NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

May 10, 2011

MATERIALS LABORATORY FACTUAL REPORT Report No. 11-060

A. ACCIDENT INFORMATION

Place	:	San Bruno, California
Date	:	September 9, 2010
Vehicle	:	Pacific Gas & Electric Natural Gas Transmission Pipeline
NTSB No.	:	DCA10MP008
Investigator	:	Ravindra Chhatre, RPH-20

B. COMPONENTS EXAMINED

Three pieces of 30-inch diameter pipe from Line 132, Segment 180, intersection of Earl Ave and Glenview Drive, San Bruno, California with the following lengths:

1) 12 foot 4 inch
2) 27 foot 8 inch
3) 15 foot 9 inch

C. DETAILS OF THE EXAMINATION

This report contains external reports and test data associated with the examination of the three pieces of pipe listed above. Appendix A contains the weld inspection, magnetic particle inspection, and radiography reader sheets referenced in Materials Laboratory Factual Report 10-119. A sketch is provided at the end with each weld labeled with its reader sheet ID.

Appendix B contains the following documents referenced in Materials Laboratory Report 11-005:

1) Mechanical Test Data
2) Chemical Analysis Data

Donald Kramer, Ph.D.
Materials Engineer

APPENDIX A: WELD INSPECTION REPORT, MAGNETIC PARTICLE INSPECTION, AND RADIOGRAPHY READER SHEETS REFERRED TO IN MATERIALS LABORATORY REPORT 10-119

TESTING TECHNOLOGIES, INC.

TESTING AND
INSPECTION SERVICES

1241 FEATHERSTONE ROAD • WOODBRIDGE, VA 22191 • 703-491-5500/Metro 643-5578 • Fax: 703-491-9245

October 7, 2010

National Transportation Safety Board
490 L'Efant Plaza SW
Washington, DC 20024

Ref.: Nondestructive Testing
30" Diameter Standard Wall Pipe
Ashburn, Virginia

Gentlemen;

Testing Technologies, Inc. has performed nondestructive testing of the weld joints and shell of the above referenced pipe. The following is a report of our findings.

Radiographic testing was performed on each circumferential and longitudinal weld in accordance with API 1104. We understand that this section of pipe had been in service since approximately 1950. A review of the API 1104, sixth edition, 1959, was provided for our use for interpretation. This edition has the same acceptance criteria as the most current, 20th edition. Following radiographic testing, the pipe was cleaned and visual inspection was performed on each of the longitudinal and circumferential welds, both on the exterior and on the interior sides of the pipe. We noted that in some areas the protective coating had not been removed from the outside diameter of the pipe These locations are noted in our visual interpretation. Wet fluorescent magnetic particle was then performed on the weld's exterior and the circumferential inside diameter, as well as 100% of the inside diameter of the pipe in "Pup #1"

Welds have been identified as longitudinal seams, L-1 through L-7, while circumferential welds are identified as C-1 through C-7. Longitudinal weld L-1 is located on the South of Center Section and progress in the direction of flow to the north end. The circumferential welds begin on the center section, south end, and progress toward the north in the direction of flow. Please see diagram "A" below for details.

The numbering of radiographs and areas inspected on each weld begins on the south end of each longitudinal weld and progresses northward. Circumferential welds are numbered 0, 1, 2, 3, etc. back to 0 in three inch increments, beginning at the twelve o'clock position and going clockwise as one is looking from south to north. Please see Diagram "A" for clarification of the above.

Welds on the longitudinal seams appear to have been done using the submerged arc welding process, both on the exterior and interior. Circumferential welds were done using the shielded metal arc welding method, both on the exterior and interior.

Our radiographic inspection of longitudinal and circumferential welds found them not to be in compliance with the API 1104 code, sixth edition. We noted numerous areas with slag,

incomplete fusion, incomplete penetration, undercut, under fill and burn through. Please see the attached radiographic reports for details of our testing.

Visual inspection found the outside surface of both the longitudinal and circumferential welds to be relatively free of any rejectable deficiencies, while the interior of the longitudinal welds also appeared to be visually acceptable except in Pup #2 and #3. At these two locations, we noted these welds had not been welded on the interior and incomplete penetration was found for their full length. Visual inspection of the inside diameter of the circumferential welds found them to be back welded rather than welded from the outside diameter. These welds were found deficient in that they had poor weld profile consistent with too low welding amperage, cold lap, incomplete fusion between the weld metal and the base metal, slag, under fill along the weld joint, and incomplete penetration. In some locations, we found what appears to be the lack of proper weld joint preparation prior to welding. These locations were noted on weld G-2, and the longitudinal seam in Pup #2. At these locations, the pipe appears to have been fit for welding with a square butt and a slight .06 to .18" root opening, which, when welded, will not allow adequate fusion or full penetration of the pipe wall. Please see below for the details of our inspection.

