus	= 190800 MPa	(Estimated Value)

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

J _{ic}	= 80.2 kJ/m ²
K _{Jc}	= 123.7 MPa √m
J (θJ/T=8.8)	= 0 kJ/m ²
Exponent N	= .2377
Coefficient C	= 114 kJ/m ²
T (average)	= 21

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

J _{ic}	= 51.8 kJ/m ²
K _{Jc}	= 99.4 MPa √m
Slope M	= 113429.9 kJ/m ³
Intercept B	= 46.3 kJ/m ²
T (ASTM)	= 76
Validity (J _{ic})	= INVALID--b, c (.33 vs .12)
Validity (R-curve)	= INVALID--2, 3 (.33 vs .12)
J maximum allowed	= 540.8 kJ/m ² (J _{max} =B _{net} *Flow stress/20.
Delta a max. allowed	= 2.28 mm (Delta a max = 0.1*bo)
Final Delta a	= .51 mm
Poisson's Ratio (ν)	= 0



TEST SPECIMEN DATA

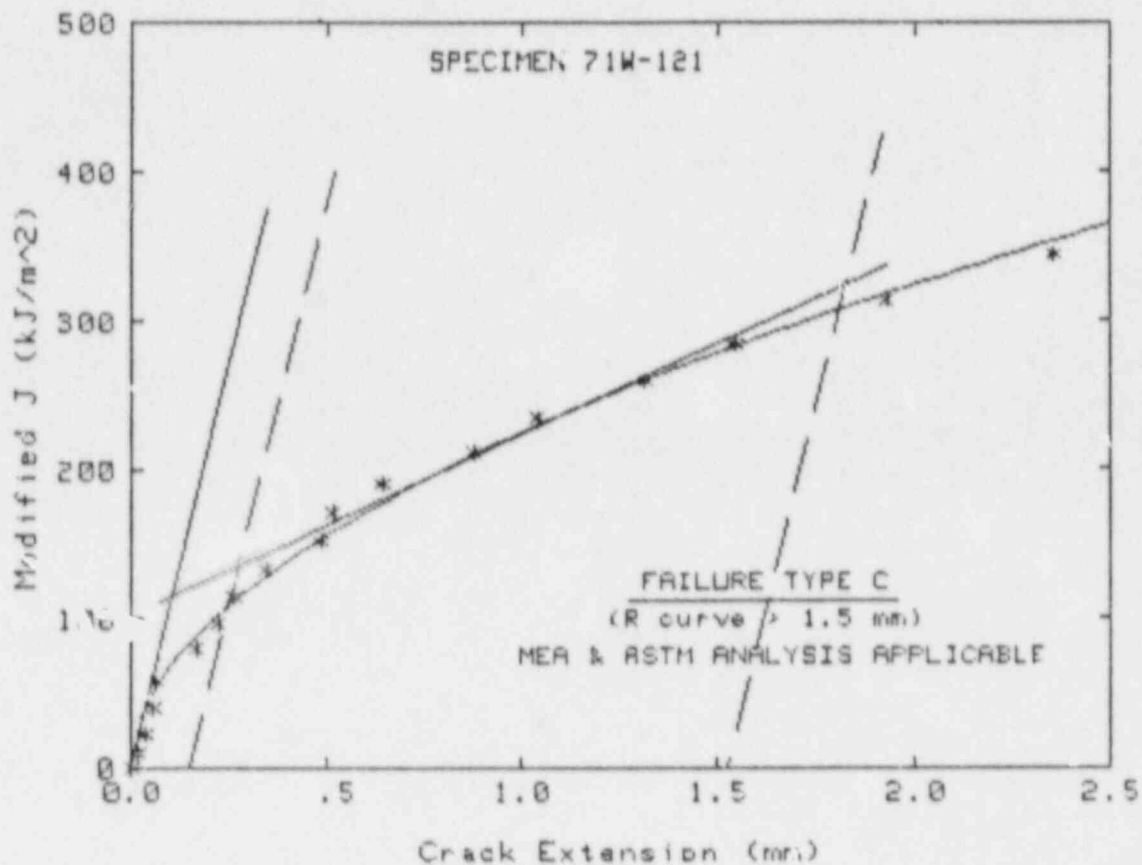
Material Type	= HSST S/A Weld (1)	
Test Temperature	= 204 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.58 mm	Init a/W = .542
Final crack length	= 41.26 mm	Final a/W = .812
Flow stress	= 527 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^n$

J _{ic}	= 95.3 kJ/m ²
K _{Jc}	= 136.5 MPa √m
J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 95.7 kJ/m ²
K _{Jc}	= 136.8 MPa √m
Slope M	= 114956 kJ/m ³
Intercept B	= 85.2 kJ/m ²
T (ASTM)	= 81
Validity (J _{ic})	= VALID
Validity (R-curve)	= INVALID--1, 3 (.51 vs .33)
J maximum allowed	= 535 kJ/m ² (J _{max} =B _{net} *Flow stress/20)
Δa max. allowed	= 2.22 mm (Δa max = 0.1*bo)



TEST SPECIMEN DATA

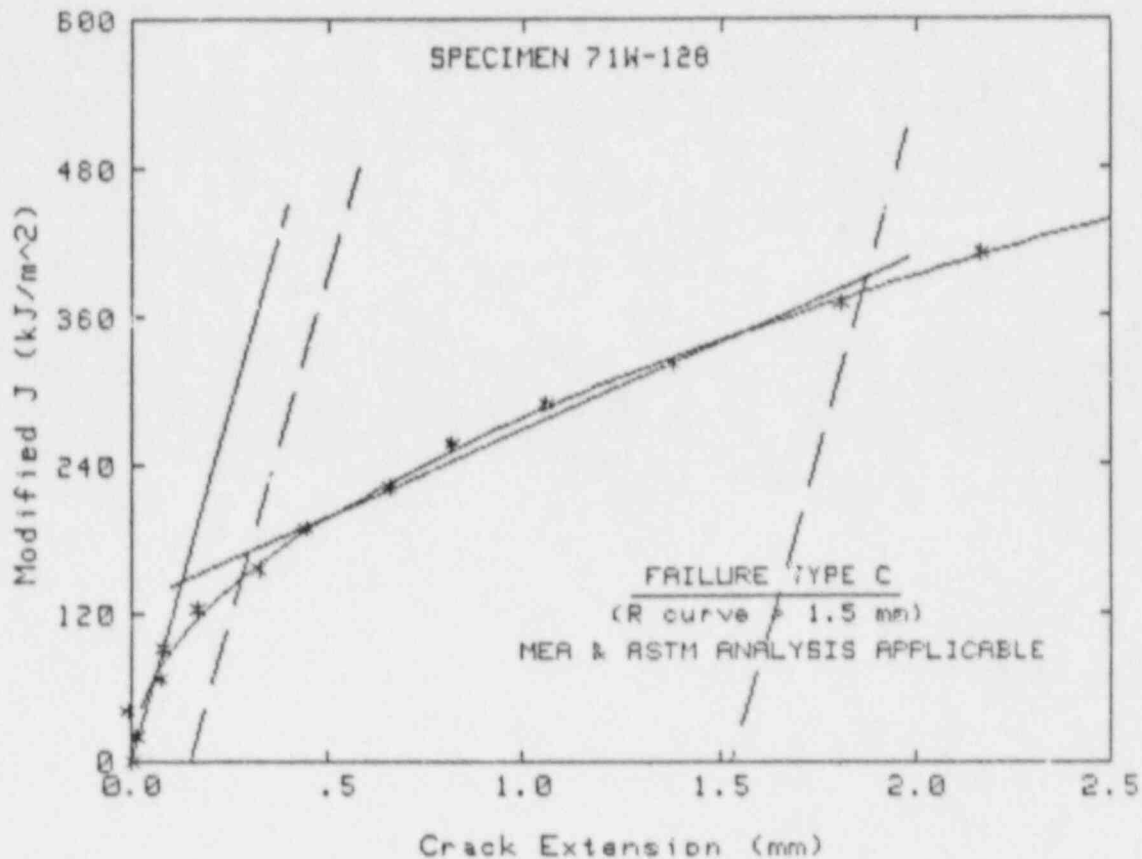
Material Type	= HEST S-A Weld (1)	
Test Temperature	= 121 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.81 mm	Init a/W = .547
Final crack length	= 39.14 mm	Final a/W = .77
Flow stress	= 545.5 MPa	
Young's modulus	= 200300 MPa	(Estimated Value)

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

J _{ic}	= 109.4 kJ/m ²
K _{jc}	= 148 MPa √m
J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 115 kJ/m ²
K _{jc}	= 151.8 MPa √m
Slope M	= 121637.2 kJ/m ³
Intercept B	= 102.2 kJ/m ²
T (ASTM)	= 82
Validity (J _{ic})	= VALID
Validity (R-curve)	= INVALID--1
J maximum allowed	= 553.8 kJ/m ² (J _{max} =B _{net} *Flow stress/20)
Delta a max. allowed	= 2.3 mm (Delta a max = 0.1*bo)



TEST SPECIMEN DATA

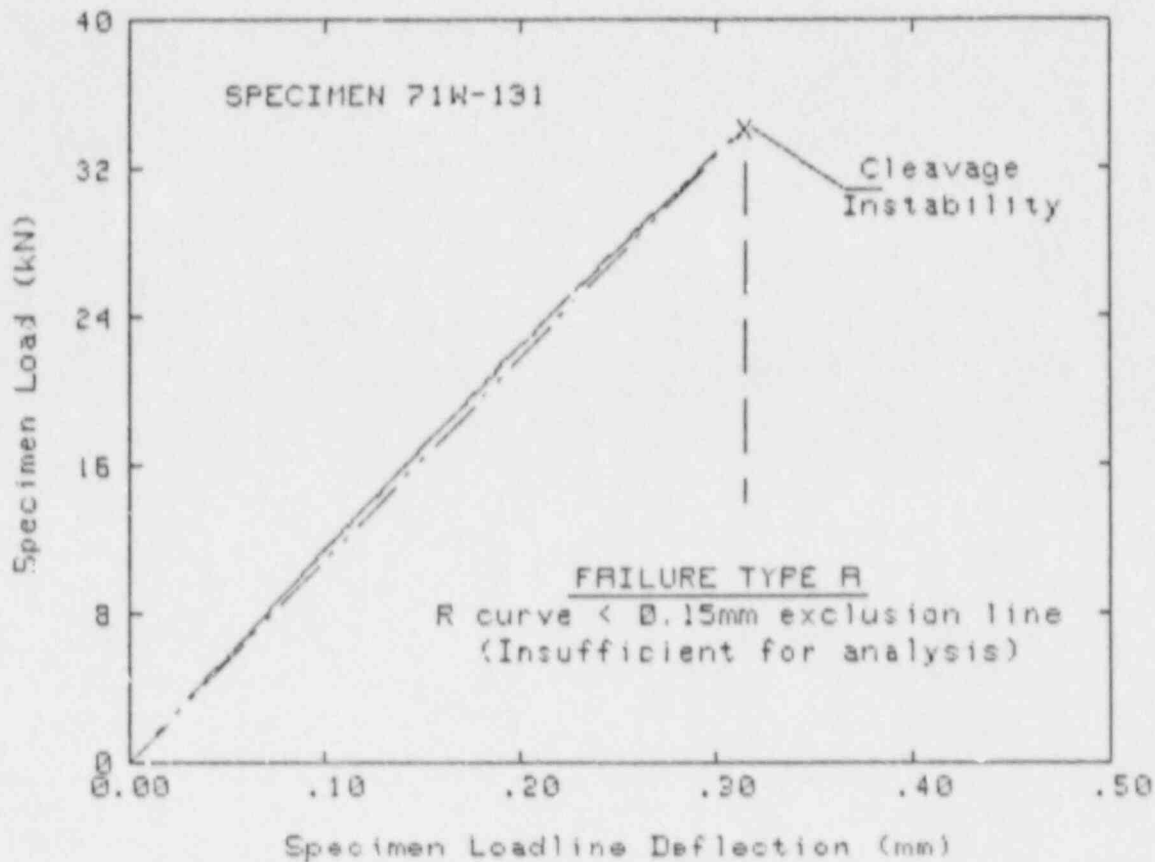
Material Type	= A533-B HSST WELD	
Test Temperature	= 50 C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 28.21 mm	Init a/W = .555
Final crack length	= 38.74 mm	Final a/W = .762
Flow stress	= 569.5 MPa	
Young's modulus	= 204400 MPa	(Estimated Value)

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

J _{ic}	= 148.7 kJ/m ²
K _{Jc}	= 174.3 MPa √m
J (θJ/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) $J = M (\Delta a) + B$

J _{ic}	= 145.7 kJ/m ²	
K _{Jc}	= 172.5 MPa √m	
Slope M	= 141857.5 kJ/m ³	
Intercept B	= 127.6 kJ/m ²	
T (ASTM)	= 89	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= INVALID--2	
J maximum allowed	= 578.2 kJ/m ²	(J _{max} =B _{net} *Flow stress/20)
Δa max. allowed	= .26 mm	(Δa max = 0.1*bo)
Final Δa	= .38 mm	
Poisson's Ratio (ν)	=	



TEST SPECIMEN DATA

Material Type	= HSST S/A Weld (1)	
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 = J _{ic})		
J _{ic}	= 21.4 kJ/m ²	
K _{Jc} = (EJ _{ic}) ^{0.5}	= 67.1 MPa √m	ν=.3
K _{ic} (Beta Corrected)	= 60.2 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

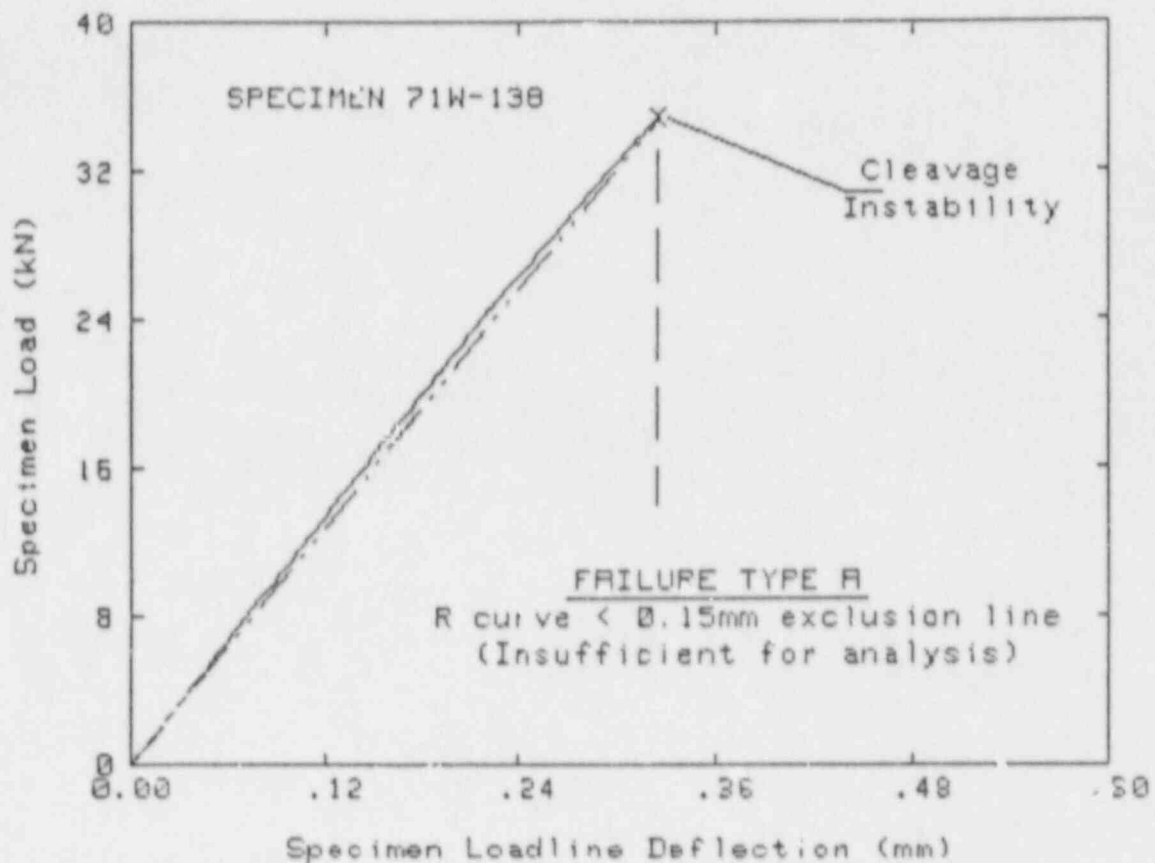
Modified K _{ic} Equation; B = (BB _n) ^{0.5}	
Maximum Load P	= 34.14 kN
5% Secant Offset P _q	= 33.66 kN
K _{ic}	= 67.5 MPa √m
Validity	= INVALID-1, 2

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 = J_{ic})

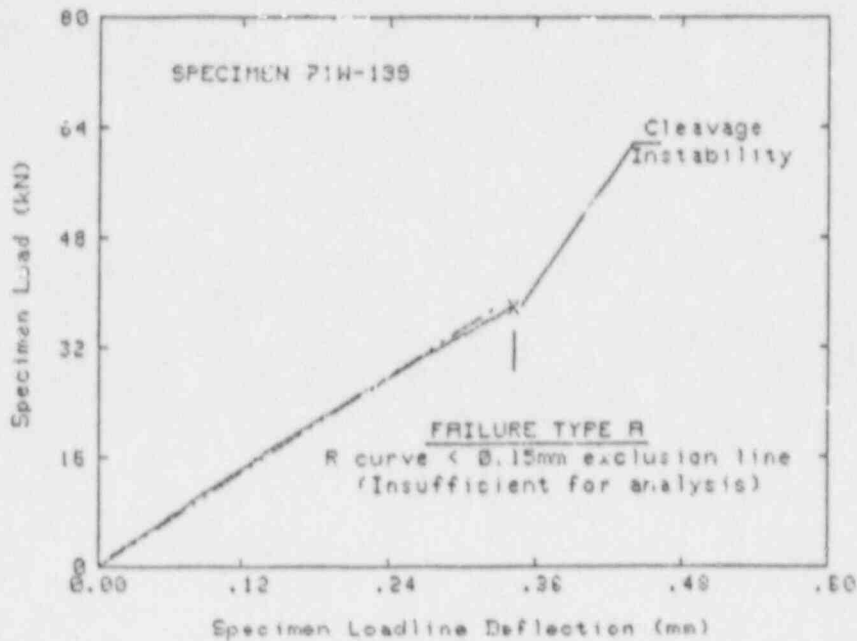
J _{ic}	= 22.2 kJ/m ²	
K _{ic} =(EJ _{ic}) ^{.5}	= 68.6 MPa √m	ν=.3
K _{ic} (Beta Corrected)	= 61.8 MPa √m	ν=.3

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B	= (BBn) ^{.5}
Maximum Load P	= 34.9 kN
5% Secant Offset P _q	= 34.91 kN
K _{ic}	= 68.8 MPa √m
Validity	= INVALID--1, 2

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Herkle-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

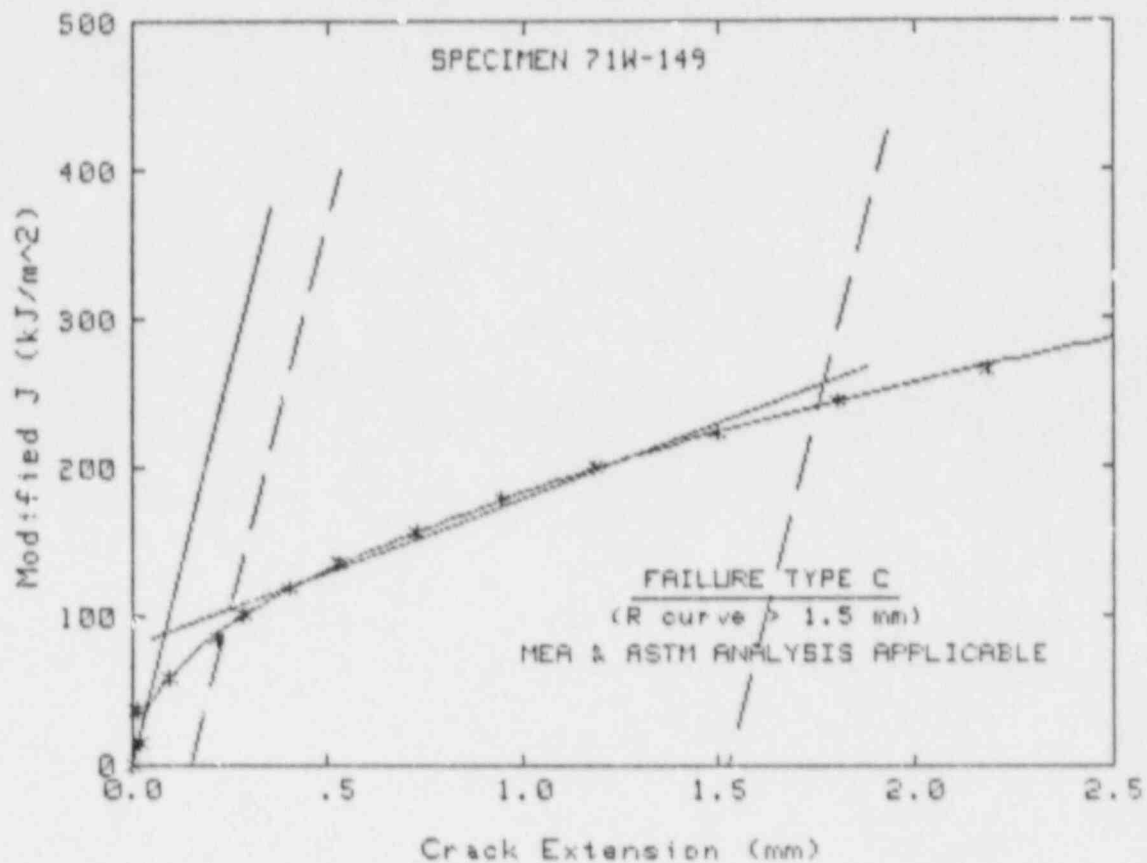
Failure Type A (J at instability = J _{ic})		
J _{ic}	* 25.9 kJ/m ²	
K _{Jic} = (E J _{ic} / (1 - v ²)) ^{0.5}	* 73.6 MPa √m	v = .3
K _{ic} (Beta Corrected)	* 63.9 MPa √m	v = .3

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation:	B = (BB _n) ^{0.5}
Maximum Load P	* 37.8 kN
5% Secant Offset P _Q	* 27.02 kN
K _{ic}	* 53.7 MPa √m
Validity	* INVALID--3
K at Maximum Load	* 75.1 MPa √m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Hinkle-Torten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 6.7018514881E-05 in.
 Specimen rotation Load intercept elastic slope = -.00000037 lb
 Fitted elastic load range = 2500 TO 2000 Correction to J for crack extension



TEST SPECIMEN DATA

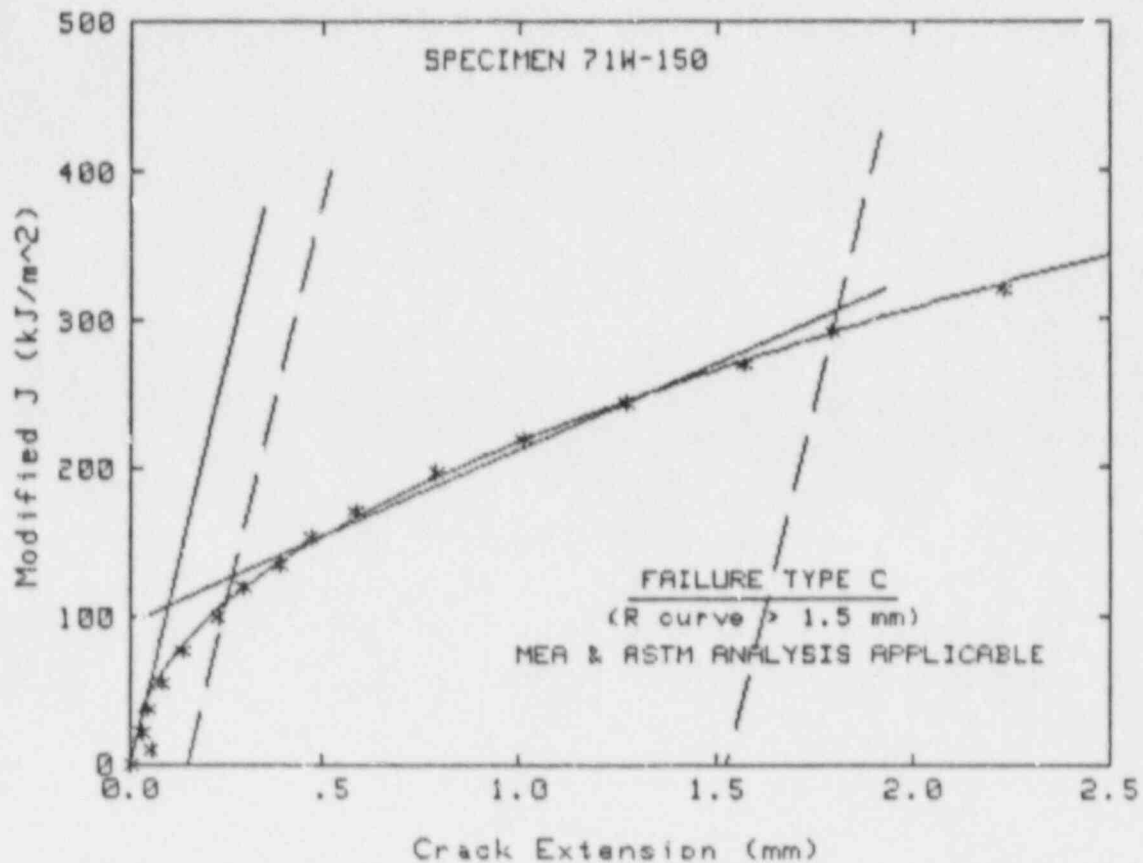
Material Type	= HSST S/A Weld (I)	
Test Temperature	= 204 °C	
Percent Side Groove	= 20 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 27.99 mm	Init a/W = .55
Final crack length	= 41.12 mm	Final a/W = .899
Flow stress	= 527 MPa	
Youngs modulus	= 195500 MPa	(Estimated Value)

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

J _{ic}	= 92 kJ/m ²
K _{ic}	= 134.1 MPa √m
J (σ _J /T=8.8)	= 305.6 kJ/m ²
Exponent N	= .4844
Coefficient C	= 183.7 kJ/m ²
T (average)	= 66

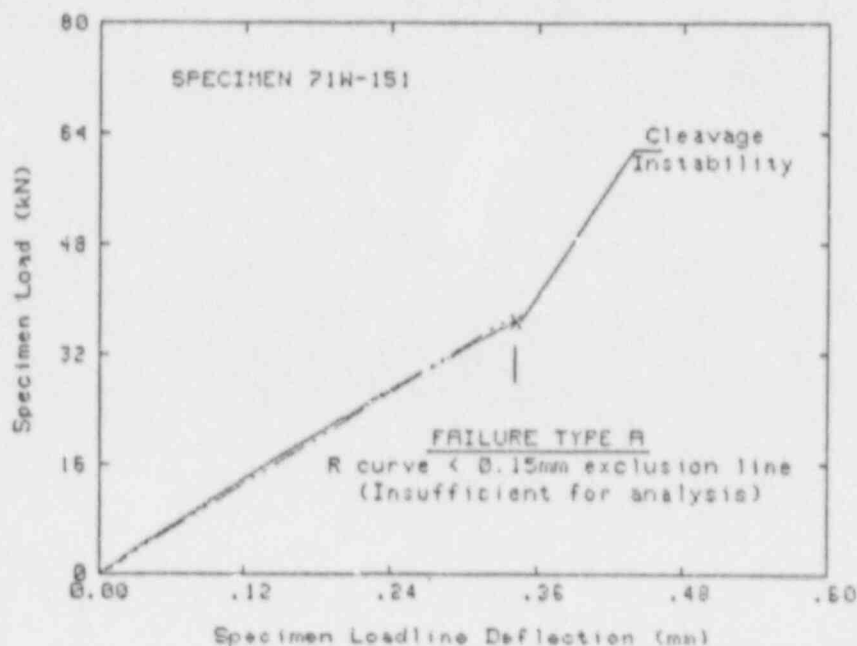
LEAST SQUARE LINEAR LINE (ASTM) $J = M (\Delta a) + B$

J _{ic}	= 89 kJ/m ²
K _{ic}	= 131.9 MPa √m
Slope M	= 98998.8 kJ/m ³
Intercept B	= 80.6 kJ/m ²
T (ASTM)	= 70
Validity (J _{ic})	= VALID
Validity (R-curve)	= VALID
J maximum allowed	= 535 kJ/m ² (J _{max} =B _{net} *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 $J = C (\Delta a)^N$		
J _{ic}	= 109.9 kJ/m ²	
K _{jc}	= 155.5 MPa √m	K _{ic} (Beta) = 92.7 MPa √m
J (θJ/T=0.8)	= 365 kJ/m ²	
Exponent N	= .4972	
Coefficient C	= 217.6 kJ/m ²	
T (average)	= 76	
LEAST SQUARE LINEAR LINE (ASTM) $J = M (\Delta a) + B$		
J _{ic}	= 107.4 kJ/m ²	
K _{jc}	= 153.7 MPa √m	K _{ic} (Beta) = 92.3 MPa √m
Slope M	= 116347.5 kJ/m ³	
Intercept B	= 95.9 kJ/m ²	
T (ASTM)	= 78	
Validity (J _{ic})	= VALID	
Validity (R-curve)	= INVALID--1	
J maximum allowed	= 553.8 kJ/m ²	(J _{max} =B _{net} *Flow stress/20)
Delta a max, allowed	= 2.31 mm	(Delta a max = 0.1*bo)



TEST SPECIMEN DATA

Material Type * A532-B HST 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
 Young's modulus E * 208900 MPa (Estimated Value)
 Poisson's Ratio (ν) * 0

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J_{ic})
 J_{ic} * 25.3 kJ/m²
 K_{Jc} = (E J_{ic} / (1 - ν²))^{0.5} * 72.8 MPa √m ν=.3
 K_{ic} (Beta Corrected) * 63.4 MPa √m ν=.3

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B * (B B_n)^{0.5}
 Maximum Load P * 36.8 kN
 5% Secant Offset P_Q * 30.77 kN
 K_{ic} * 61.6 MPa √m
 Validity * INVALID--1, 2, 3
 K at Maximum Load * 73.7 MPa √m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Herkle-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 track extension

Appendix F

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

ORNL VALIDITY INDEXJ_{Ic} (ASTM E813)

1. < 4 data points between 0.15 and 1.5 mm exclusion lines.
2. Data clustering problem.
3. $BW < 25 J_Q/\sigma_y$
4. $b_o < 25 J_Q/\sigma_y$
5. $dJ/da > \sigma_{flow}$
6. Delta-a prediction error too large,
 $|(\Delta a)_{pred} - (\Delta a)_{meas}| > 0.15 (\Delta a)_{meas}$

Tentative J_I - R Curve Procedure

1. < 3 data points between $(\Delta a)=0$ and secant line
 $[J=4/3 \sigma_y (\Delta a)]$
2. < 10 data points between secant line and $(\Delta a)_{max}$
 $[0.1 b_o]$
3. (Δa) prediction error too large,
 $|(\Delta a)_{pred} - (\Delta a)_{meas}| >$
 $\text{MINIMUM } [0.15 (\Delta a)_{meas}, 0.15 (\Delta a)_{max}]$

ORNL IRRADIATED 1TCS DATA SHEETS
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F-311	02G285	F-407	69W173
F-313	02G288	F-409	70W106
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
F-343	02G407	F-439	71W111
F-345	02G414	F-441	71W116
F-347	02G421	F-443	71W119
F-349	02G422	F-445	71W122
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
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 604 MPa
FLOW STRENGTH= 672 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

$a/W)i = .618$

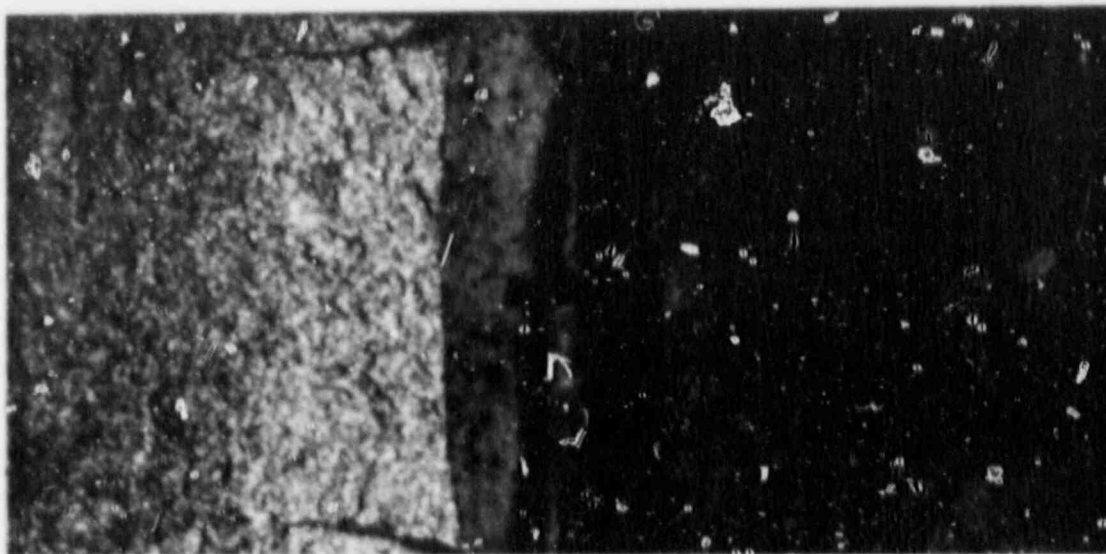
SPECIMEN CLEAVED AT $K = 116.5 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 90.7 kJ/m²
KJc= 136.1 MPa SQR[m]
K-beta-c= 92.2 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

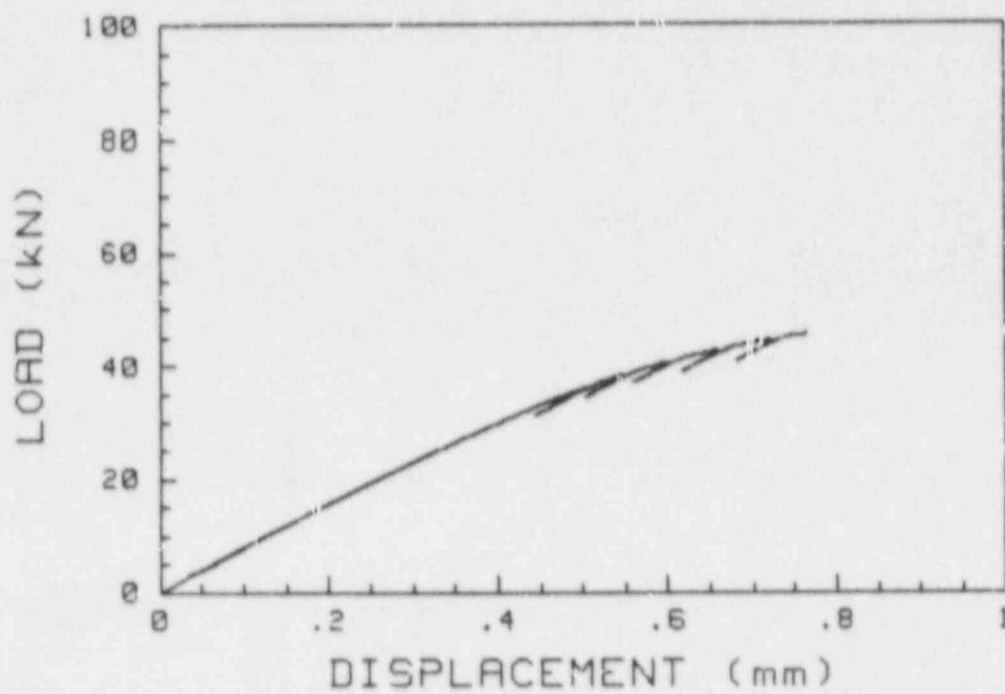
J-INTEGRAL= 90.3 kJ/m²
KJc= 135.9 MPa SQR[m]
K-beta-c= 92.2 MPa SQR[m]



ORNL-DWG 87-7995

02G282

50 DEGREES C



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/m²
 KJ-MAX LOAD= 202.2 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 156.7 kJ/m²
 K-JIc= 177.2 MPa SQR[m]
 POWER= .4336
 COEFFICIENT= 275.4 kJ/m²
 T (AVERAGE)= 61

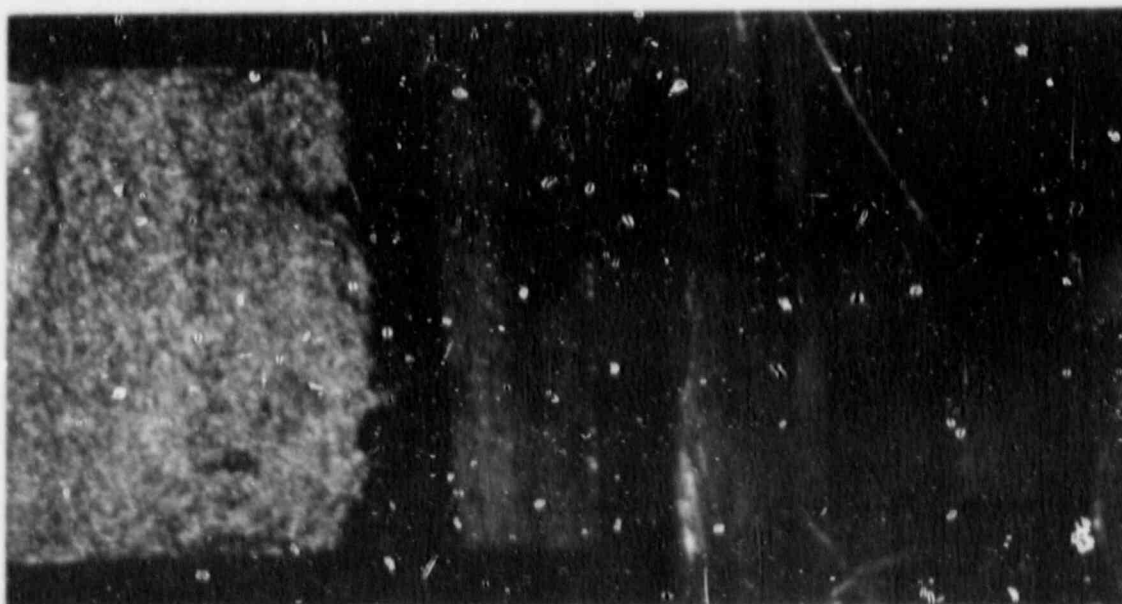
ASTM LINEAR PROCEDURE

 JIc= 141.6 kJ/m²
 K-JIc= 168.4 MPa SQR[m]
 SLOPE= 139549 kJ/m³
 INTERCEPT= 126.2 kJ/m²
 T (ASTM)= 68
 VALID, E813

J1-R CURVE CALCULATIONS

 J (BJ/T=8.8)= 376.5 kJ/m²
 POWER= .4614
 J-MAX ALLOWED= 609.4 kJ/m²
 RCURVE INVALID, 1 3

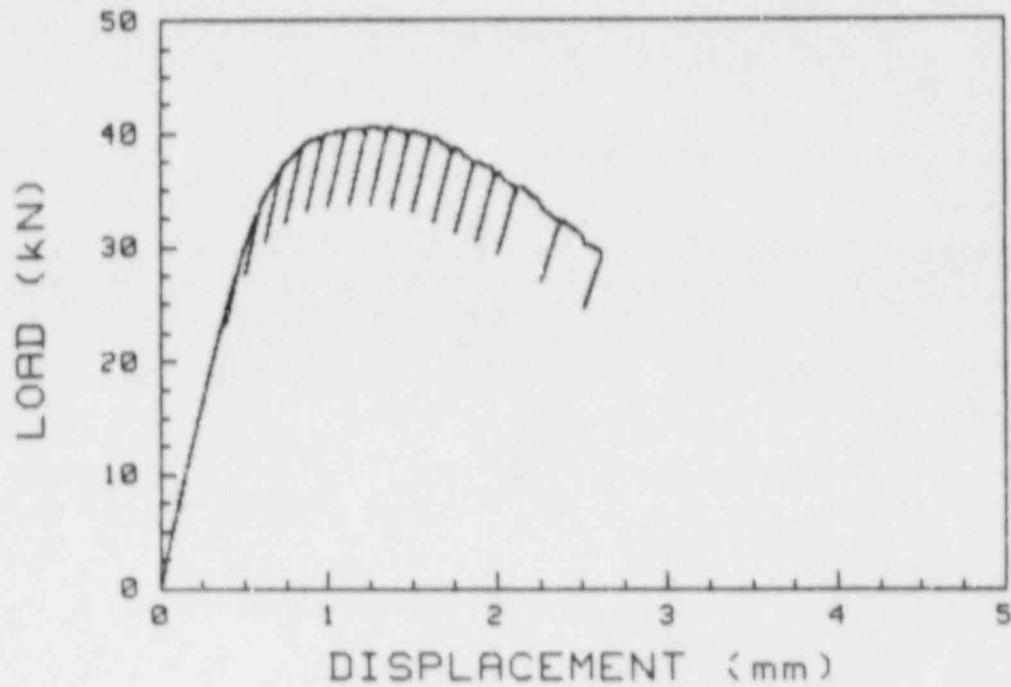
COEFFICIENT= 274 kJ/m²
 DELTA-A MAX ALLOWED= 1.91 mm



ORNL-DWG 87-7996

02GA285

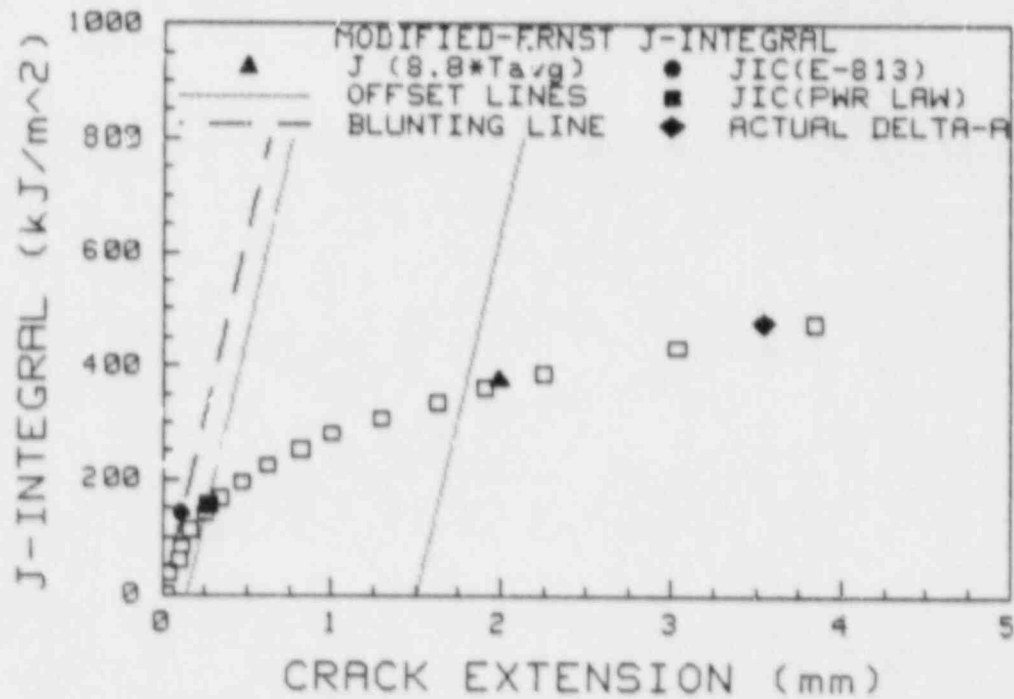
121 DEGREES C



ORNL-DWG 87-7997

02GA285

121 DEGREES C



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 $K = 111.3 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 84.9 kJ/m²
KJc= 131.2 MPa SQR[m]
K-beta-c= 89.6 MPa SQR[m]

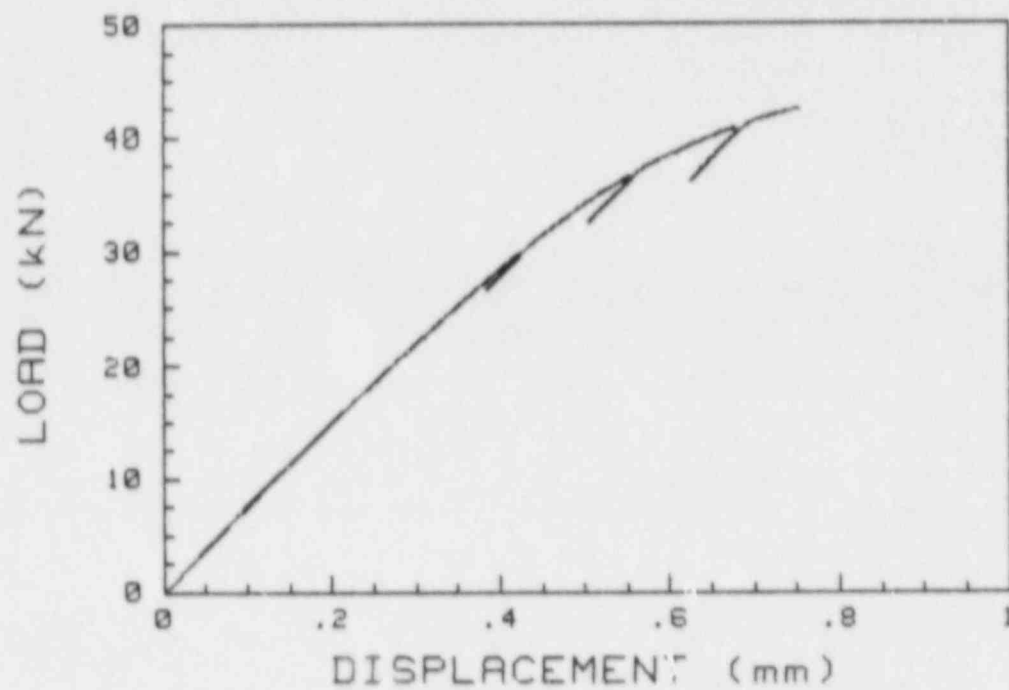
VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 84.7 kJ/m²
KJc= 131.1 MPa SQR[m]
K-beta-c= 89.5 MPa SQR[m]



02GA288

79 DEGREES C



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/m²
 KJ-MAX LOAD= 204.6 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 159.6 kJ/m²
 K-JIc= 179.8 MPa SQR[m]
 POWER= .3918
 COEFFICIENT= 264.7 kJ/m²
 T (AVERAGE)= 54

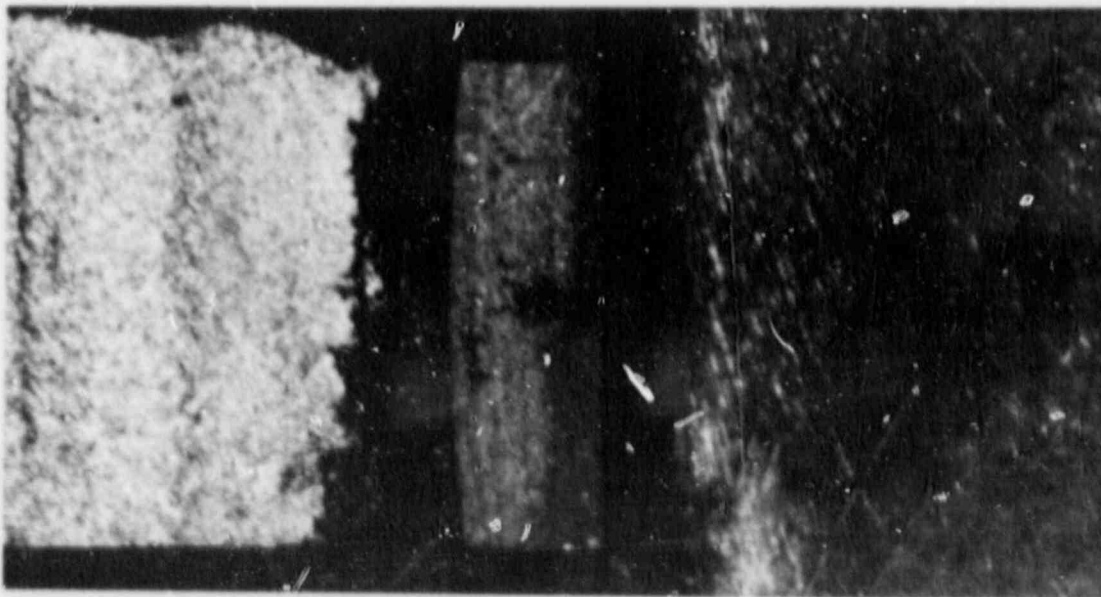
ASTM LINEAR PROCEDURE

 JIc= 146.3 kJ/m²
 K-JIc= 171.2 MPa SQR[m]
 SLOPE= 123731 kJ/m³
 INTERCEPT= 132.2 kJ/m²
 T (ASTM)= 61
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 337.8 kJ/m²
 POWER= .4162
 J-MAX ALLOWED= 614.3 kJ/m²
 RCURVE INVALID, 2 3

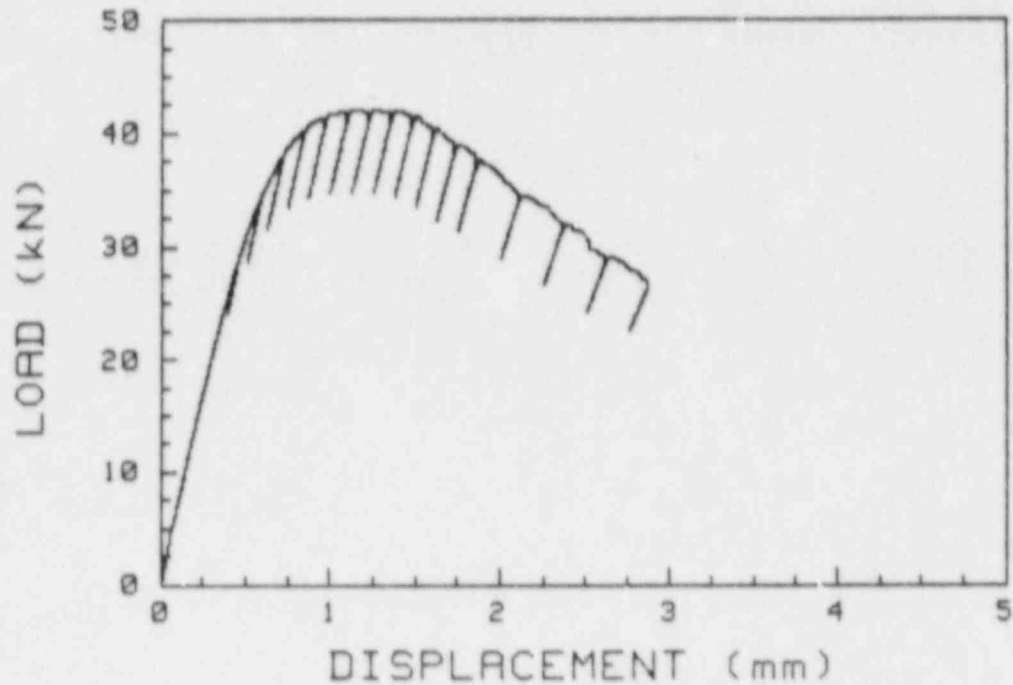
COEFFICIENT= 264.7 kJ/m²
 DELTA-A MAX ALLOWED= 1.92 mm



ORNL-DWG 87-7999

02GA298

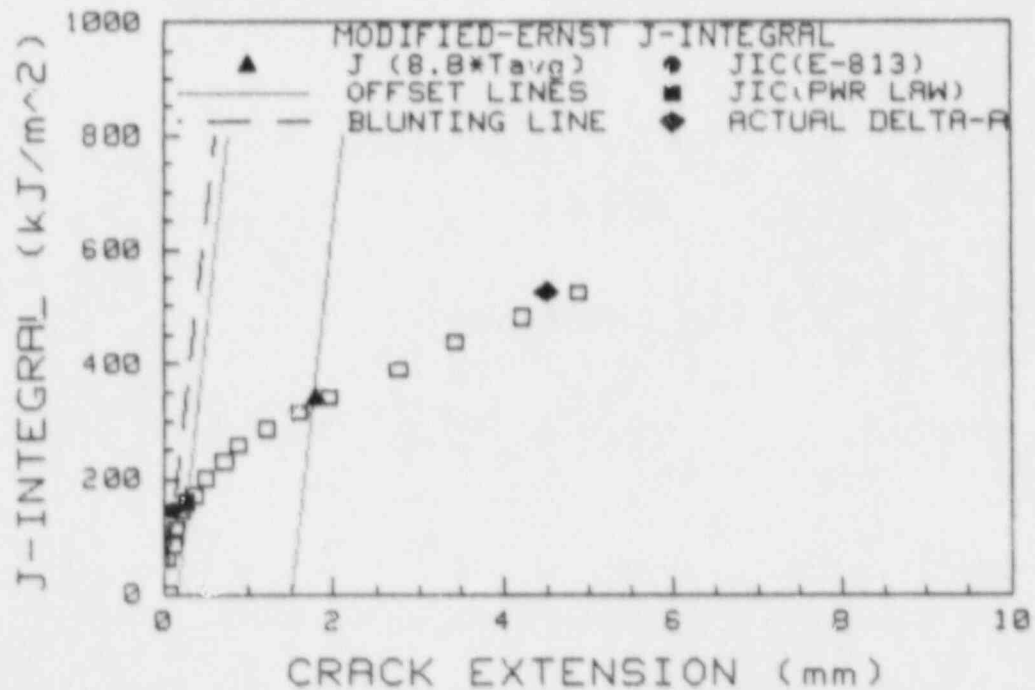
121 DEGREES C



ORNL-DWG 87-8001

02GA298

121 DEGREES C



SPECIMEN ID= 02G316
 MATERIAL TYPE= A533
 TEST TEMPERATURE= 80 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 31.6 mm
 MEASURED DUCTILE DELTA-A= .05 mm
 YIELD STRENGTH= 590 MPa
 FLOW STRENGTH= 656 MPa
 ESTIMATED YOUNG'S MODULUS= 203 GPa

$a/W)i = .619$

SPECIMEN CLEAVED AT $K = 96.9 \text{ MPa SQR(m)}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 50.2 kJ/m²
 $K_{Jc} = 100.9 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 78.2 \text{ MPa SQR(m)}$

VALUES AT CLEAVAGE LOAD

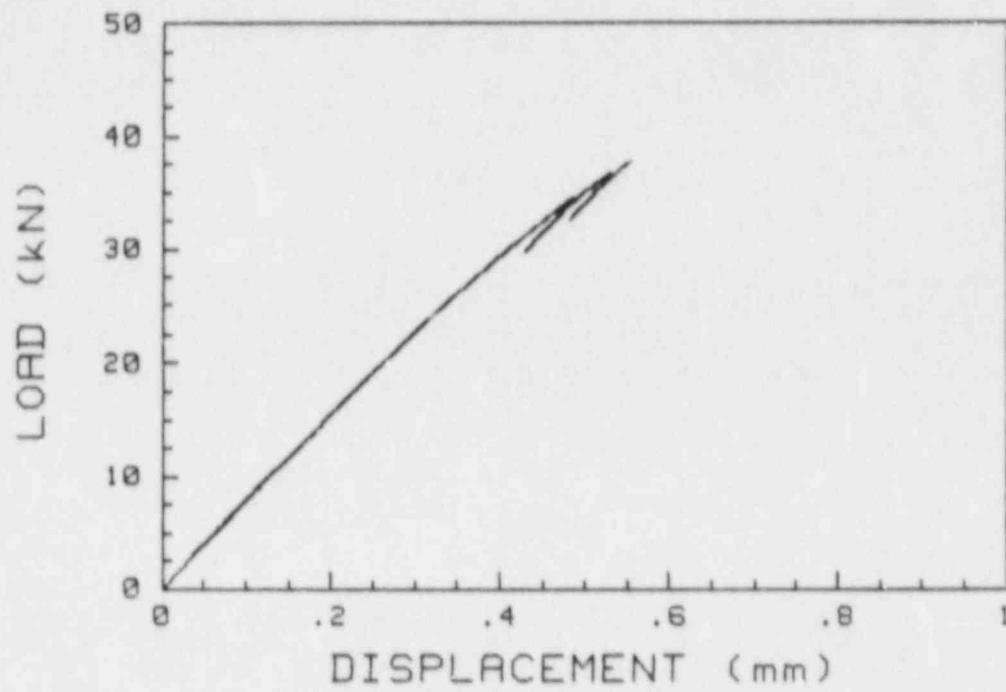
 J-INTEGRAL= 50.1 kJ/m²
 $K_{Jc} = 100.7 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 78.1 \text{ MPa SQR(m)}$



ORNL-DWG 87-8002

Ø2G316

80 DEGREES C



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/m²
 KJ-MAX LOAD= 191.6 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 162.4 kJ/m²
 K-JIc= 176 MPa SQR[m]
 POWER= .3464
 COEFFICIENT= 251.7 kJ/m²
 T (AVERAGE)= 47

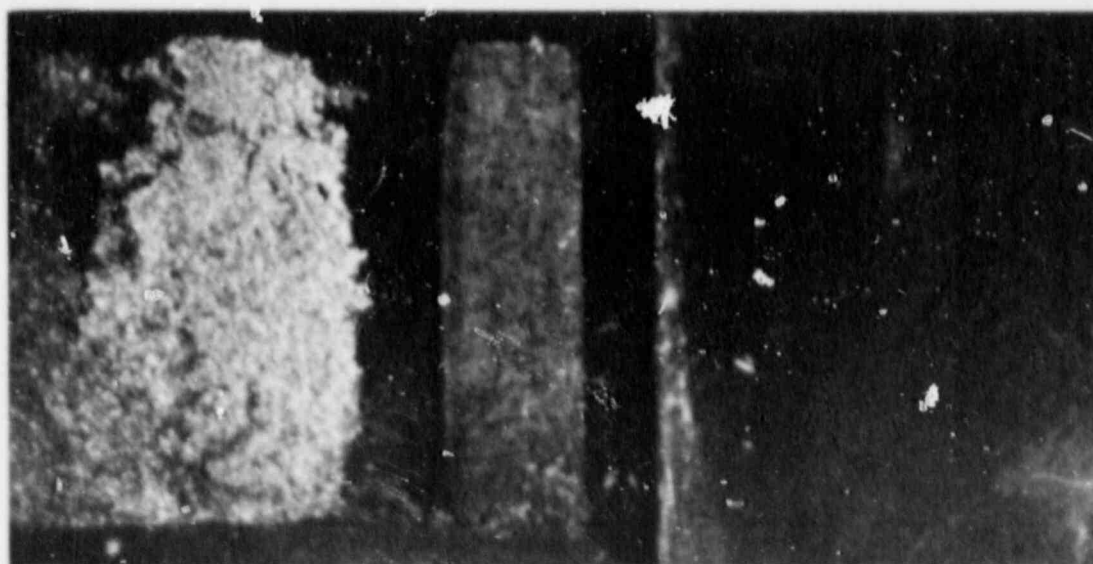
ASTM LINEAR PROCEDURE

 JIc= 157 kJ/m²
 K-JIc= 173.1 MPa SQR[m]
 SLOPE= 100182 kJ/m³
 INTERCEPT= 144.1 kJ/m²
 T (ASTM)= 51
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 282.6 kJ/m²
 POWER= .3256
 J-MAX ALLOWED= 605 kJ/m²
 RCURVE INVALID, 2 3

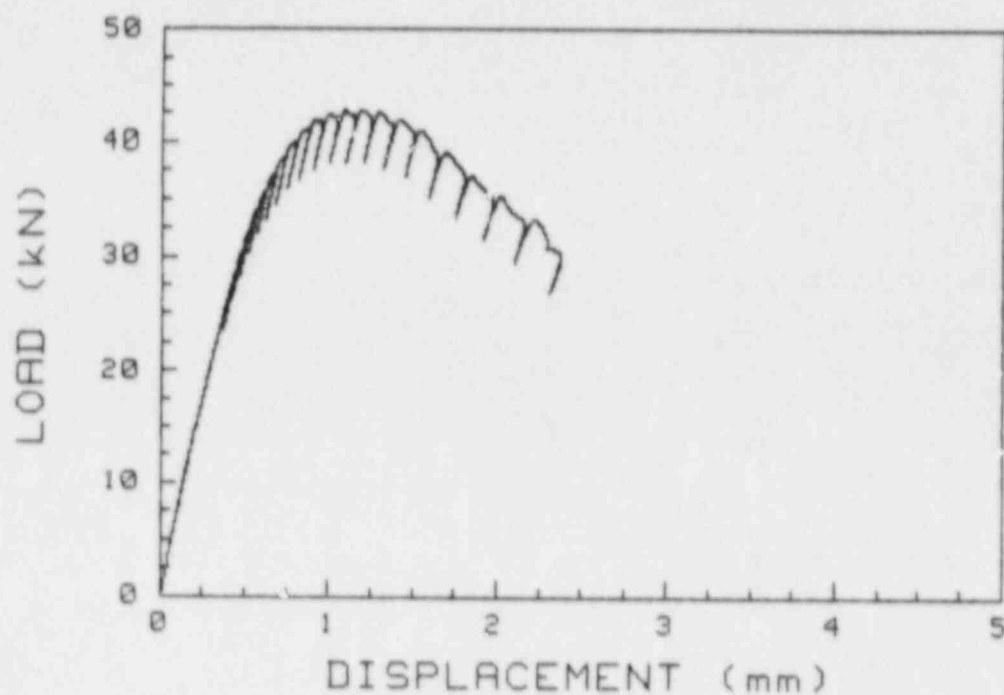
COEFFICIENT= 250.2 kJ/m²
 DELTA-A MAX ALLOWED= 1.97 mm



ORNL-DWG 87-8003

02G328

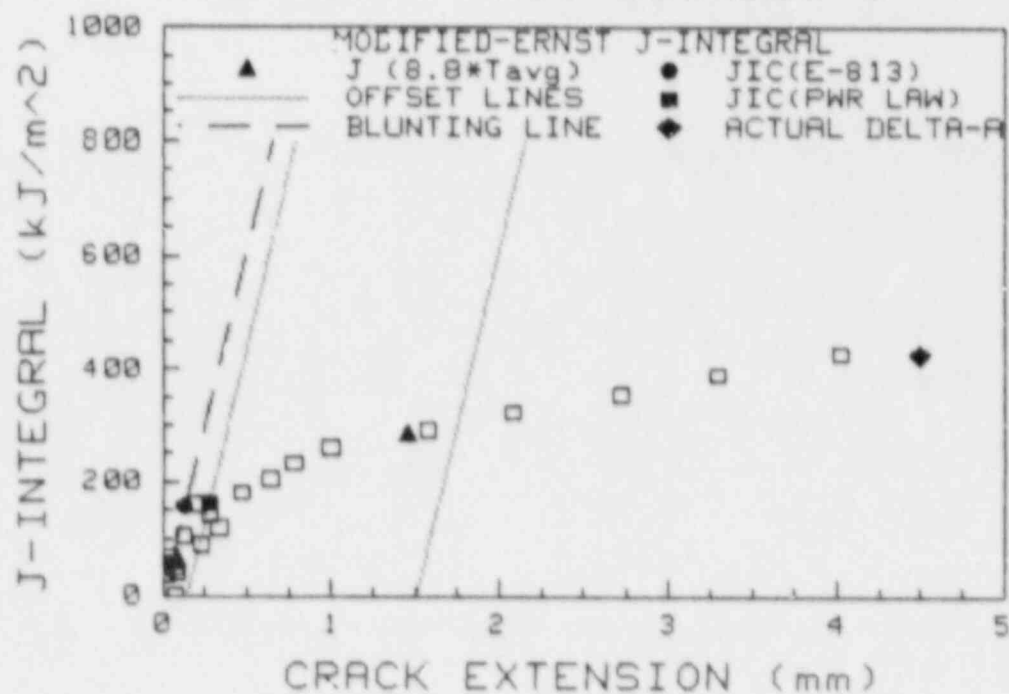
288 DEGREES C



ORNL-DWG 87-8004

02G328

288 DEGREES C



SPECIMEN ID= 02G329
 TEST TEMPERATURE= 80 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 31.2 mm $a/W_1 = .612$
 MEASURED DUCTILE DELTA-A= .51 mm
 YIELD STRENGTH= 590 MPa
 FLOW STRENGTH= 656 MPa
 ESTIMATED YOUNG'S MODULUS= 203 GPa

