DUKE ENERGY®

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September 22, 2020

Ms. Tanowa M. Troupe
Ohio Power Siting Board
PUCO Docketing Division
180 East Broad Street, 11th Floor
Columbus, OH 43215-3716

Re: Case No. 16-253-GA-BTX
Staff Report Condition No. 34-revised

Dear Ms. Troupe:

On August 4, 2020, Duke Energy Ohio, Inc. (Duke Energy Ohio) filed its welding qualifications, welding procedures, and nondestructive testing procedures, in compliance with condition 34 of the Opinion, Order, and Certificate in this case. Upon recent review, we have discovered that not all pages were included with the August 4, 2020, filing.

Duke Energy Ohio files herewith a complete copy of its welding qualifications, welding procedures, and nondestructive testing procedures so that they may be reviewed prior to the preconstruction conference.

If you have any questions, please do not hesitate to contact me.

Sincerely,

/s/ Jeanne W. Kingery

Jeanne W. Kingery
Associate General Counsel

cc: Theresa White, Executive Director
Ashton Holderbaum

Table of Contents

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 1-1 **Date:** 12/4/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeff Ellis, Piedmont Natural Gas

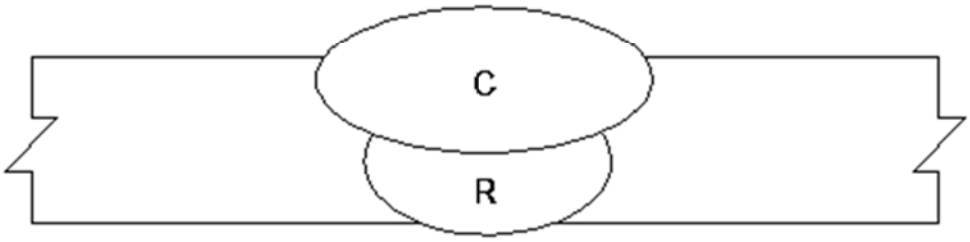
Welding Process: Manual Oxy-Acetylene Welding
Pipe Material: 2.375" diameter, 0.154" thick API 5L X42 to 2.375" diameter, 0.154" thick API 5L X42
Joint Design: No land, 1/16" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Uphill
Filler Metal: RG60
Time Between Passes: 31 minutes between root and hot pass
Preheat Temperature: Ambient (58°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments: Number 3 oxy-acetylene weld tip was used
The flow rate of the acetylene was 8 CFH and the flow rate of the oxygen was 20 CFH

WELDING PARAMETERS

Pass:	Root	Cap				
AWS Classification:	RG60	RG60				
Manufacture:	NR	NR				
Electrode Diameter:	3/32"	3/32"				
Current/Polarity:	NA	NA				
Current Range:	NA	NA				
Voltage Range:	NA	NA				
Travel Speed Range, ipm:	0.9 – 1.3	1.3				

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 1-1 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:				
Coupon Width:				
Coupon Thickness:				
Coupon Area:				
Maximum Load:				
Tensile Strength:				
Fracture Location:				

BEND TEST

Coupon Number:	W1 RB1	W1 RB2						
Type:	Root	Root						
Results:	Pass (1)	Pass						

NICK-BREAK TEST

Coupon Number:	W1 NB1	W1 NB2		
Results:	Pass (1)	Pass		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 12/4/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 1-2 **Date:** 12/4/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeff Ellis, Piedmont Natural Gas

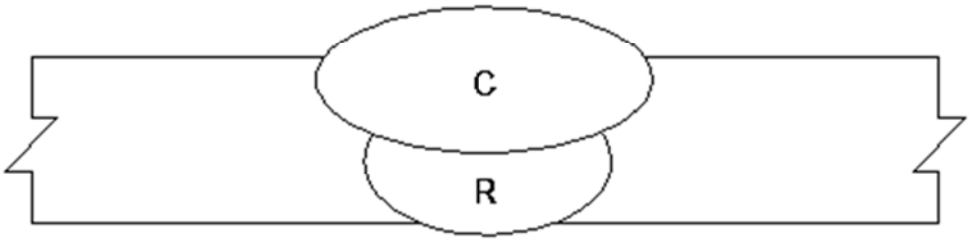
Welding Process: Manual Oxy-Acetylene Welding
Pipe Material: 2.375" diameter, 0.218" thick API 5L X42 to 2.375" diameter, 0.218" thick API 5L X42
Joint Design: No land, 3/32" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Uphill
Filler Metal: RG60
Time Between Passes: 31 minutes between root and hot pass
Preheat Temperature: Ambient (67°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments: Number 4 oxy-acetylene weld tip was used
The flow rate of the acetylene was 8 CFH and the flow rate of the oxygen was 22 CFH

WELDING PARAMETERS

Pass:	Root	Cap				
AWS Classification:	RG60	RG60				
Manufacture:	NR	NR				
Electrode Diameter:	3/32"	3/32"				
Current/Polarity:	NA	NA				
Current Range:	NA	NA				
Voltage Range:	NA	NA				
Travel Speed Range, ipm:	0.8 – 0.9	0.5 – 0.6				

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 1-2 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:				
Coupon Width:				
Coupon Thickness:				
Coupon Area:				
Maximum Load:				
Tensile Strength:				
Fracture Location:				

BEND TEST

Coupon Number:	W1 RB1	W1 RB2						
Type:	Root	Root						
Results:	Pass	Pass (1)						

NICK-BREAK TEST

Coupon Number:	W1 NB1	W1 NB2		
Results:	Pass	Pass		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 12/4/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 1-3 **Date:** 12/4/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeff Ellis, Piedmont Natural Gas

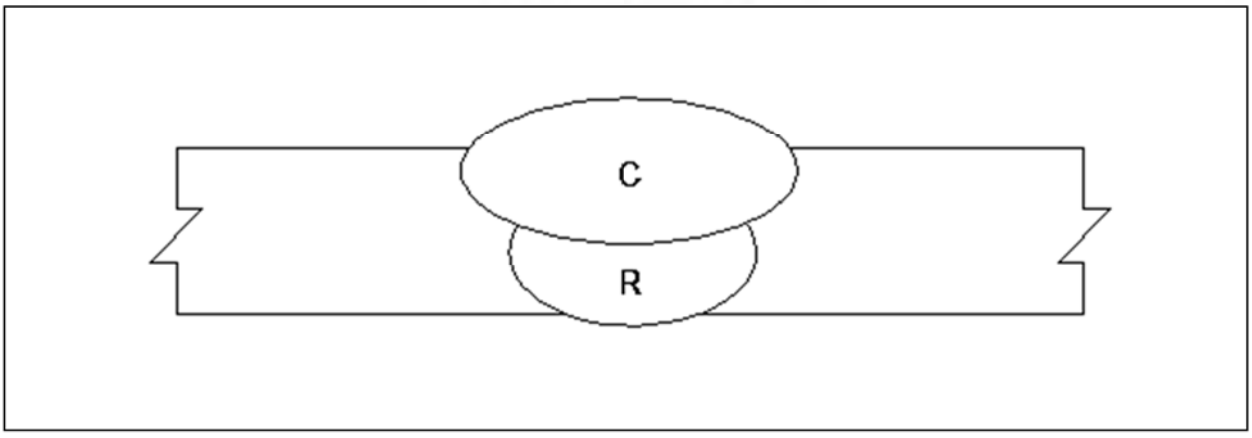
Welding Process: Manual Oxy-Acetylene Welding
Pipe Material: 2.375" diameter, 0.154" thick API 5L X52 to 2.375" diameter, 0.154" thick API 5L X52
Joint Design: No land, 1/16" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Uphill
Filler Metal: RG60
Time Between Passes: 30 minutes between root and hot pass
Preheat Temperature: Ambient (61°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments: Number 3 oxy-acetylene weld tip was used
The flow rate of the acetylene was 7 CFH and the flow rate of the oxygen was 18 CFH

WELDING PARAMETERS

Pass:	Root	Cap				
AWS Classification:	RG60	RG60				
Manufacture:	NR	NR				
Electrode Diameter:	3/32"	3/32"				
Current/Polarity:	NA	NA				
Current Range:	NA	NA				
Voltage Range:	NA	NA				
Travel Speed Range, ipm:	0.9 – 1.3	0.9				

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 1-3 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:	W3 T1			
Coupon Width:	1.070 inch			
Coupon Thickness:	0.155 inch			
Coupon Area:	0.166 $inch^2$			
Maximum Load:	14,204 lb			
Tensile Strength:	85,565 psi			
Fracture Location:	Base Metal			

BEND TEST

Coupon Number:	W3 RB1	W3 RB2						
Type:	Root	Root						
Results:	Pass	Pass						

NICK-BREAK TEST

Coupon Number:	W3 NB1	W3 NB2		
Results:	Pass	Pass		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments:

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 12/4/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 1-4 **Date:** 12/4/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeff Ellis, Piedmont Natural Gas

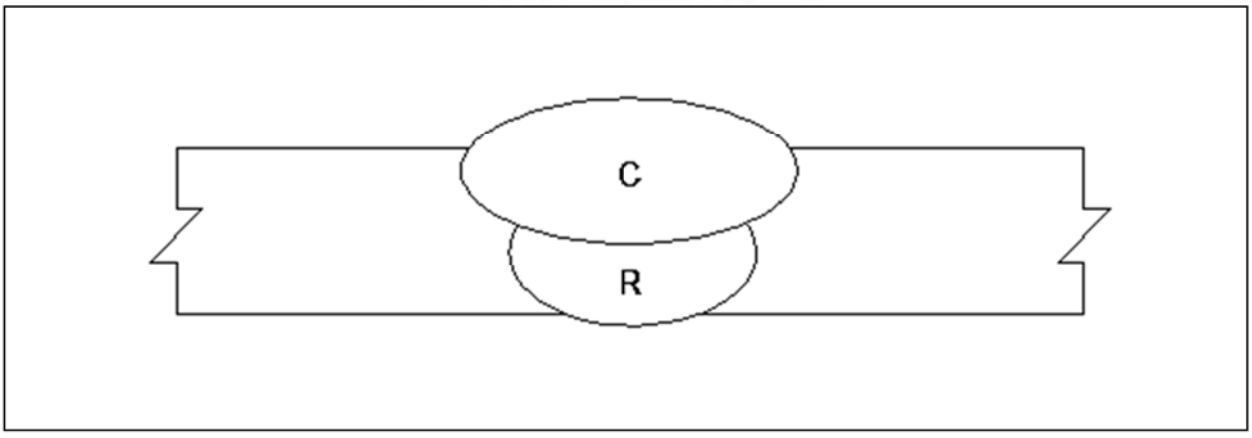
Welding Process: Manual Oxy-Acetylene Welding
Pipe Material: 2.375" diameter, 0.218" thick API 5L X52 to 2.375" diameter, 0.218" thick API 5L X52
Joint Design: No land, 3/32" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Uphill
Filler Metal: RG60
Time Between Passes: 32 minutes between root and hot pass
Preheat Temperature: Ambient (70°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments: Number 4 oxy-acetylene weld tip was used
The flow rate of the acetylene was 10 CFH and the flow rate of the oxygen was 20 CFH

WELDING PARAMETERS

Pass:	Root	Cap				
AWS Classification:	RG60	RG60				
Manufacture:	NR	NR				
Electrode Diameter:	3/32"	3/32"				
Current/Polarity:	NA	NA				
Current Range:	NA	NA				
Voltage Range:	NA	NA				
Travel Speed Range, ipm:	0.6 – 0.9	0.6				

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 1-4 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:	W4 T1			
Coupon Width:	0.957 inch			
Coupon Thickness:	0.218 inch			
Coupon Area:	0.209 $inch^2$			
Maximum Load:	16,355 psi			
Tensile Strength:	78,251 lb			
Fracture Location:	Weld (1)			

BEND TEST

Coupon Number:	W4 RB1	W4 RB2						
Type:	Root	Root						
Results:	Pass	Pass						

NICK-BREAK TEST

Coupon Number:	W4 NB1	W4 NB2		
Results:	Pass	Pass		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) The fracture surface passed the requirements of API 1104 5.6.3.3

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 12/4/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 2-1 **Date:** 12/4/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeff Ellis, Piedmont Natural Gas

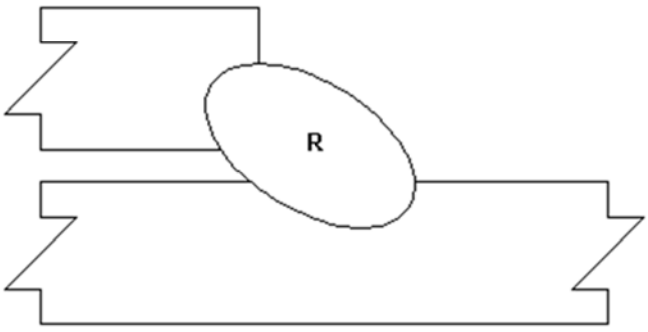
Welding Process: Manual Oxy-Acetylene Welding
Pipe Material: 2.375" diameter, 0.154" thick API 5L X42 to 2.375" diameter, 0.154" thick API 5L X42
Joint Design: Lap fillet joint with 1/16" gap
Position: 5G, Fixed **Welding Direction:** Uphill
Filler Metal: RG60
Time Between Passes: 30 minutes between root and hot pass
Preheat Temperature: Ambient (66°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments: Number 3 oxy-acetylene weld tip was used
The flow rate of the acetylene was 8 CFH and the flow rate of the oxygen was 20 CFH

WELDING PARAMETERS

Pass:	Root					
AWS Classification:	RG60					
Manufacture:	NR					
Electrode Diameter:	3/32"					
Current/Polarity:	NA					
Current Range:	NA					
Voltage Range:	NA					
Travel Speed Range, ipm:	0.8					

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 2-1 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:				
Coupon Width:				
Coupon Thickness:				
Coupon Area:				
Maximum Load:				
Tensile Strength:				
Fracture Location:				

BEND TEST

Coupon Number:								
Type:								
Results:								

NICK-BREAK TEST

Coupon Number:	W5 NB1	W5 NB2	W5 NB3	W5 NB4
Results:	Pass	Pass	Pass (1)	Pass

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 12/4/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 2-2 **Date:** 12/4/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeff Ellis, Piedmont Natural Gas

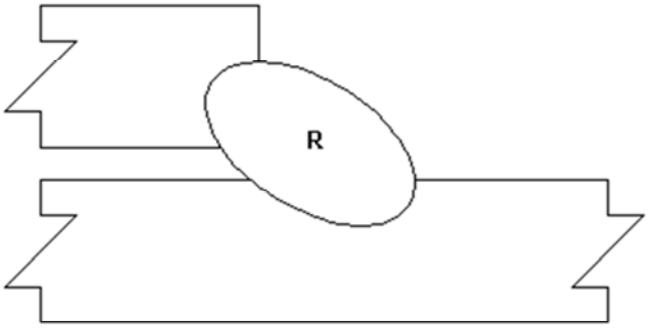
Welding Process: Manual Oxy-Acetylene Welding
Pipe Material: 2.375" diameter, 0.218" thick API 5L X42 to 2.375" diameter, 0.218" thick API 5L X42
Joint Design: Lap fillet joint with 1/16" gap
Position: 5G, Fixed **Welding Direction:** Uphill
Filler Metal: RG60
Time Between Passes: 32 minutes between root and hot pass
Preheat Temperature: Ambient (59°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments: Number 3 oxy-acetylene weld tip was used
The flow rate of the acetylene was 8 CFH and the flow rate of the oxygen was 20 CFH

WELDING PARAMETERS

Pass:	Root					
AWS Classification:	RG60					
Manufacture:	NR					
Electrode Diameter:	3/32"					
Current/Polarity:	NA					
Current Range:	NA					
Voltage Range:	NA					
Travel Speed Range, ipm:	0.4 – 0.5					

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 2-2 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:				
Coupon Width:				
Coupon Thickness:				
Coupon Area:				
Maximum Load:				
Tensile Strength:				
Fracture Location:				

BEND TEST

Coupon Number:								
Type:								
Results:								

NICK-BREAK TEST

Coupon Number:	W6 NB1	W6 NB2	W6 NB3	W6 NB4
Results:	Pass	Pass	Pass	Pass

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments:

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 12/4/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 2-3 **Date:** 12/4/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeff Ellis, Piedmont Natural Gas

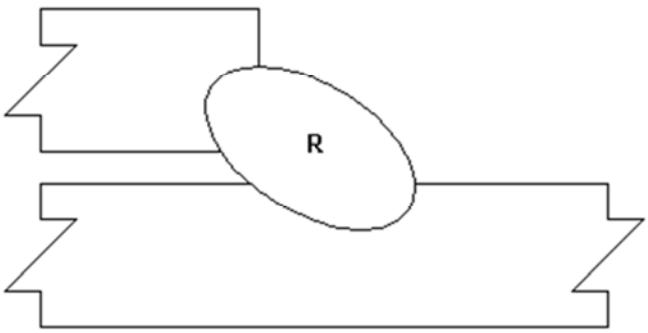
Welding Process: Manual Oxy-Acetylene Welding
Pipe Material: 2.375" diameter, 0.154" thick API 5L X52 to 2.375" diameter, 0.154" thick API 5L X52
Joint Design: Lap fillet joint with 1/16" gap
Position: 5G, Fixed **Welding Direction:** Uphill
Filler Metal: RG60
Time Between Passes: 32 minutes between root and hot pass
Preheat Temperature: Ambient (64°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments: Number 3 oxy-acetylene weld tip was used
The flow rate of the acetylene was 10 CFH and the flow rate of the oxygen was 22 CFH

WELDING PARAMETERS

Pass:	Root					
AWS Classification:	RG60					
Manufacture:	NR					
Electrode Diameter:	3/32"					
Current/Polarity:	NA					
Current Range:	NA					
Voltage Range:	NA					
Travel Speed Range, ipm:	0.8 – 0.9					

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 2-3 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:				
Coupon Width:				
Coupon Thickness:				
Coupon Area:				
Maximum Load:				
Tensile Strength:				
Fracture Location:				

BEND TEST

Coupon Number:								
Type:								
Results:								

NICK-BREAK TEST

Coupon Number:	W7 NB1	W7 NB2	W7 NB3	W7 NB4
Results:	Pass	Pass	Pass	Pass

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments:

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 12/4/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 2-4 **Date:** 12/4/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeff Ellis, Piedmont Natural Gas

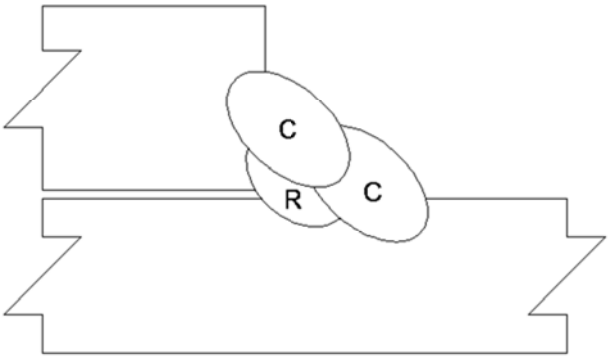
Welding Process: Manual Oxy-Acetylene Welding
Pipe Material: 2.375" diameter, 0.218" thick API 5L X52 to 2.375" diameter, 0.218" thick API 5L X52
Joint Design: Lap fillet joint with 1/16" gap
Position: 5G, Fixed **Welding Direction:** Uphill
Filler Metal: RG60
Time Between Passes: 34 minutes between root and hot pass
Preheat Temperature: Ambient (67°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments: Number 3 oxy-acetylene weld tip was used
The flow rate of the acetylene was 10 CFH and the flow rate of the oxygen was 20 CFH

WELDING PARAMETERS

Pass:	Root	Cap				
AWS Classification:	RG60	RG60				
Manufacture:	NR	NR				
Electrode Diameter:	3/32"	3/32"				
Current/Polarity:	NA	NA				
Current Range:	NA	NA				
Voltage Range:	NA	NA				
Travel Speed Range, ipm:	0.4 – 0.5	0.6 – 0.8				

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 2-4 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:				
Coupon Width:				
Coupon Thickness:				
Coupon Area:				
Maximum Load:				
Tensile Strength:				
Fracture Location:				

BEND TEST

Coupon Number:								
Type:								
Results:								

NICK-BREAK TEST

Coupon Number:	W8 NB1	W8 NB2	W8 NB3	W8 NB4
Results:	Pass	Pass (1)	Pass	Pass (1)

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 12/4/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 3-1 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeff Ellis, Piedmont Natural Gas

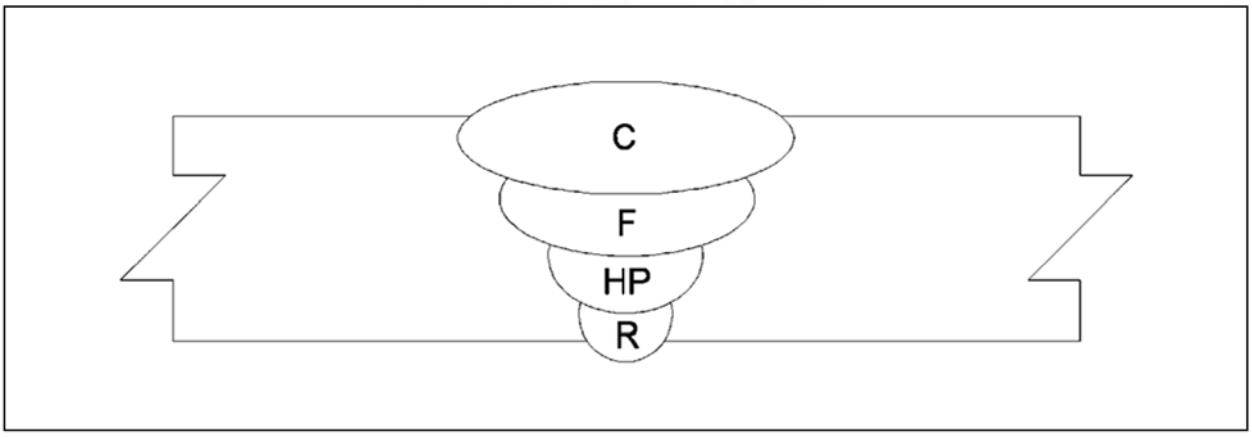
Welding Process: Manual SMAW
Pipe Material: 2.375" diameter, 0.154" thick API 5L X42 to 2.375" diameter, 0.154" thick API 5L X42
Joint Design: 1/16" land, 1/16" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Downhill
Filler Metal: E6010
Time Between Passes: 30 minutes between root and hot pass
Preheat Temperature: Ambient (68°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fill	Cap		
AWS Classification:	E6010	E6010	E6010	E6010		
Manufacture:	Lincoln	Lincoln	Lincoln	Lincoln		
Electrode Diameter:	1/8"	1/8"	1/8"	1/8"		
Current/Polarity:	DCEP	DCEP	DCEP	DCEP		
Current Range:	102 – 105	100 – 101	95 – 100	90		
Voltage Range:	27 – 28	30 – 31	30 – 31	30 – 31		
Travel Speed Range, ipm:	6.4 – 6.8	9.1 – 9.5	11.1 – 13.1	8.1 – 8.4		

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 3-1 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:				
Coupon Width:				
Coupon Thickness:				
Coupon Area:				
Maximum Load:				
Tensile Strength:				
Fracture Location:				

BEND TEST

Coupon Number:	W9 RB1	W9 RB2						
Type:	Root	Root						
Results:	Pass	Pass						

NICK-BREAK TEST

Coupon Number:	W9 NB1	W9 NB2		
Results:	Pass	Pass (1)		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 3-2 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

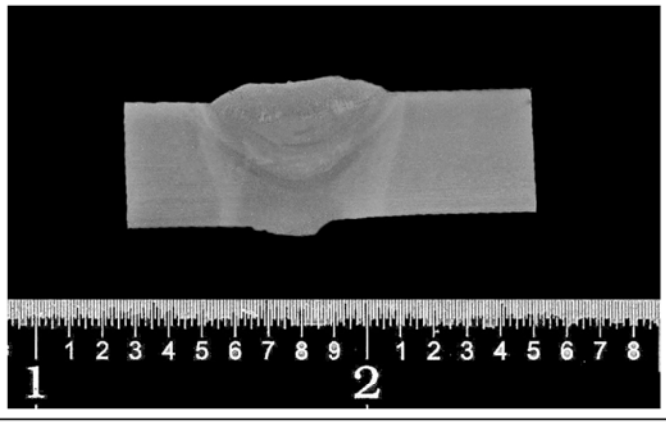
Welding Process: Manual SMAW
Pipe Material: 12.75" diameter, 0.375" thick API 5L X42 to 12.75" diameter, 0.375" thick API 5L X42
Joint Design: 3/32" land, 3/32" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Downhill
Filler Metal: E6010 root, E7010-P1 remainder
Time Between Passes: 1 hour, 2 minutes between root and hot pass
Preheat Temperature: Ambient (65°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fill	Cap		
AWS Classification:	E6010	E7010-P1	E7010-P1	E7010-P1		
Manufacture:	Lincoln	Lincoln	Lincoln	Lincoln		
Electrode Diameter:	1/8"	5/32"	5/32"	5/32"		
Current/Polarity:	DCEP	DCEP	DCEP	DCEP		
Current Range:	75 – 77	100 – 110	105 – 112	100 – 105		
Voltage Range:	24 – 27	25 – 28	25 – 29	25 – 29		
Travel Speed Range, ipm:	3.5 – 5.7	4.1 – 5.5	3.1 – 4.4	2.9 – 4.8		

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 3-2 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:	W10 T1	W10 T2		
Coupon Width:	0.970 inch	1.039 inch		
Coupon Thickness:	0.382 inch	0.374 inch		
Coupon Area:	0.371 $inch^2$	0.389 $inch^2$		
Maximum Load:	30,872 lb	31,569 lb		
Tensile Strength:	83,213 psi	81,155 psi		
Fracture Location:	Base Metal	Base Metal		

BEND TEST

Coupon Number:	W10 FB1	W10 FB2	W10 RB1	W10 RB2				
Type:	Face	Face	Root	Root				
Results:	Pass	Pass	Pass (1)	Pass				

NICK-BREAK TEST

Coupon Number:	W10 NB1	W10 NB2		
Results:	Pass (1)	Pass (1)		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 3-3 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeff Ellis, Piedmont Natural Gas

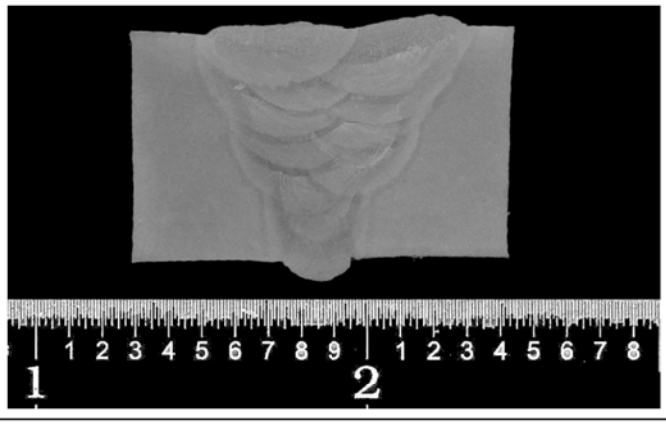
Welding Process: Manual SMAW
Pipe Material: 10.75" diameter, 0.844" thick API 5L X42 to 10.75" diameter, 0.844" thick API 5L X42
Joint Design: 3/32" land, 3/32" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Downhill
Filler Metal: E6010 root, E7010-P1 remainder
Time Between Passes: 2 hours, 25 minutes between root and hot pass
Preheat Temperature: Ambient (59°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fill	Cap		
AWS Classification:	E6010	E7010-P1	E7010-P1	E7010-P1		
Manufacture:	Lincoln	Lincoln	Lincoln	Lincoln		
Electrode Diameter:	1/8"	5/32"	5/32"	5/32"		
Current/Polarity:	DCEP	DCEP	DCEP	DCEP		
Current Range:	107 – 113	134 – 141	120 – 143	108 – 115		
Voltage Range:	24 – 26	26 – 31	26 – 30	27 – 29		
Travel Speed Range, ipm:	5.1 – 8.8	7.2 – 14.3	4.5 – 10.7	4.0 – 8.3		

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 3-3 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:	W11 T1	W11 T2		
Coupon Width:	1.167 inch	1.133 inch		
Coupon Thickness:	0.870 inch	0.826 inch		
Coupon Area:	1.015 $inch^2$	0.936 $inch^2$		
Maximum Load:	71,300 lb	72,600 lb		
Tensile Strength:	70,200 psi	77,600 psi		
Fracture Location:	Base Metal	Base Metal		

BEND TEST

Coupon Number:	W11 SB1	W11 SB2	W11 SB3	W11 SB4				
Type:	Face	Face	Root	Root				
Results:	Pass	Pass (1)	Pass (1)	Pass (1)				

NICK-BREAK TEST

Coupon Number:	W11 NB1	W11 NB2		
Results:	Pass (1)	Pass (1)		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. 1-X42-179		Orig. Issue Date	Revision Date
	WPS No. BW-1-A-*I*		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Process Name: Shielded Metal Arc Welding (SMAW)		Type of Process: Manual	
	For: Butt Welding ☑	Fillet Welding ☐		
PIPE	Material Specification: 1.315" O.D.- X-42 -0.179" WT. API 5L			
DIAMETER	API 1104 6.2.2 Guidelines	☑ Under 2-3/8" OD	☐ 2-3/8" to 12-3/4" OD	☐ > 12-3/4" OD
MATERIAL	API 1104 5.4.2.2 Guidelines	☑ ≤ 42,000 PSI Yield	☐ > 42,000 to < 65,000 PSI Yield	☐ ≥ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☑ Under 3/16" thick	☐ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: E6010	AWS Electrode Size: 1/8"	AWS Specification: A5.1	Filler Metal Group: 1
	AWS Electrode Nos:	AWS Electrode Size:	AWS Specification:	Filler Metal Group:
GAS	SHIELDING GAS: N/A	FLOW RATE: N/A	FLUX: N/A	
PREHEAT	Minimum Preheat Temperature (F): 50°	Interpass Temperature (F):	Other:	

POSITION

WELD AXIS		TECHNIQUE		DIRECTION	
Flat (1G, 1F, 1FR)	☐	Plate	☐	Backhand	☐	Vertical - Up	☐
Horizontal (2G, 2F, 2FR)	☐	Pipe	☑	Forehand	☑	Vertical - Down	☑
Vertical (3G, 3F)	☐	Rotated	☐				
Overhead (4G, 4F)	☐	Fixed	☑				
Multiple (5G, 5F)	☑	Inclined (6G, 6F)	☐				
Combination	☐						

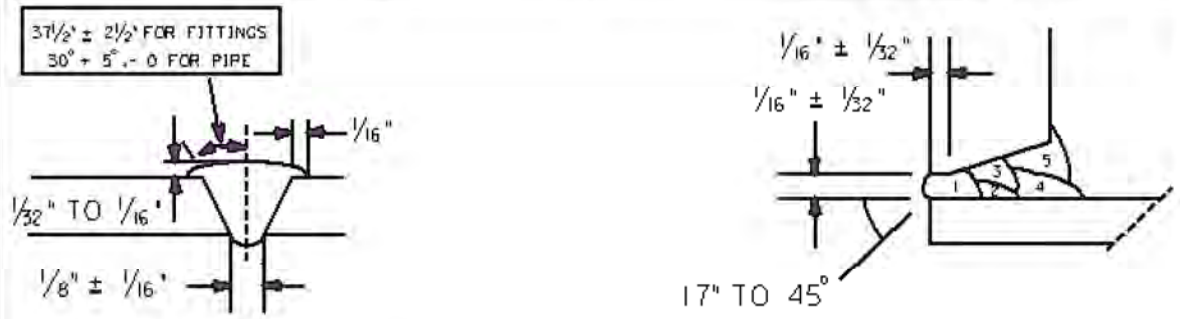
TECHNIQUE

DISPOSITION STYLE		METHOD		ARC TYPE		
Stringer Beads	☑	Multiple Pass	☑	Single Arc	☑	Other: ☐
Weave Beads	☐	Single Pass	☐	Multiple Arc	☐	

CLEANING	Base Material: Power ☑ Hand ☐	Weld: Power ☑	Hand ☐

JOINT DESIGN

BUTT WELD ☑ FILLET WELD ☐



Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ **Polarity:** Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE		MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
				VOLTS	AMPS		
Root	1	E6010	1/8"	20-24	75-130	5	3-20
Hot Pass	1	E6010	1/8"	20-24	75-130	5	3-20
Fill							
Cap	1	E6010	1/8"	20-24	75-130	5	3-20

(Over)

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1							
2							
3							
4							

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
5	180 Degrees	NA	NA	Yes ☐ No ☐	
6	180 Degrees	NA	NA	Yes ☐ No ☐	
7	180 Degrees	NA	NA	Yes ☐ No ☐	
8	180 Degrees	NA	NA	Yes ☐ No ☐	
9	NA	180 Degrees	NA	Yes ☐ No ☐	
10	NA	180 Degrees	NA	Yes ☐ No ☐	
11	NA	180 Degrees	NA	Yes ☐ No ☐	
12	NA	180 Degrees	NA	Yes ☐ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☐ No ☐	
14	Yes ☐ No ☐	
15	Yes ☐ No ☐	
16	Yes ☐ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☐ No ☐		Penetration into Parent Metal: Yes ☐ No ☐	
Fillet Weld - Fracture Test		Length of Percent of Defect	in.: %:

WELDER INFO

Welder Name:	License Number & State	Stencil Mark
Contractor:		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By:		
Visual Examination Results:		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography):		
Mechanical Test Conducted By:		Laboratory Test No:
Approved By:		Organization:
APPROVED ☐	REJECTED ☐	Date:

REMARKS

APPROVAL

Engineer:		Date:
Weld Supervisor:		Date:
Director of Gas Engineering:		Date:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. 2-X42-154		Orig. Issue Date	Revision Date
	WPS No. BW-2-A-*I*		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Process Name: Shielded Metal Arc Welding (SMAW)		Type of Process: Manual	
	For: Butt Welding ☑	Fillet Welding ☐		
PIPE	Material Specification: 2.375" O.D.- X-42 -0.154" WT. API 5L			
DIAMETER	API 1104 6.2.2 Guidelines	☐ Under 2-3/8" OD	☑ 2-3/8" to 12-3/4" OD	☐ > 12-3/4" OD
MATERIAL	API 1104 5.4.2.2 Guidelines	☑ ≤ 42,000 PSI Yield	☐ > 42,000 to < 65,000 PSI Yield	☐ ≥ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☑ Under 3/16" thick	☐ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: E6010	AWS Electrode Size: 1/8"	AWS Specification: A5.1	Filler Metal Group: 1
	AWS Electrode Nos:	AWS Electrode Size:	AWS Specification:	Filler Metal Group:
GAS	SHIELDING GAS: N/A	FLOW RATE: N/A	FLUX: N/A	
PREHEAT	Minimum Preheat Temperature (F): 50°	Interpass Temperature (F):	Other:	

POSITION

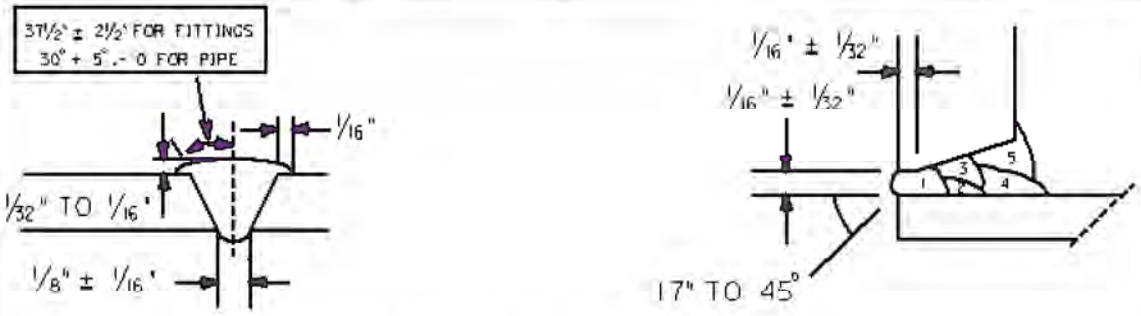
WELD AXIS				TECHNIQUE		DIRECTION	
Flat (1G, 1F, 1FR)	☐	Plate	☐	Backhand	☐	Vertical - Up	☐
Horizontal (2G, 2F, 2FR)	☐	Pipe	☑	Forehand	☑	Vertical - Down	☑
Vertical (3G, 3F)	☐	Rotated	☐				
Overhead (4G, 4F)	☐	Fixed	☑				
Multiple (5G, 5F)	☑	Inclined (6G, 6F)	☐				
Combination	☐						

TECHNIQUE

DISPOSITION STYLE		METHOD		ARC TYPE		
Stringer Beads	☑	Multiple Pass	☑	Single Arc	☑	Other: ☐
Weave Beads	☐	Single Pass	☐	Multiple Arc	☐	

CLEANING	Base Material: Power ☑	Hand ☐	Weld: Power ☑	Hand ☐	
	BUTT WELD ☑		FILLET WELD ☐		

JOINT DESIGN



Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ **Polarity:** Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE		MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
				VOLTS	AMPS		
Root	1	E6010	1/8"	19-24	75-130	5	3-20
Hot Pass	1	E6010	1/8"	19-24	75-130	5	3-20
Fill							
Cap	1	E6010	1/8"	19-24	75-130	5	3-20

(Over)

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1							
2							
3							
4							

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
5	180 Degrees	NA	NA	Yes ☐ No ☐	
6	180 Degrees	NA	NA	Yes ☐ No ☐	
7	180 Degrees	NA	NA	Yes ☐ No ☐	
8	180 Degrees	NA	NA	Yes ☐ No ☐	
9	NA	180 Degrees	NA	Yes ☐ No ☐	
10	NA	180 Degrees	NA	Yes ☐ No ☐	
11	NA	180 Degrees	NA	Yes ☐ No ☐	
12	NA	180 Degrees	NA	Yes ☐ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☐ No ☐	
14	Yes ☐ No ☐	
15	Yes ☐ No ☐	
16	Yes ☐ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☐ No ☐		Penetration into Parent Metal: Yes ☐ No ☐	
Fillet Weld - Fracture Test		Length of Percent of Defect	in.: %:

WELDER INFO

Welder Name:	License Number & State	Stencil Mark
Contractor:		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By:		
Visual Examination Results:		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography):		
Mechanical Test Conducted By:		Laboratory Test No:
Approved By:		Organization:
APPROVED ☐	REJECTED ☐	Date:

REMARKS

APPROVAL

Engineer:		Date:
Weld Supervisor:		Date:
Director of Gas Engineering:		Date:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. 12-X42-219		Orig. Issue Date	Revision Date
	WPS No. BW-2-A-*II*		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Process Name: Shielded Metal Arc Welding (SMAW)		Type of Process: Manual	
	For: Butt Welding ☑	Fillet Welding ☐		
PIPE	Material Specification: 12.375" O.D.- X-42- 0.219" WT. API 5L			
DIAMETER	API 1104 6.2.2 Guidelines	☐ Under 2-3/8" OD	☑ 2-3/8" to 12-3/4" OD	☐ > 12-3/4" OD
MATERIAL	API 1104 5.4.2.2 Guidelines	☑ ≤ 42,000 PSI Yield	☐ > 42,000 to < 65,000 PSI Yield	☐ ≥ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☐ Under 3/16" thick	☑ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: E6010	AWS Electrode Size: 1/8"	AWS Specification: A5.1	Filler Metal Group: 1
	AWS Electrode Nos:	AWS Electrode Size:	AWS Specification:	Filler Metal Group:
GAS	SHIELDING GAS: N/A	FLOW RATE: N/A	FLUX: N/A	
PREHEAT	Minimum Preheat Temperature (F): 50°	Interpass Temperature (F):	Other:	

POSITION

WELD AXIS		TECHNIQUE		DIRECTION	
Flat (1G, 1F, 1FR)	☐	Plate	☐	Backhand	☐	Vertical - Up	☐
Horizontal (2G, 2F, 2FR)	☐	Pipe	☑	Forehand	☑	Vertical - Down	☑
Vertical (3G, 3F)	☐	Rotated	☐				
Overhead (4G, 4F)	☐	Fixed	☑				
Multiple (5G, 5F)	☑	Inclined (6G, 6F)	☐				
Combination	☐						

TECHNIQUE

DISPOSITION STYLE		METHOD		ARC TYPE		
Stringer Beads	☑	Multiple Pass	☑	Single Arc	☑	Other: ☐
Weave Beads	☐	Single Pass	☐	Multiple Arc	☐	

CLEANING

Base Material: Power ☑ Hand ☐ | Weld: Power ☑ Hand ☐

JOINT DESIGN

BUTT WELD ☑ | FILLET WELD ☐

Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ | **Polarity:** Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE VOLTS	RANGE AMPS	MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
Root	1	E6010	1/8"	19-24	75-130	5	3-20
Hot Pass	1	E6010	1/8"	20-24	75-130	5	3-20
Fill	1	E6010	1/8"	20-24	75-130	5	3-20
Cap	1	E6010	1/8"	20-24	75-130	5	3-20

(Over)

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1	1.111	0.237	0.263	17,220	65,399	DUCTILE	BASE
2	0.944	0.230	0.217	19,440	89,536	DUCTILE	WELD
3							
4							

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
5	180 Degrees	NA	NA	Yes ☑ No ☐	
6	180 Degrees	NA	NA	Yes ☑ No ☐	
7	180 Degrees	NA	NA	Yes ☐ No ☐	
8	180 Degrees	NA	NA	Yes ☐ No ☐	
9	NA	180 Degrees	NA	Yes ☑ No ☐	
10	NA	180 Degrees	NA	Yes ☑ No ☐	
11	NA	180 Degrees	NA	Yes ☐ No ☐	
12	NA	180 Degrees	NA	Yes ☐ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☑ No ☐	
14	Yes ☑ No ☐	
15	Yes ☐ No ☐	
16	Yes ☐ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☐ No ☐		Penetration into Parent Metal: Yes ☐ No ☐	
Fillet Weld - Fracture Test		Length of Percent of Defect	in.: %:

WELDER INFO

Welder Name: Andrew Green & Austin Hipsher	License Number & State	Stencil Mark
Contractor: AMS		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By:		
Visual Examination Results:		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography):		
Mechanical Test Conducted By:		Laboratory Test No:
Approved By:		Organization:
APPROVED ☐	REJECTED ☐	Date:

REMARKS

APPROVAL

Engineer:		Date:
Weld Supervisor:		Date:
Director of Gas Engineering:		Date:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. 20-GRB-250		Orig. Issue Date	Revision Date
	WPS No. BW-3-A-*II*		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Process Name: Shielded Metal Arc Welding (SMAW)		Type of Process: Manual	
	For: Butt Welding ☑	Fillet Welding ☐		
PIPE	Material Specification: 20.0" O.D. -GRADE-B- 0.250" WT. API 5L			
DIAMETER	API 1104 6.2.2 Guidelines	☐ Under 2-3/8" OD	☐ 2-3/8" to 12-3/4" OD	☑ > 12-3/4" OD
MATERIAL	API 1104 5.4.2.2 Guidelines	☑ ≤ 42,000 PSI Yield	☐ > 42,000 to < 65,000 PSI Yield	☐ ≥ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☐ Under 3/16" thick	☑ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: E6010	AWS Electrode Size: 1/8"	AWS Specification: A5.1	Filler Metal Group: 1
	AWS Electrode Nos:	AWS Electrode Size:	AWS Specification:	Filler Metal Group:
GAS	SHIELDING GAS: N/A	FLOW RATE: N/A	FLUX: N/A	
PREHEAT	Minimum Preheat Temperature (F): 50°	Interpass Temperature (F):	Other:	

POSITION

WELD AXIS		TECHNIQUE	DIRECTION
Flat (1G, 1F, 1FR) ☐	Plate ☐	Backhand ☐	Vertical - Up ☐
Horizontal (2G, 2F, 2FR) ☐	Pipe ☑	Forehand ☑	Vertical - Down ☑
Vertical (3G, 3F) ☐	Rotated ☐		
Overhead (4G, 4F) ☐	Fixed ☑		
Multiple (5G, 5F) ☑	Inclined (6G, 6F) ☐		
Combination ☐			

TECHNIQUE

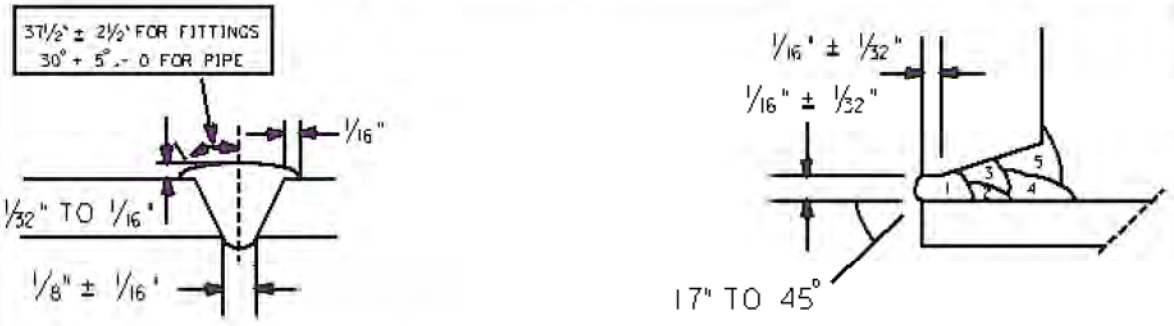
DISPOSITION STYLE	METHOD	ARC TYPE
Stringer Beads ☑	Multiple Pass ☑	Single Arc ☑
Weave Beads ☐	Single Pass ☐	Multiple Arc ☐
		Other: ☐

CLEANING

Base Material: Power ☑ Hand ☐ Weld: Power ☑ Hand ☐

JOINT DESIGN

BUTT WELD ☑ FILLET WELD ☐



Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ **Polarity:** Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE VOLTS	RANGE AMPS	MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
Root	1	E6010	1/8"	20-24	75-130	5	3-20
Hot Pass	1	E6010	1/8"	20-24	75-130	5	3-20
Fill	1	E6010	1/8"	20-24	75-130	5	3-20
Cap	1	E6010	1/8"	20-24	75-130	5	3-20

(Over)

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1	1.027	0.264	0.271	24030	88630	DUCTILE	WELD
2	0.966	0.252	0.243	21640	88895	DUCTILE	BASE
3	1.034	0.274	0.283	25260	89158	DUCTILE	BASE
4	1.143	0.282	0.322	25410	78833	DUCTILE	BASE

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
5	180 Degrees	NA	NA	Yes ☑ No ☐	
6	180 Degrees	NA	NA	Yes ☑ No ☐	
7	180 Degrees	NA	NA	Yes ☑ No ☐	
8	180 Degrees	NA	NA	Yes ☑ No ☐	
9	NA	180 Degrees	NA	Yes ☑ No ☐	
10	NA	180 Degrees	NA	Yes ☑ No ☐	
11	NA	180 Degrees	NA	Yes ☑ No ☐	
12	NA	180 Degrees	NA	Yes ☑ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☑ No ☐	
14	Yes ☑ No ☐	
15	Yes ☑ No ☐	
16	Yes ☑ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☐ No ☐		Penetration into Parent Metal: Yes ☐ No ☐	
Fillet Weld - Fracture Test		Length of Percent of Defect	in.: %:

WELDER INFO

Welder Name: Andrew Green & Austin Hipsher	License Number & State	Stencil Mark
Contractor: AMS		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By:		
Visual Examination Results:		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography):		
Mechanical Test Conducted By:		Laboratory Test No:
Approved By:		Organization:
APPROVED ☐	REJECTED ☐	Date:

REMARKS

APPROVAL

Engineer:		Date:
Weld Supervisor:		Date:
Director of Gas Engineering:		Date:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 4-1 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

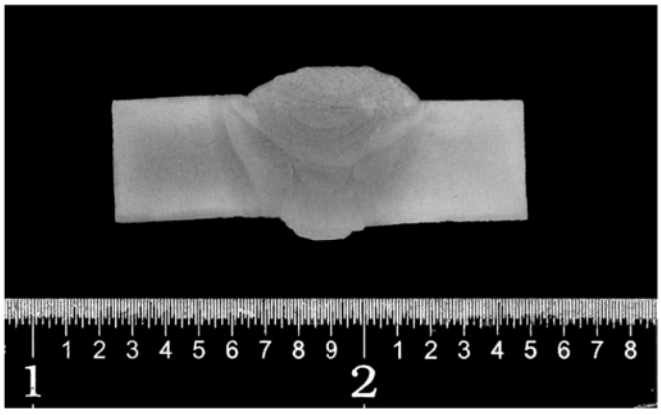
Welding Process: Manual SMAW
Pipe Material: 12.75" diameter, 0.375" thick API 5L X60 to 12.75" diameter, 0.375" thick API 5L X60
Joint Design: 3/32" land, 3/32" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Downhill
Filler Metal: E6010 root, E7010-P1 remainder
Time Between Passes: 1 hour, 52 minutes between root and hot pass
Preheat Temperature: Ambient (73°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fill	Cap		
AWS Classification:	E6010	E7010-P1	E7010-P1	E7010-P1		
Manufacture:	Lincoln	Lincoln	Lincoln	Lincoln		
Electrode Diameter:	1/8"	5/32"	5/32"	5/32"		
Current/Polarity:	DCEP	DCEP	DCEP	DCEP		
Current Range:	75 – 76	96 – 100	95 – 98	93 – 95		
Voltage Range:	24 – 26	24 – 27	25 – 28	27 – 29		
Travel Speed Range, ipm:	3.5 – 5.2	3.4 – 5.4	4.4 – 5.3	3.4 – 5.5		

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 4-1 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:	W12 T1	W12 T2		
Coupon Width:	1.067 inch	1.023 inch		
Coupon Thickness:	0.367 inch	0.368 inch		
Coupon Area:	0.392 $inch^2$	0.376 $inch^2$		
Maximum Load:	35,340 lb	31984 lb		
Tensile Strength:	90,154 psi	85,065 psi		
Fracture Location:	Base Metal	Base Metal		

BEND TEST

Coupon Number:	W12 FB1	W12 FB2	W12 RB2	W12 RB2				
Type:	Face	Face	Root	Root				
Results:	Pass	Pass	Pass	Pass				

NICK-BREAK TEST

Coupon Number:	W12 NB1	W12 NB2		
Results:	Pass	Pass (1)		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 4-2 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

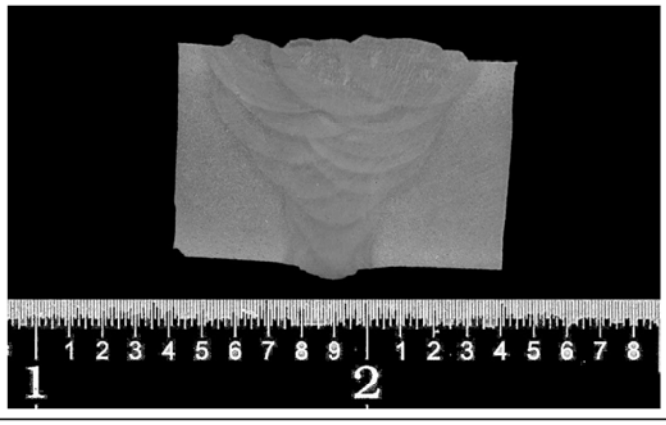
Welding Process: Manual SMAW
Pipe Material: 10.75" diameter, 0.875" thick API 5L X60 to 10.75" diameter, 0.875" thick API 5L X60
Joint Design: 3/32" land, 3/32" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Downhill
Filler Metal: E6010 root, E7010-P1 remainder
Time Between Passes: 18 hours 30 minutes between root and hot pass
Preheat Temperature: Ambient (60°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fill	Cap		
AWS Classification:	E6010	E7010-P1	E7010-P1	E7010-P1		
Manufacture:	Lincoln	Lincoln	Lincoln	Lincoln		
Electrode Diameter:	1/8"	5/32"	5/32"	5/32"		
Current/Polarity:	DCEP	DCEP	DCEP	DCEP		
Current Range:	78 – 79	107 – 118	107 – 119	105 – 116		
Voltage Range:	24 – 26	26 – 30	20 – 31	27 – 31		
Travel Speed Range, ipm:	3.9 – 4.8	5.2 – 7.2	2.4 – 6.7	2.7 – 5.1		

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 4-2 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:	W13 T1	W13 T2		
Coupon Width:	1.144 inch	1.128 inch		
Coupon Thickness:	0.905 inch	0.912 inch		
Coupon Area:	1.035 $inch^2$	1.029 $inch^2$		
Maximum Load:	89060 lb	87,130 lb		
Tensile Strength:	86,000 psi	84,700 psi		
Fracture Location:	Base Metal	Base Metal		

BEND TEST

Coupon Number:	W13 SB1	W13 SB2	W13 SB3	W13 SB4				
Type:	Side	Side	Side	Side				
Results:	Pass (1)	Pass (1)	Pass	Pass (1)				

NICK-BREAK TEST

Coupon Number:	W13 NB1	W13 NB2		
Results:	Pass (1)	Pass (1)		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 4-3 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

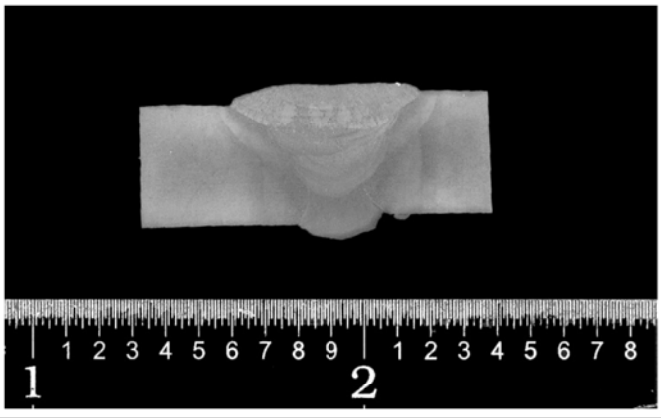
Welding Process: Manual SMAW
Pipe Material: 12.75" diameter, 0.375" thick API 5L X60 to 12.75" diameter, 0.375" thick API 5L X60
Joint Design: 3/32" land, 3/32" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Downhill
Filler Metal: E6010 root, E8010-P1 remainder
Time Between Passes: 4 hours, 22 minutes between root and hot pass
Preheat Temperature: Ambient (68°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fill	Cap		
AWS Classification:	E6010	E8010-P1	E8010-P1	E8010-P1		
Manufacture:	Lincoln	Lincoln	Lincoln	Lincoln		
Electrode Diameter:	1/8"	5/32"	5/32"	5/32"		
Current/Polarity:	DCEP	DCEP	DCEP	DCEP		
Current Range:	68 – 76	98 – 100	99 – 109	92 – 107		
Voltage Range:	22 – 26	24 – 27	24 – 26	24 – 28		
Travel Speed Range, ipm:	2.9 – 5.2	3.8 – 5.5	4.7 – 7.3	3.1 – 5.4		

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 4-3 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:	W14 T1	W14 T2		
Coupon Width:	1.215 inch	1.102 inch		
Coupon Thickness:	0.374 inch	0.370 inch		
Coupon Area:	0.454 $inch^2$	0.408 $inch^2$		
Maximum Load:	40,575 lb	37,168 lb		
Tensile Strength:	89,373 psi	91,097 psi		
Fracture Location:	Base Metal	Base Metal		

BEND TEST

Coupon Number:	W14 FB1	W14 FB2	W14 RB2	W14 RB2				
Type:	Face	Face	Root	Root				
Results:	Pass (1)	Pass (1)	Pass (1)	Pass (1)				

NICK-BREAK TEST

Coupon Number:	W14 NB1	W14 NB2		
Results:	Pass (1)	Pass (1)		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014
Test Conducted By: Jim Winigman, Kiefner
Certified By: Matt Boring, P.E., CWI, CEng, Kiefner
Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 4-4 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeff Ellis, Piedmont Natural Gas

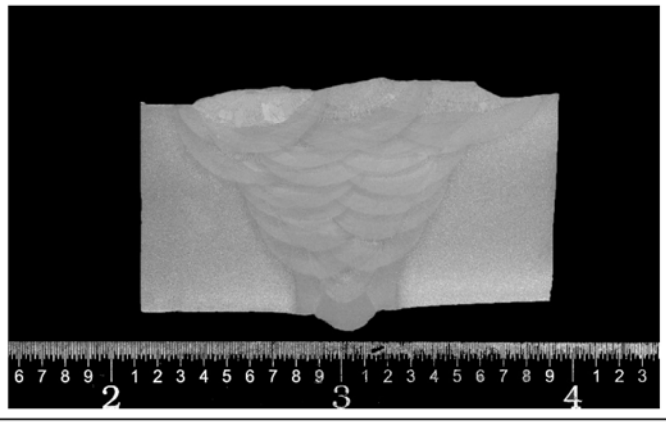
Welding Process: Manual SMAW
Pipe Material: 10.75" diameter, 0.875" thick API 5L X60 to 10.75" diameter, 0.875" thick API 5L X60
Joint Design: 3/32" land, 3/32" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Downhill
Filler Metal: E6010 root, E8010-P1 remainder
Time Between Passes: 6 hours, 27 minutes between root and hot pass
Preheat Temperature: Ambient (64°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fill	Cap		
AWS Classification:	E6010	E8010-P1	E8010-P1	E8010-P1		
Manufacture:	Lincoln	Lincoln	Lincoln	Lincoln		
Electrode Diameter:	1/8"	5/32"	5/32"	5/32"		
Current/Polarity:	DCEP	DCEP	DCEP	DCEP		
Current Range:	99 – 108	132 – 136	121 – 152	105 – 116		
Voltage Range:	24 – 25	25 – 27	25 – 29	27 – 31		
Travel Speed Range, ipm:	7.6 – 11.5	8.2 – 12.6	2.4 – 6.7	4.6 – 14.5		

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 4-4 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:	W15 T1	W15 T2		
Coupon Width:	1.121 inch	1.087 inch		
Coupon Thickness:	0.897 inch	0.879 inch		
Coupon Area:	1.006 inch2	0.955 $inch^2$		
Maximum Load:	76,800 lb	83,800 lb		
Tensile Strength:	76,400 psi	87,700 psi		
Fracture Location:	Base Metal	Base Metal		

BEND TEST

Coupon Number:	W15 SB1	W15 SB2	W15 SB3	W15 SB4				
Type:	Side	Side	Side	Side				
Results:	Pass (1)	Pass (1)	Pass (1)	Pass				

NICK-BREAK TEST

Coupon Number:	W15 NB1	W15 NB2		
Results:	Pass	Pass (1)		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. 12-X60-375		Orig. Issue Date	Revision Date
	WPS No. BW-2-B-*II*		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Process Name: Shielded Metal Arc Welding (SMAW)		Type of Process: Manual	
	For: Butt Welding ☑	Fillet Welding ☐		
PIPE	Material Specification: 12.0" O.D. - X-60- 0.375" WT. API 5L			
DIAMETER	API 1104 6.2.2 Guidelines	☐ Under 2-3/8" OD	☑ 2-3/8" to 12-3/4" OD	☐ > 12-3/4" OD
MATERIAL	API 1104 5.4.2.2 Guidelines	☐ ≤ 42,000 PSI Yield	☑ > 42,000 to < 65,000 PSI Yield	☐ ≥ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☐ Under 3/16" thick	☑ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: E6010	AWS Electrode Size: 1/8"	AWS Specification: A5.1	Filler Metal Group: 1
	AWS Electrode Nos: E7010	AWS Electrode Size: 1/8"	AWS Specification: A5.5	Filler Metal Group: 1
GAS	SHIELDING GAS: N/A	FLOW RATE: N/A	FLUX: N/A	
PREHEAT	Minimum Preheat Temperature (F): 50°	Interpass Temperature (F):	Other:	

POSITION

WELD AXIS		TECHNIQUE		DIRECTION	
Flat (1G, 1F, 1FR)	☐	Plate	☐	Backhand	☐	Vertical - Up	☐
Horizontal (2G, 2F, 2FR)	☐	Pipe	☑	Forehand	☑	Vertical - Down	☑
Vertical (3G, 3F)	☐	Rotated	☐				
Overhead (4G, 4F)	☐	Fixed	☑				
Multiple (5G, 5F)	☑	Inclined (6G, 6F)	☐				
Combination	☐						

TECHNIQUE

DISPOSITION STYLE		METHOD		ARC TYPE		
Stringer Beads	☑	Multiple Pass	☑	Single Arc	☑	Other: ☐
Weave Beads	☐	Single Pass	☐	Multiple Arc	☐	

CLEANING

Base Material: Power ☑ Hand ☐ | Weld: Power ☑ Hand ☐

JOINT DESIGN

BUTT WELD ☑ | FILLET WELD ☐

Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ **Polarity:** Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE		MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
				VOLTS	AMPS		
Root	1	E6010	1/8"	20-24	75-130	5	3-20
Hot Pass	1	E7010	1/8"	18-23	65-140	5	3-20
Fill	2	E7010	1/8"	18-24	65-140	5	3-20
Cap	1	E7010	1/8"	18-24	65-140	5	3-20

(Over)

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1	0.946	0.378	0.358	28,497	79,692	DUCTILE	WELD
2	1.031	0.403	0.415	35,710	85,946	DUCTILE	BASE
3							
4							

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
5	180 Degrees	NA	NA	Yes ☑ No ☐	
6	180 Degrees	NA	NA	Yes ☑ No ☐	
7	180 Degrees	NA	NA	Yes ☐ No ☐	
8	180 Degrees	NA	NA	Yes ☐ No ☐	
9	NA	180 Degrees	NA	Yes ☑ No ☐	
10	NA	180 Degrees	NA	Yes ☑ No ☐	
11	NA	180 Degrees	NA	Yes ☐ No ☐	
12	NA	180 Degrees	NA	Yes ☐ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☑ No ☐	
14	Yes ☑ No ☐	
15	Yes ☐ No ☐	
16	Yes ☐ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☐ No ☐		Penetration into Parent Metal: Yes ☐ No ☐	
Fillet Weld - Fracture Test		Length of Percent of Defect	in.: %:

WELDER INFO

Welder Name: Andrew Green & Austin Hipsher	License Number & State	Stencil Mark
Contractor: AMS		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By:		
Visual Examination Results:		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography):		
Mechanical Test Conducted By:		Laboratory Test No:
Approved By:		Organization:
APPROVED ☐	REJECTED ☐	Date:

REMARKS

APPROVAL

Engineer:		Date:
Weld Supervisor:		Date:
Director of Gas Engineering:		Date:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. 12-X52-375		Orig. Issue Date	Revision Date
	WPS No. BW-2-B-II R		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Process Name: Shielded Metal Arc Welding (SMAW)		Type of Process: Manual	
	For: Butt Welding ☑	Fillet Welding ☐		
PIPE	Material Specification: 12.375" O.D.- X-52 - 0.375" WT. API 5L			
DIAMETER	API 1104 6.2.2 Guidelines	☐ Under 2-3/8" OD	☑ 2-3/8" to 12-3/4" OD	☐ > 12-3/4" OD
MATERIAL	RESTRICTED	☐ ≤ 42,000 PSI Yield	☑ > 42,000 to ≤ 52,000 PSI Yield	☐ ≥ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☐ Under 3/16" thick	☑ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: E6010	AWS Electrode Size: 1/8"	AWS Specification: A5.1	Filler Metal Group: 1
	AWS Electrode Nos:	AWS Electrode Size:	AWS Specification:	Filler Metal Group:
GAS	SHIELDING GAS: N/A	FLOW RATE: N/A	FLUX: N/A	
PREHEAT	Minimum Preheat Temperature (F): 50°	Interpass Temperature (F):	Other:	

POSITION

WELD AXIS		TECHNIQUE	DIRECTION
Flat (1G, 1F, 1FR) ☐	Plate ☐	Backhand ☐	Vertical - Up ☐
Horizontal (2G, 2F, 2FR) ☐	Pipe ☑	Forehand ☑	Vertical - Down ☑
Vertical (3G, 3F) ☐	Rotated ☐		
Overhead (4G, 4F) ☐	Fixed ☑		
Multiple (5G, 5F) ☑	Inclined (6G, 6F) ☐		
Combination ☐			

TECHNIQUE

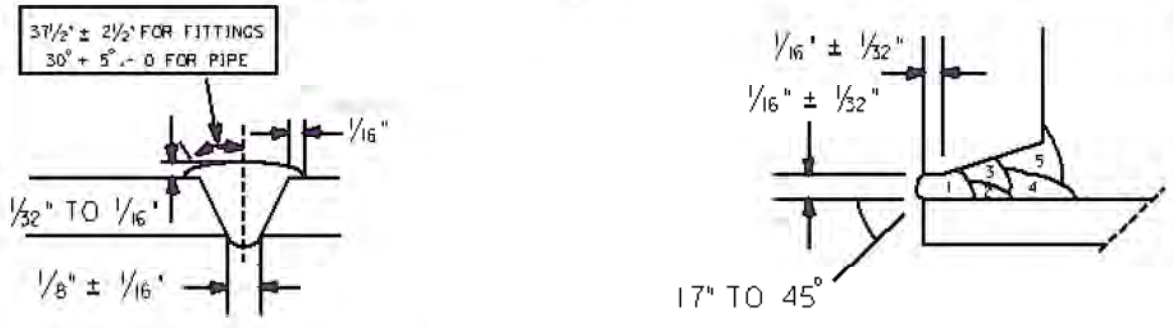
DISPOSITION STYLE	METHOD	ARC TYPE
Stringer Beads ☑	Multiple Pass ☑	Single Arc ☑
Weave Beads ☐	Single Pass ☐	Multiple Arc ☐
		Other: ☐

CLEANING

Base Material: Power ☑ Hand ☐ | Weld: Power ☑ Hand ☐

JOINT DESIGN

BUTT WELD ☑ | FILLET WELD ☐



Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ **Polarity:** Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE VOLTS	RANGE AMPS	MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
Root	1	E6010	1/8"	20-25	75-130	5	3-20
Hot Pass	1	E6010	1/8"	20-25	75-130	5	3-20
Fill	2	E6010	1/8"	20-25	75-130	5	3-20
Cap	1	E6010	1/8"	20-25	75-130	5	3-20

(Over)

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1	0.950	0.450	0.428	33480	78316	DUCTILE	BASE
2	0.890	0.490	0.436	33650	77161	DUCTILE	BASE
3							
4							

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
5	180 Degrees	NA	NA	Yes ☑ No ☐	
6	180 Degrees	NA	NA	Yes ☑ No ☐	
7	180 Degrees	NA	NA	Yes ☐ No ☐	
8	180 Degrees	NA	NA	Yes ☐ No ☐	
9	NA	180 Degrees	NA	Yes ☑ No ☐	
10	NA	180 Degrees	NA	Yes ☑ No ☐	
11	NA	180 Degrees	NA	Yes ☐ No ☐	
12	NA	180 Degrees	NA	Yes ☐ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☑ No ☐	
14	Yes ☑ No ☐	
15	Yes ☐ No ☐	
16	Yes ☐ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☐ No ☐		Penetration into Parent Metal: Yes ☐ No ☐	
Fillet Weld - Fracture Test		Length of Percent of Defect	in.: %:

WELDER INFO

Welder Name: Andrew Green & Austin Hipsher	License Number & State	Stencil Mark
Contractor: AMS		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By:		
Visual Examination Results:		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography):		
Mechanical Test Conducted By:		Laboratory Test No:
Approved By:		Organization:
APPROVED ☐	REJECTED ☐	Date:

REMARKS

APPROVAL

Engineer:		Date:
Weld Supervisor:		Date:
Director of Gas Engineering:		Date:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. 16-X60-312		Orig. Issue Date	Revision Date
	WPS No. BW-3-B-*II*		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Process Name: Shielded Metal Arc Welding (SMAW)		Type of Process: Manual	
	For: Butt Welding ☑	Fillet Welding ☐		
PIPE	Material Specification: 16.0" O.D. - X-60 - 0.312" WT. API 5L			
DIAMETER	API 1104 6.2.2 Guidelines	☐ Under 2-3/8" OD	☐ 2-3/8" to 12-3/4" OD	☑ > 12-3/4" OD
MATERIAL	API 1104 5.4.2.2 Guidelines	☐ ≤ 42,000 PSI Yield	☑ > 42,000 to < 65,000 PSI Yield	☐ ≥ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☐ Under 3/16" thick	☑ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: E6010	AWS Electrode Size: 1/8"	AWS Specification: A5.1	Filler Metal Group: 1
	AWS Electrode Nos: E7010	AWS Electrode Size: 1/8"	AWS Specification: A5.5	Filler Metal Group: 1
GAS	SHIELDING GAS: N/A	FLOW RATE: N/A	FLUX: N/A	
PREHEAT	Minimum Preheat Temperature (F): 50°	Interpass Temperature (F):	Other:	

