Doc number: FARE-190603-1 Part I

Report

Measurement of Yield strength, Tensile strength and Fracture toughness of API 5L pipe using Instrumented Indentation Testing

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FRONTICS
FAST & PRECISE SOLUTIONS FOR QUALITY & RELIABILITY

June, 2019

Prepared for

GTI

Content

1. Executive Summary

According to the Gas Mega Rule (PHMSA-2011-0023) proposed by the PHMSA, PHMSA operates the transmission pipelines at pressures below the pipe's yield strength and for the purpose of considering the safety factors of the pipe, PHMSA is seeking to require operators to verify the Maximum Allowable Operating Pressure Determination (MOAP) of Transmission pipe segments without TVC records in the MAOP Verification § 192.624. PHMSA allowed for the verification of yield strength, tensile strength and fracture toughness using the non-destructive test in Material Verification § 192.607.

Instrumented Indentation Testing (IIT) applied FRONTICS AIS2100 can measure yield strength, tensile strength and fracture toughness by non-destructive. This technology can be applied directly to in-service and in-situ pipelines so that the test sample can be used after the test. In addition, Since the space required for the test is very small, it is also effective in evaluating the weldment.

This test is for the evaluation of the yield and tensile strength of pipes using the IIT included in the DOT Project (DOT Project Number: 729) 'Validating Non-Destructive Tools for Surface to Bulk Correlations of Yield Strength, Toughness, and Chemistry'. In addition, if the test sample included a seam weld, strength and fracture toughness (KJC value) of weldments were also evaluated.

There is a total of 70 test pipes and within those pipes, 40 pipes have seam welds. For the pipes including the seam weld, 5 to 6 locations were tested, and 2 locations were tested on seamless pipe.

2. Objective

The objective of this DOT Project is;

"The deliverables of this project will facilitate the use of non-destructive surface testing: micro-indentation, micro-machining, in situ chemistry, and replicate microscopy analysis as accurate, efficient, and cost-effective tools for material property confirmation.

This work will provide benefits to pipeline safety, energy continuity, and integrity assessment programs since the developed techniques and models and validated testing technology will not require a line to be taken out of service or destructively cut out samples from the in-service pipeline. The results of this project will also be applicable to pending DOT/PHMSA regulations that require operators to backfill their material property records for grandfathered pipeline segments and/or those that do not have adequate material records."

The objective of this test is to evaluate the yield strength, tensile strength and fracture toughness using the indentation method, and compare it with destructive test results to validate the technology.

3. Introduction

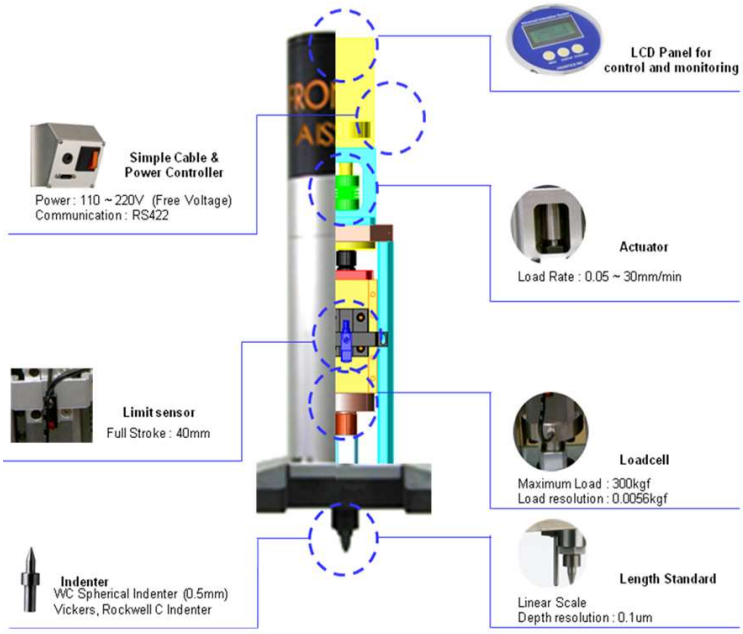
What follows is a test report on the yield strength, tensile strength and fracture toughness measurement on GTI's 70 API pipes using the instrumented indentation testing (IIT). The test involved 3 indentation tests at two to six locations on each pipe. AIS2100 of FRONTICS, Inc. was used for this test.

4. Basic operating principles

The Instrumented Indentation Test is a method developed from the conventional hardness test, and is a technology applying load to materials and measuring load-displacement continuously by using a sharp indenter. The Instrumented Indentation Test is a simple test method that doesn't require shape of a specific sample, compared to the existing uniaxial tensile test, and is a multiscale evaluation method that can assess localized and wide area properties. Also, the Instrumented Indentation Test is an innovative technology that can nondestructively measure real-time field properties of equipment being operated and can assess various properties such as tensile properties, fracture properties and residual stress, etc. through analysis of one load-displacement curve because it leaves only micro indentation marks on the test target.

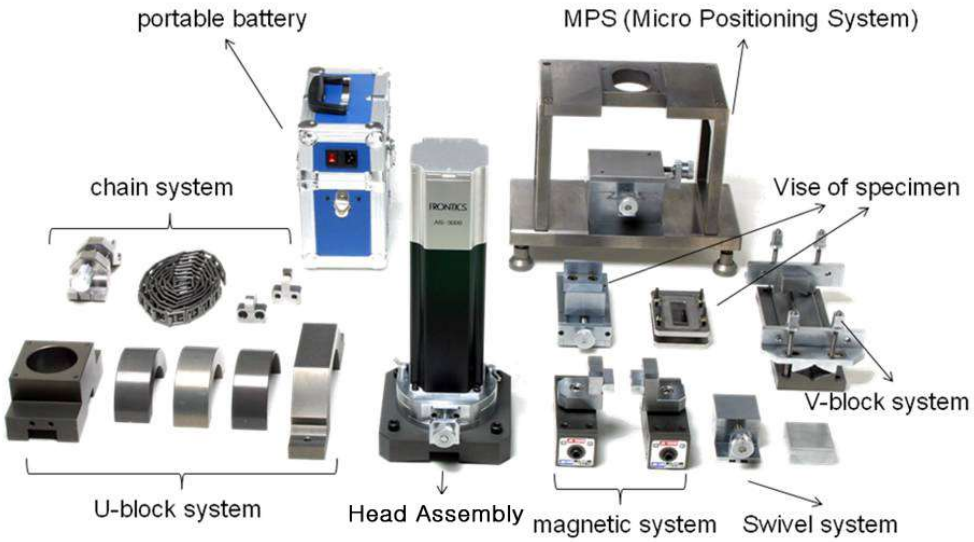
(1) Head Assembly

The AIS series of FRONTICS Company applying the Instrumented Indentation Test guarantee high-level measurement precision and reliability with development know-how and introduction of new technology for more than 10 years. The AIS series of FRONTICS Company have an advantage that can measure conveniently and fast due to improvement of sensor performance, data processing performance as well as characteristics of user-friendly software of the inside of equipment, and have an advantage that can use various attachment devices that the field application to structures among almost all operations is possible.



(2) Various attachments

The power plant and oil refinery equipment are composed of various shaped parts such as Rotor, Shaft, Valve, Casing and pipe, etc. The various attachment devices should be applied to the test equipment according to these targets. The AIS series have various attachment devices formed on the basis of field experience for more than 10 years.



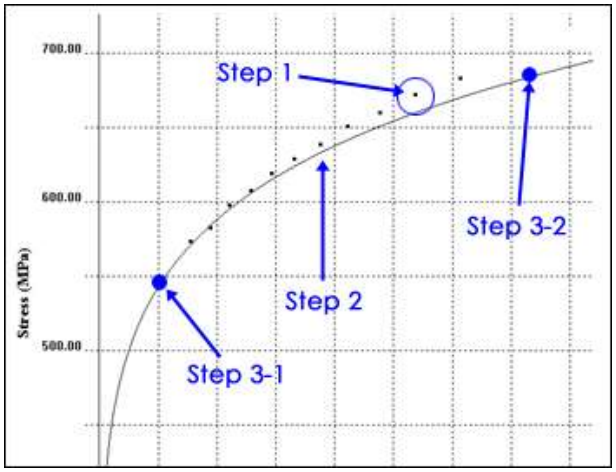
Model		**AIS2100**
Size	Driving Unit	4.0 x 4.0 x 13.9 inch (Cylinder structure)
	Horizontal moving Unit	5.5 x 5.5 x 1.7 inch (two-story dovetail slider structure)
	Base Unit	7 x 7 x 1.6 inch (V block structure)
Maximum load		660 lbf (300 kgf)
Load / Depth resolution		**5.6 gf / 0.1 um**
Maximum stroke		1.57 inch (40 mm)
Loading rate		0.1 ~ 30 mm/min
Communication method		RS-422
Power supply		**AC 110 ~ 220V (free voltage)**
Analysis equipment		Laptop PC (w/SW)
Indenter		Spherical Indenter (Dia. 0.5 mm)

(3) Analysis algorithms

AIS2100 has revised its S/W for more accurate and reliable data results:

- Revision of contact area determination procedure considering pile-up effect dependent on indentation depth and materials' work-hardening characteristics

- Revision of yield strength determination procedure based on indentation-derived elastic modulus



Step 0 Determination of **contact area**

a → a_c

Step 1 Derivation of **stress-strain points**

$$\sigma = \frac{L}{\pi a^2}\frac{1}{\psi}, \quad \varepsilon = \frac{\alpha}{\sqrt{1-(a/R)^2}}\frac{a}{R} = \alpha\tan\gamma$$

Step 2 Determination of **flow curve**

$\sigma = K\varepsilon^n$ for Hollomon-type materials

$\sigma = A + E_r\varepsilon$ for FCC materials

Step 3 Determination of **yield strength** (3-1) and **tensile strength** (3-2)

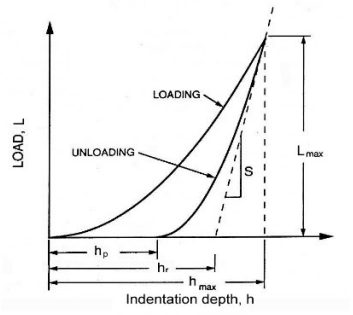
$\sigma_y = K(\varepsilon_y + b)^n$ yield strength

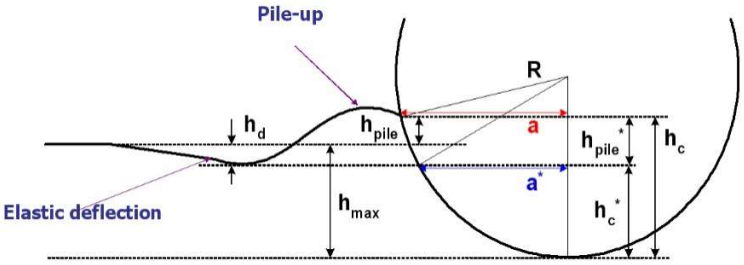
$\sigma_{UTS} = Kn^n$ tensile strength

<Details>

Step 0 Calibration of contact area

: Change in contact depth by **elastic deflection** and **plastic pile-up/sink-in** at maximum indentation load





(0-1) elastic deflection

$$h_c^* = h_{\max} - h_d = h_{\max} - 0.75\frac{L_{\max}}{S}$$

(0-2) plastic pile-up

$$\frac{h_{pile}^*}{h_c^*} = f(n, \frac{a_{\max}}{R})$$

$h_c = h_c^* + h_{pile}^* = h_{\max} - h_d + h_{pile}^*$ and $A_c = f(h_c)$.

Step 1 Determination of stress-strain points

(1-1) Definitions of stress and strain

$$\sigma = \frac{L}{\pi a^2}\frac{1}{\psi}, \quad \varepsilon = \frac{\alpha}{\sqrt{1-(a/R)^2}}\frac{a}{R} = \alpha\tan\gamma$$

(1-2) Selection of constants (α, ψ)

(α=0.14 and ψ=3.0)

Step 2 Flow curve determination

(2-1) Determination of fitting type

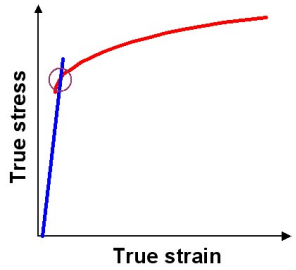
$\sigma = K\varepsilon^n$ for Hollomon-type materials

$\sigma = A + E_r\varepsilon$ for FCC materials

Step 3 Strength determination

(3-1) Yield strength

: using Intercept point of elastic line and plastic flow curve



$K\varepsilon_y^n = E(\varepsilon_y - 0.002)$ ➔ ε_y determination

$\sigma_y = K(\varepsilon_y + b)^n$

(3-1-1) Elastic modulus

: Using initial slope of unloading curve reflecting elastic recovery of material

: Unloading curve can be expressed in a power law relation as

$L = k(h - h_f)^m$, where m and K = fitting constants.

$$S = \left(\frac{dL}{dh}\right)_{h=h_{\max}} = km(h_{\max} - h_f)^{m-1} = \frac{2}{\sqrt{\pi}} E_r \sqrt{A_c},$$

where

$$\frac{1}{E_r} = \frac{1-\nu^2}{E} + \frac{1-\nu_i^2}{E_i}$$

and subscript, *i* indicates indenter.

(3-2) Tensile strength

: Using the fact that tensile strain is same as work-hardening exponent

$\sigma_{UTS} = Kn^n$

5. Test conditions

(1) Samples

- Pipe: API 5L pipe 70EA
- Test location: Total 287 locations

pipe #	OD (in)	Length (in)	Seam weld	Test location #
3	12	20, 18	O	6
4	12	20, 18	O	6
5	24	38	O	6
6	24	38	O	6
12	12	20 cut out, 11 cut out	X	2
13	16	18.5, 12.5, 11 cut out	O	6
18	20	32	O	6
19	20	37	O	6
24	12	20	O	6
25	18	39	X	6
26	18	32	X	2
27	18	36	X	2
28	16	36.5	X	2
29	16	32	X	2
31	16	32	O	6
32	26	39 (not full ring)	X	2
33	16	28	O	6
34	8	24 and piece	X	2
35	12	23, 12.5	O	6
37	12	20, 16	O	6

pipe #	OD	Length	Seam weld	Test location #
40	30	36 (not full ring)	O	6
42	12	19 cut out, 30	X	2
43	20	37	O	6
44	26	24 (not full ring)	O	6
50	24	24	O	6
107	6	36	O	5
108	8	29	X	2
109	4	30	X	2
110	6	23	X	2
111	4	27	O	5
112	4	28	O	5
113	6	27	O	5
114	8	24	O	5
115	8	18	O	5
116	8	24	O	5
117	10	28	X	2
118	10	27	X	2
119	10	20	O	6
121	6	19	X	2
122	10	24	O	6

pipe #	OD	Length	Seam weld	Test location #
123	10	27	X	2
124	6	26	O	5
125	10	25.5	O	6
126	10	25.5	O	6
127	10	25.5	X	2
130	4	28	O	5
132	12	27	X	2
133	8	27	O	5
134	8	27	O	5
136	8	27	X	2
137	6	27.5	O	5
138	6	29	X	2
139	6	28.5	X	2
140	8	25	O	5
141	8	28	O	5
142	6	30	O	5
143	4	25	O	5
144	12	27	O	6
145	10	27.5	X	2
146	10	16	X	2

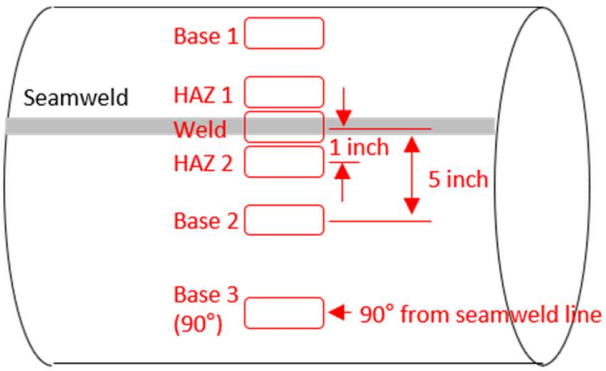
pipe #	OD	Length	Seam weld	Test location #
147	8	28	X	2
148	8	18	X	2
149	8	18	X	2
150	8	19	X	2
151	8	19	X	2
155	8	24	X	2
165	10	30	O	6
167	10	23	O	6
169	12	29	O	6
170	20	24	O	6

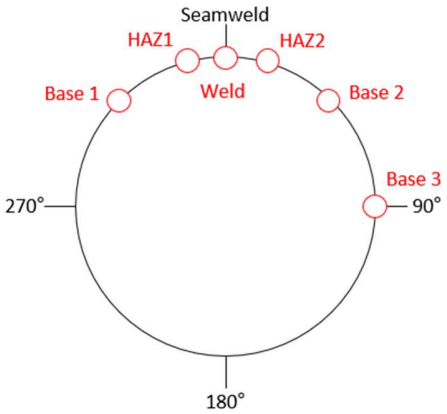
(2) Determination of the test location

Test location were determined by considering the presence of seam weld and pipe OD. The test location was classified as follows.

Test location name	Description
Base 1	5 inch from seamweld line
HAZ 1	1 inch from seamweld line
Weld	Seamweld line
HAZ 2	1 inch from seamweld line
Base 2	5 inch from seamweld line
Base 3 (90°)	90 degree from seamweld line

If the pipe OD is 4 to 8 inches in the seam weld pipes, Base 3 (90°) was omitted because Base 2 is very close to the 90-degree location. Seamless pipe was tested on two base metals of 0 degree and 90 degree.





(3) Sample images

#003

#004

#005

#006

#012

#013

#018

#019

#024

#025

#026

#027

#028

#029

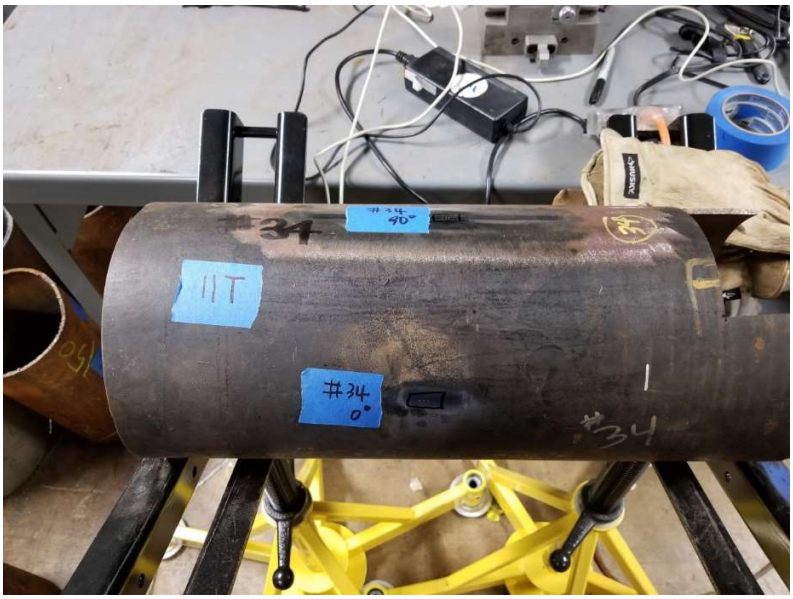
#031


CAUTION
CAUTION
#31 Base 2
#31 HAZ 2
#31 Weld
#31 HAZ 1
#31 Base 1

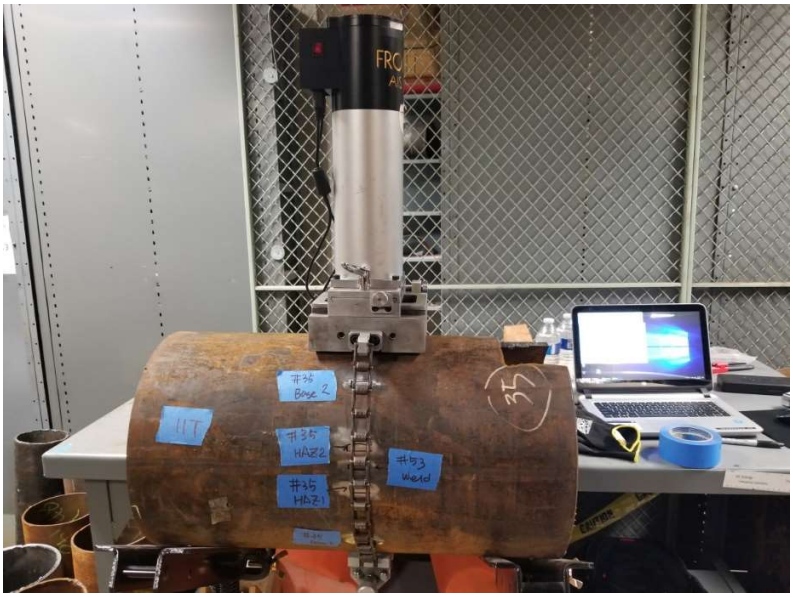
#032


#32 Base 2

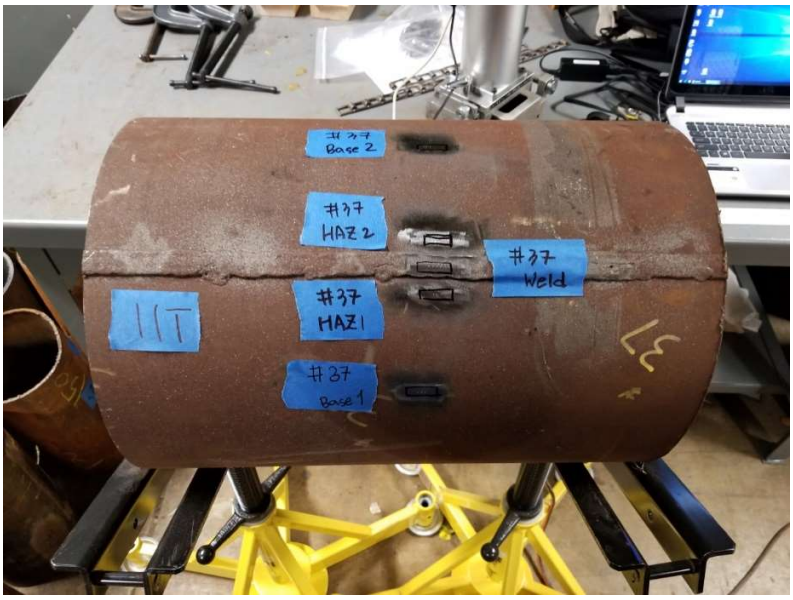
#034



#035



#037

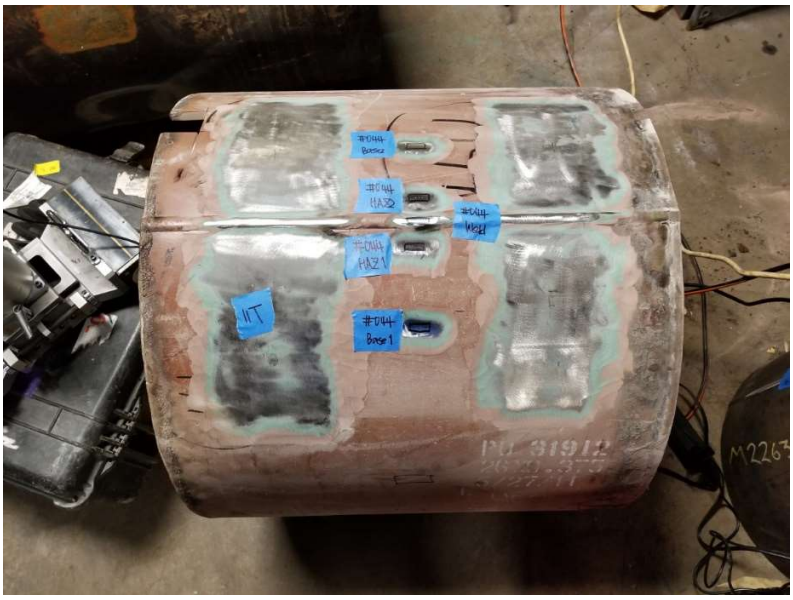


#040

#042

#043

#044



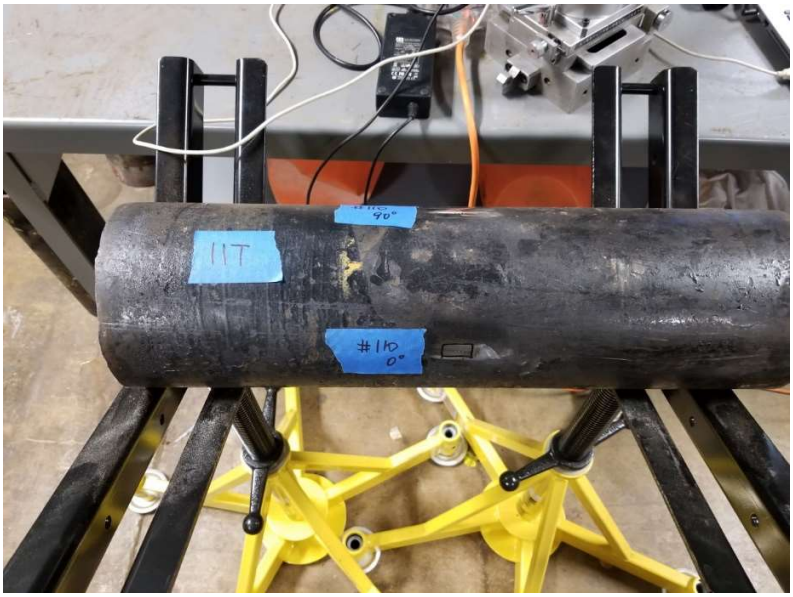
#050

#0107

#108

#109

#110



#111


#111
HAZ 2
#111
HAZ 1
#111
Base
#111
Weld

#112


#112
HAZ2
#112
HAZ1
#112
Base
#112
Weld

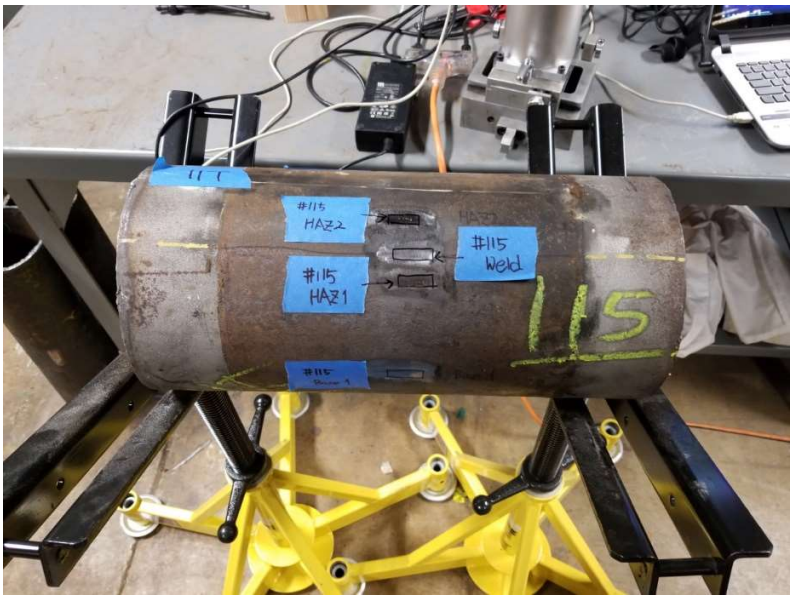
#113


#113 HAZ2
#113 Weld
#113 HAZ1
#113 Base 1
IIT
Sh

#114


IIT
#114 HAZ2
#114 HAZ1
#114 Weld
114
114

#115



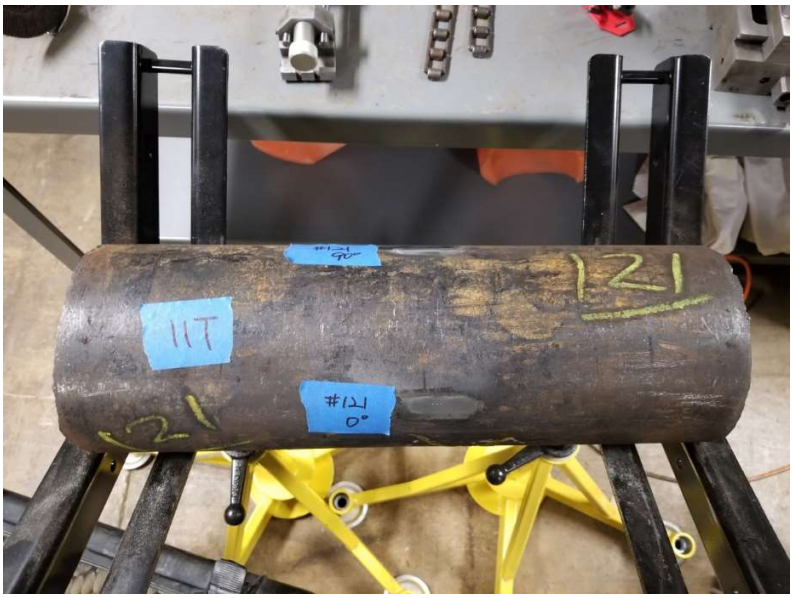
#116

#117

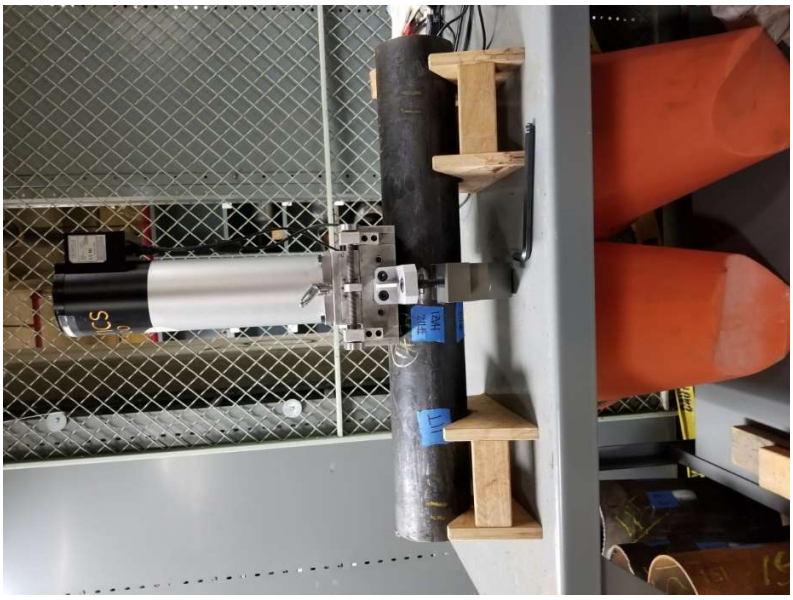
#118

#119

#121



#122



#123

#124


#124
HAZ 2
#124
HAZ 1
#124
Weld
SUMTER TB

#125


#125
HAZ 2
#125
Weld
#125
HAZ 1
#125
Boss 1

#126


126
#126 HAZ2
IIT
#126 HAZ1
#126 WELD
#126 Base 1
126

#127


127
IIT
#127 00°
127

#130

#132

#133


#133
HAZ2
#133
Weld
#133
HAZ1
PIERMONT

#134


#134
HAZ2
#134
Weld
#134
HAZ1

#136

#137

#138

#139

#140


140
11T
#140 HAZ2
#140 HAZ1
#140 weld
140

#141


11T
#141 HAZ2
#141 HAZ1
#141 weld
SEAM
141

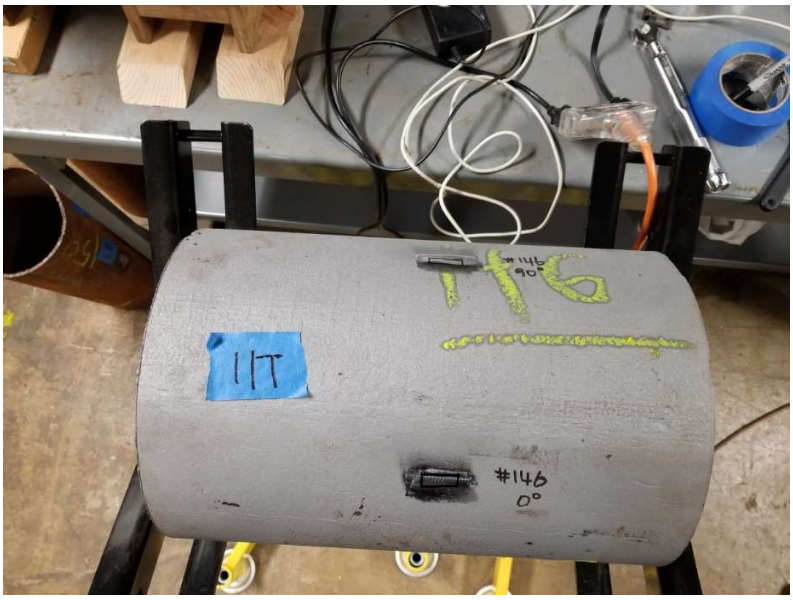
#142

#143

#144

#145

#146

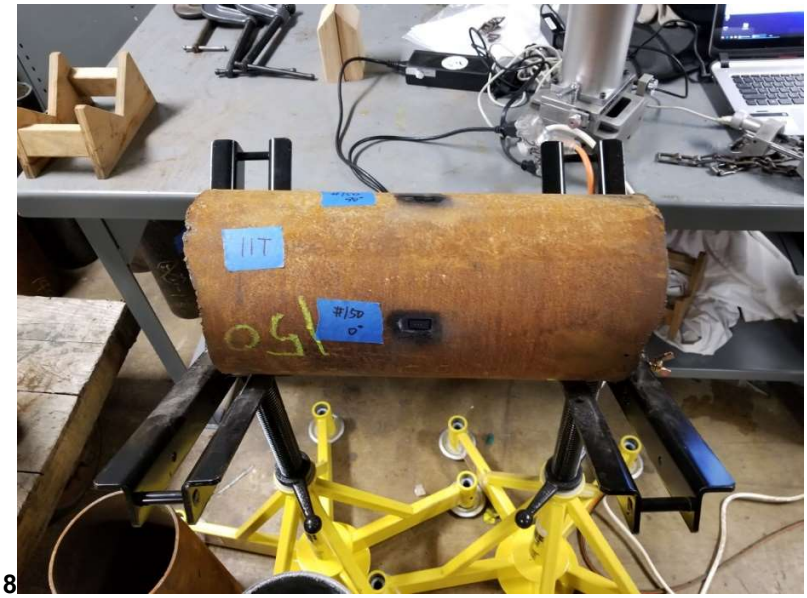


#147

#148

#149

#150

8 

#151

#155

#165

#167


#167 Base 2
#167 HAZ2
#167 Weld
#167 HAZ1

#169


#169 Weld
#169 HAZ2
#169 HAZ1
#169 Base
TOLEDO

#170

6. Test procedures

(1) Surface grinding of sample

- Surfaces of specimens were polished up to #800 grit using hand-polisher

(2) Selection of Jig

- The attachment is selected according to a test target.

Target		Attachment	Feature
Pipe & tube	2 ~ 8 inch	U-block system	
	6 ~ 40 inch	Chain system	
	10 ~ 20 inch 20 ~ 48 inch	Curvature magnet system	

(3) Attachment of Jig

- U-block system : 3~6 inch pipe/tube

- Chain system : 6 ~ 20 inch pipe

- Curvature magnet system : 10 ~ 40 inch pipe

7. Results

Figure below shows locations of the test from AIS 2100. The appendix shows all the detail measured results.

