BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking on the Commission's Own Motion to Adopt New Safety and Reliability Regulations for Natural Gas Transmission and Distribution Pipelines and Related Ratemaking Mechanisms

R.11-02-019 (Filed February 24, 2011)

DECLARATION OF SUMEET SINGH SUPPLEMENTING THE VERIFIED STATEMENT OF PACIFIC GAS AND ELECTRIC COMPANY'S VICE PRESIDENT OF GAS TRANSMISSION MAINTENANCE AND CONSTRUCTION IN RESPONSE TO RULING OF ASSIGNED COMMISSIONER AND ASSIGNED ADMINISTRATIVE LAW JUDGE

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Attorneys for PACIFIC GAS AND ELECTRIC COMPANY

Dated: October 18, 2013

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

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I, SUMEET SINGH, do declare:

 I am the Senior Director of Integrity Management in Gas Operations for Pacific Gas and Electric Company (PG&E). Prior to that I was the Senior Director of Asset Knowledge Management in Gas Operations for PG&E.

2. I received a B.S. in civil engineering from the University of California, Berkeley, in 2000, and a Masters of Business Administration from the University of California, Los Angeles, in 2008. I have been employed by PG&E for a total of 11 years, spending approximately 9 years in gas operations.

3. I am providing this declaration as a supplement to the Verified Statement of M. Kirk Johnson submitted on August 30, 2013 based on the ongoing analysis of documentation and information on Line 147 conducted by David Harrison, a former PG&E pipeline engineer and now a technical consultant working on our maximum allowable operating pressure (MAOP) validation effort. The ongoing work conducted by Mr. Harrison and his team is discussed in paragraphs 39 through 48 of the Verified Statement. I am also providing copies of recent expert reports from Exponent and from Kiefner and Associates.

4. As discussed in the Verified Statement, in early 2013 Mr. Harrison and his team learned that portions of Segments 108 and 108.7 of Line 147 had been cut out as part of the 2011 hydrostatic testing process. Mr. Harrison was able to confirm from photographs of four sections

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of pipe that had been cut out of Line 147 in connection with the strength tests that the long seam for two sections of the pipe was DSAW. Another was seamless, and the fourth was SSAW. Based on this, we updated the MAOP validation documentation for Segments 108 and 108.7 to show the SSAW seam type. Despite the fact that destructive testing confirmed a specified minimum yield strength (SMYS) value of 42,000 psi, we reduced the SMYS value of these segments to 33,000 psi in order to reflect a more conservative SMYS value based on the seam type and installation year.

5. At the time PG&E submitted the Verified Statement, our best available information indicated that while the updated SMYS value did affect the MAOP for the two segments (reduced from 525 psig to 412 psig), these segments were still commensurate with an MAOP of 365 psig. This was based upon, among other things, the conservative SMYS value of 33,000 psi, a wall thickness of 0.3125 inches, and a design factor of 0.5 for a class 3 location.

6. The wall thickness of 0.3125 inches was derived from a 1957 strength test pressure report, the bill of material for performing the hydrostatic testing in 2011, the drawing detail from the 2011 hydrostatic testing that corresponds to the bill of material, and the associated record of material removed form (chain of custody form). A copy of the 1957 strength test pressure report is attached as Exhibit A.

7. Prior to submitting the Verified Statement, we had an "H form" dated December 2, 2011, from a contractor involved with our pressure testing work. The H form was associated with mile point 1.89 that corresponded to segment 107.7 and identified 20 inch diameter pipe with a wall thickness between 0.261 inches and 0.275 inches. It also indicated that the seam type for this pipe was DSAW. A copy of this H form is attached as Exhibit B. Once we confirmed that segment 107.7 pipe was 24 inch diameter pipe and not 20 inch pipe as indicated on the H-form, we discounted this H form due to the inaccuracy and were uncertain of the location due to the incorrect mile point information. We continued to rely on the documentation of 0.3125 inches of wall thickness described in paragraph 6 above for segments 108 and 108.7, although we have also continued to analyze our records for Line 147 and for our entire system.

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8. PG&E's review of its records and examination of pipe has been ongoing, and did not end while PG&E was preparing the Verified Statement. We have continued to gather, review and analyze additional information about Line 147. Attached as Exhibit C is a report prepared by PG&E's Applied Technology Services (ATS) Department dated August 29, 2013. ATS performed ultrasonic measurements of the wall thickness of the pipe cutout stored in our Modesto pipe storage yard. This test indicated a pipe wall thickness range of 0.25 inches (from 0.247 inches to 0.258 inches) for pipe believed to be for segment 108, rather than 0.3125 inches as was previously identified on the records. After receipt of this report, we double-checked to confirm that ATS had tested the correct pipe sample, which was confirmed last month.

9. In addition, on August 27, 2013, PG&E received a revised H form from the contractor for the pressure testing work. The revised H form changed the mile point, which now associated it with Segment 108, and also changed the seam type, but did not change its wall thickness measurements. Given the number of changes to the H form, PG&E conducted additional diligence to ensure the correct location and data accuracy by discussing these changes further with our pressure testing team. A copy of this revised H form is attached as Exhibit D. The updated seam type on this form shows A.O. Smith pipe. However, we believe the seam type is actually SSAW, based on a review performed by Michael Rosenfeld of Kiefner and Associates. Both A.O. Smith and SSAW pipe have a joint efficiency factor of 0.8, so this difference in the seam type does not affect the MAOP.

10. Given the updated information from two sources consisting of the ATS report (Exhibit C) and revised H form (Exhibit D), PG&E has applied a conservative representation for the entire length of segments 108 and 108.7 by using a wall thickness of 0.250 inches instead of 0.3125 inches and thus the MAOP for both of these segments would be 330 psig, not 412 psig as described in paragraphs 48 and 49 of the Verified Statement. The MAOP for the entire line remains at 330 psig.

11. On September 13, 2013, I submitted a Declaration supplementing the Verified Statement by submitting reports from Anamet, Inc. concerning the metallurgical evaluation of

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the pipe where the leak that was found in October 2012 on Line 147, Segment 109. PG&E also retained Exponent to conduct an analysis to identify why the October 2012 leak on Line 147, Segment 109 was not detected during the hydrotest. Exponent conducted visual, metallographic, fractographic, and chemical analysis of the leak site. Exponent concluded that "[t]he subject leak was caused by cracking that occurred within a location on the pipe body that had been repaired using a weld-metal deposition ('weld repair'). This weld repair was not associated with either a girth or longitudinal seam weld." Moreover, Exponent found "no metallographic or fractographic evidence that any crack growth occurred following the repair weld. Specifically, there was no evidence of progressive crack growth due to fatigue, stress corrosion cracking (SCC) or ductile tearing[.]" The Exponent report is attached as Exhibit E.

12. PG&E also retained Kiefner and Associates to determine whether the hydrostatic pressure tests on Line 147 still established Line 147's fitness for service. Kiefner and Associates conclude that Line 147 is safe to operate. For convenience and clarity, I am quoting the conclusions of Kiefner and Associates in full below:

- 1. PG&E has substantial knowledge of the type of pipe, construction features, and appurtenances present in Line 147. Data from metallurgical examination of a leak that occurred in 2012 suggests that the affected pipe was reconditioned first-generation A.O. Smith line pipe. Records indicate that such pipe was shipped to the site in 1957, although it is not listed in the PFL, confirming that the database is not perfect.
- 2. The October 2011 hydrostatic pressure spike test confirmed the fitness for service of the pipeline for its MAOP without doubt. The concept of pressure testing to establish the ability of a pipeline to safely hold pressure at a lower pressure is an accepted practice that is logical and supported by industry experience and research. NTSB and PHMSA have recommended and required, respectively, hydrostatic pressure testing to revalidate pipeline operating pressures. The test was performed to a sufficient margin to assure the integrity of the pipeline well into the future assuming routine maintenance practices such as catholic protection monitoring and damage prevention programs continue to be implemented.
- 3. A review of data concerning specific pipeline integrity threats provides no evidence that the integrity or fitness for service of Line 147 has degraded in the 2 years since the October 2011 hydrostatic tests were conducted.

In addition, Kiefner and Associates' letter states, "The fact that PG&E may not know all facts about every piece of pipe or component in Line 147 does not cause me particular concern considering that the pipeline in its current condition was successfully pressure tested to a level that supports a maximum allowable operating pressure (MAOP) of 400 psig." A copy of the Kiefner and Associates report is attached as Exhibit F.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct to the best of my knowledge and belief.

Executed this 18th day of October 2013, at San Ramon, California.

Shing timp

SUMEET SINGH, Senior Director Integrity Management PACIFIC GAS AND ELECTRIC COMPANY

EXHIBIT A

475	N -	· ···	•	i se t	-	•
11174 A	27	• 7 18d		**	Sheet 2	
12-20	U⇔56	740u	DEPARTMENT OF	GAS OPERATIONS		
· ·	. ·	(Per ASA B 31.1	FIELD PRESSURI 8 - 1955 Code for	E TEST RZPORT Pressure Piping	, Paragraph 841.4)	
•				• •	Date October 2, 1	957
G.M.	No.	139349	•			
1 .)	Proje	ect Descriptions_R	elocato 24º Main L	47; Brittan Avenu	ie, San Carlos	
	•					2
2. 1	Pipel	ine Data:	Size	Wall Thickness	Steel Specifications	
i	(a)	Mainline	20"	0:3125	API 51X, Gr x 42	
	(b)	Design Operating P	ressure, maximum	<u>500</u>)	psi psi	•
ļ	(c)	Stress at Max. D.O	.P. <u>16;000</u> ps: ps:	i; as % of yield i; " " " "	<u>38.1</u>	
I	(d)	Location class	3	construction	C	
	(e)	Test pressure	750 psi; fly psi;	uid <u>Nater</u>	Period of test1 hou	
I	(f)	Stress at Test Pre	ssure <u>24,000</u>	psi; as % of yiel psi; " " " "	ld <u>57:2</u>	- -
3.	Test	Data		•		
	(a)	Date and time star	ted test 10-21-57_	<u>];20 py</u> f]	uid used	
	(b)	Date and time read	hed test pressure	10-22-57-6:09	_ <u>PM</u>	
	(c)	Date and time conc	luded test 10.21 c	act و <u>15 25 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 </u>	tual test pressure	750 /
	(d)	Date and time Purg	ing started 10_00	CONC	cluded <u>loss all</u>	
	(e)	Date and time Pipe	line tied into Sys	tem <u>20.00 57</u> 2	. <u></u>	
	(f)	Date and time Pipe	eline Placed in Ope	ration 10.20-57	3. CO	· .
	(g)	Name of FG&E Super	visor conducting t	est Was Mendonsa	2	
	(h)	Who made test? _p	<u> </u>			-
	ral (Construction Depart	ment <u>xxx</u>			
Gene Divi Cont	racto	or (Indicate Name)				
Gene Divi Cont Inst	racto ructi	or (Indicate Name) Lons: Retain one cop Send one copy Division Manag	y of this complete each to V.P. in Ch er concerned.	d test report in arge of Gas Opera	Project file. ations and to	

EXHIBIT B

INSPECTION SERVICES Pipeline Integrity Team CWA # 2500461774 GEIS Job # LAPI0015

IN-FIELD SERVICES

GEIS Pipeline Integrity Team NDE

Pacific Gas & Electric Company Hydrostatic Test Dig from October 7, 2011 to November 5, 2011 T43A/B_L147_B _MP-1.89 Documents Contained Within:

H-Form Report T43A/B_L147_B MP-1.89 NDE Reports of T43A/B_L147_B MP-1.89 Photo Report of T43A/B_L147_B MP-1.89

Authors: H. Mayer & J. Hayes

Date: December 2, 2011



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Form H: Direct Examination Data S	heet - Page 1 of 10								
<u>DA/ILI</u> Route Number:	L-147	Site I	<u>DA</u> Designation:	T43A/B_B		ILI	Log Distance:	NA	
Date of Excavation:	10/7/2011	_	N-Segment:	NA		RMP-1	1 Ref. Section:	Table 5	.6.2
Mile Point:	1.89 H Mayer/1 Hayes	I	MA Number:	NA		Referer	ce Girth Weld:	NA	
PG&E Project Manager:	Donovan Fink	Reg	ion Number:	NA		Distance		INA.	
Approved By:	Kenji Gailey	Subre	gion # (ICDA):	NA					
Order Number:	41497360	_	Stationing:	NA					
Excavation Priority:	_		_	Excavation Re	ason				
Immediate S	cheduled (For ILI -	1 Year	Other)	ECDA			Recoat		
Monitor E	ffectiveness	X Hydro Test		ICDA		Other <u>NA</u>			
If practical take P/S or CIS read	s before excavation:					NΔ			
xcavation Details: U/S Ditch Start	GPS Coordinates	(Uncorrected Fie	d Measurement)			11/4			
Northing: 37.4878	3247306		PDOP:	NA	Planned	Excavation Leng	h (Ft.):	NA	
Easung: -122.27	01986194		Acc~:	INA	Actual	Excavation Leng	n (FL):	21.01	
Centerline C Northing: NA	SPS Coordinates	(Uncorrected Fie	Id Measurement)	NΔ		GPS File	Name:	Guida 148T43	13
Easting: NA			Acc~:	NA					
D/S Ditch E	nd GPS Coordinates	(Uncorrected Fie	d Measurement)						
Northing: 37.4878	3664944	-	PDOP:	NA					
Easting: -122.27	02163300		Acc~:	NA					
0 Data Before Coating Removal									
1.1 Native Soil Type:	X Clay	X Rock	X Sand	Loam	Wet	Other		NA	
1.1A Backfill Material F	ound:	Silt	Slurry	Native		of Cover (Ft.):		6.00ft	
Comments:				NA NA		_			
1.2 Coating Type:		Somastic	Plastic Tar		Wax Tane			Powercrete	
Des Alex				~ ப				1 On GIOIOLO	
Bare/None		Otner:	NA		omments:		NA		
Coating Thickness (Inche	es): 0.:	250in	N	umber of Layers:			2		
1.3 Holiday Testing Perform	ned?:	Yes X N	o V	oltage Used:	NA		Map Location of Ho	lidays Below.	
	Device Used:	Coil 🔲 V	/et Sponge		Comment	5:	NA		
1.4 Pipe-to-Soil Potentials i	n Ditch (-mV):	US: 12	:00526	3:00	530	6:00	-535 <u>9</u> :00	-526	_
		DS: 12	:00 -661	3:00 -	658	6:00	- 640 9:00	-663	_
Comments:		C	P appears to be v	ery low, may be turn	ed off at time	of inspection.			
1.5 Soil Resistivity in Ditch	(Ω-cm): 4-Pin	24469 5 obr	n/cm	Г		NΔ			
Comments:	· · · · · · · · · · · · · · · · · · ·	NA	li/Gill	L		SRM-100	US: N/A	DS:	N/A
1.6 Soil Sample Location	Comments			Ditcl	h end (DS) 6:	- 00 position under	pipe.		
1.7 Ground Water Present?	: TYes	X No	Sample(s)) Collected?:	Yes	X No	Sample of	-1: N	IA
Comments:				NA NA	-				
1.8 Coating Condition:	X Good -	Adhered to Pipe		Fair - Coating	g Partially Dis	bonded or Degrad	ied		
	Poor - (Coating Significantly	Disbonded or Mis	sing					
Comments:	Coating removed	& tie in weld areas	plasted. Pipe secti	on removed and tes	t pipes install	ed. Removed pip	e section was also	assesed and	
	was in go	od conition except fo	r coating damage	from removal and tr	ansportation.	See comments p	age 10.		
1.9 Map of Coating Degrad	ation*:		ž	Zero Reference Poi	nt:		US Exposed Pipe	360 degrees	
*Note any calcareous de	posit locations				_			0	
Holidays	Disbondments				Flow -				
12 o'clock						T		T	Т
9 o'clock									-
								1	
6 o'clock		1		++		1	1		4
								1	
	1					1	1		
		-				1	1	+	┥
3 o'clock							-	1	1
3 o'clock									
3 o'clock									
3 o'clock 12 o'clock Feet 0 1	2	3	4	5 6		7	8	9	10
3 o'clock 12 o'clock Feet 0 1	2	3	4	5 6		7	8	9	10
3 o'clock 12 o'clock Feet 0 1 1 CaCO3 - C	2 Calcareous deposits c	3 ontaining calciur	4 n	5 6		7	8	9	10
3 o'clock 12 o'clock Feet 0 1	2 Calcareous deposits c	3 ontaining calciur	n	5 6		7	8	9	10
3 o'clock 12 o'clock Feet 0 1 1 CaCO3 - (2 FeO - (2 Calcareous deposits co General iron oxide with	3 ontaining calciur	4 n	5 6		7	8	9	10
3 o'clock 12 o'clock Feet 0 1 1 CaCO3 - (2 FeO - (3 FeCO3 - (2 Calcareous deposits co General iron oxide with Calcareous deposits co	3 ontaining calciur n scale ontaining iron	n	5 6		7	8	9	10

