Irradiation Effects on Fracture Toughness of Two High-Copper Submerged-Arc Welds, HSSI Series 5

Appendices E and F

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Prepared for
U.S. Nuclear Regulatory Commission

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Appendices E and F

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Abstract

The Fifth Irradiation Series in the Heavy-Section Steel Irradiation (HSSI) Program was aimed at obtaining a statistically significant fracture toughness data base on two weldments with high-copper contents to determine the shift and shape of the K_{Ic} curve as a consequence of irradiation. The program included irradiated Charpy V-notch impact, tensile, and drop-weight specimens in addition to compact fracture toughness specimens. Compact specimens with thicknesses of 25.4, 50.8, and 101.6 mm [1T C(T), 2T C(T), and 4T C(T), respectively] were irradiated. Additionally, unirradiated 6T C(T) and 8T C(T) specimens with the same K_{Ic} measuring capacity as the irradiated specimens were tested. The materials for this irradiation series were two weldments fabricated from special heats of weld wire with copper added to the melt. One lot of Linde 0124 flux was used for all the welds. Copper levels for the two welds are 0.23 and 0.31 wt %, while the nickel contents for both welds are 0.60 wt %.

Twelve capsules of specimens were irradiated in the poolside facility of the Oak Ridge Research Reactor at a nominal temperature of 288°C and an average fluence of about 1.5×10^{19} neutrons/cm² (>1 MeV). The Charpy 41-J temperature shifts are about the same as the corresponding drop-weight nil-ductility transition temperature shifts. The

Charpy data were analyzed by various curve-fitting techniques, as well as a Weibull-based parametric analysis, to determine standard errors and associated temperature intervals. The irradiated welds exhibited substantial numbers of cleavage pop-ins that were judged significant and included in the data base for analysis. Mean curve fits using two-parameter (with fixed intercept) nonlinear and linearized exponential regression analyses revealed that the fracture toughness shifts (at 100 MPa•√m) exceeded the Charpy 41-J shifts for both welds. The same observation applies to the shifts of curves fit as lower boundaries to the fracture toughness data. The data were also analyzed to examine effects of precleavage ductile tearing, small-scale yielding limits, and the β_{Ic} adjustment. Those analyses provided essentially the same results as with the full data sets. Analyses of curve shape changes using the linearized model indicate irradiation-induced decreases in the slopes of the fracture toughness curves, especially for the higher copper weld. Three-parameter Weibull analyses were performed to investigate development of lower bound curves to the data, including the use of a variable K_{min} parameter. The results were used to compare various procedures for shifting the K_{Ic} curve to establish a suitable bounding curve for irradiated material.

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Previous Reports In Series

The work reported here was performed at Oak Ridge National Laboratory (ORNL) under the Heavy-Section Steel Irradiation (HSSI) Program, W. R. Corwin, Program Manager. The program is sponsored by the Office of Nuclear Regulatory Research of the U.S. Nuclear Regulatory Commission (NRC). The former and current technical monitors for the NRC are A. Taboada and E. Hackett, respectively.

This report is designated HSSI Report 7. It is published in two volumes. Volume 1 contains the main body with Appendices A, B, C, and D. Volume 2 contains only Appendices E and F, which provide detailed load-displacement traces, fracture surfaces, etc. In recognition of its large size, Vol. 2 will be distributed only to those in the RF distribution requesting a copy from the HSSI Program Office. Reports in this series are listed below:

1. F. M. Haggag, W. R. Corwin, and R. K. Nanstad, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Irradiation Effects on Strength and Toughness of Three-Wire Series-Arc Stainless Steel Weld Overlay Cladding*, NUREG/CR-5511 (ORNL/TM-11439), February 1990.
2. L. F. Miller, C. A. Baldwin, F. W. Stallman, and F. B. K. Kam, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Neutron Exposure Parameters for the Metallurgical Test Specimens in the Sixth Heavy-Section Steel Irradiation Series*, NUREG/CR-5409 (ORNL/TM-11267), March 1990.
3. S. K. Iskander, W. R. Corwin, and R. K. Nanstad, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Results of Crack-Arrest Tests on Two Irradiated High-Copper Welds*,

NUREG/CR-5584 (ORNL/TM-11575), December 1990.

4. R. K. Nanstad and R. G. Berggren, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., *Irradiation Effects on Charpy Impact and Tensile Properties of Low Upper-Shelf Welds, HSSI Series 2 and 3*, USNRC Report NUREG/CR-5696 (ORNL/TM-11804), August 1991.
5. R. E. Stoller, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., *Modeling the Influence of Irradiation Temperature and Displacement Rate on Radiation-Induced Hardening in Ferritic Steels*, USNRC Report NUREG/CR-5859 (ORNL/TM-12073), August 1992.
6. R. K. Nanstad, D. E. McCabe, and R. L. Swain, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., *Chemical Composition and RT_{NDT} Determinations For Midland Weld WF-70*, USNRC Report NUREG/CR-5914 (ORNL/TM-12157), to be published.

7. This report.

The HSSI Program includes both follow-on and the direct continuation of work that was performed under the Heavy-Section Steel Technology (HSST) Program. The HSST reports related to irradiation effects in pressure vessel materials and those containing unirradiated properties of materials used in HSSI and HSST irradiation programs are tabulated below as a convenience to the reader.

C. E. Childress, Union Carbide Corp. Nuclear Div., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Fabrication History of the First Two 12-in.-Thick A-533 Grade B, Class 1 Steel Plates of the Heavy Section Steel Technology Program*, ORNL-4313, February 1969.

T. R. Mager and F. O. Thomas, Westinghouse Electric Corporation, PWR Systems Division, Pittsburgh, Pa., *Evaluation by Linear Elastic Fracture Mechanics of Radiation Damage to*

Pressure Vessel Steels, WCAP-7328 (Rev.), October 1969.

P. N. Randall, TRW Systems Group, Redondo Beach, Calif., *Gross Strain Measure of Fracture Toughness of Steels*, HSSTP-TR-3, Nov. 1, 1969.

L. W. Loechel, Martin Marietta Corporation, Denver, Colo., *The Effect of Testing Variables on the Transition Temperature in Steel*, MCR-69-189, Nov. 20, 1969.

W. O. Shabbits, W. H. Pryle, and E. T. Wessel, Westinghouse Electric Corporation, PWR Systems Division, Pittsburgh, Pa., *Heavy-Section Fracture Toughness Properties of A533 Grade B Class 1 Steel Plate and Submerged Arc Weldment*, WCAP-7414, December 1969.

C. E. Childress, Union Carbide Corp. Nuclear Div., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Fabrication History of the Third and Fourth ASTM A-533 Steel Plates of the Heavy Section Steel Technology Program*, ORNL-4313-2, February 1970.

P. B. Crosley and E. J. Ripling, Materials Research Laboratory, Inc., Glenwood, Ill., *Crack Arrest Fracture Toughness of A533 Grade B Class 1 Pressure Vessel Steel*, HSSTP-TR-8, March 1970.

F. J. Loss, Naval Research Laboratory, Washington, D.C., *Dynamic Tear Test Investigations of the Fracture Toughness of Thick-Section Steel*, NRL-7056, May 14, 1970.

T. R. Mager, Westinghouse Electric Corporation, PWR Systems Div., Pittsburgh, Pa., *Post-Irradiation Testing of 2T Compact Tension Specimens*, WCAP-7561, August 1970.

F. J. Witt and R. G. Berggren, Union Carbide Corp. Nuclear Div., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Size Effects and Energy Disposition in Impact Specimen Testing of ASTM A533 Grade B Steel*, ORNL/TM-3030, August 1970.

D. A. Canonico, Union Carbide Corp. Nuclear Div., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Transition Temperature Considerations for Thick-Wall Nuclear Pressure Vessels*, ORNL/TM-3114, October 1970.

T. R. Mager, Westinghouse Electric Corporation, PWR Systems Div., Pittsburgh, Pa., *Fracture Toughness Characterization Study of A533, Grade B, Class 1 Steel*, WCAP-7578, October 1970.

W. O. Shabbits, Westinghouse Electric Corp., PWR Systems Div., Pittsburgh, Pa., *Dynamic Fracture Toughness Properties of Heavy Section A533 Grade B Class 1 Steel Plate*, WCAP-7623, December 1970.

C. E. Childress, Union Carbide Corp. Nuclear Div., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Fabrication Procedures and Acceptance Data for ASTM A-533 Welds and a 10-in.-Thick ASTM A-543 Plate of the Heavy Section Steel Technology Program*, ORNL-TM-4313-3, January 1971.

D. A. Canonico and R. G. Berggren, Union Carbide Corp. Nuclear Div., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Tensile and Impact Properties of Thick-Section Plate and Weldments*, ORNL/TM-3211, January 1971.

C. W. Hunter and J. A. Williams, Hanford Eng. Dev. Lab., Richland, Wash., *Fracture and Tensile Behavior of Neutron-Irradiated A533-B Pressure Vessel Steel*, HEDL-TME-71-76, February 6, 1971.

C. E. Childress, Union Carbide Corp. Nuclear Div., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Manual for ASTM A533 Grade B Class 1 Steel (HSST Plate 03) Provided to the International Atomic Energy Agency*, ORNL/TM-3193, March 1971.

P. N. Randall, TRW Systems Group, Redondo Beach, Calif., *Gross Strain Crack Tolerance of A533-B Steel*, HSSTP-TR-14, May 1, 1971.

C. L. Segaser, Union Carbide Corp. Nuclear Div., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Feasibility*

Study, Irradiation of Heavy-Section Steel Specimens in the South Test Facility of the Oak Ridge Research Reactor, ORNL/TM-3234, May 1971.

H. T. Corten and R. H. Sailors, University of Illinois, Urbana, Ill., *Relationship Between Material Fracture Toughness Using Fracture Mechanics and Transition Temperature Tests*, T&AM Report 346, August 1, 1971.

L. A. James and J. A. Williams, Hanford Eng. Dev. Lab., Richland, Wash., *Heavy Section Steel Technology Program Technical Report No. 21, The Effect of Temperature and Neutron Irradiation Upon the Fatigue-Crack Propagation Behavior of ASTM A533 Grade B, Class 1 Steel*, HEDL-TME 72-132, September 1972.

P. B. Crosley and E. J. Ripling, Materials Research Laboratory, Inc., Glenwood, Ill., *Crack Arrest in an Increasing K-Field*, HSSTP-TR-27, January 1973.

W. J. Stelzman and R. G. Berggren, Union Carbide Corp. Nuclear Div., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Radiation Strengthening and Embrittlement in Heavy-Section Steel Plates and Welds*, ORNL-4871, June 1973.

J. M. Steichen and J. A. Williams, Hanford Eng. Dev. Lab., Richland, Wash., *High Strain Rate Tensile Properties of Irradiated ASTM A533 Grade B Class 1 Pressure Vessel Steel*, HEDL-TME 73-74, July 1973.

J. A. Williams, Hanford Eng. Dev. Lab., Richland, Wash., *The Irradiation and Temperature Dependence of Tensile and Fracture Properties of ASTM A533, Grade B, Class 1 Steel Plate and Weldment*, HEDL-TME 73-75, August 1973.

J. A. Williams, Hanford Eng. Dev. Lab., Richland, Wash., *Some Comments Related to the Effect of Rate on the Fracture Toughness of Irradiated ASTM A533-B Steel Based on Yield Strength Behavior*, HEDL-SA 797, December 1974.

J. A. Williams, Hanford Eng. Dev. Lab., Richland, Wash., *The Irradiated Fracture Toughness of ASTM A533, Grade B, Class 1 Steel Measured with a*

Four-Inch-Thick Compact Tension Specimen, HEDL-TME 75-10, January 1975.

J. G. Merkle, G. D. Whitman, and R. H. Bryan, Union Carbide Corp. Nuclear Div., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *An Evaluation of the HSST Program Intermediate Pressure Vessel Tests in Terms of Light-Water-Reactor Pressure Vessel Safety*, ORNL/TM-5090, November 1975.

J. A. Davidson, L. J. Ceschini, R. P. Shogan, and G. V. Rao, Westinghouse Electric Corporation, Pittsburgh, Pa., *The Irradiated Dynamic Fracture Toughness of ASTM A533, Grade B, Class 1 Steel Plate and Submerged Arc Weldment*, WCAP-8775, October 1976.

J. A. Williams, Hanford Eng. Dev. Lab., Richland, Wash., *Tensile Properties of Irradiated and Unirradiated Welds of A533 Steel Plate and A508 Forgings*, NUREG/CR-1158 (ORNL/SUB-79/50917/2), July 1979.

J. A. Williams, Hanford Eng. Dev. Lab., Richland, Wash., *The Ductile Fracture Toughness of Heavy Section Steel Plate*, NUREG/CR-0859, September 1979.

K. W. Carlson and J. A. Williams, Hanford Eng. Dev. Lab., Richland, Wash., *The Effect of Crack Length and Side Grooves on the Ductile Fracture Toughness Properties of ASTM A533 Steel*, NUREG/CR-1171 (ORNL/SUB-79/50917/3), October 1979.

G. A. Clarke, Westinghouse Electric Corp., Pittsburgh, Pa., *An Evaluation of the Unloading Compliance Procedure for J-Integral Testing in the Hot Cell, Final Report*, NUREG/CR-1070 (ORNL/Sub-7394/1), October 1979.

P. B. Crosley and E. J. Ripling, Materials Research Laboratory, Inc., Glenwood, Ill., *Development of a Standard Test for Measuring K_{Ia} with a Modified Compact Specimen*, NUREG/CR-2294 (ORNL/SUB-81/7755/1), August 1981.

H. A. Domian, Babcock and Wilcox Company, Alliance, Ohio, *Vessel V-8 Repair and Preparation*

of Low Upper-Shelf Weldment, NUREG/CR-2676 (ORNL/Sub/81-85813/1), June 1982.

R. D. Cheverton, S. K. Iskander, and D. G. Ball, Union Carbide Corp. Nuclear Div., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *PWR Pressure Vessel Integrity During Overcooling Accidents: A Parametric Analysis*, NUREG/CR-2895 (ORNL/TM-7931), February 1983.

J. G. Merkle, Union Carbide Corp. Nuclear Div., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *An Examination of the Size Effects and Data Scatter Observed in Small Specimen Cleavage Fracture Toughness Testing*, NUREG/CR-3672 (ORNL/TM-9088), April 1984.

W. R. Corwin, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Assessment of Radiation Effects Relating to Reactor Pressure Vessel Cladding*, NUREG/CR-3671 (ORNL-6047), July 1984.

W. R. Corwin, R. G. Berggren, and R. K. Nanstad, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Charpy Toughness and Tensile Properties of a Neutron Irradiated Stainless Steel Submerged-Arc Weld Cladding Overlay*, NUREG/CR-3927 (ORNL/TM-9709), September 1984.

J. J. McGowan, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Tensile Properties of Irradiated Nuclear Grade Pressure Vessel Plate and Welds for the Fourth HSST Irradiation Series*, NUREG/CR-3978 (ORNL/TM-9516), January 1985.

J. J. McGowan, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Tensile Properties of Irradiated Nuclear Grade Pressure Vessel Welds for the Third HSST Irradiation Series*, NUREG/CR-4086 (ORNL/TM-9477), March 1985.

W. R. Corwin, G. C. Robinson, R. K. Nanstad, J. G. Merkle, R. G. Berggren, G. M. Goodwin, R. L. Swain, and T. D. Owings, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab.,

Oak Ridge, Tenn., *Effects of Stainless Steel Weld Overlay Cladding on the Structural Integrity of Flawed Steel Plates in Bending, Series 1*, NUREG/CR-4015 (ORNL/TM-9390), April 1985.

W. J. Stelzman, R. G. Berggren, and T. N. Jones, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *ORNL Characterization of Heavy-Section Steel Technology Program Plates 01, 02, and 03*, NUREG/CR-4092 (ORNL/TM-9491), April 1985.

G. D. Whitman, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Historical Summary of the Heavy-Section Steel Technology Program and Some Related Activities in Light-Water Reactor Pressure Vessel Safety Research*, NUREG/CR-4489 (ORNL-6259), March 1986.

R. H. Bryan, B. R. Bass, S. E. Bolt, J. W. Bryson, J. G. Merkle, R. K. Nanstad, and G. C. Robinson, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Test of 6-in.-Thick Pressure Vessels. Series 3: Intermediate Test Vessel V-8A — Tearing Behavior of Low Upper-Shelf Material*, NUREG-CR-4760 (ORNL-6187), May 1987.

D. B. Barker, R. Chona, W. L. Fournery, and G. R. Irwin, University of Maryland, College Park, Md., *A Report on the Round Robin Program Conducted to Evaluate the Proposed ASTM Standard Test Method for Determining the Plane Strain Crack Arrest Fracture Toughness, K_{Ia} , of Ferritic Materials*, NUREG/CR-4966 (ORNL/Sub/79-7778/4), January 1988.

L. F. Miller, C. A. Baldwin, F. W. Stallman, and F. B. K. Kam, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Neutron Exposure Parameters for the Metallurgical Test Specimens in the Fifth Heavy-Section Steel Technology Irradiation Series Capsules*, NUREG/CR-5019 (ORNL/TM-10582), March 1988.

J. J. McGowan, R. K. Nanstad, and K. R. Thoms, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Characterization of Irradiated Current-Practice Welds and A533*

Grade B Class 1 Plate for Nuclear Pressure Vessel Service, NUREG/CR-4880 (ORNL-6484/V1 and V2), July 1988.

R. D. Cheverton, W. E. Pennell, G. C. Robinson, and R. K. Nanstad, Martin Marietta Energy Systems, Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Impact of Radiation Embrittlement on Integrity of Pressure Vessel Supports for Two PWR Plants*, NUREG/CR-5320 (ORNL/TM-10966), February 1989.

J. G. Merkle, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *An Overview of the Low-Upper-Shelf Toughness Safety Margin Issue*, NUREG/CR-5552 (ORNL/TM-11314), August 1990.

R. D. Cheverton, T. L. Dickson, J. G. Merkle, and R. K. Nanstad, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., *Review of Reactor Pressure Vessel Evaluation Report for Yankee Rowe Nuclear Power Station (YAEC No. 1735)*, NUREG/CR-5799 (ORNL/TM-11982), March 1992.

Appendix E

Load-Displacement Curves and Photographs of the Fracture Toughness Specimens From the 72W Weld (0.23 wt % Cu)

8/22/85

72W-135

-150°C

IT-CT

0% SG

8/22/85

NUREG/CR-5913

N/91 0052

N/91

peo7

72W-135

72W-135

Front Face Deflection

W/in

.0384 .0358105 in/V

E-2

8/21/85 MRP/MJL

72W-138

-150°C

17-CT

0% SG

N/# 0052

1 V/in_p

LOAD

NUREG/CR-5913

FRONT FACE DEFLECTION

1 V/in_p

0.0358105"/V

SPECIMEN ID= 72W113
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -150 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.9 mm $a/W)i = .529$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 733 MPa
FLOW STRENGTH= 775 MPa
ESTIMATED YOUNG'S MODULUS= 216 GPa

SPECIMEN CLEAVED AT $KIc = 41.7 \text{ MPa SQR}[m]$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 8 kJ/m²
KJc= 41.6 MPa SQR[m]
K-beta-c= 41.2 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 8 kJ/m²
KJc= 41.6 MPa SQR[m]
K-beta-c= 41.2 MPa SQR[m]

E-5

ORNL-DWG 92-11495

72W113

-150 DEGREES C

72W-113

NUREG/CR-5913

SPECIMEN ID= 72W103
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -101 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.7 mm $a/W)i = .525$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 607 MPa
FLOW STRENGTH= 674 MPa
ESTIMATED YOUNG'S MODULUS= 213 GPa

SPECIMEN CLEAVED AT $K_{Ic} = 48.3 \text{ MPa SQR}[m]$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 10.3 kJ/m²

$K_{Jc} = 46.8 \text{ MPa SQR}[m]$

$K\text{-beta-c} = 45.3 \text{ MPa SQR}[m]$

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 10.3 kJ/m²

$K_{Jc} = 46.8 \text{ MPa SQR}[m]$

$K\text{-beta-c} = 45.3 \text{ MPa SQR}[m]$

72W103

-101 DEGREES C

72W-103

SPECIMEN ID= 72W168
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -80 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.6 mm $a/W)i = .544$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 576 MPa
FLOW STRENGTH= 645 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

SPECIMEN CLEAVED AT $KIc = 50.1 \text{ MPa SQR}[m]$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 11.6 kJ/m²
KJc= 49.6 MPa SQR[m]
K-beta-c= 47.3 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 11.6 kJ/m²
KJc= 49.6 MPa SQR[m]
K-beta-c= 47.3 MPa SQR[m]

72W168

-80 DEGREES C

72W-168

LKF

9/5/85

72W-140

IT-CT

07.56

-80°C

E-11

SPECIMEN ID= 72W164
 MATERIAL TYPE= MCUWELD
 TEST TEMPERATURE= -80 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 27.8 mm
 MEASURED DUCTILE DELTA-A= .05 mm
 YIELD STRENGTH= 576 MPa
 FLOW STRENGTH= 645 MPa
 ESTIMATED YOUNG'S MODULUS= 212 GPa

$a/W)i = .548$

SPECIMEN CLEAVED AT KQ= 66 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 21 kJ/m²

KJc= 66.7 MPa SQR[m]

K-beta-c= 59.7 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

 J-INTEGRAL= 21 kJ/m²

KJc= 66.7 MPa SQR[m]

K-beta-c= 59.7 MPa SQR[m]

72W164

-80 DEGREES C

72W-164

SPECIMEN ID= 72W121
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -80 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.7 mm $a/W)i = .528$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 576 MPa
FLOW STRENGTH= 645 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

SPECIMEN CLEAVED AT KQ= 88.9 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 40.5 kJ/m²
KJc= 92.6 MPa SQR[m]
K-beta-c= 73.6 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 40.5 kJ/m²
KJc= 92.6 MPa SQR[m]
K-beta-c= 73.6 MPa SQR[m]

72W121

-80 DEGREES C

72W-121

SPECIMEN ID= 72W127
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -80 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27 mm $a/W)i = .532$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 576 MPa
FLOW STRENGTH= 645 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

SPECIMEN CLEAVED AT KQ= 102.4 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 52 kJ/m²
KJc= 105 MPa SQR[m]
K-beta-c= 79 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 52 kJ/m²
KJc= 105 MPa SQR[m]
K-beta-c= 79 MPa SQR[m]

72W127

-80 DEGREES C

72W-127

72W142 -80°C 1T-CT 0%SG 8/22/85 MJL

72W-142

2500#/V

1V/inp

LOAD

NUREG/CR-5913

FRONT FACE DEFLECTION 1V/inp .0358105 "/V

SPECIMEN ID= 72W105
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -59 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.8 mm $a/W)i = .528$
MEASURED DUCTILE DELTA-A= .06 mm
YIELD STRENGTH= 554 MPa
FLOW STRENGTH= 623 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

SPECIMEN CLEAVED AT KQ= 108.6 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 68.7 kJ/m²
KJc= 120.3 MPa SQR[m]
K-beta-c= 83.1 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 69.1 kJ/m²
KJc= 120.7 MPa SQR[m]
K-beta-c= 83.2 MPa SQR[m]

72W105

-59 DEGREES C

72W-105

NUREG/CR-5913

LAF

9/4/85

72W-147

IT-ET 0856

-50°C

SPECIMEN ID= 72W156
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0. %
INITIAL CRACK LENGTH= 27.4 mm $a/W)i = .54$
MEASURED DUCTILE DELTA-A= .06 mm
YIELD STRENGTH= 547 MPa
FLOW STRENGTH= 614 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

SPECIMEN CLEAVED AT KQ= 104.2 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 66.8 kJ/m²
K_{Jc}= 118.4 MPa SQR[m]
K-beta-c= 81.9 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 64.9 kJ/m²
K_{Jc}= 116.8 MPa SQR[m]
K-beta-c= 81.3 MPa SQR[m]

72W156

-50 DEGREES C

72W-156

SPECIMEN ID= 72W154
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.7 mm $a/W)i = .526$
MEASURED DUCTILE DELTA-A= .07 mm
YIELD STRENGTH= 547 MPa
FLOW STRENGTH= 614 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

SPECIMEN CLEAVED AT $KQ = 106 \text{ MPa SQR}[m]$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 67.3 kJ/m²
KJc= 118.9 MPa SQR[m]
K-beta-c= 82.1 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 67.1 kJ/m²
KJc= 118.7 MPa SQR[m]
K-beta-c= 82 MPa SQR[m]

72W154

-50 DEGREES C

72W-154

SPECIMEN ID= 72W157
MATERIAL TYPE= MCWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.9 mm $a/W)i = .53$
MEASURED DUCTILE DELTA-A= .06 mm
YIELD STRENGTH= 547 MPa
FLOW STRENGTH= 614 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

SPECIMEN CLEAVED AT KQ= 107.4 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 68.2 kJ/m²
KJc= 119.7 MPa SQR[m]
K-beta-c= 82.3 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 68.2 kJ/m²
KJc= 119.7 MPa SQR[m]
K-beta-c= 82.3 MPa SQR[m]

72W157

-50 DEGREES C

72W-157

Aug 23, 1985

72-W-148

-50°C

0% SG

IT-CT

MRP/MJL

NUREG/CR-5913

250052

dui/vi

NUREG/CR-5913

Front Face Deflection $\mu\text{in}/\text{in}$

.0358105 in/V

72W-148

SPECIMEN ID= 72W153
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 25.3 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 30.1 mm $a/W)i = .592$
MEASURED DUCTILE DELTA-A= .07 mm
YIELD STRENGTH= 547 MPa
FLOW STRENGTH= 614 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

SPECIMEN CLEAVED AT KQ= 110.6 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 73.8 kJ/m²
KJc= 124.5 MPa SQR[m]
K-beta-c= 83.9 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 74.9 kJ/m²
KJc= 125.4 MPa SQR[m]
K-beta-c= 84.2 MPa SQR[m]

72W153

-50 DEGREES C

72W-153

NUREG/CR-5913

SPECIMEN ID= 72W162
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.3 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 534 MPa
FLOW STRENGTH= 598 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

$a/W)i = .537$

SPECIMEN CLEAVED AT $KQ = 97.5 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 50.1 kJ/m²
KJc= 102.3 MPa SQR[m]
K-beta-c= 75.2 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 50.4 kJ/m²
KJc= 102.6 MPa SQR[m]
K-beta-c= 75.3 MPa SQR[m]

72W162

-30 DEGREES C

72W-162

NUREG/CR-5913

SPECIMEN ID= 72W158
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.8 mm $a/W)_i = .528$
MEASURED DUCTILE DELTA-A= .08 mm
YIELD STRENGTH= 534 MPa
FLOW STRENGTH= 598 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT KQ= 111.2 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 78.4 kJ/m²
KJc= 128 MPa SQR[m]
K-beta-c= 84 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 78.2 kJ/m²
KJc= 127.8 MPa SQR[m]
K-beta-c= 83.9 MPa SQR[m]

72W158

-30 DEGREES C

72W-158

NUREG/CR-5913

SPECIMEN ID= 72W131
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.9 mm $a/W)i = .53$
MEASURED DUCTILE DELTA-A= .11 mm
YIELD STRENGTH= 534 MPa
FLOW STRENGTH= 598 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT KQ= 118.2 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 93 kJ/m²
KJc= 139.4 MPa SQR[m]
K-beta-c= 87.3 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 93.5 kJ/m²
KJc= 139.7 MPa SQR[m]
K-beta-c= 87.4 MPa SQR[m]

72W131

-30 DEGREES C

72W-131

NUREG/CR-5913

SPECIMEN ID= 72W133
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.2 mm
MEASURED DUCTILE DELTA-A= .25 mm
YIELD STRENGTH= 534 MPa
FLOW STRENGTH= 598 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

$a/W)i = .536$

SPECIMEN CLEAVED AT $KQ = 125.4 \text{ MPa SQR}[m]$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 141.1 kJ/m²
KJc= 171.7 MPa SQR[m]
K-beta-c= 95.6 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 176.8 kJ/m²
KJc= 192.2 MPa SQR[m]
K-beta-c= 100.2 MPa SQR[m]

72W133

-30 DEGREES C

72W-133

NUREG/CR-5913

SPECIMEN ID= 72W109
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -26 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.7 mm $a/W)i = .526$
MEASURED DUCTILE DELTA-A= .11 mm
YIELD STRENGTH= 532 MPa
FLOW STRENGTH= 595 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT KQ= 119.8 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 96.3 kJ/m²
KJc= 141.8 MPa SQR[m]
K-beta-c= 87.8 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 96.9 kJ/m²
KJc= 142.2 MPa SQR[m]
K-beta-c= 87.9 MPa SQR[m]

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ORNL-DWG 92-11510

72W109

-26 DEGREES C

72W-109

NUREG/CR-5913

SPECIMEN ID= 72W161
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.9 mm $a/W)i = .53$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 526 MPa
FLOW STRENGTH= 586 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

SPECIMEN CLEAVED AT KQ= 81.7 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 32.4 kJ/m²
KJc= 82.1 MPa SQR[m]
K-beta-c= 66.1 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 32.4 kJ/m²
KJc= 82.1 MPa SQR[m]
K-beta-c= 66.1 MPa SQR[m]

72W161

-15 DEGREES C

72W-161

NUREG/CR-5913

SPECIMEN ID= 72W169
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.1 mm $a/W)i = .535$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 526 MPa
FLOW STRENGTH= 586 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

SPECIMEN CLEAVED AT KQ= 84 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 35.8 kJ/m²
KJc= 86.3 MPa SQR[m]
K-beta-c= 68.1 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 35.8 kJ/m²
KJc= 86.3 MPa SQR[m]
K-beta-c= 68.1 MPa SQR[m]

E-44

ORNL-DWG 92-11512

72W169

-15 DEGREES C

72W-169

NUREG/CR-5913

SPECIMEN ID= 72W170
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.1 mm
MEASURED DUCTILE DELTA-A= .14 mm
YIELD STRENGTH= 526 MPa
FLOW STRENGTH= 586 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

$a/W)i = .534$

SPECIMEN CLEAVED AT $KQ = 118.5 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 109.7 kJ/m²
KJc= 151 MPa SQR[m]
K-beta-c= 89.7 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 109.9 kJ/m²
KJc= 151.2 MPa SQR[m]
K-beta-c= 89.7 MPa SQR[m]

72W170

-15 DEGREES C

72W-170

SPECIMEN ID= 72W166
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.6 mm $a/W)i = .525$
MEASURED DUCTILE DELTA-A= .15 mm
YIELD STRENGTH= 526 MPa
FLOW STRENGTH= 586 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

SPECIMEN CLEAVED AT KQ= 123.8 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 139.1 kJ/m²
KJc= 170.1 MPa SQR[m]
K-beta-c= 94.3 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 136.8 kJ/m²
KJc= 168.7 MPa SQR[m]
K-beta-c= 94 MPa SQR[m]

72W166

-15 DEGREES C

72W-166

TEST SPECIMEN DATA

Material Type = HSST WELD
 Test Temperature = 0°C
 Percent Side Groove = 0%
 Specimen Thickness B = 25.4 mm
 Initial a/W = .511
 Init crack length a = 25.94 mm
 Flow strength = 575 MPa
 Yield strength = 517.1 MPa
 Youngs modulus E = 207200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 82.1 kJ/m ²	76.2 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{1/2}	= 130.5 MPa√m	125.7 MPa√m
Kc (Beta Corrected)	= 83.2 MPa√m	81.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 60.61 kN
 5% Secant Offset Pq = 43.35 kN
 Kq = 75.6 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 105.7 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .007 mm
 Fitted elastic load range = 10 kN TO 25 kN
 Elastic slope = 8.133E+01 kN/mm

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SPECIMEN ID= 72W151
MATERIAL TYPE= MCU WELD
TEST TEMPERATURE= 0 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.6 mm
MEASURED DUCTILE DELTA-A= .13 mm
YIELD STRENGTH= 517 MPa
FLOW STRENGTH= 575 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

$a/W)i = .525$

SPECIMEN CLEAVED AT KQ= 121.3 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 124.3 kJ/m²
K_{Jc}= 160.5 MPa SQR[m]
K-beta-c= 91.2 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 124 kJ/m²
K_{Jc}= 160.3 MPa SQR[m]
K-beta-c= 91.2 MPa SQR[m]

72W151

0 DEGREES C

72W-151

SPECIMEN ID= 72W128
MATERIAL TYPE= MCU WELD
TEST TEMPERATURE= 0 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.9 mm $a/W)i = .529$
MEASURED DUCTILE DELTA-A= .34 mm
YIELD STRENGTH= 517 MPa
FLOW STRENGTH= 575 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

SPECIMEN CLEAVED AT KQ= 127.5 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 209.2 kJ/m²
K_{Jc}= 208.2 MPa SQR[m]
K-beta-c= 101.4 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 209.8 kJ/m²
K_{Jc}= 208.5 MPa SQR[m]
K-beta-c= 101.5 MPa SQR[m]

72W128

0 DEGREES C

72W-128

TEST SPECIMEN DATA

Material Type = A533-B Weld (U)
 Test Temperature = 0 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .512
 Init crack length a = 26.03 mm
 Flow stress = 568 MPa
 Yield stress = 506 MPa
 Youngs modulus E = 207200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS[Failure Type A (J at instability = J_c)]

	Merkle-Corten	Deformation-J*
J _c	= 295.6 kJ/m ²	287.6 kJ/m ²
K _{Jc} = (EJ _c / (1-ν ²)) ^{0.5}	= 247.5 MPa√m	244.2 MPa√m
K _c (Beta Corrected)	= 107 MPa√m	106.5 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{1/2}
 Maximum Load P = 67.02 kN
 5% Secant Offset P_q = 41.22 kN
 K_q = 72.3 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 117.5 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .015 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 8.007E+01 kN/mm

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10 X 10 PER INCH
DIETZEN CORPORATION
MADE IN U.S.A.

TEST SPECIMEN DATA

Material Type = A533-B Weld (U)
 Test Temperature = 0 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .521
 Init crack length a = 26.47 mm
 Flow stress = 568 MPa
 Yield stress = 506 MPa
 Youngs modulus E = 207200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 1097.4 kJ/m ²	1123.1 kJ/m ²
K _{Jc} = (EJc / (1-ν ²)) ^{1/2}	= 476.9 MPa√m	482.4 MPa√m
Kc (Beta Corrected)	= 135.9 MPa√m	136.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 66.85 kN
 5% Secant Offset P_q = 38.09 kN
 K_q = 68.7 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 120.5 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .014 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 1.145E+02 kN/mm

✓ 2 9-03-83

TEST SPECIMEN DATA

Material Type = A533-B Weld (U)
 Test Temperature = 0 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .521
 Init crack length a = 26.47 mm
 Flow stress = 568 MPa
 Yield stress = 506 MPa
 Youngs modulus E = 207200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 1082.7 kJ/m ²	1103.2 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 473.7 MPa√m	478.2 MPa√m
Kc (Beta Corrected)	= 135.6 MPa√m	136.1 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 66.85 kN
 5% Secant Offset Pq = 39.59 kN
 Kq = 71.4 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 120.5 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .021 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 8.202E+01 kN/mm

TEST SPECIMEN DATA

Material Type	= HSST 5th WELD	
Test Temperature	= 0 C	
Percent Side Groove	= 0 %	
Specimen Thickness	= 25.4 mm	
Init crack length	= 26.47 mm	Init a/W = .521
Final crack length	= 30.24 mm	Final a/W = .595
Flow stress	= 568 MPa	
Youngs modulus	= 207200 MPa	(Estimated Value)

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

J (@J/T=8.8)	= 1458.1 kJ/m ²
J _{ic}	= 195.6 kJ/m ²
K _{jc}	= 201.3 MPa √m
Exponent N	= .7779
Coefficient C	= 471.6 kJ/m ²
T (average)	= 220

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

J _{ic}	= 161.6 kJ/m ²
K _{jc}	= 183 MPa √m
Slope M	= 347354.4 kJ/m ³
Intercept B	= 112.8 kJ/m ²
T (ASTM)	= 218
Validity (J _{ic})	= VALID
Validity (R-curve)	= INVALID--1, 3 (.5 vs .36)
J maximum allowed	= 699 kJ/m ² (J _{max} =B _{net} *Flow stress/20)
Delta a max. allowed	= 2.43 mm (Delta a max = 0.1*bo)
Final Delta a	= 3.26 mm
Poisson's Ratio (ν)	= 0

NUREG/CR-5913

29/0005 = 1

DIETZEN CORPORATION
MADE IN U.S.A.

DATE: 12 DIETZEN GRAIN PAPER
10 X 10 PER INCH

LRF

1/13/86

72W-155

IT-CT

02SG

0°C

LOAD (W/in)

FRONT FACE DEFLECTION (0.5V/in)

1V = 0.037989 in.

