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SUMMARY OF FRACTURE TOUGHNESS

316-0-1

Specimen Type: CT
Material: SS316
Drawing No.: Fig. 2
Temperature: RT
Relative Humidity: 51%

Requestor: Wall
Company: Electric Power Research Institute
P.O. No.: 4700007062
Job No.: 02039-011217
Machining Source: Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	Notch Depth (in)	0.400
Net Thickness (in)	0.4	Gage Length (in)	0.300
Width (in)	1	Alpha Ratio	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	Stress Ratio	0.1
Final a (in)	0.5255	Kmax (ksi sqrt (in))	8.2
Pf (lbf)	1203.7		

Initial measured crack lengths (in)

0.530	0.530	0.530	0.529	0.523	0.522	0.523	0.522	0.515

Final measured crack lengths (in)

0.560	0.560	0.560	0.559	0.555	0.553	0.552	0.553	0.544

Ave. initial crack length (in)	0.5255	aoq (in)	0.501
Ave. final crack length (in)	0.5557	Compliance Adj. Factor	0.748
Delta a measured (in)	0.0302	Effective Modulus (Msi)	19.8
Delta a predicted (in)	0.0677		

Results

JQ (E1820)	362.0 lbf-in/in^2
KJIC(E*JQ)^1/2	102.7 ksi sqrt(in)

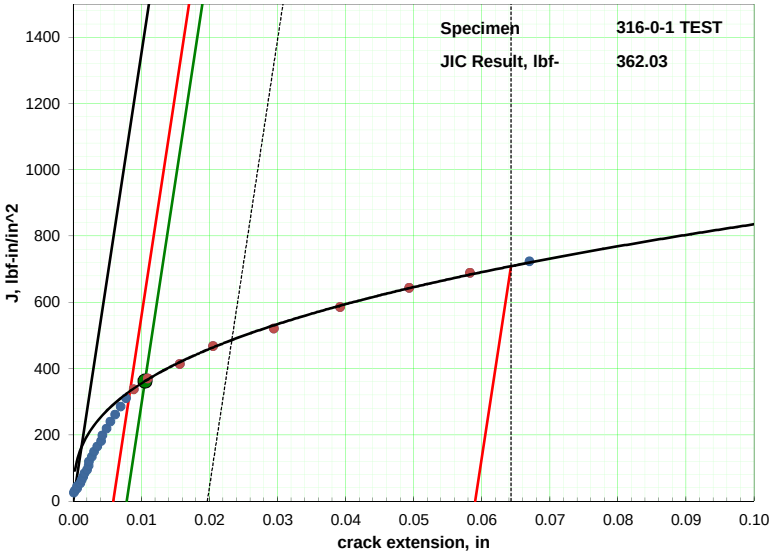
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	valid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	valid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	valid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	valid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

Approved for release by:

Digitally signed by Tim Esau
Date: 2020.09.23 12:59:50 -04'00'

Tim Esau, Quality Manager

element

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SUMMARY OF FRACTURE TOUGHNESS

316-0-2

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	51%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	**Stress Ratio**	0.1
Final a (in)	0.5431	**Kmax (ksi sqrt (in))**	8.7
Pf (lbf)	1108.3		

Initial measured crack lengths (in)

0.576	0.574	0.563	0.555	0.544	0.534	0.525	0.512	0.502

Final measured crack lengths (in)

0.600	0.631	0.658	0.677	0.683	0.683	0.674	0.615	0.567
x								x

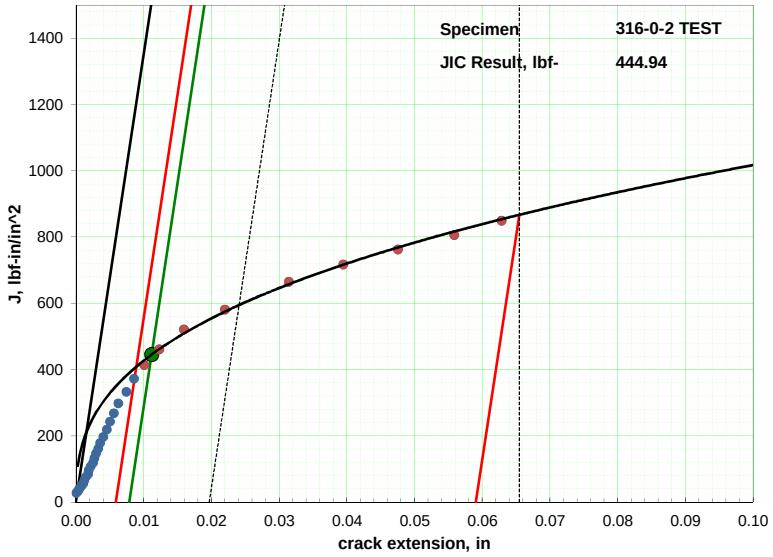
Ave. initial crack length (in)	0.5431	**aoq (in)**	0.501
Ave. final crack length (in)	0.6503	**Compliance Adj. Factor**	0.775
Delta a measured (in)	0.1072	**Effective Modulus (Msi)**	20.5
Delta a predicted (in)	0.0635		

Results

JQ (E1820)	444.9 lbf-in/in^2
KJIC(E*JQ)^1/2	113.8 ksi sqrt(in)

Qualification of Data		**Qualification of JQ as JIC**	
7.4.2: precrack length	valid		
9.1.4.1; precrack	valid	**A9.10.1; thickness**	valid
9.1.4.2; final crack	invalid	**A9.10.2; ligament**	valid
9.1.5.1; Da meas	valid	**A9.11; slope**	valid
9.1.5.2; Da pred	invalid		
A9.6.4; # of pnts in reg.A	valid		
A9.6.4; # of pnts in reg.B	valid		
A9.9.1; C2<1	valid		
A9.9.2.1; a0q-a0	invalid		
A9.9.2.2; # of pnts for JQ	valid		
A9.9.2.2; # of pnts < JQ	valid		
A9.9.2.2; correlation	valid		

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-0-3

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	48%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	410	**Stress Ratio**	0.1
Final a (in)	0.5405	**Kmax (ksi sqrt (in))**	9.0
Pf (lbf)	1122		

Initial measured crack lengths (in)

0.575	0.569	0.560	0.554	0.538	0.530	0.520	0.513	0.506

Final measured crack lengths (in)

0.646	0.657	0.662	0.667	0.670	0.670	0.673	0.668	0.665

Ave. initial crack length (in)	0.5405	**aoq (in)**	0.494
Ave. final crack length (in)	0.6653	**Compliance Adj. Factor**	0.695
Delta a measured (in)	0.1248	**Effective Modulus (Msi)**	18.4
Delta a predicted (in)	0.0786		

Results

JQ (E1820)	649.9 lbf-in/in^2
KJIC(E*JQ)^1/2	137.6 ksi sqrt(in)

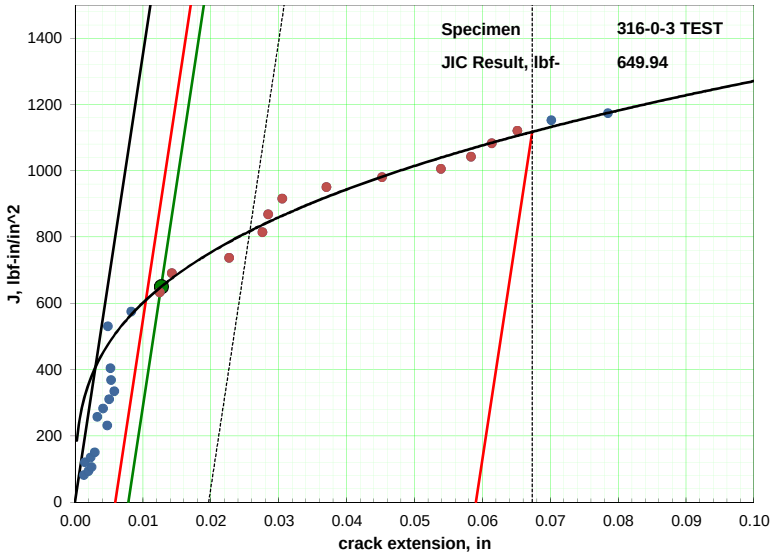
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	valid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	valid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	valid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	invalid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-0-4