(1) Analysis results of all locations (Average data)

Pipe #	Location	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
#003	Base 1	57.60	80.31	294.59
	HAZ 1	59.14	79.44	304.37
	Weld	61.98	85.11	297.80
	HAZ 2	61.46	83.56	320.76
	Base 2	58.46	78.80	286.68
	Base 3 (90°)	59.14	79.44	304.37
#004	Base 1	58.16	79.90	272.13
	HAZ 1	58.87	79.20	325.41
	Weld	63.86	87.41	313.62
	HAZ 2	63.74	87.18	310.88
	Base 2	60.45	81.53	320.54
	Base 3 (90°)	58.87	79.20	325.41
#005	Base 1	55.98	72.84	291.23
	HAZ 1	56.49	76.14	261.66
	Weld	59.80	76.80	366.07
	HAZ 2	56.49	76.14	261.66
	Base 2 (90°)	51.61	69.85	252.59
#006	Base 1	50.20	66.35	199.12
	HAZ 1	52.35	71.26	241.92
	Weld	56.36	75.48	257.23
	HAZ 2	55.60	73.66	228.87
	Base 2	53.30	72.66	245.00
	Base 3 (90°)	52.35	71.26	241.92
#012	00°	50.53	68.49	291.94
	90°	50.99	70.18	307.84

(Continues)

Pipe #	Location	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
#013	Base 1	52.46	71.77	277.32
	HAZ 1	51.52	72.04	239.11
	Weld	62.12	84.57	307.08
	HAZ 2	58.81	80.60	294.26
	Base 2	54.37	73.14	254.16
	Base 3 (90°)	51.52	72.04	239.11
#018	Base 1	58.06	78.29	357.29
	HAZ 1	57.73	77.77	343.04
	Weld	64.71	86.49	375.70
	HAZ 2	64.27	86.51	363.46
	Base 2	60.36	81.26	336.35
	Base 3 (90°)	57.73	77.77	343.04
#019	Base 1	48.89	65.29	269.41
	HAZ 1	48.68	66.85	239.56
	Weld	54.30	72.60	298.72
	HAZ 2	56.38	74.07	330.25
	Base 2	48.46	66.25	260.85
	Base 3 (90°)	48.68	66.85	239.56
#024	Base 1	50.17	66.35	298.46
	HAZ 1	50.63	67.14	294.11
	Weld	56.71	73.74	321.62
	HAZ 2	53.35	70.15	302.04
	Base 2	50.79	68.56	272.77
	Base 3 (90°)	50.63	67.14	294.11
#025	00°	56.66	76.49	303.60
	90°	58.05	77.93	313.97

(Continues)

Pipe #	Location	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
#026	00°	61.22	82.78	412.68
	90°	62.72	84.08	412.49
#027	00°	67.39	90.96	467.04
	90°	68.04	90.23	461.70
#028	00°	50.20	70.65	335.15
	90°	54.41	75.07	380.04
#029	00°	49.58	68.64	328.55
	90°	54.19	73.65	355.40
#031	Base 1	51.84	69.23	335.04
	HAZ 1	54.34	71.96	355.62
	Weld	65.69	83.40	419.83
	HAZ 2	52.97	70.71	326.51
	Base 2	52.48	69.82	321.03
	Base 3 (90°)	51.11	68.43	329.16

(Continues)

Pipe #	Location	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
#032	Base 1	52.83	71.63	286.31
	HAZ 1	53.70	73.39	295.19
	Weld	53.26	72.17	350.34
	HAZ 2	56.00	76.55	287.25
	Base 2	51.65	71.64	296.63
	Base 3 (90°)	50.76	68.20	308.83
#033	00°	59.93	79.68	306.11
	90°	58.89	78.54	295.95
#034	00°	41.91	57.58	208.97
	90°	43.12	57.96	244.41
#035	Base 1	43.09	57.44	198.11
	HAZ 1	44.11	58.64	215.19
	Weld	53.61	72.16	259.71
	HAZ 2	43.31	58.57	207.96
	Base 2	40.54	56.21	183.90
	Base 3 (90°)	43.49	57.60	222.18
#037	Base 1	53.65	73.95	270.78
	HAZ 1	54.64	74.01	280.02
	Weld	48.14	64.59	275.70
	HAZ 2	54.65	70.98	266.36
	Base 2	53.85	73.77	248.35
	Base 3 (90°)	56.45	74.53	306.86

(Continues)

Pipe #	Location	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
#040	Base 1	65.15	84.22	379.79
	HAZ 1	68.51	86.65	363.39
	Weld	56.29	75.66	290.67
	HAZ 2	69.11	89.98	407.31
	Base 2	66.16	86.78	414.23
	Base 3 (90°)	61.39	77.34	304.02
#042	00°	47.28	64.43	286.29
	90°	45.79	64.68	244.80
#043	Base 1	49.34	66.52	319.98
	HAZ 1	60.00	77.65	344.27
	Weld	56.12	74.68	318.09
	HAZ 2	54.56	71.84	302.81
	Base 2	53.07	69.62	311.08
	Base 3 (90°)	53.20	69.35	324.91
#044	Base 1	62.88	85.16	276.14
	HAZ 1	60.83	82.66	292.67
	Weld	67.39	85.82	408.89
	HAZ 2	60.31	82.46	274.69
	Base 2 (90°)	61.78	85.64	264.55
#050	00°	57.15	76.31	343.26
	90°	61.37	77.70	284.51

(Continues)

Pipe #	Location	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
#107	Base 1	38.27	50.32	207.18
	HAZ 1	38.35	51.40	208.18
	Weld	40.56	54.39	220.13
	HAZ 2	41.37	56.47	207.20
	Base 2 (90°)	36.65	51.62	215.95
#108	00°	54.84	73.28	340.14
	90°	56.93	75.38	344.28
#109	00°	43.92	60.49	279.98
	90°	44.59	61.76	275.50
#110	00°	51.35	66.96	302.66
	90°	52.26	70.55	311.72
#111	Base 1	46.98	61.53	278.57
	HAZ 1	45.54	61.90	285.37
	Weld	47.04	63.61	283.85
	HAZ 2	47.59	64.69	288.75
	Base 2 (90°)	47.83	65.26	300.10

(Continues)

Pipe #	Location	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
#112	Base 1	45.70	62.66	288.32
	HAZ 1	45.67	63.00	292.35
	Weld	47.03	63.57	295.42
	HAZ 2	47.92	64.77	282.12
	Base 2 (90°)	48.45	65.33	303.83
#113	Base 1	47.66	64.51	282.33
	HAZ 1	51.61	68.51	296.89
	Weld	59.28	79.01	363.16
	HAZ 2	53.05	70.50	316.76
	Base 2 (90°)	47.75	64.29	295.77
#114	Base 1	48.01	63.90	300.74
	HAZ 1	53.52	70.30	315.53
	Weld	63.58	82.57	383.03
	HAZ 2	52.45	68.73	301.63
	Base 2 (90°)	44.96	55.86	232.81
#115	Base 1	45.13	60.57	257.28
	HAZ 1	46.29	63.19	267.81
	Weld	52.93	70.07	302.58
	HAZ 2	51.76	67.98	286.40
	Base 2 (90°)	46.41	61.26	275.49
#116	Base 1	45.41	59.41	263.11
	HAZ 1	47.61	63.30	285.90
	Weld	65.56	87.05	393.62
	HAZ 2	49.72	65.97	281.16
	Base 2 (90°)	45.24	61.59	285.04

(Continues)

Pipe #	Location	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
#117	00°	55.52	75.24	350.08
	90°	58.23	78.34	375.45
#118	00°	54.49	73.68	340.81
	90°	56.01	74.25	371.35
#119	Base 1	58.54	78.70	387.94
	HAZ 1	57.06	78.53	377.75
	Weld	57.78	78.23	383.14
	HAZ 2	57.09	78.13	363.52
	Base 2	59.81	80.80	407.42
	Base 3 (90°)	56.75	77.15	365.56
#121	00°	54.14	72.15	309.34
	90°	51.51	69.18	306.49
#122	Base 1	57.52	76.29	355.91
	HAZ 1	63.93	84.18	386.49
	Weld	63.89	85.26	404.59
	HAZ 2	64.87	83.98	400.69
	Base 2	56.16	74.89	346.06
	Base 3 (90°)	57.27	75.89	366.91

(Continues)

Pipe #	Location	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
#123	00°	58.77	78.36	342.41
	90°	60.59	79.33	348.98
#124	Base 1	47.15	65.34	242.10
	HAZ 1	50.11	68.34	261.99
	Weld	57.41	78.69	273.79
	HAZ 2	49.78	68.10	236.83
	Base 2 (90°)	47.63	65.26	229.11
#125	Base 1	59.30	79.62	309.89
	HAZ 1	62.63	84.72	320.28
	Weld	62.52	84.44	307.26
	HAZ 2	63.87	87.39	333.13
	Base 2	58.38	79.12	316.17
	Base 3 (90°)	60.45	81.74	295.82
#126	Base 1	55.22	75.69	302.30
	HAZ 1	59.86	82.61	305.63
	Weld	58.72	81.60	296.70
	HAZ 2	60.38	81.06	341.26
	Base 2	58.79	79.44	330.11
	Base 3 (90°)	60.60	80.97	353.41
#127	00°	55.76	74.58	343.24
	90°	56.13	76.88	312.61

(Continues)

Pipe #	Location	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
#130	Base 1	52.66	69.91	313.41
	HAZ 1	51.33	68.90	307.51
	Weld	72.16	90.50	438.99
	HAZ 2	50.70	68.46	305.47
	Base 2 (90°)	52.46	69.70	313.84
#132	00°	56.16	75.28	337.52
	90°	55.61	76.89	321.24
#133	Base 1	48.83	66.07	303.71
	HAZ 1	53.52	71.45	317.27
	Weld	62.50	84.62	341.55
	HAZ 2	52.57	70.68	302.32
	Base 2 (90°)	48.82	65.94	305.15
#134	Base 1	49.28	64.27	245.40
	HAZ 1	52.08	70.94	268.93
	Weld	65.14	85.85	356.31
	HAZ 2	57.35	75.50	320.61
	Base 2 (90°)	50.67	68.14	277.38
#136	00°	57.58	80.22	336.97
	90°	61.18	82.15	336.23

(Continues)

Pipe #	Location	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
#137	Base 1	50.36	68.09	274.90
	HAZ 1	53.60	70.57	300.75
	Weld	68.88	90.27	370.28
	HAZ 2	58.24	75.44	326.90
	Base 2 (90°)	54.24	70.36	299.52
#138	00°	53.17	72.45	336.12
	90°	53.75	73.42	322.11
#139	00°	56.90	78.11	307.65
	90°	56.12	76.97	304.67
#140	Base 1	55.97	75.01	367.40
	HAZ 1	55.39	74.41	346.32
	Weld	69.39	93.29	426.77
	HAZ 2	56.01	72.32	334.91
	Base 2 (90°)	55.73	71.93	350.11
#141	Base 1	57.17	78.03	310.07
	HAZ 1	61.14	82.29	359.32
	Weld	66.34	88.30	368.95
	HAZ 2	62.70	84.69	353.36
	Base 2 (90°)	59.71	80.07	359.03

(Continues)

Pipe #	Location	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
#142	Base 1	51.05	66.03	283.10
	HAZ 1	57.97	77.70	323.87
	Weld	64.41	85.17	390.32
	HAZ 2	56.95	75.66	341.90
	Base 2 (90°)	52.66	70.46	296.39
#143	Base 1	52.87	71.98	285.78
	HAZ 1	56.80	75.73	301.31
	Weld	58.11	78.51	317.35
	HAZ 2	57.13	77.21	313.95
	Base 2 (90°)	53.86	71.74	277.44
#144	Base 1	55.31	74.71	308.40
	HAZ 1	63.78	83.38	378.76
	Weld	67.85	91.67	386.56
	HAZ 2	60.31	82.22	308.52
	Base 2	55.22	74.11	332.74
	Base 3 (90°)	55.27	76.57	280.29
#145	00°	52.32	71.63	339.58
	90°	52.99	72.06	331.32
#146	00°	39.48	54.45	206.86
	90°	38.89	52.51	217.99

(Continues)

		Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
#147	00°	52.34	70.21	311.81
	90°	50.96	67.76	316.87
#148	00°	50.95	68.51	309.05
	90°	52.61	69.28	347.67
#149	00°	51.29	70.43	348.37
	90°	53.01	71.99	332.86
#150	00°	51.41	69.68	224.02
	90°	49.88	68.19	307.15
#151	00°	55.08	72.58	332.72
	90°	50.86	69.24	300.07

(Continues)

Pipe #	Location	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
#155	00°	51.05	69.09	305.24
	90°	51.85	70.00	310.64
#165	Base 1	51.34	68.81	305.46
	HAZ 1	52.28	70.38	315.17
	Weld	71.34	94.55	478.81
	HAZ 2	52.55	70.94	318.10
	Base 2	51.14	68.62	308.66
	Base 3 (90°)	52.04	68.42	314.71
#167	Base 1	55.16	73.31	327.71
	HAZ 1	55.53	74.12	324.94
	Weld	69.07	92.30	410.21
	HAZ 2	60.51	78.92	376.49
	Base 2	55.01	73.77	310.19
	Base 3 (90°)	54.66	72.87	331.59
#169	Base 1	50.85	68.33	290.01
	HAZ 1	58.48	75.92	328.59
	Weld	61.11	81.63	371.56
	HAZ 2	56.72	75.15	327.34
	Base 2	50.54	68.14	297.25
	Base 3 (90°)	52.24	70.35	318.16
#170	Base 1	55.64	71.47	298.34
	HAZ 1	54.90	71.87	306.43
	Weld	57.71	73.09	360.25
	HAZ 2	58.89	76.08	350.04
	Base 2	58.76	77.11	334.17
	Base 3 (90°)	58.38	76.09	347.31

(2) Analysis results of base metal (average data)

Pipe #	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
#003	58.40	79.52	295.21
#004	59.16	80.21	306.03
#005	53.79	71.34	271.91
#006	51.95	70.09	228.68
#012	50.76	69.34	299.89
#013	52.78	72.32	256.86
#018	58.72	79.11	345.56
#019	48.67	66.13	256.61
#024	50.53	67.35	288.45
#025	57.35	77.21	308.78
#026	61.97	83.43	412.59
#027	67.71	90.60	464.37
#028	52.31	72.86	357.59
#029	51.89	71.15	341.98
#031	51.81	69.16	328.41
#032	51.75	70.49	297.26
#033	59.41	79.11	301.03
#034	42.52	57.77	226.69
#035	42.37	57.08	201.40
#037	54.65	74.09	275.33

Pipe #	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
#040	64.24	82.78	366.01
#042	46.54	64.56	265.55
#043	51.87	68.50	318.66
#044	62.33	85.40	270.34
#050	59.26	77.01	313.89
#107	37.30	51.10	212.44
#108	55.89	74.33	342.21
#109	44.25	61.12	277.74
#110	51.81	68.76	307.19
#111	47.40	63.40	289.33
#112	47.07	63.99	296.08
#113	47.71	64.40	289.05
#114	46.49	59.88	266.77
#115	45.77	60.91	266.38
#116	45.32	60.50	274.07
#117	56.87	76.79	362.76
#118	55.25	73.97	356.08
#119	58.37	78.88	386.98
#121	52.82	70.66	307.91
#122	56.98	75.69	356.29

Pipe #	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
#123	59.68	78.85	345.69
#124	47.39	65.30	235.60
#125	59.38	80.16	307.29
#126	58.20	78.70	328.61
#127	55.95	75.73	327.93
#130	52.56	69.81	313.63
#132	55.89	76.09	329.38
#133	48.83	66.01	304.43
#134	49.97	66.20	261.39
#136	59.38	81.18	336.60
#137	52.30	69.22	287.21
#138	53.46	72.93	329.12
#139	56.51	77.54	306.16
#140	55.85	73.47	358.75
#141	58.44	79.05	334.55
#142	51.85	68.24	289.74
#143	53.36	71.86	281.61
#144	55.27	75.13	307.14
#145	52.65	71.85	335.45
#146	39.18	53.48	212.42

Pipe #	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
#147	51.65	68.98	314.34
#148	51.78	68.90	328.36
#149	52.15	71.21	340.62
#150	50.64	68.94	305.58
#151	52.97	70.91	316.40
#155	51.45	69.54	307.94
#165	51.51	68.62	309.61
#167	54.94	73.32	323.16
#169	51.21	68.94	301.81
#170	57.59	74.89	326.61

(3) Detail testing results (Base metal)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#003	Base 1	1	58.10	80.02	297.46
		2	57.25	80.67	294.22
		3	57.46	80.24	292.09
		Avg.	**57.60**	**80.31**	**294.59**
	Base 2	1	58.84	77.80	311.40
		2	57.47	77.76	283.48
		3	59.08	80.84	265.15
		Avg.	**58.46**	**78.80**	**286.68**
	Base 3 (90°)	1	56.43	77.53	290.80
		2	60.06	79.21	329.87
		3	60.94	81.58	292.45
		Avg.	**59.14**	**79.44**	**304.37**
	Total	**Total avg.**	**58.40**	**79.52**	**295.21**
		Std.	**1.45**	**1.51**	**17.84**
#004	Base 1	1	56.70	77.27	256.24
		2	56.19	79.92	264.49
		3	61.59	82.50	295.67
		Avg.	**58.16**	**79.90**	**272.13**
	Base 2	1	63.43	82.72	343.22
		2	60.45	81.29	320.04
		3	57.48	80.59	298.38
		Avg.	**60.45**	**81.53**	**320.54**
	Base 3 (90°)	1	59.40	78.98	338.16
		2	58.07	79.21	305.48
		3	59.13	79.41	332.58
		Avg.	**58.87**	**79.20**	**325.41**
	Total	**Total avg.**	**59.16**	**80.21**	**306.03**
		Std.	**2.37**	**1.76**	**31.00**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#005	00°	1	55.89	71.99	303.62
		2	58.15	75.19	297.90
		3	53.89	71.34	272.17
		Avg.	**55.98**	**72.84**	**291.23**
	90°	1	51.89	71.22	242.94
		2	51.02	69.44	256.59
		3	51.92	68.89	258.24
		Avg.	**51.61**	**69.85**	**252.59**
	Total	**Total avg.**	**53.79**	**71.34**	**271.91**
		Std.	**2.76**	**2.23**	**24.26**
#006	Base 1	1	50.44	67.33	194.09
		2	49.54	66.52	197.54
		3	50.62	65.21	205.74
		Avg.	**50.20**	**66.35**	**199.12**
	Base 2	1	52.53	71.59	252.68
		2	53.37	72.99	240.98
		3	54.00	73.41	241.34
		Avg.	**53.30**	**72.66**	**245.00**
	Base 3 (90°)	1	52.59	70.94	243.42
		2	52.53	70.23	265.63
		3	51.94	72.61	216.72
		Avg.	**52.35**	**71.26**	**241.92**
	Total	**Total avg.**	**51.95**	**70.09**	**228.68**
		Std.	**1.47**	**3.02**	**25.75**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#012	00°	1	49.75	66.83	309.48
		2	50.23	68.14	297.95
		3	51.63	70.51	268.39
		Avg.	**50.53**	**68.49**	**291.94**
	90°	1	52.46	71.85	301.86
		2	50.46	70.11	282.62
		3	50.07	68.60	339.05
		Avg.	**50.99**	**70.18**	**307.84**
	Total	**Total avg.**	**50.76**	**69.34**	**299.89**
		Std.	**1.05**	**1.82**	**24.18**
#013	Base 1	1	53.25	71.77	294.79
		2	51.35	71.90	262.59
		3	52.77	71.65	274.58
		Avg.	**52.46**	**71.77**	**277.32**
	Base 2	1	53.02	73.11	234.67
		2	54.68	73.62	248.56
		3	55.40	72.70	279.24
		Avg.	**54.37**	**73.14**	**254.16**
	Base 3 (90°)	1	51.36	71.51	234.55
		2	50.44	72.17	237.07
		3	52.75	72.44	245.73
		Avg.	**51.52**	**72.04**	**239.11**
	Total	**Total avg.**	**52.78**	**72.32**	**256.86**
		Std.	**1.59**	**0.71**	**21.97**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#018	Base 1	1	59.11	79.12	367.38
		2	56.98	77.23	329.24
		3	58.09	78.53	375.25
		Avg.	**58.06**	**78.29**	**357.29**
	Base 2	1	59.25	79.98	360.88
		2	61.45	82.05	343.03
		3	60.39	81.75	305.14
		Avg.	**60.36**	**81.26**	**336.35**
	Base 3 (90°)	1	56.18	76.24	324.83
		2	58.53	78.92	324.54
		3	58.48	78.16	379.75
		Avg.	**57.73**	**77.77**	**343.04**
	Total	**Total avg.**	**58.72**	**79.11**	**345.56**
		Std.	**1.61**	**1.92**	**26.31**
#019	Base 1	1	48.48	65.88	247.45
		2	48.51	64.58	275.58
		3	49.66	65.41	285.20
		Avg.	**48.89**	**65.29**	**269.41**
	Base 2	1	47.99	65.76	245.18
		2	51.01	66.94	296.99
		3	46.36	66.07	240.38
		Avg.	**48.46**	**66.25**	**260.85**
	Base 3 (90°)	1	48.13	66.47	225.14
		2	49.36	66.28	278.63
		3	48.55	67.78	214.93
		Avg.	**48.68**	**66.85**	**239.56**
	Total	**Total avg.**	**48.67**	**66.13**	**256.61**
		Std.	**1.28**	**0.91**	**28.50**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#024	Base 1	1	49.82	65.42	294.87
		2	50.85	66.84	303.54
		3	49.85	66.80	296.97
		Avg.	**50.17**	**66.35**	**298.46**
	Base 2	1	49.97	68.61	246.39
		2	50.70	68.41	273.69
		3	51.72	68.66	298.24
		Avg.	**50.79**	**68.56**	**272.77**
	Base 3 (90°)	1	50.56	67.00	298.88
		2	50.87	67.33	306.41
		3	50.46	67.08	277.04
		Avg.	**50.63**	**67.14**	**294.11**
	Total	**Total avg.**	**50.53**	**67.35**	**288.45**
		Std.	**0.61**	**1.06**	**19.32**
#025	00°	1	56.17	76.18	299.55
		2	57.42	76.50	321.49
		3	56.38	76.80	289.76
		Avg.	**56.66**	**76.49**	**303.60**
	90°	1	56.62	78.24	286.70
		2	57.90	77.62	321.34
		3	59.64	77.92	333.88
		Avg.	**58.05**	**77.93**	**313.97**
	Total	**Total avg.**	**57.35**	**77.21**	**308.78**
		Std.	**1.30**	**0.83**	**19.41**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#026	00°	1	60.46	82.65	418.61
		2	62.57	83.72	422.62
		3	60.63	81.97	396.81
		Avg.	**61.22**	**82.78**	**412.68**
	90°	1	62.41	83.99	419.00
		2	62.87	83.92	396.54
		3	62.88	84.32	421.94
		Avg.	**62.72**	**84.08**	**412.49**
	Total	**Total avg.**	**61.97**	**83.43**	**412.59**
		Std.	**1.12**	**0.92**	**12.42**
#027	00°	1	69.12	91.90	474.85
		2	66.43	90.71	468.56
		3	66.60	90.28	457.71
		Avg.	**67.39**	**90.96**	**467.04**
	90°	1	67.44	90.01	459.89
		2	68.60	90.43	465.37
		3	68.07	90.25	459.84
		Avg.	**68.04**	**90.23**	**461.70**
	Total	**Total avg.**	**67.71**	**90.60**	**464.37**
		Std.	**1.08**	**0.68**	**6.53**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#028	00°	1	50.90	71.10	336.75
		2	49.60	70.07	330.50
		3	50.09	70.78	338.19
		Avg.	**50.20**	**70.65**	**335.15**
	90°	1	53.93	74.19	377.37
		2	54.81	75.66	387.42
		3	54.51	75.35	375.33
		Avg.	**54.41**	**75.07**	**380.04**
	Total	**Total avg.**	**52.31**	**72.86**	**357.59**
		Std.	**2.36**	**2.49**	**25.06**
#029	00°	1	49.40	68.43	317.42
		2	49.75	68.65	334.94
		3	49.61	68.84	333.31
		Avg.	**49.58**	**68.64**	**328.55**
	90°	1	52.13	72.25	350.17
		2	57.62	76.05	373.19
		3	52.82	72.66	342.83
		Avg.	**54.19**	**73.65**	**355.40**
	Total	**Total avg.**	**51.89**	**71.15**	**341.98**
		Std.	**3.16**	**3.05**	**18.82**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#031	Base 1	1	51.99	69.06	336.75
		2	51.74	69.41	335.90
		3	51.78	69.23	332.47
		Avg.	**51.84**	**69.23**	**335.04**
	Base 2	1	53.49	70.74	328.47
		2	51.93	69.45	322.27
		3	52.03	69.28	312.37
		Avg.	**52.48**	**69.82**	**321.03**
	Base 3 (90°)	1	50.80	68.19	326.94
		2	50.93	68.12	321.13
		3	51.59	68.99	339.41
		Avg.	**51.11**	**68.43**	**329.16**
	Total	**Total avg.**	**51.81**	**69.16**	**328.41**
		Std.	**0.77**	**0.77**	**8.76**
#032	Base 1	1	52.30	72.50	246.74
		2	54.44	72.74	296.38
		3	51.76	69.66	315.82
		Avg.	**52.83**	**71.63**	**286.31**
	Base 2	1	51.77	72.24	313.10
		2	48.41	68.41	287.06
		3	54.78	74.28	289.72
		Avg.	**51.65**	**71.64**	**296.63**
	Base 3 (90°)	1	50.24	66.73	288.20
		2	50.93	68.61	318.64
		3	51.11	69.26	319.66
		Avg.	**50.76**	**68.20**	**308.83**
	Total	**Total avg.**	**51.75**	**70.49**	**297.26**
		Std.	**1.98**	**2.52**	**23.32**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#033	00°	1	59.30	80.01	290.62
		2	58.99	76.70	337.87
		3	61.51	82.33	289.85
		Avg.	**59.93**	**79.68**	**306.11**
	90°	1	60.24	78.32	323.27
		2	58.93	80.75	266.14
		3	57.52	76.55	298.44
		Avg.	**58.89**	**78.54**	**295.95**
	Total	**Total avg.**	**59.41**	**79.11**	**301.03**
		Std.	**1.35**	**2.32**	**25.73**
#034	00°	1	42.21	57.30	202.00
		2	41.05	57.76	199.57
		3	42.48	57.69	225.33
		Avg.	**41.91**	**57.58**	**208.97**
	90°	1	42.40	57.38	232.70
		2	43.09	58.14	252.06
		3	43.86	58.35	248.46
		Avg.	**43.12**	**57.96**	**244.41**
	Total	**Total avg.**	**42.52**	**57.77**	**226.69**
		Std.	**0.94**	**0.41**	**22.36**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#035	Base 1	1	42.55	56.96	190.57
		2	45.18	57.25	235.76
		3	41.54	58.11	168.00
		Avg.	**43.09**	**57.44**	**198.11**
	Base 2	1	40.03	55.76	179.73
		2	40.95	56.37	186.64
		3	40.63	56.52	185.33
		Avg.	**40.54**	**56.21**	**183.90**
	Base 3 (90°)	1	43.71	57.36	238.53
		2	43.11	58.32	200.69
		3	43.66	57.11	227.33
		Avg.	**43.49**	**57.60**	**222.18**
	Total	**Total avg.**	**42.37**	**57.08**	**201.40**
		Std.	**1.70**	**0.81**	**26.01**
#037	Base 1	1	53.26	74.26	251.40
		2	55.44	74.36	302.06
		3	52.24	73.24	258.88
		Avg.	**53.65**	**73.95**	**270.78**
	Base 2	1	52.30	71.31	234.19
		2	52.65	74.31	235.84
		3	56.62	75.70	275.01
		Avg.	**53.85**	**73.77**	**248.35**
	Base 3 (90°)	1	53.97	73.02	283.29
		2	57.61	75.02	325.70
		3	57.77	75.57	311.60
		Avg.	**56.45**	**74.53**	**306.86**
	Total	**Total avg.**	**54.65**	**74.09**	**275.33**
		Std.	**2.26**	**1.39**	**33.02**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#040	Base 1	1	63.79	83.63	365.67
		2	65.49	84.28	395.26
		3	66.17	84.76	378.43
		Avg.	**65.15**	**84.22**	**379.79**
	Base 2	1	64.32	85.48	398.17
		2	67.01	87.50	418.16
		3	67.16	87.35	426.36
		Avg.	**66.16**	**86.78**	**414.23**
	Base 3 (90°)	1	62.18	77.22	318.19
		2	59.93	78.68	261.42
		3	62.06	76.12	332.45
		Avg.	**61.39**	**77.34**	**304.02**
	Total	**Total avg.**	**64.24**	**82.78**	**366.01**
		Std.	**2.48**	**4.32**	**53.34**
#042	00°	1	47.18	64.40	287.17
		2	47.69	64.57	296.63
		3	46.97	64.33	275.09
		Avg.	**47.28**	**64.43**	**286.29**
	90°	1	46.89	65.22	246.95
		2	46.52	65.57	244.26
		3	43.95	63.25	243.20
		Avg.	**45.79**	**64.68**	**244.80**
	Total	**Total avg.**	**46.54**	**64.56**	**265.55**
		Std.	**1.32**	**0.81**	**23.76**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#043	Base 1	1	49.72	66.89	333.80
		2	49.28	66.56	306.81
		3	49.00	66.12	319.33
		Avg.	**49.34**	**66.52**	**319.98**
	Base 2	1	54.01	70.38	318.25
		2	51.47	68.73	295.09
		3	53.74	69.75	319.90
		Avg.	**53.07**	**69.62**	**311.08**
	Base 3 (90°)	1	52.44	68.06	324.97
		2	54.40	70.83	322.27
		3	52.74	69.15	327.48
		Avg.	**53.20**	**69.35**	**324.91**
	Total	**Total avg.**	**51.87**	**68.50**	**318.66**
		Std.	**2.10**	**1.70**	**11.50**
#044	Base 1	1	62.68	86.38	271.95
		2	63.54	85.93	277.20
		3	62.43	83.16	279.26
		Avg.	**62.88**	**85.16**	**276.14**
	Base 2 (90°)	1	60.90	82.77	276.97
		2	62.43	89.16	251.60
		3	62.02	85.00	265.09
		Avg.	**61.78**	**85.64**	**264.55**
	Total	**Total avg.**	**62.33**	**85.40**	**270.34**
		Std.	**0.87**	**2.34**	**10.51**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#050	00°	1	57.15	76.73	323.64
		2	58.12	76.26	351.54
		3	56.17	75.93	354.60
		Avg.	**57.15**	**76.31**	**343.26**
	90°	1	68.01	88.93	259.91
		2	58.35	72.17	292.90
		3	57.75	72.01	300.72
		Avg.	**61.37**	**77.70**	**284.51**
	Total	**Total avg.**	**59.26**	**77.01**	**313.89**
		Std.	**4.36**	**6.20**	**36.60**
#107	Base 1	1	38.26	49.78	183.95
		2	38.29	50.87	230.42
		3			
		Avg.	**38.27**	**50.32**	**207.18**
	Base 2 (90°)	1	38.77	52.94	224.24
		2	36.06	51.41	212.25
		3	35.13	50.50	211.35
		Avg.	**36.65**	**51.62**	**215.95**
	Total	**Total avg.**	**37.30**	**51.10**	**212.44**
		Std.	**1.61**	**1.19**	**17.85**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#108	00°	1	55.04	73.34	334.85
		2	54.94	73.42	342.87
		3	54.55	73.07	342.70
		Avg.	**54.84**	**73.28**	**340.14**
	90°	1	57.00	74.95	367.74
		2	59.32	77.43	322.63
		3	54.46	73.77	342.46
		Avg.	**56.93**	**75.38**	**344.28**
	Total	**Total avg.**	**55.89**	**74.33**	**342.21**
		Std.	**1.92**	**1.66**	**14.77**
#109	00°	1	44.43	60.45	283.36
		2	44.20	60.57	288.00
		3	43.12	60.44	268.58
		Avg.	**43.92**	**60.49**	**279.98**
	90°	1	45.42	62.05	273.94
		2	44.50	61.52	266.55
		3	43.84	61.71	286.01
		Avg.	**44.59**	**61.76**	**275.50**
	Total	**Total avg.**	**44.25**	**61.12**	**277.74**
		Std.	**0.76**	**0.72**	**9.26**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#110	00°	1	50.26	67.28	305.09
		2	51.32	67.22	299.61
		3	52.48	66.38	303.28
		Avg.	**51.35**	**66.96**	**302.66**
	90°	1	53.85	69.07	326.15
		2	51.16	70.10	312.15
		3	51.78	72.49	296.87
		Avg.	**52.26**	**70.55**	**311.72**
	Total	**Total avg.**	**51.81**	**68.76**	**307.19**
		Std.	**1.24**	**2.28**	**10.65**
#111	Base 1	1	46.87	62.93	293.69
		2	46.88	61.04	277.14
		3	47.18	60.63	264.89
		Avg.	**46.98**	**61.53**	**278.57**
	Base 2 (90°)	1	49.95	67.06	317.36
		2	47.32	64.96	299.36
		3	46.23	63.77	283.57
		Avg.	**47.83**	**65.26**	**300.10**
	Total	**Total avg.**	**47.40**	**63.40**	**289.33**
		Std.	**1.30**	**2.43**	**18.36**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#112	Base 1	1	46.63	63.91	313.38
		2	45.40	62.08	275.52
		3	45.05	62.00	276.07
		Avg.	45.70	62.66	288.32
	Base 2 (90°)	1	49.02	65.31	308.31
		2	47.65	65.06	291.14
		3	48.68	65.61	312.05
		Avg.	48.45	65.33	303.83
	Total	**Total avg.**	**47.07**	**63.99**	**296.08**
		Std.	**1.66**	**1.62**	**17.61**
#113	Base 1	1	48.37	64.69	287.73
		2	47.40	64.50	286.36
		3	47.21	64.33	272.90
		Avg.	47.66	64.51	282.33
	Base 2 (90°)	1	48.38	64.52	306.07
		2	47.87	64.25	287.35
		3	46.99	64.10	293.89
		Avg.	47.75	64.29	295.77
	Total	**Total avg.**	**47.71**	**64.40**	**289.05**
		Std.	**0.60**	**0.21**	**10.83**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#114	Base 1	1	48.25	64.03	310.95
		2	48.32	64.25	306.46
		3	47.48	63.41	284.80
		Avg.	48.01	63.90	300.74
	Base 2 (90°)	1	45.98	56.10	251.92
		2	45.91	56.01	249.28
		3	43.01	55.45	197.22
		Avg.	44.96	55.86	232.81
	Total	**Total avg.**	**46.49**	**59.88**	**266.77**
		Std.	**2.00**	**4.42**	**42.93**
#115	Base 1	1	43.64	59.80	244.60
		2	45.47	60.55	261.80
		3	46.27	61.35	265.44
		Avg.	45.13	60.57	257.28
	Base 2 (90°)	1	46.58	61.39	275.76
		2	46.64	61.51	284.79
		3	46.02	60.87	265.91
		Avg.	46.41	61.26	275.49
	Total	**Total avg.**	**45.77**	**60.91**	**266.38**
		Std.	**1.13**	**0.65**	**13.59**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#116	Base 1	1	44.00	56.56	246.95
		2	46.01	59.81	266.61
		3	46.21	61.87	275.75
		Avg.	45.41	59.41	263.11
	Base 2 (90°)	1	45.80	61.93	282.49
		2	45.34	61.42	284.05
		3	44.59	61.42	288.59
		Avg.	45.24	61.59	285.04
	Total	**Total avg.**	**45.32**	**60.50**	**274.07**
		Std.	**0.87**	**2.08**	**15.33**
#117	00°	1	55.42	76.27	377.42
		2	55.74	74.86	344.34
		3	55.39	74.60	328.47
		Avg.	55.52	75.24	350.08
	90°	1	58.35	77.94	372.32
		2	58.17	78.19	373.82
		3	58.16	78.89	380.21
		Avg.	58.23	78.34	375.45
	Total	**Total avg.**	**56.87**	**76.79**	**362.76**
		Std.	**1.49**	**1.81**	**21.20**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#118	00°	1	55.53	74.23	345.90
		2	53.80	73.48	330.68
		3	54.13	73.32	345.84
		Avg.	54.49	73.68	340.81
	90°	1	56.59	73.63	362.67
		2	55.80	74.24	369.72
		3	55.63	74.89	381.65
		Avg.	56.01	74.25	371.35
	Total	**Total avg.**	**55.25**	**73.97**	**356.08**
		Std.	**1.06**	**0.60**	**18.64**
#119	Base 1	1	58.57	78.41	393.59
		2	58.01	78.29	392.84
		3	59.03	79.39	377.39
		Avg.	58.54	78.70	387.94
	Base 2	1	60.45	81.04	422.56
		2	59.52	80.84	385.89
		3	59.46	80.51	413.82
		Avg.	59.81	80.80	407.42
	Base 3 (90°)	1	56.73	76.90	356.65
		2	56.51	77.29	371.63
		3	57.00	77.25	368.42
		Avg.	56.75	77.15	365.56
	Total	**Total avg.**	**58.37**	**78.88**	**386.98**
		Std.	**1.39**	**1.62**	**21.38**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#121	00°	1	56.92	74.59	300.77
		2	52.74	71.51	293.30
		3	52.77	70.34	333.94
		Avg.	54.14	72.15	309.34
	90°	1	51.48	68.81	303.79
		2	50.88	69.15	301.27
		3	52.15	69.57	314.42
		Avg.	51.51	69.18	306.49
	Total	**Total avg.**	**52.82**	**70.66**	**307.91**
		Std.	**2.14**	**2.15**	**14.46**
#122	Base 1	1	58.69	76.34	362.17
		2	57.46	76.56	365.26
		3	56.40	75.97	340.31
		Avg.	57.52	76.29	355.91
	Base 2	1	56.31	74.83	352.36
		2	55.96	74.70	342.61
		3	56.21	75.13	343.22
		Avg.	56.16	74.89	346.06
	Base 3 (90°)	1	56.94	75.73	364.83
		2	57.65	75.77	365.46
		3	57.23	76.17	370.44
		Avg.	57.27	75.89	366.91
	Total	**Total avg.**	**56.98**	**75.69**	**356.29**
		Std.	**0.87**	**0.66**	**11.73**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#123	00°	1	57.69	77.86	309.62
		2	59.63	78.72	353.45
		3	58.99	78.49	364.15
		Avg.	58.77	78.36	342.41
	90°	1	61.03	79.54	360.46
		2	61.03	79.44	336.16
		3	59.71	79.02	350.34
		Avg.	60.59	79.33	348.98
	Total	**Total avg.**	**59.68**	**78.85**	**345.69**
		Std.	**1.27**	**0.63**	**20.16**
#124	Base 1	1	47.25	65.52	238.22
		2	47.48	65.59	235.81
		3	46.72	64.93	252.28
		Avg.	47.15	65.34	242.10
	Base 2 (90°)	1	46.43	63.93	227.30
		2	49.16	66.58	228.25
		3	47.28	65.26	231.76
		Avg.	47.63	65.26	229.11
	Total	**Total avg.**	**47.39**	**65.30**	**235.60**
		Std.	**0.95**	**0.87**	**9.20**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#125	Base 1	1	58.42	79.23	302.70
		2	59.38	79.63	309.33
		3	60.09	79.98	317.65
		Avg.	59.30	79.62	309.89
	Base 2	1	59.92	79.45	334.26
		2	57.71	79.33	288.29
		3	57.51	78.58	325.96
		Avg.	58.38	79.12	316.17
	Base 3 (90°)	1	60.73	81.50	297.26
		2	60.29	81.58	288.35
		3	60.35	82.12	301.86
		Avg.	60.45	81.74	295.82
	Total	**Total avg.**	**59.38**	**80.16**	**307.29**
		Std.	**1.20**	**1.25**	**16.04**
#126	Base 1	1	54.96	75.84	284.29
		2	54.72	75.68	298.81
		3	55.97	75.55	323.81
		Avg.	55.22	75.69	302.30
	Base 2	1	55.73	79.27	255.21
		2	61.48	79.67	407.36
		3	59.16	79.38	327.77
		Avg.	58.79	79.44	330.11
	Base 3 (90°)	1	63.55	81.71	391.65
		2	60.75	81.19	361.38
		3	57.49	80.01	307.20
		Avg.	60.60	80.97	353.41
	Total	**Total avg.**	**58.20**	**78.70**	**328.61**
		Std.	**3.18**	**2.40**	**49.96**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#127	00°	1	56.04	74.70	344.89
		2	55.46	74.45	340.08
		3	55.78	74.59	344.74
		Avg.	55.76	74.58	343.24
	90°	1	55.32	76.58	294.71
		2	56.22	76.86	317.89
		3	56.85	77.18	325.25
		Avg.	56.13	76.88	312.61
	Total	**Total avg.**	**55.95**	**75.73**	**327.93**
		Std.	**0.56**	**1.28**	**19.65**
#130	Base 1	1	53.66	70.14	329.04
		2	51.79	69.67	297.09
		3	52.53	69.93	314.12
		Avg.	52.66	69.91	313.41
	Base 2 (90°)	1	52.06	69.38	312.79
		2	52.09	69.50	301.77
		3	53.22	70.22	326.95
		Avg.	52.46	69.70	313.84
	Total	**Total avg.**	**52.56**	**69.81**	**313.63**
		Std.	**0.73**	**0.35**	**12.89**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#132	00°	1	56.44	73.59	324.49
		2	54.70	75.06	320.14
		3	57.34	77.19	367.92
		Avg.	56.16	75.28	337.52
	90°	1	54.21	76.34	292.53
		2	55.41	76.64	322.30
		3	57.22	77.70	348.89
		Avg.	55.61	76.89	321.24
	Total	**Total avg.**	**55.89**	**76.09**	**329.38**
		Std.	**1.32**	**1.52**	**26.01**
#133	Base 1	1	49.04	66.09	305.43
		2	49.15	66.23	310.78
		3	48.31	65.89	294.91
		Avg.	48.83	66.07	303.71
	Base 2 (90°)	1	48.89	65.81	299.83
		2	48.90	66.08	311.25
		3	48.66	65.94	304.36
		Avg.	48.82	65.94	305.15
	Total	**Total avg.**	**48.83**	**66.01**	**304.43**
		Std.	**0.30**	**0.15**	**6.32**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#134	Base 1	1	49.38	63.12	229.79
		2	47.90	63.43	247.17
		3	50.56	66.25	259.23
		Avg.	49.28	64.27	245.40
	Base 2 (90°)	1	52.81	68.71	294.14
		2	47.96	67.36	240.34
		3	51.24	68.35	297.66
		Avg.	50.67	68.14	277.38
	Total	**Total avg.**	**49.97**	**66.20**	**261.39**
		Std.	**1.94**	**2.43**	**28.41**
#136	00°	1	55.87	80.07	321.57
		2	57.89	80.00	330.61
		3	58.99	80.59	358.72
		Avg.	57.58	80.22	336.97
	90°	1	62.95	82.38	354.89
		2	61.37	81.57	368.19
		3	59.22	82.50	285.61
		Avg.	61.18	82.15	336.23
	Total	**Total avg.**	**59.38**	**81.18**	**336.60**
		Std.	**2.51**	**1.12**	**30.61**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#137	Base 1	1	50.90	68.27	272.75
		2	51.75	68.41	318.61
		3	48.43	67.58	233.33
		Avg.	50.36	68.09	274.90
	Base 2 (90°)	1	55.82	70.95	300.94
		2	55.36	71.14	320.28
		3	51.53	68.98	277.34
		Avg.	54.24	70.36	299.52
	Total	**Total avg.**	**52.30**	**69.22**	**287.21**
		Std.	**2.81**	**1.48**	**33.10**
#138	00°	1	52.63	72.31	337.28
		2	53.87	72.80	345.63
		3	53.01	72.23	325.47
		Avg.	53.17	72.45	336.12
	90°	1	53.81	73.13	337.33
		2	53.39	73.23	283.98
		3	54.05	73.91	345.02
		Avg.	53.75	73.42	322.11
	Total	**Total avg.**	**53.46**	**72.93**	**329.12**
		Std.	**0.56**	**0.63**	**23.28**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#139	00°	1	58.05	77.83	346.17
		2	57.03	78.01	293.58
		3	55.61	78.49	283.22
		Avg.	56.90	78.11	307.65
	90°	1	55.86	76.72	308.42
		2	56.17	76.94	310.23
		3	56.34	77.27	295.35
		Avg.	56.12	76.97	304.67
	Total	**Total avg.**	**56.51**	**77.54**	**306.16**
		Std.	**0.90**	**0.68**	**22.02**
#140	Base 1	1	55.58	74.63	358.55
		2	57.43	75.71	373.25
		3	54.89	74.69	370.39
		Avg.	55.97	75.01	367.40
	Base 2 (90°)	1	55.42	70.28	315.87
		2	55.58	72.09	351.48
		3	56.17	73.43	382.98
		Avg.	55.73	71.93	350.11
	Total	**Total avg.**	**55.85**	**73.47**	**358.75**
		Std.	**0.88**	**2.00**	**23.77**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#141	Base 1	1	59.34	77.73	353.11
		2	57.19	77.82	323.36
		3	54.98	78.55	253.74
		Avg.	57.17	78.03	310.07
	Base 2 (90°)	1	60.11	80.12	364.61
		2	59.54	80.04	352.37
		3	59.48	80.03	360.12
		Avg.	59.71	80.07	359.03
	Total	**Total avg.**	**58.44**	**79.05**	**334.55**
		Std.	**1.97**	**1.15**	**42.13**
#142	Base 1	1	51.35	64.19	284.39
		2	49.81	65.59	273.34
		3	51.98	68.30	291.57
		Avg.	51.05	66.03	283.10
	Base 2 (90°)	1	55.09	71.72	323.13
		2	51.39	69.12	283.80
		3	51.49	70.55	282.23
		Avg.	52.66	70.46	296.39
	Total	**Total avg.**	**51.85**	**68.24**	**289.74**
		Std.	**1.75**	**2.89**	**17.37**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#143	Base 1	1	54.53	72.55	311.10
		2	51.50	71.63	262.07
		3	52.57	71.76	284.18
		Avg.	52.87	71.98	285.78
	Base 2 (90°)	1	53.06	70.51	283.16
		2	54.78	72.72	282.81
		3	53.73	72.01	266.34
		Avg.	53.86	71.74	277.44
	Total	**Total avg.**	**53.36**	**71.86**	**281.61**
		Std.	**1.24**	**0.79**	**17.29**
#144	Base 1	1	56.83	75.79	325.09
		2	54.32	73.64	314.81
		3	54.79	74.71	285.31
		Avg.	55.31	74.71	308.40
	Base 2	1	55.72	73.83	346.23
		2	53.51	73.87	305.49
		3	56.42	74.63	346.51
		Avg.	55.22	74.11	332.74
	Base 3 (90°)	1	55.70	78.68	253.67
		2	53.87	76.07	262.81
		3	56.25	74.96	324.38
		Avg.	55.27	76.57	280.29
	Total	**Total avg.**	**55.27**	**75.13**	**307.14**
		Std.	**1.19**	**1.58**	**33.65**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#145	00°	1	52.49	71.36	337.24
		2	52.46	72.03	343.77
		3	52.02	71.52	337.72
		Avg.	52.32	71.63	339.58
	90°	1	54.02	72.38	337.47
		2	52.06	71.53	315.32
		3	52.88	72.26	341.17
		Avg.	52.99	72.06	331.32
	Total	**Total avg.**	**52.65**	**71.85**	**335.45**
		Std.	**0.74**	**0.43**	**10.19**
#146	00°	1	38.65	54.47	192.01
		2	39.83	54.67	212.53
		3	39.95	54.19	216.03
		Avg.	39.48	54.45	206.86
	90°	1	39.07	52.48	210.14
		2	39.12	52.84	222.29
		3	38.47	52.20	221.54
		Avg.	38.89	52.51	217.99
	Total	**Total avg.**	**39.18**	**53.48**	**212.42**
		Std.	**0.60**	**1.09**	**11.09**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#147	00°	1	54.91	72.24	335.40
		2	52.29	70.57	318.84
		3	49.81	67.80	281.18
		Avg.	52.34	70.21	311.81
	90°	1	51.01	68.46	314.14
		2	51.24	67.45	318.81
		3	50.63	67.38	317.67
		Avg.	50.96	67.76	316.87
	Total	**Total avg.**	**51.65**	**68.98**	**314.34**
		Std.	**1.79**	**1.99**	**17.86**
#148	00°	1	49.37	67.73	304.91
		2	51.36	68.32	315.92
		3	52.11	69.49	306.33
		Avg.	50.95	68.51	309.05
	90°	1	53.85	70.03	380.87
		2	52.51	69.48	343.68
		3	51.47	68.32	318.45
		Avg.	52.61	69.28	347.67
	Total	**Total avg.**	**51.78**	**68.90**	**328.36**
		Std.	**1.48**	**0.90**	**29.26**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#149	00°	1	51.31	70.26	352.93
		2	50.59	69.92	345.01
		3	51.98	71.12	347.18
		Avg.	51.29	70.43	348.37
	90°	1	53.43	72.71	358.35
		2	52.87	71.74	322.26
		3	52.72	71.54	317.97
		Avg.	53.01	71.99	332.86
	Total	**Total avg.**	**52.15**	**71.21**	**340.62**
		Std.	**1.06**	**1.02**	**16.60**
#150	00°	1	52.31	69.47	315.78
		2	50.38	69.83	302.01
		3	51.53	69.75	294.25
		Avg.	51.41	69.68	304.02
	90°	1	50.46	68.16	313.03
		2	49.69	68.03	317.42
		3	49.50	68.39	291.00
		Avg.	49.88	68.19	307.15
	Total	**Total avg.**	**50.64**	**68.94**	**305.58**
		Std.	**1.09**	**0.83**	**11.43**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#151	00°	1	55.64	70.48	335.50
		2	54.98	74.16	310.08
		3	54.62	73.10	352.59
		Avg.	55.08	72.58	332.72
	90°	1	52.21	70.16	327.63
		2	49.49	68.66	268.77
		3	50.89	68.89	303.83
		Avg.	50.86	69.24	300.07
	Total	**Total avg.**	**52.97**	**70.91**	**316.40**
		Std.	**2.49**	**2.25**	**29.22**
#155	00°	1	50.72	68.96	314.75
		2	51.77	69.54	327.39
		3	50.64	68.75	273.58
		Avg.	51.05	69.09	305.24
	90°	1	51.84	70.15	333.20
		2	51.38	69.60	272.24
		3	52.34	70.24	326.48
		Avg.	51.85	70.00	310.64
	Total	**Total avg.**	**51.45**	**69.54**	**307.94**
		Std.	**0.67**	**0.60**	**27.79**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#165	Base 1	1	50.32	67.81	291.99
		2	51.25	69.11	298.50
		3	52.44	69.51	325.89
		Avg.	51.34	68.81	305.46
	Base 2	1	51.63	69.01	316.71
		2	50.47	68.27	292.21
		3	51.32	68.57	317.06
		Avg.	51.14	68.62	308.66
	Base 3 (90°)	1	52.84	67.93	319.32
		2	52.82	69.53	313.37
		3	50.46	67.80	311.43
		Avg.	52.04	68.42	314.71
	Total	**Total avg.**	**51.51**	**68.62**	**309.61**
		Std.	**1.00**	**0.70**	**12.35**
#167	Base 1	1	55.25	73.26	333.47
		2	54.50	73.02	326.55
		3	55.72	73.67	323.10
		Avg.	55.16	73.31	327.71
	Base 2	1	55.31	73.88	316.68
		2	54.49	73.83	284.14
		3	55.23	73.60	329.76
		Avg.	55.01	73.77	310.19
	Base 3 (90°)	1	54.86	72.89	318.00
		2	53.52	72.22	320.47
		3	55.59	73.50	356.30
		Avg.	54.66	72.87	331.59
	Total	**Total avg.**	**54.94**	**73.32**	**323.16**
		Std.	**0.69**	**0.54**	**18.90**