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	<u>DA/ILI</u>				DA			<u>ILI</u>			
	Route Number:	L-14	47	Site De	esignation	T43A/B	_B	ILI Lo	g Distance:	NA	
	Date of Excavation:	10/7/2	2011		N-Segment:	NA		RMP-11 F	tef. Section:	Table 5.6	.2
	Mile Point:	1.8	9		MA Number:	NA		Reference	Girth Weld:	NA	
Examin	ation Performed By:	H. Mayer/	J. Hayes		_	NA		Distance From	n Girth Weld:	NA	
PG	&E Project Manager:	Donova	in Fink	Reg	ion Number:	NA					
	Approved By:	Kenji G	Bailey	Subre	gion # (ICDA):	NA					
	Order Number:	41497	7360		Stationing:	NA					
1.10	Photos Taken?*: *See Photo Log for a	X Yes additional info	No No ormation.		_						
1.11	Coating Sample Ta	ken?:	Yes	X No	Loc	ation of Sample	:		NA		
1.12	Liquid Underneath	Coating?:	Yes	X No	lf Ye	s, pH of Liquid			NA		
1.13	Corrosion Product	Present?:	Yes	X No	lf Ye	es, Was Sample	e Taken?:	Yes	X No		
	Comments:					NA		<u> </u>			
1.14	Soil pH (Sb Electro	de): (Jpstream:	6.0	Dow	nstream:	7.5	- Pip	e pH:	6.0	-
<u>2.0 Data Af</u>	ter Coating Remo	<u>oval</u>									
2.1	Pipe Temperature (°F):	60.0° F	_	N	leasured Pipe	Diameter (In.):	. <u> </u>	63" =	20.05"	
2.2	Weld Seam Type:		SAW	SSAW Lap	ERW		LS Smith		RMINE, VISUA	LLY PERFORM	
								MACROETCH	LOCATE		
2.3	Girth Weld Coordin	iates & Iden	tify Type (See	Table 5.7.3)	:						
	Northing:		NA			P: <u>NA</u>				0.55	
	Easting:		NA		Acc	~: <u>NA</u>	LS Weld	Clock Position	s):	8:55	
	Elevation:		NA								
2.4	Damage Found: Corrosion Dama Other Damage:	ge	Yes	X No Nor	n relevant too	Mechanical Da I marks, no cor	amage rosion found gr	Teater than 20%	No		
2.5		Magaurama	untos LIC/	De							
2.5	UT wall Thickness	Measureme		US 1 075" 1 /		05/05	2 Olalask	0.067"/0.074"	2 Olalaak	0.365"/0.1	5 274"
			0.270/C	0.270 10		207 /0.272		0.207 /0.271		0.205 /0.2	272
		4 O CIO 8 O'ala	ok 0.208/0	0.270 50		200 /0.271		0.208 /0.273		0.200 /0.	272
		8000	0.20970	9.209 90		.20170.203		0.200 /0.204		0.20970.2	.70
	UT Wall Thickness	Grid @ 6:00) is required. E	Be sure to at	tach grid to	H-Form electro	onically. See	page 6 of 10.			
2.6	Wet Fluorescent M	ag. Part. Is I	Required.	Comment	s:	2 linear indica	ations on the re	moved pipe se	ction. See MT	& Photo repor	t
	Were there any linea	ar indications	? X	Yes		Yes, attach NE	DE report electr	onically as part	of the H-Forr	n.	
2.7	Take Photos to Do	cument Cor	rosion and Otl	her Anomali	es*	lepon to include	e black light an	d white light ph			
	*See Photo Log for a	additional info	ormation.								
2.8	Overview Map of C	orroded Are	ea*:								
	*See Pit Depth Meas	surement Gri	id for additional	Information		Zero Referen	ce Point:	U	S Exposed Pipe 3	360 degrees	
							Flow -			>	
*Note anv	calcareous deposits.										
12 o'cl	ock										ĩ
9 o'cl	ock										İ
6 o'cl	ock										1
3 o'cl	ock					1	1	1		1	1
0.00											
12 0'0	ock										
12 U CI	eet 0 1		2 3	3	4	5	6	7	8	9	10

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DA		DA		<u>ILI</u>	ILI		
Route Number:	L-147	Site Designation	T43A/B_B	ILI Log Distance:	NA	_	
Date of Excavation:	10/7/2011	N-Segment:	NA	RMP-11 Ref. Section:	Table 5.6.2		
Mile Point:	1.89	IMA Number:	NA	Reference Girth Weld:	NA	_	
Examination Performed By:	H. Mayer/J. Hayes		NA	Distance From Girth Weld:	NA		
PG&E Project Manager:	Donovan Fink	Region Number:	NA			_	
Approved By:	Kenji Gailey	Subregion # (ICDA):	NA				
Order Number:	41497360	Stationing:	NA				

Excavation Drawing:

At minimum draw pipe elevation profile and indicate stationing of 1) low point and 2) critical inclination angle. Place an arrow on the drawing indicating direction of gas flow in the region(s). Other labels may also be added (e.g. "to Station").



NOTES: (Record stationing and names of nearby landmarks such as creeks and roads. Provide any additional information that may help in spatially positioning pipe):

**See attached Delorme screen shot on page 11.

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EXTERNAL PIT DEPTH MEASUREMENT GRID SHEETS



PIT DEPTH GRID 1 OF 2

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EXTERNAL PIT DEPTH MEASUREMENT GRID SHEETS



PIT DEPTH GRID 2 OF 2

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INTERNAL CORROSION WALL LOSS GRID

DA	/1_1	DA		<u>ILI</u>	
Route Number:	L-147	Site Designation	T43A/B_B	ILI Log Distance:	NA
Date of Excavation:	10/7/2011	N-Segment:	NA	RMP-11 Ref. Section:	Table 5.6.2
Mile Point:	1.89	IMA Number:	NA	Reference Girth Weld:	NA
Examination Performed By:	H. Mayer/J. Hayes		NA	Distance From Girth Weld:	NA
PG&E Project Manager:	Donovan Fink	Region Number:	NA		
Approved By:	Kenji Gailey	Subregion # (ICDA):	NA		
Order Number:	41497360	Stationing:	NA		

Grid Size = 1 Inch x 1 Inch Clock Position (specify below)

All measurements are in inches.

UT Grid is centered @ 6:	00 position on pipe.
1	

	1	2	3	4	5	6 \	/ 7	8	9	10	11	12
A	0.251"	0.251"	0.249"	0.249"	0.249"	0.249"	0.249"	0.248"	0.248"	0.248"	0.248"	0.248"
в	0.251"	0.254"	0.251"	0.251"	0.249"	0.249"	0.249"	0.249"	0.248"	0.248"	0.248"	0.249"
с	0.253"	0.251"	0.251"	0.251"	0.251"	0.251"	0.251"	0.249"	0.249"	0.248"	0.249"	0.249"
D	0.251"	0.251"	0.251"	0.251"	0.251"	0.249"	0.250"	0.249"	0.249"	0.248"	0.247"	0.249"
E	0.251"	0.251"	0.251"	0.251"	0.251"	0.251"	0.251"	0.251"	0.247"	0.248"	0.247"	0.248"
F	0.251"	0.251"	0.251"	0.251"	0.249"	0.249"	0.251"	0.249"	0.249"	0.247"	0.248"	0.249"
G	0.251"	0.251"	0.247"	0.246"	0.249"	0.248"	0.247"	0.247"	0.246"	0.247"	0.248"	0.247"
н	0.248"	0.249"	0.249"	0.249"	0.248"	0.247"	0.247"	0.247"	0.246"	0.246"	0.246"	0.246"
1	0.249"	0.249"	0.249"	0.249"	0.247"	0.246"	0.244"	0.247"	0.244"	0.244"	0.247"	0.246"
J	0.247"	0.247"	0.247"	0.246"	0.246"	0.246"	0.242"	0.244"	0.244"	0.243"	0.244"	0.246"
к	0.247"	0.247"	0.247"	0.246"	0.246"	0.246"	0.244"	0.244"	0.244"	0.244"	0.244"	0.246"
L	0.249"	0.247"	0.247"	0.247"	0.248"	0.248"	0.248"	0.242"	0.244"	0.244"	0.246"	0.244"

INTERNAL CORROSION GRID 1 of 1

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Form H: Direct Examination Data Sheet - Page 7 of 10

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COATING DAMAGE

DA/	<u>ILI</u>	DA		<u>ILI</u>	
Route Number:	L-147	Site Designation	T43A/B_B	ILI Log Distance:	NA
Date of Excavation:	10/7/2011	N-Segment:	NA	RMP-11 Ref. Section:	Table 5.6.2
Mile Point:	1.89	IMA Number:	NA	Reference Girth Weld:	NA
Examination Performed By:	H. Mayer/J. Hayes		NA	Distance From Girth Weld:	NA
PG&E Project Manager:	Donovan Fink	Region Number:	NA		
Approved By:	Kenji Gailey	Subregion # (ICDA):	NA		
Order Number:	41497360	Stationing:	NA	_	

NO.	FEET FROM REFERENCE	O'CLOCK	MAX LENGTH (IN.)	MAX CIRC EXTENT (IN.)
NA	NA	NA	NA	NA

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Form H: Direct Examination Data Sheet - Page 8 of 10

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CORROSION LOG

DA/	<u>LI</u>	DA		<u>ILI</u>		
Route Number:	L-147	Site Designation	T43A/B_B	ILI Log Distance:	NA	
Date of Excavation:	10/7/2011	N-Segment:	NA	RMP-11 Ref. Section:	Table 5.6.2	
Mile Point:	1.89	IMA Number:	NA	Reference Girth Weld:	NA	
Examination Performed By:	H. Mayer/J. Hayes		NA	Distance From Girth Weld:	NA	
PG&E Project Manager:	Donovan Fink	Region Number:	NA			
Approved By:	Kenji Gailey	Subregion # (ICDA):	NA			
Order Number:	41497360	Stationing:	NA			
-						

IC or EC	FEET FROM REFERENCE	O'CLOCK	MAX PIT DEPTH (MILS)	MAX LENGTH (IN.)	MAX CIRC EXTENT (IN.)
NA	NA	NA	NA	NA	NA

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Form H: Direct Examination Data Sheet - Page 9 of 10

PHOTO LOG

DA/	<u>ILI</u>	DA		<u>ILI</u>	<u>ILI</u>		
Route Number:	L-147	Site Designation	T43A/B_B	ILI Log Distance:	NA		
Date of Excavation:	10/7/2011	N-Segment:	NA	RMP-11 Ref. Section:	Table 5.6.2	_	
Mile Point:	1.89	IMA Number:	NA	Reference Girth Weld:	NA		
Examination Performed By:	H. Mayer/J. Hayes		NA	Distance From Girth Weld:	NA		
PG&E Project Manager:	Donovan Fink	Region Number:	NA				
Approved By:	Kenji Gailey	Subregion # (ICDA):	NA				
Order Number:	41497360	Stationing:	NA				

PHOTO NO.	LOCATION	DESCRIPTION	COMMENTS								
	****See attached photo report.										

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Rev 1.0 (06-05-12)

Form H: D	irect Examination Data Sheet	- Page 10 of 10			
	DA/ILI Boute Number: 1-147	Site Designa	DA tion T434/B B	ILL og Distance: NA	
	Date of Excavation: 10/7/20	11 N-Segm	ent: NA	RMP-11 Ref. Section: Table 3	5.6.2
	Mile Point: 1.89	IMA Num	ber: NA	Reference Girth Weld: NA	
Exami	nation Performed By: H. Mayer/J.	Hayes	NA	Distance From Girth Weld: NA	<u> </u>
PG	3&E Project Manager: Donovan	-ink Region Num	ber: <u>NA</u>	_	
	Order Number: 414973	60 Station	ing: NA	_	
0 0 D = 0					
<u>3.0 REC</u>	Sandhlaat Madia		Anches Drofile B		
3.1	Sandblast Media:	Sharp Shot 30/60	Anchor Profile N	Average: 3.2 mils	
3.2					0F T
		ape Bar-Rust 235		Dev lar 247 X Protai 7200	PETape
3.3	For Epoxy Coating Syste	ms, Record Environmental Cor	ndition: Dew Point	45 1°F	
	Pipe Temperature: 67	.0°F	Relative Humidity:	51.4%	
	Time of Day: 12:	30 pm	·		
3.4	Repair Coating Hardness (If AR	Coating:) US 3:0	00 - 82 6:00 - 79	9:00 - 79 12:00 - 79	
		DS 3:0	00 - 79 6:00 - 75	9:00 - 79 12:00 - 81	
3.5	Measured Coating Thickness:	US 3:00 - 33.7	76:0038.7	9:00 - 57.5 12:00 -	27.4
		DS 3:00 - 37.3	3 6:00 - 28.6	9:00 - 39.0 12:00 -	29.3
	Holiday Tested?: X Yes	No No			
	Device Used: Coil	Wet Sponge Volt	age Used: UNK	Repair All Holidays. YES	
3.6	Coupon Test Station Installe	ed?: Yes X No	ETS Installed?:	Yes X No	
	If Yes, Date Installed:	NA			
	Surface Configuration::	Fink 🔲 G-5 Box 🔲 C	Carsonite Other:	NA	
3.7	Backfill Material:	ve Imported Sand	Other:	NA	
	If Vas Chack Oper			r: STACquard (transitions only)	
2.9	Bine-to-Soii Beadings Over Bell				
5.0	*If specified, a CIS should be done	for approximately 100' on either	side of the bell hole. Attach	data.	
	Comments:		NA		
3.9	Attach site sketch of excavation	site.			
4.0 REPA					
4.1	Repair Made: Yes	X No 4.2 Nur	mber of Repair Made:	Replacement "In-Kind configuration"	
4.3	Repair Type Met	allic Sleeve Non M	etallic Sleeve	ace Can Filler Metal	Other
4.4	Damage Repaired:	Corrosion	Mechanical C	Dther	
		<u> </u>			
Misc. Co	mments/Information: T43A	had coating removed, area for in	spection was blasted from co	ating up to test pipe tie in weld. About 1 ft of coa	ating
was inspecte	ed. T43B had coating removed, area	for inspection was blasted from o	coating up to test pipe tie in w	veld. About 1.5 ft of coating was inspected. Rem	oved
pipe section	was inspected at the PG&E yard.				