E-60

TEST SPECIMEN DATA

Material Type = A533-B Weld (U)
 Test Temperature = 0 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .52
 Init crack length a = 26.39 mm
 Flow stress = 568 MPa
 Yield stress = 506 MPa
 Youngs modulus E = 207200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 327.8 kJ/m ²	323.9 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 260.6 MPa√m	259.1 MPa√m
Kc (Beta Corrected)	= 109.2 MPa√m	108.9 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 66.99 kN
 5% Secant Offset Pq = 39.82 kN
 Kq = 71.4 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 120.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .006 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 8.257E+01 kN/mm

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SPECIMEN ID= 72W111
 TEST TEMPERATURE= 23 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 26.4 mm $a/W)i = .52$
 MEASURED DUCTILE DELTA-A= .92 mm
 YIELD STRENGTH= 501 MPa
 FLOW STRENGTH= 556 MPa
 ESTIMATED YOUNG'S MODULUS= 206 GPa

SPECIMEN CLEAVED AT KQ= 121 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 271.1 kJ/m²
 K_{Jc}= 236.2 MPa SQR[m]
 K-beta-c= 104.5 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 387.6 kJ/m²
 K_{Jc}= 282.5 MPa SQR[m]
 K-beta-c= 111.8 MPa SQR[m]

POWER LAW PROCEDURE

J_{Ic}= 162.4 kJ/m²
 K-J_{Ic}= 182.9 MPa SQR[m]
 POWER= .7588
 COEFFICIENT= 408.9 kJ/m²
 T (AVERAGE)= 201

ASTM LINEAR PROCEDURE

J_{Ic}= 87.9 kJ/m²
 K-J_{Ic}= 134.5 MPa SQR[m]
 SLOPE= 357781 kJ/m³
 INTERCEPT= 59.6 kJ/m²
 T (ASTM)= 239
 VALID, E813

JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 1175.9 kJ/m²
 POWER= .7342
 J-MAX ALLOWED= 676.2 kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 402.2 kJ/m²
 DELTA-A MAX ALLOWED= 2.43 mm

72W-111

NUREG/CR-5913

72W111

23 DEGREES C

72W111

23 DEGREES C

SPECIMEN ID= 72W101
 TEST TEMPERATURE= 50 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 20 %
 INITIAL CRACK LENGTH= 30.9 mm $a/W)i = .609$
 MEASURED DUCTILE DELTA-A= 5.52 mm
 YIELD STRENGTH= 472 MPa
 FLOW STRENGTH= 527 MPa
 ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 241.7 kJ/m²
 KJ-MAX LOAD= 222.2 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 165.2 kJ/m²
 K-JIc= 183.7 MPa SQR[m]
 POWER= .6141
 COEFFICIENT= 341.4 kJ/m²
 T (AVERAGE)= 151

ASTM LINEAR PROCEDURE

 JIc= 142.9 kJ/m²
 K-JIc= 170.9 MPa SQR[m]
 SLOPE= 215115 kJ/m³
 INTERCEPT= 113.8 kJ/m²
 T (ASTM)= 158
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 793.5 kJ/m²
 POWER= .6128
 J-MAX ALLOWED= 523.3 kJ/m²
 VALID R-CURVE

COEFFICIENT= 341.3 kJ/m²
 DELTA-A MAX ALLOWED= 1.98 mm

72W-101

72W101

50 DEGREES C

72W101

50 DEGREES C

SPECIMEN ID= 72W66
MATERIAL TYPE= MCuWELD
TEST TEMPERATURE= -80 DEG C
THICKNESS= 50.9 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 54.3 mm $a/W)_i = .535$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 576 MPa
FLOW STRENGTH= 645 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

SPECIMEN CLEAVED AT $K_{Ic} = 67.4 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 19.7 kJ/m²
KJc= 64.6 MPa SQR[m]
K-beta-c= 62.4 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 19.7 kJ/m²
KJc= 64.6 MPa SQR[m]
K-beta-c= 62.4 MPa SQR[m]

E-68

ORNL-DWG 92-11548

72W66

-80 DEGREES C

72W-66

NUREG/CR-5913

LKF 9/13/85

72W-54

2T-CT

0% SG

-80°C

IV = 10,000 lbs

LOAD (IV/in)

NUREG/CR-5913

FRONT FACE DEFLECTION (0.5°/in)

IV = 0.03603 in.

SPECIMEN ID= 72W73
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -80 DEG C
THICKNESS= 50.9 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 53.3 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 576 MPa
FLOW STRENGTH= 645 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

$a/W)i = .524$

SPECIMEN CLEAVED AT $KQ = 91 \text{ MPa SQR}[m]$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 39.5 kJ/m²
KJc= 91.4 MPa SQR[m]
K-beta-c= 82.5 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 39.5 kJ/m²
KJc= 91.4 MPa SQR[m]
K-beta-c= 82.5 MPa SQR[m]

E-71

ORNL-DWG 92-11549

72W73

-80 DEGREES C

72W-73

NUREG/CR-5913

LKF

9/13/85

72W-53

RT-CT 09.56

-80°C

LOAD (V/I.N.)

1V = 0.03603 in.

72W-53

FRONT FACE DEFLECTION (0.5V/in.)

1V = 0.03603 in.

SPECIMEN ID= 72W72
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 50.9 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 53.8 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 547 MPa
FLOW STRENGTH= 614 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

$a/W)i = .53$

SPECIMEN CLEAVED AT $K_{Ic} = 71.1 \text{ MPa SQR}[m]$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 23 kJ/m²
KJc= 69.6 MPa SQR[m]
K-beta-c= 65.9 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 23 kJ/m²
KJc= 69.6 MPa SQR[m]
K-beta-c= 65.9 MPa SQR[m]

E-74

ORNL-DWG 92-11550

72W72

-50 DEGREES C

72W-72

SPECIMEN ID= 72W86
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 50.8 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 53.4 mm $a/W)i = .526$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 547 MPa
FLOW STRENGTH= 614 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

SPECIMEN CLEAVED AT KQ= 84.8 MPa SQR[m]. (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 33.8 kJ/m²
K_{Jc}= 84.3 MPa SQR[m]
K-beta-c= 76.7 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 33.8 kJ/m²
K_{Jc}= 84.3 MPa SQR[m]
K-beta-c= 76.7 MPa SQR[m]

72W86

-50 DEGREES C

72W-86

LKF

9/6/85

72W-68

RT-CT

09.56

-50°C

IV = 10,000 lbs.

LOAD (IV/in)

NUREG/CR-5913

RT

FRONT FACE DEFLECTION (0.5V/in)

IV = 0.036026

72W-68

72W-68

E-77

NUREG/CR-5913

LKF

9/10/85

72W-69

RT-CT

0% SG

-50°C

LOAD (V/in)

591 000 01 = 1

72W-69

FRONT FACE DEFLECTION (0.05V/in)

1V = 0.03603

E-78

SPECIMEN ID= 72W81
MATERIAL TYPE= MCWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 50.9 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 52.9 mm $a/W)i = .521$
MEASURED DUCTILE DELTA-A= .1 mm
YIELD STRENGTH= 547 MPa
FLOW STRENGTH= 614 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

SPECIMEN CLEAVED AT KQ= 124.7 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 77.3 kJ/m²
K_{Jc}= 127.4 MPa SQR[m]
K-beta-c= 100.4 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 77.3 kJ/m²
K_{Jc}= 127.4 MPa SQR[m]
K-beta-c= 100.4 MPa SQR[m]

E-80

ORNL-DWG 92-11552

72W81

-50 DEGREES C

72W-81

NUREG/CR-5913

SPECIMEN ID= 72W76
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 50.8 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 54.3 mm $a/W)i = .535$
MEASURED DUCTILE DELTA-A= .07 mm
YIELD STRENGTH= 534 MPa
FLOW STRENGTH= 598 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT KQ= 126.3 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 80.6 kJ/m²
KJc= 129.7 MPa SQR[m]
K-beta-c= 100.3 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 81 kJ/m²
KJc= 130.1 MPa SQR[m]
K-beta-c= 100.5 MPa SQR[m]

E-82

ORNL-DWG 92-11553

72W76

-30 DEGREES C

72W-76

NUREG/CR-5913

SPECIMEN ID= 72W75
MATERIAL TYPE= MCuWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 50.5 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 54.4 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 534 MPa
FLOW STRENGTH= 598 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

$a/W)_i = .532$

SPECIMEN CLEAVED AT $KQ = 130.6 \text{ MPa SQR}[m]$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= $87.4 \text{ kJ}/m^2$
 $KJc = 135.2 \text{ MPa SQR}[m]$
 $K\text{-beta-c} = 102.5 \text{ MPa SQR}[m]$

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= $87.4 \text{ kJ}/m^2$
 $KJc = 135.2 \text{ MPa SQR}[m]$
 $K\text{-beta-c} = 102.5 \text{ MPa SQR}[m]$

72W75

-30 DEGREES C

72W-75

SPECIMEN ID= 72W85
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 50.9 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 52.6 mm $a/W)i = .518$
MEASURED DUCTILE DELTA-A= .16 mm
YIELD STRENGTH= 534 MPa
FLOW STRENGTH= 598 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT KQ= 152.5 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 130.4 kJ/m²
K_{Jc}= 165.1 MPa SQR[m]
K-beta-c= 113.7 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 131.7 kJ/m²
K_{Jc}= 165.8 MPa SQR[m]
K-beta-c= 114 MPa SQR[m]

E-86

ORNL-DWG 92-11555

72W85

-30 DEGREES C

72W-85

SPECIMEN ID= 72W50
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 50.9 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 54.8 mm $a/W)i = .54$
MEASURED DUCTILE DELTA-A= .06 mm
YIELD STRENGTH= 526 MPa
FLOW STRENGTH= 586 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

SPECIMEN CLEAVED AT KQ= 98.4 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 46.6 kJ/m²
KJc= 98.5 MPa SQR[m]
K-beta-c= 84.5 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 46.6 kJ/m²
KJc= 98.5 MPa SQR[m]
K-beta-c= 84.5 MPa SQR[m]

E-88

ORNL-DWG 92-11556

72W50

-15 DEGREES C

SPECIMEN ID= 72W87
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 50.8 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 53.2 mm $a/W)i = .524$
MEASURED DUCTILE DELTA-A= .1 mm
YIELD STRENGTH= 526 MPa
FLOW STRENGTH= 586 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

SPECIMEN CLEAVED AT KQ= 117.6 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 68.5 kJ/m²
KJc= 119.4 MPa SQR[m]
K-beta-c= 95 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 68.5 kJ/m²
KJc= 119.4 MPa SQR[m]
K-beta-c= 95 MPa SQR[m]

E-90

ORNL-DWG 92-11557

72W87

-15 DEGREES C

72W-87

SPECIMEN ID= 72W62
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 50.8 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 53.7 mm
MEASURED DUCTILE DELTA-A= .15 mm
YIELD STRENGTH= 526 MPa
FLOW STRENGTH= 586 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

 $a/W)i = .529$

SPECIMEN CLEAVED AT KQ= 150.5 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 138.5 kJ/m²
KJc= 169.8 MPa SQR[m]
K-beta-c= 114.3 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 140.5 kJ/m²
KJc= 171 MPa SQR[m]
K-beta-c= 114.7 MPa SQR[m]

E-92

ORNL-DWG 92-11558

72W62

-15 DEGREES C

72W-62

NUREG/CR-5913

SPECIMEN ID= 72W79
MATERIAL TYPE= MCWELD
TEST TEMPERATURE= -2 DEG C
THICKNESS= 50.8 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 57.7 mm $a/W)i = .568$
MEASURED DUCTILE DELTA-A= .52 mm
YIELD STRENGTH= 519 MPa
FLOW STRENGTH= 576 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

SPECIMEN CLEAVED AT KQ= 136.9 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 108.5 kJ/m²
KJc= 150 MPa SQR[m]
K-beta-c= 106.8 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 108.2 kJ/m²
KJc= 149.8 MPa SQR[m]
K-beta-c= 106.7 MPa SQR[m]

E-94

ORNL-DWG 92-11559

72W79

-2 DEGREES C

72W-79

NUREG/CR-5913

TEST SPECIMEN DATA

Material Type = HSST WELD
 Test Temperature = 10°C
 Percent Side Groove = 0%
 Specimen Thickness B = 50.8 mm
 Initial a/W = .52
 Init crack length a = 52.8 mm
 Flow strength = 566.7 MPa
 Yield strength = 510.9 MPa
 Youngs modulus E = 206600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 108.4 kJ/m ²	106.9 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{1/2}	= 149.7 MPa√m	148.6 MPa√m
Kc (Beta Corrected)	= 105.8 MPa√m	105.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 212.71 kN
 5% Secant Offset Pq = 161.89 kN
 Kq = 102.7 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 135 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .016 mm

Fitted elastic load range = 25 kN TO 75 kN

Elastic slope = 1.698E+02 kN/mm

10 = 18 800 lbs.

10 AD (in/in)

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TEST SPECIMEN DATA

Material Type = HSST WELD
 Test Temperature = 10°C
 Percent Side Groove = 0%
 Specimen Thickness B = 50.8 mm
 Initial a/W = .512
 Init crack length a = 52.04 mm
 Flow strength = 566.7 MPa
 Yield strength = 510.9 MPa
 Youngs modulus E = 206600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 261.7 kJ/m ²	252.3 kJ/m ²
Kjc = (EJc / (1 - ν ²)) ^{1/2}	= 232.6 MPa√m	228.3 MPa√m
Kc (Beta Corrected)	= 129.4 MPa√m	128.4 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 279.33 kN
 5% Secant Offset Pq = 202.64 kN
 Kq = 125.6 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 173.1 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .027 mm

Fitted elastic load range = 50 kN TO 125 kN

Elastic slope = 1.680E+02 kN/mm

NO. 3410-10 DITZGEN GRAPH PAPER
10 X 10 PER INCH

TEST SPECIMEN DATA

Material Type = HSST WELD
 Test Temperature = 10°C
 Percent Side Groove = 0%
 Specimen Thickness B = 50.8 mm
 Initial a/W = .519
 Init crack length a = 52.71 mm
 Flow strength = 566.7 MPa
 Yield strength = 510.9 MPa
 Youngs modulus E = 206600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 273.6 kJ/m ²	269.2 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{1/2}	= 237.8 MPa√m	235.8 MPa√m
Kc (Beta Corrected)	= 130.6 MPa√m	130.1 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 273.16 kN
 5% Secant Offset Pq = 180.44 kN
 Kq = 114.2 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 172.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .022 mm

Fitted elastic load range = 50 kN TO 100 kN

Elastic slope = 1.685E+02 kN/mm

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NO. 3410-10 DIETZEN GRAPH PAPER
10 X 10 PER INCH

Specimen Crackmouth Deflection (in.) ORNL-DWG 92-11563

TEST SPECIMEN DATA

Material Type = HSST 5th WELD
 Test Temperature = 10°C
 Percent Side Groove = 0%
 Specimen Thickness B = 50.8 mm
 Initial a/W = .517
 Init crack length a = 52.57 mm
 Flow strength = 359.9 MPa
 Yield strength = 510.9 MPa
 Youngs modulus E = 206600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 343.8 kJ/m ²	335.3 kJ/m ²
Kjc = (EJc / ((1-ν ²))) ^{1/2}	= 266.5 MPa√m	263.2 MPa√m
Kc (Beta Corrected)	= 136.9 MPa√m	136.2 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 275.95 kN
 5% Secant Offset Pq = 181.5 kN
 Kq = 114.3 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 173.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .031 mm

Fitted elastic load range = 50 kN TO 100 kN

Elastic slope = 1.653E+02 kN/mm

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SPECIMEN ID= 72W12
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 101.9 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 106.6 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 547 MPa
FLOW STRENGTH= 614 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

 $a/W)i = .524$

SPECIMEN CLEAVED AT $K_{Ic} = 83.8 \text{ MPa SQR}[m]$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 31.4 kJ/m²
KJc= 81.2 MPa SQR[m]
K-beta-c= 78.9 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 31.4 kJ/m²
KJc= 81.2 MPa SQR[m]
K-beta-c= 78.9 MPa SQR[m]

72W12

-50 DEGREES C

72W-12

SPECIMEN ID= 72W21
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 101.6 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 106.7 mm $a/W)i = .526$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 547 MPa
FLOW STRENGTH= 614 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

SPECIMEN CLEAVED AT $K_{Ic} = 102.4 \text{ MPa SQR}[m]$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 47.6 kJ/m²
KJc= 100 MPa SQR[m]
K-beta-c= 94.5 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 47.6 kJ/m²
KJc= 100 MPa SQR[m]
K-beta-c= 94.5 MPa SQR[m]

72W21

-50 DEGREES C

72W-21

SPECIMEN ID= 72W23
MATERIAL TYPE= MCWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 101.6 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 106.2 mm $a/W)i = .522$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 534 MPa
FLOW STRENGTH= 598 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT $K_{Ic} = 105.2 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 50.6 kJ/m²
KJc= 102.8 MPa SQR[m]
K-beta-c= 96.2 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 50.6 kJ/m²
KJc= 102.8 MPa SQR[m]
K-beta-c= 96.2 MPa SQR[m]

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72W23

-30 DEGREES C

72W-23

NUREG/CR-5913

SPECIMEN ID= 72W10
MATERIAL TYPE= A533BW
TEST TEMPERATURE= -30 DEG C
THICKNESS= 101.6 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 109 mm $a/W)i = .536$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 534 MPa
FLOW STRENGTH= 598 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT KQ= 144.9 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 101.2 kJ/m²
KJc= 145.4 MPa SQR[m]
K-beta-c= 123.5 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 101.2 kJ/m²
KJc= 145.4 MPa SQR[m]
K-beta-c= 123.5 MPa SQR[m]

E-110

ORNL-DWG 92-11567

72W10

-30 DEGREES C

72W-10

NUREG/CR-5913

E-111

SPECIMEN ID= 72W24
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 101.6 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 110.5 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 526 MPa
FLOW STRENGTH= 586 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

$a/W)i = .544$

SPECIMEN CLEAVED AT $K_{Ic} = 85.8 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 32.4 kJ/m²
K_{Jc}= 82.1 MPa SQR[m]
K-beta-c= 79.4 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 32.4 kJ/m²
K_{Jc}= 82.1 MPa SQR[m]
K-beta-c= 79.4 MPa SQR[m]

72W24

-15 DEGREES C

72W-24

SPECIMEN ID= 72W15
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 101.8 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 108.4 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 526 MPa
FLOW STRENGTH= 586 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

$a/W)i = .533$

SPECIMEN CLEAVED AT $KQ = 165.6 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 134.2 kJ/m²
KJc= 167.1 MPa SQR[m]
K-beta-c= 133.6 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 134.2 kJ/m²
KJc= 167.1 MPa SQR[m]
K-beta-c= 133.6 MPa SQR[m]

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ORNL-DWG 92-11569

72W15

-15 DEGREES C

72W-15

NUREG/CR-5913

TEST SPECIMEN DATA

Material Type	= A533-B HSST 5th Irrad. Weld
Test Temperature	= 0 °C
Percent Side Groove	= 0 %
Specimen Thickness B	= 101.6 mm
Initial a/W	= .527
Init crack length a	= 107.04 mm
Flow stress	= 575 MPa
Yield stress	= 517.1 MPa
Youngs modulus E	= 207200 MPa (Estimated Value)
Poisson's Ratio (ν)	= 0

J-INTEGRAL ANALYSIS

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

J _{ic}	= 84 kJ/m ²
K _{Jc} = (EJ _{ic} / (1 - ν ²)) ^{0.5}	= 132 MPa √m
K _{ic} (Beta Corrected)	= 114.6 MPa √m

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B	= (BB _n) ^{0.5}
Maximum Load P	= 560.8 kN
5% Secant Offset P _q	= 560.84 kN
K _{ic}	= 128.7 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

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NO. 3410-10 DIETZEN GRAPH PAPER
10 X 10 PER INCH

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 0 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .521
 Init crack length a = 105.85 mm
 Flow stress = 575 MPa
 Yield stress = 517.1 MPa
 Young's modulus E = 207200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J_{ic})
 J_{ic} = 90.2 kJ/m²
 $K_{Jc} = (E J_{ic} / (1 - \nu^2))^{.5} = 136.7 \text{ MPa } \sqrt{m}$
 K_{ic} (Beta Corrected) = 117.3 MPa $\sqrt{m}$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (B_{Bn})^{.5}
 Maximum Load P = 593.7 kN
 5% Secant Offset P_q = 593.69 kN
 K_{ic} = 133.7 MPa $\sqrt{m}$
 Validity = INVALID--1, 2

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

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

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 0 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .532
 Init crack length a = 108.1 mm
 Flow stress = 575 MPa
 Yield stress = 517.1 MPa
 Youngs modulus E = 207200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J_{ic})
 J_{ic} = 92.8 kJ/m²
 $K_{Jc} = (EJ_{ic} / (1 - \nu^2))^{.5} = 138.7 \text{ MPa } \sqrt{\text{m}}$
 K_{ic} (Beta Corrected) = 118.4 MPa $\sqrt{\text{m}}$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{.5}
 Maximum Load P = 580.6 kN
 5% Secant Offset P_q = 567.7 kN
 K_{ic} = 132.6 MPa $\sqrt{\text{m}}$
 Validity = INVALID--1, 2
 K at Maximum Load = 135.6 MPa $\sqrt{\text{m}}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 1.19747985986E-03 in.
 Specimen rotation Load intercept elastic slope = -1.32051282051E-05 lb
 Fitted elastic load range = 50000 TO 25000 Correction to J for crack exten

TEST SPECIMEN DATA

Material Type	= A533-B HSST 5th Irrad. Weld
Test Temperature	= 0 C
Percent Side Groove	= 0 %
Specimen Thickness B	= 101.6 mm
Initial a/W	= .528
Init crack length a	= 107.22 mm
Flow stress	= 575 MPa
Yield stress	= 517.1 MPa
Youngs modulus E	= 207200 MPa (Estimated Value)
Poisson's Ratio (ν)	= 0

J-INTEGRAL ANALYSIS

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

J _{ic}	= 148.9 kJ/m ²
K _{Jc} = (EJ _{ic} / (1 - ν ²)) ^{.5}	= 175.7 MPa √m
K _{ic} (Beta Corrected)	= 136.5 MPa √m

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B	= (BB _n) ^{.5}
Maximum Load P	= 716.8 kN
5% Secant Offset P _q	= 542.93 kN
K _{ic}	= 125 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 = WELD
 Test Temperature = 10 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .534
 Init crack length a = 108.44 mm
 Flow stress = 566.7 MPa
 Yield stress = 510.9 MPa
 Young's modulus E = 206600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J_{ic})
 J_{ic} = 159.8 kJ/m²
 $K_{Jc} = (EJ_{ic} / (1 - \nu^2))^{.5} = 181.8 \text{ MPa } \sqrt{\text{m}}$
 K_{ic} (Beta Corrected) = 138.3 MPa $\sqrt{\text{m}}$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{.5}
 Maximum Load P = 723 kN
 5% Secant Offset P_q = 661.79 kN
 K_{ic} = 155.4 MPa $\sqrt{\text{m}}$
 Validity = INVALID--1, 2
 K at Maximum Load = 169.8 MPa $\sqrt{\text{m}}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 4.23685749505E-03 in.
 Specimen rotation Load intercept elastic slope = -2.31016949153E-04 lb
 Fitted elastic load range = 75000 TO 50000 Correction to J for crack exten

TEST SPECIMEN DATA

Material Type = HSST 72 WELD
 Test Temperature = 10 C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .526
 Init crack length a = 106.8 mm
 Flow stress = 566.7 MPa
 Yield stress = 510.9 MPa
 Youngs modulus E = 206600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J_{ic})
 J_{ic} = 242.9 kJ/m²
 $K_{Jc} = (E J_{ic} / (1 - \nu^2))^{.5} = 224.1 \text{ MPa } \sqrt{\text{m}}$
 K_{ic} (Beta Corrected) = 154 MPa $\sqrt{\text{m}}$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{.5}
 Maximum Load P = 860 kN
 5% Secant Offset P_q = 664.88 kN
 K_{ic} = 152 MPa $\sqrt{\text{m}}$
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 196.6 MPa $\sqrt{\text{m}}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 2.62628156829E-03 in.
 Specimen rotation Load intercept elastic slope = -1.61551724138E-04 lb
 Fitted elastic load range = 75000 TO 50000 Correction to J for crack exten

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20 X 20 PER INCH

SPECIMEN CLEAVED

132910	PQ (LB)
591.18	PQ (KN)
148030	MAX LOAD (LB)
658.46	MAX LOAD (KN)
0.005	MEASURED FINAL CRACK EXTENSION (IN)
0.127	MEASURED FINAL CRACK EXTENSION (MM)
29885	REFERENCE MODULUS (KSI)
206.06	REFERENCE MODULUS (GPA)
124.82	UC KQ (KSI*SQRT(IN))
137.17	UC KQ (MPA*SQRT(M))
139.03	UC MAX LOAD K (KSI*SQRT(IN))
152.78	UC MAX LOAD K (MPA*SQRT(M))
0	#UC FINAL CRACK EXTENSION (IN)
0	#UC FINAL CRACK EXTENSION (MM)
-100	#UC FINAL CRACK EXTENSION ERROR (PERCENT)

INVALID UC KIC TEST

696.4	UC MERKLE-CORTEN	MAX LOAD J-INTEGRAL (IN*LB/IN^2)
121.97	UC MERKLE-CORTEN	MAX LOAD J-INTEGRAL (KJ/M^2)
144.27	UC MERKLE-CORTEN	MAX LOAD KJ (KSI*SQRT(IN))
158.54	UC MERKLE-CORTEN	MAX LOAD KJ (MPA*SQRT(M))
115.56	UC MERKLE-CORTEN	BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
126.99	UC MERKLE-CORTEN	BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
144.27	UC MERKLE-CORTEN	FINAL KJ (KSI*SQRT(IN))
158.54	UC MERKLE-CORTEN	FINAL KJ (MPA*SQRT(M))
115.56	UC MERKLE-CORTEN	BETA-ADJ FINAL KJ (KSI*SQRT(IN))
126.99	UC MERKLE-CORTEN	BETA-ADJ FINAL KJ (MPA*SQRT(M))
671.5	#UC ERNST	MAX LOAD J-INTEGRAL (IN*LB/IN^2)
117.59	#UC ERNST	MAX LOAD J-INTEGRAL (KJ/M^2)
141.66	#UC ERNST	MAX LOAD KJ (KSI*SQRT(IN))
155.67	#UC ERNST	MAX LOAD KJ (MPA*SQRT(M))
114.33	#UC ERNST	BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
125.64	#UC ERNST	BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
141.66	#UC ERNST	FINAL KJ (KSI*SQRT(IN))
155.67	#UC ERNST	FINAL KJ (MPA*SQRT(M))
114.33	#UC ERNST	BETA-ADJ FINAL KJ (KSI*SQRT(IN))
125.64	#UC ERNST	BETA-ADJ FINAL KJ (MPA*SQRT(M))
671.5	#UC MODIFIED ERNST	MAX LOAD J-INTEGRAL (IN*LB/IN^2)
117.59	#UC MODIFIED ERNST	MAX LOAD J-INTEGRAL (KJ/M^2)
141.66	#UC MODIFIED ERNST	MAX LOAD KJ (KSI*SQRT(IN))
155.67	#UC MODIFIED ERNST	MAX LOAD KJ (MPA*SQRT(M))
114.33	#UC MODIFIED ERNST	BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
125.64	#UC MODIFIED ERNST	BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
141.66	#UC MODIFIED ERNST	FINAL KJ (KSI*SQRT(IN))
155.67	#UC MODIFIED ERNST	FINAL KJ (MPA*SQRT(M))
114.33	#UC MODIFIED ERNST	BETA-ADJ FINAL KJ (KSI*SQRT(IN))
125.64	#UC MODIFIED ERNST	BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

UC MERKLE-CORTEN JIC,CEIC,KJIC AND TAVG NOT DEFINED--NOT ENOUGH DATA POINTS
FOR POWER LAW FIT

72W-30

SPECIMEN CLEAVED

134110	PQ (LB)
596.5	PQ (KN)
162750	MAX LOAD (LB)
723.93	MAX LOAD (KN)
0.005	MEASURED FINAL CRACK EXTENSION (IN)
0.127	MEASURED FINAL CRACK EXTENSION (MM)
29885	REFERENCE MODULUS (KSI)
206.06	REFERENCE MODULUS (GPA)
121.43	UC KQ (KSI*SQRT(IN))
133.44	UC KQ (MPA*SQRT(M))
147.37	UC MAX LOAD K (KSI*SQRT(IN))
161.95	UC MAX LOAD K (MPA*SQRT(M))
-0.047	#UC FINAL CRACK EXTENSION (IN)
-1.194	#UC FINAL CRACK EXTENSION (MM)
-1040.5	#UC FINAL CRACK EXTENSION ERROR (PERCENT)

INVALID UC KIC TEST

799.4	UC MERKLE-CORTEN	MAX LOAD J-INTEGRAL (IN*LB/IN^2)
140	UC MERKLE-CORTEN	MAX LOAD J-INTEGRAL (KJ/M^2)
154.57	UC MERKLE-CORTEN	MAX LOAD KJ (KSI*SQRT(IN))
169.86	UC MERKLE-CORTEN	MAX LOAD KJ (MPA*SQRT(M))
120.19	UC MERKLE-CORTEN	BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
132.08	UC MERKLE-CORTEN	BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
154.57	UC MERKLE-CORTEN	FINAL KJ (KSI*SQRT(IN))
169.86	UC MERKLE-CORTEN	FINAL KJ (MPA*SQRT(M))
120.19	UC MERKLE-CORTEN	BETA-ADJ FINAL KJ (KSI*SQRT(IN))
132.08	UC MERKLE-CORTEN	BETA-ADJ FINAL KJ (MPA*SQRT(M))
779.2	#UC ERNST	MAX LOAD J-INTEGRAL (IN*LB/IN^2)
136.46	#UC ERNST	MAX LOAD J-INTEGRAL (KJ/M^2)
152.6	#UC ERNST	MAX LOAD KJ (KSI*SQRT(IN))
167.69	#UC ERNST	MAX LOAD KJ (MPA*SQRT(M))
119.33	#UC ERNST	BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
131.14	#UC ERNST	BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
152.6	#UC ERNST	FINAL KJ (KSI*SQRT(IN))
167.69	#UC ERNST	FINAL KJ (MPA*SQRT(M))
119.33	#UC ERNST	BETA-ADJ FINAL KJ (KSI*SQRT(IN))
131.14	#UC ERNST	BETA-ADJ FINAL KJ (MPA*SQRT(M))
787	#UC MODIFIED ERNST	MAX LOAD J-INTEGRAL (IN*LB/IN^2)
137.82	#UC MODIFIED ERNST	MAX LOAD J-INTEGRAL (KJ/M^2)
153.36	#UC MODIFIED ERNST	MAX LOAD KJ (KSI*SQRT(IN))
168.53	#UC MODIFIED ERNST	MAX LOAD KJ (MPA*SQRT(M))
119.67	#UC MODIFIED ERNST	BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
131.5	#UC MODIFIED ERNST	BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
153.36	#UC MODIFIED ERNST	FINAL KJ (KSI*SQRT(IN))
168.53	#UC MODIFIED ERNST	FINAL KJ (MPA*SQRT(M))
119.67	#UC MODIFIED ERNST	BETA-ADJ FINAL KJ (KSI*SQRT(IN))
131.5	#UC MODIFIED ERNST	BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO UC MERKLE-CORTEN TEST RESULTS ■■ NO

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SPECIMEN CLEAVED

138450	PQ (LB)
615.82	PQ (KN)
200140	MAX LOAD (LB)
890.22	MAX LOAD (KN)
0.005	MEASURED FINAL CRACK EXTENSION (IN)
0.127	MEASURED FINAL CRACK EXTENSION (MM)
29885	REFERENCE MODULUS (KSI)
206.06	REFERENCE MODULUS (GPA)
126.38	UC KQ (KSI*SQRT(IN))
138.87	UC KQ (MPA*SQRT(M))
182.69	UC MAX LOAD K (KSI*SQRT(IN))
200.76	UC MAX LOAD K (MPA*SQRT(M))
-0.0341	#UC FINAL CRACK EXTENSION (IN)
-0.867	#UC FINAL CRACK EXTENSION (MM)
-782.4	#UC FINAL CRACK EXTENSION ERROR (PERCENT)

INVALID UC KIC TEST

1388.5	UC MERKLE-CORTEN	MAX LOAD J-INTEGRAL (IN*LB/IN ²)
243.17	UC MERKLE-CORTEN	MAX LOAD J-INTEGRAL (KJ/M ²)
203.7	UC MERKLE-CORTEN	MAX LOAD KJ (KSI*SQRT(IN))
223.85	UC MERKLE-CORTEN	MAX LOAD KJ (MPA*SQRT(M))
138.67	UC MERKLE-CORTEN	BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
152.38	UC MERKLE-CORTEN	BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
216.42	UC MERKLE-CORTEN	FINAL KJ (KSI*SQRT(IN))
237.82	UC MERKLE-CORTEN	FINAL KJ (MPA*SQRT(M))
142.72	UC MERKLE-CORTEN	BETA-ADJ FINAL KJ (KSI*SQRT(IN))
156.83	UC MERKLE-CORTEN	BETA-ADJ FINAL KJ (MPA*SQRT(M))
1351.6	#UC ERNST	MAX LOAD J-INTEGRAL (IN*LB/IN ²)
236.69	#UC ERNST	MAX LOAD J-INTEGRAL (KJ/M ²)
200.98	#UC ERNST	MAX LOAD KJ (KSI*SQRT(IN))
220.85	#UC ERNST	MAX LOAD KJ (MPA*SQRT(M))
137.76	#UC ERNST	BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
151.39	#UC ERNST	BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
213.66	#UC ERNST	FINAL KJ (KSI*SQRT(IN))
234.79	#UC ERNST	FINAL KJ (MPA*SQRT(M))
141.86	#UC ERNST	BETA-ADJ FINAL KJ (KSI*SQRT(IN))
155.89	#UC ERNST	BETA-ADJ FINAL KJ (MPA*SQRT(M))
1361	#UC MODIFIED ERNST	MAX LOAD J-INTEGRAL (IN*LB/IN ²)
238.35	#UC MODIFIED ERNST	MAX LOAD J-INTEGRAL (KJ/M ²)
201.68	#UC MODIFIED ERNST	MAX LOAD KJ (KSI*SQRT(IN))
221.62	#UC MODIFIED ERNST	MAX LOAD KJ (MPA*SQRT(M))
138	#UC MODIFIED ERNST	BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
151.64	#UC MODIFIED ERNST	BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
214.32	#UC MODIFIED ERNST	FINAL KJ (KSI*SQRT(IN))
235.51	#UC MODIFIED ERNST	FINAL KJ (MPA*SQRT(M))
142.06	#UC MODIFIED ERNST	BETA-ADJ FINAL KJ (KSI*SQRT(IN))
156.11	#UC MODIFIED ERNST	BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO UC MERKLE-CORTEN TEST RESULTS ■■ NO

NUREG/CR-5913

SPECIMEN CLEAVED

144310 PQ (LB)
 641.89 PQ (KN)
 149800 MAX LOAD (LB)
 666.33 MAX LOAD (KN)
 0.005 MEASURED FINAL CRACK EXTENSION (IN)
 0.127 MEASURED FINAL CRACK EXTENSION (MM)

 29885 REFERENCE MODULUS (KSI)
 206.06 REFERENCE MODULUS (GPA)

 128.61 UC KQ (KSI*SQRT(IN))
 141.33 UC KQ (MPA*SQRT(M))
 133.5 UC MAX LOAD K (KSI*SQRT(IN))
 146.71 UC MAX LOAD K (MPA*SQRT(M))
 0 #UC FINAL CRACK EXTENSION (IN)
 0 #UC FINAL CRACK EXTENSION (MM)
 100 #UC FINAL CRACK EXTENSION ERROR (PERCENT)

INVALID UC KIC TEST

631.6 UC MERKLE-CORTEN MAX LOAD J-INTEGRAL (IN*LB/IN²)
 110.61 UC MERKLE-CORTEN MAX LOAD J-INTEGRAL (KJ/M²)
 137.39 UC MERKLE-CORTEN MAX LOAD KJ (KSI*SQRT(IN))
 150.97 UC MERKLE-CORTEN MAX LOAD KJ (MPA*SQRT(M))
 112.27 UC MERKLE-CORTEN BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
 123.37 UC MERKLE-CORTEN BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
 137.39 UC MERKLE-CORTEN FINAL KJ (KSI*SQRT(IN))
 150.97 UC MERKLE-CORTEN FINAL KJ (MPA*SQRT(M))
 112.27 UC MERKLE-CORTEN BETA-ADJ FINAL KJ (KSI*SQRT(IN))
 123.37 UC MERKLE-CORTEN BETA-ADJ FINAL KJ (MPA*SQRT(M))

 608.3 #UC ERNST MAX LOAD J-INTEGRAL (IN*LB/IN²)
 106.53 #UC ERNST MAX LOAD J-INTEGRAL (KJ/M²)
 134.83 #UC ERNST MAX LOAD KJ (KSI*SQRT(IN))
 148.16 #UC ERNST MAX LOAD KJ (MPA*SQRT(M))
 111 #UC ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
 121.98 #UC ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
 134.83 #UC ERNST FINAL KJ (KSI*SQRT(IN))
 148.16 #UC ERNST FINAL KJ (MPA*SQRT(M))
 111 #UC ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
 121.98 #UC ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

 608.3 #UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN²)
 106.53 #UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M²)
 134.83 #UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
 148.16 #UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
 111 #UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
 121.98 #UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
 134.83 #UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
 148.16 #UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
 111 #UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
 121.98 #UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

UC MERKLE-CORTEN JIC,CEIC,KJIC AND TAVG NOT DEFINED--NOT ENOUGH DATA POINTS
 FOR POWER LAW FIT

72W-33

TEST SPECIMEN DATA

Material Type = A533-B Weld (U)
 Test Temperature = 10 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 152.4 mm
 Initial a/W = .511
 Init crack length a = 155.74 mm
 Flow stress = 562.1 MPa
 Yield stress = 502.9 MPa
 Youngs modulus E = 206600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 229 kJ/m ²	241.2 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 217.5 MPa√m	223.3 MPa√m
Kc (Beta Corrected)	= 166 MPa√m	168.4 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 1700.11 kN
 5% Secant Offset Pq = 929.94 kN
 Kq = 110.5 MPa√m
 Validity = INVALID--3
 K at Maximum Load = 201.9 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.009 mm

Fitted elastic load range = 200 kN TO 600 kN

Elastic slope = 7.769E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (U)
 Test Temperature = 10 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 152.4 mm
 Initial a/W = .511
 Init crack length a = 155.74 mm
 Flow stress = 562.1 MPa
 Yield stress = 502.9 MPa
 Youngs modulus E = 206600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 229 kJ/m ²	241.2 kJ/m ²
Kjc=(EJc/((1-ν ²))) ^{.5}	= 217.5 MPa√m	223.3 MPa√m
Kc (Beta Corrected)	= 166 MPa√m	168.4 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 1700.11 kN
 5% Secant Offset Pq = 929.94 kN
 Kq = 110.5 MPa√m
 Validity = INVALID--3
 K at Maximum Load = 201.9 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.009 mm
 Fitted elastic load range = 200 kN TO 600 kN
 Elastic slope = 7.769E+02 kN/mm

Specimen Crackmouth Deflection (in.) ORNL-DWG 92-11582

TEST SPECIMEN DATA

Material Type = A533-B Weld (U)
 Test Temperature = 10 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 152.4 mm
 Initial a/W = .511
 Init crack length a = 155.74 mm
 Flow stress = 562.1 MPa
 Yield stress = 502.9 MPa
 Youngs modulus E = 206600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 236.8 kJ/m ²	240.7 kJ/m ²
Kjc = (EJc / (1-ν ²)) ^{0.5}	= 221.2 MPa√m	223.1 MPa√m
Kc (Beta Corrected)	= 167.6 MPa√m	168.3 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 1700.11 kN
 5% Secant Offset Pq = 929.94 kN
 Kq = 110.5 MPa√m
 Validity = INVALID--3
 K at Maximum Load = 201.9 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .006 mm

Fitted elastic load range = 200 kN TO 600 kN

Elastic slope = 5.501E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (U)
 Test Temperature = 10 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 152.4 mm
 Initial a/W = .511
 Init crack length a = 155.74 mm
 Flow stress = 562.1 MPa
 Yield stress = 502.9 MPa
 Youngs modulus E = 206600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 233.6 kJ/m ²	239.8 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 219.7 MPa√m	222.6 MPa√m
Kc (Beta Corrected)	= 167 MPa√m	168.1 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 1700.11 kN
 5% Secant Offset Pq = 929.94 kN
 Kq = 110.5 MPa√m
 Validity = INVALID--3
 K at Maximum Load = 201.9 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .007 mm

Fitted elastic load range = 200 kN TO 600 kN

Elastic slope = 5.567E+02 kN/mm

NUREG/CR-5913

LRF

3/11/76

72W-007

0.858

6T-CT

10°C

72W-007

LOAD (1V/1W)

NUREG/CR-5913

1V = 58 000 lbs

DEFLECTION (2.5 V/1W)

1V = 0.015446 in.