POSITION

WELD AXIS		TECHNIQUE	DIRECTION
Flat (1G, 1F, 1FR) ☐	Plate ☐	Backhand ☐	Vertical - Up ☐
Horizontal (2G, 2F, 2FR) ☐	Pipe ☑	Forehand ☑	Vertical - Down ☑
Vertical (3G, 3F) ☐	Rotated ☐		
Overhead (4G, 4F) ☐	Fixed ☑		
Multiple (5G, 5F) ☑	Inclined (6G, 6F) ☐		
Combination ☐			

TECHNIQUE

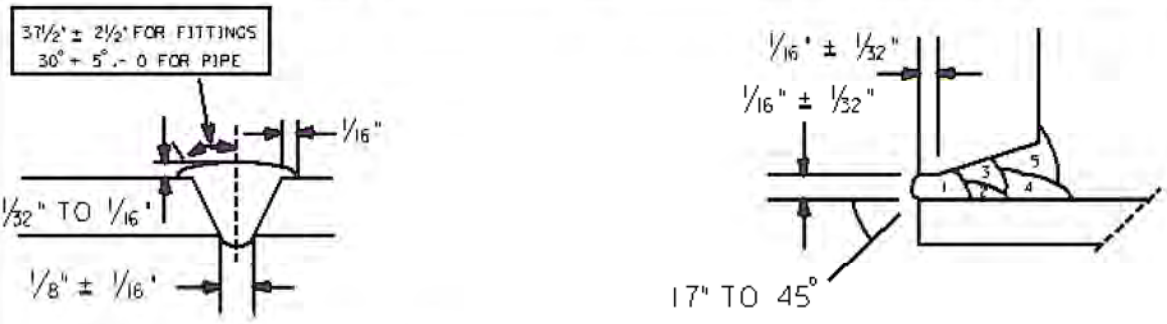
DISPOSITION STYLE	METHOD	ARC TYPE
Stringer Beads ☑	Multiple Pass ☑	Single Arc ☑
Weave Beads ☐	Single Pass ☐	Multiple Arc ☐
		Other: ☐

CLEANING

Base Material: Power ☑ Hand ☐ | Weld: Power ☑ Hand ☐

JOINT DESIGN

BUTT WELD ☑ | FILLET WELD ☐



Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ | Polarity: Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE		MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
				VOLTS	AMPS		
Root	1	E6010	1/8"	20-24	75-130	5	3-20
Hot Pass	1	E7010	1/8"	18-23	65-140	5	3-20
Fill	2	E7010	1/8"	18-23	65-140	5	3-20
Cap	1	E7010	1/8"	18-23	65-140	5	3-20

(Over)

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1	0.984	0.327	0.322	26,720	83,041	DUCTILE	WELD
2	1.021	0.336	0.343	26,930	78,500	DUCTILE	BASE
3	1.114	0.336	0.374	28,640	76,515	DUCTILE	BASE
4	1.02	0.321	0.327	26,020	79,470	DUCTILE	BASE

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
5	180 Degrees	NA	NA	Yes ☑ No ☐	
6	180 Degrees	NA	NA	Yes ☑ No ☐	
7	180 Degrees	NA	NA	Yes ☑ No ☐	
8	180 Degrees	NA	NA	Yes ☑ No ☐	
9	NA	180 Degrees	NA	Yes ☑ No ☐	
10	NA	180 Degrees	NA	Yes ☑ No ☐	
11	NA	180 Degrees	NA	Yes ☑ No ☐	
12	NA	180 Degrees	NA	Yes ☑ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☑ No ☐	
14	Yes ☑ No ☐	
15	Yes ☑ No ☐	
16	Yes ☑ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☐ No ☐		Penetration into Parent Metal: Yes ☐ No ☐	
Fillet Weld - Fracture Test		Length of Percent of Defect	in.: %:

WELDER INFO

Welder Name: Andrew Green & Austin Hipsher	License Number & State	Stencil Mark
Contractor: AMS		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By:		
Visual Examination Results:		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography):		
Mechanical Test Conducted By:		Laboratory Test No:
Approved By:		Organization:
APPROVED ☐	REJECTED ☐	Date:

REMARKS

APPROVAL

Engineer:		Date:
Weld Supervisor:		Date:
Director of Gas Engineering:		Date:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 5-1 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeff Ellis, Piedmont Natural Gas

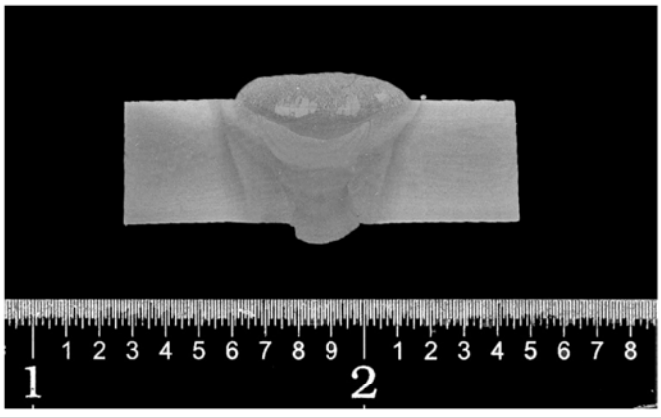
Welding Process: Manual SMAW
Pipe Material: 12.75" diameter, 0.375" thick API 5L X65 to 12.75" diameter, 0.375" thick API 5L X65
Joint Design: 3/32" land, 3/32" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Downhill
Filler Metal: E6010 root, E8010-P1 remainder
Time Between Passes: 5 hours, 15 minutes between root and hot pass
Preheat Temperature: Ambient (64°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Cap		
AWS Classification:	E6010	E8010-P1	E8010-P1	E8010-P1		
Manufacture:	Lincoln	Lincoln	Lincoln	Lincoln		
Electrode Diameter:	1/8"	5/32"	5/32"	5/32"		
Current/Polarity:	DCEP	DCEP	DCEP	DCEP		
Current Range:	106 – 113	141 – 145	131 – 137	114 – 119		
Voltage Range:	24 – 26	25 – 27	26 – 28	25 – 28		
Travel Speed Range, ipm:	7.0 – 11.2	8.0 – 11.4	5.7 – 8.5	4.3 – 6.0		

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 5-1 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:	W16 T1	W16 T2		
Coupon Width:	1.029 inch	1.073 inch		
Coupon Thickness:	0.370 inch	0.377 inch		
Coupon Area:	0.381 $inch^2$	0.405 $inch^2$		
Maximum Load:	32,841 lb	33,019 lb		
Tensile Strength:	86,196 psi	81,530 psi		
Fracture Location:	Base Metal	Base Metal		

BEND TEST

Coupon Number:	W16 FB1	W16 FB2	W16 RB1	W16 RB2				
Type:	Face	Face	Root	Root				
Results:	Pass	Pass	Pass (1)	Pass				

NICK-BREAK TEST

Coupon Number:	W16 NB1	W16 NB2		
Results:	Pass (1)	Pass (1)		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. 16-X65-375		Orig. Issue Date	Revision Date
	WPS No. BW-3-C-*II*		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Process Name: Shielded Metal Arc Welding (SMAW)		Type of Process: Manual	
	For: Butt Welding ☑	Fillet Welding ☐		
PIPE	Material Specification: 16.0" O.D.- X-65- 0.375" WT. API 5L			
DIAMETER	API 1104 6.2.2 Guidelines	☐ Under 2-3/8" OD	☐ 2-3/8" to 12-3/4" OD	☑ > 12-3/4" OD
MATERIAL	API 1104 5.4.2.2 Guidelines	☐ ≤ 42,000 PSI Yield	☐ > 42,000 to < 65,000 PSI Yield	☑ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☐ Under 3/16" thick	☑ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: E6010	AWS Electrode Size: 1/8"	AWS Specification: A5.1	Filler Metal Group: 1
	AWS Electrode Nos: E8010	AWS Electrode Size: 1/8"	AWS Specification: A5.5	Filler Metal Group: 2
GAS	SHIELDING GAS: N/A	FLOW RATE: N/A	FLUX: N/A	
PREHEAT	Minimum Preheat Temperature (F): 50°	Interpass Temperature (F):	Other:	

POSITION

WELD AXIS		TECHNIQUE		DIRECTION	
Flat (1G, 1F, 1FR)	☐	Plate	☐	Backhand	☐	Vertical - Up	☐
Horizontal (2G, 2F, 2FR)	☐	Pipe	☑	Forehand	☑	Vertical - Down	☑
Vertical (3G, 3F)	☐	Rotated	☐				
Overhead (4G, 4F)	☐	Fixed	☑				
Multiple (5G, 5F)	☑	Inclined (6G, 6F)	☐				
Combination	☐						

TECHNIQUE

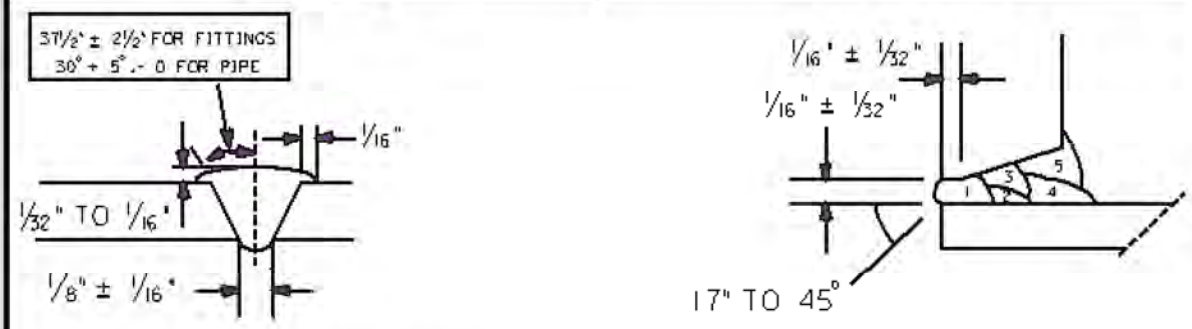
DISPOSITION STYLE		METHOD		ARC TYPE		
Stringer Beads	☑	Multiple Pass	☑	Single Arc	☑	Other: ☐
Weave Beads	☐	Single Pass	☐	Multiple Arc	☐	

CLEANING

Base Material: Power ☑ Hand ☐ | Weld: Power ☑ Hand ☐

JOINT DESIGN

BUTT WELD ☑ | FILLET WELD ☐



Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ **Polarity:** Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE VOLTS	RANGE AMPS	MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
Root	1	E6010	1/8"	20-24	75-130	5	3-20
Hot Pass	1	E8010	1/8"	22-26	75-135	5	3-20
Fill	2	E8010	1/8"	22-26	75-135	5	3-20
Cap	1	E8010	1/8"	22-26	75-135	5	3-20

(Over)

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1	1.046	0.395	0.413	35140	85050	DUCTILE	WELD
2	0.969	0.367	0.356	31220	87790	DUCTILE	BASE
3	1.069	0.381	0.407	36370	89298	DUCTILE	WELD
4	0.951	0.38	0.361	32590	90182	DUCTILE	BASE

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend*	Bend Acceptable	Comments
5	180 Degrees	NA	NA	Yes ☑ No ☐	
6	180 Degrees	NA	NA	Yes ☑ No ☐	
7	180 Degrees	NA	NA	Yes ☑ No ☐	
8	180 Degrees	NA	NA	Yes ☑ No ☐	
9	NA	180 Degrees	NA	Yes ☑ No ☐	
10	NA	180 Degrees	NA	Yes ☑ No ☐	
11	NA	180 Degrees	NA	Yes ☑ No ☐	
12	NA	180 Degrees	NA	Yes ☑ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☑ No ☐	
14	Yes ☑ No ☐	
15	Yes ☑ No ☐	
16	Yes ☑ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☐ No ☐		Penetration into Parent Metal: Yes ☐ No ☐	
Fillet Weld - Fracture Test		Length of Percent of Defect	in.: %:

WELDER INFO

Welder Name: Andrew Green & Austin Hipsher	License Number & State	Stencil Mark
Contractor: AMS		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By:		
Visual Examination Results:		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography):		
Mechanical Test Conducted By:		Laboratory Test No:
Approved By:		Organization:
APPROVED ☐	REJECTED ☐	Date:

REMARKS

APPROVAL

Engineer:		Date:
Weld Supervisor:		Date:
Director of Gas Engineering:		Date:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 6-1 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeff Ellis, Piedmont Natural Gas

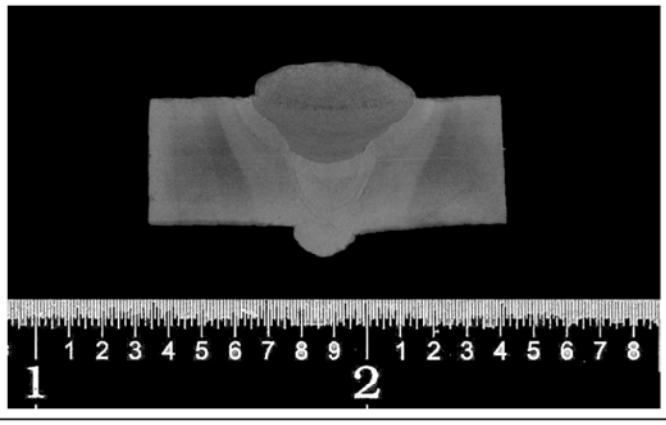
Welding Process: Manual SMAW
Pipe Material: 24" diameter, 0.375" thick API 5L X70 to 24" diameter, 0.375" thick API 5L X70
Joint Design: 3/32" land, 3/32" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Downhill
Filler Metal: E6010 root, E8010-P1 remainder
Time Between Passes: 24 hours between root and hot pass
Preheat Temperature: Ambient (65°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Cap		
AWS Classification:	E6010	E8010-P1	E8010-P1	E8010-P1		
Manufacture:	Lincoln	Lincoln	Lincoln	Lincoln		
Electrode Diameter:	1/8"	5/32"	5/32"	5/32"		
Current/Polarity:	DCEP	DCEP	DCEP	DCEP		
Current Range:	102 – 114	139 – 141	126 – 142	111 – 132		
Voltage Range:	22 – 25	26 – 27	25 – 28	20 – 29		
Travel Speed Range, ipm:	6.1 – 11.3	5.9 – 8.7	4.8 – 9.3	4.4 – 7.5		

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 6-1 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:	W17 T1	W17 T2	W17 T3	W17 T4
Coupon Width:	1.015 inch	0.953 inch	1.041 inch	1.084 inch
Coupon Thickness:	0.382 inch	0.383 inch	0.386 inch	0.382 inch
Coupon Area:	0.388 $inch^2$	0.365 $inch^2$	0.402 $inch^2$	0.414 $inch^2$
Maximum Load:	34,230 lb	32,731 lb	35,591 lb	35,871 lb
Tensile Strength:	88,222 psi	89,675 psi	88,535 psi	86,646 psi
Fracture Location:	Base Metal	Base Metal	Base Metal	Base Metal

BEND TEST

Coupon Number:	W17FB1	W17FB2	W17FB3	W17FB4	W17RB1	W17RB2	W17RB3	W17RB4
Type:	Face	Face	Face	Face	Root	Root	Root	Root
Results:	Pass (1)	Pass	Pass	Pass	Pass (1)	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	W17 NB1	W17 NB2	W17 NB3	W17 NB4
Results:	Pass (1)	Pass	Pass (1)	Pass

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 7-1 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

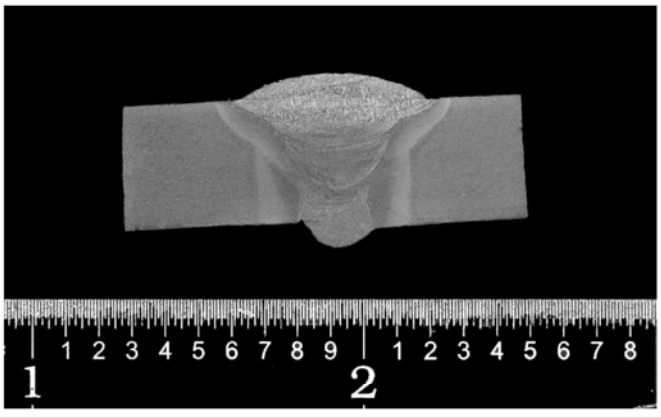
Welding Process: Manual SMAW
Pipe Material: 12.75" diameter, 0.375" thick API 5L X42 to 12.75" diameter, 0.375" thick API 5L X42
Joint Design: 3/32" land, 3/32" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Uphill
Filler Metal: E7016 root, E7018 remainder
Time Between Passes: 2 hours, 55 minutes between root and hot pass
Preheat Temperature: Ambient (62°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fill	Cap		
AWS Classification:	E7016	E7018	E7018	E7018		
Manufacture:	Lincoln	Lincoln	Lincoln	Lincoln		
Electrode Diameter:	3/32"	1/8"	1/8"	1/8"		
Current/Polarity:	DCEP	DCEP	DCEP	DCEP		
Current Range:	76 – 84	97 – 108	111 – 115	99 – 111		
Voltage Range:	20 – 25	20 – 22	21 – 23	20 – 22		
Travel Speed Range, ipm:	2.5 – 5.2	3.4 – 5.9	3.0 – 4.3	2.3 – 4.4		

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 7-1 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:	W18 T1	W18 T2		
Coupon Width:	1.028 inch	1.016 inch		
Coupon Thickness:	0.374 inch	0.381 inch		
Coupon Area:	0.384 $inch^2$	0.387 $inch^2$		
Maximum Load:	29,486 lb	29,733 lb		
Tensile Strength:	76,787 psi	76,829 psi		
Fracture Location:	Base Metal	Base Metal		

BEND TEST

Coupon Number:	W18 FB1	W18 FB2	W18 RB1	W18 RB2				
Type:	Face	Face	Root	Root				
Results:	Pass	Pass	Pass	Pass				

NICK-BREAK TEST

Coupon Number:	W18 NB1	W18 NB2		
Results:	Pass (1)	Pass (1)		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 7-2 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

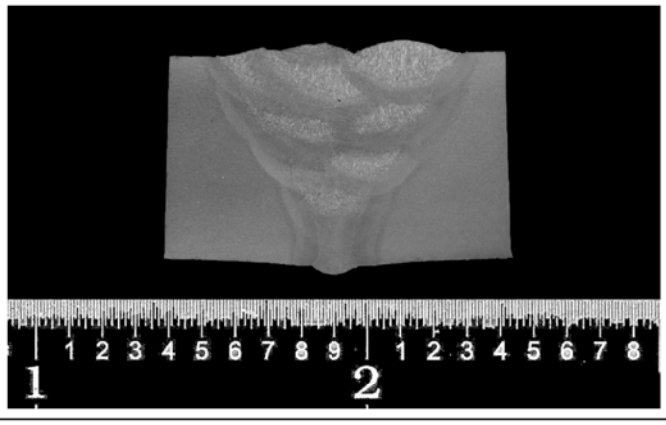
Welding Process: Manual SMAW
Pipe Material: 10.75" diameter, 0.844" thick API 5L X42 to 10.75" diameter, 0.844" thick API 5L X42
Joint Design: 3/32" land, 3/32" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Uphill
Filler Metal: E7016 root, E7018 remainder
Time Between Passes: 22 hours, 55 minutes between root and hot pass
Preheat Temperature: Ambient (65°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fill	Cap		
AWS Classification:	E7016	E7018	E7018	E7018		
Manufacture:	Lincoln	Lincoln	Lincoln	Lincoln		
Electrode Diameter:	3/32"	1/8"	1/8"	1/8"		
Current/Polarity:	DCEP	DCEP	DCEP	DCEP		
Current Range:	79 – 82	104 – 110	110 – 119	109 – 119		
Voltage Range:	21 – 24	22 – 23	21 – 24	21 – 23		
Travel Speed Range, ipm:	2.6 – 4.3	2.9 – 4.8	2.1 – 4.8	2.3 – 4.9		

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 7-2 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:	W19 T1	W19 T2		
Coupon Width:	0.991 inch	0.980 inch		
Coupon Thickness:	0.863 inch	0.866 inch		
Coupon Area:	0.855 $inch^2$	0.849 $inch^2$		
Maximum Load:	66,240 lb	67,470 lb		
Tensile Strength:	77,500 psi	79,500 psi		
Fracture Location:	Base Metal	Base Metal		

BEND TEST

Coupon Number:	W19 SB1	W19 SB2	W19 SB3	W19 SB4				
Type:	Face	Face	Root	Root				
Results:	Pass	Pass (1)	Pass	Pass				

NICK-BREAK TEST

Coupon Number:	W19 NB1	W19 NB2		
Results:	Pass	Pass (1)		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 8-1 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

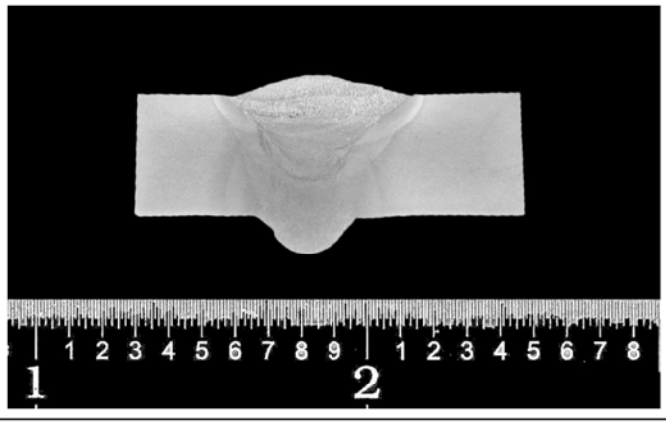
Welding Process: Manual SMAW
Pipe Material: 12.75" diameter, 0.375" thick API 5L X60 to 12.75" diameter, 0.375" thick API 5L X60
Joint Design: 3/32" land, 3/32" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Uphill
Filler Metal: E7016 root, E7018 remainder
Time Between Passes: 1 hour, 22 minutes between root and hot pass
Preheat Temperature: Ambient (64°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fill	Cap		
AWS Classification:	E7016	E7018	E7018	E7018		
Manufacture:	Lincoln	Lincoln	Lincoln	Lincoln		
Electrode Diameter:	3/32"	1/8"	1/8"	1/8"		
Current/Polarity:	DCEP	DCEP	DCEP	DCEP		
Current Range:	78 – 89	96 – 102	106 – 109	100 – 118		
Voltage Range:	20 – 28	20 – 22	20 – 23	20 – 24		
Travel Speed Range, ipm:	2.5 – 6.0	3.7 – 5.3	3.2 – 4.5	2.6 – 6.5		

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 8-1 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:	W20 T1	W20 T2		
Coupon Width:	1.067 inch	1.046 inch		
Coupon Thickness:	0.369 inch	0.370 inch		
Coupon Area:	0.394 $inch^2$	0.387 $inch^2$		
Maximum Load:	34,143 lb	33,609 lb		
Tensile Strength:	86,656 psi	86,845 psi		
Fracture Location:	Base Metal	Base Metal		

BEND TEST

Coupon Number:	W20 FB1	W20 FB2	W20 RB1	W20 RB2				
Type:	Face	Face	Root	Root				
Results:	Pass	Pass (1)	Pass	Pass (1)				

NICK-BREAK TEST

Coupon Number:	W20 NB1	W20 NB2		
Results:	Pass (1)	Pass (1)		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 8-2 **Date:** 12/4/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

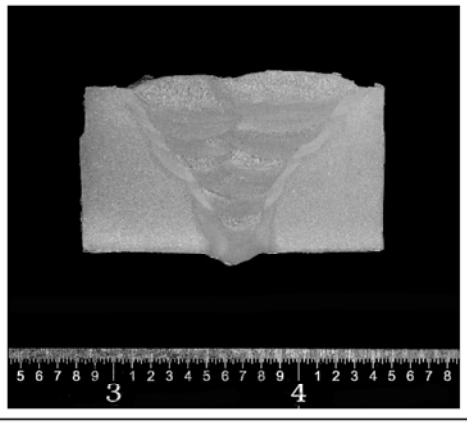
Welding Process: Manual SMAW
Pipe Material: 10.75" diameter, 0.875" thick API 5L X60 to 10.75" diameter, 0.875" thick API 5L X60
Joint Design: 3/32" land, 3/32" gap, 70 degree bevel butt joint
Position: 5G, Fixed **Welding Direction:** Uphill
Filler Metal: E7016 root, E7018 remainder
Time Between Passes: 8 hours, 3 minutes between root and hot pass
Preheat Temperature: Ambient (43°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fill	Cap		
AWS Classification:	E7016	E7018	E7018	E7018		
Manufacture:	Lincoln	Lincoln	Lincoln	Lincoln		
Electrode Diameter:	3/32"	1/8"	1/8"	1/8"		
Current/Polarity:	DCEP	DCEP	DCEP	DCEP		
Current Range:	68 – 75	101 – 108	120 – 137	120 – 130		
Voltage Range:	20 – 23	20 – 22	20 – 23	20 – 22		
Travel Speed Range, ipm:	2.7 – 4.3	2.6 – 4.4	2.0 – 5.0	2.0 – 4.1		

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 8-2 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:	W21 T1	W21 T2		
Coupon Width:	1.120 inch	1.041 inch		
Coupon Thickness:	0.886 inch	0.887 inch		
Coupon Area:	0.992 $inch^2$	0.923 $inch^2$		
Maximum Load:	87,487 lb	77,811 lb		
Tensile Strength:	88,192 psi	84,302 psi		
Fracture Location:	Base Metal	Base Metal		

BEND TEST

Coupon Number:	W21 SB1	W21 SB2	W21 SB3	W21 SB4				
Type:	Side	Side	Side	Side				
Results:	Pass (1)	Pass	Pass (1)	Pass				

NICK-BREAK TEST

Coupon Number:	W21 NB1	W21 NB2		
Results:	Pass	Pass		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 12/4/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 9-1 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

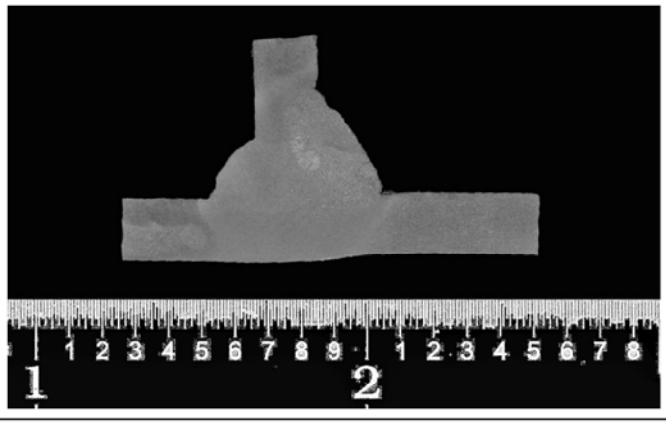
Welding Process: Manual SMAW
Pipe Material: 2.375" diameter, 0.154" thick API 5L X42 to 2.375" diameter, 0.154" thick API 5L X42
Joint Design: 3/32" land, 3/32" gap, 45 degree bevel branch groove
Position: 5G, Fixed **Welding Direction:** Downhill
Filler Metal: E6010
Time Between Passes: 17 hours, 10 minutes between root and hot pass
Preheat Temperature: Ambient (65°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Cap			
AWS Classification:	E6010	E6010	E6010			
Manufacture:	Lincoln	Lincoln	Lincoln			
Electrode Diameter:	1/8"	1/8"	1/8"			
Current/Polarity:	DCEP	DCEP	DCEP			
Current Range:	65 – 71	85 – 89	84 – 90			
Voltage Range:	24 – 26	25 – 28	25 – 28			
Travel Speed Range, ipm:	2.2 – 3.4	5.4 – 10.7	4.0 – 5.6			

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 9-1 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:				
Coupon Width:				
Coupon Thickness:				
Coupon Area:				
Maximum Load:				
Tensile Strength:				
Fracture Location:				

BEND TEST

Coupon Number:								
Type:								
Results:								

NICK-BREAK TEST

Coupon Number:	W22 NB1	W22 NB2	W22 NB3	W22 NB4
Results:	Pass	Pass	Pass	Pass (1)

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 9-2 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

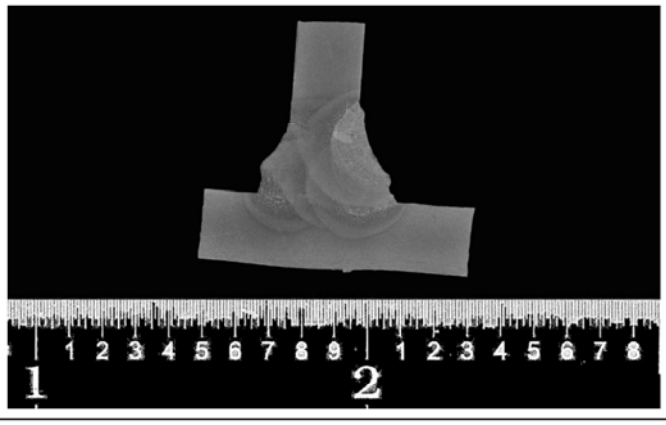
Welding Process: Manual SMAW
Pipe Material: 6.625" diameter, 0.280" thick API 5L X42 to 6.625" diameter, 0.280" thick API 5L X42
Joint Design: 3/32" land, 3/32" gap, 45 degree bevel branch groove
Position: 5G, Fixed **Welding Direction:** Downhill
Filler Metal: E6010 root, E7010-P1 remainder
Time Between Passes: 18 hours, 11 minutes between root and hot pass
Preheat Temperature: Ambient (65°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Cap			
AWS Classification:	E6010	E7010-P1	E7010-P1			
Manufacture:	Lincoln	Lincoln	Lincoln			
Electrode Diameter:	1/8"	5/32"	5/32"			
Current/Polarity:	DCEP	DCEP	DCEP			
Current Range:	85 – 95	110 – 111	110 – 113			
Voltage Range:	24 – 28	26 – 28	26 – 28			
Travel Speed Range, ipm:	2.9 – 4.5	4.0 – 6.4	3.5 – 6.4			

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 9-2 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:				
Coupon Width:				
Coupon Thickness:				
Coupon Area:				
Maximum Load:				
Tensile Strength:				
Fracture Location:				

BEND TEST

Coupon Number:								
Type:								
Results:								

NICK-BREAK TEST

Coupon Number:	W23 NB1	W23 NB2	W23 NB3	W23 NB4
Results:	Pass	Pass	Pass	Pass

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments:

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. F12-X42-219		Orig. Issue Date	Revision Date
	WPS No. FW-A-*II*		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Process Name: Shielded Metal Arc Welding (SMAW)		Type of Process: Manual	
	For: Butt Welding ☐	Fillet Welding ☑		
PIPE	Material Specification: 12.375" O.D. - X-42 - 0.219" WT. API 5L			
~~**DIAMETER**~~	~~API 1104 6.2.2 Guidelines~~	☐ ~~Under 2 3/8" OD~~	☐ ~~2 3/8" to 12 3/4" OD~~	☐ ~~> 12 3/4" OD~~
MATERIAL	API 1104 5.4.2.2 Guidelines	☑ ≤ 42,000 PSI Yield	☐ > 42,000 to < 65,000 PSI Yield	☐ ≥ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☐ Under 3/16" thick	☑ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: E6010	AWS Electrode Size: 1/8"	AWS Specification: A5.1	Filler Metal Group: 1
	AWS Electrode Nos:	AWS Electrode Size:	AWS Specification:	Filler Metal Group:
GAS	SHIELDING GAS: N/A	FLOW RATE: N/A	FLUX: N/A	
PREHEAT	Minimum Preheat Temperature (F): 50°	Interpass Temperature (F):	Other:	

POSITION

WELD AXIS		TECHNIQUE	DIRECTION
Flat (1G, 1F, 1FR) ☐	Plate ☐	Backhand ☐	Vertical - Up ☐
Horizontal (2G, 2F, 2FR) ☐	Pipe ☑	Forehand ☑	Vertical - Down ☑
Vertical (3G, 3F) ☐	Rotated ☐		
Overhead (4G, 4F) ☐	Fixed ☑		
Multiple (5G, 5F) ☑	Inclined (6G, 6F) ☐		
Combination ☐			

TECHNIQUE

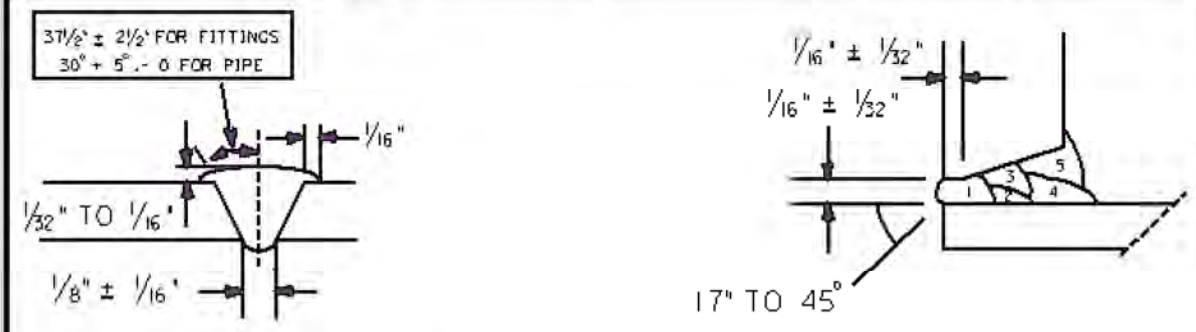
DISPOSITION STYLE	METHOD	ARC TYPE
Stringer Beads ☑	Multiple Pass ☑	Single Arc ☑
Weave Beads ☐	Single Pass ☐	Multiple Arc ☐
		Other: ☐