Fluorescent magnetic particle testing was performed on each longitudinal and circumferential weld, as well as the entire pipe wall, both inside and outside of Pup #2. This was done to locate stress cracking, if present. Our inspection found no evidence of stress cracking in either the welds, the heat effected zone or the pipe wall of Pup #2. Please see the attached magnetic particle reports for details.

The following is a breakdown of each weld and area inspected with our observations for each. Attached are our radiographic and magnetic particle reports. These have each location or weld identified as discussed above, as well as our observations.

Should you have any further questions concerning this report, please contact us at your convenience.

Sincerely
TESTING TECHNOLOGIES, INC.

Gary Kolbenstetter

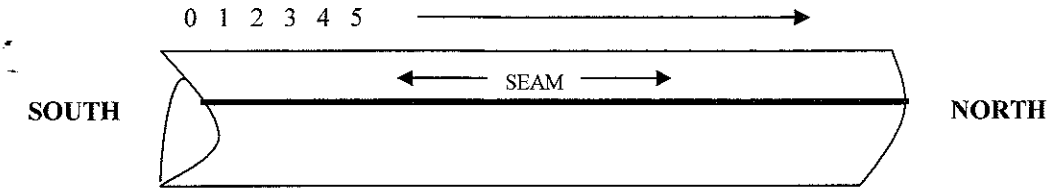
Gary Kolbenstetter
CWI #80052901

attachments: radiographic reports
magnetic particle reports

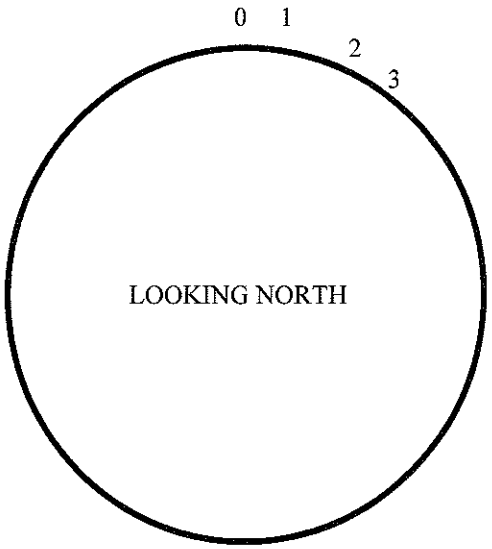
30" DIAMETER GAS LINE WELD & SHELL OBSERVATIONS				
LOCATION	**LENGTH (in.)**	**VISUAL**	**MT**	**RADIOGRAPHIC**
L-1 (OD)	0-6	No defects noted	No Relevant Indications	Acceptable entire length
L-1 (OD)	6-38	Coating	No MT	
L-1 (OD)	38-118	No defects noted	No Relevant Indications	
L-1 (ID)	0-118	No defects noted	No Relevant Indications	
L-2 (OD) Ctr. Sect.	0-111	No defects noted	No Relevant Indications	Acceptable, entire length, porosity in code between 33 to 50
L-2 (OD) Ctr. Sect.	111-132	No defects noted	No Relevant Indications	
L-2 (ID) Ctr. Sect.	0-132	No defects noted	No Relevant Indications	
Long Seam (OD) Pup 1	0-44	Little evidence of weld cap	No Relevant Indications	No RT, weld seam split at center line
Long Seam (ID) pup 1	0-44	IP to ID, weld appears to be 50% of wall thkns.	No Relevant Indications on long seam. MT of shell ID and OD, no indications noted	No RT, weld seam split at center line
Long Seam (OD) pup 2	0-44	Little evidence of weld cap	No Relevant Indications	No RT, weld seam split at center line
Long Seam (ID) pup 2	0-44	no penetration to ID, weld appears to be 50% of wall thkns.	No Relevant Indications	No RT, weld seam split at center line
L-3 pup 3 (OD)	0-44	Little or no weld cap visible	No Relevant Indications	Rejected, IP, slag, porosity, entire length
L-3 pup 3 (ID)	0-44	No penetration, fusion appears to be 50% of wall thkns.	No Relevant Indications	
L-4 pup 4 (OD)	0-46	No defects noted	No Relevant Indications	Rejected, LoF, slag, porosity, under cut, entire length
L-4 pup 4 (ID)	0-46	Joint back welded, UC, repair at 43-46	No Relevant Indications	
L-5 (OD) pup 5	0-42	Weld ground flush, possible fusion lines evident	MT verifies LOF between base metal and weld, rejectable	Rejected, IP, porosity, entire length. Porosity in code in views 0-12, 12-24, and 33-42
L-5 (ID) Pup 5	0-42	Joint back welded, no defects noted	No Relevant Indications	