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GE Energy INSPECTION & LIFE EXTENSION SERVICES

MAGNETIC PARTICLE EXAMINATION REPORT								Nuclear	✓ Non-N	luclear	
To: F						From:			Date:		
Pacific Gas & Electric Company					H. N	1ayer/J. Ho	iyes	10/7/2011			
Project:			T 47	A/D 11/7		1 00					
Purchasa Ordar No			143			-1.89					
	Weld	Structural (Castina	Machineru	Mac	h. Parts	Pipe		15 Other:		
							تا اتا		other.	N/A	
Item	Non-Weld	Plate	Pipe	Bar	Cc	Isting	Mach. Parts	5 N/A	Other:		
			য		[N/A	
he and a set of a	Size	Material Thickne	ess Ty	pe of Base Ma	terial	 	Jpe of Filler Mc	iterial	Weld	✓ N/A	
Materiai	20''	0.250"		Carbon Ste	el		C/S	Smooth	SnAnsokow/belo	led As V	Velded
Location	70.6 Ft SW of	the intersection	n of Brittan	Ave and Mile	ano	System					
		Way in San Carl	os, CA 940	70					L-147		
Acceptance		Customer Spe	ecification	s		Procedur	re C) # 500 Boy 1	7	
Stundulus	Initial Diato Edge In Dragons Dank Course				GEIS GEIS				QCF # 500 KeV 17		
Type of Check					NOC			12			
	Longitudina	l Coil		DC Pr	obe	[✓ Continuou	IS	Other:		
	🗹 Wet	Dry		Direc	t Conta	ct [✓ Residual				
Type of Inspection	Circular	AC P	rod	✓ Yoke		[Other				
	MT Yoke &	Model – Serial No. ,	/ Blacklight M	1odel - Serial N	0.		Surface Preparation Method				
	Parker DA-400 - S# 18830 / Spectroline BIP - S# 1597251						Abrasive Blasting (Kleen Blast) - NACE 2 Finish				
	Inspection Medium / Color / Batch No.						Demagnetization Method / Equipment				
	Magnag	lo 14A / Floure	escent Gre	en / 09M12	K				N/A		
Reference: Summa	ry			⊡ S€	e Attac	hment			Results of Ir	nspectior	1
The following are	eas were request 1 35' from original	ted to be inspect	ted:					- No relevar	t indications found (a time of inso	
Bare pipe : 17.4' to	18.45' from original	U/S ditch start.			- No relev			- No relevar	vant indications found @ time of insp.		
Removed pipe sect	ion.							2 Linear ind	ications were found.		
Lin-01: Axial Start=	=1.60' (From U/S en	d of pipe), AL=1.58	3" , CW=0.02	0" , CLK Positi	on= 4:0	0					
Lin-02: Axial Start=	=2.33' (From U/S en	nd of pipe), AL=1.20	0", CW=0.020	0", CLK Positio	n= 4:06						
These are on the removed pipe section.											
Indications was an t	he removed nine cost	ion Diagon con atta	had photo rec	ort for addition	alinform	ation					
Copy To:	ne removed pipe sect	ion, rieuse see ullac	.neu prioto rep	Renu	ested B	ianon. Il			Reported Bu (Te	chnician).	
Pacific Gas & Electric Company					David Aquiar				H. Mauer/J. Haues		
GE Inspection Servi	ces (Los Angeles)			~					NDT supervisor		
									Andre Filiatrault		
NOTICE. THIS EXAMI	INIATION REPORT IS A		SULTS OF THE		IRE ACTI		PEORMED BY TH			TO THE UM	ITATIONS

NOTICE: THIS EXAMINATION REPORT IS A REPORT OF THE RESULTS OF THE NOT PROCEDURE ACTUALLY PERFORMED BY THIS COMPANY IT IS SUBJECT TO THE LIMITATIONS OF THE TESTING SPECIFICATIONS AND PROCEDURES WHICH WERE UTILIZED. BY FURNISHING THIS REPORT, **GE INSPECTION & LIFE EXTENSION SERVICES** DOES NOT GUARANTEE ANY CONDITION OF THE TESTED SPECIMEN.



GE Energy **Inspection & Life Extension Services**

8									
	ULTRAS	ONIC EXAM	INATION RE	PORT			Nuclear	Non-Nuclear	
To:		From:		Date:					
Proiect:	Fucine dus & En	ecure compu	nig		n. Muger	a J. Huges		10,7,2011	
			T43A/B L	147 B MP	-1.89				
Purchase Order 1	No:			GEIS Job No:					
	41497360				LAPIO)015			
ltem	Weld Structural	Casting	Machinery	Mach. Parts	Pipe	N/A	Other:		
	Non-Weld Plate	Pipe	Bar	Casting	Mach. Parts	N/A	Other		
Material	Size:	No. of Pieces	Type of B	ase Metal	Tupe of Fil	ler Material	Weld	✓ N/A	
	20" 1 Carl				с ³¹ с	/S	Smooth	As Welded	
Location	70.6 Ft SW of the inte	ersection of B	rittan Ave c	and Milano	System				
	Way in S	San Carlos, C	A 94070				L-147		
Acceptance	Custo				Procedure				
Standards	Custo Soundnoss Thicknoss	Pond	ations		Transducer		QCP-601	Transducar Social No :	
	Soundness mickness			Single Crustal		Dual Crusta	1	020HEC	
	Pulse Echo Angle-Begm			Frequencu		Ar	igle	Couplant / Batch #	
			5 1	- 1Hz	0.375"	0°		Sonatest Ultragel II	
Tupe of		UT Seviewent (Model Flat Concave Convex		nvex	/ 25-901 07225 AF				
Inspection	USN-60								
порессион	Serial # 01NL	Standard		Material	Notch Depth		Serial No.:		
	Calibration Do								
	10/5/2011		Step Wedge		Material	Thickne	ss Range	Serial No.:	
	Calibration Due: 1/5	/2012	Tube Wedge		C/S	0.200"	- 0.500"	V34693	
Reference: Sum	nmary			✓ See	Attachment		Deculse of h		
The following	g areas were requeste	d to be inspe	ected:				nesults of i	nspection.	
12" x 12" (1"x:	1" grid) at a random 6:00	position on t	he pipe.			- No relevant	indications @ t	ime of inspection.	
12" laminatio	n scans at cut-line locati	ons.				- No relevant indications @ time of inspection.			
Thickness rea	adings US & DS inspection	n areas at the	clock positi	ons.		- No relevant	indications @ t	ime of inspection.	
** Please se	e attached reports for a	dditional info	rmation.						
Сору То:			Requested B	y:		Reported By	ported By (Technician):		
Pacific Gas & Electric Company David Aguiar							H. Mayer/J. Hayes		
GE Inspection S	ervices (Los Angeles)			Customer Specifications NDT Superv				ior:	
			Accept Reject Andre J.				e J. Filiatrault		

NOTICE: THIS EXAMINATION REPORT IS A REPORT OF THE RESULTS OF THE NDT PROCEDURE ACTUALLY PERFORMED BY THIS COMPANY IT IS SUBJECT TO THE LIMITATIONS OF THE TESTING SPECIFICATIONS AND PROCEDURES WHICH WERE UTILIZED. BY FURNISHING THIS REPORT, *GE INSPECTION SERVICES* DOES NOT GUARANTEE ANY CONDITION OF THE TESTED SPECIMEN.



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Pacific Gas & Electric Company 20" Route L-147 Excavation Site T43A-B_L147_B_MP-1.89



Topography looking upstream



Topography looking downstream



Typical surrounding topography



Typical surrounding topography

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Overview of Dig Site T43A-B_L147_B_MP-1.89



Overview of Dig Site T43A-B_L147_B_MP-1.89



Overview of T43A(US) & T43B(DS) in same excavation.



Closeup of T43A(US) & T43B(DS) in same excavation.

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Pacific Gas & Electric Company 20" Route L-147 Excavation Site T43A-B_L147_B_MP-1.89



Overview of Reference Girth Weld measurments were taken from.



Overview of coating condition -1ft to 2ft, 3:00 position



Overview of coating condition -1ft to 2ft, 3:00 position



Overview of coating condition -1ft to 2ft, 9:00 position

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Pacific Gas & Electric Company 20" Route L-147 Excavation Site T43A-B_L147_B_MP-1.89



Overview of coating condition -1ft to 2ft, 9:00 position



Overview of coating condition 17ft to 20ft, 3:00 position



Overview of coating condition 17ft to 20ft, 3:00 position



Overview of coating condition 17ft to 20ft, 9:00 position

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Pacific Gas & Electric Company 20" Route L-147 Excavation Site T43A-B_L147_B_MP-1.89



Overview of coating condition 17ft to 20ft, 9:00 position



Overview of MPI layout -1ft to 2ft, 3:00 position



Overview of MPI layout -1ft to 2ft, 3:00 position



Overview of MPI layout -1ft to 2ft, 9:00 position

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Pacific Gas & Electric Company 20" Route L-147 Excavation Site T43A-B_L147_B_MP-1.89



Overview of MPI layout -1ft to 2ft, 9:00 position



Overview of MPI layout 17ft to 20ft, 3:00 position



Overview of MPI layout 17ft to 20ft, 3:00 position



Overview of MPI layout 17ft to 20ft, 9:00 position

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Pacific Gas & Electric Company 20" Route L-147 Excavation Site T43A-B_L147_B_MP-1.89



Overview of MPI layout 17ft to 20ft, 9:00 position



Overview of bare pipe start



Overview of bare pipe end



Overview of bare pipe start

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Pacific Gas & Electric Company 20" Route L-147 Excavation Site T43A-B_L147_B_MP-1.89



Overview of bare pipe end



Overview of feature joint long seam @8:55



Overview of US lamination scan area.



Overview of DS lamination scan area.

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Pacific Gas & Electric Company 20" Route L-147 Excavation Site T43A-B_L147_B_MP-1.89



Overview of US MPIOK and Lamination scan OK.



Overview DS of MPIOK and Lamination scan OK.



Overview of pipe Ph.



Closeup of pipe Ph.

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Pacific Gas & Electric Company 20" Route L-147 Excavation Site T43A-B_L147_B_MP-1.89



Removed pipe section coating assessment 3:00



Overview of coating condition 3:00 position



Overview of coating condition 3:00 position



Overview of coating condition 3:00 position

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Pacific Gas & Electric Company 20" Route L-147 Excavation Site T43A-B_L147_B_MP-1.89



Removed pipe section coating assessment 9:00



Overview of coating condition 9:00 position



Overview of coating condition 9:00 position



Overview of coating condition 9:00 position

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Pacific Gas & Electric Company 20" Route L-147 Excavation Site T43A-B_L147_B_MP-1.89



Coating damaged from removal process.



Coating damaged from removal process.



Coating damaged from removal process.



Removed pipe section linear indication-01

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Pacific Gas & Electric Company 20" Route L-147 Excavation Site T43A-B_L147_B_MP-1.89



Close up of MT Indications of LIN-01



Removed pipe section linear indication-02



Close up of MT Indications of LIN-02



Overview of UT Grid.

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GE Energy Inspection Services

Page

Pacific Gas & Electric Company 20" Route L-147 Excavation Site T43A-B_L147_B_MP-1.89

Rev 1.0 (06-05-12)



Overview of clean blasted inspection area prior to recoat activities



Overview of clean blasted inspection area prior to recoat activities



Overview of clean blasted inspection area prior to recoat activities



Overview of final coating condition US 3:00

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Pacific Gas & Electric Company 20" Route L-147 Excavation Site T43A-B_L147_B_MP-1.89



Overview of final coating condition 3:00



Overview of final coating condition 3:00



Overview of final coating condition 3:00



Overview of final coating condition US 3:00

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Page



Overview of completed Slurry



Overview of completed Slurry



Overview of completed Cover looking upstream



Overview of completed Cover looking downstream

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EXHIBIT C



Line 147 T-43A, Location B MP. 1.951 Pipe Spool UT Thickness

Prepared by

Robert de Haas Sr. Engineering Technician Welding & NDE Services

Prepared for

Joe Medina Director Transmission Process & MAOI August 29, 2013

Report No.: 413.61-13.327

Pacific Gas and Electric Company Applied Technology Services 3400 Crow Canyon Road, San Ramon, California 94583



APPLIED TECHNICAL SERVICES

Non Destructive Examination

3400 Crow Canyon Road, San Ramon, CA 94583

Robert de Haas (925) 866-5849 Cell (209) 480-1063



	NONDESTRUC	TIVE EXAMINAT	ION DA	АТА					
Location and Unit No:	Modesto, Line 147 pipe spool	Examination Da	nte:08/2	29/2013	Job	08607 - 01K			
Client Contact:	Joe Medina	Examiner(s):	Rot	oert de Haas	6				
Manufacturer:	N/A								
INTRODUCTION:	At the request of Joe M thickness measurement	At the request of Joe Medina, Director Transmission Process and MAOI, Ultrasonic thickness measurements were taken on a pipe spool, stored in the Modesto pipe storage yard.							
COMPONENT EXAMIN	ED: 20" Diameter pipe spo	ol removed from Line 1	47, (T - 43 <i>A</i>	A), MP 1.95	1.				
	Pipe spool markings:	Line 147 T-43A-11-B, Loc E Lat. 37.4878247306	6 5 / Lon. 12	2.27019661	194				
EXAMINATION METH	OD: Ultrasonic Thickness M Procedure – ATS-UT- Panametrics – EPOCH Aerotech Alpha HP - 0 Calibration block – Par Pipe surface condition	Measurements (UTT) 302, Rev 3 [4, Sn. 21417606).25" diameter, 10 mHz nametrics 2214E, Sn. 8 – Flash rust	transducer 840	r, Sn. G1050)7				
EXAMINATION RESUL	.TS: UT readings showed a four points on the pipe area where previous pi	UT readings showed a pipe wall thickness range of 0.25 ". Wall thickness readings were taken at four points on the pipe circumference, 90° apart. One additional reading was taken at a polished area where previous pipe grade testing was performed on the upstream end of the spool.							
	<u>U/S end</u>								
	Clock position	<u>12:00</u>	3:00	<u>06:00</u>	<u>)</u>	<u>09:00</u>			
		0.256" 0	.258"	0.257	,,,	0.247"			
	Polished area	0.256"							
	<u>D/S end</u>								
	<u>Clock position</u>	<u>12:00</u>	<u>3:00</u>	<u>06:00</u>	<u>)</u>	<u>09:00</u>			
		0.251" 0	.253"	0.254		0.247"			