E-139

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 10 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 152.4 mm
 Initial a/W = .512
 Init crack length a = 156.08 mm
 Flow stress = 566.7 MPa
 Yield stress = 510.9 MPa
 Youngs modulus E = 206600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
Jc	= 126.4 kJ/m ²	131.7 kJ/m ²
Kjc = (EJc / (1 - ν ²)) ^{.5}	= 161.6 MPa√m	165 MPa√m
Kc (Beta Corrected)	= 139.7 MPa√m	141.7 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 1339.68 kN
 5% Secant Offset Pq = 1339.68 kN
 Kq = 159.7 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 159.7 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .004 mm

Fitted elastic load range = 222 kN TO 444 kN

Elastic slope = 5.606E+02 kN/mm

NUREG/CR-5913

LKF 3/13/86

72W-008

0%SG

6T-C

E-141

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 10 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 203.2 mm
 Initial a/W = .551
 Init crack length a = 223.79 mm
 Flow stress = 566.7 MPa
 Yield stress = 510.9 MPa
 Youngs modulus E = 206600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
Jc	= 181.4 kJ/m ²	189 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 193.6 MPa√m	197.6 MPa√m
Kc (Beta Corrected)	= 165.3 MPa√m	167.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 2138.19 kN
 5% Secant Offset Pq = 1664.23 kN
 Kq = 146.3 MPa√m
 Validity = INVALID--2, 3
 K at Maximum Load = 188 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.007 mm

Fitted elastic load range = 222 kN TO 444 kN

Elastic slope = 6.248E+02 kN/mm

NUREG/CR-5913

4/2/86

72W-001

8T-C7

NUREG/CR-5913

E-143

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 10 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 203.2 mm
 Initial a/W = .58
 Init crack length a = 235.57 mm
 Flow stress = 566.7 MPa
 Yield stress = 510.9 MPa
 Youngs modulus E = 206600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 189 kJ/m ²	195.5 kJ/m ²
Kjc = (EJc / (1-ν ²)) ^{0.5}	= 197.6 MPa√m	201 MPa√m
Kc (Beta Corrected)	= 167.5 MPa√m	169.3 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 1972.62 kN
 5% Secant Offset Pq = 1842.66 kN
 Kq = 179.7 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 192.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .001 mm
 Fitted elastic load range = 222 kN TO 444 kN
 Elastic slope = 5.340E+02 kN/mm
 NUREG/CR-5913

LRF 4/25/86

12W-002

87-C1

0756

LV = 50000 lbs

LOAD (LV/IN)

GREY #101

DEFLECTION (2.5V/IN)

NUREG/CR-5913

E-145

TEST SPECIMEN DATA

Material Type	=	A533-B HSST 5th Irrad. Weld
Test Temperature	=	20 °C
Percent Side Groove	=	0 %
Specimen Thickness B	=	203.2 mm
Initial a/W	=	.628
Init crack length a	=	255.07 mm
Flow stress	=	558.2 MPa
Yield stress	=	503.6 MPa
Youngs modulus E	=	206100 MPa (Estimated Value)
Poisson's Ratio (ν)	=	0

J-INTEGRAL ANALYSIS

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

J _{ic}	=	344.8 kJ/m ²
K _{jic} = (EJ _{ic} / (1-ν ²)) ^{0.5}	=	266.7 MPa√m
K _{ic} (Beta Corrected)	=	198.1 MPa√m

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B = (BB _n) ^{1/2}	
Maximum Load P	= 2037.81 kN
5% Secant Offset P _q	= 1593.86 kN
K _q	= 188 MPa√m
Validity	= INVALID--1, 2, 3
K at Maximum Load	= 240.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction for specimen rotation

Correction to J for crack extension

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .015 mm

Fitted elastic load range = 800 kN TO 400 kN

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 20 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 203.2 mm
 Initial a/W = .628
 Init crack length a = 255.07 mm
 Flow stress = 558.2 MPa
 Yield stress = 503.6 MPa
 Youngs modulus E = 206100 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J_{ic})
 J_{ic} = 339.9 kJ/m² (Defl. * 0.740)
 $K_{Jc} = (EJ_{ic} / (1 - \nu^2))^{.5}$ = 264.8 MPa√m
 K_{ic} (Beta Corrected) = 197.4 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{1/2}
 Maximum Load P = 2037.81 kN
 5% Secant Offset P_q = 1593.86 kN
 K_q = 188 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 240.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction for specimen rotation
 Correction to J for crack extension
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .018 mm
 Fitted elastic load range = 800 kN TO 400 kN

TEST SPECIMEN DATA

Material Type	= A533-B HSST 5th Irrad. Weld
Test Temperature	= 20 °C
Percent Side Groove	= 0 %
Specimen Thickness B	= 203.2 mm
Initial a/W	= .628
Init crack length a	= 255.07 mm
Flow stress	= 558.2 MPa
Yield stress	= 503.6 MPa
Youngs modulus E	= 206100 MPa (Estimated Value)
Poisson's Ratio (ν)	= 0

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J _{ic})	
J _{ic}	= 342.1 kJ/m ² (Defl. * 0.740)
$K_{jc} = (EJ_{ic} / (1 - \nu^2))^{.5}$	= 265.6 MPa√m
K _{ic} (Beta Corrected)	= 197.7 MPa√m

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation;	B = (BB _n) ^{1/2}
Maximum Load P	= 2037.81 kN
5% Secant Offset P _q	= 1657.03 kN
K _q	= 195.5 MPa√m
Validity	= INVALID--1, 2, 3
K at Maximum Load	= 240.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction for specimen rotation

Correction to J for crack extension

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .011 mm

Fitted elastic load range = 800 kN TO 400 kN

8T-CT

0.945 g

72W-003

6.5°F = 20°C

EMI

72W-003

11.000 05

Load (N) / (in)

NUREG/CR-5913

clip gage 101 deflection (in/in)

0.02151

40.3 TALOT

E-149

TEST SPECIMEN DATA

Material Type	= A533-B HSST 5th Irrad. Weld
Test Temperature	= 20 °C
Percent Side Groove	= 0 %
Specimen Thickness B	= 203.2 mm
Initial a/W	= .626
Init crack length a	= 254.33 mm
Flow stress	= 558.2 MPa
Yield stress	= 503.6 MPa
Youngs modulus E	= 206100 MPa (Estimated Value)
Poisson's Ratio (ν)	= 0

J-INTEGRAL ANALYSIS

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

J _{ic}	= 582.3 kJ/m ²
K _{jc} = (EJ _{ic} / (1 - ν ²)) ^{0.5}	= 346.5 MPa√m
K _{ic} (Beta Corrected)	= 225.5 MPa√m

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B	= (BB _n) ^{1/2}
Maximum Load P	= 2370.55 kN
5% Secant Offset P _q	= 1708.85 kN
K _q	= 200 MPa√m
Validity	= INVALID--1, 2, 3
K at Maximum Load	= 277.5 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction for specimen rotation

Correction to J for crack extension

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .015 mm

Fitted elastic load range = 800 kN TO 400 kN

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 20 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 203.2 mm
 Initial a/W = .626
 Init crack length a = 254.33 mm
 Flow stress = 558.2 MPa
 Yield stress = 503.6 MPa
 Youngs modulus E = 206100 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J_{ic})
 J_{ic} = 573.2 kJ/m² (Defl. * 0.740)
 $K_{Jc} = (EJ_{ic} / (1 - \nu^2))^{.5}$ = 343.8 MPa√m
 K_{ic} (Beta Corrected) = 224.6 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{1/2}
 Maximum Load P = 2370.55 kN
 5% Secant Offset P_q = 1771.35 kN
 K_q = 207.4 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 277.5 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction for specimen rotation
 Correction to J for crack extension
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .024 mm
 Fitted elastic load range = 800 kN TO 400 kN

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 20 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 203.2 mm
 Initial a/W = .626
 Init crack length a = 254.33 mm
 Flow stress = 558.2 MPa
 Yield stress = 503.6 MPa
 Youngs modulus E = 206100 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

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

J_{ic} = 573.5 kJ/m² (Defl. * 0.740)
 $K_{Jc} = (E J_{ic} / (1 - \nu^2))^{.5} = 343.9 \text{ MPa}\sqrt{\text{m}}$
 $K_{ic} \text{ (Beta Corrected)} = 224.7 \text{ MPa}\sqrt{\text{m}}$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (BB_n)^{1/2}$
 Maximum Load P = 2370.55 kN
 5% Secant Offset P_q = 1708.85 kN
 $K_q = 200 \text{ MPa}\sqrt{\text{m}}$
 Validity = INVALID--1, 2, 3
 $K \text{ at Maximum Load} = 277.5 \text{ MPa}\sqrt{\text{m}}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction for specimen rotation
 Correction to J for crack extension
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .03 mm
 Fitted elastic load range = 800 kN TO 400 kN

81-CT 10-18

0905 = 200

72W-004

0905

81-CT

1100005 (11/11) 1007

NUREG/CR-5913

03-57 11

(11/11) 101 (101) 101

**Load-Displacement Curves and Photographs
of the Fracture Toughness Specimens
from the Irradiated 72W Weld
(0.23 wt% Cu)**

SPECIMEN ID= 72W137
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -75 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.5 mm $a/W)i = .522$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 621 MPa
FLOW STRENGTH= 672 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

SPECIMEN CLEAVED AT $K_{Ic} = 40.8 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 9 kJ/m²
K_{Jc}= 43.6 MPa SQR[m]
K-beta-c= 42.6 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 9 kJ/m²
K_{Jc}= 43.6 MPa SQR[m]
K-beta-c= 42.6 MPa SQR[m]

E-156

ORNL-DWG 92-11593

72W137

-75 DEGREES C

72W137

SPECIMEN ID= 72W141
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= -25 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.1 mm $a/W)i = .534$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 621 MPa
FLOW STRENGTH= 672 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT KQ= 68.9 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 26.9 kJ/m²
KJc= 74.9 MPa SQR[m]
K-beta-c= 66.2 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 26.9 kJ/m²
KJc= 74.9 MPa SQR[m]
K-beta-c= 66.2 MPa SQR[m]

72W141

-25 DEGREES C

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = -25 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .506
 Init crack length a = 25.69 mm
 Flow stress = 704.2 MPa
 Yield stress = 655 MPa
 Youngs modulus E = 208600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 11.7 kJ/m ²	11.5 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 49.3 MPa√m	48.9 MPa√m
Kc (Beta Corrected)	= 47.9 MPa√m	47.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 28.31 kN
 5% Secant Offset Pq = 28.31 kN
 Kq = 48.6 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 48.6 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = 0 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 1.233E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = -25 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .506
 Init crack length a = 25.69 mm
 Flow stress = 704.2 MPa
 Yield stress = 655 MPa
 Youngs modulus E = 208600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 12.4 kJ/m ²	11.5 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 50.8 MPa√m	48.9 MPa√m
Kc (Beta Corrected)	= 49.1 MPa√m	47.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 28.31 kN
 5% Secant Offset Pq = 28.31 kN
 Kq = 48.6 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 48.6 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .009 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 8.622E+01 kN/mm

IT-CT

IRRADIATED

72W-104

$t = -25^{\circ}\text{C}$

0% S.G

7/27/86 SHM

2500 lb

Load 0.1007

NUREG/CR-5913

72W-104

4.121 $\mu\text{V}/\text{volt}$

Front Face Deflection $10 \mu\text{V}/\text{inch}$

4.121 $\frac{\text{inch}}{\text{volt}}$

E-161

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = -25 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .524
 Init crack length a = 26.61 mm
 Flow stress = 704.2 MPa
 Yield stress = 655 MPa
 Youngs modulus E = 208600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 17.1 kJ/m ²	18.9 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 59.7 MPa√m	62.7 MPa√m
Kc (Beta Corrected)	= 56.4 MPa√m	58.7 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 33.24 kN
 5% Secant Offset Pq = 33.24 kN
 Kq = 60.5 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 60.5 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .005 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 1.287E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = -25 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .524
 Init crack length a = 26.61 mm
 Flow stress = 704.2 MPa
 Yield stress = 655 MPa
 Young's modulus E = 208600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 17.4 kJ/m ²	18.1 kJ/m ²
Kjc = (EJc / (1 - ν ²)) ^{0.5}	= 60.2 MPa√m	61.5 MPa√m
Kc (Beta Corrected)	= 56.8 MPa√m	57.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 33.24 kN
 5% Secant Offset Pq = 33.24 kN
 Kq = 60.5 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 60.5 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .013 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 8.949E+01 kN/mm

NUREG/CR-5913

IT-CT

IRRADIATED

72W-125

-25°C

0% S.G.

1/27/86 BHM

4 mm / 0.052

4 mm / 0.1 inch

72W-125

E-164

4.121 in/volt

FRONT FACE Deflection 10 mm/inch

4.121 inch/volt

SPECIMEN ID= 72W124
MATERIAL TYPE= MCUWELD
TEST TEMPERATURE= 25 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.7 mm $a/W)i = .526$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 621 MPa
FLOW STRENGTH= 672 MPa
ESTIMATED YOUNG'S MODULUS= 206 GPa

SPECIMEN CLEAVED AT KQ= 96.8 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 55.5 kJ/m²
KJc= 106.9 MPa SQR[m]
K-beta-c= 82.5 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 55.5 kJ/m²
KJc= 106.9 MPa SQR[m]
K-beta-c= 82.5 MPa SQR[m]

72W124

25 DEGREES C

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 29 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .522
 Init crack length a = 26.5 mm
 Flow stress = 666 MPa
 Yield stress = 617.8 MPa
 Youngs modulus E = 205600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 46.6 kJ/m ²	48.7 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 97.9 MPa√m	100 MPa√m
Kc (Beta Corrected)	= 78.4 MPa√m	79.3 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 52.87 kN
 5% Secant Offset Pq = 51.2 kN
 Kq = 92.5 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 95.5 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.002 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 1.206E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 29 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .504
 Init crack length a = 25.58 mm
 Flow stress = 666 MPa
 Yield stress = 617.8 MPa
 Youngs modulus E = 205600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 86.4 kJ/m ²	78.7 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 133.3 MPa√m	127.2 MPa√m
Kc (Beta Corrected)	= 92.3 MPa√m	90.2 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 66.31 kN
 5% Secant Offset Pq = 48.47 kN
 Kq = 82.7 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 113.1 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .018 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 8.216E+01 kN/mm

IT-CT

72W-115

090

290C

EMD 7/24/80

M/0052 (u/11) P 007

NUREG/CR-5913

Failure of
Front Face Clip Gage

72W-115

Loadline Deflection (1.0 volt/mch)

0.09155"/V ~~Front Face Deflection (1.0 volt/mch)~~

~~0.0757"/V~~ Load line deflection (1V/in)

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 29 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .52
 Init crack length a = 26.42 mm
 Flow stress = 666 MPa
 Yield stress = 617.8 MPa
 Young's modulus E = 205600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 22.7 kJ/m ²	23.3 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 68.2 MPa√m	69.2 MPa√m
Kc (Beta Corrected)	= 61.8 MPa√m	62.4 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 37.83 kN
 5% Secant Offset Pq = 37.83 kN
 Kq = 68 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 68 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = 0 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 1.191E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 29 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .52
 Init crack length a = 26.42 mm
 Flow stress = 666 MPa
 Yield stress = 617.8 MPa
 Youngs modulus E = 205500 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 25 kJ/m ²	23.7 kJ/m ²
Kjc = (EJc / (1 - ν ²)) ^{.5}	= 71.7 MPa√m	69.8 MPa√m
Kc (Beta Corrected)	= 64.1 MPa√m	62.9 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 38.02 kN
 5% Secant Offset Pq = 38.02 kN
 Kq = 68.3 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 68.3 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .014 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 8.120E+01 kN/mm

NUREG/CR-5913

1F-CT

72W-100 IRRADIATED 098

29°C

EMD 7/23/86

72W-100

✓ 11 # 0052 (in/in) pba 7

2.9757 in/volt

AE Front Face Deflection (10mv/in)

2.9757 in/V

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 29 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .504
 Init crack length a = 25.58 mm
 Flow stress = 666 MPa
 Yield stress = 617.8 MPa
 Youngs modulus E = 205600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 79.7 kJ/m ²	77 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 128 MPa√m	125.8 MPa√m
Kc (Beta Corrected)	= 90.5 MPa√m	89.7 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 66.1 kN
 5% Secant Offset Pq = 49.32 kN
 Kq = 84.1 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 112.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .001 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 1.197E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 29 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .504
 Init crack length a = 25.58 mm
 Flow stress = 666 MPa
 Yield stress = 617.8 MPa
 Youngs modulus E = 205600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
Jc	= 86.4 kJ/m ²	78.7 kJ/m ²
Kjc = (EJc / ((1-ν ²))) ^{.5}	= 133.3 MPa√m	127.2 MPa√m
Kc (Beta Corrected)	= 92.3 MPa√m	90.2 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 66.31 kN
 5% Secant Offset Pq = 48.47 kN
 Kq = 82.7 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 113.1 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .018 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 8.216E+01 kN/mm

IT-CT

72W-132(I)

090

290C

EMD 7/24/84

72W-132

1/10052 (in/in) 9007

NUREG/CR-5913

2.9757 in/volt

Front Face deflection (in/in)

2.9757 in/v

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .55
 Init crack length a = 27.94 mm
 Flow stress = 654.5 MPa
 Yield stress = 607.1 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
Jc	= 105 kJ/m ²	113.8 kJ/m ²
Kjc = (EJc / (1-ν ²)) ^{.5}	= 146.5 MPa√m	152.5 MPa√m
Kc (Beta Corrected)	= 95.7 MPa√m	97.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 59.86 kN
 5% Secant Offset Pq = 41.12 kN
 Kq = 81.6 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 118.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .001 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 1.148E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .55
 Init crack length a = 27.94 mm
 Flow stress = 654.5 MPa
 Yield stress = 607.1 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 29.2 kJ/m ²	33.3 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 77.2 MPa√m	82.5 MPa√m
Kc (Beta Corrected)	= 67.1 MPa√m	70.1 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 40.66 kN
 5% Secant Offset Pq = 40.66 kN
 Kq = 80.7 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 80.7 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .001 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 1.148E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .55
 Init crack length a = 27.94 mm
 Flow stress = 654.5 MPa
 Yield stress = 607.1 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 108.8 kJ/m ²	115.4 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 149.1 MPa√m	153.6 MPa√m
Kc (Beta Corrected)	= 96.5 MPa√m	97.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 59.86 kN
 5% Secant Offset Pq = 41.12 kN
 Kq = 81.6 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 118.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .011 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 8.203E+01 kN/mm

0% Side Groove

1P-CT

72W-152

+50°C (122°F)

9/14/86 RHM

No photo → Compliance Crack Length

PK #73

0.025079 $\frac{\text{mV}}{\text{volt}}$

FRONT FACE Deflection 0.5 $\frac{\text{volt}}{\text{inch}}$

0.025079 $\frac{\text{inch}}{\text{volt}}$

2500 $\frac{\text{mV}}{\text{volt}}$

Load 0.1 $\frac{\text{volt}}{\text{inch}}$

NUREG/CR-5913

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .518
 Init crack length a = 26.29 mm
 Flow stress = 654.5 MPa
 Yield stress = 607.1 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 261.3 kJ/m ²	273.7 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 231.1 MPa√m	236.5 MPa√m
Kc (Beta Corrected)	= 116.4 MPa√m	117.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 57.15 kN
 5% Secant Offset Pq = 48.54 kN
 Kq = 86.5 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 101.9 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.003 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 1.144E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .518
 Init crack length a = 26.29 mm
 Flow stress = 645.5 MPa
 Yield stress = 607.1 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 95.4 kJ/m ²	94.4 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 139.6 MPa√m	138.9 MPa√m
Kc (Beta Corrected)	= 93.6 MPa√m	93.4 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 57.15 kN
 5% Secant Offset Pq = 48.54 kN
 Kq = 86.5 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 101.9 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.003 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 1.144E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .518
 Init crack length a = 26.29 mm
 Flow stress = 654.5 MPa
 Yield stress = 607.1 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 42.9 kJ/m ²	42.2 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 93.7 MPa√m	92.9 MPa√m
Kc (Beta Corrected)	= 75.8 MPa√m	75.4 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 49.79 kN
 5% Secant Offset Pq = 48.54 kN
 Kq = 86.5 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 88.7 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.003 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 1.144E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .518
 Init crack length a = 26.29 mm
 Flow stress = 654.5 MPa
 Yield stress = 607.1 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 254.3 kJ/m ²	265.1 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 228 MPa√m	232.8 MPa√m
Kc (Beta Corrected)	= 115.8 MPa√m	116.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 57.15 kN
 5% Secant Offset Pq = 49 kN
 Kq = 87.3 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 101.9 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .007 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 8.126E+01 kN/mm

0% Side Gauge

IT-CT

72W-134

+50°C (122°F)

7/13/86 poov

72W-134

E-184

0.025079 in/volt

Front Face Deflection 0.5 $\frac{\text{volt}}{\text{inch}}$

0.025079 $\frac{\text{inch}}{\text{volt}}$

SPECIMEN ID= 72W116
MATERIAL TYPE= MCWELD
TEST TEMPERATURE= 75 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.8 mm $a/W)i = .527$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 621 MPa
FLOW STRENGTH= 672 MPa
ESTIMATED YOUNG'S MODULUS= 203 GPa

SPECIMEN CLEAVED AT KQ= 119 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 94.8 kJ/m²
KJc= 138.7 MPa SQR[m]
K-beta-c= 94.3 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 94.8 kJ/m²
KJc= 138.7 MPa SQR[m]
K-beta-c= 94.3 MPa SQR[m]

0.9% Side Groove

IT-CT

72W-152

+50°C (122°F)

9/14/86 BHM

72W-152

No Photo → Compliance Crack Length

Load 1.0 $\frac{\text{volt}}{\text{inch}}$

NUREG/CR-5913

0.025079 $\frac{\text{volt}}{\text{inch}}$

Front Face Deflection 0.5 $\frac{\text{inch}}{\text{inch}}$

0.025079 $\frac{\text{inch}}{\text{volt}}$

E-185A

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .55
 Init crack length a = 27.94 mm
 Flow stress = 654.5 MPa
 Yield stress = 607.1 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = .3

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 30.2 kJ/m ²	29 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 82.4 MPa√m	80.8 MPa√m
Kc (Beta Corrected)	= 70 MPa√m	69.1 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 40.66 kN
 5% Secant Offset Pq = 40.66 kN
 Kq = 80.7 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 80.7 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .024 mm
 Fitted elastic load range = 15 kN TO 45 kN
 Elastic slope = 7.816E+01 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .55
 Init crack length a = 27.94 mm
 Flow stress = 654.5 MPa
 Yield stress = 607.1 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 30.2 kJ/m ²	31.9 kJ/m ²
Kjc = (EJc / (1 - ν ²)) ^{0.5}	= 78.6 MPa√m	80.8 MPa√m
Kc (Beta Corrected)	= 67.9 MPa√m	69.1 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 40.66 kN
 5% Secant Offset Pq = 40.66 kN
 Kq = 80.7 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 80.7 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .024 mm
 Fitted elastic load range = 15 kN TO 45 kN
 Elastic slope = 7.816E+01 kN/mm

72W116

75 DEGREES C

TEST SPECIMEN DATA

Material Type	= A533-B WELD (I)
Test Temperature	= 75 °C
Percent Side Groove	= 0 %
Specimen Thickness B	= 25.4 mm
Initial a/W	= .516
Init crack length a	= 26.21 mm
Flow stress	= 643.2 MPa
Yield stress	= 597.1 MPa
Young's modulus E	= 202900 MPa (Estimated Value)
Poisson's Ratio (ν)	= 0

J-INTEGRAL ANALYSIS[Failure Type A (J at instability = J_c)]

	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
J _c	= 84.2 kJ/m ²	86.2 kJ/m ²
K _{Jc} = (EJ _c / (1-ν ²)) ^{0.5}	= 130.7 MPa√m	132.2 MPa√m
K _c (Beta Corrected)	= 89.9 MPa√m	90.4 MPa√m

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation;	B = (BB _n) ^{1/2}
Maximum Load P	= 66.78 kN
5% Secant Offset P _q	= 48.96 kN
K _q	= 86.8 MPa√m
Validity	= INVALID--1, 2, 3
K at Maximum Load	= 118.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.009 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 1.201E+02 kN/mm

TEST SPECIMEN DATA

Material Type	= A533-B WELD (I)
Test Temperature	= 75 °C
Percent Side Groove	= 0 %
Specimen Thickness B	= 25.4 mm
Initial a/W	= .516
Init crack length a	= 26.21 mm
Flow stress	= 643.2 MPa
Yield stress	= 597.1 MPa
Youngs modulus E	= 202900 MPa (Estimated Value)
Poisson's Ratio (ν)	= 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
Jc	= 88.5 kJ/m ²	87.5 kJ/m ²
K _{Jc} = (EJc / (1 - ν ²)) ^{0.5}	= 134 MPa√m	133.2 MPa√m
K _c (Beta Corrected)	= 91 MPa√m	90.7 MPa√m

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation;	B = (BBn) ^{1/2}
Maximum Load P	= 66.78 kN
5% Secant Offset P _q	= 46.61 kN
K _q	= 82.7 MPa√m
Validity	= INVALID--1, 2, 3
K at Maximum Load	= 118.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .003 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 8.507E+01 kN/mm

1T-CT

72W-110

090

75°C

EMD 7/26/86

72W-110

NA0052 (in/in) P307

NUREG/CR-5913

4.121 in/volt

Front Face deflection (10W/in)

4.121 in/V

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 75 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .527
 Init crack length a = 26.77 mm
 Flow stress = 643.2 MPa
 Yield stress = 597.1 MPa
 Youngs modulus E = 202900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 779.7 kJ/m ²	866 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 397.8 MPa√m	419.2 MPa√m
Kc (Beta Corrected)	= 141.7 MPa√m	144.4 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 75 kN
 5% Secant Offset Pq = 46.64 kN
 Kq = 85.7 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 137.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.002 mm

Fitted elastic load range = 5 kN TO 15 kN

Elastic slope = 1.233E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 75 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .527
 Init crack length a = 26.77 mm
 Flow stress = 643.2 MPa
 Yield stress = 567.1 MPa
 Youngs modulus E = 202900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 370.7 kJ/m ²	409.2 kJ/m ²
Kjc=(EJc/((1-ν ²))) ^{.5}	= 274.3 MPa√m	288.2 MPa√m
Kc (Beta Corrected)	= 119.5 MPa√m	121.7 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 75 kN
 5% Secant Offset Pq = 48.84 kN
 Kq = 89.7 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 137.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.001 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 1.222E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 75 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .527
 Init crack length a = 26.77 mm
 Flow stress = 643.2 MPa
 Yield stress = 597.1 MPa
 Youngs modulus E = 202900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 136.2 kJ/m ²	144.9 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 166.3 MPa√m	171.5 MPa√m
Kc (Beta Corrected)	= 100.5 MPa√m	101.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 75 kN
 5% Secant Offset Pq = 48.84 kN
 Kq = 89.7 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 137.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.001 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 1.222E+02 kN/mm

Specimen Crackmouth Deflection (in.)

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 75 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .527
 Init crack length a = 26.77 mm
 Flow stress = 643.2 MPa
 Yield stress = 597.1 MPa
 Youngs modulus E = 202900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 776.6 kJ/m ²	861.1 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 397 MPa√m	418.1 MPa√m
Kc (Beta Corrected)	= 141.6 MPa√m	144.3 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 75 kN
 5% Secant Offset Pq = 43.29 kN
 Kq = 79.6 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 137.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .01 mm

Fitted elastic load range = 5 kN TO 15 kN

Elastic slope = 8.630E+01 kN/mm

1T-9T

72W-130

096

75°C

EMD 7/27/86

No Photo
Compliance Crack Length

4.121 mm/volt

Front - Face deflection (mm) (10mv/in)

4.121"V

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 75 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .524
 Init crack length a = 26.63 mm
 Flow stress = 643.2 MPa
 Yield stress = 597.1 MPa
 Youngs modulus E = 202900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
Jc	= 74.2 kJ/m ²	78.1 kJ/m ²
K _{Jc} = (EJc / (1-ν ²)) ^{.5}	= 122.7 MPa√m	125.9 MPa√m
Kc (Beta Corrected)	= 87.1 MPa√m	88.3 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{IC} Equation; B = (BBn)^{1/2}
 Maximum Load P = 62.4 kN
 5% Secant Offset P_q = 46.48 kN
 K_q = 84.7 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 113.6 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .002 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 1.197E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 75 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .524
 Init crack length a = 26.63 mm
 Flow stress = 643.2 MPa (Estimated Value)
 Yield stress = 597.1 MPa (Estimated Value)
 Youngs modulus E = 202900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 76.5 kJ/m ²	77.1 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 124.6 MPa√m	125.1 MPa√m
Kc (Beta Corrected)	= 87.8 MPa√m	88 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 61.88 kN
 5% Secant Offset Pq = 45.88 kN
 Kq = 83.6 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 112.7 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .008 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 8.392E+01 kN/mm

IT-CT

+75°C

72W-150

0% Side Groove

7/27/86 BHM

2500 lb/ft

4000 lb/ft

NUREG/CR-5913

72W-150

4.121 in/ft

Front Face Clip Gage 10 mm/inch

4.121 in/ft

E-199

72W-106

NUREG/CR-5913

8752	PQ (LB)
38.931	PQ (KN)
17156	MAX LOAD (LB)
76.309	MAX LOAD (KN)
66.16	UC KQ (KSI*SQRT(IN))
72.65	UC KQ (MPA*SQRT(M))
129.69	UC MAX LOAD K (KSI*SQRT(IN))
142.4	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
<u>1178</u>	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
206.2	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
185.91	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
204.3	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
102.02	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
112.11	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
<u>305.85</u>	#UC MODIFIED ERNST <u>FINAL KJ</u> (KSI*SQRT(IN))
336.1	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
124.07	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
136.34	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA *** YES

ACCEPT POWER LAW FIT TO TEST DATA *** YES

14447	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
304.37	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0.65469	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
0.65469	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
276.06	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
48.346	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0.00103	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN)
0.02629	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (MM)
0.0115	UC MODIFIED ERNST CEIC (IN)
0.293	UC MODIFIED ERNST CEIC (MM)
1099.5	UC MODIFIED ERNST JIC (IN*LB/IN^2)
192.56	UC MODIFIED ERNST JIC (KJ/M^2)
179.64	UC MODIFIED ERNST KJIC (KSI*SQRT(IN))
<u>197.4</u>	UC MODIFIED ERNST KJIC (MPA*SQRT(M))
<u>93.8</u>	UC MODIFIED ERNST TAUG

E-201

ORNL-DWG 92-11899

72W-107

NUREG/CR-5913

SPECIMEN DID NOT CLEAVE

9040	PQ (LB)
40.212	PQ (KN)
14430	MAX LOAD (LB)
64.184	MAX LOAD (KN)
0.0062	MEASURED FINAL CRACK EXTENSION (IN)
0.158	MEASURED FINAL CRACK EXTENSION (MM)
29348	REFERENCE MODULUS (KSI)
202.35	REFERENCE MODULUS (GPA)
68.57	UC KQ (KSI*SQRT(IN))
75.35	UC KQ (MPA*SQRT(M))
109.45	UC MAX LOAD K (KSI*SQRT(IN))
120.27	UC MAX LOAD K (MPA*SQRT(M))
0.0068	#UC FINAL CRACK EXTENSION (IN)
0.174	#UC FINAL CRACK EXTENSION (MM)
9.6	#UC FINAL CRACK EXTENSION ERROR (PERCENT)

INVALID UC KIC TEST

472.6	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
82.76	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
117.77	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
129.41	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
81.59	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
89.66	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
117.77	UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
129.41	UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
81.59	UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
89.66	UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO UC MODIFIED ERNST TEST RESULTS ■■ NO

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAVG NOT DEFINED--POWER LAW FIT DECLINED BY TECHNICIAN

72W-102

SPECIMEN CLEAVED

9002	PQ (LB)
40.043	PQ (KN)
16605	MAX LOAD (LB)
73.859	MAX LOAD (KN)
0.0099	MEASURED FINAL CRACK EXTENSION (IN)
0.252	MEASURED FINAL CRACK EXTENSION (MM)
29348	REFERENCE MODULUS (KSI)
202.35	REFERENCE MODULUS (GPA)
66.69	UC KQ (KSI*SQRT(IN))
73.29	UC KQ (MPA*SQRT(M))
123.02	UC MAX LOAD K (KSI*SQRT(IN))
135.18	UC MAX LOAD K (MPA*SQRT(M))
0.0001	#UC FINAL CRACK EXTENSION (IN)
0.002	#UC FINAL CRACK EXTENSION (MM)
-99.1	#UC FINAL CRACK EXTENSION ERROR (PERCENT)

INVALID UC KIC TEST

686.9	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
120.3	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
141.99	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
156.03	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
89.09	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
97.91	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
141.99	UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
156.03	UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
89.09	UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
97.91	UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO UC MODIFIED ERNST TEST RESULTS ☒ YES
 51 ITERATIONS--STOP AND RETURN CURRENT COEFFICIENTS ☒ YES
 ACCEPT POWER LAW FIT TO UC MODIFIED ERNST TEST RESULTS ☒ NO
 SUPPRESS SELECTED DATA AND REFIT DATA ☒ NO

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAVG NOT DEFINED--POWER LAW FIT REJECTED BY TECHNICIAN

72W-108

NUREG/CR-5913

SPECIMEN DID NOT CLEAVE

9388	PQ (LB)
41.756	PQ (KN)
17330	MAX LOAD (LB)
77.084	MAX LOAD (KN)
0.1287	MEASURED FINAL CRACK EXTENSION (IN)
3.269	MEASURED FINAL CRACK EXTENSION (MM)
29348	REFERENCE MODULUS (KSI)
202.35	REFERENCE MODULUS (GPA)
71.26	UC KQ (KSI*SQRT(IN))
78.3	UC KQ (MPA*SQRT(M))
131.54	UC MAX LOAD K (KSI*SQRT(IN))
144.55	UC MAX LOAD K (MPA*SQRT(M))
0.0003	#UC FINAL CRACK EXTENSION (IN)
0.008	#UC FINAL CRACK EXTENSION (MM)
-99.7	#UC FINAL CRACK EXTENSION ERROR (PERCENT)

INVALID UC KIC TEST

872.7	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN ²)
152.83	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M ²)
160.03	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
175.86	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
93.93	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
103.22	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
160.03	UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
175.86	UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
93.93	UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
103.22	UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO UC MODIFIED ERNST TEST RESULTS ### NO