(Continues)

Pipe #	Location	No.	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
#169	Base 1	1	51.18	68.39	290.48
		2	51.86	69.04	315.47
		3	49.50	67.56	264.07
		Avg.	50.85	68.33	290.01
	Base 2	1	50.53	67.96	306.92
		2	50.41	68.10	286.40
		3	50.67	68.34	298.42
		Avg.	50.54	68.14	297.25
	Base 3 (90°)	1	52.04	69.82	317.02
		2	52.01	70.14	334.24
		3	52.67	71.09	303.22
		Avg.	52.24	70.35	318.16
	Total	**Total avg.**	**51.21**	**68.94**	**301.81**
		Std.	**1.01**	**1.18**	**20.31**
#170	Base 1	1	55.73	72.36	294.66
		2	56.03	73.77	319.05
		3	55.15	68.28	281.30
		Avg.	55.64	71.47	298.34
	Base 2	1	60.24	77.47	343.86
		2	56.97	76.01	328.91
		3	59.05	77.86	329.74
		Avg.	58.76	77.11	334.17
	Base 3 (90°)	1	59.63	77.73	336.99
		2	57.54	74.93	357.83
		3	57.95	75.60	347.10
		Avg.	58.38	76.09	347.31
	Total	**Total avg.**	**57.59**	**74.89**	**326.61**
		Std.	**1.79**	**3.09**	**24.86**

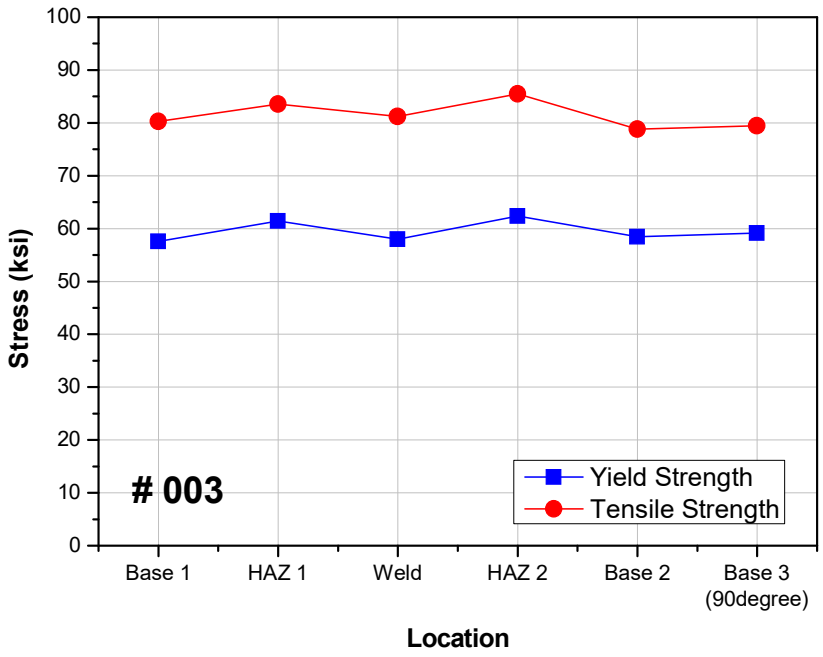
(4) Analysis results of seam weld pipe

Pipe # : # 003

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	57.60	80.31	294.59
HAZ 1	61.46	83.56	320.76
Weld	58.00	81.21	278.01
HAZ 2	62.40	85.50	291.37
Base 2	58.46	78.80	286.68
Base 3 (90°)	59.14	79.44	304.37

< Comparison graph – Yield and Tensile Strength >



< Detail results >

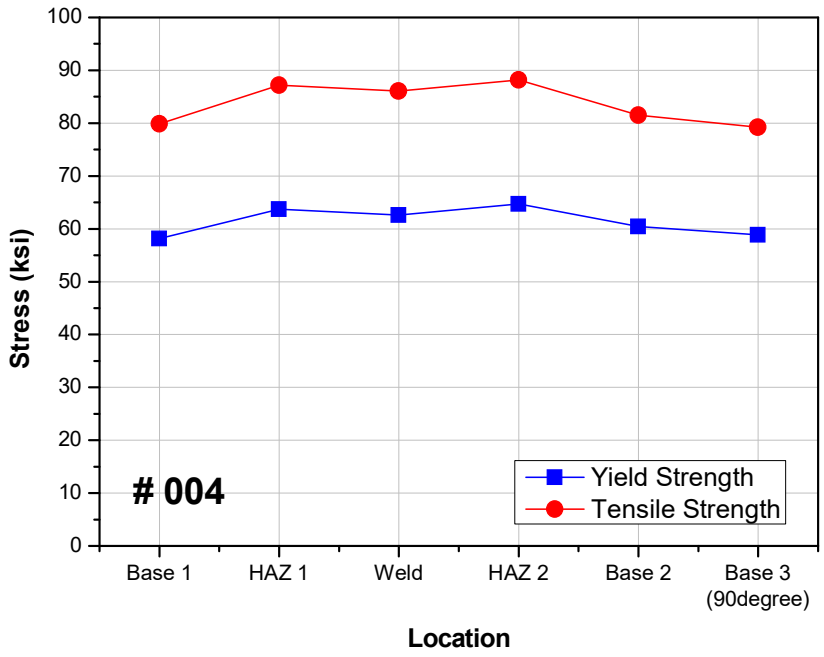
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 003	Base 1	1	58.10	80.02	297.46
		2	57.25	80.67	294.22
		3	57.46	80.24	292.09
	HAZ 1	1	61.89	83.24	331.31
		2	62.67	83.26	337.76
		3	59.82	84.20	293.21
	Weld	1	57.33	82.02	279.08
		2	58.33	80.90	281.32
		3	58.32	80.72	273.64
	HAZ 2	1	62.72	84.74	301.48
		2	61.72	86.24	277.61
		3	62.77	85.53	295.02
	Base 2	1	58.84	77.80	311.40
		2	57.47	77.76	283.48
		3	59.08	80.84	265.15
	Base 3 (90°)	1	56.43	77.53	290.80
		2	60.06	79.21	329.87
		3	60.94	81.58	292.45

Pipe# : # 004

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	58.16	79.90	272.13
HAZ 1	63.74	87.18	310.88
Weld	62.63	86.08	313.55
HAZ 2	64.74	88.18	313.98
Base 2	60.45	81.53	320.54
Base 3 (90°)	58.87	79.20	325.41

< Comparison graph – Yield and Tensile Strength >



< Detail results >

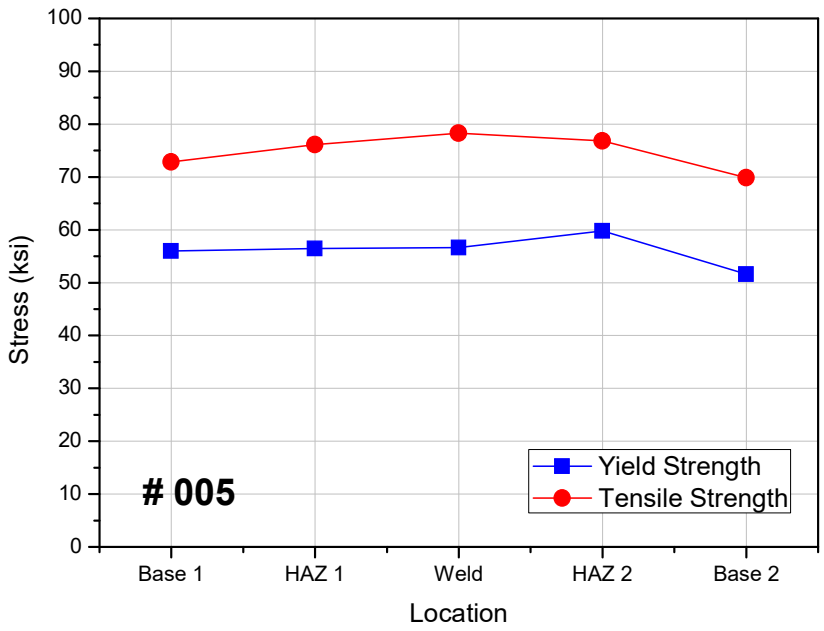
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 004	Base 1	1	56.70	77.27	256.24
		2	56.19	79.92	264.49
		3	61.59	82.50	295.67
	HAZ 1	1	63.32	87.14	306.63
		2	63.77	87.21	308.85
		3	64.15	87.21	317.16
	Weld	1	63.22	85.75	331.14
		2	61.58	86.81	283.60
		3	63.08	85.67	325.91
	HAZ 2	1	66.38	89.51	311.97
		2	62.55	87.49	300.50
		3	65.28	87.56	329.48
	Base 2	1	63.43	82.72	343.22
		2	60.45	81.29	320.04
		3	57.48	80.59	298.38
	Base 3 (90°)	1	59.40	78.98	338.16
		2	58.07	79.21	305.48
		3	59.13	79.41	332.58

Pipe# : # 005

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	55.98	72.84	291.23
HAZ 1	56.49	76.14	261.66
Weld	56.62	78.31	252.72
HAZ 2	59.80	76.80	366.07
Base 2	51.61	69.85	252.59

< Comparison graph – Yield and Tensile Strength >



< Detail results >

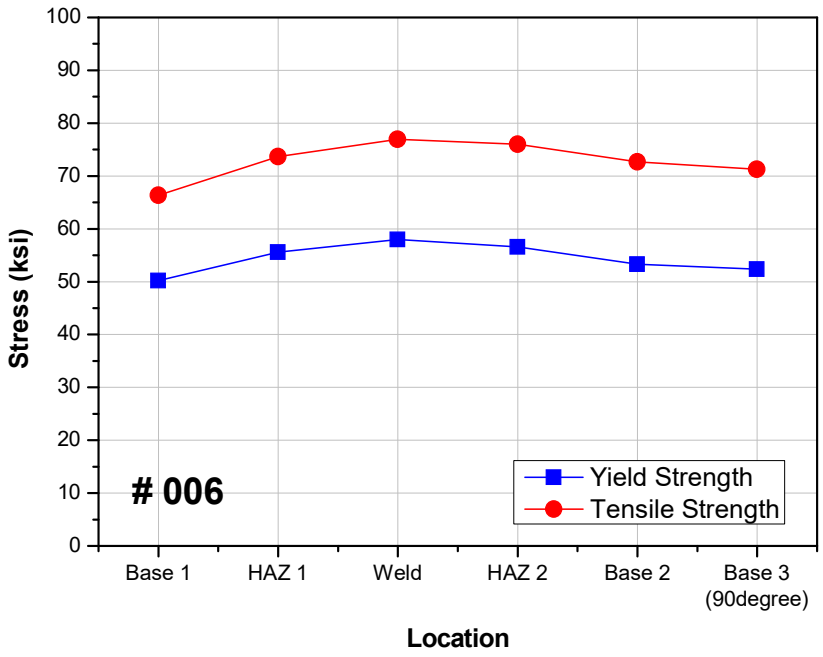
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 005	Base 1	1	55.89	71.99	303.62
		2	58.15	75.19	297.90
		3	53.89	71.34	272.17
	HAZ 1	1	55.48	75.59	256.20
		2	56.27	76.73	257.81
		3	57.73	76.11	270.98
	Weld	1	56.42	79.06	245.33
		2	57.22	78.41	262.95
		3	56.22	77.45	249.87
	HAZ 2	1	59.69	75.29	342.89
		2	57.22	76.18	279.64
		3	62.49	78.94	475.68
	Base 2	1	51.89	71.22	242.94
		2	51.02	69.44	256.59
		3	51.92	68.89	258.24

Pipe# : # 006

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	50.20	66.35	199.12
HAZ 1	55.60	73.66	228.87
Weld	57.97	76.94	259.00
HAZ 2	56.57	75.99	271.10
Base 2	53.30	72.66	245.00
Base 3 (90°)	52.35	71.26	241.92

< Comparison graph – Yield and Tensile Strength >



< Detail results >

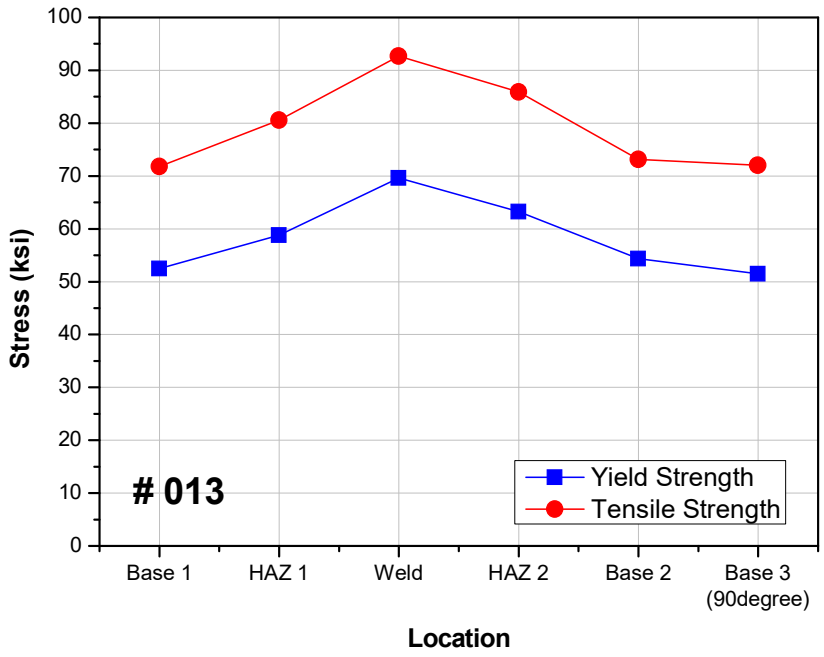
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 006	Base 1	1	50.44	67.33	194.09
		2	49.54	66.52	197.54
		3	50.62	65.21	205.74
	HAZ 1	1	53.36	73.71	202.47
		2	56.33	73.82	236.90
		3	57.09	73.44	247.26
	Weld	1	57.80	75.54	264.75
		2	58.58	78.09	249.38
		3	57.54	77.19	262.88
	HAZ 2	1	56.25	75.17	270.48
		2	56.72	76.04	274.36
		3	56.76	76.76	268.47
	Base 2	1	52.53	71.59	252.68
		2	53.37	72.99	240.98
		3	54.00	73.41	241.34
	Base 3 (90°)	1	52.59	70.94	243.42
		2	52.53	70.23	265.63
		3	51.94	72.61	216.72

Pipe# : # 013

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	52.46	71.77	277.32
HAZ 1	58.81	80.60	294.26
Weld	69.62	92.67	361.33
HAZ 2	63.26	85.92	310.29
Base 2	54.37	73.14	254.16
Base 3 (90°)	51.52	72.04	239.11

< Comparison graph – Yield and Tensile Strength >



< Detail results >

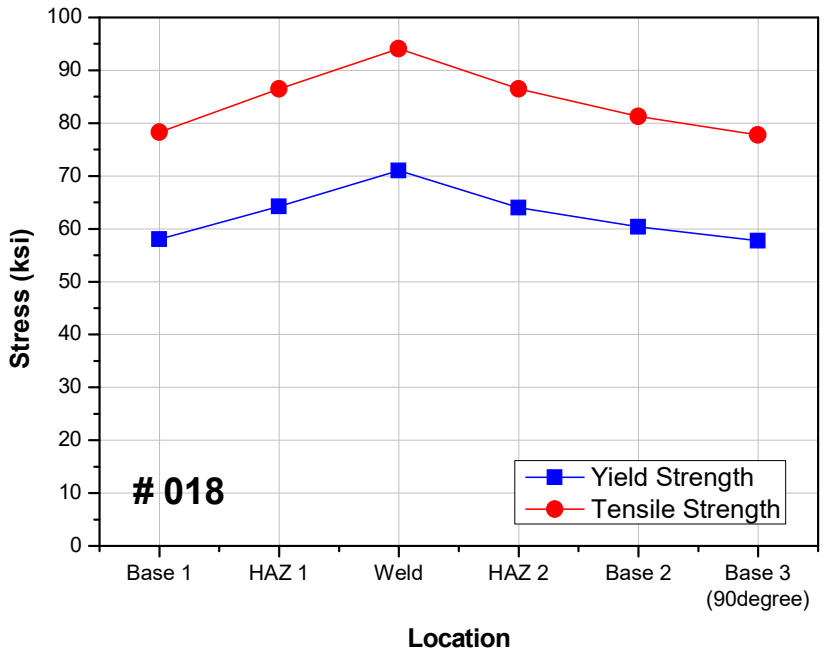
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 013	Base 1	1	53.25	71.77	294.79
		2	51.35	71.90	262.59
		3	52.77	71.65	274.58
	HAZ 1	1	59.83	81.04	301.66
		2	58.05	80.40	291.92
		3	58.53	80.37	289.19
	Weld	1	69.62	93.55	340.05
		2	70.41	92.92	376.12
		3	68.82	91.53	367.81
	HAZ 2	1	62.23	84.65	303.91
		2	63.42	85.80	316.85
		3	64.13	87.31	310.12
	Base 2	1	53.02	73.11	234.67
		2	54.68	73.62	248.56
		3	55.40	72.70	279.24
	Base 3 (90°)	1	51.36	71.51	234.55
		2	50.44	72.17	237.07
		3	52.75	72.44	245.73

Pipe# : # 018

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	58.06	78.29	357.29
HAZ 1	64.27	86.51	363.46
Weld	71.06	94.07	412.62
HAZ 2	64.00	86.47	358.61
Base 2	60.36	81.26	336.35
Base 3 (90°)	57.73	77.77	343.04

< Comparison graph – Yield and Tensile Strength >



< Detail results >

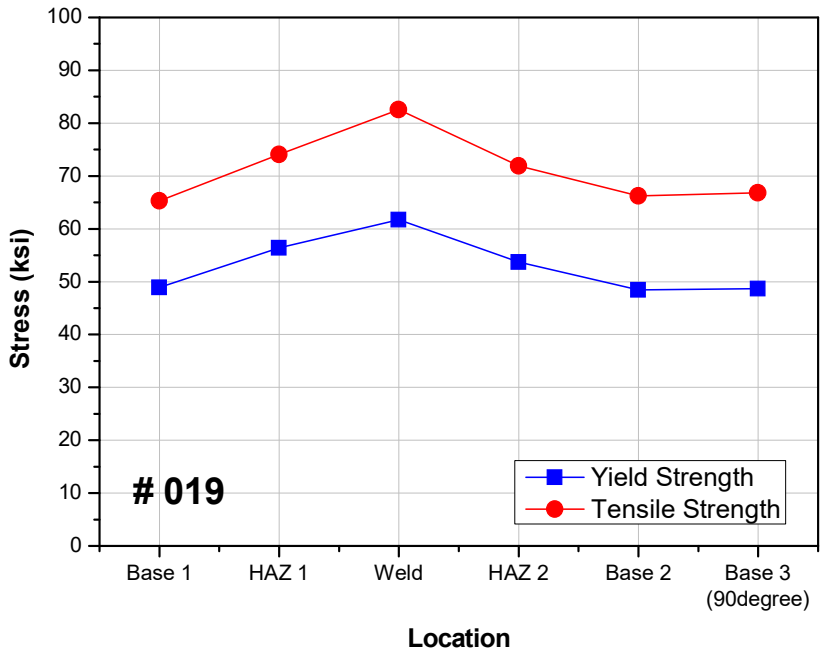
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 018	Base 1	1	59.11	79.12	367.38
		2	56.98	77.23	329.24
		3	58.09	78.53	375.25
	HAZ 1	1	64.88	86.53	376.41
		2	63.46	86.17	354.41
		3	64.47	86.82	359.55
	Weld	1	72.09	94.43	448.54
		2	70.94	94.16	404.73
		3	70.14	93.62	384.58
	HAZ 2	1	62.14	86.46	312.19
		2	65.58	86.46	391.03
		3	64.27	86.50	372.63
	Base 2	1	59.25	79.98	360.88
		2	61.45	82.05	343.03
		3	60.39	81.75	305.14
	Base 3 (90°)	1	56.18	76.24	324.83
		2	58.53	78.92	324.54
		3	58.48	78.16	379.75