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	44%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	355	**Stress Ratio**	0.1
Final a (in)	0.54	**Kmax (ksi sqrt (in))**	7.8
Pf (lbf)	1124.9		

Initial measured crack lengths (in)

0.542	0.539	0.539	0.534	0.535	0.535	0.539	0.548	0.558

Final measured crack lengths (in)

0.658	0.678	0.678	0.682	0.683	0.684	0.666	0.662	0.656

Ave. initial crack length (in)	0.54	**aoq (in)**	0.501
Ave. final crack length (in)	0.6737	**Compliance Adj. Factor**	0.735
Delta a measured (in)	0.1338	**Effective Modulus (Msi)**	19.5
Delta a predicted (in)	0.0684		

Results

JQ (E1820)	416.1 lbf-in/in^2
KJIC(E*JQ)^1/2	110.1 ksi sqrt(in)

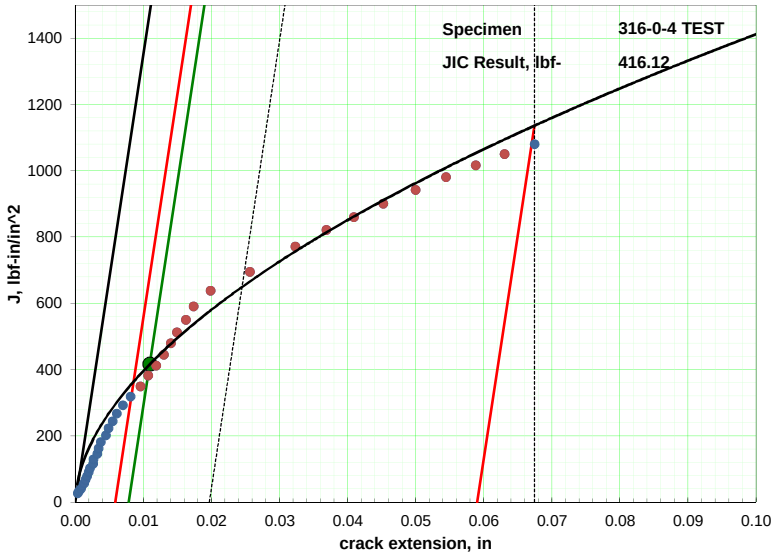
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	valid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	valid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	valid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	valid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-0-5

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	54%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	412	**Stress Ratio**	0.1
Final a (in)	0.533	**Kmax (ksi sqrt (in))**	8.8
Pf (lbf)	1162.2		

Initial measured crack lengths (in)

0.530	0.533	0.535	0.535	0.535	0.535	0.532	0.532	0.527

Final measured crack lengths (in)

0.661	0.674	0.700	0.727	0.721	0.709	0.700	0.685	0.661

Ave. initial crack length (in)	0.533	**aoq (in)**	0.484
Ave. final crack length (in)	0.6972	**Compliance Adj. Factor**	0.672
Delta a measured (in)	0.1641	**Effective Modulus (Msi)**	17.8
Delta a predicted (in)	0.0861		

Results

JQ (E1820)	290.8 lbf-in/in^2
KJIC(E*JQ)^1/2	92.0 ksi sqrt(in)

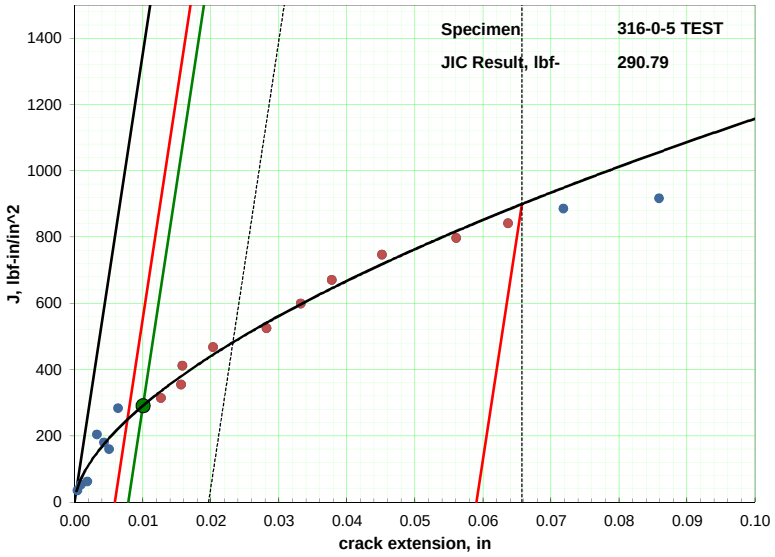
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	valid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	valid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	valid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	valid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



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Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-20-1

Specimen Type: CT
Material: SS316
Drawing No.: Fig. 2
Temperature: RT
Relative Humidity: 49%

Requestor: Wall
Company: Electric Power Research Institute
P.O. No.: 4700007062
Job No.: 02039-011217
Machining Source: Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	Notch Depth (in)	0.400
Net Thickness (in)	0.4	Gage Length (in)	0.300
Width (in)	1	Alpha Ratio	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	Stress Ratio	0.1
Final a (in)	0.5361	Kmax (ksi sqrt (in))	8.5
Pf (lbf)	1145.6		

Initial measured crack lengths (in)

0.556	0.553	0.541	0.530	0.528	0.528	0.528	0.534	0.537

Final measured crack lengths (in)

0.574	0.598	0.598	0.602	0.605	0.605	0.605	0.603	0.598

Ave. initial crack length (in)	0.5361	aoq (in)	0.501
Ave. final crack length (in)	0.6003	Compliance Adj. Factor	0.799
Delta a measured (in)	0.0642	Effective Modulus (Msi)	21.2
Delta a predicted (in)	0.1443		

Results

JQ (E1820)	187.0 lbf-in/in^2
KJIC(E*JQ)^1/2	73.8 ksi sqrt(in)

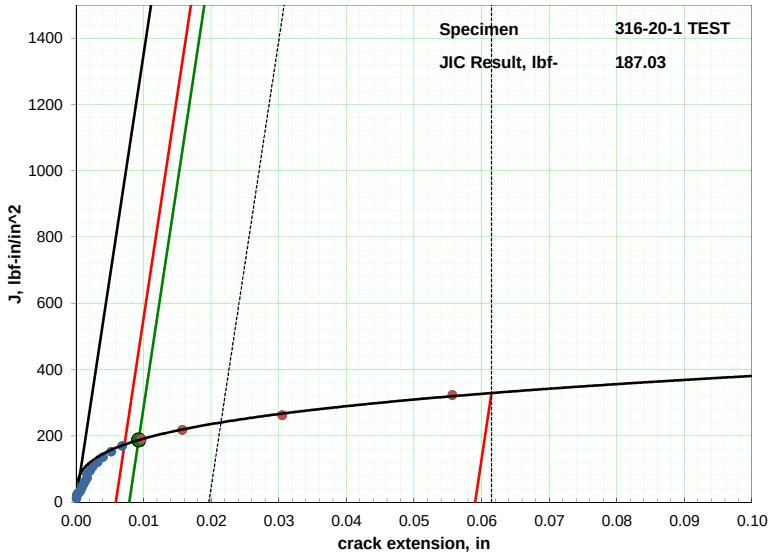
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	valid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	valid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	invalid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	valid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



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Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-20-2

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	49%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	**Stress Ratio**	0.1
Final a (in)	0.541	**Kmax (ksi sqrt (in))**	8.7
Pf (lbf)	1119.2		

Initial measured crack lengths (in)

0.547	0.538	0.538	0.538	0.538	0.540	0.544	0.548	0.545

Final measured crack lengths (in)