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAVG NOT DEFINED--POWER LAW FIT DECLINED BY TECHNICIAN

72W-119

NUREG/CR-5913

9439	PQ (LB)
41.985	PQ (KN)
16642	MAX LOAD (LB)
74.022	MAX LOAD (KN)
69.73	UC KQ (KSI*SQRT(IN))
76.57	UC KQ (MPA*SQRT(M))
122.95	UC MAX LOAD K (KSI*SQRT(IN))
135	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
563	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
98.6	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
128.56	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
141.28	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
85.11	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
93.52	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
144.74	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
159.05	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
89.87	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
98.76	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ### NO

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAUG NOT DEFINED--POWER LAW FIT NOT REQUESTED BY TECHNICIAN

E-210

72W-120

NUREG/CR-5913

9559	PQ (LB)
42.52	PQ (KN)
17818	MAX LOAD (LB)
79.254	MAX LOAD (KN)
70.04	UC KQ (KSI*SQRT(IN))
76.9	UC KQ (MPA*SQRT(M))
130.54	UC MAX LOAD K (KSI*SQRT(IN))
143.33	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
1343	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
235.3	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
198.56	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
218.2	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
102.81	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
112.98	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
244.69	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
268.89	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
111.68	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
122.72	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ### YES

ACCEPT POWER LAW FIT TO TEST DATA ### YES

28288	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
335.42	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0.83239	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
0.83239	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
377.13	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
66.046	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0.0058	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN)
0.14742	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (MM)
0.0136	UC MODIFIED ERNST CEIC (IN)
0.346	UC MODIFIED ERNST CEIC (MM)
1440.3	UC MODIFIED ERNST JIC (IN*LB/IN^2)
252.23	UC MODIFIED ERNST JIC (KJ/M^2)
205.6	UC MODIFIED ERNST KJIC (KSI*SQRT(IN))
225.93	UC MODIFIED ERNST KJIC (MPA*SQRT(M))
128.9	UC MODIFIED ERNST TAVG

9281	PQ (LB)
41.283	PQ (KN)
17842	MAX LOAD (LB)
79.363	MAX LOAD (KN)
68.36	UC KQ (KSI*SQRT(IN))
75.05	UC KQ (MPA*SQRT(M))
131.41	UC MAX LOAD K (KSI*SQRT(IN))
144.29	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
760	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
133.1	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
149.37	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
164.14	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
91.14	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
100.15	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
173.61	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
190.78	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
97.26	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
106.88	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ## YES

E-213

72W-136

NUREG/CR-5913

72W-139

9226	PQ (LB)
41.036	PQ (KN)
17328	MAX LOAD (LB)
77.073	MAX LOAD (KN)
67.01	UC KQ (KSI*SQRT(IN))
73.58	UC KQ (MPA*SQRT(M))
125.86	UC MAX LOAD K (KSI*SQRT(IN))
138.19	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
746	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
130.6	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
147.94	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
162.58	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
90.73	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
99.7	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
166.71	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
183.2	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
95.57	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
105.02	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ### NO

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAVG NOT DEFINED--POWER LAW FIT NOT REQUESTED BY TECHNICIAN

E-217

72W-149

NUREG/CR-5913

9290	PQ (LB)
41.321	PQ (KN)
17249	MAX LOAD (LB)
76.725	MAX LOAD (KN)
68.4	UC KQ (KSI*SQRT(IN))
75.1	UC KQ (MPA*SQRT(M))
127	UC MAX LOAD K (KSI*SQRT(IN))
139.45	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
721	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
126.3	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
145.48	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
159.86	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
90.07	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
98.98	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
200.63	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
220.47	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
103.24	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
113.45	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA *** YES

ACCEPT POWER LAW FIT TO TEST DATA *** YES

22600	A0	IN UC MODIFIED ERNST	J=A0*(CE+E0)^A1+A2	FIT (IN*LB/IN^2)
198.3	A0	IN UC MODIFIED ERNST	J=A0*(CE+E0)^A1+A2	FIT (KJ/M^2)
0.92546	A1	IN UC MODIFIED ERNST	J=A0*(CE+E0)^A1+A2	FIT (IN*LB/IN^2)
0.92546	A1	IN UC MODIFIED ERNST	J=A0*(CE+E0)^A1+A2	FIT (KJ/M^2)
408.46	A2	IN UC MODIFIED ERNST	J=A0*(CE+E0)^A1+A2	FIT (IN*LB/IN^2)
71.532	A2	IN UC MODIFIED ERNST	J=A0*(CE+E0)^A1+A2	FIT (KJ/M^2)
0	E0	IN UC MODIFIED ERNST	J=A0*(CE+E0)^A1+A2	FIT (IN)
0	E0	IN UC MODIFIED ERNST	J=A0*(CE+E0)^A1+A2	FIT (MM)
0.0098		UC MODIFIED ERNST	CEIC (IN)	
0.248		UC MODIFIED ERNST	CEIC (MM)	
719.8		UC MODIFIED ERNST	JIC (IN*LB/IN^2)	
126.05		UC MODIFIED ERNST	JIC (KJ/M^2)	
145.34		UC MODIFIED ERNST	KJIC (KSI*SQRT(IN))	
159.71		UC MODIFIED ERNST	KJIC (MPA*SQRT(M))	
95.2		UC MODIFIED ERNST	TAUG

14738 PQ (LB)
 65.555 PQ (KN)
 17375 MAX LOAD (LB)
 77.282 MAX LOAD (KN)
 111.58 UC KQ (KSI*SQRT(IN))
 122.52 UC KQ (MPA*SQRT(M))
 131.55 UC MAX LOAD K (KSI*SQRT(IN))
 144.44 UC MAX LOAD K (MPA*SQRT(M))
 29265 REFERENCE MODULUS (KSI)
 201.79 REFERENCE MODULUS (GPA)

1093 UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
 191.5 UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
 178.87 UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
 196.56 UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
 97.82 UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
 107.5 UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
 249.02 #UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
 273.65 #UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
 111.64 #UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
 122.68 #UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ### YES
 ACCEPT POWER LAW FIT TO TEST DATA ### YES.

15104 A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
 246.12 A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
 0.73411 A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
 0.73411 A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
 474.5 A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
 83.097 A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
 0.00111 E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN)
 0.02813 E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (MM)
 0.0118 UC MODIFIED ERNST CEIC (IN)
 0.3 UC MODIFIED ERNST CEIC (MM)
 1095.2 UC MODIFIED ERNST JIC (IN*LB/IN^2)
 191.8 UC MODIFIED ERNST JIC (KJ/M^2)
 179.03 UC MODIFIED ERNST KJIC (KSI*SQRT(IN))
 196.73 UC MODIFIED ERNST KJIC (MPA*SQRT(M))
 94.1 UC MODIFIED ERNST TAUG

72W-118

8994	PQ (LB)
40.005	PQ (KN)
17424	MAX LOAD (LB)
77.503	MAX LOAD (KN)
65.24	UC KQ (KSI*SQRT(IN))
71.63	UC KQ (MPA*SQRT(M))
126.39	UC MAX LOAD K (KSI*SQRT(IN))
138.78	UC MAX LOAD K (MPA*SQRT(M))
29265	REFERENCE MODULUS (KSI)
201.79	REFERENCE MODULUS (GPA)
655	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
114.8	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
138.48	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
152.17	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
87.51	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
96.17	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
153.35	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
168.51	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
91.58	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
100.64	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ### NO

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAUG NOT DEFINED--POWER LAW FIT NOT REQUESTED BY TECHNICIAN

E-225

72W-123

NUREG/CR-5913

8878	PQ (LB)
39.488	PQ (KN)
17810	MAX LOAD (LB)
79.218	MAX LOAD (KN)
66.09	UC KQ (KSI*SQRT(IN))
72.57	UC KQ (MPA*SQRT(M))
132.59	UC MAX LOAD K (KSI*SQRT(IN))
145.58	UC MAX LOAD K (MPA*SQRT(M))
29265	REFERENCE MODULUS (KSI)
201.79	REFERENCE MODULUS (GPA)
1206	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
211.2	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
187.87	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
206.46	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
99.8	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
109.67	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
266	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
292.31	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
114.46	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
125.78	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ### YES

ACCEPT POWER LAW FIT TO TEST DATA ### YES

13459	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
349.9	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0.58969	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
0.58969	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
-97.43	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
-17.062	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN)
0	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (MM)
0.0103	UC MODIFIED ERNST CEIC (IN)
0.261	UC MODIFIED ERNST CEIC (MM)
807.1	UC MODIFIED ERNST JIC (IN*LB/IN^2)
141.34	UC MODIFIED ERNST JIC (KJ/M^2)
153.68	UC MODIFIED ERNST KJIC (KSI*SQRT(IN))
168.88	UC MODIFIED ERNST KJIC (MPA*SQRT(M))
109.7	UC MODIFIED ERNST TAUG

9298 PQ (LB)
 41.359 PQ (KN)
 17567 MAX LOAD (LB)
 78.139 MAX LOAD (KN)
 68.77 UC KQ (KSI*SQRT(IN))
 75.51 UC KQ (MPA*SQRT(M))
 129.93 UC MAX LOAD K (KSI*SQRT(IN))
 142.66 UC MAX LOAD K (MPA*SQRT(M))
 29265 REFERENCE MODULUS (KSI)
 201.79 REFERENCE MODULUS (GPA)

 1092 UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
 191.3 UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
 178.78 UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
 196.47 UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
 97.83 UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
 107.51 UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
 198.22 #UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
 217.83 #UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
 102.07 #UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
 112.16 #UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ### YES

ACCEPT POWER LAW FIT TO TEST DATA ### YES

17345 A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
 223.69 A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
 0.80641 A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
 0.80641 A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
 365.66 A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
 64.037 A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
 0.00439 E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN)
 0.1114 E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (MM)
 0.0111 UC MODIFIED ERNST CEIC (IN)
 0.283 UC MODIFIED ERNST CEIC (MM)
 968.9 UC MODIFIED ERNST JIC (IN*LB/IN^2)
 169.68 UC MODIFIED ERNST JIC (KJ/M^2)
 168.39 UC MODIFIED ERNST KJIC (KSI*SQRT(IN))
 185.04 UC MODIFIED ERNST KJIC (MPA*SQRT(M))
 89.5 UC MODIFIED ERNST TAUG

E-231

72W-129

NUREG/CR-5913

8155	PQ (LB)
36.274	PQ (KN)
17517	MAX LOAD (LB)
77.916	MAX LOAD (KN)
61.21	UC KQ (KSI*SQRT(IN))
67.21	UC KQ (MPA*SQRT(M))
131.49	UC MAX LOAD K (KSI*SQRT(IN))
144.37	UC MAX LOAD K (MPA*SQRT(M))
29265	REFERENCE MODULUS (KSI)
201.79	REFERENCE MODULUS (GPA)
1023	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
179.1	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
173	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
190.11	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
96.46	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
106.01	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
192.25	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
211.26	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
100.77	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
110.74	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA *** YES

ACCEPT POWER LAW FIT TO TEST DATA *** YES

7757.5	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
312.31	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0.45449	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
0.45449	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
-264.51	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
-46.323	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN)
0	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (MM)
0.0095	UC MODIFIED ERNST CEIC (IN)
0.242	UC MODIFIED ERNST CEIC (MM)
671.7	UC MODIFIED ERNST JIC (IN*LB/IN^2)
117.63	UC MODIFIED ERNST JIC (KJ/M^2)
140.2	UC MODIFIED ERNST KJIC (KSI*SQRT(IN))
154.07	UC MODIFIED ERNST KJIC (MPA*SQRT(M))
81.7	UC MODIFIED ERNST TAUG

SPECIMEN ID= 72W112
 TEST TEMPERATURE= 125 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 26.8 mm $a/W)_i = .528$
 MEASURED DUCTILE DELTA-A= 3.81 mm
 YIELD STRENGTH= 621 MPa
 FLOW STRENGTH= 672 MPa
 ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 260.4 kJ/m²
 KJ-MAX LOAD= 228.3 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 379.9 kJ/m²
 K-JIc= 275.7 MPa SQR[m]
 POWER= .368
 COEFFICIENT= 517.1 kJ/m²
 T (AVERAGE)= 78

ASTM LINEAR PROCEDURE

 JIc= 392.3 kJ/m²
 K-JIc= 280.2 MPa SQR[m]
 SLOPE= 159700 kJ/m³
 INTERCEPT= 345.7 kJ/m²
 T (ASTM)= 71
 INVALID, 6

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 537.8 kJ/m²
 POWER= .2641
 J-MAX ALLOWED= 805.4 kJ/m²
 RCURVE INVALID, 2 3

COEFFICIENT= 533.7 kJ/m²
 DELTA-A MAX ALLOWED= 2.4 mm

72W112

125 DEGREES C

72W112

125 DEGREES C

NUREG/CR-5913

0% Side Groove

2T-CT

72W-65

+25°C (77°F)

9/22/86 PHM

72W-65

Load
1/1000 in/lb

Front Face Deflection 0.5 $\frac{\text{volt}}{\text{inch}}$

0.025025 $\frac{\text{inch}}{\text{volt}}$

E-236A

TEST SPECIMEN DATA

Material Type = A533-B Weld
 Test Temperature = 25 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .523
 Init crack length a = 53.14 mm
 Flow stress = 620.5 MPa
 Yield stress = 551.6 MPa
 Youngs modulus E = 205800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 36.2 kJ/m ²	37 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{0.5}	= 86.3 MPa√m	87.2 MPa√m
Kc (Beta Corrected)	= 78.2 MPa√m	78.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 131.35 kN
 5% Secant Offset Pq = 131.35 kN
 Kq = 84.3 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 84.3 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.026 mm

Fitted elastic load range = 15 kN TO 45 kN

Elastic slope = 1.734E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld
 Test Temperature = 25 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .523
 Init crack length a = 53.14 mm
 Flow stress = 620.5 MPa
 Yield stress = 551.6 MPa
 Youngs modulus E = 205800 MPa (Estimated Value)
 Poisson's Ratio (ν) = .3

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
Jc	= 36.2 kJ/m ²	33.9 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 90.4 MPa√m	87.5 MPa√m
Kc (Beta Corrected)	= 80.9 MPa√m	79 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 131.35 kN
 5% Secant Offset Pq = 131.35 kN
 Kq = 84.3 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 84.3 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.026 mm
 Fitted elastic load range = 15 kN TO 45 kN
 Elastic slope = 1.734E+02 kN/mm

0% Side Groove

RT-CT

72W-64

+25°C (77°F)

12,000 $\frac{\text{volt}}{\text{inch}}$

Load 1.0 $\frac{\text{volt}}{\text{inch}}$

72W-64

Front Face Deflection 0.5 $\frac{\text{volt}}{\text{inch}}$

0.02514"/Volt

NUREG/CR-5913

E-239

72W-56

28785	PQ (LB)
128.04	PQ (KN)
53374	MAX LOAD (LB)
237.41	MAX LOAD (KN)
76.09	UC KQ (KSI*SQRT(IN))
83.55	UC KQ (MPA*SQRT(M))
141.09	UC MAX LOAD K (KSI*SQRT(IN))
154.92	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
500	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
87.6	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
121.14	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
133.12	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
97.37	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
107	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
143.51	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
157.71	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
107	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
117.58	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA *** NO

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAUG NOT DEFINED--POWER LAW FIT NOT REQUESTED BY TECHNICIAN

E-243

ORNL-DWG 92-11647

72W-57

NUREG/CR-5913

34316	PQ (LB)
152.64	PQ (KN)
43701	MAX LOAD (LB)
194.38	MAX LOAD (KN)
89.24	UC KQ (KSI*SQRT(IN))
97.98	UC KQ (MPA*SQRT(M))
113.65	UC MAX LOAD K (KSI*SQRT(IN))
124.78	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
457	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
80	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
115.78	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
127.23	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
94.77	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
104.15	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
115.78	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
127.23	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
94.77	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
104.15	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAUG NOT DEFINED--NOT ENOUGH DATA POINTS FOR POWER LAW FIT

E-245

ORNL-DWG 92-11648

YP5282

NUREG/CR-5913

SPECIMEN CLEAVED

41778 PQ (LB)
 185.83 PQ (KN)
 46758 MAX LOAD (LB)
 207.98 MAX LOAD (KN)
 0 MEASURED FINAL CRACK EXTENSION (IN)
 0 MEASURED FINAL CRACK EXTENSION (MM)

29348 REFERENCE MODULUS (KSI)
 202.35 REFERENCE MODULUS (GPA)

134.9 UC KQ (KSI*SQRT(IN))
 148.24 UC KQ (MPA*SQRT(M))
 150.98 UC MAX LOAD K (KSI*SQRT(IN))
 165.91 UC MAX LOAD K (MPA*SQRT(M))
 0.043 #UC FINAL CRACK EXTENSION (IN)
 1.093 #UC FINAL CRACK EXTENSION (MM)
 0.043 #UC FINAL CRACK EXTENSION ERROR (IN)

INVALID UC KIC TEST

1441.8 #UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
 252.49 #UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
 205.7 #UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
 226.04 #UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
 127.39 #UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
 139.99 #UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
 212.53 #UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
 233.55 #UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
 129.26 #UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
 142.04 #UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO UC MODIFIED ERNST TEST RESULTS *** YES
 CALC_NLCOF TROUBLE--ERROR 22 IN 14058 REAL OVERFLOW

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAVG NOT DEFINED--POWER LAW REGRESSION FAILED

OUTPUT UC MODIFIED ERNST TEST RESULTS PLOT *** YES
 CHANGE PLOT AXIS TYPE/ASSIGNMENT/SCALING/LABEL *** NO

E-247

ORNL-DWG 92-11649

COMMAND *** ANALYZE

72W-61

NUREG/CR-5913

40396	PQ (LB)
179.68	PQ (KN)
56269	MAX LOAD (LB)
250.29	MAX LOAD (KN)
104.3	UC KQ (KSI*SQRT(IN))
114.52	UC KQ (MPA*SQRT(M))
145.29	UC MAX LOAD K (KSI*SQRT(IN))
159.52	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
753	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
131.8	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
148.63	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
163.33	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
109	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
119.78	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
154.85	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
170.16	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
111.32	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
122.33	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAUG NOT DEFINED--NOT ENOUGH DATA POINTS FOR POWER LAW FIT

72W-52

39785	PQ (LB)
176.96	PQ (KN)
64841	MAX LOAD (LB)
288.41	MAX LOAD (KN)
102.62	UC KQ (KSI*SQRT(IN))
112.68	UC KQ (MPA*SQRT(M))
167.25	UC MAX LOAD K (KSI*SQRT(IN))
183.64	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
955	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
167.3	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
167.43	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
183.99	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
115.75	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
127.2	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
195.29	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
214.61	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
124.48	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
136.79	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA *** NO

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAUG NOT DEFINED--POWER LAW FIT NOT REQUESTED BY TECHNICIAN

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .526
 Init crack length a = 53.4 mm
 Flow stress = 636 MPa
 Yield stress = 591.3 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS[Failure Type A (J at instability = J_c)]

	Merkle-Corten	Deformation-J*
J _c	= 246 kJ/m ²	254.2 kJ/m ²
K _{Jc} =(EJ _c /(1-ν ²)) ^{.5}	= 222.8 MPa√m	226.5 MPa√m
K _c (Beta Corrected)	= 138 MPa√m	139 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{1/2}
 Maximum Load P = 247.9 kN
 5% Secant Offset P_q = 188.8 kN
 K_q = 122.1 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 160.3 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .006 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 2.376E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .526
 Init crack length a = 53.4 mm
 Flow stress = 636 MPa
 Yield stress = 591.3 MPa
 Young's modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
Jc	= 166.1 kJ/m ²	173.5 kJ/m ²
Kjc = (EJc / (1 - ν ²)) ^{.5}	= 183.1 MPa√m	187.1 MPa√m
Kc (Beta Corrected)	= 125.9 MPa√m	127.2 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 234.72 kN
 5% Secant Offset Pq = 188.8 kN
 Kq = 122.1 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 151.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .006 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 2.376E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .526
 Init crack length a = 53.4 mm
 Flow stress = 636 MPa
 Yield stress = 591.3 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 145.4 kJ/m ²	152.9 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 171.3 MPa√m	175.6 MPa√m
Kc (Beta Corrected)	= 121.8 MPa√m	123.3 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 234.45 kN
 5% Secant Offset Pq = 188.8 kN
 Kq = 122.1 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 151.6 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .006 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 2.376E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .526
 Init crack length a = 53.4 mm
 Flow stress = 636 MPa
 Yield stress = 591.3 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 82.6 kJ/m ²	87.9 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 129.1 MPa√m	133.2 MPa√m
Kc (Beta Corrected)	= 104.4 MPa√m	106.4 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 197.05 kN
 5% Secant Offset Pq = 188.8 kN
 Kq = 122.1 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 127.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .006 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 2.376E+02 kN/mm

Specimen Crackmouth Deflection (in.) ORNL-DWG 92-11655

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .526
 Init crack length a = 53.4 mm
 Flow stress = 636 MPa
 Yield stress = 591.3 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 255.1 kJ/m ²	258.7 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 226.9 MPa√m	228.5 MPa√m
Kc (Beta Corrected)	= 139.1 MPa√m	139.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 247.9 kN
 5% Secant Offset Pq = 195.21 kN
 Kq = 126.3 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 160.3 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .017 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 1.692E+02 kN/mm

NUREG/CR-5913

Front Face Clip Gage Control

0.7% Side Gauge

72W-55

96°C (203°F)

10/1/87 BHM
72W-55

Load 0.175 lb

#723
128
131

Front Face Deflection 1.0 $\frac{\text{volt}}{\text{inch}}$

0.021396 $\frac{\text{mV}}{\text{V}}$

E-256

Front Face Clip Gage Control

9% Side Gage

72W-59

95°C (203°F)

72W-59

10,000 lb/volt

Load 0.1 volt

Front Face Deflection 1.0 $\frac{\text{volt}}{\text{inch}}$

0.021396/volt

NUREG/CR-5913

E-257

Front Face Clip Gage Control

0% Side Gauge

72W-60

95°C (203°F)

4m/0.006 in

4m/0.011 in

72W-60

Front Face Deflection 1.0 $\frac{\text{volt}}{\text{inch}}$

0.021396 $\frac{\text{in}}{\text{volt}}$

Front Face Clip Gage Control 72W-63

0% Side Gage

72W-63

95°C (203°F)

Front Face Deflection 1.0 $\frac{\text{volt}}{\text{inch}}$

0.021396"/VdE

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 105 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .536
 Init crack length a = 54.48 mm
 Flow stress = 633.1 MPa
 Yield stress = 589.1 MPa
 Youngs modulus E = 201200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 468.5 kJ/m ²	485.1 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 307 MPa√m	312.4 MPa√m
Kc (Beta Corrected)	= 157.7 MPa√m	158.9 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 309.49 kN
 5% Secant Offset Pq = 190.87 kN
 Kq = 127.8 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 207.3 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .013 mm
 Fitted elastic load range = 20 kN TO 110 kN
 Elastic slope = 1.666E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 105 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .536
 Init crack length a = 54.48 mm
 Flow stress = 633.1 MPa
 Yield stress = 589.1 MPa
 Youngs modulus E = 201200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 480.1 kJ/m ²	498.9 kJ/m ²
Kjc=(EJc/((1-ν ²))) ^{.5}	= 310.8 MPa√m	316.9 MPa√m
Kc (Beta Corrected)	= 158.5 MPa√m	159.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 309.49 kN
 5% Secant Offset Pq = 183.71 kN
 Kq = 123.1 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 207.3 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .002 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 2.278E+02 kN/mm

TEST SPECIMEN DATA

Material Type	= A533-B Weld	
Test Temperature	= 105 °C	
Percent Side Groove	= 0 %	
Specimen Thickness	= 50.8 mm	
Initial Crack Length	= 54.48 mm	Init a/W = .536
Final Crack Length	= 54.97 mm	Final a/W = .541
Flow Stress	= 633 MPa	
Youngs Modulus	= 201200 MPa	(Estimated Value)

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

Jic	= 308.5 kJ/m ²
Kjc	= 249.1 MPa $\sqrt{m}$
Exponent N	= .6171
Coefficient C	= 4 kJ/m ²

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

Jic	= 250 kJ/m ²
Kjc	= 241.6 MPa $\sqrt{m}$
Slope M	= 172289.5 kJ/m ³
Intercept B	= 250.5 kJ/m ²
Validity (Jic)	= INVALID--c (.61 vs .07)
Validity (R-curve)	= INVALID--2, 3 (.61 vs .07)
J maximum allowed	= 1490.3 kJ/m ² (Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 4.71 mm (Delta a max = 0.1*bo)
Final Delta a	= 1.1 mm
Poisson's Ratio (v)	= 0
Points Left	= 0
Points Right	= 0

Front Face Clip Gage Control

0% Side Groove

72W-67

105°C (231°F)

10/3/87

72W-67

F_{le}

Load
1.0
lb

NUREG/CR-5913

Front Face Deflection 1.0 $\frac{in}{in}$

0.021396 $\frac{in}{in}$

E-263

Front Face Clip Gage Control

0% Side Groove

72W-77

105°C (231°F)

Load 10.0 $\frac{\text{volt}}{\text{inch}}$

72W-77

Load 1.0 $\frac{\text{volt}}{\text{inch}}$

Front Face Deflection 1.0 $\frac{\text{volt}}{\text{inch}}$

0.021396/volt

TEST SPECIMEN DATA

Material Type	= A533-B Weld	
Test Temperature	= 105 °C	
Percent Side Groove	= 0 %	
Specimen Thickness	= 50.8 mm	
Initial Crack Length	= 53.91 mm	Init a/W = .53
Final Crack Length	= 54.55 mm	Final a/W = .536
Flow Stress	= 633 MPa	
Young's Modulus	= 201200 MPa	(Estimated Value)
POWER LAW DATA $J = C (\Delta a)^N$		

J _{ic}	= 215.4 kJ/m ²
K _{jc}	= 208.2 MPa $\sqrt{m}$
Exponent N	= .5322
Coefficient C	= 393.3 kJ/m ²

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

J _{ic}	= 161.7 kJ/m ²
K _{jc}	= 180.4 MPa $\sqrt{m}$
Slope M	= 287119.5 kJ/m ³
Intercept B	= 125 kJ/m ²
Validity (J _{ic})	= INVALID--a, b, c (.1 vs .09)
Validity (R-curve)	= INVALID--1, 2, 3 (.1 vs .09)
J maximum allowed	= 1508.3 kJ/m ² (J _{max} =B _{net} *Flow stress/20)
Delta a max. allowed	= 4.77 mm (Delta a max = 0.1*bo)
Final Delta a	= .74 mm
Poisson's Ratio (ν)	= 0
Points Left	= 0
Points Right	= 0

Specimen Loadline Deflection (in.) ORNL-DWG 92-11660

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 105 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .531
 Init crack length a = 53.91 mm
 Flow stress = 633.1 MPa
 Yield stress = 589.1 MPa
 Youngs modulus E = 201200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 353.6 kJ/m ²	373.6 kJ/m ²
Kjc=(EJc/((1-ν ²))) ^{.5}	= 266.8 MPa√m	274.2 MPa√m
Kc (Beta Corrected)	= 148.9 MPa√m	150.6 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 301.63 kN
 5% Secant Offset Pq = 187.48 kN
 Kq = 123.3 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 198.3 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .001 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 2.396E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 105 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .531
 Init crack length a = 53.91 mm
 Flow stress = 633.1 MPa
 Yield stress = 589.1 MPa
 Youngs modulus E = 201200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 347.1 kJ/m ²	364 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 264.3 MPa√m	270.6 MPa√m
Kc (Beta Corrected)	= 148.3 MPa√m	149.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 301.63 kN
 5% Secant Offset Pq = 193.07 kN
 Kq = 126.9 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 198.3 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .014 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 1.742E+02 kN/mm

FRONT FACE CLIP GAGE CONTROL

0% SIDE GROOVE

72W-78

105°C (221°F)

10/3/87

BHM

72W-78

Load 0.10
pH
inch

NUREG/CR-5913

FRONT FACE DEFLECTIONS 1.0
pH
inch

0.021396
inch
pH

E-269

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .519
 Init crack length a = 105.41 mm
 Flow stress = 654.5 MPa
 Yield stress = 607 MPa
 Young's modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 89.9 kJ/m ²	107.2 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 135.5 MPa√m	148 MPa√m
Kc (Beta Corrected)	= 122.5 MPa√m	130.4 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 429.92 kN
 5% Secant Offset Pq = 416.66 kN
 Kq = 93.2 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 96.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.011 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 5.274E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .519
 Init crack length a = 105.41 mm
 Flow stress = 654.5 MPa
 Yield stress = 607 MPa
 Young's modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 45.6 kJ/m ²	51.1 kJ/m ²
K _{Jc} = (EJc / (1-ν ²)) ^{.5}	= 96.5 MPa√m	102.2 MPa√m
K _c (Beta Corrected)	= 93.1 MPa√m	97.8 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{1/2}
 Maximum Load P = 429.92 kN
 5% Secant Offset P_q = 416.66 kN
 K_q = 93.2 MPa√m
 Validity = VALID K_{ic} value
 K at Maximum Load = 96.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.011 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 5.274E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .519
 Init crack length a = 105.41 mm
 Flow stress = 654.5 MPa
 Yield stress = 607 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 39.9 kJ/m ²	45.1 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 90.3 MPa√m	96 MPa√m
Kc (Beta Corrected)	= 87.8 MPa√m	92.6 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 416.66 kN
 5% Secant Offset Pq = 416.66 kN
 Kq = 93.2 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 93.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.011 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 5.274E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .519
 Init crack length a = 105.41 mm
 Flow stress = 654.5 MPa
 Yield stress = 607 MPa
 Young's modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = J_c)]

	Merkle-Corten	Deformation-J*
J _c	= 28.2 kJ/m ²	32 kJ/m ²
K _{Jc} = (EJ _c / (1-ν ²)) ^{0.5}	= 75.9 MPa√m	80.9 MPa√m
K _c (Beta Corrected)	= 74.7 MPa√m	79.4 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{1/2}
 Maximum Load P = 360.96 kN
 5% Secant Offset P_q = 360.96 kN
 K_q = 80.7 MPa√m
 Validity = VALID K_{ic} value
 K at Maximum Load = 80.7 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.011 mm
 Fitted elastic load range = 50 kN TO 200 kN
 Elastic slope = 5.274E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .519
 Init crack length a = 105.41 mm
 Flow stress = 654.5 MPa
 Yield stress = 607 MPa
 Young's modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 90.2 kJ/m ²	106.6 kJ/m ²
K _{Jc} =(EJc/(1-ν ²)) ^{.5}	= 135.8 MPa√m	147.6 MPa√m
Kc (Beta Corrected)	= 122.7 MPa√m	130.1 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BBn)^{1/2}
 Maximum Load P = 429.92 kN
 5% Secant Offset P_q = 416.66 kN
 K_q = 93.2 MPa√m
 Validity = VALID K_{ic} value
 K at Maximum Load = 96.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .001 mm
 Fitted elastic load range = 50 kN TO 200 kN
 Elastic slope = 3.773E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .519
 Init crack length a = 105.41 mm
 Flow stress = 654.5 MPa
 Yield stress = 607 MPa
 Young's modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS[Failure Type A (J at instability = J_c)]

	Merkle-Corten	Deformation-J*
J _c	= 86.5 kJ/m ²	103.3 kJ/m ²
K _{Jc} = (EJ _c /(1-ν ²)) ^{.5}	= 133 MPa√m	145.3 MPa√m
K _c (Beta Corrected)	= 120.8 MPa√m	128.7 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{IC} Equation; B = (BB_n)^{1/2}
 Maximum Load P = 429.92 kN
 5% Secant Offset P_Q = 416.66 kN
 K_Q = 93.2 MPa√m
 Validity = VALID K_{IC} value
 K at Maximum Load = 96.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN, OFFSET DEFLECTION = -.001 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 3.831E+02 kN/mm

NUREG/CR-5913

Load 1.0 $\frac{\text{lb}}{\text{in}^2}$

Irradiated 0% Side Groove Stroke Control

72W-19

+122°F (50°C)

5/18/87 RHM

72W-19

Front Face Deflection (CG 100) $\frac{\text{in}}{\text{in}} 1.0$

0.18696 $\frac{\text{in}}{\text{in}}$

E-276

72W-26

+50°C (122°F)

5/19/87 JHM

10000 0% Side Groove Stroke Control

28392 $\frac{1}{16}$ in

Load 0.1 psi

NUREG/CR-5913

E-277

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 75 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .526
 Init crack length a = 106.78 mm
 Flow stress = 643.2 MPa
 Yield stress = 597.1 MPa
 Youngs modulus E = 202900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 144.8 kJ/m ²	164.6 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 171.4 MPa√m	182.8 MPa√m
Kc (Beta Corrected)	= 142.7 MPa√m	148.4 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 771.05 kN
 5% Secant Offset Pq = 771.05 kN
 Kq = 176.3 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 176.3 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = 0 mm
 Fitted elastic load range = 50 kN TO 200 kN
 Elastic slope = 5.127E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 75 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .526
 Init crack length a = 106.78 mm
 Flow stress = 643.2 MPa
 Yield stress = 597.1 MPa
 Youngs modulus E = 202900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = J_c)]

	Merkle-Corten	Deformation-J*
J _c	= 127.9 kJ/m ²	145.8 kJ/m ²
K _{Jc} = (EJ _c / (1-ν ²)) ^{0.5}	= 161.1 MPa√m	172 MPa√m
K _c (Beta Corrected)	= 137.2 MPa√m	143 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{1/2}
 Maximum Load P = 733.92 kN
 5% Secant Offset P_q = 733.92 kN
 K_q = 167.8 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 167.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = 0 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 5.127E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 75 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .526
 Init crack length a = 106.78 mm
 Flow stress = 643.2 MPa
 Yield stress = 597.1 MPa
 Youngs modulus E = 202900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 148.6 kJ/m ²	165.2 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 173.7 MPa√m	183.1 MPa√m
Kc (Beta Corrected)	= 143.9 MPa√m	148.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 771.05 kN
 5% Secant Offset Pq = 765.12 kN
 Kq = 174.9 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 176.3 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .003 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 3.704E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 75 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .526
 Init crack length a = 106.78 mm
 Flow stress = 643.2 MPa
 Yield stress = 597.1 MPa
 Youngs modulus E = 202900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
Jc	= 147.3 kJ/m ²	164.9 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 172.9 MPa√m	183 MPa√m
Kc (Beta Corrected)	= 143.5 MPa√m	148.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 771.05 kN
 5% Secant Offset Pq = 765.12 kN
 Kq = 174.9 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 176.3 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .006 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 3.733E+02 kN/mm

NUREG/CR-5913

Load 1.0 $\frac{\text{volt}}{\text{inch}}$

IAAad.