SPECIMEN CLEAVED AT $K = 121.2 \text{ MPa SQR(m)}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 157 kJ/m²
 $KJc = 178.4 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 102.9 \text{ MPa SQR(m)}$

VALUES AT CLEAVAGE LOAD

 J-INTEGRAL= 161.1 kJ/m²
 $KJc = 180.7 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 103.5 \text{ MPa SQR(m)}$

POWER LAW PROCEDURE

 $J_{Ic} = 150.4 \text{ kJ/m}^2$
 $K\text{-}J_{Ic} = 174.5 \text{ MPa SQR(m)}$
 POWER= .5613
 COEFFICIENT= 317.1 kJ/m²
 T (AVERAGE)= 85

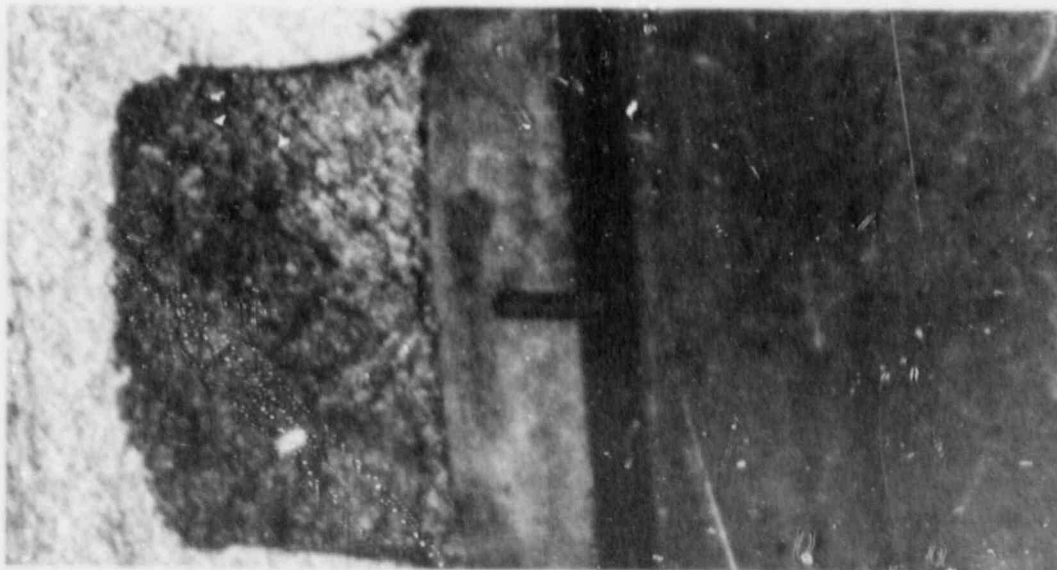
ASTM LINEAR PROCEDURE

 $J_{Ic} = 0 \text{ kJ/m}^2$
 $K\text{-}J_{Ic} = 0 \text{ MPa SQR(m)}$
 SLOPE= 0 kJ/m³
 INTERCEPT= 0 kJ/m²
 T (ASTM)= 0
 INVALID, 1 6

J1-R CURVE CALCULATIONS

 $J (\Delta J/T=8.8) = 0 \text{ kJ/m}^2$
 POWER= 0
 $J\text{-MAX ALLOWED} = 650.3 \text{ kJ/m}^2$
 RCURVE INVALID, 2 3

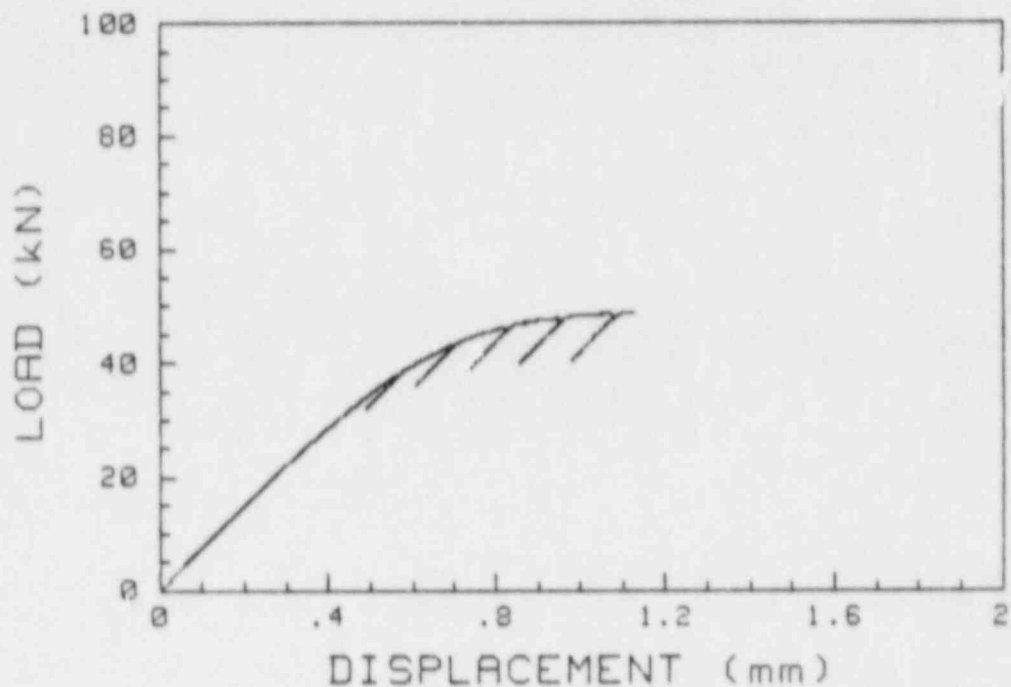
COEFFICIENT= 0 kJ/m²
 DELTA-A MAX ALLOWED= 1.98 mm



ORNL-DWG 87-8005

02G329

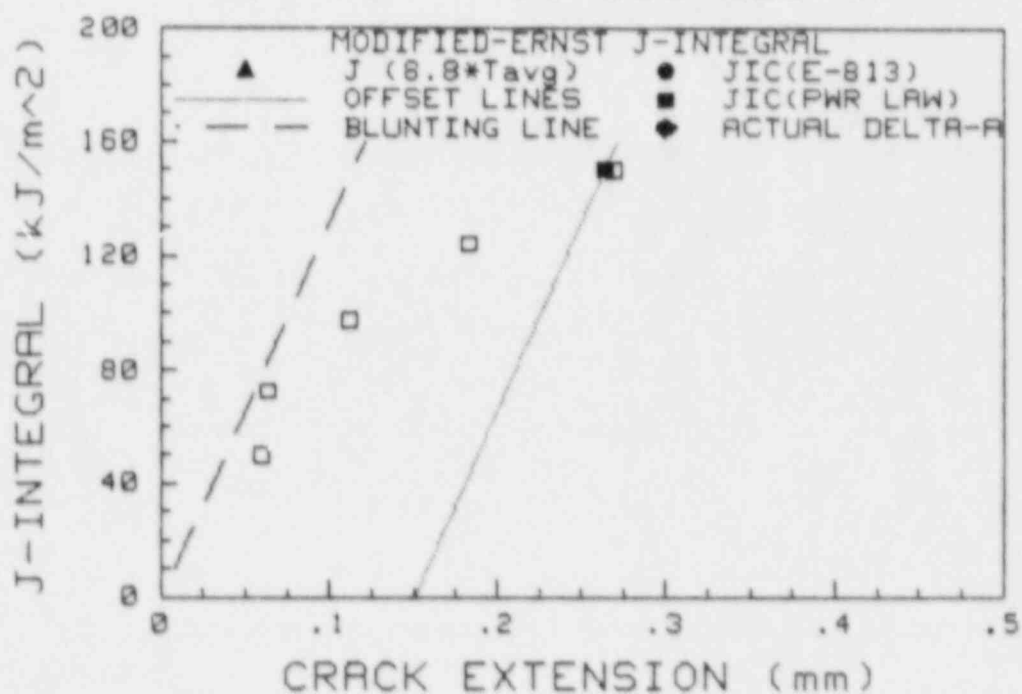
80 DEGREES C



ORNL-DWG 87-8006

02G329

80 DEGREES C



SPECIMEN ID* 07GA338
 TEST TEMPERATURE* 288 DEG C
 THICKNESS* 25.4 mm
 SIDE GROOVES* 20 %
 INITIAL CRACK LENGTH* 31.7 mm a/W_1 * .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/m²
 KJ-MAX LOAD* 193.7 MPa SQR[m]

POWER LAW PROCEDURE

J_{1c}* 139.5 kJ/m²
 K-J_{1c}* 163.2 MPa SQR[m]
 POWER* .3854
 COEFFICIENT* 233.2 kJ/m²
 T (AVERAGE)* 49

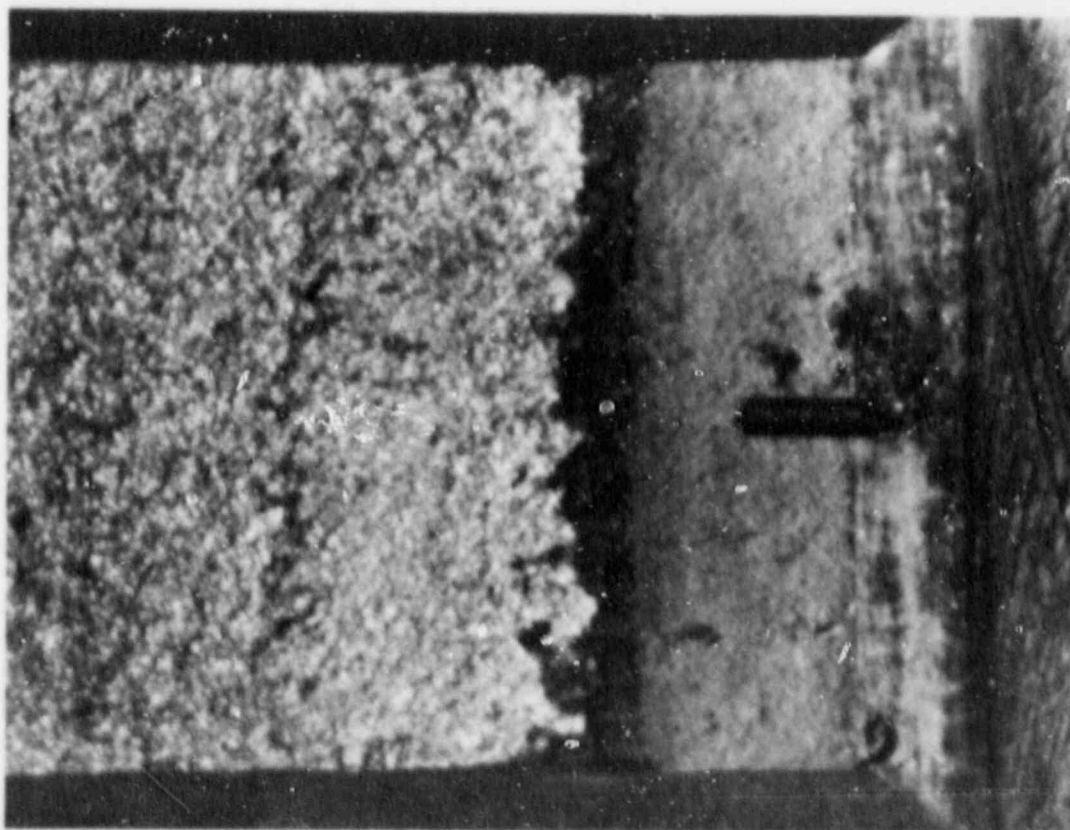
ASTM LINEAR PROCEDURE

J_{1c}* 116.8 kJ/m²
 K-J_{1c}* 149.3 MPa SQR[m]
 SLOPE* 121740 kJ/m³
 INTERCEPT* 105.2 kJ/m²
 T (ASTM)* 62
 VALID, E813

J1-R CURVE CALCULATIONS

J (B/T=8.8)* 299.6 kJ/m²
 POWER* .4119
 J-MAX ALLOWED* 591.3 kJ/m²
 RCURVE INVALID, 2

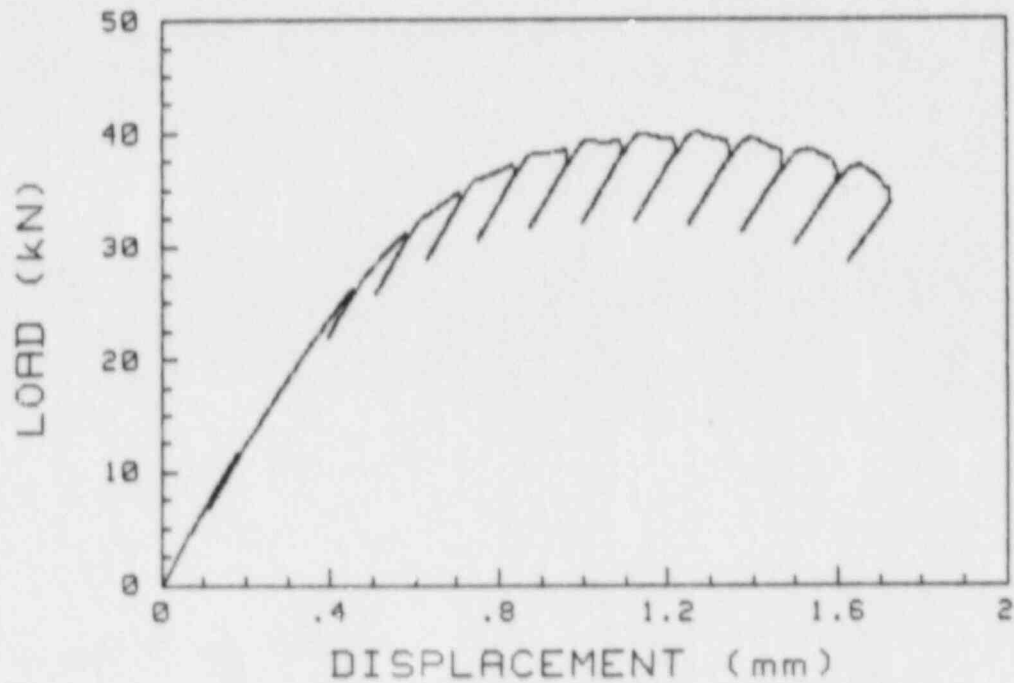
COEFFICIENT* 233.1 kJ/m²
 DELTA-A MAX ALLOWED* 1.93 mm



ORNL-DWG 87-8007

Ø2GA338

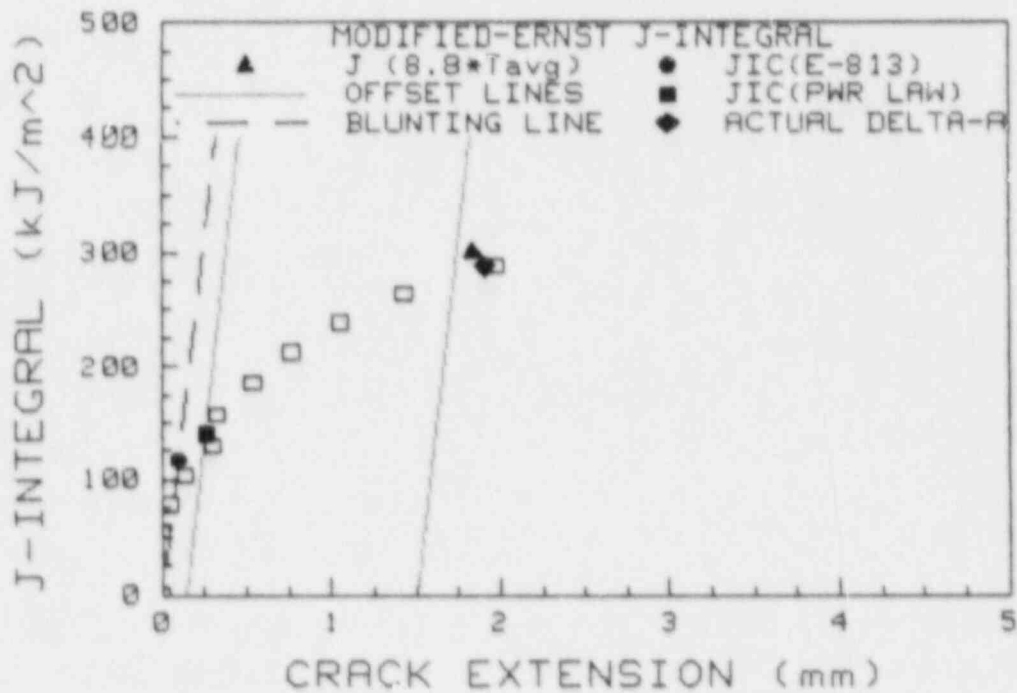
288 DEGREES C



ORNL-DWG 87-8008

Ø2GA338

288 DEGREES C



SPECIMEN ID* 02GA340
 TEST TEMPERATURE* 204 DEG C
 THICKNESS* 25.4 mm
 SIDE GROOVES* 20 N
 INITIAL CRACK LENGTH* 31.8 mm a/W * .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/m²
 KJ-MAX LOAD* 186.1 MPa SQR(m)

POWER LAW PROCEDURE

J_{1c}* 125.2 kJ/m²
 K-J_{1c}* 156.5 MPa SQR(m)
 POWER* .4775
 COEFFICIENT* 242.7 kJ/m²
 T (AVERAGE)* 62

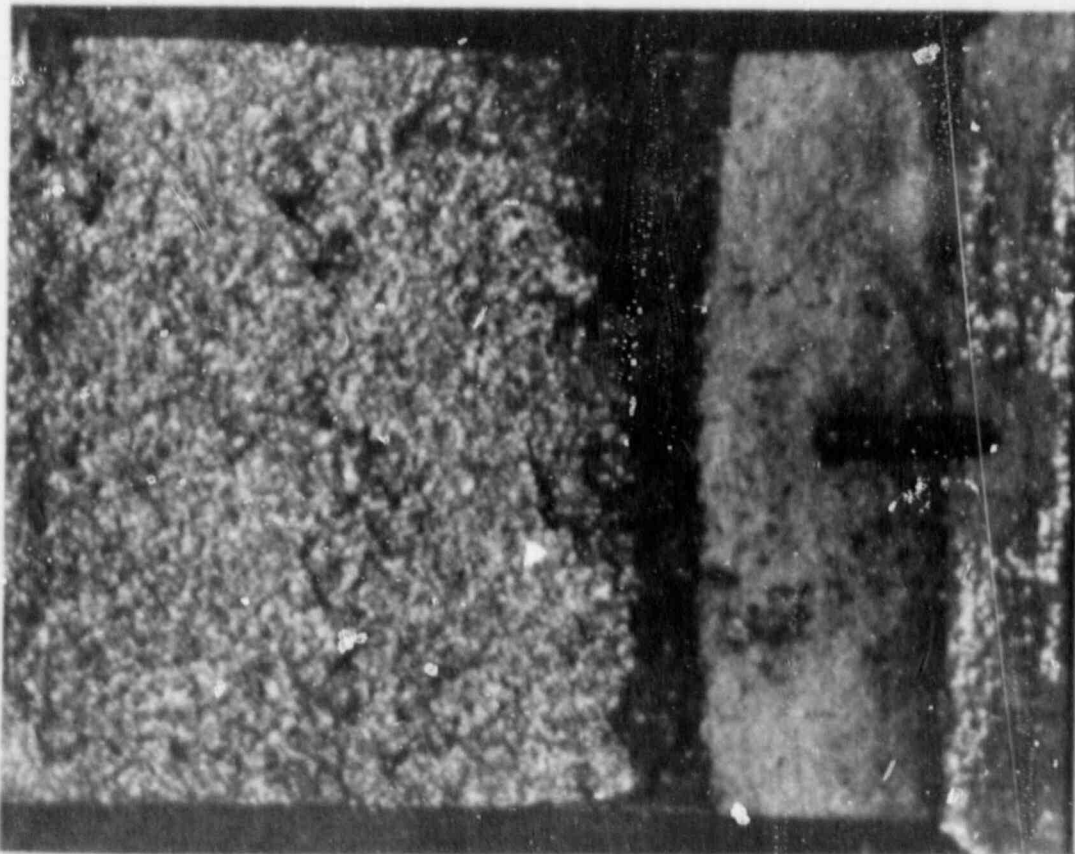
ASTM LINEAR PROCEDURE

J_{1c}* 118.8 kJ/m²
 K-J_{1c}* 152.4 MPa SQR(m)
 SLOPE* 126681 kJ/m³
 INTERCEPT* 106.6 kJ/m²
 T (ASTM)* 65
 INVALID, 6

J1-R CURVE CALCULATIONS

J (W/T*8.8)* 310.2 kJ/m²
 POWER* .4079
 J-MAX ALLOWED* 596.3 kJ/m²
 RCURVE INVALID, 2 3

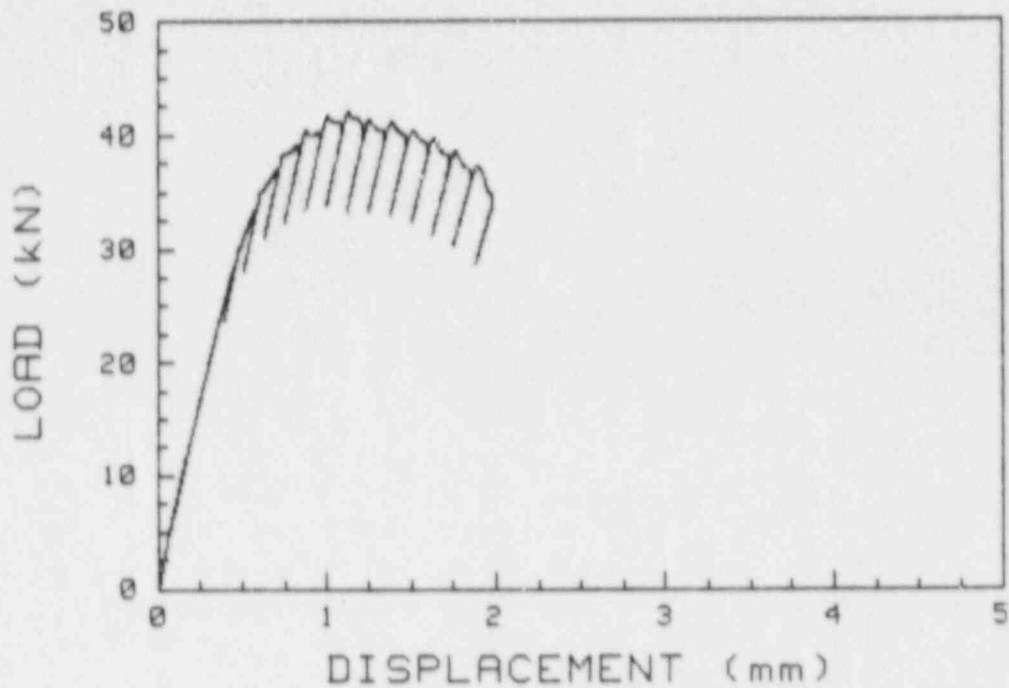
COEFFICIENT* 241.8 kJ/m²
 DELTA-A MAX ALLOWED* 1.93 mm



ORNL-DWG 87-8009

02GA340

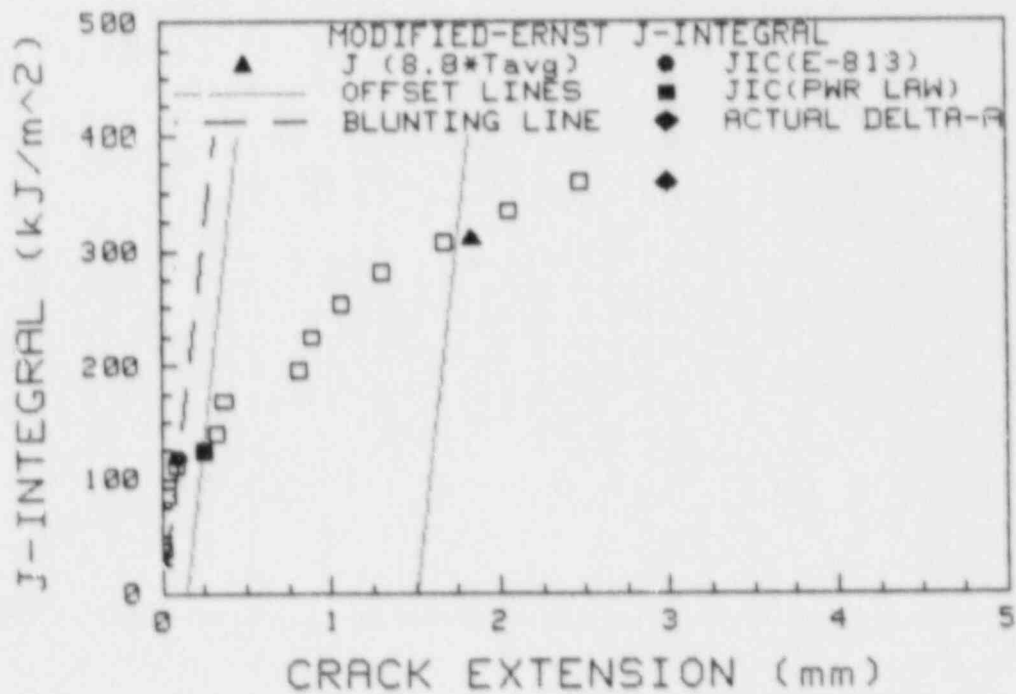
204 DEGREES C



ORNL-DWG 87-8010

02GA340

204 DEGREES C



SPECIMEN ID= 02G344
 TEST TEMPERATURE= 80 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 31 mm $a/W_1 = .607$
 MEASURED DUCTILE DELTA-A= .25 mm
 YIELD STRENGTH= 590 MPa
 FLOW STRENGTH= 656 MPa
 ESTIMATED YOUNG'S MODULUS= 203 GPa

SPECIMEN CLEAVED AT $K = 115.1 \text{ MPa SQR(m)}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 151.2 kJ/m²
 $K_{Jc} = 175.1 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 102.1 \text{ MPa SQR(m)}$

VALUES AT CLEAVAGE LOAD

 J-INTEGRAL= 152 kJ/m²
 $K_{Jc} = 175.5 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 102.2 \text{ MPa SQR(m)}$

POWER LAW PROCEDURE

 $J_{Ic} = 140.8 \text{ kJ/m}^2$
 $K\text{-}J_{Ic} = 168.9 \text{ MPa SQR(m)}$
 POWER= .8626
 COEFFICIENT= 454.2 kJ/m²
 T (AVERAGE)= 181

ASTM LINEAR PROCEDURE

 $J_{Ic} = 0 \text{ kJ/m}^2$
 $K\text{-}J_{Ic} = 0 \text{ MPa SQR(m)}$
 SLOPE= kJ/m³
 INTERCEPT= 0 kJ/m²
 T (ASTM)= 0
 INVALID, 1

J1-R CURVE CALCULATIONS

 $J (\Delta J/T=8.8) = 0 \text{ kJ/m}^2$
 POWER= 0
 J-MAX ALLOWED= 658.6 kJ/m²
 RCURVE INVALID, 2

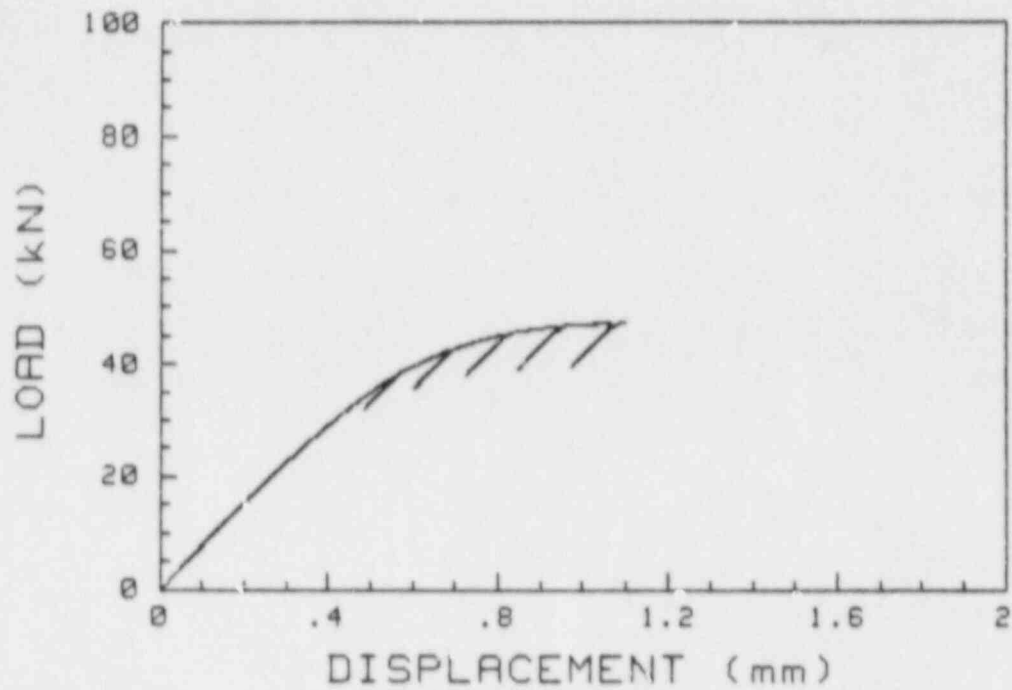
COEFFICIENT= 0 kJ/m²
 DELTA-A MAX ALLOWED= 2.01 mm



ORNL-DWG 87-8011

02G344

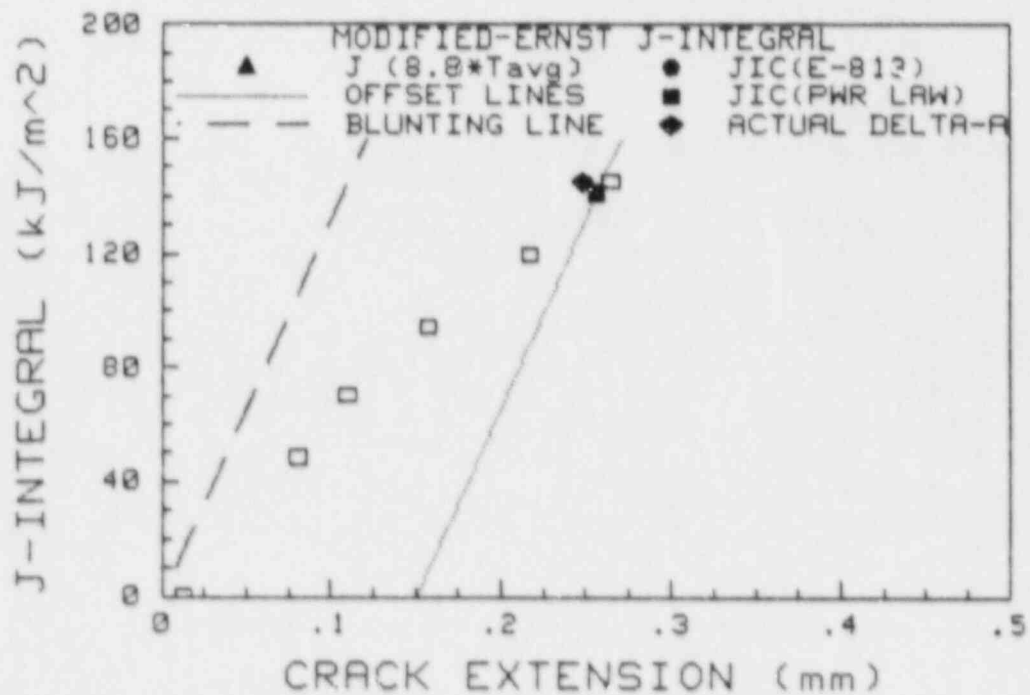
80 DEGREES C



ORNL-DWG 87-8012

02G344

80 DEGREES C



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

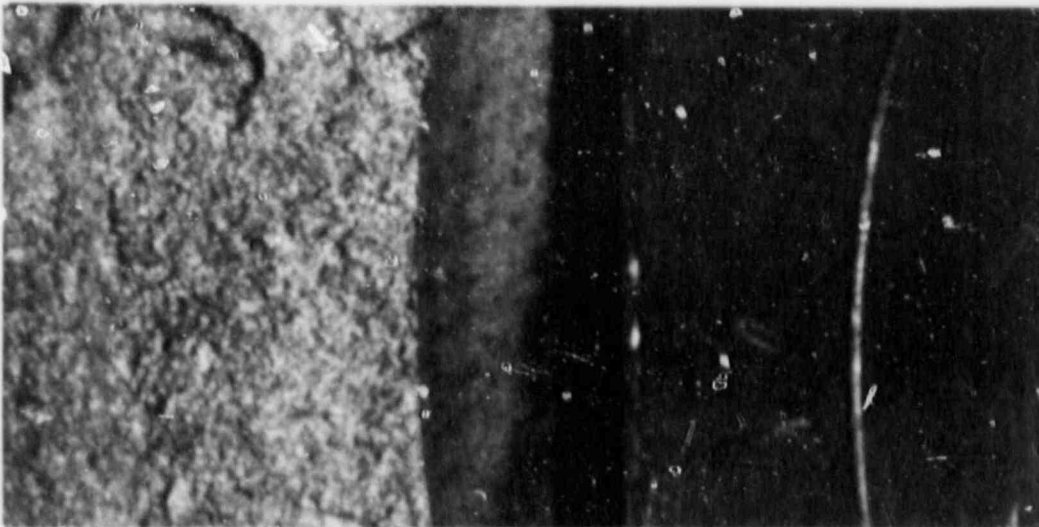
SPECIMEN CLEAVED AT $K = 78.9 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 29.8 kJ/m²
 $KJc = 78 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 67.5 \text{ MPa SQR[m]}$

VALUES AT CLEAVAGE LOAD

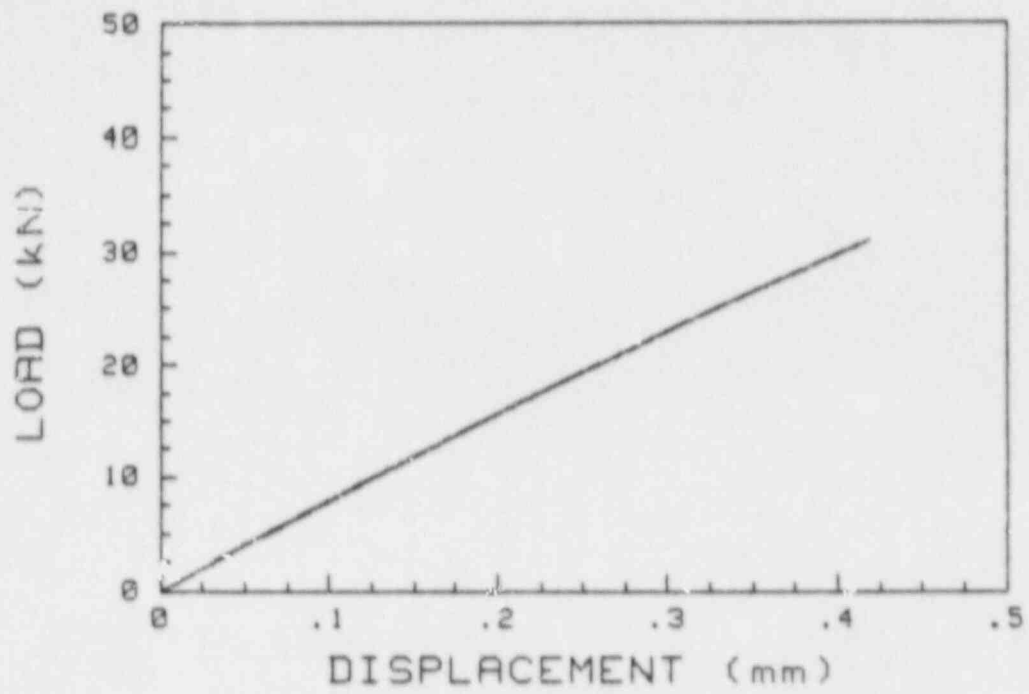
 J-INTEGRAL= 29.8 kJ/m²
 $KJc = 78 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 67.5 \text{ MPa SQR[m]}$



ORNL-DWG 87-8013

02G353

50 DEGREES C



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/m²
 KJ-MAX LOAD= 196.2 MPa SQR(m)

POWER LAW PROCEDURE

 JIc= 148.7 kJ/m²
 K-JIc= 172.6 MPa SQR(m)
 POWER= .3731
 COEFFICIENT= 243.6 kJ/m²
 T (AVERAGE)= 48

ASTM LINEAR PROCEDURE

 JIc= 146.3 kJ/m²
 K-JIc= 171.2 MPa SQR(m)
 SLOPE= 99999 kJ/m³
 INTERCEPT= 134.8 kJ/m²
 T (ASTM)= 49
 VALID, E813

JI-R CURVE CALCULATIONS

 J (BJ/T=8.8)= 246.2 kJ/m²
 POWER= .2567
 J-MAX ALLOWED= 617.5 kJ/m²
 RCURVE INVALID, 2

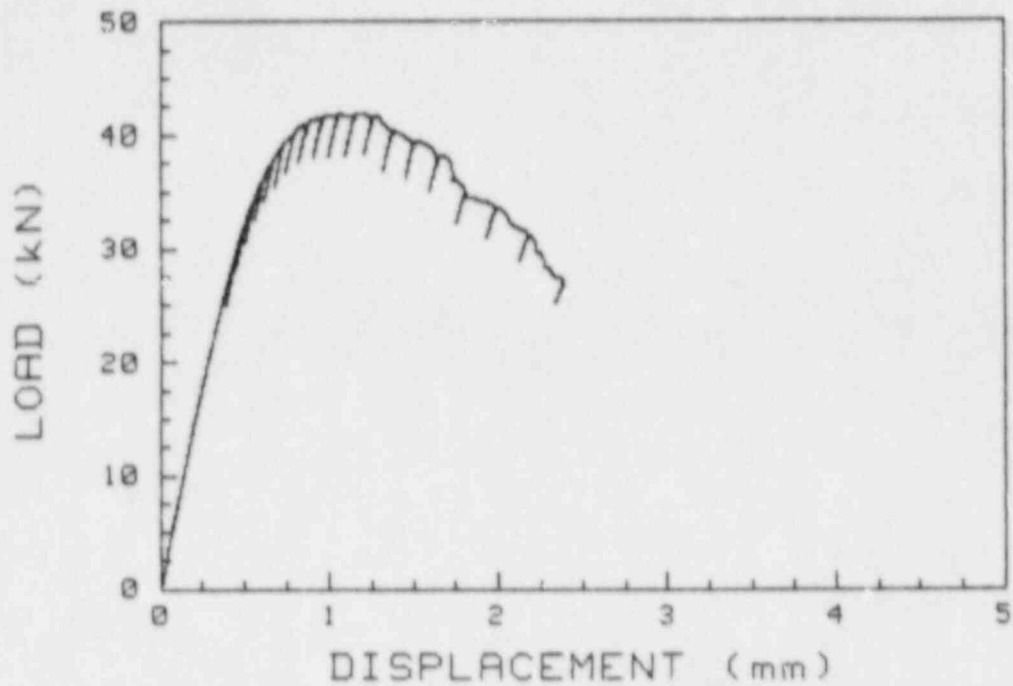
COEFFICIENT= 239.9 kJ/m²
 DELTA-A MAX ALLOWED= 1.93 mm



ORNL-DWG 87-8014

02G362

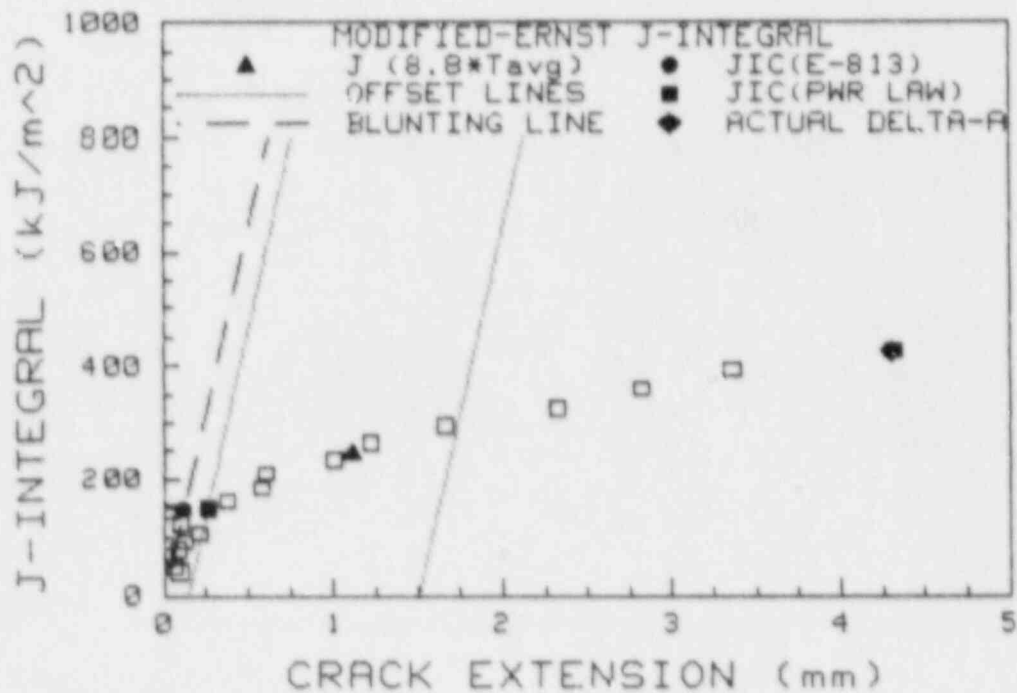
121 DEGREES C



ORNL-DWG 87-8015

02G362

121 DEGREES C



SPECIMEN ID* 02GA763
 TEST TEMPERATURE* 204 DEG C
 THICKNESS* 25.5 mm
 SIDE GROOVES* 20 N
 INITIAL CRACK LENGTH* 31.8 mm a/wt* .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/m²
 KJ-MAX LOAD* 185.4 MPa SQR[m]

POWER LAW PROCEDURE

J1c* 129.2 kJ/m²
 K-J1c* 159 MPa SQR[m]
 POWER* .4543
 COEFFICIENT* 240.6 kJ/m²
 T (AVERAGE)* 59

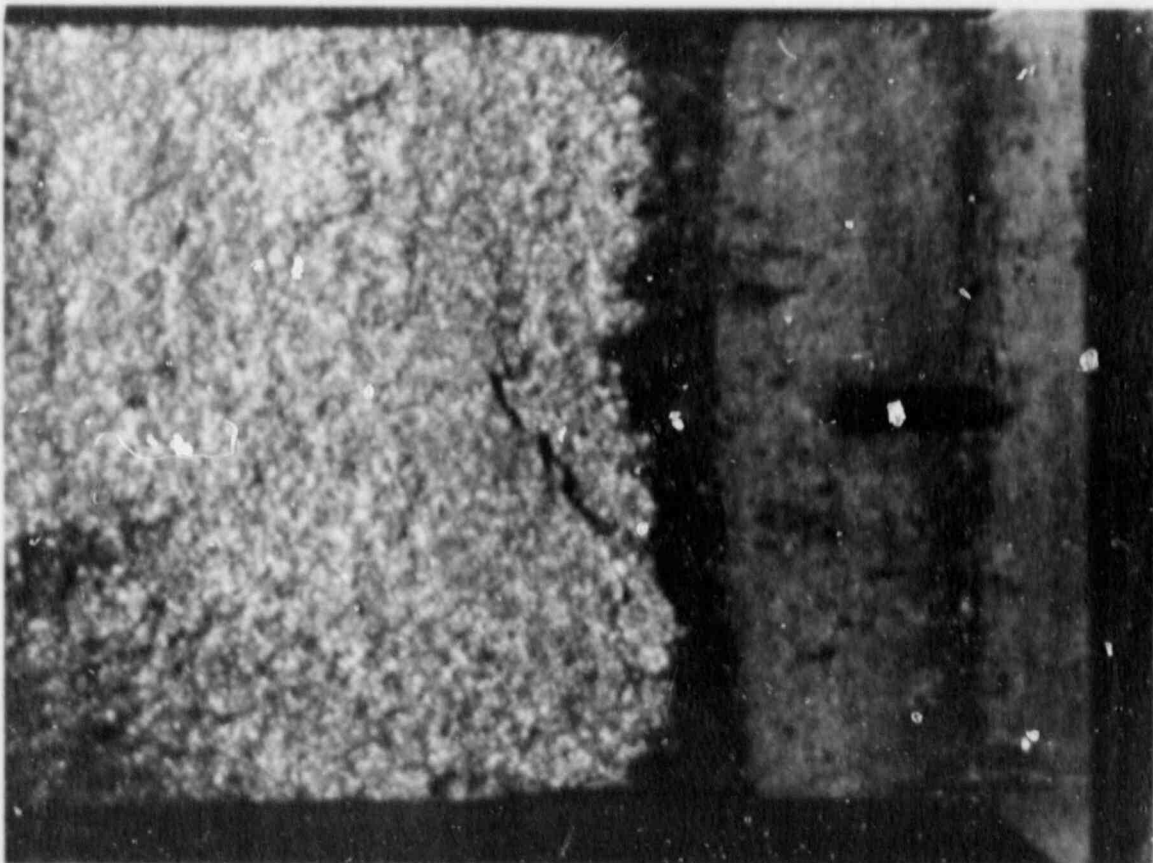
ASTM LINEAR PROCEDURE

J1c* 128.5 kJ/m²
 K-J1c* 158.5 MPa SQR[m]
 SLOPE* 116277 kJ/m³
 INTERCEPT* 116.4 kJ/m²
 T (ASTM)* 60
 VALID, E813

J1-R CURVE CALCULATIONS

J (W/1+0.8)* 309.4 kJ/m²
 POWER* .4119
 J-MAX ALLOWED* 591 kJ/m²
 RCURVE INVALID, 2

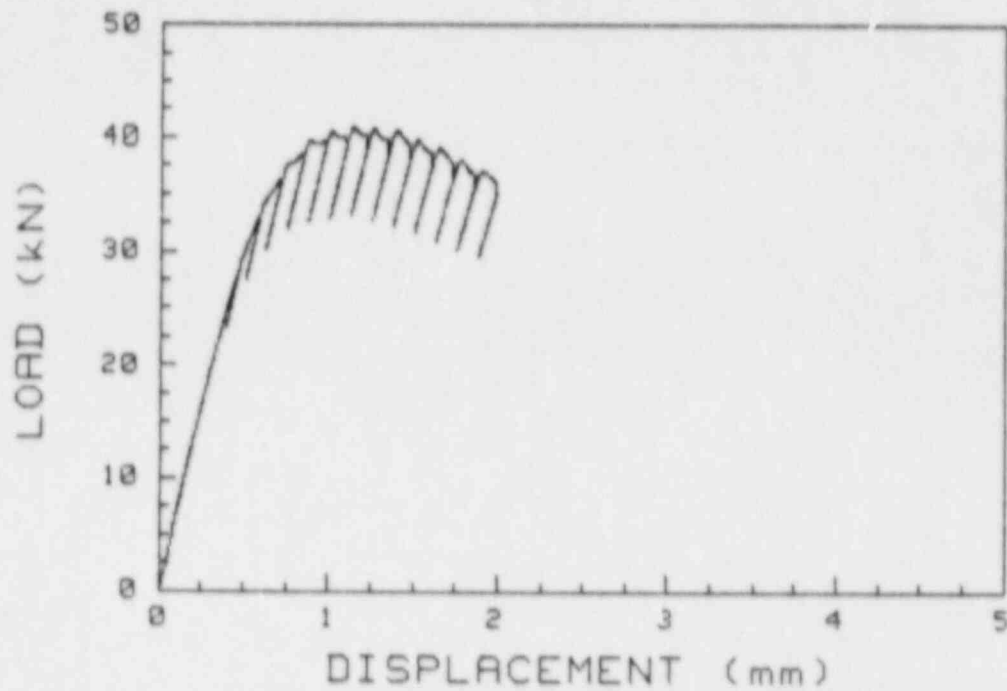
COEFFICIENT* 239.6 kJ/m²
 DELTA-A MAX ALLOWED* 1.92 mm



ORNL-DWG 87-8016

02GA363

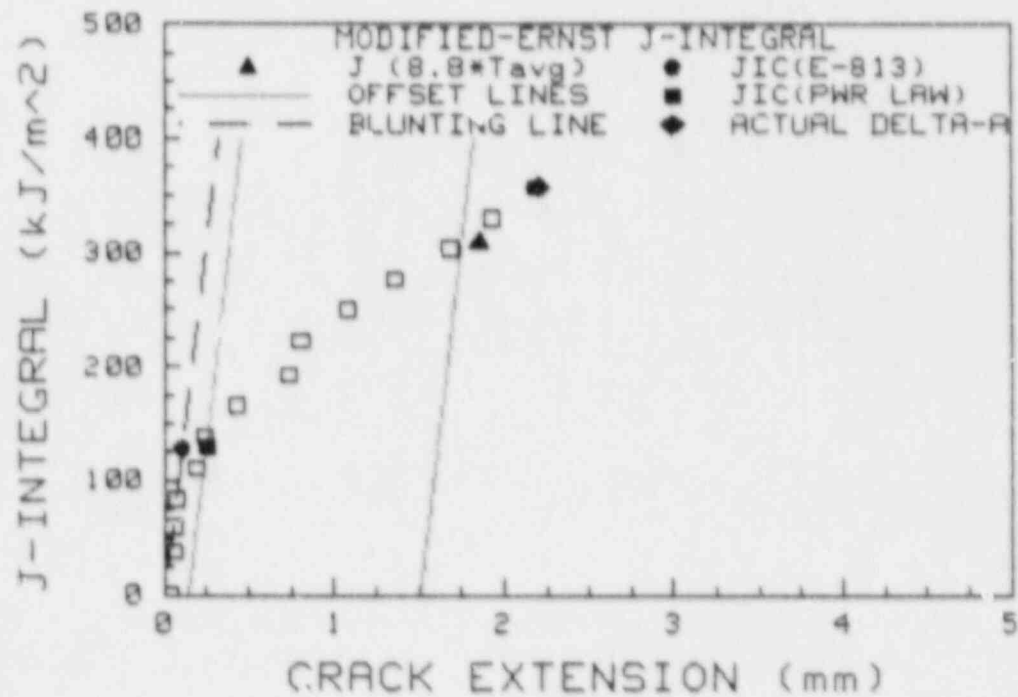
204 DEGREES C



ORNL-DWG 87-8017

02GA363

204 DEGREES C



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

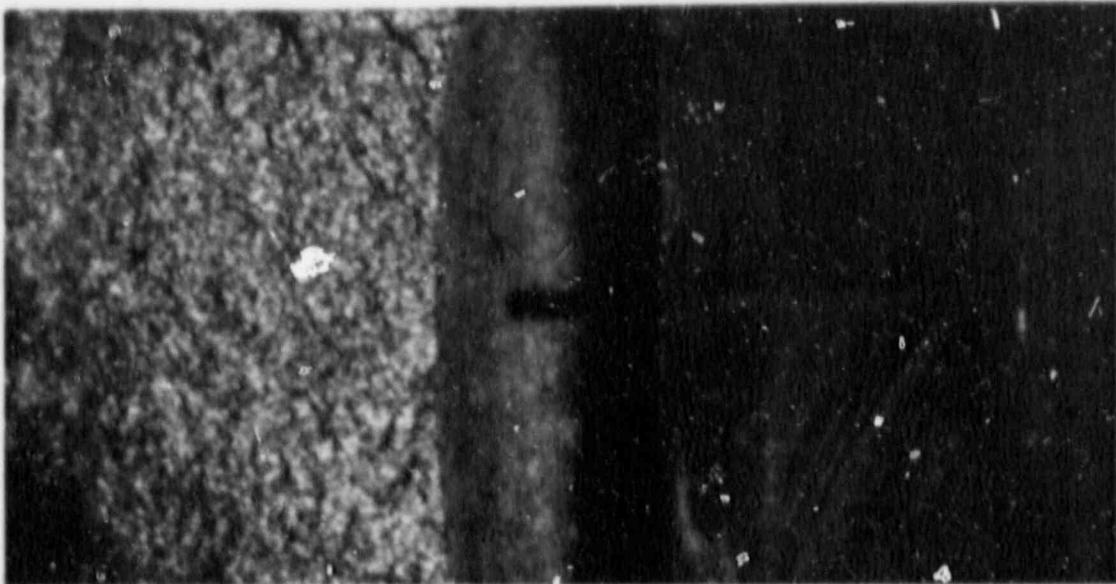
SPECIMEN CLEAVED AT $K = 69.4 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 22.5 kJ/m²
KJc= 67.8 MPa SQR[m]
K-beta-c= 61.2 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

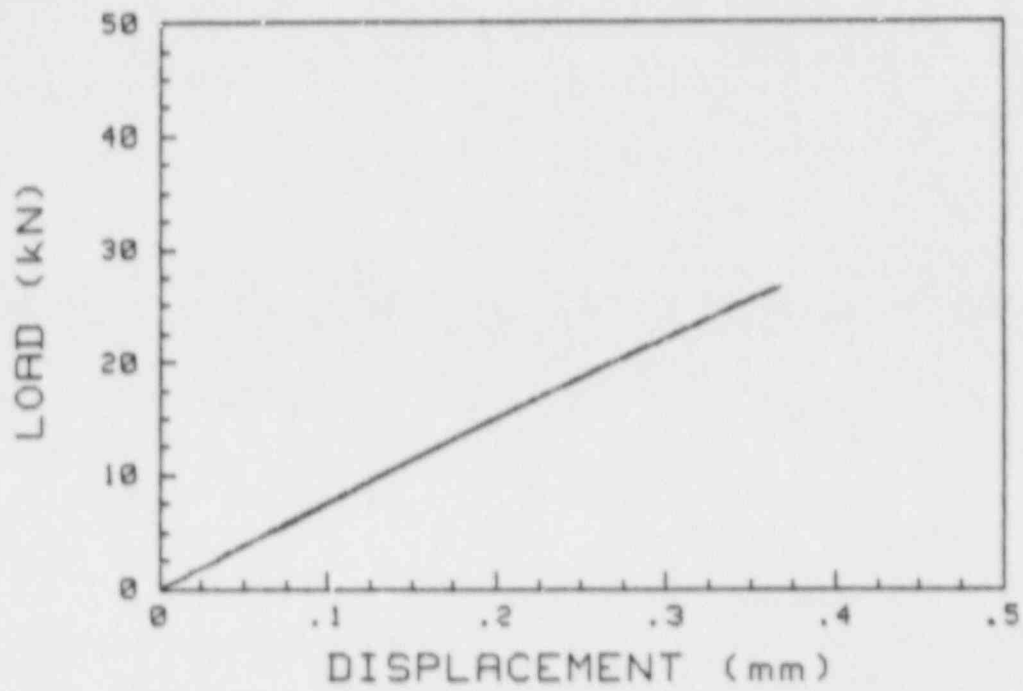
J-INTEGRAL= 22.5 kJ/m²
KJc= 67.8 MPa SQR[m]
K-beta-c= 61.2 MPa SQR[m]



ORNL-DWG 87-8018

02G365

50 DEGREES C



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

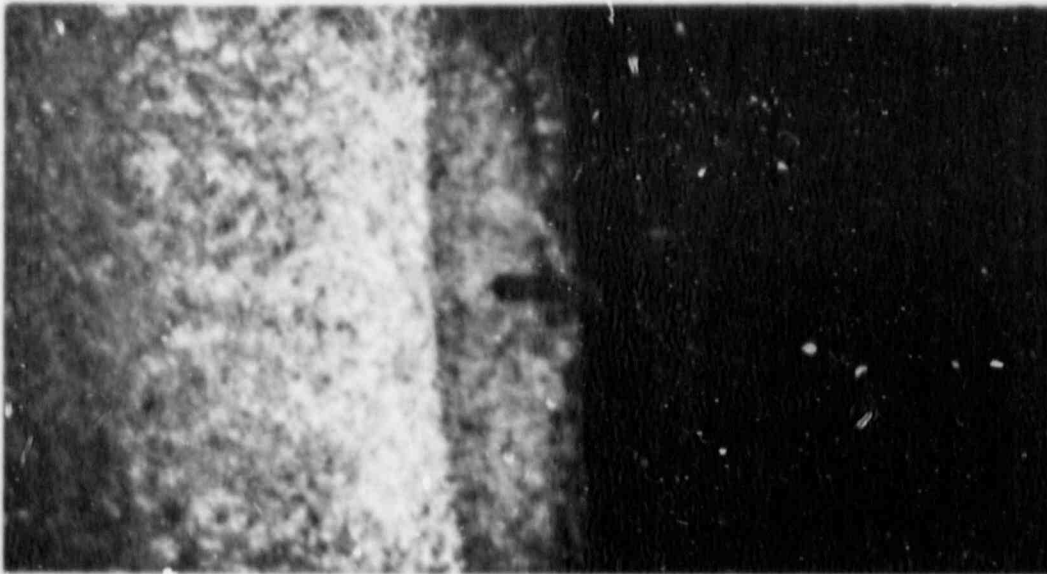
SPECIMEN CLEAVED AT $K_{Ic} = 58.9 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 13.6 kJ/m²
 $KJc = 58.8 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 55.6 \text{ MPa SQR[m]}$

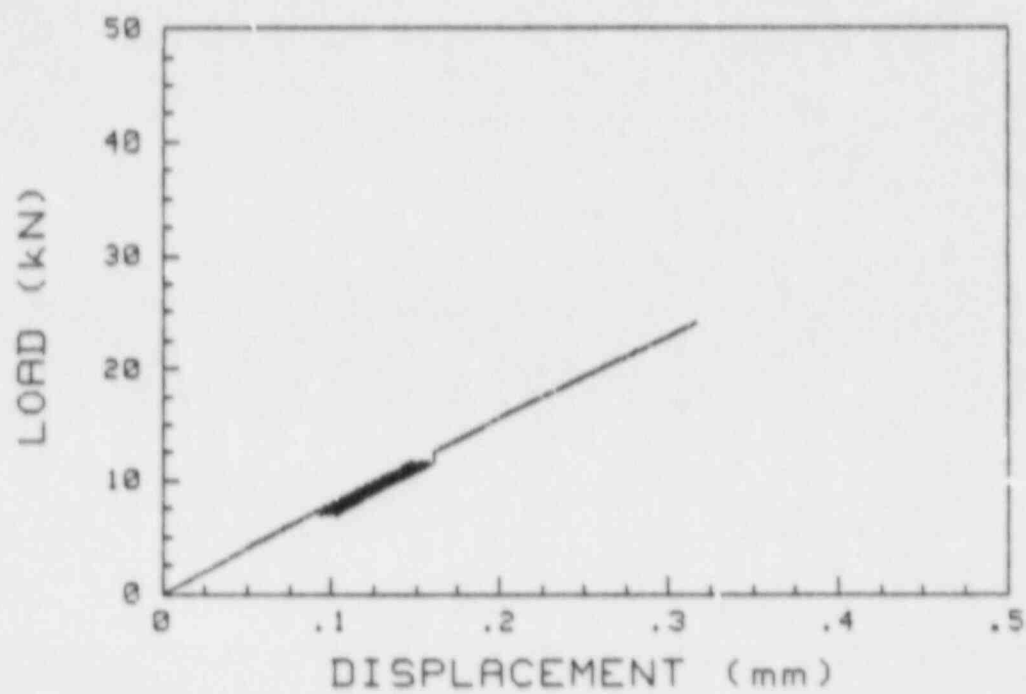
VALUES AT CLEAVAGE LOAD

 J-INTEGRAL= 16.6 kJ/m²
 $KJc = 58.8 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 55.6 \text{ MPa SQR[m]}$



02G401

-25 DEGREES C



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 $K = 79.9 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 36.7 kJ/m²
KJc= 86.6 MPa SQR[m]
K-beta-c= 72.1 MPa SQR[m]

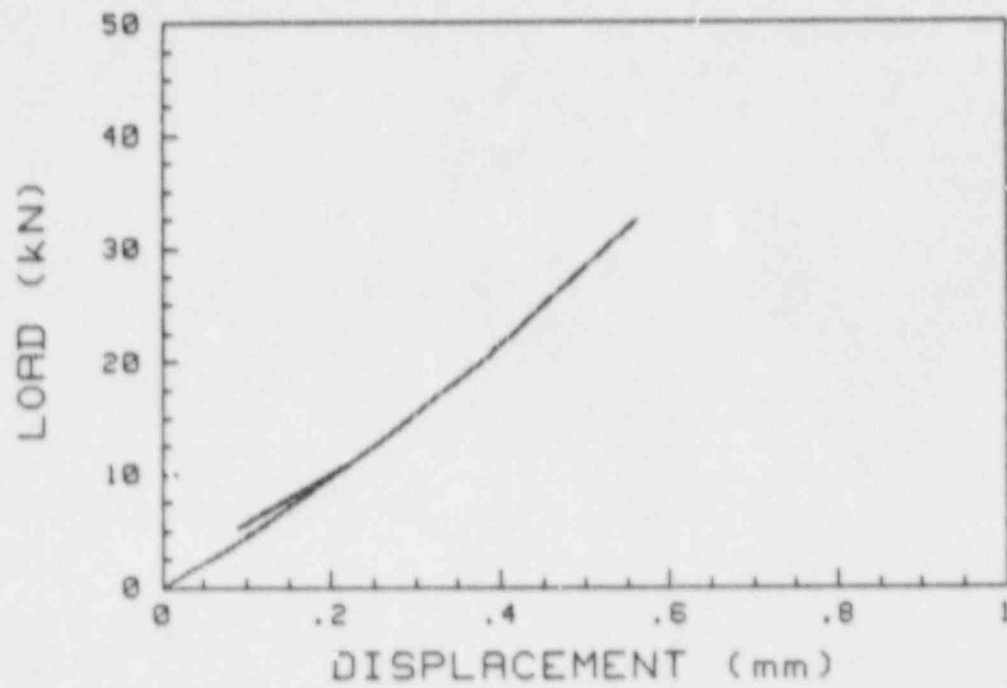
VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 36.7 kJ/m²
KJc= 86.6 MPa SQR[m]
K-beta-c= 72.1 MPa SQR[m]



02G404

50 DEGREES C



SPECIMEN ID= 02G406
 MATERIAL TYPE= A533B
 TEST TEMPERATURE= -25 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 30.7 mm
 MEASURED DUCTILE DELTA-A= .05 mm
 YIELD STRENGTH= 647 MPa
 FLOW STRENGTH= 717 MPa
 ESTIMATED YOUNG'S MODULUS= 209 GPa