0.617	0.623	0.625	0.630	0.634	0.634	0.632	0.631	0.631

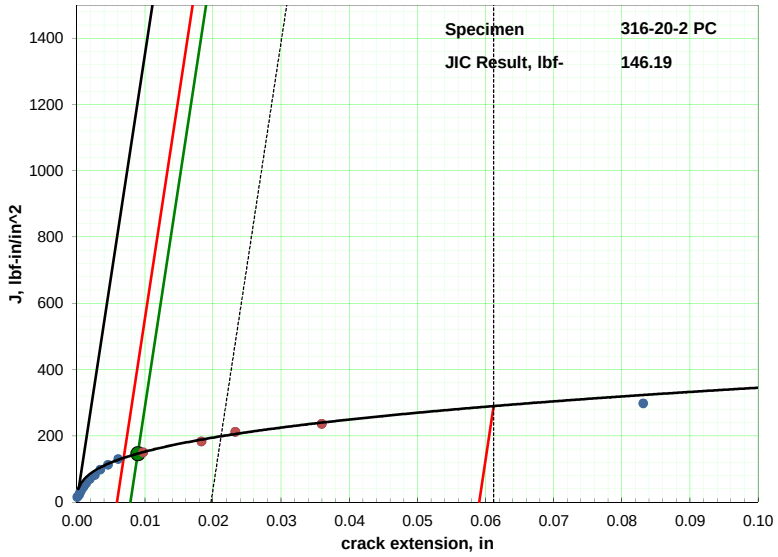
Ave. initial crack length (in)	0.541	**aoq (in)**	0.500
Ave. final crack length (in)	0.6291	**Compliance Adj. Factor**	0.887
Delta a measured (in)	0.0881	**Effective Modulus (Msi)**	23.5
Delta a predicted (in)	0.0834		

Results

JQ (E1820)	146.2 lbf-in/in^2
KJIC(E'*JQ)^1/2	65.2 ksi sqrt(in)

Qualification of Data		**Qualification of JQ as JIC**	
7.4.2: precrack length	valid		
9.1.4.1; precrack	valid	**A9.10.1; thickness**	valid
9.1.4.2; final crack	valid	**A9.10.2; ligament**	valid
9.1.5.1; Da meas	valid	**A9.11; slope**	valid
9.1.5.2; Da pred	valid		
A9.6.4; # of pnts in reg.A	valid		
A9.6.4; # of pnts in reg.B	valid		
A9.9.1; C2<1	valid		
A9.9.2.1; a0q-a0	invalid		
A9.9.2.2; # of pnts for JQ	invalid		
A9.9.2.2; # of pnts < JQ	valid		
A9.9.2.2; correlation	valid		

ASTM E1820-20 Standard Test



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Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-20-3

Specimen Type: CT
Material: SS316
Drawing No.: Fig. 2
Temperature: RT
Relative Humidity: 56%

Requestor: Wall
Company: Electric Power Research Institute
P.O. No.: 4700007062
Job No.: 02039-011217
Machining Source: Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	Notch Depth (in)	0.400
Net Thickness (in)	0.4	Gage Length (in)	0.300
Width (in)	1	Alpha Ratio	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	Stress Ratio	0.1
Final a (in)	0.5384	Kmax (ksi sqrt (in))	8.6
Pf (lbf)	1133.3		

Initial measured crack lengths (in)

0.535	0.537	0.537	0.537	0.536	0.536	0.539	0.543	0.547

Final measured crack lengths (in)

0.757	0.761	0.768	0.774	0.778	0.780	0.776	0.773	0.768

Ave. initial crack length (in)	0.5384	aoq (in)	0.501
Ave. final crack length (in)	0.7717	Compliance Adj. Factor	0.773
Delta a measured (in)	0.2333	Effective Modulus (Msi)	20.5
Delta a predicted (in)	0.0787		

Results

JQ (E1820)	193.0 lbf-in/in^2
KJIC(E*JQ)^1/2	75.0 ksi sqrt(in)

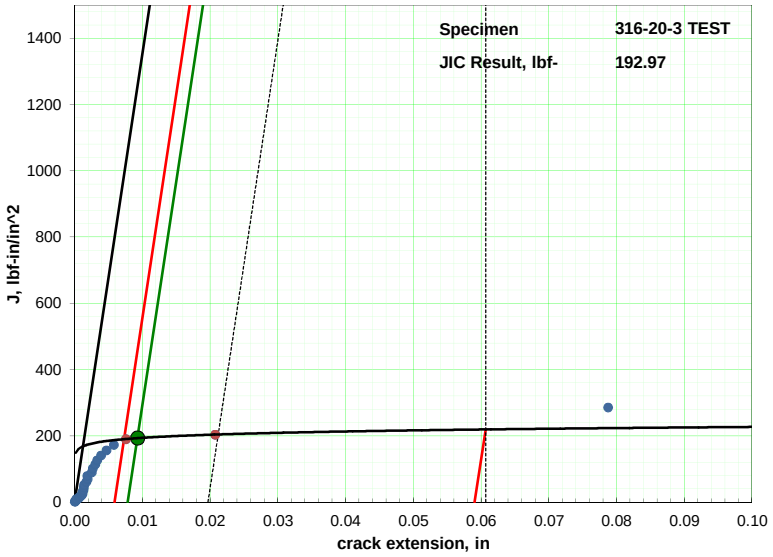
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	valid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	invalid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	invalid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	invalid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-20-4

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	57%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	**Stress Ratio**	0.1
Final a (in)	0.5349	**Kmax (ksi sqrt (in))**	8.5
Pf (lbf)	1152		

Initial measured crack lengths (in)

0.565	0.559	0.557	0.542	0.532	0.523	0.516	0.515	0.508

Final measured crack lengths (in)

0.662	0.678	0.682	0.690	0.707	0.714	0.708	0.694	0.681

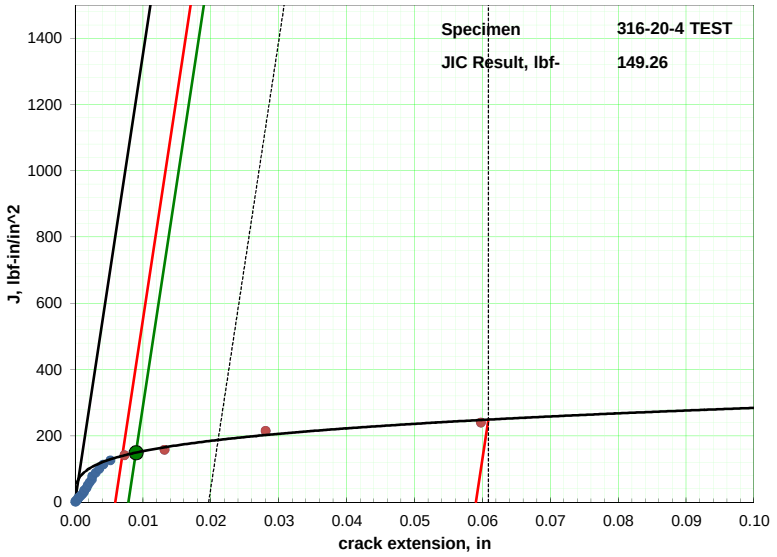
Ave. initial crack length (in)	0.5349	**aoq (in)**	0.500
Ave. final crack length (in)	0.6931	**Compliance Adj. Factor**	0.822
Delta a measured (in)	0.1582	**Effective Modulus (Msi)**	21.8
Delta a predicted (in)	0.0597		

Results

JQ (E1820)	149.3 lbf-in/in^2
KJIC(E*JQ)^1/2	65.9 ksi sqrt(in)

Qualification of Data		**Qualification of JQ as JIC**	
7.4.2: precrack length	valid		
9.1.4.1; precrack	valid	**A9.10.1; thickness**	valid
9.1.4.2; final crack	valid	**A9.10.2; ligament**	valid
9.1.5.1; Da meas	valid	**A9.11; slope**	valid
9.1.5.2; Da pred	invalid		
A9.6.4; # of pnts in reg.A	valid		
A9.6.4; # of pnts in reg.B	valid		
A9.9.1; C2<1	valid		
A9.9.2.1; a0q-a0	invalid		
A9.9.2.2; # of pnts for JQ	invalid		
A9.9.2.2; # of pnts < JQ	valid		
A9.9.2.2; correlation	valid		

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-20-5

Specimen Type: CT
Material: SS316
Drawing No.: Fig. 2
Temperature: RT
Relative Humidity: 57%

Requestor: Wall
Company: Electric Power Research Institute
P.O. No.: 4700007062
Job No.: 02039-011217
Machining Source: Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	Notch Depth (in)	0.400
Net Thickness (in)	0.4	Gage Length (in)	0.300
Width (in)	1	Alpha Ratio	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	Stress Ratio	0.1
Final a (in)	0.5165	Kmax (ksi sqrt (in))	8.0
Pf (lbf)	1253.9		

Initial measured crack lengths (in)

0.491	0.491	0.493	0.500	0.505	0.518	0.538	0.555	0.571 x

Final measured crack lengths (in)