Upstream end on spool



Downstream end of spool

EXHIBIT D

INSPECTION SERVICES Pipeline Integrity Team CWA # 2500461774 GEIS Job # LAP10015

IN-FIELD SERVICES

GEIS Pipeline Integrity Team NDE

Pacific Gas & Electric Company

Hydrostatic Test Dig from October 7, 2011 to November 5, 2011 T43A/B_L147_B_MP-1.95 Documents Contained Within:

> H-Form Report T43A/B_L147_B MP-1.95 NDE Reports of T43A/B_L147_B MP-1.95 Photo Report of T43A/B_L147_B MP-1.95

Authors: H. Mayer & J. Hayes

Date: December 2, 2011



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Form H: Direct Examination Da	ata Sheet - Page 1 of 10				
D. Route Number	A/ILI	Site Decignation	DA TASA/R R		<u>I</u>
Date of Excavation	10/7/2011	N.Seamen	NA	RMP-11 Ref. Section:	Table 5.6.2
Mile Point	1.95	IMA Number	NA NA	Reference Girth Weld:	NA
Examination Performed By	H. Mayer/J. Hayes	_		Distance From Girth Weld:	NA
PG&E Project Manager	Donovan Fink	Region Number	: NA		
Approved By	: Kenji Gailey	Subregion # (ICDA): NA	_	
Order Number	41497360	Stationing	NA NA	_	
Excavation Priority:			Excavation Reason		
Immediate	Scheduled (For II I -	1 Year Other)		III Recoat	
Wonitor	Effectiveness	X Hydro i est	ICDA	Other NA	
If practical, take P/S or CIS	reads before excavation:			NA	
Excavation Details: U/S Ditch S	Start GPS Coordinates	(Uncorrected Field Measure	ment)		
Northing: 37	.4878247306	P	DOP: NA Pla	nned Excavation Length (Ft.):	NA
Easting: -1	22.2701986194	Ai	C~: NA A	ctual Excavation Length (Ft.):	21.0ft
Center	line GPS Coordinates	(Uncorrected Field Measure	ment)	GPS File Name:	Guida 148T4313
Northing: NA		P			
Easting. IV	N N				
D/S D	tch End GPS Coordinates	(Uncorrected Field Measure	ment)		
Northing: 37 Easting: -13	.48/8664944	P			
Zubung.					
1.0 Data Before Coating Remo	val				
1.1 Native Soil Type:	X Clav	X Rock X Sand	Loam 🗖 We	t 🗖 Other	NA
1 1 Backfill Mate	vial Found:		/ Nafive D	Penth of Cover (Et):	6.000
					0.0011
Comments:			NA		
1.2 Coating Type:	X HAA	Somastic Plas	tic Tape 📃 Wax Ta	pe FBE	Powercrete
Bare	None Coal Tar	Other: N	A Commen	ts: N/	A
Costing Thisknoon /			Number of Lovers	î	
Coaung mickness (incries).	23011	Number of Layers.	2	
1.3 Holiday Testing Pe	rformed?:	Yes X No	Voltage Used: NA	Map Location of	Holidays Below.
	Device Used:	Coil Wet Sponge	Com	ments: NA	
1.4 Pipe-to-Soil Potent	ials in Ditch (-mV):	US: 12:00 -	526 3:00 -530	6:00 -535 9:0	0 -526
		DS: 12:00 -	661 3:00 -658	6:00 -640 9:0	0 -663
					· <u> </u>
Comments:		CP appears	obe very low, may be turned off a	t time of inspection.	
Comments:	Ditch (O-cm):	CP appears	o be very low, may be turned off a	t time of inspection.	
Comments: 1.5 Soil Resistivity in I Method:	Ditch (Ω-cm):	CP appears to 24469.5 ohm/cm	o be very low, may be turned off a	t time of inspection.	
Comments: 1.5 Soil Resistivity in I Method: Comments:	Ditch (Ω-cm): X 4-Pin	CP appears t 24469.5 ohm/cm NA	o be very low, may be turned off a	t time of inspection. Box <u>NA</u> SRM-100 US: N/	'A DS: N/A
Comments:	Ditch (Ω-cm): Δ 4-Pin on Comments	CP appears i 24469.5 ohm/cm NA	o be very low, may be turned off a	t time of inspection. Box NA SRM-100 US: N VS) 6:00 position under pipe.	A DS: N/A
Comments:	Xitch (Q-cm): X 4-Pin on Comments control:	CP appears 1 24469.5 ohm/cm NA	o be very low, may be turned off a	t time of inspection. Box NA SRM-100 US: N S) 6:00 position under pipe. S ANA	A DS: N/A
Comments:	Xitch (Q-cm): X 4-Pin on Comments ient?:	CP appears to 24469.5 ohm/cm NA X No Sat	o be very low, may be turned off a Soil Ditch end ([mple(s) Collected?: Yes NA	t time of inspection. Box NA SRM-100 US: N SS) 6:00 position under pipe. SS XN No Sample	A DS: N/A
Comments:	Xitch (Q-cm): X 4-Pin on Comments ient?:	CP appears to Dipa	o be very low, may be turned off a Soil Ditch end ([mple(s) Collected?: Yes NA	t time of inspection. Box NA SRM-100 US: N SS 6:00 position under pipe.	A DS: N/A
Comments:	Xitch (Q-cm): X 4-Pin on Comments ient?: Yes X Good -	CP appears t 24469.5 ohm/cm NA X No Sat Adhered to Pipe	o be very low, may be turned off a bitch end (D bitch end (D mple(s) Collected?: Yes NA Fair - Coating Partial	t time of inspection. Box NA SRM-100 US: N SS) 6:00 position under pipe. T No Sample y Disbonded or Degraded	A DS: N/A
Comments:	Δitch (Ω-cm):	CP appears t	o be very low, may be turned off a bitch end (D bitch end (D mple(s) Collected?: Yes NA Fair - Coating Partiall or Missing	t time of inspection. Box NA SRM-100 US: No SR 6:00 position under pipe. No Sample y Disbonded or Degraded	A DS: N/A
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	DA/IL	<u>.1</u>	5		DA				<u>ILI</u>		
	Route Number:	L-1	47	Site De	esignation	T43A/B_	_B	ILI Log) Distance:	NA	
	Date of Excavation:	10/7/	2011		N-Segment:	NA		RMP-11 Re	f. Section:	Table 5.6	i.2
Examin	Mile Point:	L. Movor	90 // Hoves	I	MA Number:	NA		Reference C	Sirth Weid:	NA	
DC	&E Project Manager:	Donovi	n Fink	Pog	ion Number:	NA		Distance From	Giftil Weld.	NA NA	
FG	Approved By	Kenii (Gailey	Subre	raion # (ICDA):	NA					
	Order Number:	4149	7360	Gabre	Stationing:	NA					
		1110									
1.10	Photos Taken?*: *See Photo Log for a	X Yes additional inf	formation.								
1.11	Coating Sample Ta	ken?:	Yes	X No	Loca	tion of Sample	:		NA		
1.12	Liquid Underneath	Coating?:	Yes	X No	lf Ye	s, pH of Liquid:			NA		
1.13	Corrosion Product	Present?:	Yes	X No	lf Ye	s, Was Sample	e Taken?:	Yes	X No		
	Comments:		—	<u> </u>		NA			<u> </u>		
1.14	Soil pH (Sb Electro	ode):	Upstream:	6.0	Dowr	nstream:	7.5	Pipe	, pH:	6.0	-
2.0 Data Af	ter Coating Remo	oval									
2.1	Pipe Temperature	(°F):	60.0° F		М	easured Pipe	Diameter (In.):		63" =	20.05"	
2.2	Weld Seam Type:		SAW	SSAW	ERW	SMI	LS				
		□ □ s	piral 🗖	Lap	Flash		Smith		MINE, VISUAI	LY PERFORM	
23	Girth Weld Coordir	nates & Ider	tify Type (See	Table 5 7 3)	••••			MACROETCH &	LOCATE		
2.0	Northing		NA	14510 0.1.0)	PDOF	: NA					
	Easting:		NA		Acc~	NA NA	LS Weld	Clock Position(s	;):	8:55	
	Elevation:		NA								
2.4	Damage Found: Corrosion Dama Other Damage	age	Yes	X No Nor	n relevant too	Mechanical Da I marks, no con	amage rosion found gr	Yes reater than 20%	X No		
2.5	UT Wall Thickness	Measurem	ents: US/	ns						US / D	 S
2.0	o i Maii Thickness	TE	DC: 0.270"/(0.275" 1	O'clock 0	.267"/0.272"	2 O'clock	0.267"/0.271"	3 O'clock	0.265"/0.2	271"
		4 O'clo	ock 0.268"/(0.270" 5	O'clock 0	.266"/0.271"	6 O'clock	0.268"/0.273"	7 O'clock	0.266"/0.1	272
		8 O'clo	ock 0.269"/0	0.269" 9	O'clock 0	.261"/0.263"	10 O'clock	0.266"/0.264"	11 O'clock	0.269"/0.2	270"
	UT Wall Thickness	Grid @ 6:0	0 is required. E	Be sure to at	tach grid to	H-Form electro	onically. See	page 6 of 10.	-		
2.6	Wet Fluorescent M	ag. Part. Is	Required.	Comment	is:	2 linear indica	ations on the re	moved pipe sec	tion. See MT	& Photo repo	rt.
	Were there any line	ar indications	s? X	Yes	No If	Yes, attach ND	DE report electr	onically as part	of the H-Forn	n.	
0.7	Taka Bhataa ta Da		······································		R	eport to include	e black light an	d white light pho	tos of indicat	ions.	
2.7	*See Photo Log for	additional inf	formation.	ner Anomali	es						
2.8	Overview Map of C	orroded Ar	ea*:								
	*See Pit Depth Mea	surement Gr	id for additional	I Information		Zero Referen	ce Point:	US	Exposed Pipe 3	360 degrees	
							Flow -				
*Note any	calcareous deposits									-	_
12 o'cl	ock										Ï .
9 o'cl	ock							╂───┼			4
000	ook										
6 o'cl	ock										
										1	
3 o'cl	ock					1					1
										1	
12 o'cl	ock		Ļ	3	I	5	ļ	Ļ	2	L	J ₁₀
1			- `	-	·	-	•		·	~	

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Excavation Drawing:

At minimum draw pipe elevation profile and indicate stationing of 1) low point and 2) critical inclination angle. Place an arrow on the drawing indicating direction of gas flow in the region(s). Other labels may also be added (e.g. "to Station").



NOTES: (Record stationing and names of nearby landmarks such as creeks and roads. Provide any additional information that may help in spatially positioning pipe):

**See attached Delorme screen shot on page 11.

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EXTERNAL PIT DEPTH MEASUREMENT GRID SHEETS



PIT DEPTH GRID 1 OF 2

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Form H: Direct Examination Data Sheet - Page 5 of 10

EXTERNAL PIT DEPTH MEASUREMENT GRID SHEETS



PIT DEPTH GRID 2 OF 2

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INTERNAL CORROSION WALL LOSS GRID

<u>ILI</u>	DA		<u>ILI</u>	
L-147	Site Designation	T43A/B_B	ILI Log Distance:	NA
10/7/2011	N-Segment:	NA	RMP-11 Ref. Section:	Table 5.6.2
1.95	IMA Number:	NA	Reference Girth Weld:	NA
H. Mayer/J. Hayes		NA	Distance From Girth Weld:	NA
Donovan Fink	Region Number:	NA		
Kenji Gailey	Subregion # (ICDA):	NA		
41497360	Stationing:	NA		
	L-147 10/7/2011 1.95 H. Mayer/J. Hayes Donovan Fink Kenji Gailey 41497360	ILI DA L-147 Site Designation 10/7/2011 N-Segment: 1.95 IMA Number: H. Mayer/J. Hayes IMA Number: Donovan Fink Region Number: Kenji Gailey Subregion # (ICDA): 41497360 Stationing:	DA L-147 Site Designation T43A/B_B 10/7/2011 N-Segment: NA 1.95 IMA Number: NA H. Mayer/J. Hayes NA NA Donovan Fink Region Number: NA Kenji Gailey Subregion # (ICDA): NA 41497360 Stationing: NA	ILI DA L-147 Site Designation T43A/B_B ILI Log Distance: 10/7/2011 N-Segment: NA RMP-11 Ref. Section: 1.95 IMA Number: NA Reference Girth Weld: H. Mayer/J. Hayes NA Distance From Girth Weld: Donovan Fink Region Number: NA Kenji Gailey Subregion # (ICDA): NA 41497360 Stationing: NA

Grid Size = 1 Inch x 1 Inch Clock Position (specify below)

All measurements are in inches.

UT Grid is centered @ 6:00 position on pipe.