CLEANING

Base Material: Power ☑ Hand ☐ | Weld: Power ☑ Hand ☐

JOINT DESIGN

BUTT WELD ☐ | FILLET WELD ☑



Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ **Polarity:** Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE		MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
				VOLTS	AMPS		
Root	1	E6010	1/8"	20-24	75-130	5	3-20
Hot Pass	1	E6010	1/8"	20-24	75-130	5	3-20
Fill	1	E6010	1/8"	20-24	75-130	5	3-20
Cap	1	E6010	1/8"	20-24	75-130	5	3-20

(Over)

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1							
2							
3							
4							

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
5	180 Degrees			Yes ☐ No ☐	
6	180 Degrees			Yes ☐ No ☐	
7	180 Degrees			Yes ☐ No ☐	
8	180 Degrees			Yes ☐ No ☐	
9		180 Degrees		Yes ☐ No ☐	
10		180 Degrees		Yes ☐ No ☐	
11		180 Degrees		Yes ☐ No ☐	
12		180 Degrees		Yes ☐ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☐ No ☐	
14	Yes ☐ No ☐	
15	Yes ☐ No ☐	
16	Yes ☐ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☑ No ☐		Penetration into Parent Metal: Yes ☑ No ☐	
Fillet Weld - Fracture Test FOUND ACCEPTABLE		Length of Percent of Defect	in.: NONE %:

WELDER INFO

Welder Name: Rusty Stutts	License Number & State	Stencil Mark
Contractor: CHC Fabricating		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.		
Welding Test Conducted By:		
Visual Examination Results:		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography):		
Mechanical Test Conducted By:		Laboratory Test No:
Approved By:		Organization:
APPROVED ☐	REJECTED ☐	Date:

REMARKS

APPROVAL

Engineer:		Date:
Weld Supervisor:		Date:
Director of Gas Engineering:		Date:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 10-1 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

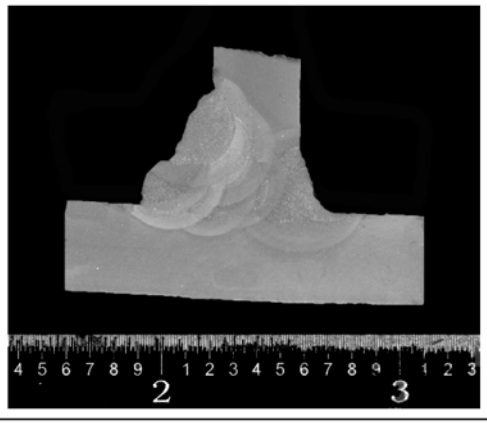
Welding Process: Manual SMAW
Pipe Material: 12.75" diameter, 0.375" thick API 5L X60 to 12.75" diameter, 0.375" thick API 5L X60
Joint Design: 3/32" land, 3/32" gap, 45 degree bevel branch groove
Position: 5G, Fixed **Welding Direction:** Downhill
Filler Metal: E6010 root, E7010-P1 remainder
Time Between Passes: 44 hours, 39 minutes between root and hot pass
Preheat Temperature: Ambient (52°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fill	Cap		
AWS Classification:	E6010	E7010-P1	E7010-P1	E7010-P1		
Manufacture:	Lincoln	Lincoln	Lincoln	Lincoln		
Electrode Diameter:	1/8"	5/32"	5/32"	5/32"		
Current/Polarity:	DCEP	DCEP	DCEP	DCEP		
Current Range:	83 – 106	113 – 120	110 – 118	100 – 115		
Voltage Range:	25 – 33	25 – 28	25 – 29	26 – 30		
Travel Speed Range, ipm:	3.2 – 5.5	3.4 – 5.5	3.7 – 6.8	3.2 – 7.0		

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 10-1 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:				
Coupon Width:				
Coupon Thickness:				
Coupon Area:				
Maximum Load:				
Tensile Strength:				
Fracture Location:				

BEND TEST

Coupon Number:								
Type:								
Results:								

NICK-BREAK TEST

Coupon Number:	W24 NB1	W24 NB2	W24 NB3	W24 NB4
Results:	Pass (1)	Pass	Pass (1)	Pass

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 10-3 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

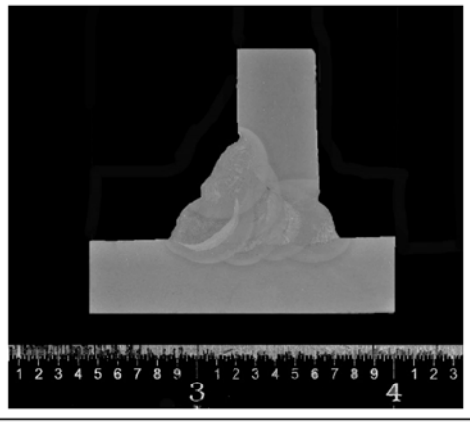
Welding Process: Manual SMAW
Pipe Material: 12.75" diameter, 0.375" thick API 5L X60 to 12.75" diameter, 0.375" thick API 5L X60
Joint Design: 3/32" land, 1/16" gap, 45 degree bevel branch groove
Position: 5G, Fixed **Welding Direction:** Downhill
Filler Metal: E6010 root, E8010-P1 remainder
Time Between Passes: 20 hours, 18 minutes between root and hot pass
Preheat Temperature: Ambient (74°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fill	Cap		
AWS Classification:	E6010	E8010-P1	E8010-P1	E8010-P1		
Manufacture:	Lincoln	Lincoln	Lincoln	Lincoln		
Electrode Diameter:	1/8"	5/32"	5/32"	5/32"		
Current/Polarity:	DCEP	DCEP	DCEP	DCEP		
Current Range:	75 – 98	115 – 123	117 – 133	116 – 122		
Voltage Range:	23 – 30	24 – 27	23 – 27	25 – 28		
Travel Speed Range, ipm:	3.2 – 5.5	3.4 – 5.6	3.8 – 9.3	3.3 – 6.2		

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 10-3 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:				
Coupon Width:				
Coupon Thickness:				
Coupon Area:				
Maximum Load:				
Tensile Strength:				
Fracture Location:				

BEND TEST

Coupon Number:								
Type:								
Results:								

NICK-BREAK TEST

Coupon Number:	W26 NB1	W26 NB2	W26 NB3	W26 NB4
Results:	Pass (1)	Pass	Pass (1)	Pass

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. F6-X60-280		Orig. Issue Date	Revision Date
	WPS No. FW-B-*II*		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Process Name: Shielded Metal Arc Welding (SMAW)		Type of Process: Manual	
	For: Butt Welding ☐	Fillet Welding ☑		
BASE METAL	Material Specification: 6.625" O.D. - X-60 - 0.280" WT. API 5L			
~~**DIAMETER**~~	~~API 1104 6.2.2 Guidelines~~	☐ ~~Under 2 3/8" OD~~	☐ ~~2 3/8" to 12 3/4" OD~~	☐ ~~> 12 3/4" OD~~
MATERIAL	API 1104 5.4.2.2 Guidelines	☐ ≤ 42,000 PSI Yield	☑ > 42,000 to < 65,000 PSI Yield	☐ ≥ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☐ Under 3/16" thick	☑ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: E6010	AWS Electrode Size: 1/8"	AWS Specification: A5.1	Filler Metal Group: 1
	AWS Electrode Nos: E7010	AWS Electrode Size: 1/8"	AWS Specification: A5.5	Filler Metal Group: 1
GAS	SHIELDING GAS: N/A	FLOW RATE: N/A	FLUX: N/A	
PREHEAT	Minimum Preheat Temperature (F): 50°	Interpass Temperature (F):	Other:	

POSITION

WELD AXIS			TECHNIQUE		DIRECTION	
Flat (1G, 1F, 1FR)	☐	Plate	☐	Backhand	☐	Vertical - Up	☐
Horizontal (2G, 2F, 2FR)	☐	Pipe	☑	Forehand	☑	Vertical - Down	☑
Vertical (3G, 3F)	☐	Rotated	☐				
Overhead (4G, 4F)	☐	Fixed	☑				
Multiple (5G, 5F)	☑	Inclined (6G, 6F)	☐				
Combination	☐						

TECHNIQUE

DISPOSITION STYLE		METHOD		ARC TYPE		
Stringer Beads	☑	Multiple Pass	☑	Single Arc	☑	Other: ☐
Weave Beads	☐	Single Pass	☐	Multiple Arc	☐	

CLEANING

Base Material: Power ☑ Hand ☐ | Weld: Power ☑ Hand ☐

JOINT DESIGN

BUTT WELD ☐ FILLET WELD ☑

Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ **Polarity:** Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE VOLTS	RANGE AMPS	MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
Root	1	E6010	1/8"	19-24	75-130	5	3-20
Hot Pass	1	E7010	1/8"	18-22	65-140	5	3-20
Fill	1	E7010	1/8"	18-22	65-140	5	3-20
Cap	1	E7010	1/8"	18-24	65-140	5	3-20

(Over)

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1							
2							
3							
4							

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
5	180 Degrees			Yes ☐ No ☐	
6	180 Degrees			Yes ☐ No ☐	
7	180 Degrees			Yes ☐ No ☐	
8	180 Degrees			Yes ☐ No ☐	
9		180 Degrees		Yes ☐ No ☐	
10		180 Degrees		Yes ☐ No ☐	
11		180 Degrees		Yes ☐ No ☐	
12		180 Degrees		Yes ☐ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☐ No ☐	
14	Yes ☐ No ☐	
15	Yes ☐ No ☐	
16	Yes ☐ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☑ No ☐		Penetration into Parent Metal: Yes ☑ No ☐	
Fillet Weld - Fracture Test FOUND ACCEPTABLE		Length of Percent of Defect	in.: NONE %:

WELDER INFO

Welder Name: Rusty Stutts	License Number & State	Stencil Mark
Contractor: CHC Fabricating		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By:		
Visual Examination Results:		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography):		
Mechanical Test Conducted By:		Laboratory Test No:
Approved By:		Organization:
APPROVED ☐	REJECTED ☐	Date:

REMARKS

APPROVAL

Engineer:		Date:
Weld Supervisor:		Date:
Director of Gas Engineering:		Date:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 11-1 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

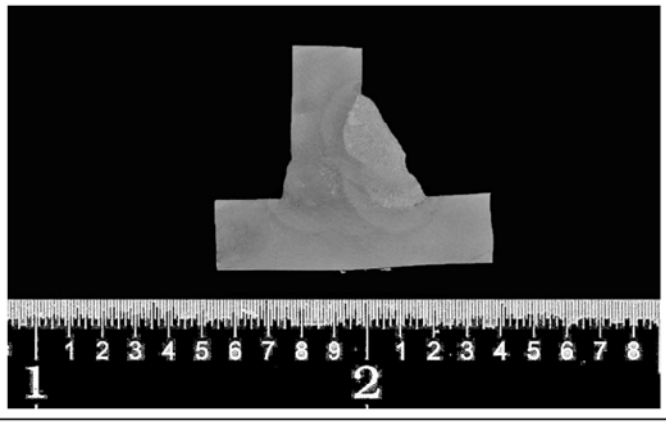
Welding Process: Manual SMAW
Pipe Material: 6.625" diameter, 0.280" thick API 5L X65 to 6.625" diameter, 0.280" thick API 5L X65
Joint Design: 3/32" land, 3/32" gap, 45 degree bevel branch groove
Position: 5G, Fixed **Welding Direction:** Downhill
Filler Metal: E6010 root, E8010-P1 remainder
Time Between Passes: 3 hours, 14 minutes between root and hot pass
Preheat Temperature: Ambient (61°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Cap			
AWS Classification:	E6010	E8010-P1	E8010-P1			
Manufacture:	Lincoln	Lincoln	Lincoln			
Electrode Diameter:	1/8"	5/32"	5/32"			
Current/Polarity:	DCEP	DCEP	DCEP			
Current Range:	82 – 89	113 – 122	118 – 121			
Voltage Range:	25 – 29	24 – 28	24 – 26			
Travel Speed Range, ipm:	3.7 – 4.8	4.7 – 6.9	4.9 – 6.7			

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 11-1 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:				
Coupon Width:				
Coupon Thickness:				
Coupon Area:				
Maximum Load:				
Tensile Strength:				
Fracture Location:				

BEND TEST

Coupon Number:								
Type:								
Results:								

NICK-BREAK TEST

Coupon Number:	W28 NB1	W28 NB2	W28 NB3	W28 NB4
Results:	Pass	Pass (1)	Pass	Pass

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments: (1) Indications were present but were within the acceptable limits of API 1104

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY.

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. F8-X65-322		Orig. Issue Date	Revision Date
	WPS No. FW-C-II		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Process Name: Shielded Metal Arc Welding (SMAW)		Type of Process: Manual	
	For: Butt Welding ☐	Fillet Welding ☑		
PIPE	Material Specification: 8.625" O.D.- X-65- 0.322" WT. API 5L			
~~**DIAMETER**~~	~~API 1104 6.2.2 Guidelines~~	☐ ~~Under 2-3/8" OD~~	☐ ~~2-3/8" to 12-3/4" OD~~	☐ ~~>12-3/4" OD~~
MATERIAL	API 1104 5.4.2.2 Guidelines	☐ ≤ 42,000 PSI Yield	☐ > 42,000 to < 65,000 PSI Yield	☑ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☐ Under 3/16" thick	☑ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: E6010	AWS Electrode Size: 3/32"	AWS Specification: A5.1	Filler Metal Group: 1
	AWS Electrode Nos: E8010	AWS Electrode Size: 1/8"	AWS Specification: A5.5	Filler Metal Group: 2
GAS	SHIELDING GAS: N/A	FLOW RATE: N/A	FLUX: N/A	
PREHEAT	Minimum Preheat Temperature (F): 50°	Interpass Temperature (F):	Other:	

POSITION

WELD AXIS			TECHNIQUE		DIRECTION	
Flat (1G, 1F, 1FR)	☐	Plate ☐	Backhand	☐	Vertical - Up	☐
Horizontal (2G, 2F, 2FR)	☐	Pipe ☑	Forehand	☑	Vertical - Down	☑
Vertical (3G, 3F)	☐	Rotated ☐				
Overhead (4G, 4F)	☐	Fixed ☑				
Multiple (5G, 5F)	☑	Inclined (6G, 6F) ☐				
Combination	☐					

TECHNIQUE

DISPOSITION STYLE		METHOD		ARC TYPE		
Stringer Beads	☑	Multiple Pass	☑	Single Arc	☑	Other: ☐
Weave Beads	☐	Single Pass	☐	Multiple Arc	☐	

CLEANING	Base Material: Power ☑	Hand ☐	Weld: Power ☑	Hand ☐	
JOINT DESIGN	BUTT WELD ☐		FILLET WELD ☑		

Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ **Polarity:** Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE VOLTS	RANGE AMPS	MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
Root	1	E6010	1/8"	20-24	75-130	5	3-20
Hot Pass	1	E8010	1/8"	21-24	75-135	5	3-20
Fill	2	E8010	1/8"	20-24	75-135	5	3-20
Cap	1	E8010	1/8"	20-24	75-135	5	3-20

(Over)

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1							
2							
3							
4							

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
5	180 Degrees			Yes ☐ No ☐	
6	180 Degrees			Yes ☐ No ☐	
7	180 Degrees			Yes ☐ No ☐	
8	180 Degrees			Yes ☐ No ☐	
9		180 Degrees		Yes ☐ No ☐	
10		180 Degrees		Yes ☐ No ☐	
11		180 Degrees		Yes ☐ No ☐	
12		180 Degrees		Yes ☐ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☐ No ☐	
14	Yes ☐ No ☐	
15	Yes ☐ No ☐	
16	Yes ☐ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☑ No ☐		Penetration into Parent Metal:	Yes ☑ No ☐
Fillet Weld - Fracture Test FOUND ACCEPTABLE		Length of Percent of Defect	in.: NONE %:

WELDER INFO

Welder Name: Rusty Stutts	License Number & State	Stencil Mark
Contractor: CHC Fabricating		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By:		
Visual Examination Results:		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography):		
Mechanical Test Conducted By:		Laboratory Test No:
Approved By:		Organization:
APPROVED ☐	REJECTED ☐	Date:

REMARKS

APPROVAL

Engineer:		Date:
Weld Supervisor:		Date:
Director of Gas Engineering:		Date:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 12-1 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeff Ellis, Piedmont Natural Gas

Welding Process: Manual SMAW
Pipe Material: 24" diameter, 0.375" thick API 5L X70 to 2.375" diameter, 0.700" thick F70
Joint Design: 3/32" land, 3/32" gap, 45 degree bevel branch groove
Position: 5G, Fixed **Welding Direction:** Downhill
Filler Metal: E6010 root, E8010-P1 remainder
Time Between Passes: 24 hours between root and hot pass
Preheat Temperature: Ambient (65°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fill	Cap		
AWS Classification:	E6010	E8010-P1	E8010-P1	E8010-P1		
Manufacture:	Lincoln	Lincoln	Lincoln	Lincoln		
Electrode Diameter:	1/8"	5/32"	5/32"	5/32"		
Current/Polarity:	DCEP	DCEP	DCEP	DCEP		
Current Range:	88 – 106	106 – 109	117 – 145	114 – 124		
Voltage Range:	23 – 27	28 – 29	25 – 28	24 – 27		
Travel Speed Range, ipm:	5.1 – 14.9	8.2 – 9.6	6.6 – 10.6	5.3 – 6.9		

Comments:

FIGURE 1 – BEAD SEQUENCE

DUKE ENERGY

Test Number: 12-1 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:				
Coupon Width:				
Coupon Thickness:				
Coupon Area:				
Maximum Load:				
Tensile Strength:				
Fracture Location:				

BEND TEST

Coupon Number:								
Type:								
Results:								

NICK-BREAK TEST

Coupon Number:	W29 NB1	W29 NB2	W29 NB3	W29 NB4
Results:	Pass	Pass	Pass	Pass

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments:

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

DUKE ENERGY

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: 13-1 **Date:** 10/16/2014
Location: Kiefner, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

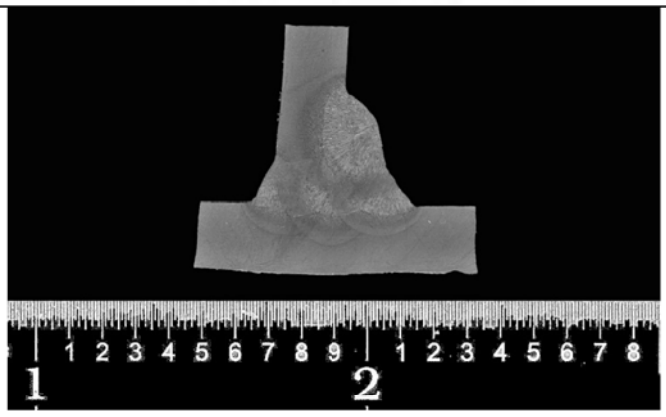
Welding Process: Manual SMAW
Pipe Material: 6.625" diameter, 0.280" thick API 5L X42 to 6.625" diameter, 0.280" thick API 5L X42
Joint Design: 3/32" land, 3/32" gap, 45 degree bevel branch groove
Position: 5G, Fixed **Welding Direction:** Uphill
Filler Metal: E7016 root, E7018 remainder
Time Between Passes: 3 hours, 15 minutes between root and hot pass
Preheat Temperature: Ambient (65°F) **Interpass Temperature:** NR
Post-weld Heat Treatment: None
Line-up Clamps: None used
Comments:

WELDING PARAMETERS

Pass:	Root	Hot Pass	Cap			
AWS Classification:	E7016	E7018	E7018			
Manufacture:	Lincoln	Lincoln	Lincoln			
Electrode Diameter:	3/32"	1/8"	1/8"			
Current/Polarity:	DCEP	DCEP	DCEP			
Current Range:	75 – 81	99 – 102	100 – 104			
Voltage Range:	21 – 25	20 – 22	20 – 22			
Travel Speed Range, ipm:	2.7 – 5.6	2.2 – 3.6	2.4 – 4.9			

Comments:

FIGURE 1 – BEAD SEQUENCE



DUKE ENERGY

Test Number: 13-1 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:				
Coupon Width:				
Coupon Thickness:				
Coupon Area:				
Maximum Load:				
Tensile Strength:				
Fracture Location:				

BEND TEST

Coupon Number:								
Type:								
Results:								

NICK-BREAK TEST

Coupon Number:	W30 NB1	W30 NB2	W30 NB3	W30 NB4
Results:	Pass	Pass	Pass	Pass

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy:						
% Shear:						
Lateral Expansion:						

Comments:

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 10/16/2014

Test Conducted By: Jim Winigman, Kiefner

Certified By: Matt Boring, P.E., CWI, CEng, Kiefner

Approved By:

Piedmont Natural Gas

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: N16-02081 **Date:** 10-07-16
Location:
Welder: Jeff A Ellis

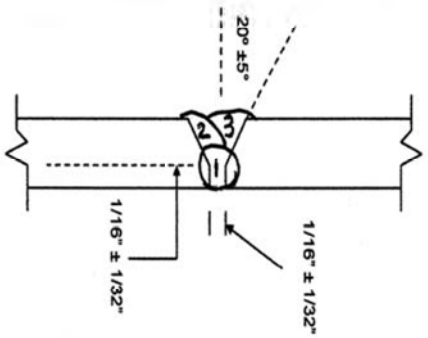
Welding Process: SMAW – Stringer Bead
Pipe Material: ASTM A572 Gr. 50 (Sleeve) to ASTM A135/795 Gr. A (Carrier Pipe)
Joint Design: Single "V" Butt Weld
Position: Horizontal (Fixed) **Welding Direction:** Horizontal
Filler Metal: Lincoln Fleetweld® 5P – E6010
Time Between Passes: 12 Minutes
Preheat Temperature: Ambient (65°F - 70°F) **Interpass Temperature:** 80°F
Post-weld Heat Treatment: N/A
Line-up Clamps: Yes
Comments:

WELDING PARAMETERS

Pass:	1	2	3			
AWS Classification:	A5.1	A5.1	A5.1			
Manufacture:	Lincoln	Lincoln	Lincoln			
Electrode Diameter:	1/8"	3/32"	3/32"			
Current/Polarity:	DCRP	DCRP	DCRP			
Current Range:	72 - 75	75 - 80	80 - 84			
Voltage Range:	20 - 22	22 - 24	24 -26			
Travel Speed Range, ipm:	6 - 12 IPM	4 - 8 IPM	4 - 8 IPM			

Comments:

FIGURE 1 – BEAD SEQUENCE



Piedmont Natural Gas

Test Number: N16-02081 **Page:** 2 of 2

TENSILE STRENGTH TEST

Coupon Number:	1	2		
Coupon Width:	1.00"	1.00"		
Coupon Thickness:	0.186"	0.184"		
Coupon Area:	0.186"	0.184"		
Maximum Load:	13,600	13,300		
Tensile Strength:	73,118	72,282		
Fracture Location:	Base Material	Base Material		

BEND TEST

Coupon Number:	1	2	3	4				
Type:	Face	Face	Root	Root				
Results:	Accept	Accept	Accept	Accept				

NICK-BREAK TEST

Coupon Number:	NB-1	NB-2		
Results:	Accept	Accept		

CHARPY TOUGHNESS TEST

Coupon Number:						
Depth:						
Width:						
Notch Location:						
Test Temperature:						
Impact Energy: (1)						
% Shear:						
Lateral Expansion:						

Comments:

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 11-03-16

Test Conducted By: David P. Hawkins (SCWI 14090058)

Certified By: David P. Hawkins (SCWI 14090058)

Approved By:

Piedmont Natural Gas

API 1104 COUPON TEST REPORT

Page: 1 of 2

Test Number: N16-02081 **Date:** 10-07-16
Location: 112 Verbena St., Charlotte NC
Welder: Jeff A Ellis

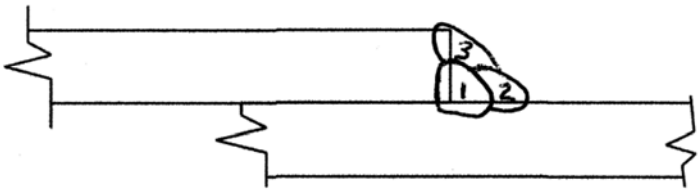
Welding Process: SMAW – Stringer Bead
Pipe Material: ASTM A572 Gr. 50 (Sleeve) to ASTM A135/795 Gr. A (Carrier Pipe)
Joint Design: Single "V" Butt Weld
Position: Horizontal (Fixed) **Welding Direction:** Horizontal
Filler Metal: Lincoln Fleetweld® 5P – E6010
Time Between Passes: 12 Minutes
Preheat Temperature: Ambient (65°F - 70°F) **Interpass Temperature:** 80°F
Post-weld Heat Treatment: N/A
Line-up Clamps: External
Comments:

WELDING PARAMETERS

Pass:	1	2	3			
AWS Classification:	A5.1	A5.1	A5.1			
Manufacture:	Lincoln	Lincoln	Lincoln			
Electrode Diameter:	1/8"	3/32"	3/32"			
Current/Polarity:	DCRP	DCRP	DCRP			
Current Range:	72 - 75	75 - 80	80 - 84			
Voltage Range:	20 - 22	22 - 24	24 -26			
Travel Speed Range, ipm:	6 - 12 IPM	4 - 8 IPM	4 - 8 IPM			

Comments:

FIGURE 1 – BEAD SEQUENCE



Piedmont Natural Gas

Test Number: N16-02081 **Page:** 2 of 2

BEND TEST

Coupon Number:	1	2	3	4				
Type:	Face	Face	Face	Face				
Results:	Accept	Accept	Accept	Accept				

NICK-BREAK TEST

Coupon Number:	NB-1	NB-2	NB-3	NB-4
Results:	Accept	Accept	Accept	Accept

MACRO-ETCH TEST

Coupon Number:	ME-1	ME-2	ME-3	ME-4
Results:	Accept	Accept	Accept	Accept

Weld Hardness Test

Coupon 1	Koop (HK)	Vickers (HV)	**Coupon 2**	Koop (HD)	Vickers (HV)
A	180	165	A	196	180
B	213	200	B	178	162
C	209	195	C	176	162
D	184	169	D	192	176
E	209	195	E	178	162
Average:	199	185	**Average:**	184	168

Comments: Results were converted from Knoop 500-gram load to Vickers using ASTM E140

OTHER TESTS

Test Type:

Results:

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104.

Date: 11-03-16

Test Conducted By: David P. Hawkins (SCWI 14090058)

Certified By: David P. Hawkins (SCWI 14090058)

Approved By:

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 25CLH-B-1 **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 24 inch O.D., 0.375 inch wall, API 5L X70, 0.33 C.E. (IIW) pipe
Branch Material: 12.75 inch O.D., 0.375 inch wall, API 5L X42, 0.31 C.E. (IIW) pipe
Joint Design: Branch-groove and fillet weld with a 3/32 inch gap, 1/16 inch land and 45° bevel on the branch
Position: 5G, branch and pipe **Welding Direction:** Downhill-Root/Uphill-Rem.
Time Between Passes: 17 minutes between the root and hot pass, 3 hours to finish the weld
Preheat Temperature: Ambient (67°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Oil
Test Medium Temperature: 75 – 85°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Oil was not pressurized

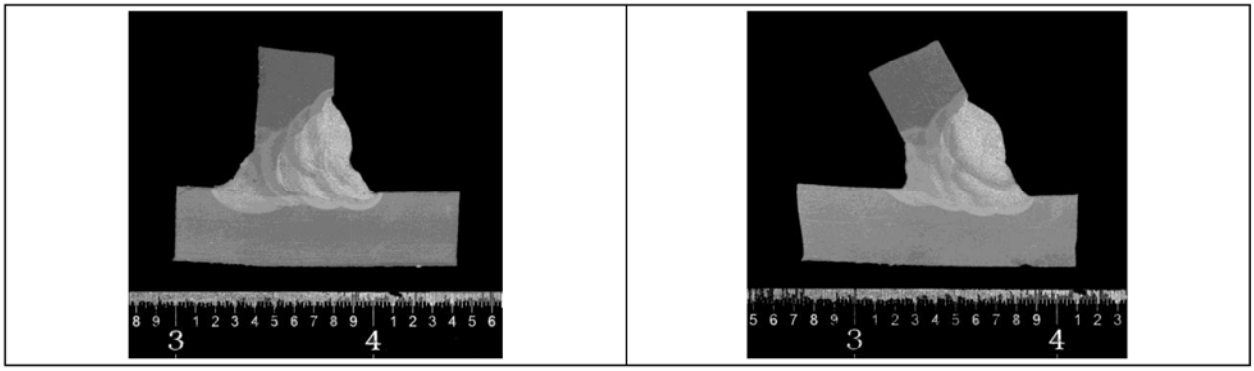
WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Caps
AWS Classification:	E6010	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	Lincoln	ESAB	ESAB	ESAB
Electrode Diameter (in.):	1/8	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	80 – 103	91 – 93	90 – 100	89 – 91
Voltage Range (volts):	23 – 32	22 – 25	21 – 26	21 – 24
Travel Speed Range (ipm):	2.1 – 7.9	4.3 – 6.0	4.1 – 7.0	4.2 – 5.5
Heat Input Range (kJ/in.):	17.9 – 73.3	21.8 – 30.6	16.4 – 32.4	22.0 – 29.4
Ave. Heat Input (kJ/in.):	43.6	26.8	25.7	26.4

Kiefner DNV·GL

Test Number: 25CLH-B-1 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	25CLH-B-1 FB3	25CLH-B-1 FB6	25CLH-B-1 FB9	25CLH-B-1 FB12
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	25CLH-B-1 NB3	25CLH-B-1 NB6	25CLH-B-1 NB9	25CLH-B-1 NB12
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	25CLH-B-1 M3	25CLH-B-1 M6	25CLH-B-1 M9	25CLH-B-1 M12
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	25CLH-B-1 M3	25CLH-B-1 M12
Max. Hardness (1):	291.6	303.7
Ave. Hardness (2):	267.1	292.0
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 35LH **Date:** 9/15/2014
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.375 inch wall, A516 Grade 70, 0.35 C.E. (IIW) plate
Branch Material: 0.375 inch wall, A516 Grade 70, 0.35 C.E. (IIW) plate
Joint Design: Branch-groove and fillet weld with a 1/8 gap, 3/32 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 17 minutes between the root and hot pass, 1 hour to finish the weld
Preheat Temperature: Ambient (71°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized
Comments: Measured heat sink capacity time of 11, 10, 11, 10.5, 11.5 and 12 seconds

WELDING PARAMETERS

Pass:	Root	Hot Pass	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP
Current Range (amps):	85 – 89	89 – 90	89
Voltage Range (volts):	22 – 25	21 – 24	22 – 24
Travel Speed Range (ipm):	2.9 – 3.8	4.1 – 4.9	4.1 – 5.6
Heat Input Range (kJ/in.):	30.3 – 44.7	24.5 – 29.0	21.1 – 29.8
Average Heat Input (kJ/in.):	36.2	27.0	25.7

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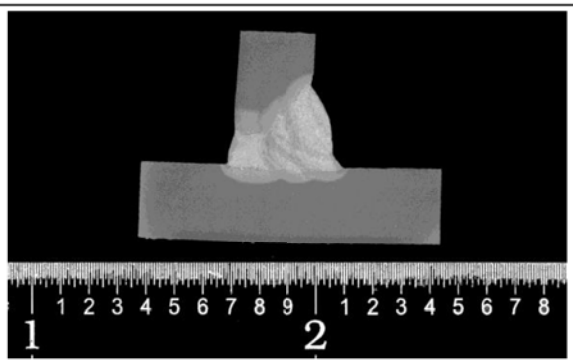
Test Number: 35LH **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	35LH FB1	35LH FB2	35LH FB3	35LH FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	35LH NB1	35LH NB2	35LH NB3	35LH NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	35LH M1	35LH M2	35LH M3	35LH M4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	35LH M2	35LH M4
Max. Hardness (1):	336.9	348.9
Ave. Hardness (2):	324.6	337.7
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 9/15/2014
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 35LH-BW **Date:** 9/15/2014
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.375 inch wall, A516 Grade 70, 0.35 C.E. (IIW) plate
Branch Material: 0.375 inch wall, A516 Grade 70, 0.35 C.E. (IIW) plate
Joint Design: Branch-groove and fillet weld with a 3/32 inch gap, 3/32 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 16 minutes between the root and hot pass, 1 hour to finish the weld
Preheat Temperature: Ambient (80°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized
Comments: Measured heat sink capacity time of 11, 10, 11, 10.5, 11.5 and 12 seconds

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	82 – 90	90 – 99	89 – 90	89
Voltage Range (volts):	20 – 25	23 – 26	21 – 23	21 – 23
Travel Speed Range (ipm):	4.0 – 5.2	3.8 – 5.0	3.7 – 5.3	4.1 – 5.5
Heat Input Range (kJ/in.):	21.7 – 33.2	30.5 – 34.2	22.1 – 32.2	20.8 – 28.8
Average Heat Input (kJ/in.):	26.8	33.1	27.1	25.5
Comments:	The root pass was a back weld and was deposited as the first pass			

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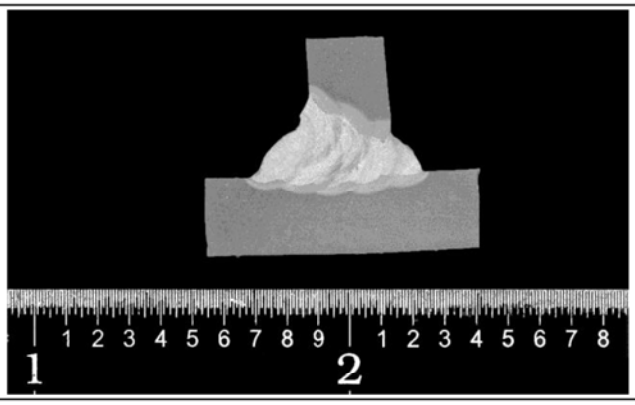
Test Number: 35LH-BW **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	35LH-BW FB1	35LH-BW FB2	35LH-BW FB3	35LH-BW FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	35LH-BW NB1	35LH-BW NB2	35LH-BW NB3	35LH-BW NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	35LH-BW M1	35LH-BW M2	35LH-BW M3	35LH-BW M4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	35LH-BW M2	35LH-BW M4
Max. Hardness (1):	342.2	367.6
Ave. Hardness (2):	326.4	346.5