$a/W)i = .602$

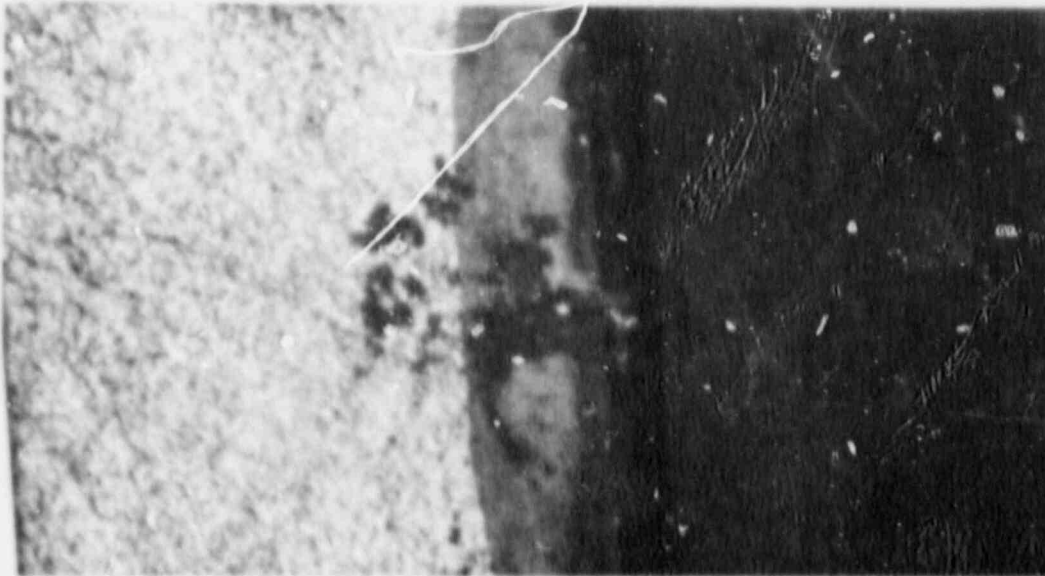
SPECIMEN CLEAVED AT $K_{Ic} = 45.1 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 14.3 kJ/m²
 $K_{Jc} = 54.6 \text{ MPa SQR[m]}$
 $K_{\beta c} = 52.2 \text{ MPa SQR[m]}$

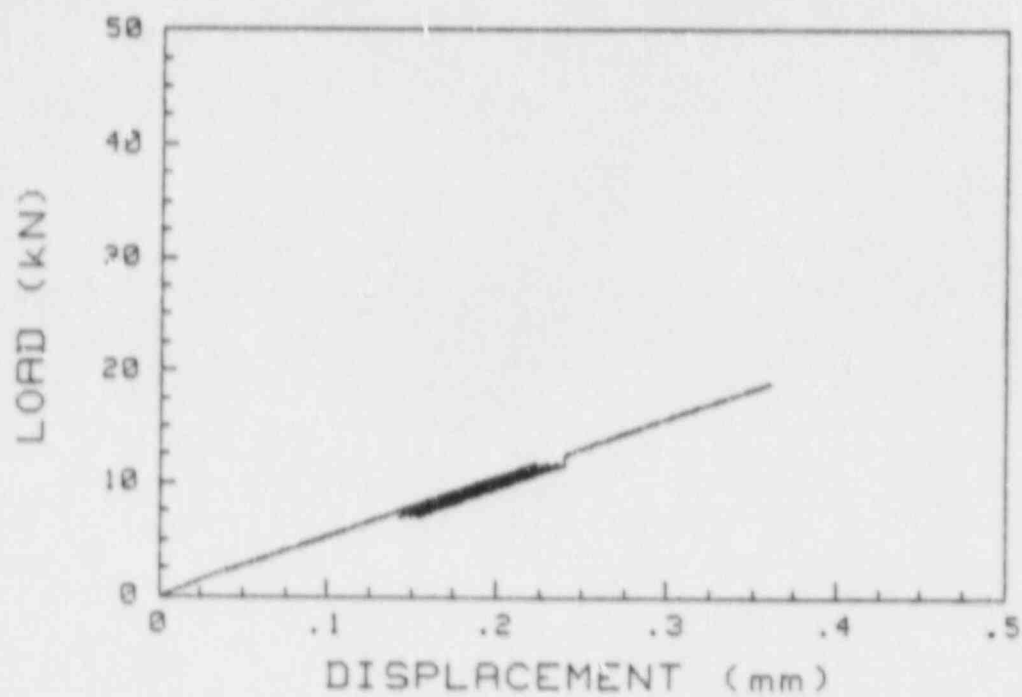
VALUES AT CLEAVAGE LOAD

 J-INTEGRAL= 14.3 kJ/m²
 $K_{Jc} = 54.6 \text{ MPa SQR[m]}$
 $K_{\beta c} = 52.2 \text{ MPa SQR[m]}$



02G406

-25 DEGREES C



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

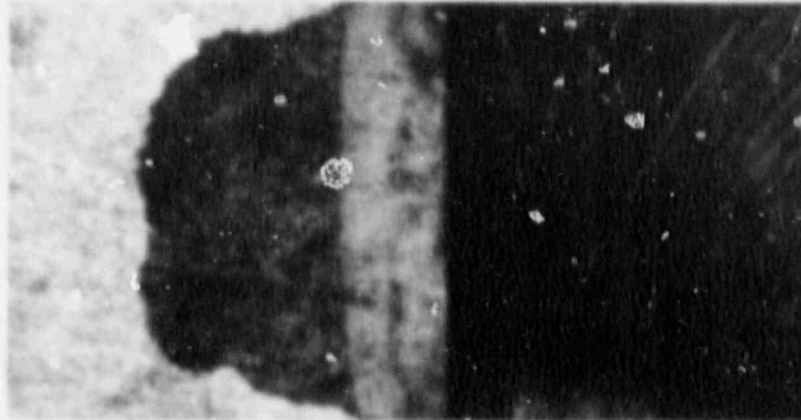
SPECIMEN CLEAVED AT $K = 62.3 \text{ MPa SQR(m)}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 18.3 kJ/m²
 $K_{Jc} = 61.1 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 56.6 \text{ MPa SQR(m)}$

VALUES AT CLEAVAGE LOAD

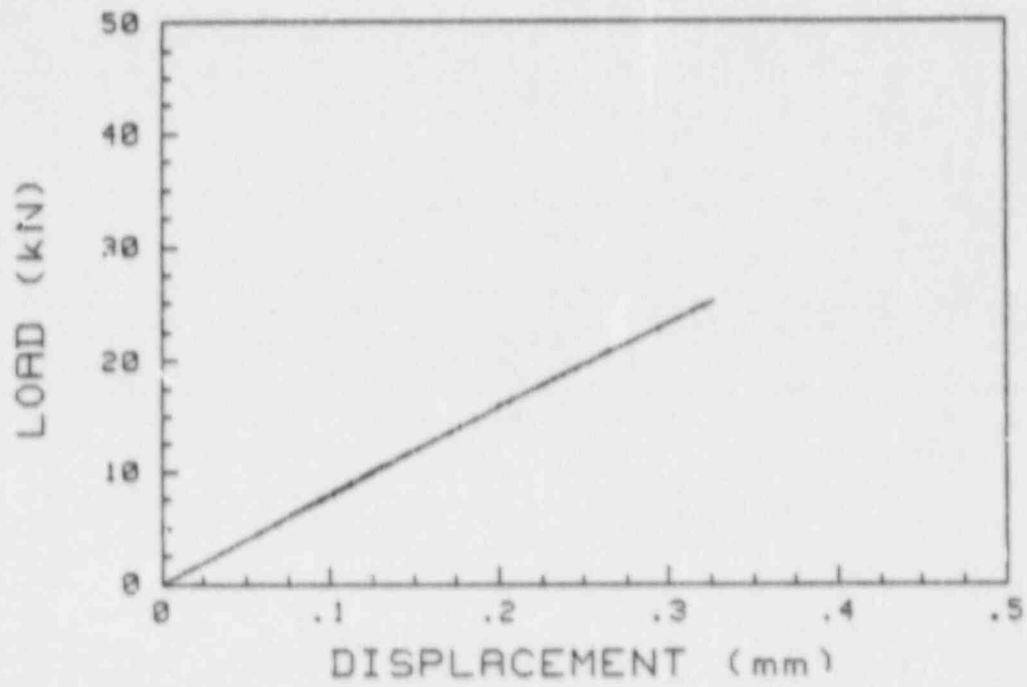
 J-INTEGRAL= 18.3 kJ/m²
 $K_{Jc} = 61.1 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 56.6 \text{ MPa SQR(m)}$



ORNL-DWG 87-3022

02GA407

50 DEGREES C



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

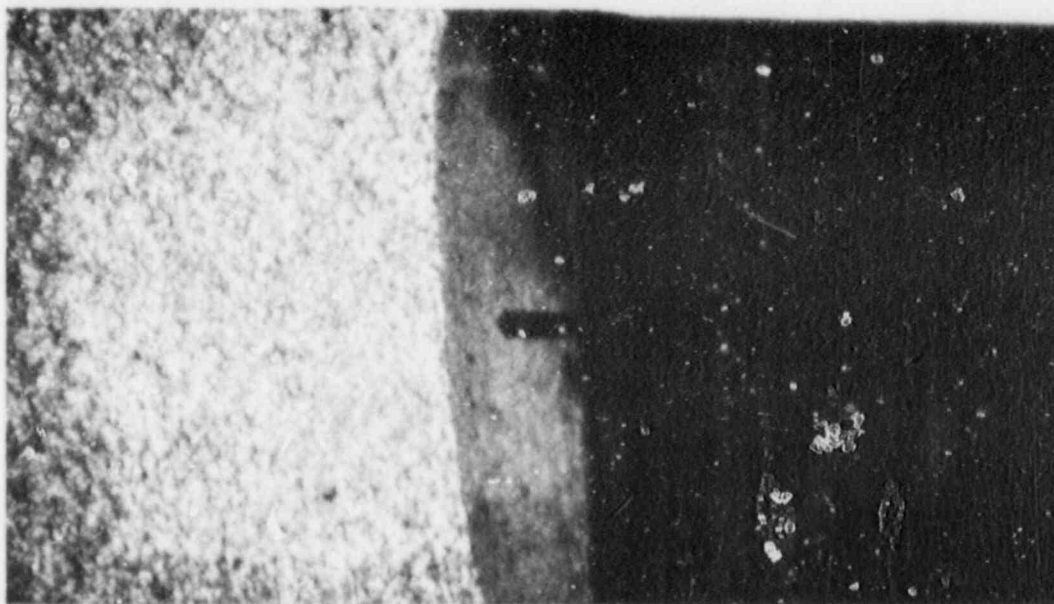
SPECIMEN CLEAVED AT $K_{Ic} = 36 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 6.9 kJ/m²
K_{Jc}= 38 MPa SQR[m]
K-beta-c= 37.5 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

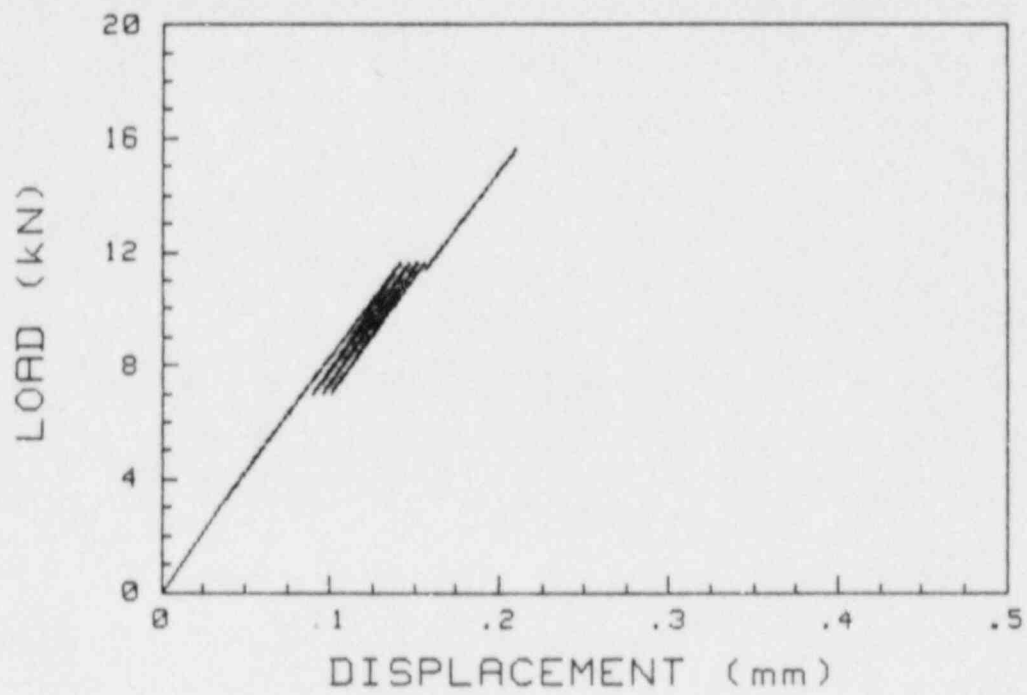
J-INTEGRAL= 6.9 kJ/m²
K_{Jc}= 38 MPa SQR[m]
K-beta-c= 37.5 MPa SQR[m]



ORNL-DWG 87-8023

Ø2G414

-25 DEGREES C



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 $K = 118.4 \text{ MPa SQR(m)}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 138.1 kJ/m^2
 $K_{Jc} = 167.3 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 100.1 \text{ MPa SQR(m)}$

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 198.8 kJ/m^2
 $K_{Jc} = 200.7 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 108.1 \text{ MPa SQR(m)}$

POWER LAW PROCEDURE

$J_{Ic} = 151.4 \text{ kJ/m}^2$
 $K\text{-}J_{Ic} = 175.2 \text{ MPa SQR(m)}$
 POWER= .353
 COEFFICIENT= 241.9 kJ/m^2
 T (AVERAGE)= 43

ASTM LINEAR PROCEDURE

$J_{Ic} = 0 \text{ kJ/m}^2$
 $K\text{-}J_{Ic} = 0 \text{ MPa SQR(m)}$
 SLOPE= kJ/m^3
 INTERCEPT= 0 kJ/m^2
 T (ASTM)= 0
 INVALID, 1

J1-R CURVE CALCULATIONS

$J (\theta J/T=8.8) = 236.7 \text{ kJ/m}^2$
 POWER= .2921
 J-MAX ALLOWED= 662.8 kJ/m^2
 RCURVE INVALID, 2

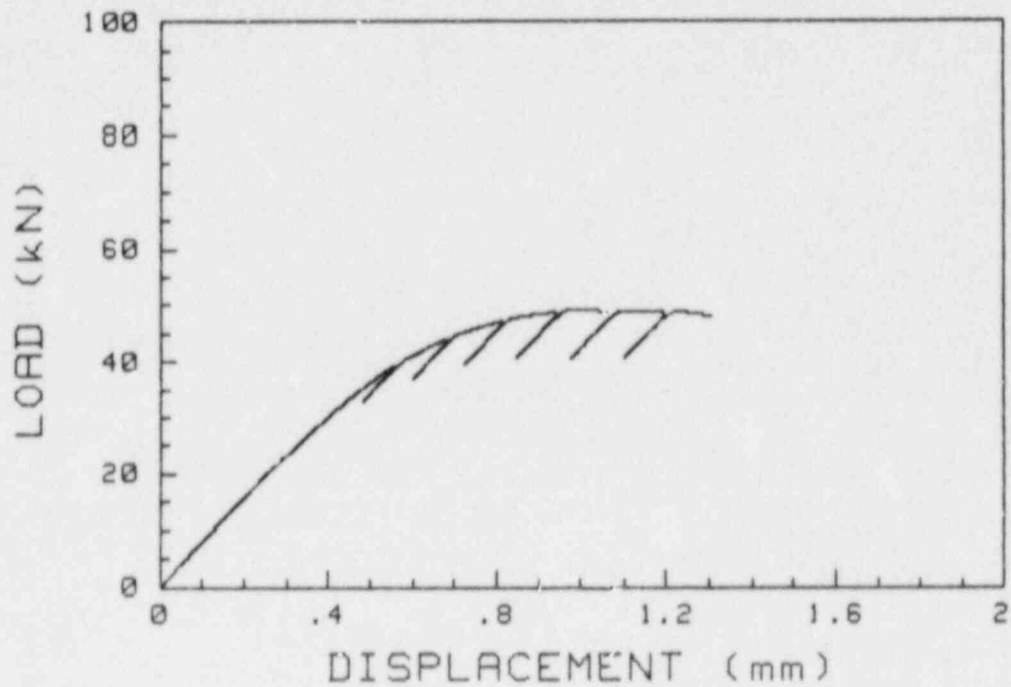
COEFFICIENT= 223.9 kJ/m^2
 DELTA-A MAX ALLOWED= 2.02 mm



ORNL-DWG 87-8024

02G421

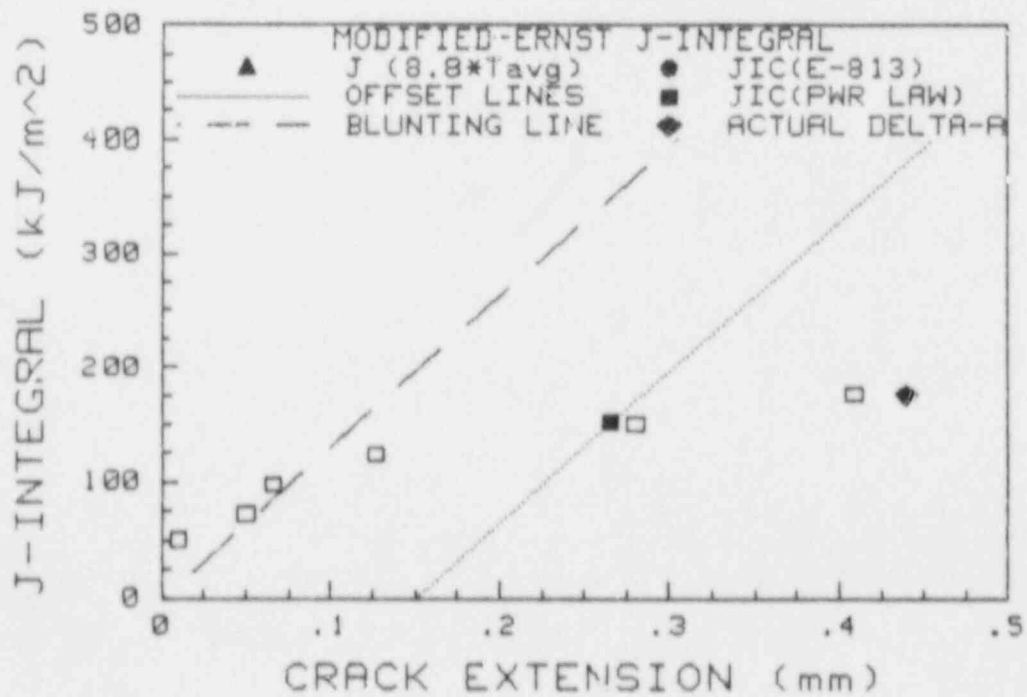
80 DEGREES C



ORNL-DWG 87-8025

02G421

80 DEGREES C



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/m²
 KJ-MAX LOAD= 193.1 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 154.4 kJ/m²
 K-JIc= 171.6 MPa SQR[m]
 POWER= .3786
 COEFFICIENT= 251.4 kJ/m²
 T (AVERAGE)= 51

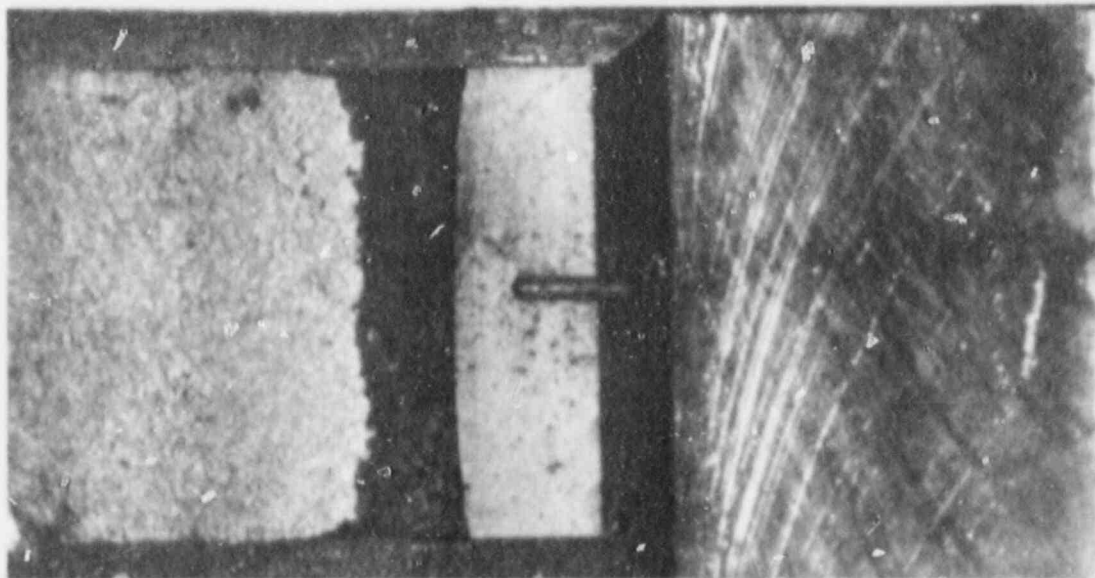
ASTM LINEAR PROCEDURE

 JIc= 153.8 kJ/m²
 K-JIc= 171.3 MPa SQR[m]
 SLOPE= 103020 kJ/m³
 INTERCEPT= 140.9 kJ/m²
 T (ASTM)= 52
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 293.9 kJ/m²
 POWER= .3509
 J-MAX ALLOWED= 614.4 kJ/m²
 RCURVE INVALID, 2 3

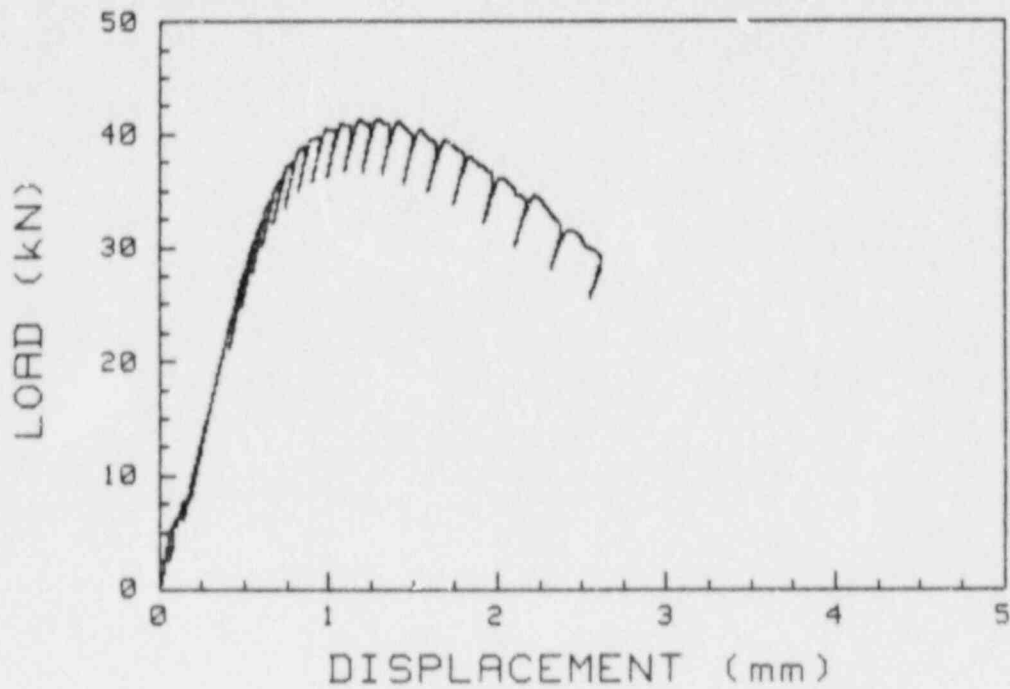
COEFFICIENT= 251 kJ/m²
 DELTA-A MAX ALLOWED= 2 mm



ORNL-DWG 87-8026

02G422

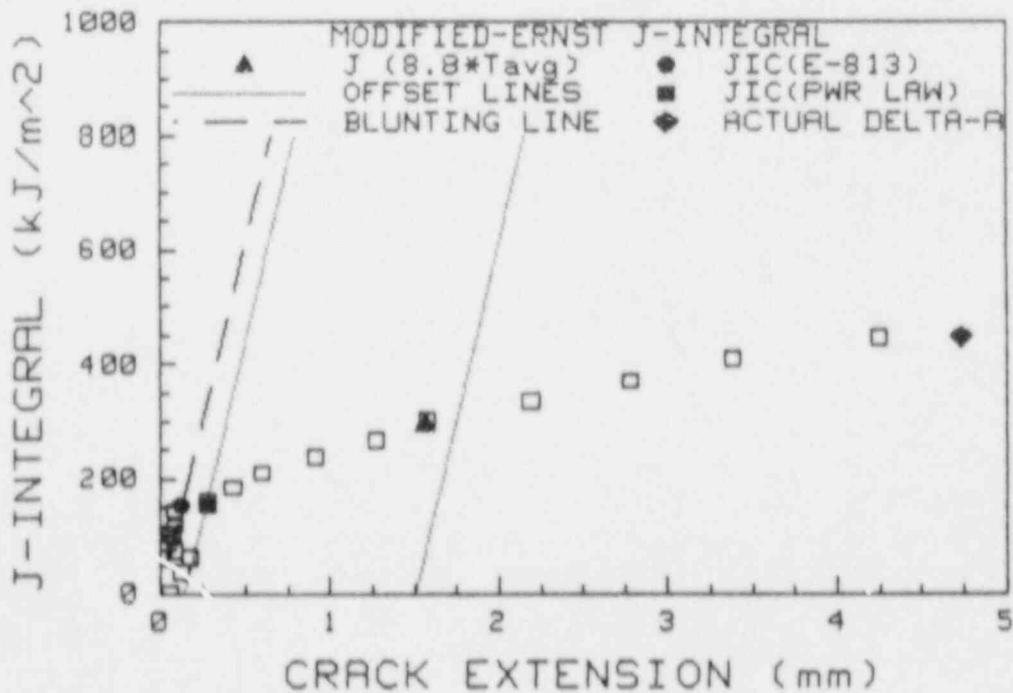
288 DEGREES C



ORNL-DWG 87-8027

02G422

288 DEGREES C



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 $K = 131.3 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 140.3 kJ/m²
KJc= 171.7 MPa SQR[m]
K-beta-c= 113.5 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

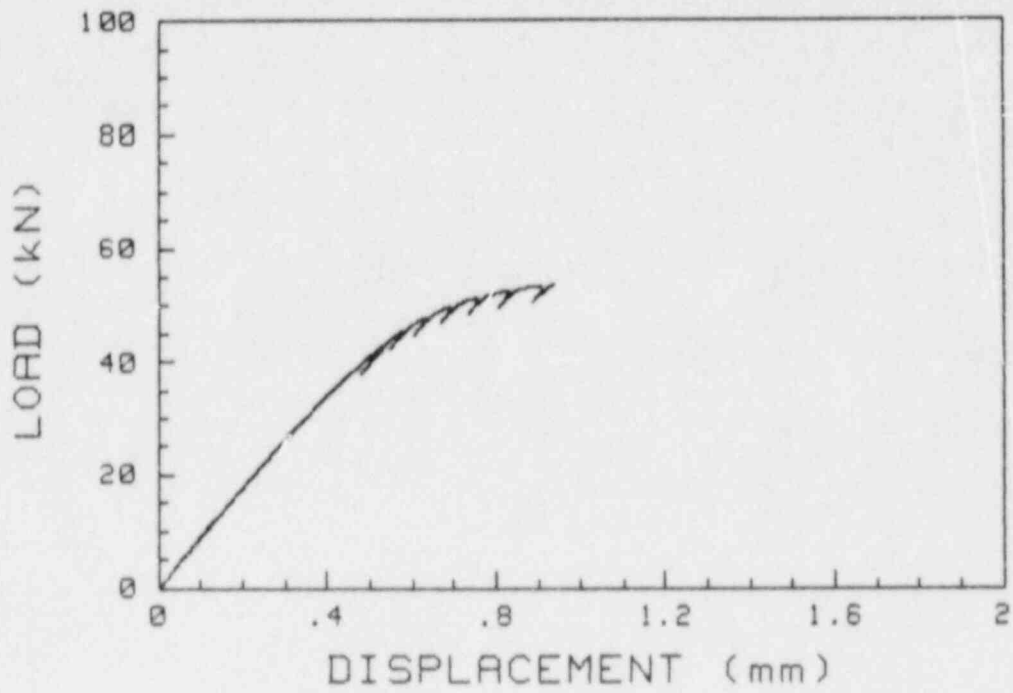
J-INTEGRAL= 140.4 kJ/m²
KJc= 171.7 MPa SQR[m]
K-beta-c= 113.5 MPa SQR[m]



ORNL-DWG 87-3028

68WAD

-50 DEGREES C



SPECIMEN ID= 68WBB
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -75 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.1 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 757 MPa
FLOW STRENGTH= 757 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

$a/W)i = .593$

SPECIMEN CLEAVED AT $K = 116.1 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 84.3 kJ/m^2
KJc= 133.6 MPa SQR[m]
K-beta-c= 102 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

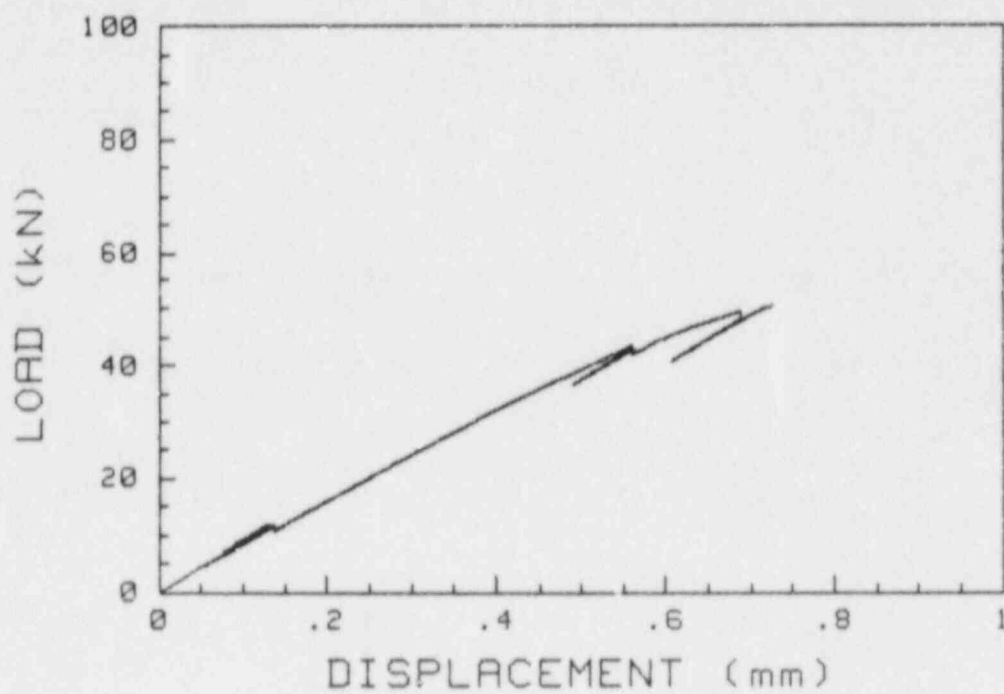
J-INTEGRAL= 84.9 kJ/m^2
KJc= 134 MPa SQR[m]
K-beta-c= 102.2 MPa SQR[m]



ORNL-DWG 87-8029

68WBB

-75 DEGREES C



SPECIMEN ID# 680CE
 TEST TEMPERATURE# 289 DEG C
 THICKNESS# 25.4 mm
 SIDE GROOVES# 20 %
 INITIAL CRACK LENGTH# 30.3 mm a/W # .606
 MEASURED DUCTILE DELTA# 2.98 mm
 YIELD STRENGTH# 548 MPa
 FLOW STRENGTH# 593 MPa
 ESTIMATED YOUNG'S MODULUS# 191 GPa

SPEC MEN DID NOT CLEAVE. J-MAX LOAD# 295.6 kJ/m²
 KJ-MAX LOAD# 237.5 MPa SQRT(m)

POWER LAW PROCEDURE

 JIc# 144.4 kJ/m²
 K-JIc# 166 MPa SQRT(m)
 POWER# .6841
 COEFFICIENT# 352 kJ/m²
 T (AVERAGE)# 130

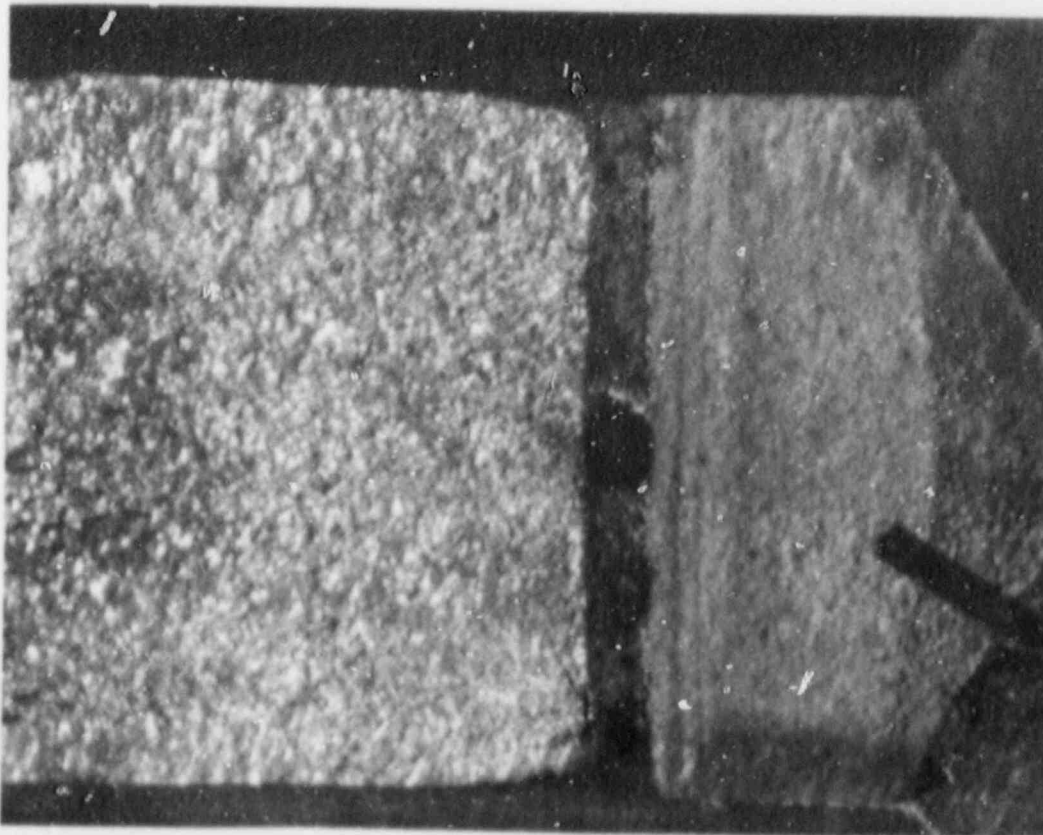
ASTM LINEAR PROCEDURE

 JIc# 113.4 kJ/m²
 K-JIc# 147.1 MPa SQRT(m)
 SLOPE# 250748 kJ/m³
 INTERCEPT# 99.4 kJ/m²
 T (ASTM)# 136
 VALID, E617

J1-R CURVE CALCULATIONS

 J (QJ-T#8.81)# 278.6 kJ/m²
 POWER# .6777
 J-MAX ALLOWED# 592.4 kJ/m²
 VALID R-CURVE

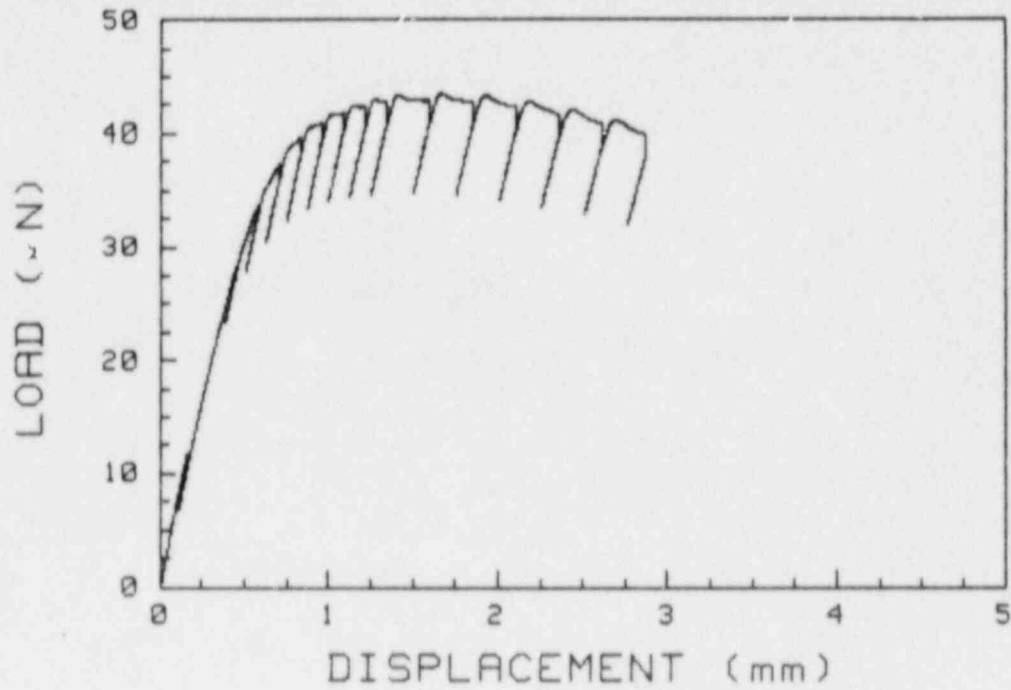
COEFFICIENT# 391.2 kJ/m²
 DELTA-R MAX ALLOWED# 2 mm



ORNL-DWG 87-8030

68WCE

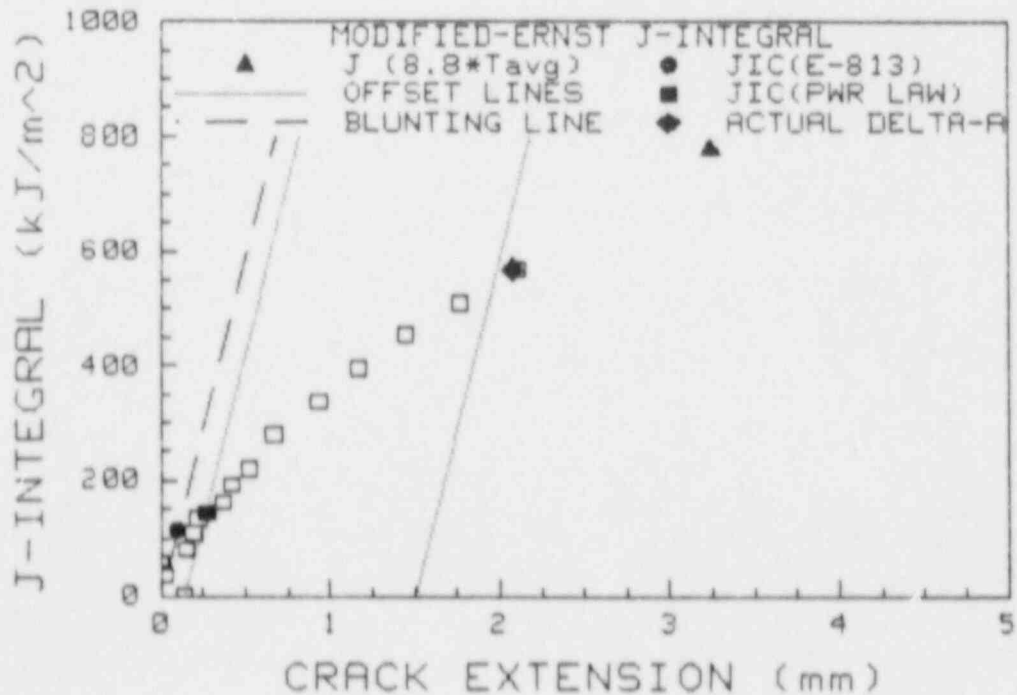
288 DEGREES C



ORNL-DWG 87-8031

68WCE

288 DEGREES C



SPECIMEN ID# 68W0R
 TEST TEMPERATURE# 204 DEG C
 THICKNESS# 25.4 mm
 SIDE GROOVES# 20 %
 INITIAL CRACK LENGTH# 30.4 mm $a/b \pm 1$ = .6
 MEASURED DUCTILE DELTA-A# 2.47 mm
 YIELD STRENGTH# 513 MPa
 FLOW STRENGTH# 572 MPa
 ESTIMATED YOUNG'S MODULUS# 196 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD# 275.1 kJ/m²
 KJ-MAX LOAD# 231.9 MPa SQR(m)

POWER LAW PROCEDURE

J1c# 173.8 kJ/m²
 K-J1c# 184.2 MPa SQR(m)
 POWER# .6523
 COEFFICIENT# 379.2 kJ/m²
 T (AVERAGE)# 145

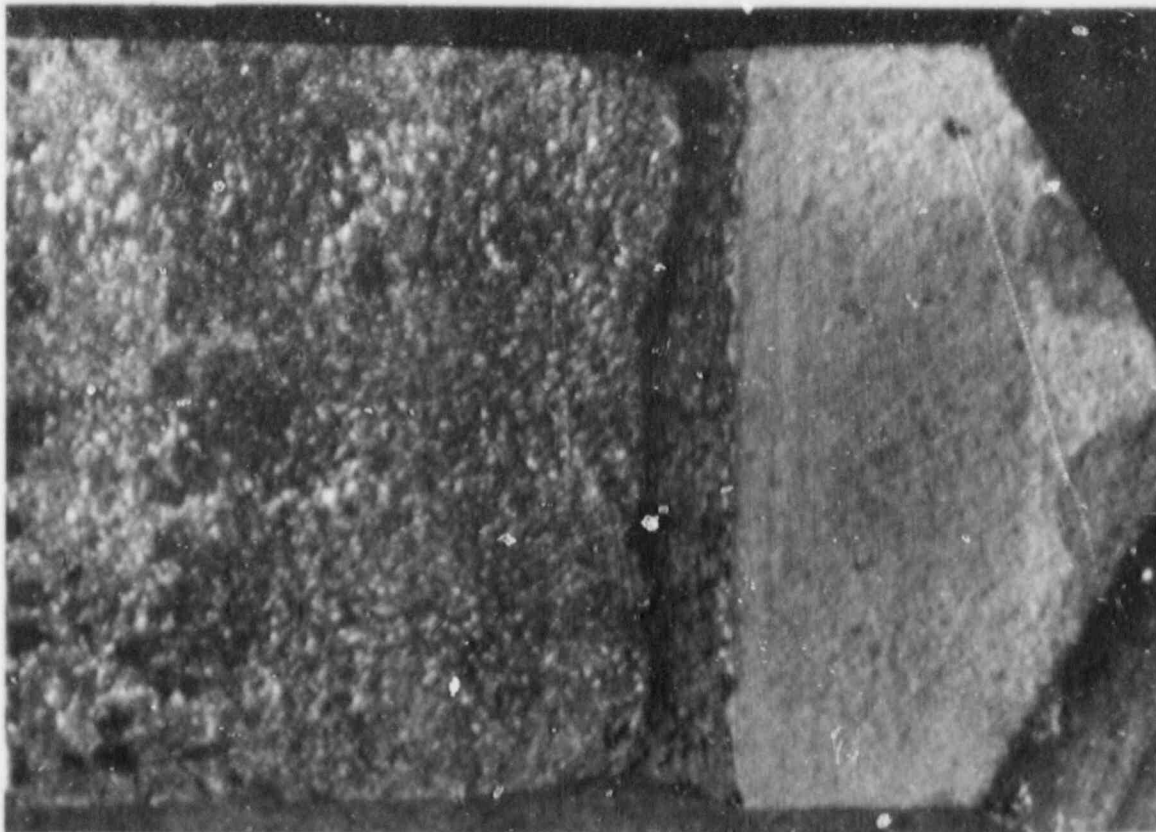
ASTM LINEAR PROCEDURE

J1c# 137.9 kJ/m²
 K-J1c# 164.2 MPa SQR(m)
 SLOPE# 261042 kJ/m³
 INTERCEPT# 106.4 kJ/m²
 T (ASTM)# 156
 INVALID, E917

J1-R CURVE CALCULATIONS

J (aJ/T#8.8)* 939.5 kJ/m²
 POWER# .6485
 J-MAX ALLOWED# 599.9 kJ/m²
 RCURVE INVALID, 1

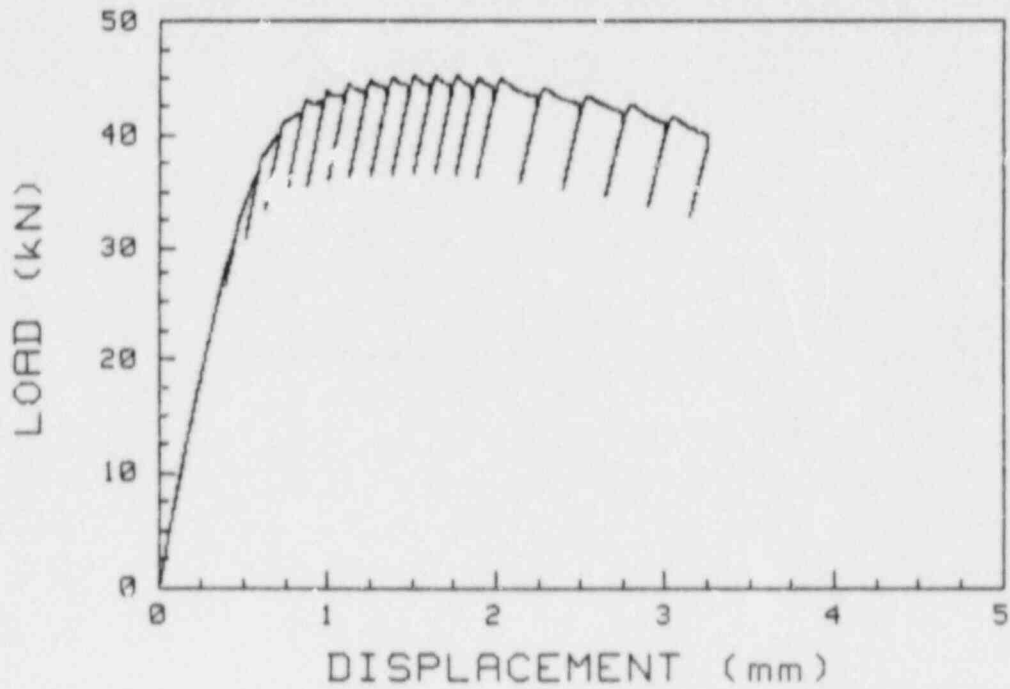
COEFFICIENT# 378.7 kJ/m²
 DELTA-A MAX ALLOWED# 2.03 mm



ORNL-DWG 87-8032

68WDA

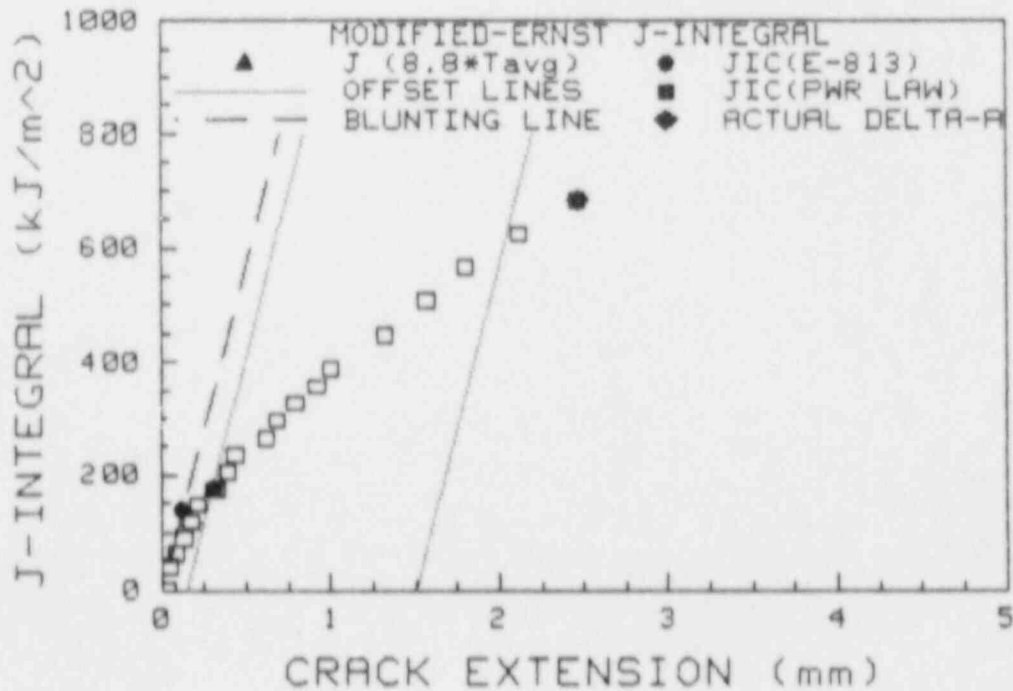
204 DEGREES C



ORNL-DWG 87-8033

68WDA

204 DEGREES C



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/m²
 KJ-MAX LOAD= 250.4 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 163.8 kJ/m²
 K-JIc= 181.1 MPa SQR[m]
 POWER= .7302
 COEFFICIENT= 402.1 kJ/m²
 T (AVERAGE)= 173

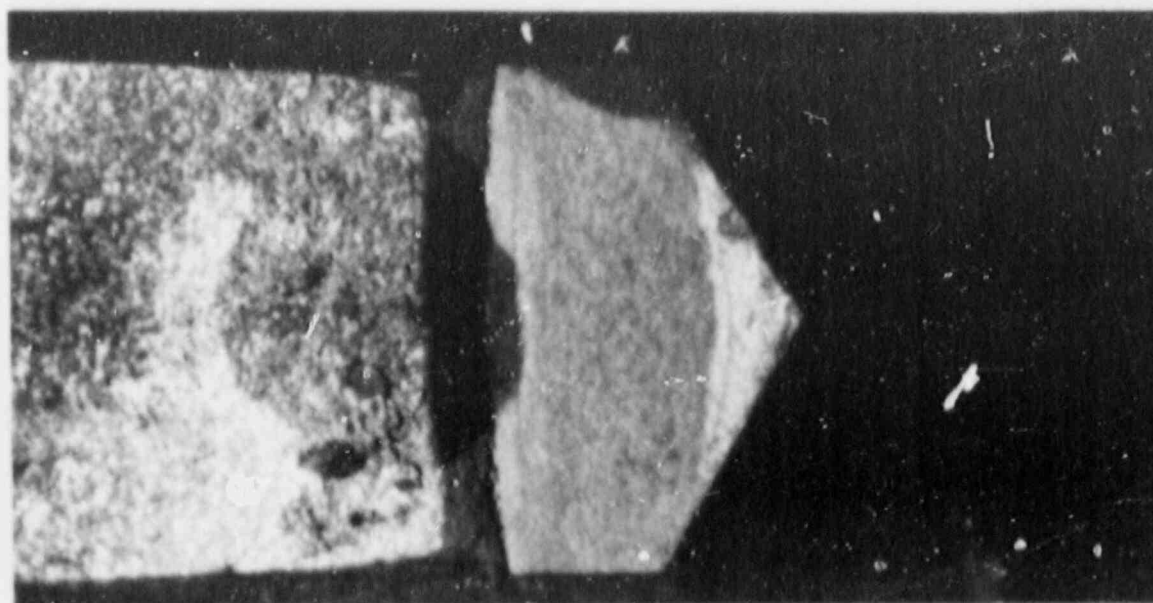
ASTM LINEAR PROCEDURE

 JIc= 131.2 kJ/m²
 K-JIc= 162.1 MPa SQR[m]
 SLOPE= 292740 kJ/m³
 INTERCEPT= 97.8 kJ/m²
 T (ASTM)= 177
 VALID, E813

J1-R CURVE CALCULATIONS

 J (@J/T=8.8)= 1090 kJ/m²
 POWER= .7321
 J-MAX ALLOWED= 583.3 kJ/m²
 RCURVE INVALID, 2

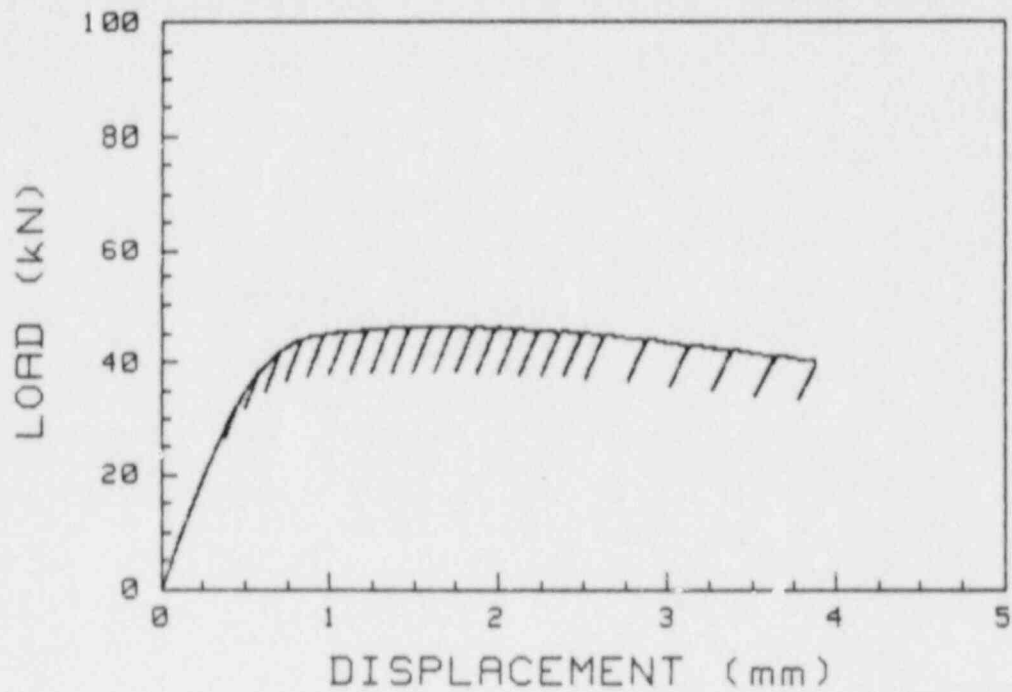
COEFFICIENT= 402.7 kJ/m²
 DELTA-A MAX ALLOWED= 2.03 mm



ORNL-DWG 87-8034

68WDC

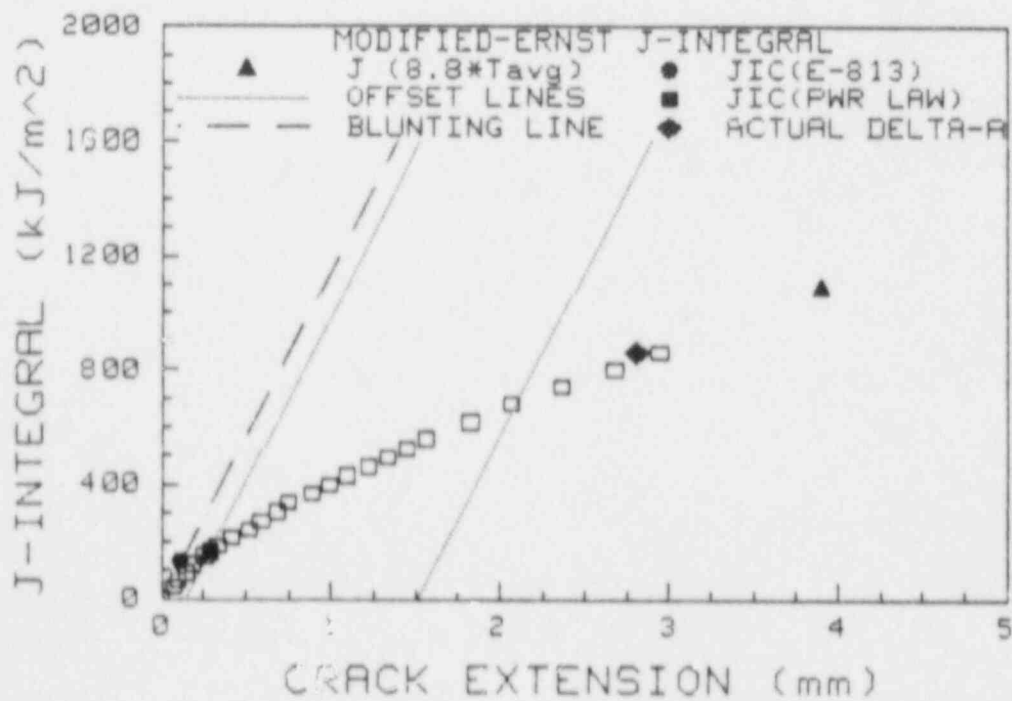
121 DEGREES C



ORNL-DWG 87-8035

68WDC

121 DEGREES C



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

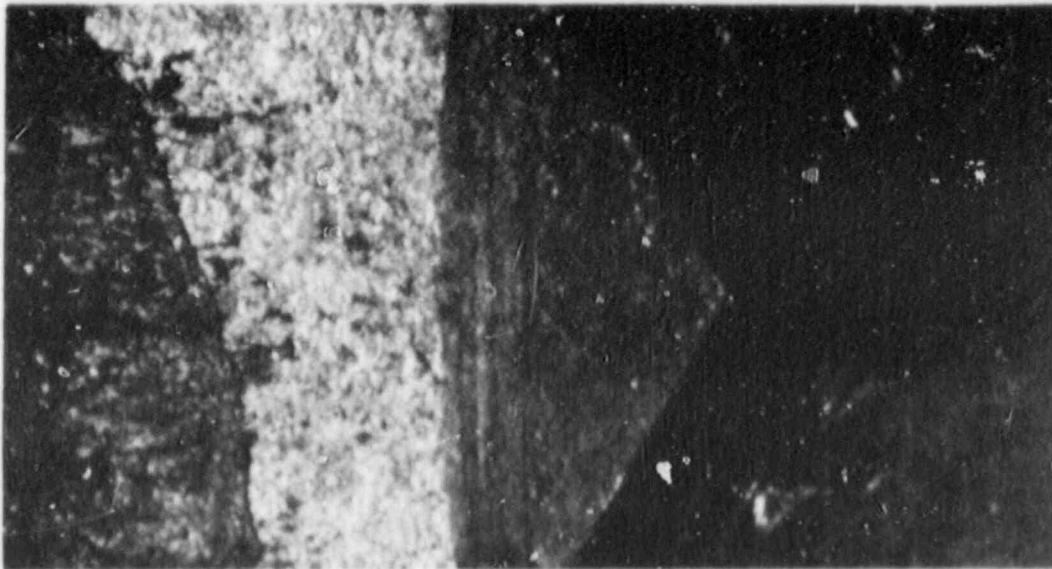
SPECIMEN CLEAVED AT $K_{Ic} = 52.5 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 13.5 kJ/m²
KJc= 53.9 MPa SQR[m]
K-beta-cr 52.9 MPa SQR[m]

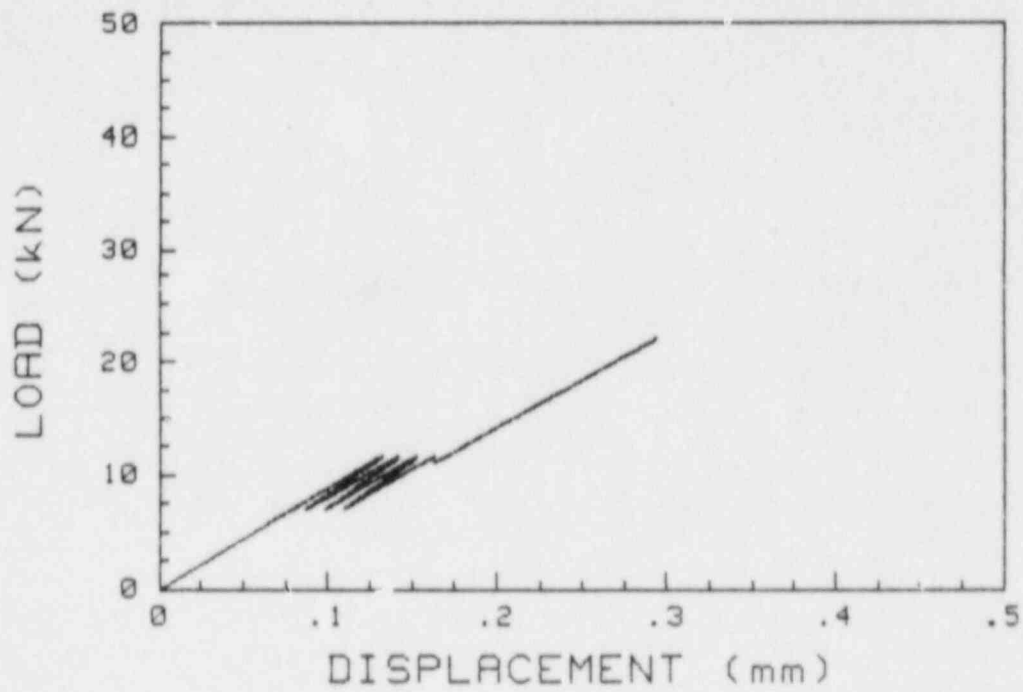
VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 13.5 kJ/m²
KJc= 53.9 MPa SQR[m]
K-beta-cr 52.9 MPa SQR[m]



68WHC

-130 DEGREES C



SPECIMEN ID= 68WKB
 TEST TEMPERATURE= 204 DEG C
 THICKNESS= 25.5 mm
 SIDE GROOVES= 20 %
 INITIAL CRACK LENGTH= 30.5 mm $a/W_1 = .602$
 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/m²
 KJ-MAX LOAD= 233.1 MPa SQR(m)