0.773	0.789	0.816	0.823	0.818	0.816	0.810	0.806	0.801

Ave. initial crack length (in)	0.5165	aoq (in)	0.502
Ave. final crack length (in)	0.808	Compliance Adj. Factor	0.824
Delta a measured (in)	0.2915	Effective Modulus (Msi)	21.8
Delta a predicted (in)	0.0835		

Results

JQ (E1820)	167.8 lbf-in/in^2
KJIC(E*JQ)^1/2	69.9 ksi sqrt(in)

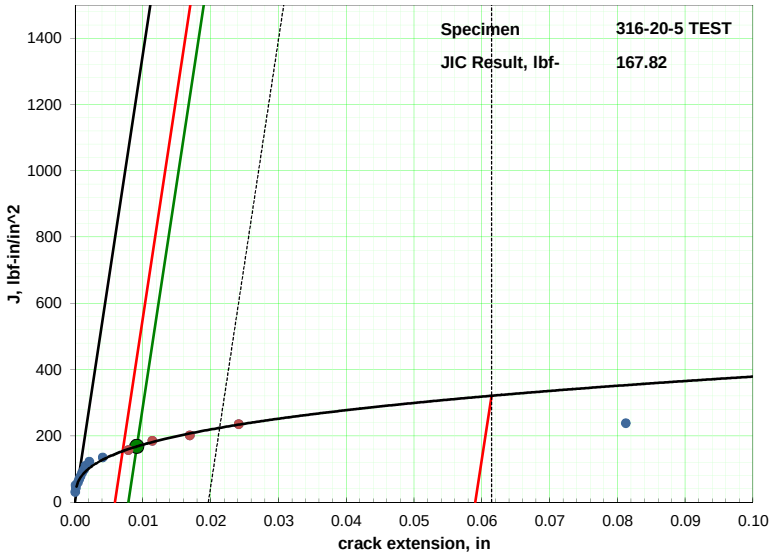
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	invalid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	valid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	invalid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	invalid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-40-1

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	54%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	**Stress Ratio**	0.1
Final a (in)	0.5344	**Kmax (ksi sqrt (in))**	8.5
Pf (lbf)	1154.7		

Initial measured crack lengths (in)

0.568	0.563	0.551	0.539	0.530	0.524	0.518	0.512	0.508

Final measured crack lengths (in)

0.781	0.794	0.800	0.803	0.803	0.808	0.813	0.817	0.822

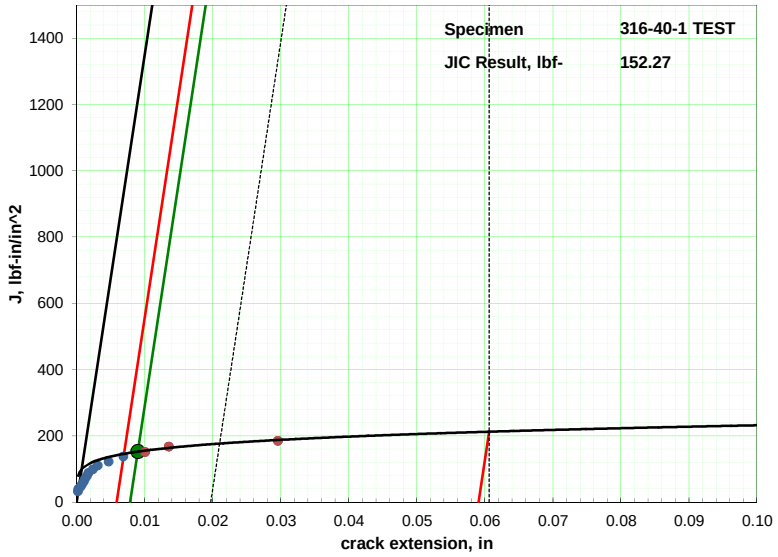
Ave. initial crack length (in)	0.5344	**aoq (in)**	0.501
Ave. final crack length (in)	0.8049	**Compliance Adj. Factor**	0.804
Delta a measured (in)	0.2705	**Effective Modulus (Msi)**	21.3
Delta a predicted (in)	0.1197		

Results

JQ (E1820)	152.3 lbf-in/in^2
KJIC(E*JQ)^1/2	66.6 ksi sqrt(in)

Qualification of Data		**Qualification of JQ as JIC**	
7.4.2: precrack length	valid		
9.1.4.1; precrack	valid	**A9.10.1; thickness**	valid
9.1.4.2; final crack	valid	**A9.10.2; ligament**	valid
9.1.5.1; Da meas	valid	**A9.11; slope**	valid
9.1.5.2; Da pred	invalid		
A9.6.4; # of pnts in reg.A	valid		
A9.6.4; # of pnts in reg.B	valid		
A9.9.1; C2<1	valid		
A9.9.2.1; a0q-a0	invalid		
A9.9.2.2; # of pnts for JQ	invalid		
A9.9.2.2; # of pnts < JQ	valid		
A9.9.2.2; correlation	valid		

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-40-2

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	47%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	**Stress Ratio**	0.1
Final a (in)	0.5409	**Kmax (ksi sqrt (in))**	8.7
Pf (lbf)	1119.7		

Initial measured crack lengths (in)

0.562	0.558	0.549	0.542	0.536	0.533	0.533	0.531	0.529

Final measured crack lengths (in)

0.868	0.880	0.882	0.882	0.887	0.884	0.880	0.880	0.870

Ave. initial crack length (in)	0.5409	**aoq (in)**	0.501
Ave. final crack length (in)	0.8804	**Compliance Adj. Factor**	0.818
Delta a measured (in)	0.3394	**Effective Modulus (Msi)**	21.7
Delta a predicted (in)	0.163		

Results

JQ (E1820)	145.6 lbf-in/in^2
KJIC(E*JQ)^1/2	65.1 ksi sqrt(in)

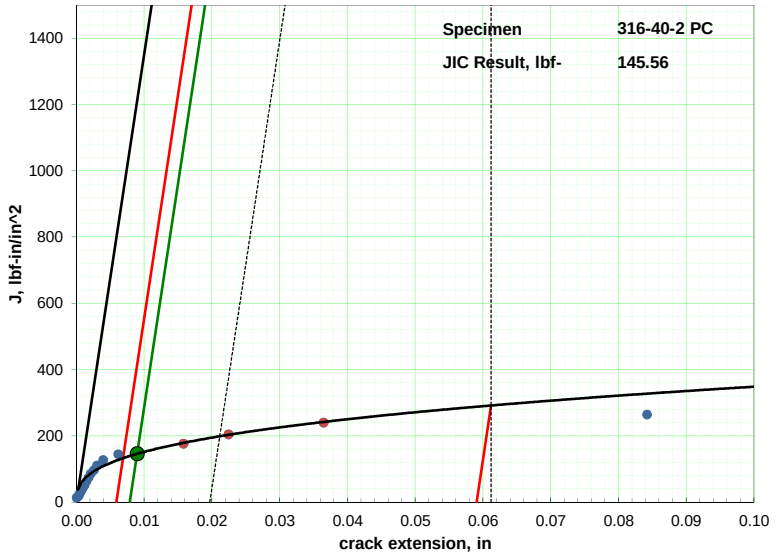
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	valid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	valid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	invalid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	valid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-40-3

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	53%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	**Stress Ratio**	0.1
Final a (in)	0.5353	**Kmax (ksi sqrt (in))**	8.5
Pf (lbf)	1149.7		

Initial measured crack lengths (in)

0.523	0.521	0.521	0.521	0.525	0.534	0.548	0.564	0.576

Final measured crack lengths (in)

0.817	0.830	0.837	0.843	0.847	0.852	0.857	0.861	0.868

Ave. initial crack length (in)	0.5353	**aoq (in)**	0.500
Ave. final crack length (in)	0.8463	**Compliance Adj. Factor**	0.807
Delta a measured (in)	0.3109	**Effective Modulus (Msi)**	21.4
Delta a predicted (in)	0.0861		

Results

JQ (E1820)	161.1 lbf-in/in^2
KJIC(E*JQ)^1/2	68.5 ksi sqrt(in)