Pipe# : # 019

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	48.89	65.29	269.41
HAZ 1	56.38	74.07	330.25
Weld	61.75	82.59	334.64
HAZ 2	53.69	71.94	287.92
Base 2	48.46	66.25	260.85
Base 3 (90°)	48.68	66.85	239.56

< Comparison graph – Yield and Tensile Strength >



< Detail results >

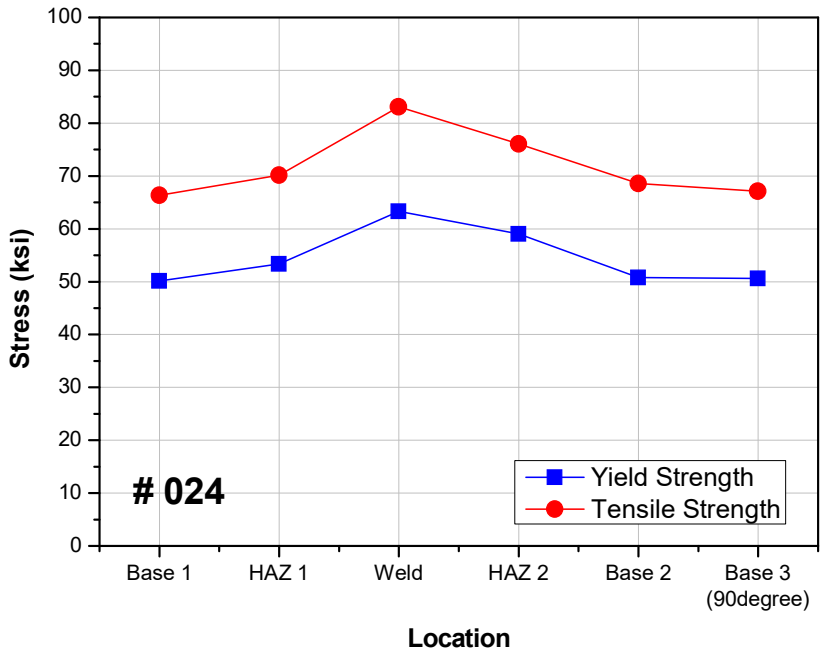
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 019	Base 1	1	48.48	65.88	247.45
		2	48.51	64.58	275.58
		3	49.66	65.41	285.20
	HAZ 1	1	54.89	73.39	294.70
		2	57.05	74.16	349.43
		3	57.22	74.66	346.62
	Weld	1	62.96	83.44	310.65
		2	62.40	81.94	353.45
		3	59.88	82.40	339.82
	HAZ 2	1	54.57	72.07	297.85
		2	52.06	71.48	271.22
		3	54.45	72.26	294.70
	Base 2	1	47.99	65.76	245.18
		2	51.01	66.94	296.99
		3	46.36	66.07	240.38
	Base 3 (90°)	1	48.13	66.47	225.14
		2	49.36	66.28	278.63
		3	48.55	67.78	214.93

Pipe# : # 024

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	50.17	66.35	298.46
HAZ 1	53.35	70.15	302.04
Weld	63.32	83.09	349.19
HAZ 2	59.02	76.04	332.04
Base 2	50.79	68.56	272.77
Base 3 (90°)	50.63	67.14	294.11

< Comparison graph – Yield and Tensile Strength >



< Detail results >

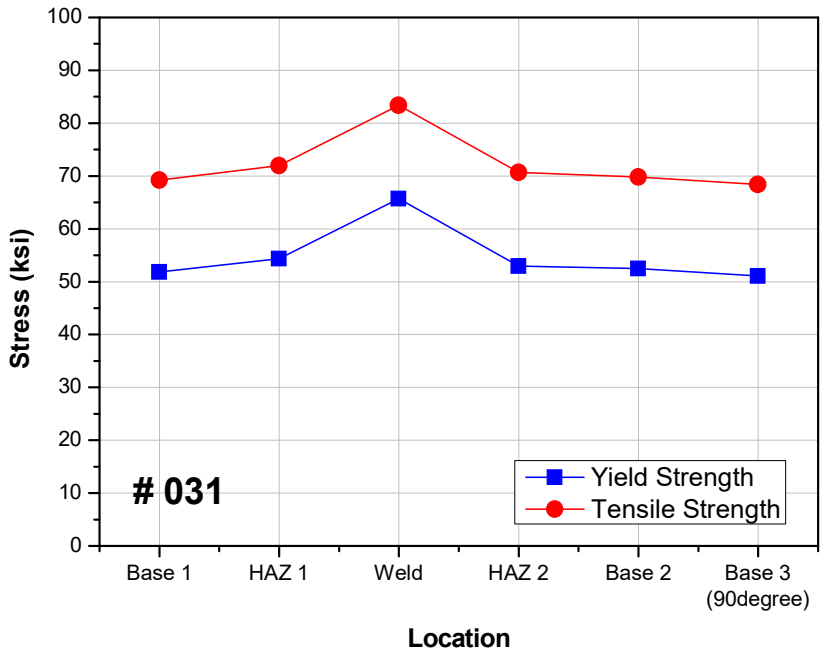
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 024	Base 1	1	49.82	65.42	294.87
		2	50.85	66.84	303.54
		3	49.85	66.80	296.97
	HAZ 1	1	52.87	69.77	291.23
		2	53.93	70.42	315.64
		3	53.24	70.27	299.24
	Weld	1	63.91	82.90	360.05
		2	63.02	83.09	355.62
		3	63.03	83.29	331.92
	HAZ 2	1	60.28	77.07	333.31
		2	58.10	75.88	318.76
		3	58.68	75.18	344.06
	Base 2	1	49.97	68.61	246.39
		2	50.70	68.41	273.69
		3	51.72	68.66	298.24
	Base 3 (90°)	1	50.56	67.00	298.88
		2	50.87	67.33	306.41
		3	50.46	67.08	277.04

Pipe# : # 031

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	51.84	69.23	335.04
HAZ 1	54.34	71.96	355.62
Weld	65.69	83.40	419.83
HAZ 2	52.97	70.71	326.51
Base 2	52.48	69.82	321.03
Base 3 (90°)	51.11	68.43	329.16

< Comparison graph – Yield and Tensile Strength >



< Detail results >

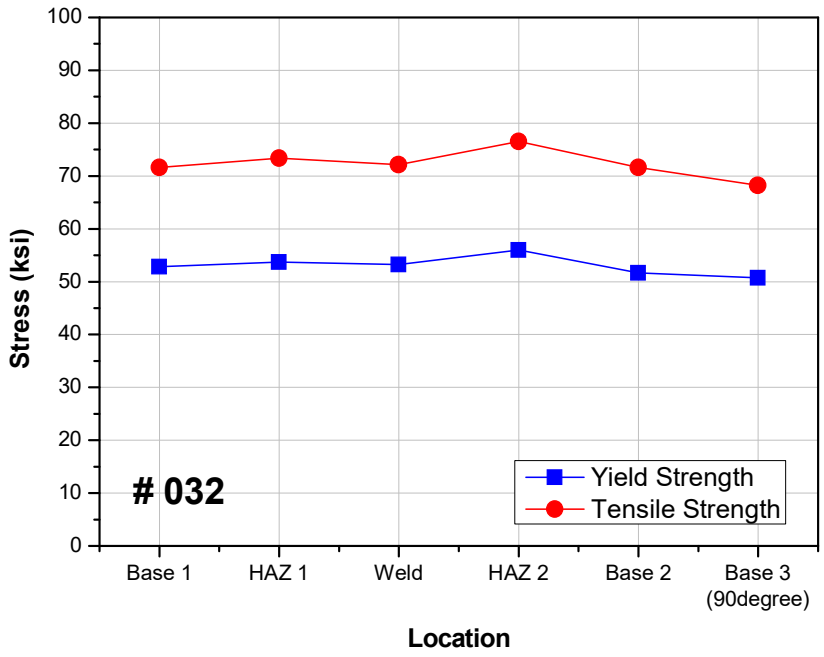
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 031	Base 1	1	51.99	69.06	336.75
		2	51.74	69.41	335.90
		3	51.78	69.23	332.47
	HAZ 1	1	54.14	71.92	356.36
		2	54.50	72.06	350.92
		3	54.38	71.91	359.59
	Weld	1	66.29	83.76	445.20
		2	65.35	83.61	404.21
		3	65.42	82.83	410.09
	HAZ 2	1	52.58	70.25	330.54
		2	53.28	70.82	307.95
		3	53.04	71.06	341.03
	Base 2	1	53.49	70.74	328.47
		2	51.93	69.45	322.27
		3	52.03	69.28	312.37
	Base 3 (90°)	1	50.80	68.19	326.94
		2	50.93	68.12	321.13
		3	51.59	68.99	339.41

Pipe# : # 032

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	52.83	71.63	286.31
HAZ 1	53.70	73.39	295.19
Weld	53.26	72.17	350.34
HAZ 2	56.00	76.55	287.25
Base 2	51.65	71.64	296.63
Base 3 (90°)	50.76	68.20	308.83

< Comparison graph – Yield and Tensile Strength >



< Detail results >

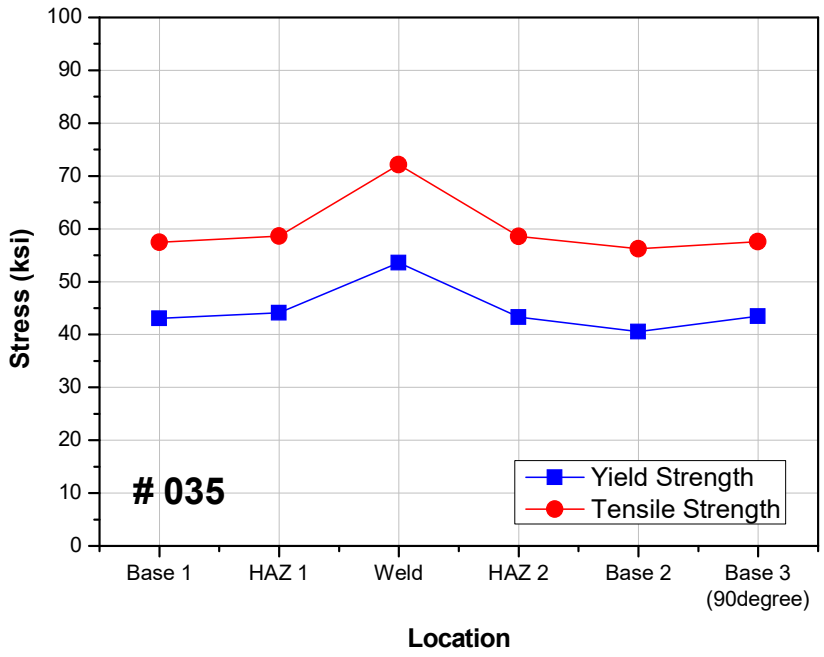
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 032	Base 1	1	52.30	72.50	246.74
		2	54.44	72.74	296.38
		3	51.76	69.66	315.82
	HAZ 1	1	51.94	71.79	300.10
		2	54.13	74.60	267.41
		3	55.04	73.76	318.05
	Weld	1	53.08	72.00	349.54
		2	53.61	72.68	352.06
		3	53.09	71.84	349.43
	HAZ 2	1	53.17	74.59	253.71
		2	57.22	76.12	348.42
		3	57.62	78.94	259.62
	Base 2	1	51.77	72.24	313.10
		2	48.41	68.41	287.06
		3	54.78	74.28	289.72
	Base 3 (90°)	1	50.24	66.73	288.20
		2	50.93	68.61	318.64
		3	51.11	69.26	319.66

Pipe# : # 035

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	43.09	57.44	198.11
HAZ 1	44.11	58.64	215.19
Weld	53.61	72.16	259.71
HAZ 2	43.31	58.57	207.96
Base 2	40.54	56.21	183.90
Base 3 (90°)	43.49	57.60	222.18

< Comparison graph – Yield and Tensile Strength >



< Detail results >

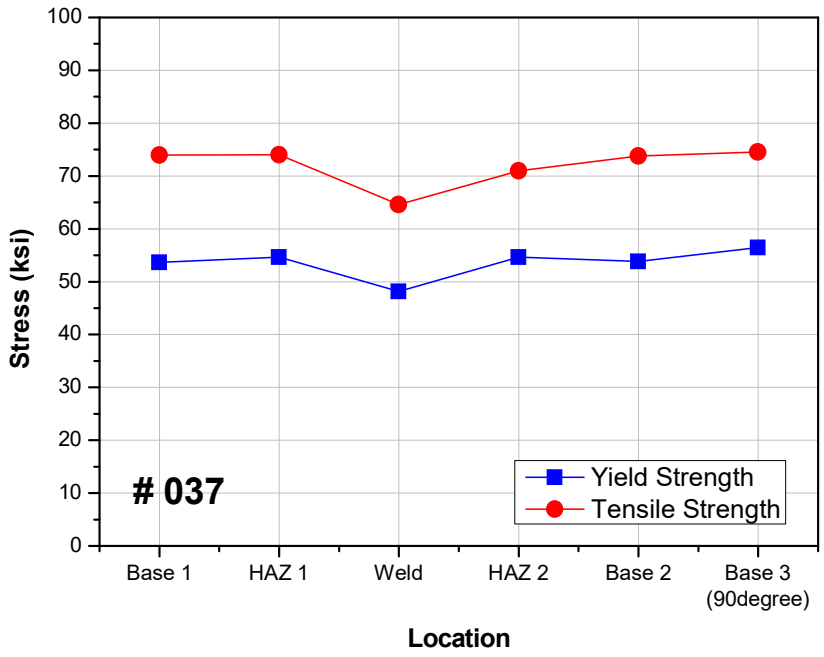
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 035	Base 1	1	42.55	56.96	190.57
		2	45.18	57.25	235.76
		3	41.54	58.11	168.00
	HAZ 1	1	44.80	58.30	220.38
		2	43.70	59.38	198.80
		3	43.84	58.24	226.37
	Weld	1	53.96	72.83	255.26
		2	53.78	72.21	268.20
		3	53.09	71.45	255.68
	HAZ 2	1	42.57	58.68	191.25
		2	44.13	58.59	221.31
		3	43.23	58.43	211.31
	Base 2	1	40.03	55.76	179.73
		2	40.95	56.37	186.64
		3	40.63	56.52	185.33
	Base 3 (90°)	1	43.71	57.36	238.53
		2	43.11	58.32	200.69
		3	43.66	57.11	227.33

Pipe# : # 037

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	53.65	73.95	270.78
HAZ 1	54.64	74.01	280.02
Weld	48.14	64.59	275.70
HAZ 2	54.65	70.98	266.36
Base 2	53.85	73.77	248.35
Base 3 (90°)	56.45	74.53	306.86

< Comparison graph – Yield and Tensile Strength >



< Detail results >

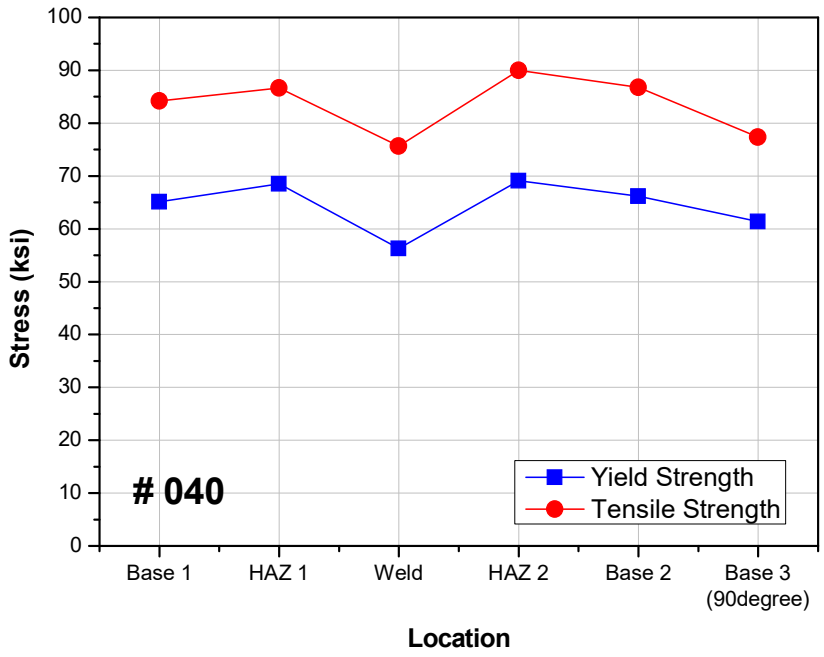
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 037	Base 1	1	53.26	74.26	251.40
		2	55.44	74.36	302.06
		3	52.24	73.24	258.88
	HAZ 1	1	54.89	75.00	275.93
		2	55.47	74.00	287.95
		3	53.55	73.05	276.17
	Weld	1	50.25	66.02	294.27
		2	46.22	62.15	280.56
		3	47.94	65.61	252.27
	HAZ 2	1	56.38	71.47	300.53
		2	53.12	71.44	230.98
		3	54.45	70.03	267.57
	Base 2	1	52.30	71.31	234.19
		2	52.65	74.31	235.84
		3	56.62	75.70	275.01
	Base 3 (90°)	1	53.97	73.02	283.29
		2	57.61	75.02	325.70
		3	57.77	75.57	311.60

Pipe# : # 040

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	65.15	84.22	379.79
HAZ 1	68.51	86.65	363.39
Weld	56.29	75.66	290.67
HAZ 2	69.11	89.98	407.31
Base 2	66.16	86.78	414.23
Base 3 (90°)	61.39	77.34	304.02

< Comparison graph – Yield and Tensile Strength >



< Detail results >

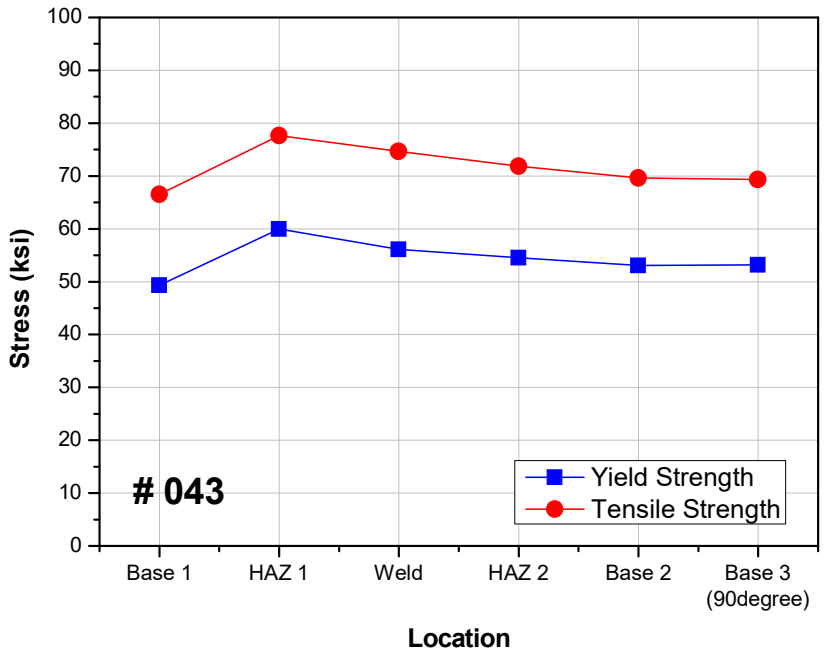
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 040	Base 1	1	63.79	83.63	365.67
		2	65.49	84.28	395.26
		3	66.17	84.76	378.43
	HAZ 1	1	66.26	84.51	327.71
		2	68.09	86.08	356.44
		3	71.19	89.38	406.03
	Weld	1	55.45	75.23	275.97
		2	55.28	72.62	316.58
		3	58.13	79.13	279.45
	HAZ 2	1	67.43	89.02	387.18
		2	69.49	89.94	404.58
		3	70.41	90.99	430.17
	Base 2	1	64.32	85.48	398.17
		2	67.01	87.50	418.16
		3	67.16	87.35	426.36
	Base 3 (90°)	1	62.18	77.22	318.19
		2	59.93	78.68	261.42
		3	62.06	76.12	332.45

Pipe# : # 043

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	49.34	66.52	319.98
HAZ 1	60.00	77.65	344.27
Weld	56.12	74.68	318.09
HAZ 2	54.56	71.84	302.81
Base 2	53.07	69.62	311.08
Base 3 (90°)	53.20	69.35	324.91

< Comparison graph – Yield and Tensile Strength >



< Detail results >

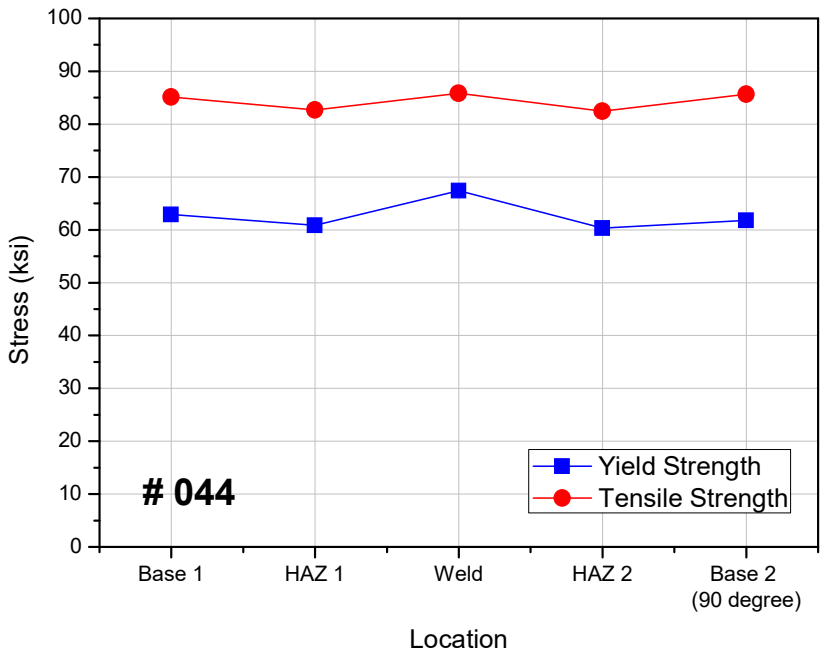
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 043	Base 1	1	49.72	66.89	333.80
		2	49.28	66.56	306.81
		3	49.00	66.12	319.33
	HAZ 1	1	59.82	77.75	336.51
		2	59.88	77.64	336.48
		3	60.29	77.57	359.82
	Weld	1	56.14	75.11	311.27
		2	55.41	74.37	302.35
		3	56.81	74.57	340.64
	HAZ 2	1	54.18	71.53	307.69
		2	52.74	71.20	271.73
		3	56.75	72.78	329.02
	Base 2	1	54.01	70.38	318.25
		2	51.47	68.73	295.09
		3	53.74	69.75	319.90
	Base 3 (90°)	1	52.44	68.06	324.97
		2	54.40	70.83	322.27
		3	52.74	69.15	327.48

Pipe# : # 044

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	62.88	85.16	276.14
HAZ 1	60.83	82.66	292.67
Weld	67.39	85.82	408.89
HAZ 2	60.31	82.46	274.69
Base 2 (90°)	61.78	85.64	264.55

< Comparison graph – Yield and Tensile Strength >



< Detail results >

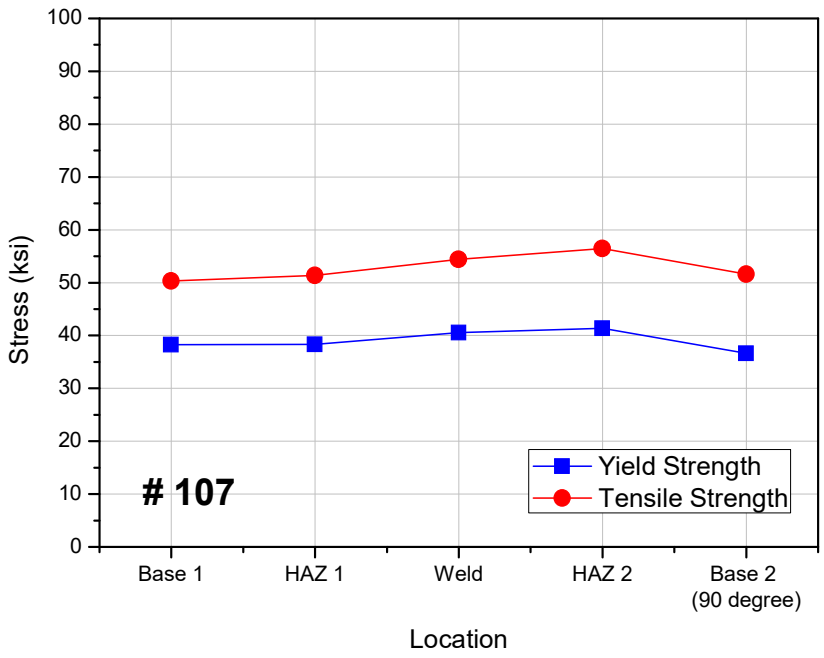
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
	Base 1	1	62.68	86.38	271.95
		2	63.54	85.93	277.20
		3	62.43	83.16	279.26
	HAZ 1	1	60.98	83.05	294.24
		2	59.63	81.54	290.64
		3	61.89	83.40	293.14
	Weld	1	64.00	83.08	376.67
		2	69.55	87.68	422.10
		3	68.61	86.71	427.90
	HAZ 2	1	61.92	83.06	277.48
		2	58.40	81.47	261.31
		3	60.60	82.85	285.29
	Base 2 (90°)	1	60.90	82.77	276.97
		2	62.43	89.16	251.60
		3	62.02	85.00	265.09

Pipe# : # 107

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	38.27	50.32	207.18
HAZ 1	38.35	51.40	208.18
Weld	40.56	54.39	220.13
HAZ 2	41.37	56.47	207.20
Base 2 (90°)	36.65	51.62	215.95

< Comparison graph – Yield and Tensile Strength >



< Detail results >

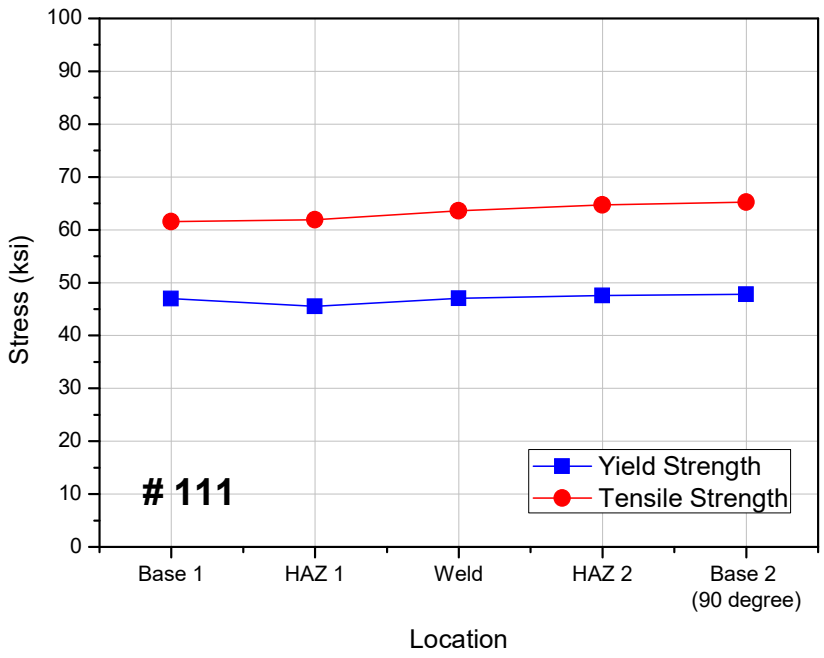
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 107	Base 1	1	38.26	49.78	183.95
		2	38.29	50.87	230.42
		3			
	HAZ 1	1	38.73	51.09	183.52
		2	37.56	50.54	210.95
		3	38.76	52.58	230.07
	Weld	1	39.65	53.93	227.62
		2	41.04	53.76	215.91
		3	41.01	55.47	216.87
	HAZ 2	1	42.22	57.65	197.61
		2	40.56	55.78	201.69
		3	41.33	55.97	222.30
	Base 2 (90°)	1	38.77	52.94	224.24
		2	36.06	51.41	212.25
		3	35.13	50.50	211.35

Pipe# : # 111

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	46.98	61.53	278.57
HAZ 1	45.54	61.90	285.37
Weld	47.04	63.61	283.85
HAZ 2	47.59	64.69	288.75
Base 2 (90°)	47.83	65.26	300.10

< Comparison graph – Yield and Tensile Strength >



< Detail results >

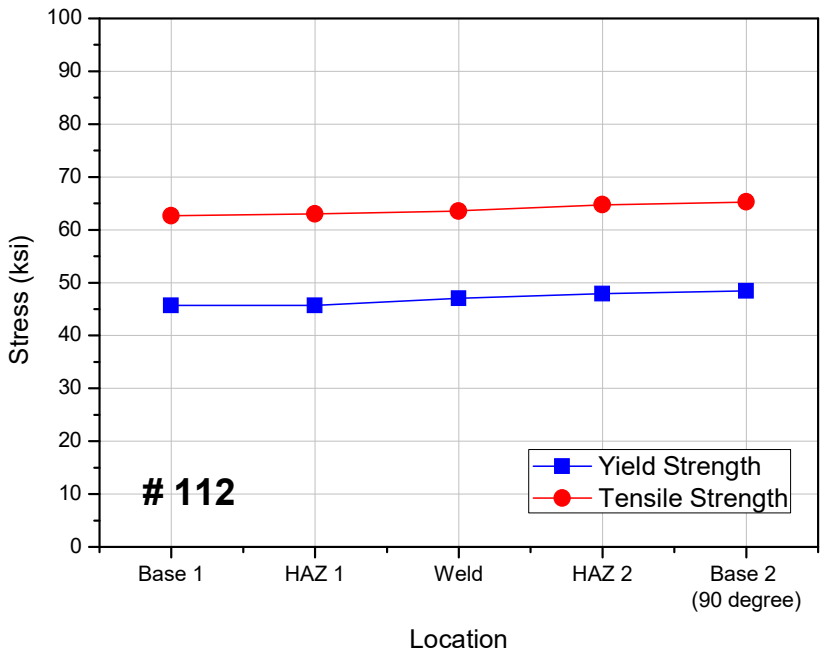
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 111	Base 1	1	46.87	62.93	293.69
		2	46.88	61.04	277.14
		3	47.18	60.63	264.89
	HAZ 1	1	47.36	62.13	288.53
		2	44.57	61.90	277.65
		3	44.71	61.68	289.92
	Weld	1	48.02	63.74	304.51
		2	45.85	62.80	274.10
		3	47.25	64.29	272.94
	HAZ 2	1	48.00	64.89	279.75
		2	47.20	64.52	293.76
		3	47.58	64.68	292.73
	Base 2 (90°)	1	49.95	67.06	317.36
		2	47.32	64.96	299.36
		3	46.23	63.77	283.57

Pipe# : # 112

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	45.70	62.66	288.32
HAZ 1	45.67	63.00	292.35
Weld	47.03	63.57	295.42
HAZ 2	47.92	64.77	282.12
Base 2 (90°)	48.45	65.33	303.83

< Comparison graph – Yield and Tensile Strength >



< Detail results >

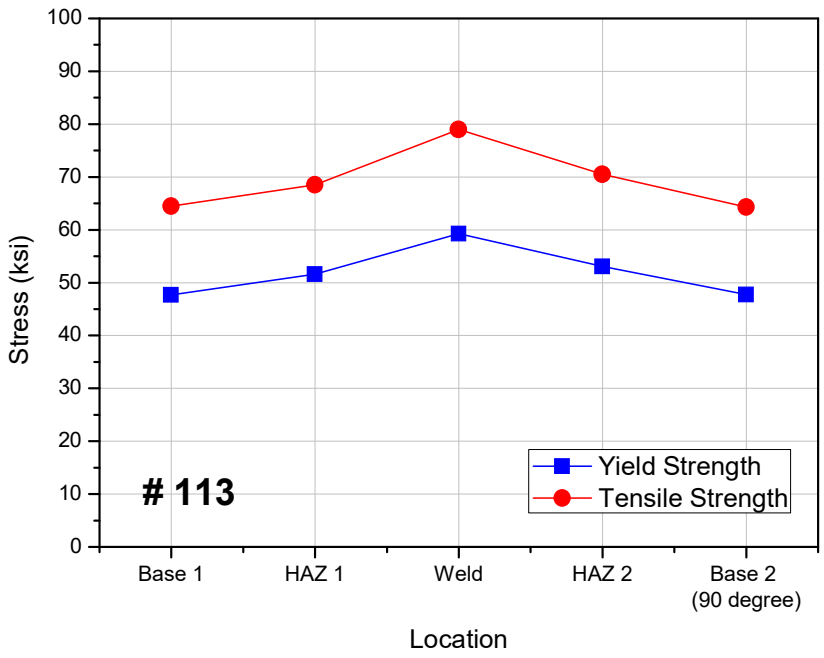
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 112	Base 1	1	46.63	63.91	313.38
		2	45.40	62.08	275.52
		3	45.05	62.00	276.07
	HAZ 1	1	44.61	62.88	281.74
		2	45.16	62.22	287.47
		3	47.24	63.90	307.84
	Weld	1	46.16	62.70	284.66
		2	47.70	64.19	308.91
		3	47.23	63.83	292.70
	HAZ 2	1	46.06	63.49	245.18
		2	48.71	65.00	287.95
		3	48.98	65.82	313.24
	Base 2 (90°)	1	49.02	65.31	308.31
		2	47.65	65.06	291.14
		3	48.68	65.61	312.05

Pipe# : # 113

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	47.66	64.51	282.33
HAZ 1	51.61	68.51	296.89
Weld	59.28	79.01	363.16
HAZ 2	53.05	70.50	316.76
Base 2 (90°)	47.75	64.29	295.77

< Comparison graph – Yield and Tensile Strength >



< Detail results >

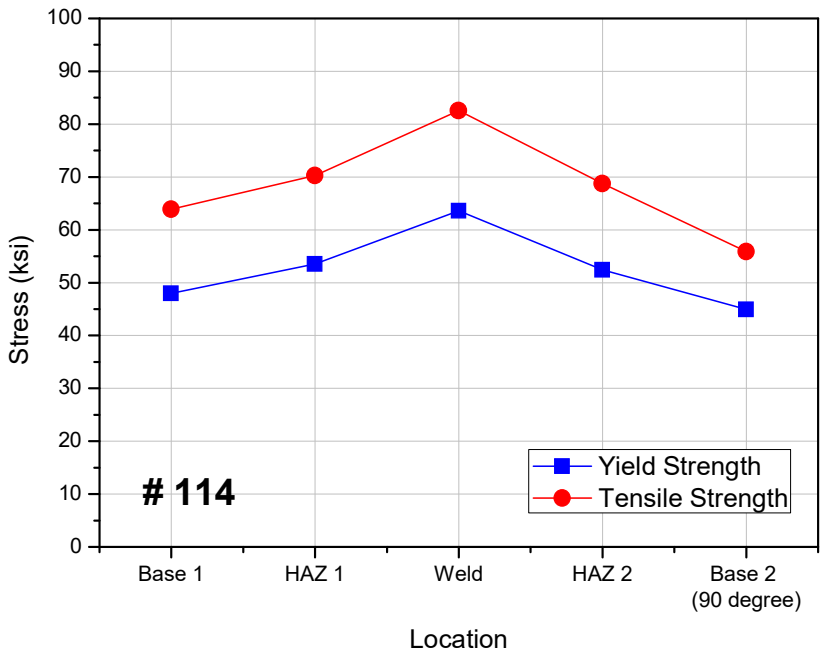
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 113	Base 1	1	48.37	64.69	287.73
		2	47.40	64.50	286.36
		3	47.21	64.33	272.90
	HAZ 1	1	52.07	68.26	306.80
		2	50.90	68.57	283.31
		3	51.87	68.69	300.57
	Weld	1	58.91	79.00	350.80
		2	59.44	79.03	365.60
		3	59.48	78.99	373.07
	HAZ 2	1	53.91	71.12	330.06
		2	52.76	70.42	318.09
		3	52.49	69.97	302.14
	Base 2 (90°)	1	48.38	64.52	306.07
		2	47.87	64.25	287.35
		3	46.99	64.10	293.89