POWER LAW PROCEDURE

J_{1c}= 144.7 kJ/m²
 K-J_{1c}= 168.2 MPa SQR(m)
 POWER= .6506
 COEFFICIENT= 333.9 kJ/m²
 T (AVERAGE)= 129

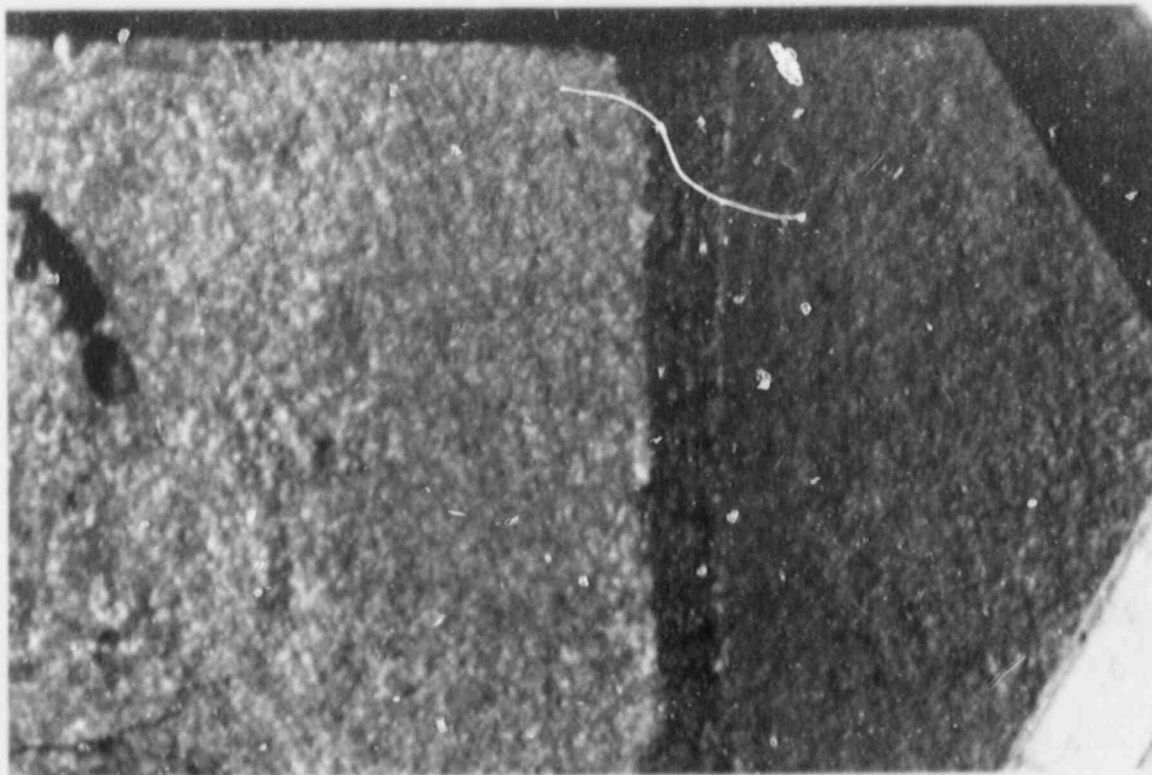
ASTM LINEAR PROCEDURE

J_{1c}= 122.3 kJ/m²
 K-J_{1c}= 154.7 MPa SQR(m)
 SLOPE= 227311 kJ/m³
 INTERCEPT= 98 kJ/m²
 T (ASTM)= 136
 VALID, E813

J1-R CURVE CALCULATIONS

J (a₁/T=8.8)= 730.4 kJ/m²
 POWER= .6433
 J-MAX ALLOWED= 577.6 kJ/m²
 PCURVE INVALID, 1

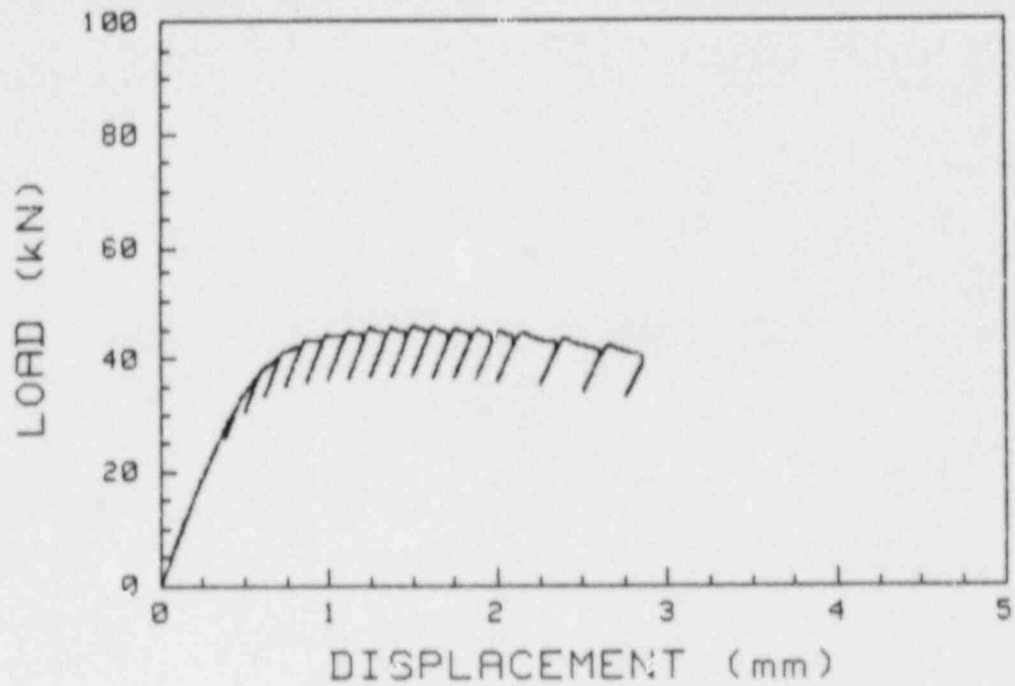
COEFFICIENT= 333.2 kJ/m²
 DELTA-A MAX ALLOWED= 2.02 mm



ORNL-DWG 87-8037

68WKB

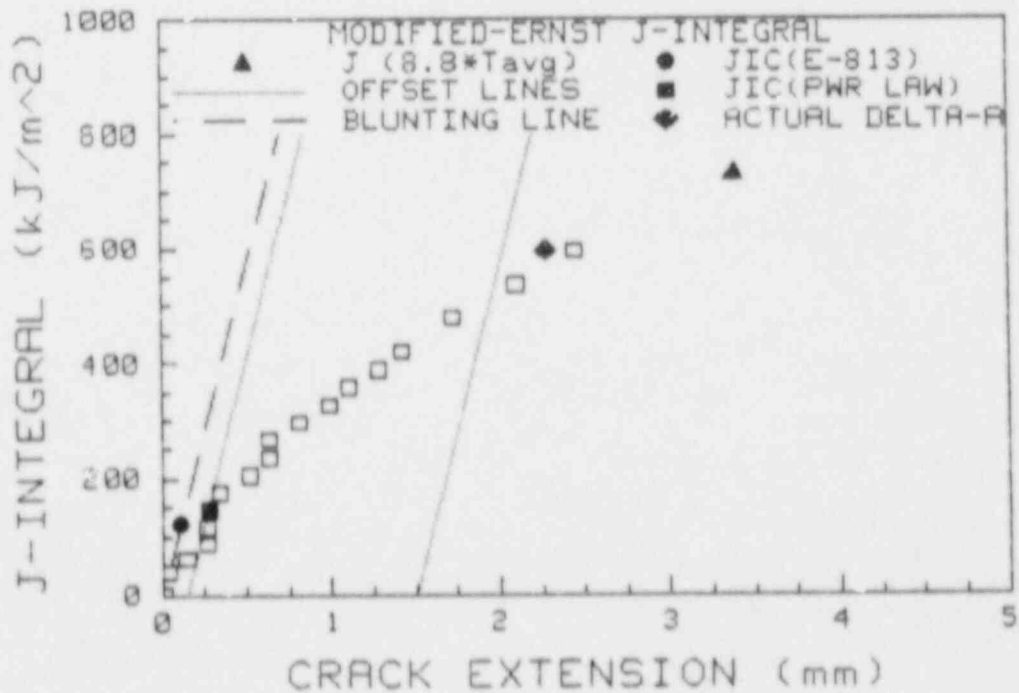
204 DEGREES C



ORNL-DWG 87-8038

68WKB

204 DEGREES C



SPECIMEN ID* 68WKC
 TEST TEMPERATURE* 288 DEG C
 THICKNESS* 25.4 mm
 SIDE GROOVES* 20 %
 INITIAL CRACK LENGTH* 30.3 mm $a/W_{I1} = .598$
 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/m²
 KJ-MAX LOAD* 241.8 MPa SQR(m)

POWER LAW PROCEDURE

J1c* 180 kJ/m²
 K-J1c* 185.3 MPa SQR(m)
 POWER* .5888
 COEFFICIENT* 364.5 kJ/m²
 T (AVERAGE)* 115

ASTM LINEAR PROCEDURE

J1c* 164.1 kJ/m²
 K-J1c* 176.9 MPa SQR(m)
 SLOPE* 218095 kJ/m³
 INTERCEPT* 133.9 kJ/m²
 T (ASTM)* 118
 VALID, E813

J1-R CURVE CALCULATIONS

J (8J/T*8.8)* 657.4 kJ/m²
 POWER* .5801
 J-MAX ALLOWED* 602.4 kJ/m²
 RCURVE INVALID, 2

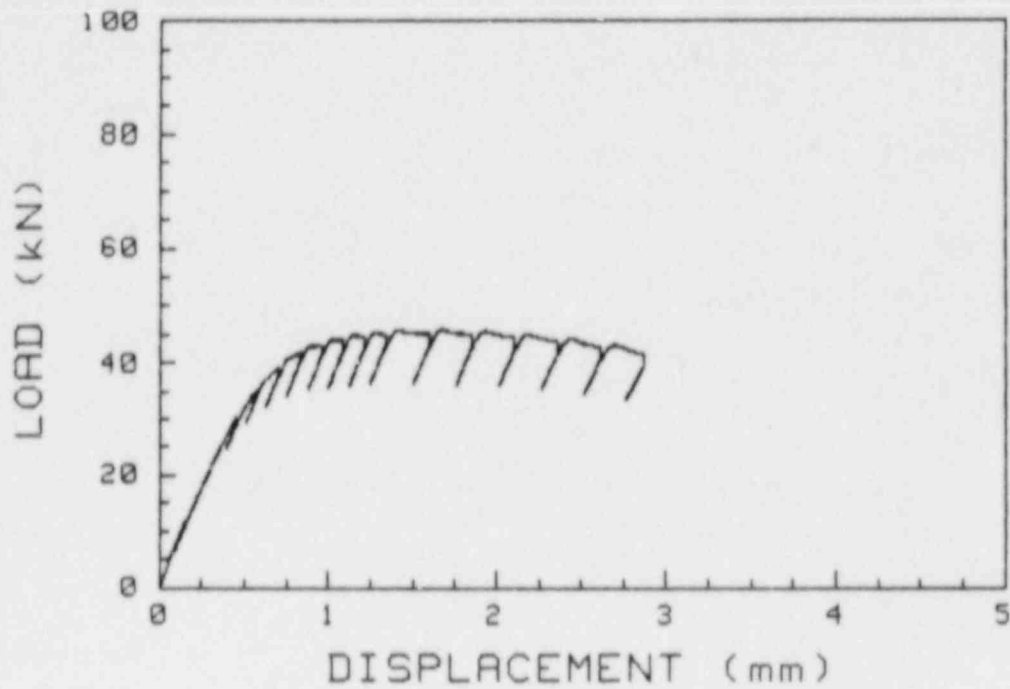
COEFFICIENT* 364 kJ/m²
 DELTA-A MAX ALLOWED* 2.04 mm



ORNL-DWG 87-8039

68WKC

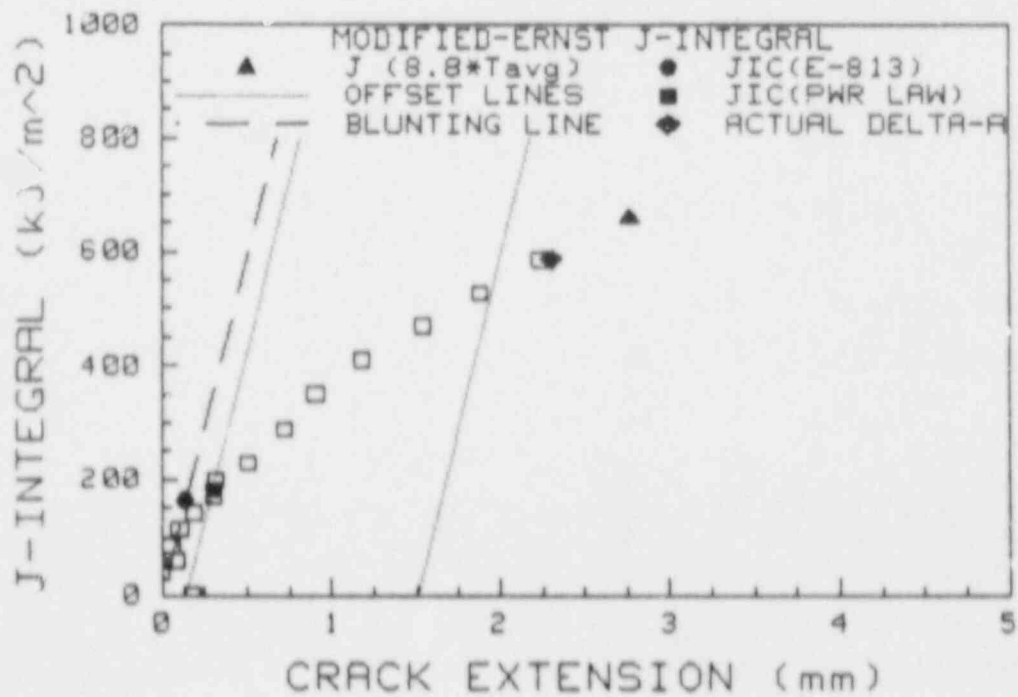
288 DEGREES C



ORNL-DWG 87-8040

68WKC

288 DEGREES C



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/m²
 KJ-MAX LOAD= 261.8 MPa SQR(m)

POWER LAW PROCEDURE

 JIc= 196.8 kJ/m²
 K-JIc= 198.6 MPa SQR(m)
 POWER= .6466
 COEFFICIENT= 410.4 kJ/m²
 T (AVERAGE)= 155

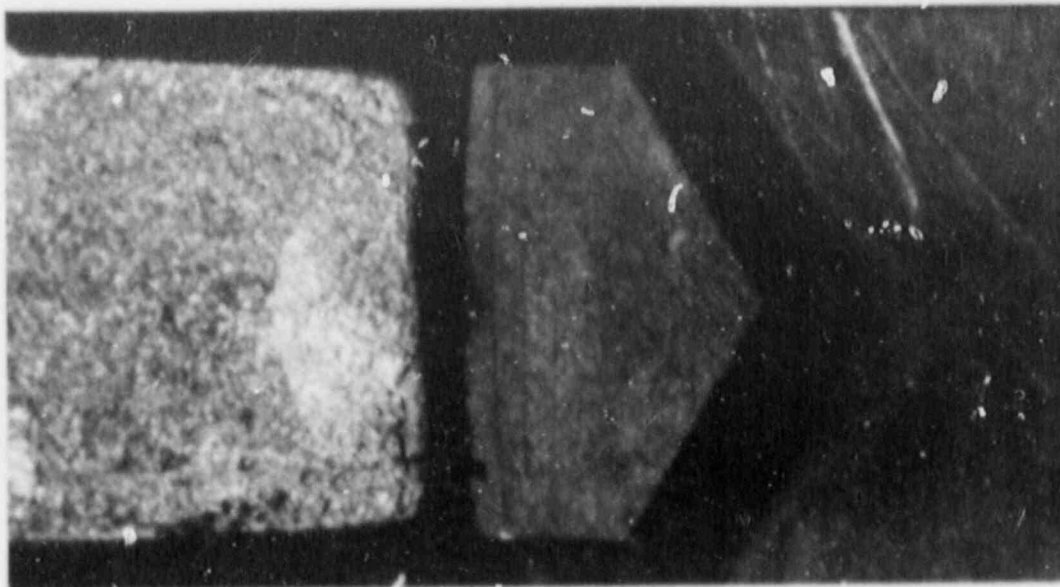
ASTM LINEAR PROCEDURE

 JIc= 172.6 kJ/m²
 K-JIc= 185.9 MPa SQR(m)
 SLOPE= 263609 kJ/m²
 INTERCEPT= 133.1 kJ/m²
 T (ASTM)= 159
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 903.8 kJ/m²
 POWER= .643
 J-MAX ALLOWED= 583.1 kJ/m²
 VALID R-CURVE

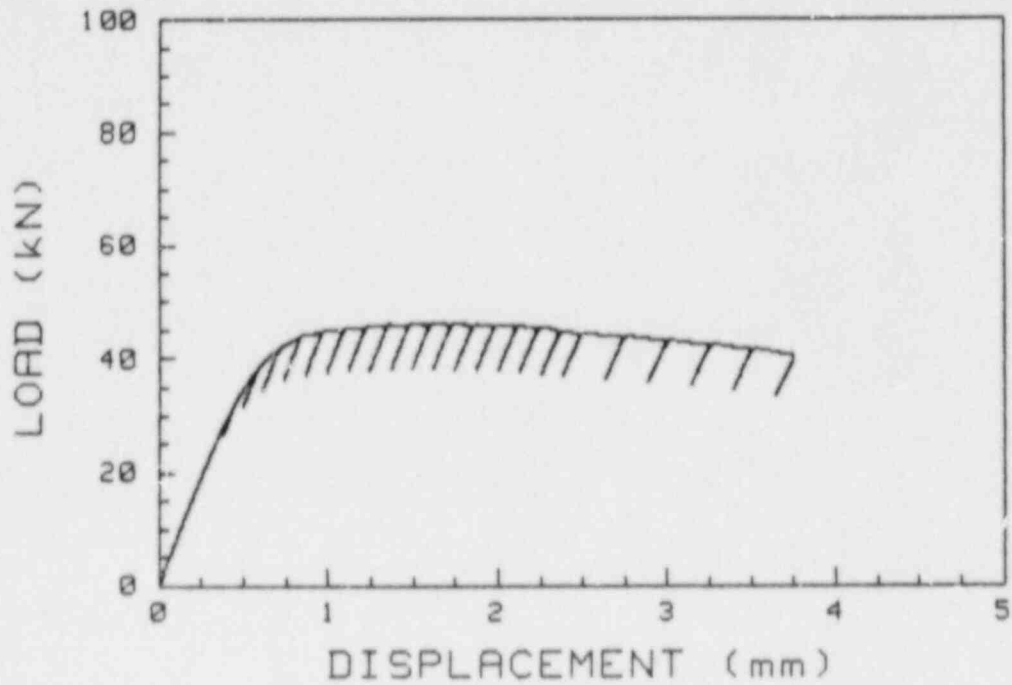
COEFFICIENT= 409.8 kJ/m²
 DELTA-A MAX ALLOWED= 2.03 mm



ORNL-DWG 87-8041

68WKE

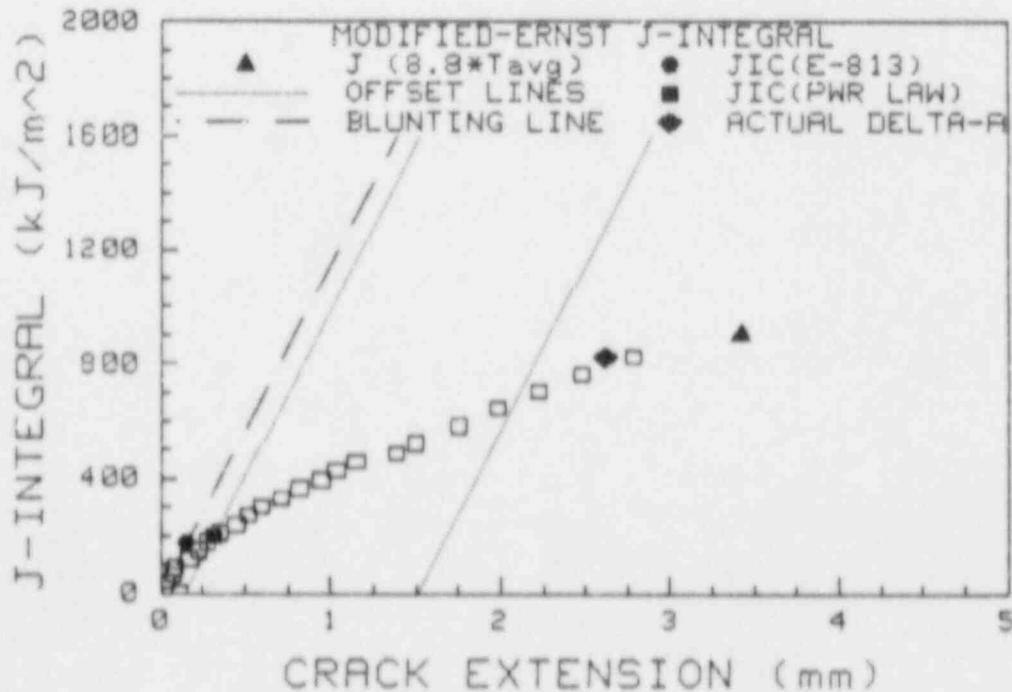
121 DEGREES C



ORNL-DWG 87-8042

68WKE

121 DEGREES C



SPECIMEN ID= 68WLC
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -75 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.3 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 757 MPa
FLOW STRENGTH= 757 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

$a/W)i = .597$

SPECIMEN CLEAVED AT $K = 118.2 \text{ MPa SQR(m)}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 67.9 kJ/m²
KJc= 119.8 MPa SQR(m)
K-beta-c= 96 MPa SQR(m)

VALUES AT CLEAVAGE LOAD

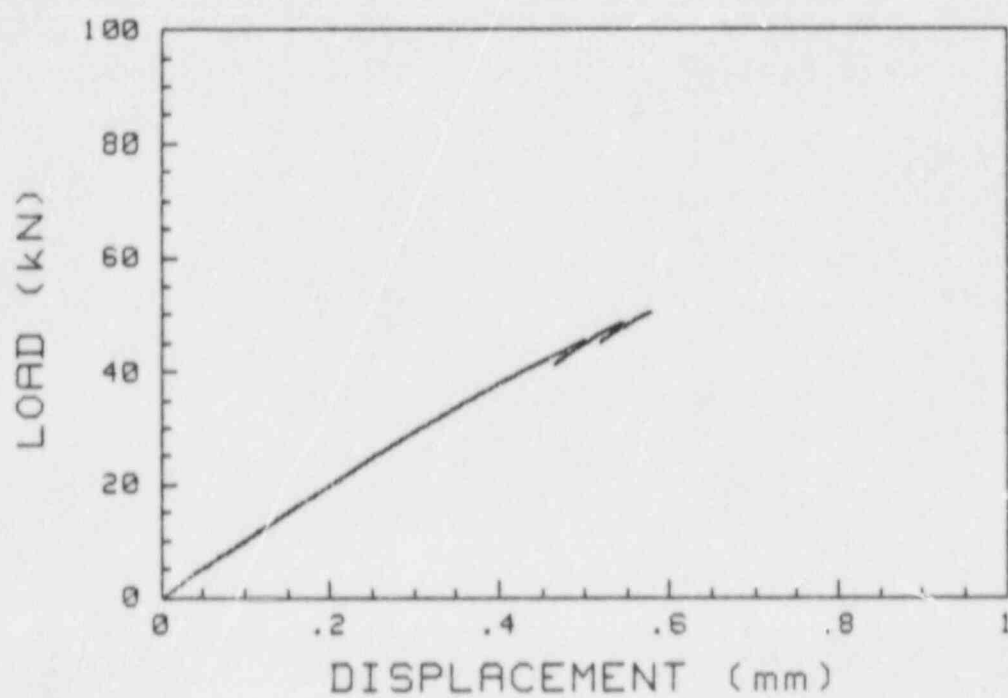
J-INTEGRAL= 67.7 kJ/m²
KJc= 119.6 MPa SQR(m)
K-beta-c= 95.9 MPa SQR(m)



URNL-DWG 87-8043

68WLC

-75 DEGREES C



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

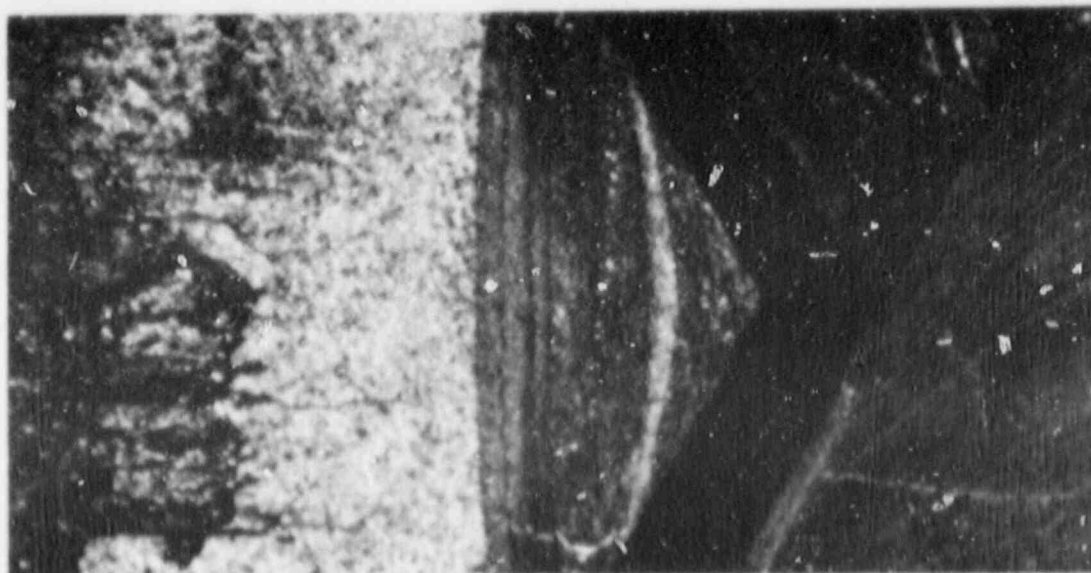
SPECIMEN CLEAVED AT $K_{Ic} = 37.4 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 6.5 kJ/m^2
 $K_{Jc} = 37.4 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 37.2 \text{ MPa SQR[m]}$

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 6.5 kJ/m^2
 $K_{Jc} = 37.4 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 37.2 \text{ MPa SQR[m]}$



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/m²
 KJ-MAX LOAD= 266.8 MPa SQR[m]

POWER LAW PROCEDURE

J_{Ic}= 206.4 kJ/m²
 K-J_{Ic}= 205.9 MPa SQR[m]
 POWER= .6942
 COEFFICIENT= 456 kJ/m²
 T (AVERAGE)= 168

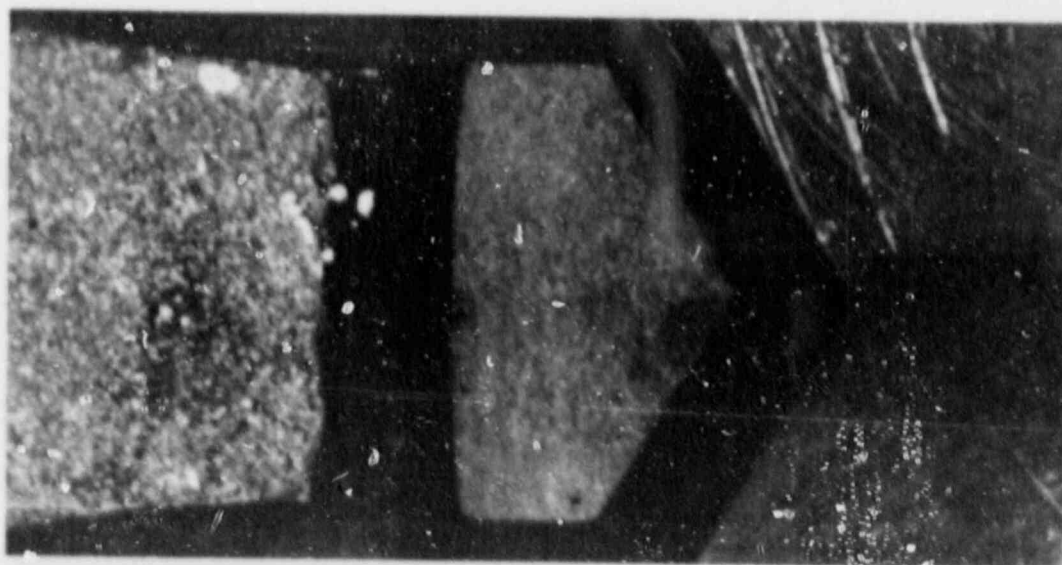
ASTM LINEAR PROCEDURE

J_{Ic}= 178.3 kJ/m²
 K-J_{Ic}= 191.3 MPa SQR[m]
 SLOPE= 310973 kJ/m³
 INTERCEPT= 132.8 kJ/m²
 T (ASTM)= 172
 VALID, E813

JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 1113.1 kJ/m²
 POWER= .7141
 J-MAX ALLOWED= 611 kJ/m²
 RCURVE INVALID, 3

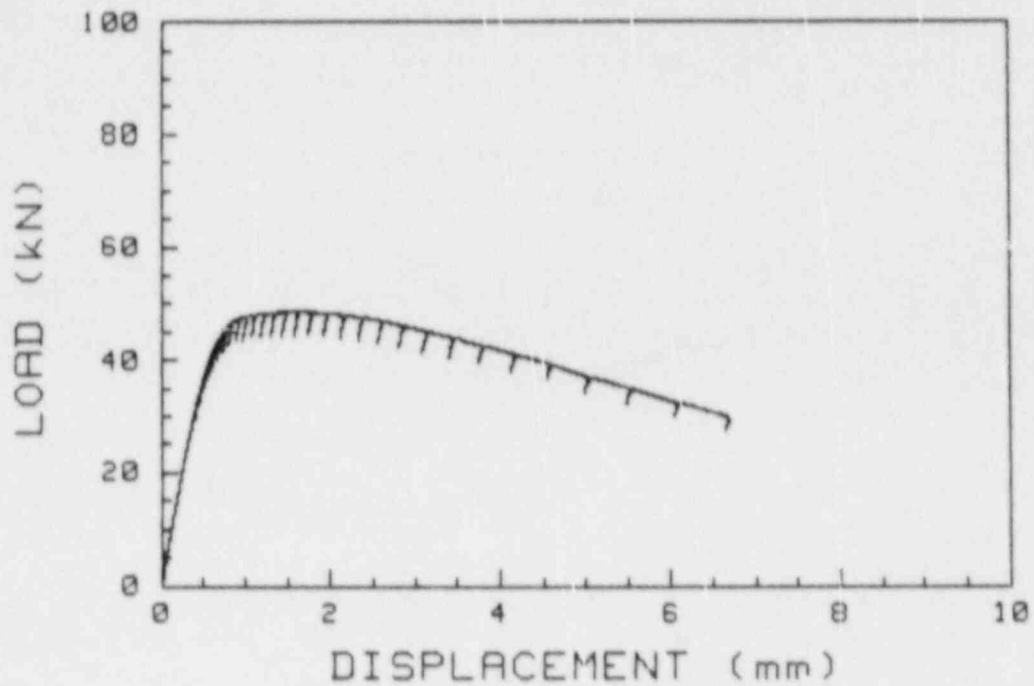
COEFFICIENT= 458.1 kJ/m²
 DELTA-A MAX ALLOWED= 2 mm



ORNL-DWG 87-8044

68WMD

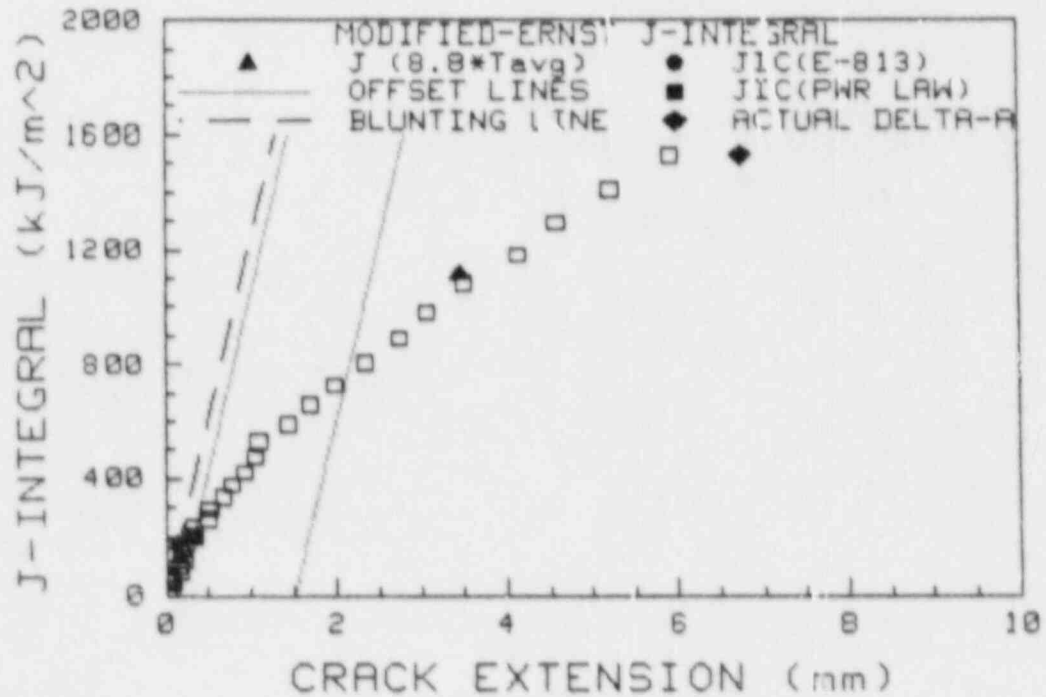
32 DEGREES C



ORNL-DWG 87-8045

68WMD

32 DEGREES C



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/m²
 KJ-MAX LOAD= 202.3 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 150.1 kJ/m²
 K-JIc= 173.4 MPa SQR[m]
 POWER= .4034
 COEFFICIENT= 260.3 kJ/m²
 T (AVERAGE)= 44

ASTM LINEAR PROCEDURE

 JIc= 133.4 kJ/m²
 K-JIc= 163.4 MPa SQR[m]
 SLOPE= 134114 kJ/m³
 INTERCEPT= 120.8 kJ/m²
 T (ASTM)= 53
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 296.7 kJ/m²
 POWER= .4009
 J-MAX ALLOWED= 717 kJ/m²
 RCURVE INVALID, 1 2

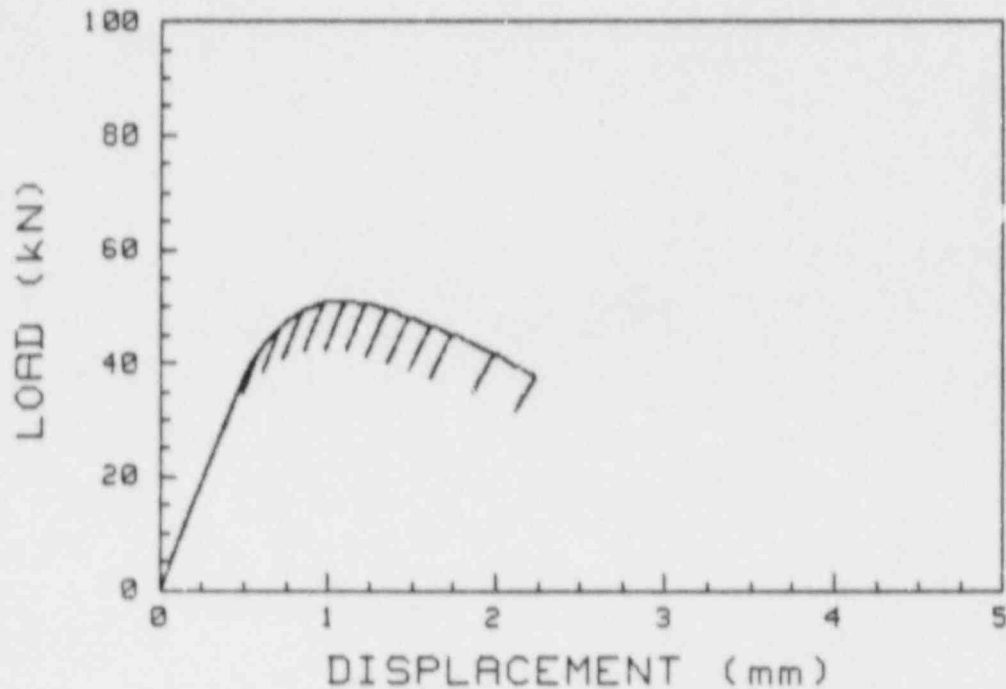
COEFFICIENT= 259.6 kJ/m²
 DELTA-A MAX ALLOWED= 2.02 mm



ORNL-DWG 87-8046

69W102

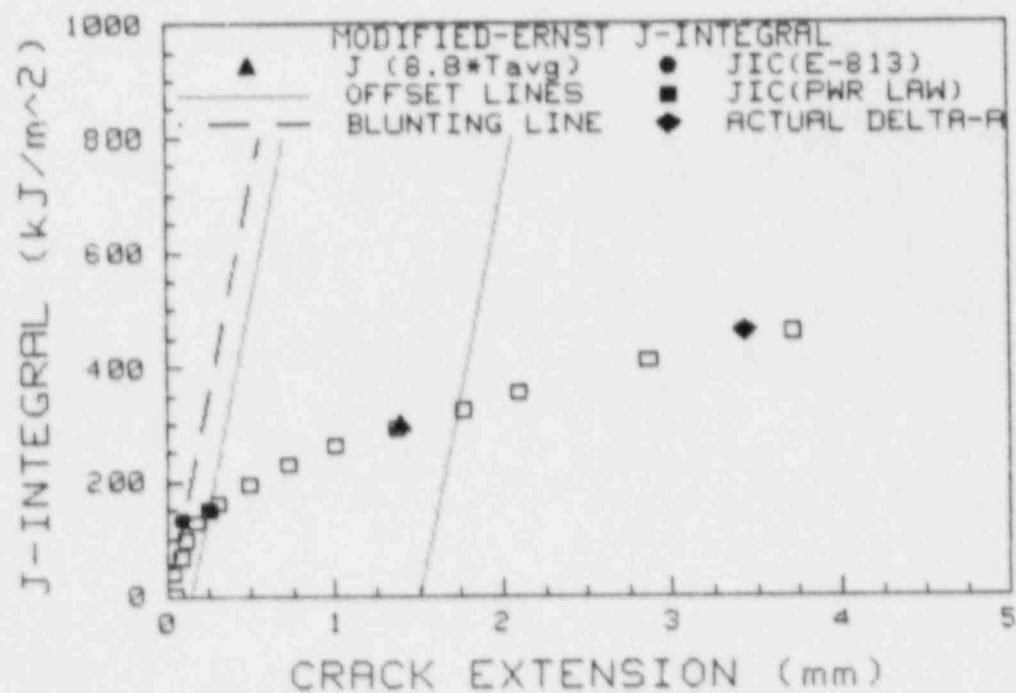
121 DEGREES C



ORNL-DWG 87-8047

69W102

121 DEGREES C



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

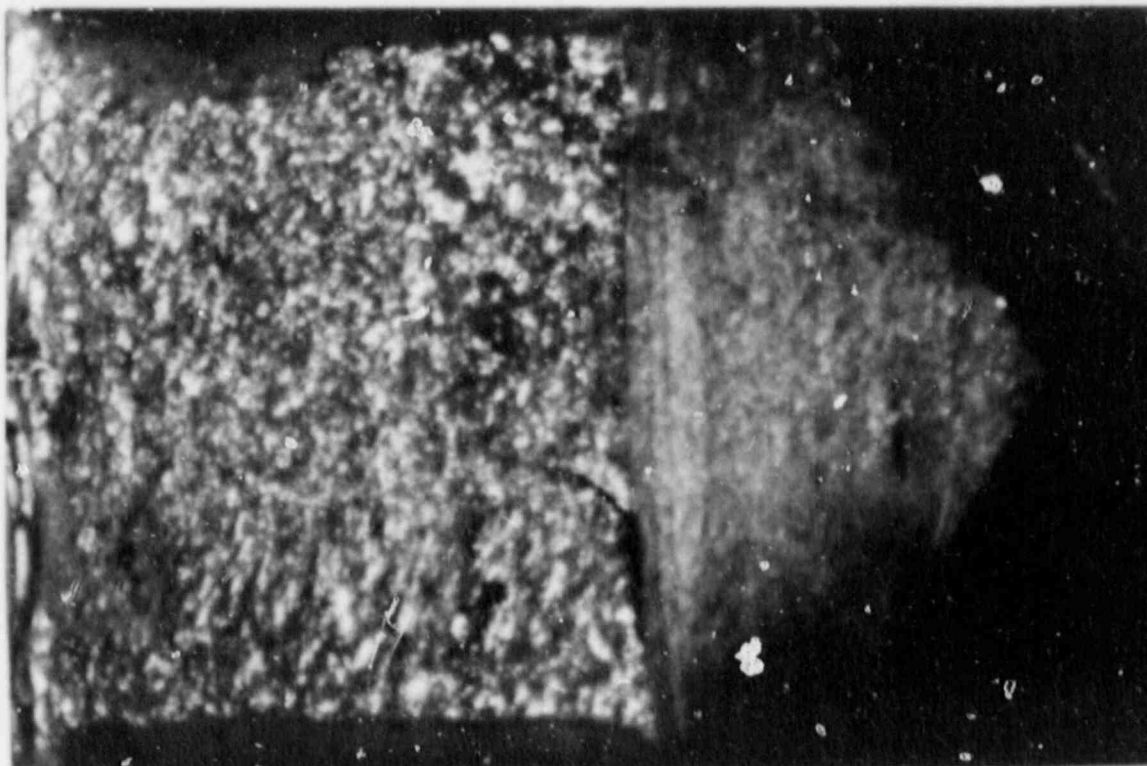
SPECIMEN CLEAVED AT $K = 106.3 \text{ MPa SQR(m)}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 54.3 kJ/m²
 $KJc = 105.7 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 87 \text{ MPa SQR(m)}$

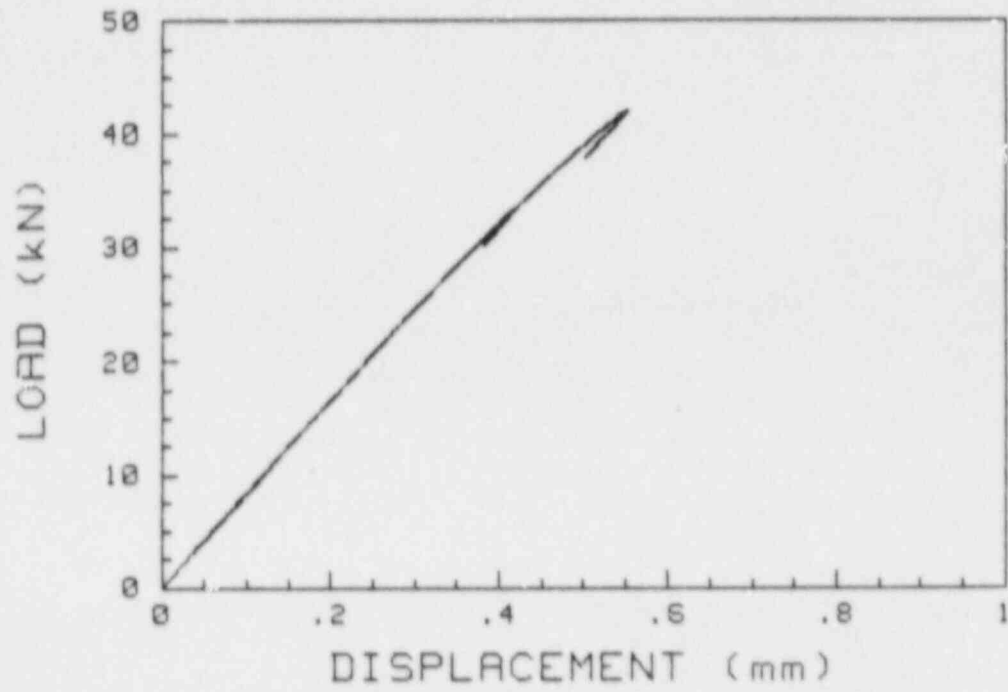
VALUES AT CLEAVAGE LOAD

 J-INTEGRAL= 54.7 kJ/m²
 $KJc = 105.7 \text{ MPa SQR(m)}$
 $K\text{-beta-c} = 87 \text{ MPa SQR(m)}$



69W113

2.9 DEGREES C



SPECIMEN ID= 69W114
 MATERIAL TYPE= A533BW
 TEST TEMPERATURE= 10 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 30.4 mm
 MEASURED DUCTILE DELTA-A= .05 mm
 YIELD STRENGTH= 739 MPa
 FLOW STRENGTH= 768 MPa
 ESTIMATED YOUNG'S MODULUS= 207 GPa

$a/W)i = .598$

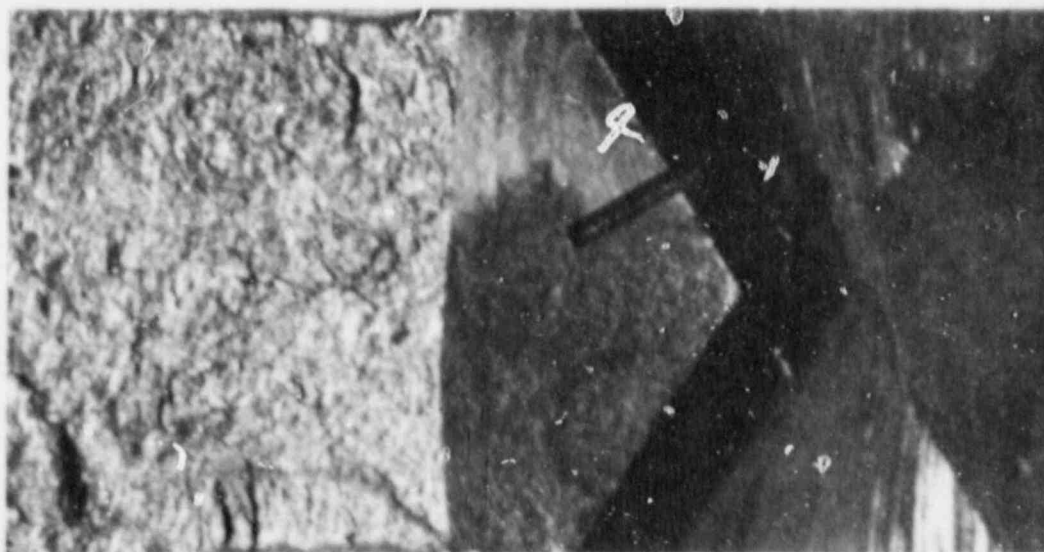
SPECIMEN CLEAVED AT $K = 77.3 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 25 kJ/m^2
 $KJc = 71.9 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 67.1 \text{ MPa SQR[m]}$

VALUES AT CLEAVAGE LOAD

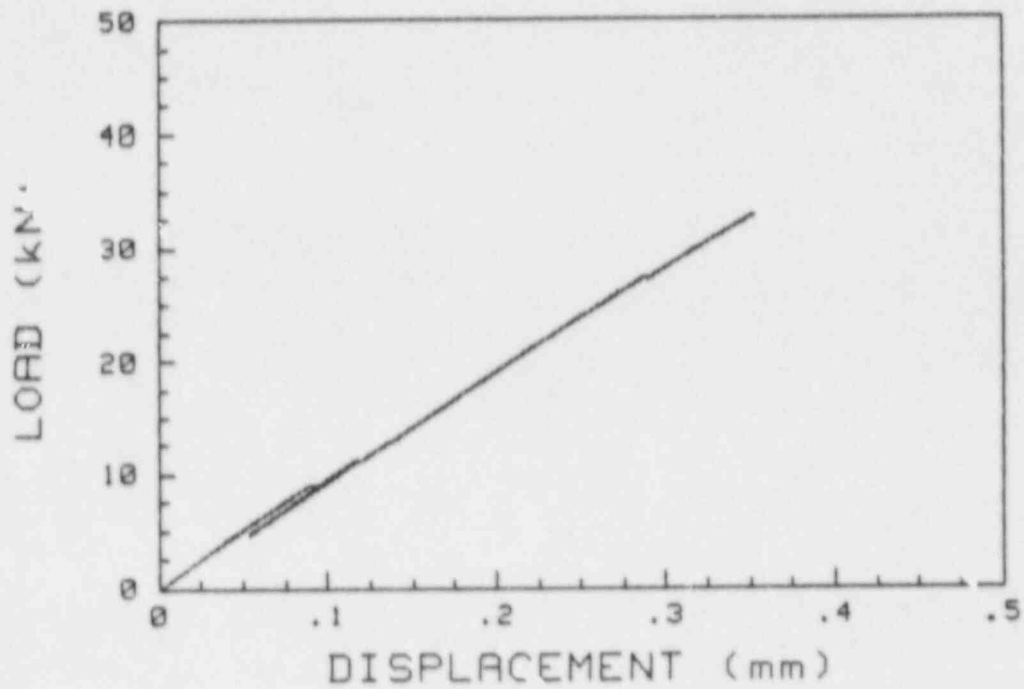
 J-INTEGRAL= 25 kJ/m^2
 $KJc = 71.9 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 67.1 \text{ MPa SQR[m]}$



ORNL-DWG 87-8049

69W114

10 DEGREES C



SPECIMEN ID* 69W116
 TEST TEMPERATURE* 52 DEG C
 THICKNESS* 25.4 mm
 SIDE GROOVES* 0 %
 INITIAL CRACK LENGTH* 29.4 mm a/W1* .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/m²
 KJ-MAX LOAD* 187.2 MPa SQR(m)

POWER LAW PROCEDURE

 J1c* 103.2 kJ/m²
 K-J1c* 145.2 MPa SQR(m)
 POWER* .5673
 COEFFICIENT* 243.7 kJ/m²
 T (AVERAGE)* 55

ASTM LINEAR PROCEDURE

 J1c* 75.2 kJ/m²
 K-J1c* 123.9 MPa SQR(m)
 SLOPE* 182326 kJ/m³
 INTERCEPT* 65.9 kJ/m²
 T (ASTM)* 68
 INVALID, 6

J1-R CURVE CALCULATIONS

 J (@J/T*8.8)* 312.9 kJ/m²
 POWER* .5153
 J-MAX ALLOWED* 786.9 kJ/m²
 RCURVE INVALID, 2.3

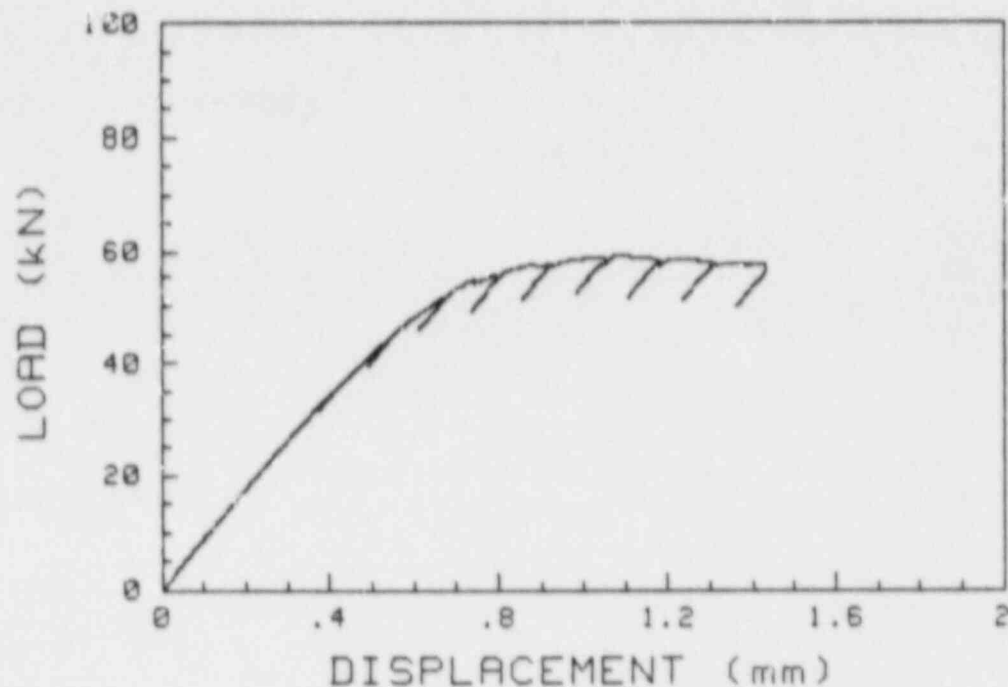
COEFFICIENT* 238.2 kJ/m²
 DELTA-A MAX ALLOWED* 2.13 mm



ORNL-DWG 87-8050

69W116

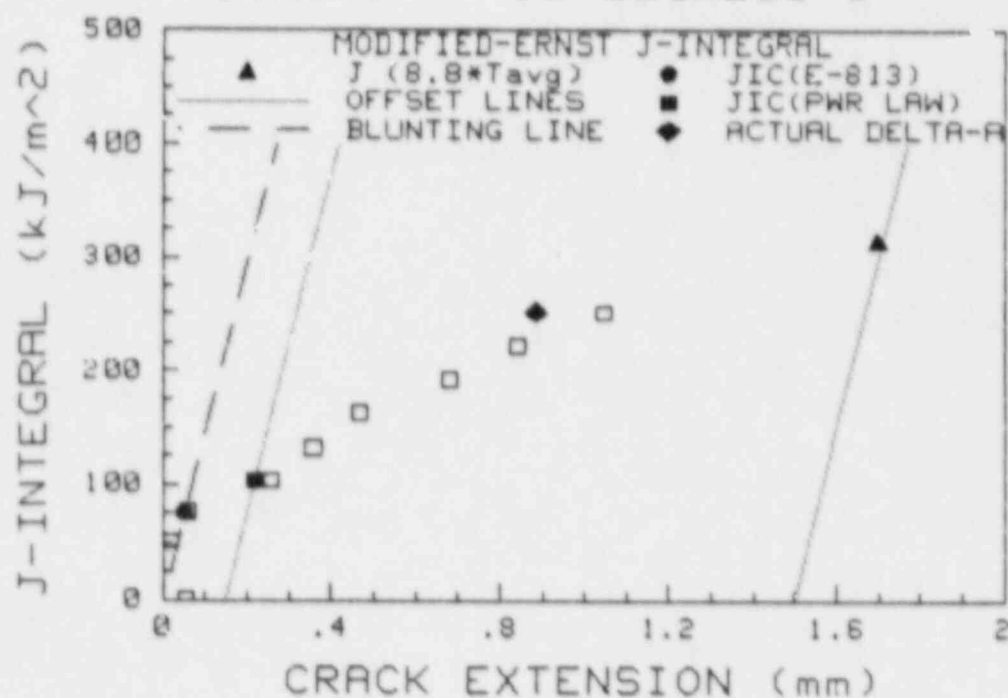
52 DEGREES C



ORNL-DWG 87-8051

69W116

52 DEGREES C



SPECIMEN ID= 69W119
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -35 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.1 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 784 MPa
FLOW STRENGTH= 812 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

$a/W)_i = .593$

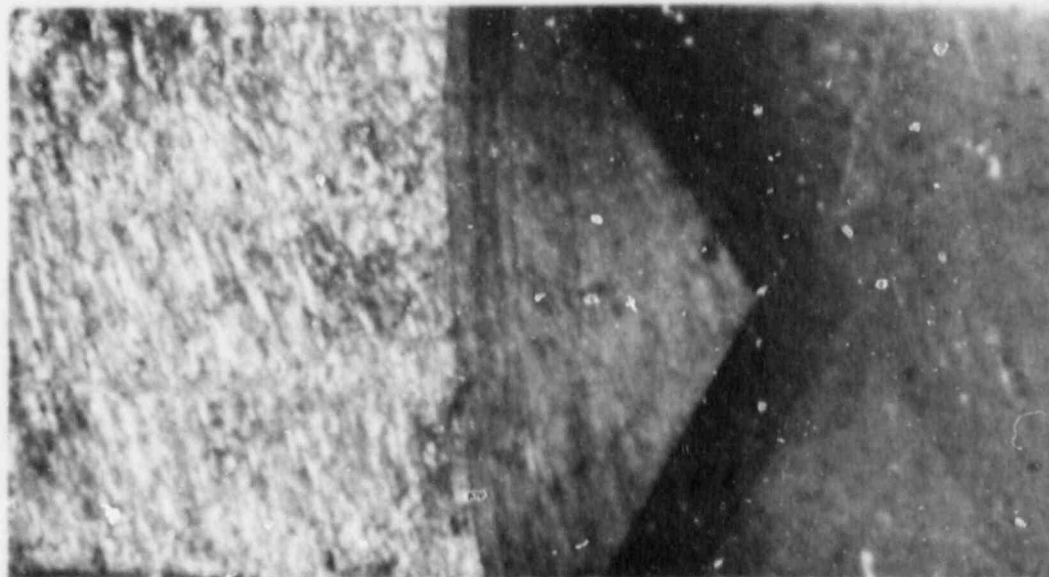
SPECIMEN CLEAVED AT $K_{Ic} = 56.9 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 15.2 kJ/m²
KJc= 56.4 MPa SQR[m]
K-beta-c= 55 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

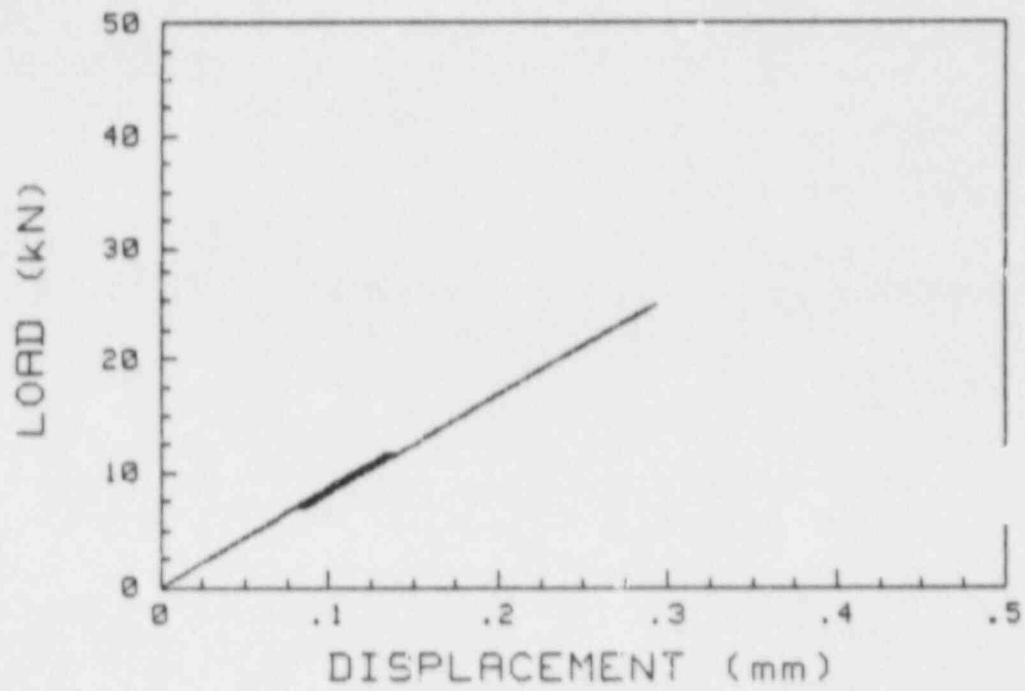
J-INTEGRAL= 15.2 kJ/m²
KJc= 56.4 MPa SQR[m]
K-beta-c= 55 MPa SQR[m]



ORNL-DWG 87-8052

69W119

-35 DEGREES C



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
 YIELD STRENGTH= 739 MPa
 FLOW STRENGTH= 768 MPa
 ESTIMATED YOUNG'S MODULUS= 207 GPa

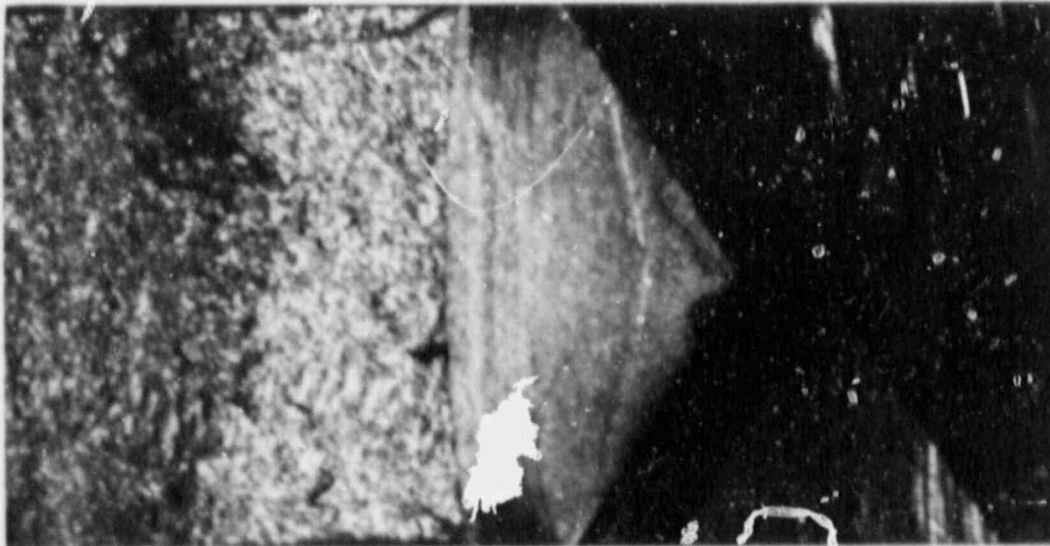
SPECIMEN CLEAVED AT $K = 78.3 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 24.7 kJ/m²
 KJc= 71.4 MPa SQR[m]
 K-beta-c= 66.7 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

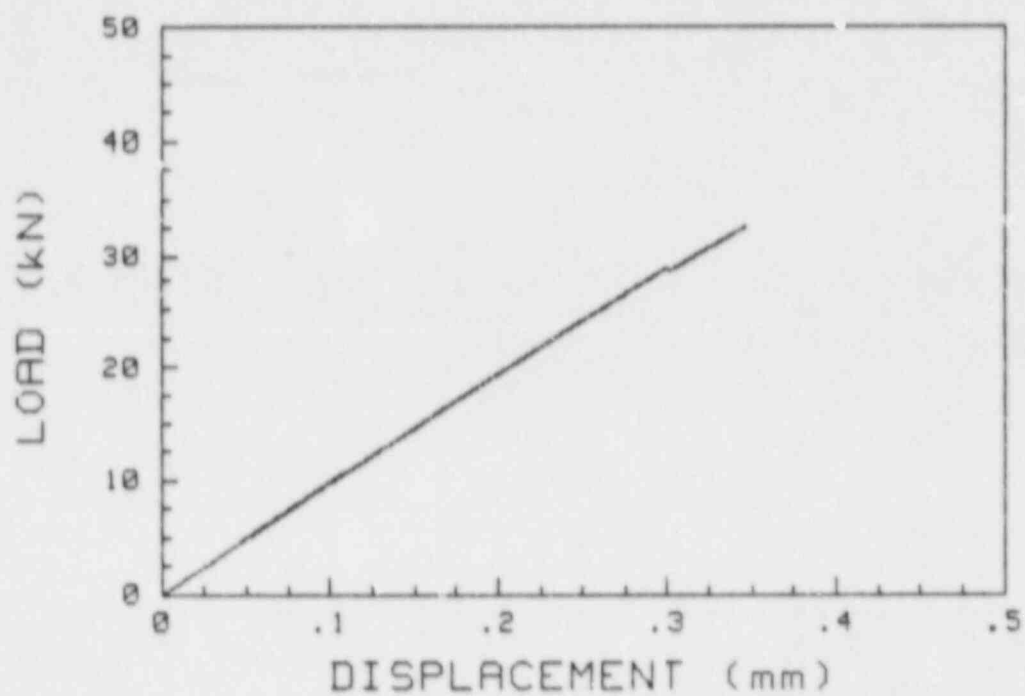
 J-INTEGRAL= 24.7 kJ/m²
 KJc= 71.4 MPa SQR[m]
 K-beta-c= 66.7 MPa SQR[m]