Comments: (1) Maximum hardness of a single indent
(2) Average of five indents at weld toe

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 9/15/2014
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 48LH **Date:** 9/15/2014
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.375 inch wall, A516 Grade 70, 0.35 C.E. (IIW) plate
Branch Material: 0.250 inch wall, A516 Grade 70, 0.48 C.E. (IIW) plate
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap, 3/32 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 15 minutes between the root and hot pass, 1 hour to finish the weld
Preheat Temperature: Ambient (83°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized
Comments: Measured heat sink capacity time of 11, 10, 11, 10.5, 11.5 and 12 seconds

WELDING PARAMETERS

Pass:	Root	Hot Pass	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP
Current Range (amps):	88 – 94	87 – 92	83 – 84
Voltage Range (volts):	22 – 26	22 – 24	22 – 23
Travel Speed Range (ipm):	2.6 – 3.8	3.7 – 5.2	3.4 – 5.5
Heat Input Range (kJ/in.):	31.2 – 56.8	24.0 – 35.1	25.2 – 33.7
Average Heat Input (kJ/in.):	43.3	28.3	28.3

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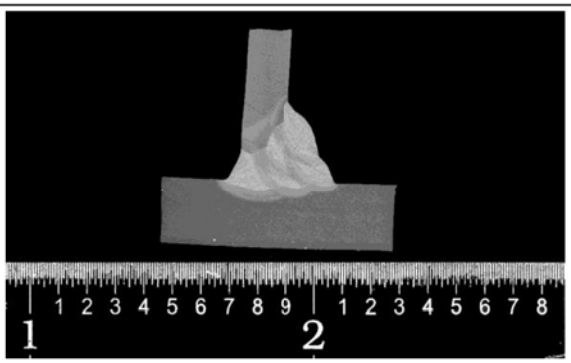
Test Number: 48LH **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	48LH FB1	48LH FB2	48LH FB3	48LH FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	48LH NB1	48LH NB2	48LH NB3	48LH NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	48LH M1	48LH M2	48LH M3	48LH M4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	48LH M2	48LH M4
Max. Hardness (1):	299.9	322.9
Ave. Hardness (2):	270.3	303.6
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 9/15/2014

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 42LH-O **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.375 inch wall, A516 Grade 70, 0.42 C.E. (IIW) plate
Branch Material: 0.375 inch wall, A516 Grade 70, 0.42 C.E. (IIW) plate
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap, 3/32 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 13 minutes between the root and hot pass, 1 hour to finish the weld
Preheat Temperature: Ambient (82°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Oil
Test Medium Temperature: 75 – 85°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Oil was not pressurized
Comments: Measured heat sink capacity time of 45, 48, 53, 55 and 49 seconds

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	86 – 90	91 – 92	90 – 94	89 – 92
Voltage Range (volts):	23 – 26	22 – 24	22 – 25	22 – 23
Travel Speed Range (ipm):	2.9 – 3.2	4.1 – 5.2	4.0 – 4.9	4.5 – 5.6
Heat Input Range (kJ/in.):	38.7 – 44.8	24.1 – 30.9	25.8 – 32.7	21.6 – 28.0
Average Heat Input (kJ/in.):	42.6	27.9	28.0	24.8

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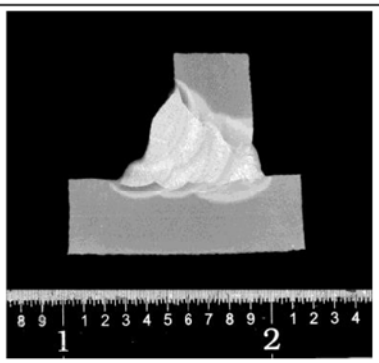
Test Number: 42LH-O **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	42LH-O FB1	42LH-O FB2	42LH-O FB3	42LH-O FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	42LH-O NB1	42LH-O NB2	42LH-O NB3	42LH-O NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	42LH-O NB1	42LH-O NB2	42LH-O NB3	42LH-O NB4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	42LH-O M2	42LH-O M4
Max. Hardness (1):	387.4	370.4
Ave. Hardness (2):	374.3	360.9
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 40LH-B-1 **Date:** 4/3/2014
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 24 inch O.D., 0.375 inch wall, A106 Grade B, 0.30 C.E. (IIW) pipe
Branch Material: 12.75 inch O.D., 0.375 inch wall, A106 Grade B, 0.31 C.E. (IIW) pipe
Joint Design: Branch-groove and fillet weld with a 3/32 inch gap, 3/32 inch land and 45° bevel on the branch
Position: 5G, branch and pipe **Welding Direction:** Uphill
Time Between Passes: 104 minutes between the root and hot pass, 3 hours to finish the weld
Preheat Temperature: Ambient (39°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized

WELDING PARAMETERS

Pass:	Root	Hot Pass	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP
Current Range (amps):	84 – 90	93 – 94	93 – 94
Voltage Range (volts):	22 – 26	23 – 25	22 – 26
Travel Speed Range (ipm):	2.0 – 3.5	2.5 – 3.8	2.6 – 4.0
Heat Input Range (kJ/in.):	35.4 – 69.3	34.3 – 53.2	33.1 – 52.8
Ave. Heat Input (kJ/in.):	48.5	39.0	41.2

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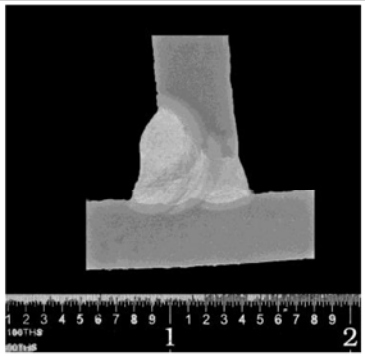
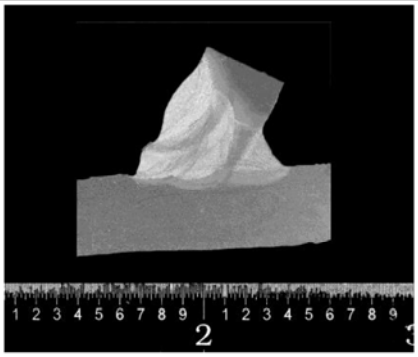
Test Number: 40LH-B-1 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE





BEND TEST

Coupon Number:	40LH-B-1 FB3	40LH-B-1 FB6	40LH-B-1 FB9	40LH-B-1 FB12
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	40LH-B-1 NB3	40LH-B-1 NB6	40LH-B-1 NB9	40LH-B-1 NB12
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	40LH-B-1 M3	40LH-B-1 M6	40LH-B-1 M9	40LH-B-1 M12
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST, 10 kg

Coupon Number:	40LH-B-1 M3	40LH-B-1 M12
Max. Hardness (1):	260.0	295.4
Ave. Hardness (2):	239.3	282.2

Comments: (1) Maximum hardness of a single indent

(2) Average of five indents at weld toe

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 4/3/2014

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 42LH **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.375 inch wall, A516 Grade 70, 0.42 C.E. (IIW) plate
Branch Material: 0.375 inch wall, A516 Grade 70, 0.42 C.E. (IIW) plate
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap, 3/32 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 15 minutes between the root and hot pass, 1 hour to finish the weld
Preheat Temperature: Ambient (48°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized
Comments: Measured heat sink capacity time of 11, 10, 11, 10.5, 11.5 and 12 seconds

WELDING PARAMETERS

Pass:	Root	Hot Pass	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP
Current Range (amps):	85 – 93	88 – 89	88 – 94
Voltage Range (volts):	23 – 25	22 – 23	22 – 24
Travel Speed Range (ipm):	3.0 – 3.6	2.9 – 3.3	2.9 – 3.5
Heat Input Range (kJ/in.):	35.5 – 43.6	36.3 – 41.8	34.6 – 42.7
Average Heat Input (kJ/in.):	38.7	39.0	39.5

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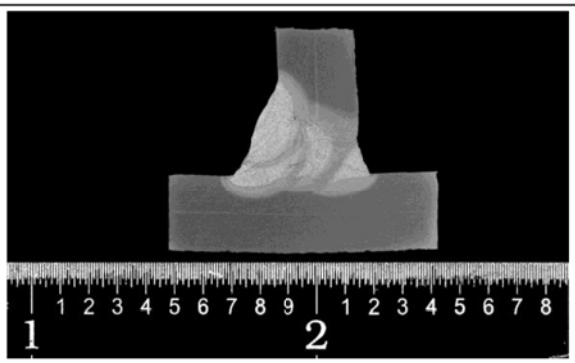
Test Number: 42LH **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	42LH FB1	42LH FB2	42LH FB3	42LH FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	42LH NB1	42LH NB2	42LH NB3	42LH NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	42LH M1	42LH M2	42LH M3	42LH M4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	42LH M2	42LH M4
Max. Hardness (1):	372.2	366.0
Ave. Hardness (2):	349.2	327.0

Comments: (1) Maximum hardness of a single indent
(2) Average of five indents at weld toe

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 42LH-BW **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.375 inch wall, A516 Grade 70, 0.42 C.E. (IIW) plate
Branch Material: 0.375 inch wall, A516 Grade 70, 0.42 C.E. (IIW) plate
Joint Design: Branch-groove and fillet weld with a 3/32 inch gap, 3/32 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 22 minutes between the root and hot pass, 1 hour to finish the weld
Preheat Temperature: Ambient (47°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 - 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized
Comments: Measured heat sink capacity time of 11, 10, 11, 10.5, 11.5 and 12 seconds

WELDING PARAMETERS

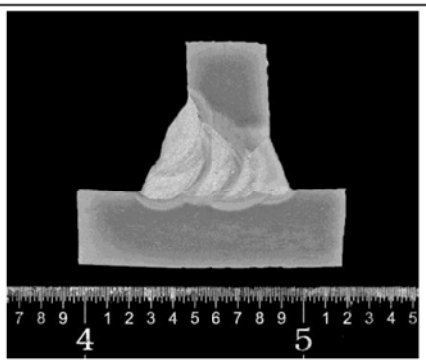
Pass:	Root	Hot Pass	Fill	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	69 – 75	85 – 89	83 – 84	83 – 92
Voltage Range (volts):	21 – 23	22 – 25	22 – 24	22 – 24
Travel Speed Range (ipm):	2.1 – 2. 8	2.7 – 3.8	2.5 – 2.8	2.6 – 3.4
Heat Input Range (kJ/in.):	35.5 – 44.4	33.2 – 45.0	40.3 – 44.9	32.4 – 43.8
Average Heat Input (kJ/in.):	38.0	39.0	42.6	38.7

Comments: The root pass was a back weld and was deposited as the first pass

Kiefner DNV·GL

Test Number: 42LH-BW **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	42LH-BW FB1	42LH-BW FB2	42LH-BW FB3	42LH-BW FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	42LH-BW NB1	42LH-BW NB2	42LH-BW NB3	42LH-BW NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	42LH-BW M1	42LH-BW M2	42LH-BW M3	42LH-BW M4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	42LH-BW M2	42LH-BW M4
Max. Hardness (1):	392.9	374.7
Ave. Hardness (2):	381.2	339.2
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 50LH-O **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.250 inch wall, API 5L X52, 0.52 C.E. (IIW) pipe flattened into plate
Branch Material: 0.250 inch wall, API 5L X52, 0.52 C.E. (IIW) pipe flattened into plate
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap, 3/32 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 15 minutes between the root and hot pass, 1 hour to finish the weld
Preheat Temperature: Ambient (77°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Oil
Test Medium Temperature: 75 – 85°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Oil was not pressurized
Comments: The heat sink capacity time was not measured

WELDING PARAMETERS

Pass:	Root	Hot Pass	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP
Current Range (amps):	82 – 87	82 – 83	83 – 85
Voltage Range (volts):	23 – 25	21 – 24	21 – 23
Travel Speed Range (ipm):	2.5 – 3.4	2.6 – 2.9	2.7 – 3.6
Heat Input Range (kJ/in.):	38.2 – 45.6	39.6 – 41.3	30.2 – 40.6
Average Heat Input (kJ/in.):	42.9	40.5	36.7

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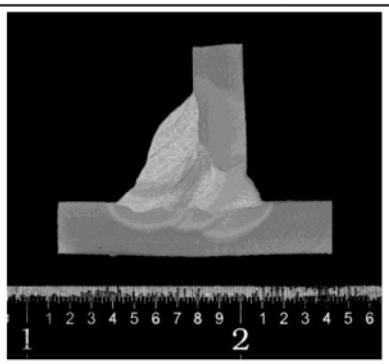
Test Number: 50LH-O **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	50LH-O FB1	50LH-O FB2	50LH-O FB3	50LH-O FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	50LH-O NB1	50LH-O NB2	50LH-O NB3	50LH-O NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	50LH-O M1	50LH-O M2	50LH-O M3	50LH-O M4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	50LH-O M2	50LH-O M4
Max. Hardness (1):	297.7	290.3
Ave. Hardness (2):	285.7	274.9
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: TBLH-B-1 **Date:** 4/3/2014
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 24 inch O.D., 0.375 inch wall, A106 Grade B, 0.30 C.E. (IIW) pipe
Branch Material: 12.75 inch O.D., 0.375 inch wall, A106 Grade B, 0.31 C.E. (IIW) pipe
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap, 3/32 inch land and 45° bevel on the branch
Position: 5G, branch and pipe **Welding Direction:** Uphill
Time Between Passes: 35 minutes between the root and hot pass, 6 hours to finish the weld
Preheat Temperature: Ambient (41°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized

WELDING PARAMETERS

Pass:	Butter Layer	Temper Layer	Root	Hot Pass	Fills	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	88 – 89	87 – 88	79 – 92	88	88	87 – 88
Voltage Range (volts):	22 – 25	22 – 24	22 – 26	22 – 23	22 – 24	22 – 25
Travel Speed Range (ipm):	6.8 – 10.3	4.0 – 6.2	2.0 – 3.6	3.9 – 5.2	4.1 – 6.5	4.0 – 5.6
Heat Input Range (kJ/in.):	12.0 – 17.3	20.2 – 30.2	32.1 – 63.8	22.9 – 31.0	18.6 – 28.9	22.1 – 29.3
Ave. Heat Input (kJ/in.):	15.1	24.8	48.8	28.0	23.5	25.2

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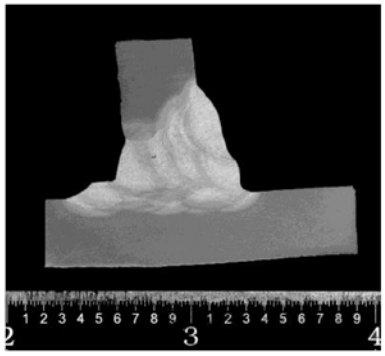
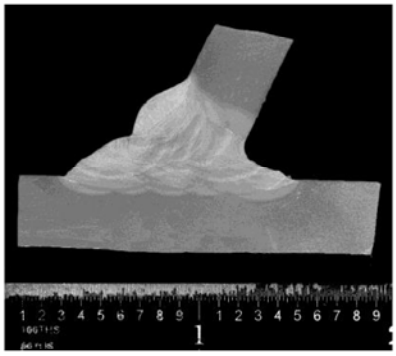
Test Number: TBLH-B-1 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE





BEND TEST

Coupon Number:	TBLH-B-1 FB3	TBLH-B-1 FB6	TBLH-B-1 FB9	TBLH-B-1 FB12
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	TBLH-B-1 NB3	TBLH-B-1 NB6	TBLH-B-1 NB9	TBLH-B-1 NB12
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	TBLH-B-1 M3	TBLH-B-1 M6	TBLH-B-1 M9	TBLH-B-1 M12
Results:	Pass	Pass	Pass	Pass
Max. Toe Spacing:	0.100 inch	0.098 inch	0.088 inch	0.080 inch

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	TBLH-B-1 M3	TBLH-B-1 M12
Max. Hardness (1):	278.5	289.6
Ave. Hardness (2):	259.1	249.1

Comments: (1) Maximum hardness of a single indent

(2) Average of five indents at weld toe

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 4/3/2014

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 50LH-2 **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.250 inch wall, API 5L X52, 0.51 C.E. (IIW) pipe flattened into plate
Branch Material: 0.250 inch wall, API 5L X52, 0.51 C.E. (IIW) pipe flattened into plate
Joint Design: Branch-groove and fillet weld with a 3/32 inch gap, 3/32 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 15 minutes between the root and hot pass, 1 hours to finish the weld
Preheat Temperature: Ambient (44°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized
Comments: The heat sink capacity time was not measured

WELDING PARAMETERS

Pass:	Butter Layer	Temper Layer	Root	Hot Pass	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	87 – 89	87 – 89	79 – 80	90	89 – 90
Voltage Range (volts):	21 – 23	21 – 23	22 – 24	21 – 23	21 – 23
Travel Speed Range (ipm):	6.9 – 11.0	4.4 – 6.3	2.9 – 3.8	4.3 – 4.5	4.4 – 5.3
Heat Input Range (kJ/in.):	10.6 – 17.9	19.0 – 26.7	29.6 – 38.9	26.0 – 27.9	22.5 – 27.0
Average Heat Input (kJ/in.):	14.9	23.3	34.7	26.9	24.0

Comment: A block welding sequence was used

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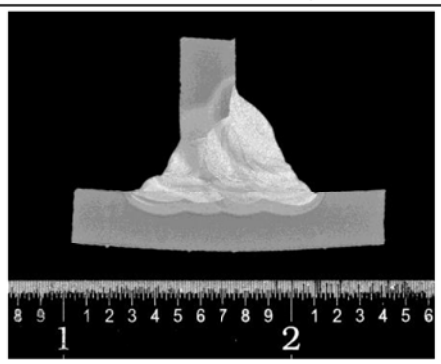
Test Number: 50LH-2 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	50LH-2 FB1	50LH-2 FB2	50LH-2 FB3	50LH-2 FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	50LH-2 NB1	50LH-2 NB2	50LH-2 NB3	50LH-2 NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	50LH-2 M1	50LH-2 M2	50LH-2 M3	50LH-2 M4
Results:	Pass	Pass	Pass	Pass
Max. Toe Spacing:	0.047 inch	0.026 inch	0.025 inch	0.089 inch

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	50LH-2 M2	50LH-2 M4
Max. Hardness (1):	305.1	355.6
Ave. Hardness (2):	275.3	308.1

Comments: (1) Maximum hardness of a single indent

(2) Average of five indents at weld toe

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 50LH-BW **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.250 inch wall, API 5L X52, 0.52 C.E. (IIW) pipe flattened into plate
Branch Material: 0.250 in. wall, API 5L X52, 0.52 C.E. (IIW) pipe flattened into plate
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap, 3/32 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 12 minutes between the root and hot pass, 30 minutes to finish the weld
Preheat Temperature: Ambient (48°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized
Comments: The heat sink capacity time was not measured

WELDING PARAMETERS

Pass:	Butter Layer	Temper Layer	Root	Hot Pass	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	80 – 83	80 – 81	79 – 82	84 – 89	89 – 90
Voltage Range (volts):	21 – 23	21 – 23	20 – 24	21 – 24	22 – 24
Travel Speed Range (ipm):	7.5 – 9.5	3.8 – 5.0	3.3 – 4.7	3.7 – 4.6	4.0 – 4.8
Heat Input Range (kJ/in.):	11.1 – 15.1	21.4 – 27.8	22.0 – 31.3	26.5 – 29.6	25.5 – 31.9
Average Heat Input (kJ/in.):	12.9	25.1	26.3	27.8	27.9

Comment: The root pass was a back weld and was deposited as the first pass
All butter layer passes were deposited prior to any temper layer passes

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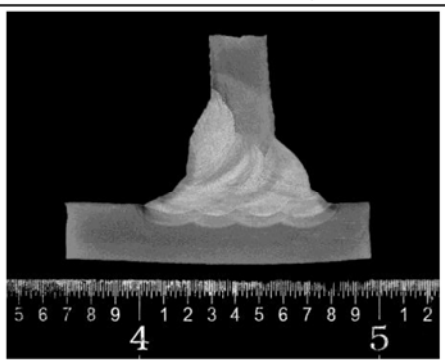
Test Number: 50LH-BW **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	50LH-BW FB1	50LH-BW FB2	50LH-BW FB3	50LH-BW FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	50LH-BW NB1	50LH-BW NB2	50LH-BW NB3	50LH-BW NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	50LH-BW M1	50LH-BW M2	50LH-BW M3	50LH-BW M4
Results:	Pass	Pass	Pass	Pass
Max. Toe Spacing:	0.065 inch	0.040 inch	0.088 inch	0037 inch

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	50LH-BW M2	50LH-BW M4
Max. Hardness (1):	372.6	414.0
Ave. Hardness (2):	323.4	366.3

Comments: (1) Maximum hardness of a single indent

(2) Average of five indents at weld toe

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: TBLH-B-1 **Date:** 4/3/2014
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 24 inch O.D., 0.375 inch wall, A106 Grade B, 0.30 C.E. (IIW) pipe
Branch Material: 12.75 inch O.D., 0.375 inch wall, A106 Grade B, 0.31 C.E. (IIW) pipe
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap, 3/32 inch land and 45° bevel on the branch
Position: 5G, branch and pipe **Welding Direction:** Uphill
Time Between Passes: 35 minutes between the root and hot pass, 6 hours to finish the weld
Preheat Temperature: Ambient (41°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized

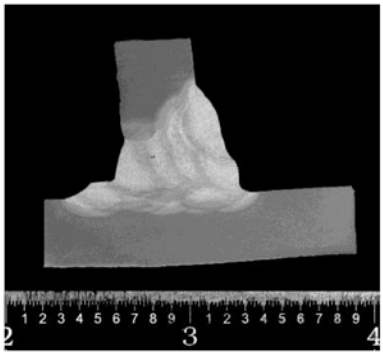
WELDING PARAMETERS

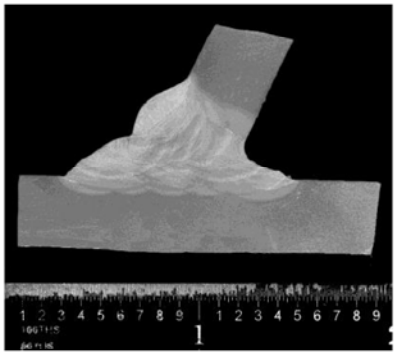
Pass:	Butter Layer	Temper Layer	Root	Hot Pass	Fills	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	88 – 89	87 – 88	79 – 92	88	88	87 – 88
Voltage Range (volts):	22 – 25	22 – 24	22 – 26	22 – 23	22 – 24	22 – 25
Travel Speed Range (ipm):	6.8 – 10.3	4.0 – 6.2	2.0 – 3.6	3.9 – 5.2	4.1 – 6.5	4.0 – 5.6
Heat Input Range (kJ/in.):	12.0 – 17.3	20.2 – 30.2	32.1 – 63.8	22.9 – 31.0	18.6 – 28.9	22.1 – 29.3
Ave. Heat Input (kJ/in.):	15.1	24.8	48.8	28.0	23.5	25.2

Kiefner DNV·GL

Test Number: TBLH-B-1 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE





BEND TEST

Coupon Number:	TBLH-B-1 FB3	TBLH-B-1 FB6	TBLH-B-1 FB9	TBLH-B-1 FB12
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	TBLH-B-1 NB3	TBLH-B-1 NB6	TBLH-B-1 NB9	TBLH-B-1 NB12
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	TBLH-B-1 M3	TBLH-B-1 M6	TBLH-B-1 M9	TBLH-B-1 M12
Results:	Pass	Pass	Pass	Pass
Max. Toe Spacing:	0.100 inch	0.098 inch	0.088 inch	0.080 inch

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	TBLH-B-1 M3	TBLH-B-1 M12
Max. Hardness (1):	278.5	289.6
Ave. Hardness (2):	259.1	249.1

Comments: (1) Maximum hardness of a single indent

(2) Average of five indents at weld toe

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 4/3/2014

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 50LH-TW-2 **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.125 inch wall, API 5L X52, 0.51 C.E. (IIW) pipe flattened into plate
Branch Material: 0.125 inch wall, API 5L X52, 0.51 C.E. (IIW) pipe flattened into plate
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap and no bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 15 minutes between the root and hot pass, 30 minutes to finish the weld
Preheat Temperature: Ambient (44°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized
Comments: The heat sink capacity time was not measured

WELDING PARAMETERS

Pass:	Butter Layer	Temper Layer	Root	Cap
AWS Classification:	E7018 H5	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	5/64	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	62 – 66	63 – 96	89	89 – 90
Voltage Range (volts):	21 – 23	20 – 23	21 – 23	22 – 23
Travel Speed Range (ipm):	5.2 – 6.8	3.8 – 5.7	4.9 – 5.1	4.3 – 5.3
Heat Input Range (kJ/in.):	12.8 – 16.2	15.5 – 30.2	23.4 – 24.4	23.0 – 27.4
Average Heat Input (kJ/in.):	14.4	24.8	23.9	25.8

Comment: A block welding sequence was used

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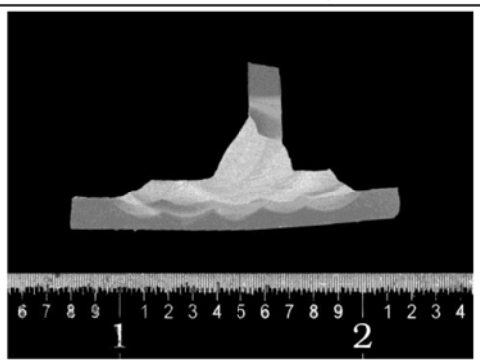
Test Number: 50LH-TW-2 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	50LH-TW-2 FB1	50LH-TW-2 FB2	50LH-TW-2 FB3	50LH-TW-2 FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	50LH-TW-2 NB1	50LH-TW-2 NB2	50LH-TW-2 NB3	50LH-TW-2 NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	50LH-TW-2 M1	50LH-TW-2 M2	50LH-TW-2 M3	50LH-TW-2 M4
Results:	Pass	Pass	Pass	Pass
Max. Toe Spacing:	0.076 inch	0.095 inch	0.072 inch	0.108 inch

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	50LH-TW-2 M2	50LH-TW-2 M4
Max. Hardness (1):	307.3	343.1
Ave. Hardness (2):	283.8	304.4

Comments: (1) Maximum hardness of a single indent

(2) Average of five indents at weld toe

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 50LH-TW-3 **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.125 inch wall, API 5L X52, 0.52 C.E. (IIW) pipe flattened into plate
Branch Material: 0.125 inch wall, API 5L X52, 0.52 C.E. (IIW) pipe flattened into plate
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap and no bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 18 minutes between the root and hot pass, 30 minutes to finish the weld
Preheat Temperature: Ambient (72°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized
Comments: The heat sink capacity time was not measured

WELDING PARAMETERS

Pass:	Butter Layer	Temper Layer	Root	Cap
AWS Classification:	E7018 H5	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	5/64	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	61 – 66	80 – 82	76 – 81	85 – 86
Voltage Range (volts):	21 – 24	21 – 22	21 – 22	21 – 23
Travel Speed Range (ipm):	8.9 – 13.0	5.5 – 8.9	3.9 – 4.5	4.2 – 5.0
Heat Input Range (kJ/in.):	6.9 – 10.8	11.9 – 18.0	23.6 – 25.2	22.4 – 27.3
Average Heat Input (kJ/in.):	8.9	15.4	24.3	25.2

Comment: A block welding sequence was used

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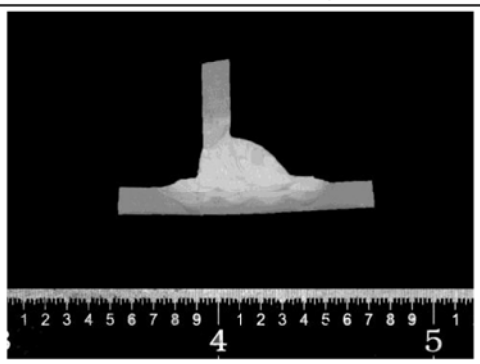
Test Number: 50LH-TW-3 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	50LH-TW-3 FB1	50LH-TW-3 FB2	50LH-TW-3 FB3	50LH-TW-3 FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	50LH-TW-3 NB1	50LH-TW-3 NB2	50LH-TW-3 NB3	50LH-TW-3 NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	50LH-TW-3 M1	50LH-TW-3 M2	50LH-TW-3 M3	50LH-TW-3 M4
Results:	Pass	Pass	Pass	Pass
Max. Toe Spacing	0.079 inch	0.107 inch	0.080 inch	0.098 inch

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	50LH-TW-3 M2	50LH-TW-3 M4
Max. Hardness (1):	494.1	474.9
Ave. Hardness (2):	443.9	460.9

Comments: (1) Maximum hardness of a single indent

(2) Average of five indents at weld toe

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 25LH-S-1 **Date:** 4/22/2014
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 12.75 inch O.D., 0.375 inch wall, A106 Grade B, 0.31 C.E. (IIW) pipe
Sleeve Material: 14 inch O.D., 0.375 inch wall, API 5L X42, 0.41 C.E. (IIW) pipe
Joint Design: Circumferential fillet weld
Position: 5G **Welding Direction:** Uphill
Time Between Passes: 15 minutes between the root and first cap pass, 2 hours to finish the weld
Preheat Temperature: Ambient (49°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized

WELDING PARAMETERS

Pass:	Root	Caps
AWS Classification:	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32
Current/Polarity:	DCEP	DCEP
Current Range (amps):	86	86 – 87
Voltage Range (volts):	22 – 25	21 – 23
Travel Speed Range (ipm):	2.4 – 7.3	4.1 – 6.8
Heat Input Range (kJ/in.):	15.9 – 54.0	17.1 – 28.1
Ave. Heat Input (kJ/in.):	29.8	24.3

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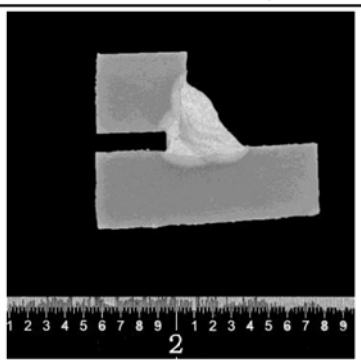
Test Number: 25LH-S-1 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	25LH-S-1 FB1	25LH-S-1 FB2	25LH-S-1 FB3	25LH-S-1 FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	25LH-S-1 NB1	25LH-S-1 NB2	25LH-S-1 NB3	25LH-S-1 NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	25LH-S-1 M1	25LH-S-1 M2	25LH-S-1 M3	25LH-S-1 M4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	25LH-S-1 M2	25LH-S-1 M4
Max. Hardness (1):	323.2	277.0
Ave. Hardness (2):	318.4	241.2
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 4/22/2014

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 35LH **Date:** 9/15/2014
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.375 inch wall, A516 Grade 70, 0.35 C.E. (IIW) plate
Branch Material: 0.375 inch wall, A516 Grade 70, 0.35 C.E. (IIW) plate
Joint Design: Branch-groove and fillet weld with a 1/8 gap, 3/32 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 17 minutes between the root and hot pass, 1 hour to finish the weld
Preheat Temperature: Ambient (71°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized
Comments: Measured heat sink capacity time of 11, 10, 11, 10.5, 11.5 and 12 seconds

WELDING PARAMETERS

Pass:	Root	Hot Pass	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP
Current Range (amps):	85 – 89	89 – 90	89
Voltage Range (volts):	22 – 25	21 – 24	22 – 24
Travel Speed Range (ipm):	2.9 – 3.8	4.1 – 4.9	4.1 – 5.6
Heat Input Range (kJ/in.):	30.3 – 44.7	24.5 – 29.0	21.1 – 29.8
Average Heat Input (kJ/in.):	36.2	27.0	25.7

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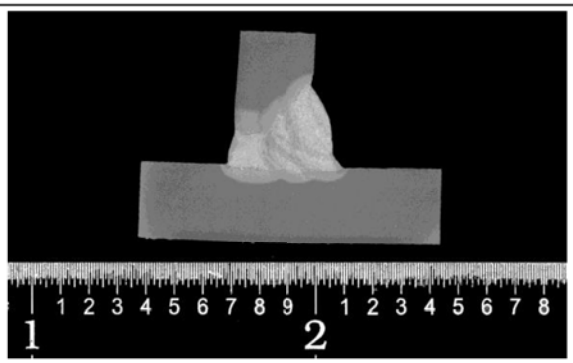
Test Number: 35LH **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	35LH FB1	35LH FB2	35LH FB3	35LH FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	35LH NB1	35LH NB2	35LH NB3	35LH NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	35LH M1	35LH M2	35LH M3	35LH M4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	35LH M2	35LH M4
Max. Hardness (1):	336.9	348.9
Ave. Hardness (2):	324.6	337.7
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 9/15/2014

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 48LH **Date:** 9/15/2014
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.375 inch wall, A516 Grade 70, 0.35 C.E. (IIW) plate
Branch Material: 0.250 inch wall, A516 Grade 70, 0.48 C.E. (IIW) plate
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap, 3/32 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 15 minutes between the root and hot pass, 1 hour to finish the weld
Preheat Temperature: Ambient (83°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized
Comments: Measured heat sink capacity time of 11, 10, 11, 10.5, 11.5 and 12 seconds

WELDING PARAMETERS

Pass:	Root	Hot Pass	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP
Current Range (amps):	88 – 94	87 – 92	83 – 84
Voltage Range (volts):	22 – 26	22 – 24	22 – 23
Travel Speed Range (ipm):	2.6 – 3.8	3.7 – 5.2	3.4 – 5.5
Heat Input Range (kJ/in.):	31.2 – 56.8	24.0 – 35.1	25.2 – 33.7
Average Heat Input (kJ/in.):	43.3	28.3	28.3