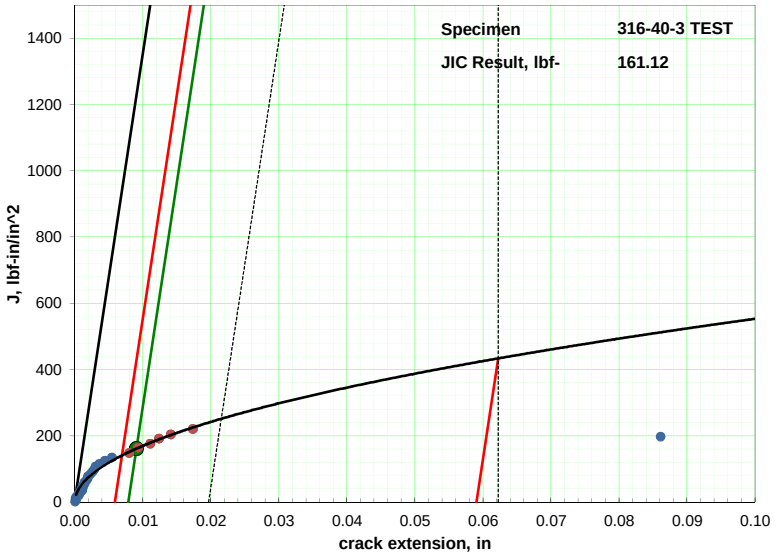
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	valid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	invalid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	invalid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	invalid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-40-4

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	52%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	**Stress Ratio**	0.1
Final a (in)	0.537	**Kmax (ksi sqrt (in))**	8.6
Pf (lbf)	1140.6		

Initial measured crack lengths (in)

0.563	0.559	0.553	0.540	0.531	0.524	0.524	0.521	0.527

Final measured crack lengths (in)

0.840	0.868	0.865	0.861	0.859	0.856	0.846	0.833	0.825

Ave. initial crack length (in)	0.537	**aoq (in)**	0.501
Ave. final crack length (in)	0.8526	**Compliance Adj. Factor**	0.737
Delta a measured (in)	0.3156	**Effective Modulus (Msi)**	19.5
Delta a predicted (in)	0.1745		

Results

JQ (E1820)	162.3 lbf-in/in^2
KJIC(E*JQ)^1/2	68.7 ksi sqrt(in)

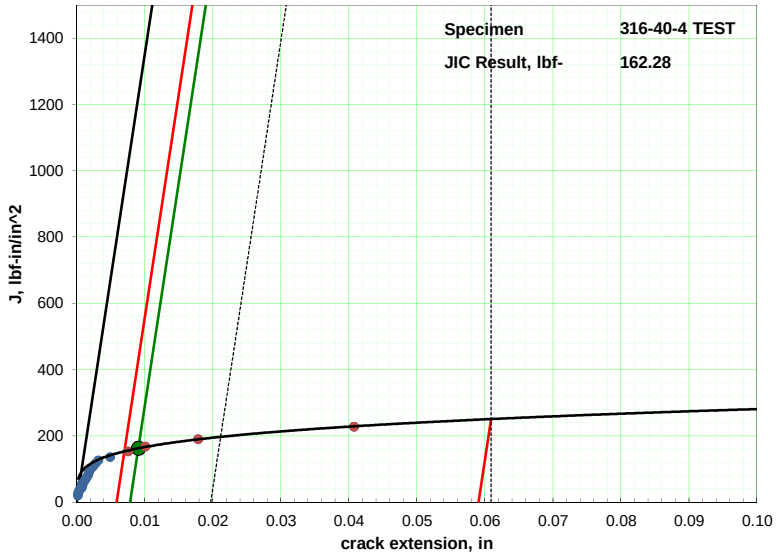
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	valid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	valid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	invalid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	valid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-40-5

Specimen Type: CT
Material: SS316
Drawing No.: Fig. 2
Temperature: RT
Relative Humidity: 51%

Requestor: Wall
Company: Electric Power Research Institute
P.O. No.: 4700007062
Job No.: 02039-011217
Machining Source: Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	Notch Depth (in)	0.400
Net Thickness (in)	0.4	Gage Length (in)	0.300
Width (in)	1	Alpha Ratio	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	Stress Ratio	0.1
Final a (in)	0.5392	Kmax (ksi sqrt (in))	8.6
Pf (lbf)	1128.9		

Initial measured crack lengths (in)

0.547	0.536	0.534	0.526	0.526	0.533	0.544	0.557	0.566

Final measured crack lengths (in)

0.711	0.711	0.711	0.723	0.732	0.740	0.747	0.746	0.738

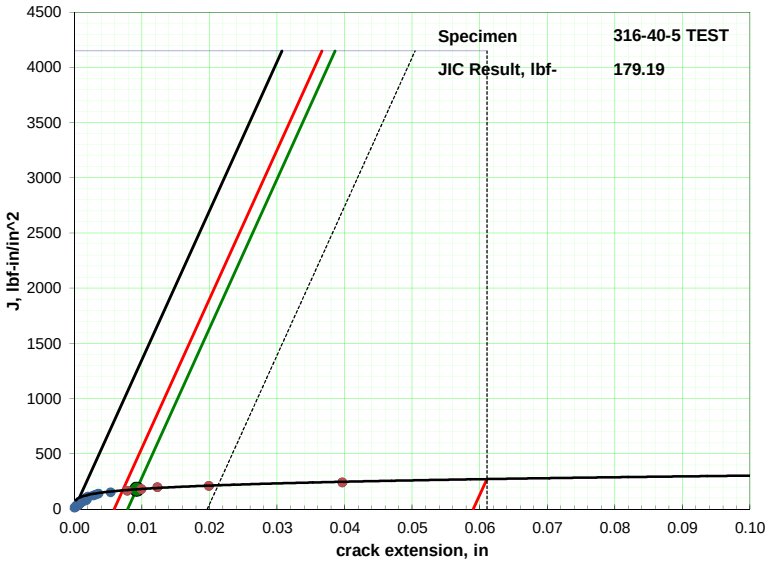
Ave. initial crack length (in)	0.5392	aoq (in)	0.501
Ave. final crack length (in)	0.7295	Compliance Adj. Factor	0.821
Delta a measured (in)	0.1903	Effective Modulus (Msi)	21.8
Delta a predicted (in)	0.1565		

Results

JQ (E1820)	179.2 lbf-in/in^2
KJIC(E*JQ)^1/2	72.2 ksi sqrt(in)

Qualification of Data		Qualification of JQ as JIC	
7.4.2: precrack length	valid		
9.1.4.1; precrack	valid	A9.10.1; thickness	valid
9.1.4.2; final crack	valid	A9.10.2; ligament	valid
9.1.5.1; Da meas	valid	A9.11; slope	valid
9.1.5.2; Da pred	invalid		
A9.6.4; # of pnts in reg.A	valid		
A9.6.4; # of pnts in reg.B	valid		
A9.9.1; C2<1	valid		
A9.9.2.1; a0q-a0	invalid		
A9.9.2.2; # of pnts for JQ	invalid		
A9.9.2.2; # of pnts < JQ	valid		
A9.9.2.2; correlation	valid		

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-60-1

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	49%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	**Stress Ratio**	0.1
Final a (in)	0.5357	**Kmax (ksi sqrt (in))**	8.5
Pf (lbf)	1147.9		

Initial measured crack lengths (in)

0.544	0.542	0.539	0.538	0.535	0.533	0.531	0.530	0.529

Final measured crack lengths (in)

0.834	0.821	0.821	0.818	0.819	0.819	0.815	0.813	0.820

Ave. initial crack length (in)	0.5357	**aoq (in)**	0.501
Ave. final crack length (in)	0.8192	**Compliance Adj. Factor**	0.878
Delta a measured (in)	0.2835	**Effective Modulus (Msi)**	23.3
Delta a predicted (in)	0.0306		

Results

JQ (E1820)	193.5 lbf-in/in^2
KJIC(E*JQ)^1/2	75.1 ksi sqrt(in)