ORNL-DWG 87-8053

69W121

10 DEGREES C



SPECIMEN ID= 69W126
 TEST TEMPERATURE= 121 DEG C
 THICKNESS= 25.5 mm
 SIDE GROOVES= 20 %
 INITIAL CRACK LENGTH= 30.3 mm $a/W)_1 = .597$
 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/m²
 KJ-MAX LOAD= 203.1 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 124.3 kJ/m²
 K-JIc= 157.8 MPa SQR[m]
 POWER= .4793
 COEFFICIENT= 247.6 kJ/m²
 T (AVERAGE)= 50

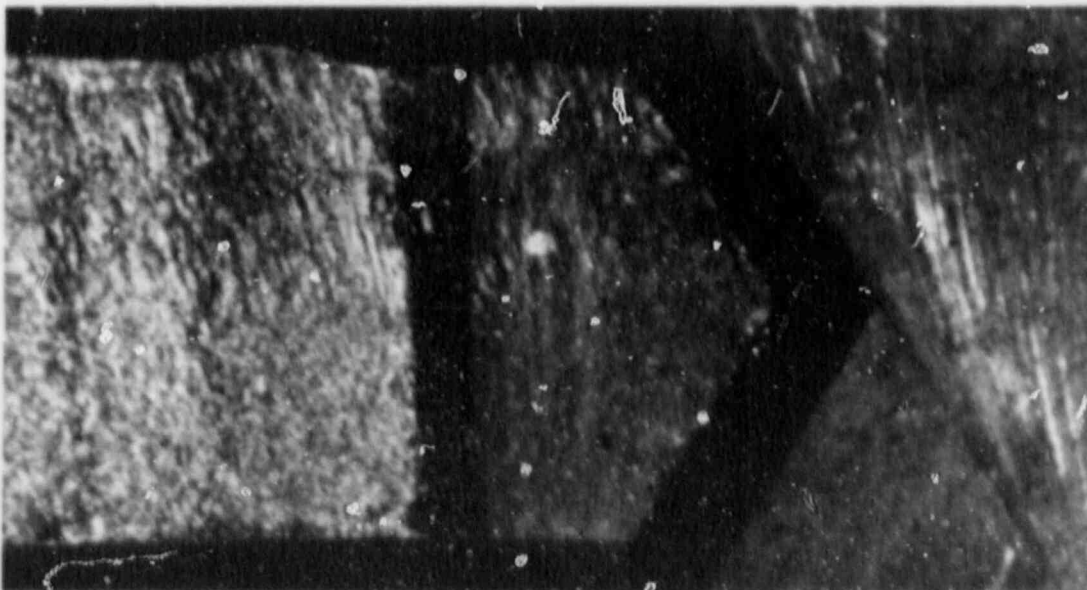
ASTM LINEAR PROCEDURE

 JIc= 105 kJ/m²
 K-JIc= 145 MPa SQR[m]
 SLOPE= 144801 kJ/m³
 INTERCEPT= 94.4 kJ/m²
 T (ASTM)= 57
 VALID, E813

J1-R CURVE CALCULATIONS

 J (@J/T=8.8)= 303.1 kJ/m²
 POWER= .4567
 J-MAX ALLOWED= 724.4 kJ/m²
 RCURVE INVALID, 2

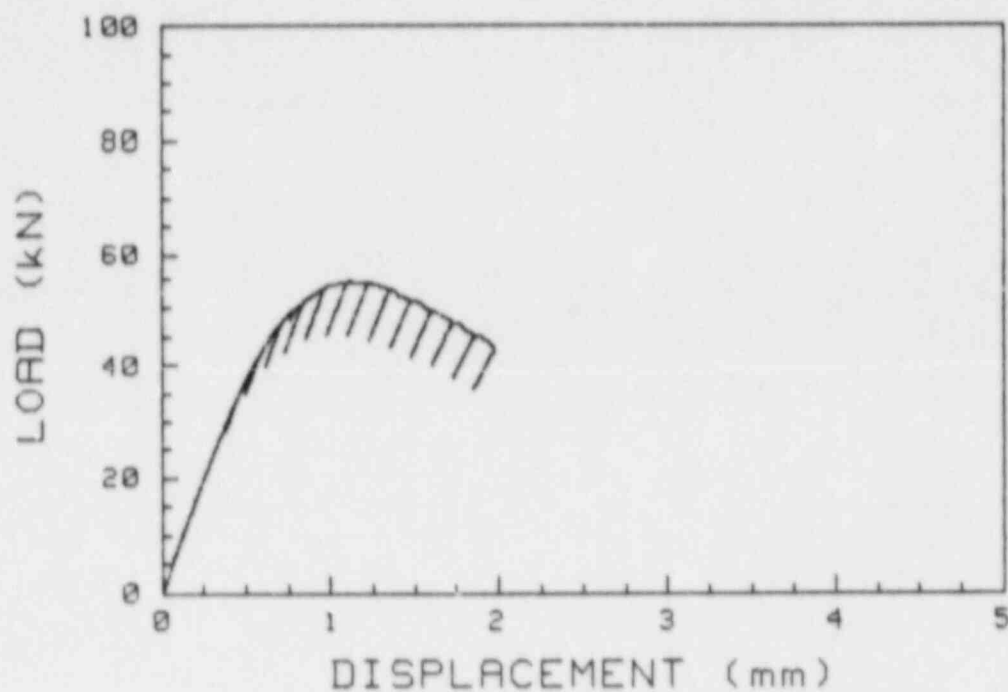
COEFFICIENT= 245.2 kJ/m²
 DELTA-A MAX ALLOWED= 2.05 mm



ORNL-DWG 87-8054

69W126

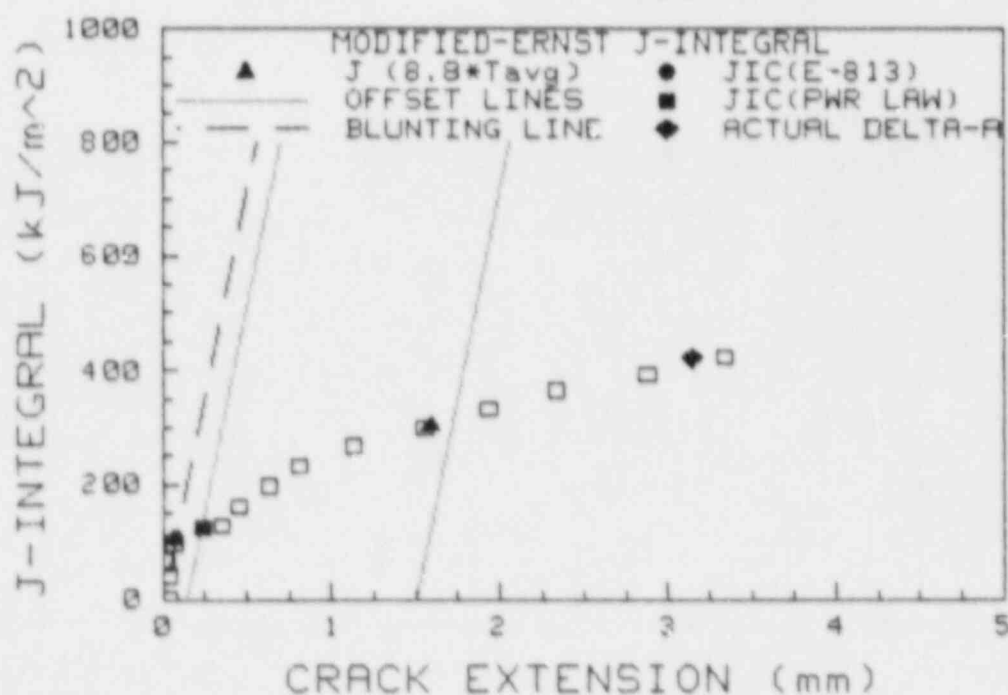
121 DEGREES C



ORNL-DWG 87-8055

69W126

121 DEGREES C



SPECIMEN ID= 69W142
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -36 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.1 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 785 MPa
FLOW STRENGTH= 813 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

$a/W)i = .594$

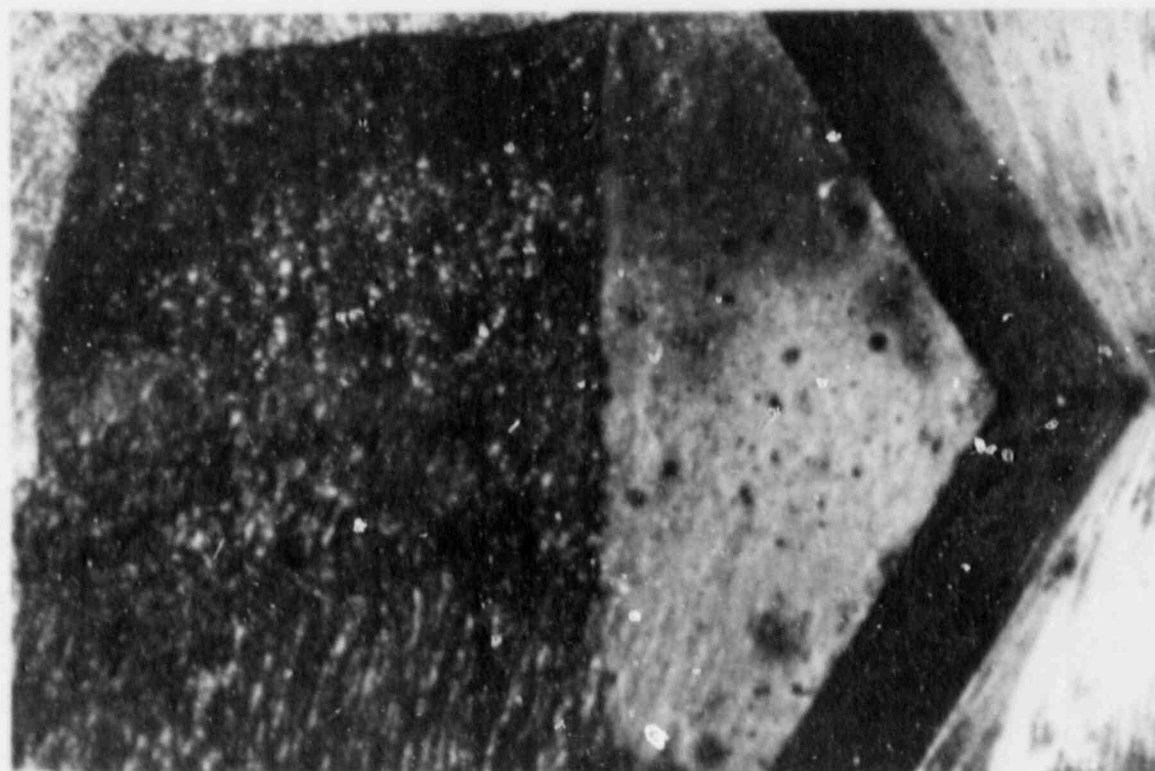
SPECIMEN CLEAVED AT $K_{Ic} = 55 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 12.9 kJ/m²
KJc= 52 MPa SQR[m]
K-beta-c= 51.1 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

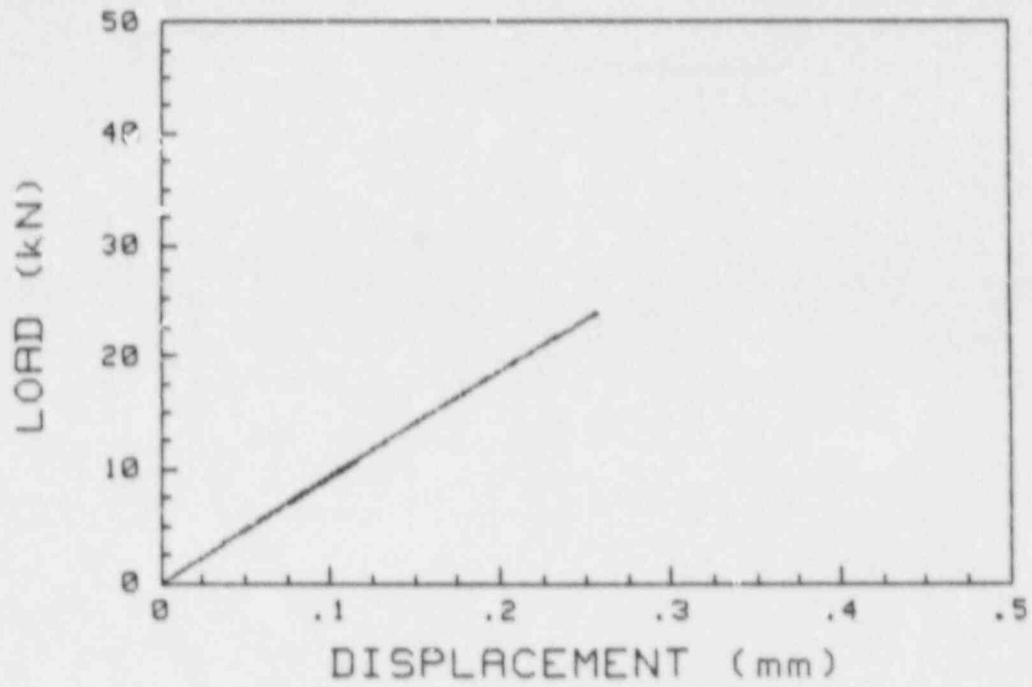
J-INTEGRAL= 12.9 kJ/m²
KJc= 52 MPa SQR[m]
K-beta-c= 51.1 MPa SQR[m]



ORNL-DWG 87-8056

69W142

-36 DEGREES C



SPECIMEN ID= 69W143
MATERIAL TYPE= A533BW
TEST TEMPERATURE= 50 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.3 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 703 MPa
FLOW STRENGTH= 739 MPa
ESTIMATED YOUNG'S MODULUS= 204 GPa

$a/W)i = .597$

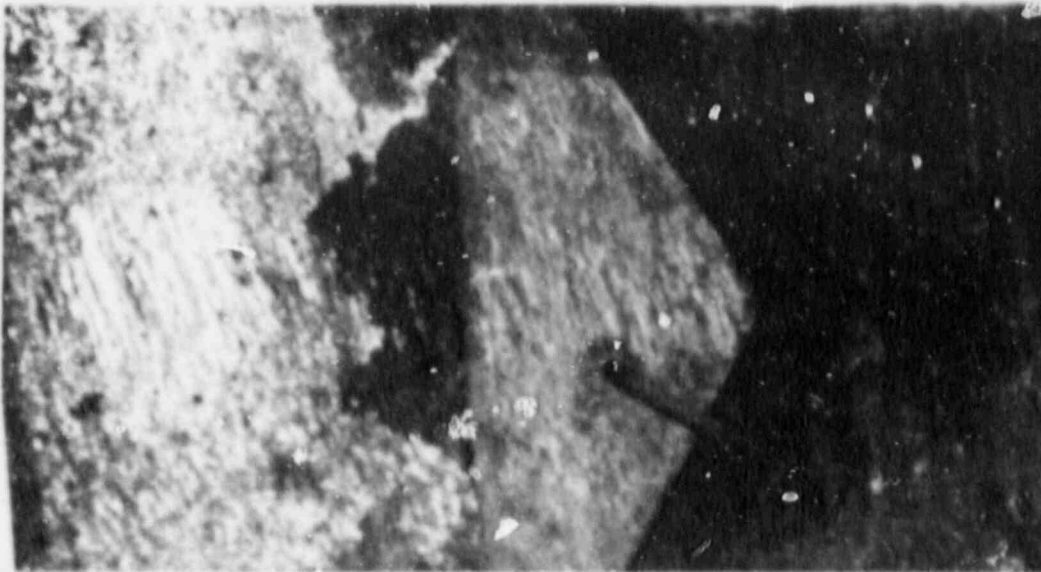
SPECIMEN CLEAVED AT $K = 112.6 \text{ MPa SQR}(m)$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 68.5 kJ/m^2
 $KJc = 118.3 \text{ MPa SQR}(m)$
 $K\text{-beta-c} = 92.3 \text{ MPa SQR}(m)$

VALUES AT CLEAVAGE LOAD

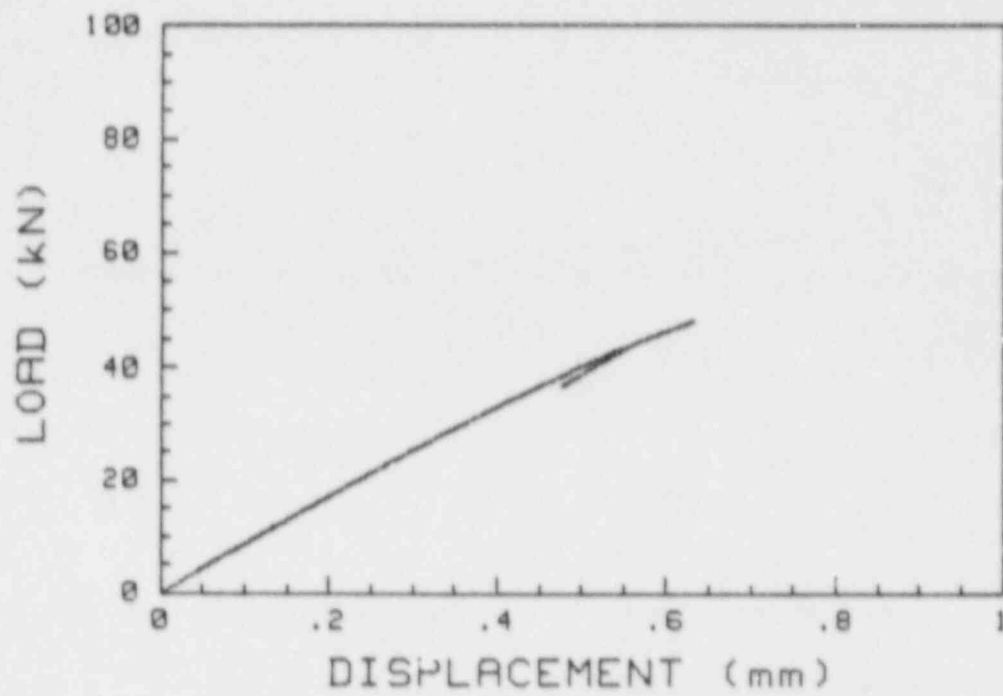
J-INTEGRAL= 68.5 kJ/m^2
 $KJc = 118.3 \text{ MPa SQR}(m)$
 $K\text{-beta-c} = 92.3 \text{ MPa SQR}(m)$



ORNL-DWG 87-8057

69W143

50 DEGREES C



SPECIMEN ID* 69W144
 TEST TEMPERATURE* 288 DEG C
 THICKNESS* 25.4 mm
 SIDE GROOVES* 20 %
 INITIAL CRACK LENGTH* 30.9 mm a/W * .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/m²
 KJ-MAX LOAD* 190.9 MPa SQR(m)

POWER LAW PROCEDURE

 JIc* 118.8 kJ/m²
 K-JIc* 150.6 MPa SQR(m)
 POWER* .4537
 COEFFICIENT* 229.5 kJ/m²
 T (AVERAGE)* 43

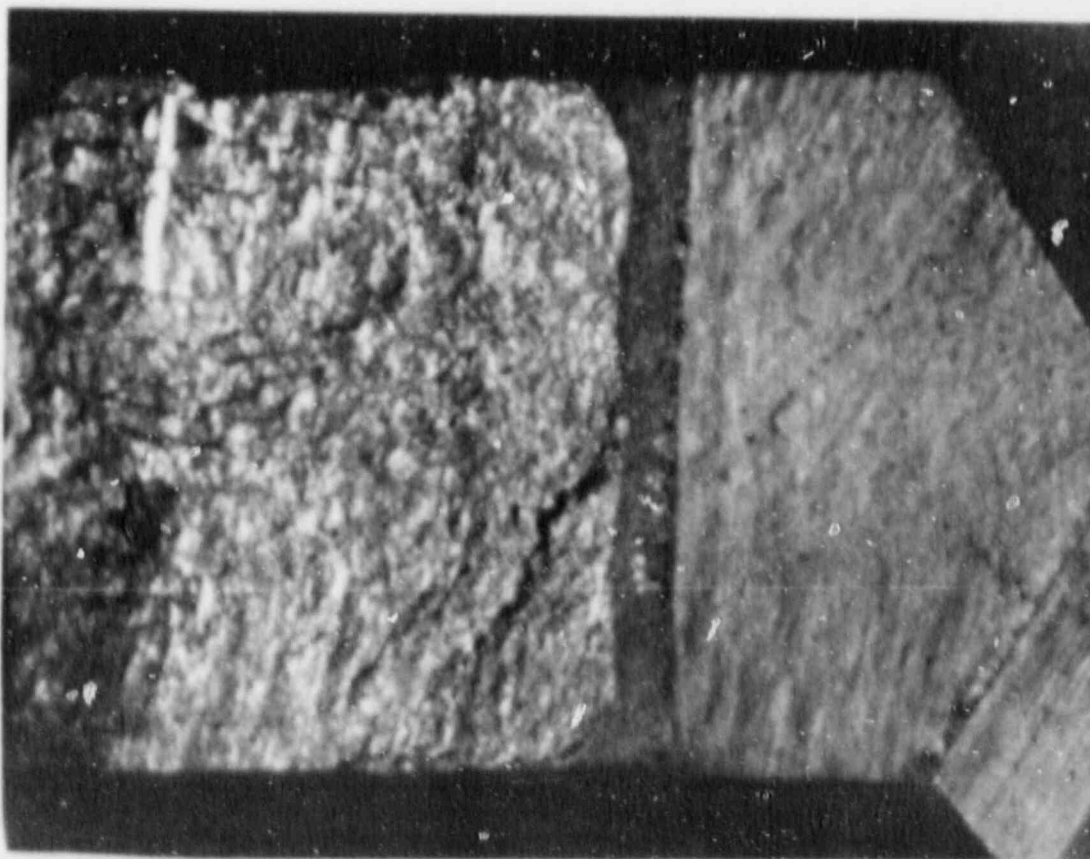
ASTM LINEAR PROCEDURE

 JIc* 97.6 kJ/m²
 K-JIc* 136.4 MPa SQR(m)
 SLOPE* 131858 kJ/m³
 INTERCEPT* 88.4 kJ/m²
 T (ASTM)* 51
 VALID, E813

J1-R CURVE CALCULATIONS

 J (WJ/T*8.8)* 297.4 kJ/m²
 POWER* .4973
 J-MAX ALLOWED* 701.9 kJ/m²
 RCURVE INVALID, 2

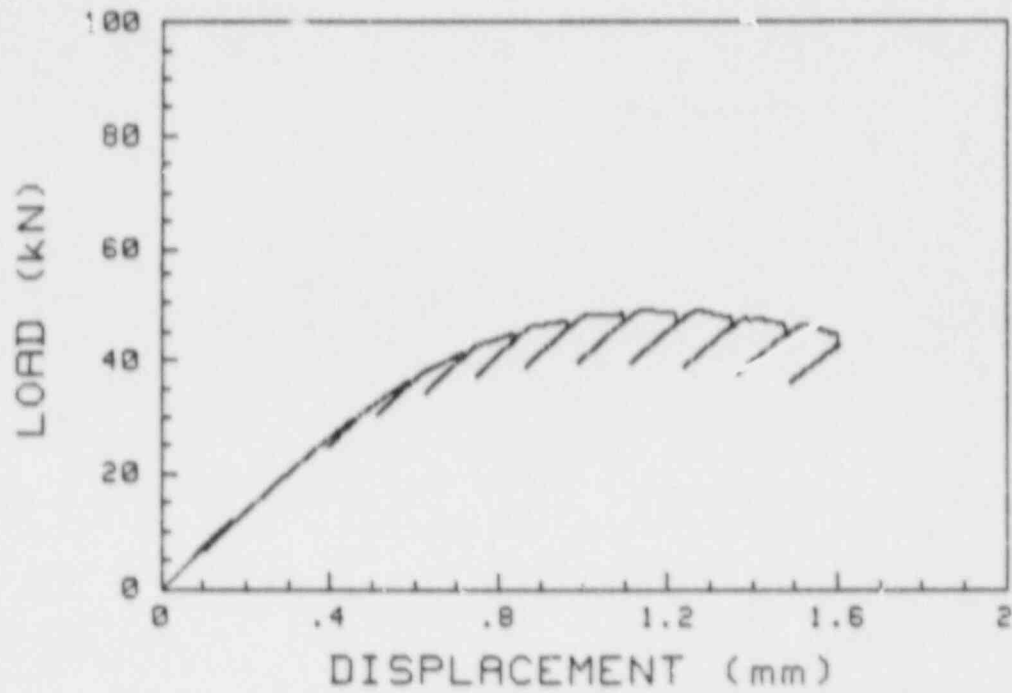
COEFFICIENT* 229.6 kJ/m²
 DELTA-A MAX ALLOWED* 1.99 mm



ORNL-DWG 87-8058

69W144

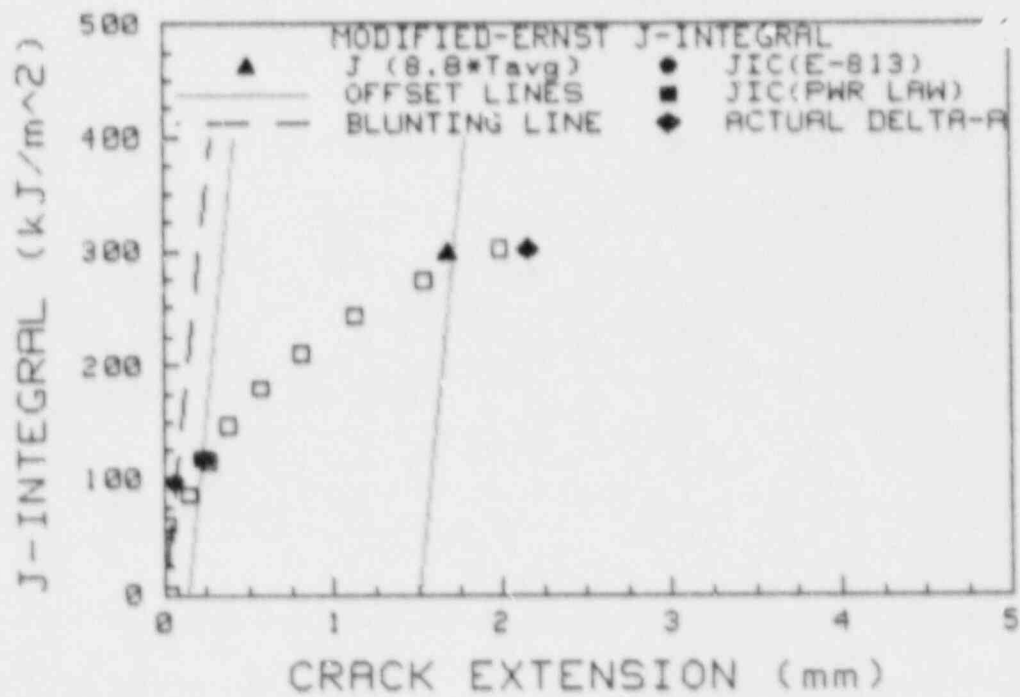
288 DEGREES C



ORNL-DWG 87-8059

69W144

288 DEGREES C



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 $K_{Ic} = 69.8 \text{ MPa SQR(m)}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 24.1 kJ/m²
KJc= 71.1 MPa SQR(m)
K-beta-c= 67.2 MPa SQR(m)

VALUES AT CLEAVAGE LOAD

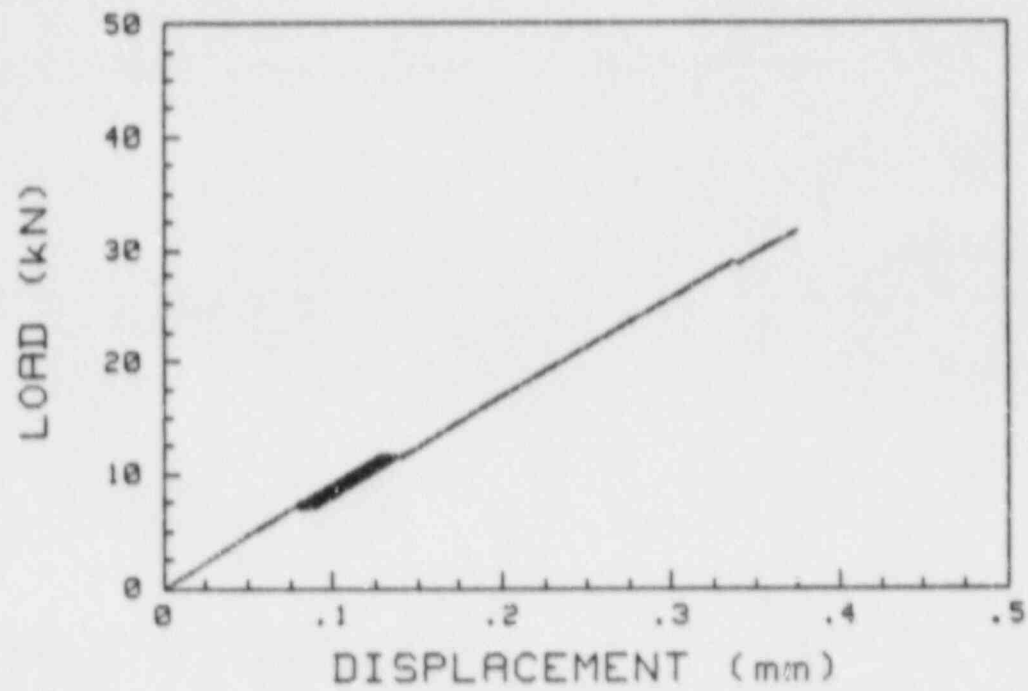
J-INTEGRAL= 24.1 kJ/m²
KJc= 71.1 MPa SQR(m)
K-beta-c= 67.2 MPa SQR(m)



ORNL-DWG 87-8060

69W149

-35 DEGREES C



SPECIMEN ID* 69W193
 TEST TEMPERATURE* 204 DEG C
 THICKNESS* 25.4 mm
 SIDE GROOVES* 20 %
 INITIAL CRACK LENGTH* 30.8 mm a/W_1 * .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/m²
 KJ-MAX LOAD* 195.7 MPa SQR(m)

POWER LAW PROCEDURE

J1c* 156.8 kJ/m²
 K-J1c* 175.1 MPa SQR(m)
 POWER* .4002
 COEFFICIENT* 267.9 kJ/m²
 T (AVERAGE)* 46

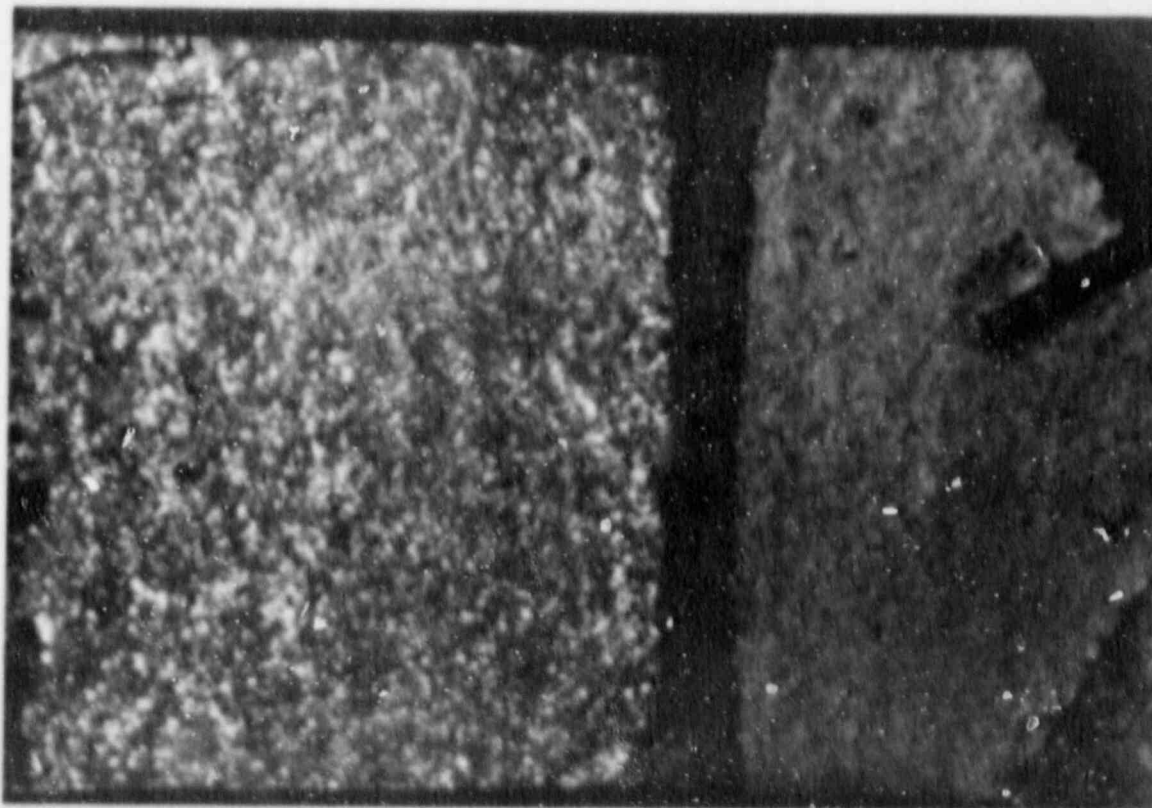
ASTM LINEAR PROCEDURE

J1c* 134.4 kJ/m²
 K-J1c* 162.1 MPa SQR(m)
 SLOPE* 138378 kJ/m³
 INTERCEPT* 121.1 kJ/m²
 T (ASTM)* 56
 VALID, E813

J1-R CURVE CALCULATIONS

J (WJ/T=8.8)* 296.2 kJ/m²
 POWER* .3772
 J-MAX ALLOWED* 698.2 kJ/m²
 RCURVE INVALID, 2

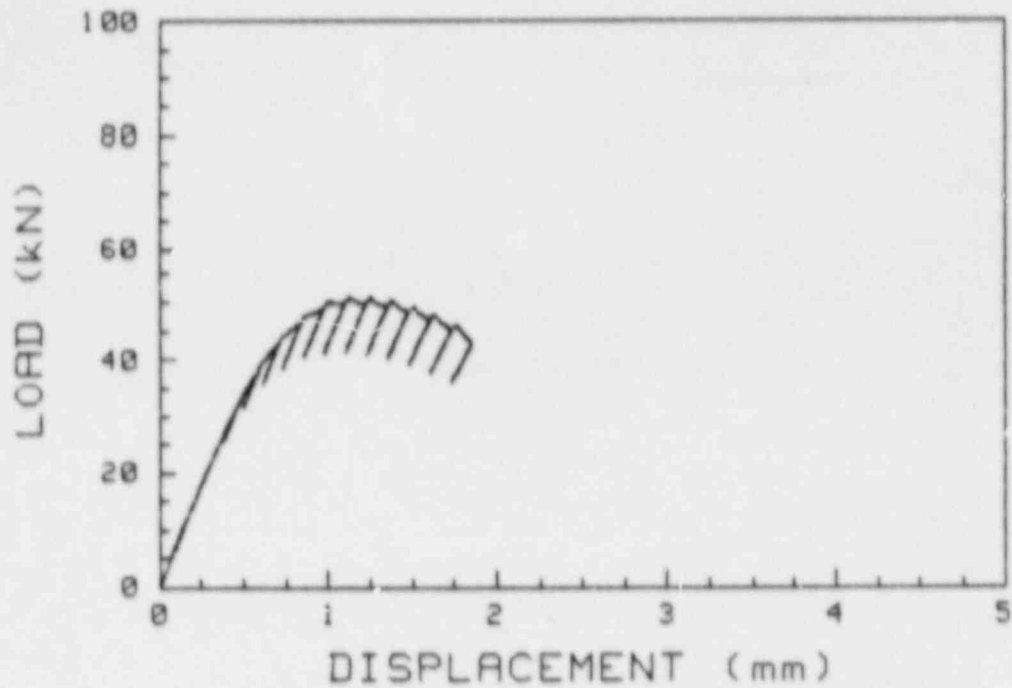
COEFFICIENT* 265.8 kJ/m²
 DELTA-A MAX ALLOWED* 2 mm



ORNL-DWG 87-8061

69W153

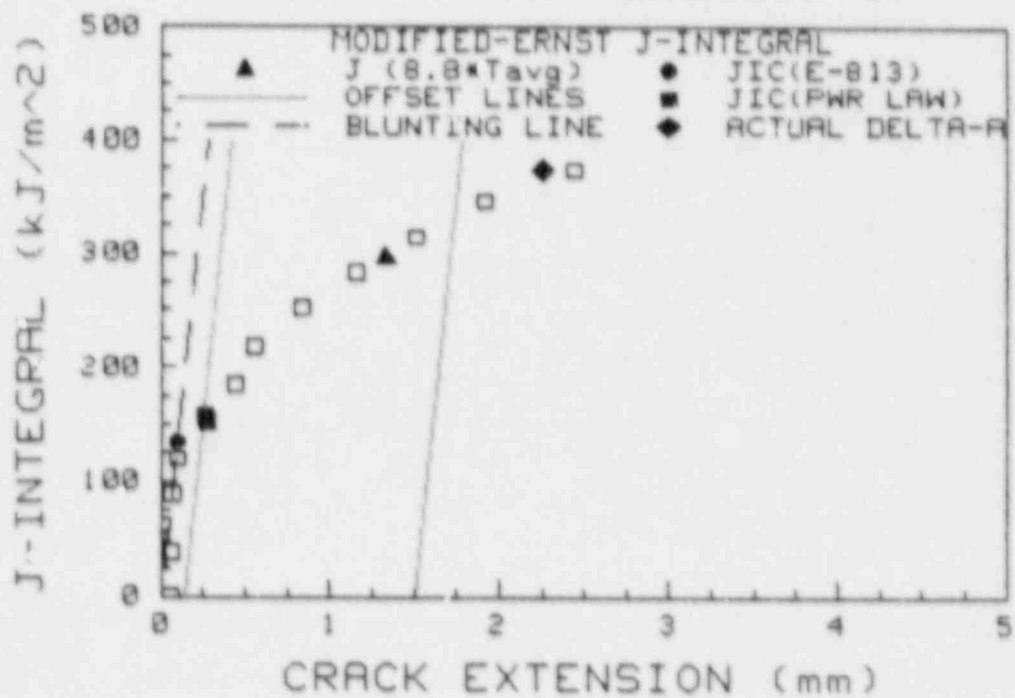
204 DEGREES C



ORNL-DWG 87-8062

69W153

204 DEGREES C



SPECIMEN ID* 69W160
 TEST TEMPERATURE* 204 DEG C
 THICKNESS* 25.5 mm
 SIDE GROOVES* 20 %
 INITIAL CRACK LENGTH* 30.5 mm a/W11* .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/m²
 KJ-MAX LOAD* 195.2 MPa SQR(m)

POWER LAW PROCEDURE

 J1c* 125.9 kJ/m²
 K-J1c* 156.9 MPa SQR(m)
 POWER* .4538
 COEFFICIENT* 240.5 kJ/m²
 T (AVERAGE)* 47

ASTM LINEAR PROCEDURE

 J1c* 112.8 kJ/m²
 K-J1c* 148.5 MPa SQR(m)
 SLOPE* 134036 kJ/m³
 INTERCZPT* 102 kJ/m²
 T (ASTM)* 54
 VALID, E813

J1-R CURVE CALCULATIONS

 J (B/T*8.811) 298.1 kJ/m²
 POWER* .4537
 J-MAX ALLOWED* 705.7 kJ/m²
 RCURVE INVALID, 2

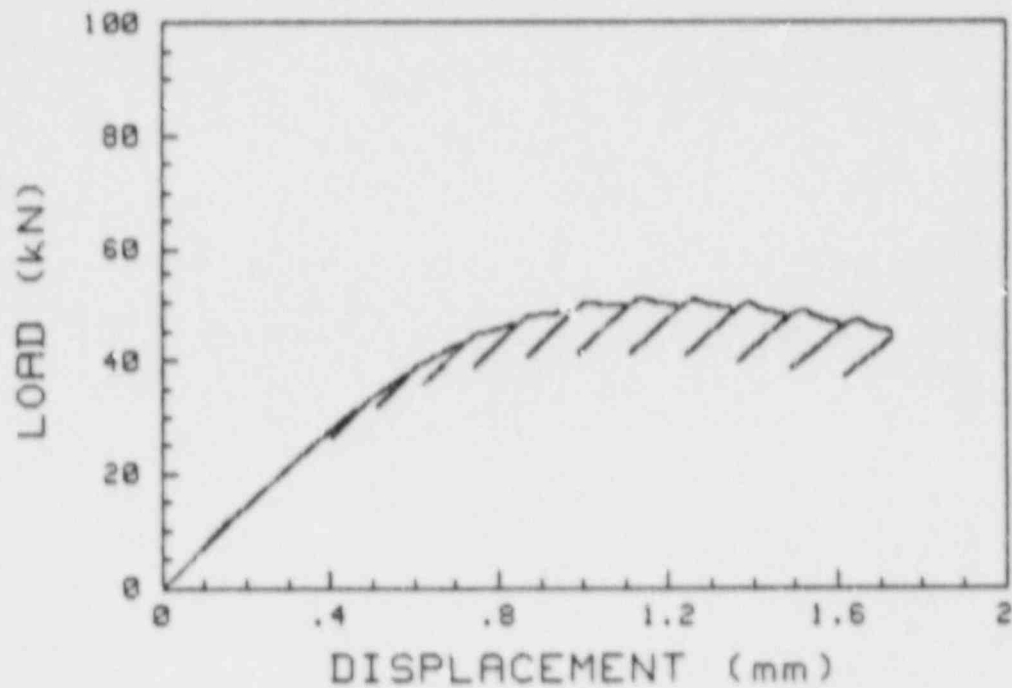
COEFFICIENT* 240.6 kJ/m²
 DELTA-A MAX ALLOWED* 2.02 mm



ORNL-DWG 87-8063

69W160

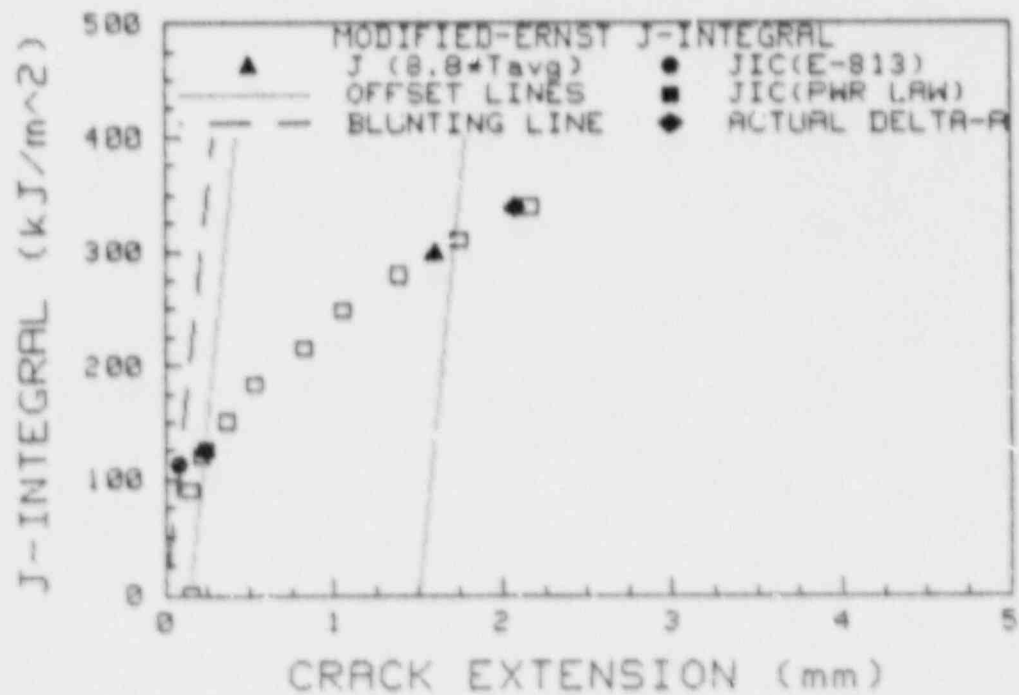
204 DEGREES C



ORNL-DWG 87-8064

69W160

204 DEGREES C



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/m²
 KJ-MAX LOAD= 197.7 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 94.1 kJ/m²
 K-JIc= 138.7 MPa SQR[m]
 POWER= .6252
 COEFFICIENT= 247 kJ/m²
 T (AVERAGE)= 61

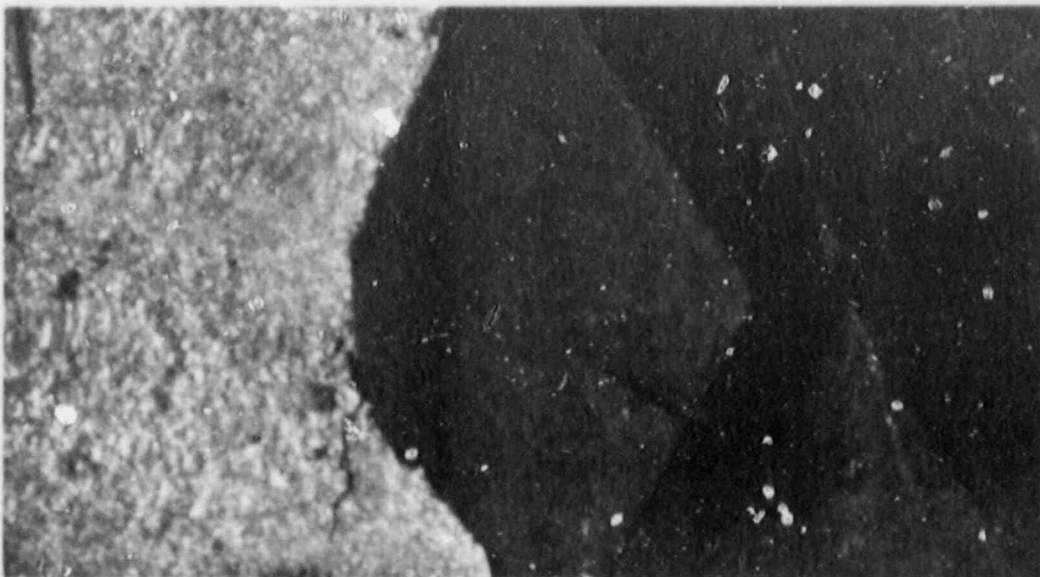
ASTM LINEAR PROCEDURE

 JIc= 74.5 J/m²
 K-JIc= 123.4 MPa SQR[m]
 SLOPE= 174054 kJ/m³
 INTERCEPT= 65.7 kJ/m²
 T (ASTM)= 65
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 411.6 kJ/m²
 POWER= .6547
 J-MAX ALLOWED= 767.3 kJ/m²
 RCURVE INVALID, 2

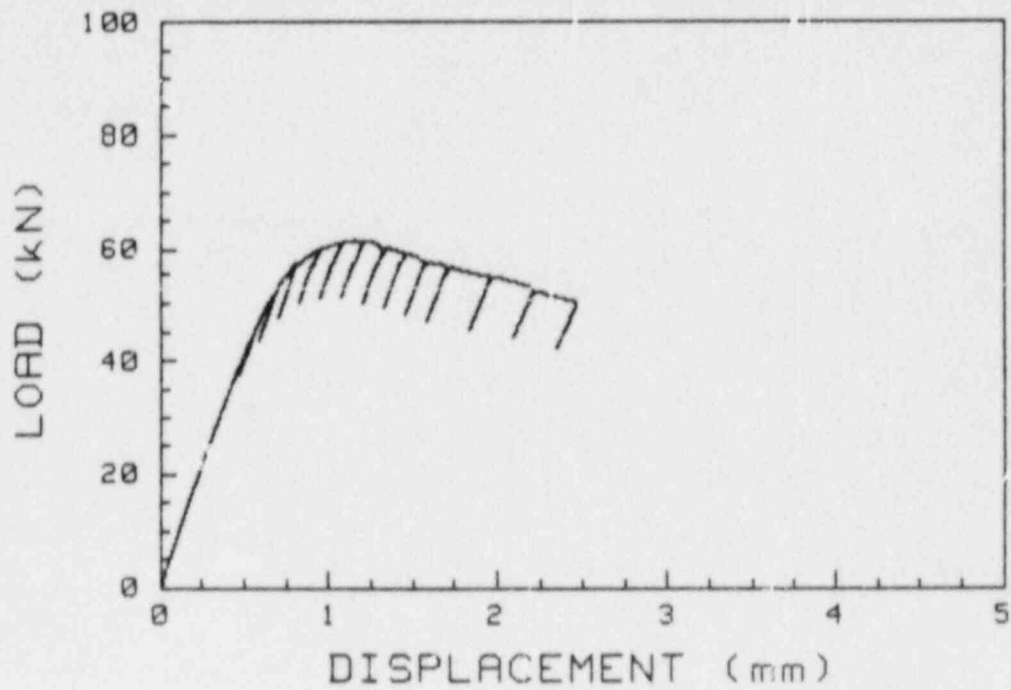
COEFFICIENT= 249.1 kJ/m²
 DELTA-A MAX ALLOWED= 2.08 mm



ORNL-DWG 87-8065

69W165

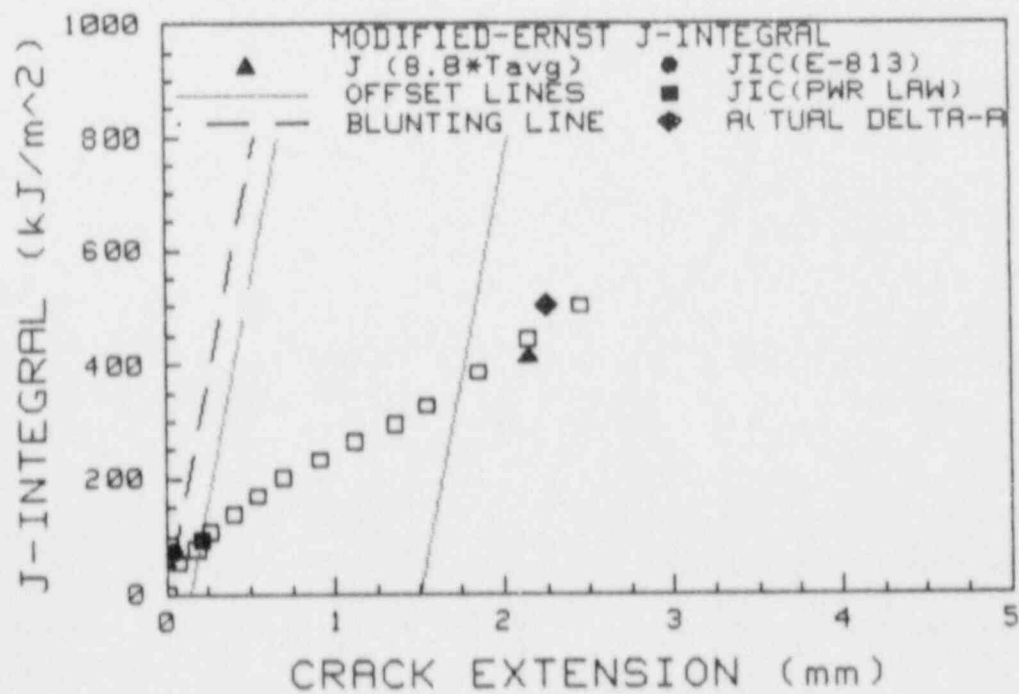
50 DEGREES C



ORNL-DWG 87-8066

69W165

50 DEGREES C



SPECIMEN ID= 69W167
 TEST TEMPERATURE= 288 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 20 %
 INITIAL CRACK LENGTH= 30.6 mm $a/W = .602$
 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/m²
 KJ-MAX LOAD= 190.7 MPa SQR(m)

POWER LAW PROCEDURE

 JIc= 148 kJ/m²
 K-JIc= 168 MPa SQR(m)
 POWER= .3378
 COEFFICIENT= 234.8 kJ/m²
 T (AVERAGE)= 33

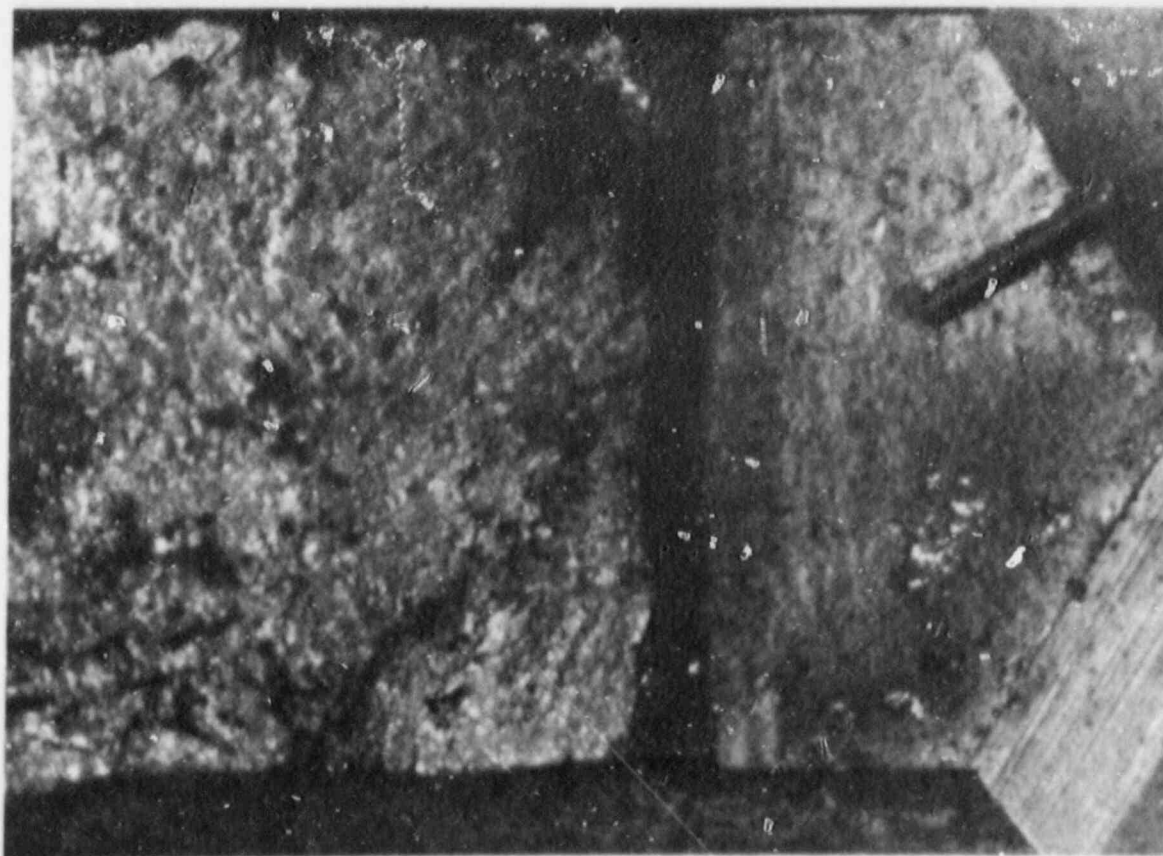
ASTM LINEAR PROCEDURE

 JIc= 132 kJ/m²
 K-JIc= 158.7 MPa SQR(m)
 SLOPE= 104737 kJ/m³
 INTERCEPT= 122.2 kJ/m²
 T (ASTM)= 40
 VALID, E813

J1-R CURVE CALCULATIONS

 J (@J/T=8.8)= 238.1 kJ/m²
 POWER= .303
 J-MAX ALLOWED= 712.1 kJ/m²
 RCURVE INVALID, 2

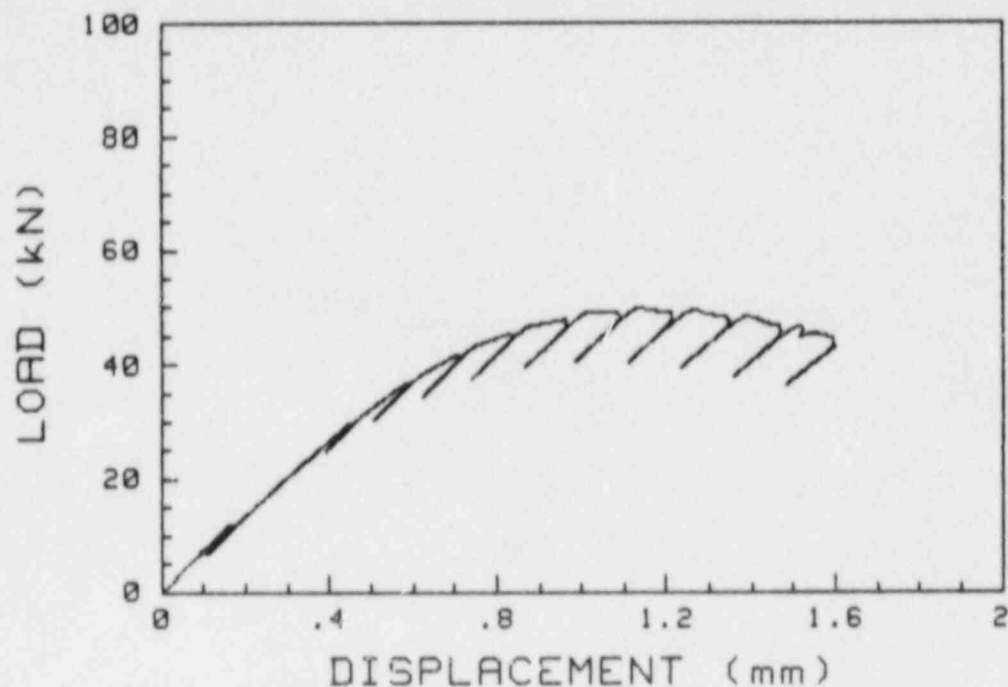
COEFFICIENT= 236.3 kJ/m²
 DELTA-A MAX ALLOWED= 2.02 mm



ORNL-DWG 87-8067

69W167

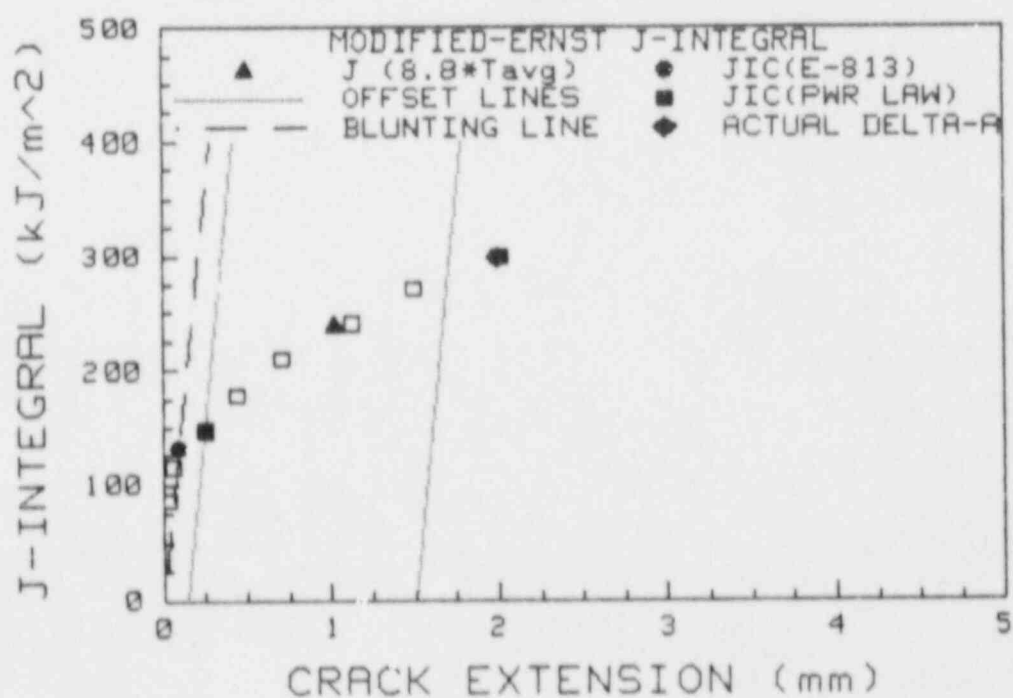
288 DEGREES C



ORNL-DWG 87-8068

69W167

288 DEGREES C



SPECIMEN ID# 69W172
 TEST TEMPERATURE= 50 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 29 mm a/W = .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 K_{Ic})

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 183.2 kJ/m²
 K_{Jc} = 193.5 MPa SQR[m]
 K_{beta-c} = 117.7 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

 J-INTEGRAL= 186.4 kJ/m²
 K_{Jc} = 195.2 MPa SQR[m]
 K_{beta-c} = 118.2 MPa SQR[m]

POWER LAW PROCEDURE

 J_{Ic} = 141.2 kJ/m²
 $K-J_{Ic}$ = 169.9 MPa SQR[m]
 POWER= .5859
 COEFFICIENT= 321.6 kJ/m²
 T (AVERAGE)= 73

ASTM LINEAR PROCEDURE

 J_{Ic} = 0 kJ/m²
 $K-J_{Ic}$ = 0 MPa SQR[m]
 SLOPE= 0 kJ/m³
 INTERCEPT= 0 kJ/m²
 T (ASTM)= 0
 INVALID, 1.6

JI-R CURVE CALCULATIONS

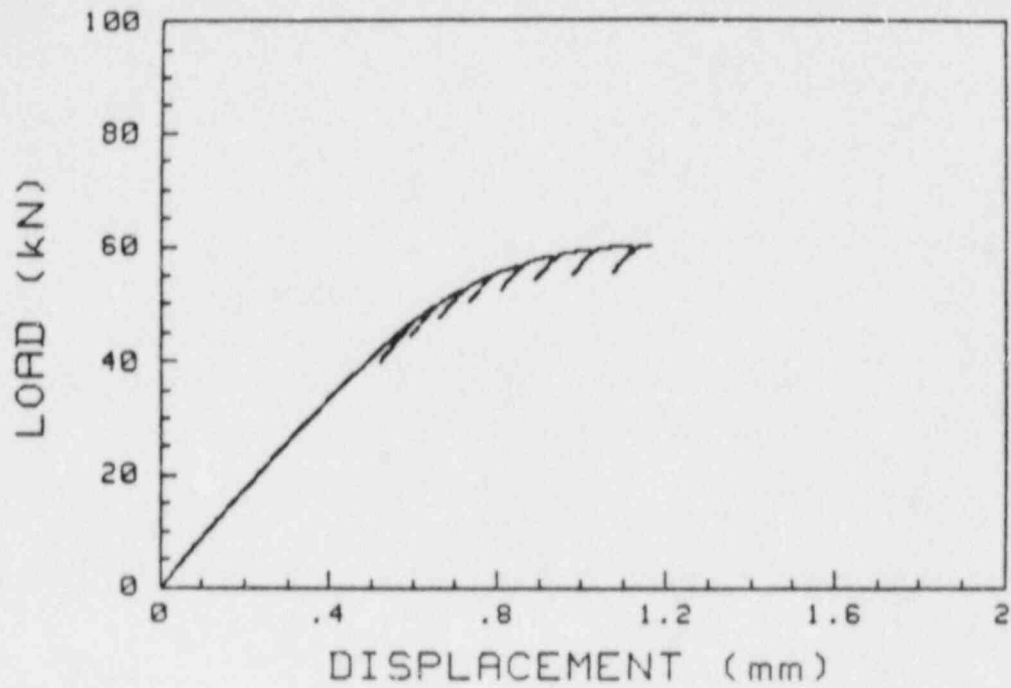
 J ($WJ/T=8.8$) = 318.7 kJ/m²
 POWER= .4342
 J-MAX ALLOWED= 803 kJ/m²
 RCURVE INVALID, 2.3