L-6 (OD) Pup 6	0-53	No defects noted	No Relevant Indications	Rejected ¾ of weld, porosity. View 0-12 porosity in code.
L-6 (ID) Pup 6	0-53	No defects noted	No Relevant Indications	
L-7 (OD)	0-91	0-18 no defects; 18-91 coating	No Relevant Indications	Rejected 0-12, LoF. Accepted 12-24
L-7 (ID)	0-91	No defects noted	No Relevant Indications	
C-1 (OD)	Full Circum.	UC, arc strikes	No Relevant Indications	Rejected entire weld, LoF, Slag, porosity, crack, UC
C-1 (ID)	Full Circum.	CL, Excess weld cap, icicles, OL	No Relevant Indications	
C-2 (OD)	2/3 of circum.	No defects noted	No Relevant Indications	Rejected entire weld, LoF, Slag, porosity, crack, UC
C-2 (ID)	2/3 of circum.	CL, LoF, UF, IP	No Relevant Indications	Pipe tear
C-3 (OD)	Full Circum.	No defects noted, very wide weld	No Relevant Indications	Rejected entire weld, IP, LoF, Slag, porosity, crack
C-3 (ID)	Full Circum.	UC; BT; WC	No Relevant Indications	
C-4 (OD)	Full Circum.	4- plug welds; welds from fit up dogs remain	No Relevant Indications	Rejected entire weld, IP, LoF, Slag, porosity, UC. Four plug welds in shell evenly spaced, RT rejectable
C-4 (ID)	Full Circum.	UC; Excess weld cap; CL; misalignment	No Relevant Indications	
C-5 (OD)	Full Circum.	Weld fractured full circum. remaining weld ok; plug welds	No Relevant Indications	No radiographic testing, end of center section.
C-5 (ID)	Full Circum.	Circum. Weld fractured; UC; UF; IP	No Relevant Indications	
C-6 (OD)	Full Circum.	UC; 1/16" gouge	No Relevant Indications	Reject weld for IP, LoF, Slag, crack, Porosity, UC.
C-6 (ID)	Full Circum.	WC; Excessive Cap	No Relevant Indications	View 36-48 accepted, LoF, slag, and UC in code
C-7 (OD)	Full Circum.	No defects noted	No Relevant Indications	Reject weld for IP, LoF, slag, crack, porosity under cut.
C-7 (ID)	Full Circum.	IP, WC, Misalign.	No Relevant Indications	

UC = undercut; **LoF** = lack of fusion; **CL** = cold lap; **UF** = under fill; **IP** = incomplete penetration; **OL** = over lap; **BT** = burn through; **WC** = weld concavity



TYPICAL LONGITUDINAL SEAM LAYOUT



TYPICAL CIRCUMFERENTIAL WELD LAYOUT

DIAGRAM "A"

TESTING TECHNOLOGIES, INC.

1241 FEATHERSTONE RD., WOODBRIDGE, VA. 22191

703. 491.5500 fax 703. 491.9245

MAGNETIC PARTICLE REPORT

CLIENT: NATIONAL TRANSPORTATION SAFETY BOARD **PROJECT:** 30" Gas Line
LOCATION: Ashburn, VA **P.O. NO.:** Verbal per Mr. Kramer

ITEM/REFERENCE: Longitudinal Seams **PROCEDURE NO.:** MT-01 Rev.: 04
ACCEPTANCE STANDARD: API 1104 20th ED. **MATERIAL:** Carbon Steel
STAGE OF MFG.: Previously in svs. **SURFACE CONDITION:** as welded or pipe wall **SURFACE TEMP.:** 75°F+