	1	2	3	4	5	6 \	/ 7	8	9	10	11	12
A	0.251"	0.251"	0.249"	0.249"	0.249"	0.249"	0.249"	0.248"	0.248"	0.248"	0.248"	0.248"
в	0.251"	0.254"	0.251"	0.251"	0.249"	0.249"	0.249"	0.249"	0.248"	0.248"	0.248"	0.249"
с	0.253"	0.251"	0.251"	0.251"	0.251"	0.251"	0.251"	0.249"	0.249"	0.248"	0.249"	0.249"
D	0.251"	0.251"	0.251"	0.251"	0.251"	0.249"	0.250"	0.249"	0.249"	0.248"	0.247"	0.249"
Е	0.251"	0.251"	0.251"	0.251"	0.251"	0.251"	0.251"	0.251"	0.247"	0.248"	0.247"	0.248"
F	0.251"	0.251"	0.251"	0.251"	0.249"	0.249"	0.251"	0.249"	0.249"	0.247"	0.248"	0.249"
G	0.251"	0.251"	0.247"	0.246"	0.249"	0.248"	0.247"	0.247"	0.246"	0.247"	0.248"	0.247"
н	0.248"	0.249"	0.249"	0.249"	0.248"	0.247"	0.247"	0.247"	0.246"	0.246"	0.246"	0.246"
I	0.249"	0.249"	0.249"	0.249"	0.247"	0.246"	0.244"	0.247"	0.244"	0.244"	0.247"	0.246"
J	0.247"	0.247"	0.247"	0.246"	0.246"	0.246"	0.242"	0.244"	0.244"	0.243"	0.244"	0.246"
к	0.247"	0.247"	0.247"	0.246"	0.246"	0.246"	0.244"	0.244"	0.244"	0.244"	0.244"	0.246"
	0.249"	0.247"	0.247"	0.247"	0.248"	0.248"	0.248"	0.242"	0.244"	0.244"	0.246"	0.244"

INTERNAL CORROSION GRID 1 of 1

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SB_GT&S_0477015

Form H: Direct Examination Data Sheet - Page 7 of 10

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COATING DAMAGE

DA/	<u>ILI</u>	DA		<u>ILI</u>	
Route Number:	L-147	Site Designation	T43A/B_B	ILI Log Distance:	NA
Date of Excavation:	10/7/2011	N-Segment:	NA	RMP-11 Ref. Section:	Table 5.6.2
Mile Point:	1.95	IMA Number:	NA	Reference Girth Weld:	NA
Examination Performed By:	H. Mayer/J. Hayes		NA	Distance From Girth Weld:	NA
PG&E Project Manager:	Donovan Fink	Region Number:	NA		
Approved By:	Kenji Gailey	Subregion # (ICDA):	NA		
Order Number:	41497360	Stationing:	NA		

NO.	FEET FROM REFERENCE	O'CLOCK	MAX LENGTH (IN.)	MAX CIRC EXTENT (IN.)
NA	NA	NA	NA	NA

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Form H: Direct Examination Data Sheet - Page 8 of 10

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CORROSION LOG

DA/I	<u>LI</u>	DA		<u>ILI</u>		
Route Number:	L-147	Site Designation	T43A/B_B	ILI Log Distance:	NA	
Date of Excavation:	10/7/2011	N-Segment:	NA	RMP-11 Ref. Section:	Table 5.6.2	
Mile Point:	1.95	IMA Number:	NA	Reference Girth Weld:	NA	
Examination Performed By:	H. Mayer/J. Hayes	-	NA	Distance From Girth Weld:	NA	
PG&E Project Manager:	Donovan Fink	Region Number:	NA			
Approved By:	Kenji Gailey	Subregion # (ICDA):	NA			
Order Number:	41497360	Stationing:	NA			
-						

IC or EC	FEET FROM REFERENCE	O'CLOCK	MAX PIT DEPTH (MILS)	MAX LENGTH (IN.)	MAX CIRC EXTENT (IN.)
NA	NA	NA	NA	NA	NA

Page 9 of 31

Form H: Direct Examination Data Sheet - Page 9 of 10

PHOTO LOG

DA/	<u>LI</u>	DA		<u>ILI</u>	
Route Number:	L-147	Site Designation	T43A/B_B	ILI Log Distance:	NA
Date of Excavation:	10/7/2011	N-Segment:	NA	RMP-11 Ref. Section:	Table 5.6.2
Mile Point:	1.95	IMA Number:	NA	Reference Girth Weld:	NA
Examination Performed By:	H. Mayer/J. Hayes		NA	Distance From Girth Weld:	NA
PG&E Project Manager:	Donovan Fink	Region Number:	NA		
Approved By:	Kenji Gailey	Subregion # (ICDA):	NA		
Order Number:	41497360	Stationing:	NA		
-		-			

LOCATION	DESCRIPTION	COMMENTS
***	*See attached photo report.	
	· · ·	
	LOCATION ***	LOCATION DESCRIPTION *****See attached photo report.

Page 10 of 31

Date	Form H: D	irect Examination Da	ata Sheet - Page 10 of 1	10		, , , , , , , , , , , , , , , , , , ,
Date of Exavation UD30 Distance Disconce Disconce<		<u>DA/ILI</u> Bauta Numbari	1 447	<u>DA</u> Site Designation	T42A/D D	
Mile Faint 135 MA Kumber NA Reference Girth Weld: NA PG&E Project Manager Docoran Fink Approved By Na Region Number: NA Distance From Girth Weld: NA Stationing: NA Stationing: NA Distance From Girth Weld: NA Stationing: NA Stationing: NA Distance From Girth Weld: NA Stationing: NA Stationing: NA Distance From Girth Weld: NA Stationing: MA Stationing: NA Distance From Girth Weld: NA Stationing: NA NA Distance From Girth Weld: NA Distance From Girth Weld: NA Stationing: Mainter Stationing: NA Distance From Girth Weld: NA Distance From Girth Weld: NA Stationing: Mainter Stationing: Mainter Stationing: Na Distance From Girth Weld: NA Stationing: Properture: 62.079 Dev Tar 247 X Probal 7200 P E Tape Station: Station: Station: Station: Station: Station: Station:		Date of Excavation:	10/7/2011	N-Segment:	NA	RMP-11 Ref. Section: Table 5.6.2
NA Datance From Girth Weld: NA PG6E Project Manage: Dorouge finds NA Approved By: Kaniji Galley Stationing: NA Stationing: NA Stationing: NA Stationing: NA NA NA NA Stationing: Na Anchor Profile Measurement: Average: 32 mils Stationing: Stationing: Na Dev Cirp 1280 c. Pot 1200 c.<		Mile Point:	1.95	IMA Number:	NA	Reference Girth Weld: NA
PG&E Project Munager: Dream Fink Kanji (Galler, Order Number: NA 3.0 Stationing: NA 3.1 Sandollast Media: Sharp Shot 30/60 Anchor Profile Measurement: Average: 3.2 mils 3.2 Pipe Recoated With: Ban-Rust 235 Dev Grip 238 Dev Tar 247 Protal 7200 PE Tape 3.3 For Epoxy Coating Systems, Record Environmental Condition: Average: 3.2 mils 45.1°F Pipe Temperature: 62.4°F Relative Hundity: 51.4% 7 Time of Day: 12.30 pm Ds 3.00. 82.6 00.0 79 9.00. 79 12.00. 75 3.4 Repair Coating Hardness (If ARC Coating:) US 3.00. 32.7 6:00. 38.7 9:00. 57.5 12:00. 27.4 3.5 Measured Coating Thickness: US 3:00. 37.3 6:00. 38.7 9:00. 57.5 12:00. 27.4 4 Measured Coating Thickness: US 3:00. 37.3 6:00. 28.6 9:00. 57.5 12:00. 27.4 4 Measured Coating Thickness: US 3:00. 37.3 6:00. 28.6<	Exami	ination Performed By:	H. Mayer/J. Hayes		NA	Distance From Girth Weld: NA
Approved by	PC	G&E Project Manager:	Donovan Fink	Region Number:	NA	
Order National Iter 3.1 Sandblast Media:		Approved By:	Kenji Gailey	Subregion # (ICDA):	NA	-
3.1 Sandblast Medla:		Order Number.	41497300	Stationing.	NA	-
3.1 Sandblast Media:	<u>3.0 REC</u>	OAT DATA				
3.2 Pipe Recoated With:	3.1	Sandblast Media:	Sharp Shot	30/60	Anchor Profile Mea	asurement: Average: 3.2 mils
□ Powercrete J ∑ Poly Tape □ Bar-Rust 235 □ Dev Grip 238 □ Dev Tar 247 ∑ Protal 7200 □ PE Tape 3.3 For Epoxy Coating Systems, Record Environmental Condition: Air Temperature: 62.4 fr 67.0 fr Time of Day: 12:30 pm Dew Point: 45.1 fr 81.4% 3.4 Repair Coating Hardness (If ARC Coating:) US 3:00 - 82 6:00 - 79 9:00 - 79 12:00 - 79 3.5 Measured Coating Thickness: US 3:00 - 32.7 6:00 - 38.7 9:00 - 57.5 12:00 - 27.4 3.6 Measured Coating Thickness: US 3:00 - 32.7 6:00 - 38.7 9:00 - 57.5 12:00 - 27.4 3.6 Coupon Test Station Installed?: □ Yes No ETS Installed?: □ Yes No Device Used: □ Other: NA NA	3.2	Pipe Recoated With:				
3.3 For Epoxy Coating Systems, Record Environmental Condition: Air Temperature: 62.4'F Pipe Temperature: 62.4'F Relative Humidity: 51.4% 3.4 Repair Coating Hardness (If ARC Coating): US 3:00 - 82 6:00 - 79 9:00 - 79 12:00 - 79 12:00 - 79 12:00 - 79 12:00 - 79 12:00 - 79 12:00 - 79 12:00 - 79 12:00 - 27.4 3.5 Measured Coating Thickness: US 3:00 - 33.7 6:00 - 38.7 9:00 - 57.5 12:00 - 27.4 DS 3:00 - 37.3 6:00 - 38.7 9:00 - 57.5 12:00 - 27.4 DS 3:00 - 37.3 6:00 - 38.7 9:00 - 57.5 12:00 - 27.4 Holiday Tested?: X Yes No Device Used: Coll Wet Sponge Voltage Used: UNK Repair All Holidays. YES So Coupon Test Station Installed?: Yes No ETS Installed?: Yes No ETS Installed?: Na Surface Configuration: Fink G-5 Box Carsonite Other: NA Coating Protections?: X Yes No Imported Sand Other: STACguard (transitions only) 3.8 Pipe-to-Soil Readinge Over Bell Hole After Backfill: NA NA Stackfield data. Comments: Ma No etheside of the bell hole. Att		Powercrete J	X Poly Tape	Bar-Rust 235	Dev Grip 238	Dev Tar 247 🗙 Protal 7200 🔲 PE Tape
Air Temperature: 62.4'F Dew Point: 45.1'F Pipe Temperature: 67.0'F Relative Humidity: 51.4% 3.4 Repair Coating Hardness (If ARC Coating:) US 3:00 - 82 - 6:00 - 79 - 9:00 - 79 - 12:00 - 79 - 12:00 - 81 - 75 - 9:00 - 79 - 12:00 - 81 - 75 - 9:00 - 79 - 12:00 - 27.4 3.5 Measured Coating Thickness: US 3:00 - 32.7 - 6:00 - 38.7 - 9:00 - 57.5 - 12:00 - 27.4 Ds 3:00 - 28.6 - 9:00 - 39.0 - 12:00 - 29.3 Holiday Tested?: X res Holiday Tested?: X res No Device Used: Coil Wet Sponge Voltage Used: UNK Repair All Holidays. YES No ETS Installed?: Yes Surface Configuration: Fink G-5 Box Carsonite Other: NA Surface Configuration: Fink G-5 Box Carsonite Other: NA Surface Configuration: Rockguard Tuf-E-Nuf Conwed Other: STACguard (transitions only) 3.8 Pipe-to-soil Readings Over Bell Hole After Backfill: NA NA Coating Protections?: X res No If repecified, a CIS should be done for approximately 100' on either side of the bell hole. Attach data. Comments:	3.3	For Epoxy Coa	ting Systems, Record En	vironmental Condition	:	
Pipe Temperature: 67.0°F Relative Humidity: 51.4% Time of Day: 12:30 pm US 3:00 - 82 6:00 - 79 9:00 - 79 12:00 - 79 12:00 - 81 3.4 Repair Coating Hardness (If ARC Coating:) US 3:00 - 33.7 6:00 - 38.7 9:00 - 79 12:00 - 81 79 9:00 - 79 12:00 - 79 12:00 - 27.4 05 3:00 - 28.6 9:00 - 39.0 12:00 - 29.3 12:00 - 29:00 - 20.0 12:00 - 20:00 - 20:00 - 20:00 - 20:00 -		Air Temperature:	62.4°F		Dew Point:	45.1°F
3.4 Repair Coating Hardness (If ARC Coating): US 3:00 - 82 / 6:00 - 79 / 9:00 - 79 / 12:00 - 81 / 9:00 - 79 / 12:00 - 81 / 9:00 - 79 / 12:00 - 81 / 9:00 - 79 / 12:00 - 81 / 9:00 - 79 / 12:00 - 27.4 3.5 Measured Coating Thickness: US 3:00 - 33.7 / 6:00 - 28.6 / 9:00 - 38.7 / 9:00 - 57.5 / 12:00 - 27.4 / US 3:00 - 28.6 / 9:00 - 38.7 / 9:00 - 39.0 / 12:00 - 29.3 Holiday Tested?: Yes No Device Used: Coll Wet Sponge Voltage Used: UNK Repair All Holidays. YES 3.6 Coupon Test Station Installed?: Yes No ETS Installed?: Yes No 1f Yes, Date Installed: NA Surface Configuration: Fink G 5 Box Carsonite Other: NA 3.7 Backfill Material: No Imported Sand Other: Surface Configurations only) 3.8 Pipe-to-Soil Readings Over Bell Hole After Backfill: NA NA NA NA Surface Configurations only)		Pipe Temperature:	67.0°F	I	Relative Humidity:	51.4%
3.4 Repair Coating Hardness (If ARC Coating:) US 3:00 - 62 6:00 - 79 9:00 - 79 12:00 - 79 12:00 - 79 12:00 - 79 12:00 - 79 12:00 - 81 3.5 Measured Coating Thickness: US 3:00 - 33.7 6:00 - 38.7 9:00 - 75 12:00 - 27.4 DS 3:00 - 37.3 6:00 - 38.7 9:00 - 38.7 9:00 - 57.5 12:00 - 27.4 DS 3:00 - 37.3 6:00 - 38.7 9:00 - 79 12:00 - 27.4 DS 3:00 - 37.3 6:00 - 38.7 9:00 - 38.7 9:00 - 57.5 12:00 - 27.4 Ds 3:00 - 37.3 6:00 - 38.7 9:00 - 38.7 9:00 - 38.7 9:00 - 39.0 12:00 - 29.3 Holiday Tested?: Yes Ds 3:00 - 0 - 38.7 9:00 - 79 12:00 - 27.4 Ds 3:00 - 37.3 6:00 - 38.7 9:00 - 38.7 9:00 - 38.7 9:00 - 39.0 12:00 - 29.3 Holiday Tested?: Yes Ds 3:00 - 0 - 79 12:00 - 27.4 Suface Contiguration:: No Ds 400 - 79 12:00 - 27.4 Surface Configuration:: NA Surface Configuration:: NA Surface Configuration:: NA Goating Protections?: X Yes No If Yes, Check One: Rockguard If Yes, Check One: Rockguard Tuf-E-Nuf Conwed Other: STACguard (transitions only) 3.8 Pipet-0-Soli Readings Over Bell Hole After Backfill: NA "If specified, a CIS s		Time of Day:	12:30 pm			
Joint Status Joint Status <td< td=""><td>3.4</td><td>Repair Coating Hardn</td><td>ess (If ARC Coating:)</td><td>US 3:00 -</td><td>82 6:00 - 79</td><td>-9:00 - 79 - 12:00 - 79 - 9:00 - 79 - 12:00 - 79 - 9:00 - 79 - 9:00 -</td></td<>	3.4	Repair Coating Hardn	ess (If ARC Coating:)	US 3:00 -	82 6:00 - 79	-9:00 - 79 - 12:00 - 79 - 9:00 - 79 - 12:00 - 79 - 9:00 - 79 - 9:00 -
3.5 Measured Coating Thickness: US 3:00 - 33.7 6:00 - 38.7 9:00 - 57.5 12:00 - 27.4 BS 3:00 - 37.3 6:00 - 28.6 9:00 - 39.0 12:00 - 29.3 Holiday Tested?: X Yes No Device Used: Coil Wet Sponge Voltage Used: UNK Repair All Holidays. YES 3.6 Coupon Test Station Installed?: Yes X No ETS Installed?: Yes No 1f Yes, Date Installed: NA Surface Configuration:: Fink G-5 Box Carsonite Other: NA 3.7 Backfill Material: Native Imported Sand Other: NA NA Coating Protections?: X Yes No If Yes, Check One: Rockguard Tuf-E-Nuf Conwed Other: STACguard (transitions only) 3.8 Pipe-to-Soil Readings Over Bell Hole After Backfill: NA NA "If specified, a CIS should be done for approximately 100' on either side of the bell hole. Attach data. Comments: NA					19 0.00 - 15	9.00 - 79 12.00 - 81
Holiday Tested?: X Yes No Device Used: Coil Wet Sponge Voltage Used: UNK Repair All Holidays. YES 3.6 Coupon Test Station Installed?: Yes X No ETS Installed?: Yes X No If Yes, Date Installed: NA Surface Configuration:: Fink G-5 Box Carsonite Other: NA 3.7 Backfill Material: Native Imported Sand Other: NA Coating Protections?: X Yes No If especified, a CIS should be done for approximately 100' on either side of the bell hole. Attach data. Comments: NA 3.9 Attach site sketch of excavation site. 4.0 REPAIR DATA Yes No 4.2 Number of Repair Made: Replacement "In-Kind configuration" 4.3 Repair Type Metallic Sleeve No Metallic Sleeve Replace Can Filler Metal Other	3.5	Measured Coating Th	ickness: US	3:00 - 33.7	6:00 - <u>38.7</u> 6:00 - <u>28.6</u>	9:00 - 57.5 12:00 - 27.4
Holiday festedr. Image Repaired: Device Used: Image Repaired: Device Used: Image Repaired: Vets Sponge Voltage Used: UNK Repair All Holidays. YES 3.6 Coupon Test Station Installed?: Yes Yes No ETS Installed?: Yes No Surface Configuration: Fink G-5 Box Carsonite Other: NA Surface Configuration: NA G-5 Box Carsonite Other: NA Coating Protections?: Yes Yes No If Yes, Check One: Reckfill: Na NA 'If specified, a CIS should be done for approximately 100' on either side of the bell hole. Attach data. Comments: NA <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
Device Used: Coll Wet Sponge Voltage Used: UNK Repair All Holidays. YES 3.6 Coupon Test Station Installed?: Yes No ETS Installed?: Yes No If Yes, Date Installed: NA G-5 Box Carsonite Other: NA Surface Configuration: Fink G-5 Box Carsonite Other: NA 3.7 Backfill Material: Native Imported Sand Other: NA Coating Protections?: X Yes No If Yes, Check One: Rockguard Tuf-E-Nuf Coating Protections?: X Yes No If Yes, Check One: STACguard (transitions only) 3.8 Pipe-to-Soil Readings Over Bell Hole After Backfill: NA "If specified, a CIS should be done for approximately 100' on either side of the bell hole. Attach data. Comments: NA						
3.6 Coupon rest station instanted?:						
If Yes, Date Installed:NA	3.6	Coupon Test Stat				
Surface Configuration:: Fink G-5 Box Carsonite Other: NA 3.7 Backfill Material: Native Imported Sand Other: NA Coating Protections?: X Yes No If Yes, Check One: Rockguard Tuf-E-Nuf Conwed Other: STACguard (transitions only) 3.8 Pipe-to-Soil Readings Over Bell Hole After Backfill: NA NA ***********************************		If Yes, Date Installed:			_	
3.7 Backfill Material: Native Imported Sand Other: NA Coating Protections?: X Yes No Other: STACguard (transitions only) 3.8 Pipe-to-Soil Readings Over Bell Hole After Backfill: NA NA "If specified, a CIS should be done for approximately 100' on either side of the bell hole. Attach data. Comments: NA		Surface Configuration::	Fink G	-5 Box Carsoni	te Other:	NA
Coating Protections?: X Yes No If Yes, Check One: Rockguard Tuf-E-Nuf Conwed Other: STACguard (transitions only) 3.8 Pipe-to-Soil Readings Over Bell Hole After Backfill: "If specified, a CIS should be done for approximately 100' on either side of the bell hole. Attach data. Comments: NA 3.9 Attach site sketch of excavation site. 4.1 Repair Made: Yes X No 4.2 Number of Repair Made: Replacement "In-Kind configuration" 4.3 Repair Type Metallic Sleeve Non Metallic Sleeve Replace Can Filler Metal Other	3.7	Backfill Material:	Native Im	ported Sand	Other:	NA
If Yes, Check One: Rockguard Tuf-E-Nuf Conwed Other: STACguard (transitions only) 3.8 Pipe-to-Soil Readings Over Bell Hole After Backfill: *If specified, a CIS should be done for approximately 100' on either side of the bell hole. Attach data. Comments: NA NA NA /b>		Coating Protections?:	X Yes 🗌 No	•		
3.8 Pipe-to-Soil Readings Over Bell Hole After Backfill: NA *If specified, a CIS should be done for approximately 100' on either side of the bell hole. Attach data. Comments: NA 3.9 Attach site sketch of excavation site. 4.1 Repair Made: Yes No 4.2 Number of Repair Made: Replacement "In-Kind configuration" 4.3 Repair Type Metallic Sleeve Non Metallic Sleeve Corrosion Mechanical Other		If Yes, Check One:	Rockguard	Tuf-E-Nuf 🔲 C	Conwed Other:	STACguard (transitions only)
*If specified, a CIS should be done for approximately 100' on either side of the bell hole. Attach data. Comments: NA 3.9 Attach site sketch of excavation site. 4.1 Repair Made: Yes X No 4.2 Number of Repair Made: Replacement "In-Kind configuration" 4.3 Repair Type Metallic Sleeve Non Metallic Sleeve Replace Can Filler Metal Other 4.4 Damage Repaired: Corrosion Mechanical Other	3.8	Pipe-to-Soil Readings	Over Bell Hole After Bac	kfill:	NA	
Comments: NA 3.9 Attach site sketch of excavation site. 4.0 Repair Made: 4.1 Repair Made: Yes No 4.2 Number of Repair Made: Repair Type Metallic Sleeve Metallic Sleeve Replace Can Filler Metal Other		*If specified, a CIS sho	uld be done for approximate	ely 100' on either side of	the bell hole. Attach dat	ta.
3.9 Attach site sketch of excavation site. 4.0 REPAIR DATA 4.1 Repair Made: Yes X No 4.2 Number of Repair Made: Replacement "In-Kind configuration" 4.3 Repair Type Metallic Sleeve Non Metallic Sleeve Replace Can Filler Metal Other 4.4 Damage Repaired: Corrosion Mechanical Other		Comments:			NA	
3.9 Attach site sketch of excavation site. 4.0 REPAIR DATA 4.1 Repair Made: Yes X No 4.2 Number of Repair Made: Replacement "In-Kind configuration" 4.3 Repair Type Metallic Sleeve Non Metallic Sleeve Replace Can Filler Metal Other 4.4 Damage Repaired: Corrosion Mechanical Other						
3.9 Attach site sketch of excavation site. 4.0 REPAIR DATA						
4.0 REPAIR DATA 4.1 Repair Made: Yes No 4.2 Number of Repair Made: Replacement "In-Kind configuration" 4.3 Repair Type Metallic Sleeve Non Metallic Sleeve Replace Can Filler Metal Other 4.4 Damage Repaired: Corrosion Mechanical Other	3.9	Attach site sketch of e	excavation site.			
A.1 Repair Made: Yes X No 4.2 Number of Repair Made: Replacement "In-Kind configuration" 4.3 Repair Type Metallic Sleeve Non Metallic Sleeve Replace Can Filler Metal Other 4.4 Damage Repaired: Corrosion Mechanical Other						
4.3 Repair Type Metallic Sleeve Non Metallic Sleeve Replace Can Filler Metal Other 4.4 Damage Repaired: Corrosion Mechanical Other	<u>4.0 ((217</u> 4.1	Repair Made:	Yes X No	4.2 Number of	f Repair Made:	Replacement "In-Kind configuration"
4.4 Damage Repaired: Corrosion Mechanical Other	4.3	Repair Type	Metallic Sleeve	Non Metallic S	Sleeve Replace	e 🗖 Can 🗖 Filler Metal 🗖 Other
	4 4	Damage Repaired:			chanical 🗖 Othe	
		Buillage Repaired.				51
	was inspecte	ed. T43B had coating rem	noved, area for inspection w	as blasted from coating	up to test pipe tie in weld	d. About 1.5 ft of coating was inspected. Removed
was inspected. T43B had coating removed, area for inspection was blasted from coating up to test pipe tie in weld. About 1.5 ft of coating was inspected. Removed	pipe section	was inspected at the FG	s⊑ yaru.			
was inspected. T43B had coating removed, area for inspection was blasted from coating up to test pipe tie in weld. About 1.5 ft of coating was inspected. Removed pipe section was inspected at the PG&E yard.						
was inspected. T43B had coating removed, area for inspection was blasted from coating up to test pipe tie in weld. About 1.5 ft of coating was inspected. Removed pipe section was inspected at the PG&E yard.						
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was inspected. T43B had coating removed, area for inspection was blasted from coating up to test pipe tie in weld. About 1.5 ft of coating was inspected. Removed pipe section was inspected at the PG&E yard.						