COEFFICIENT= 273.1 kJ/m²
 DELTA-A MAX ALLOWED= 2.17 mm



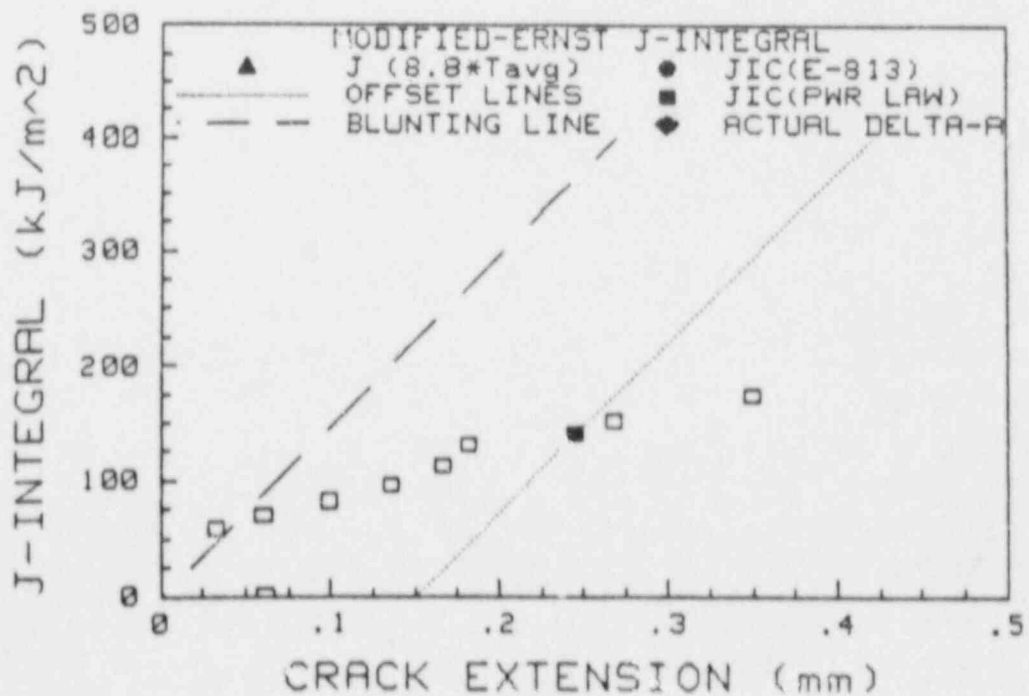
69W172

50 DEGREES C



69W172

50 DEGREES C



SPECIMEN ID= 69W173
MATERIAL TYPE= A533BW
TEST TEMPERATURE= 10 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.7 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 739 MPa
FLOW STRENGTH= 768 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

$a/W)_i = .604$

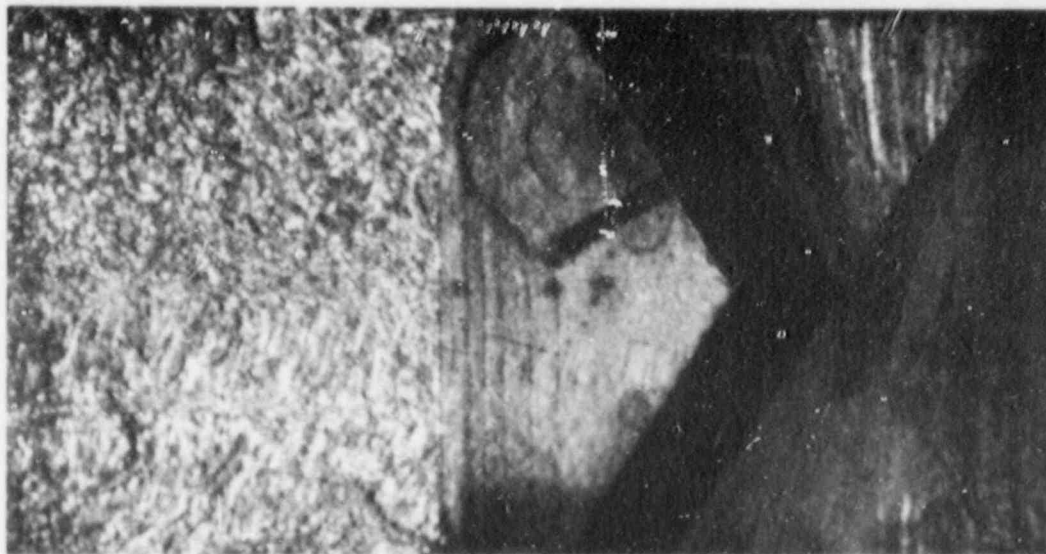
SPECIMEN CLEAVED AT $K = 85.9 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 29.5 kJ/m²
KJc= 78.1 MPa SQR[m]
K-beta-c= 71.6 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

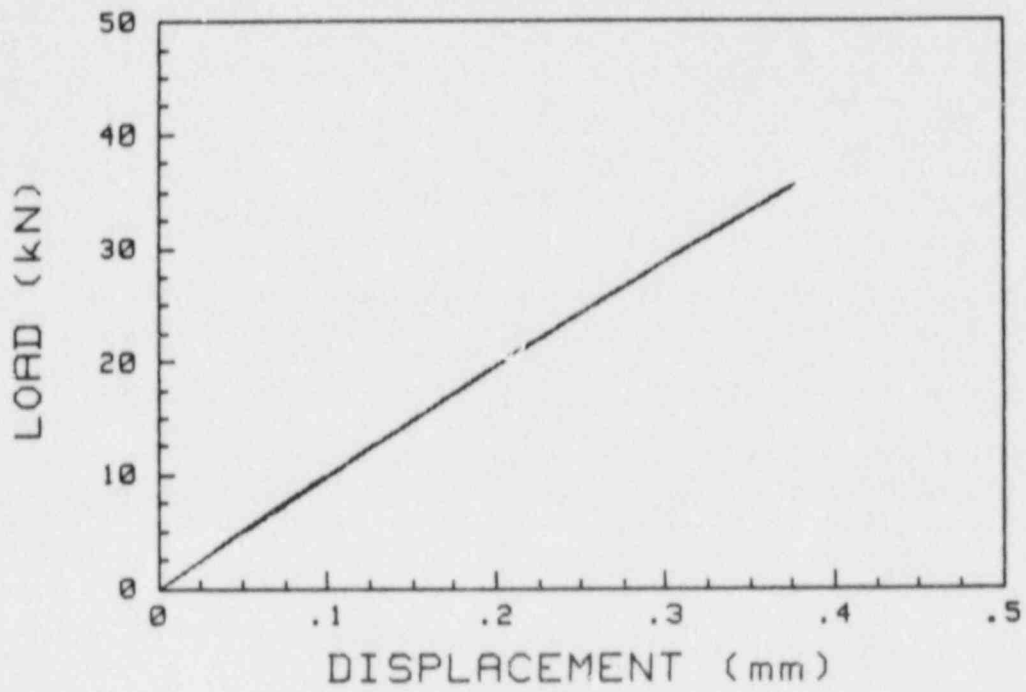
J-INTEGRAL= 29.5 kJ/m²
KJc= 78.1 MPa SQR[m]
K-beta-c= 71.6 MPa SQR[m]



ORNL-DWG 87-8071

69W173

10 DEGREES C



SPECIMEN ID= 70W106
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.7 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 603 MPa
FLOW STRENGTH= 660 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

$a/W)i = .544$

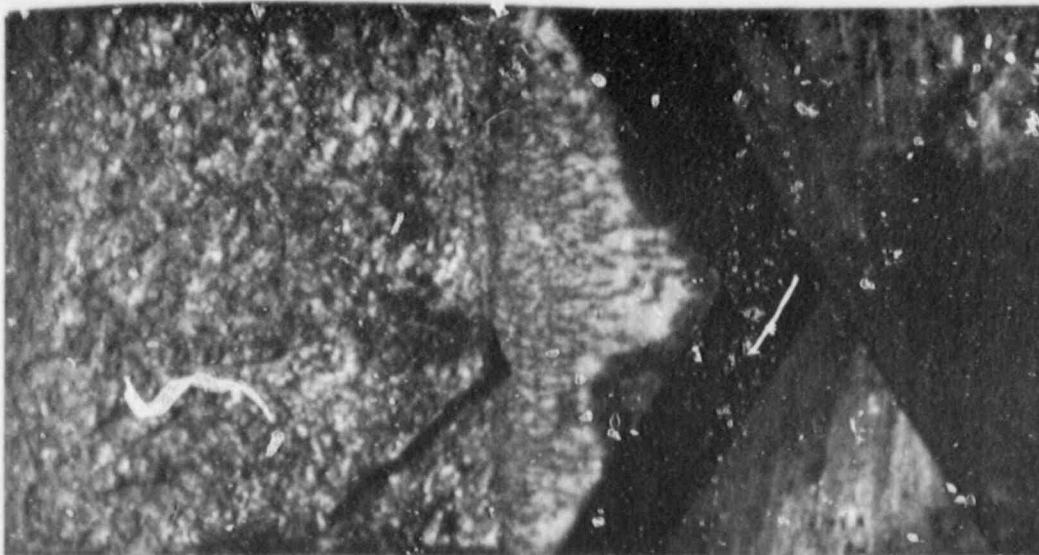
SPECIMEN CLEAVED AT $K = 96.8 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 39.6 kJ/m²
KJc= 91.2 MPa SQR[m]
K-beta-c= 74.4 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

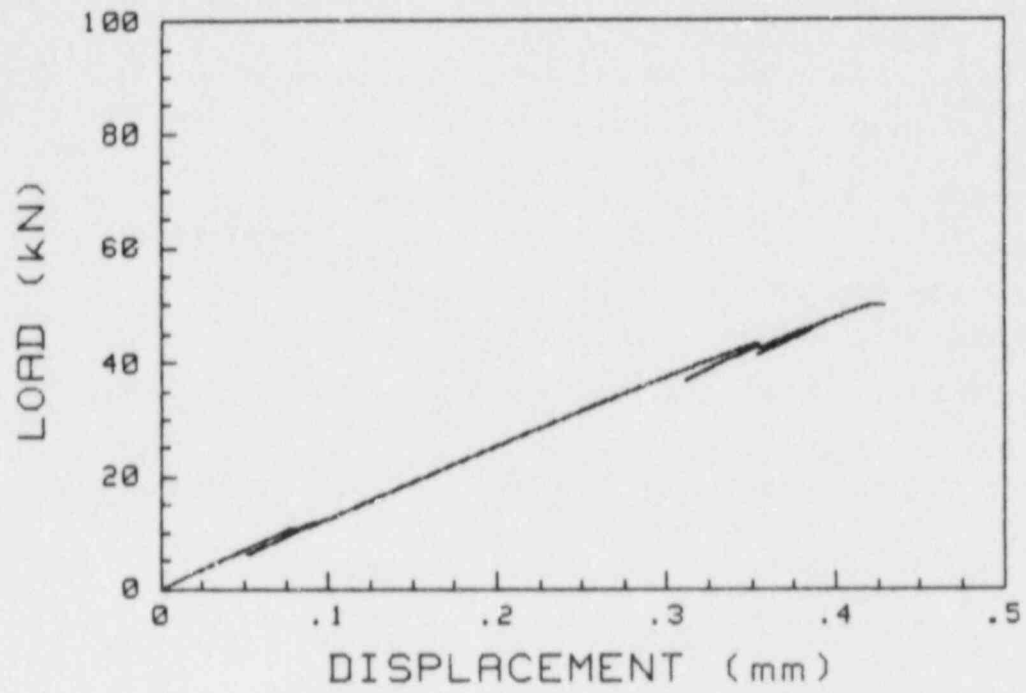
J-INTEGRAL= 42.7 kJ/m²
KJc= 94.7 MPa SQR[m]
K-beta-c= 76.1 MPa SQR[m]



ORNL-DWG 87-8072

70W106

-50 DEGREES C



SPECIMEN ID= 70W107
 TEST TEMPERATURE= 288 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 20 %
 INITIAL CRACK LENGTH= 27.9 mm a/W = .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/m²
 KJ-MAX LOAD= 176.3 MPa SQR(m)

POWER LAW PROCEDURE

 JIc= 113.1 kJ/m²
 K-JIc= 146.9 MPa SQR(m)
 POWER= .3722
 COEFFICIENT= 189.6 kJ/m²
 T (AVERAGE)= 50

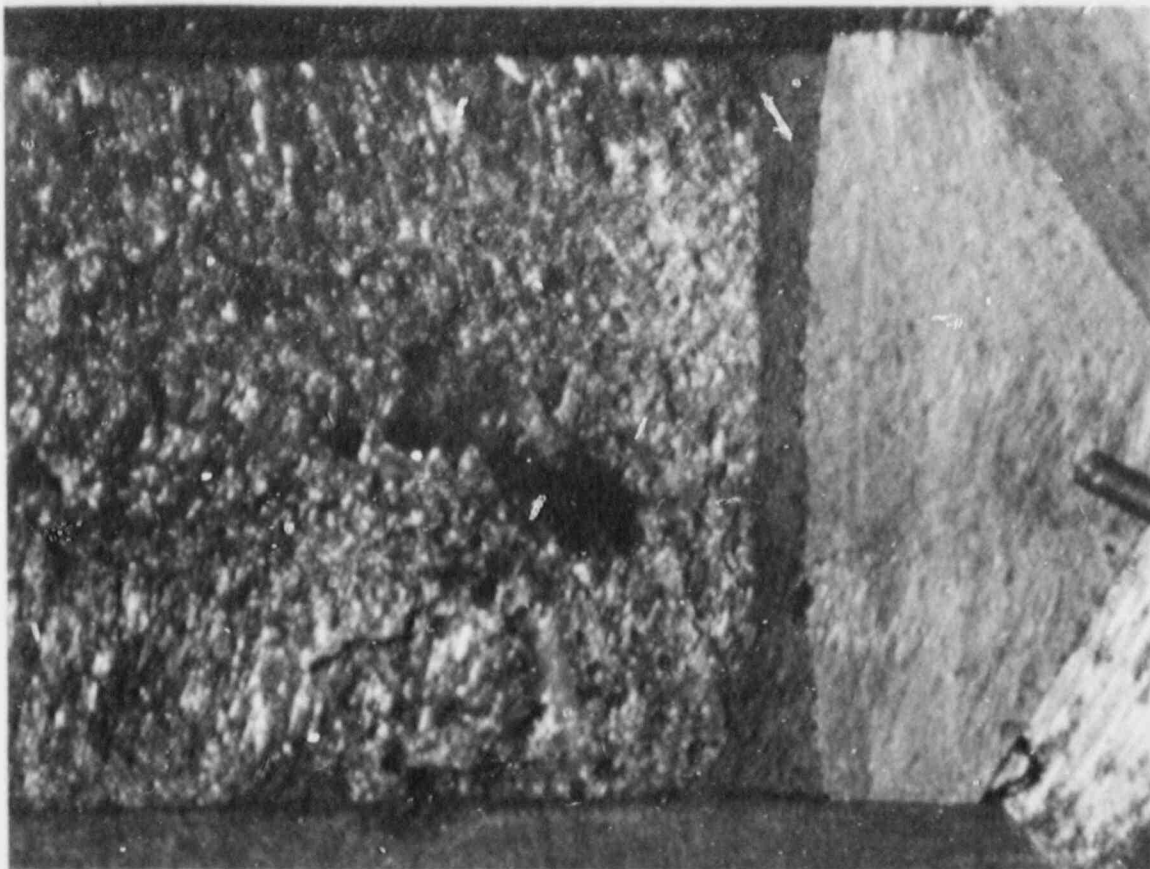
ASTM LINEAR PROCEDURE

 JIc= 97 kJ/m²
 K-JIc= 136 MPa SQR(m)
 SLOPE= 97489 kJ/m³
 INTERCEPT= 88.3 kJ/m²
 T (ASTM)= 63
 INVALID, 6

JI-R CURVE CALCULATIONS

 J (BJ/T=8.8)= 251.4 kJ/m²
 POWER= .3722
 J-MAX ALLOWED= 551.3 kJ/m²
 RCURVE INVALID, 2 3

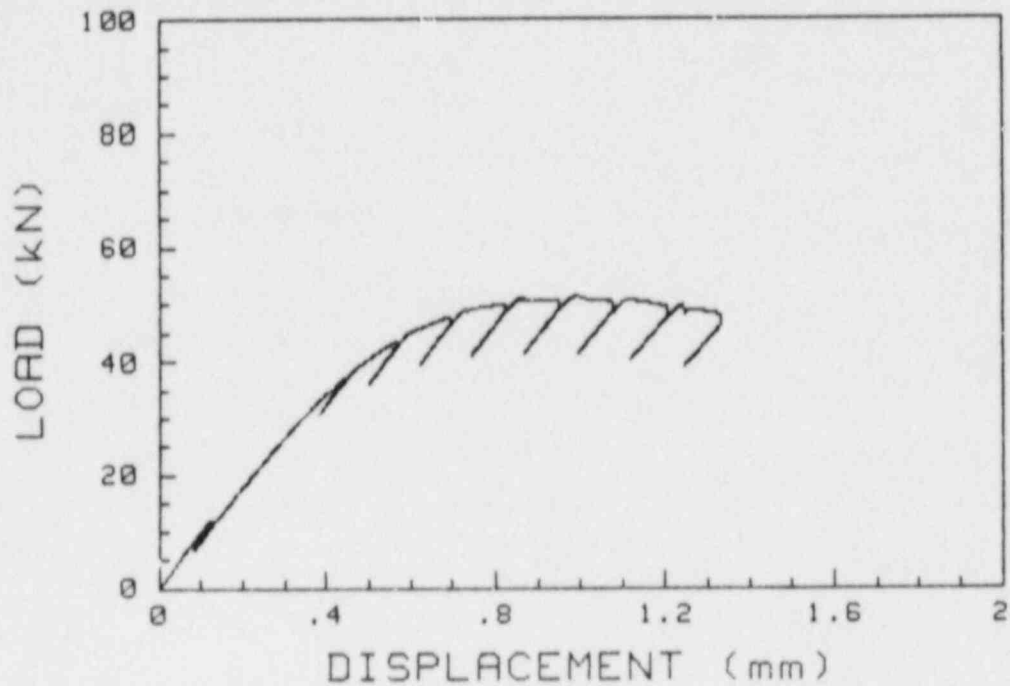
COEFFICIENT= 189.8 kJ/m²
 DELTA-A MAX ALLOWED= 2.29 mm



ORNL-DWG 87-8073

70W107

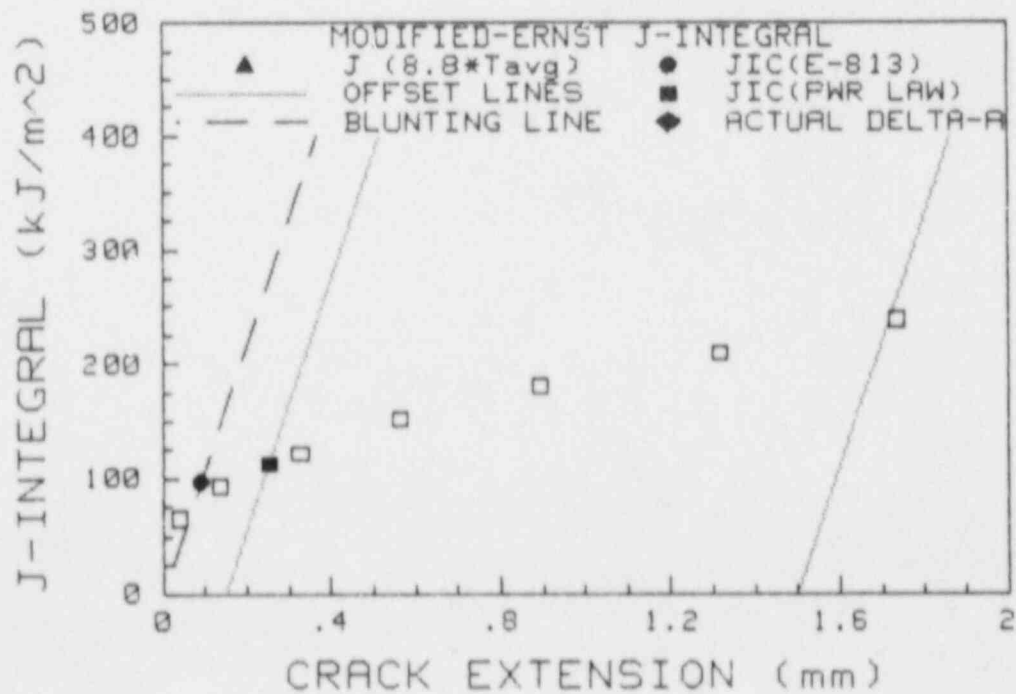
288 DEGREES C



ORNL-DWG 87-8074

70W107

288 DEGREES C



SPECIMEN ID= 70W108
 TEST TEMPERATURE= 204 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 20 %
 INITIAL CRACK LENGTH= 28 mm $a/W = .551$
 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/m²
 KJ-MAX LOAD= 196 MPa SQR(m)

POWER LAW PROCEDURE

J_{1c}= 132.9 kJ/m²
 K-J_{1c}= 161.2 MPa SQR(m)
 POWER= .4716
 COEFFICIENT= 244.6 kJ/m²
 T (AVER/GE)= 81

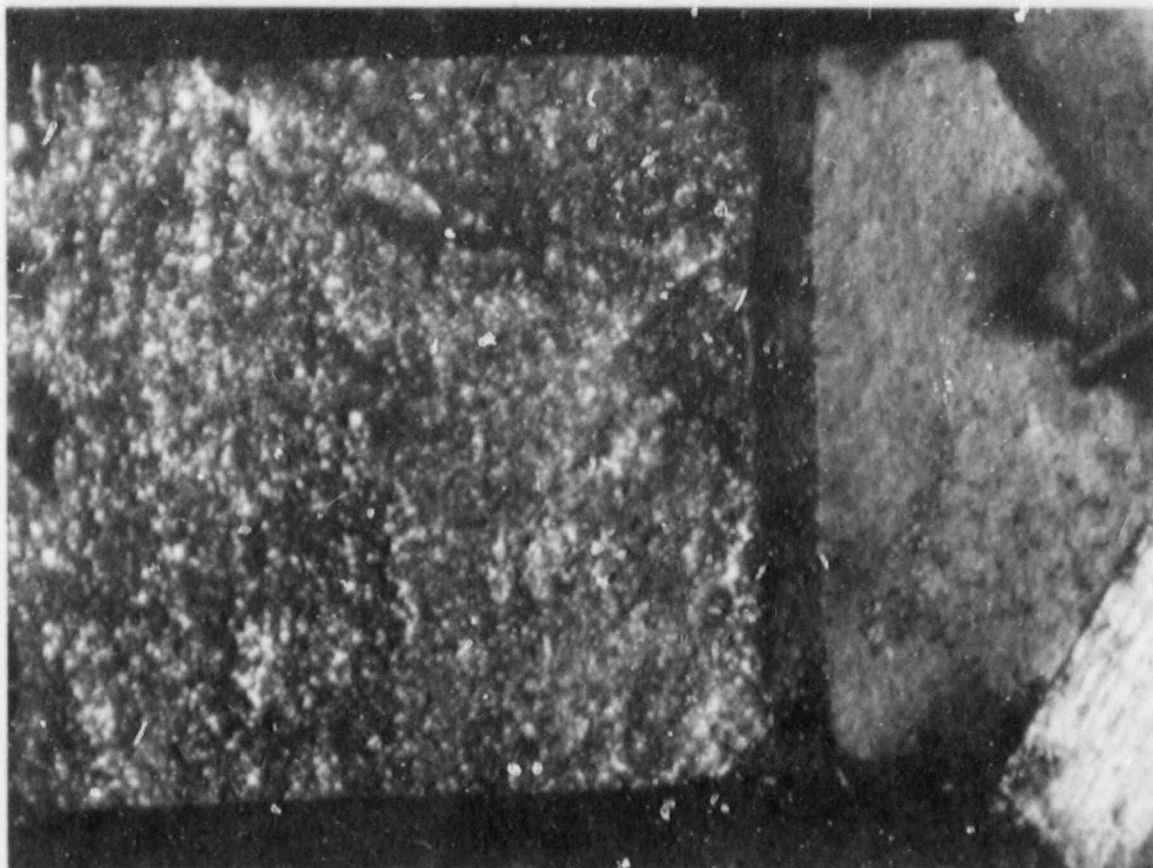
ASTM LINEAR PROCEDURE

J_{1c}= 124.7 kJ/m²
 K-J_{1c}= 156.1 MPa SQR(m)
 SLOPE= 125840 kJ/m³
 INTERCEPT= 110 kJ/m²
 T (ASTM)= 86
 VALID, E813

J1-R CURVE CALCULATIONS

J (R/T=8.8)= 384 kJ/m²
 POWER= .4507
 J-MAX ALLOWED= 543.9 kJ/m²
 RCURVE INVALID, 2

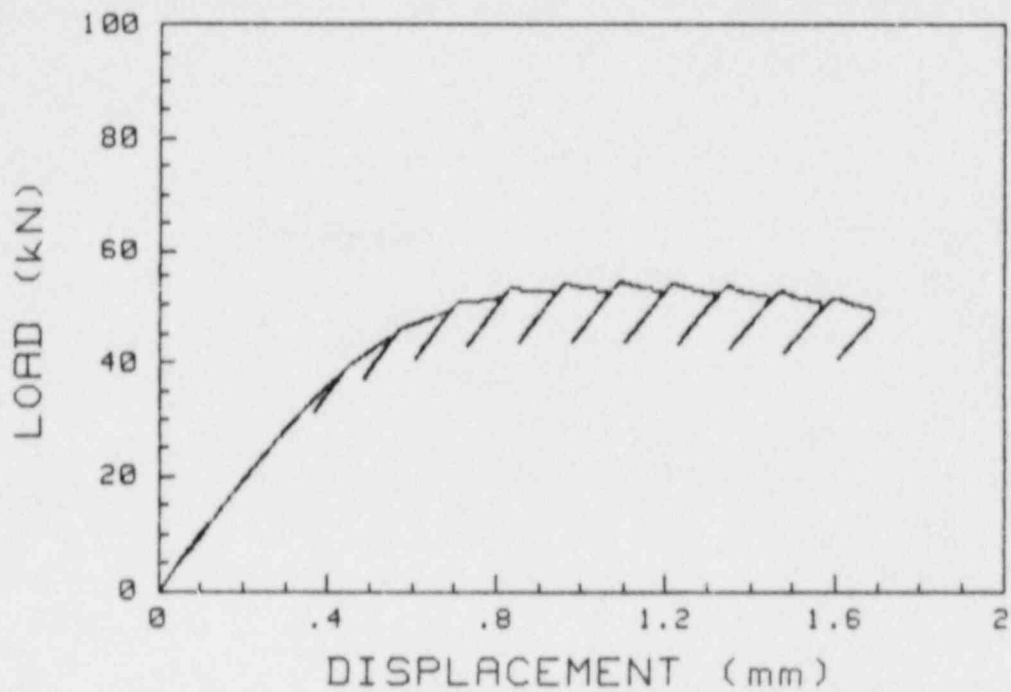
COEFFICIENT= 245.1 kJ/m²
 DELTA-A MAX ALLOWED= 2.28 mm



ORNL-DWG 87-8075

70W108

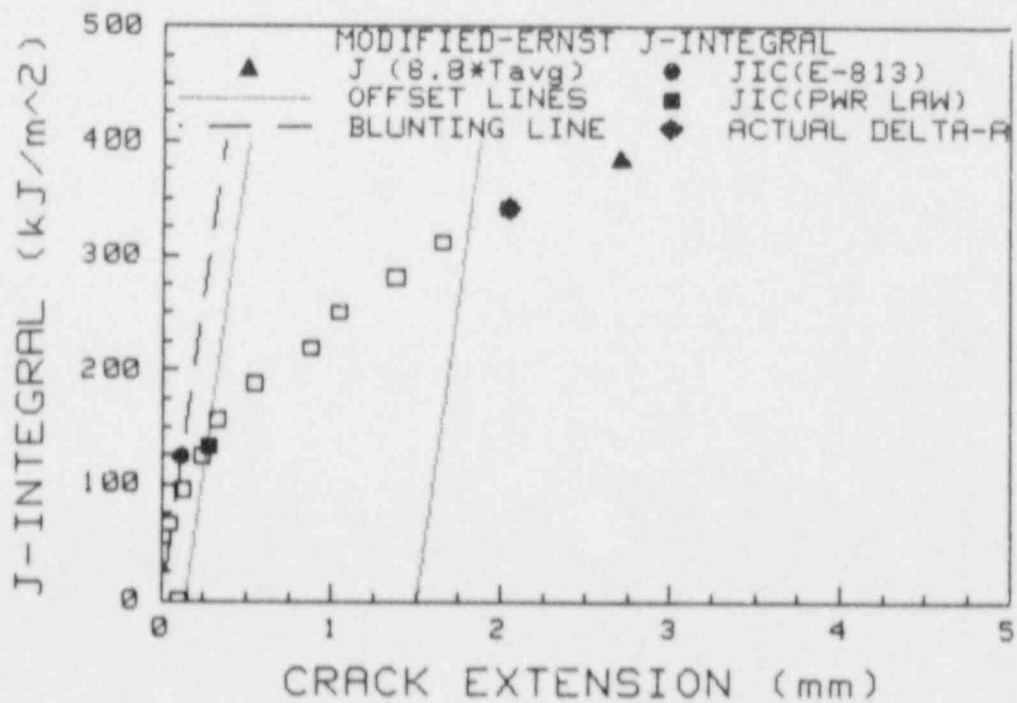
204 DEGREES C



ORNL-DWG 87-8076

70W108

204 DEGREES C



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/m²
 KJ-MAX LOAD= 202.5 MPa SQR(m)

POWER LAW PROCEDURE

 JIc= 115 kJ/m²
 K-JIc= 151.8 MPa SQR(m)
 POWER= .5992
 COEFFICIENT= 261.1 kJ/m²
 T (AVERAGE)= 106

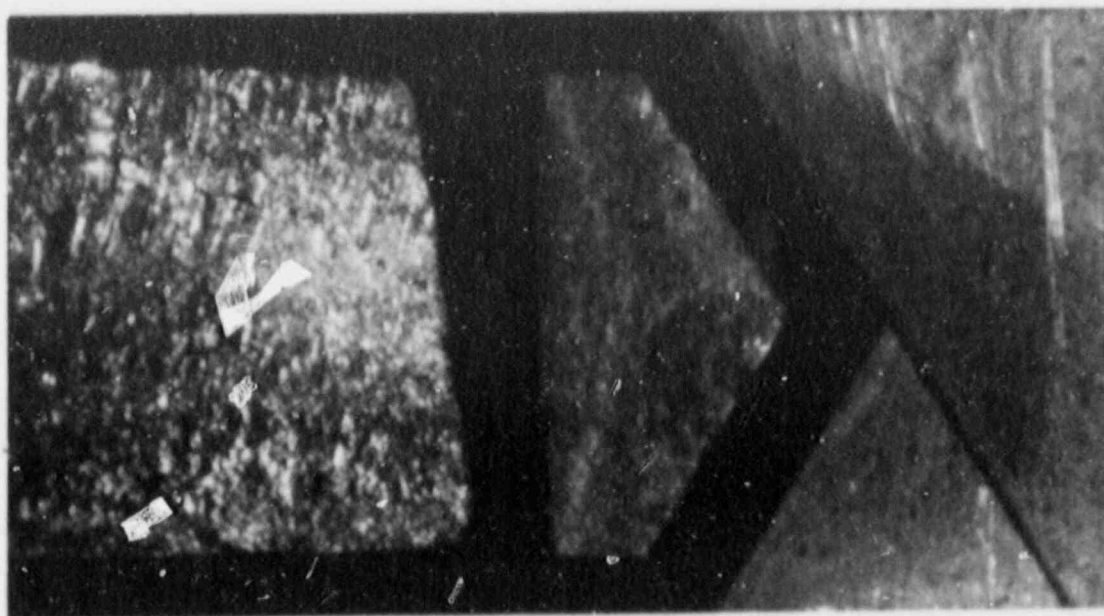
ASTM LINEAR PROCEDURE

 JIc= 96.3 kJ/m²
 K-JIc= 138.9 MPa SQR(m)
 SLOPE= 169933 kJ/m³
 INTERCEPT= 81.4 kJ/m²
 T (ASTM)= 113
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 571.4 kJ/m²
 POWER= .6168
 J-MAX ALLOWED= 558.6 kJ/m²
 RCURVE INVALID, 1

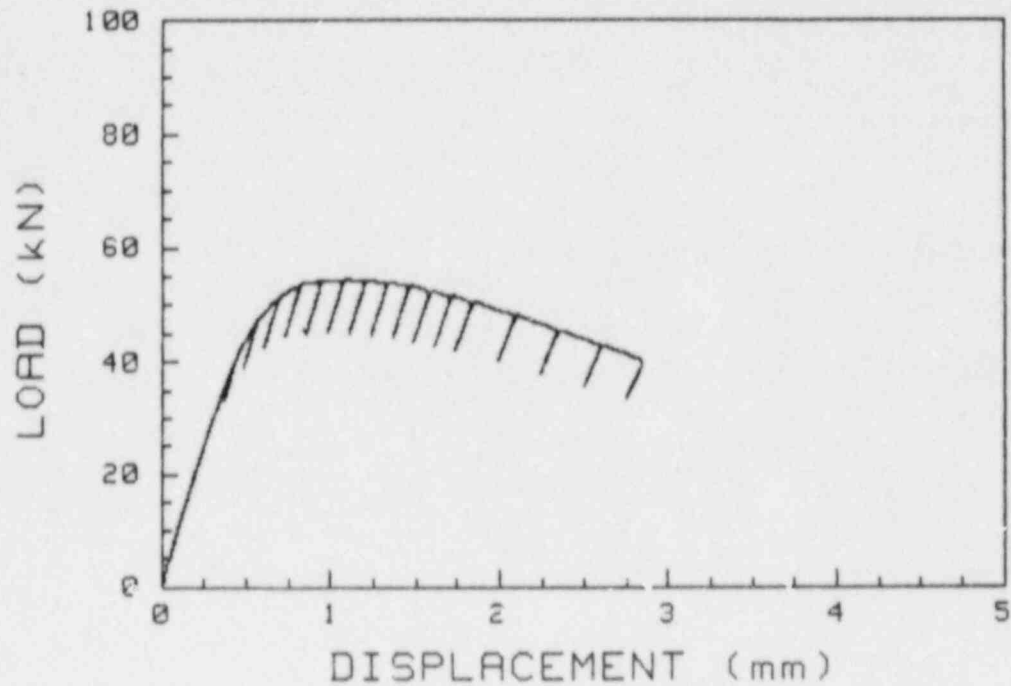
COEFFICIENT= 259.4 kJ/m²
 DELTA-A MAX ALLOWED= 2.28 mm



ORNL-DWG 87-8077

70W110

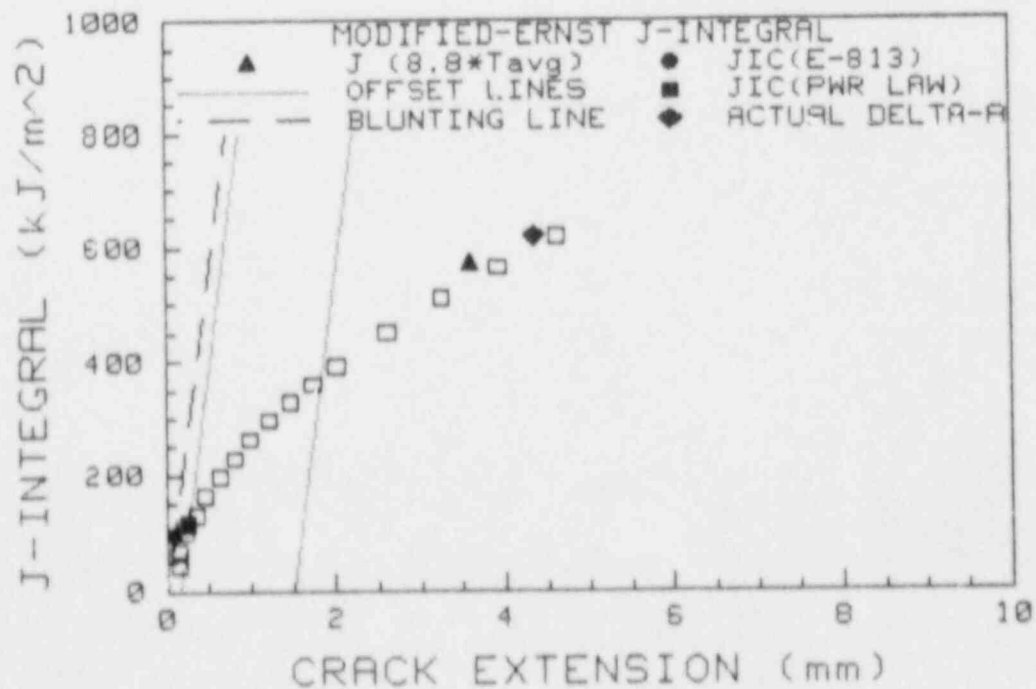
121 DEGREES C



ORNL-DWG 87-8078

70W110

121 DEGREES C



SPECIMEN ID= 70W117
 TEST TEMPERATURE= 288 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 20 %
 INITIAL CRACK LENGTH= 28 mm $a/W)= .551$
 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/m²
 KJ-MAX LOAD= 177.3 MPa SQR(m)

POWER LAW PROCEDURE

J_{1c}= 123.4 kJ/m²
 K-J_{1c}= 153.4 MPa SQR(m)
 POWER= .4106
 COEFFICIENT= 213.3 kJ/m²
 T (AVERAGE)= 60

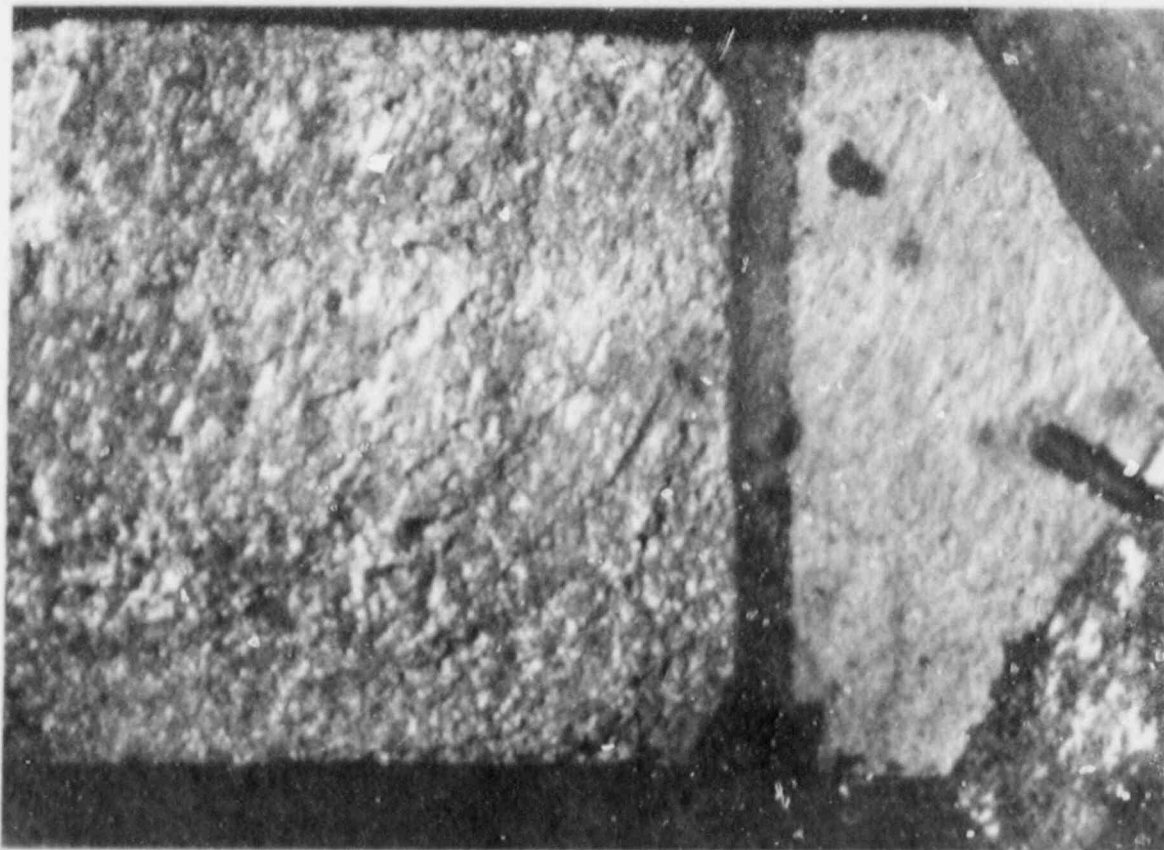
ASTM LINEAR PROCEDURE

J_{1c}= 105 kJ/m²
 K-J_{1c}= 141.5 MPa SQR(m)
 SLOPE= 110431 kJ/m³
 INTERCEPT= 94.3 kJ/m²
 T (ASTM)= 72
 VALID, E813

J1-R CURVE CALCULATIONS

J (B/T=8.8)= 287.4 kJ/m²
 POWER= .3975
 J-MAX ALLOWED= 551.3 kJ/m²
 RCURVE INVALID, 2

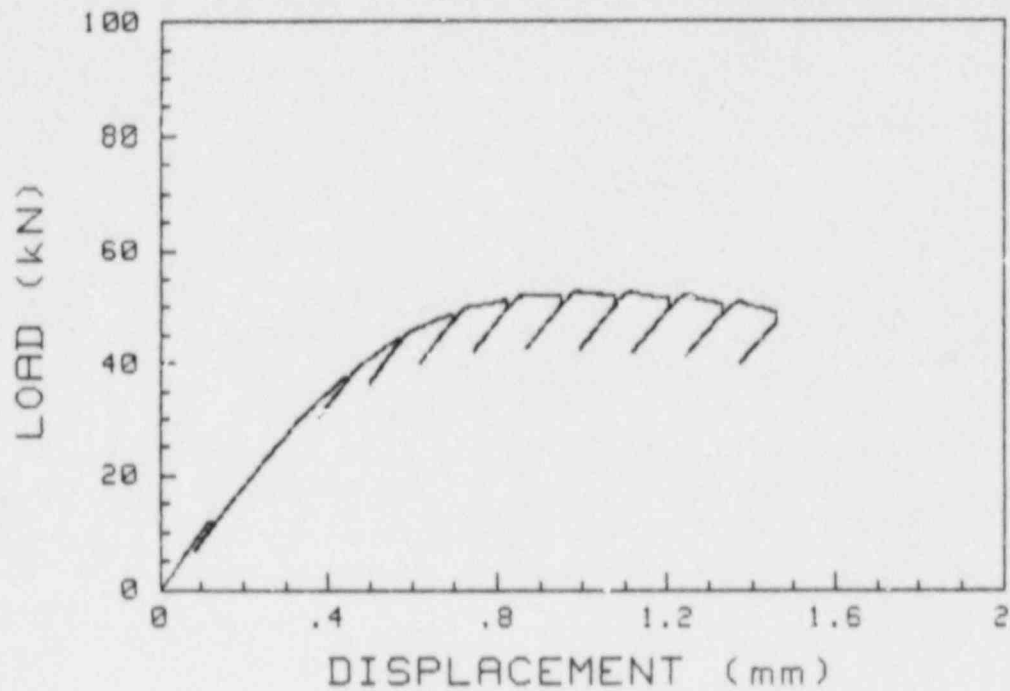
COEFFICIENT= 211.4 kJ/m²
 DELTA-A MAX ALLOWED= 2.28 mm



ORNL-DWG 87-8079

70W117

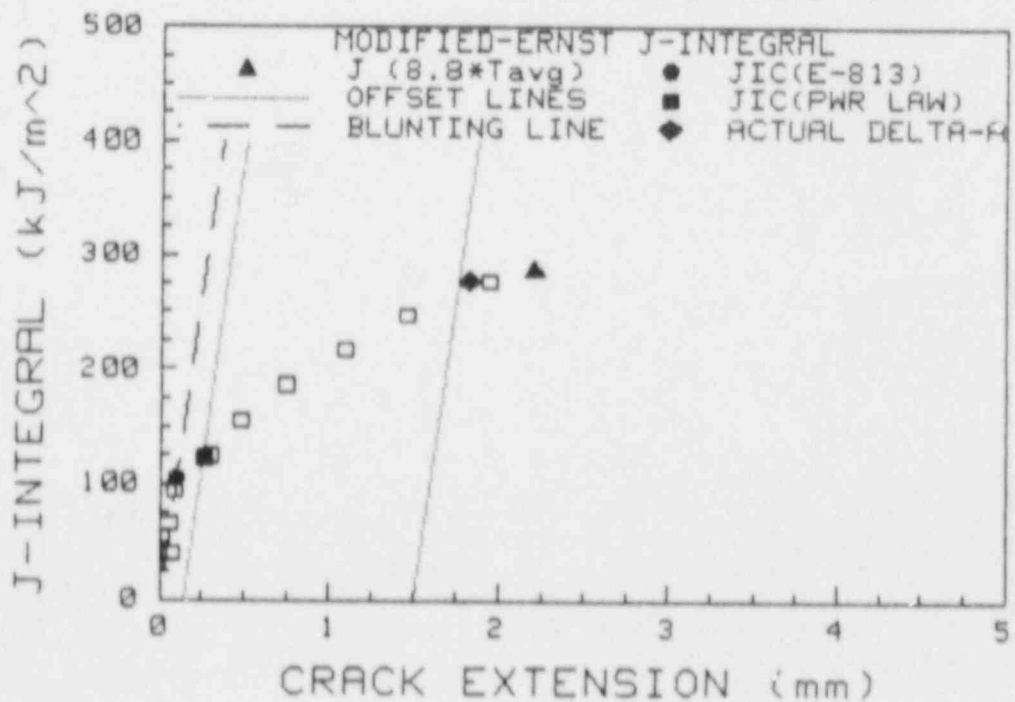
288 DEGREES C



ORNL-DWG 87-8080

70W117

288 DEGREES C



SPECIMEN ID= 70W118
 TEST TEMPERATURE= 204 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 20 %
 INITIAL CRACK LENGTH= 28.2 mm $a/W = .556$
 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/m²
 KJ-MAX LOAD= 182 MPa SQR(m)

POWER LAW PROCEDURE

J_{1c}= 141.5 kJ/m²
 K-J_{1c}= 166.4 MPa SQR(m)
 POWER= .4312
 COEFFICIENT= 244.2 kJ/m²
 T (AVERAGE)= 74

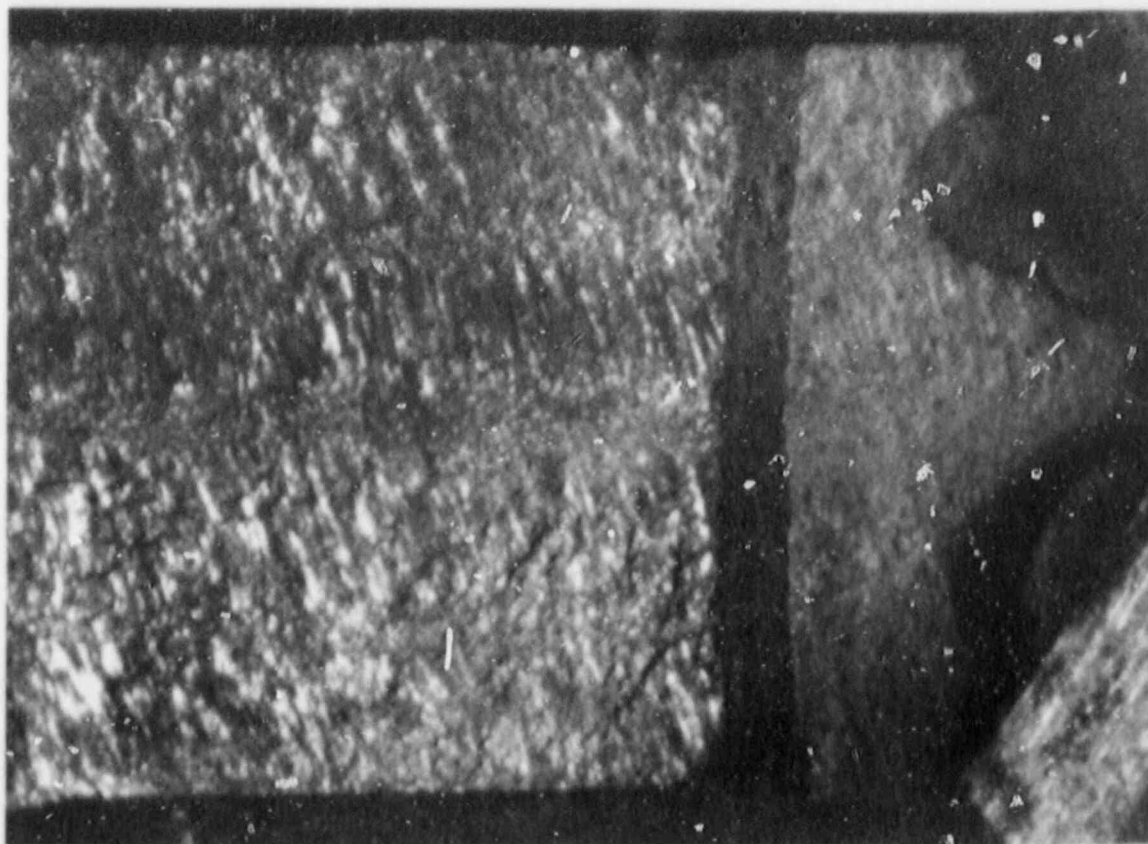
ASTM LINEAR PROCEDURE

J_{1c}= 132.5 kJ/m²
 K-J_{1c}= 160.9 MPa SQR(m)
 SLOPE= 116006 kJ/m³
 INTERCEPT= 118.1 kJ/m²
 T (ASTM)= 79
 VALID, E813

J1-R CURVE CALCULATIONS

J (BJ/T=8.8)= 371.5 kJ/m²
 POWER= .4345
 J-MAX ALLOWED= 543.9 kJ/m²
 RCURVE INVALID, 1 3

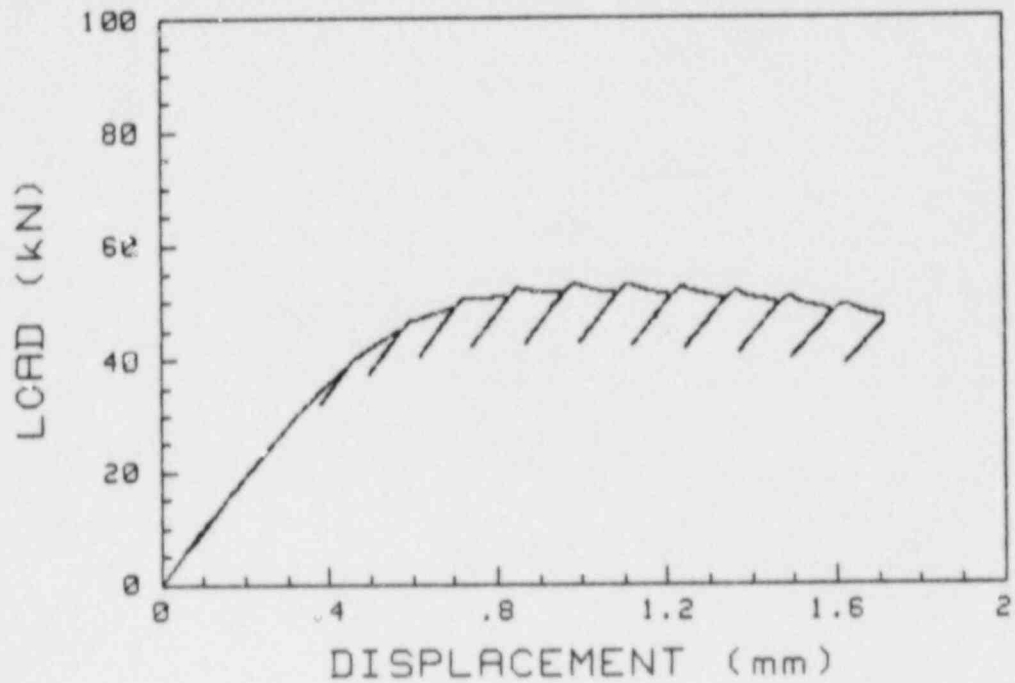
COEFFICIENT= 244.9 kJ/m²
 DELTA-A MAX ALLOWED= 2.26 mm



ORNL-DWG 87-8081

70W118

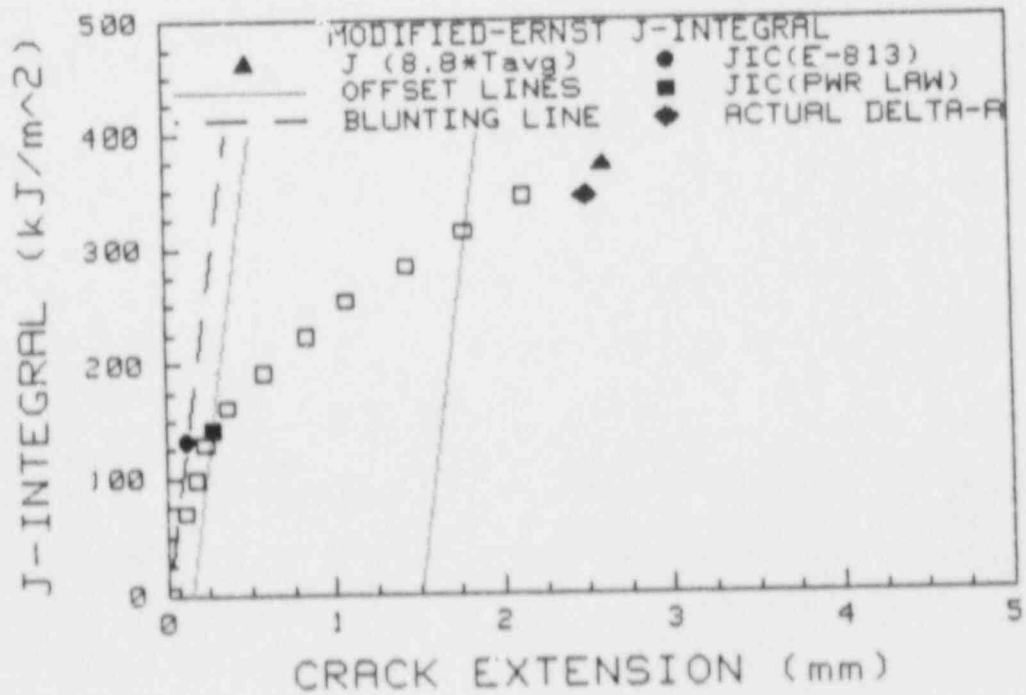
204 DEGREES C



ORNL-DWG 87-8082

70W118

204 DEGREES C



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

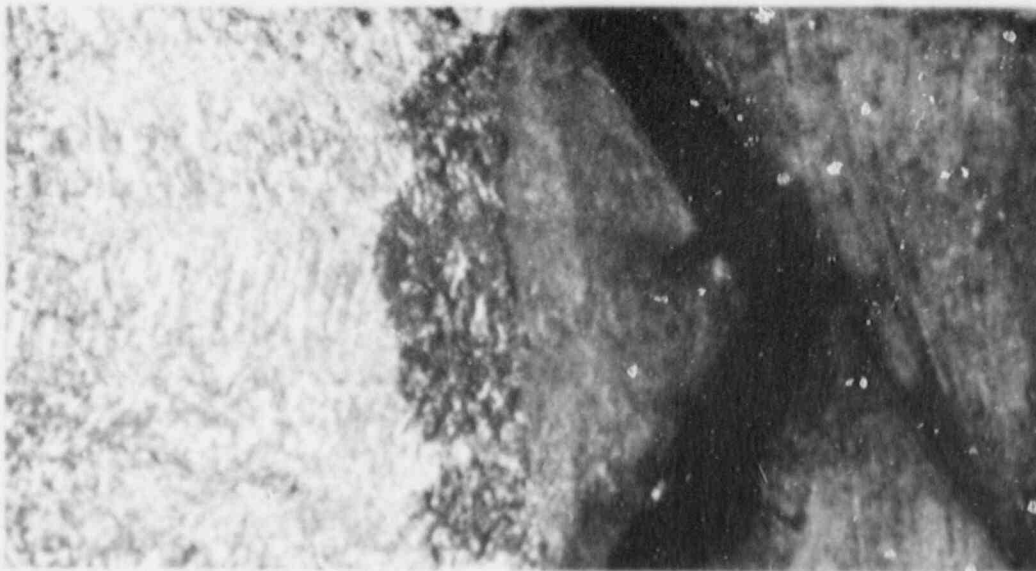
SPECIMEN CLEAVED AT $K = 63.5 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 19.3 kJ/m²
KJc= 63.4 MPa SQR[m]
K-beta-c= 57.6 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

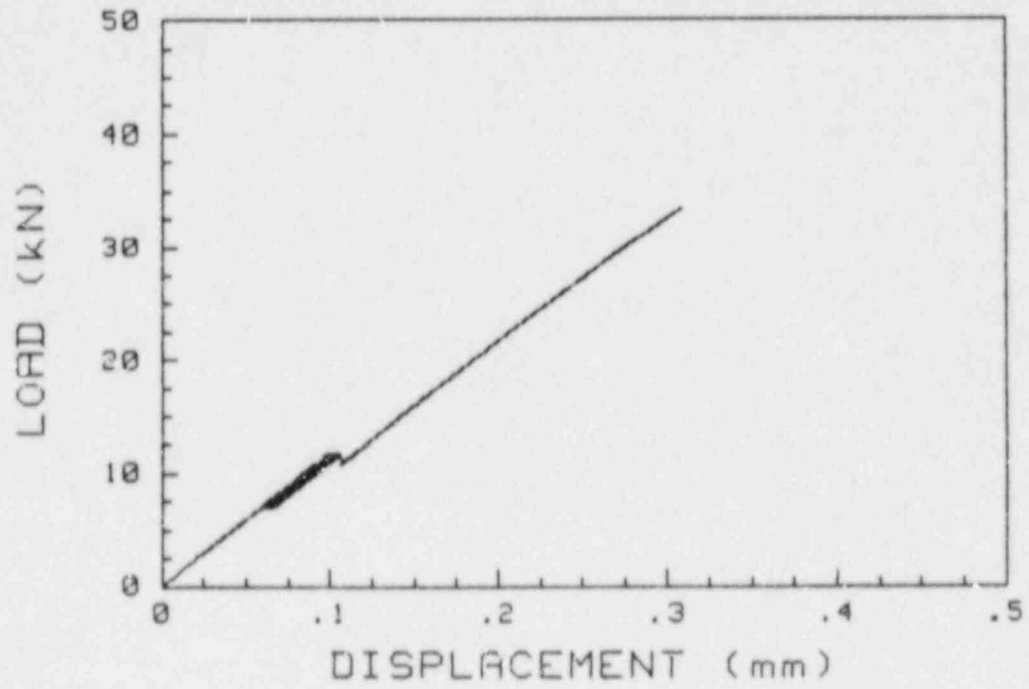
J-INTEGRAL= 19.3 kJ/m²
KJc= 63.4 MPa SQR[m]
K-beta-c= 57.6 MPa SQR[m]



ORNL-DWG 87-8083

70W123

-25 DEGREES C



SPECIMEN ID= 70W124
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.6 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 603 MPa
FLOW STRENGTH= 660 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

$a/W)i = .543$

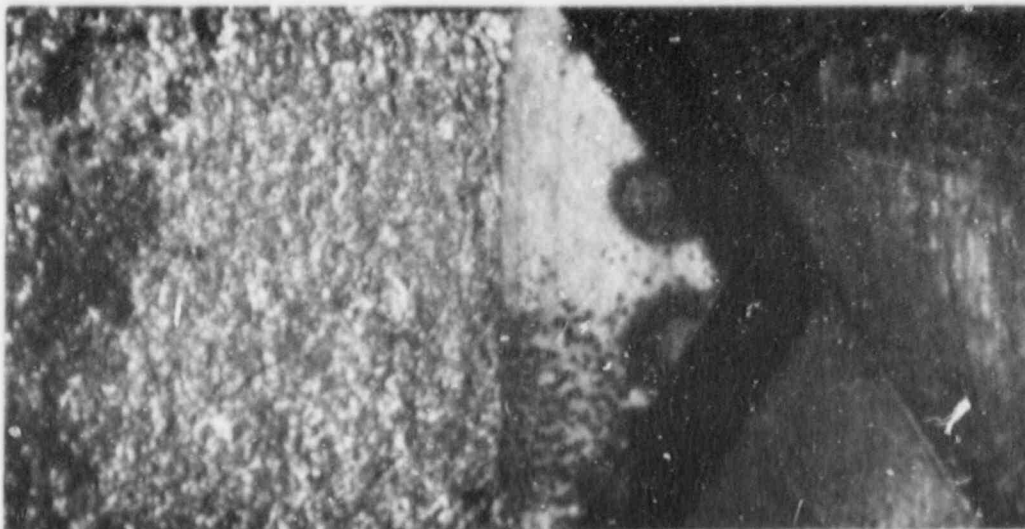
SPECIMEN CLEAVED AT $K = 82 \text{ MPa SQR}[m]$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 28.4 kJ/m²
KJc= 77.2 MPa SQR[m]
K-beta-c= 66.9 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

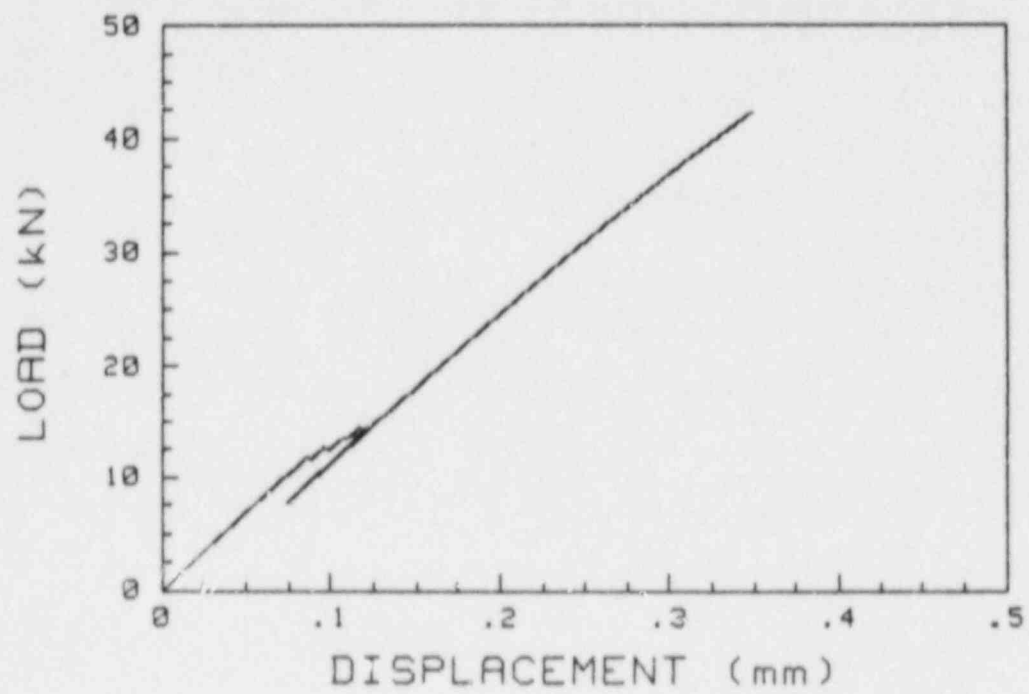
J-INTEGRAL= 28.4 kJ/m²
KJc= 77.2 MPa SQR[m]
K-beta-c= 66.9 MPa SQR[m]