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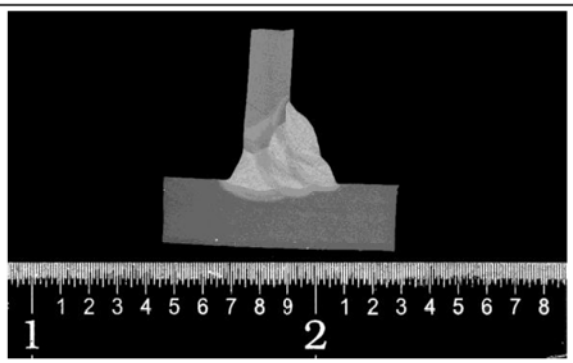
Test Number: 48LH **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	48LH FB1	48LH FB2	48LH FB3	48LH FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	48LH NB1	48LH NB2	48LH NB3	48LH NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	48LH M1	48LH M2	48LH M3	48LH M4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	48LH M2	48LH M4
Max. Hardness (1):	299.9	322.9
Ave. Hardness (2):	270.3	303.6
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 9/15/2014

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 42LH-O **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.375 inch wall, A516 Grade 70, 0.42 C.E. (IIW) plate
Branch Material: 0.375 inch wall, A516 Grade 70, 0.42 C.E. (IIW) plate
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap, 3/32 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 13 minutes between the root and hot pass, 1 hour to finish the weld
Preheat Temperature: Ambient (82°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Oil
Test Medium Temperature: 75 – 85°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Oil was not pressurized
Comments: Measured heat sink capacity time of 45, 48, 53, 55 and 49 seconds

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	86 – 90	91 – 92	90 – 94	89 – 92
Voltage Range (volts):	23 – 26	22 – 24	22 – 25	22 – 23
Travel Speed Range (ipm):	2.9 – 3.2	4.1 – 5.2	4.0 – 4.9	4.5 – 5.6
Heat Input Range (kJ/in.):	38.7 – 44.8	24.1 – 30.9	25.8 – 32.7	21.6 – 28.0
Average Heat Input (kJ/in.):	42.6	27.9	28.0	24.8

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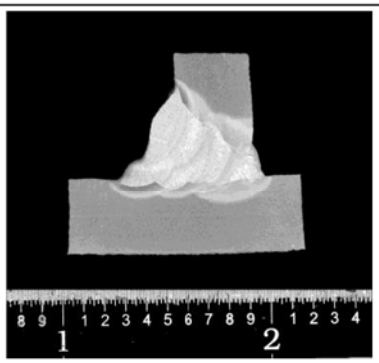
Test Number: 42LH-O **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	42LH-O FB1	42LH-O FB2	42LH-O FB3	42LH-O FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	42LH-O NB1	42LH-O NB2	42LH-O NB3	42LH-O NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	42LH-O NB1	42LH-O NB2	42LH-O NB3	42LH-O NB4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	42LH-O M2	42LH-O M4
Max. Hardness (1):	387.4	370.4
Ave. Hardness (2):	374.3	360.9
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 40LH-S-1 **Date:** 4/22/2014
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 12.75 inch O.D., 0.375 inch wall, A106 Grade B, 0.31 C.E. (IIW) pipe
Sleeve Material: 14 inch O.D., 0.375 inch wall, A106 Grade B, 0.41 C.E. (IIW) pipe
Joint Design: Circumferential fillet weld
Position: 5G **Welding Direction:** Uphill
Time Between Passes: 60 minutes between the root and first cap pass, 3 hours to finish the weld
Preheat Temperature: Ambient (65°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized

WELDING PARAMETERS

Pass:	Root	Caps
AWS Classification:	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32
Current/Polarity:	DCEP	DCEP
Current Range (amps):	84 – 85	84 – 85
Voltage Range (volts):	21 – 24	21 – 24
Travel Speed Range (ipm):	2.5 – 3.6	2.3 – 3.8
Heat Input Range (kJ/in.):	32.2 – 44.2	30.0 –48.6
Ave. Heat Input (kJ/in.):	36.5	39.5

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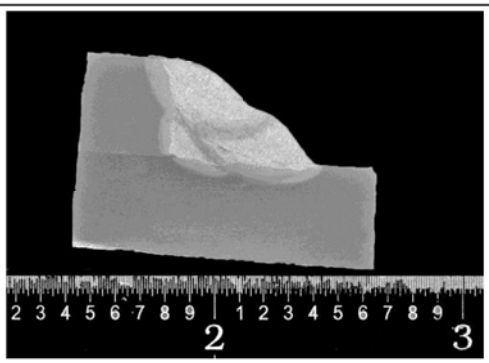
Test Number: 40LH-S-1 **Page:** 2 **of** 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	40LH-S-1 FB1	40LH-S-1 FB2	40LH-S-1 FB3	40LH-S-1 FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	40LH-S-1 NB1	40LH-S-1 NB2	40LH-S-1 NB3	40LH-S-1 NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	40LH-S-1 M1	40LH-S-1 M2	40LH-S-1 M3	40LH-S-1 M4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	40LH-S-1 M2	40LH-S-1 M4
Max. Hardness (1):	255.8	286.1
Ave. Hardness (2):	237.6	249.3

Comments: (1) Maximum hardness of a single indent
(2) Average of five indents at weld toe

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 4/22/2014
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 42LH **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.375 inch wall, A516 Grade 70, 0.42 C.E. (IIW) plate
Branch Material: 0.375 inch wall, A516 Grade 70, 0.42 C.E. (IIW) plate
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap, 3/32 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 15 minutes between the root and hot pass, 1 hour to finish the weld
Preheat Temperature: Ambient (48°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized
Comments: Measured heat sink capacity time of 11, 10, 11, 10.5, 11.5 and 12 seconds

WELDING PARAMETERS

Pass:	Root	Hot Pass	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP
Current Range (amps):	85 – 93	88 – 89	88 – 94
Voltage Range (volts):	23 – 25	22 – 23	22 – 24
Travel Speed Range (ipm):	3.0 – 3.6	2.9 – 3.3	2.9 – 3.5
Heat Input Range (kJ/in.):	35.5 – 43.6	36.3 – 41.8	34.6 – 42.7
Average Heat Input (kJ/in.):	38.7	39.0	39.5

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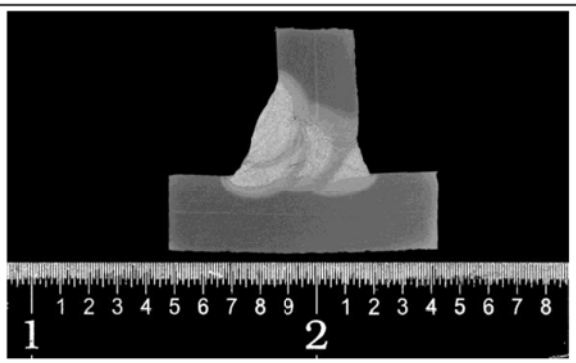
Test Number: 42LH **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	42LH FB1	42LH FB2	42LH FB3	42LH FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	42LH NB1	42LH NB2	42LH NB3	42LH NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	42LH M1	42LH M2	42LH M3	42LH M4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	42LH M2	42LH M4
Max. Hardness (1):	372.2	366.0
Ave. Hardness (2):	349.2	327.0
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 50LH-O **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.250 inch wall, API 5L X52, 0.52 C.E. (IIW) pipe flattened into plate
Branch Material: 0.250 inch wall, API 5L X52, 0.52 C.E. (IIW) pipe flattened into plate
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap, 3/32 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 15 minutes between the root and hot pass, 1 hour to finish the weld
Preheat Temperature: Ambient (77°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Oil
Test Medium Temperature: 75 – 85°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Oil was not pressurized
Comments: The heat sink capacity time was not measured

WELDING PARAMETERS

Pass:	Root	Hot Pass	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP
Current Range (amps):	82 – 87	82 – 83	83 – 85
Voltage Range (volts):	23 – 25	21 – 24	21 – 23
Travel Speed Range (ipm):	2.5 – 3.4	2.6 – 2.9	2.7 – 3.6
Heat Input Range (kJ/in.):	38.2 – 45.6	39.6 – 41.3	30.2 – 40.6
Average Heat Input (kJ/in.):	42.9	40.5	36.7

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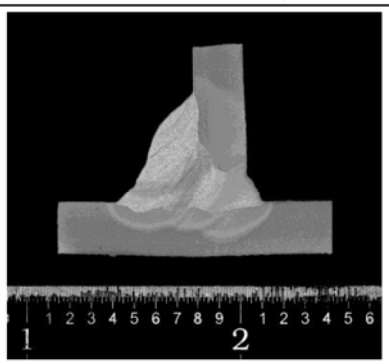
Test Number: 50LH-O **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	50LH-O FB1	50LH-O FB2	50LH-O FB3	50LH-O FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	50LH-O NB1	50LH-O NB2	50LH-O NB3	50LH-O NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	50LH-O M1	50LH-O M2	50LH-O M3	50LH-O M4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	50LH-O M2	50LH-O M4
Max. Hardness (1):	297.7	290.3
Ave. Hardness (2):	285.7	274.9
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: TBLH-S-1 **Date:** 4/22/2014
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 12.75 inch O.D., 0.375 inch wall, A106 Grade B, 0.31 C.E. (IIW) pipe
Sleeve Material: 14 inch O.D., 0.375 inch wall, A106 Grade B, 0.41 C.E. (IIW) pipe
Joint Design: Circumferential fillet weld
Position: 5G **Welding Direction:** Uphill
Time Between Passes: 19 minutes between the root and hot pass, 3 hours to finish the weld
Preheat Temperature: Ambient (49°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized

WELDING PARAMETERS

Pass:	Butter Layer	Temper Layer	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP
Current Range (amps):	73 – 77	81	81
Voltage Range (volts):	21 – 24	21 – 25	21 – 23
Travel Speed Range (ipm):	6.0 – 8.5	3.0 – 5.6	3.7 – 5.2
Heat Input Range (kJ/in.):	12.0 – 16.4	20.3 – 28.0	19.8 – 29.4
Ave.e Heat Input (kJ/in.):	14.3	25.8	24.6

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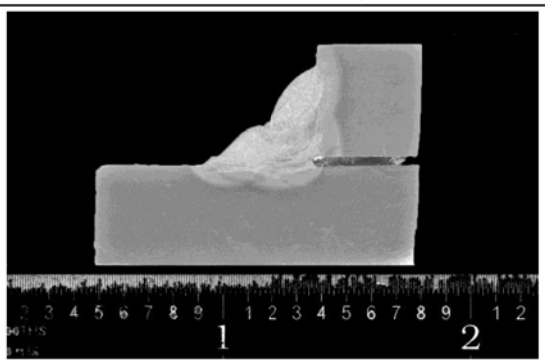
Test Number: TBLH-S-1 **Page:** 2 **of** 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	TBLH-S-1 FB1	TBLH-S-1 FB2	TBLH-S-1 FB3	TBLH-S-1 FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	TBLH-S-1 NB1	TBLH-S-1 NB2	TBLH-S-1 NB3	TBLH-S-1 NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	TBLH-S-1 M1	TBLH-S-1 M2	TBLH-S-1 M3	TBLH-S-1 M4
Results:	Pass	Pass	Pass	Pass
Max. Toe Spacing:	0.060 inch	0.058 inch	0.079 inch	0.014 inch

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	TBLH-S-1 M2	TBLH-S-1 M4
Max. Hardness (1):	278.9	222.4
Ave. Hardness (2):	248.3	212.4

Comments: (1) Maximum hardness of a single indent

(2) Average of five indent at weld toe

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 4/22/2014

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 50LH-2 **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.250 inch wall, API 5L X52, 0.51 C.E. (IIW) pipe flattened into plate
Branch Material: 0.250 inch wall, API 5L X52, 0.51 C.E. (IIW) pipe flattened into plate
Joint Design: Branch-groove and fillet weld with a 3/32 inch gap, 3/32 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 15 minutes between the root and hot pass, 1 hours to finish the weld
Preheat Temperature: Ambient (44°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized
Comments: The heat sink capacity time was not measured

WELDING PARAMETERS

Pass:	Butter Layer	Temper Layer	Root	Hot Pass	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	87 – 89	87 – 89	79 – 80	90	89 – 90
Voltage Range (volts):	21 – 23	21 – 23	22 – 24	21 – 23	21 – 23
Travel Speed Range (ipm):	6.9 – 11.0	4.4 – 6.3	2.9 – 3.8	4.3 – 4.5	4.4 – 5.3
Heat Input Range (kJ/in.):	10.6 – 17.9	19.0 – 26.7	29.6 – 38.9	26.0 – 27.9	22.5 – 27.0
Average Heat Input (kJ/in.):	14.9	23.3	34.7	26.9	24.0

Comment: A block welding sequence was used

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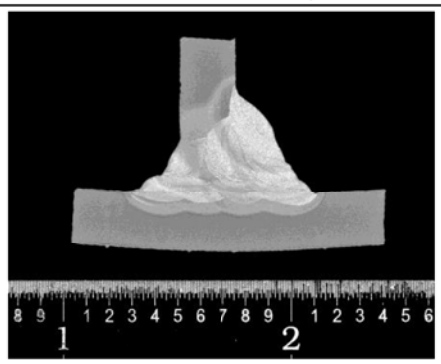
Test Number: 50LH-2 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	50LH-2 FB1	50LH-2 FB2	50LH-2 FB3	50LH-2 FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	50LH-2 NB1	50LH-2 NB2	50LH-2 NB3	50LH-2 NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	50LH-2 M1	50LH-2 M2	50LH-2 M3	50LH-2 M4
Results:	Pass	Pass	Pass	Pass
Max. Toe Spacing:	0.047 inch	0.026 inch	0.025 inch	0.089 inch

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	50LH-2 M2	50LH-2 M4
Max. Hardness (1):	305.1	355.6
Ave. Hardness (2):	275.3	308.1

Comments: (1) Maximum hardness of a single indent

(2) Average of five indents at weld toe

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: TBLH-S-1 **Date:** 4/22/2014
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 12.75 inch O.D., 0.375 inch wall, A106 Grade B, 0.31 C.E. (IIW) pipe
Sleeve Material: 14 inch O.D., 0.375 inch wall, A106 Grade B, 0.41 C.E. (IIW) pipe
Joint Design: Circumferential fillet weld
Position: 5G **Welding Direction:** Uphill
Time Between Passes: 19 minutes between the root and hot pass, 3 hours to finish the weld
Preheat Temperature: Ambient (49°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized

WELDING PARAMETERS

Pass:	Butter Layer	Temper Layer	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP
Current Range (amps):	73 – 77	81	81
Voltage Range (volts):	21 – 24	21 – 25	21 – 23
Travel Speed Range (ipm):	6.0 – 8.5	3.0 – 5.6	3.7 – 5.2
Heat Input Range (kJ/in.):	12.0 – 16.4	20.3 – 28.0	19.8 – 29.4
Ave.e Heat Input (kJ/in.):	14.3	25.8	24.6

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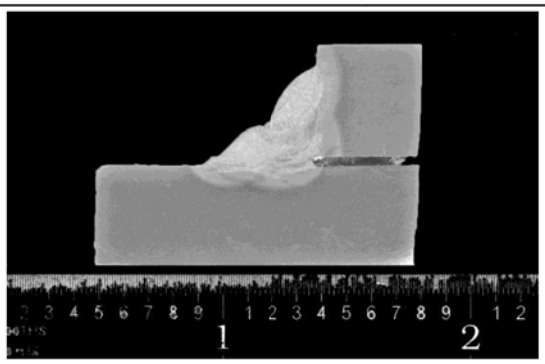
Test Number: TBLH-S-1 **Page:** 2 **of** 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	TBLH-S-1 FB1	TBLH-S-1 FB2	TBLH-S-1 FB3	TBLH-S-1 FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	TBLH-S-1 NB1	TBLH-S-1 NB2	TBLH-S-1 NB3	TBLH-S-1 NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	TBLH-S-1 M1	TBLH-S-1 M2	TBLH-S-1 M3	TBLH-S-1 M4
Results:	Pass	Pass	Pass	Pass
Max. Toe Spacing:	0.060 inch	0.058 inch	0.079 inch	0.014 inch

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	TBLH-S-1 M2	TBLH-S-1 M4
Max. Hardness (1):	278.9	222.4
Ave. Hardness (2):	248.3	212.4

Comments: (1) Maximum hardness of a single indent

(2) Average of five indent at weld toe

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 4/22/2014

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 50LH-TW-2 **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.125 inch wall, API 5L X52, 0.51 C.E. (IIW) pipe flattened into plate
Branch Material: 0.125 inch wall, API 5L X52, 0.51 C.E. (IIW) pipe flattened into plate
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap and no bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 15 minutes between the root and hot pass, 30 minutes to finish the weld
Preheat Temperature: Ambient (44°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized
Comments: The heat sink capacity time was not measured

WELDING PARAMETERS

Pass:	Butter Layer	Temper Layer	Root	Cap
AWS Classification:	E7018 H5	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	5/64	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	62 – 66	63 – 96	89	89 – 90
Voltage Range (volts):	21 – 23	20 – 23	21 – 23	22 – 23
Travel Speed Range (ipm):	5.2 – 6.8	3.8 – 5.7	4.9 – 5.1	4.3 – 5.3
Heat Input Range (kJ/in.):	12.8 – 16.2	15.5 – 30.2	23.4 – 24.4	23.0 – 27.4
Average Heat Input (kJ/in.):	14.4	24.8	23.9	25.8

Comment: A block welding sequence was used

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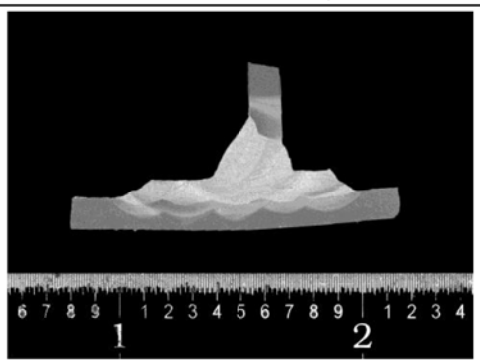
Test Number: 50LH-TW-2 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	50LH-TW-2 FB1	50LH-TW-2 FB2	50LH-TW-2 FB3	50LH-TW-2 FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	50LH-TW-2 NB1	50LH-TW-2 NB2	50LH-TW-2 NB3	50LH-TW-2 NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	50LH-TW-2 M1	50LH-TW-2 M2	50LH-TW-2 M3	50LH-TW-2 M4
Results:	Pass	Pass	Pass	Pass
Max. Toe Spacing:	0.076 inch	0.095 inch	0.072 inch	0.108 inch

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	50LH-TW-2 M2	50LH-TW-2 M4
Max. Hardness (1):	307.3	343.1
Ave. Hardness (2):	283.8	304.4

Comments: (1) Maximum hardness of a single indent

(2) Average of five indents at weld toe

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 50LH-TW-3 **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.125 inch wall, API 5L X52, 0.52 C.E. (IIW) pipe flattened into plate
Branch Material: 0.125 inch wall, API 5L X52, 0.52 C.E. (IIW) pipe flattened into plate
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap and no bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Uphill
Time Between Passes: 18 minutes between the root and hot pass, 30 minutes to finish the weld
Preheat Temperature: Ambient (72°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized
Comments: The heat sink capacity time was not measured

WELDING PARAMETERS

Pass:	Butter Layer	Temper Layer	Root	Cap
AWS Classification:	E7018 H5	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	5/64	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	61 – 66	80 – 82	76 – 81	85 – 86
Voltage Range (volts):	21 – 24	21 – 22	21 – 22	21 – 23
Travel Speed Range (ipm):	8.9 – 13.0	5.5 – 8.9	3.9 – 4.5	4.2 – 5.0
Heat Input Range (kJ/in.):	6.9 – 10.8	11.9 – 18.0	23.6 – 25.2	22.4 – 27.3
Average Heat Input (kJ/in.):	8.9	15.4	24.3	25.2

Comment: A block welding sequence was used

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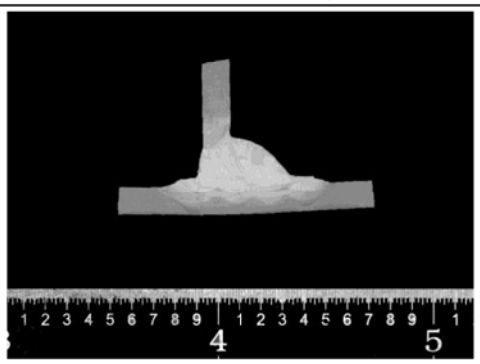
Test Number: 50LH-TW-3 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	50LH-TW-3 FB1	50LH-TW-3 FB2	50LH-TW-3 FB3	50LH-TW-3 FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	50LH-TW-3 NB1	50LH-TW-3 NB2	50LH-TW-3 NB3	50LH-TW-3 NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	50LH-TW-3 M1	50LH-TW-3 M2	50LH-TW-3 M3	50LH-TW-3 M4
Results:	Pass	Pass	Pass	Pass
Max. Toe Spacing	0.079 inch	0.107 inch	0.080 inch	0.098 inch

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	50LH-TW-3 M2	50LH-TW-3 M4
Max. Hardness (1):	494.1	474.9
Ave. Hardness (2):	443.9	460.9

Comments: (1) Maximum hardness of a single indent

(2) Average of five indents at weld toe

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 25CLH-B-1 **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 24 inch O.D., 0.375 inch wall, API 5L X70, 0.33 C.E. (IIW) pipe
Branch Material: 12.75 inch O.D., 0.375 inch wall, API 5L X42, 0.31 C.E. (IIW) pipe
Joint Design: Branch-groove and fillet weld with a 3/32 inch gap, 1/16 inch land and 45° bevel on the branch
Position: 5G, branch and pipe **Welding Direction:** Downhill-Root/Uphill-Rem.
Time Between Passes: 17 minutes between the root and hot pass, 3 hours to finish the weld
Preheat Temperature: Ambient (67°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Oil
Test Medium Temperature: 75 – 85°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Oil was not pressurized

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Caps
AWS Classification:	E6010	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	Lincoln	ESAB	ESAB	ESAB
Electrode Diameter (in.):	1/8	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	80 – 103	91 – 93	90 – 100	89 – 91
Voltage Range (volts):	23 – 32	22 – 25	21 – 26	21 – 24
Travel Speed Range (ipm):	2.1 – 7.9	4.3 – 6.0	4.1 – 7.0	4.2 – 5.5
Heat Input Range (kJ/in.):	17.9 – 73.3	21.8 – 30.6	16.4 – 32.4	22.0 – 29.4
Ave. Heat Input (kJ/in.):	43.6	26.8	25.7	26.4

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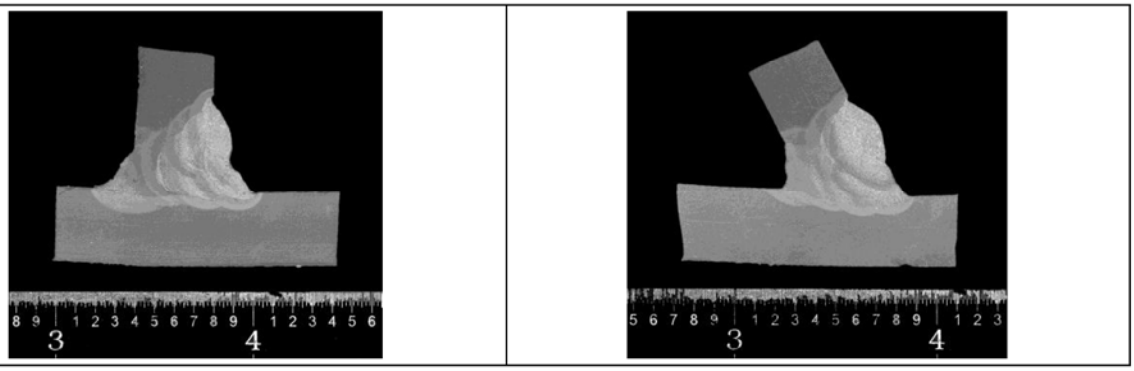
Test Number: 25CLH-B-1 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	25CLH-B-1 FB3	25CLH-B-1 FB6	25CLH-B-1 FB9	25CLH-B-1 FB12
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	25CLH-B-1 NB3	25CLH-B-1 NB6	25CLH-B-1 NB9	25CLH-B-1 NB12
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	25CLH-B-1 M3	25CLH-B-1 M6	25CLH-B-1 M9	25CLH-B-1 M12
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	25CLH-B-1 M3	25CLH-B-1 M12
Max. Hardness (1):	291.6	303.7
Ave. Hardness (2):	267.1	292.0
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 35CLH-O **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.375 inch wall, A516 Grade 70, 0.35 C.E. (IIW) plate
Branch Material: 0.375 inch wall, A516 Grade 70, 0.35 C.E. (IIW) plate
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap, 1/8 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Downhill-Root/Uphill-Rem.
Time Between Passes: 15 minutes between the root and hot pass, 1 hour to finish the weld
Preheat Temperature: Ambient (67°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Oil
Test Medium Temperature: 75 – 85°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Oil was not pressurized
Comments: Measured heat sink capacity time of 45, 48, 53, 55 and 49 seconds

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Caps
AWS Classification:	E6010	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	Lincoln	ESAB	ESAB	ESAB
Electrode Diameter (in.):	1/8	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	79 – 83	97 – 99	87 – 88	87 – 89
Voltage Range (volts):	24 – 26	23 – 24	21 – 23	21 – 23
Travel Speed Range (ipm):	4.0 – 4.4	4.2 – 5.0	4.1 – 5.5	4.1 – 5.4
Heat Input Range (kJ/in.):	27.5 – 30.1	28.1 – 33.4	21.1 – 28.6	21.2 – 28.3
Average Heat Input (kJ/in.):	28.8	29.6	24.7	25.2

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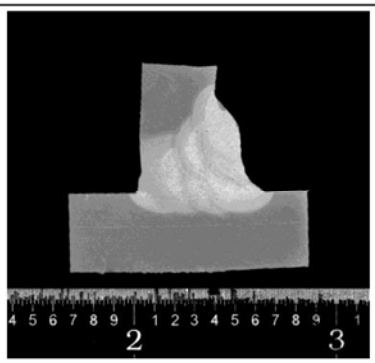
Test Number: 35CLH-O **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	35CLH-O FB1	35CLH-O FB2	35CLH-O FB3	35CLH-O FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	35CLH-O NB1	35CLH-O NB2	35CLH-O NB3	35CLH-O NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	35CLH-O M1	35CLH-O M2	35CLH-O M3	35CLH-O M4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	35CLH-O M2	35CLH-O M4
Max. Hardness (1):	230.2	270.6
Ave. Hardness (2):	220.5	249.8
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 25CLH-S-1 **Date:** 8/29/2016
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 12.75 inch O.D., 0.375 inch wall, API 5L X42, 0.41 C.E. (IIW) pipe
Sleeve Material: 12.75 inch O.D., 0.250 inch wall, API 5L X60, 0.28 C.E. (IIW) pipe
Joint Design: Circumferential fillet weld
Position: 5G **Welding Direction:** Downhill-Root/Uphill-Rem.
Time Between Passes: 19 minutes between the root and first cap pass, 2 hours to finish the weld
Preheat Temperature: Ambient (79°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Oil
Test Medium Temperature: 75 – 85°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Oil was not pressurized

WELDING PARAMETERS

Pass:	Root	Caps
AWS Classification:	E6010	E7018 H4R
Manufacture:	Lincoln	ESAB
Electrode Diameter (in.):	1/8	3/32
Current/Polarity:	DCEP	DCEP
Current Range (amps):	86 – 92	92 – 95
Voltage Range (volts):	20 – 29	22 – 25
Travel Speed Range (ipm):	4.1 – 8.4	3.7 – 6.6
Heat Input Range (kJ/in.):	16.2 – 34.8	19.5 – 35.5
Ave. Heat Input (kJ/in.):	24.1	23.7

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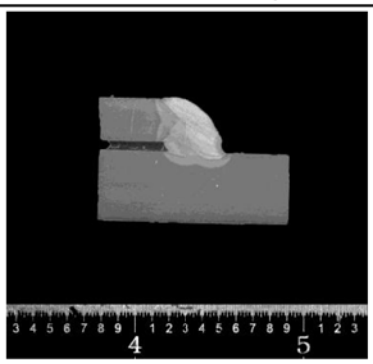
Test Number: 25CLH-S-1 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	25CLH-S-1 FB1	25CLH-S-1 FB2	25CLH-S-1 FB3	25CLH-S-1 FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	25CLH-S-1 NB1	25CLH-S-1 NB2	25CLH-S-1 NB3	25CLH-S-1 NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	25CLH-S-1 M1	25CLH-S-1 M2	25CLH-S-1 M3	25CLH-S-1 M4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	25CLH-S-1 M2	25CLH-S-1 M4
Max. Hardness (1):	283.6	332.0
Ave. Hardness (2):	267.2	305.7
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 8/29/2016
Test Conducted By: Jeff Balka
Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 35CLH-O **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.375 inch wall, A516 Grade 70, 0.35 C.E. (IIW) plate
Branch Material: 0.375 inch wall, A516 Grade 70, 0.35 C.E. (IIW) plate
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap, 1/8 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Downhill-Root/Uphill-Rem.
Time Between Passes: 15 minutes between the root and hot pass, 1 hour to finish the weld
Preheat Temperature: Ambient (67°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Oil
Test Medium Temperature: 75 – 85°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Oil was not pressurized
Comments: Measured heat sink capacity time of 45, 48, 53, 55 and 49 seconds

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Caps
AWS Classification:	E6010	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	Lincoln	ESAB	ESAB	ESAB
Electrode Diameter (in.):	1/8	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	79 – 83	97 – 99	87 – 88	87 – 89
Voltage Range (volts):	24 – 26	23 – 24	21 – 23	21 – 23
Travel Speed Range (ipm):	4.0 – 4.4	4.2 – 5.0	4.1 – 5.5	4.1 – 5.4
Heat Input Range (kJ/in.):	27.5 – 30.1	28.1 – 33.4	21.1 – 28.6	21.2 – 28.3
Average Heat Input (kJ/in.):	28.8	29.6	24.7	25.2

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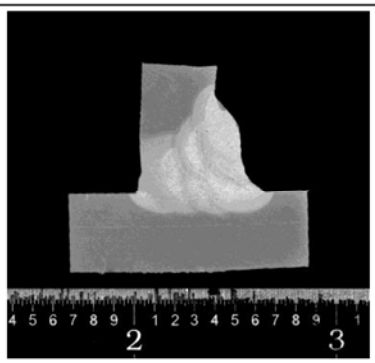
Test Number: 35CLH-O **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	35CLH-O FB1	35CLH-O FB2	35CLH-O FB3	35CLH-O FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	35CLH-O NB1	35CLH-O NB2	35CLH-O NB3	35CLH-O NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	35CLH-O M1	35CLH-O M2	35CLH-O M3	35CLH-O M4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	35CLH-O M2	35CLH-O M4
Max. Hardness (1):	230.2	270.6
Ave. Hardness (2):	220.5	249.8
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015

Test Conducted By: Jim Winigman

Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 40CLH-B-2 **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 24 inch O.D., 0.375 inch wall, API 5L X70, 0.33 C.E. (IIW) pipe
Branch Material: 12.75 inch O.D., 0.375 inch wall, API 5L X42, 0.31 C.E. (IIW) pipe
Joint Design: Branch-groove and fillet weld with a 3/32 inch gap, 1/16 inch land and 45° bevel on the branch
Position: 5G, branch and pipe **Welding Direction:** Downhill-Root/Uphill-Rem.
Time Between Passes: 20 minutes between the root and hot pass, 5 hours to finish the weld
Preheat Temperature: Ambient (62°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Oil
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Oil was not pressurized

WELDING PARAMETERS

Pass:	Root	Hot Pass	Caps
AWS Classification:	E6010	E7018 H4R	E7018 H4R
Manufacture:	Lincoln	ESAB	ESAB
Electrode Diameter (in.):	1/8	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP
Current Range (amps):	80 – 101	78 – 89	81 – 89
Voltage Range (volts):	23 – 31	21 – 25	22 – 27
Travel Speed Range (ipm):	2.6 – 6.0	2.5 – 3.7	2.6 – 3.7
Heat Input Range (kJ/in.):	22.1 – 54.1	33.7 – 51.0	32.3 – 48.4
Ave. Heat Input (kJ/in.):	37.1	41.2	41.6

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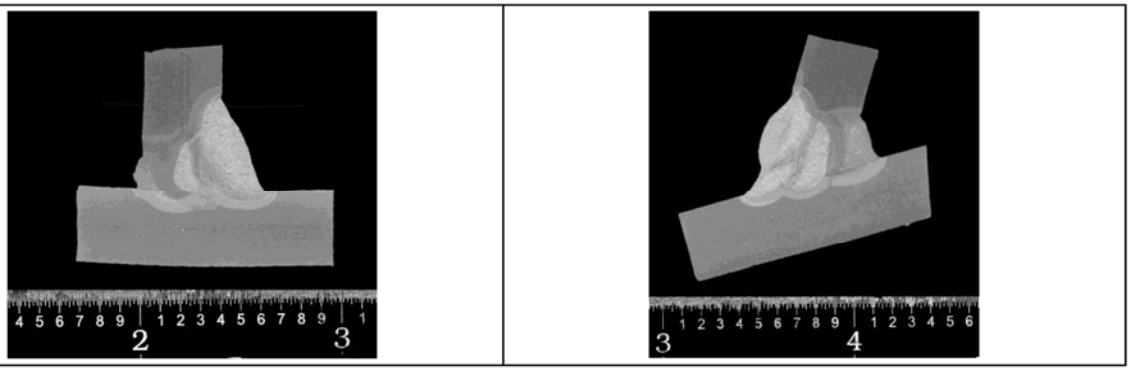
Test Number: 40CLH-B-2 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	40CLH-B-2 FB3	40CLH-B-2 FB6	40CLH-B-2 FB9	40CLH-B-2 FB12
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Fail	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	40CLH-B-2 NB3	40CLH-B-2 NB6	40CLH-B-2 NB9	40CLH-B-2 NB12
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	40CLH-B-2 M3	40CLH-B-2 M6	40CLH-B-2 M9	40CLH-B-2 M12
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	40CLH-B-2 M3	40CLH-B-2 M12
Max. Hardness (1):	238.4	285.7
Ave. Hardness (2):	234.6	273.6
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 42CLH-O **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 0.375 inch wall, A516 Grade 70, 0.42 C.E. (IIW) plate
Branch Material: 0.375 inch wall, A516 Grade 70, 0.42 C.E. (IIW) plate
Joint Design: Branch-groove and fillet weld with a 1/8 inch gap, 3/32 inch land and 45° bevel on the branch
Position: Fixed, both plates at 45° **Welding Direction:** Downhill-Root/Uphill-Rem.
Time Between Passes: 17 minutes between the Root and Hot Pass, 1 hour to finish the weld
Preheat Temperature: Ambient (73°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Oil
Test Medium Temperature: 75 – 85°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Oil was not pressurized
Comments: Measured heat sink capacity time of 45, 48, 53, 55 and 49 seconds