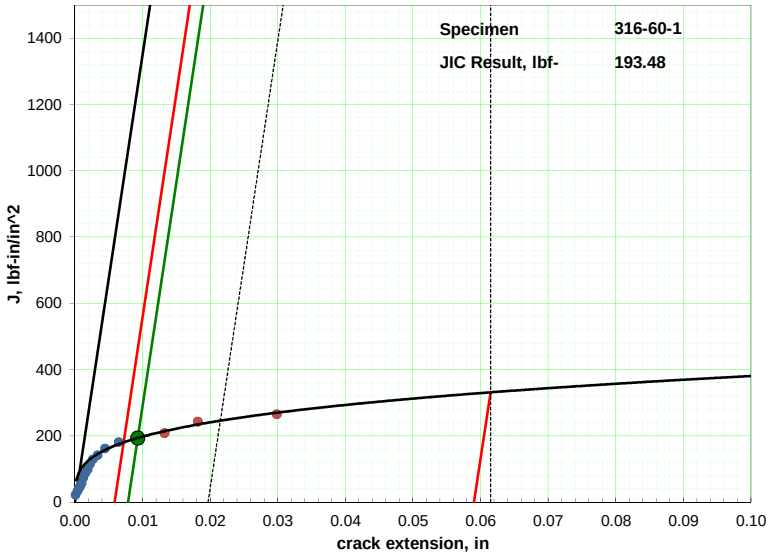
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	valid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	valid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	invalid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	valid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-60-2

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	49%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	**Stress Ratio**	0.1
Final a (in)	0.5391	**Kmax (ksi sqrt (in))**	8.6
Pf (lbf)	1129.7		

Initial measured crack lengths (in)

0.536	0.539	0.543	0.546	0.545	0.540	0.536	0.531	0.526

Final measured crack lengths (in)

0.921	0.917	0.914	0.909	0.908	0.910	0.910	0.910	0.903

Ave. initial crack length (in)	0.5391	**aoq (in)**	0.501
Ave. final crack length (in)	0.9113	**Compliance Adj. Factor**	0.778
Delta a measured (in)	0.3723	**Effective Modulus (Msi)**	20.6
Delta a predicted (in)	0.0238		

Results

JQ (E1820)	143.9 lbf-in/in^2
KJIC(E'*JQ)^1/2	64.7 ksi sqrt(in)

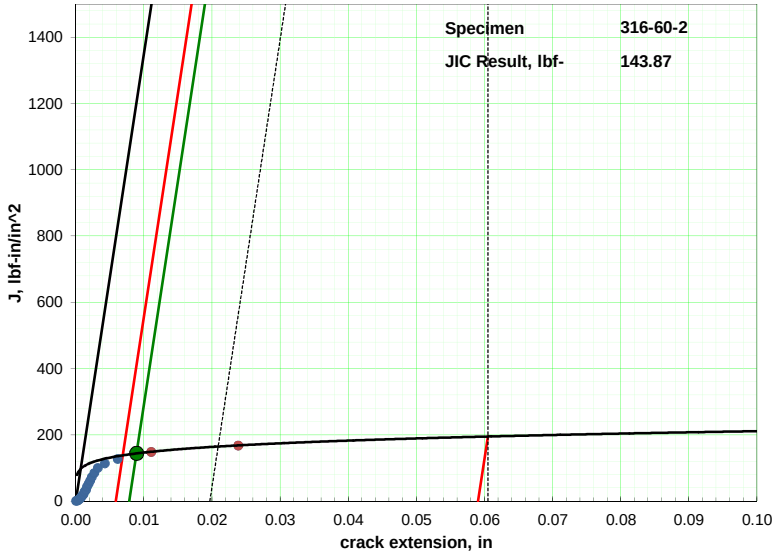
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	valid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	valid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	invalid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	valid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-60-3

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	49%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	**Stress Ratio**	0.1
Final a (in)	0.5385	**Kmax (ksi sqrt (in))**	8.6
Pf (lbf)	1132.7		

Initial measured crack lengths (in)

0.539	0.539	0.541	0.542	0.543	0.541	0.536	0.532	0.529

Final measured crack lengths (in)

0.878	0.884	0.891	0.896	0.900	0.900	0.900	0.900	0.902

Ave. initial crack length (in)	0.5385	**aoq (in)**	0.501
Ave. final crack length (in)	0.8951	**Compliance Adj. Factor**	0.830
Delta a measured (in)	0.3566	**Effective Modulus (Msi)**	22.0
Delta a predicted (in)	0.0359		

Results

JQ (E1820)	159.7 lbf-in/in^2
KJIC(E'*JQ)^1/2	68.2 ksi sqrt(in)

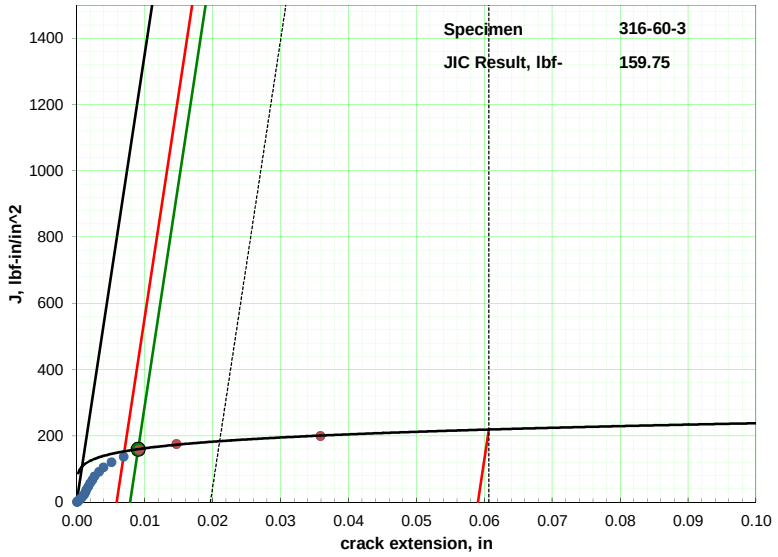
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	valid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	valid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	invalid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	valid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-60-4

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	49%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	**Stress Ratio**	0.1
Final a (in)	0.5391	**Kmax (ksi sqrt (in))**	8.6
Pf (lbf)	1129.7		

Initial measured crack lengths (in)

0.543	0.543	0.541	0.539	0.539	0.536	0.536	0.536	0.539

Final measured crack lengths (in)

0.727	0.721	0.718	0.716	0.714	0.711	0.707	0.706	0.709

Ave. initial crack length (in)	0.5391	**aoq (in)**	0.501
Ave. final crack length (in)	0.7141	**Compliance Adj. Factor**	0.770
Delta a measured (in)	0.175	**Effective Modulus (Msi)**	20.4
Delta a predicted (in)	0.0299		

Results

JQ (E1820)	194.0 lbf-in/in^2
KJIC(E*JQ)^1/2	75.2 ksi sqrt(in)

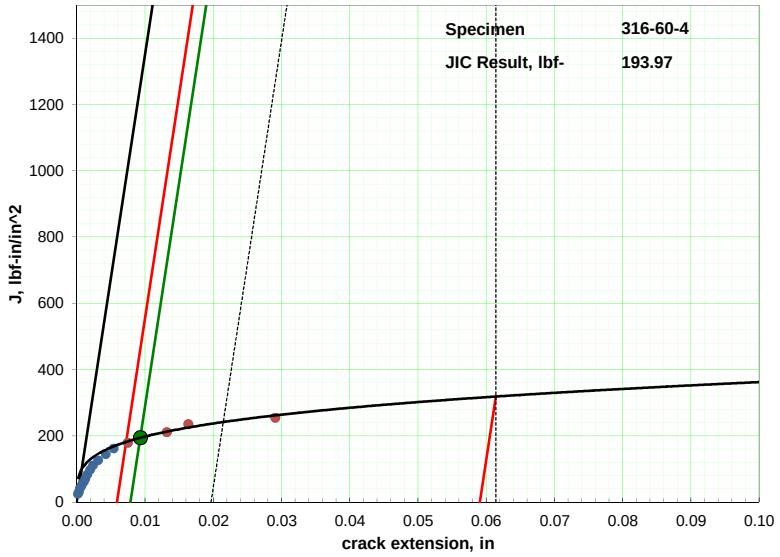
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	valid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	valid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	invalid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	valid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-60-5

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	49%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	394	**Stress Ratio**	0.1
Final a (in)	0.5444	**Kmax (ksi sqrt (in))**	8.8
Pf (lbf)	1101.6		

Initial measured crack lengths (in)

0.506	0.518	0.532	0.548	0.556	0.561	0.557	0.551	0.556

Final measured crack lengths (in)