ORNL-DWG 87-8084

70W124

-50 DEGREES C



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

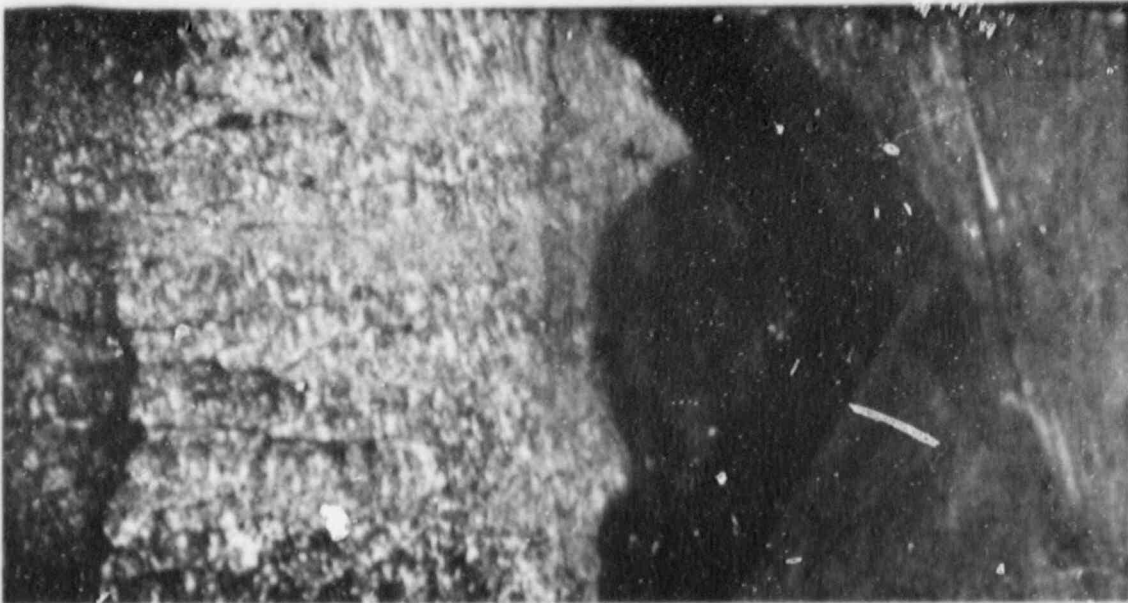
SPECIMEN CLEAVED AT $K_{Ic} = 37.9 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 6.2 kJ/m²
KJc= 36.4 MPa SQR[m]
K-beta-c= 36.1 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

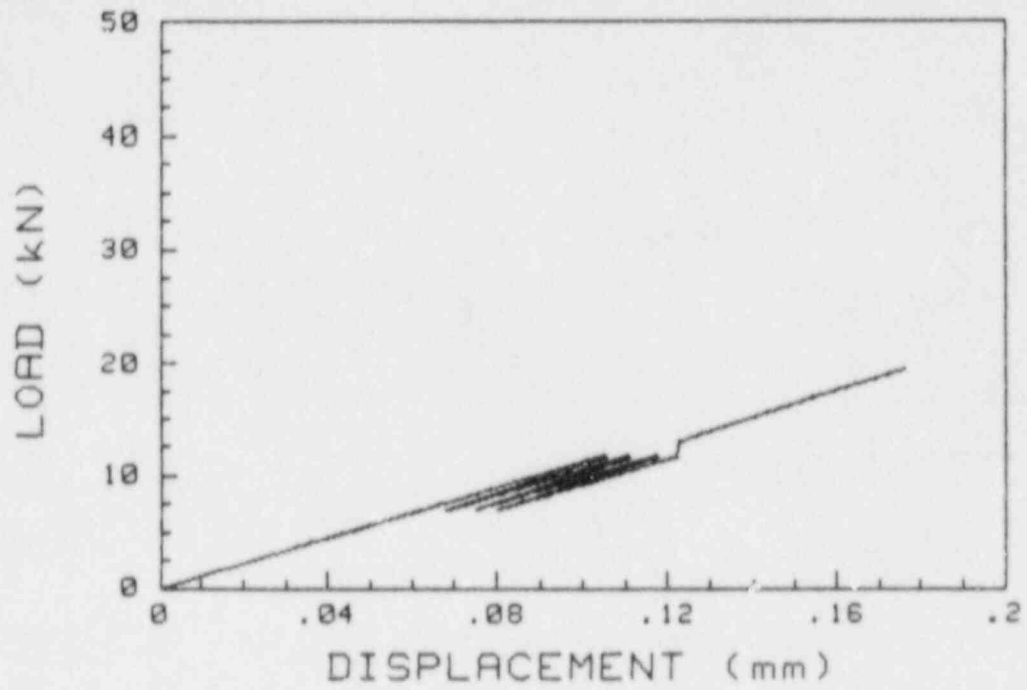
J-INTEGRAL= 6.2 kJ/m²
KJc= 36.4 MPa SQR[m]
K-beta-c= 36.1 MPa SQR[m]



ORNL-DWG 87-8085

70W126

-125 DEGREES C



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/m²
 KJ-MAX LOAD= 218.5 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 140 kJ/m²
 K-JIc= 162.5 MPa SQR[m]
 POWER= .5878
 COEFFICIENT= 297.6 kJ/m²
 T (AVERAGE)= 116

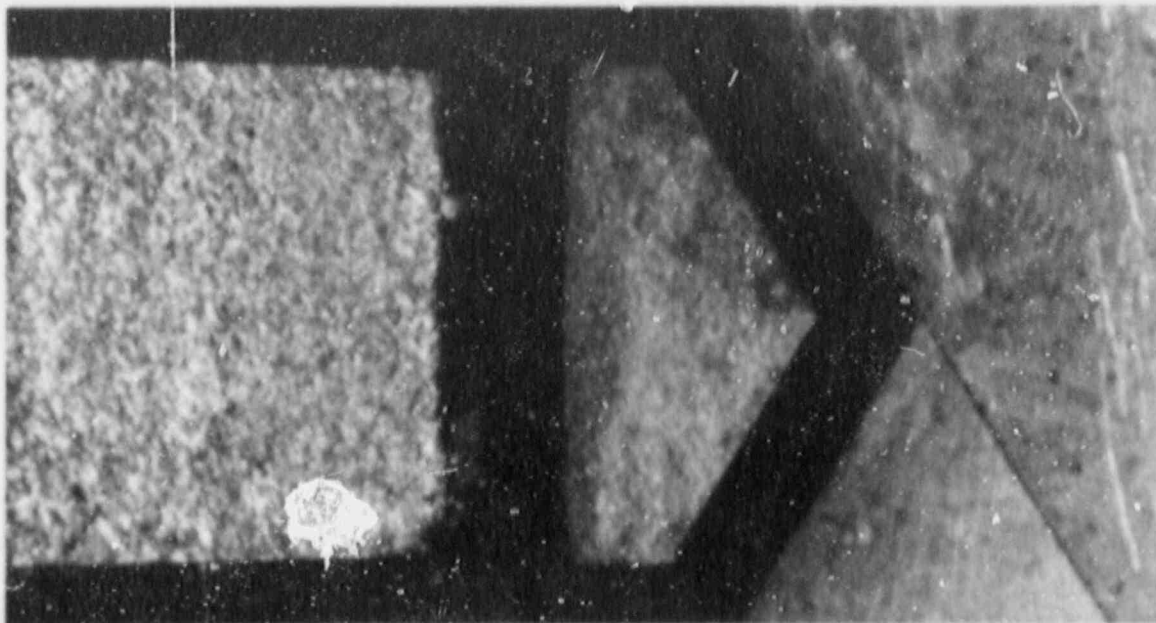
ASTM LINEAR PROCEDURE

 JIc= 126 kJ/m²
 K-JIc= 158.9 MPa SQR[m]
 SLOPE= 18.248 kJ/m³
 INTERCEPT= 105.3 kJ/m²
 T (ASTM)= 120
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 610.1 kJ/m²
 POWER= .5856
 J-MAX ALLOWED= 558.6 kJ/m²
 VALID R-CURVE

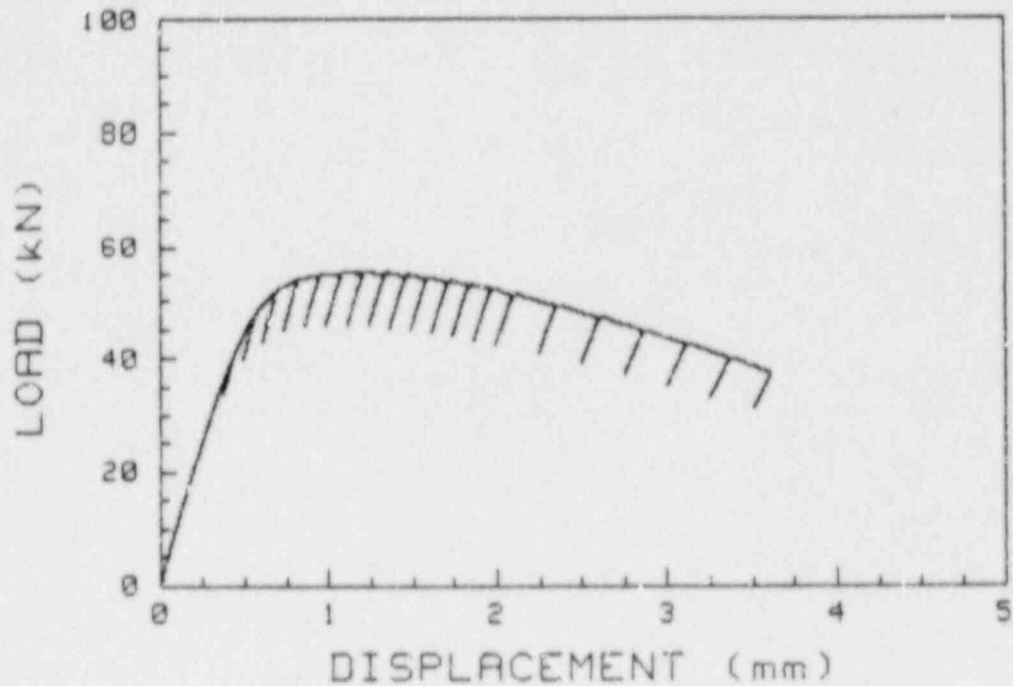
COEFFICIENT= 297.2 kJ/m²
 DELTA-A MAX ALLOWED= 2.31 mm



ORNL-DWG 87-8086

70W136

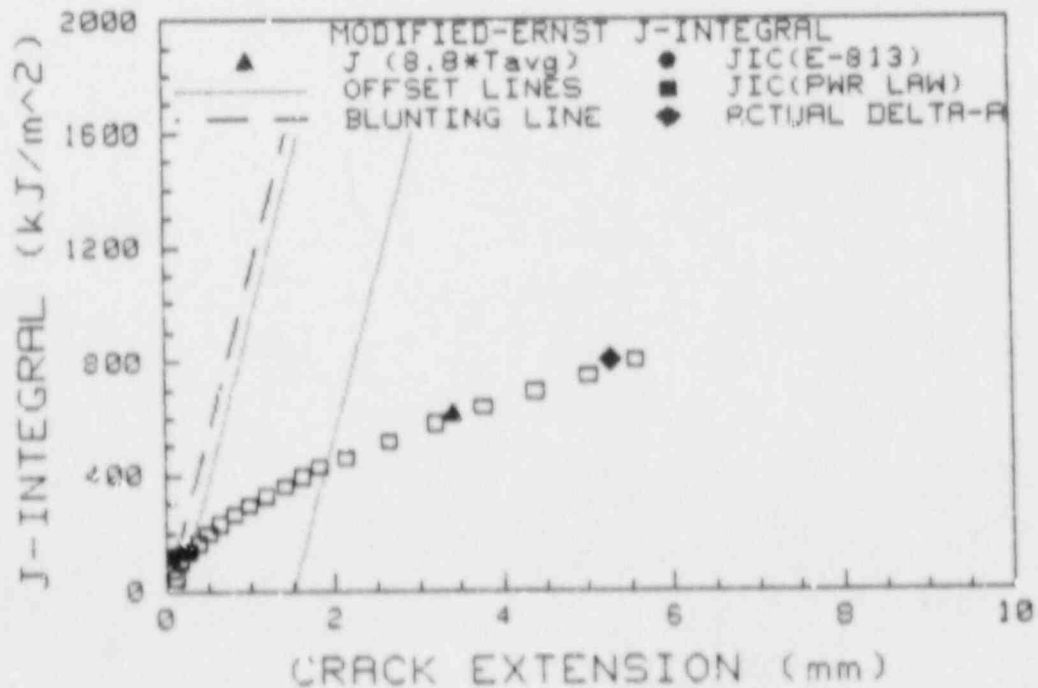
121 DEGREES C



ORNL-DWG 87-8087

70W136

121 DEGREES C



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/m²
 KJ-MAX LOAD= 179.6 MPa SQR(m)

POWER LAW PROCEDURE

 JIc= 136.7 kJ/m²
 K-JIc= 167.6 MPa SQR(m)
 POWER= .5089
 COEFFICIENT= 268.3 kJ/m²
 T (AVERAGE)= 83

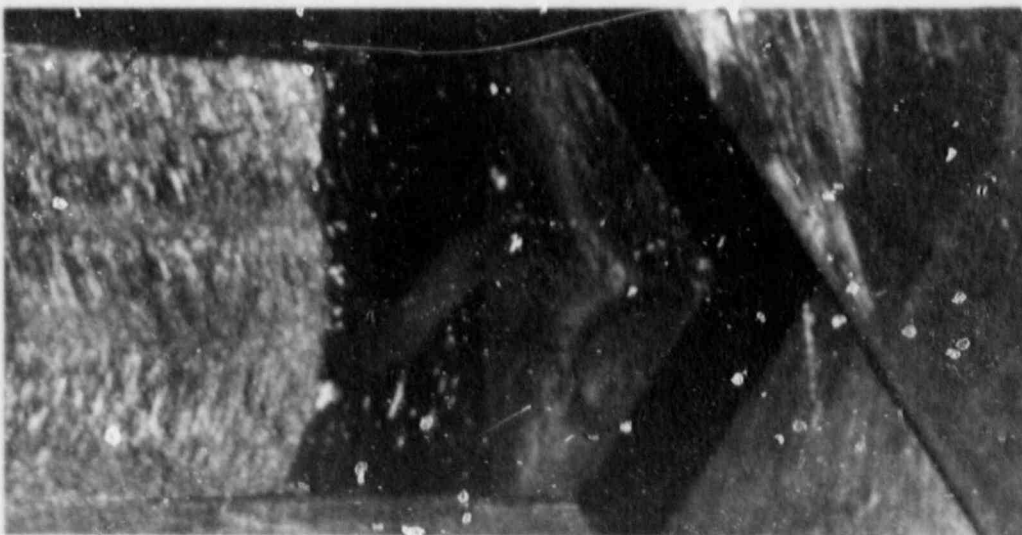
ASTM LINEAR PROCEDURE

 JIc= 121.9 kJ/m²
 K-JIc= 158.1 MPa SQR(m)
 SLOPE= 15325 kJ/m³
 INTERCEPT= 106.1 kJ/m²
 T (ASTM)= 90
 VALID, E813

J1-R (JSOL) CALCULATIONS

 J (@J/T=8.8)= 456.4 kJ/m²
 POWER= .5277
 J-MAX ALLOWED= 599.9 kJ/m²
 RCURVE INVALID, 3

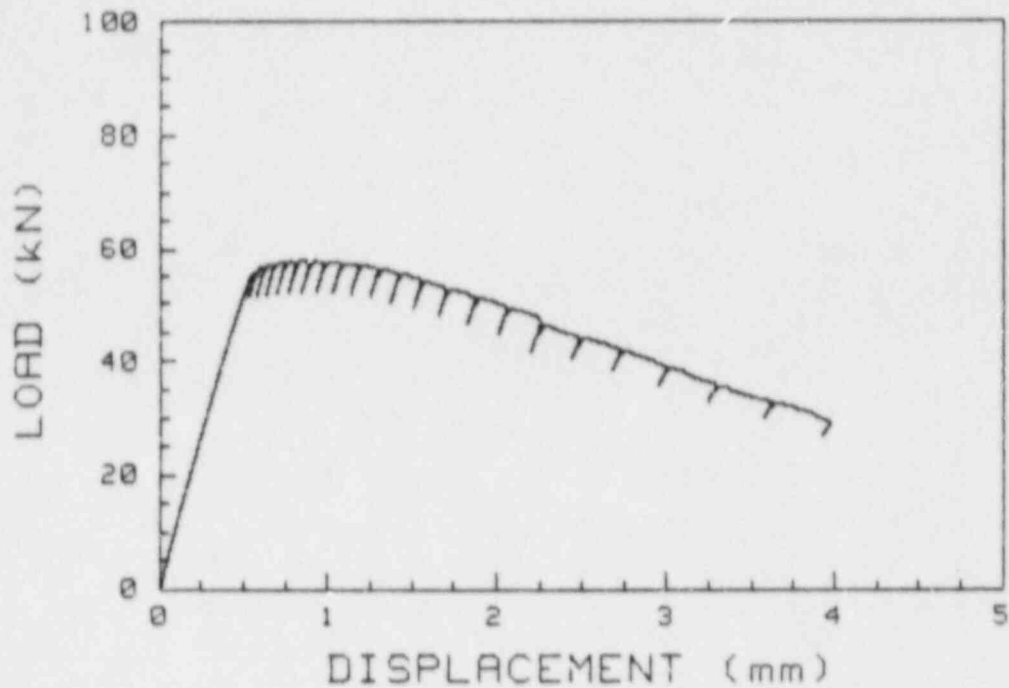
COEFFICIENT= 268.3 kJ/m²
 DELTA-A MAX ALLOWED= 2.3 mm



ORNL-DWG 87-8088

70W139

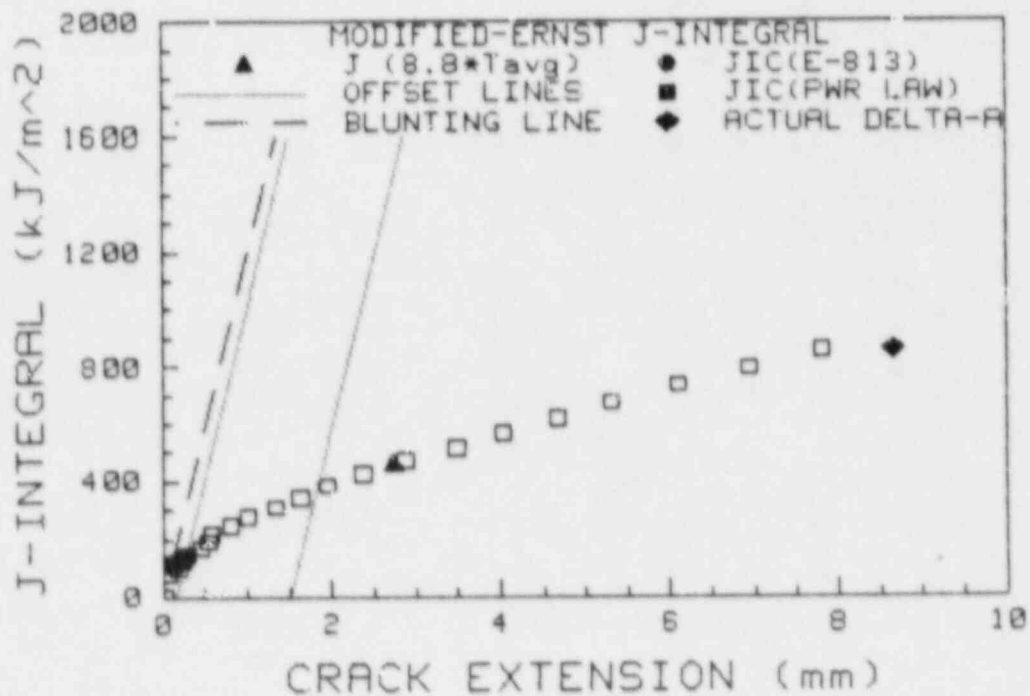
32 DEGREES C



ORNL-DWG 87-8089

70W139

32 DEGREES C



SPECIMEN ID= 70W140
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -125 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.5 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 691 MPa
FLOW STRENGTH= 753 MPa
ESTIMATED YOUNG'S MODULUS= 214 GPa

$a/W)i = .541$

SPECIMEN CLEAVED AT $K_{Ic} = 36.9 \text{ MPa SQR}[m]$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 6.3 kJ/m^2
 $KJc = 36.7 \text{ MPa SQR}[m]$
 $K\text{-beta-c} = 36.4 \text{ MPa SQR}[m]$

VALUES AT CLEAVAGE LOAD

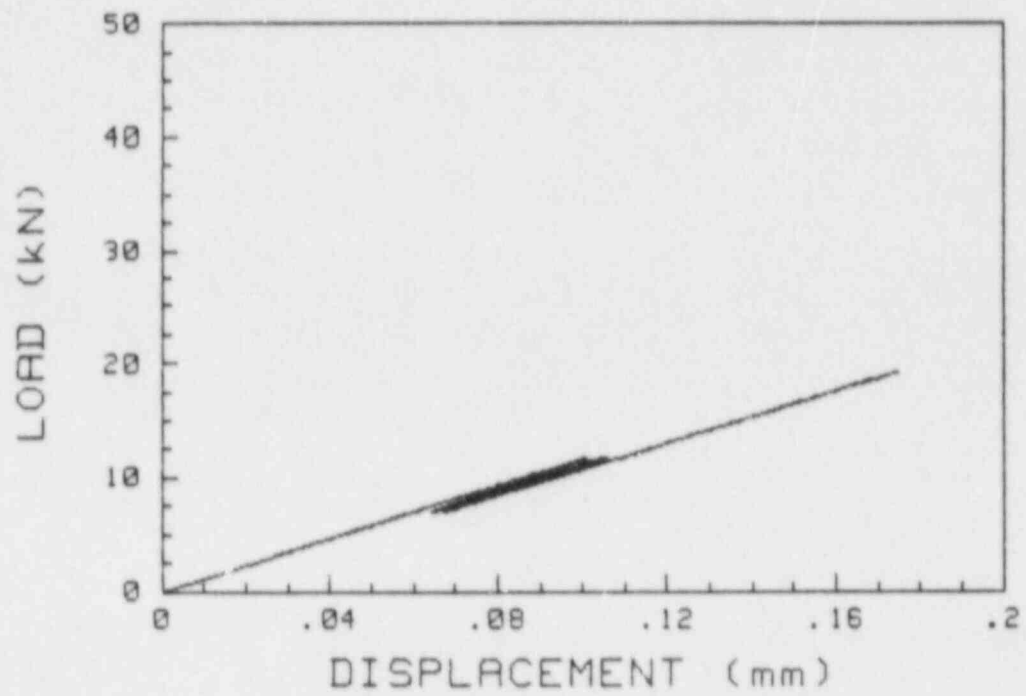
J-INTEGRAL= 6.3 kJ/m^2
 $KJc = 36.7 \text{ MPa SQR}[m]$
 $K\text{-beta-c} = 36.4 \text{ MPa SQR}[m]$



ORNL-DWG 87-8090

70W140

-125 DEGREES C



SPECIMEN ID= 70W148
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -25 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.4 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 579 MPa
FLOW STRENGTH= 634 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

$a/W)_i = .538$

SPECIMEN CLEAVED AT $K = 121.6 \text{ MPa SQR(m)}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 124.6 kJ/m²
KJc= 161.2 MPa SQR(m)
K-beta-c= 97.4 MPa SQR(m)

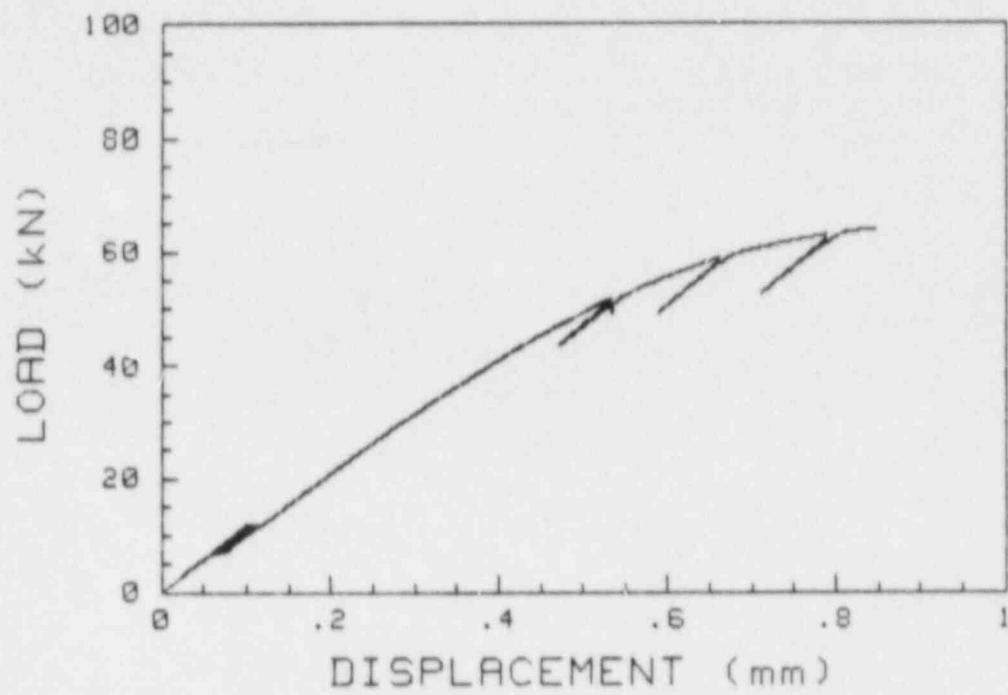
VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 123.3 kJ/m²
KJc= 160.4 MPa SQR(m)
K-beta-c= 97.2 MPa SQR(m)



70W148

-25 DEGREES C



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/m²
 KJ-MAX LOAD= 182.2 MPa SQR(m)

POWER LAW PROCEDURE

 J_{Ic}= 102.3 kJ/m²
 K-J_{Ic}= 143.1 MPa SQR(m)
 POWER= .5005
 COEFFICIENT= 207.3 kJ/m²
 T (AVERAGE)= 74

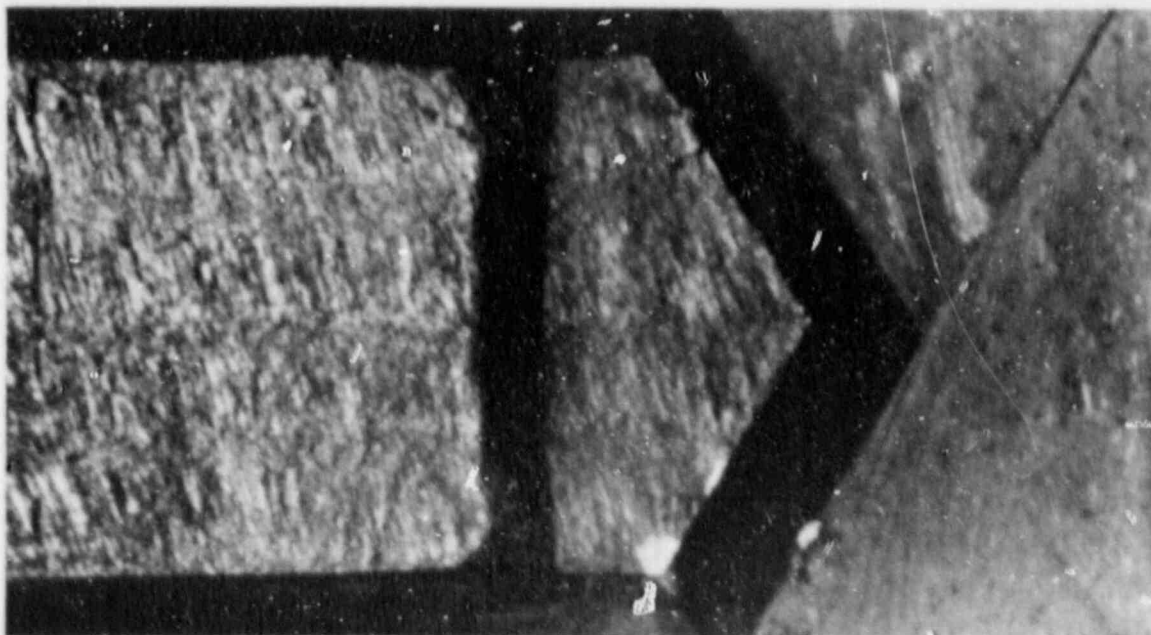
ASTM LINEAR PROCEDURE

 J_{Ic}= 79.5 kJ/m²
 K-J_{Ic}= 126.2 MPa SQR(m)
 SLOPE= 126247 kJ/m³
 INTERCEPT= 70.3 kJ/m²
 T (ASTM)= 85
 VALID, E813

J1-R CURVE CALCULATIONS

 J (@J/T=8.8)= 357.5 kJ/m²
 POWER= .5131
 J-MAX ALLOWED= 554.2 kJ/m²
 RCURVE INVALID, 1 2 3

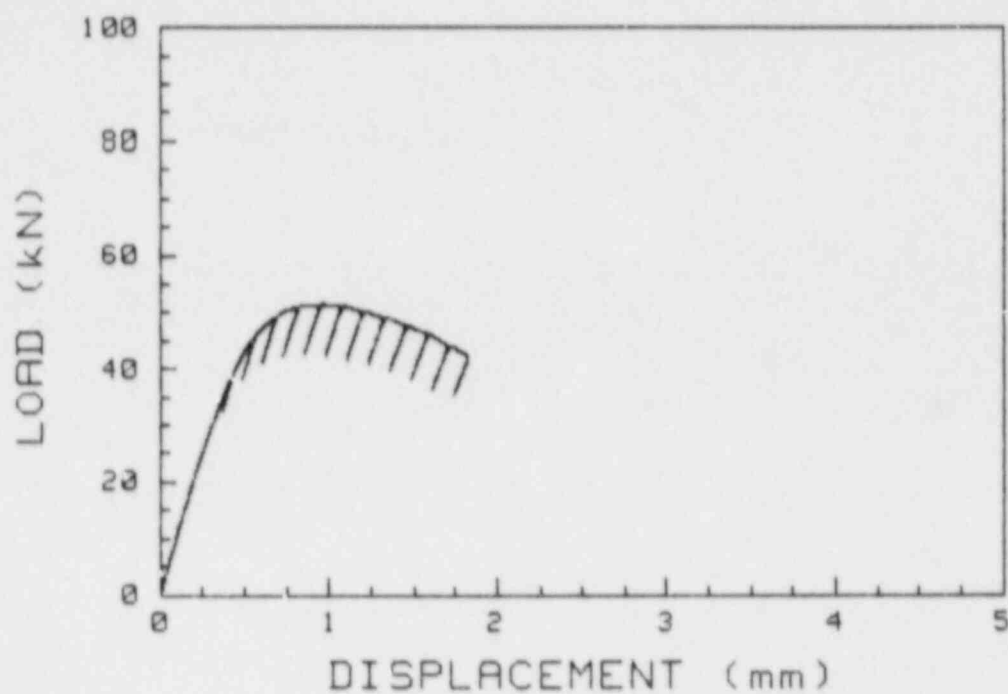
COEFFICIENT= 202.1 kJ/m²
 DELTA-A MAX ALLOWED= 2.26 mm



ORNL-DWG 87-8092

71W101

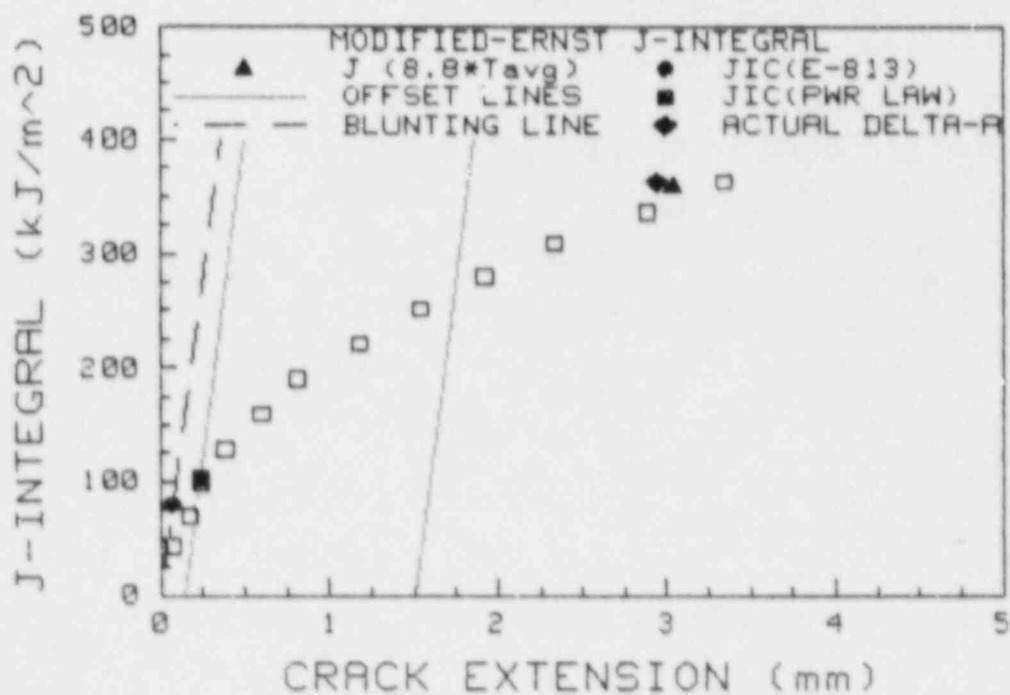
121 DEGREES C



ORNL-DWG 87-8093

71W101

121 DEGREES C



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

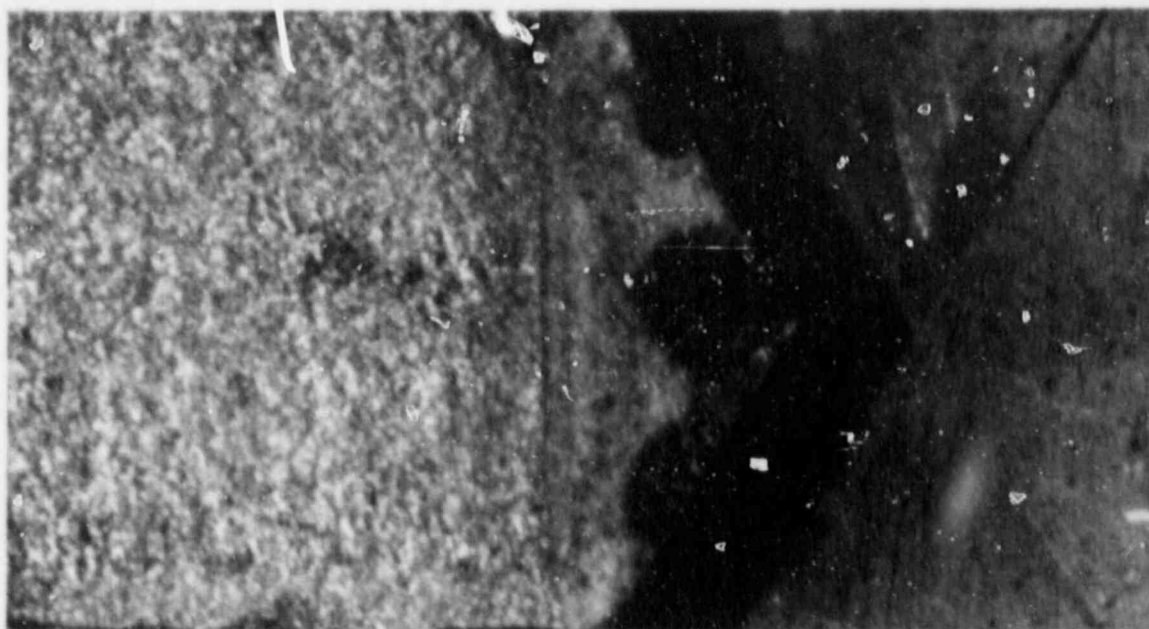
SPECIMEN CLEAVED AT $K = 65.1 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 20.1 kJ/m²
KJc= 65.2 MPa SQR[m]
K-beta-c= 59.9 MPa SQR[m]

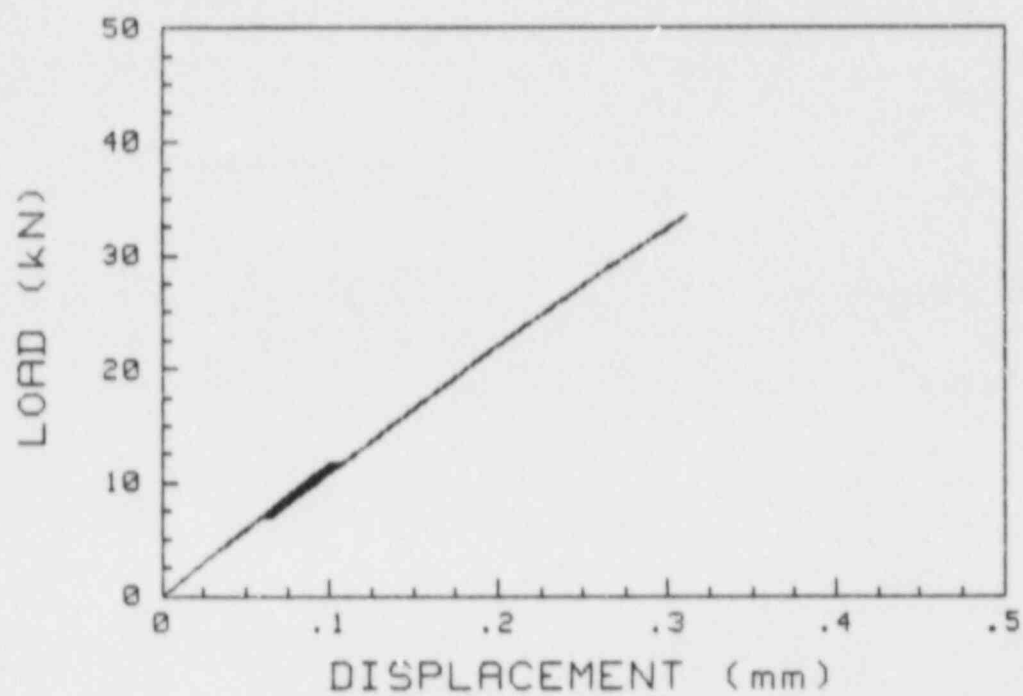
VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 20.1 kJ/m²
KJc= 65.2 MPa SQR[m]
K-beta-c= 59.9 MPa SQR[m]



71W108

-70 DEGREES C



SPECIMEN ID= 71W111
 MATERIAL TYPE= A533BW
 TEST TEMPERATURE= -30 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 27.5 mm
 MEASURED DUCTILE DELTA-A= .05 mm
 YIELD STRENGTH= 579 MPa
 FLOW STRENGTH= 635 MPa
 ESTIMATED YOUNG'S MODULUS= 209 GPa

$a/W)i = .542$

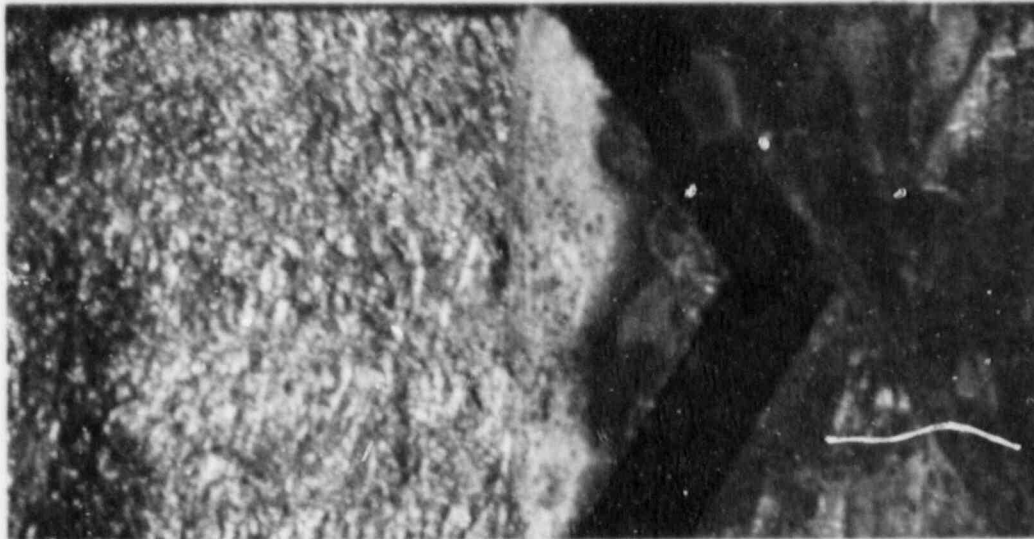
SPECIMEN CLEAVED AT $K = 80.3 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 27.1 kJ/m²
 KJc= 75.3 MPa SQR[m]
 K-beta-c= 65 MPa SQR[m]

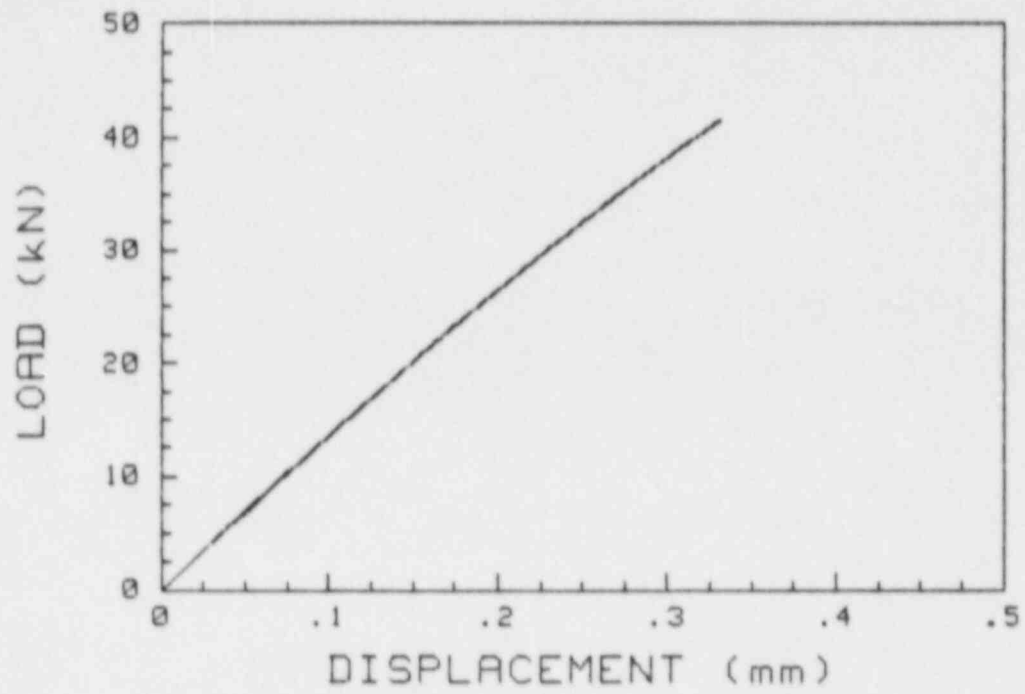
VALUES AT CLEAVAGE LOAD

 J-INTEGRAL= 27.1 kJ/m²
 KJc= 75.3 MPa SQR[m]
 K-beta-c= 65 MPa SQR[m]



71W111

-30 DEGREES C



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

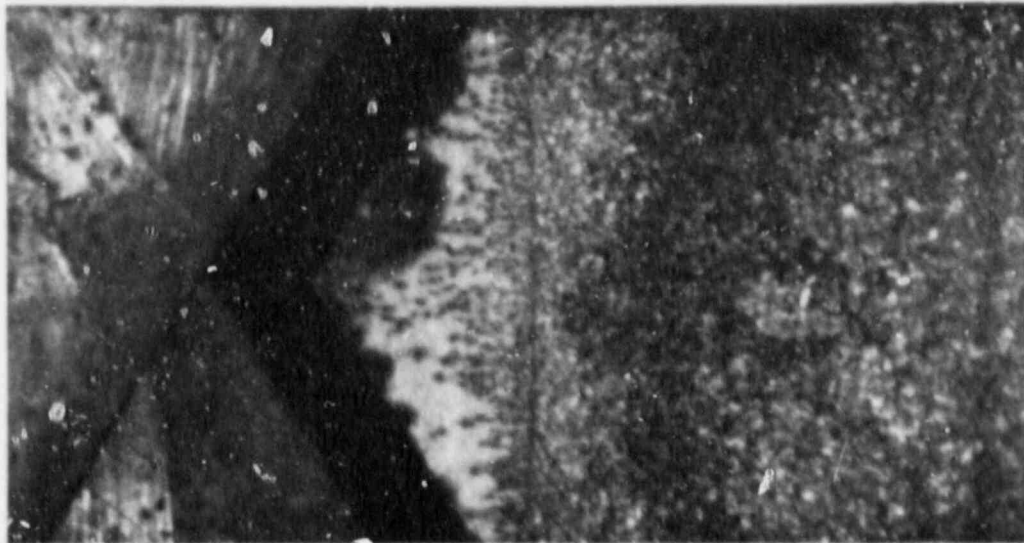
SPECIMEN CLEAVED AT $K_{Ic} = 61.9 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 15.7 kJ/m²
KJc= 57.6 MPa SQR[m]
K-beta-c= 54.2 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

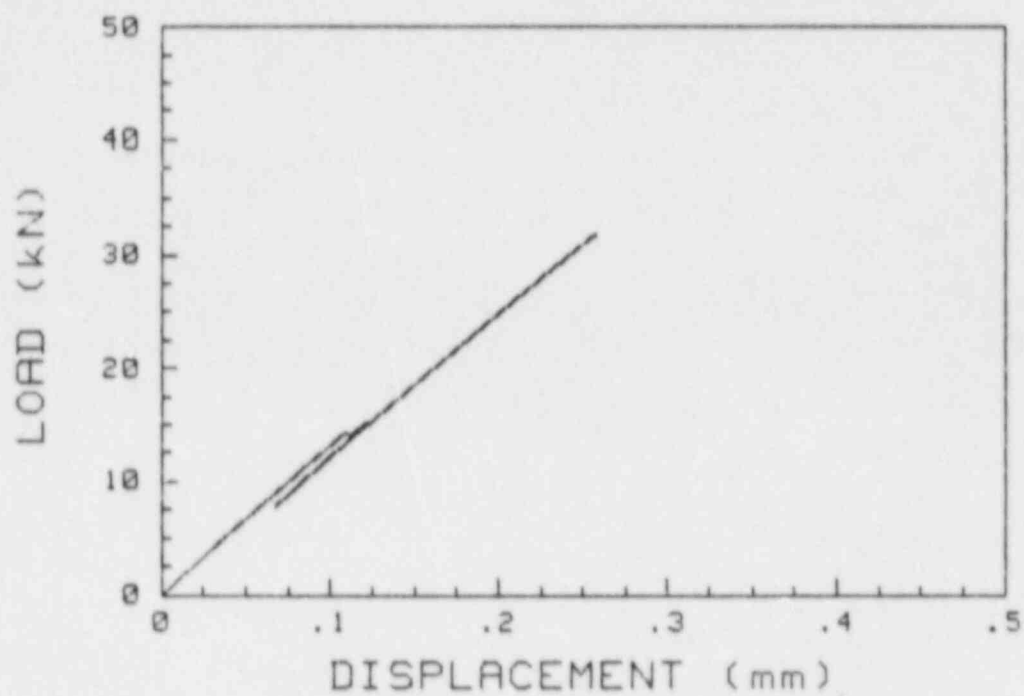
J-INTEGRAL= 15.7 kJ/m²
KJc= 57.6 MPa SQR[m]
K-beta-c= 54.2 MPa SQR[m]



ORNL-DWG 87-8096

71W116

-70 DEGREES C



SPECIMEN ID= 71W119
 TEST TEMPERATURE= 204 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 20 %
 INITIAL CRACK LENGTH= 27.8 mm $a/W)_1 = .546$
 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= 11.2 kJ/m²
 KJ-MAX LOAD= 177 MPa SQR(m)

POWER LAW PROCEDURE

 JIc= 106.5 kJ/m²
 K-JIc= 144.3 MPa SQR(m)
 POWER= .4144
 COEFFICIENT= 188.9 kJ/m²
 T (AVERAGE)= 59

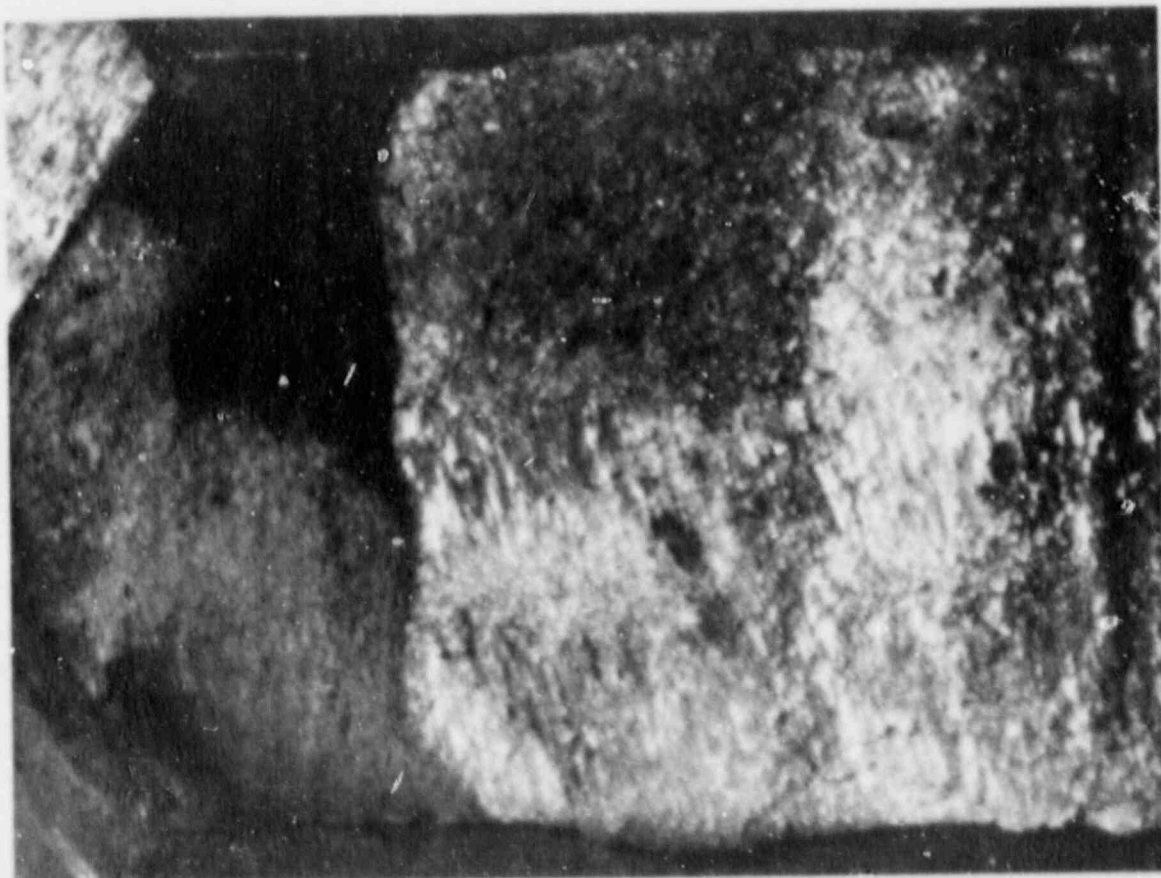
ASTM LINEAR PROCEDURE

 JIc= 114.1 kJ/m²
 K-JIc= 149.4 MPa SQR(m)
 SLOPE= 77975 kJ/m³
 INTERCEPT= 105.7 kJ/m²
 T (ASTM)= 55
 VALID, E813

J1-R CURVE CALCULATIONS

 J (QJ/T+8.8)= 276.9 kJ/m²
 POWER= .3963
 J-MAX ALLOWED= 535.4 kJ/m²
 RCURVE INVALID, 2

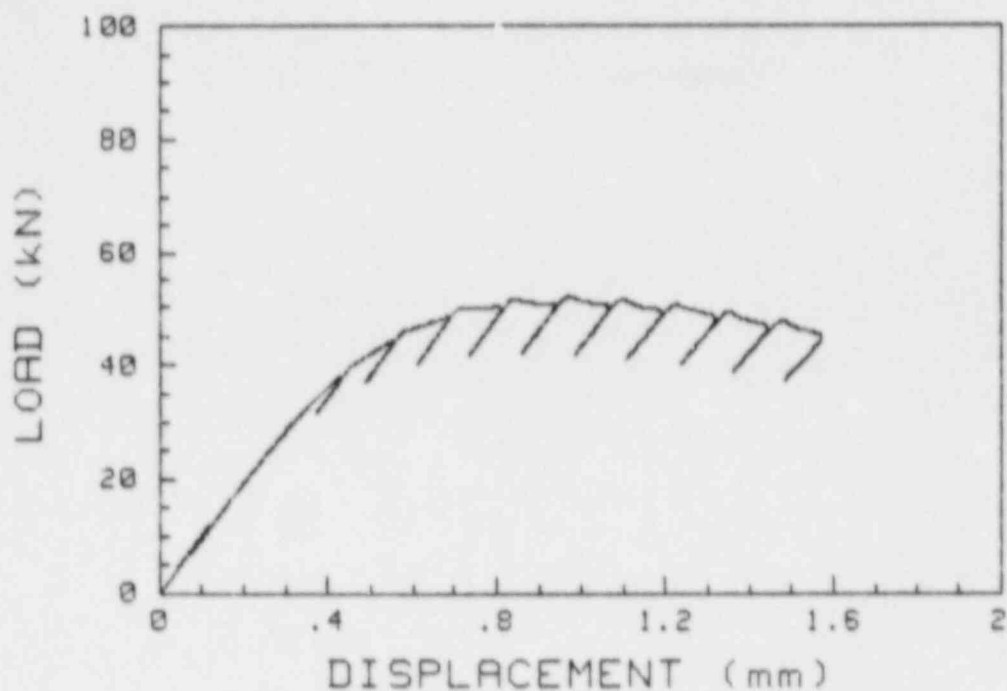
COEFFICIENT= 193.9 kJ/m²
 DELTA-A MAX ALLOWED= 2.3 mm



ORNL-DWG 87-8097

71W119

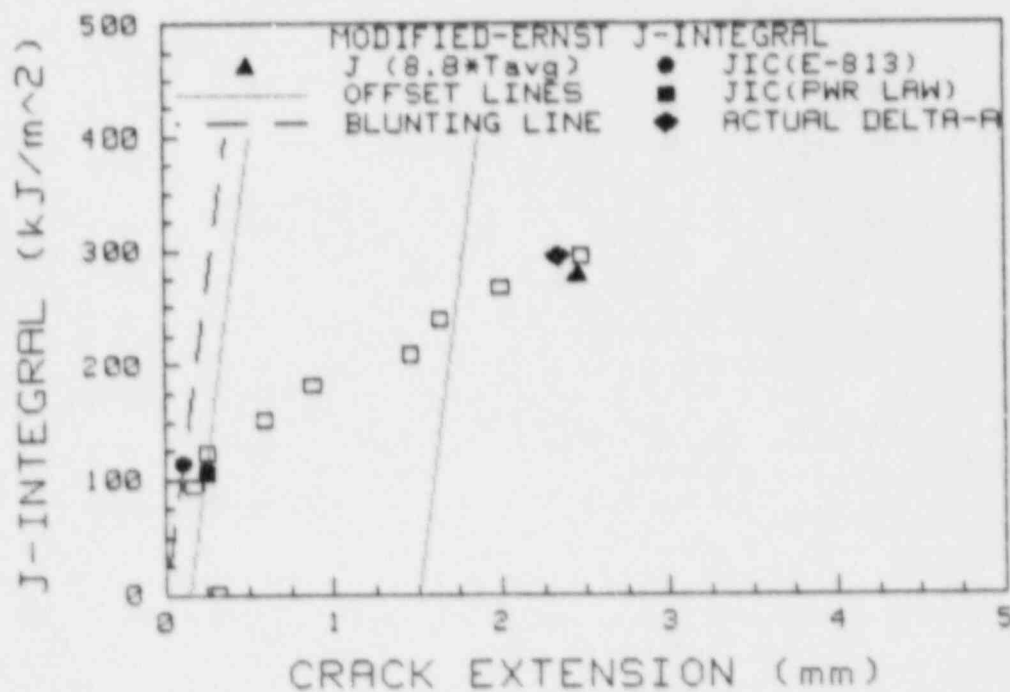
204 DEGREES C



ORNL-DWG 87-8098

71W119

204 DEGREES C



SPECIMEN ID= 71W122
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -13 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.7 mm $a/W)_1 = .546$
MEASURED DUCTILE DELTA-A= .09 mm
YIELD STRENGTH= 563 MPa
FLOW STRENGTH= 619 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

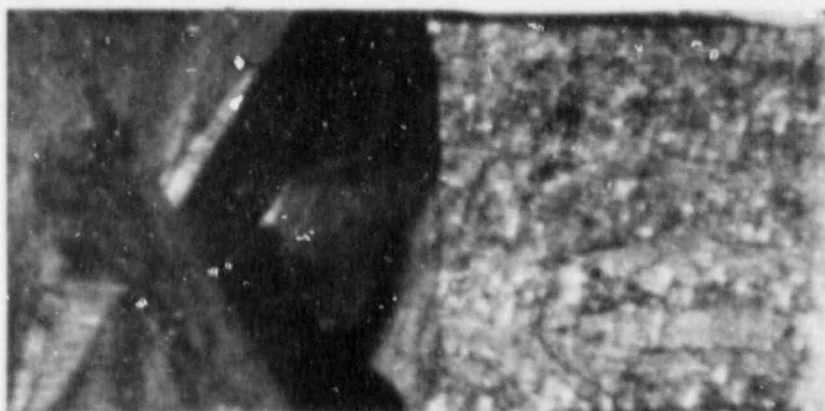
SPECIMEN CLEAVED AT $K = 103.2 \text{ MPa SQR(m)}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 57.4 kJ/m²
KJc= 109.3 MPa SQR(m)
K-beta-c= 79.8 MPa SQR(m)

VALUES AT CLEAVAGE LOAD

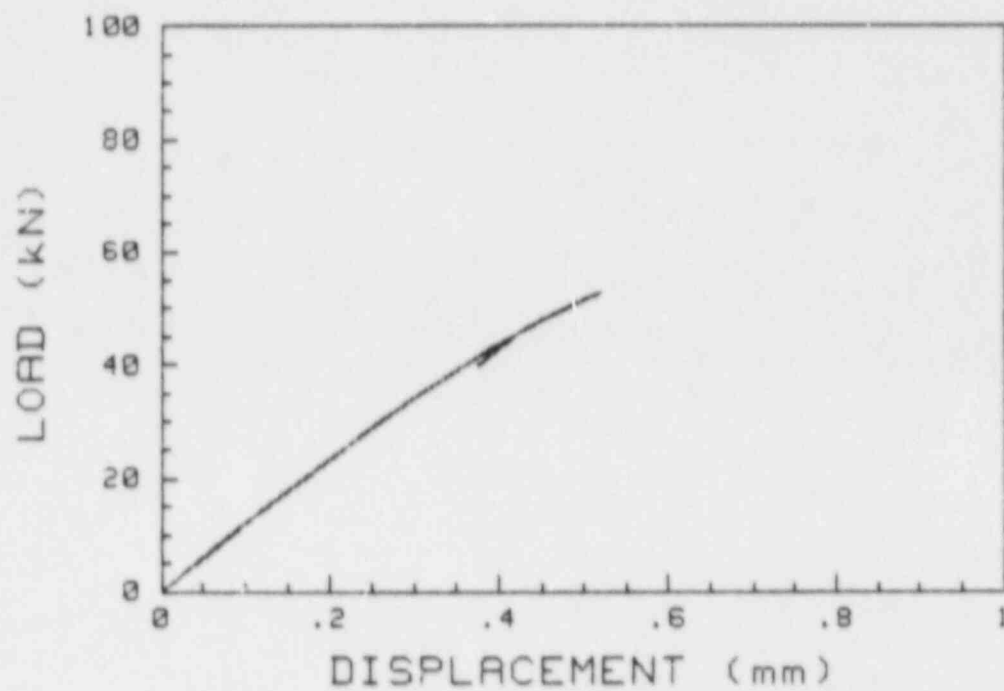
J-INTEGRAL= 57.4 kJ/m²
KJc= 109.3 MPa SQR(m)
K-beta-c= 79.8 MPa SQR(m)



ORNL-DWG 87-8099

71W122

-13 DEGREES C



SPECIMEN ID= 71W123
 TEST TEMPERATURE= 298 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 20 N
 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/m²
 KJ-MAX LOAD= 173 MPa SQR(m)