Pipe# : # 114

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	48.01	63.90	300.74
HAZ 1	53.52	70.30	315.53
Weld	63.58	82.57	383.03
HAZ 2	52.45	68.73	301.63
Base 2 (90°)	44.96	55.86	232.81

< Comparison graph – Yield and Tensile Strength >



< Detail results >

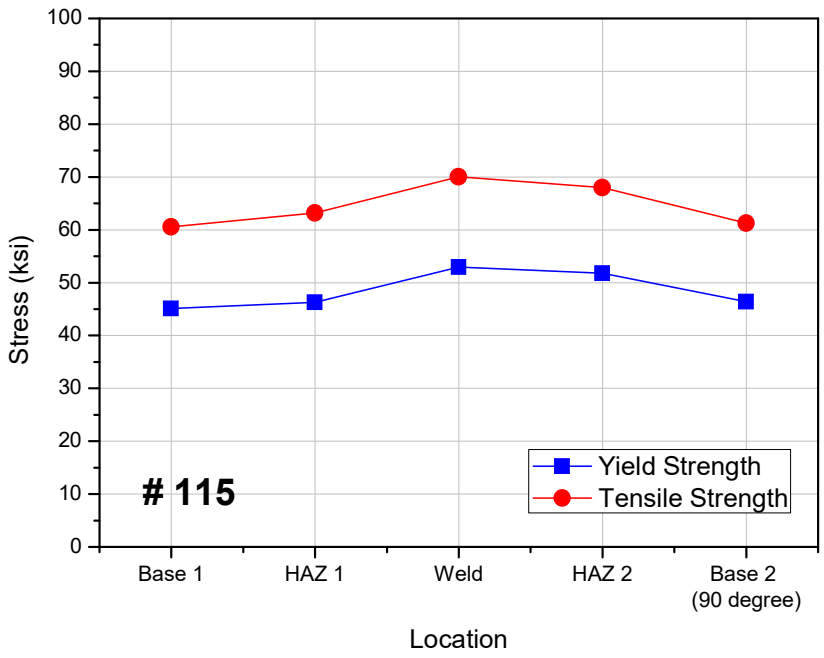
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 114	Base 1	1	48.25	64.03	310.95
		2	48.32	64.25	306.46
		3	47.48	63.41	284.80
	HAZ 1	1	52.01	69.52	287.28
		2	55.13	71.17	349.11
		3	53.44	70.21	310.21
	Weld	1	64.56	82.94	387.38
		2	64.20	83.09	391.57
		3	61.99	81.67	370.15
	HAZ 2	1	53.66	69.08	314.14
		2	51.47	68.57	291.14
		3	52.22	68.52	299.61
	Base 2 (90°)	1	45.98	56.10	251.92
		2	45.91	56.01	249.28
		3	43.01	55.45	197.22

Pipe# : # 115

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	45.13	60.57	257.28
HAZ 1	46.29	63.19	267.81
Weld	52.93	70.07	302.58
HAZ 2	51.76	67.98	286.40
Base 2 (90°)	46.41	61.26	275.49

< Comparison graph – Yield and Tensile Strength >



< Detail results >

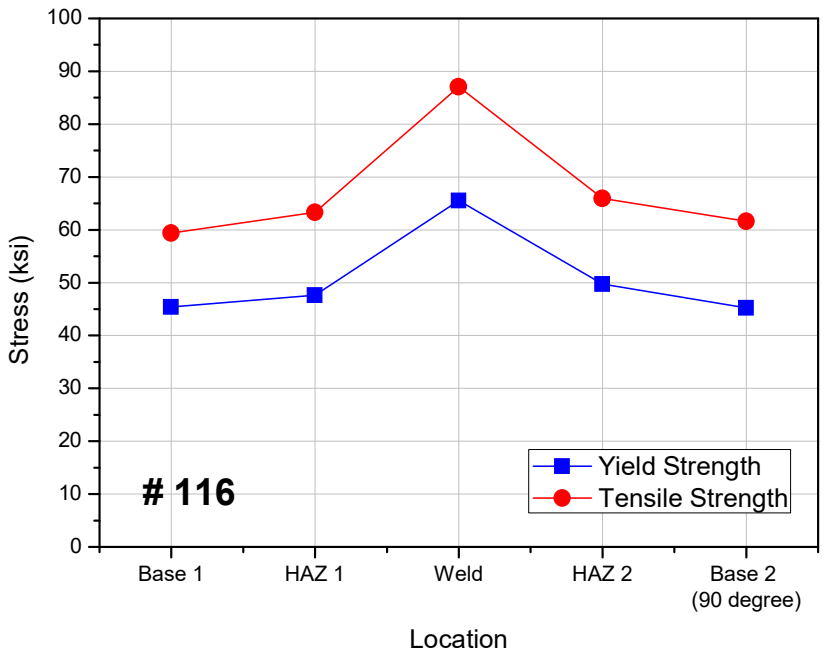
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 115	Base 1	1	43.64	59.80	244.60
		2	45.47	60.55	261.80
		3	46.27	61.35	265.44
	HAZ 1	1	47.32	64.19	279.87
		2	44.73	62.31	245.90
		3	46.81	63.08	277.66
	Weld	1	54.19	70.81	310.53
		2	52.77	69.84	311.11
		3	51.82	69.56	286.10
	HAZ 2	1	50.94	67.86	271.16
		2	52.40	68.48	300.49
		3	51.93	67.58	287.56
	Base 2 (90°)	1	46.58	61.39	275.76
		2	46.64	61.51	284.79
		3	46.02	60.87	265.91

Pipe# : # 116

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	45.41	59.41	263.11
HAZ 1	47.61	63.30	285.90
Weld	65.56	87.05	393.62
HAZ 2	49.72	65.97	281.16
Base 2 (90°)	45.24	61.59	285.04

< Comparison graph – Yield and Tensile Strength >



< Detail results >

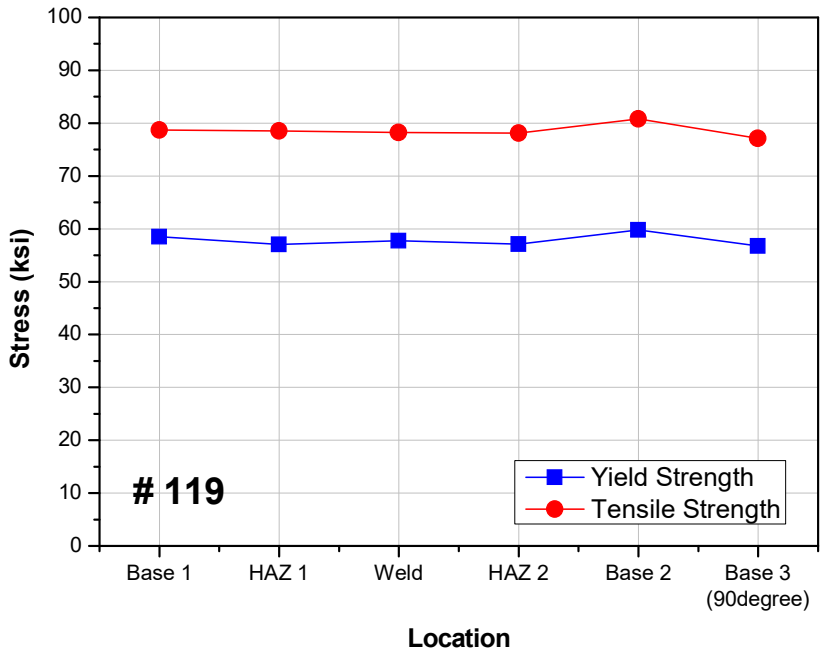
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 116	Base 1	1	44.00	56.56	246.95
		2	46.01	59.81	266.61
		3	46.21	61.87	275.75
	HAZ 1	1	49.74	64.69	316.91
		2	45.86	62.23	261.45
		3	47.24	62.98	279.34
	Weld	1	64.96	86.30	384.80
		2	66.17	87.80	402.44
		3			
	HAZ 2	1	50.71	66.78	279.63
		2	49.50	65.74	283.65
		3	48.94	65.40	280.20
	Base 2 (90°)	1	45.80	61.93	282.49
		2	45.34	61.42	284.05
		3	44.59	61.42	288.59

Pipe# : # 119

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	58.54	78.70	387.94
HAZ 1	57.06	78.53	377.75
Weld	57.78	78.23	383.14
HAZ 2	57.09	78.13	363.52
Base 2	59.81	80.80	407.42
Base 3 (90°)	56.75	77.15	365.56

< Comparison graph – Yield and Tensile Strength >



< Detail results >

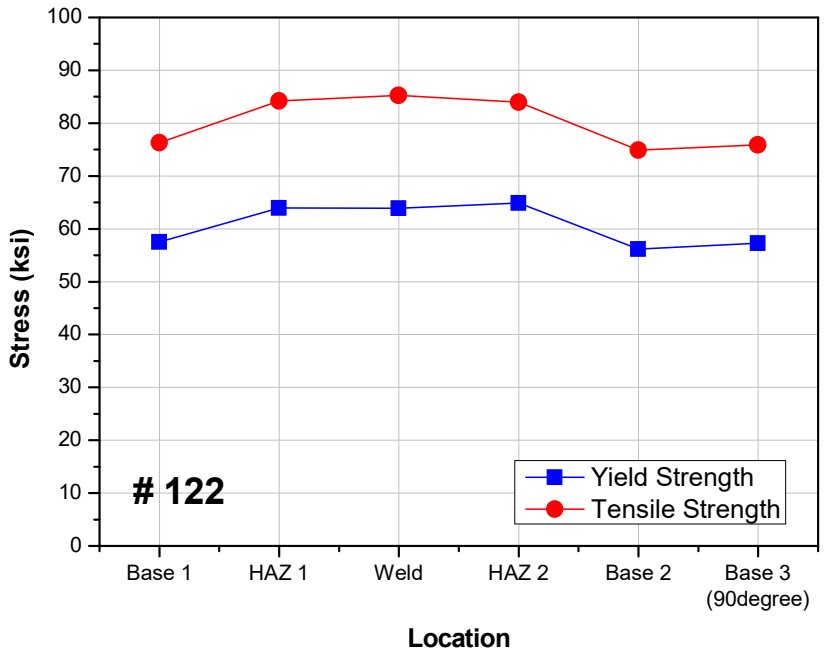
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 119	Base 1	1	58.57	78.41	393.59
		2	58.01	78.29	392.84
		3	59.03	79.39	377.39
	HAZ 1	1	58.19	78.67	367.96
		2	57.87	79.80	415.38
		3	55.12	77.12	349.92
	Weld	1	57.41	77.72	371.37
		2	57.40	77.81	380.58
		3	58.54	79.16	397.49
	HAZ 2	1	58.12	78.62	367.82
		2	57.72	78.71	385.81
		3	55.42	77.07	336.94
	Base 2	1	60.45	81.04	422.56
		2	59.52	80.84	385.89
		3	59.46	80.51	413.82
	Base 3 (90°)	1	56.73	76.90	356.65
		2	56.51	77.29	371.63
		3	57.00	77.25	368.42

Pipe# : # 122

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	57.52	76.29	355.91
HAZ 1	63.93	84.18	386.49
Weld	63.89	85.26	404.59
HAZ 2	64.87	83.98	400.69
Base 2	56.16	74.89	346.06
Base 3 (90°)	57.27	75.89	366.91

< Comparison graph – Yield and Tensile Strength >



< Detail results >

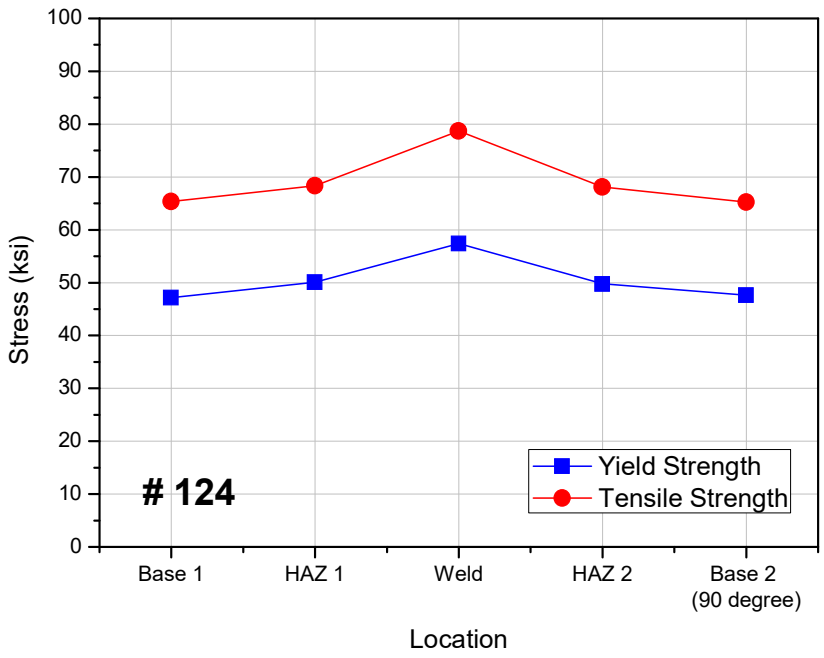
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 122	Base 1	1	58.69	76.34	362.17
		2	57.46	76.56	365.26
		3	56.40	75.97	340.31
	HAZ 1	1	63.15	83.66	366.69
		2	64.61	84.59	396.54
		3	64.04	84.30	396.24
	Weld	1	65.58	86.22	422.77
		2	63.16	84.74	383.54
		3	62.92	84.82	407.44
	HAZ 2	1	65.61	84.09	396.18
		2	65.06	84.29	412.50
		3	63.95	83.56	393.39
	Base 2	1	56.31	74.83	352.36
		2	55.96	74.70	342.61
		3	56.21	75.13	343.22
	Base 3 (90°)	1	56.94	75.73	364.83
		2	57.65	75.77	365.46
		3	57.23	76.17	370.44

Pipe# : # 124

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	47.15	65.34	242.10
HAZ 1	50.11	68.34	261.99
Weld	57.41	78.69	273.79
HAZ 2	49.78	68.10	236.83
Base 2 (90°)	47.63	65.26	229.11

< Comparison graph – Yield and Tensile Strength >



< Detail results >

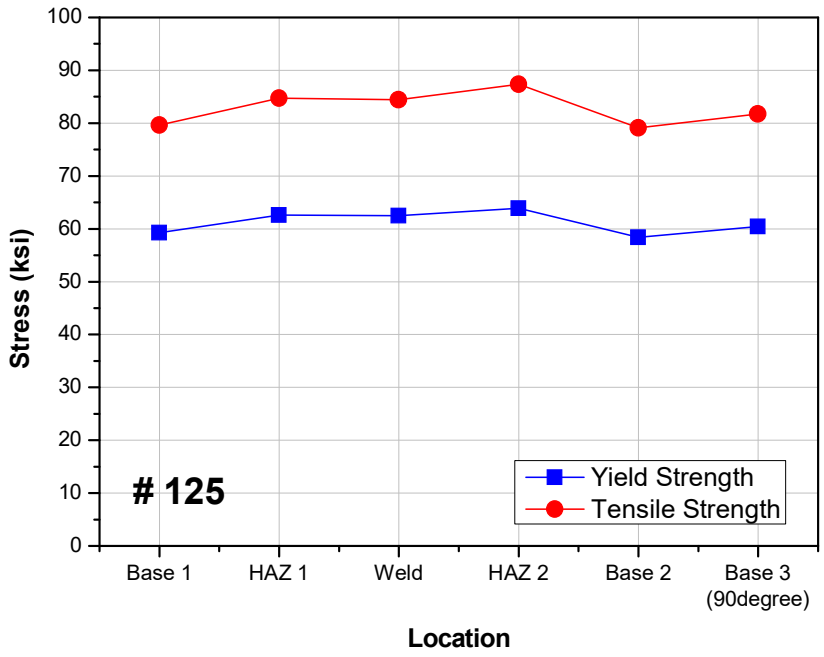
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
	Base 1	1	47.25	65.52	238.22
		2	47.48	65.59	235.81
		3	46.72	64.93	252.28
	HAZ 1	1	51.08	68.20	275.77
		2	48.95	68.35	251.64
		3	50.30	68.46	258.56
	Weld	1	56.20	78.92	251.61
		2	57.60	78.27	281.36
		3	58.43	78.87	288.41
	HAZ 2	1	49.25	68.14	239.29
		2	50.11	68.29	236.79
		3	49.99	67.87	234.40
	Base 2 (90°)	1	46.43	63.93	227.30
		2	49.16	66.58	228.25
		3	47.28	65.26	231.76

Pipe# : # 125

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	59.30	79.62	309.89
HAZ 1	62.63	84.72	320.28
Weld	62.52	84.44	307.26
HAZ 2	63.87	87.39	333.13
Base 2	58.38	79.12	316.17
Base 3 (90°)	60.45	81.74	295.82

< Comparison graph – Yield and Tensile Strength >



< Detail results >

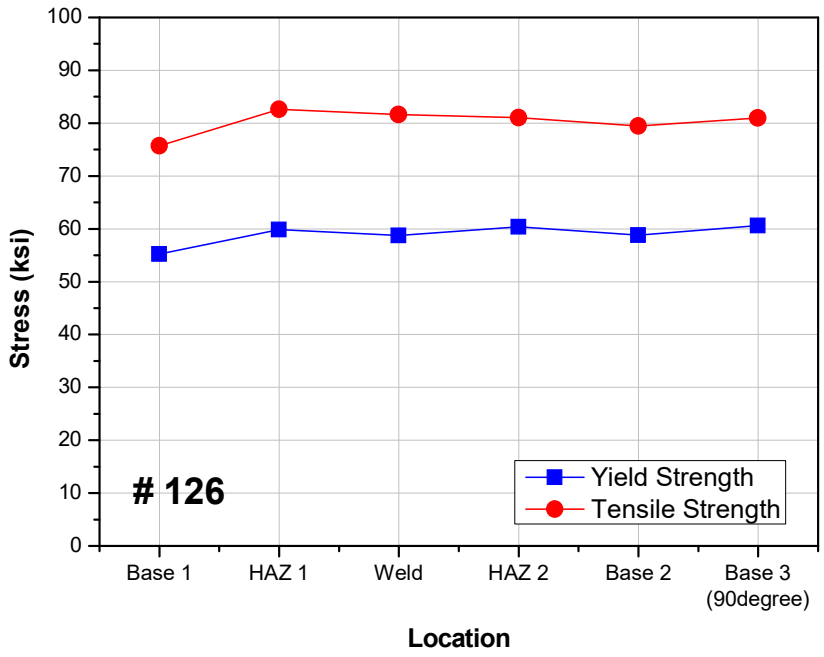
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 125	Base 1	1	58.42	79.23	302.70
		2	59.38	79.63	309.33
		3	60.09	79.98	317.65
	HAZ 1	1	63.61	83.59	343.27
		2	62.87	84.63	320.24
		3	61.42	85.95	297.34
	Weld	1	63.43	85.02	321.22
		2	61.34	84.88	282.04
		3	62.79	83.41	318.52
	HAZ 2	1	64.46	88.20	326.30
		2	64.56	87.38	342.06
		3	62.59	86.59	331.03
	Base 2	1	59.92	79.45	334.26
		2	57.71	79.33	288.29
		3	57.51	78.58	325.96
	Base 3 (90°)	1	60.73	81.50	297.26
		2	60.29	81.58	288.35
		3	60.35	82.12	301.86

Pipe# : # 126

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	55.22	75.69	302.30
HAZ 1	59.86	82.61	305.63
Weld	58.72	81.60	296.70
HAZ 2	60.38	81.06	341.26
Base 2	58.79	79.44	330.11
Base 3 (90°)	60.60	80.97	353.41

< Comparison graph – Yield and Tensile Strength >



< Detail results >

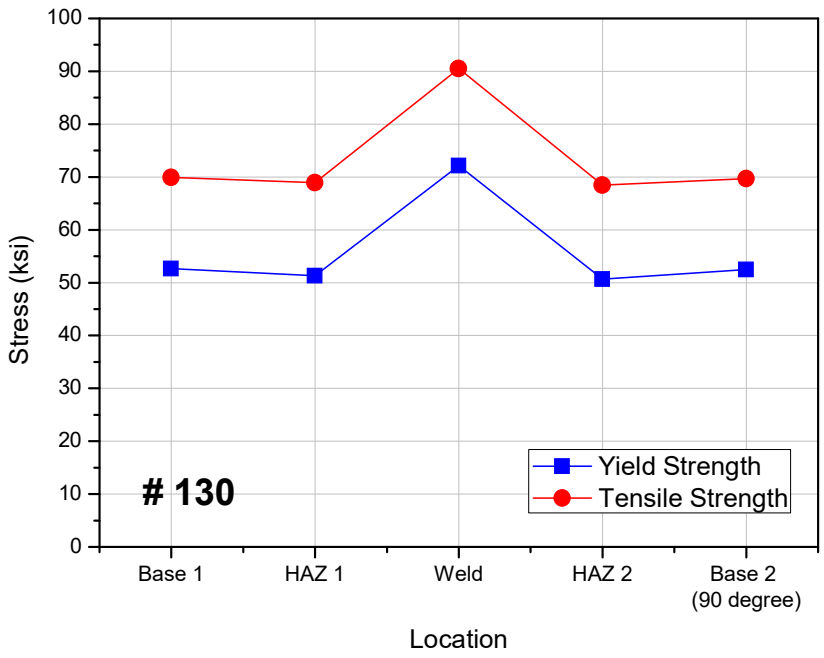
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 126	Base 1	1	54.96	75.84	284.29
		2	54.72	75.68	298.81
		3	55.97	75.55	323.81
	HAZ 1	1	61.33	82.54	342.63
		2	59.44	82.55	296.34
		3	58.81	82.73	277.92
	Weld	1	59.37	82.17	294.30
		2	58.80	81.79	299.45
		3	57.98	80.84	296.36
	HAZ 2	1	62.20	81.65	350.74
		2	60.40	80.44	371.06
		3	58.54	81.09	301.97
	Base 2	1	55.73	79.27	255.21
		2	61.48	79.67	407.36
		3	59.16	79.38	327.77
	Base 3 (90°)	1	63.55	81.71	391.65
		2	60.75	81.19	361.38
		3	57.49	80.01	307.20

Pipe# : # 130

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	52.66	69.91	313.41
HAZ 1	51.33	68.90	307.51
Weld	72.16	90.50	438.99
HAZ 2	50.70	68.46	305.47
Base 2 (90°)	52.46	69.70	313.84

< Comparison graph – Yield and Tensile Strength >



< Detail results >

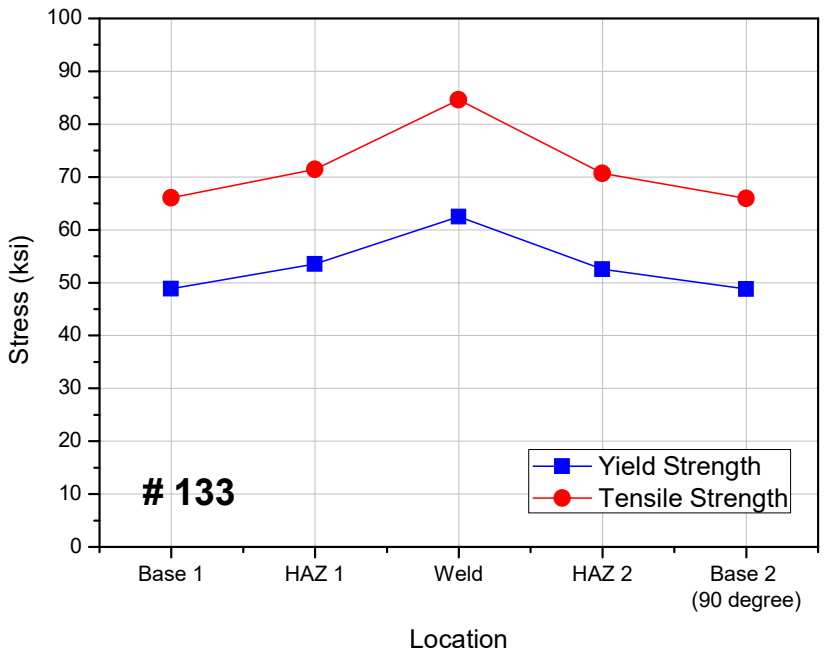
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 130	Base 1	1	53.66	70.14	329.04
		2	51.79	69.67	297.09
		3	52.53	69.93	314.12
	HAZ 1	1	52.39	69.16	325.27
		2	51.41	68.94	310.02
		3	50.18	68.60	287.24
	Weld	1	69.62	88.99	438.82
		2	70.29	88.80	421.20
		3	76.56	93.71	456.95
	HAZ 2	1	51.63	68.88	318.27
		2	50.38	68.48	302.86
		3	50.09	68.01	295.28
	Base 2 (90°)	1	52.06	69.38	312.79
		2	52.09	69.50	301.77
		3	53.22	70.22	326.95

Pipe# : # 133

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	48.83	66.07	303.71
HAZ 1	53.52	71.45	317.27
Weld	62.50	84.62	341.55
HAZ 2	52.57	70.68	302.32
Base 2 (90°)	48.82	65.94	305.15

< Comparison graph – Yield and Tensile Strength >



< Detail results >

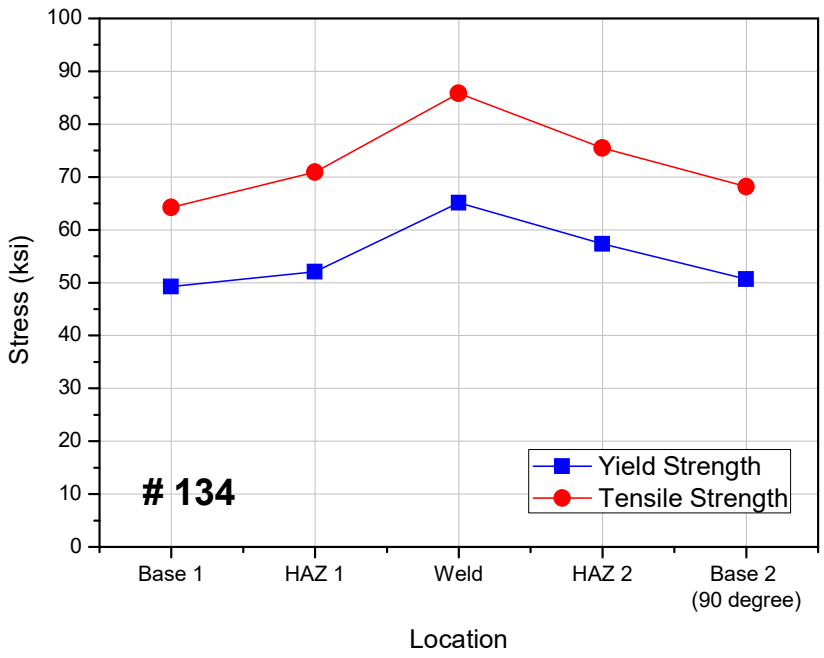
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 133	Base 1	1	49.04	66.09	305.43
		2	49.15	66.23	310.78
		3	48.31	65.89	294.91
	HAZ 1	1	53.68	71.25	314.82
		2	53.44	71.55	320.25
		3	53.43	71.54	316.75
	Weld	1	60.62	83.73	321.02
		2	65.36	85.20	400.48
		3	61.51	84.91	303.14
	HAZ 2	1	52.12	70.12	279.95
		2	52.61	70.82	310.02
		3	52.98	71.09	316.98
	Base 2 (90°)	1	48.89	65.81	299.83
		2	48.90	66.08	311.25
		3	48.66	65.94	304.36

Pipe# : # 134

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	49.28	64.27	245.40
HAZ 1	52.08	70.94	268.93
Weld	65.14	85.85	356.31
HAZ 2	57.35	75.50	320.61
Base 2 (90°)	50.67	68.14	277.38

< Comparison graph – Yield and Tensile Strength >



< Detail results >

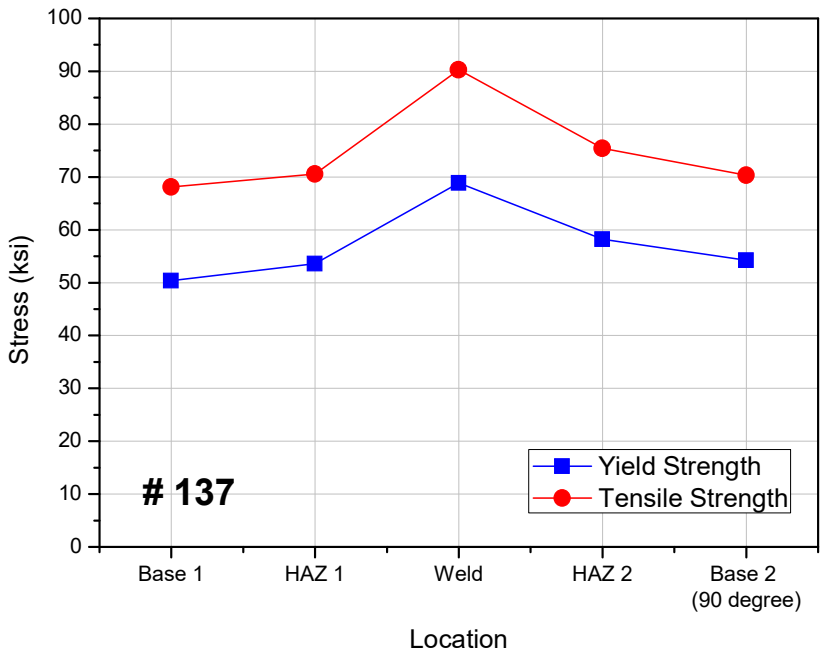
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 134	Base 1	1	49.38	63.12	229.79
		2	47.90	63.43	247.17
		3	50.56	66.25	259.23
	HAZ 1	1	51.34	71.02	245.18
		2	52.02	70.74	276.80
		3	52.86	71.06	284.83
	Weld	1	66.27	85.87	379.13
		2	64.19	86.09	323.11
		3	64.96	85.59	366.69
	HAZ 2	1	57.10	75.34	315.39
		2	56.60	75.31	315.79
		3	58.36	75.86	330.66
	Base 2 (90°)	1	52.81	68.71	294.14
		2	47.96	67.36	240.34
		3	51.24	68.35	297.66

Pipe# : # 137

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	50.36	68.09	274.90
HAZ 1	53.60	70.57	300.75
Weld	68.88	90.27	370.28
HAZ 2	58.24	75.44	326.90
Base 2 (90°)	54.24	70.36	299.52

< Comparison graph – Yield and Tensile Strength >



< Detail results >

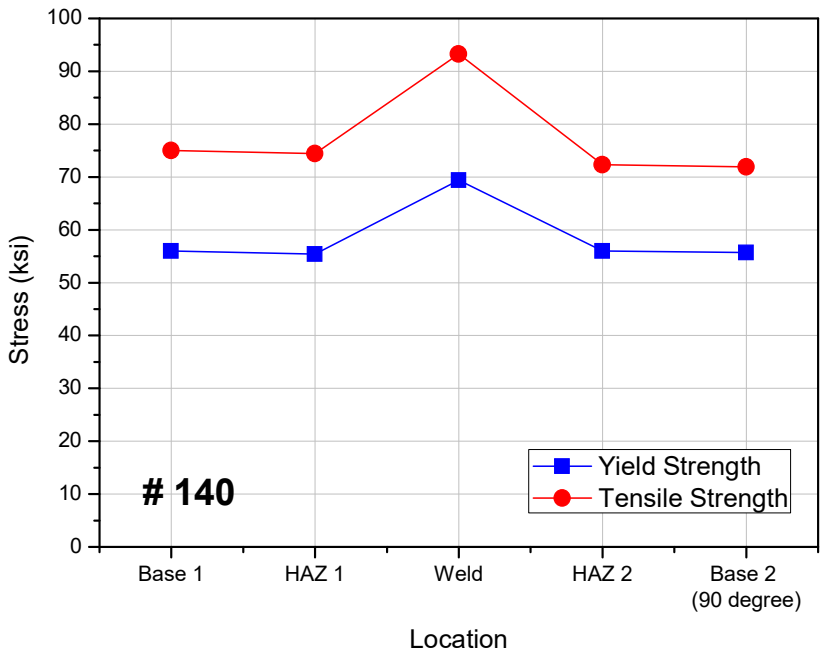
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 137	Base 1	1	50.90	68.27	272.75
		2	51.75	68.41	318.61
		3	48.43	67.58	233.33
	HAZ 1	1	54.53	71.21	320.71
		2	52.43	69.59	292.74
		3	53.84	70.89	288.79
	Weld	1	68.99	90.12	382.29
		2	68.60	90.73	354.19
		3	69.05	89.96	374.37
	HAZ 2	1	59.61	75.55	358.68
		2	56.60	74.80	299.49
		3	58.52	75.96	322.53
	Base 2 (90°)	1	55.82	70.95	300.94
		2	55.36	71.14	320.28
		3	51.53	68.98	277.34

Pipe# : # 140

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	55.97	75.01	367.40
HAZ 1	55.39	74.41	346.32
Weld	69.39	93.29	426.77
HAZ 2	56.01	72.32	334.91
Base 2 (90°)	55.73	71.93	350.11

< Comparison graph – Yield and Tensile Strength >



< Detail results >

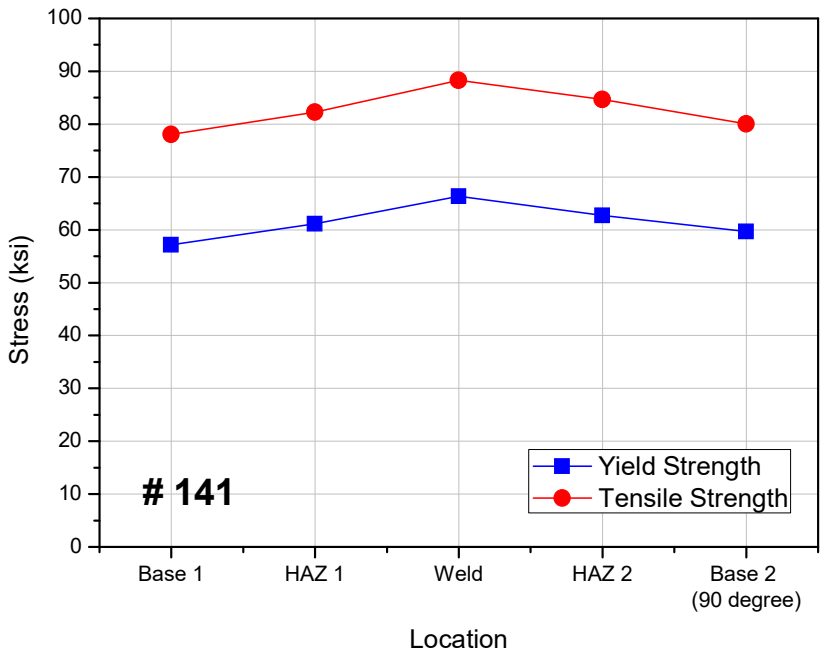
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 140	Base 1	1	55.58	74.63	358.55
		2	57.43	75.71	373.25
		3	54.89	74.69	370.39
	HAZ 1	1	55.36	74.25	354.14
		2	54.54	73.54	326.23
		3	56.26	75.44	358.60
	Weld	1	71.58	94.26	477.41
		2	71.08	93.73	446.85
		3	65.53	91.88	356.03
	HAZ 2	1	57.77	75.31	346.30
		2	55.83	74.21	324.63
		3	54.44	67.46	333.79
	Base 2 (90°)	1	55.42	70.28	315.87
		2	55.58	72.09	351.48
		3	56.17	73.43	382.98