EQUIPMENT

EQUIP. MFG.: Parker Research **MODEL:** DA-400 **SERIAL NO.:** 7855 **CALIB. DATE:** 10/9/09
AC ☑ **or DC** ☐

- **LONG. AMPS:** _____ **COIL DIA.:** _____ **AMP/TURNS:** _____
- **CIRCULAR:** _____ **AMPS:** _____
- **BLACK LIGHT MFG.:** Spectraline **LIGHT LEVEL CHECK:** 1100µW/cm2
- **CENTRAL CONDUCTOR:** _____

TEST MEDIUM

- **DRY POWDER COLOR:** _____ **MFG.:** _____ **BATCH NO.:** _____
- **WET FLOURESCENT:** Red **MFG.:** Circle Safe **BATCH NO.:** 15773-06044
- **OTHER (SPECIFY):** _____

ITEM / AREA INSPECTED	INDICATION SIZE / LOCATION	ACCEPT	REJECT
L-1 OD/ID	NO RELEVANT INDICATIONS	√	
L-2 OD/ID	NO RELEVANT INDICATIONS	√	
Long Seam, pup#1 OD/ID	NO RELEVANT INDICATIONS	√	
Long Seam, pup #2 OD/ID	NO RELEVANT INDICATIONS	√	
L-3, pup# 3 OD/ID	NO RELEVANT INDICATIONS	√	
L-4, PUP #4 OD/ID	NO RELEVANT INDICATIONS	√	
L-5, pup #5 OD	Weld ground flush, evidence of LoF between passes, <2" in code	√	
L-5, pup #5 ID	NO RELEVANT INDICATIONS	√	
L-6, pup #6 OD/ID	NO RELEVANT INDICATIONS	√	
L-7, OD/ID	NO RELEVANT INDICATIONS	√	
C-1, OD/ID	NO RELEVANT INDICATIONS	√	
C-2, OD/ID	NO RELEVANT INDICATIONS	√	
C-3, OD/ID	NO RELEVANT INDICATIONS	√	
C-4, OD/ID	NO RELEVANT INDICATIONS	√	
C-5, OD/ID	NO RELEVANT INDICATIONS	√	
C-6, OD/ID	NO RELEVANT INDICATIONS	√	
C-7, OD/ID	NO RELEVANT INDICATIONS	√	
Pup #1 pipe, wall, OD/ID	NO RELEVANT INDICATIONS	√	

SUPPLEMENTAL SKETCH ATTACHED **YES** **NO**

Gary Kolbenstetter | III | 10/6/10 | **REMARKS:**
INSPECTED BY | **Level** | **Date**

_____ | _____ | _____
REVIEWED BY | **Level** | **Date**

Time Depart Shop: _____

Time Arrive Site: _____

Testing Technologies, Inc.

"TESTING AND INSPECTION SERVICES"

RADIOGRAPHIC EXAMINATION REPORT

1241 Featherstone Road
Woodbridge, VA 22191
(703) 491 5500

Time Depart Site: _____

Time Arrive Shop: _____

Customer NTSB Date 10/13/10

Job Location Ashburn VA. Travel Mileage _____

Hours Traveled _____ Film Used Size 4.5x17 No 22

Customer No. _____ Hours Worked _____

Project No. _____ Total Hours _____

Report No. 01

ITEM IDENTIFICATION	ACCEPT	REJECT	INC. PENETRATION	INC. FUSION	BURN-THROUGH	ROOT CONCAVITY	ROOT CONVEXITY	SLAG INCLUSION	CRACK	TUNGSTEN INCLUSION	POROSITY	UNDERCUT	REMARKS
L-1 South	—												
36-51"	✓												
48-63	✓												
57-72	✓												
72-84	✓												
84-96	✓												
96-108	✓												
105-117	✓												
L-2 Center	—												
0-12	✓												
12-24	✓												
24-36	✓												
36-48	✓												
48-60	✓												
60-72	✓												
72-84	✓												
84-96	✓												
96-108	✓												
108-120	✓												
120-132	✓										✓		IN CODE
L-3 Center	~~X~~	X											
0-15		X	X										
12-27		X	X						✓		✓		
24-36		X	X								✓		
33-50		X	X								✓		