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GE Energy INSPECTION & LIFE EXTENSION SERVICES

	MAGNE	ETIC PART	ICLE EXA	MINATI	ON REPO	X			Nuclear	Non-N	luclear	
To:	Pacific Gas & Electric Company					From: H. Maver/J. Haves				Date: 10/7/2011		
Project:			. ,					,	-			
-			T	43A/B L1	47 B MF	-1.95						
Purchase Order No	:				GEIS Job No							
41497360 LAPI0015												
ltem	Weld Structural Casting			Machin	 achinery Mach. Parts Pipe			N/A Other:				
	5									N/A		
	Non-Weld	Plate	Pipe	Bar	C	asting	Mach. Parts	N/A	Other:	1073		
							П			N/A		
	Size	Material Thi	ckness	Type of Bas	se Material		vpe of Filler Ma	terial	Weld			
Material	20"	0.250		Carbo	Steel		C/S	terial			ladad	
		the intersec	tion of Britts		i Milano	System	0/3		Sinootin		velueu	
Location	70.0 Ft 3W 01	Way in San C	arlos CA 9	4070	a minario	Oystern			-147			
Accontonco		inay in our c				Procedu	Iro		_ 171			
Standards		Customer	Specificati	ons		FIOCEUC	CEIS OCD # 500 Poy 17					
	Initial	Plate Edge	In Process	Back Go	ure Ro	nt Pass	Renair	12	Hour 2	4 Hour	Final	
Type of Check					age to			12				
	Longitudinal Coil DC Probe						Continuou	s	Other:			
	✓ Wet Dry] Direct Contact 📿 Residual							
Type of Inspection	Circular	A	AC Prod		Yoke		Other					
	MT Yoke &	Model - Serial I	No. / Blackligh	it Model - Se	erial No.		Surface Preparation Method					
	Parker DA-400 - S# 18830 / Spectroline BIP - S# 1597251						Abrasive Blasting (Kleen Blast) - NACE 2 Finish					
	Inspection Medium / Color / Batch No.						Demagnetization Method / Equipment					
	Magnaglo 14A / Flourescent Green / 09M12K							-	N/A			
Reference: Summa	ry			7	See Attac	hment			Dec. 16 (1			
The following an	eas were request	ted to be insp	ected:	Recording					Results of	Inspection		
Bare pipe: -0.40' to	1.35' from original	U/S ditch start.					Ē	No relevar	nt indications found	@ time of insp.		
Bare pipe : 17.4' to 18.45' from original U/S ditch start. Removed pipe section					- 1			No relevant indications found @ time of insp.				
Summary:								Entour mu				
Lin-01: Axial Start	=1.60' (From U/S en	id of pipe), AL=	1.58", CW=0	.020" , CLKI	Position= 4:0	0						
These are on the r	=2.33" (From U/S en emoved pipe section	id of pipe), AL= on.	1.20°, CVV=0.9	020", CLK P	osition= 4:00	ò	ŀ					
							F					
Indications were on t	ne removed pipe sect	ion. Please see a	ittached photo	report for ad	ditional infor	nation.			Demonstrati Du C	la - la ! \-		
					Requested By:				Reported By (Technician):			
Pacific Gas & Electric Company GE Inspection Services (Los Angeles)				ļ	David Aguiar				H. Mayer/J. Hayes			
				Customer Specifications				NDT supervisor:				
Accept Reject Andre J. Filiatrault								ault				
NOTICE: THIS EXAMI	INATION REPORT IS A	REPORT OF THE	ERESULTS OF 1	THE NDT PRO	CEDURE ACT	UALLY PE	RFORMED BY TH	IS COMPA	ANY IT IS SUBJEC	T TO THE LIM	ITATIONS	

OF THE TESTING SPECIFICATIONS AND PROCEDURES WHICH WERE UTILIZED. BY FURNISHING THIS REPORT, GE INSPECTION & LIFE EXTENSION SERVICES DOES NOT GUARANTEE ANY CONDITION OF THE TESTED SPECIMEN.



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GE Energy Inspection & Life Extension Services

			Nuclear	Non-Nuclear							
To:							From:				
Pacific Gas & Electric Company						H. Mayer	& J. Hayes	10/7/2011			
Project:											
Purchase Order No: GEIS Job No:											
	1	41497360				LAPIC	015				
ltem	Weld	Structural	Casting	Machinery	Mach. Parts	Pipe	N/A	Other:			
	Non-Weld	Plate	Pipe	Bar	Casting	Mach. Parts	N/A	Other			
Material	Size:	ze: No. of Pieces Ty		Type of E	Type of Base Metal		Type of Filler Material		⊡N/A		
	20" 1			Carbo	n Steel	C/S		Smooth	AsWelded		
Location	70.6 Ft SV	v of the inte	ersection of H	Fittan Ave a	and Milano	System	System				
Acceptance		way in a	san Carlos, C	A 94070		Procedure		L-14/			
Standards		Custo	mer Specific	ations		OCP-601					
Clandards	Soundness	Thickness	Bond			Transducer			Transducer Serial No.:		
	~				Single Crystal		Dual Crysta		020HFC		
	Pulse Echo	Angle-Beam	Other	Freq	Frequency Size Angle		gle	Couplant / Batch #			
	\checkmark			5 MHz		0.375"	0°		Sonatest Ultragel II		
Type of	UTEquipment	JT Equipment/Model			Flat		Convex		/ 25-901 07225 AF		
Inspection	Inspection USN-60			\checkmark							
	Serial # 01NLKN			Standard		Material	Notch Depth		Serial No.:		
	Calibration Date:										
	10/5/2011			Step Wedge		Material	Thickness Range		Serial No.:		
Calibration Due: 1/5/2012			Tube Wedge		C/S	0.200" - 0.500"		V34693			
Reference: Sum The following	mary n areas wer	e requeste	d to be inspe	ected.	See	Attachment		Results of li	nspection:		
12" x 12" (1"x1	" orid) at a r	andom 6:00	position on t	he pipe.			- No relevant	indications @ t	ime of inspection.		
12" lamination	n scans at cu	ut-line locati	ons.				- No relevant	indications@t	ime of inspection.		
Thickness rea	dings US & E)Sinspectior	n areas at the	clock positi	ons.		- No relevant	indications@t	ime of inspection.		
	-	·									
** Please see attached reports for additional information.											
Copy To:		Requested B	y:		Reported By (Technician):						
Pacific Gas & Electric Company					David Aguia			H. Mayer/J. Hayes			
GE Inspection Services (Los Angeles)						er Specificatior	IS	NDT Supervisor:			
					Accept	Reject		Andre	e J. Filiatrault		
NOTIOE											

NOTICE: THIS EXAMINATION REPORT IS A REPORT OF THE RESULTS OF THE NDT PROCEDURE ACTUALLY PERFORMED BY THIS COMPANY IT IS SUBJECT TO THE LIMITATIONS OF THE TESTING SPECIFICATIONS AND PROCEDURES WHICH WERE UTILIZED. BY FURNISHING THIS REPORT, *GE INSPECTION SERVICES* DOES NOT GUARANTEE ANY CONDITION OF THE TESTED SPECIMEN.