Pipe# : # 141

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	57.17	78.03	310.07
HAZ 1	61.14	82.29	359.32
Weld	66.34	88.30	368.95
HAZ 2	62.70	84.69	353.36
Base 2 (90°)	59.71	80.07	359.03

< Comparison graph – Yield and Tensile Strength >



< Detail results >

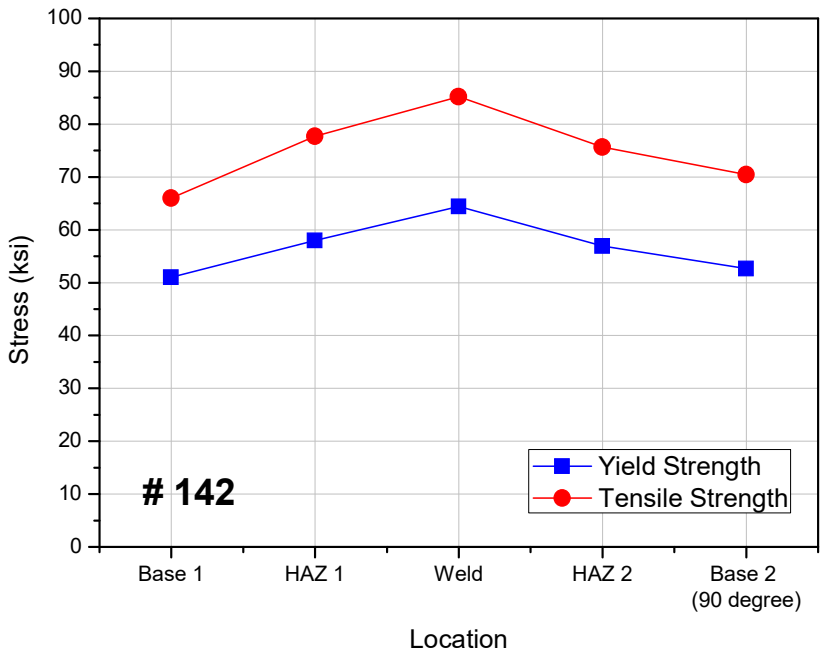
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 141	Base 1	1	59.34	77.73	353.11
		2	57.19	77.82	323.36
		3	54.98	78.55	253.74
	HAZ 1	1	61.40	82.59	382.84
		2	62.16	82.47	363.73
		3	59.87	81.80	331.40
	Weld	1	68.05	89.03	384.23
		2	64.77	87.78	340.93
		3	66.19	88.07	381.68
	HAZ 2	1	64.96	85.51	380.54
		2	60.52	84.25	340.02
		3	62.62	84.30	339.54
	Base 2 (90°)	1	60.11	80.12	364.61
		2	59.54	80.04	352.37
		3	59.48	80.03	360.12

Pipe# : # 142

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	51.05	66.03	283.10
HAZ 1	57.97	77.70	323.87
Weld	64.41	85.17	390.32
HAZ 2	56.95	75.66	341.90
Base 2 (90°)	52.66	70.46	296.39

< Comparison graph – Yield and Tensile Strength >



< Detail results >

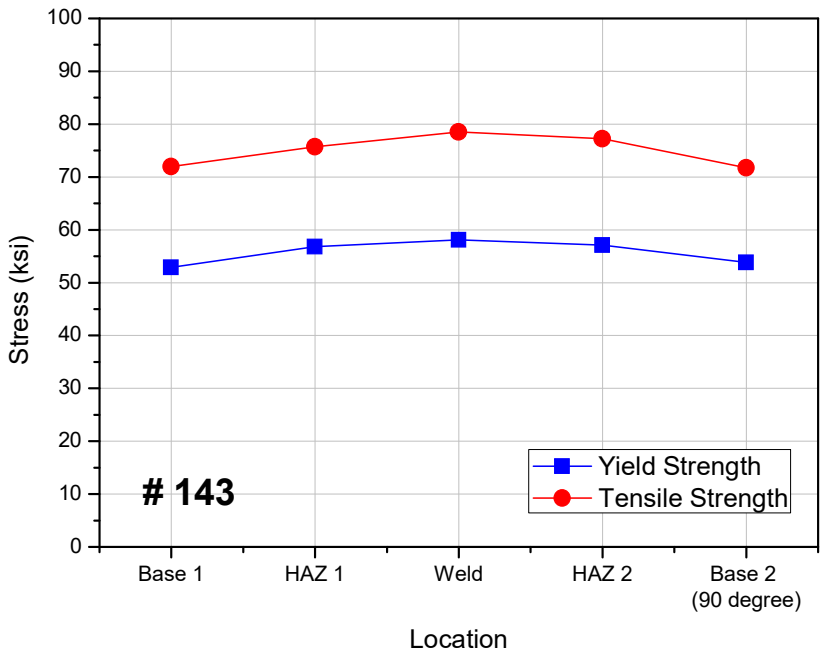
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 142	Base 1	1	51.35	64.19	284.39
		2	49.81	65.59	273.34
		3	51.98	68.30	291.57
	HAZ 1	1	58.69	77.81	324.87
		2	58.86	78.21	338.75
		3	56.37	77.06	307.99
	Weld	1	65.38	85.79	380.58
		2	64.86	85.34	407.18
		3	63.00	84.38	383.19
	HAZ 2	1	56.70	75.54	354.23
		2	56.36	75.52	321.78
		3	57.80	75.91	349.67
	Base 2 (90°)	1	55.09	71.72	323.13
		2	51.39	69.12	283.80
		3	51.49	70.55	282.23

Pipe# : # 143

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	52.87	71.98	285.78
HAZ 1	56.80	75.73	301.31
Weld	58.11	78.51	317.35
HAZ 2	57.13	77.21	313.95
Base 2 (90°)	53.86	71.74	277.44

< Comparison graph – Yield and Tensile Strength >



< Detail results >

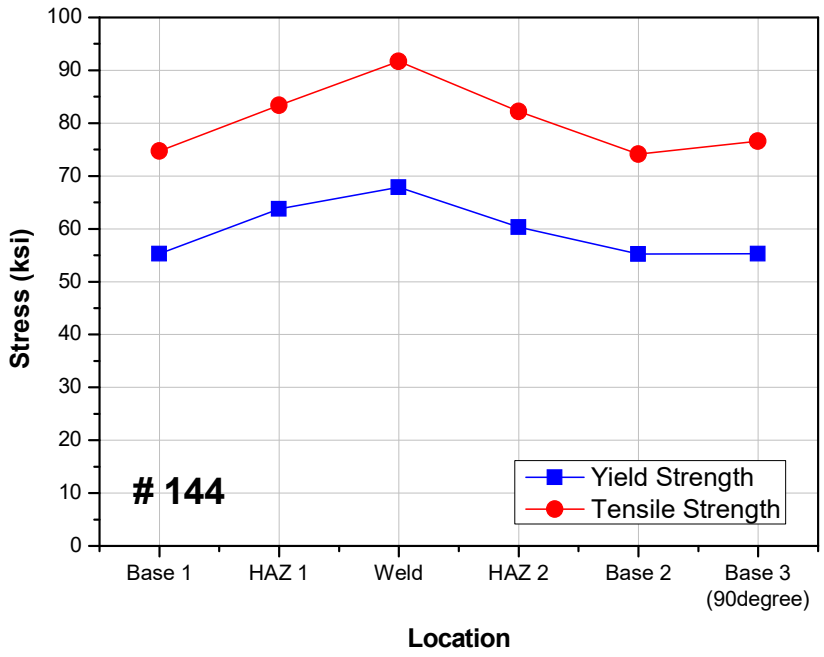
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 143	Base 1	1	54.53	72.55	311.10
		2	51.50	71.63	262.07
		3	52.57	71.76	284.18
	HAZ 1	1	56.95	76.03	289.99
		2	56.60	75.85	297.38
		3	56.85	75.29	316.55
	Weld	1	58.98	78.64	318.32
		2	57.17	78.27	314.55
		3	58.19	78.62	319.19
	HAZ 2	1	58.28	77.34	342.23
		2	55.66	77.74	267.07
		3	57.44	76.54	332.55
	Base 2 (90°)	1	53.06	70.51	283.16
		2	54.78	72.72	282.81
		3	53.73	72.01	266.34

Pipe# : # 144

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	55.31	74.71	308.40
HAZ 1	63.78	83.38	378.76
Weld	67.85	91.67	386.56
HAZ 2	60.31	82.22	308.52
Base 2	55.22	74.11	332.74
Base 3 (90°)	55.27	76.57	280.29

< Comparison graph – Yield and Tensile Strength >



< Detail results >

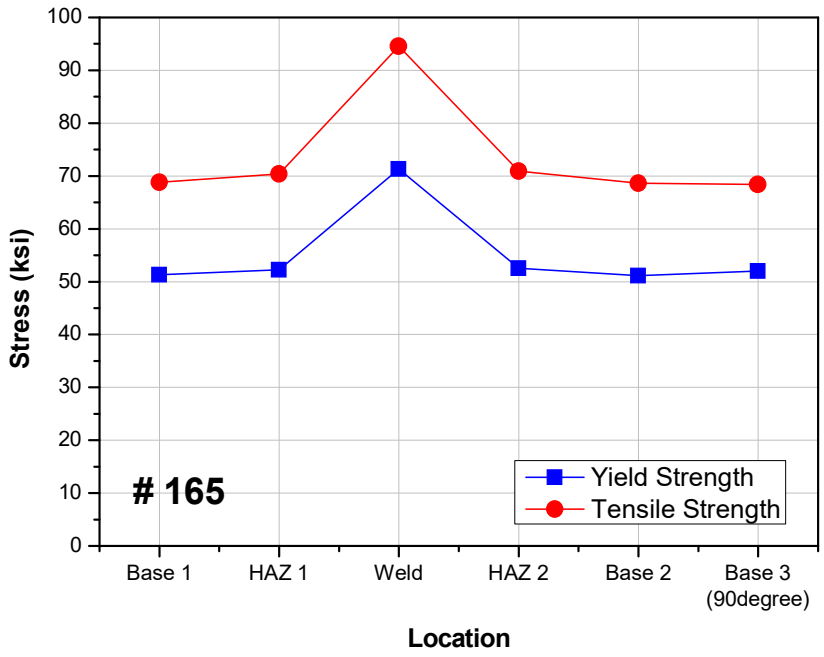
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 144	Base 1	1	56.83	75.79	325.09
		2	54.32	73.64	314.81
		3	54.79	74.71	285.31
	HAZ 1	1	61.50	81.85	351.48
		2	69.48	86.34	483.92
		3	60.36	81.94	300.86
	Weld	1	65.92	93.44	360.41
		2	66.68	89.21	390.74
		3	70.96	92.37	408.53
	HAZ 2	1	60.45	83.27	297.19
		2	60.69	82.69	292.41
		3	59.78	80.70	335.96
	Base 2	1	55.72	73.83	346.23
		2	53.51	73.87	305.49
		3	56.42	74.63	346.51
	Base 3 (90°)	1	55.70	78.68	253.67
		2	53.87	76.07	262.81
		3	56.25	74.96	324.38

Pipe# : # 165

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	51.34	68.81	305.46
HAZ 1	52.28	70.38	315.17
Weld	71.34	94.55	478.81
HAZ 2	52.55	70.94	318.10
Base 2	51.14	68.62	308.66
Base 3 (90°)	52.04	68.42	314.71

< Comparison graph – Yield and Tensile Strength >



< Detail results >

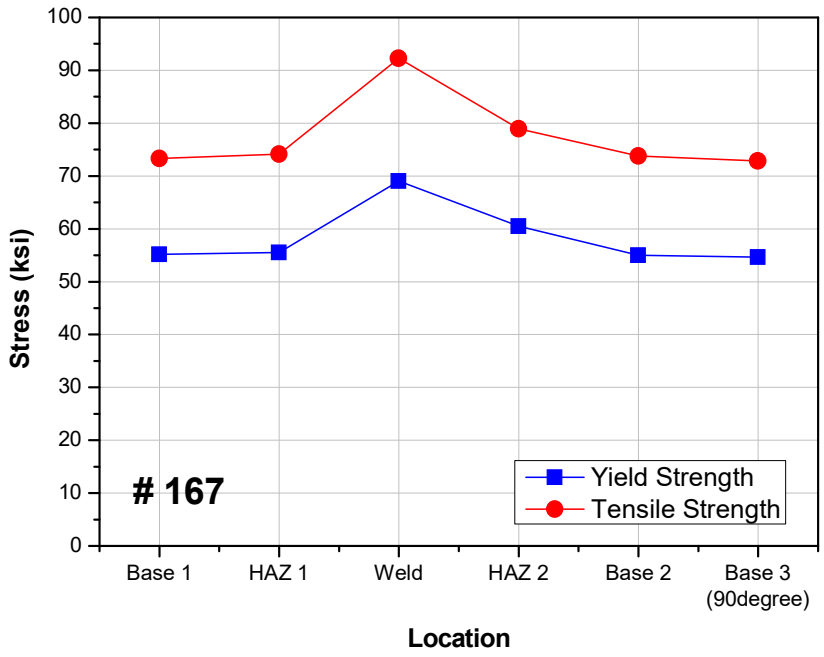
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 165	Base 1	1	50.32	67.81	291.99
		2	51.25	69.11	298.50
		3	52.44	69.51	325.89
	HAZ 1	1	52.22	70.01	307.02
		2	52.17	70.35	312.63
		3	52.45	70.79	325.85
	Weld	1	71.71	94.63	477.65
		2	70.77	94.06	469.48
		3	71.53	94.98	489.29
	HAZ 2	1	52.82	70.97	320.96
		2	52.90	70.92	320.05
		3	51.93	70.92	313.29
	Base 2	1	51.63	69.01	316.71
		2	50.47	68.27	292.21
		3	51.32	68.57	317.06
	Base 3 (90°)	1	52.84	67.93	319.32
		2	52.82	69.53	313.37
		3	50.46	67.80	311.43

Pipe# : # 167

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	55.16	73.31	327.71
HAZ 1	55.53	74.12	324.94
Weld	69.07	92.30	410.21
HAZ 2	60.51	78.92	376.49
Base 2	55.01	73.77	310.19
Base 3 (90°)	54.66	72.87	331.59

< Comparison graph – Yield and Tensile Strength >



< Detail results >

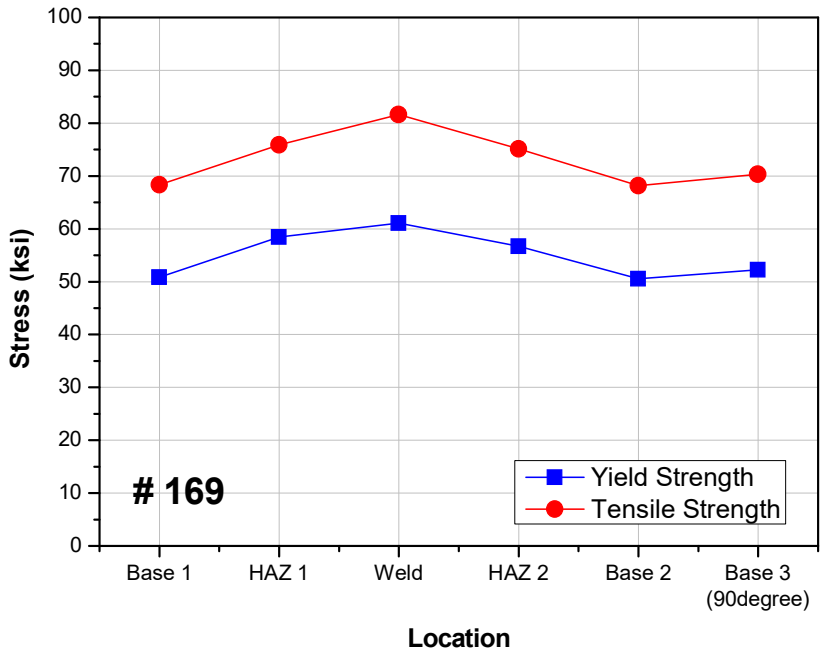
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 167	Base 1	1	55.25	73.26	333.47
		2	54.50	73.02	326.55
		3	55.72	73.67	323.10
	HAZ 1	1	55.45	74.08	317.85
		2	56.22	74.56	337.33
		3	54.92	73.71	319.65
	Weld	1	69.77	92.41	424.14
		2	68.21	91.90	407.20
		3	69.23	92.59	399.30
	HAZ 2	1	59.29	78.22	350.35
		2	64.14	81.02	462.70
		3	58.12	77.53	316.40
	Base 2	1	55.31	73.88	316.68
		2	54.49	73.83	284.14
		3	55.23	73.60	329.76
	Base 3 (90°)	1	54.86	72.89	318.00
		2	53.52	72.22	320.47
		3	55.59	73.50	356.30

Pipe# : # 169

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	50.85	68.33	290.01
HAZ 1	58.48	75.92	328.59
Weld	61.11	81.63	371.56
HAZ 2	56.72	75.15	327.34
Base 2	50.54	68.14	297.25
Base 3 (90°)	52.24	70.35	318.16

< Comparison graph – Yield and Tensile Strength >



< Detail results >

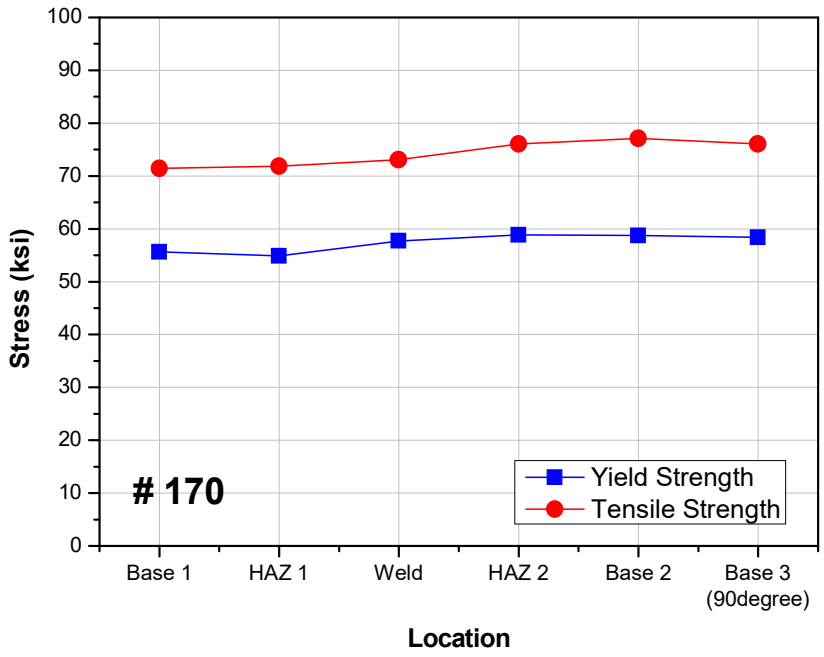
Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 169	Base 1	1	51.18	68.39	290.48
		2	51.86	69.04	315.47
		3	49.50	67.56	264.07
	HAZ 1	1	59.31	76.01	350.50
		2	58.01	75.49	313.86
		3	58.12	76.26	321.40
	Weld	1	60.87	81.39	374.25
		2	61.43	81.87	363.40
		3	61.03	81.62	377.04
	HAZ 2	1	55.80	74.35	311.96
		2	57.66	75.63	339.70
		3	56.69	75.47	330.36
	Base 2	1	50.53	67.96	306.92
		2	50.41	68.10	286.40
		3	50.67	68.34	298.42
	Base 3 (90°)	1	52.04	69.82	317.02
		2	52.01	70.14	334.24
		3	52.67	71.09	303.22

Pipe# : # 170

< Average results >

Location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	55.64	71.47	298.34
HAZ 1	54.90	71.87	306.43
Weld	57.71	73.09	360.25
HAZ 2	58.89	76.08	350.04
Base 2	58.76	77.11	334.17
Base 3 (90°)	58.38	76.09	347.31

< Comparison graph – Yield and Tensile Strength >



< Detail results >

Pipe #	Location	Location	Yield strength	Tensile strength	Fracture toughness
			ksi	ksi	MPa·m^1/2
# 170	Base 1	1	55.73	72.36	294.66
		2	56.03	73.77	319.05
		3	55.15	68.28	281.30
	HAZ 1	1	53.01	69.69	265.30
		2	55.76	71.78	327.44
		3	55.94	74.14	326.53
	Weld	1	58.97	75.20	383.78
		2	56.96	73.08	350.73
		3	57.19	70.98	346.23
	HAZ 2	1	58.00	73.61	331.37
		2	59.10	76.91	346.89
		3	59.57	77.71	371.87
	Base 2	1	60.24	77.47	343.86
		2	56.97	76.01	328.91
		3	59.05	77.86	329.74
	Base 3 (90°)	1	59.63	77.73	336.99
		2	57.54	74.93	357.83
		3	57.95	75.60	347.10

< Appendix 1 >

All the detail measured results

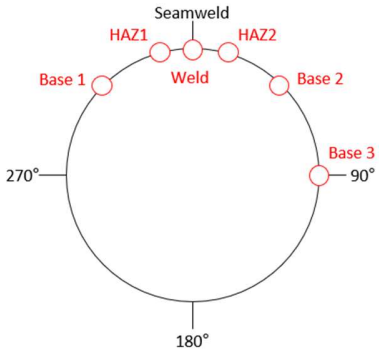
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	003
Location	GTI office (Des Plaines, IL)	Pipe size (in)	12
Test date	4/2/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	57.60	80.31	294.59
HAZ 1	61.46	83.56	320.76
Weld	58.00	81.21	278.01
HAZ 2	62.40	85.50	291.37
Base 2	58.46	78.80	286.68
Base 3 (90°)	59.14	79.44	304.37

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	58.10	80.02	297.46
	2	57.25	80.67	294.22
	3	57.46	80.24	292.09
HAZ 1	1	61.89	83.24	331.31
	2	62.67	83.26	337.76
	3	59.82	84.20	293.21
Weld	1	57.33	82.02	279.08
	2	58.33	80.90	281.32
	3	58.32	80.72	273.64
HAZ 2	1	62.72	84.74	301.48
	2	61.72	86.24	277.61
	3	62.77	85.53	295.02
Base 2	1	58.84	77.80	311.40
	2	57.47	77.76	283.48
	3	59.08	80.84	265.15
Base 3 (90°)	1	56.43	77.53	290.80
	2	60.06	79.21	329.87
	3	60.94	81.58	292.45

* Analysis result is engineering value

Remark

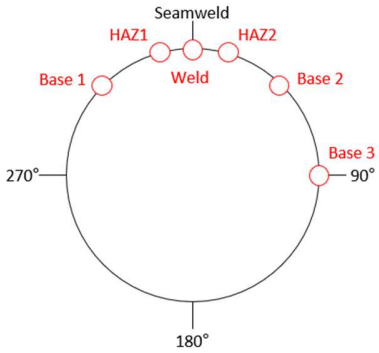
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	004
Location	GTI office (Des Plaines, IL)	Pipe size (in)	12
Test date	4/1/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	58.16	79.90	272.13
HAZ 1	63.74	87.18	310.88
Weld	62.63	86.08	313.55
HAZ 2	64.74	88.18	313.98
Base 2	60.45	81.53	320.54
Base 3 (90°)	58.87	79.20	325.41

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	56.70	77.27	256.24
	2	56.19	79.92	264.49
	3	61.59	82.50	295.67
HAZ 1	1	63.32	87.14	306.63
	2	63.77	87.21	308.85
	3	64.15	87.21	317.16
Weld	1	63.22	85.75	331.14
	2	61.58	86.81	283.60
	3	63.08	85.67	325.91
HAZ 2	1	66.38	89.51	311.97
	2	62.55	87.49	300.50
	3	65.28	87.56	329.48
Base 2	1	63.43	82.72	343.22
	2	60.45	81.29	320.04
	3	57.48	80.59	298.38
Base 3 (90°)	1	59.40	78.98	338.16
	2	58.07	79.21	305.48
	3	59.13	79.41	332.58

* Analysis result is engineering value

Remark

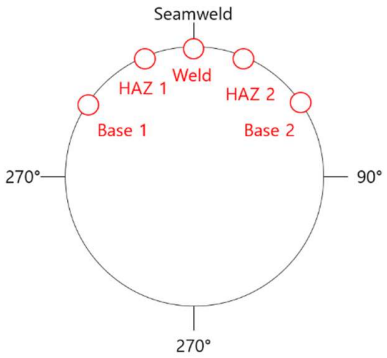
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	005
Location	GTI office (Des Plaines, IL)	Pipe size (in)	24
Test date	4/1/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	55.98	72.84	291.23
HAZ 1	56.49	76.14	261.66
Weld	56.62	78.31	252.72
HAZ 2	59.80	76.80	366.07
Base 2	51.61	69.85	252.59

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	55.89	71.99	303.62
	2	58.15	75.19	297.90
	3	53.89	71.34	272.17
HAZ 1	1	55.48	75.59	256.20
	2	56.27	76.73	257.81
	3	57.73	76.11	270.98
Weld	1	56.42	79.06	245.33
	2	57.22	78.41	262.95
	3	56.22	77.45	249.87
HAZ 2	1	59.69	75.29	342.89
	2	57.22	76.18	279.64
	3	62.49	78.94	475.68
Base 2	1	51.89	71.22	242.94
	2	51.02	69.44	256.59
	3	51.92	68.89	258.24

* Analysis result is engineering value

Remark

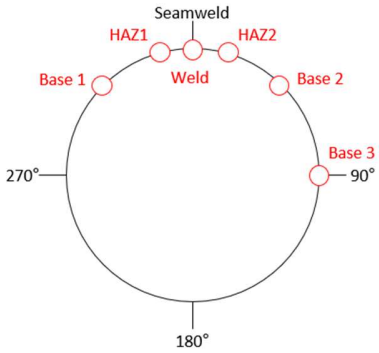
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	006
Location	GTI office (Des Plaines, IL)	Pipe size (in)	24
Test date	4/1/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	50.20	66.35	199.12
HAZ 1	55.60	73.66	228.87
Weld	57.97	76.94	259.00
HAZ 2	56.57	75.99	271.10
Base 2	53.30	72.66	245.00
Base 3 (90°)	52.35	71.26	241.92

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	50.44	67.33	194.09
	2	49.54	66.52	197.54
	3	50.62	65.21	205.74
HAZ 1	1	53.36	73.71	202.47
	2	56.33	73.82	236.90
	3	57.09	73.44	247.26
Weld	1	57.80	75.54	264.75
	2	58.58	78.09	249.38
	3	57.54	77.19	262.88
HAZ 2	1	56.25	75.17	270.48
	2	56.72	76.04	274.36
	3	56.76	76.76	268.47
Base 2	1	52.53	71.59	252.68
	2	53.37	72.99	240.98
	3	54.00	73.41	241.34
Base 3 (90°)	1	52.59	70.94	243.42
	2	52.53	70.23	265.63
	3	51.94	72.61	216.72

* Analysis result is engineering value

Remark

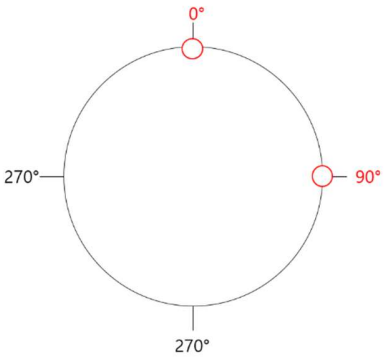
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	012
Location	GTI office (Des Plaines, IL)	Pipe size (in)	12
Test date	4/3/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	50.53	68.49	291.94
90°	50.99	70.18	307.84

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	49.75	66.83	309.48
	2	50.23	68.14	297.95
	3	51.63	70.51	268.39
90°	1	52.46	71.85	301.86
	2	50.46	70.11	282.62
	3	50.07	68.60	339.05

* Analysis result is engineering value

Remark

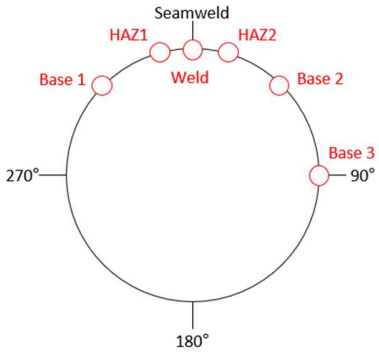
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	13
Location	GTI office (Des Plaines, IL)	Pipe size (in)	16
Test date	4/1/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	52.46	71.77	277.32
HAZ 1	51.52	72.04	239.11
Weld	62.12	84.57	307.08
HAZ 2	58.81	80.60	294.26
Base 2	54.37	73.14	254.16
Base 3	51.52	72.04	239.11

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	53.25	71.77	294.79
	2	51.35	71.90	262.59
	3	52.77	71.65	274.58
HAZ 1	1	59.83	81.04	301.66
	2	58.05	80.40	291.92
	3	58.53	80.37	289.19
Weld	1	69.62	93.55	340.05
	2	70.41	92.92	376.12
	3	68.82	91.53	367.81
HAZ 2	1	62.23	84.65	303.91
	2	63.42	85.80	316.85
	3	64.13	87.31	310.12
Base 2	1	53.02	73.11	234.67
	2	54.68	73.62	248.56
	3	55.40	72.70	279.24
Base 3	1	51.36	71.51	234.55
	2	50.44	72.17	237.07
	3	52.75	72.44	245.73

* Analysis result is engineering value

Remark

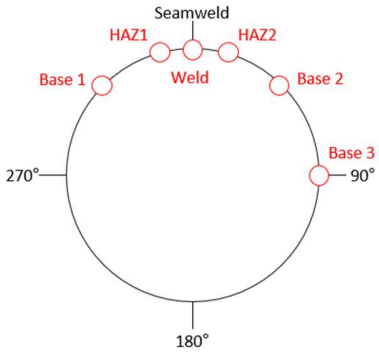
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	18
Location	GTI office (Des Plaines, IL)	Pipe size (in)	20
Test date	4/16/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	58.06	78.29	357.29
HAZ 1	64.27	86.51	363.46
Weld	71.06	94.07	412.62
HAZ 2	64.00	86.47	358.61
Base 2	60.36	81.26	336.35
Base 3	57.73	77.77	343.04

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	59.11	79.12	367.38
	2	56.98	77.23	329.24
	3	58.09	78.53	375.25
HAZ 1	1	64.88	86.53	376.41
	2	63.46	86.17	354.41
	3	64.47	86.82	359.55
Weld	1	72.09	94.43	448.54
	2	70.94	94.16	404.73
	3	70.14	93.62	384.58
HAZ 2	1	62.14	86.46	312.19
	2	65.58	86.46	391.03
	3	64.27	86.50	372.63
Base 2	1	59.25	79.98	360.88
	2	61.45	82.05	343.03
	3	60.39	81.75	305.14
Base 3	1	56.18	76.24	324.83
	2	58.53	78.92	324.54
	3	58.48	78.16	379.75

* Analysis result is engineering value

Remark

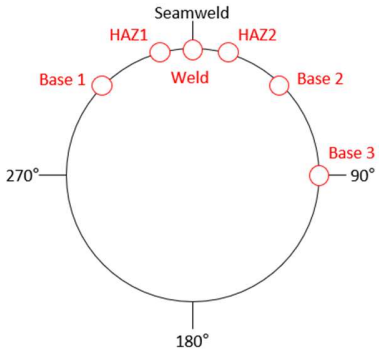
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	19
Location	GTI office (Des Plaines, IL)	Pipe size (in)	20
Test date	4/16/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	48.89	65.29	269.41
HAZ 1	56.38	74.07	330.25
Weld	61.75	82.59	334.64
HAZ 2	53.69	71.94	287.92
Base 2	48.46	66.25	260.85
Base 3	48.68	66.85	239.56

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	48.48	65.88	247.45
	2	48.51	64.58	275.58
	3	49.66	65.41	285.20
HAZ 1	1	54.89	73.39	294.70
	2	57.05	74.16	349.43
	3	57.22	74.66	346.62
Weld	1	62.96	83.44	310.65
	2	62.40	81.94	353.45
	3	59.88	82.40	339.82
HAZ 2	1	54.57	72.07	297.85
	2	52.06	71.48	271.22
	3	54.45	72.26	294.70
Base 2	1	47.99	65.76	245.18
	2	51.01	66.94	296.99
	3	46.36	66.07	240.38
Base 3	1	48.13	66.47	225.14
	2	49.36	66.28	278.63
	3	48.55	67.78	214.93

* Analysis result is engineering value

Remark

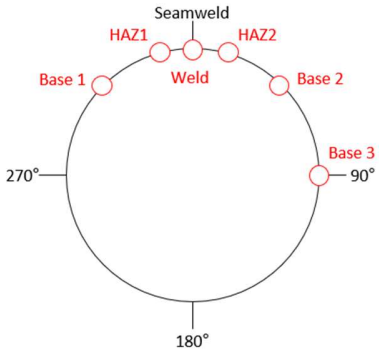
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	24
Location	GTI office (Des Plaines, IL)	Pipe size (in)	12
Test date	4/16/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	50.17	66.35	298.46
HAZ 1	53.35	70.15	302.04
Weld	63.32	83.09	349.19
HAZ 2	59.02	76.04	332.04
Base 2	50.79	68.56	272.77
Base 3	50.63	67.14	294.11

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	49.82	65.42	294.87
	2	50.85	66.84	303.54
	3	49.85	66.80	296.97
HAZ 1	1	52.87	69.77	291.23
	2	53.93	70.42	315.64
	3	53.24	70.27	299.24
Weld	1	63.91	82.90	360.05
	2	63.02	83.09	355.62
	3	63.03	83.29	331.92
HAZ 2	1	60.28	77.07	333.31
	2	58.10	75.88	318.76
	3	58.68	75.18	344.06
Base 2	1	49.97	68.61	246.39
	2	50.70	68.41	273.69
	3	51.72	68.66	298.24
Base 3	1	50.56	67.00	298.88
	2	50.87	67.33	306.41
	3	50.46	67.08	277.04

* Analysis result is engineering value

Remark

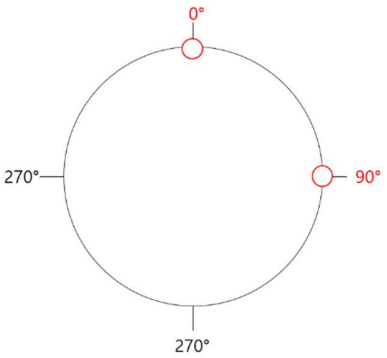
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	025
Location	GTI office (Des Plaines, IL)	Pipe size (in)	18
Test date	4/16/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	56.66	76.49	303.60
90°	58.05	77.93	313.97

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	56.17	76.18	299.55
	2	57.42	76.50	321.49
	3	56.38	76.80	289.76
90°	1	56.62	78.24	286.70
	2	57.90	77.62	321.34
	3	59.64	77.92	333.88

* Analysis result is engineering value

Remark

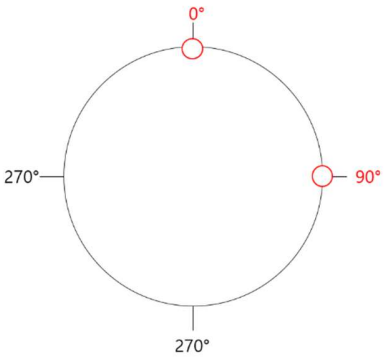
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	026
Location	GTI office (Des Plaines, IL)	Pipe size (in)	18
Test date	4/16/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	61.22	82.78	412.68
90°	62.72	84.08	412.49

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	60.46	82.65	418.61
	2	62.57	83.72	422.62
	3	60.63	81.97	396.81
90°	1	62.41	83.99	419.00
	2	62.87	83.92	396.54
	3	62.88	84.32	421.94