CODES AND PROCEDURES

Interpretation Requirements

Code API 1104 ~~Year~~ 20th Ed. Section 9

Part _____ Para _____ Addenda _____

Procedure No. RT-01 Rev. 04

Customer Procedure No. _____ Rev. _____

MATERIAL TYPE CS NOMINAL WALL .375

REINFORCEMENT .125 TOTAL THICKNESS .500

ISOTOPE TYPE IR 192 EFF. SIZE .12 CURIES 87

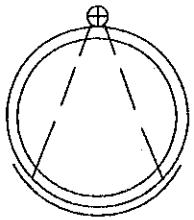
EXPOSURE TIME _____

FILM MFG'R Fuji TYPE 80 (SINGLE) DOUBLE

SCREEN TYPE AND THICKNESS: FRONT .010 Pb BACK .010 Pb

PENETRAMETER SIZE: SOURCE SIDE — FILM SIDE 1B

SHIM THICKNESS N/A SFD 30" Ug _____



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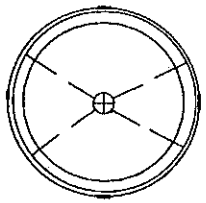

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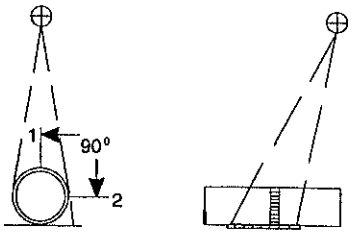

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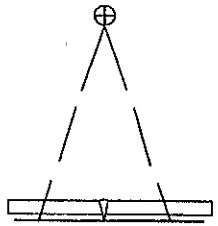
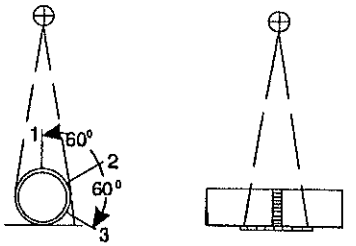


☐ PLATE

☐ OTHER



☐ DWE/DWV 3 exp.

Radiographer (R) [redacted] Level III

Assistant _____ Customer Rep _____

Interpretation of radiographs represent good faith opinions only and in no way guarantee the quality, usability or classification of welds or other items inspected.

Testing Technologies, Inc.

SUPPLEMENTAL
RADIOGRAPHIC EXAMINATION REPORT

1241 Featherstone Road
Woodbridge, VA 22191
(703) 491-5500 Metro (703) 643-5578

Customer NTSB Date 10/13/10

Job Location Ashburn Va Travel Mileage ____

Hours Traveled ____

Customer No. ____ Hours Worked ____

Project No. ____ Total Hours ____

Report No. 01

Film Used: Size 4.5x17 No 14

ITEM IDENTIFICATION	ACCEPT	REJECT	INC. PENETRATION	INC. FUSION	BURN-THROUGH	ROOT CONCAVITY	ROOT CONVEXITY	SLAG INCLUSION	CRACK	TUNGSTEN INCLUSION	POROSITY	UNDERCUT	REMARKS
L-4 center	—												
0-12		X		X						X	X		
12-24		X		X			X			X	X		
24-36		X		X			X			X	X		
36-45		X		X						X	X		
L-5 center	—												
0-12		X	X							✓			
12-24		X	X							✓			
21-36		X	X							X			
33-42		X	X							✓			
L-6 center	—												
0-12	✓									✓			IN code
12-24		X								X			
24-39		X								X			
39-51		X								X			
L-7 North	—												
0-12		X		X									
12-24	✓												

ITEM IDENTIFICATION	ACCEPT	REJECT	INC. PENETRATION	INC. FUSION	BURN-THROUGH	ROOT CONCAVITY	ROOT CONVEXITY	SLAG INCLUSION	CRACK	TUNGSTEN INCLUSION	POROSITY	UNDERCUT	REMARKS

Time Depart Shop: _____

Time Arrive Site: _____

Testing Technologies, Inc.

"TESTING AND INSPECTION SERVICES"