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Topography looking upstream



Topography looking downstream



Typical surrounding topography



Typical surrounding topography

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Overview of Dig Site T43A-B_L147_B_MP-1.89



Overview of Dig Site T43A-B_L147_B_MP-1.89



Overview of T43A(US) & T43B(DS) in same excavation.



Closeup of T43A(US) & T43B(DS) in same excavation.

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Overview of Reference Girth Weld measurments were taken from.



Overview of coating condition -1ft to 2ft, 3:00 position



Overview of coating condition -1ft to 2ft, 3:00 position



Overview of coating condition -1ft to 2ft, 9:00 position

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Overview of coating condition -1ft to 2ft, 9:00 position



Overview of coating condition 17ft to 20ft, 3:00 position



Overview of coating condition 17ft to 20ft, 3:00 position



Overview of coating condition 17ft to 20ft, 9:00 position

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Overview of coating condition 17ft to 20ft, 9:00 position



Overview of MPI layout -1ft to 2ft, 3:00 position



Overview of MPI layout -1ft to 2ft, 3:00 position



Overview of MPI layout -1ft to 2ft, 9:00 position

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Overview of MPI layout -1ft to 2ft, 9:00 position



Overview of MPI layout 17ft to 20ft, 3:00 position



Overview of MPI layout 17ft to 20ft, 3:00 position



Overview of MPI layout 17ft to 20ft, 9:00 position

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Overview of MPI layout 17ft to 20ft, 9:00 position



Overview of bare pipe start

Overview of bare pipe end

Overview of bare pipe start

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Overview of bare pipe end

Overview of feature joint long seam @8:55

Overview of US lamination scan area.

Overview of DS lamination scan area.

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Overview of US MPIOK and Lamination scan OK.

Overview DS of MPIOK and Lamination scan OK.

Overview of pipe Ph.

Closeup of pipe Ph.

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Removed pipe section coating assessment 3:00

Overview of coating condition 3:00 position

Overview of coating condition 3:00 position

Overview of coating condition 3:00 position

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Removed pipe section coating assesment 9:00

Overview of coating condition 9:00 position

Overview of coating condition 9:00 position

Overview of coating condition 9:00 position

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Coating damaged from removal process.

Coating damaged from removal process.

Coating damaged from removal process.

Removed pipe section linear indication-01

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Close up of MT Indications of LIN-01

Removed pipe section linear indication-02

Close up of MT Indications of LIN-02

Overview of UT Grid.

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Overview of clean blasted inspection area prior to recoat activities



Overview of clean blasted inspection area prior to recoat activities



Overview of clean blasted inspection area prior to recoat activities



Overview of final coating condition US 3:00

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Pacific Gas & Electric Company 20" Route L-147 Excavation Site T43A-B_L147_B_MP-1.95



Overview of final coating condition 3:00



Overview of final coating condition 3:00



Overview of final coating condition 3:00



Overview of final coating condition US 3:00

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Overview of completed Slurry



Overview of completed Slurry



Overview of completed Cover looking upstream



Overview of completed Cover looking downstream

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Overview of completed Cover, 3:00 view



Overview of completed Cover, 9:00 view

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EXHIBIT E

Exponent

Failure Analysis Associates

PG&E Line 147 Britton and Rogers Avenue Leak: Metallurgical Analysis

SB_GT&S_0477041

Exponent

PG&E Line 147 Britton and Rogers Avenue Leak: Metallurgical Analysis

Prepared by:

- Agames

Brad James, Ph.D., P.E., FASM Exponent Failure Analysis Associates 149 Commonwealth Drive Menlo Park, CA 94025

October 2013

• Exponent, Inc.

Doc. no. 1306838.000 A0T0 1013 RE15

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Appendix A Microhardness Testing

Exponent Failure Analysis Associates (Exponent) has been retained by Pacific Gas and Electric (PG&E) to help determine the cause of the leak identified in Line 147 along Brittan Avenue in San Carlos, California, and why the leak was not detected during a recent hydrostatic test (hydrotest). The subject leak was identified on October 18, 2012, and the hydrotest had been performed approximately one year earlier, on October 24, 2011.

Exponent's metallurgical investigation of the leak followed work conducted by Anamet laboratories. Our work included visual, metallographic, fractographic, and chemical analysis of the leak site. Our analysis largely agreed with the opinions presented by Anamet: the leak occurred within a weld repair section, all cracking occurred during the repair itself, with no metallographic or fractographic evidence that any crack growth occurred following the repair weld. Specifically, there was no evidence of progressive crack growth due to fatigue, stress corrosion cracking (SCC) or ductile tearing from the "pressure reversal" phenomenon occasionally observed during hydrotesting. Significant deposits were observed within the cracks. These deposits were largely iron-oxide based, although high levels of sulfur (likely associated with mercaptan-odorizer present in the natural gas) were identified.

The subject leak was caused by cracking that occurred within a location on the pipe body that had been repaired using weld-metal deposition ("weld repair"). This weld repair was not associated with either a girth or longitudinal seam weld. The cracks associated with the leak within the outer diameter (OD) weld were caused by solidification cracking during the weld repair. Cracks that initiated along the pipe inner diameter (ID), within the heat-affected zone (HAZ) beneath the repair weld were also observed. The HAZ exhibited significant grain coarsening with areas of Widmanstatten ferrite along the prior-austenite grain boundaries. Areas of fracture along the prior-austenite grain boundaries were observed, indicative of the low-toughness associated with severely-coarsened grains, possible segregation of impurity elements (such as sulfur and phosphorus), and high residual stresses from the weld repair. Microhardness testing indicated hardness levels less than 190 HV (approximately 90 on the Rockwell B Scale) within the HAZ. At this low hardness level, hydrogen embrittlement is unlikely to have contributed to the intergranular fracture observed within the HAZ. Like the solidification cracking observed at the pipe outer diameter, these HAZ cracks occurred during or shortly after the weld was made as the metal cooled.

The cracks showed no evidence of propagation over time. The relatively large pressures associated with the hydrotest were insufficient to grow the subject cracks. The subject leak was not detected during hydrotesting. The primary purpose of hydrotesting is to help establish pipeline integrity and find large-scale leaks. The leak path was small, full of oxide, and provided a tortuous path for liquid water to escape.

Background

PG&E Line 147 connects Lines 132 and 101, and extends along a portion of Brittan Avenue in San Carlos, California. The maximum allowable operating pressure (MAOP) of Line 147 documented on the hydrotesting test report was 400 psig.¹ The portion of Line 147 that contained the leak was installed in 1957.²

On October 24, 2011, Line 147 was hydrotested between mile posts 1.95 and 3.4.¹ The 8.32-hour-long hydrotest was conducted at a minimum sustained pressure of 607 psig (at the maximum elevation), and included a 30-minute pressure spike to 748 psig (maximum). Thus, the hydrotest was conducted at a pressure in excess of 50-percent greater than the Line 147 MAOP. The hydrotest was certified by RCP Inc.¹ to meet the requirements of the Federal Code of Regulations, Title 49, Part 192, Subpart J for a Class 3 location. The buried pipe segment (7,541 feet) gained 2-degrees F fluid temperature, and the exposed pipe segment (175 feet) lost 3-degrees F over the test period. Given the coefficient of thermal expansion of water, a variation of 1-degree Fahrenheit is equal to 10.14 gallons of water. Thus, a small hydrostatic test leak would have been within the inherent error associated with the test.

On October 13, 2012, approximately one-year after the Line 147 hydrotest, a PG&E gas crew leader observed bubble formations in water associated with an excavation on Brittan Avenue. PG&E testing on October 15, 2012 confirmed the gas leak near the intersection of Brittan Avenue and Rogers Avenue. On November 13, a 6-inch PLIDCO cap was welded over the leak site (50-feet east of Rogers Avenue on Brittan Avenue) at the bottom (6 o'clock position) of the pipe.

Exponent conducted a metallurgical analysis to help determine the cause of the leak and why the leak was not detected during hydrotesting. Our analysis included visual, fractographic, metallographic, and chemical analysis of the leak and associated welds/piping. The results of our investigation are described below.

¹ RCP Inc., Hydrostatic Test Certification, March 15, 2012.

² PG&E Leak Repair, Inspection and Gas Quarterly Incident Report (A-Form), 58-12-60279- updated.

Non-Destructive Examination

The portion of Line 147 that contained the subject leak was initially examined by Anamet Inc. (Anamet). As described in their September 6, 2013 report, Anamet conducted leak testing, metallographic analysis, as well as tensile and Charpy V-notch (CVN) testing of the subject pipe. The subject leak and adjacent pipe were transferred from Anamet to Exponent; received by Exponent on September 23, 2013 in the condition shown in Figure 1 and Figure 2.



Figure 1. Photograph of the section of L-147 containing the crack and the PLIDCO cap welded over it to stop the gas leak. The red box shows the area magnified in Figure 3. Note the sectioning of the pipe and the yellow markings were made by Anamet.



Figure 2. Photograph of a section of L-147 removed from the section of pipe containing the crack. Note the sectioning of the pipe and the yellow markings were made by Anamet.

The leak site was located in the area in the red box in Figure 1; enlarged in Figure 3. A PLIDCO cap had been welded onto the pipe to stop the leak until the subject pipe section could be removed. Beneath the cap, several weld repairs had been conducted. Anamet had sectioned the approximately 0.4-inch long crack into two pieces, then mounted, polished and etched the parts for analysis. The two metallurgical mounts are shown in Figure 4 as received from Anamet. Exponent retained Anamet's sample ID numbers, which for the metallurgical mounts are A-1-1-8 and A-1-1-7, left and right, respectively in Figure 4. As indicated in Anamet's report, these samples were subjected to serial grinding to evaluate different leak cross-sections. As such, portions of the leak that have been ground-away are no longer available for examination.



Figure 3. Photograph of the section of L-147 (boxed in red in Figure 1) containing the crack and the PLIDCO cap. Note the sectioning of the pipe and the yellow markings were made by Anamet.



Figure 4. Photograph of the metallurgical mounts of the area containing the crack in L-147 under the PLIDCO cap. Note the metallurgical mounts were made by Anamet: Exponent retained Anamet's sample ID numbers A-1-1-8 (left); A-1-1-7 (right).

Fractographic Examination

Optical Microscopy

Exponent extracted each of leak sections remnants that had been encapsulated by Anamet in metallographic mounts, cooled them in liquid nitrogen, and then fractured them to analyze the leak surfaces. Optical microscope images of the post-fractured leak surfaces are shown in Figure 5 and Figure 6. The dark portions of each sample are the pre-existing crack/leak locations. The brighter-colored areas occurred when Exponent broke the samples open to reveal the leak surface.



Figure 5. Optical micrographs of the leak surface after opening Anamet's A-1-1-8 metallurgical mount.



Figure 6. Optical micrographs of the leak surface after opening Anamet's A-1-1-7 metallurgical mount.

As shown in Figure 5, the pre-existing crack in Sample A-1-1-8 only extended from the OD approximately halfway through the pipe wall. The pre-existing crack A-1-1-7 extended from the ID nearly to the OD surface. While neither of these two samples display a clear ID-to-OD leak path, the pre-existing crack in Sample A-1-1-7 extends nearly through the pipe wall thickness. Based on the metallographic images in Anamet's report, as well as fractographic analysis of the remaining broken-open metallographic specimens, it is apparent that the through-wall (ID-to-OD) path for the subject leak was less than the 0.4 inch total length of the cracks.

Scanning Electron Microscopy

The leak surface fracture morphologies were analyzed using SEM/EDS. SEM images of the Sample A-1-1-8 fracture surface are shown in Figure 7. Interdentritic fracture morphology was observed at the pre-existing OD fracture area, consistent with cracking that occurred during cooling of the original weld (known as solidification or "hot cracking"). Solidification cracking occurs when the final solidifying metal cannot support the thermally or mechanically-induced strain from the welding process, and can be caused by poor joint restraint, improper welding parameters, and by interdendritic segregation of steel impurities (such as sulfur). The fracture surface was heavily oxidized, also consistent with solidification cracks in welds.³ Brittle cleavage fracture morphology was observed on the bottom-half of the fractured Sample A-1-1-8. This cleavage fracture occurred when the sample was cooled in liquid nitrogen and then fractured to allow observation of the leak surfaces. Ductile tearing associated with the intentional fracture of Sample A-1-1-8 was observed at the inner surface. The ductile tearing is

³ ASM Handbook, Volume 6: Welding, Brazing, and Soldering, ASM International, 2003, pp. 649-651.

caused by a transition from a triaxial stress state to a biaxial stress state when the final ligament breaks, and results in a characteristic ductile "shear-lip" at the final fracture location.



Figure 7. SEM images of Sample A-1-1-8 fracture surface (left side of Figure 5). Top image shows the entire surface with one red box magnified (bottom image) and another red box for the area analyzed with EDS in Figure 8.

The Sample A-1-1-8 fracture surface was examined using EDS, which is highlighted in the red box in top image of Figure 7 and presented in Figure 8. The freshly-induced cleavage fracture surface below shows only the presence of iron and a small amount of carbon. The original crack surface, however, exhibited significantly increased levels of carbon, oxygen and sulfur, consistent with iron oxide (rust) as well as sulfur deposits. The sulfur is most likely from mercaptan-based odorizer added to natural gas to give the characteristic "rotten-egg" smell.



Figure 8. EDS analysis of the area in the red box in the right side of the top image in Figure 7. The lower portion is the freshly cracked surface; the top is the surface of the original crack composed of iron oxide with a large amount of sulfur, likely from the mercaptans added to give scent to the gas.

Similar SEM and EDS examination was performed on the Sample A-1-1-7 fracture surface faces, example images are shown in Figure 9 and Figure 10. The substantial oxide deposits on the original leak surface obscured much of fracture morphology in the original-cracked portion of Sample A-1-1-7, as shown in Figure 9. However, the transition between the original crack surface and the intentional brittle (cleavage) fracture area showed no evidence of progressive growth, also shown in Figure 9.