* Analysis result is engineering value

Remark

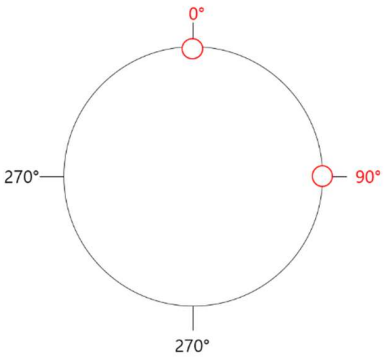
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	027
Location	GTI office (Des Plaines, IL)	Pipe size (in)	18
Test date	4/17/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	67.39	90.96	467.04
90°	68.04	90.23	461.70

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	69.12	91.90	474.85
	2	66.43	90.71	468.56
	3	66.60	90.28	457.71
90°	1	67.44	90.01	459.89
	2	68.60	90.43	465.37
	3	68.07	90.25	459.84

* Analysis result is engineering value

Remark

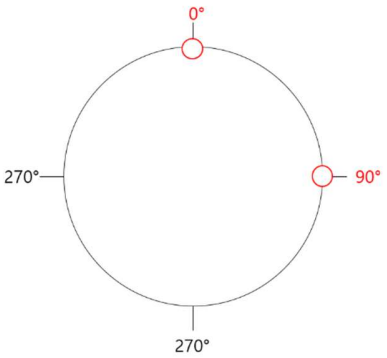
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	028
Location	GTI office (Des Plaines, IL)	Pipe size (in)	16
Test date	4/17/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	50.20	70.65	335.15
90°	54.41	75.07	380.04

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	50.90	71.10	336.75
	2	49.60	70.07	330.50
	3	50.09	70.78	338.19
90°	1	53.93	74.19	377.37
	2	54.81	75.66	387.42
	3	54.51	75.35	375.33

* Analysis result is engineering value

Remark

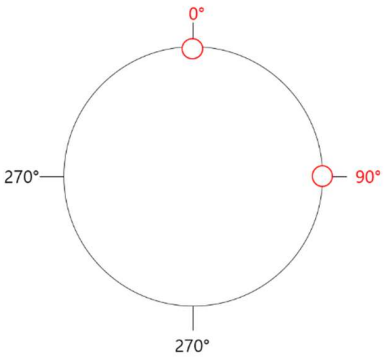
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	029
Location	GTI office (Des Plaines, IL)	Pipe size (in)	16
Test date	4/17/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	49.58	68.64	328.55
90°	54.19	73.65	355.40

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	49.40	68.43	317.42
	2	49.75	68.65	334.94
	3	49.61	68.84	333.31
90°	1	52.13	72.25	350.17
	2	57.62	76.05	373.19
	3	52.82	72.66	342.83

* Analysis result is engineering value

Remark

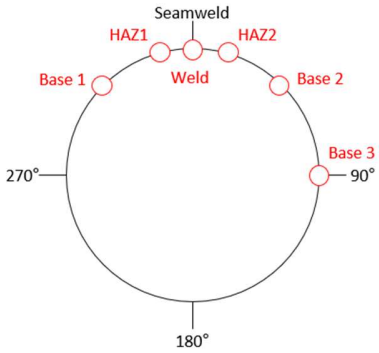
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	031
Location	GTI office (Des Plaines, IL)	Pipe size (in)	16
Test date	4/17/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	51.84	69.23	335.04
HAZ 1	54.34	71.96	355.62
Weld	65.69	83.40	419.83
HAZ 2	52.97	70.71	326.51
Base 2	52.48	69.82	321.03
Base 3	51.11	68.43	329.16

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	51.99	69.06	336.75
	2	51.74	69.41	335.90
	3	51.78	69.23	332.47
HAZ 1	1	54.14	71.92	356.36
	2	54.50	72.06	350.92
	3	54.38	71.91	359.59
Weld	1	66.29	83.76	445.20
	2	65.35	83.61	404.21
	3	65.42	82.83	410.09
HAZ 2	1	52.58	70.25	330.54
	2	53.28	70.82	307.95
	3	53.04	71.06	341.03
Base 2	1	53.49	70.74	328.47
	2	51.93	69.45	322.27
	3	52.03	69.28	312.37
Base 3	1	50.80	68.19	326.94
	2	50.93	68.12	321.13
	3	51.59	68.99	339.41

* Analysis result is engineering value

Remark

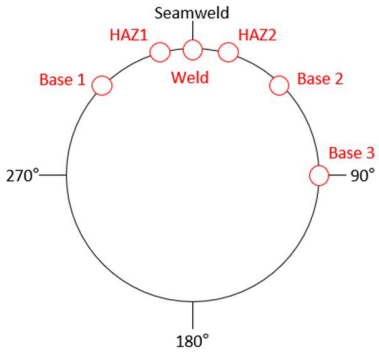
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	032
Location	GTI office (Des Plaines, IL)	Pipe size (in)	26
Test date	4/17/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	52.83	71.63	286.31
HAZ 1	53.70	73.39	295.19
Weld	53.26	72.17	350.34
HAZ 2	56.00	76.55	287.25
Base 2	51.65	71.64	296.63
Base 3	50.76	68.20	308.83

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	52.30	72.50	246.74
	2	54.44	72.74	296.38
	3	51.76	69.66	315.82
HAZ 1	1	51.94	71.79	300.10
	2	54.13	74.60	267.41
	3	55.04	73.76	318.05
Weld	1	53.08	72.00	349.54
	2	53.61	72.68	352.06
	3	53.09	71.84	349.43
HAZ 2	1	53.17	74.59	253.71
	2	57.22	76.12	348.42
	3	57.62	78.94	259.62
Base 2	1	51.77	72.24	313.10
	2	48.41	68.41	287.06
	3	54.78	74.28	289.72
Base 3	1	50.24	66.73	288.20
	2	50.93	68.61	318.64
	3	51.11	69.26	319.66

* Analysis result is engineering value

Remark

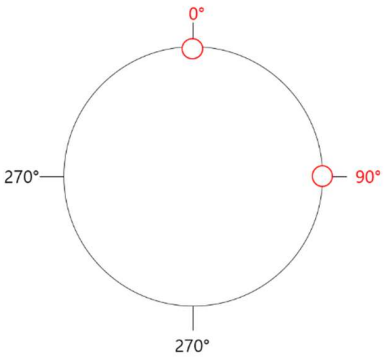
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	033
Location	GTI office (Des Plaines, IL)	Pipe size (in)	16
Test date	4/1/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	59.93	79.68	306.11
90°	58.89	78.54	295.95

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	59.30	80.01	290.62
	2	58.99	76.70	337.87
	3	61.51	82.33	289.85
90°	1	60.24	78.32	323.27
	2	58.93	80.75	266.14
	3	57.52	76.55	298.44

* Analysis result is engineering value

Remark

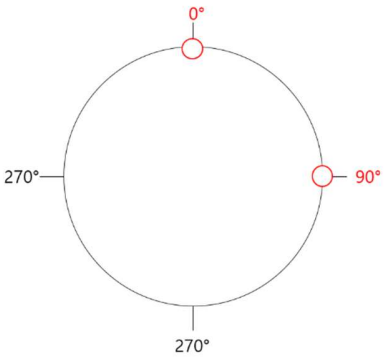
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	034
Location	GTI office (Des Plaines, IL)	Pipe size (in)	8
Test date	4/3/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	41.91	57.58	208.97
90°	43.12	57.96	244.41

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	42.21	57.30	202.00
	2	41.05	57.76	199.57
	3	42.48	57.69	225.33
90°	1	42.40	57.38	232.70
	2	43.09	58.14	252.06
	3	43.86	58.35	248.46

* Analysis result is engineering value

Remark

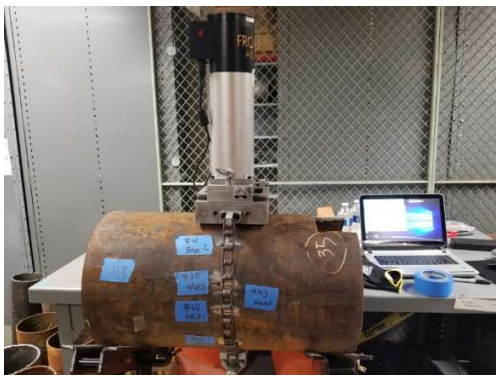
Instrumented Indentation Test (IIT) Results

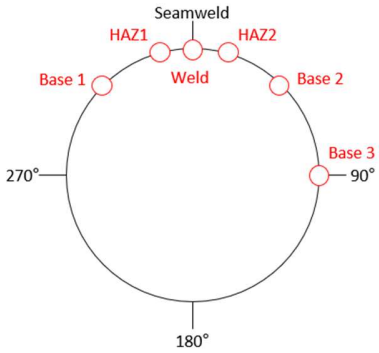
- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	035
Location	GTI office (Des Plaines, IL)	Pipe size (in)	12
Test date	4/5/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample





Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	43.09	57.44	198.11
HAZ 1	44.11	58.64	215.19
Weld	53.61	72.16	259.71
HAZ 2	43.31	58.57	207.96
Base 2	40.54	56.21	183.90
Base 3	43.49	57.60	222.18

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	42.55	56.96	190.57
	2	45.18	57.25	235.76
	3	41.54	58.11	168.00
HAZ 1	1	44.80	58.30	220.38
	2	43.70	59.38	198.80
	3	43.84	58.24	226.37
Weld	1	53.96	72.83	255.26
	2	53.78	72.21	268.20
	3	53.09	71.45	255.68
HAZ 2	1	42.57	58.68	191.25
	2	44.13	58.59	221.31
	3	43.23	58.43	211.31
Base 2	1	40.03	55.76	179.73
	2	40.95	56.37	186.64
	3	40.63	56.52	185.33
Base 3	1	43.71	57.36	238.53
	2	43.11	58.32	200.69
	3	43.66	57.11	227.33

* Analysis result is engineering value

Remark

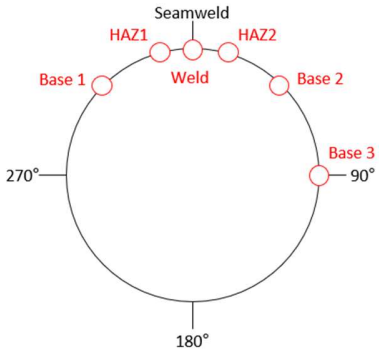
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	037
Location	GTI office (Des Plaines, IL)	Pipe size (in)	12
Test date	4/3/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	53.65	73.95	270.78
HAZ 1	54.64	74.01	280.02
Weld	48.14	64.59	275.70
HAZ 2	54.65	70.98	266.36
Base 2	53.85	73.77	248.35
Base 3	56.45	74.53	306.86

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	53.26	74.26	251.40
	2	55.44	74.36	302.06
	3	52.24	73.24	258.88
HAZ 1	1	54.89	75.00	275.93
	2	55.47	74.00	287.95
	3	53.55	73.05	276.17
Weld	1	50.25	66.02	294.27
	2	46.22	62.15	280.56
	3	47.94	65.61	252.27
HAZ 2	1	56.38	71.47	300.53
	2	53.12	71.44	230.98
	3	54.45	70.03	267.57
Base 2	1	52.30	71.31	234.19
	2	52.65	74.31	235.84
	3	56.62	75.70	275.01
Base 3	1	53.97	73.02	283.29
	2	57.61	75.02	325.70
	3	57.77	75.57	311.60

* Analysis result is engineering value

Remark

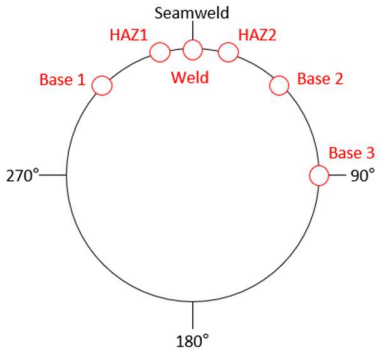
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	040
Location	GTI office (Des Plaines, IL)	Pipe size (in)	30
Test date	4/18/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	65.15	84.22	379.79
HAZ 1	68.51	86.65	363.39
Weld	56.29	75.66	290.67
HAZ 2	69.11	89.98	407.31
Base 2	66.16	86.78	414.23
Base 3	61.39	77.34	304.02

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	63.79	83.63	365.67
	2	65.49	84.28	395.26
	3	66.17	84.76	378.43
HAZ 1	1	66.26	84.51	327.71
	2	68.09	86.08	356.44
	3	71.19	89.38	406.03
Weld	1	55.45	75.23	275.97
	2	55.28	72.62	316.58
	3	58.13	79.13	279.45
HAZ 2	1	67.43	89.02	387.18
	2	69.49	89.94	404.58
	3	70.41	90.99	430.17
Base 2	1	64.32	85.48	398.17
	2	67.01	87.50	418.16
	3	67.16	87.35	426.36
Base 3	1	62.18	77.22	318.19
	2	59.93	78.68	261.42
	3	62.06	76.12	332.45

* Analysis result is engineering value

Remark

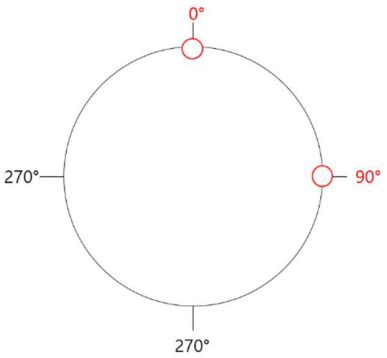
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	042
Location	GTI office (Des Plaines, IL)	Pipe size (in)	12
Test date	4/3/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	47.28	64.43	286.29
90°	45.79	64.68	244.80

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	47.18	64.40	287.17
	2	47.69	64.57	296.63
	3	46.97	64.33	275.09
90°	1	46.89	65.22	246.95
	2	46.52	65.57	244.26
	3	43.95	63.25	243.20

* Analysis result is engineering value

Remark

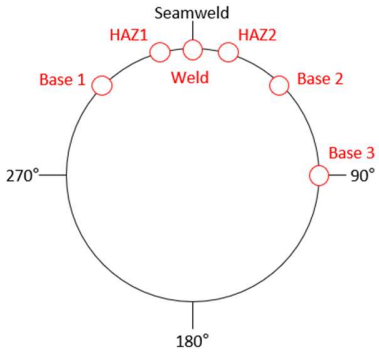
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	043
Location	GTI office (Des Plaines, IL)	Pipe size (in)	20
Test date	4/17/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	49.34	66.52	319.98
HAZ 1	60.00	77.65	344.27
Weld	56.12	74.68	318.09
HAZ 2	54.56	71.84	302.81
Base 2	53.07	69.62	311.08
Base 3	53.20	69.35	324.91

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	49.72	66.89	333.80
	2	49.28	66.56	306.81
	3	49.00	66.12	319.33
HAZ 1	1	59.82	77.75	336.51
	2	59.88	77.64	336.48
	3	60.29	77.57	359.82
Weld	1	56.14	75.11	311.27
	2	55.41	74.37	302.35
	3	56.81	74.57	340.64
HAZ 2	1	54.18	71.53	307.69
	2	52.74	71.20	271.73
	3	56.75	72.78	329.02
Base 2	1	54.01	70.38	318.25
	2	51.47	68.73	295.09
	3	53.74	69.75	319.90
Base 3	1	52.44	68.06	324.97
	2	54.40	70.83	322.27
	3	52.74	69.15	327.48

* Analysis result is engineering value

Remark

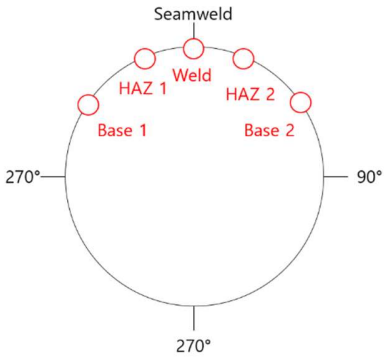
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	044
Location	GTI office (Des Plaines, IL)	Pipe size (in)	26
Test date	4/18/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	62.88	85.16	276.14
HAZ 1	60.83	82.66	292.67
Weld	67.39	85.82	408.89
HAZ 2	60.31	82.46	274.69
Base 2	61.78	85.64	264.55

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	62.68	86.38	271.95
	2	63.54	85.93	277.20
	3	62.43	83.16	279.26
HAZ 1	1	60.98	83.05	294.24
	2	59.63	81.54	290.64
	3	61.89	83.40	293.14
Weld	1	64.00	83.08	376.67
	2	69.55	87.68	422.10
	3	68.61	86.71	427.90
HAZ 2	1	61.92	83.06	277.48
	2	58.40	81.47	261.31
	3	60.60	82.85	285.29
Base 2	1	60.90	82.77	276.97
	2	62.43	89.16	251.60
	3	62.02	85.00	265.09

* Analysis result is engineering value

Remark

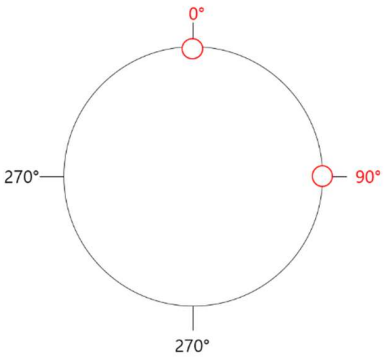
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	050
Location	GTI office (Des Plaines, IL)	Pipe size (in)	24
Test date	4/18/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	57.15	76.31	343.26
90°	61.37	77.70	284.51

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	57.15	76.73	323.64
	2	58.12	76.26	351.54
	3	56.17	75.93	354.60
90°	1	68.01	88.93	259.91
	2	58.35	72.17	292.90
	3	57.75	72.01	300.72

* Analysis result is engineering value

Remark

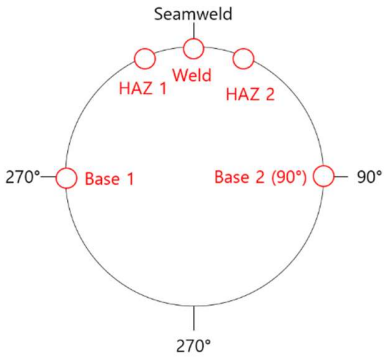
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	107
Location	GTI office (Des Plaines, IL)	Pipe size (in)	6
Test date	4/5/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	38.27	50.32	207.18
HAZ 1	38.35	51.40	208.18
Weld	40.56	54.39	220.13
HAZ 2	41.37	56.47	207.20
Base 2	36.65	51.62	215.95

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	38.26	49.78	183.95
	2	38.29	50.87	230.42
	3			
HAZ 1	1	38.73	51.09	183.52
	2	37.56	50.54	210.95
	3	38.76	52.58	230.07
Weld	1	39.65	53.93	227.62
	2	41.04	53.76	215.91
	3	41.01	55.47	216.87
HAZ 2	1	42.22	57.65	197.61
	2	40.56	55.78	201.69
	3	41.33	55.97	222.30
Base 2	1	38.77	52.94	224.24
	2	36.06	51.41	212.25
	3	35.13	50.50	211.35

* Analysis result is engineering value

Remark

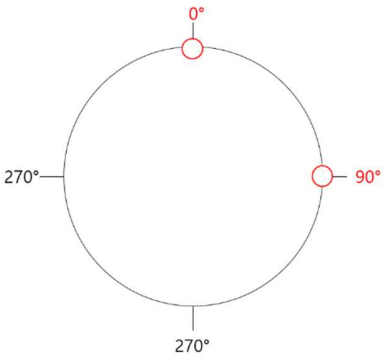
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	108
Location	GTI office (Des Plaines, IL)	Pipe size (in)	8
Test date	4/5/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	54.84	73.28	340.14
90°	56.93	75.38	344.28

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	55.04	73.34	334.85
	2	54.94	73.42	342.87
	3	54.55	73.07	342.70
90°	1	57.00	74.95	367.74
	2	59.32	77.43	322.63
	3	54.46	73.77	342.46

* Analysis result is engineering value

Remark

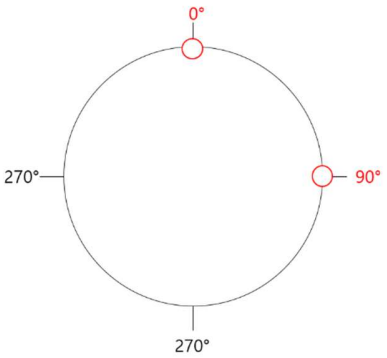
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	109
Location	GTI office (Des Plaines, IL)	Pipe size (in)	4
Test date	4/5/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	43.92	60.49	279.98
90°	44.59	61.76	275.50

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	44.43	60.45	283.36
	2	44.20	60.57	288.00
	3	43.12	60.44	268.58
90°	1	45.42	62.05	273.94
	2	44.50	61.52	266.55
	3	43.84	61.71	286.01

* Analysis result is engineering value

Remark

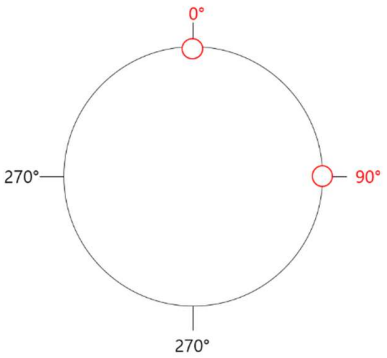
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	110
Location	GTI office (Des Plaines, IL)	Pipe size (in)	6
Test date	4/9/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	51.35	66.96	302.66
90°	52.26	70.55	311.72

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	50.26	67.28	305.09
	2	51.32	67.22	299.61
	3	52.48	66.38	303.28
90°	1	53.85	69.07	326.15
	2	51.16	70.10	312.15
	3	51.78	72.49	296.87

* Analysis result is engineering value

Remark

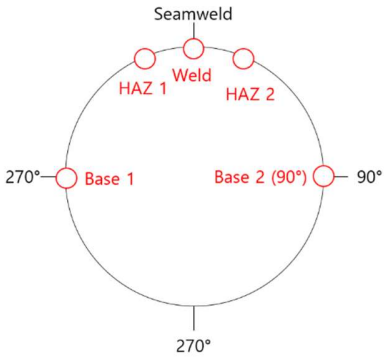
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	111
Location	GTI office (Des Plaines, IL)	Pipe size (in)	4
Test date	4/9/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	46.98	61.53	278.57
HAZ 1	45.54	61.90	285.37
Weld	47.04	63.61	283.85
HAZ 2	47.59	64.69	288.75
Base 2	47.83	65.26	300.10

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	46.87	62.93	293.69
	2	46.88	61.04	277.14
	3	47.18	60.63	264.89
HAZ 1	1	47.36	62.13	288.53
	2	44.57	61.90	277.65
	3	44.71	61.68	289.92
Weld	1	48.02	63.74	304.51
	2	45.85	62.80	274.10
	3	47.25	64.29	272.94
HAZ 2	1	48.00	64.89	279.75
	2	47.20	64.52	293.76
	3	47.58	64.68	292.73
Base 2	1	49.95	67.06	317.36
	2	47.32	64.96	299.36
	3	46.23	63.77	283.57

* Analysis result is engineering value

Remark

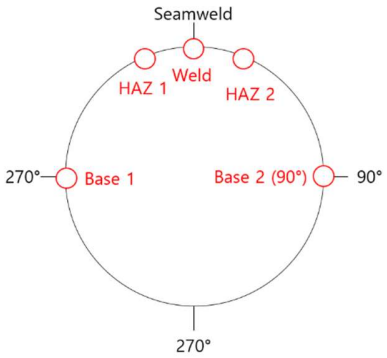
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	112
Location	GTI office (Des Plaines, IL)	Pipe size (in)	4
Test date	4/9/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	45.70	62.66	288.32
HAZ 1	45.67	63.00	292.35
Weld	47.03	63.57	295.42
HAZ 2	47.92	64.77	282.12
Base 2	48.45	65.33	303.83

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	46.63	63.91	313.38
	2	45.40	62.08	275.52
	3	45.05	62.00	276.07
HAZ 1	1	44.61	62.88	281.74
	2	45.16	62.22	287.47
	3	47.24	63.90	307.84
Weld	1	46.16	62.70	284.66
	2	47.70	64.19	308.91
	3	47.23	63.83	292.70
HAZ 2	1	46.06	63.49	245.18
	2	48.71	65.00	287.95
	3	48.98	65.82	313.24
Base 2	1	49.02	65.31	308.31
	2	47.65	65.06	291.14
	3	48.68	65.61	312.05

* Analysis result is engineering value

Remark

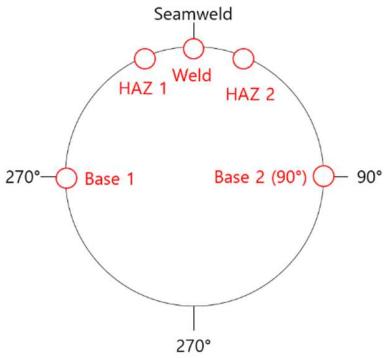
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	113
Location	GTI office (Des Plaines, IL)	Pipe size (in)	6
Test date	4/5/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	47.66	64.51	282.33
HAZ 1	51.61	68.51	296.89
Weld	59.28	79.01	363.16
HAZ 2	53.05	70.50	316.76
Base 2	47.75	64.29	295.77

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	48.37	64.69	287.73
	2	47.40	64.50	286.36
	3	47.21	64.33	272.90
HAZ 1	1	52.07	68.26	306.80
	2	50.90	68.57	283.31
	3	51.87	68.69	300.57
Weld	1	58.91	79.00	350.80
	2	59.44	79.03	365.60
	3	59.48	78.99	373.07
HAZ 2	1	53.91	71.12	330.06
	2	52.76	70.42	318.09
	3	52.49	69.97	302.14
Base 2	1	48.38	64.52	306.07
	2	47.87	64.25	287.35
	3	46.99	64.10	293.89

* Analysis result is engineering value

Remark

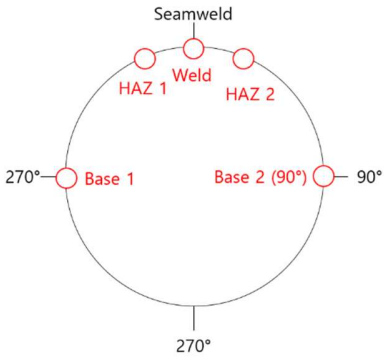
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	114
Location	GTI office (Des Plaines, IL)	Pipe size (in)	8
Test date	4/5/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	48.01	63.90	300.74
HAZ 1	53.52	70.30	315.53
Weld	63.58	82.57	383.03
HAZ 2	52.45	68.73	301.63
Base 2	44.96	55.86	232.81

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	48.25	64.03	310.95
	2	48.32	64.25	306.46
	3	47.48	63.41	284.80
HAZ 1	1	52.01	69.52	287.28
	2	55.13	71.17	349.11
	3	53.44	70.21	310.21
Weld	1	64.56	82.94	387.38
	2	64.20	83.09	391.57
	3	61.99	81.67	370.15
HAZ 2	1	53.66	69.08	314.14
	2	51.47	68.57	291.14
	3	52.22	68.52	299.61
Base 2	1	45.98	56.10	251.92
	2	45.91	56.01	249.28
	3	43.01	55.45	197.22

* Analysis result is engineering value

Remark

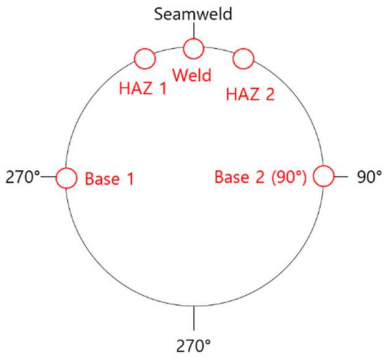
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	115
Location	GTI office (Des Plaines, IL)	Pipe size (in)	8
Test date	4/2/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	45.13	60.57	257.28
HAZ 1	46.29	63.19	267.81
Weld	52.93	70.07	302.58
HAZ 2	51.76	67.98	286.40
Base 2	46.41	61.26	275.49

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	43.64	59.80	244.60
	2	45.47	60.55	261.80
	3	46.27	61.35	265.44
HAZ 1	1	47.32	64.19	279.87
	2	44.73	62.31	245.90
	3	46.81	63.08	277.66
Weld	1	54.19	70.81	310.53
	2	52.77	69.84	311.11
	3	51.82	69.56	286.10
HAZ 2	1	50.94	67.86	271.16
	2	52.40	68.48	300.49
	3	51.93	67.58	287.56
Base 2	1	46.58	61.39	275.76
	2	46.64	61.51	284.79
	3	46.02	60.87	265.91

* Analysis result is engineering value

Remark

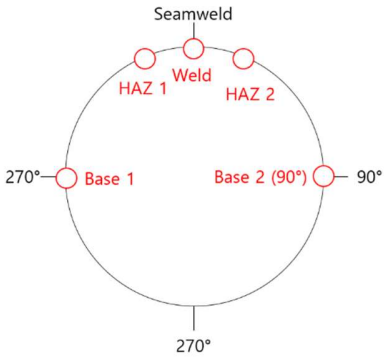
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	116
Location	GTI office (Des Plaines, IL)	Pipe size (in)	8
Test date	4/4/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	45.41	59.41	263.11
HAZ 1	47.61	63.30	285.90
Weld	65.56	87.05	393.62
HAZ 2	49.72	65.97	281.16
Base 2	45.24	61.59	285.04

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	44.00	56.56	246.95
	2	46.01	59.81	266.61
	3	46.21	61.87	275.75
HAZ 1	1	49.74	64.69	316.91
	2	45.86	62.23	261.45
	3	47.24	62.98	279.34
Weld	1	64.96	86.30	384.80
	2	66.17	87.80	402.44
	3			
HAZ 2	1	50.71	66.78	279.63
	2	49.50	65.74	283.65
	3	48.94	65.40	280.20
Base 2	1	45.80	61.93	282.49
	2	45.34	61.42	284.05
	3	44.59	61.42	288.59

* Analysis result is engineering value

Remark

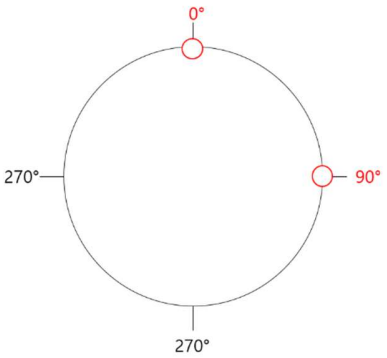
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	117
Location	GTI office (Des Plaines, IL)	Pipe size (in)	10
Test date	4/8/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	55.52	75.24	350.08
90°	58.23	78.34	375.45

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	55.42	76.27	377.42
	2	55.74	74.86	344.34
	3	55.39	74.60	328.47
90°	1	58.35	77.94	372.32
	2	58.17	78.19	373.82
	3	58.16	78.89	380.21

* Analysis result is engineering value

Remark

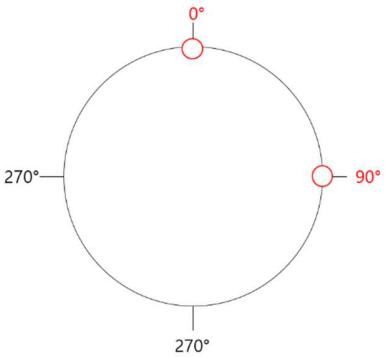
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	118
Location	GTI office (Des Plaines, IL)	Pipe size (in)	10
Test date	4/8/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	54.49	73.68	340.81
90°	56.01	74.25	371.35

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	55.53	74.23	345.90
	2	53.80	73.48	330.68
	3	54.13	73.32	345.84
90°	1	56.59	73.63	362.67
	2	55.80	74.24	369.72
	3	55.63	74.89	381.65

* Analysis result is engineering value

Remark

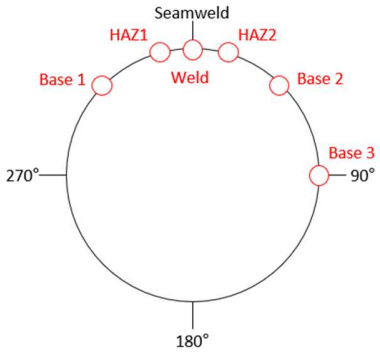
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	119
Location	GTI office (Des Plaines, IL)	Pipe size (in)	10
Test date	4/2/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	58.54	78.70	387.94
HAZ 1	57.06	78.53	377.75
Weld	57.78	78.23	383.14
HAZ 2	57.09	78.13	363.52
Base 2	59.81	80.80	407.42
Base 3	56.75	77.15	365.56

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	58.57	78.41	393.59
	2	58.01	78.29	392.84
	3	59.03	79.39	377.39
HAZ 1	1	58.19	78.67	367.96
	2	57.87	79.80	415.38
	3	55.12	77.12	349.92
Weld	1	57.41	77.72	371.37
	2	57.40	77.81	380.58
	3	58.54	79.16	397.49
HAZ 2	1	58.12	78.62	367.82
	2	57.72	78.71	385.81
	3	55.42	77.07	336.94
Base 2	1	60.45	81.04	422.56
	2	59.52	80.84	385.89
	3	59.46	80.51	413.82
Base 3	1	56.73	76.90	356.65
	2	56.51	77.29	371.63
	3	57.00	77.25	368.42

* Analysis result is engineering value

Remark

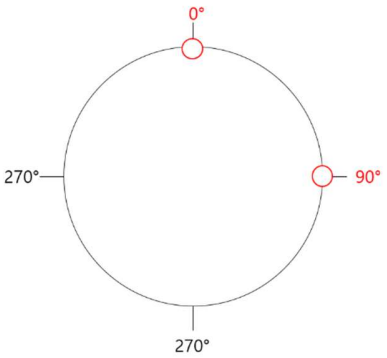
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	121
Location	GTI office (Des Plaines, IL)	Pipe size (in)	6
Test date	4/2/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	54.14	72.15	309.34
90°	51.51	69.18	306.49

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	56.92	74.59	300.77
	2	52.74	71.51	293.30
	3	52.77	70.34	333.94
90°	1	51.48	68.81	303.79
	2	50.88	69.15	301.27
	3	52.15	69.57	314.42

* Analysis result is engineering value

Remark

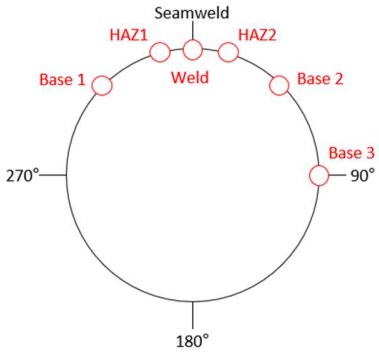
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	122
Location	GTI office (Des Plaines, IL)	Pipe size (in)	10
Test date	4/9/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	57.52	76.29	355.91
HAZ 1	63.93	84.18	386.49
Weld	63.89	85.26	404.59
HAZ 2	64.87	83.98	400.69
Base 2	56.16	74.89	346.06
Base 3	57.27	75.89	366.91

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	58.69	76.34	362.17
	2	57.46	76.56	365.26
	3	56.40	75.97	340.31
HAZ 1	1	63.15	83.66	366.69
	2	64.61	84.59	396.54
	3	64.04	84.30	396.24
Weld	1	65.58	86.22	422.77
	2	63.16	84.74	383.54
	3	62.92	84.82	407.44
HAZ 2	1	65.61	84.09	396.18
	2	65.06	84.29	412.50
	3	63.95	83.56	393.39
Base 2	1	56.31	74.83	352.36
	2	55.96	74.70	342.61
	3	56.21	75.13	343.22
Base 3	1	56.94	75.73	364.83
	2	57.65	75.77	365.46
	3	57.23	76.17	370.44

* Analysis result is engineering value

Remark

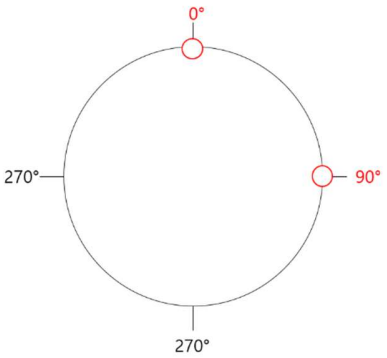
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	123
Location	GTI office (Des Plaines, IL)	Pipe size (in)	10
Test date	4/8/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	58.77	78.36	342.41
90°	60.59	79.33	348.98