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Caps
AWS Classification:	E6010	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	Lincoln	ESAB	ESAB	ESAB
Electrode Diameter (in.):	1/8	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	92 – 95	91 – 93	87 – 89	87 – 90
Voltage Range (volts):	25 – 27	22 – 26	22 – 24	22 – 24
Travel Speed Range (ipm):	4.2 – 5.5	2.9 – 3.6	2.7 – 3.1	2.9 – 3.3
Heat Input Range (kJ/in.):	26.4 – 33.9	37.3 – 43.7	39.7 – 44.4	36.5 – 43.2
Average Heat Input (kJ/in.):	30.8	40.2	41.5	38.6

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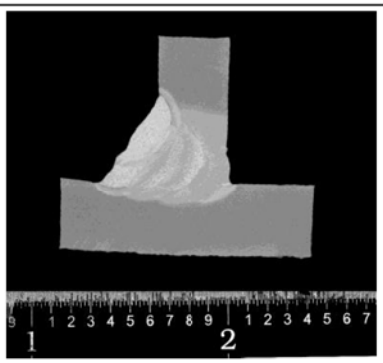
Test Number: 42CLH-O **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



BEND TEST

Coupon Number:	42CLH-O FB1	42CLH-O FB2	42CLH-O FB3	42CLH-O FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	42CLH-O NB1	42CLH-O NB2	42CLH-O NB3	42CLH-O NB4
Results:	Pass	Pass	Pass	Pass

MACRO-SECTION TEST

Coupon Number:	42CLH-O M1	42CLH-O M2	42CLH-O M3	42CLH-O M4
Results:	Pass	Pass	Pass	Pass

VICKERS HAZ HARDNESS TEST (HV), 10 kg

Coupon Number:	42CLH-O M2	42CLH-O M4
Max. Hardness (1):	327.2	231.3
Ave. Hardness (2):	289.6	224.12
Comments:	(1) Maximum hardness of a single indent	
	(2) Average of five indents at weld toe	

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: X42LH-LS-1 **Date:** 5/29/2014
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Sleeve Material: 14 inch O.D., 0.375 inch wall, API 5L X42, 0.41 C.E. (IIW) pipe
Joint Design: Long seam on a 1/8 inch backing bar with a 3/8 inch gap, no land and 20° bevel on the sleeve
Position: 5G **Welding Direction:** Horizontal
Time Between Passes: 16 minutes between the root and hot pass, 3 hours to finish the weld
Preheat Temperature: Ambient (52°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water flowing through the run pipe
Test Medium Temperature: 40 – 60°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	3/32	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	84 – 86	84 – 89	87 – 88	86 – 87
Voltage Range (volts):	21 – 25	24 – 26	21 – 23	21 – 24
Travel Speed Range (ipm):	4.7 – 7.8	4.1 – 5.6	4.4 – 9.9	5.7 – 10.0

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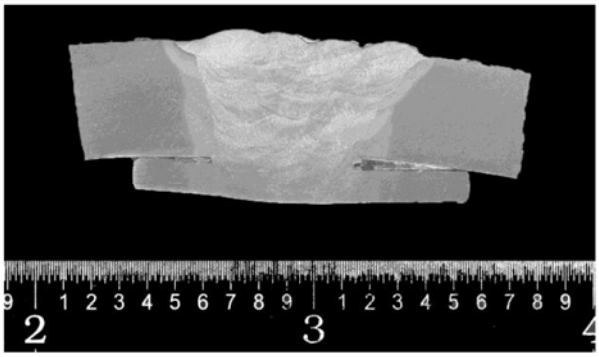
Test Number: X42LH-LS-1 **Page:** 2 of 2

FIGURE 1 –BEAD SEQUENCE



TENSILE TEST

Coupon Number:	X42LH-LS-1 T1	X42LH-LS-1 T2
Coupon Width:	0.966 inch	0.800 inch
Coupon Thickness:	0.386 inch	0.384 inch
Coupon Area:	0.373 inch^2	0.307 inch^2
Maximum Load:	28,766 lb.	24,636 lb.
Tensile Strength:	77,120 psi	80,249 psi
Fracture Location:	Sleeve	Sleeve

BEND TEST

Coupon Number:	X42LH-LS-1 FB1	X42LH-LS-1 FB2	X42LH-LS-1 RB1	X42LH-LS-1 RB2
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Root	Root
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	X42LH-LS-1 NB1	X42LH-LS-1 NB2
Results:	Pass	Pass

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 5/29/2014
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: X60LH-LS-1 **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Sleeve Material: 12.75 inch O.D., 0.375 inch wall, API 5L X60, 0.43 C.E. (IIW) pipe
Joint Design: Long seam on a 1/16 inch backing bar with a 3/32 inch gap, no land and 20° bevel on the sleeve
Position: 5G **Welding Direction:** Horizontal
Time Between Passes: 46 minutes between the root and hot pass, 2 hours to finish the weld
Preheat Temperature: Ambient (69°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water flowing through the run pipe
Test Medium Temperature: 40 – 60°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	1/8	1/8	1/8	1/8
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	91 – 92	92 – 102	102 – 103	102 – 103
Voltage Range (volts):	21 – 22	20 – 22	20 – 22	20 – 22
Travel Speed Range (ipm):	6.6 – 10.2	5.9 – 9.2	6.4 – 8.1	6.3 – 12.0

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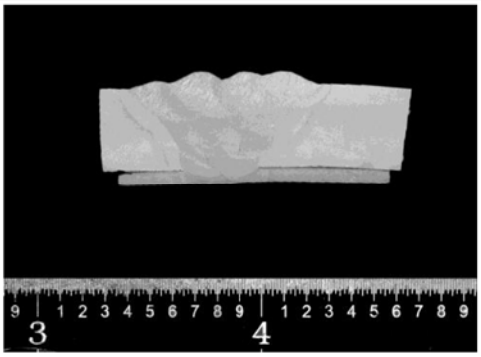
Test Number: X60LH-LS-1 **Page:** 2 of 2

FIGURE 1 –BEAD SEQUENCE



TENSILE TEST

Coupon Number:	X60LH-LS-1 T1	X60LH-LS-1 T2
Coupon Width:	1.009 inch	1.023 inch
Coupon Thickness:	0.360 in.ch	0.360 inch
Coupon Area:	0.363 inch^2	0.368 inch^2
Maximum Load:	31,259 lb.	32,502 lb.
Tensile Strength:	86,113 psi	88,321 psi
Fracture Location:	Sleeve	Sleeve

BEND TEST

Coupon Number:	X60LH-LS-1 FB1	X60LH-LS-1 FB2	X60LH-LS-1 RB1	X60LH-LS-1 RB2
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Root	Root
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	X60LH-LS-1 NB1	X60LH-LS-1 NB2
Results:	Pass	Pass

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: X65LH-LS-7018-1 **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Sleeve Material: 12.75 inch O.D., 0.250 inch wall, API 5L X65 pipe
Joint Design: Long seam on a 1/16 inch backing bar with a 3/32 inch gap, no land and 30° bevel on the sleeve
Position: 5G **Welding Direction:** Horizontal
Time Between Passes: 31 minutes between the root and first cap pass, 1 hour to finish the weld
Preheat Temperature: Ambient (71°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water flowing through the run pipe
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized

WELDING PARAMETERS

Pass:	Root	Caps
AWS Classification:	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB
Electrode Diameter (in.):	1/8	1/8
Current/Polarity:	DCEP	DCEP
Current Range (amps):	91 – 92	91 – 92
Voltage Range (volts):	21 – 22	19 – 23
Travel Speed Range (ipm):	6.1 – 6.2	4.4 – 12.0

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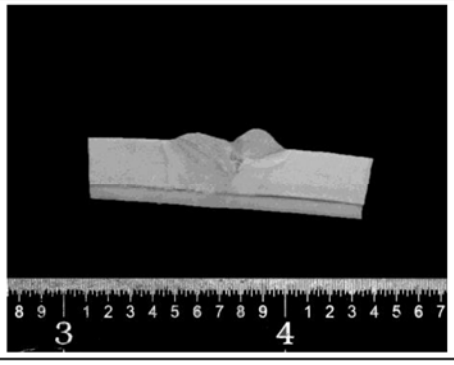
Test Number: X65LH-LS-7018-1 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



TENSILE TEST

Coupon Number:	X65LH-LS-7018-1 T1	X65LH-LS-7018-1 T2
Coupon Width:	1.023 inch	0.984 inch
Coupon Thickness:	0.217 inch	0.222 inch
Coupon Area:	0.222 inch^2	0.218 inch^2
Maximum Load:	19,687 lb.	17,801 lb.
Tensile Strength:	88,678 psi	81,657 psi
Fracture Location:	Sleeve	Sleeve

BEND TEST

Coupon Number:	X65LH-LS-7018-1 FB1	X65LH-LS-7018-1 FB2	X65LH-LS-7018-1 RB1	X65LH-LS-7018-1 RB2
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Root	Root
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	X65LH-LS-7018-1 NB1	X65LH-LS-7018-1 NB2
Results:	Pass	Pass

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: X65LH-LS-8018-1 **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Sleeve Material: 12.75 inch O.D., 0.250 inch wall, API 5L X65 pipe
Joint Design: Long seam on a 1/16 inch backing bar with a 3/32 inch gap, no land and 30° bevel on the sleeve
Position: 5G **Welding Direction:** Horizontal
Time Between Passes: 73 minutes between the root and first cap pass, 1 hour to finish the weld
Preheat Temperature: Ambient (70°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Water flowing through the run pipe
Test Medium Temperature: 50 – 70°F
Test Medium Flow Rate: Approximately 3 gallons a minute
Test Medium Pressure: Water was not pressurized

WELDING PARAMETERS

Pass:	Root	Caps
AWS Classification:	E8018-C3 H4R	E8018-C3 H4R
Manufacture:	ESAB	ESAB
Electrode Diameter (in.):	1/8	1/8
Current/Polarity:	DCEP	DCEP
Current Range (amps):	91 – 92	91 – 93
Voltage Range (volts):	21 – 24	19 – 23
Travel Speed Range (ipm):	4.5 – 5.7	3.8 – 10.3

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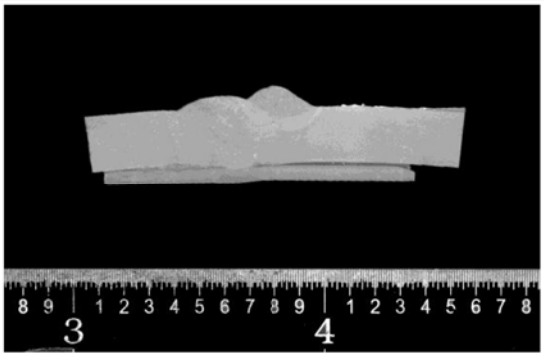
Test Number: X65LH-LS-8018-1 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



TENSILE TEST

Coupon Number:	X65LH-LS-8018-1 T1	X65LH-LS-8018-1 T2
Coupon Width:	1.005 inch	0.980 inch
Coupon Thickness:	0.221 inch	0.217 inch
Coupon Area:	0.222 inch^2	0.213 inch^2
Maximum Load:	18,062 lb.	18,446 lb.
Tensile Strength:	81,360 psi	86,600 psi
Fracture Location:	Sleeve	Sleeve

BEND TEST

Coupon Number:	X65LH-LS-8018-1 FB1	X65LH-LS-8018-1 FB2	X65LH-LS-8018-1 RB1	X65LH-LS-8018-1 RB2
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Root	Root
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	X65LH-LS-8018-1 NB1	X65LH-LS-8018-1 NB2
Results:	Pass	Pass

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 10/5/2015
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: X70LH-LS-7018-1 **Date:** 11/24/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Sleeve Material: 20 inch O.D., 0.500 inch wall, API 5L X70, 0.29 C.E. (IIW) pipe
Joint Design: Long seam on a 1/2 inch backing bar with a 5/32 inch gap, no land and 30° bevel on the sleeve
Position: 5G **Welding Direction:** Horizontal
Time Between Passes: 21 minutes between the root and hot Pass, 1 hours to finish the weld
Preheat Temperature: Ambient (75°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Air
Test Medium Temperature: Ambient
Test Medium Flow Rate: Not flowing
Test Medium Pressure: Air was not pressurized

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Caps
AWS Classification:	E7018 H4R	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	1/8	1/8	1/8	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	97 – 111	121 – 124	121 – 126	122 – 125
Voltage Range (volts):	22 – 24	21 – 23	21 – 22	21 – 22
Travel Speed Range (ipm):	5.2 – 6.4	5.8 – 7.3	5.0 – 10.9	7.4 – 8.6

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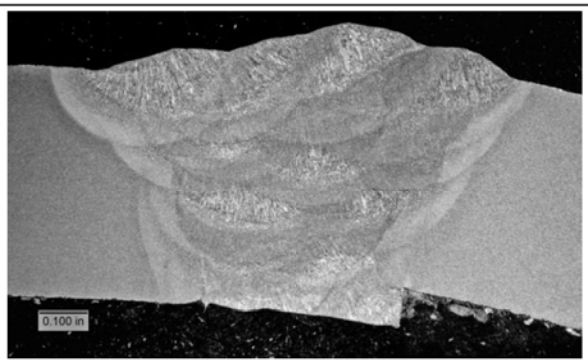
Test Number: X70LH-LS-7018-1 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



TENSILE TEST

Coupon Number:	X70LH-LS-7018-1 T1	X70LH-LS-7018-1 T2
Coupon Width:	0.960 inch	0.973 inch
Coupon Thickness:	0.485 inch	0.486 inch
Coupon Area:	0.466 inch^2	0.473 inch^2
Maximum Load:	43,429 lb.	44,332 lb.
Tensile Strength:	93,195 psi	93,725 psi
Fracture Location:	Weld (1)	Weld (1)
Comment:	(1) The weld meets the acceptance criteria of API 1104 Section 5.6.3.3.	

BEND TEST

Coupon Number:	X70LH-LS-7018-1 FB1	X70LH-LS-7018-1 FB2	X70LH-LS-7018-1 RB1	X70LH-LS-7018-1 RB2
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Root	Root
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	X70LH-LS-7018-1 NB1	X70LH-LS-7018-1 NB2
Results:	Pass	Pass

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 11/24/2015
Test Conducted By: Gerald McDaniel
Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

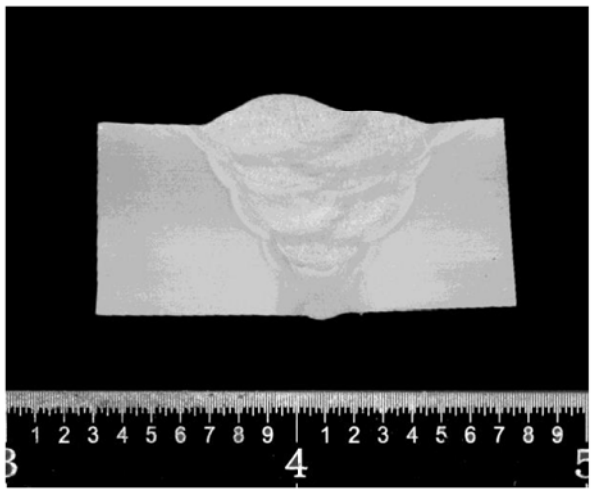
Test Number: 7018LS-1 **Date:** 5/29/2014
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 24 inch O.D., 0.688 inch wall, API 5L X70, 0.36 C.E. (IIW) pipe
Joint Design: Butt joint with a 3/32 inch gap, 3/32 inch land and 30° bevel on the pipe
Position: 5G **Welding Direction:** Uphill
Time Between Passes: 17 minutes between the root and hot Pass, 5 hours to finish the weld
Preheat Temperature: Ambient (56°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Root and hot pass deposited on air and the remainder deposited on water
Test Medium Temperature: Air was ambient and water was 50 – 70°F
Test Medium Flow Rate: Air was not flowing and water was approximately 3 gallons a minute
Test Medium Pressure: Air and water was not pressurized

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Caps
AWS Classification:	E7016 H4	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	1/8	1/8	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	65 – 74	99 – 102	105 – 109	103 – 104
Voltage Range (volts):	20 – 23	21 – 22	20 – 23	21 – 22
Travel Speed Range (ipm):	2.1 – 4.1	2.9 – 4.7	2.9 – 5.8	2.3 – 3.9

FIGURE 1 – BEAD SEQUENCE



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Test Number: 7018LS-1 **Page:** 2 of 2

TENSILE TEST

Coupon Number:	7018LS-1 T1	7018LS-1 T2	7018LS-1 T3	7018LS-1 T4
Coupon Width:	1.110 inch	1.060 inch	0.865 inch	0.935 inch
Coupon Thickness:	0.660 inch	0.660 inch	0.678 inch	0.677 inch
Coupon Area:	0.733 $inch^2$	0.700 $inch^2$	0.586 $inch^2$	0.633 $inch^2$
Maximum Load:	71,700 lb.	68,400 lb.	54,987 lb.	63,806 lb.
Tensile Strength:	97,817 psi	97,714 psi	93,800 psi	100,800 psi
Fracture Location:	Pipe	Pipe	Pipe	Pipe

BEND TEST

Coupon Number:	7018LS-1 SB1	7018LS-1 SB2	7018LS-1 SB3	7018LS-1 SB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Side	Side	Side	Side
Results:	Pass	Pass	Pass	Pass

Coupon Number:	7018LS-1 SB5	7018LS-1 SB6	7018LS-1 SB7	7018LS-1 SB8
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Side	Side	Side	Side
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	7018LS-1 NB1	7018LS-1 NB2	7018LS-1 NB3	7018LS-1 NB4
Results:	Pass	Pass	Pass	Pass

CHARPY TOUGHNESS TEST

Coupon Number:	7018LS-1 H1	7018LS-1 H2	7018LS-1 H3	7018LS-1 W1	7018LS-1 W2	7018LS-1 W3
Depth:	0.394 inch	0.394 inch	0.394 inch	0.394 inch	0.394 inch	0.394 inch
Width:	0.394 inch	0.394 inch	0.394 inch	0.394 inch	0.394 inch	0.394 inch
Notch Location:	HAZ	HAZ	HAZ	Centerline	Centerline	Centerline
Test Temperature:	-20°F	-20°F	-20°F	-20°F	-20°F	-20°F
Impact Energy:	139.0 ft-lb	160.0 ft-lb	65.0 ft-lb	22.0 ft-lb	29.0 ft-lb	28.5 ft-lb
% Shear:	67	66	47	41	38	31

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 5/29/2014
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

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API 1104 COUPON TEST REPORT **Page: 1 of 2**

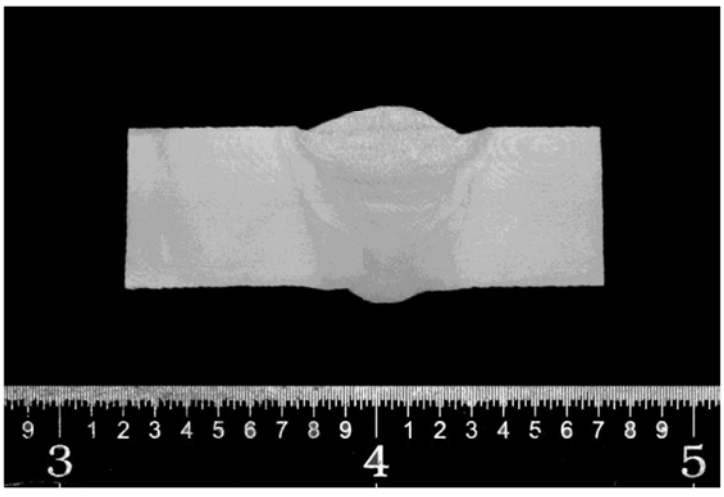
Test Number: 7018LS-2 **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 20 inch O.D., 0.500 inch wall, API 5L X70 pipe
Joint Design: Butt joint with a 3/32 inch gap, 3/32 inch land and 30° bevel on the pipe
Position: 5G **Welding Direction:** Uphill
Time Between Passes: 21 minutes between the root and hot pass, 4 hours to finish the weld
Preheat Temperature: Ambient (90°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Air
Test Medium Temperature: Ambient
Test Medium Flow Rate: Air was not flowing
Test Medium Pressure: Air was not pressure

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Caps
AWS Classification:	E7016 H4	E7018 H4R	E7018 H4R	E7018 H4R
Manufacture:	Lincoln	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	3/32	1/8	1/8
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	72 – 79	96 – 97	112 – 113	106 – 113
Voltage Range (volts):	20 – 23	21 – 22	22 – 23	21 – 23
Travel Speed Range (ipm):	2.8 – 4.7	2.4 – 3.4	2.7 – 4.9	2.8 – 3.7

FIGURE 1 – BEAD SEQUENCE



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Test Number: 7018LS-2 **Page:** 2 of 2

TENSILE TEST

Coupon Number:	7018LS-2 T1	7018LS-2 T2	7018LS-2 T3	7018LS-2 T4
Coupon Width:	1.153 inch	1.129 inch	1.076 inch	1.066 inch
Coupon Thickness:	0.510 inch	0.513 inch	0.502 inch	0.510 inch
Coupon Area:	0.588 $inch^2$	0.579 $inch^2$	0.540 $inch^2$	0.544 $inch^2$
Maximum Load:	48,569 lb.	48,173 lb.	45,468 lb.	46,566 lb.
Tensile Strength:	82,600 psi	83,200 psi	84,200 psi	85,600 psi
Fracture Location:	Pipe	Pipe	Pipe	Pipe

BEND TEST

Coupon Number:	7018LS-2 FB1	7018LS-2 FB2	7018LS-2 FB3	7018LS-2 FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Face	Face
Results:	Pass	Pass	Pass	Pass

Coupon Number:	7018LS-2 RB1	7018LS-2 RB2	7018LS-2 RB3	7018LS-2 RB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Root	Root	Root	Root
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	7018LS-2 NB1	7018LS-2 NB2	7018LS-2 NB3	7018LS-2 NB4
Results:	Pass	Pass	Pass	Pass

CHARPY TOUGHNESS TEST

Coupon Number:	7018LS-2 H1	7018LS-2 H2	7018LS-2 H3	7018LS-2 W1	7018LS-2 W2	7018LS-2 W3
Depth:	0.394 inch	0.394 inch	0.394 inch	0.394 inch	0.394 inch	0.394 inch
Width:	0.394 inch	0.394 inch	0.394 inch	0.394 inch	0.394 inch	0.394 inch
Notch Location:	HAZ	HAZ	HAZ	Centerline	Centerline	Centerline
Test Temperature:	-20°F	-20°F	-20°F	-20°F	-20°F	-20°F
Impact Energy:	76.0 ft-lb	70.0 ft-lb	22.5 ft-lb	18.0 ft-lb	82.0 ft-lb	96.0 ft-lb
% Shear:	47	41	22	21	42	46

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104

Date: 10/5/2015
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: X70LH-LS-8018-1 **Date:** 11/24/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Sleeve Material: 20 inch O.D., 0.500 inch wall, API 5L X70, 0.29 C.E. (IIW) pipe
Joint Design: Long seam on a 1/2 inch backing bar with a 3/16 inch gap, no and 30° bevel on the sleeve
Position: 5G **Welding Direction:** Horizontal
Time Between Passes: 48 minutes between the root and hot pass, 2 hours to finish the weld
Preheat Temperature: Ambient (75°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Air
Test Medium Temperature: Ambient
Test Medium Flow Rate: Not flowing
Test Medium Pressure: Air was no pressurized

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Caps
AWS Classification:	E8018-C3 H4R	E8018-C3 H4R	E8018-C3 H4R	E8018-C3 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	1/8	1/8	1/8	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	111 – 113	119 – 122	119 – 123	120 – 123
Voltage Range (volts):	21 – 24	21 – 23	21 – 23	21 – 23
Travel Speed Range (ipm):	4.0 – 8.5	6.0 – 7.0	6.3 – 9.4	5.9 – 10.0

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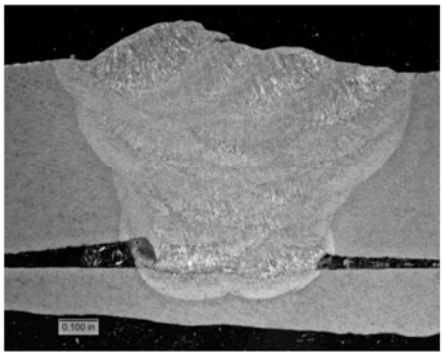
Test Number: X70LH-LS-8018-1 **Page:** 2 of 2

FIGURE 1 – BEAD SEQUENCE



TENSILE TEST

Coupon Number:	X70LH-LS-8018-1 T1	X70LH-LS-8018-1 T2
Coupon Width:	0.947 inch	0.987 inch
Coupon Thickness:	0.481 inch	0.488 inch
Coupon Area:	0.456 $inch^2$	0.482 $inch^2$
Maximum Load:	41,598 lb.	45,270 lb.
Tensile Strength:	91,224 psi	93,921 psi
Fracture Location:	Weld (1)	Weld (1)
Comment:	(1) The weld meets the acceptance criteria of API 1104 Section 5.6.3.3.	

BEND TEST

Coupon Number:	X70LH-LS-8018-1 FB1	X70LH-LS-8018-1 FB2	X70LH-LS-8018-1 RB1	X70LH-LS-8018-1 RB2
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Face	Face	Root	Root
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	X70LH-LS-8018-1 NB1	X70LH-LS-8018-1 NB2
Results:	Pass	Pass

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 5/29/2014
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

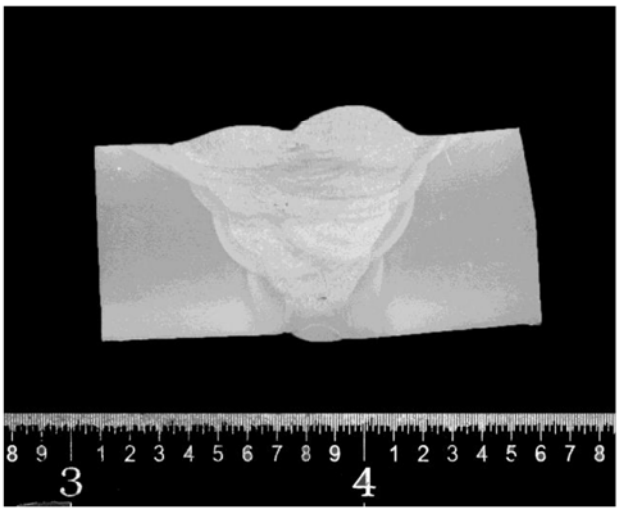
Test Number: 8018LS-1 **Date:** 5/29/2014
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 24 inch O.D., 0.688 inch wall, API 5L X70, 0.36 C.E. (IIW) pipe
Joint Design: Butt joint with a 3/32inch gap, 3/32 inch land and 30° bevel on the pipe
Position: 5G **Welding Direction:** Uphill
Time Between Passes: 17 minutes between the root and hot pass, 4 hours to finish the weld
Preheat Temperature: Ambient (56°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Root and hot pass deposited on air and the remainder deposited on water
Test Medium Temperature: Air was ambient and the water was 50 – 70°F
Test Medium Flow Rate: Air was not flowing and water was approximately 3 gallons a minute
Test Medium Pressure: Air and water was no pressurized

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Caps
AWS Classification:	E7016 H4	E8018-C3 H4R	E8018-C3 H4R	E8018-C3 H4R
Manufacture:	ESAB	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	1/8	1/8	3/32
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	66 – 75	102 – 103	104 – 109	103
Voltage Range (volts):	20 – 23	21 – 22	20 – 22	20 – 22
Travel Speed Range (ipm):	2.0 – 4.2	3.6 – 4.2	2.9 – 6.4	2.7 – 5.1

FIGURE 1 – BEAD SEQUENCE



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Test Number: 8018LS-1 **Page:** 2 of 2

TENSILE TEST

Coupon Number:	8018LS-1 T1	8018LS-1 T2	8018LS-1 T3	8018LS-1 T4
Coupon Width:	1.031 inch	1.150 inch	0.932 inch	0.922 inch
Coupon Thickness:	0.640 inch	0.670 inch	0.675 inch	0.679 inch
Coupon Area:	0.660 $inch^2$	0.771 $inch^2$	0.629 $inch^2$	0.626 $inch^2$
Maximum Load:	66,198 lb.	70,800 lb.	59,503 lb.	58,719 lb.
Tensile Strength:	100,300 psi	91,829 psi	94,600 psi	93,800 psi
Fracture Location:	Pipe	Pipe	Pipe	Pipe

BEND TEST

Coupon Number:	8018LS-1 SB1	8018LS-1 SB2	8018LS-1 SB3	8018LS-1 SB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Side	Side	Side	Side
Results:	Pass	Pass	Pass	Pass

Coupon Number:	8018LS-1 SB5	8018LS-1 SB6	8018LS-1 SB7	8018LS-1 SB8
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Side	Side	Side	Side
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	8018LS-1 NB1	8018LS-1 NB2	8018LS-1 NB3	8018LS-1 NB4
Results:	Pass	Pass	Pass	Pass

CHARPY TOUGHNESS TEST

Coupon Number:	8018LS-1 H1	8018LS-1 H2	8018LS-1 H3	8018LS-1 W1	8018LS-1 W2	8018LS-1 W3
Depth:	0.394 inch	0.394 inch	0.394 inch	0.394 inch	0.394 inch	0.394 inch
Width:	0.394 inch	0.394 inch	0.394 inch	0.394 inch	0.394 inch	0.394 inch
Notch Location:	HAZ	HAZ	HAZ	Centerline	Centerline	Centerline
Test Temperature:	-20°F	-20°F	-20°F	-20°F	-20°F	-20°F
Impact Energy:	113.0 ft-lb	48.0 ft-lb	108.0 ft-lb	49.0 ft-lb	56.0 ft-lb	59.5 ft-lb
% Shear:	57	33	48	49	49	57

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 20th Edition of API 1104 and the 21st Edition of API 1104

Date: 5/29/2014
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

Kiefner DNV·GL

API 1104 COUPON TEST REPORT **Page: 1 of 2**

Test Number: 8018LS-2 **Date:** 10/5/2015
Location: Kiefner Mechanical Test Lab, Worthington, Ohio
Welder: Jeremy Didion, Apeks Fabrication

Welding Process: Manual SMAW **Welding Machine:** Miller CST 280
Pipe Material: 20 inch O.D., 0.500 inch wall, API 5L X70 pipe
Joint Design: Butt joint with a 3/32 inch gap, 3/32 inch land and 30° bevel
Position: 5G **Welding Direction:** Uphill
Time Between Passes: 21 minutes between the root and hot pass, 4 hours to finish the weld
Preheat Temperature: Ambient (90°F) **Post-weld Heat Treatment:** None used
Line-up Clamps: None used
Test Medium: Air
Test Medium Temperature: Ambient
Test Medium Flow Rate: Air was not flowing
Test Medium Pressure: Air was not pressurized

WELDING PARAMETERS

Pass:	Root	Hot Pass	Fills	Caps
AWS Classification:	E7016 H4	E8018-C3 H4R	E8018-C3 H4R	E8018-C3 H4R
Manufacture:	Lincoln	ESAB	ESAB	ESAB
Electrode Diameter (in.):	3/32	1/8	1/8	1/8
Current/Polarity:	DCEP	DCEP	DCEP	DCEP
Current Range (amps):	74 – 78	107 – 108	112 – 115	113 – 114
Voltage Range (volts):	20 – 23	21 – 22	21 – 23	21 – 23
Travel Speed Range (ipm):	3.1 – 4.6	3.5 – 4.8	3.1 – 5.3	2.5 – 4.1

FIGURE 1 – BEAD SEQUENCE

Macro Section Not Available

Kiefner DNV·GL

Test Number: 8018LS-2 **Page:** 2 of 2

TENSILE TEST

Coupon Number:	8018LS-2 T1	8018LS-2 T2	8018LS-2 T3	8018LS-2 T4
Coupon Width:	1.130 inch	1.130 inch	1.076 inch	1.128 inch
Coupon Thickness:	0.506 inch	0.505 inch	0.506 inch	0.501 inch
Coupon Area:	0.572 $inch^2$	0.571 $inch^2$	0.544 $inch^2$	0.565 $inch^2$
Maximum Load:	51,308 lb.	46,879 lb.	46,294 lb.	47,291 lb.
Tensile Strength:	89,700 psi	82,100 psi	85,100 psi	83,700 psi
Fracture Location:	Pipe	Pipe	Pipe	Pipe

BEND TEST

Coupon Number:	8018LS-2 FB1	8018LS-2 FB2	8018LS-2 FB3	8018LS-2 FB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Side	Side	Side	Side
Results:	Pass	Pass	Pass	Pass

Coupon Number:	8018LS-2 RB1	8018LS-2 RB2	8018LS-2 RB3	8018LS-2 RB4
Bend Diameter:	3.5 inch	3.5 inch	3.5 inch	3.5 inch
Type:	Side	Side	Side	Side
Results:	Pass	Pass	Pass	Pass

NICK-BREAK TEST

Coupon Number:	8018LS-2 NB1	8018LS-2 NB2	8018LS-2 NB3	8018LS-2 NB4
Results:	Pass	Pass	Pass	Pass

CHARPY TOUGHNESS TEST

Coupon Number:	8018LS-2 H1	8018LS-2 H2	LS8018-2 H3	8018LS-2 W1	801LS8-2 W2	8018LS-2 W3
Depth:	0.394 inch	0.394 inch	0.394 inch	0.394 inch	0.394 inch	0.394 inch
Width:	0.394 inch	0.394 inch	0.394 inch	0.394 inch	0.394 inch	0.394 inch
Notch Location:	HAZ	HAZ	HAZ	Centerline	Centerline	Centerline
Test Temperature:	-20°F	-20°F	-20°F	-20°F	-20°F	-20°F
Impact Energy:	24.0 ft-lb	33.0 ft-lb	53.5 ft-lb	76.5 ft-lb	40.0 ft-lb	70.0 ft-lb
% Shear:	26	37	39	45	41	52