EDS analysis of the Sample A-1-1-7 fracture surface showed similar findings as exhibited in Sample A-1-1-8. The freshly-exposed brittle fracture surface showed primarily iron with a small amount of carbon, while the original leak surface exhibited significant amounts of carbon, oxygen, and sulfur, as shown in Figure 10.



Figure 9. One side of the crack surface in Sample A-1-1-7 (right side of Figure 6). The red box shows the area analyzed with EDS in Figure 10.



Figure 10. EDS analysis of the area in the red box in the top image in Figure 9. The right side is the freshly cracked surface; the left side is the surface of the original crack composed of iron oxide with significant sulfur.

Anamet sectioned the subject leak perpendicular to the longitudinal axis of the pipe, and conducted metallographic analyses as described in their September 6, 2013 report. A composite optical image from Anamet's report, shown here as Figure 11, shows that the weld repair contained significant weld porosity and cracks near the center of the weld bead that run parallel to the dendritic structure. There is also evidence of intergranular fracture in the heat-affected zone (HAZ) next to the weld.

Following our fractographic examination, Exponent put the broken halves of the crack back together for further metallographic analysis and microhardness testing, shown in Figure 12 and Figure 13. The samples were re-polished and etched with two-percent nital solution. Like Anamet's analysis, significant porosity and interdendritic cracking were observed within the repair weld. The HAZ below the weld was characterized by grain coarsening with Widmanstatten-morphology pro-eutectoid ferrite, shown in Figure 14. The very large grains within the HAZ and the solidification cracking of the weld pool are both consistent of slow weld speeds with high heat input.



Figure 11. Composite optical micrograph of a metallurgical mount prepared by Anamet. Image reproduced from the September 6, 2013 Anamet report with permission from Anamet.



Figure 12. Images of Sample A-1-1-8, re-mounted following fractographic examination.



Figure 13. Images of Sample A-1-1-7, remounted following fractographic examination.



Figure 14. Metallographic image that shows significant grain coarsening beneath the weld in Sample A-1-1-8, with Widmanstatten ferrite at the prior-austenite grain boundaries in the heat-affected zone (HAZ).

Anamet conducted SEM/EDS analysis of the unopened crack in a metallographic mount: originally Figure 20 in their September 6, 2013 report, shown here as Figure 15. Consistent with Exponent's analysis, Anamet determined that the crack was filled with iron oxide and contained appreciable amounts of sulfur.



Figure 15. Composite SEM micrograph of the metallographic mount prepared by Anamet. Image reproduced from the September 6, 2013 Anamet report with permission from Anamet.

Vickers microhardness (HV) traverses were conducted over both metallographic mounts to assess hardness in the weld, HAZ, and base metal, shown by red lines in Figure 16. Each microhardness traverse and associated values are shown in Appendix B. Accounting for all testing samples, the base and weld metal exhibited average hardness values between 130-155 HV. The HAZ exhibited slightly higher hardness levels, between 155-190HV. However, it should be noted that the HAZ hardness levels are relatively low, consistent with the significant

grain coarsening observed. For carbon steels, a hardness of over 350HV would be considered excessive, and indicate a possible susceptibility to hydrogen cracking in the HAZ.^{4, 5}



Figure 16. Metallurgical mounts of samples A-1-1-8 and A-1-1-7 made subsequent to opening the crack and examining it via optical microscopy and SEM/EDS. The red lines show where strings of microhardness testing points.

⁴ J.F. Lancaster, <u>Metallurgy of Welding</u>, Fourth Edition, 1987, pg. 177.

⁵ ASM Metals Handbook, Volume 6, Welding, Brazing and Soldering, pg. 648.

Chemical analyses of the base and weld metal near the leak were performed using direct-current optical-emission spectrometry, shown in Table 1 below. The analysis indicated elemental levels consistent with typical carbon steel. Lower carbon and manganese contents were observed in the weld metal compared to the pipe material, while sulfur and silicon levels were slightly higher.

Element	Base Metal (wt.%)	Weld metal (wt.%)
Fe	Matrix	Matrix
С	0.21	0.15
Mn	0.42	0.33
Cu	0.04	0.03
S	0.02	0.03
Р	0.02	0.02
Cr	0.01	0.02
Ni	0.01	0.01
Мо	<0.005	<0.005
V	<0.005	<0.005
В	<0.005	<0.005
Si	<0.005	0.04

 Table 1
 Chemical analysis of the base and weld metal near the crack in L-147.

The carbon equivalents of the pipe base and weld metal were calculated using the equation:⁶

$$C_{equiv} = C + \frac{\mathrm{Mn}}{6} + \frac{(\mathrm{Cr} + \mathrm{Mo} + \mathrm{V})}{5} + \frac{(\mathrm{Cu} + \mathrm{Ni})}{15}$$

Carbon equivalent is an indicator as to the hardenability of the steel and the propensity for hydrogen-induced cracking. Based on this formula, the carbon equivalent of the base metal was 0.29, while the carbon equivalent of the weld was 0.21. Both these carbon equivalents are relatively low: carbon steels with a carbon equivalent around 0.30 will usually form a pearlite-bainite structure in the HAZ,⁷ and are not particularly susceptible to cracking from hydrogen embrittlement.

⁶ G. Krauss, <u>Steels: Processing, Structure, and Performance</u>, ASM International, 2005, pg. 407.

⁷ J.F. Lancaster, <u>Metallurgy of Welding</u>, Fourth Edition, 1987, pg. 180.

Mechanical Testing

Tensile testing of the base and seam-weld metal was performed on a section of L-147 by Anamet. The results of the testing are given below in Table 2. The base metal exhibited a slightly higher tensile strength than the seam weld, while the seam-weld metal had a slightly higher yield strength.

	Base Metal	Seam-Weld Metal
Width of Specimen (in.)	1.508	1.508
Thickness of Specimen (in.)	0.254	0.257
Area (sq. in.)	0.383	0.388
Tensile Strength (psi)	61800	58700
Yield Strength (psi)*	39300	42900
Elongation in 2.0 Gage (%)	41	11
Fracture location	-	weld
Fracture Characteristic	-	Ductile**

Table 2. Anamet's transverse tensile testing (ASTM A370-10) of base and seam-weld metal from L-147.

* Upper Yield Strength (formerly Y.P.) 0.5% E.U.L.

** Indication observed.

Discussion

Our analysis confirmed that the subject leak in Line 147 occurred at a location in the pipe body that was repaired using weld metal deposition; not associated with a girth or a longitudinal seam weld. The leak was caused by porosity and solidification cracking within the weld metal that occurred during the repair process. Further, significant grain coarsening was observed in portions of the HAZ beneath the OD repair weld, which resulted in areas of intergranular fracture and contributed to the leak. This HAZ cracking also occurred during or shortly after the weld-repair process. HAZ hardness levels were insufficient to result in hydrogen embrittlement.

The cracks associated with the subject Line 147 leak have been present since the time of the weld repair. No fractographic or metallographic evidence of crack propagation (i.e. crack growth) during service or hydrotesting was observed.

Based on our analysis, it is clear that the cracks associated with the subject leak were present during the 2011 Line 147 hydrotest. The 8.32-hour hydrotest was conducted at a minimum of 600 psig, with a half-hour pressure "spike" to a maximum line pressure of 748 psig. No evidence of ductile tearing from the hydrotest was observed on the leak fracture surface. Ductile tearing can result in growth of large anomalies in pipelines during hydrotesting: known as the "pressure reversal" phenomenon. Given that the cracks associated with the leak were relatively short in axial length (less than approximately ½-inch), and relatively blunt (as observed in Anamet metallographic images), the 748-psig hydrotest pressures were insufficient to result in ductile tearing.

The subject leak was not detected during the 2011 hydrotesting. The Code of Federal Regulations Title 49, Part §192.505 indicates that a hydrotest is a strength test for pipelines to be operated at pressures that result in hoop stresses above 30% SMYS. The hydrotest conducted by PG&E on Line 147 was conducted at a minimum of 1.5 times the pipe MAOP, consistent with the federal regulations for a Class 3 location. The eight-hour portion of the hydrotest is intended to catch large-scale leaks. However, small-scale leaks can escape detection; particularly over a long test duration with large temperature changes throughout the day. The subject leak path was small, full of oxide, and provided a tortuous path for liquid water to escape.

Conclusions

- The subject leak discovered in PG&E Line 147 occurred in a weld repair of the pipe body; not associated with either a longitudinal seam or girth weld.
- The cracks associated with the subject leak occurred during the weld repair. Solidification cracking was observed within the weld deposit, while excessive grain growth, associated with high heat input, resulted in decreased toughness and local areas of intergranular fracture within the weld heat-affected zone.
- No evidence of progressive crack growth during service was observed at the leak site. Thus, the subject leak did not grow during service.
- The cracks associated with the subject leak were present during the October 2011 hydrotest. However, the hydrotest did not result in any ductile tearing or crack extension (pressure reversal) at the leak site.
- The leak path was small, full of oxide, and provided a tortuous path that limited the amount of water that could escape during hydrotesting.

Limitations

At the request of PG&E, Exponent has conducted an investigation of a crack that was present in Line-147 and how this was not detected by hydrotesting. Exponent examined the remaining material of the crack (some was destroyed during examination by Anamet Inc.) via optical microscopy and scanning electron microscopy with energy dispersive x-ray spectroscopy. The scope of services performed during this investigation may not adequately address the needs of other users of this report, and any re-use of this report or its findings, conclusions, or recommendations presented herein is at the sole risk of the user. The opinions and comments formulated during this assessment are based on observations and information available at the time of the investigation. No guarantee or warranty as to future life or performance of any reviewed condition is expressed or implied.

The findings presented herein are made to a reasonable degree of engineering certainty. We have made every effort to accurately and completely investigate all areas of concern identified during our investigation. If new data becomes available or there are perceived omissions or misstatements in this report regarding any aspect of those conditions, we ask that they be brought to our attention as soon as possible so that we have the opportunity to fully address them.

Appendix A

Microhardness Testing



Job Number	Item Number	Comments	Operator
1306838	105299	Kevin Moore	C. Jewett

		500 gm
Trace A Loc	Mean Length	Hardness (HV)
1	78.8	149
2	79.3	147
3	80.1	145
4	78.1	152
5	79.4	147
6	82.7	135
7	83.1	134
8	79.5	147
9	78.8	149
10	83.1	134
	Avg:	144
	Max:	152
	Min:	134



Job Number	Item Number	Comments	Operator
1306838	105299	Kevin Moore	C. Jewett

		500 gm
Trace B Loc	Mean Length	Hardness (HV)
1	73.1	173
2	73.4	172
3	77.2	156
4	77.9	153
5	72.8	175
6	76.4	159
7	78.7	150
8	70.5	187
9	79.2	148
10	76.6	158
11	75.9	161
12	82.2	137
	Avg:	161
	Max:	187
	Min:	137



Job Number	Item Number	Comments	Operator
1306838	105299	Kevin Moore	C. Jewett

		500 gm
Trace C Loc	Mean Length	Hardness (HV)
1	69.3	193
2	72.1	178
3	78	152
4	77.1	156
5	73.3	173
6	72.7	175
7	78.6	150
8	69.6	191
9	75.6	162
10	72	179
11	72.6	176
12	75.6	162
13	71.3	183
14	75	165
15	68.4	198
16	74.8	166
17	82.1	137
18	80.9	142
19	80.3	144
20	78.3	151
21	78.5	150
22	80	145
	Avg:	165
	Max:	198
	Min:	137



Job Number	Item Number	Comments	Operator
1306838	105299	Kevin Moore	C. Jewett

		500 gm
Mean Length	Mean Length	Hardness (HV)
1	83.4	133
2	76.9	157
3	78.8	149
4	80.6	143
5	79.0	149
6	78.5	151
7	79.6	146
8	79.1	148
9	79.9	145
10	80.1	145
11	77.8	153
12	78.4	151
	Avg:	148
	Max:	157
	Min:	133


Job Number	Item Number	Comments	Operator
1306838	105299	Kevin Moore	C. Jewett

		500 gm
Mean Length	Mean Length	Hardness (HV)
1	77.5	154
2	77.3	155
3	80.7	142
4	79.8	146
5	79.3	147
6	84.5	130
7	77.7	153
8	79.8	146
9	79.3	147
10	82.5	136
	Avg:	146
	Max:	155
	Min:	130



Job Number	Item Number	Comments	Operator
1306838	105300	Kevin Moore	C. Jewett

		500 gm
Trace A Loc	Mean Length	Hardness (HV)
1	81.3	140
2	82.9	135
3	85.1	128
4	80.0	145
5	78.2	151
6	81.6	139
7	79.3	147
8	79.0	149
9	80.2	144
10	77.3	155
	Avg:	143
	Max:	155
	Min:	128



Job Number	Item Number	Comments	Operator
1306838	105300	Kevin Moore	C. Jewett

		500 gm
Trace B Loc	Mean Length	Hardness (HV)
1	76.9	157
2	79.2	148
3	79.7	146
4	79.6	146
5	80.1	144
6	79.4	147
7	79.0	149
8	78.2	152
9	79.3	148
10	77.3	155
11	79.6	146
12	69.8	190
	Avg:	152
	Max:	190
	Min:	144



Job Number	Item Number	Comments	Operator
1306838	105300	Kevin Moore	C. Jewett

		500 gm
Trace C Loc	Mean Length	Hardness (HV)
1	70.1	189
2	71.2	183
3	73.5	171
4	70.4	187
5	75.8	161
6	75.2	164
7	72.4	177
8	73.1	173
9	71.8	180
Avg:	Avg:	176
Max:	Max:	189
Min:	Min:	161



Job Number	Item Number	Comments	Operator
1306838	105300	Kevin Moore	C. Jewett

		500 gm
Trace D Loc	Mean Length	Hardness (HV)
1	78.0	152
2	75.0	165
3	75.9	161
4	76.9	157
5	77.8	153
6	78.0	152
7	74.7	166
8	75.4	163
9	76.2	160
10	76.5	158
	Avg:	159
	Max:	166
	Min:	152



Job Number	Item Number	Comments	Operator
1306838	105300	Kevin Moore	C. Jewett

		500 gm
Trace E Loc	Mean Length	Hardness (HV)
1	76.8	157
2	76.4	159
3	80.1	145
4	79.0	149
5	78.2	152
6	82.3	137
7	83.1	134
8	85.4	127
9	84.5	130
10	83.4	133
	Avg:	142
	Max:	159
	Min:	127



Job Number	Item Number	Comments	Operator
1306838	105300	Kevin Moore	C. Jewett

	500 gm	
Trace F Loc	Mean Length	Hardness (HV)
1	70.9	184
2	75.3	164
3	74.6	167
4	75.6	162
5	74.9	165
6	80.1	144
7	81.8	139
8	81.8	139
9	82.7	136
10	84.3	130
	Avg:	153
	Max:	184
	Min:	130