0% Side Groove

Stroke Control

72W-20

+75°C (167°F)

5/20/87 1344

72W-20

E-282

Front Face Deflection (CG-100) 1.0 $\frac{\text{volt}}{\text{inch}}$

0.018696 $\frac{\text{inch}}{\text{volt}}$

Irradiated 4I-CT

0% side Grease

Stroke Control

72W-25

75°C (167°F)

5/21/87 BMM

72W-25

28392 11/10/87

Load 0.1 pascals

NUREG/CR-5913

Front Face Deflection (CG-100) 1.0 volt/inch

0.01902 inch/volt

E-283

NUREG/CR-5913

100% 26882

100% 0.1 pasc

Irradiated 4T-CT

0% Side Groove

Stroke Control

72W-13

85°C (185°F)

5/21/87 RHM
72W-13

Front Face Deflection (GG-100) 1.0 $\frac{\text{volt}}{\text{inch}}$

0.01902 $\frac{\text{inch}}{\text{volt}}$

E-284

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 85 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .517
 Init crack length a = 105.11 mm
 Flow stress = 639.4 MPa
 Yield stress = 593.9 MPa
 Youngs modulus E = 202400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 161.8 kJ/m ²	182.7 kJ/m ²
Kjc = (EJc / ((1-ν ²))) ^{.5}	= 181 MPa√m	192.3 MPa√m
Kc (Beta Corrected)	= 147.2 MPa√m	152.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 816.52 kN
 5% Secant Offset Pq = 681.51 kN
 Kq = 151.7 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 181.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.014 mm
 Fitted elastic load range = 50 kN TO 200 kN
 Elastic slope = 5.299E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 85 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .517
 Init crack length a = 105.11 mm
 Flow stress = 639.4 MPa
 Yield stress = 593.9 MPa
 Youngs modulus E = 202400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 103.7 kJ/m ²	118.2 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 144.8 MPa√m	154.7 MPa√m
Kc (Beta Corrected)	= 127.6 MPa√m	133.4 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 681.51 kN
 5% Secant Offset Pq = 681.51 kN
 Kq = 151.7 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 151.7 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.014 mm
 Fitted elastic load range = 50 kN TO 200 kN
 Elastic slope = 5.299E+02 kN/mm

Specimen Crackmouth Deflection (in.) ORNL-DWG 92-11674

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 85 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .517
 Init crack length a = 105.11 mm
 Flow stress = 639.4 MPa
 Yield stress = 593.9 MPa
 Young's modulus E = 202400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 170.8 kJ/m ²	184.6 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 185.9 MPa√m	193.3 MPa√m
Kc (Beta Corrected)	= 149.6 MPa√m	153 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 816.52 kN
 5% Secant Offset Pq = 681.51 kN
 Kq = 151.7 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 181.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = 0 mm
 Fitted elastic load range = 50 kN TO 200 kN
 Elastic slope = 3.737E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 85 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .517
 Init crack length a = 105.11 mm
 Flow stress = 639.4 MPa
 Yield stress = 593.9 MPa
 Young's modulus E = 202400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 165.8 kJ/m ²	181 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 183.2 MPa√m	191.4 MPa√m
Kc (Beta Corrected)	= 148.3 MPa√m	152.1 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 816.52 kN
 5% Secant Offset Pq = 689.34 kN
 Kq = 153.5 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 181.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.002 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 3.770E+02 kN/mm

NUREG/CR-5913

Load 0.1 psi

Irradiated 4T-GT

0% Side Groove

Stroke Control

72W-11

95°C (203°F)

5/27/87

72W-11

Front Face Deflection (G.G. -100) 1.0 mil/inch

0.01898 inch

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .556
 Init crack length a = 112.95 mm
 Flow stress = 636 MPa
 Yield stress = 591.3 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
Jc	= 259 kJ/m ²	286.7 kJ/m ²
Kjc = (EJc / (1 - ν ²)) ^{.5}	= 228.6 MPa√m	240.5 MPa√m
Kc (Beta Corrected)	= 167.3 MPa√m	171.7 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 866.28 kN
 5% Secant Offset Pq = 586.66 kN
 Kq = 148.6 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 219.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .008 mm

Fitted elastic load range = 100 kN TO 400 kN

Elastic slope = 4.343E+02 kN/mm

NUREG/CR-5913

1994-2-26882

Load 0.010 volt/inch

Irradiated 4T-CT 0% Side Groove Stroke Control

72W-14

+95°C (208°F)

6/2/87 BHM

72W-14

E-292

Front Face Deformation (GG-10) 1.0 volt/inch

0.018982 volt

Specimen Loadline Deflection (in.) ORNL-DWG 92-11677

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .556
 Init crack length a = 112.95 mm
 Flow stress = 636 MPa
 Yield stress = 591.3 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
Jc	= 90.3 kJ/m ²	101.9 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 135 MPa√m	143.4 MPa√m
Kc (Beta Corrected)	= 121.3 MPa√m	126.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 559.25 kN
 5% Secant Offset Pq = 559.25 kN
 Kq = 141.6 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 141.6 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .008 mm

Fitted elastic load range = 100 kN TO 400 kN

Elastic slope = 4.343E+02 kN/mm

Specimen Crackmouth Deflection (in.) ORNL-DWG 92-11678

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .556
 Init crack length a = 112.95 mm
 Flow stress = 636 MPa
 Yield stress = 591.3 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 262.6 kJ/m ²	288.5 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 230.2 MPa√m	241.3 MPa√m
Kc (Beta Corrected)	= 167.8 MPa√m	171.9 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 866.28 kN
 5% Secant Offset Pq = 559.25 kN
 Kq = 141.6 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 219.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .002 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 3.187E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .556
 Init crack length a = 112.95 mm
 Flow stress = 636 MPa
 Yield stress = 591.3 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 259.7 kJ/m ²	286.9 kJ/m ²
Kjc = (EJc / (1 - ν ²)) ^{.5}	= 228.9 MPa√m	240.6 MPa√m
Kc (Beta Corrected)	= 167.4 MPa√m	171.7 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 866.28 kN
 5% Secant Offset Pq = 571 kN
 Kq = 144.6 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 219.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .004 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 3.206E+02 kN/mm

Appendix F

Load-Displacement Curves and Photographs of the Fracture Toughness Specimens From the 73W Weld (0.31 wt % Cu)

SPECIMEN ID= 73W137
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -150 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.5 mm $a/W)i = .541$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 712 MPa
FLOW STRENGTH= 760 MPa
ESTIMATED YOUNG'S MODULUS= 216 GPa

SPECIMEN CLEAVED AT $K_{Ic} = 39.3 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 6.7 kJ/m²
KJc= 38.1 MPa SQR[m]
K-beta-c= 37.8 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 6.7 kJ/m²
KJc= 38.1 MPa SQR[m]
K-beta-c= 37.8 MPa SQR[m]

F-3

ORNL-DWG 92-11315

73W137

-150 DEGREES C

73W-137

NUREG/CR-5913

SPECIMEN ID= 73W141
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -150 DEG C
THICKNESS= 25.3 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27 mm $a/W)i = .531$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 712 MPa
FLOW STRENGTH= 760 MPa
ESTIMATED YOUNG'S MODULUS= 216 GPa

SPECIMEN CLEAVED AT $K_{Ic} = 41.2 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 8 kJ/m²
KJc= 41.6 MPa SQR[m]
K-beta-c= 41.1 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 8 kJ/m²
KJc= 41.6 MPa SQR[m]
K-beta-c= 41.1 MPa SQR[m]

F-5

ORNL-DWG 92-11316

73W141

-150 DEGREES C

73W-141

NUREG/CR-5913

-150°C 8/24/85 BHM/MJL

73W-157

N/# 0052

LOAD 1 V/inp

FRONT FACE DEFLECTION 1V/inp .0358105 in/V

73W153 -150°C 0%56 IT-CT 8/22/85 MRP/MJL

73W-153

73W-153

F-7

25004/

00052

00052

NUREG/CR-5913

FRONT FACE DEFLECTION 1V/inp 0.0358105 in/V

SPECIMEN ID= 73W127
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -101 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= 600 MPa
FLOW STRENGTH= 666 MPa
ESTIMATED YOUNG'S MODULUS= 213 GPa

SPECIMEN CLEAVED AT KQ= 65.8 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 19.8 kJ/m²

KJc= 64.9 MPa SQR[m]

K-beta-c= 59.2 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 19.8 kJ/m²

KJc= 64.9 MPa SQR[m]

K-beta-c= 59.2 MPa SQR[m]

73W127

-101 DEGREES C

73W-127

SPECIMEN ID= 73W123
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -80 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.7 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 571 MPa
FLOW STRENGTH= 639 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

$a/W)i = .525$

SPECIMEN CLEAVED AT $KQ = 60.6 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 17 kJ/m²
KJc= 60.1 MPa SQR[m]
K-beta-c= 55.1 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 17 kJ/m²
KJc= 60.1 MPa SQR[m]
K-beta-c= 55.1 MPa SQR[m]

73W123

-80 DEGREES C

73W-123

SPECIMEN ID= 73W121
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -80 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.6 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 571 MPa
FLOW STRENGTH= 639 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

a/W)i= .543

SPECIMEN CLEAVED AT KQ= 61.8 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 17.5 kJ/m²
KJc= 60.9 MPa SQR[m]
K-beta-c= 55.7 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 17.5 kJ/m²
KJc= 60.9 MPa SQR[m]
K-beta-c= 55.7 MPa SQR[m]

F-13

ORNL-DWG 92-11319

73W121

-80 DEGREES C

73W-121

NUREG/CR-5913

LKF

9/6/85

73W-159

1T-CT 0.056

-80°C

IV = 2000 / in.

LOAD (IN/IN)

73W-159

73W-159

F-14

FRONT FACE DEFLECTION (0.5V/in)

IV = 0.035961 in.

SPECIMEN ID= 73W143
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -80 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.5 mm $a/W)i = .542$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 571 MPa
FLOW STRENGTH= 639 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

SPECIMEN CLEAVED AT KQ= 66.8 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 21.2 kJ/m²
KJc= 67.1 MPa SQR[m]
K-beta-c= 59.8 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 21.2 kJ/m²
KJc= 67.1 MPa SQR[m]
K-beta-c= 59.8 MPa SQR[m]

F-16

ORNL-DWG 92-11320

73W143

-80 DEGREES C

73W-143

NUREG/CR-5913

73W 161

-112°F

-80°C

8/19/85

V/591005Z

vi/vi po07

NUREG/CR-5913

73W-161

F-17

FRONT FACE

Deflection

in/in

.0366388 in/in

SPECIMEN ID= 73W122
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -80 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.1 mm $a/W)i = .515$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 571 MPa
FLOW STRENGTH= 639 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

SPECIMEN CLEAVED AT $KQ = 78.2 \text{ MPa SQR}[m]$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 30.1 kJ/m²
KJc= 79.8 MPa SQR[m]
K-beta-c= 67.1 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 30.1 kJ/m²
KJc= 79.8 MPa SQR[m]
K-beta-c= 67.1 MPa SQR[m]

73W122

-80 DEGREES C

73W-122

SPECIMEN ID= 73W175
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -80 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 571 MPa
FLOW STRENGTH= 639 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

$a/W)i = .531$

SPECIMEN CLEAVED AT $KQ = 85.2 \text{ MPa SQR}[m]$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 36.6 kJ/m²
KJc= 88.1 MPa SQR[m]
K-beta-c= 71.3 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 36.6 kJ/m²
KJc= 88.1 MPa SQR[m]
K-beta-c= 71.3 MPa SQR[m]

73W175

-80 DEGREES C

73W-175

NUREG/CR-5913

SPECIMEN ID= 73W145
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -80 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 28 mm $a/W)i = .551$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 571 MPa
FLOW STRENGTH= 639 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

SPECIMEN CLEAVED AT $KQ = 92.6 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 44.4 kJ/m²
KJc= 96.9 MPa SQR[m]
K-beta-c= 75.3 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 44.4 kJ/m²
KJc= 96.9 MPa SQR[m]
K-beta-c= 75.3 MPa SQR[m]

73W145

-80 DEGREES C

73W-145

SPECIMEN ID= 73W174
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -80 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.7 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 571 MPa
FLOW STRENGTH= 639 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

$a/W)i = .525$

SPECIMEN CLEAVED AT $KQ = 105 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 61.2 kJ/m²
KJc= 113.8 MPa SQR[m]
K-beta-c= 82.1 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 61.2 kJ/m²
KJc= 113.8 MPa SQR[m]
K-beta-c= 82.1 MPa SQR[m]

73W174

-80 DEGREES C

73W-174

SPECIMEN ID= 73W129
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -59 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 28.3 mm $a/W)i = .557$
MEASURED DUCTILE DELTA-A= .06 mm
YIELD STRENGTH= 550 MPa
FLOW STRENGTH= 617 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

SPECIMEN CLEAVED AT $KQ = 100.8 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 56.5 kJ/m²
 $KJc = 109 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 78.8 \text{ MPa SQR[m]}$

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 55.1 kJ/m²
 $KJc = 107.7 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 78.3 \text{ MPa SQR[m]}$

73W129

-59 DEGREES C

73W-129

SPECIMEN ID= 73W172
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27 mm $a/W)i = .533$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 543 MPa
FLOW STRENGTH= 609 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

SPECIMEN CLEAVED AT KQ= 87.4 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 38.6 kJ/m²
KJc= 90 MPa SQR[m]
K-beta-c= 70.7 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 38.6 kJ/m²
KJc= 90 MPa SQR[m]
K-beta-c= 70.7 MPa SQR[m]

73W172

-50 DEGREES C

73W-172

NUREG/CR-5913

SPECIMEN ID= 73W181
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.7 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 543 MPa
FLOW STRENGTH= 609 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

$a/W)i = .526$

SPECIMEN CLEAVED AT KQ= 88.6 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 40.4 kJ/m²
KJc= 92.1 MPa SQR[m]
K-beta-c= 71.6 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 40.4 kJ/m²
KJc= 92.1 MPa SQR[m]
K-beta-c= 71.6 MPa SQR[m]

73W181

-50 DEGREES C

73W-181

NUREG/CR-5913

LRF

9/14/85

73W-165

IT-CT

09.56

 -50°C

LOAD (1V/in)

LOAD (1V/in)

73W-165

73W-165

FRONT FACE DEFLECTION (5V/in)

1V = 0.035961 in.

73W-167

- 58°F

8/31/85

MRP/BHM

IT-CT 09.56

9/3/85 LKF

N/91 0052
in/in
1001

NUREG/CR-5913

73W-167

F-33

Front Face Deflection

.5V/in

.03596078 in/in

SPECIMEN ID= 73W180
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.7 mm $a/W)i = .526$
MEASURED DUCTILE DELTA-A= .06 mm
YIELD STRENGTH= 543 MPa
FLOW STRENGTH= 609 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

SPECIMEN CLEAVED AT KQ= 109.3 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 72.7 kJ/m²
K_{Jc}= 123.5 MPa SQR[m]
K-beta-c= 83.3 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 72.5 kJ/m²
K_{Jc}= 123.4 MPa SQR[m]
K-beta-c= 83.3 MPa SQR[m]

F-35

ORNL-DWG 92-11328

73W180

-50 DEGREES C

73W-180

NUREG/CR-5913

SPECIMEN ID= 73W176
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.5 mm $a/W)i = .522$
MEASURED DUCTILE DELTA-A= .1 mm
YIELD STRENGTH= 543 MPa
FLOW STRENGTH= 609 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

SPECIMEN CLEAVED AT KQ= 121.5 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 101.5 kJ/m²
KJc= 146 MPa SQR[m]
K-beta-c= 90 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 101.9 kJ/m²
KJc= 146.3 MPa SQR[m]
K-beta-c= 90.1 MPa SQR[m]

F-37

ORNL-DWG 92-11329

73W176

-50 DEGREES C

73W-176

NUREG/CR-5913

SPECIMEN ID= 73W151
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.8 mm $a/W)i = .548$
MEASURED DUCTILE DELTA-A= .09 mm
YIELD STRENGTH= 529 MPa
FLOW STRENGTH= 593 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT KQ= 110 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 79.5 kJ/m²
KJc= 128.8 MPa SQR[m]
K-beta-c= 83.8 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 78.8 kJ/m²
KJc= 128.3 MPa SQR[m]
K-beta-c= 83.7 MPa SQR[m]

73W151

-30 DEGREES C

73W-151

SPECIMEN ID= 73W149
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 28.5 mm $a/W)i = .561$
MEASURED DUCTILE DELTA-A= .1 mm
YIELD STRENGTH= 529 MPa
FLOW STRENGTH= 593 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT KQ= 114.6 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 91.4 kJ/m²
KJc= 138.2 MPa SQR[m]
K-beta-c= 86.6 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 91.2 kJ/m²
KJc= 138 MPa SQR[m]
K-beta-c= 86.5 MPa SQR[m]

F-41

ORNL-DWG 92-11331

73W149

-30 DEGREES C

73W-149

NUREG/CR-5913

SPECIMEN ID= 73W178
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.9 mm $a/W)i = .53$
MEASURED DUCTILE DELTA-A= .12 mm
YIELD STRENGTH= 529 MPa
FLOW STRENGTH= 593 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT $KQ = 120.3 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 107.7 kJ/m²
KJc= 150 MPa SQR[m]
K-beta-c= 89.8 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 107.5 kJ/m²
KJc= 149.8 MPa SQR[m]
K-beta-c= 89.7 MPa SQR[m]

F-43

ORNL-DWG 92-11332

73W178

-30 DEGREES C

73W-178

NUREG/CR-5913

SPECIMEN ID= 73W182
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.9 mm $a/W)i = .529$
MEASURED DUCTILE DELTA-A= .17 mm
YIELD STRENGTH= 529 MPa
FLOW STRENGTH= 593 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT KQ= 126.6 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 144.5 kJ/m²
KJc= 173.7 MPa SQR[m]
K-beta-c= 95.6 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 144.6 kJ/m²
KJc= 173.8 MPa SQR[m]
K-beta-c= 95.6 MPa SQR[m]

F-45

ORNL-DWG 92-11333

73W182

-30 DEGREES C

73W-182

NUREG/CR-5913

SPECIMEN ID= 73W133
 TEST TEMPERATURE= -26 DEG C
 THICKNESS= 25.5 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 28.1 mm $a/W)_i = .553$
 MEASURED DUCTILE DELTA-A= .12 mm
 YIELD STRENGTH= 527 MPa
 FLOW STRENGTH= 590 MPa
 ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT $KQ = 117.3$ MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

 J-INTEGRAL= 100.1 kJ/m²
 $KJc = 144.5$ MPa SQR[m]
 $K-beta-c = 88.1$ MPa SQR[m]

VALUES AT CLEAVAGE LOAD

 J-INTEGRAL= 99.5 kJ/m²
 $KJc = 144.1$ MPa SQR[m]
 $K-beta-c = 88$ MPa SQR[m]

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 0 kJ/m²
 POWER= 0
 J-MAX ALLOWED= 667.8 kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 0 kJ/m²
 DELTA-A MAX ALLOWED= 2.27 mm

73W-133

F-47

ORNL-DWG 92-11334

73W133

-26 DEGREES C

ORNL-DWG 92-11335

73W133

-26 DEGREES C

NUREG/CR-5913

TEST SPECIMEN DATA

Material Type = HSST WELD
 Test Temperature = -15°C
 Percent Side Groove = 0%
 Specimen Thickness B = 25.4 mm
 Initial a/W = .51
 Init crack length a = 25.92 mm
 Flow strength = 581.2 MPa
 Yield strength = 521.2 MPa
 Youngs modulus E = 208100 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

	[Failure Type A (J at instability = Jc)]	
	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
Jc	= 117.1 kJ/m ²	110.7 kJ/m ²
Kjc=(EJc/((1-ν ²))) ^{1/2}	= 156.1 MPa√m	151.8 MPa√m
Kc (Beta Corrected)	= 90.5 MPa√m	89.4 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 68.11 kN
 5% Secant Offset Pq = 45.71 kN
 Kq = 79.6 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 118.6 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .006 mm
 Fitted elastic load range = 10 kN TO 25 kN
 Elastic slope = 8.294E+01 kN/mm

TEST SPECIMEN DATA

Material Type	= HSST WELD
Test Temperature	= -15°C
Percent Side Groove	= 0%
Specimen Thickness B	= 25.4 mm
Initial a/W	= .513
Init crack length a	= 26.06 mm
Flow strength	= 581.2 MPa
Yield strength	= 521.2 MPa
Young's modulus E	= 208100 MPa (Estimated Value)
Poisson's Ratio (ν)	= 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
Jc	= 157.8 kJ/m ²	150.8 kJ/m ²
K _{Jc} = (EJ _c / (1-ν ²)) ^{1/2}	= 181.2 MPa√m	177.2 MPa√m
K _c (Beta Corrected)	= 96.4 MPa√m	95.5 MPa√m

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B = (BB _n) ^{1/2}	
Maximum Load P	= 68.53 kN
5% Secant Offset P _q	= 43.51 kN
K _q	= 76.4 MPa√m
Validity	= INVALID--1, 2, 3
K at Maximum Load	= 120.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .018 mm

Fitted elastic load range = 10 kN TO 25 kN

Elastic slope = 8.155E+01 kN/mm

SPECIMEN ID= 73W117
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.7 mm $a/W)i = .526$
MEASURED DUCTILE DELTA-A= .23 mm
YIELD STRENGTH= 520 MPa
FLOW STRENGTH= 581 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

SPECIMEN CLEAVED AT KQ= 126.8 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 188.3 kJ/m²
KJc= 198 MPa SQR[m]
K-beta-c= 99.8 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 185 kJ/m²
KJc= 196.2 MPa SQR[m]
K-beta-c= 99.4 MPa SQR[m]

F-53

ORNL-DWG 92-11338

73W117

-15 DEGREES C

73W-117

NUREG/CR-5913

SPECIMEN ID= 73W179
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.7 mm $a/W)i = .527$
MEASURED DUCTILE DELTA-A= .3 mm
YIELD STRENGTH= 520 MPa
FLOW STRENGTH= 581 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

SPECIMEN CLEAVED AT KQ= 126.8 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 193.5 kJ/m²
KJc= 200.6 MPa SQR[m]
K-beta-c= 100.4 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 189.1 kJ/m²
KJc= 198.3 MPa SQR[m]
K-beta-c= 99.9 MPa SQR[m]

73W179

-15 DEGREES C

73W-179

SPECIMEN ID= 73W118
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 25.3 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.7 mm
MEASURED DUCTILE DELTA-A= .33 mm
YIELD STRENGTH= 520 MPa
FLOW STRENGTH= 581 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

$a/W)i = .527$

SPECIMEN CLEAVED AT $KQ = 125.2 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 198.9 kJ/m²
KJc= 203.5 MPa SQR[m]
K-beta-c= 100.7 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 199.5 kJ/m²
KJc= 203.7 MPa SQR[m]
K-beta-c= 100.8 MPa SQR[m]

73W118

-15 DEGREES C

73W-118

NUREG/CR-5913

TEST SPECIMEN DATA

Material Type = A533-B Weld (U)
 Test Temperature = -15 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .513
 Init crack length a = 26.05 mm
 Flow stress = 578.7 MPa
 Yield stress = 513.4 MPa
 Young's modulus E = 208100 MPa (Estimated Value)
 Poisson's Ratio (ν) = .3

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 233.4 kJ/m ²	220 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 231 MPa√m	224.3 MPa√m
Kc (Beta Corrected)	= 105.2 MPa√m	104 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 68.53 kN
 5% Secant Offset Pq = 40.96 kN
 Kq = 71.9 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 120.3 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .008 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 8.164E+01 kN/mm

LRF

1/14/86

13W-119

1T-CT

0.5s

SPECIMEN ID= 73W183
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.9 mm $a/W)i = .53$
MEASURED DUCTILE DELTA-A= .55 mm
YIELD STRENGTH= 520 MPa
FLOW STRENGTH= 581 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

SPECIMEN CLEAVED AT $KQ = 127.9 \text{ MPa SQR}[m]$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 287.5 kJ/m^2
 $KJc = 244.6 \text{ MPa SQR}[m]$
 $K\text{-beta-c} = 108.4 \text{ MPa SQR}[m]$

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 291.1 kJ/m^2
 $KJc = 246.1 \text{ MPa SQR}[m]$
 $K\text{-beta-c} = 108.7 \text{ MPa SQR}[m]$

73W183

-15 DEGREES C

73W-183

NUREG/CR-5913

TEST SPECIMEN DATA

Material Type = A533-B Weld (U)
 Test Temperature = -15 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .523
 Init crack length a = 26.59 mm
 Flow stress = 578.7 MPa
 Yield stress = 513.4 MPa
 Youngs modulus E = 208100 MPa (Estimated Value)
 Poisson's Ratio (ν) = .3

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
Jc	= 503.6 kJ/m ²	491.7 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 339.4 MPa√m	335.3 MPa√m
Kc (Beta Corrected)	= 121.5 MPa√m	120.9 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 69.45 kN
 5% Secant Offset Pq = 42.26 kN
 Kq = 76.8 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 126.1 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .02 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 7.873E+01 kN/mm

LIFE

1/15/86

13W-113

0856 17-C

SPECIMEN ID= 73W169
MATERIAL TYPE= HCU WELD
TEST TEMPERATURE= 0 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 26.5 mm
MEASURED DUCTILE DELTA-A= .58 mm
YIELD STRENGTH= 511 MPa
FLOW STRENGTH= 569 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

 $a/W)i = .522$

SPECIMEN CLEAVED AT $KQ = 121.3 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 227.8 kJ/m^2
 $KJc = 217.2 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 102.5 \text{ MPa SQR[m]}$

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 250.1 kJ/m^2
 $KJc = 227.7 \text{ MPa SQR[m]}$
 $K\text{-beta-c} = 104.4 \text{ MPa SQR[m]}$

73W-169

73W169

0 DEGREES C

73W169

0 DEGREES C

SPECIMEN ID= 73W116
 TEST TEMPERATURE= 0 DEG C
 THICKNESS= 25.4 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 26.9 mm $a/W)i = .529$
 MEASURED DUCTILE DELTA-A= 1.02 mm
 YIELD STRENGTH= 511 MPa
 FLOW STRENGTH= 569 MPa
 ESTIMATED YOUNG'S MODULUS= 207 GPa

SPECIMEN CLEAVED AT KQ= 125 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 319.4 kJ/m²
 KJc= 257.3 MPa SQR[m]
 K-beta-c= 109.3 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 448.2 kJ/m²
 KJc= 304.7 MPa SQR[m]
 K-beta-c= 116.4 MPa SQR[m]

POWER LAW PROCEDURE

JIc= 350.7 kJ/m²
 K-JIc= 269.6 MPa SQR[m]
 POWER= .5598
 COEFFICIENT= 542.9 kJ/m²
 T (AVERAGE)= 176

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

JI-R CURVE CALCULATIONS

J (@J/T=8.8)= 1245.1 kJ/m²
 POWER= .6306
 J-MAX ALLOWED= 680.9 kJ/m²
 RCURVE INVALID, 2 3

COEFFICIENT= 560.2 kJ/m²
 DELTA-A MAX ALLOWED= 2.39 mm

73W-116

73W116

0 DEGREES C

73W116

0 DEGREES C

SPECIMEN ID= 73W135
 TEST TEMPERATURE= 23 DEG C
 THICKNESS= 25.5 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 28.1 mm $a/W)i = .553$
 MEASURED DUCTILE DELTA-A= 1.75 mm
 YIELD STRENGTH= 494 MPa
 FLOW STRENGTH= 549 MPa
 ESTIMATED YOUNG'S MODULUS= 206 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 358.3 kJ/m²
 KJ-MAX LOAD= 271.6 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 309.2 kJ/m²
 K-JIc= 252.3 MPa SQR[m]
 POWER= .69
 COEFFICIENT= 552.3 kJ/m²
 T (AVERAGE)= 238

ASTM LINEAR PROCEDURE

 JIc= 234 kJ/m²
 K-JIc= 219.5 MPa SQR[m]
 SLOPE= 396249 kJ/m³
 INTERCEPT= 149.6 kJ/m²
 T (ASTM)= 270
 INVALID, 6

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 1528.5 kJ/m²
 POWER= .7026
 J-MAX ALLOWED= 623.5 kJ/m²
 RCURVE INVALID, 2 3

COEFFICIENT= 556 kJ/m²
 DELTA-A MAX ALLOWED= 2.27 mm

73W-135

73W135

23 DEGREES C

73W135

23 DEGREES C

SPECIMEN ID= 73W125
 TEST TEMPERATURE= 50 DEG C
 THICKNESS= 25.5 mm
 SIDE GROOVES= 20 %
 INITIAL CRACK LENGTH= 31.5 mm $a/W)i = .621$
 MEASURED DUCTILE DELTA-A= 7.4 mm
 YIELD STRENGTH= 467 MPa
 FLOW STRENGTH= 521 MPa
 ESTIMATED YOUNG'S MODULUS= 204 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 230.5 kJ/m²
 KJ-MAX LOAD= 217 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= 139.2 kJ/m²
 K-JIc= 168.7 MPa SQR[m]
 POWER= .5759
 COEFFICIENT= 287.7 kJ/m²
 T (AVERAGE)= 125

ASTM LINEAR PROCEDURE

 JIc= 113.6 kJ/m²
 K-JIc= 152.3 MPa SQR[m]
 SLOPE= 183200 kJ/m³
 INTERCEPT= 93.6 kJ/m²
 T (ASTM)= 138
 VALID, E813

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 636.9 kJ/m²
 POWER= .5881
 J-MAX ALLOWED= 500.7 kJ/m²
 RCURVE INVALID, 2

COEFFICIENT= 286.3 kJ/m²
 DELTA-A MAX ALLOWED= 1.92 mm

73W-125

73W125

50 DEGREES C

73W125

50 DEGREES C

LKF

9/13/75

73W-59

RT-CT

07.56

-80°C

SPECIMEN ID= 73W73
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -80 DEG C
THICKNESS= 50.8 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 53.1 mm $a/W_i = .523$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 571 MPa
FLOW STRENGTH= 639 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

SPECIMEN CLEAVED AT $K_{Ic} = 67.6 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 21 kJ/m²
KJc= 66.7 MPa SQR[m]
K-beta-c= 64 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 21 kJ/m²
KJc= 66.7 MPa SQR[m]
K-beta-c= 64 MPa SQR[m]

73W73

-80 DEGREES C

73W-73

SPECIMEN ID= 73W66
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -80 DEG C
THICKNESS= 50.9 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 53.2 mm $a/W)i = .523$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 571 MPa
FLOW STRENGTH= 639 MPa
ESTIMATED YOUNG'S MODULUS= 212 GPa

SPECIMEN CLEAVED AT $K_{Ic} = 72.7 \text{ MPa SQR}[m]$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 24.6 kJ/m²
KJc= 72.1 MPa SQR[m]
K-beta-c= 68.4 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 24.6 kJ/m²
KJc= 72.1 MPa SQR[m]
K-beta-c= 68.4 MPa SQR[m]

73W66

-80 DEGREES C

73W-66

LKF 9/12/95

73W-54

2T-CT

09.56

-80°C

IV = 10,000 lbs.

LOAD (IV/in)

73W-54

73W-54

F-77

NUREG/CR-5913

FRONT FACE DEFLECTION (0.5V/in)

IV = 0.03603 in.

SPECIMEN ID= 73W88
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 50.8 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 53.4 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 543 MPa
FLOW STRENGTH= 609 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

$a/W)i = .526$

SPECIMEN CLEAVED AT $K_{Ic} = 74.3 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 25.2 kJ/m²
KJc= 72.7 MPa SQR[m]
K-beta-c= 68.2 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 25.2 kJ/m²
KJc= 72.7 MPa SQR[m]
K-beta-c= 68.2 MPa SQR[m]

73W88

-50 DEGREES C

73W-88

NUREG/CR-5913

SPECIMEN ID= 73W72
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 50.9 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 52.7 mm $a/W)_i = .519$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 543 MPa
FLOW STRENGTH= 609 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

SPECIMEN CLEAVED AT $KQ = 96.6 \text{ MPa SQR}[m]$ (NOT VALID KI_c)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 43.7 kJ/m^2
 $KJc = 95.9 \text{ MPa SQR}[m]$
 $K\text{-beta-c} = 83.8 \text{ MPa SQR}[m]$

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 43.7 kJ/m^2
 $KJc = 95.9 \text{ MPa SQR}[m]$
 $K\text{-beta-c} = 83.8 \text{ MPa SQR}[m]$

73W72

-50 DEGREES C

73W-72

SPECIMEN ID= 73W80
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 50.9 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 52.8 mm $a/W)i = .52$
MEASURED DUCTILE DELTA-A= .07 mm
YIELD STRENGTH= 543 MPa
FLOW STRENGTH= 609 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

SPECIMEN CLEAVED AT KQ= 114.8 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 64.9 kJ/m²
KJc= 116.7 MPa SQR[m]
K-beta-c= 95.1 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 64.9 kJ/m²
KJc= 116.7 MPa SQR[m]
K-beta-c= 95.1 MPa SQR[m]

F-83

ORNL-DWG 92-11356

73W80

-50 DEGREES C

73W-80

NUREG/CR-5913

LKE 9/9/85

73W-61

RT-CT

0%SG

-50°C

59/000'01" = 1

LOAD (10/in)

73W-61

73W-61

F-84

FRONT FACE DEFLECTION (0.5V/in)

1V = 0.036026 in.

LKP 9/9/85

73W-64

2T-CT

07.5C

-50°C

1V = 10,000 lbs

LOAD (1V/IN)

73W-64

73W-64

FRONT FACE DEFLECTION @ 5V/IN

1V = 0.036826 in.

NUREG/CR-5913

F-85

SPECIMEN ID= 73W87
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 50.8 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 52.9 mm $a/W)i = .521$
MEASURED DUCTILE DELTA-A= .08 mm
YIELD STRENGTH= 529 MPa
FLOW STRENGTH= 593 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT KQ= 116.8 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 67.6 kJ/m²
KJc= 118.8 MPa SQR[m]
K-beta-c= 95 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 67.6 kJ/m²
KJc= 118.8 MPa SQR[m]
K-beta-c= 95 MPa SQR[m]

F-87

ORNL-DWG 92-11357

73W87

-30 DEGREES C

73W-87

NUREG/CR-5913

SPECIMEN ID= 73W81
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 50.9 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 52.6 mm
MEASURED DUCTILE DELTA-A= .09 mm
YIELD STRENGTH= 529 MPa
FLOW STRENGTH= 593 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

$a/W)i = .519$

SPECIMEN CLEAVED AT $KQ = 117.7 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 70.4 kJ/m²
KJc= 121.2 MPa SQR[m]
K-beta-c= 96.2 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 69.9 kJ/m²
KJc= 120.9 MPa SQR[m]
K-beta-c= 96 MPa SQR[m]

73W81

-30 DEGREES C

73W-81

NUREG/CR-5913

SPECIMEN ID= 73W67
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 50.7 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 53.4 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 529 MPa
FLOW STRENGTH= 593 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

$a/W)i = .523$

SPECIMEN CLEAVED AT KQ= 122.4 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 77.7 kJ/m²
K_{Jc}= 127.4 MPa SQR[m]
K-beta-c= 98.8 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 77.7 kJ/m²
K_{Jc}= 127.4 MPa SQR[m]
K-beta-c= 98.8 MPa SQR[m]

73W67

-30 DEGREES C

73W-67

NUREG/CR-5913

SPECIMEN ID= 73W86
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 50.8 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 52.6 mm $a/W)i = .519$
MEASURED DUCTILE DELTA-A= .15 mm
YIELD STRENGTH= 520 MPa
FLOW STRENGTH= 581 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

SPECIMEN CLEAVED AT KQ= 141.7 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 99.2 kJ/m²
KJc= 143.6 MPa SQR[m]
K-beta-c= 104.6 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 99.2 kJ/m²
KJc= 143.6 MPa SQR[m]
K-beta-c= 104.6 MPa SQR[m]

73W86

-15 DEGREES C

73W-86

SPECIMEN ID= 73W70
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 50.8 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 57.6 mm
MEASURED DUCTILE DELTA-A= .1 mm
YIELD STRENGTH= 520 MPa
FLOW STRENGTH= 581 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

$a/W)i = .567$

SPECIMEN CLEAVED AT $KQ = 141.1 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 109.7 kJ/m²
KJc= 151 MPa SQR[m]
K-beta-c= 107.3 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 109.3 kJ/m²
KJc= 150.8 MPa SQR[m]
K-beta-c= 107.2 MPa SQR[m]

73W70

-15 DEGREES C

73W-70

NUREG/CR-5913

SPECIMEN ID= 73W71
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 50.8 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 52.8 mm
MEASURED DUCTILE DELTA-A= .19 mm
YIELD STRENGTH= 520 MPa
FLOW STRENGTH= 581 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

$a/W)i = .52$

SPECIMEN CLEAVED AT $KQ = 149.3 \text{ MPa SQR}[m]$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 133.1 kJ/m²
KJc= 166.4 MPa SQR[m]
K-beta-c= 112.5 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 132.4 kJ/m²
KJc= 165.9 MPa SQR[m]
K-beta-c= 112.4 MPa SQR[m]

73W71

-15 DEGREES C

73W-71

NUREG/CR-5913

TEST SPECIMEN DATA

Material Type = HSST WELD
 Test Temperature = -5°C
 Percent Side Groove = 0%
 Specimen Thickness B = 50.8 mm
 Initial a/W = .516
 Init crack length a = 52.46 mm
 Flow strength = 572.9 MPa
 Yield strength = 514.3 MPa
 Young's modulus E = 207500 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 109.5 kJ/m ²	103.9 kJ/m ²
Kjc = (EJc / (1 - ν ²)) ^{1/2}	= 150.8 MPa√m	146.9 MPa√m
Kc (Beta Corrected)	= 106.6 MPa√m	105.2 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 216.52 kN
 5% Secant Offset Pq = 188.75 kN
 Kq = 118.5 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 135.9 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .042 mm

Fitted elastic load range = 50 kN TO 100 kN

Elastic slope = 1.657E+02 kN/mm

LKF 1/30/86

73W-82

09.56

2T

TEST SPECIMEN DATA

Material Type = HSST WELD
 Test Temperature = -5°C
 Percent Side Groove = 0%
 Specimen Thickness B = 50.8 mm
 Initial a/W = .516
 Init crack length a = 52.39 mm
 Flow strength = 572.9 MPa
 Yield strength = 514.3 MPa
 Youngs modulus E = 207500 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 184.4 kJ/m ²	179 kJ/m ²
Kjc = (EJc / ((1-ν ²)) ^{1/2}	= 195.6 MPa√m	192.7 MPa√m
Kc (Beta Corrected)	= 120.5 MPa√m	119.7 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 254.52 kN
 5% Secant Offset Pq = 182.42 kN
 Kq = 114.3 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 159.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .01 mm

Fitted elastic load range = 50 kN TO 100 kN

Elastic slope = 1.693E+02 kN/mm

TEST SPECIMEN DATA

Material Type	= HSST 5th WELD
Test Temperature	= -5 C
Percent Side Groove	= 0 %
Specimen Thickness B	= 50.8 mm
Initial a/W	= .534
Init crack length a	= 54.26 mm
Flow stress	= 572.9 MPa
Yield stress	= 514.3 MPa
Youngs modulus E	= 207500 MPa (Estimated Value)
Poisson's Ratio (ν)	= 0

J-INTEGRAL ANALYSIS

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

J _{ic}	= 195.2 kJ/m ²
K _{ic} = (EJ _{ic} / (1-ν ²)) ^{0.5}	= 201.3 MPa √m
K _{ic} (Beta Corrected)	= 122 MPa √m

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B = (BB _n) ^{0.5}	
Maximum Load P	= 239.3 kN
5% Secant Offset P _q	= 149.11 kN
K _{ic}	= 99.2 MPa √m
Validity	= INVALID--1, 2, 3

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

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

LKF 1/28/86

73W-85

27-CT

09.56

F-103

TEST SPECIMEN DATA

Material Type = HSST WELD
 Test Temperature = -5°C
 Percent Side Groove = 0%
 Specimen Thickness B = 50.8 mm
 Initial a/W = .518
 Init crack length a = 52.66 mm
 Flow strength = 572.9 MPa
 Yield strength = 514.3 MPa
 Youngs modulus E = 207500 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 229 kJ/m ²	220.2 kJ/m ²
Kjc=(EJc/((1-ν ²)) ^{1/2}	= 218 MPa√m	213.8 MPa√m
Kc (Beta Corrected)	= 126.4 MPa√m	125.3 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 262.04 kN
 5% Secant Offset Pq = 187.63 kN
 Kq = 118.5 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 165.5 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)

LKF 1/30/86

73W-84

0.56

21

SPECIMEN ID= 73W69
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= 0 DEG C
THICKNESS= 50.6 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 53.1 mm $a/W)i = .523$
MEASURED DUCTILE DELTA-A= .59 mm
YIELD STRENGTH= 511 MPa
FLOW STRENGTH= 569 MPa
ESTIMATED YOUNG'S MODULUS= 207 GPa

SPECIMEN CLEAVED AT KQ= 171.7 MPa SQR[m] (NOT VALID K_{Ic})

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 293.2 kJ/m²
KJc= 246.5 MPa SQR[m]
K-beta-c= 132.4 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 293.3 kJ/m²
KJc= 246.5 MPa SQR[m]
K-beta-c= 132.5 MPa SQR[m]

73W69

0 DEGREES C

73W-69

NUREG/CR-5913

SPECIMEN ID= 73W20
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 101.6 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 103.3 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 543 MPa
FLOW STRENGTH= 609 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

$a/W)i = .508$

SPECIMEN CLEAVED AT $K_{Ic} = 85.5 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 32.9 kJ/m²
K_{Jc}= 83.1 MPa SQR[m]
K-beta-c= 80.5 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 32.9 kJ/m²
K_{Jc}= 83.1 MPa SQR[m]
K-beta-c= 80.5 MPa SQR[m]

73W20

-50 DEGREES C

73W-20

SPECIMEN ID= 73W24
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -50 DEG C
THICKNESS= 101.6 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 108.2 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 543 MPa
FLOW STRENGTH= 609 MPa
ESTIMATED YOUNG'S MODULUS= 210 GPa

$a/W)i = .532$

SPECIMEN CLEAVED AT $K_{Ic} = 86.9 \text{ MPa SQR}[m]$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 33.7 kJ/m²
KJc= 84.1 MPa SQR[m]
K-beta-c= 81.4 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 33.7 kJ/m²
KJc= 84.1 MPa SQR[m]
K-beta-c= 81.4 MPa SQR[m]

73W24

-50 DEGREES C

73W-24

NUREG/CR-5913

SPECIMEN ID= 73W10
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 101.6 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 103.9 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 529 MPa
FLOW STRENGTH= 593 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

$a/W)i = .511$

SPECIMEN CLEAVED AT $KQ = 115.8 \text{ MPa SQR}[m]$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 61.2 kJ/m²
KJc= 113.1 MPa SQR[m]
K-beta-c= 103.4 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 61.2 kJ/m²
KJc= 113.1 MPa SQR[m]
K-beta-c= 103.4 MPa SQR[m]

73W10

-30 DEGREES C

73W-10

NUREG/CR-5913

TEST SPECIMEN DATA

Material Type	= A533-B HSST 5th Irrad. Weld
Test Temperature	= -30 C
Percent Side Groove	= 0 %
Specimen Thickness B	= 101.6 mm
Initial a/W	= .517
Init crack length a	= 105.03 mm
Flow stress	= 592.7 MPa
Yield stress	= 533.6 MPa
Youngs modulus E	= 208900 MPa (Estimated Value)
Poisson's Ratio (ν)	= 0

J-INTEGRAL ANALYSIS

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

J _{ic}	= 72.4 kJ/m ²
K _{jc} = (EJ _{ic} / (1-ν ²)) ^{.5}	= 123 MPa √m
K _{ic} (Beta Corrected)	= 110.2 MPa √m

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B = (BB _n) ^{.5}	
Maximum Load P	= 533.1 kN
5% Secant Offset P _q	= 533.12 kN
K _{ic}	= 118.5 MPa √m
Validity	= INVALID--1, 2
K at Maximum Load	= 118.5 MPa √m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 7.55527742376E-05 in.
 Specimen rotation Load intercept elastic slope = -9.44838709677E-05 lb
 Fitted elastic load range = 35000 TO 25000 Correction to J for crack exten

sion

LKT

2/25/86

13W-29

0%56

7.