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	57.69	77.86	309.62
	2	59.63	78.72	353.45
	3	58.99	78.49	364.15
90°	1	61.03	79.54	360.46
	2	61.03	79.44	336.16
	3	59.71	79.02	350.34

* Analysis result is engineering value

Remark

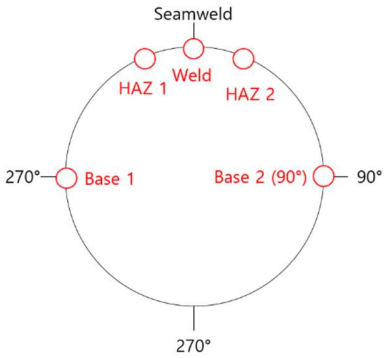
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	124
Location	GTI office (Des Plaines, IL)	Pipe size (in)	6
Test date	4/8/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	47.15	65.34	242.10
HAZ 1	50.11	68.34	261.99
Weld	57.41	78.69	273.79
HAZ 2	49.78	68.10	236.83
Base 2	47.63	65.26	229.11

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	47.25	65.52	238.22
	2	47.48	65.59	235.81
	3	46.72	64.93	252.28
HAZ 1	1	51.08	68.20	275.77
	2	48.95	68.35	251.64
	3	50.30	68.46	258.56
Weld	1	56.20	78.92	251.61
	2	57.60	78.27	281.36
	3	58.43	78.87	288.41
HAZ 2	1	49.25	68.14	239.29
	2	50.11	68.29	236.79
	3	49.99	67.87	234.40
Base 2	1	46.43	63.93	227.30
	2	49.16	66.58	228.25
	3	47.28	65.26	231.76

* Analysis result is engineering value

Remark

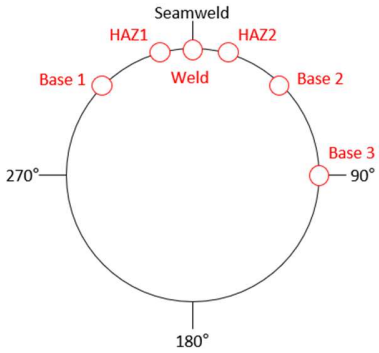
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	125
Location	GTI office (Des Plaines, IL)	Pipe size (in)	10
Test date	4/8/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	59.30	79.62	309.89
HAZ 1	62.63	84.72	320.28
Weld	62.52	84.44	307.26
HAZ 2	63.87	87.39	333.13
Base 2	58.38	79.12	316.17
Base 3	60.45	81.74	295.82

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	58.42	79.23	302.70
	2	59.38	79.63	309.33
	3	60.09	79.98	317.65
HAZ 1	1	63.61	83.59	343.27
	2	62.87	84.63	320.24
	3	61.42	85.95	297.34
Weld	1	63.43	85.02	321.22
	2	61.34	84.88	282.04
	3	62.79	83.41	318.52
HAZ 2	1	64.46	88.20	326.30
	2	64.56	87.38	342.06
	3	62.59	86.59	331.03
Base 2	1	59.92	79.45	334.26
	2	57.71	79.33	288.29
	3	57.51	78.58	325.96
Base 3	1	60.73	81.50	297.26
	2	60.29	81.58	288.35
	3	60.35	82.12	301.86

* Analysis result is engineering value

Remark

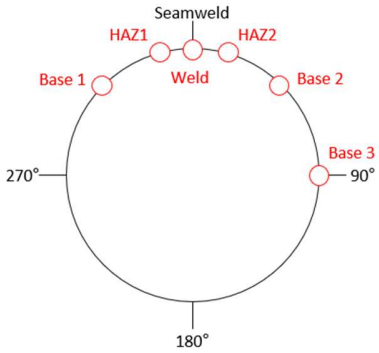
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	126
Location	GTI office (Des Plaines, IL)	Pipe size (in)	10
Test date	4/8/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	55.22	75.69	302.30
HAZ 1	59.86	82.61	305.63
Weld	58.72	81.60	296.70
HAZ 2	60.38	81.06	341.26
Base 2	58.79	79.44	330.11
Base 3	60.60	80.97	353.41

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	54.96	75.84	284.29
	2	54.72	75.68	298.81
	3	55.97	75.55	323.81
HAZ 1	1	61.33	82.54	342.63
	2	59.44	82.55	296.34
	3	58.81	82.73	277.92
Weld	1	59.37	82.17	294.30
	2	58.80	81.79	299.45
	3	57.98	80.84	296.36
HAZ 2	1	62.20	81.65	350.74
	2	60.40	80.44	371.06
	3	58.54	81.09	301.97
Base 2	1	55.73	79.27	255.21
	2	61.48	79.67	407.36
	3	59.16	79.38	327.77
Base 3	1	63.55	81.71	391.65
	2	60.75	81.19	361.38
	3	57.49	80.01	307.20

* Analysis result is engineering value

Remark

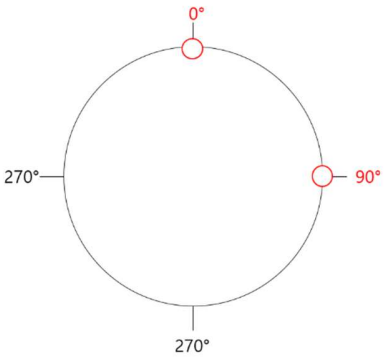
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	127
Location	GTI office (Des Plaines, IL)	Pipe size (in)	10
Test date	4/9/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	55.76	74.58	343.24
90°	56.13	76.88	312.61

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	56.04	74.70	344.89
	2	55.46	74.45	340.08
	3	55.78	74.59	344.74
90°	1	55.32	76.58	294.71
	2	56.22	76.86	317.89
	3	56.85	77.18	325.25

* Analysis result is engineering value

Remark

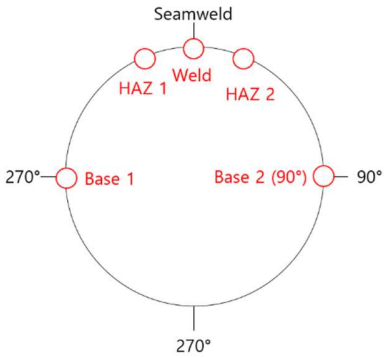
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	130
Location	GTI office (Des Plaines, IL)	Pipe size (in)	4
Test date	4/9/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	52.66	69.91	313.41
HAZ 1	51.33	68.90	307.51
Weld	72.16	90.50	438.99
HAZ 2	50.70	68.46	305.47
Base 2	52.46	69.70	313.84

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	53.66	70.14	329.04
	2	51.79	69.67	297.09
	3	52.53	69.93	314.12
HAZ 1	1	52.39	69.16	325.27
	2	51.41	68.94	310.02
	3	50.18	68.60	287.24
Weld	1	69.62	88.99	438.82
	2	70.29	88.80	421.20
	3	76.56	93.71	456.95
HAZ 2	1	51.63	68.88	318.27
	2	50.38	68.48	302.86
	3	50.09	68.01	295.28
Base 2	1	52.06	69.38	312.79
	2	52.09	69.50	301.77
	3	53.22	70.22	326.95

* Analysis result is engineering value

Remark

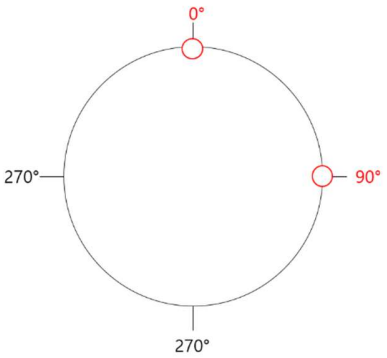
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	132
Location	GTI office (Des Plaines, IL)	Pipe size (in)	12
Test date	4/9/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	56.16	75.28	337.52
90°	55.61	76.89	321.24

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	56.44	73.59	324.49
	2	54.70	75.06	320.14
	3	57.34	77.19	367.92
90°	1	54.21	76.34	292.53
	2	55.41	76.64	322.30
	3	57.22	77.70	348.89

* Analysis result is engineering value

Remark

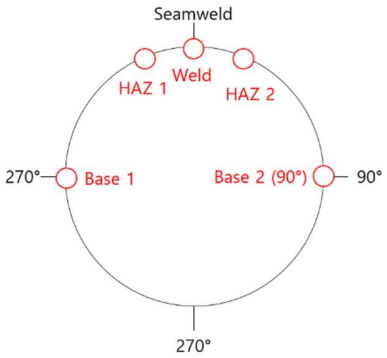
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	133
Location	GTI office (Des Plaines, IL)	Pipe size (in)	8
Test date	4/10/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	48.83	66.07	303.71
HAZ 1	53.52	71.45	317.27
Weld	62.50	84.62	341.55
HAZ 2	52.57	70.68	302.32
Base 2	48.82	65.94	305.15

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	49.04	66.09	305.43
	2	49.15	66.23	310.78
	3	48.31	65.89	294.91
HAZ 1	1	53.68	71.25	314.82
	2	53.44	71.55	320.25
	3	53.43	71.54	316.75
Weld	1	60.62	83.73	321.02
	2	65.36	85.20	400.48
	3	61.51	84.91	303.14
HAZ 2	1	52.12	70.12	279.95
	2	52.61	70.82	310.02
	3	52.98	71.09	316.98
Base 2	1	48.89	65.81	299.83
	2	48.90	66.08	311.25
	3	48.66	65.94	304.36

* Analysis result is engineering value

Remark

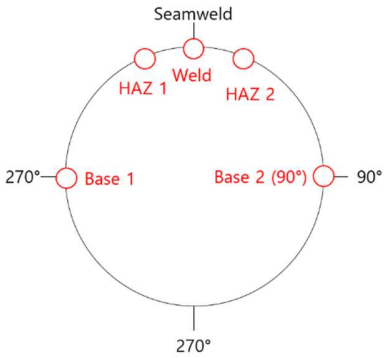
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	134
Location	GTI office (Des Plaines, IL)	Pipe size (in)	8
Test date	4/10/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	49.28	64.27	245.40
HAZ 1	52.08	70.94	268.93
Weld	65.14	85.85	356.31
HAZ 2	57.35	75.50	320.61
Base 2	50.67	68.14	277.38

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	49.38	63.12	229.79
	2	47.90	63.43	247.17
	3	50.56	66.25	259.23
HAZ 1	1	51.34	71.02	245.18
	2	52.02	70.74	276.80
	3	52.86	71.06	284.83
Weld	1	66.27	85.87	379.13
	2	64.19	86.09	323.11
	3	64.96	85.59	366.69
HAZ 2	1	57.10	75.34	315.39
	2	56.60	75.31	315.79
	3	58.36	75.86	330.66
Base 2	1	52.81	68.71	294.14
	2	47.96	67.36	240.34
	3	51.24	68.35	297.66

* Analysis result is engineering value

Remark

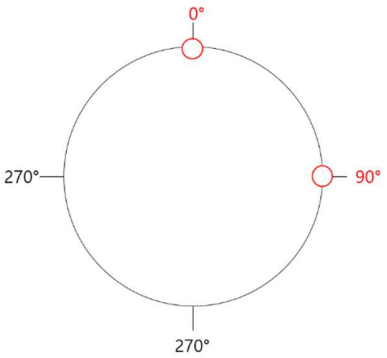
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	136
Location	GTI office (Des Plaines, IL)	Pipe size (in)	8
Test date	4/10/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	57.58	80.22	336.97
90°	61.18	82.15	336.23

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	55.87	80.07	321.57
	2	57.89	80.00	330.61
	3	58.99	80.59	358.72
90°	1	62.95	82.38	354.89
	2	61.37	81.57	368.19
	3	59.22	82.50	285.61

* Analysis result is engineering value

Remark

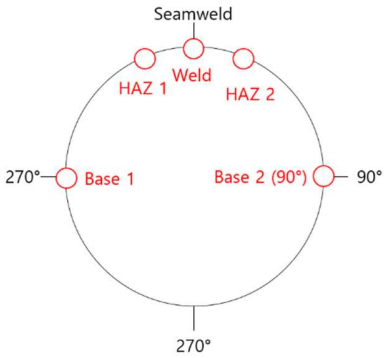
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	137
Location	GTI office (Des Plaines, IL)	Pipe size (in)	6
Test date	4/10/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	50.36	68.09	274.90
HAZ 1	53.60	70.57	300.75
Weld	68.88	90.27	370.28
HAZ 2	58.24	75.44	326.90
Base 2	54.24	70.36	299.52

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	50.90	68.27	272.75
	2	51.75	68.41	318.61
	3	48.43	67.58	233.33
HAZ 1	1	54.53	71.21	320.71
	2	52.43	69.59	292.74
	3	53.84	70.89	288.79
Weld	1	68.99	90.12	382.29
	2	68.60	90.73	354.19
	3	69.05	89.96	374.37
HAZ 2	1	59.61	75.55	358.68
	2	56.60	74.80	299.49
	3	58.52	75.96	322.53
Base 2	1	55.82	70.95	300.94
	2	55.36	71.14	320.28
	3	51.53	68.98	277.34

* Analysis result is engineering value

Remark

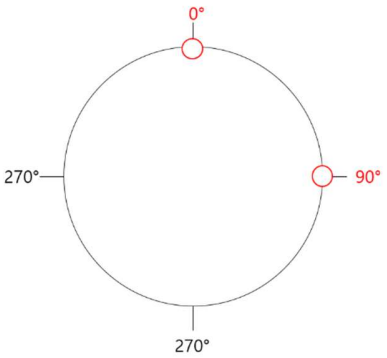
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	138
Location	GTI office (Des Plaines, IL)	Pipe size (in)	6
Test date	4/11/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	53.17	72.45	336.12
90°	53.75	73.42	322.11

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	52.63	72.31	337.28
	2	53.87	72.80	345.63
	3	53.01	72.23	325.47
90°	1	53.81	73.13	337.33
	2	53.39	73.23	283.98
	3	54.05	73.91	345.02

* Analysis result is engineering value

Remark

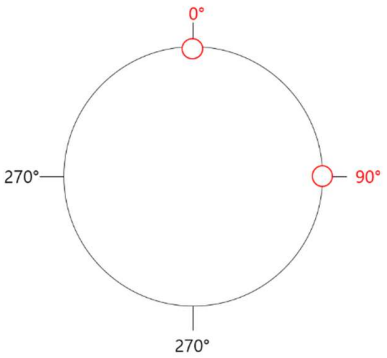
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	139
Location	GTI office (Des Plaines, IL)	Pipe size (in)	6
Test date	4/11/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	56.90	78.11	307.65
90°	56.12	76.97	304.67

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	58.05	77.83	346.17
	2	57.03	78.01	293.58
	3	55.61	78.49	283.22
90°	1	55.86	76.72	308.42
	2	56.17	76.94	310.23
	3	56.34	77.27	295.35

* Analysis result is engineering value

Remark

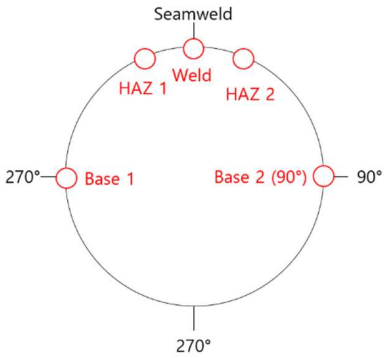
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	140
Location	GTI office (Des Plaines, IL)	Pipe size (in)	8
Test date	4/10/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	55.97	75.01	367.40
HAZ 1	55.39	74.41	346.32
Weld	69.39	93.29	426.77
HAZ 2	56.01	72.32	334.91
Base 2	55.73	71.93	350.11

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	55.58	74.63	358.55
	2	57.43	75.71	373.25
	3	54.89	74.69	370.39
HAZ 1	1	55.36	74.25	354.14
	2	54.54	73.54	326.23
	3	56.26	75.44	358.60
Weld	1	71.58	94.26	477.41
	2	71.08	93.73	446.85
	3	65.53	91.88	356.03
HAZ 2	1	57.77	75.31	346.30
	2	55.83	74.21	324.63
	3	54.44	67.46	333.79
Base 2	1	55.42	70.28	315.87
	2	55.58	72.09	351.48
	3	56.17	73.43	382.98

* Analysis result is engineering value

Remark

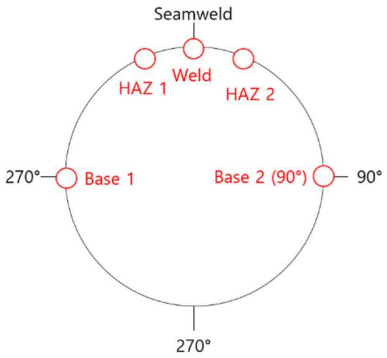
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	141
Location	GTI office (Des Plaines, IL)	Pipe size (in)	8
Test date	4/10/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	57.17	78.03	310.07
HAZ 1	61.14	82.29	359.32
Weld	66.34	88.30	368.95
HAZ 2	62.70	84.69	353.36
Base 2	59.71	80.07	359.03

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	59.34	77.73	353.11
	2	57.19	77.82	323.36
	3	54.98	78.55	253.74
HAZ 1	1	61.40	82.59	382.84
	2	62.16	82.47	363.73
	3	59.87	81.80	331.40
Weld	1	68.05	89.03	384.23
	2	64.77	87.78	340.93
	3	66.19	88.07	381.68
HAZ 2	1	64.96	85.51	380.54
	2	60.52	84.25	340.02
	3	62.62	84.30	339.54
Base 2	1	60.11	80.12	364.61
	2	59.54	80.04	352.37
	3	59.48	80.03	360.12

* Analysis result is engineering value

Remark

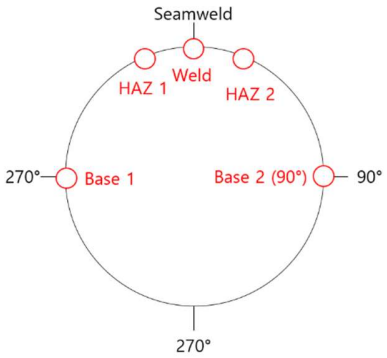
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	142
Location	GTI office (Des Plaines, IL)	Pipe size (in)	6
Test date	4/11/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	51.05	66.03	283.10
HAZ 1	57.97	77.70	323.87
Weld	64.41	85.17	390.32
HAZ 2	56.95	75.66	341.90
Base 2	52.66	70.46	296.39

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	51.35	64.19	284.39
	2	49.81	65.59	273.34
	3	51.98	68.30	291.57
HAZ 1	1	58.69	77.81	324.87
	2	58.86	78.21	338.75
	3	56.37	77.06	307.99
Weld	1	65.38	85.79	380.58
	2	64.86	85.34	407.18
	3	63.00	84.38	383.19
HAZ 2	1	56.70	75.54	354.23
	2	56.36	75.52	321.78
	3	57.80	75.91	349.67
Base 2	1	55.09	71.72	323.13
	2	51.39	69.12	283.80
	3	51.49	70.55	282.23

* Analysis result is engineering value

Remark

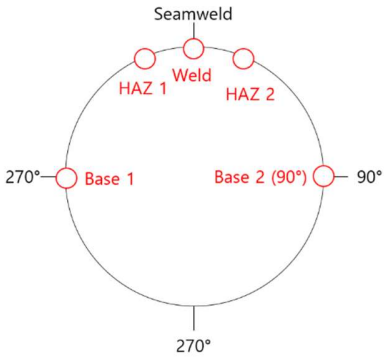
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	143
Location	GTI office (Des Plaines, IL)	Pipe size (in)	4
Test date	4/11/2019	Testing location #	5
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	52.87	71.98	285.78
HAZ 1	56.80	75.73	301.31
Weld	58.11	78.51	317.35
HAZ 2	57.13	77.21	313.95
Base 2	53.86	71.74	277.44

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	54.53	72.55	311.10
	2	51.50	71.63	262.07
	3	52.57	71.76	284.18
HAZ 1	1	56.95	76.03	289.99
	2	56.60	75.85	297.38
	3	56.85	75.29	316.55
Weld	1	58.98	78.64	318.32
	2	57.17	78.27	314.55
	3	58.19	78.62	319.19
HAZ 2	1	58.28	77.34	342.23
	2	55.66	77.74	267.07
	3	57.44	76.54	332.55
Base 2	1	53.06	70.51	283.16
	2	54.78	72.72	282.81
	3	53.73	72.01	266.34

* Analysis result is engineering value

Remark

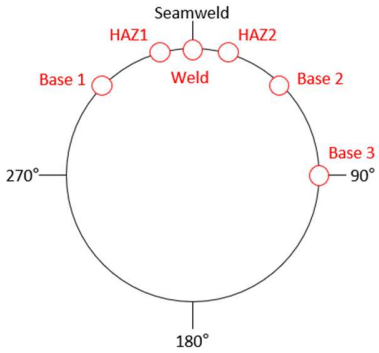
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	144
Location	GTI office (Des Plaines, IL)	Pipe size (in)	12
Test date	4/11/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	55.31	74.71	308.40
HAZ 1	63.78	83.38	378.76
Weld	67.85	91.67	386.56
HAZ 2	60.31	82.22	308.52
Base 2	55.22	74.11	332.74
Base 3	55.27	76.57	280.29

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	56.83	75.79	325.09
	2	54.32	73.64	314.81
	3	54.79	74.71	285.31
HAZ 1	1	61.50	81.85	351.48
	2	69.48	86.34	483.92
	3	60.36	81.94	300.86
Weld	1	65.92	93.44	360.41
	2	66.68	89.21	390.74
	3	70.96	92.37	408.53
HAZ 2	1	60.45	83.27	297.19
	2	60.69	82.69	292.41
	3	59.78	80.70	335.96
Base 2	1	55.72	73.83	346.23
	2	53.51	73.87	305.49
	3	56.42	74.63	346.51
Base 3	1	55.70	78.68	253.67
	2	53.87	76.07	262.81
	3	56.25	74.96	324.38

* Analysis result is engineering value

Remark

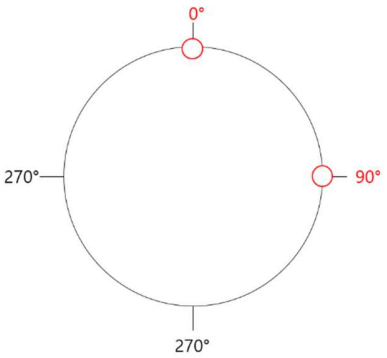
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	145
Location	GTI office (Des Plaines, IL)	Pipe size (in)	10
Test date	4/11/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	52.32	71.63	339.58
90°	52.99	72.06	331.32

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	52.49	71.36	337.24
	2	52.46	72.03	343.77
	3	52.02	71.52	337.72
90°	1	54.02	72.38	337.47
	2	52.06	71.53	315.32
	3	52.88	72.26	341.17

* Analysis result is engineering value

Remark

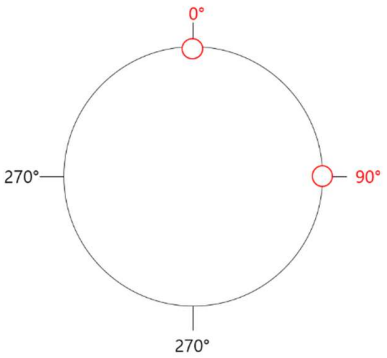
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	146
Location	GTI office (Des Plaines, IL)	Pipe size (in)	10
Test date	4/3/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	39.48	54.45	206.86
90°	38.89	52.51	217.99

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	38.65	54.47	192.01
	2	39.83	54.67	212.53
	3	39.95	54.19	216.03
90°	1	39.07	52.48	210.14
	2	39.12	52.84	222.29
	3	38.47	52.20	221.54

* Analysis result is engineering value

Remark

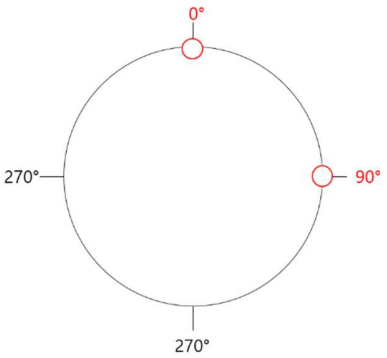
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	147
Location	GTI office (Des Plaines, IL)	Pipe size (in)	8
Test date	4/11/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	52.34	70.21	311.81
90°	50.96	67.76	316.87

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	54.91	72.24	335.40
	2	52.29	70.57	318.84
	3	49.81	67.80	281.18
90°	1	51.01	68.46	314.14
	2	51.24	67.45	318.81
	3	50.63	67.38	317.67

* Analysis result is engineering value

Remark

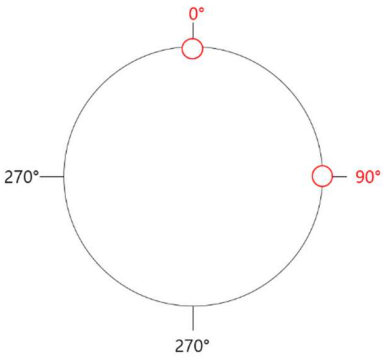
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	148
Location	GTI office (Des Plaines, IL)	Pipe size (in)	8
Test date	4/3/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	50.95	68.51	309.05
90°	52.61	69.28	347.67

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	49.37	67.73	304.91
	2	51.36	68.32	315.92
	3	52.11	69.49	306.33
90°	1	53.85	70.03	380.87
	2	52.51	69.48	343.68
	3	51.47	68.32	318.45

* Analysis result is engineering value

Remark

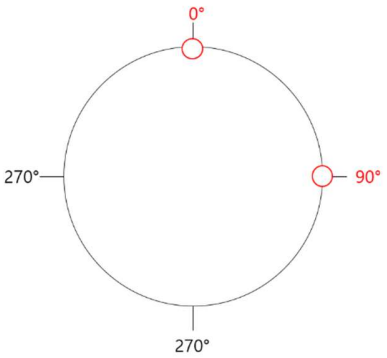
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	149
Location	GTI office (Des Plaines, IL)	Pipe size (in)	8
Test date	4/5/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	51.29	70.43	348.37
90°	53.01	71.99	332.86

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	51.31	70.26	352.93
	2	50.59	69.92	345.01
	3	51.98	71.12	347.18
90°	1	53.43	72.71	358.35
	2	52.87	71.74	322.26
	3	52.72	71.54	317.97

* Analysis result is engineering value

Remark

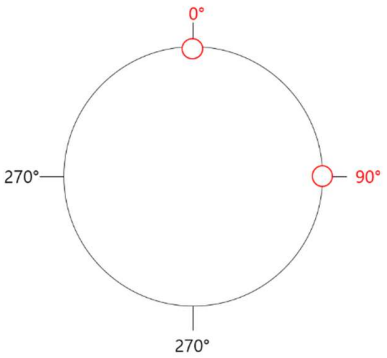
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	150
Location	GTI office (Des Plaines, IL)	Pipe size (in)	8
Test date	4/3/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	51.41	69.68	224.02
90°	49.88	68.19	307.15

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	52.31	69.47	315.78
	2	50.38	69.83	302.01
	3	51.53	69.75	294.25
90°	1	50.46	68.16	313.03
	2	49.69	68.03	317.42
	3	49.50	68.39	291.00

* Analysis result is engineering value

Remark

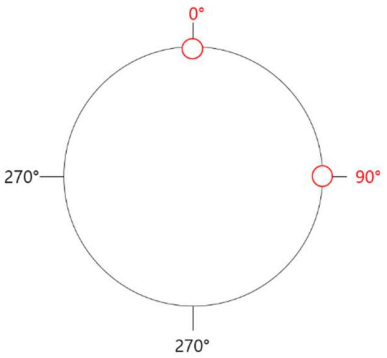
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	151
Location	GTI office (Des Plaines, IL)	Pipe size (in)	8
Test date	4/3/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	55.08	72.58	332.72
90°	50.86	69.24	300.07

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	55.64	70.48	335.50
	2	54.98	74.16	310.08
	3	54.62	73.10	352.59
90°	1	52.21	70.16	327.63
	2	49.49	68.66	268.77
	3	50.89	68.89	303.83

* Analysis result is engineering value

Remark

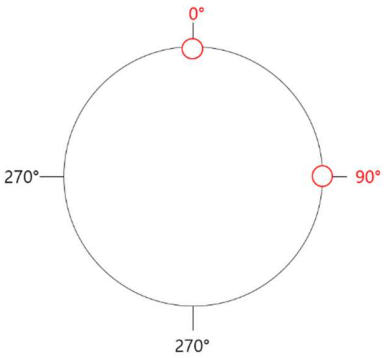
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	155
Location	GTI office (Des Plaines, IL)	Pipe size (in)	8
Test date	4/12/2019	Testing location #	2
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
0°	51.05	69.09	305.24
90°	51.85	70.00	310.64

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
0°	1	50.72	68.96	314.75
	2	51.77	69.54	327.39
	3	50.64	68.75	273.58
90°	1	51.84	70.15	333.20
	2	51.38	69.60	272.24
	3	52.34	70.24	326.48

* Analysis result is engineering value

Remark

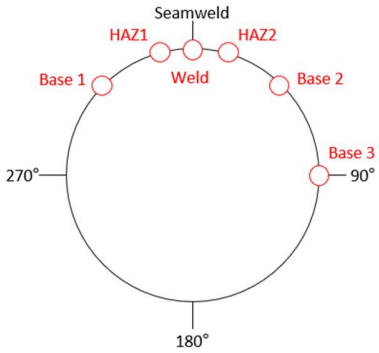
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	165
Location	GTI office (Des Plaines, IL)	Pipe size (in)	10
Test date	4/12/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	51.34	68.81	305.46
HAZ 1	52.28	70.38	315.17
Weld	71.34	94.55	478.81
HAZ 2	52.55	70.94	318.10
Base 2	51.14	68.62	308.66
Base 3	52.04	68.42	314.71

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	50.32	67.81	291.99
	2	51.25	69.11	298.50
	3	52.44	69.51	325.89
HAZ 1	1	52.22	70.01	307.02
	2	52.17	70.35	312.63
	3	52.45	70.79	325.85
Weld	1	71.71	94.63	477.65
	2	70.77	94.06	469.48
	3	71.53	94.98	489.29
HAZ 2	1	52.82	70.97	320.96
	2	52.90	70.92	320.05
	3	51.93	70.92	313.29
Base 2	1	51.63	69.01	316.71
	2	50.47	68.27	292.21
	3	51.32	68.57	317.06
Base 3	1	52.84	67.93	319.32
	2	52.82	69.53	313.37
	3	50.46	67.80	311.43

* Analysis result is engineering value

Remark

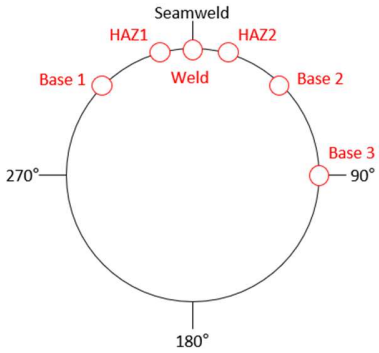
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	167
Location	GTI office (Des Plaines, IL)	Pipe size (in)	10
Test date	4/12/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	55.16	73.31	327.71
HAZ 1	55.53	74.12	324.94
Weld	69.07	92.30	410.21
HAZ 2	60.51	78.92	376.49
Base 2	55.01	73.77	310.19
Base 3	54.66	72.87	331.59

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	55.25	73.26	333.47
	2	54.50	73.02	326.55
	3	55.72	73.67	323.10
HAZ 1	1	55.45	74.08	317.85
	2	56.22	74.56	337.33
	3	54.92	73.71	319.65
Weld	1	69.77	92.41	424.14
	2	68.21	91.90	407.20
	3	69.23	92.59	399.30
HAZ 2	1	59.29	78.22	350.35
	2	64.14	81.02	462.70
	3	58.12	77.53	316.40
Base 2	1	55.31	73.88	316.68
	2	54.49	73.83	284.14
	3	55.23	73.60	329.76
Base 3	1	54.86	72.89	318.00
	2	53.52	72.22	320.47
	3	55.59	73.50	356.30

* Analysis result is engineering value

Remark

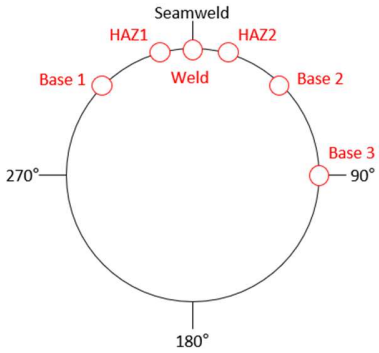
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	169
Location	GTI office (Des Plaines, IL)	Pipe size (in)	12
Test date	4/12/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	50.85	68.33	290.01
HAZ 1	58.48	75.92	328.59
Weld	61.11	81.63	371.56
HAZ 2	56.72	75.15	327.34
Base 2	50.54	68.14	297.25
Base 3	52.24	70.35	318.16

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	51.18	68.39	290.48
	2	51.86	69.04	315.47
	3	49.50	67.56	264.07
HAZ 1	1	59.31	76.01	350.50
	2	58.01	75.49	313.86
	3	58.12	76.26	321.40
Weld	1	60.87	81.39	374.25
	2	61.43	81.87	363.40
	3	61.03	81.62	377.04
HAZ 2	1	55.80	74.35	311.96
	2	57.66	75.63	339.70
	3	56.69	75.47	330.36
Base 2	1	50.53	67.96	306.92
	2	50.41	68.10	286.40
	3	50.67	68.34	298.42
Base 3	1	52.04	69.82	317.02
	2	52.01	70.14	334.24
	3	52.67	71.09	303.22

* Analysis result is engineering value

Remark

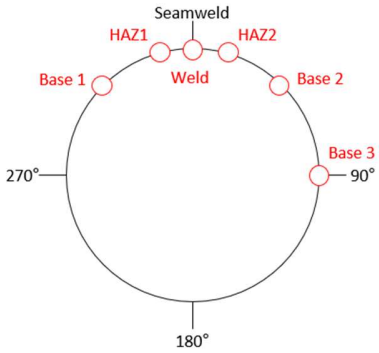
Instrumented Indentation Test (IIT) Results

- Yield strength, Tensile strength and Fracture toughness

Test Information

Customer	GTI	Pipe #	170
Location	GTI office (Des Plaines, IL)	Pipe size (in)	20
Test date	4/18/2019	Testing location #	6
Operator	Dongseong Ro	Max. testing depth	150 μm
Equipment	AIS2100	Indenter #	K05343

Sample



Results

Test location	Yield strength	Tensile strength	Fracture toughness
	ksi	ksi	MPa·m^1/2
Base 1	55.64	71.47	298.34
HAZ 1	54.90	71.87	306.43
Weld	57.71	73.09	360.25
HAZ 2	58.89	76.08	350.04
Base 2	58.76	77.11	334.17
Base 3	58.38	76.09	347.31

* Analysis result is engineering value

Detail Results

Test location	No.	Yield strength	Tensile strength	Fracture toughness
		ksi	ksi	MPa·m^1/2
Base 1	1	55.73	72.36	294.66
	2	56.03	73.77	319.05
	3	55.15	68.28	281.30
HAZ 1	1	53.01	69.69	265.30
	2	55.76	71.78	327.44
	3	55.94	74.14	326.53
Weld	1	58.97	75.20	383.78
	2	56.96	73.08	350.73
	3	57.19	70.98	346.23
HAZ 2	1	58.00	73.61	331.37
	2	59.10	76.91	346.89
	3	59.57	77.71	371.87
Base 2	1	60.24	77.47	343.86
	2	56.97	76.01	328.91
	3	59.05	77.86	329.74
Base 3	1	59.63	77.73	336.99
	2	57.54	74.93	357.83
	3	57.95	75.60	347.10

* Analysis result is engineering value

Remark