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of the 21st Edition of API 1104

Date: 10/5/2015
Test Conducted By: Jim Winigman
Certified By: Matt Boring, P.E., CWI

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. M-1-GRB-179		Orig. Issue Date	Revision Date
	WPS No. M-BW-1-A-I		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Metal Inert Gas (MIG)		Type of Process: Manual	
	For: Butt Welding ☑	Fillet Welding ☐		
PIPE	Material Specification: 1.315" O.D. - GR-B - 0.179" WT. API 5L			
DIAMETER	API 1104 6.2.2 Guidelines	☑ Under 2-3/8" OD	☐ 2-3/8" to 12-3/4" OD	☐ > 12-3/4" OD
MATERIAL	API 1104 5.4.2.2 Guidelines	☑ ≤ 42,000 PSI Yield	☐ > 42,000 to < 65,000 PSI Yield	☐ ≥ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☑ Under 3/16" thick	☐ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: ER70S-3	AWS Electrode Size: 0.035"	AWS Specification: A5.18	Filler Metal Group: 5^b
	Wire Feed Rate (IPM) : 170-200			
GAS	75/25 Argon/CO2	40 cfm		
PREHEAT	Minimum Preheat Temperature (F): 50^0	Interpass Temperature (F): $>100^0$	Other:	

POSITION

WELD AXIS			TECHNIQUE		DIRECTION	
Flat (1G, 1F, 1FR)	☑	Plate ☐	Backhand	☑	Vertical - Up	☐
Horizontal (2G, 2F, 2FR)	☐	Pipe ☑	Forehand	☐	Vertical - Down	☑
Vertical (3G, 3F)	☐	Rotated ☑				
Overhead (4G, 4F)	☐	Fixed ☐				
Multiple (5G, 5F)	☐	Inclined (6G, 6F) ☐				
Combination ☐						

TECHNIQUE

DISPOSITION STYLE		METHOD		ARC TYPE		
Stringer Beads	☑	Multiple Pass	☑	Single Arc	☑	Other: ☐
Weave Beads	☐	Single Pass	☐	Multiple Arc	☐	

CLEANING

Base Material: Power ☑ Hand ☐ | Weld: Power ☑ Hand ☐

JOINT DESIGN

BUTT WELD ☑ FILLET WELD ☐

Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ Polarity: Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE VOLTS	RANGE AMPS	MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
Root	1	ER70S-3	0.035	15-19		5	12
Hot Pass	1	ER70S-3	0.035	15-19		5	12
Fill							
Cap	1	ER70S-3	0.035	15-19		5	12

(Over)

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1	0.87	0.24	0.21	7613	36461	Ductile	Base Metal
2							
3							
4							

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
5	180 Degrees			Yes ☑ No ☐	
6	180 Degrees			Yes ☑ No ☐	
7	180 Degrees			Yes ☐ No ☐	
8	180 Degrees			Yes ☐ No ☐	
9		180 Degrees		Yes ☐ No ☐	
10		180 Degrees		Yes ☐ No ☐	
11		180 Degrees		Yes ☐ No ☐	
12		180 Degrees		Yes ☐ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☑ No ☐	
14	Yes ☑ No ☐	
15	Yes ☐ No ☐	
16	Yes ☐ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☐ No ☐		Penetration into Parent Metal: Yes ☐ No ☐	
Fillet Weld - Fracture Test		Length of Percent of Defect	in.: %:

WELDER INFO

Chris Jobert	License Number & State J00-435-533	Stencil Mark
Contractor Duke Energy		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By: Ralph Pfister		
Visual Examination Results: Satisfactory		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography): NA		
Mechanical Test Conducted By: Walter C. Dumford		Laboratory Test No:
Approved By: Walter C. Dumford		Organization: Terracon Consultants
APPROVED ☑	REJECTED ☐	Date: 5/7/15

REMARKS

SUBMITTAL

By: Walter C. Dumford		Title: Certified Welding Inspector
Company/Organization: Terracon Consultants		Date: 5/7/15

APPROVAL

Engineer:	Date:
Weld Supervisor:	Date:
Director of Gas Engineering:	Date:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. M-2-X42-154		Orig. Issue Date	Revision Date
	WPS No. M-BW-2-A-I		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Metal Inert Gas (MIG)		Type of Process: Manual	
	For: Butt Welding ☑	Fillet Welding ☐		
PIPE	Material Specification: 2.375" O.D. X - X-42 -0.154" WT. API 5L			
DIAMETER	API 1104 6.2.2 Guidelines	☐ Under 2-3/8" OD	☑ 2-3/8" to 12-3/4" OD	☐ > 12-3/4" OD
MATERIAL	API 1104 5.4.2.2 Guidelines	☑ ≤ 42,000 PSI Yield	☐ > 42,000 to < 65,000 PSI Yield	☐ ≥ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☑ Under 3/16" thick	☐ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: ER70S-3	AWS Electrode Size: 0.035"	AWS Specification: A5.18	Filler Metal Group: 5^b
	Wire Feed Rate (IPM) : 200-280			
GAS	75/25 Argon/CO2	40 cfm		
PREHEAT	Minimum Preheat Temperature (F): 50^0	Interpass Temperature (F): $>100^0$	Other:	

POSITION

WELD AXIS				TECHNIQUE		DIRECTION	
Flat (1G, 1F, 1FR)	☑	Plate	☐	Backhand	☑	Vertical - Up	☐
Horizontal (2G, 2F, 2FR)	☐	Pipe	☑	Forehand	☐	Vertical - Down	☑
Vertical (3G, 3F)	☐	Rotated	☑				
Overhead (4G, 4F)	☐	Fixed	☐				
Multiple (5G, 5F)	☐	Inclined (6G, 6F)	☐				
Combination	☐						

TECHNIQUE

DISPOSITION STYLE		METHOD		ARC TYPE		
Stringer Beads	☑	Multiple Pass	☑	Single Arc	☑	Other: ☐
Weave Beads	☐	Single Pass	☐	Multiple Arc	☐	

CLEANING

Base Material: Power ☑ Hand ☐ | Weld: Power ☑ Hand ☐

JOINT DESIGN

BUTT WELD ☑ | FILLET WELD ☐

Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ **Polarity:** Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE VOLTS	RANGE AMPS	MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
Root	1	ER70S-3	0.035	15-19		5	12
Hot Pass	1	ER70S-3	0.035	15-19		5	12
Fill							
Cap	1	ER70S-3	0.035	15-19		5	12

(Over)

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1							
2							
3							
4							

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
5	180 Degrees			Yes ☑ No ☐	
6	180 Degrees			Yes ☑ No ☐	
7	180 Degrees			Yes ☐ No ☐	
8	180 Degrees			Yes ☐ No ☐	
9		180 Degrees		Yes ☐ No ☐	
10		180 Degrees		Yes ☐ No ☐	
11		180 Degrees		Yes ☐ No ☐	
12		180 Degrees		Yes ☐ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☑ No ☐	
14	Yes ☑ No ☐	
15	Yes ☐ No ☐	
16	Yes ☐ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☐ No ☐		Penetration into Parent Metal: Yes ☐ No ☐	
Fillet Weld - Fracture Test		Length of Percent of Defect	in.: %:

WELDER INFO

Welder Name Chris Jobert	License Number & State J00-435-533	Stencil Mark
Contractor Duke Energy		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By: Ralph Pfister		
Visual Examination Results: Satisfactory		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography): NA		
Mechanical Test Conducted By: Walter C. Dumford		Laboratory Test No:
Approved By: Walter C. Dumford		Organization: Terracon Consultants
APPROVED ☑	REJECTED ☐	Date: 5/7/15

REMARKS

SUBMITTAL

By: Walter C. Dumford		Title: Certified Welding Inspector
Company/Organization: Terracon Consultants		Date: 5/7/15

APPROVAL

Engineer:	Date:
Weld Supervisor:	Date:
Director of Gas Engineering:	Date:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. M-1-X52-179		Orig. Issue Date	Revision Date
	WPS No. M-BW-1-B-I		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Metal Inert Gas (MIG)		Type of Process: Manual	
	For: Butt Welding ☑	Fillet Welding ☐		
PIPE	Material Specification: 1.315" O.D. - X-52 - 0.179" WT. API 5L			
DIAMETER	API 1104 6.2.2 Guidelines	☑ Under 2-3/8" OD	☐ 2-3/8" to 12-3/4" OD	☐ > 12-3/4" OD
MATERIAL	API 1104 5.4.2.2 Guidelines	☐ ≤ 42,000 PSI Yield	☑ > 42,000 to < 65,000 PSI Yield	☐ ≥ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☑ Under 3/16" thick	☐ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: ER70S-3	AWS Electrode Size: 0.035"	AWS Specification: A5.18	Filler Metal Group: 5^b
	Wire Feed Rate (IPM) : 170-200			
GAS	75/25 Argon/CO2	40 cfm		
PREHEAT	Minimum Preheat Temperature (F): 50^0	Interpass Temperature (F): $>100^0$	Other:	

POSITION

WELD AXIS			TECHNIQUE		DIRECTION	
Flat (1G, 1F, 1FR)	☑	Plate ☐	Backhand	☑	Vertical - Up	☐
Horizontal (2G, 2F, 2FR)	☐	Pipe ☑	Forehand	☐	Vertical - Down	☑
Vertical (3G, 3F)	☐	Rotated ☑				
Overhead (4G, 4F)	☐	Fixed ☐				
Multiple (5G, 5F)	☐	Inclined (6G, 6F) ☐				
Combination ☐						

TECHNIQUE

DISPOSITION STYLE		METHOD		ARC TYPE		
Stringer Beads	☑	Multiple Pass	☑	Single Arc	☑	Other: ☐
Weave Beads	☐	Single Pass	☐	Multiple Arc	☐	

CLEANING

Base Material: Power ☑ Hand ☐ | Weld: Power ☑ Hand ☐

JOINT DESIGN

BUTT WELD ☑ FILLET WELD ☐

Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ Polarity: Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE VOLTS	RANGE AMPS	MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
Root	1	ER70S-3	0.035	15-19		5	12
Hot Pass	1	ER70S-3	0.035	15-19		5	12
Fill							
Cap	1	ER70S-3	0.035	15-19		5	12

(Over)

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1	0.87	0.22	0.19	14660	76594	Ductile	Base Metal
2							
3							
4							

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
5	180 Degrees			Yes ☑ No ☐	
6	180 Degrees			Yes ☑ No ☐	
7	180 Degrees			Yes ☐ No ☐	
8	180 Degrees			Yes ☐ No ☐	
9		180 Degrees		Yes ☐ No ☐	
10		180 Degrees		Yes ☐ No ☐	
11		180 Degrees		Yes ☐ No ☐	
12		180 Degrees		Yes ☐ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☑ No ☐	
14	Yes ☑ No ☐	
15	Yes ☐ No ☐	
16	Yes ☐ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☐ No ☐		Penetration into Parent Metal: Yes ☐ No ☐	
Fillet Weld - Fracture Test		Length of Percent of Defect	in.: %:

WELDER INFO

Chris Jobert	License Number & State J00-435-533	Stencil Mark
Contractor Duke Energy		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By: Ralph Pfister		
Visual Examination Results: Satisfactory		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography): NA		
Mechanical Test Conducted By: Walter C. Dumford		Laboratory Test No:
Approved By: Walter C. Dumford		Organization: Terracon Consultants
APPROVED ☑	REJECTED ☐	Date: 5/7/15

REMARKS

SUBMITTAL

By: Walter C. Dumford		Title : Certified Welding Inspector
Company/Organization: Terracon Consultants		Date: 5/7/15

APPROVAL

Engineer:	Date:
Weld Supervisor:	Date:
Director of Gas Engineering:	Date:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. M-2-X52-154		Orig. Issue Date	Revision Date
	WPS No. M-BW-2-B-I		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Metal Inert Gas (MIG)		Type of Process: Manual	
	For: Butt Welding ☑	Fillet Welding ☐		
PIPE	Material Specification: 2.375" O.D. X-52-0.154" WT. API 5L			
DIAMETER	API 1104 6.2.2 Guidelines	☐ Under 2-3/8" OD	☑ 2-3/8" to 12-3/4" OD	☐ > 12-3/4" OD
MATERIAL	API 1104 5.4.2.2 Guidelines	☐ ≤ 42,000 PSI Yield	☑ > 42,000 to < 65,000 PSI Yield	☐ ≥ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☑ Under 3/16" thick	☐ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: ER70S-3	AWS Electrode Size: 0.035"	AWS Specification: A5.18	Filler Metal Group: 5^b
	Wire Feed Rate (IPM) : 200-280			
GAS	75/25 Argon/CO2	40 cfm		
PREHEAT	Minimum Preheat Temperature (F): 50^0	Interpass Temperature (F): $>100^0$	Other:	

POSITION

WELD AXIS				TECHNIQUE		DIRECTION	
Flat (1G, 1F, 1FR)	☑	Plate	☐	Backhand	☑	Vertical - Up	☐
Horizontal (2G, 2F, 2FR)	☐	Pipe	☑	Forehand	☐	Vertical - Down	☑
Vertical (3G, 3F)	☐	Rotated	☑				
Overhead (4G, 4F)	☐	Fixed	☐				
Multiple (5G, 5F)	☐	Inclined (6G, 6F)	☐				
Combination	☐						

TECHNIQUE

DISPOSITION STYLE		METHOD		ARC TYPE		
Stringer Beads	☑	Multiple Pass	☑	Single Arc	☑	Other: ☐
Weave Beads	☐	Single Pass	☐	Multiple Arc	☐	

CLEANING	Base Material: Power ☑	Hand ☐	Weld: Power ☑	Hand ☐	

JOINT DESIGN

BUTT WELD ☑ FILLET WELD ☐

Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ **Polarity:** Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE VOLTS	RANGE AMPS	MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
Root	1	ER70S-3	0.035	15 - 19		5	12
Hot Pass	1	ER70S-3	0.035	15 - 19		5	12
Fill							
Cap	1	ER70S-3	0.035	15 - 19		5	12

(Over)

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1	1.05	0.18	0.19	13527	71571	Ductile	Base Metal
2							
3							
4							

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
5	180 Degrees			Yes ☑ No ☐	
6	180 Degrees			Yes ☑ No ☐	
7	180 Degrees			Yes ☐ No ☐	
8	180 Degrees			Yes ☐ No ☐	
9		180 Degrees		Yes ☐ No ☐	
10		180 Degrees		Yes ☐ No ☐	
11		180 Degrees		Yes ☐ No ☐	
12		180 Degrees		Yes ☐ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☑ No ☐	
14	Yes ☑ No ☐	
15	Yes ☐ No ☐	
16	Yes ☐ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☐ No ☐

Penetration into Parent Metal: Yes ☐ No ☐

Macro Results (Fusion):

Fillet Weld Fracture Test

Length of Percent of Defect in.: %:

Fillet Leg Size: _____inches x _____ inches

Concavity/Convexity in.:

WELDER INFO

Welder Name Chris Jobert

License Number & State J00-435-533

Stencil Mark

Contractor Duke Energy

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By: Ralph Pfister

Visual Examination Results: Satisfactory

Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography): NA

Mechanical Test Conducted By: Walter C. Dumford

Laboratory Test No:

Approved By: Walter C. Dumford

Organization: Terracon Consultants

APPROVED ☑ REJECTED ☐

Date: 5/7/15

REMARKS

SUBMITTAL

By: Walter C. Dumford

Title: Certified Welding Inspector

Company/Organization: Terracon Consultants

Date: 5/7/15

APPROVAL

Engineer:

Date:

Weld Supervisor:

Date:

Director of Gas Engineering:

Date:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. M-4-X52-188		Orig. Issue Date	Revision Date
	WPS No. M-BW-2-B-II		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Metal Inert Gas (MIG)		Type of Process: Manual	
	For: Butt Welding ☑	Fillet Welding ☐		
PIPE	Material Specification: 4.5"O.D. - X-52 - 0.188" WT. API 5L			
DIAMETER	API 1104 6.2.2 Guidelines	☐ Under 2-3/8" OD	☑ 2-3/8" to 12-3/4" OD	☐ > 12-3/4" OD
MATERIAL	API 1104 5.4.2.2 Guidelines	☐ ≤ 42,000 PSI Yield	☑ > 42,000 to < 65,000 PSI Yield	☐ ≥ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☐ Under 3/16" thick	☑ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: ER70S-3	AWS Electrode Size: 0.035"	AWS Specification: A5.18	Filler Metal Group: 5^b
	Wire Feed Rate (IPM) : 200-280			
GAS	75/25 Argon/CO2	40 cfm		
PREHEAT	Minimum Preheat Temperature (F): 50^0	Interpass Temperature (F): $>100^0$	Other:	

POSITION

WELD AXIS			TECHNIQUE		DIRECTION	
Flat (1G, 1F, 1FR)	☑	Plate ☐	Backhand	☑	Vertical - Up	☐
Horizontal (2G, 2F, 2FR)	☐	Pipe ☑	Forehand	☐	Vertical - Down	☑
Vertical (3G, 3F)	☐	Rotated ☑				
Overhead (4G, 4F)	☐	Fixed ☐				
Multiple (5G, 5F)	☐	Inclined (6G, 6F) ☐				
Combination	☐					

TECHNIQUE

DISPOSITION STYLE		METHOD		ARC TYPE		
Stringer Beads	☑	Multiple Pass	☑	Single Arc	☑	Other: ☐
Weave Beads	☐	Single Pass	☐	Multiple Arc	☐	

CLEANING	Base Material: Power ☑	Hand ☐	Weld: Power ☑	Hand ☐	
JOINT DESIGN	BUTT WELD ☑		FILLET WELD ☐		

Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ **Polarity:** Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE VOLTS	RANGE AMPS	MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
Root	1	ER70S-3	0.035	15 - 19		5	12
Hot Pass	1	ER70S-3	0.035	15 - 19		5	12
Fill							
Cap	1	ER70S-3	0.035	15 - 19		5	12

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1	0.73	0.2	0.15	9077	62171	Ductile	Base Metal
2							
3							
4							

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
5	180 Degrees			Yes ☑ No ☐	
6	180 Degrees			Yes ☑ No ☐	
7	180 Degrees			Yes ☐ No ☐	
8	180 Degrees			Yes ☐ No ☐	
9		180 Degrees		Yes ☐ No ☐	
10		180 Degrees		Yes ☐ No ☐	
11		180 Degrees		Yes ☐ No ☐	
12		180 Degrees		Yes ☐ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☑ No ☐	
14	Yes ☑ No ☐	
15	Yes ☐ No ☐	
16	Yes ☐ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☐ No ☐		Penetration into Parent Metal: Yes ☐ No ☐	
Fillet Weld - Fracture Test		Length of Percent of Defect	in.: %:

WELDER INFO

Welder Name Chris Jobert	License Number & State J00-435-533	Stencil Mark
Contractor Duke Energy		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By: Ralph Pfister		
Visual Examination Results: Satisfactory		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography): NA		
Mechanical Test Conducted By: Walter C. Dumford		Laboratory Test No:
Approved By: Walter C. Dumford		Organization: Terracon Consultants
APPROVED ☑	REJECTED ☐	Date: 5/7/15

REMARKS

SUBMITTAL

By: Walter C. Dumford		Title: Certified Welding Inspector
Company/Organization: Terracon Consultants		Date: 5/7/15

APPROVAL

Engineer:	Date:
Weld Supervisor:	Date:
Director of Gas Engineering:	Date:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. M-F-2-X42-154		Orig. Issue Date	Revision Date
	WPS No. M-FW-A-I		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Metal Inert Gas (MIG)		Type of Process: Manual	
	For: Butt Welding ☐	Fillet Welding ☑		
PIPE	Material Specification: 2.375" O.D.- X-42 - 0.154" WT. API 5L			
DIAMETER	API 1104 6.2.2 Guidelines	☐ ~~Under 2-3/8" OD~~	☐ ~~2-3/8" to 12-3/4" OD~~	☐ ~~> 12-3/4" OD~~
MATERIAL	API 1104 5.4.2.2 Guidelines	☑ ≤ 42,000 PSI Yield	☐ > 42,000 to < 65,000 PSI Yield	☐ ≥ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☑ Under 3/16" thick	☐ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: ER70S-3	AWS Electrode Size: 0.035"	AWS Specification: A5.18	Filler Metal Group: 5^b
	Wire Feed Rate (IPM) : 200-280			
GAS	75/25 Argon/CO2	40 cfm		
PREHEAT	Minimum Preheat Temperature (F): 50^0	Interpass Temperature (F): $>100^0$	Other:	

POSITION

WELD AXIS			TECHNIQUE		DIRECTION	
Flat (1G, 1F, 1FR)	☑	Plate ☐	Backhand	☑	Vertical - Up	☐
Horizontal (2G, 2F, 2FR)	☐	Pipe ☑	Forehand	☐	Vertical - Down	☑
Vertical (3G, 3F)	☐	Rotated ☑				
Overhead (4G, 4F)	☐	Fixed ☐				
Multiple (5G, 5F)	☐	Inclined (6G, 6F) ☐				
Combination	☐					

TECHNIQUE

DISPOSITION STYLE		METHOD		ARC TYPE		
Stringer Beads	☑	Multiple Pass	☑	Single Arc	☑	Other: ☐
Weave Beads	☐	Single Pass	☐	Multiple Arc	☐	

CLEANING	Base Material: Power ☑	Hand ☐	Weld: Power ☑	Hand ☐	
JOINT DESIGN	BUTT WELD ☐		FILLET WELD ☑		

Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ **Polarity:** Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE VOLTS	RANGE AMPS	MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
Root	1	ER70S-3	0.035	15 - 19		5	12
Hot Pass	1	ER70S-3	0.035	15 - 19		5	12
Fill							
Cap	1	ER70S-3	0.035	15 - 19		5	12

TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
1							
2							
3							
4							

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
5	180 Degrees			Yes ☐ No ☐	
6	180 Degrees			Yes ☐ No ☐	
7	180 Degrees			Yes ☐ No ☐	
8	180 Degrees			Yes ☐ No ☐	
9		180 Degrees		Yes ☐ No ☐	
10		180 Degrees		Yes ☐ No ☐	
11		180 Degrees		Yes ☐ No ☐	
12		180 Degrees		Yes ☐ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☑ No ☐	
14	Yes ☑ No ☐	
15	Yes ☑ No ☐	
16	Yes ☑ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☑ No ☐		Penetration into Parent Metal: Yes ☑ No ☐	
Fillet Weld - Fracture Test: Acceptable		Length of Percent of Defect: None	in.: %:

WELDER INFO

Welder Name Chris Jobert	License Number & State J00-435-533	Stencil Mark
Contractor Duke Energy		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By: Ralph Pfister		
Visual Examination Results: Satisfactory		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography): NA		
Mechanical Test Conducted By: Walter C. Dumford		Laboratory Test No:
Approved By: Walter C. Dumford		Organization: Terracon Consultants
APPROVED ☑	REJECTED ☐	Date: 5/7/15

REMARKS

SUBMITTAL

By: Walter C. Dumford		Title: Certified Welding Inspector
Company/Organization: Terracon Consultants		Date: 5/7/15

APPROVAL

Engineer:	Date:
Weld Supervisor:	Date:
Director of Gas Engineering:	Date:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. M-F-2-X52-154		Orig. Issue Date	Revision Date
	WPS No. M-FW-B-I		Orig. Issue Date	Revision Date
	API 1104 ☑	Other ☐		
PROCESS	Metal Inert Gas (MIG)		Type of Process: Manual	
	For: Butt Welding ☐	Fillet Welding ☑		
PIPE	Material Specification: 2.375" O.D. X-52-0.154" WT. API 5L			
DIAMETER	API 1104 6.2.2 Guidelines	☐ ~~Under 2-3/8" OD~~	☐ ~~2-3/8" to 12-3/4" OD~~	☐ ~~> 12-3/4" OD~~
MATERIAL	API 1104 5.4.2.2 Guidelines	☐ ≤ 42,000 PSI Yield	☑ > 42,000 to < 65,000 PSI Yield	☐ ≥ 65,000 PSI Yield
THICKNESS	API 1104 6.2.2 Guidelines	☑ Under 3/16" thick	☐ 3/16" thru 3/4" thick	☐ Over 3/4" thick
FILLER METALS	AWS Electrode Nos: ER70S-3	AWS Electrode Size: 0.035"	AWS Specification: A5.18	Filler Metal Group: 5^b
	Wire Feed Rate (IPM) : 200-280			
GAS	75/25 Argon/CO2	40 cfm		
PREHEAT	Minimum Preheat Temperature (F): 50^0	Interpass Temperature (F): $>100^0$	Other:	

POSITION

WELD AXIS				TECHNIQUE		DIRECTION	
Flat (1G, 1F, 1FR)	☑	Plate	☐	Backhand	☑	Vertical - Up	☐
Horizontal (2G, 2F, 2FR)	☐	Pipe	☑	Forehand	☐	Vertical - Down	☑
Vertical (3G, 3F)	☐	Rotated	☑				
Overhead (4G, 4F)	☐	Fixed	☐				
Multiple (5G, 5F)	☐	Inclined (6G, 6F)	☐				
Combination	☐						

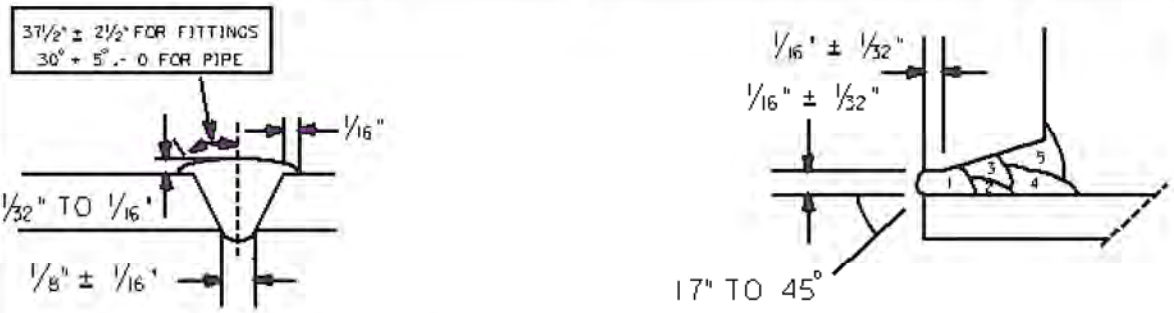
TECHNIQUE

DISPOSITION STYLE		METHOD		ARC TYPE		
Stringer Beads	☑	Multiple Pass	☑	Single Arc	☑	Other: ☐
Weave Beads	☐	Single Pass	☐	Multiple Arc	☐	

CLEANING	Base Material: Power	☑	Hand	☐	Weld: Power ☑ Hand ☐

JOINT DESIGN

BUTT WELD ☐ FILLET WELD ☑



Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ **Polarity:** Straight/Negative ☐ Reverse/Positive ☑

BEAD NO.	Passes	ELECTRODE NO. & TYPE	Size	RANGE VOLTS	RANGE AMPS	MAXIMUM TIME LAPSE ALLOWED (Min.)	SPEED RANGE (IPM)
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Fill							
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TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
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NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☑ No ☐	
14	Yes ☑ No ☐	
15	Yes ☑ No ☐	
16	Yes ☑ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☑ No ☐		Penetration into Parent Metal: Yes ☑ No ☐	
Fillet Weld - Fracture Test: Satisfactory		Length of Percent of Defect: None	in.: %:

WELDER INFO

Welder Name Chris Jobert	License Number & State J00-435-533	Stencil Mark
Contractor Duke Energy		

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Mechanical Test Conducted By: Walter C. Dumford		Laboratory Test No:
Approved By: Walter C. Dumford		Organization: Terracon Consultants
APPROVED ☑	REJECTED ☐	Date: 5/7/15

REMARKS

SUBMITTAL

By: Walter C. Dumford	Title: Certified Welding Inspector	
Company/Organization: Terracon Consultants		Date: 5/7/15

APPROVAL

Engineer:	Date:
Weld Supervisor:	Date:
Director of Gas Engineering:	Date:

DUKE ENERGY

Gas Operations

PROCEDURE QUALIFICATION RECORD (PQR)

TYPE OF RECORD	PQR No. M-F-4-X52-188		Orig. Issue Date	Revision Date
	WPS No. M-FW-B-II		Orig. Issue Date	Revision Date
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	For: Butt Welding ☐	Fillet Welding ☑		
PIPE	Material Specification: 4.5"O.D. - X-52 - 0.188" WT. API 5L			
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	Wire Feed Rate (IPM) : 200-280			
GAS	75/25 Argon/CO2	40 cfm		
PREHEAT	Minimum Preheat Temperature (F): 50^0	Interpass Temperature (F): $>100^0$	Other:	

POSITION

WELD AXIS			TECHNIQUE		DIRECTION	
Flat (1G, 1F, 1FR)	☑	Plate ☐	Backhand	☑	Vertical - Up	☐
Horizontal (2G, 2F, 2FR)	☐	Pipe ☑	Forehand	☐	Vertical - Down	☑
Vertical (3G, 3F)	☐	Rotated ☑				
Overhead (4G, 4F)	☐	Fixed ☐				
Multiple (5G, 5F)	☐	Inclined (6G, 6F) ☐				
Combination	☐					

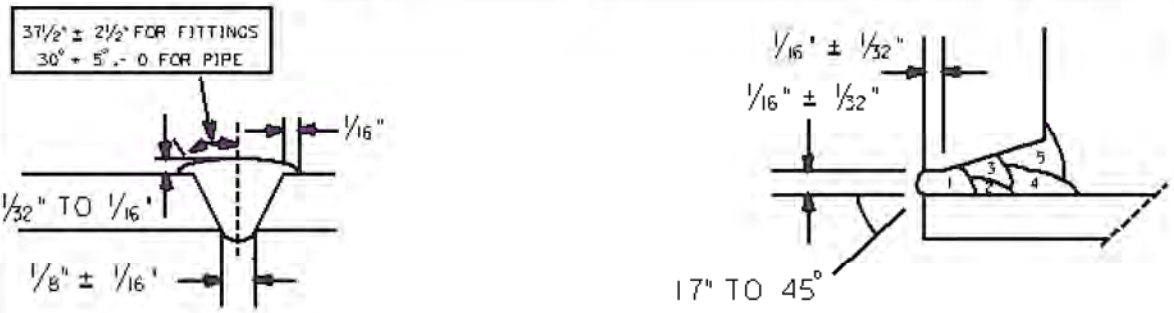
TECHNIQUE

DISPOSITION STYLE		METHOD		ARC TYPE		
Stringer Beads	☑	Multiple Pass	☑	Single Arc	☑	Other: ☐
Weave Beads	☐	Single Pass	☐	Multiple Arc	☐	

CLEANING	Base Material: Power	☑ Hand ☐	Weld: Power	☑ Hand	☐

JOINT DESIGN

BUTT WELD ☐ FILLET WELD ☑



Groove Designs of Test Coupons

ELECTRICAL CHARACTERISTICS & SEQUENCE OF BEADS

Current Type: AC ☐ DC ☑ **Polarity:** Straight/Negative ☐ Reverse/Positive ☑

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Fill							
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TENSILE TEST

Specimen No.	Width	Thickness	Area (in.^2)	Ultimate Total Load(Lbs.)	Ultimate Unit Stress (psi)	Type of Failure Ductile or Brittle	Location of Failure Base Metal or Weld
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2							
3							
4							

GUIDED BEND TEST

Specimen No.	Root Bend	Face Bend	Side Bend	Bend Acceptable	Comments
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6	180 Degrees			Yes ☐ No ☐	
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8	180 Degrees			Yes ☐ No ☐	
9		180 Degrees		Yes ☐ No ☐	
10		180 Degrees		Yes ☐ No ☐	
11		180 Degrees		Yes ☐ No ☐	
12		180 Degrees		Yes ☐ No ☐	

NICK BREAK TEST

Specimen No.	Acceptable Yes/No	Comments
13	Yes ☑ No ☐	
14	Yes ☑ No ☐	
15	Yes ☑ No ☐	
16	Yes ☑ No ☐	

FILLET WELD TEST

Satisfactory: Yes ☑ No ☐		Penetration into Parent Metal: Yes ☑ No ☐	
Fillet Weld - Fracture Test. Satisfactory		Length of Percent of Defect. None	in.: %:

WELDER INFO

Welder Name Chris Jobert	License Number & State J00-435-533	Stencil Mark
Contractor Duke Energy		

CERTIFICATION

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of API 1104.

Welding Test Conducted By: Ralph Pfister		
Visual Examination Results: Satisfactory		
Radiographic Test Results (For Alternative Qualification of Groove Welds by Radiography): NA		
Mechanical Test Conducted By: Walter C. Dumford		Laboratory Test No:
Approved By: Walter C. Dumford		Organization: Terracon Consultants
APPROVED ☑	REJECTED ☐	Date: 5/7/15

REMARKS

SUBMITTAL

By: Walter C. Dumford		Title: Certified Welding Inspector
Company/Organization: Terracon Consultants		Date: 5/7/15

APPROVAL

Engineer:	Date:
Weld Supervisor:	Date:
Director of Gas Engineering:	Date:

1. Signature

Reviewed and approved by: Members of the Work Process Integration Team

2. Revision Log

The table below documents the history of each revision issued and identifies the following: Revision Number, Date, Summary of Changes (including reason for change, and a list of Legacy Duke/Piedmont Documents used to integrate this document), Responsible Party (person or group facilitating changes).

Rev #	Date	Summary of Changes	Responsible Party
0	Effective Date	• Initial Issue Legacy Documents incorporated into this procedure: • Contributing Legacy Piedmont Documents ○ CM-PL-4000 – PNG Welding *Manual Attachment 2 – Piedmont Natural Gas Procedure Qualification Records* • Contributing Legacy Duke Documents ○ *PQR documents* • Contributing JIP PQRs that correspond to WPS' (old #) *14 – 27*	Members of Work Process Integration Team
1.0	5-19-2019	• Revised the "WHO" section, added Gas Engineering, Gas Field Operations, and Technical Field Operations • Legacy Documents incorporated into this procedure: PQRs Belonging to WPS' 1-13 (Attachment 1 of CM-PL-4000)	Members of Work Process Integration Team