$V = 25000 \text{ lbs.}$

LOAD (10/in)

GREY MKS.

DEFLECTION (2.5V/in)

NUREG/CR-5913

F-115

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 0 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .531
 Init crack length a = 107.99 mm
 Flow stress = 575 MPa
 Yield stress = 517.1 MPa
 Youngs modulus E = 207200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

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

J_{ic} = 97.3 kJ/m²
 $K_{Jc} = (EJ_{ic} / (1 - \nu^2))^{.5} = 142 \text{ MPa } \sqrt{\text{m}}$
 $K_{ic} \text{ (Beta Corrected)} = 120.2 \text{ MPa } \sqrt{\text{m}}$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{.5}
 Maximum Load P = 580.6 kN
 5% Secant Offset P_q = 546.95 kN
 $K_{ic} = 127.5 \text{ MPa } \sqrt{\text{m}}$
 Validity = INVALID--1, 2
 $K \text{ at Maximum Load} = 135.3 \text{ MPa } \sqrt{\text{m}}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 3.11977423278E-04 in.
 Specimen rotation Load intercept elastic slope = .00005990625 lb
 Fitted elastic load range = 35000 TO 25000 Correction to J for crack exten

sion

F-117

SPECIMEN ID= 73W17
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -30 DEG C
THICKNESS= 101.6 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 102.4 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 529 MPa
FLOW STRENGTH= 593 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

$a/W)i = .504$

SPECIMEN CLEAVED AT $KQ = 171.8 \text{ MPa SQR}[m]$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 149.3 kJ/m²
KJc= 176.6 MPa SQR[m]
K-beta-c= 138.3 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 149.3 kJ/m²
KJc= 176.6 MPa SQR[m]
K-beta-c= 138.3 MPa SQR[m]

73W17

-30 DEGREES C

73W-17

NUREG/CR-5913

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = -15 C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .524
 Init crack length a = 106.55 mm
 Flow stress = 581.2 MPa
 Yield stress = 521.2 MPa
 Young's modulus E = 208100 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

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

J_{ic} = 55.3 kJ/m²
 $K_{Jc} = (EJ_{ic} / (1 - \nu^2))^{.5} = 107.3 \text{ MPa } \sqrt{\text{m}}$
 K_{ic} (Beta Corrected) = 99 MPa $\sqrt{\text{m}}$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{.5}
 Maximum Load P = 462.6 kN
 5% Secant Offset P_q = 462.63 kN
 K_{ic} = 105.4 MPa $\sqrt{\text{m}}$
 Validity = INVALID--2
 K at Maximum Load = 105.4 MPa $\sqrt{\text{m}}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 1.00682895179E-03 in.
 Specimen rotation Load intercept elastic slope = -3.30769230769E-05 lb
 Fitted elastic load range = 35000 TO 25000 Correction to J for crack exten

sion

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = -15 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .523
 Init crack length a = 106.28 mm
 Flow stress = 581.2 MPa
 Yield stress = 521.2 MPa
 Youngs modulus E = 208100 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J_{ic})
 J_{ic} = 69.9 kJ/m²
 $K_{Jc} = (EJ_{ic} / (1 - \nu^2))^{\frac{1}{2}}$ = 120.6 MPa √m
 K_{ic} (Beta Corrected) = 107.9 MPa √m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (BB_n)^{\frac{1}{2}}$
 Maximum Load P = 516.5 kN
 5% Secant Offset P_Q = 516.51 kN
 K_{ic} = 117.1 MPa √m
 Validity = INVALID--1, 2
 K at Maximum Load = 117.1 MPa √m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 3.47018140054E-04 in.
 Specimen rotation Load intercept elastic slope = 2.76451612903E-05 lb
 Fitted elastic load range = 35000 TO 25000 Correction to J for crack exten

sion

SPECIMEN ID= 73W26
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 101.6 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 107.7 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 520 MPa
FLOW STRENGTH= 581 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

$a/W)i = .531$

SPECIMEN CLEAVED AT $KQ = 122.2 \text{ MPa SQR}[m]$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 69.2 kJ/m²
KJc= 120 MPa SQR[m]
K-beta-c= 107.5 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 69.2 kJ/m²
KJc= 120 MPa SQR[m]
K-beta-c= 107.5 MPa SQR[m]

73W26

-15 DEGREES C

73W-26

NUREG/CR-5913

SPECIMEN ID= 73W23
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -15 DEG C
THICKNESS= 101.7 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 103.1 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 520 MPa
FLOW STRENGTH= 581 MPa
ESTIMATED YOUNG'S MODULUS= 208 GPa

$a/W)_i = .508$

SPECIMEN CLEAVED AT $KQ = 155.5 \text{ MPa SQR[m]}$ (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 117.8 kJ/m²
KJc= 156.6 MPa SQR[m]
K-beta-c= 128 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 117.8 kJ/m²
KJc= 156.6 MPa SQR[m]
K-beta-c= 128 MPa SQR[m]

73W23

-15 DEGREES C

73W-23

NUREG/CR-5913

TEST SPECIMEN DATA

Material Type	= WELD	
Test Temperature	= -5 °C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 101.6 mm	
Initial a/W	= .505	
Init crack length a	= 102.66 mm	
Flow stress	= 572.9 MPa	
Yield stress	= 514.3 MPa	
Young's modulus E	= 207500 MPa	(Estimated Value)
Poisson's Ratio (ν)	= 0	

J-INTEGRAL ANALYSISFailure Type A (J at instability = J_{ic})J_{ic} = 152.8 kJ/m²K_{ic} = (EJ_{ic} / (1 - ν²))^{0.5} = 178.1 MPa √mK_{ic} (Beta Corrected) = 137.2 MPa √mASTM E399-81 ANALYSISModified K_{ic} Equation; B = (BB_n)^{0.5}

Maximum Load P = 779.1 kN

5% Secant Offset P_q = 715.75 kNK_{ic} = 153.4 MPa √m

Validity = INVALID--1, 2

K at Maximum Load = 167 MPa √m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 3.93959963441E-03 in.

Specimen rotation Load intercept elastic slope = 1.62641509434E-04 lb

Fitted elastic load range = 75000 TO 50000 Correction to J for crack exten

sion

LKF

9/8/96

73W-13

4T-C1

TEST SPECIMEN DATA

Material Type = WELD
 Test Temperature = -5 C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .506
 Init crack length a = 102.79 mm
 Flow stress = 572.9 MPa
 Yield stress = 514.3 MPa
 Youngs modulus E = 207500 MPa (Estimated Value)
 Poisson's Ratio (v) = 0

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J_{ic})
 J_{ic} = 246.3 kJ/m²
 $K_{Jc} = (E J_{ic} / (1 - v^2))^{.5} = 226.1 \text{ MPa } \sqrt{\text{m}}$
 K_{ic} (Beta Corrected) = 155.2 MPa $\sqrt{\text{m}}$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (B B_n)^{.5}$
 Maximum Load P = 945 kN
 5% Secant Offset P_q = 724.11 kN
 K_{ic} = 155.5 MPa $\sqrt{\text{m}}$
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 202.9 MPa $\sqrt{\text{m}}$

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten OFFSET LOAD = 0 lb OFFSET DEFLECTION = 4.25895393932E-03 in.
 Specimen rotation Load intercept elastic slope = 7.11538461538E-06 lb
 Fitted elastic load range = 75000 TO 50000 Correction to J for crack exten

sion

LKF

9/12/86

73W-14

4T-C7

$V = 25000 \text{ lbs.}$

Load (V/in)

MTS FRONT FACE DEFLECTION (2.5V/in)

F-131

NUREG/CR-5913

73W-30

SPECIMEN CLEAVED

147910 PQ (LB)
 657.91 PQ (KN)
 168490 MAX LOAD (LB)
 749.46 MAX LOAD (KN)
 0.005 MEASURED FINAL CRACK EXTENSION (IN)
 0.127 MEASURED FINAL CRACK EXTENSION (MM)

 30009 REFERENCE MODULUS (KSI)
 206.91 REFERENCE MODULUS (GPA)

 134.47 UC KQ (KSI*SQRT(IN))
 147.77 UC KQ (MPA*SQRT(M))
 153.18 UC MAX LOAD K (KSI*SQRT(IN))
 168.33 UC MAX LOAD K (MPA*SQRT(M))
 -0.0414 #UC FINAL CRACK EXTENSION (IN)
 -1.05 #UC FINAL CRACK EXTENSION (MM)
 -927 #UC FINAL CRACK EXTENSION ERROR (PERCENT)

INVALID UC KIC TEST

851.1 UC MERKLE-CORTEN MAX LOAD J-INTEGRAL (IN*LB/IN^2)
 149.05 UC MERKLE-CORTEN MAX LOAD J-INTEGRAL (KJ/M^2)
 159.81 UC MERKLE-CORTEN MAX LOAD KJ (KSI*SQRT(IN))
 175.62 UC MERKLE-CORTEN MAX LOAD KJ (MPA*SQRT(M))
 122.28 UC MERKLE-CORTEN BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
 134.37 UC MERKLE-CORTEN BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
 159.81 UC MERKLE-CORTEN FINAL KJ (KSI*SQRT(IN))
 175.62 UC MERKLE-CORTEN FINAL KJ (MPA*SQRT(M))
 122.28 UC MERKLE-CORTEN BETA-ADJ FINAL KJ (KSI*SQRT(IN))
 134.37 UC MERKLE-CORTEN BETA-ADJ FINAL KJ (MPA*SQRT(M))

 831.3 #UC ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
 145.57 #UC ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
 157.94 #UC ERNST MAX LOAD KJ (KSI*SQRT(IN))
 173.56 #UC ERNST MAX LOAD KJ (MPA*SQRT(M))
 121.49 #UC ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
 133.51 #UC ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
 157.94 #UC ERNST FINAL KJ (KSI*SQRT(IN))
 173.56 #UC ERNST FINAL KJ (MPA*SQRT(M))
 121.49 #UC ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
 133.51 #UC ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

 840.1 #UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
 147.12 #UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
 158.77 #UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
 174.48 #UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
 121.84 #UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
 133.9 #UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
 158.77 #UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
 174.48 #UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
 121.84 #UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
 133.9 #UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

UC MERKLE-CORTEN JIC,CEIC,KJIC AND TAVG NOT DEFINED--NOT ENOUGH DATA POINTS FOR POWER LAW FIT

73W-31

SPECIMEN CLEAVED

152800	PQ (LB)
679.63	PQ (KN)
221260	MAX LOAD (LB)
984.19	MAX LOAD (KN)
0.05	MEASURED FINAL CRACK EXTENSION (IN)
1.27	MEASURED FINAL CRACK EXTENSION (MM)
30009	REFERENCE MODULUS (KSI)
206.91	REFERENCE MODULUS (GPA)
135.63	UC KQ (KSI*SQRT(IN))
149.05	UC KQ (MPA*SQRT(M))
196.41	UC MAX LOAD K (KSI*SQRT(IN))
215.84	UC MAX LOAD K (MPA*SQRT(M))
-0.0472	#UC FINAL CRACK EXTENSION (IN)
-1.199	#UC FINAL CRACK EXTENSION (MM)
-194.4	#UC FINAL CRACK EXTENSION ERROR (PERCENT)

INVALID UC KIC TEST

1594.8	UC MERKLE-CORTEN	MAX LOAD J-INTEGRAL (IN*LB/IN^2)
279.3	UC MERKLE-CORTEN	MAX LOAD J-INTEGRAL (KJ/M^2)
218.77	UC MERKLE-CORTEN	MAX LOAD KJ (KSI*SQRT(IN))
240.4	UC MERKLE-CORTEN	MAX LOAD KJ (MPA*SQRT(M))
143.23	UC MERKLE-CORTEN	BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
157.4	UC MERKLE-CORTEN	BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
218.77	UC MERKLE-CORTEN	FINAL KJ (KSI*SQRT(IN))
240.4	UC MERKLE-CORTEN	FINAL KJ (MPA*SQRT(M))
143.23	UC MERKLE-CORTEN	BETA-ADJ FINAL KJ (KSI*SQRT(IN))
157.4	UC MERKLE-CORTEN	BETA-ADJ FINAL KJ (MPA*SQRT(M))
1549.7	#UC ERNST	MAX LOAD J-INTEGRAL (IN*LB/IN^2)
271.4	#UC ERNST	MAX LOAD J-INTEGRAL (KJ/M^2)
215.65	#UC ERNST	MAX LOAD KJ (KSI*SQRT(IN))
236.98	#UC ERNST	MAX LOAD KJ (MPA*SQRT(M))
142.27	#UC ERNST	BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
156.34	#UC ERNST	BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
215.65	#UC ERNST	FINAL KJ (KSI*SQRT(IN))
236.98	#UC ERNST	FINAL KJ (MPA*SQRT(M))
142.27	#UC ERNST	BETA-ADJ FINAL KJ (KSI*SQRT(IN))
156.34	#UC ERNST	BETA-ADJ FINAL KJ (MPA*SQRT(M))
1559.2	#UC MODIFIED ERNST	MAX LOAD J-INTEGRAL (IN*LB/IN^2)
273.05	#UC MODIFIED ERNST	MAX LOAD J-INTEGRAL (KJ/M^2)
216.31	#UC MODIFIED ERNST	MAX LOAD KJ (KSI*SQRT(IN))
237.7	#UC MODIFIED ERNST	MAX LOAD KJ (MPA*SQRT(M))
142.47	#UC MODIFIED ERNST	BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
156.57	#UC MODIFIED ERNST	BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
216.31	#UC MODIFIED ERNST	FINAL KJ (KSI*SQRT(IN))
237.7	#UC MODIFIED ERNST	FINAL KJ (MPA*SQRT(M))
142.47	#UC MODIFIED ERNST	BETA-ADJ FINAL KJ (KSI*SQRT(IN))
156.57	#UC MODIFIED ERNST	BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO UC MERKLE-CORTEN TEST RESULTS ■■ NO

73W-32

SPECIMEN CLEAVED

144290	PQ (LB)
641.78	PQ (KN)
192640	MAX LOAD (LB)
856.86	MAX LOAD (KN)
0.005	MEASURED FINAL CRACK EXTENSION (IN)
0.127	MEASURED FINAL CRACK EXTENSION (MM)

30009	REFERENCE MODULUS (KSI)
206.91	REFERENCE MODULUS (GPA)

130.65	UC KQ (KSI*SQRT(IN))
143.57	UC KQ (MPA*SQRT(M))
174.44	UC MAX LOAD K (KSI*SQRT(IN))
191.69	UC MAX LOAD K (MPA*SQRT(M))
-0.0439	#UC FINAL CRACK EXTENSION (IN)
-1.116	#UC FINAL CRACK EXTENSION (MM)
-978.5	#UC FINAL CRACK EXTENSION ERROR (PERCENT)

INVALID UC KIC TEST

1169	UC MERKLE-CORTEN	MAX LOAD J-INTEGRAL (IN*LB/IN^2)
204.72	UC MERKLE-CORTEN	MAX LOAD J-INTEGRAL (KJ/M^2)
187.3	UC MERKLE-CORTEN	MAX LOAD KJ (KSI*SQRT(IN))
205.82	UC MERKLE-CORTEN	MAX LOAD KJ (MPA*SQRT(M))
132.87	UC MERKLE-CORTEN	BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
146.01	UC MERKLE-CORTEN	BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
187.3	UC MERKLE-CORTEN	FINAL KJ (KSI*SQRT(IN))
205.82	UC MERKLE-CORTEN	FINAL KJ (MPA*SQRT(M))
132.87	UC MERKLE-CORTEN	BETA-ADJ FINAL KJ (KSI*SQRT(IN))
146.01	UC MERKLE-CORTEN	BETA-ADJ FINAL KJ (MPA*SQRT(M))

1137	#UC ERNST	MAX LOAD J-INTEGRAL (IN*LB/IN^2)
199.12	#UC ERNST	MAX LOAD J-INTEGRAL (KJ/M^2)
184.71	#UC ERNST	MAX LOAD KJ (KSI*SQRT(IN))
202.98	#UC ERNST	MAX LOAD KJ (MPA*SQRT(M))
131.94	#UC ERNST	BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
144.99	#UC ERNST	BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
184.71	#UC ERNST	FINAL KJ (KSI*SQRT(IN))
202.98	#UC ERNST	FINAL KJ (MPA*SQRT(M))
131.94	#UC ERNST	BETA-ADJ FINAL KJ (KSI*SQRT(IN))
144.99	#UC ERNST	BETA-ADJ FINAL KJ (MPA*SQRT(M))

1144.1	#UC MODIFIED ERNST	MAX LOAD J-INTEGRAL (IN*LB/IN^2)
200.35	#UC MODIFIED ERNST	MAX LOAD J-INTEGRAL (KJ/M^2)
185.29	#UC MODIFIED ERNST	MAX LOAD KJ (KSI*SQRT(IN))
203.61	#UC MODIFIED ERNST	MAX LOAD KJ (MPA*SQRT(M))
132.15	#UC MODIFIED ERNST	BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
145.22	#UC MODIFIED ERNST	BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
185.29	#UC MODIFIED ERNST	FINAL KJ (KSI*SQRT(IN))
203.61	#UC MODIFIED ERNST	FINAL KJ (MPA*SQRT(M))
132.15	#UC MODIFIED ERNST	BETA-ADJ FINAL KJ (KSI*SQRT(IN))
145.22	#UC MODIFIED ERNST	BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO UC MERKLE-CORTEN TEST RESULTS ~~NO~~ NO

73W-33

SPECIMEN CLEAVED

F-139

148940 PQ (LB)
 662.49 PQ (KN)
 204320 MAX LOAD (LB)
 908.79 MAX LOAD (KN)
 0.005 MEASURED FINAL CRACK EXTENSION (IN)
 0.127 MEASURED FINAL CRACK EXTENSION (MM)

 30009 REFERENCE MODULUS (KSI)
 206.91 REFERENCE MODULUS (GPA)

 133.79 UC KQ (KSI*SQRT(IN))
 147.03 UC KQ (MPA*SQRT(M))
 183.54 UC MAX LOAD K (KSI*SQRT(IN))
 201.69 UC MAX LOAD K (MPA*SQRT(M))
 -0.0407 #UC FINAL CRACK EXTENSION (IN)
 -1.035 #UC FINAL CRACK EXTENSION (MM)
 -914.8 #UC FINAL CRACK EXTENSION ERROR (PERCENT)

INVALID UC KIC TEST

1345.7 UC MERKLE-CORTEN MAX LOAD J-INTEGRAL (IN*LB/IN^2)
 235.67 UC MERKLE-CORTEN MAX LOAD J-INTEGRAL (KJ/M^2)
 200.96 UC MERKLE-CORTEN MAX LOAD KJ (KSI*SQRT(IN))
 220.83 UC MERKLE-CORTEN MAX LOAD KJ (MPA*SQRT(M))
 137.56 UC MERKLE-CORTEN BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
 151.17 UC MERKLE-CORTEN BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
 200.96 UC MERKLE-CORTEN FINAL KJ (KSI*SQRT(IN))
 220.83 UC MERKLE-CORTEN FINAL KJ (MPA*SQRT(M))
 137.56 UC MERKLE-CORTEN BETA-ADJ FINAL KJ (KSI*SQRT(IN))
 151.17 UC MERKLE-CORTEN BETA-ADJ FINAL KJ (MPA*SQRT(M))

 1305.4 #UC ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
 228.61 #UC ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
 197.92 #UC ERNST MAX LOAD KJ (KSI*SQRT(IN))
 217.5 #UC ERNST MAX LOAD KJ (MPA*SQRT(M))
 136.55 #UC ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
 150.05 #UC ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
 197.92 #UC ERNST FINAL KJ (KSI*SQRT(IN))
 217.5 #UC ERNST FINAL KJ (MPA*SQRT(M))
 136.55 #UC ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
 150.05 #UC ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

 1314.5 #UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
 230.2 #UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
 198.61 #UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
 218.25 #UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
 136.78 #UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
 150.31 #UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
 198.61 #UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
 218.25 #UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
 136.78 #UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
 150.31 #UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO UC MERKLE-CORTEN TEST RESULTS ■■ NO

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = -5°C
 Percent Side Groove = 0%
 Specimen Thickness B = 152.4 mm
 Initial a/W = .511
 Init crack length a = 155.61 mm
 Flow strength = 572.9 MPa
 Yield strength = 514.3 MPa
 Young's modulus E = 207500 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 113.4 kJ/m ²	116.8 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{1/2}	= 153.4 MPa√m	155.7 MPa√m
Kc (Beta Corrected)	= 135.2 MPa√m	136.6 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 1276.09 kN
 5% Secant Offset Pq = 1276.09 kN
 Kq = 151.4 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 151.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .006 mm

Fitted elastic load range = 250 kN TO 500 kN

Elastic slope = 5.595E+02 kN/mm

LN 3/7/86

73W-006

6T-CT 8956

10 = 50000 lb

LOAD (10/in)

73W-006

DEFLECTION (80/in)

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = -5°C
 Percent Side Groove = 0%
 Specimen Thickness B = 152.4 mm
 Initial a/W = .512
 Init crack length a = 156.01 mm
 Flow strength = 572.9 MPa
 Yield strength = 514.3 MPa
 Young's modulus E = 207500 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 153.6 kJ/m ²	156.3 kJ/m ²
Kjc = (EJc / ((1-ν²)¹/²))¹/²	= 178.5 MPa√m	180.1 MPa√m
Kc (Beta Corrected)	= 149.4 MPa√m	150.2 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)¹/²
 Maximum Load P = 1452.07 kN
 5% Secant Offset Pq = 1431.9 kN
 Kq = 170.6 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 173 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .008 mm

Fitted elastic load range = 250 kN TO 500 kN

Elastic slope = 5.496E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = -5°C
 Percent Side Groove = 0%
 Specimen Thickness B = 203.2 mm
 Initial a/W = .582
 Init crack length a = 236.61 mm
 Flow strength = 572.9 MPa
 Yield strength = 514.3 MPa
 Youngs modulus E = 207500 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 150.8 kJ/m ²	156.6 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{1/2}	= 176.9 MPa√m	180.2 MPa√m
Kc (Beta Corrected)	= 155.9 MPa√m	158 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 1779.25 kN
 5% Secant Offset Pq = 1779.25 kN
 Kq = 175.2 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 175.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .011 mm
 Fitted elastic load range = 250 kN TO 500 kN
 Elastic slope = 5.308E+02 kN/mm

LKF

4/22/86

73W-004

8T-CT

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = -5 C
 Percent Side Groove = 0 %
 Specimen Thickness B = 203.2 mm
 Initial a/W = .548
 Init crack length a = 222.55 mm
 Flow stress = 572.9 MPa
 Yield stress = 514.3 MPa
 Youngs modulus E = 207500 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J_{ic})
 J_{ic} = 223 kJ/m²
 $K_{Jc} = (EJ_{ic} / (1 - \nu^2))^{.5} = 215.2 \text{ MPa } \sqrt{\text{m}}$
 K_{ic} (Beta Corrected) = 177.1 MPa $\sqrt{\text{m}}$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{.5}
 Maximum Load P = 2421 kN
 5% Secant Offset P_q = 2380.43 kN
 K_{ic} = 207.1 MPa $\sqrt{\text{m}}$
 Validity = INVALID--1, 2

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

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

73W-001

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 5 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 203.2 mm
 Initial a/W = .593
 Init crack length a = 229.57 mm
 Flow stress = 531.2 MPa
 Yield stress = 476.8 MPa
 Youngs modulus E = 206900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

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

J_{ic} = 127.9 kJ/m²
 $K_{Jc} = (E J_{ic} / (1 - \nu^2))^{.5} = 162.7 \text{ MPa}\sqrt{\text{m}}$
 K_{ic} (Beta Corrected) = 143.8 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (BB_n)^{1/2}$
 Maximum Load P = 1358.99 kN
 5% Secant Offset P_q = 875.22 kN
 K_q = ~~91.8~~ MPa√m 142.6
 Validity = INVALID--3
 K at Maximum Load = 142.6 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction for specimen rotation
 Correction to J for crack extension
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .016 mm
 Fitted elastic load range = 600 kN TO 200 kN

TEST SPECIMEN DATA

Material Type = A533-B HSST 5th Irrad. Weld
 Test Temperature = 5 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 203.2 mm
 Initial a/W = .593
 Init crack length a = 229.57 mm
 Flow stress = 531.2 MPa
 Yield stress = 476.8 MPa
 Youngs modulus E = 206900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J_{ic})
 J_{ic} = 100.1 kJ/m² (Defl. * 0.740)
 $K_{Jc} = (EJ_{ic} / (1 - \nu^2))^{.5}$ = 144 MPa√m
 K_{ic} (Beta Corrected) = 131.6 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{1/2}
 Maximum Load P = 1358.99 kN
 5% Secant Offset P_q = 1358.99 kN
 K_q = 142.6 MPa√m
 Validity = INVALID--2
 K at Maximum Load = 142.6 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction for specimen rotation
 Correction to J for crack extension
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .018 mm
 Fitted elastic load range = 800 kN TO 400 kN

TEST SPECIMEN DATA

Material Type	= A533-B HSST 5th Irrad. Weld
Test Temperature	= 5 °C
Percent Side Groove	= 0 %
Specimen Thickness B	= 203.2 mm
Initial a/W	= .593
Init crack length a	= 229.57 mm
Flow stress	= 531.2 MPa
Yield stress	= 476.8 MPa
Young's modulus E	= 206900 MPa (Estimated Value)
Poisson's Ratio (ν)	= 0

J-INTEGRAL ANALYSIS

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

J_{ic} = 98.6 kJ/m² (Defl. * 0.740)

$K_{Jc} = (EJ_{ic} / (1 - \nu^2))^{.5}$ = 142.9 MPa√m

K_{ic} (Beta Corrected) = 130.9 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{1/2}

Maximum Load P = 1358.99 kN

5% Secant Offset P_q = 1358.99 kN

K_q = 142.6 MPa√m

Validity = INVALID--2

K at Maximum Load = 142.6 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction for specimen rotation

Correction to J for crack extension

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .013 mm

Fitted elastic load range = 800 kN TO 400 kN

TEST SPECIMEN DATA

Material Type	= A533-B HSST 5th Irrad. Weld
Test Temperature	= 5 °C
Percent Side Groove	= 0 %
Specimen Thickness B	= 203.2 mm
Initial a/W	= .627
Init crack length a	= 254.99 mm
Flow stress	= 531.2 MPa
Yield stress	= 476.8 MPa
Youngs modulus E	= 206900 MPa (Estimated Value)
Poisson's Ratio (ν)	= 0

J-INTEGRAL ANALYSIS

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

J _{ic}	= 176.5 kJ/m ²
K _{jc} = (EJ _{ic} / (1-ν ²)) ^{.5}	= 191.2 MPa√m
K _{ic} (Beta Corrected)	= 159.9 MPa√m

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B	= (BB _n) ^{1/2}
Maximum Load P	= 1588.08 kN
5% Secant Offset P _q	= 1588.08 kN
K _q	= 187.2 MPa√m
Validity	= INVALID--1, 2
K at Maximum Load	= 187.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction for specimen rotation

Correction to J for crack extension

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .018 mm

Fitted elastic load range = 800 kN TO 400 kN

73W-002

TEST SPECIMEN DATA

Material Type	= A533-B HSST 5th Irrad. Weld
Test Temperature	= 5 °C
Percent Side Groove	= 0 %
Specimen Thickness B	= 203.2 mm
Initial a/W	= .627
Init crack length a	= 254.99 mm
Flow stress	= 531.2 MPa
Yield stress	= 476.8 MPa
Youngs modulus E	= 206900 MPa (Estimated Value)
Poisson's Ratio (ν)	= 0

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J _{ic})	
J _{ic}	= 176.9 kJ/m ² (Defl. * 0.740)
K _{jc} = (EJ _{ic} / (1-ν ²)) ^{.5}	= 191.4 MPa√m
K _{ic} (Beta Corrected)	= 160 MPa√m

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B = (BB _n) ^{1/2}	
Maximum Load P	= 1588.08 kN
5% Secant Offset P _q	= 1588.08 kN
K _q	= 187.2 MPa√m
Validity	= INVALID--1, 2
K at Maximum Load	= 187.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction for specimen rotation

Correction to J for crack extension

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .015 mm

Fitted elastic load range = 800 kN TO 400 kN

F-155

YP6459

NUREG/CR-5913

TEST SPECIMEN DATA

Material Type	= A533-B HSST 5th Irrad. Weld
Test Temperature	= 5 °C
Percent Side Groove	= 0 %
Specimen Thickness B	= 203.2 mm
Initial a/W	= .627
Init crack length a	= 254.99 mm
Flow stress	= 531.2 MPa
Yield stress	= 476.8 MPa
Youngs modulus E	= 206900 MPa (Estimated Value)
Poisson's Ratio (ν)	= 0

J-INTEGRAL ANALYSISFailure Type A (J at instability = J_{ic})

J _{ic}	= 175.7 kJ/m ²	(Defl. = 0.740)
K _{jc} = (EJ _{ic} / (1-ν ²)) ^{0.5}	= 190.7 MPa√m	
K _{ic} (Beta Corrected)	= 159.7 MPa√m	

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B	= (BB _n) ^{1/2}
Maximum Load P	= 1588.08 kN
5% Secant Offset P _q	= 1588.08 kN
K _q	= 187.2 MPa√m
Validity	= INVALID--1, 2
K at Maximum Load	= 187.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction for specimen rotation

Correction to J for crack extension

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .026 mm

Fitted elastic load range = 800 kN TO 400 kN

NUREG/CR-5913

**Load-Displacement Curves and Photographs of the
Fracture Toughness Specimens From the
Irradiated 73W Weld (0.31 wt% Cu)**

SPECIMEN ID= 73W158
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -75 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.3 mm $a/W)i = .538$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 621 MPa
FLOW STRENGTH= 672 MPa
ESTIMATED YOUNG'S MODULUS= 211 GPa

SPECIMEN CLEAVED AT $K_{Ic} = 44.3$ MPa SQR[m] (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 10.4 kJ/m²
KJc= 46.9 MPa SQR[m]
K-beta-c= 45.5 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 10.4 kJ/m²
KJc= 46.9 MPa SQR[m]
K-beta-c= 45.5 MPa SQR[m]

F-160

ORNL-DWG 92-11364

73W158

-75 DEGREES C

SPECIMEN ID= 73W160
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= -25 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.8 mm $a/W)_i = .546$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 621 MPa
FLOW STRENGTH= 672 MPa
ESTIMATED YOUNG'S MODULUS= 209 GPa

SPECIMEN CLEAVED AT $K_{Ic} = 57.3 \text{ MPa SQR[m]}$ (VALID ASTM E399)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 19 kJ/m²
KJc= 62.9 MPa SQR[m]
K-beta-c= 58.2 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 19 kJ/m²
KJc= 62.9 MPa SQR[m]
K-beta-c= 58.2 MPa SQR[m]

73W160

-25 DEGREES C

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = -25 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .536
 Init crack length a = 27.24 mm
 Flow stress = 722.8 MPa
 Yield stress = 675 MPa
 Youngs modulus E = 208600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 23.4 kJ/m ²	28 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 69.8 MPa√m	76.5 MPa√m
Kc (Beta Corrected)	= 64.3 MPa√m	68.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 35.07 kN
 5% Secant Offset Pq = 21.36 kN
 Kq = 40.5 MPa√m
 Validity = INVALID--3
 K at Maximum Load = 66.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .003 mm

Fitted elastic load range = 5 kN TO 15 kN

Elastic slope = 1.399E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = -25 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .536
 Init crack length a = 27.24 mm
 Flow stress = 722.8 MPa
 Yield stress = 675 MPa
 Young's modulus E = 208600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 6.2 kJ/m ²	7.9 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 36 MPa√m	40.7 MPa√m
Kc (Beta Corrected)	= 35.7 MPa√m	40.2 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 21.36 kN
 5% Secant Offset Pq = 21.36 kN
 Kq = 40.5 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 40.5 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .003 mm

Fitted elastic load range = 5 kN TO 15 kN

Elastic slope = 1.399E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = -25 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .536
 Init crack length a = 27.24 mm
 Flow stress = 722.8 MPa
 Yield stress = 675 MPa
 Youngs modulus E = 208600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 30.2 kJ/m ²	29.1 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 79.4 MPa√m	78 MPa√m
Kc (Beta Corrected)	= 70.7 MPa√m	69.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 35.22 kN
 5% Secant Offset Pq = 21.36 kN
 Kq = 40.5 MPa√m
 Validity = INVALID--3
 K at Maximum Load = 66.7 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .023 mm

Fitted elastic load range = 5 kN TO 15 kN

Elastic slope = 7.692E+01 kN/mm

NUREG/CR-5913

Load 1.0 unit

4/14/0052

0% Side Groove

IT-CT

73W-128

-13°F (-25°C)

9/10/86

73W-128

0.025079 in/volt

Front Face Defl. 0.5 unit/inch

0.025079 in/v

F-166

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = -25 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .58
 Init crack length a = 29.44 mm
 Flow stress = 722.8 MPa
 Yield stress = 675 MPa
 Youngs modulus E = 208600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 18.4 kJ/m ²	18.9 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 61.9 MPa√m	62.8 MPa√m
Kc (Beta Corrected)	= 58.5 MPa√m	59.1 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 27.87 kN
 5% Secant Offset Pq = 27.87 kN
 Kq = 61.5 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 61.5 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .019 mm
 Fitted elastic load range = 5 kN TO 15 kN
 Elastic slope = 6.689E+01 kN/mm