POWER LAW PROCEDURE

 J_{IC}= 105.9 kJ/m²
 K-J_{IC}= 142.2 MPa SQR(m)
 POWER= .3802
 COEFFICIENT= 179.6 kJ/m²
 T (AVERAGE)= 50

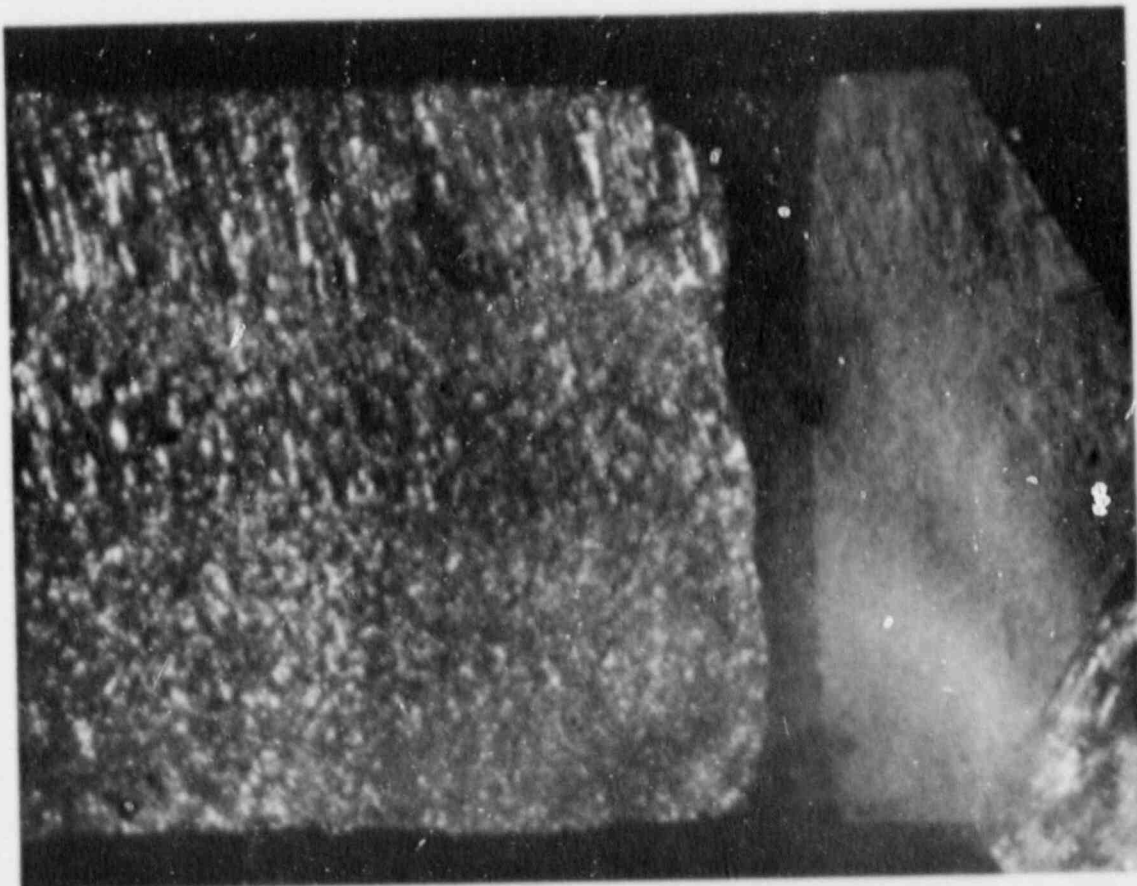
ASTM LINEAR PROCEDURE

 J_{IC}= 97 kJ/m²
 K-J_{IC}= 136.1 MPa SQR(m)
 SLOPE= 80665 kJ/m³
 INTERCEPT= 89.7 kJ/m²
 T (ASTM)= 54
 VALID, E813

J_I-R CURVE CALCULATIONS

 J (B/T=6.8)= 222.4 kJ/m²
 POWER= .3299
 J-MAX ALLOWED= 541.1 kJ/m²
 R_{CURVE} INVALID, 2

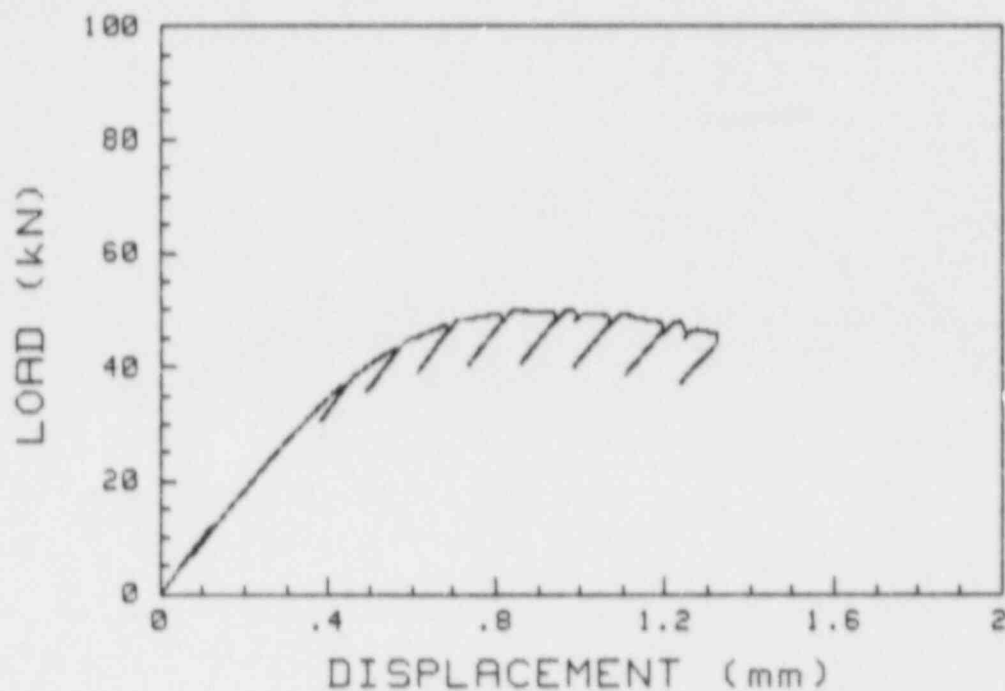
COEFFICIENT= 178.3 kJ/m²
 DELTA-A MAX ALLOWED= 2.28 mm



ORNL-DWG 87-8100

71W123

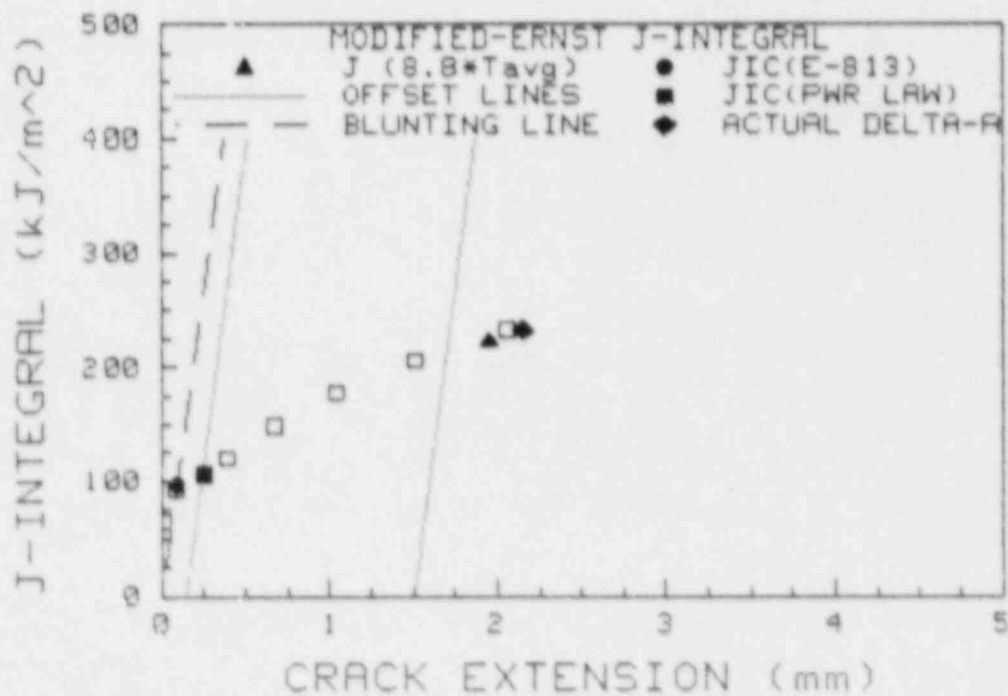
288 DEGREES C



ORNL-DWG 87-8101

71W123

288 DEGREES C



SPECIMEN ID= 71W126
 TEST TEMPERATURE= 204 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 20 %
 INITIAL CRACK LENGTH= 28 mm $a/W)_1 = .551$
 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/m²
 KJ-MAX LOAD= 179.5 MPa SQR(m)

POWER LAW PROCEDURE

 JIc= 118.2 kJ/m²
 K-JIc= 152.1 MPa SQR(m)
 POWER= .3562
 COEFFICIENT= 190.5 kJ/m²
 T (AVERAGE)= 52

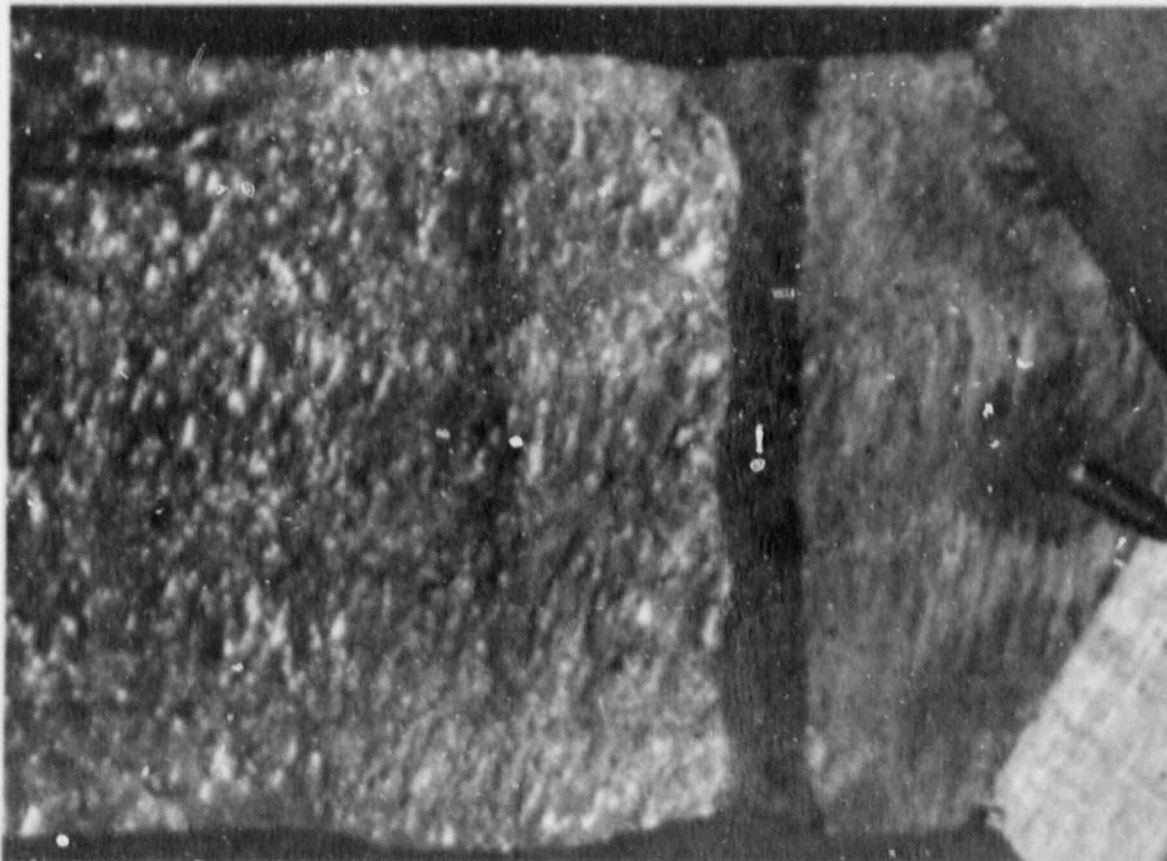
ASTM LINEAR PROCEDURE

 JIc= 102.9 kJ/m²
 K-JIc= 141.8 MPa SQR(m)
 SLOPE= 92797 kJ/m³
 INTERCEPT= 93.8 kJ/m²
 T (ASTM)= 65
 VALID, E813

J1-R CURVE CALCULATIONS

 J (8J/T=8.8)= 265.2 kJ/m²
 POWER= .3763
 J-MAX ALLOWED= 535.4 kJ/m²
 RCURVE INVALID, 2

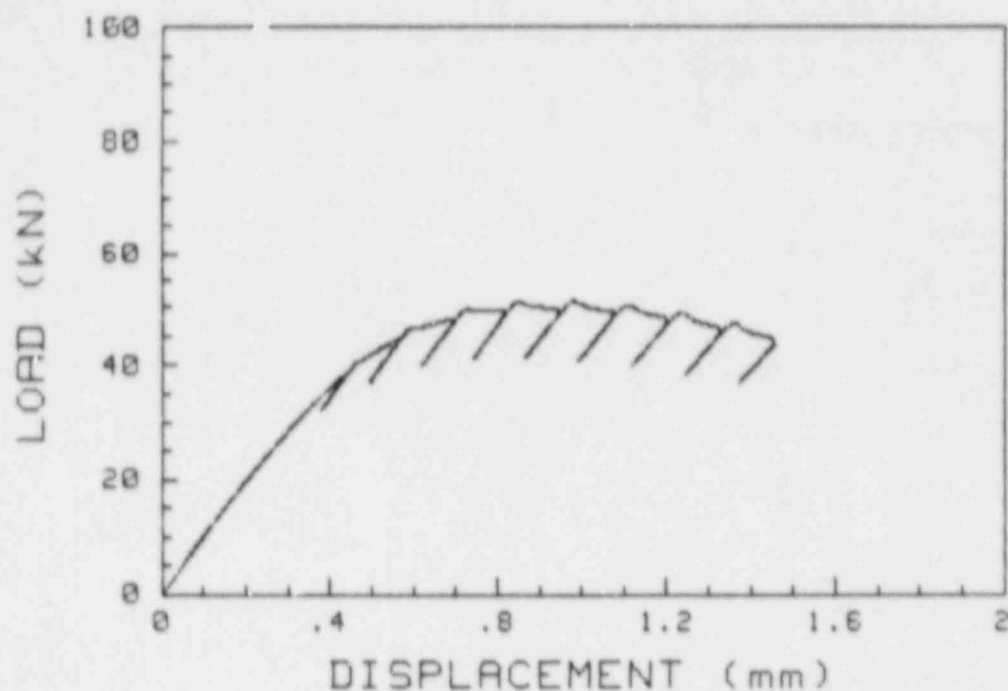
COEFFICIENT= 192.9 kJ/m²
 DELTA-A MAX ALLOWED= 2.28 mm



ORNL-DWG 87-8102

71W126

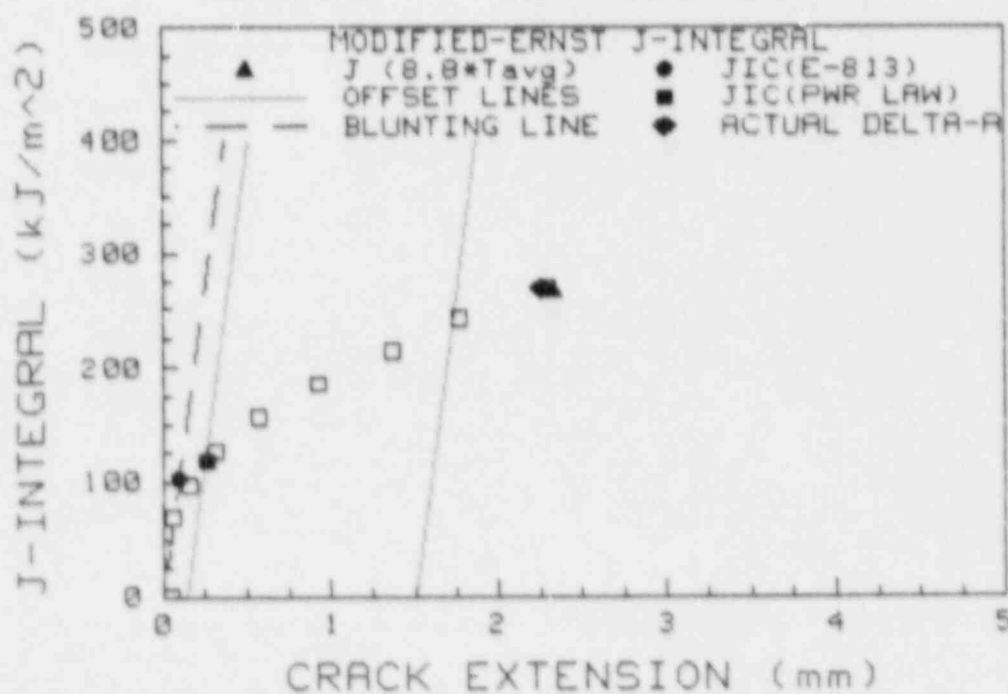
204 DEGREES C



ORNL-DWG 87-8103

71W126

204 DEGREES C



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= 109 MPa
 ESTIMATED YOUNG'S MODULUS= 207 GPa

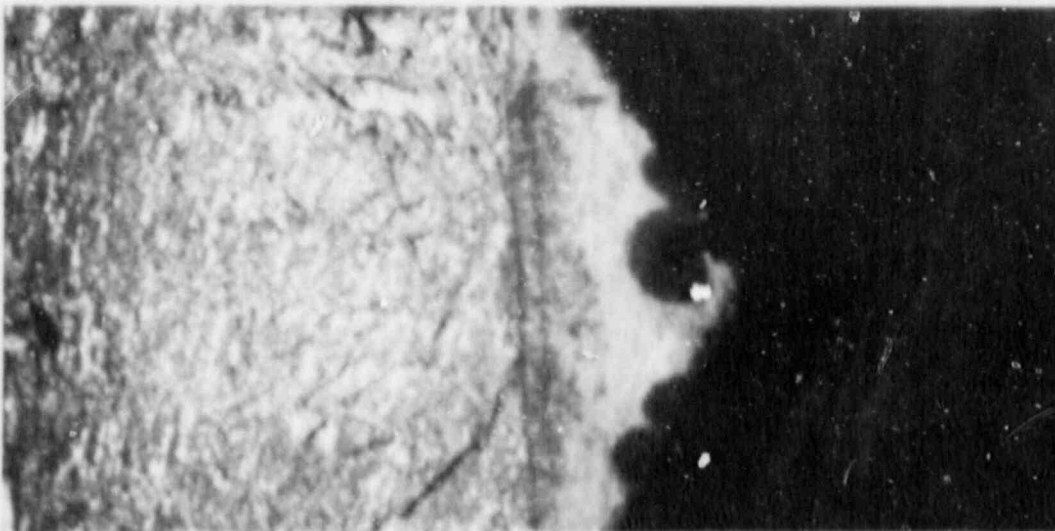
SPECIMEN CLEAVED AT $K = 108.1 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 74.5 kJ/m²
 $KJc = 124.3 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 84.2 \text{ MPa SQR[m]}$

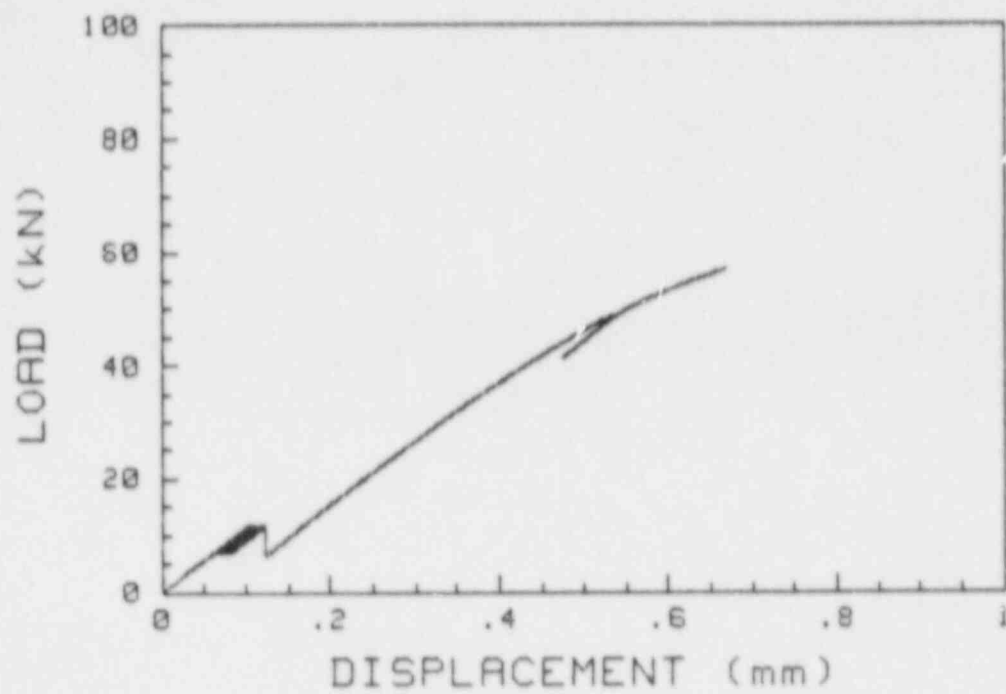
VALUES AT CLEAVAGE LOAD

 J-INTEGRAL= 74.5 kJ/m²
 $KJc = 124.3 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 84.2 \text{ MPa SQR[m]}$



71W133

0 DEGREES C



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/m²
 KJ-MAX LOAD= 183.1 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 122.3 kJ/m²
 K-JIc= 156.5 MPa SQR[m]
 POWER= .4516
 COEFFICIENT= 223.9 kJ/m²
 T (AVERAGE)= 71

ASTM LINEAR PROCEDURE

 JIc= 108.7 kJ/m²
 K-JIc= 147.6 MPa SQR[m]
 SLOPE= 117231 kJ/m³
 INTERCEPT= 97 kJ/m²
 T (ASTM)= 79
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 335.1 kJ/m²
 POWER= .4303
 J-MAX ALLOWED= 554.2 kJ/m²
 RCURVE INVALID, 2

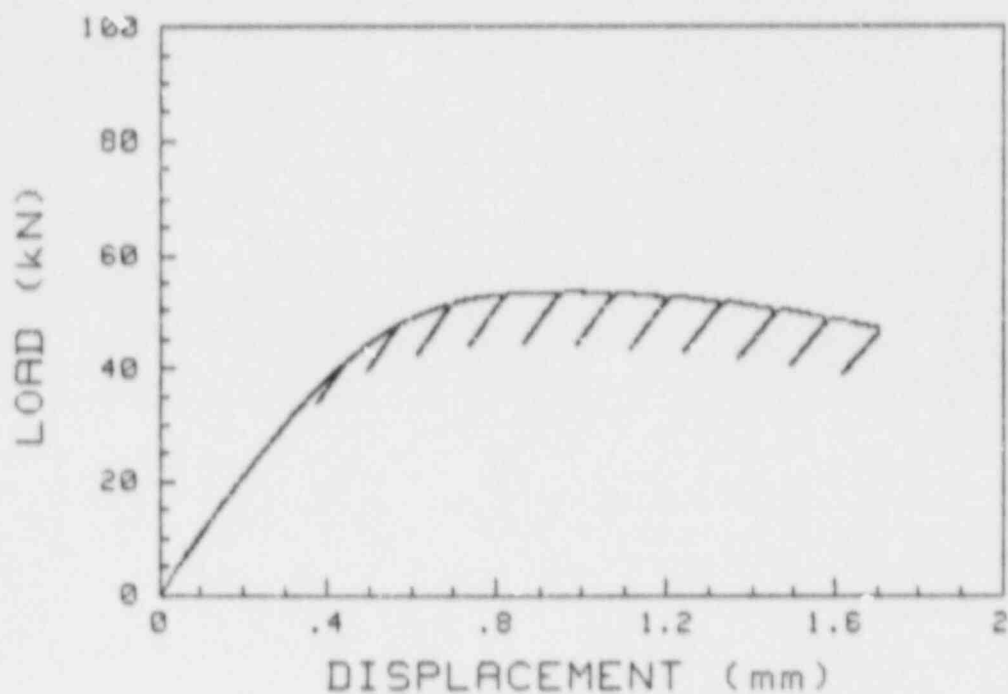
COEFFICIENT= 224.1 kJ/m²
 DELTA-A MAX ALLOWED= 2.34 mm



ORNL-DWG 87-8105

71W134

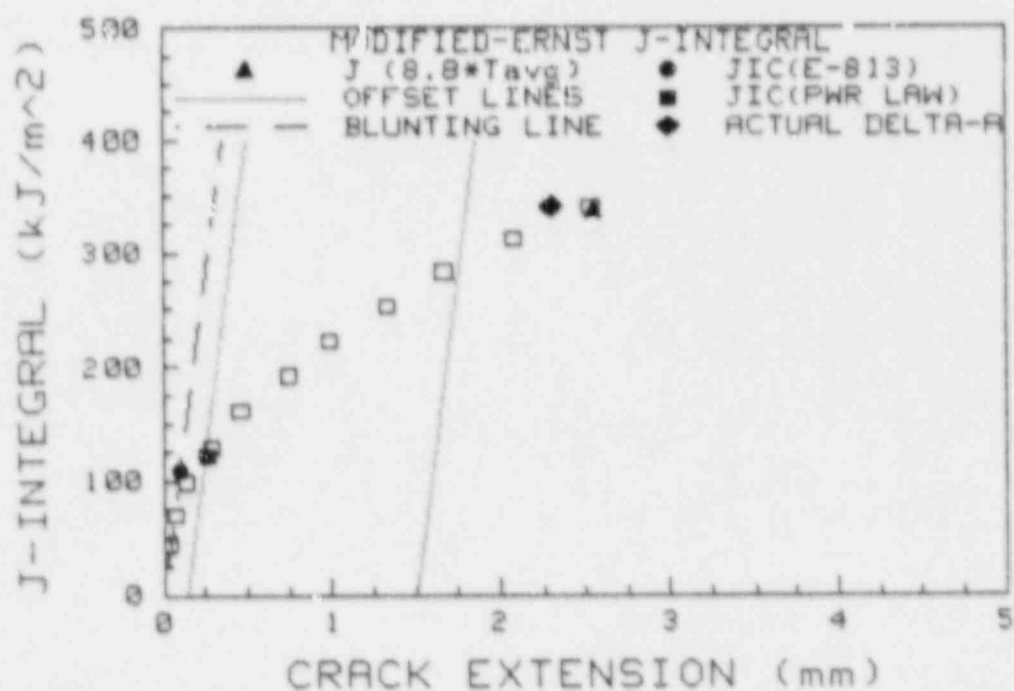
121 DEGREES C



ORNL-DWG 87-8106

71W134

121 DEGREES C



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/m²
 KJ-MAX LOAD= 169.7 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 154.9 kJ/m²
 K-JIc= 178.7 MPa SQR[m]
 POWER= .4434
 COEFFICIENT= 273 kJ/m²
 T (AVERAGE)= 71

ASTM LINEAR PROCEDURE

 JIc= 0 kJ/m²
 K-JIc= 0 MPa SQR[m]
 SLOPE= 0 kJ/m³
 INTERCEPT= 0 kJ/m²
 T (ASTM)= 0
 INVALID, 1 6

J1-R CURVE CALCULATIONS

 J (R/T=8.8)= 0 kJ/m²
 POWER= 0
 J-MAX ALLOWED= 684.2 kJ/m²
 RLURVE INVAL., 2 3

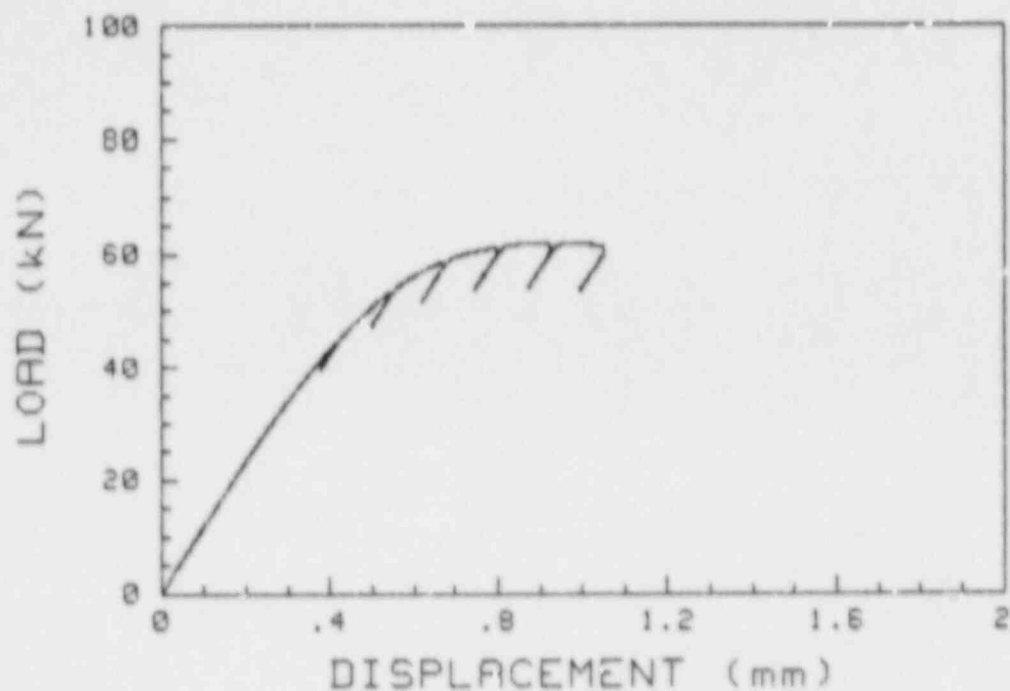
COEFFICIENT= 0 kJ/m²
 DELTA-A MAX ALLOWED= 2.27 mm



ORNL-DWG 87-8107

71W140

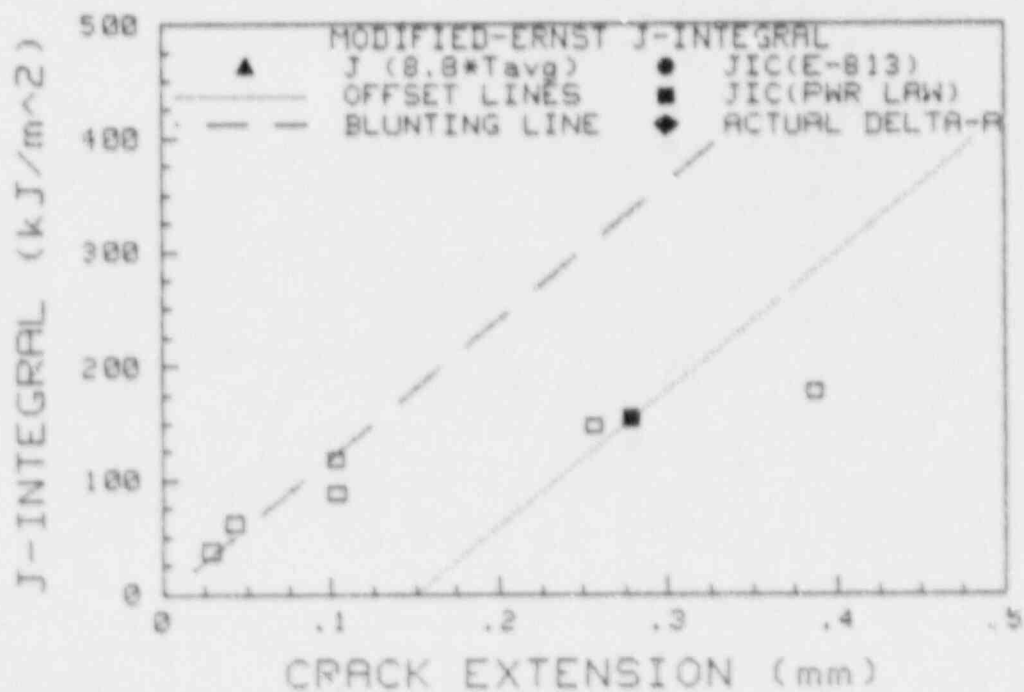
16 DEGREES C



ORNL-DWG 87-8108

71W140

16 DEGREES C



SPECIMEN ID= 71W141
 MATERIAL TYPE= 6533BW
 TEST TEMPERATURE= -70 DEG C
 THICKNESS =
 SIDE GROO
 INITIAL CRACK TH= 27.9 mm $a/W)i = .548$
 MEASURED DELTA-A= .05 mm
 YIELD STRESS= 522 MPa
 FLOW STRESS= 679 MPa
 ESTIMATED YOUNG'S MODULUS= 211 GPa

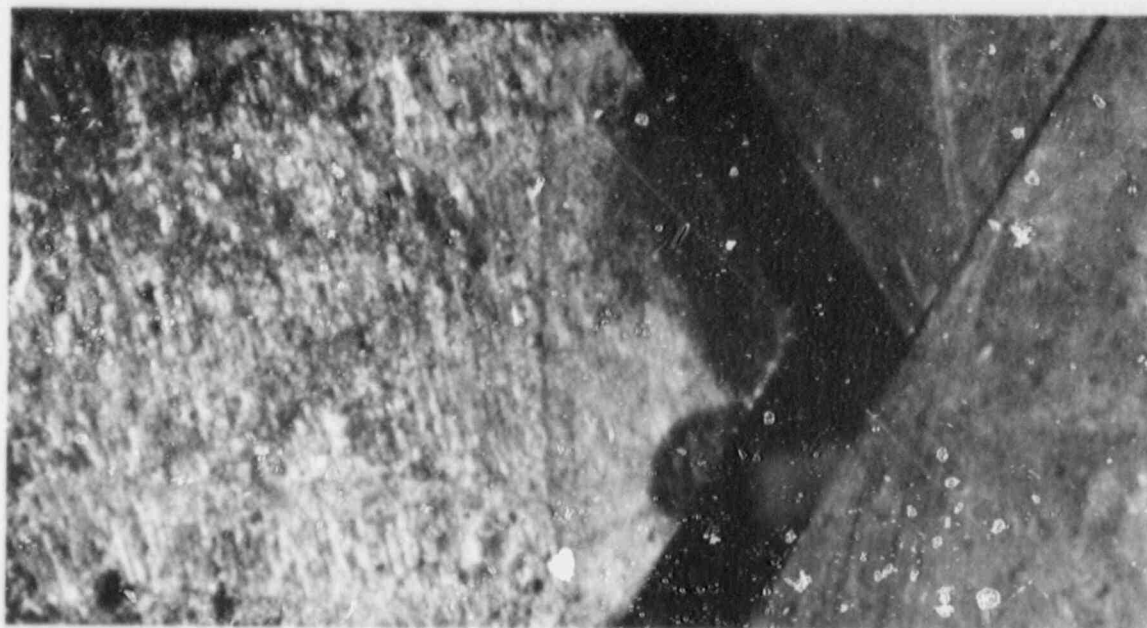
SPECIMEN CLEAVED AT $K = 68.2 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 21.7 kJ/m²
 $KJc = 67.7 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 61.6 \text{ MPa SQR[m]}$

VALUES AT CLEAVAGE LOAD

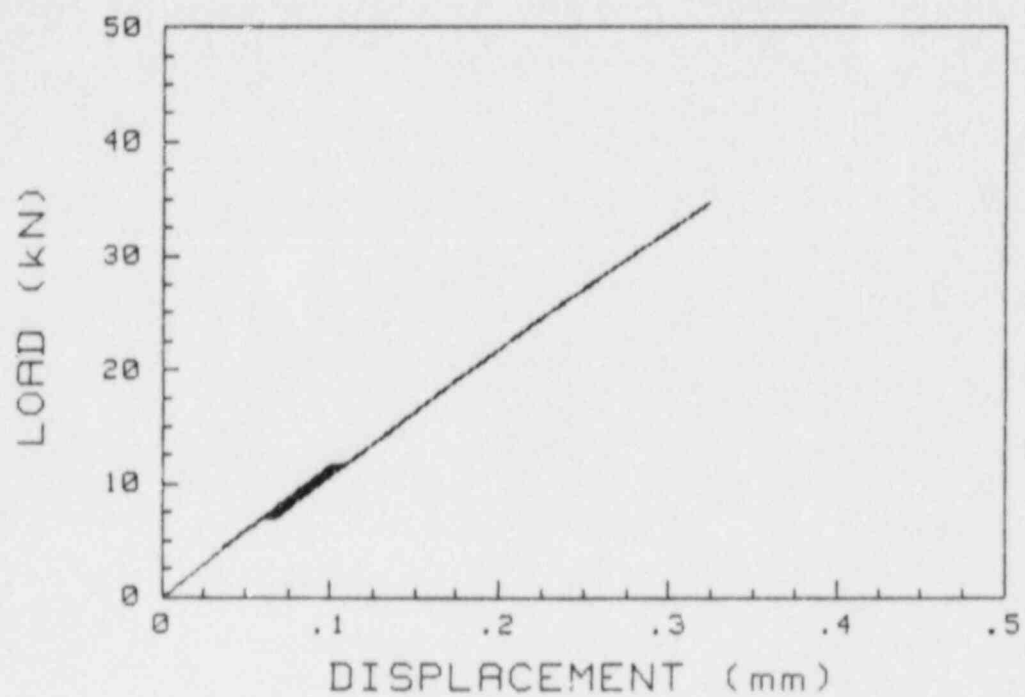
 J-INTEGRAL= 21.7 kJ/m²
 $KJc = 67.7 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 61.6 \text{ MPa SQR[m]}$



ORNL-DWG 87-8109

71W141

-70 DEGREES C



SPECIMEN ID= 71W142
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -30 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.7 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 579 MPa
FLOW STRENGTH= 635 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

$a/W)_i = .546$

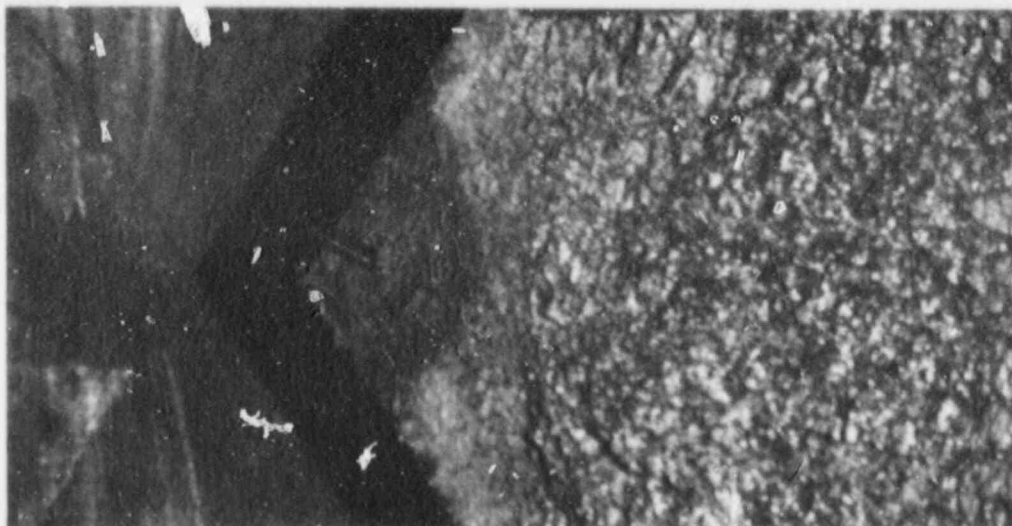
SPECIMEN CLEAVED AT $K = 98.9 \text{ MPa SQR[m]}$ (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 46.8 kJ/m²
KJc= 98.8 MPa SQR[m]
K-beta-c= 76.6 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

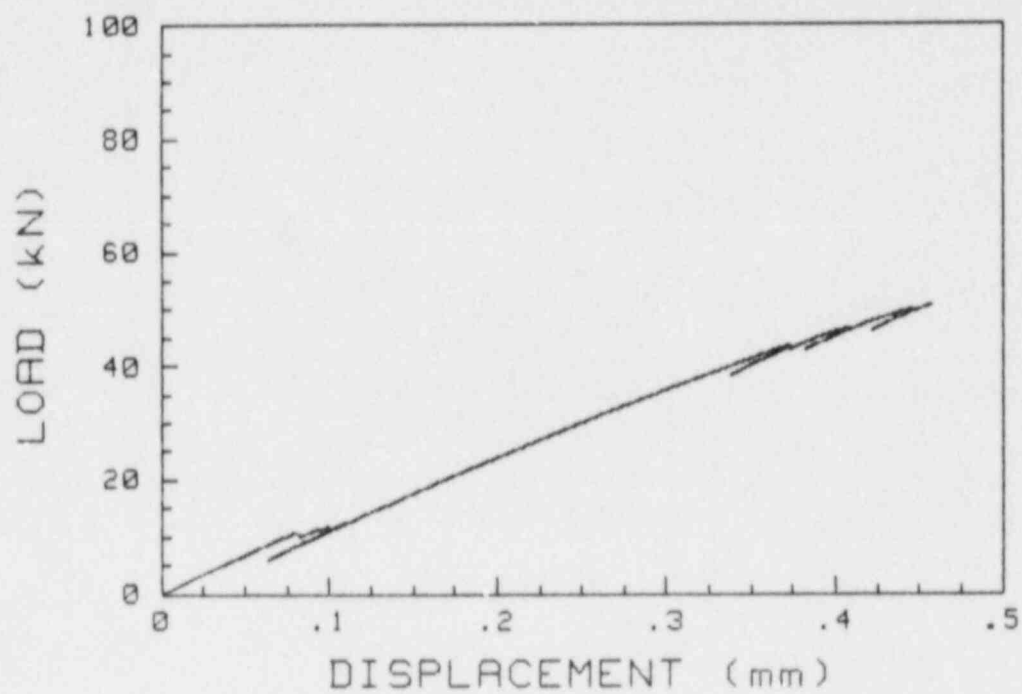
J-INTEGRAL= 46.6 kJ/m²
KJc= 98.7 MPa SQR[m]
K-beta-c= 76.5 MPa SQR[m]



ORNL-DWG 87-8110

71W142

-30 DEGREES C



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 $K_{Ic} = 36.6 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 5.6 kJ/m²

$K_{Jc} = 34.3 \text{ MPa SQR[m]}$

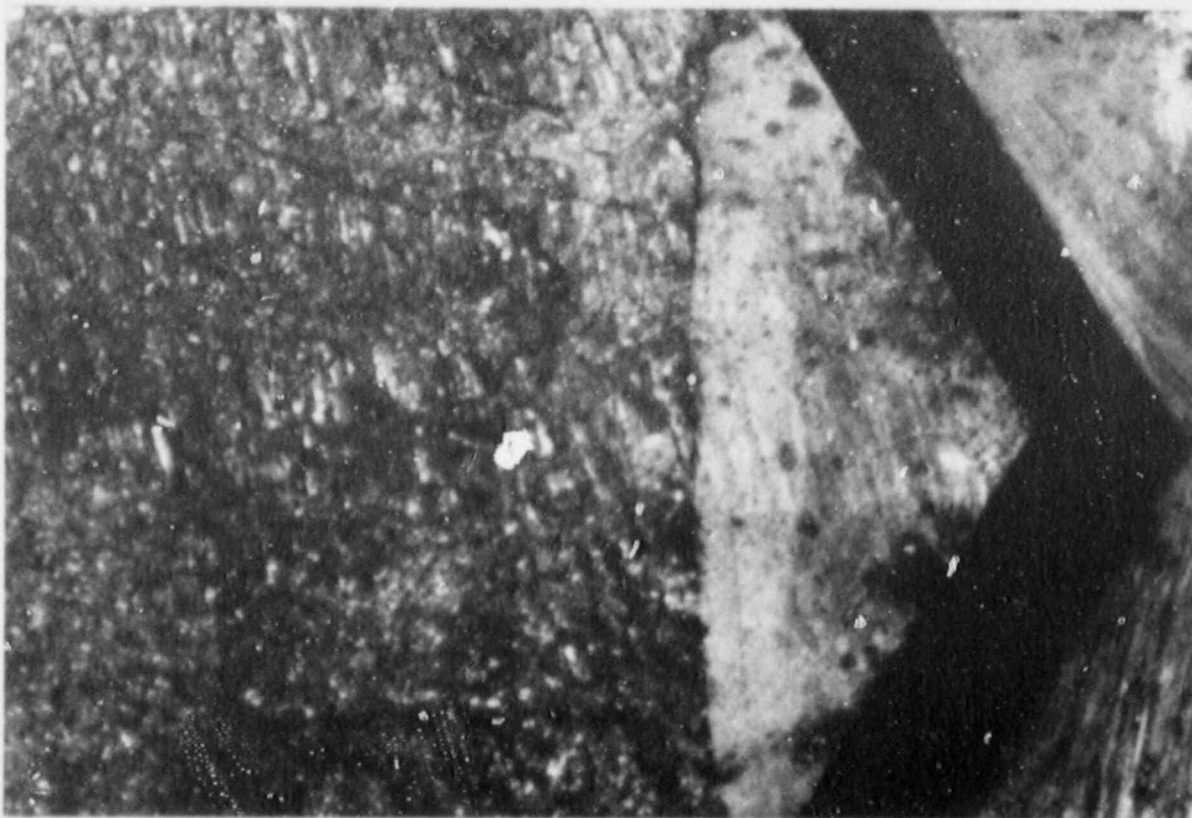
$K\text{-beta-c} = 33.8 \text{ MPa SQR[m]}$

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 5.6 kJ/m²

$K_{Jc} = 34.3 \text{ MPa SQR[m]}$

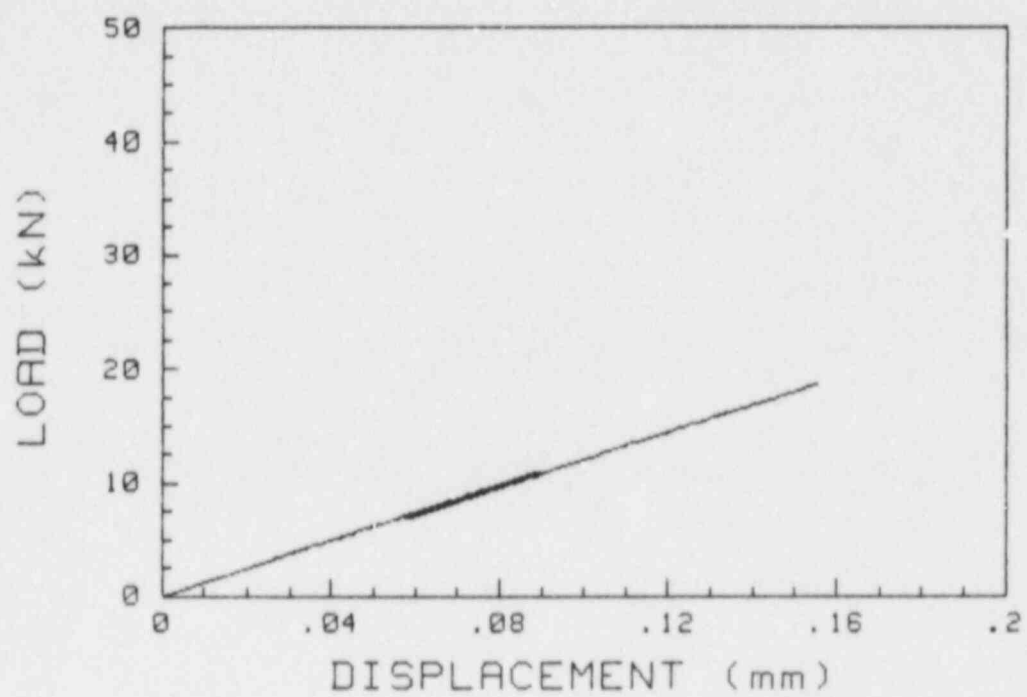
$K\text{-beta-c} = 33.8 \text{ MPa SQR[m]}$



ORNL-DWG 87-8111

71W143

-73 DEGREES C



SPECIMEN ID= 71W144
MATERIAL TYPE= A533BW
TEST TEMPERATURE= 0 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.4 mm
MEASURED DUCTILE DELTA-A= .18 mm
YIELD STRENGTH= 552 MPa
FLOW STRENGTH= 608 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

$a/W)i = .54$

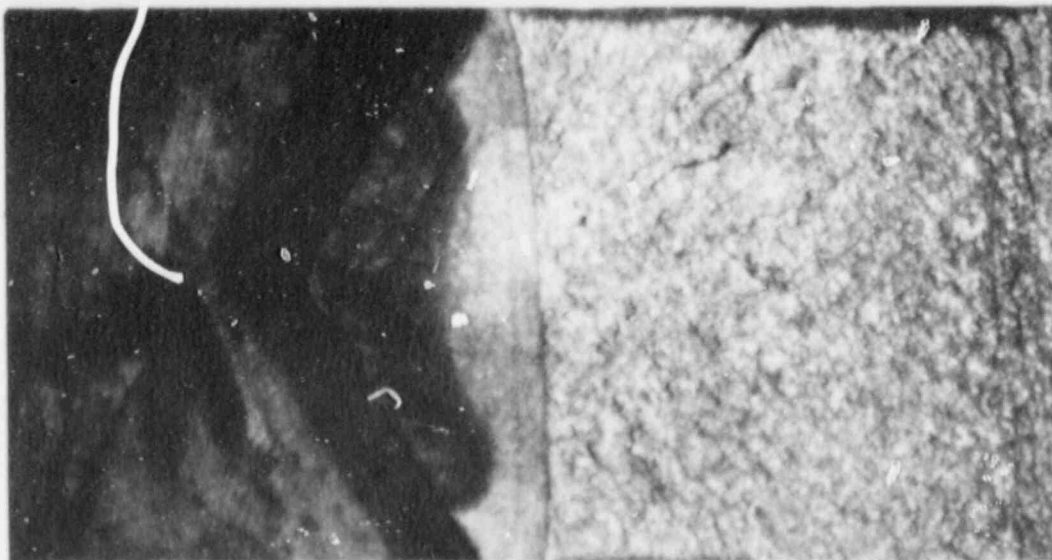
SPECIMEN CLEAVED AT $K = 117 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 123.6 kJ/m²
KJc= 160 MPa SQR[m]
K-beta-c= 94.5 MPa SQR[m]

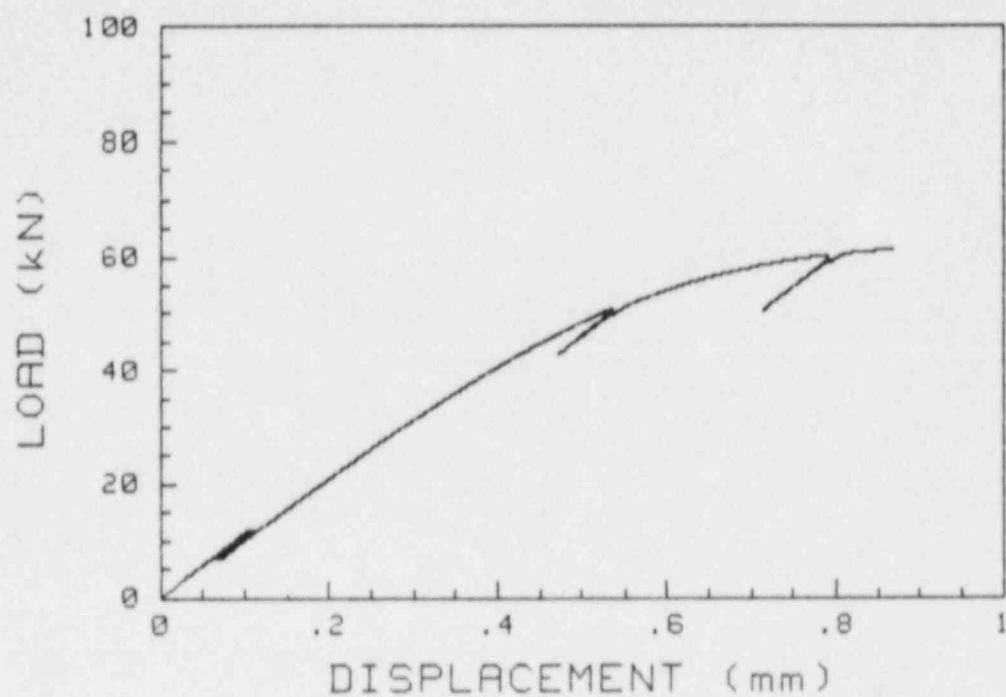
VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 125.1 kJ/m²
KJc= 161 MPa SQR[m]
K-beta-c= 94.8 MPa SQR[m]



71W144

0 DEGREES C



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/m²
 $KJc = 178.5$ MPa SQR[m]
 $K-beta-c = 90.2$ MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 243.7 kJ/m²
 $KJc = 223.2$ MPa SQR[m]
 $K-beta-c = 98.4$ MPa SQR[m]

POWER LAW PROCEDURE

$JIc = 97$ kJ/m²
 $K-JIc = 140.8$ MPa SQR[m]
 POWER= .5022
 COEFFICIENT= 201.4 kJ/m²
 T (AVERAGE)= 65

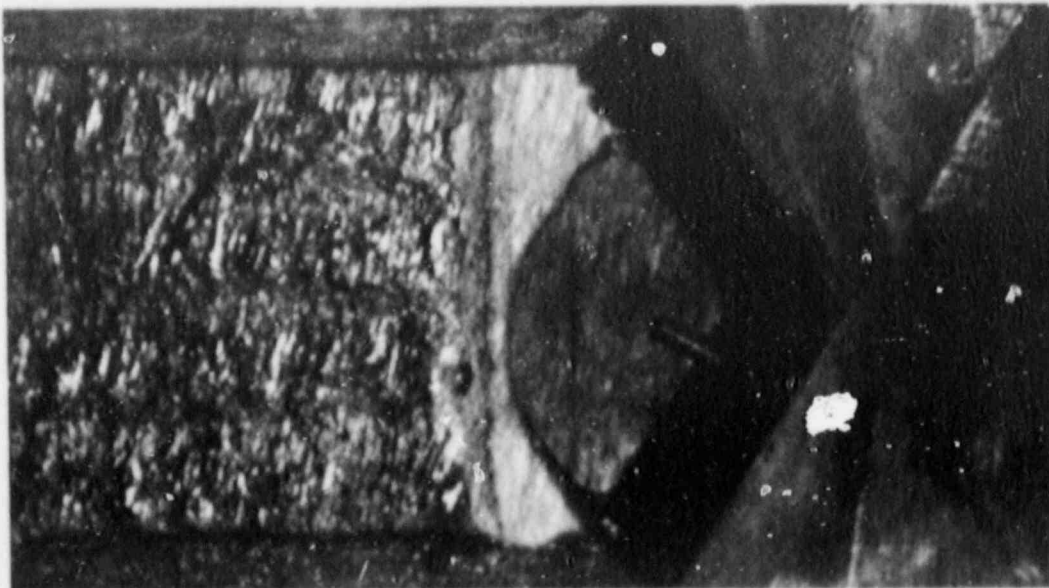
ASTM LINEAR PROCEDURE

$JIc = 74.7$ kJ/m²
 $K-JIc = 123.5$ MPa SQR[m]
 SLOPE= 127794 kJ/m³
 INTERCEPT= 66.5 kJ/m²
 T (ASTM)= 78
 VALID, E813

JI-R CURVE CALCULATIONS

$J (@J/T=8.8) = 341$ kJ/m²
 POWER= .5238
 $J-MAX ALLOWED = 589.7$ kJ/m²
 RCURVE INVALID, 2

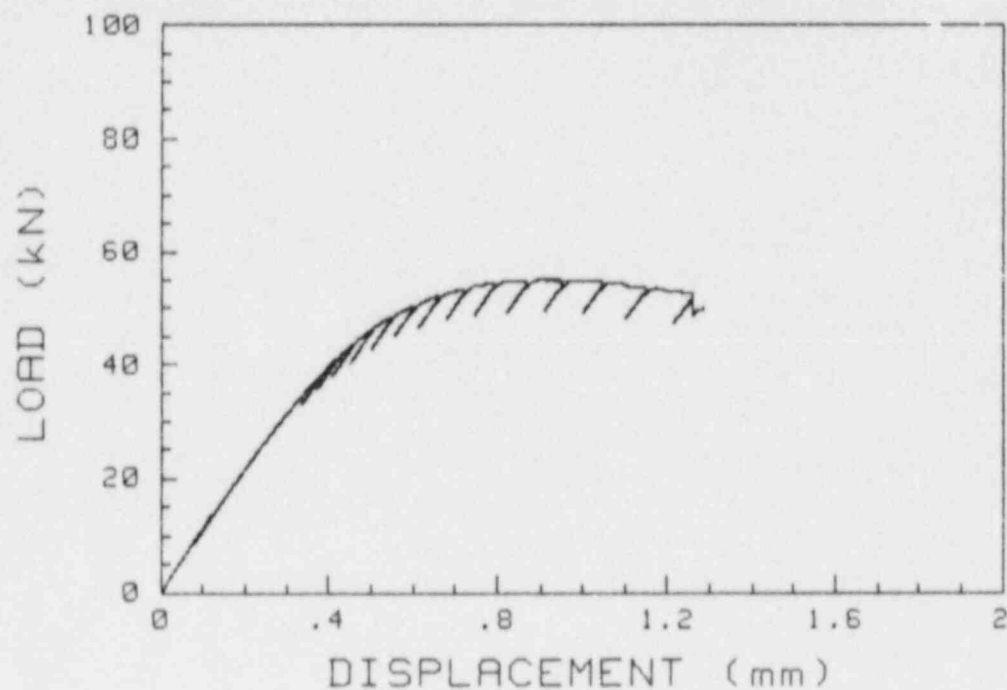
COEFFICIENT= 199 kJ/m²
 DELTA-A MAX ALLOWED= 2.43 mm



ORNL-DWG 87-8113

71W146

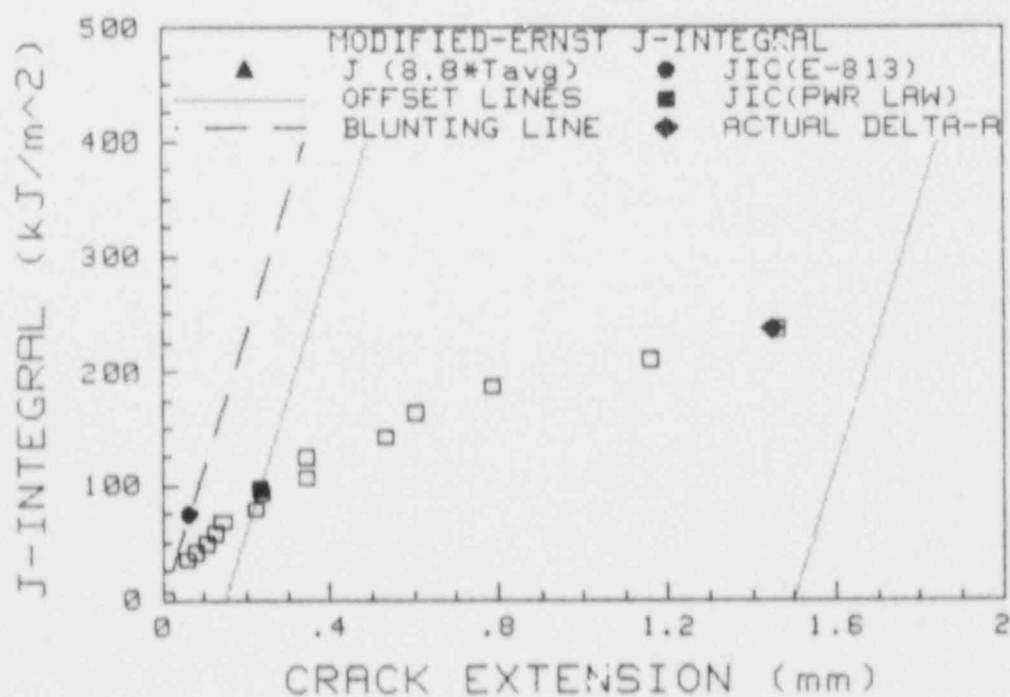
50 DEGREES C



ORNL-DWG 87-8114

71W146

50 DEGREES C



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/m²
 KJ-MAX LOAD= 172.4 MPa SQR(m)

POWER LAW PROCEDURE

Jlc= 104.1 kJ/m²
 K-Jlc= 141 MPa SQR(m)
 POWER= .3704
 COEFFICIENT= 174.6 kJ/m²
 T (AVERAGE)= 47

ASTM LINEAR PROCEDURE

Jlc= 95.9 kJ/m²
 K-Jlc= 135.2 MPa SQR(m)
 SLOPE= 80692 kJ/m³
 INTERCEPT= 88.6 kJ/m²
 T (ASTM)= 54
 VALID, E813

J1-R CURVE CALCULATIONS

J (@J/T=8.8)= 234.1 kJ/m²
 POWER= .3676
 J-MAX ALLOWED= 541.1 kJ/m²
 RCURVE INVALID, 2

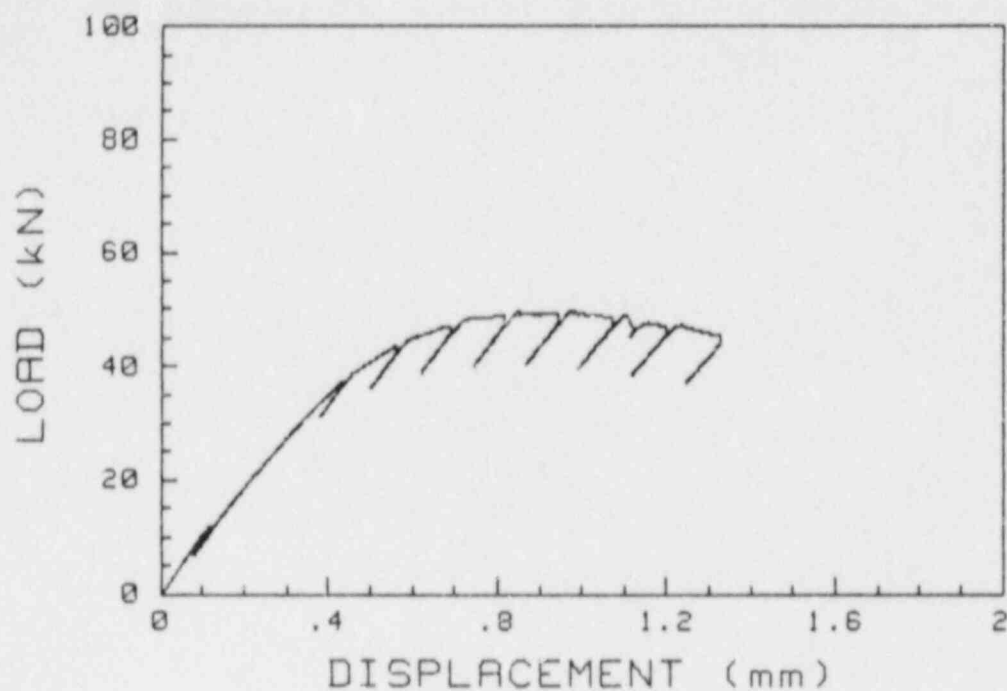
COEFFICIENT= 175.9 kJ/m²
 DELTA-A MAX ALLOWED= 2.3 mm



ORNL-DWG 87-8115

71W147

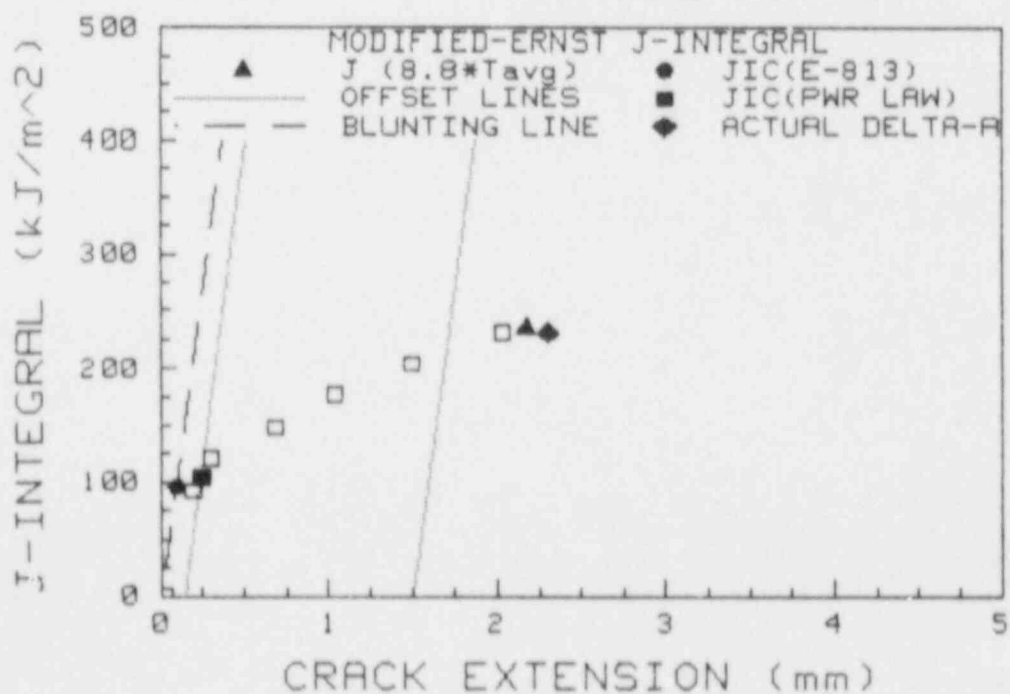
288 DEGREES C



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71W147

288 DEGREES C



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5. AUTHOR(S) J. J. McGowan, R. K. Nanstad, and K. R. Thoms			4. DATE REPORT COMPLETED <table border="1"> <tr> <td>MONTH</td> <td>YEAR</td> </tr> <tr> <td>June</td> <td>1988</td> </tr> </table>			MONTH	YEAR	June	1988
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