0.932	0.918	0.910	0.905	0.905	0.912	0.920	0.932	0.938

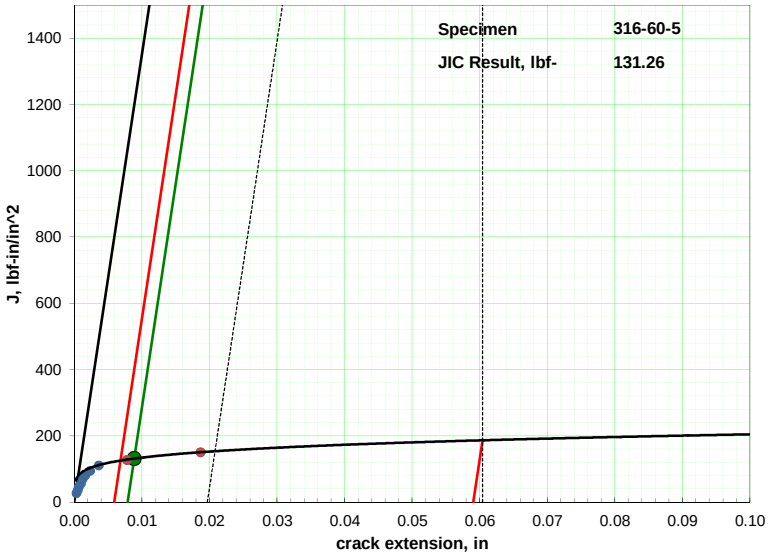
Ave. initial crack length (in)	0.5444	**aoq (in)**	0.501
Ave. final crack length (in)	0.9169	**Compliance Adj. Factor**	0.823
Delta a measured (in)	0.3725	**Effective Modulus (Msi)**	21.8
Delta a predicted (in)	0.0195		

Results

JQ (E1820)	131.3 lbf-in/in^2
KJIC(E'*JQ)^1/2	61.8 ksi sqrt(in)

Qualification of Data		**Qualification of JQ as JIC**	
7.4.2: precrack length	valid		
9.1.4.1; precrack	valid	**A9.10.1; thickness**	valid
9.1.4.2; final crack	valid	**A9.10.2; ligament**	valid
9.1.5.1; Da meas	valid	**A9.11; slope**	valid
9.1.5.2; Da pred	invalid		
A9.6.4; # of pnts in reg.A	valid		
A9.6.4; # of pnts in reg.B	invalid		
A9.9.1; C2<1	valid		
A9.9.2.1; a0q-a0	invalid		
A9.9.2.2; # of pnts for JQ	invalid		
A9.9.2.2; # of pnts < JQ	valid		
A9.9.2.2; correlation	valid		

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-80-1

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	49%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	396	**Stress Ratio**	0.1
Final a (in)	0.5459	**Kmax (ksi sqrt (in))**	8.9
Pf (lbf)	1093.5		

Initial measured crack lengths (in)

0.517	0.534	0.551	0.558	0.560	0.558	0.551	0.537	0.519

Final measured crack lengths (in)

0.687	0.747	0.789	0.815	0.830	0.823	0.815	0.798	0.735
x								x

Ave. initial crack length (in)	0.5459	**aoq (in)**	0.500
Ave. final crack length (in)	0.791	**Compliance Adj. Factor**	0.715
Delta a measured (in)	0.2451	**Effective Modulus (Msi)**	19.0
Delta a predicted (in)	0.0206		

Results

JQ (E1820)	151.9 lbf-in/in^2
KJIC(E*JQ)^1/2	66.5 ksi sqrt(in)

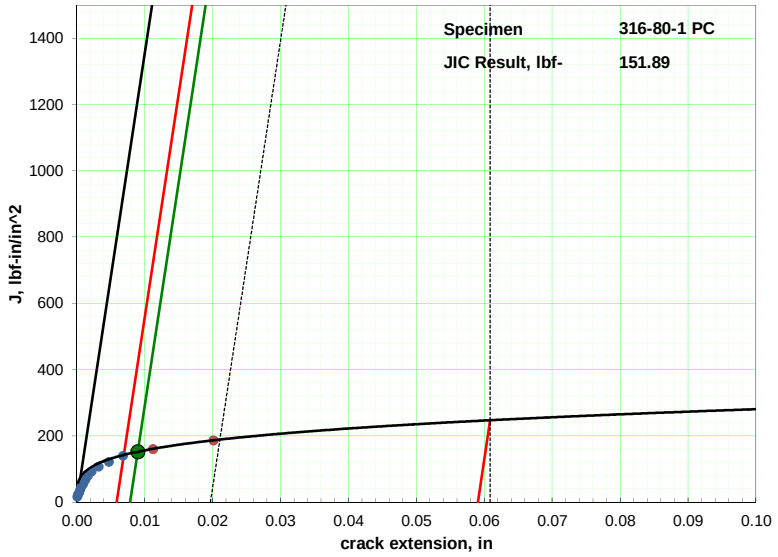
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	valid
9.1.4.2; final crack	invalid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	invalid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	invalid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	valid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-80-2

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	49%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	396	**Stress Ratio**	0.1
Final a (in)	0.5521	**Kmax (ksi sqrt (in))**	9.1
Pf (lbf)	1061.2		

Initial measured crack lengths (in)

0.545	0.558	0.570	0.573	0.571	0.565	0.548	0.517	0.483 x

Final measured crack lengths (in)

0.753	0.744	0.735	0.729	0.722	0.713	0.701	0.690	0.676

Ave. initial crack length (in)	0.5521	**aoq (in)**	0.501
Ave. final crack length (in)	0.7184	**Compliance Adj. Factor**	0.714
Delta a measured (in)	0.1663	**Effective Modulus (Msi)**	18.9
Delta a predicted (in)	0.0289		

Results

JQ (E1820)	119.0 lbf-in/in^2
KJIC(E'*JQ)^1/2	58.9 ksi sqrt(in)

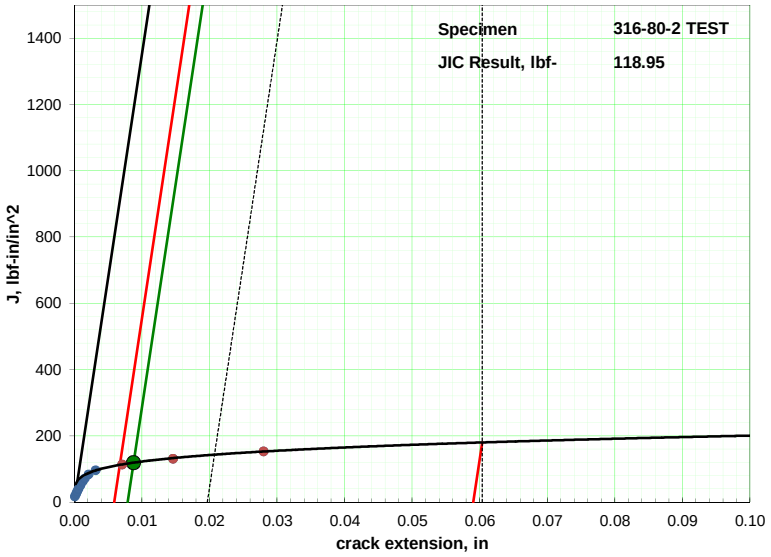
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	invalid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	valid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	invalid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	valid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-80-3

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	49%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	634	**Stress Ratio**	0.1
Final a (in)	0.5431	**Kmax (ksi sqrt (in))**	14.1
Pf (lbf)	1108.3		

Initial measured crack lengths (in)

0.496	0.520	0.544	0.557	0.561	0.561	0.556	0.540	0.516

Final measured crack lengths (in)