NUREG/CR-5913

02 Side Groove

IT-CT

73W-156

-25°C (-13°F)

9/12/86

4m4 0052

Load 1.0 volt

No Photo
Compliance Crack Length

73W-156

0.025079 in/volt

~~Front~~ Front Face Defl. 0.5 volt

0.025079 in/volt

F-168

SPECIMEN ID= 73W130
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= 25 DEG C
THICKNESS= 25.5 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.4 mm
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 621 MPa
FLOW STRENGTH= 672 MPa
ESTIMATED YOUNG'S MODULUS= 206 GPa

$a/W)i = .539$

SPECIMEN CLEAVED AT KQ= 63.8 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 25.4 kJ/m²
KJc= 72.3 MPa SQR[m]
K-beta-c= 64.6 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 25.4 kJ/m²
KJc= 72.3 MPa SQR[m]
K-beta-c= 64.6 MPa SQR[m]

F-170

ORNL-DWG 92-11370

73W130

25 DEGREES C

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 29 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .523
 Init crack length a = 26.59 mm
 Flow stress = 693.2 MPa
 Yield stress = 646.3 MPa
 Youngs modulus E = 205200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 14 kJ/m ²	14.8 kJ/m ²
Kjc = (EJc / (1 - ν ²)) ^{0.5}	= 53.6 MPa√m	55.1 MPa√m
Kc (Beta Corrected)	= 51.4 MPa√m	52.6 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 30.02 kN
 5% Secant Offset Pq = 30.02 kN
 Kq = 54.5 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 54.5 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .001 mm

Fitted elastic load range = 5 kN TO 15 kN

Elastic slope = 1.205E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 29 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .523
 Init crack length a = 26.59 mm
 Flow stress = 693.2 MPa
 Yield stress = 646.3 MPa
 Youngs modulus E = 205200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 15 kJ/m ²	14.9 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 55.5 MPa√m	55.2 MPa√m
Kc (Beta Corrected)	= 53 MPa√m	52.7 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 30.02 kN
 5% Secant Offset Pq = 30.02 kN
 Kq = 54.5 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 54.5 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .012 mm

Fitted elastic load range = 5 kN TO 15 kN

Elastic slope = 8.334E+01 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 29 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .543
 Init crack length a = 27.58 mm
 Flow stress = 693.2 MPa
 Yield stress = 646.3 MPa
 Young's modulus E = 205200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 46.7 kJ/m ²	47.7 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 97.9 MPa√m	98.9 MPa√m
Kc (Beta Corrected)	= 79.8 MPa√m	80.3 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 48.53 kN
 5% Secant Offset Pq = 45.26 kN
 Kq = 87.7 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 94 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .001 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 1.063E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 29 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .543
 Init crack length a = 27.58 mm
 Flow stress = 693.2 MPa
 Yield stress = 646.3 MPa
 Youngs modulus E = 205200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 50.4 kJ/m ²	48.1 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 101.7 MPa√m	99.4 MPa√m
Kc (Beta Corrected)	= 81.6 MPa√m	80.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 48.53 kN
 5% Secant Offset Pq = 44.3 kN
 Kq = 85.8 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 94 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .011 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 7.310E+01 kN/mm

1T-CT

73W-148

020

29°C

EMD 7/24/86

73W-148

1/1005-C
(in/in) P 307

2.9757 in/volt

Front Face Deflection (10mV/in)

2.9757 in/V

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 29 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .53
 Init crack length a = 26.94 mm
 Flow stress = 693.2 MPa
 Yield stress = 646.3 MPa
 Young's modulus E = 205200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 25.6 kJ/m ²	26.4 kJ/m ²
K _{Jc} = (EJc / (1-ν ²)) ^{0.5}	= 72.4 MPa√m	73.6 MPa√m
Kc (Beta Corrected)	= 65.4 MPa√m	66.1 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{IC} Equation; B = (BB_N)^{1/2}
 Maximum Load P = 38.65 kN
 5% Secant Offset P_Q = 38.65 kN
 K_Q = 71.8 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 71.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.016 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 1.141E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 29 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .53
 Init crack length a = 26.94 mm
 Flow stress = 693.2 MPa
 Yield stress = 646.3 MPa
 Young's modulus E = 205200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 27.7 kJ/m ²	26.5 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{0.5}	= 75.4 MPa√m	73.7 MPa√m
Kc (Beta Corrected)	= 67.3 MPa√m	66.2 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 38.65 kN
 5% Secant Offset Pq = 38.65 kN
 Kq = 71.8 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 71.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.005 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 7.779E+01 kN/mm

IT-CT

73W-163

σ₂₀

29°C

EMD/BHM 7/23/86

73W-163

in/in
(N₁ 005C) P207

F-179

NUREG/CR-5913

2.9757 in/volt

FF ~~load line~~ (at ~~load~~) deflection (10mV/in)

2.9757 in/V

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .547
 Init crack length a = 27.8 mm
 Flow stress = 683.1 MPa
 Yield stress = 636.6 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 120.6 kJ/m ²	120 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 157 MPa√m	156.6 MPa√m
Kc (Beta Corrected)	= 101.4 MPa√m	101.3 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 65.19 kN
 5% Secant Offset Pq = 42.13 kN
 Kq = 82.8 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 128.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = 0 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 1.006E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .547
 Init crack length a = 27.8 mm
 Flow stress = 683.1 MPa
 Yield stress = 636.6 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 123.2 kJ/m ²	119.1 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 158.7 MPa√m	156 MPa√m
Kc (Beta Corrected)	= 101.9 MPa√m	101.1 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 65.19 kN
 5% Secant Offset Pq = 42.47 kN
 Kq = 83.5 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 128.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .011 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 7.147E+01 kN/mm

07a Side Groove

73W-46164

122°F (50°C)

9/13/86

11.0052

Load 0.1

73W-164

0.025079 in/volt

Front Face Deflection 0.5 volt/inch

0.025079 in/volt

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .527
 Init crack length a = 26.75 mm
 Flow stress = 683.1 MPa
 Yield stress = 636.6 MPa
 Young's modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 80.8 kJ/m ²	82.3 kJ/m ²
K _{Jc} = (EJ _c /(1-ν ²)) ^{0.5}	= 128.5 MPa√m	129.7 MPa√m
K _c (Beta Corrected)	= 92.1 MPa√m	92.5 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{IC} Equation; B = (BB_N)^{1/2}
 Maximum Load P = 64.52 kN
 5% Secant Offset P_q = 49.13 kN
 K_q = 90.2 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 118.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = 0 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 1.142E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .527
 Init crack length a = 26.75 mm
 Flow stress = 683.1 MPa
 Yield stress = 636.6 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 82.7 kJ/m ²	81.9 kJ/m ²
K _{Jc} = (EJc / (1-ν ²)) ^{0.5}	= 130 MPa√m	129.4 MPa√m
K _c (Beta Corrected)	= 92.6 MPa√m	92.4 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{IC} Equation; B = (BBn)^{1/2}
 Maximum Load P = 64.52 kN
 5% Secant Offset P_q = 49.55 kN
 K_q = 90.9 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 118.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .008 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 8.184E+01 kN/mm

0% Side Groove

IT-CT

73W-170

+50°C (122°F)

9/13/86 PHN

2500 lb/ft

Load 1.0 $\frac{\text{volt}}{\text{inch}}$

73W-170

F-185

NUREG/CR-5913

0.025079 $\frac{\text{inch}}{\text{volt}}$

Front Face Deflection 0.5 $\frac{\text{volt}}{\text{inch}}$

0.025079 $\frac{\text{inch}}{\text{volt}}$

SPECIMEN ID= 73W139
MATERIAL TYPE= HCUWELD
TEST TEMPERATURE= 75 DEG C
THICKNESS= 25.4 mm
SIDE GROOVES= 0 %
INITIAL CRACK LENGTH= 27.2 mm $a/W)i = .535$
MEASURED DUCTILE DELTA-A= .05 mm
YIELD STRENGTH= 621 MPa
FLOW STRENGTH= 672 MPa
ESTIMATED YOUNG'S MODULUS= 203 GPa

SPECIMEN CLEAVED AT KQ= 126.9 MPa SQR[m] (NOT VALID KIc)

VALUES AT MAXIMUM LOAD

J-INTEGRAL= 125.3 kJ/m²
KJc= 159.4 MPa SQR[m]
K-beta-c= 100.7 MPa SQR[m]

VALUES AT CLEAVAGE LOAD

J-INTEGRAL= 125 kJ/m²
KJc= 159.3 MPa SQR[m]
K-beta-c= 100.7 MPa SQR[m]

73W139

75 DEGREES C

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 75 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .534
 Init crack length a = 27.13 mm
 Flow stress = 671.9 MPa
 Yield stress = 626.2 MPa
 Youngs modulus E = 202900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 207.4 kJ/m ²	215 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 205.1 MPa√m	208.9 MPa√m
Kc (Beta Corrected)	= 113 MPa√m	113.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 75.47 kN
 5% Secant Offset Pq = 45.51 kN
 Kq = 85.6 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 142 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .002 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 1.163E+02 kN/mm

Specimen Crackmouth Deflection (in.)

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 75 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .534
 Init crack length a = 27.13 mm
 Flow stress = 671.9 MPa
 Yield stress = 626.2 MPa
 Youngs modulus E = 202900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 206.5 kJ/m ²	209 kJ/m ²
Kjc = (EJc / (1-ν ²)) ^{0.5}	= 204.7 MPa√m	206 MPa√m
Kc (Beta Corrected)	= 112.9 MPa√m	113.2 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 75.47 kN
 5% Secant Offset Pq = 43.75 kN
 Kq = 82.3 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 142 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .008 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 8.153E+01 kN/mm

IT-CT

IRRADIATED

73W-168

+75°C

0% SG

1/27/86 RUM

41m/0052

4m/0.1 p007

73W-168

4.121 in/volt

Front Face Deflection 10 mV/inch

4.121 in/volt

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 75 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .538
 Init crack length a = 27.32 mm
 Flow stress = 671.9 MPa
 Yield stress = 626.2 MPa
 Youngs modulus E = 202900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = J_c)]

	Merkle-Corten	Deformation-J*
J_c	= 126.2 kJ/m ²	132.1 kJ/m ²
$K_{Jc} = (E J_c / (1 - \nu^2))^{.5}$	= 160 MPa√m	163.7 MPa√m
K_c (Beta Corrected)	= 101.4 MPa√m	102.4 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (BB_n)^{1/2}$
 Maximum Load P = 70 kN
 5% Secant Offset P_q = 43.72 kN
 K_q = 83.3 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 133.3 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .006 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 1.131E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 75 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .534
 Init crack length a = 27.13 mm
 Flow stress = 671.9 MPa
 Yield stress = 626.2 MPa
 Youngs modulus E = 202900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 135.6 kJ/m ²	133.8 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 165.9 MPa√m	164.8 MPa√m
Kc (Beta Corrected)	= 103 MPa√m	102.7 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 70 kN
 5% Secant Offset Pq = 43.16 kN
 Kq = 81.2 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 131.7 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .014 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 7.778E+01 kN/mm

IT-ST IRRADIATED

73W-144

+25°C

0% S.G.

1/28/86 BMM

73W-144

4mV
1000000

4mV
1000000
Load 1.0

4.121 $\frac{mV}{VOLT}$ (10mV/inch)

~~Load line~~ Front Face Deflection 10 $\frac{mV}{inch}$

4.121 $\frac{mV}{VOLT}$

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 75 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .531
 Init crack length a = 26.96 mm
 Flow stress = 671.9 MPa
 Yield stress = 626.2 MPa
 Youngs modulus E = 202900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 141 kJ/m ²	148 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 169.1 MPa√m	173.3 MPa√m
Kc (Beta Corrected)	= 103.9 MPa√m	105.1 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 74.51 kN
 5% Secant Offset Pq = 43.88 kN
 Kq = 81.6 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 138.6 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = 0 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 1.177E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B WELD (I)
 Test Temperature = 75 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 25.4 mm
 Initial a/W = .531
 Init crack length a = 26.96 mm
 Flow stress = 671.9 MPa
 Yield stress = 626.2 MPa
 Youngs modulus E = 202900 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 149.6 kJ/m ²	150.1 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 174.3 MPa√m	174.5 MPa√m
Kc (Beta Corrected)	= 105.3 MPa√m	105.4 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 74.51 kN
 5% Secant Offset Pq = 45.44 kN
 Kq = 84.5 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 138.6 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .005 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 8.107E+01 kN/mm

IT-CT IRRADIATED

73W-162

+75°C

0.7a Side Groove

7/27/86 gwen

400/0052

Load 1.0 volt/mch

73W-162

||||

4.121 $\mu\text{V}/\text{volt}$

Front Face Clip Gage 10 $\frac{\text{mV}}{\text{inch}}$

4.121 $\frac{\text{mV}}{\text{volt}}$

73W-140

NUREG/CR-5913

8244	PQ (LB)
36.668	PQ (KN)
16497	MAX LOAD (LB)
73.378	MAX LOAD (KN)
64.26	UC KQ (KSI*SQRT(IN))
70.56	UC KQ (MPA*SQRT(M))
128.6	UC MAX LOAD K (KSI*SQRT(IN))
141.2	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
1050	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
183.8	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
175.51	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
192.87	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
100.96	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
110.94	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
191.85	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
210.82	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
104.82	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
115.19	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ### YES

ACCEPT POWER LAW FIT TO TEST DATA ### YES

436200	A0	IN UC MODIFIED ERNST	$J=A0*(CE+E0)^{A1+A2}$	FIT (IN*LB/IN^2)
705.01	A0	IN UC MODIFIED ERNST	$J=A0*(CE+E0)^{A1+A2}$	FIT (KJ/M^2)
1.4485	A1	IN UC MODIFIED ERNST	$J=A0*(CE+E0)^{A1+A2}$	FIT (IN*LB/IN^2)
1.4485	A1	IN UC MODIFIED ERNST	$J=A0*(CE+E0)^{A1+A2}$	FIT (KJ/M^2)
372.06	A2	IN UC MODIFIED ERNST	$J=A0*(CE+E0)^{A1+A2}$	FIT (IN*LB/IN^2)
65.158	A2	IN UC MODIFIED ERNST	$J=A0*(CE+E0)^{A1+A2}$	FIT (KJ/M^2)
0.00147	E0	IN UC MODIFIED ERNST	$J=A0*(CE+E0)^{A1+A2}$	FIT (IN)
0.0374	E0	IN UC MODIFIED ERNST	$J=A0*(CE+E0)^{A1+A2}$	FIT (MM)

8064	PQ (LB)
35.866	PQ (KN)
16437	MAX LOAD (LB)
73.114	MAX LOAD (KN)
62.67	UC KQ (KSI*SQRT(IN))
68.81	UC KQ (MPA*SQRT(M))
127.76	UC MAX LOAD K (KSI*SQRT(IN))
140.28	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
855	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
149.7	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
158.4	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
174.07	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
96.6	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
106.16	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
196.49	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
215.92	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
105.93	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
116.4	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ### YES

ACCEPT POWER LAW FIT TO TEST DATA ### YES

28732	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
294.48	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0.87745	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
0.87745	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
314.42	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
55.063	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN)
0	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (MM)
0.0101	UC MODIFIED ERNST CEIC (IN)
0.256	UC MODIFIED ERNST CEIC (MM)
823.4	UC MODIFIED ERNST JIC (IN*LB/IN^2)
144.2	UC MODIFIED ERNST JIC (KJ/M^2)
155.45	UC MODIFIED ERNST KJIC (KSI*SQRT(IN))
170.83	UC MODIFIED ERNST KJIC (MPA*SQRT(M))
118.4	UC MODIFIED ERNST TAUG

9174	PQ (LB)
40.804	PQ (KN)
16803	MAX LOAD (LB)
74.74	MAX LOAD (KN)
74.17	UC KQ (KSI*SQRT(IN))
81.43	UC KQ (MPA*SQRT(M))
135.85	UC MAX LOAD K (KSI*SQRT(IN))
149.16	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
1060	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
185.7	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
176.41	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
193.85	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
101.21	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
111.22	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
195.06	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
214.36	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
105.58	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
116.02	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA *** YES

73W-150

73W-138

7690	PQ (LB)
34.205	PQ (KN)
15443	MAX LOAD (LB)
68.692	MAX LOAD (KN)
59.61	UC KQ (KSI*SQRT(IN))
65.45	UC KQ (MPA*SQRT(M))
119.72	UC MAX LOAD K (KSI*SQRT(IN))
131.45	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
526	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
92.1	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
124.24	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
136.53	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
86.27	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
94.8	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
143.97	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
158.21	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
92.53	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
101.68	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ~~NO~~ NO

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAUG NOT DEFINED--POWER LAW FIT NOT REQUESTED BY TECHNICIAN

F-207

73W-155

NUREG/CR-5913

8053	PQ (LB)
35.82	PQ (KN)
16587	MAX LOAD (LB)
73.777	MAX LOAD (KN)
65.56	UC KQ (KSI*SQRT(IN))
71.98	UC KQ (MPA*SQRT(M))
135.02	UC MAX LOAD K (KSI*SQRT(IN))
148.26	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
1067	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
186.9	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
176.97	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
194.47	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
101.29	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
111.3	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
227.28	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
249.75	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
112.27	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
123.37	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ### YES

ACCEPT POWER LAW FIT TO TEST DATA ### YES

34387	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
274.13	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0.95513	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
0.95513	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
369.38	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
64.688	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN)
0	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (MM)
0.0099	UC MODIFIED ERNST CEIC (IN)
0.252	UC MODIFIED ERNST CEIC (MM)
788.5	UC MODIFIED ERNST JIC (IN*LB/IN^2)
138.08	UC MODIFIED ERNST JIC (KJ/M^2)
152.12	UC MODIFIED ERNST KJIC (KSI*SQRT(IN))
167.16	UC MODIFIED ERNST KJIC (MPA*SQRT(M))
126.5	UC MODIFIED ERNST TAUG

F-210

73W-166

8175	PQ (LB)
36.364	PQ (KN)
15569	MAX LOAD (LB)
69.25	MAX LOAD (KN)
62.16	UC KQ (KSI*SQRT(IN))
68.25	UC KQ (MPA*SQRT(M))
118.38	UC MAX LOAD K (KSI*SQRT(IN))
129.98	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
608	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
106.5	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
133.58	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
146.79	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
89.34	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
98.18	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
161.54	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
177.52	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
97.45	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
107.08	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ### YES

ACCEPT POWER LAW FIT TO TEST DATA ### YES

31198	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
126.2	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
1.1648	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
1.1648	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
411.37	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
72.041	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN)
0	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (MM)
0.0086	UC MODIFIED ERNST CEIC (IN)
0.219	UC MODIFIED ERNST CEIC (MM)
534	UC MODIFIED ERNST JIC (IN*LB/IN^2)
93.52	UC MODIFIED ERNST JIC (KJ/M^2)
125.19	UC MODIFIED ERNST KJIC (KSI*SQRT(IN))
137.57	UC MODIFIED ERNST KJIC (MPA*SQRT(M))
62.3	UC MODIFIED ERNST TAUG

F-213

73W-132

NUREG/CR-5913

7835	PQ (LB)
34.849	PQ (KN)
14147	MAX LOAD (LB)
62.928	MAX LOAD (KN)
62.21	UC KQ (KSI*SQRT(IN))
68.3	UC KQ (MPA*SQRT(M))
112.33	UC MAX LOAD K (KSI*SQRT(IN))
123.34	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
524	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
91.8	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
124.06	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
136.33	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
86.19	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
94.71	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
141.19	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
155.16	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
91.67	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
100.74	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ## YES

ACCEPT POWER LAW FIT TO TEST DATA ## YES

6168.5	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
95.616	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0.74956	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
0.74956	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
275.55	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
48.256	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0.00016	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN)
0.00398	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (MM)
0.0082	UC MODIFIED ERNST CEIC (IN)
0.208	UC MODIFIED ERNST CEIC (MM)
446	UC MODIFIED ERNST JIC (IN*LB/IN^2)
78.1	UC MODIFIED ERNST JIC (KJ/M^2)
114.4	UC MODIFIED ERNST KJIC (KSI*SQRT(IN))
125.72	UC MODIFIED ERNST KJIC (MPA*SQRT(M))
34.2	UC MODIFIED ERNST TAUG

73W-124

7178	PQ (LB)
31.929	PQ (KN)
10394	MAX LOAD (LB)
46.232	MAX LOAD (KN)
60.35	UC KQ (KSI*SQRT(IN))
66.27	UC KQ (MPA*SQRT(M))
87.39	UC MAX LOAD K (KSI*SQRT(IN))
95.95	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
245	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
42.8	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
84.71	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
93.09	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
69.99	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
76.91	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
88.91	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
97.7	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
72.05	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
79.18	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAUG NOT DEFINED--NOT ENDOUGHT DATA POINTS FOR POWER LAW FIT

F-218

73W-147

73W-147

NUREG/CR-5913

7890	PQ (LB)
35.094	PQ (KN)
15909	MAX LOAD (LB)
70.764	MAX LOAD (KN)
64.49	UC KQ (KSI*SQRT(IN))
70.82	UC KQ (MPA*SQRT(M))
130.05	UC MAX LOAD K (KSI*SQRT(IN))
142.8	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
975	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
170.7	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
169.12	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
185.85	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
99.42	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
109.25	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
185.9	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
204.28	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
103.51	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
113.75	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ### YES
 ACCEPT POWER LAW FIT TO TEST DATA ### NO
 SUPPRESS SELECTED DATA AND REFIT DATA ### NO

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAVG NOT DEFINED--POWER LAW FIT REJECTED
 BY TECHNICIAN

F-221

73W-131

NUREG/CR-5913

8193	PQ (LB)
36.44	PQ (KN)
16110	MAX LOAD (LB)
71.656	MAX LOAD (KN)
64.49	UC KQ (KSI*SQRT(IN))
70.81	UC KQ (MPA*SQRT(M))
126.81	UC MAX LOAD K (KSI*SQRT(IN))
139.24	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
722	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
126.4	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
145.54	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
159.93	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
92.96	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
102.16	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
167.33	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
183.88	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
98.93	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
108.71	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ### YES

ACCEPT POWER LAW FIT TO TEST DATA ### YES

80637	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
334.05	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
1.1575	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
1.1575	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
154.55	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
27.066	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN)
0	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (MM)
0.0083	UC MODIFIED ERNST CEIC (IN)
0.21	UC MODIFIED ERNST CEIC (MM)
468.5	UC MODIFIED ERNST JIC (IN*LB/IN^2)
82.04	UC MODIFIED ERNST JIC (KJ/M^2)
117.25	UC MODIFIED ERNST KJIC (KSI*SQRT(IN))
128.85	UC MODIFIED ERNST KJIC (MPA*SQRT(M))
176.7	UC MODIFIED ERNST TAUG

8946	PQ (LB)
39.79	PIQ (KN)
17534	MAX LOAD (LB)
77.989	MAX LOAD (KN)
66.33	UC KQ (KSI*SQRT(IN))
72.83	UC KQ (MPA*SQRT(M))
130.02	UC MAX LOAD K (KSI*SQRT(IN))
142.76	UC MAX LOAD K (MPA*SQRT(M))
29183	REFERENCE MODULUS (KSI)
201.22	REFERENCE MODULUS (GPA)
1092	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
191.2	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
178.5	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
196.15	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
101.08	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
111.08	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
325.48	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
357.68	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
128.07	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
140.73	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ### YES
 ACCEPT POWER LAW FIT TO TEST DATA ### YES

12532	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
253.2	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0.66763	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
0.66763	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
217.82	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
38.147	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0.00397	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN)
0.10079	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (MM)
0.0109	UC MODIFIED ERNST CEIC (IN)
0.277	UC MODIFIED ERNST CEIC (MM)
972.2	UC MODIFIED ERNST JIC (IN*LB/IN^2)
170.26	UC MODIFIED ERNST JIC (KJ/M^2)
168.44	UC MODIFIED ERNST KJIC (KSI*SQRT(IN))
185.1	UC MODIFIED ERNST KJIC (MPA*SQRT(M))
76.8	UC MODIFIED ERNST TAUG

F-227

73W-171

NUREG/CR-5913

8353	PQ (LB)
37.155	PQ (KN)
17545	MAX LOAD (LB)
78.041	MAX LOAD (KN)
63.73	UC KQ (KSI*SQRT(IN))
69.97	UC KQ (MPA*SQRT(M))
133.86	UC MAX LOAD K (KSI*SQRT(IN))
146.98	UC MAX LOAD K (MPA*SQRT(M))
29183	REFERENCE MODULUS (KSI)
201.22	REFERENCE MODULUS (GPA)
1200	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
210.1	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
187.12	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
205.63	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
103.14	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
113.34	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
328.72	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
361.23	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
128.58	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
141.3	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ### YES

ACCEPT POWER LAW FIT TO TEST DATA ### YES

9503.8	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
416.39	A0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0.42834	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
0.42834	A1 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
-666.05	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN*LB/IN^2)
-116.64	A2 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (KJ/M^2)
0	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (IN)
0	E0 IN UC MODIFIED ERNST $J=A0*(CE+E0)^{A1+A2}$ FIT (MM)
0.009	UC MODIFIED ERNST CEIC (IN)
0.227	UC MODIFIED ERNST CEIC (MM)
594.9	UC MODIFIED ERNST JIC (IN*LB/IN^2)
104.19	UC MODIFIED ERNST JIC (KJ/M^2)
131.76	UC MODIFIED ERNST KJIC (KSI*SQRT(IN))
144.8	UC MODIFIED ERNST KJIC (MPA*SQRT(M))
92.7	UC MODIFIED ERNST TAVG

ORNL-DWG 92-11408

F-230

73W-146

7160	PQ (LB)
31.847	PQ (KN)
16065	MAX LOAD (LB)
71.458	MAX LOAD (KN)
56.18	UC KQ (KSI*SQRT(IN))
61.69	UC KQ (MPA*SQRT(M))
126.07	UC MAX LOAD K (KSI*SQRT(IN))
138.42	UC MAX LOAD K (MPA*SQRT(M))
29183	REFERENCE MODULUS (KSI)
201.22	REFERENCE MODULUS (GPA)
1125	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
197.1	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
181.21	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
199.13	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
101.75	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
111.82	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
326.38	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
358.65	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
128.24	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
140.92	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA *** YES

ACCEPT POWER LAW FIT TO TEST DATA *** YES

13881	A0	IN UC MODIFIED ERNST	$J=A0*(CE+E0)^{A1+A2}$	FIT (IN*LB/IN^2)
312.06	A0	IN UC MODIFIED ERNST	$J=A0*(CE+E0)^{A1+A2}$	FIT (KJ/M^2)
0.63461	A1	IN UC MODIFIED ERNST	$J=A0*(CE+E0)^{A1+A2}$	FIT (IN*LB/IN^2)
0.63461	A1	IN UC MODIFIED ERNST	$J=A0*(CE+E0)^{A1+A2}$	FIT (KJ/M^2)
34.61	A2	IN UC MODIFIED ERNST	$J=A0*(CE+E0)^{A1+A2}$	FIT (IN*LB/IN^2)
6.061	A2	IN UC MODIFIED ERNST	$J=A0*(CE+E0)^{A1+A2}$	FIT (KJ/M^2)
0.00075	E0	IN UC MODIFIED ERNST	$J=A0*(CE+E0)^{A1+A2}$	FIT (IN)
0.01914	E0	IN UC MODIFIED ERNST	$J=A0*(CE+E0)^{A1+A2}$	FIT (MM)
0.0101		UC MODIFIED ERNST	CEIC (IN)	
0.257		UC MODIFIED ERNST	CEIC (MM)	
822.3		UC MODIFIED ERNST	JIC (IN*LB/IN^2)	
144		UC MODIFIED ERNST	JIC (KJ/M^2)	
154.91		UC MODIFIED ERNST	KJIC (KSI*SQRT(IN))	
170.23		UC MODIFIED ERNST	KJIC (MPA*SQRT(M))	
96.1		UC MODIFIED ERNST	TAVG

ORNL-DWG 92-11410

8373 PQ (LB)
 37.242 PQ (KN)
 16263 MAX LOAD (LB)
 72.336 MAX LOAD (KN)
 0.1984 MEASURED FINAL CRACK EXTENSION (IN)
 5.039 MEASURED FINAL CRACK EXTENSION (MM)

 29183 REFERENCE MODULUS (KSI)
 201.22 REFERENCE MODULUS (GPA)

 66.38 UC KQ (KSI*SQRT(IN))
 72.95 UC KQ (MPA*SQRT(M))
 128.93 UC MAX LOAD K (KSI*SQRT(IN))
 141.69 UC MAX LOAD K (MPA*SQRT(M))
 0.131 #UC FINAL CRACK EXTENSION (IN)
 3.327 #UC FINAL CRACK EXTENSION (MM)
 -34 #UC FINAL CRACK EXTENSION ERROR (PERCENT)

INVALID UC KIC TEST

1030.5 UC MERKLE-CORTEN MAX LOAD J-INTEGRAL (IN*LB/IN^2)
 180.47 UC MERKLE-CORTEN MAX LOAD J-INTEGRAL (KJ/M^2)
 173.42 UC MERKLE-CORTEN MAX LOAD KJ (KSI*SQRT(IN))
 190.57 UC MERKLE-CORTEN MAX LOAD KJ (MPA*SQRT(M))
 99.87 UC MERKLE-CORTEN BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
 109.75 UC MERKLE-CORTEN BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
 316.12 UC MERKLE-CORTEN FINAL KJ (KSI*SQRT(IN))
 347.38 UC MERKLE-CORTEN FINAL KJ (MPA*SQRT(M))
 126.72 UC MERKLE-CORTEN BETA-ADJ FINAL KJ (KSI*SQRT(IN))
 139.26 UC MERKLE-CORTEN BETA-ADJ FINAL KJ (MPA*SQRT(M))

 1003.9 UC ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
 175.81 UC ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
 171.16 UC ERNST MAX LOAD KJ (KSI*SQRT(IN))
 188.09 UC ERNST MAX LOAD KJ (MPA*SQRT(M))
 99.31 UC ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
 109.14 UC ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
 308.6 UC ERNST FINAL KJ (KSI*SQRT(IN))
 339.12 UC ERNST FINAL KJ (MPA*SQRT(M))
 125.59 UC ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
 138.01 UC ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

 1007.8 UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
 176.49 UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
 171.5 UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
 188.46 UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
 99.4 UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
 109.23 UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
 322.36 UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
 354.24 UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
 127.65 UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
 140.27 UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO UC MERKLE-CORTEN TEST RESULTS ### NO

UC MERKLE-CORTEN JIC,CEIC,KJIC AND TAUG NOT DEFINED--POWER LAW FIT DECLINED BY
 TECHNICIAN
 NUREG/CR-5913

SPECIMEN ID= 73W136
 TEST TEMPERATURE= 125 DEG C
 THICKNESS= 25.5 mm
 SIDE GROOVES= 0 %
 INITIAL CRACK LENGTH= 27.2 mm $a/W)i = .537$
 MEASURED DUCTILE DELTA-A= 1.98 mm
 YIELD STRENGTH= 621 MPa
 FLOW STRENGTH= 672 MPa
 ESTIMATED YOUNG'S MODULUS= 200 GPa

SPECIMEN DID NOT CLEAVE, J-MAX LOAD= 245.7 kJ/m²
 KJ-MAX LOAD= 221.7 MPa SQR[m]

POWER LAW PROCEDURE

 JIc= -1000 kJ/m²
 K-JIc= 0 MPa SQR[m]
 POWER= 0
 COEFFICIENT= 0 kJ/m²
 T (AVERAGE)= 0

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

JI-R CURVE CALCULATIONS

 J (@J/T=8.8)= 0 kJ/m²
 POWER= 0
 J-MAX ALLOWED= 790.2 kJ/m²
 RCURVE INVALID, 2 3

COEFFICIENT= 0 kJ/m²
 DELTA-A MAX ALLOWED= 2.35 mm

73W136

125 DEGREES C

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = -25 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .519
 Init crack length a = 52.73 mm
 Flow stress = 722.8 MPa
 Yield stress = 675 MPa
 Youngs modulus E = 208600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 12.1 kJ/m ²	12.2 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 50.3 MPa√m	50.4 MPa√m
Kc (Beta Corrected)	= 49.9 MPa√m	50 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 74.55 kN
 5% Secant Offset Pq = 68.19 kN
 Kq = 43.2 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 47.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .013 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 2.372E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = -25 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .519
 Init crack length a = 52.73 mm
 Flow stress = 722.8 MPa
 Yield stress = 675 MPa
 Youngs modulus E = 208600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 8.7 kJ/m ²	8.7 kJ/m ²
K _{Jc} = (EJc / (1-ν ²)) ^{0.5}	= 42.5 MPa√m	42.6 MPa√m
Kc (Beta Corrected)	= 42.3 MPa√m	42.4 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 67.01 kN
 5% Secant Offset P_q = 67.01 kN
 K_q = 42.4 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 42.4 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .013 mm
 Fitted elastic load range = 5 kN TO 25 kN
 Elastic slope = 2.372E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = -25 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .519
 Init crack length a = 52.73 mm
 Flow stress = 722.8 MPa
 Yield stress = 675 MPa
 Youngs modulus E = 208600 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 12.3 kJ/m ²	12.1 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 50.6 MPa√m	50.3 MPa√m
Kc (Beta Corrected)	= 50.2 MPa√m	49.9 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 74.55 kN
 5% Secant Offset Pq = 68.19 kN
 Kq = 43.2 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 47.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .02 mm

Fitted elastic load range = 5 kN TO 25 kN

Elastic slope = 1.724E+02 kN/mm

NUREG/CR-5913

4/20/81 00001

4/20/81 01 PM 07

0% Side Groove

2T-CT

73W-76

-25°C (-13°F)

9/22/86 DHM

73W-76

Front Face Deflection 0.5 $\frac{\text{volt}}{\text{inch}}$

0.025025 $\frac{\text{inch}}{\text{volt}}$

F-240

0.7% Side Groove

2T-CT

73W-75

0°C (32°F)

~~0.001 (0.001)~~

73W-75

10000 $\frac{\text{volt}}{\text{inch}}$

Load 1.0 $\frac{\text{volt}}{\text{inch}}$

Front Face Deflection 0.5 $\frac{\text{volt}}{\text{inch}}$

0.02514 $\frac{\text{volt}}{\text{inch}}$

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .523
 Init crack length a = 53.15 mm
 Flow stress = 683.1 MPa
 Yield stress = 636.6 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 136.1 kJ/m ²	134.1 kJ/m ²
Kjc=(EJc/((1-ν ²))) ^{.5}	= 166.8 MPa√m	165.5 MPa√m
Kc (Beta Corrected)	= 124.5 MPa√m	124 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 227.71 kN
 5% Secant Offset Pq = 147.89 kN
 Kq = 94.9 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 146.1 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.021 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 2.229E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .523
 Init crack length a = 53.15 mm
 Flow stress = 683.1 MPa
 Yield stress = 636.6 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
Jc	= 47.5 kJ/m ²	46.6 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 98.5 MPa√m	97.6 MPa√m
Kc (Beta Corrected)	= 89.5 MPa√m	88.9 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 147.89 kN
 5% Secant Offset Pq = 147.89 kN
 Kq = 94.9 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 94.9 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.021 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 2.229E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .523
 Init crack length a = 53.15 mm
 Flow stress = 683.1 MPa
 Yield stress = 636.6 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 135.9 kJ/m ²	133.4 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 166.7 MPa√m	165.1 MPa√m
Kc (Beta Corrected)	= 124.5 MPa√m	123.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 227.71 kN
 5% Secant Offset Pq = 147.89 kN
 Kq = 94.9 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 146.1 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.013 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 1.642E+02 kN/mm

NUREG/CR-5913

Load 0.1 pound

0% Side Groove

2I-CT

73W-78

+50°C (122°F)

8/25/86 PHH

73W-78

Front Face Deflection 0.5 $\frac{\text{volt}}{\text{inch}}$

0.025025 $\frac{\text{mV}}{\text{volt}}$

73W-62

0% Side Groove

2T-CT

+50°C (122°F)

73W-62

Load 10000 lb/ft²
4 in
0.1 psi

Front Face Deflection $0.5 \frac{\text{in}}{\text{in}}$

0.02514"/VOLT

NUREG/CR-5913

F-247

NUREG/CR-5913

F-248

73W-50

42341	PQ (LB)
188.33	PQ (KN)
54851	MAX LOAD (LB)
243.98	MAX LOAD (KN)
108.39	UC KQ (KSI*SQRT(IN))
119.01	UC KQ (MPA*SQRT(M))
140.41	UC MAX LOAD K (KSI*SQRT(IN))
154.17	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
731	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
128	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
146.44	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
160.92	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
111.02	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
122	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
146.44	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
160.92	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
111.02	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
122	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAUG NOT DEFINED--NOT ENOUGH DATA POINTS FOR POWER LAW FIT

73W-52

42506	PQ (LB)
189.07	PQ (KN)
55162	MAX LOAD (LB)
245.36	MAX LOAD (KN)
109.13	UC KQ (KSI*SQRT(IN))
119.82	UC KQ (MPA*SQRT(M))
141.62	UC MAX LOAD K (KSI*SQRT(IN))
155.5	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
720	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
126.1	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
145.39	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
159.77	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
110.58	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
121.51	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
148.73	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
163.43	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
111.94	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
123.01	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAUG NOT DEFINED--NOT ENOUGH DATA POINTS FOR POWER LAW FIT