RADIOGRAPHIC EXAMINATION REPORT

1241 Featherstone Road
Woodbridge, VA 22191
(703) 491 5500

Time Depart Site: _____

Time Arrive Shop: _____

Customer NTSB Date 10/13/10

Job Location Ashburn, Va Travel Mileage _____

Hours Traveled _____

Customer No. _____ Hours Worked _____

Project No. _____ Total Hours _____

Report No. 01

Film Used	Size	No
	4.5x17	24

CODES AND PROCEDURES

Interpretation Requirements

Code API 1104 Year 20th Ed. Section 9

Part _____ Para _____ Addenda _____

Procedure No. RT-01 Rev. 4

Customer Procedure No. _____ Rev. _____

MATERIAL TYPE CS NOMINAL WALL .375

REINFORCEMENT .125 TOTAL THICKNESS .500

ISOTOPE TYPE Ir192 EFF. SIZE .12 CURIES 87

EXPOSURE TIME _____

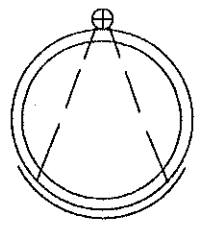
FILM MFG'R Fuji TYPE 80 (SINGLE) DOUBLE

SCREEN TYPE AND THICKNESS: FRONT Pb .010 BACK Pb .010

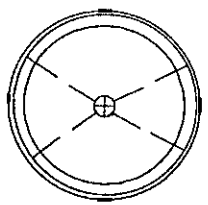
PENETRAMETER SIZE: SOURCE SIDE ~~#5~~ FILM SIDE 1B

SHIM THICKNESS N/A SFD 30" Ug _____

ITEM IDENTIFICATION	ACCEPT	REJECT	INC. PENETRATION	INC. FUSION	BURN-THROUGH	ROOT CONCAVITY	ROOT CONVEXITY	SLAG INCLUSION	CRACK	TUNGSTEN INCLUSION	POROSITY	UNDERCUT	EXCESS. REINFORC.	REMARKS
C-1	—													
0-12	X						X	X		X	X			
12-24	X		X								X			
21-36	X		X				X			X	X			
36-48	X		X				X			X	X			
48-63	X		X				X			X	X			
60-72	X		X							X	X			
72-84	X		X				X			X	X	X		
81-93	X		X				X			X	X	X		
C-3	—													
0-15	X	X	X				X			X				
12-24	X	X	X				X			X				
24-36	X	X	X				X			X				
36-48	X	X	X				X			X				
48-60	X	X	X				X			X				
60-72	X	X	X				X			X				
72-84	X	X	X				X	X		X				
84-0	X	X	X				X			X				
C-4	—													
0-12	X	X	X				X			X				~~Plug weld~~
12-24	X	X	X				X			X	X			Plug weld
24-36	X	X	X				X			X				Fit up dog welds
36-48	X	X	X				X			X				Plug weld
48-60	X	X	X				X			X				
60-72	X	X	X				X			X				Plug weld
72-84	X	X	X				X			X				
84-0	X	X	X				X			X	X	X		Plug weld/fit up dogs



☒ DWE/SWV



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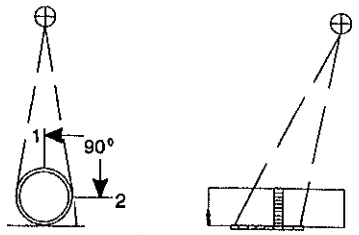

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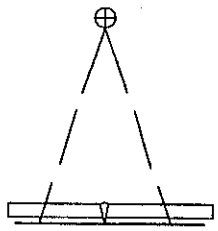
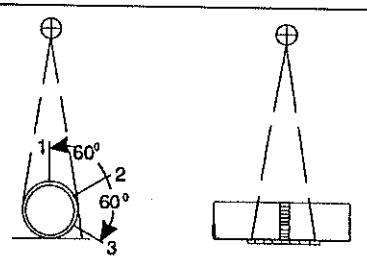


☐ PLATE

☐ OTHER



☐ DWE/DWV 3 exp.

Radiographer -(R)- Level II

Assistant _____ Customer Rep _____

Interpretation of radiographs represent good faith opinions only and in no way guarantee the quality, usability or classification of welds or other items inspected.

Testing Technologies, Inc.

SUPPLEMENTAL
RADIOGRAPHIC EXAMINATION REPORT

1241 Featherstone Road
Woodbridge, VA 22191
(703) 491-5500 Metro (703) 643-5578

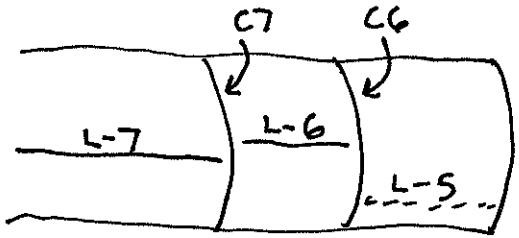
Customer NTSB — Date 10/13/10
Job Location Ashburn Va — Travel Mileage
Hours Traveled — Film Used Size 4.5x17 No 22
Customer No. — Hours Worked
Project No. — Total Hours
Report No. 01