0.685	0.705	0.712	0.718	0.715	0.708	0.698	0.687	0.676

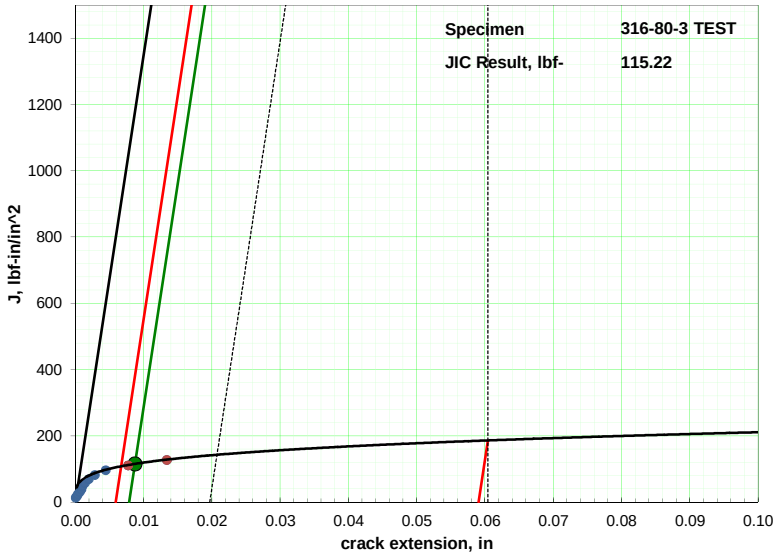
Ave. initial crack length (in)	0.5431	**aoq (in)**	0.501
Ave. final crack length (in)	0.703	**Compliance Adj. Factor**	0.755
Delta a measured (in)	0.1599	**Effective Modulus (Msi)**	20.0
Delta a predicted (in)	0.0138		

Results

JQ (E1820)	115.2 lbf-in/in^2
KJIC(E*JQ)^1/2	57.9 ksi sqrt(in)

Qualification of Data		**Qualification of JQ as JIC**	
7.4.2: precrack length	valid		
9.1.4.1; precrack	valid	**A9.10.1; thickness**	valid
9.1.4.2; final crack	valid	**A9.10.2; ligament**	valid
9.1.5.1; Da meas	valid	**A9.11; slope**	valid
9.1.5.2; Da pred	invalid		
A9.6.4; # of pnts in reg.A	valid		
A9.6.4; # of pnts in reg.B	invalid		
A9.9.1; C2<1	valid		
A9.9.2.1; a0q-a0	invalid		
A9.9.2.2; # of pnts for JQ	invalid		
A9.9.2.2; # of pnts < JQ	valid		
A9.9.2.2; correlation	valid		

ASTM E1820-20 Standard Test



All results are reported For Information Only

Applicable Specification: ASTM E1820-20

Customer: Electric Power Research Institute, Inc. 3420 Hillview Ave, Palo Alto CA 94304

Additional customer nos.: SOW: Compact Tension Testing of Cold-Worked Stainless Steel Alloys;
EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-80-4

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	49%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	293	**Stress Ratio**	0.1
Final a (in)	0.5385	**Kmax (ksi sqrt (in))**	6.4
Pf (lbf)	1132.5		

Initial measured crack lengths (in)

0.502	0.525	0.540	0.546	0.546	0.548	0.547	0.540	0.532

Final measured crack lengths (in)

0.923	0.937	0.932	0.923	0.920	0.922	0.926	0.929	0.918

Ave. initial crack length (in)	0.5385	**aoq (in)**	0.500
Ave. final crack length (in)	0.9261	**Compliance Adj. Factor**	0.916
Delta a measured (in)	0.3876	**Effective Modulus (Msi)**	24.3
Delta a predicted (in)	0.0122		

Results

JQ (E1820)	104.9 lbf-in/in^2
KJIC(E*JQ)^1/2	55.3 ksi sqrt(in)

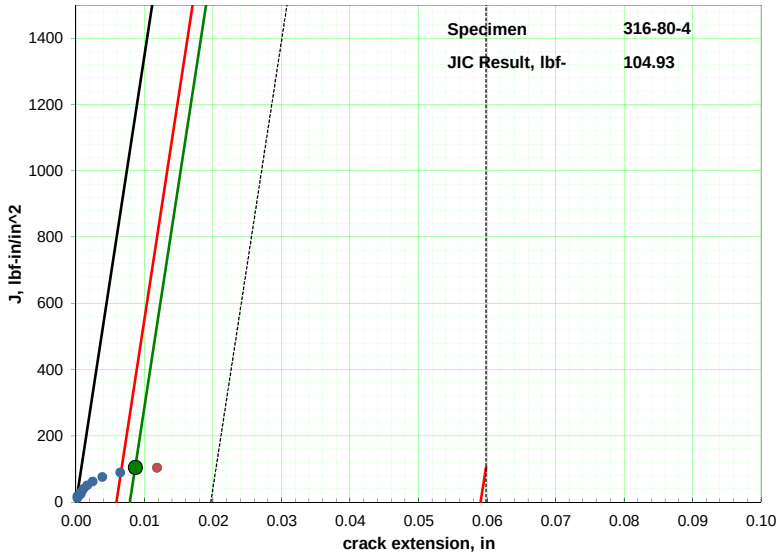
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	valid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	invalid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	invalid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	valid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



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EPRI Task ID: 1-110095-01-02;

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SUMMARY OF FRACTURE TOUGHNESS

316-80-5

Specimen Type:	CT	Requestor:	Wall
Material:	SS316	Company:	Electric Power Research Institute
Drawing No.:	Fig. 2	P.O. No.:	4700007062
Temperature:	RT	Job No.:	02039-011217
Relative Humidity:	49%	Machining Source:	Customer

Material Properties

Yield (ksi)	45
Tensile (ksi)	90
Modulus (Msi)	26.5

Specimen Dimensions

Thickness (in)	0.5	**Notch Depth (in)**	0.400
Net Thickness (in)	0.4	**Gage Length (in)**	0.300
Width (in)	1	**Alpha Ratio**	1.25
Pin Spacing (in)	0.55		

Precrack Parameters

Pmax (lbf)	293	**Stress Ratio**	0.1
Final a (in)	0.5462	**Kmax (ksi sqrt (in))**	6.6
Pf (lbf)	1092		

Initial measured crack lengths (in)

0.538	0.553	0.565	0.567	0.563	0.559	0.545	0.508	0.484 x

Final measured crack lengths (in)

0.924	0.938	0.938	0.938	0.942	0.946	0.946	0.949	0.949

Ave. initial crack length (in)	0.5462	**aoq (in)**	0.500
Ave. final crack length (in)	0.9418	**Compliance Adj. Factor**	0.873
Delta a measured (in)	0.3956	**Effective Modulus (Msi)**	23.1
Delta a predicted (in)	0.0132		

Results

JQ (E1820)	117.1 lbf-in/in^2
KJIC(E'*JQ)^1/2	58.4 ksi sqrt(in)

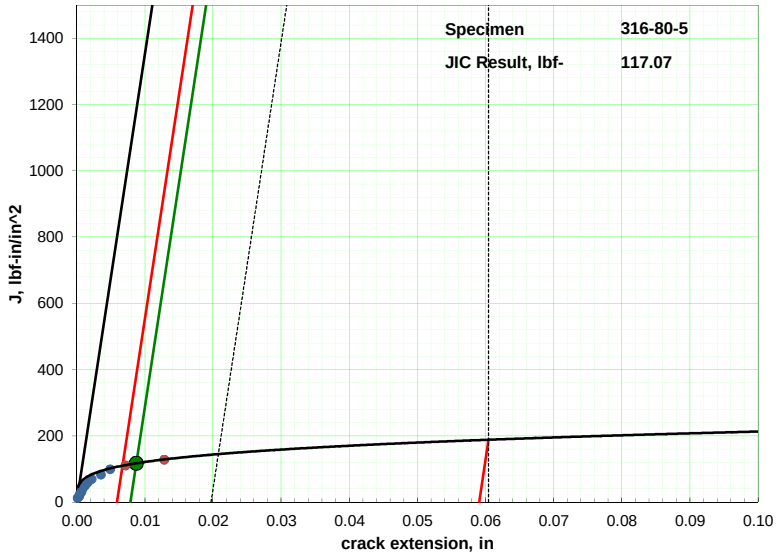
Qualification of Data

7.4.2: precrack length	valid
9.1.4.1; precrack	invalid
9.1.4.2; final crack	valid
9.1.5.1; Da meas	valid
9.1.5.2; Da pred	invalid
A9.6.4; # of pnts in reg.A	valid
A9.6.4; # of pnts in reg.B	invalid
A9.9.1; C2<1	valid
A9.9.2.1; a0q-a0	invalid
A9.9.2.2; # of pnts for JQ	invalid
A9.9.2.2; # of pnts < JQ	valid
A9.9.2.2; correlation	valid

Qualification of JQ as JIC

A9.10.1; thickness	valid
A9.10.2; ligament	valid
A9.11; slope	valid

ASTM E1820-20 Standard Test



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