73W-74

39051	PQ (LB)
173.7	PQ (KN)
45777	MAX LOAD (LB)
203.62	MAX LOAD (KN)
100.26	UC KQ (KSI*SQRT(IN))
110.09	UC KQ (MPA*SQRT(M))
117.53	UC MAX LOAD K (KSI*SQRT(IN))
129.05	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
481	UC MODIFIED ERNST MAX LOAD/ J-INTEGRAL (IN*LB/IN^2)
84.2	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
118.81	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
130.56	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
98.42	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
108.15	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
118.81	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
130.56	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
98.42	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
108.15	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAVG NOT DEFINED--NOT ENOUGH DATA POINTS FOR POWER LAW FIT

73W-79

40494	PQ (LB)
180.12	PQ (KN)
56774	MAX LOAD (LB)
252.53	MAX LOAD (KN)
107.26	UC KQ (KSI*SQRT(IN))
117.77	UC KQ (MPA*SQRT(M))
150.38	UC MAX LOAD K (KSI*SQRT(IN))
165.11	UC MAX LOAD K (MPA*SQRT(M))
29348	REFERENCE MODULUS (KSI)
202.36	REFERENCE MODULUS (GPA)
759	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (IN*LB/IN^2)
132.9	UC MODIFIED ERNST MAX LOAD J-INTEGRAL (KJ/M^2)
149.25	UC MODIFIED ERNST MAX LOAD KJ (KSI*SQRT(IN))
164.01	UC MODIFIED ERNST MAX LOAD KJ (MPA*SQRT(M))
112.16	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (KSI*SQRT(IN))
123.26	UC MODIFIED ERNST BETA-ADJ MAX LOAD KJ (MPA*SQRT(M))
163.02	#UC MODIFIED ERNST FINAL KJ (KSI*SQRT(IN))
179.15	#UC MODIFIED ERNST FINAL KJ (MPA*SQRT(M))
117.45	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (KSI*SQRT(IN))
129.07	#UC MODIFIED ERNST BETA-ADJ FINAL KJ (MPA*SQRT(M))

ESTIMATED VALUE FOR FINAL UC CRACK EXTENSION

GET POWER LAW FIT TO DATA ### NO

UC MODIFIED ERNST JIC,CEIC,KJIC AND TAUG NOT DEFINED--POWER LAW FIT NOT REQUESTED BY TECHNICIAN

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .523
 Init crack length a = 53.09 mm
 Flow stress = 663.7 MPa
 Yield stress = 618.7 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 286.1 kJ/m ²	289.3 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 240.3 MPa√m	241.6 MPa√m
Kc (Beta Corrected)	= 146.3 MPa√m	146.7 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 278.84 kN
 5% Secant Offset Pq = 195.25 kN
 Kq = 125 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 178.6 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .007 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 2.296E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .523
 Init crack length a = 53.09 mm
 Flow stress = 663.7 MPa
 Yield stress = 618.7 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 112.8 kJ/m ²	114.8 kJ/m ²
Kjc=(EJc/((1-ν ²))) ^{.5}	= 150.9 MPa√m	152.2 MPa√m
Kc (Beta Corrected)	= 116.4 MPa√m	117 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 223.49 kN
 5% Secant Offset Pq = 195.25 kN
 Kq = 125 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 143.1 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .007 mm
 Fitted elastic load range = 20 kN TO 110 kN
 Elastic slope = 2.296E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .523
 Init crack length a = 53.09 mm
 Flow stress = 663.7 MPa
 Yield stress = 618.7 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS[Failure Type A (J at instability = J_c)]

	Merkle-Corten	Deformation-J*
J _c	= 281.6 kJ/m ²	281.1 kJ/m ²
K _{Jc} = (EJ _c / (1-ν ²)) ^{.5}	= 238.4 MPa√m	238.2 MPa√m
K _c (Beta Corrected)	= 145.8 MPa√m	145.8 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{1/2}
 Maximum Load P = 278.84 kN
 5% Secant Offset P_q = 198.79 kN
 K_q = 127.3 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 178.6 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .015 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 1.663E+02 kN/mm

THIS PAGE NOT USED

TEST SPECIMEN DATA

Material Type = A533-B Weld
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .524
 Init crack length a = 53.19 mm
 Flow stress = 663.7 MPa
 Yield stress = 618.7 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

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

J_{ic} = 286.5 kJ/m²
 $K_{Jc} = (E J_{ic} / (1 - \nu^2))^{.5} = 240.5 \text{ MPa}\sqrt{\text{m}}$
 $K_{ic} \text{ (Beta Corrected)} = 146.4 \text{ MPa}\sqrt{\text{m}}$

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; $B = (B B_n)^{1/2}$
 Maximum Load P = 278.84 kN
 5% Secant Offset P_q = 195.25 kN
 K_q = 125.4 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 179.1 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction for specimen rotation

Correction to J for crack extension

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .007 mm

Fitted elastic load range = 110 kN TO 20 kN

Front Face Clip Gage Control

0% Side Groove

73W-57

95°C (203°F)

9/30/87 RHM

73W-57

Load 1.0 $\frac{\text{wt}}{\text{inch}}$ Front Face Deflection 1.0 $\frac{\text{wt}}{\text{inch}}$

0.021396 %

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .53
 Init crack length a = 53.85 mm
 Flow stress = 663.7 MPa
 Yield stress = 618.7 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 240.3 kJ/m ²	272.4 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 220.2 MPa√m	234.5 MPa√m
Kc (Beta Corrected)	= 140.7 MPa√m	144.7 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 217.69 kN
 5% Secant Offset Pq = 192.08 kN
 Kq = 126 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 142.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .005 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 2.345E+02 kN/mm

TEST SPECIMEN DATA

Material Type	= A533-B Weld
Test Temperature	= 95 °C
Percent Side Groove	= 0 %
Specimen Thickness B	= 50.8 mm
Initial a/W	= .53
Init crack length a	= 53.85 mm
Flow stress	= 663.7 MPa
Yield stress	= 618.7 MPa
Young's modulus E	= 201800 MPa (Estimated Value)
Poisson's Ratio (ν)	= 0

J-INTEGRAL ANALYSIS

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

J_{ic} = 240.2 kJ/m²

K_{ic} = (EJ_{ic} / (1 - ν²))^{0.5} = 220.2 MPa√m

K_{ic} (Beta Corrected) = 140.7 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{1/2}

Maximum Load P = 217.69 kN

5% Secant Offset P_q = 192.08 kN

K_q = 126 MPa√m

Validity = INVALID--1, 2

K at Maximum Load = 142.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction for specimen rotation

Correction to J for crack extension

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .005 mm

Fitted elastic load range = 110 kN TO 20 kN

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .53
 Init crack length a = 53.85 mm
 Flow stress = 663.7 MPa
 Yield stress = 618.7 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 212.3 kJ/m ²	227.3 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 207 MPa√m	214.2 MPa√m
Kc (Beta Corrected)	= 136.7 MPa√m	138.9 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 217.69 kN
 5% Secant Offset Pq = 192.08 kN
 Kq = 126 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 142.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .005 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 2.345E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .53
 Init crack length a = 53.85 mm
 Flow stress = 663.7 MPa
 Yield stress = 618.7 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 172 kJ/m ²	179.3 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 186.3 MPa√m	190.2 MPa√m
Kc (Beta Corrected)	= 130 MPa√m	131.3 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 217.69 kN
 5% Secant Offset Pq = 192.08 kN
 Kq = 126 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 142.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .005 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 2.345E+02 kN/mm

NUREG/CR-5913

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .53
 Init crack length a = 53.85 mm
 Flow stress = 663.7 MPa
 Yield stress = 618.7 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 99.7 kJ/m ²	106.4 kJ/m ²
Kjc = (EJc / (1 - ν ²)) ^{0.5}	= 141.9 MPa√m	146.5 MPa√m
Kc (Beta Corrected)	= 112.4 MPa√m	114.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 206.21 kN
 5% Secant Offset Pq = 192.08 kN
 Kq = 126 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 135.3 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .005 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 2.345E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)

Test Temperature = 95 °C

Percent Side Groove = 0 %

Specimen Thickness B = 50.8 mm

Initial a/W = .53

Init crack length a = 53.85 mm

Flow stress = 663.7 MPa

Yield stress = 618.7 MPa

Youngs modulus E = 201800 MPa (Estimated Value)

Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 92.5 kJ/m ²	99.1 kJ/m ²
Kjc = (EJc / (1 - ν ²)) ^{0.5}	= 136.7 MPa√m	141.4 MPa√m
Kc (Beta Corrected)	= 110 MPa√m	112.3 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}

Maximum Load P = 205.64 kN

5% Secant Offset Pq = 192.08 kN

Kq = 126 MPa√m

Validity = INVALID--1, 2

K at Maximum Load = 134.9 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .005 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 2.345E+02 kN/mm

NUREG/CR-5913

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .53
 Init crack length a = 53.85 mm
 Flow stress = 663.7 MPa
 Yield stress = 618.7 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 236.5 kJ/m ²	263.9 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 218.5 MPa√m	230.8 MPa√m
Kc (Beta Corrected)	= 140.2 MPa√m	143.7 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 217.69 kN
 5% Secant Offset Pq = 202.1 kN
 Kq = 132.6 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 142.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .017 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 1.684E+02 kN/mm

NUREG/CR-5913

Front Face Clip Gage Control

0% Side Groove

73W-58

95°C (203°F)

9/30/87 gmm

73W-58

Load 1.0 $\frac{\text{volt}}{\text{inch}}$

Front Face Deflection 1.0 $\frac{\text{volt}}{\text{inch}}$

0.021396 $\frac{\text{inch}}{\text{volt}}$

F-270

TEST SPECIMEN DATA

Material Type	= A533-B Weld
Test Temperature	= 95 °C
Percent Side Groove	= 0 %
Specimen Thickness B	= 50.8 mm
Initial a/W	= .525
Init crack length a	= 53.33 mm
Flow stress	= 663.7 MPa
Yield stress	= 618.7 MPa
Youngs modulus E	= 201800 MPa (Estimated Value)
Poisson's Ratio (ν)	= 0

J-INTEGRAL ANALYSIS

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

J _{ic}	= 211 kJ/m ²
K _{jc} = (EJ _{ic} / (1 - ν ²)) ^{0.5}	= 206.4 MPa√m
K _{ic} (Beta Corrected)	= 136.5 MPa√m

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation; B	= (BB _n) ^{1/2}
Maximum Load P	= 279.19 kN
5% Secant Offset P _q	= 176.93 kN
K _q	= 114.2 MPa√m
Validity	= INVALID--1, 2, 3
K at Maximum Load	= 180.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction for specimen rotation

Correction to J for crack extension

OFFSET LOAD = 0 kN OFFSET DEFLECTION = 0 mm

Fitted elastic load range = 110 kN TO 20 kN

TEST SPECIMEN DATA

Material Type = A533-B Weld
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .53
 Init crack length a = 53.8 mm
 Flow stress = 663.7 MPa
 Yield stress = 618.7 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

Failure Type A (J at instability = J_{ic})
 J_{ic} = 103 kJ/m²
 $K_{Jc} = (EJ_{ic} / (1 - \nu^2))^{.5} = 144.2 \text{ MPa}\sqrt{\text{m}}$
 K_{ic} (Beta Corrected) = 113.5 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{1/2}
 Maximum Load P = 209.06 kN
 5% Secant Offset P_q = 169.54 kN
 K_q = 111.1 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 137 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction for specimen rotation
 Correction to J for crack extension
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .007 mm
 Fitted elastic load range = 110 kN TO 20 kN

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .53
 Init crack length a = 53.8 mm
 Flow stress = 663.7 MPa
 Yield stress = 618.7 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 103 kJ/m ²	106.9 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 144.2 MPa√m	146.9 MPa√m
Kc (Beta Corrected)	= 113.5 MPa√m	114.7 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 209.06 kN
 5% Secant Offset Pq = 169.54 kN
 Kq = 111.1 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 137 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .007 mm
 Fitted elastic load range = 20 kN TO 110 kN
 Elastic slope = 2.274E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .53
 Init crack length a = 53.8 mm
 Flow stress = 663.7 MPa
 Yield stress = 618.7 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 52.2 kJ/m ²	54.4 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 102.6 MPa√m	104.8 MPa√m
Kc (Beta Corrected)	= 91.5 MPa√m	92.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 157.51 kN
 5% Secant Offset Pq = 157.51 kN
 Kq = 103.2 MPa√m
 Validity = INVALID--1, 2
 K at Maximum Load = 103.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .007 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 2.274E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 95 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .53
 Init crack length a = 53.8 mm
 Flow stress = 663.7 MPa
 Yield stress = 618.7 MPa
 Youngs modulus E = 201800 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 104.5 kJ/m ²	106.3 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 145.2 MPa√m	146.4 MPa√m
Kc (Beta Corrected)	= 114 MPa√m	114.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 209.06 kN
 5% Secant Offset Pq = 173.14 kN
 Kq = 113.4 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 137 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .012 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 1.643E+02 kN/mm

NUREG/CR-5913

Front Face Clip Gage Control

0% Side Groove

73W-77

95°C (203°F)

9/29/87 PNM

10,000 $\frac{\text{psi}}{\text{in}^2}$

Load 1.0 $\frac{\text{psi}}{\text{in}^2}$

Front Face Deflection: 1.0 $\frac{\text{in}}{\text{in}}$

73W-77

0.021396 $\frac{\text{in}}{\text{in}}$

TEST SPECIMEN DATA

Material Type	= A533-B Weld	
Test Temperature	= 105 °C	
Percent Side Groove	= 0 %	
Specimen Thickness	= 50.8 mm	
Initial Crack Length	= 53.48 mm	Init a/W = .526
Final Crack Length	= 59.41 mm	Final a/W = .584
Flow Stress	= 659.8 MPa	
Youngs Modulus	= 201200 MPa	(Estimated Value)

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

J _{ic}	= 239.2 kJ/m ²
K _{jc}	= 219.4 MPa $\sqrt{m}$
J (@J/T=8.8)	= 402.8 kJ/m ²
Exponent N	= .3563
Coefficient C	= 353.6 kJ/m ²
T (average)	= 58

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

J _{ic}	= 241.2 kJ/m ²
K _{jc}	= 220.3 MPa $\sqrt{m}$
Slope M	= 130230.1 kJ/m ³
Intercept B	= 217.4 kJ/m ²
T (ASTM)	= 60
Validity (J _{ic})	= INVALID--c (1.83 vs .88)
Validity (R-curve)	= INVALID--3 (1.83 vs .72)
J maximum allowed	= 1586.4 kJ/m ² (J _{max} =B _{net} *Flow stress/20)
Delta a max. allowed	= 4.81 mm (Delta a max = 0.1*bo)
Final Delta a	= 4.1 mm
Poisson's Ratio (ν)	= 0
Points Left	= 0
Points Right	= 0

TEST SPECIMEN DATA

Material Type	= A533-B Weld	
Test Temperature	= 105 °C	
Percent Side Groove	= 0 %	
Specimen Thickness	= 50.8 mm	
Initial Crack Length	= 53.48 mm	Init a/W = .526
Final Crack Length	= 59.41 mm	Final a/W = .584
Flow Stress	= 659.8 MPa	
Youngs Modulus	= 201200 MPa	(Estimated Value)

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

J (@J/T=8.8)	= 402.8 kJ/m²
J _{ic}	= 239.2 kJ/m²
K _{jc}	= 219.4 MPa $\sqrt{m}$
Exponent N	= .3563
Coefficient C	= 353.6 kJ/m²
T (average)	= 58

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

J _{ic}	= 241.2 kJ/m²
K _{jc}	= 220.3 MPa $\sqrt{m}$
Slope M	= 130230.1 kJ/m³
Intercept B	= 217.4 kJ/m²
T (ASTM)	= 60
Validity (J _{ic})	= INVALID--c (1.83 vs .88)
Validity (R-curve)	= INVALID--3 (1.83 vs .72)
J maximum allowed	= 1586.4 kJ/m² (J _{max} =B _{net} *Flow stress/20)
Delta a max. allowed	= 4.81 mm (Delta a max = 0.1*bo)
Final Delta a	= 4.1 mm
Poisson's Ratio (ν)	= 0
Points Left	= 0
Points Right	= 0

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 105 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .526
 Init crack length a = 53.48 mm
 Flow stress = 659.8 MPa
 Yield stress = 615.2 MPa
 Youngs modulus E = 201200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 640.1 kJ/m ²	723.6 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 358.9 MPa√m	381.6 MPa√m
Kc (Beta Corrected)	= 172.3 MPa√m	176.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 307.85 kN
 5% Secant Offset Pq = 187.86 kN
 Kq = 121.8 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 199.6 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .003 mm
 Fitted elastic load range = 20 kN TO 110 kN
 Elastic slope = 2.380E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 105 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .526
 Init crack length a = 53.48 mm
 Flow stress = 659.8 MPa
 Yield stress = 615.2 MPa
 Youngs modulus E = 201200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 623.6 kJ/m ²	694.8 kJ/m ²
K _{Jc} =(EJc/(1-ν ²)) ^{.5}	= 354.2 MPa√m	373.9 MPa√m
Kc (Beta Corrected)	= 171.4 MPa√m	175.1 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{IC} Equation; B = (BB_n)^{1/2}
 Maximum Load P = 307.85 kN
 5% Secant Offset P_Q = 197.07 kN
 K_Q = 127.8 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 199.6 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .013 mm

Fitted elastic load range = 20 kN TO 110 kN

Elastic slope = 1.724E+02 kN/mm

Front Face Clip Gage Control

0% Side Groove

73W-51

105°C (221°F)

10/4/87

BHM

73W-51

Load
1.0
0.1
0.007
volt
inch

Front Face Deflection 1.0 $\frac{\text{volt}}{\text{inch}}$

0.021396 $\frac{\text{inch}}{\text{volt}}$

TEST SPECIMEN DATA

Material Type = A533-B Weld
 Test Temperature = 105 °C
 Percent Side Groove = 0 %
 Specimen Thickness = 50.8 mm
 Initial Crack Length = 53.1 mm
 Final Crack Length = 53.96 mm
 Flow Stress = 659.8 MPa
 Youngs Modulus = 201200 MPa

Init a/W = .522
 Final a/W = .531
 (Estimated Value)

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

Jic = 244.3 kJ/m²
 Kjc = 221.7 MPa √m
 Exponent N = .3145
 Coefficient C = 343.7 kJ/m²

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

Jic = 215.1 kJ/m²
 Kjc = 208 MPa √m
 Slope M = 168922.6 kJ/m³
 Intercept B = 187.5 kJ/m²

Validity (Jic) = INVALID--b

Validity (R-curve) = INVALID--1,2

J maximum allowed = 1598.9 kJ/m²

Delta a max. allowed = 4.85 mm

Final Delta a = .81 mm

Poisson's Ratio (ν) = 0

Points Left = 1

(Jmax=Bnet*Flow stress/20)

(Delta a max = 0.1*bo)

Points Right = 0

TEST SPECIMEN DATA

Material Type = A533-B Weld
 Test Temperature = 105 °C
 Percent Side Groove = 0 %
 Specimen Thickness = 50.8 mm
 Initial Crack Length = 53.1 mm
 Final Crack Length = 53.96 mm
 Flow Stress = 659.8 MPa
 Young's Modulus = 201200 MPa

Init a/W = .522
 Final a/W = .531
 (Estimated Value)

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

J_{ic} = 244.3 kJ/m²
 K_{jc} = 221.7 MPa √m
 Exponent N = .3145
 Coefficient C = 343.7 kJ/m²

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

J_{ic} = 215.1 kJ/m²
 K_{jc} = 208 MPa √m
 Slope M = 168922.6 kJ/m³
 Intercept B = 137.5 kJ/m²
 Validity (J_{ic}) = 1 PLID--b
 Validity (R-curve) = 1 PLID--1,2
 J maximum allowed = 1598.9 kJ/m² (J_{max} = B_{net} * Flow stress / 20)
 Delta a max. allowed = 4.85 mm (Delta a max = 0.1 * b_o)
 Final Delta a = .81 mm
 Poisson's Ratio (ν) = 0
 Points Left = 1
 Points Right = 0

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 105 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .523
 Init crack length a = 53.1 mm
 Flow stress = 659.8 MPa
 Yield stress = 615.2 MPa
 Youngs modulus E = 201200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 356.9 kJ/m ²	370.3 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 268 MPa√m	273 MPa√m
Kc (Beta Corrected)	= 152.9 MPa√m	154.1 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 310.54 kN
 5% Secant Offset Pq = 192.28 kN
 Kq = 123.2 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 198.9 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .005 mm
 Fitted elastic load range = 20 kN TO 110 kN
 Elastic slope = 2.403E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 105 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .523
 Init crack length a = 53.1 mm
 Flow stress = 659.8 MPa
 Yield stress = 615.2 MPa
 Youngs modulus E = 201200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 355.4 kJ/m ²	363.3 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 267.4 MPa√m	270.4 MPa√m
Kc (Beta Corrected)	= 152.8 MPa√m	153.5 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 310.54 kN
 5% Secant Offset Pq = 196.01 kN
 Kq = 125.6 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 198.9 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .015 mm
 Fitted elastic load range = 20 kN TO 110 kN
 Elastic slope = 1.725E+02 kN/mm

Front Face Clip Gage Control

0% Side Gage

73W-53

105°C (221°F)

10/2/87

10,000 lb

Load 0.1 lb/inch

73W-53

NUREG/CR-5913

2

Front Face Deflection 1.0 volt/inch

0.021396 V

F-287

TEST SPECIMEN DATA

Material Type = A533-B Weld

Test Temperature = 105 °C

Percent Side Groove = 0 %

Specimen Thickness = 50.8 mm

Initial Crack Length = 53.57 mm

Init a/W = .527

Final Crack Length = 54.43 mm

Final a/W = .535

Flow Stress = 659.9 MPa

Youngs Modulus = 201200 MPa

(Estimated Value)

POWER LAW DATA $J = C (\Delta a)^N$ Jic = 209.7 kJ/m²Kjc = 205.4 MPa $\sqrt{m}$

Exponent N = .4185

Coefficient C = 341.7 kJ/m²LEAST SQUARE LINEAR LINE (ASTM) $J = M (\Delta a) + B$ Jic = 181.2 kJ/m²Kjc = 190.9 MPa $\sqrt{m}$ Slope M = 199405 kJ/m³Intercept B = 153.8 kJ/m²

Validity (Jic) = INVALID--b

Validity (R-curve) = INVALID--1,2

J maximum allowed = 1583.6 kJ/m²

(Jmax=Bnet*Flow stress/20)

Delta a max. allowed = 4.8 mm

(Delta a max = 0.1*bo)

Final Delta a = .8 mm

Poisson's Ratio (v) = 0

Points Left = 0

Points Right = 0

TEST SPECIMEN DATA

Material Type	= A533-B Weld	
Test Temperature	= 105 °C	
Percent Side Groove	= 0 %	
Specimen Thickness	= 50.8 mm	
Initial Crack Length	= 53.57 mm	Init a/W = .527
Final Crack Length	= 54.43 mm	Final a/W = .535
Flow Stress	= 659.9 MPa	
Young's Modulus	= 201200 MPa	(Estimated Value)

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

Jic	= 209.7 kJ/m ²
Kjc	= 205.4 MPa $\sqrt{m}$
Exponent N	= .4185
Coefficient C	= 7.7 kJ/m ²

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

Jic	= 181.2 kJ/m ²
Kjc	= 190.9 MPa $\sqrt{m}$
Slope M	= 199405 kJ/m ³
Intercept B	= 153.8 kJ/m ²
Validity (Jic)	= INVALID--b
Validity (R-curve)	= INVALID--1,2
J maximum allowed	= 1583.6 kJ/m ² (Jmax=Bnet*Flow stress/20)
Delta a max. allowed	= 4.8 mm (Delta a max = 0.1*bo)
Final Delta a	= .8 mm
Poisson's Ratio (v)	= 0
Points Left	= 0
Points Right	= 0

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 105 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .527
 Init crack length a = 53.57 mm
 Flow stress = 659.8 MPa
 Yield stress = 615.2 MPa
 Youngs modulus E = 201200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 349.1 kJ/m ²	360.8 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 265 MPa√m	269.5 MPa√m
Kc (Beta Corrected)	= 152.2 MPa√m	153.3 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 302.81 kN
 5% Secant Offset Pq = 186.95 kN
 Kq = 121.6 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 196.9 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .005 mm
 Fitted elastic load range = 20 kN TO 110 kN
 Elastic slope = 2.341E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 105 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .527
 Init crack length a = 53.57 mm
 Flow stress = 659.8 MPa
 Yield stress = 615.2 MPa
 Youngs modulus E = 201200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 348.2 kJ/m ²	355.1 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 264.7 MPa√m	267.3 MPa√m
Kc (Beta Corrected)	= 152.1 MPa√m	152.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 302.81 kN
 5% Secant Offset Pq = 192.48 kN
 Kq = 125.2 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 196.9 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .018 mm
 Fitted elastic load range = 20 kN TO 110 kN
 Elastic slope = 1.686E+02 kN/mm

Front Face Clip Gage Control

0.7% Side Groove

73W-55

105°C (221°F)

10/4/77

BHM

73W-55

Load 1.0 $\frac{\text{volt}}{\text{inch}}$ Load 1.0 $\frac{\text{volt}}{\text{inch}}$ Front Face Deflection 1.0 $\frac{\text{volt}}{\text{inch}}$ 0.021396 $\frac{\text{in}}{\text{V}}$

TEST SPECIMEN DATA

Material Type = A533-B Weld
 Test Temperature = 105 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 50.8 mm
 Initial a/W = .523
 Init crack length a = 53.12 mm
 Flow stress = 659.8 MPa
 Yield stress = 615.2 MPa
 Youngs modulus E = 201200 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

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

J_{ic} = 138.1 kJ/m²
 $K_{jc} = (E J_{ic} / (1 - \nu^2))^{.5} = 166.7 \text{ MPa}\sqrt{\text{m}}$
 K_{ic} (Beta Corrected) = 122.5 MPa√m

ASTM E399-81 ANALYSIS

Modified K_{ic} Equation; B = (BB_n)^{1/2}
 Maximum Load P = 241.34 kN
 5% Secant Offset P_q = 188.79 kN
 K_q = 121 MPa√m
 Validity = INVALID--1, 2, 3
 K at Maximum Load = 154.7 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction for specimen rotation
 Correction to J for crack extension
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = .006 mm
 Fitted elastic load range = 110 kN TO 20 kN

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .506
 Init crack length a = 102.72 mm
 Flow stress = 683.1 MPa
 Yield stress = 636.6 MPa
 Young's modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 64.9 kJ/m ²	74.7 kJ/m ²
Kjc = (EJc / (1 - ν ²)) ^{.5}	= 115.2 MPa√m	123.5 MPa√m
Kc (Beta Corrected)	= 109 MPa√m	115.4 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 530.58 kN
 5% Secant Offset Pq = 383.19 kN
 Kq = 82.2 MPa√m
 Validity = INVALID--3
 K at Maximum Load = 113.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.001 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 5.816E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .506
 Init crack length a = 102.72 mm
 Flow stress = 683.1 MPa
 Yield stress = 636.6 MPa
 Young's modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 28.3 kJ/m ²	33.4 kJ/m ²
Kjc = (EJc / (1 - ν ²)) ^{0.5}	= 76 MPa√m	82.6 MPa√m
Kc (Beta Corrected)	= 75.1 MPa√m	81.2 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 383.19 kN
 5% Secant Offset Pq = 383.19 kN
 Kq = 82.2 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 82.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.001 mm
 Fitted elastic load range = 50 kN TO 200 kN
 Elastic slope = 5.816E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .506
 Init crack length a = 102.72 mm
 Flow stress = 683.1 MPa
 Yield stress = 636.6 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = .3

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 69.1 kJ/m ²	70.5 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 124.6 MPa√m	125.8 MPa√m
Kc (Beta Corrected)	= 116.2 MPa√m	117.1 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 530.58 kN
 5% Secant Offset Pq = 383.19 kN
 Kq = 82.2 MPa√m
 Validity = INVALID--3
 K at Maximum Load = 113.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .001 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 4.099E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .506
 Init crack length a = 102.72 mm
 Flow stress = 683.1 MPa
 Yield stress = 636.6 MPa
 Young's modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 68.3 kJ/m ²	76.2 kJ/m ²
Kjc = (EJc / (1 - ν ²)) ^{0.5}	= 118.2 MPa√m	124.8 MPa√m
Kc (Beta Corrected)	= 111.3 MPa√m	116.3 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 530.58 kN
 5% Secant Offset Pq = 383.19 kN
 Kq = 82.2 MPa√m
 Validity = INVALID--3
 K at Maximum Load = 113.8 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .003 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 4.156E+02 kN/mm

NUREG/CR-5913

NUREG/CR-5913

F-299

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .505
 Init crack length a = 102.51 mm
 Flow stress = 683.1 MPa
 Yield stress = 636.6 MPa
 Young's modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 70.4 kJ/m ²	79.1 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 120 MPa√m	127.2 MPa√m
Kc (Beta Corrected)	= 112.7 MPa√m	118.1 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 487.26 kN
 5% Secant Offset Pq = 481.96 kN
 Kq = 103.1 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 104.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.001 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 5.786E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .505
 Init crack length a = 102.51 mm
 Flow stress = 683.1 MPa
 Yield stress = 636.6 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 45.2 kJ/m ²	52.8 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 96.1 MPa√m	103.8 MPa√m
Kc (Beta Corrected)	= 93.2 MPa√m	99.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 481.96 kN
 5% Secant Offset Pq = 481.96 kN
 Kq = 103.1 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 103.1 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.001 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 5.786E+02 kN/mm

TEST SPECIMEN DATA

Material Type	= A533-B Weld (I)	
Test Temperature	= 50 °C	
Percent Side Groove	= 0 %	
Specimen Thickness B	= 101.6 mm	
Initial a/W	= .505	
Init crack length a	= 102.51 mm	
Flow stress	= 683.1 MPa	
Yield stress	= 636.6 MPa	
Young's modulus E	= 204400 MPa (Estimated Value)	
Poisson's Ratio (ν)	= 0	
J-INTEGRAL ANALYSIS	[Failure Type A (J at instability = Jc)]	
Jc	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
K _{Jc} = (EJ _c / (1-ν ²)) ^{1/2}	= 72.4 kJ/m ²	79.2 kJ/m ²
K _c (Beta Corrected)	= 121.6 MPa√m	127.2 MPa√m
	= 113.9 MPa√m	118.1 MPa√m

ASTM E399-81 ANALYSIS

Modified K _{ic} Equation;	B = (BB _n) ^{1/2}
Maximum Load P	= 487.26 kN
5% Secant Offset P _q	= 481.96 kN
K _q	= 103.1 MPa√m
Validity	= VALID K _{ic} value
K at Maximum Load	= 104.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = 0 mm
 Fitted elastic load range = 50 kN TO 200 kN
 Elastic slope = 4.106E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 50 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .505
 Init crack length a = 102.51 mm
 Flow stress = 683.1 MPa
 Yield stress = 636.6 MPa
 Youngs modulus E = 204400 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 71.7 kJ/m ²	79.1 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 121 MPa√m	127.1 MPa√m
Kc (Beta Corrected)	= 113.5 MPa√m	118 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 487.26 kN
 5% Secant Offset Pq = 481.96 kN
 Kq = 103.1 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 104.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .001 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 4.160E+02 kN/mm

NUREG/CR-5913

IRRAD

0% SIDE GROOVE

STROKE CONTROL

73 W - 18

+ 50°C (122°F)

5/20/87 BHM

28.392

VOLT
LOAD 1.0 INCH

F-304

FRONT FACE DEFLECTION (CG-100) 1.0 $\frac{\text{VOLT}}{\text{INCH}}$

0.018696 $\frac{\text{INCH}}{\text{VOLT}}$

73W-21

+65°C (149°F)

5/20/87 BHM

IRRAD.

0% SIDE GRAINE

STROKE CONTROL

73W-21

28392 $\frac{VOLT}{INCH}$

LOAD 1.0 $\frac{VOLT}{INCH}$

NUREG/CR-5913

0.018696 $\frac{INCH}{VOLT}$

F-305

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 65 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .498
 Init crack length a = 101.14 mm
 Flow stress = 676.2 MPa
 Yield stress = 630.2 MPa
 Young's modulus E = 203500 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 78.9 kJ/m ²	91.7 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 126.7 MPa√m	136.6 MPa√m
Kc (Beta Corrected)	= 117.4 MPa√m	124.4 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 607.45 kN
 5% Secant Offset Pq = 487.03 kN
 Kq = 102 MPa√m
 Validity = INVALID--3
 K at Maximum Load = 127.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.003 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 6.045E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 65 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .498
 Init crack length a = 101.14 mm
 Flow stress = 676.2 MPa
 Yield stress = 630.2 MPa
 Youngs modulus E = 203500 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 43.4 kJ/m ²	51.7 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 94 MPa√m	102.5 MPa√m
Kc (Beta Corrected)	= 91.3 MPa√m	98.6 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 487.03 kN
 5% Secant Offset Pq = 487.03 kN
 Kq = 102 MPa√m
 Validity = VALID Kic value
 K at Maximum Load = 102 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction
 Correction to J for crack extension (Deformation-J)
 OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.003 mm
 Fitted elastic load range = 50 kN TO 200 kN
 Elastic slope = 6.045E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 65 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .498
 Init crack length a = 101.14 mm
 Flow stress = 676.2 MPa
 Yield stress = 630.2 MPa
 Youngs modulus E = 203500 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS

[Failure Type A (J at instability = Jc)]

	Merkle-Corten	Deformation-J*
Jc	= 83.2 kJ/m ²	92.4 kJ/m ²
Kjc = (EJc / (1-ν ²)) ^{.5}	= 130.1 MPa√m	137.2 MPa√m
Kc (Beta Corrected)	= 119.9 MPa√m	124.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 607.45 kN
 5% Secant Offset Pq = 487.03 kN
 Kq = 102 MPa√m
 Validity = INVALID--3
 K at Maximum Load = 127.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATAMerkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = .001 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 4.247E+02 kN/mm

TEST SPECIMEN DATA

Material Type = A533-B Weld (I)
 Test Temperature = 65 °C
 Percent Side Groove = 0 %
 Specimen Thickness B = 101.6 mm
 Initial a/W = .498
 Init crack length a = 101.14 mm
 Flow stress = 676.2 MPa
 Yield stress = 630.2 MPa
 Youngs modulus E = 203500 MPa (Estimated Value)
 Poisson's Ratio (ν) = 0

J-INTEGRAL ANALYSIS [Failure Type A (J at instability = Jc)]

	<u>Merkle-Corten</u>	<u>Deformation-J*</u>
Jc	= 83 kJ/m ²	92.4 kJ/m ²
Kjc=(EJc/(1-ν ²)) ^{.5}	= 130 MPa√m	137.1 MPa√m
Kc (Beta Corrected)	= 119.8 MPa√m	124.8 MPa√m

ASTM E399-81 ANALYSIS

Modified Kic Equation; B = (BBn)^{1/2}
 Maximum Load P = 607.45 kN
 5% Secant Offset Pq = 487.03 kN
 Kq = 102 MPa√m
 Validity = INVALID--3
 K at Maximum Load = 127.2 MPa√m

DATA CORRECTIONS USED FOR J-INTEGRAL DATA

Merkle-Corten correction

Correction to J for crack extension (Deformation-J)

OFFSET LOAD = 0 kN OFFSET DEFLECTION = -.002 mm

Fitted elastic load range = 50 kN TO 200 kN

Elastic slope = 4.255E+02 kN/mm

NUREG/CR-5913

73 W-19

IRRAD.

0% SIDE GROOVE

STROKE CONTROL

+65°C (149°F)

5/21/82 BHM

LOAD 1.0 $\frac{\text{VOLT}}{\text{INCH}}$

F-310

FRONT FACE DEFLECTION (CG-100) 1.0 $\frac{\text{VOLT}}{\text{100 u}}$

0.01902 INCH
Vol 7

#

Irradiated 4T-CT

0% Side Groove

Stroke Control

73W-16

+75°C (167°F)

5/22/87 RRM

28322 lb/ft

Load 1.0 $\frac{\text{volt}}{\text{inch}}$

163

Front Face Deflection (CG-100) 1.0 $\frac{\text{volt}}{\text{inch}}$

0.01902 $\frac{\text{inch}}{\text{volt}}$

NUREG/CR-5913

F-311

Irradiated 4T-CT 0% Side Groove Stroke Control 73W-12

85°C (185°F)

5/22/87 PMH

NUREG/CR-5913

Load 0.1 pound

Front Face Deflection (CG-100) 1.0 $\frac{\text{volt}}{\text{inch}}$

0.01902 $\frac{\text{inch}}{\text{volt}}$

F-312

Irradiated 4T-CT

0% Side Groove

Stroke Control

73W-15

~~785°C (1455°F)~~ 95°C = 203°F

5/26/87 GNM

28392 $\frac{\text{volt}}{\text{inch}}$

Load 1.0 $\frac{\text{volt}}{\text{inch}}$ post

73W-15

Front Face Deflection (CG-100) 1.0 $\frac{\text{volt}}{\text{inch}}$

0.018982 $\frac{\text{inch}}{\text{volt}}$

NUREG/CR-5913

Irradiated 4T-CT

0% Side Groove

Stroke Control

73W-11

+95°C (203°F)

6/1/87 BHM

73W-11

11/24/88

11/24/88

F-314

Front Face Deflection (GG-100) 1.0 $\frac{in}{in}$

0.01898

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