ITEM IDENTIFICATION	ACCEPT	REJECT	INC. PENETRATION	INC. FUSION	BURN-THROUGH	ROOT CONCAVITY	ROOT CONVEXITY	SLAG INCLUSION	CRACK	TUNGSTEN INCLUSION	POROSITY	UNDERCUT	excessive Reinf.	REMARKS
C-2	—													
6-15		X	X					X			X		X	
12-24		X	X					X			X			
24-36		X	X		X			X			X			
33-48		X	X					X	X		X			
45-60		X	X	X				X			X		X	
60-72		X	X					X			X		X	(Pipe tear)
C-6	—													
0-15		X							X		X	X	X	
12-24		X		X								X	X	
21-36		X		X				X			X	X		
36-48	✓			X				✓				✓		in code
48-60		X						✓	X		✓			
60-72		X		X				X				X		
72-84		X		X	X			X				X	X	
84-0		X						X			X	X	X	
C-7	—													
0-12		X						X			✓			
12-24		X						X			✓			
24-36		X	X	X				X					X	
36-48		X						X			X	X		
48-60		X						X	X		X	X		
60-72		X	X					X			X			
72-84		X						X			X			
81-0		X						X						

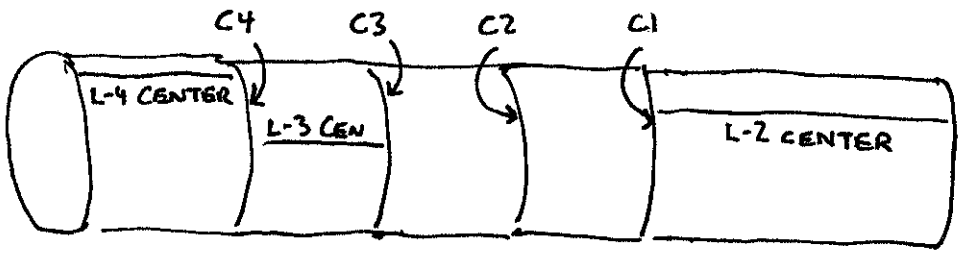
ITEM IDENTIFICATION	ACCEPT	REJECT	INC. PENETRATION	INC. FUSION	BURN-THROUGH	ROOT CONCAVITY	ROOT CONVEXITY	SLAG INCLUSION	CRACK	TUNGSTEN INCLUSION	POROSITY	UNDERCUT	REMARKS

Interpretation of radiographs represent good faith opinions only and in no way guarantee the quality, usability or classification of welds or other items inspected.

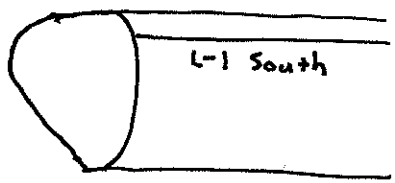
Reader Sheet Identification



North Section



Center Section



South Section.

N

APPENDIX B: MECHANICAL TESTING DATA AND CHEMICAL ANALYSIS DATA REFERENCED IN MATERIALS LABORATORY FACTUAL REPORT 11-005

TTML TENSILE TESTING
METALLURGICAL LABORATORY

A DIVISION OF J.T. ADAMS CO., INC.
4520 WILLOW PARKWAY
CLEVELAND, OHIO 44125
PHONE (216) 641-3290
FAX (216) 641-1223
www.tensile.com

CERTIFIED TEST REPORT

National Transportation Safety
490 L'enfant Plaza Sw
Washington DC 20594

Job No.: B0-350-356
Date: 1-10-11
Cust. PO#: NTSBP110006

Description: 1 sample 18.5" x 12" Steel Plate ID: LS

Temp: Charpy Test Temperature@ +32°F
2/3 Size

TEST RESULTS

Location	Center Width	Center Thickness	Tensile, ksi	Yield, ksi .2%	Yield, ksi .5%	Elong., % in 2"
T1	1.501"	0.380"	83.5	56.0	56.0	30
T2	1.500"	0.381"	83.0	56.5	57.0	31
T3	1.500"	0.381"	83.0	56.0	57.0	30
T4	1.500"	0.383"	83.0	56.5	57.5	29
T5	1.500"	0.382"	83.5	56.5	57.5	30

Width at Ends = Center Width + .002"
Test Method: ASTM A370-09a, Transverse

Item	Charpy, ft-lbs	Lateral Exp. Mils	% Shear
1-1	10.0	9.0	0
-2	11.0	12.0	0
-3	10.0	9.0	0
2-1	10.0	10.0	0
-2	11.0	10.0	0
-3	10.0	10.0	0

Test Method: ASTM E23-07ae1, Transverse

(R) [redacted]
Authorized Agent

ACCREDITED
Cert No. 0161

TTML TENSILE TESTING
METALLURGICAL LABORATORY

A DIVISION OF J.T. ADAMS CO., INC.
4520 WILLOW PARKWAY
CLEVELAND, OHIO 44125
PHONE (216) 641-3290
FAX (216) 641-1223
www.tensile.com

CERTIFIED TEST REPORT

National Transportation Safety
490 L'enfant Plaza Sw
Washington DC 20594

Job No.: B0-350-357
Date: 1-10-11
Cust. PO#: NTSBP110006

Description: 1 sample 18.5" x 12" Steel Plate ID: P1

Temp: Charpy Test Temperature@ +32°F
2/3 Size

TEST RESULTS

Location	Center Width	Center Thickness	Tensile, ksi	Yield, ksi .2%	Yield, ksi .5%	Elong., % in 2"
T1	1.499"	0.376"	63.5	36.0	36.9	39
T2	1.498"	0.376"	63.5	34.9	36.3	39
T3	1.498"	0.376"	64.0	35.2	36.8	40
T4	1.500"	0.377"	63.5	35.1	36.6	39
T5	1.500"	0.376"	63.5	34.9	36.3	40

Width at Ends = Center Width + .002"
Test Method: ASTM A370-09a, Transverse

Item	Charpy, ft-lbs	Lateral Exp. Mils	% Shear
1-1	9.0	11.0	0
-2	6.0	5.0	0
-3	7.0	9.0	0
2-1	6.0	6.0	0
-2	6.0	5.0	0
-3	8.0	10.0	0

Test Method: ASTM E23-07ae1, Transverse

(R) [redacted]
Authorized Agent

ACCREDITED
Cert No. 0161

TTML TENSILE TESTING
METALLURGICAL LABORATORY

A DIVISION OF J.T. ADAMS CO., INC.
4520 WILLOW PARKWAY
CLEVELAND, OHIO 44125
PHONE (216) 641-3290
FAX (216) 641-1223
www.tensile.com

CERTIFIED TEST REPORT

National Transportation Safety
490 L'enfant Plaza Sw
Washington DC 20594

Job No.: B0-350-358
Date: 1-10-11
Cust. PO#: NTSBP110006

Description: 1 sample 18.5" x 12" Steel Plate ID: P2

Temp: Charpy Test Temperature@ +32°F
2/3 Size

TEST RESULTS

Location	Center Width	Center Thickness	Tensile, ksi	Yield, ksi .2%	Yield, ksi .5%	Elong., % in 2"
T1	1.499"	0.371"	52.0	31.1	32.1	49
T2	1.500"	0.371"	52.0	31.0	32.0	48
T3	1.499"	0.370"	52.0	31.4	31.9	48
T4	1.499"	0.371"	52.0	30.8	32.0	50
T5	1.499"	0.371"	52.0	31.3	32.1	49

Width at Ends = Center Width + .002"
Test Method: ASTM A370-09a, Transverse

Item	Charpy, ft-lbs	Lateral Exp. Mils	% Shear
1-1	76.0	76.0	80
-2	25.0	35.0	30
-3	99.0	61.0	100
2-1	52.0	63.0	70
-2	27.0	38.0	30
-3	18.0	27.0	30

Test Method: ASTM E23-07ae1, Transverse

(R) [redacted]
Authorized Agent

TTML TENSILE TESTING
METALLURGICAL LABORATORY

A DIVISION OF J.T. ADAMS CO., INC.
4520 WILLOW PARKWAY
CLEVELAND, OHIO 44125
PHONE (216) 641-3290
FAX (216) 641-1223
www.tensile.com

CERTIFIED TEST REPORT

National Transportation Safety
490 L'enfant Plaza Sw
Washington DC 20594

Job No.: B0-350-360
Date: 1-10-11
Cust. PO#: NTSBP110006

Description: 1 sample 18.5" x 12" Steel Plate ID: P4

Temp: Charpy Test Temperature@ +32°F
2/3 Size

TEST RESULTS

Location	Center Width	Center Thickness	Tensile, ksi	Yield, ksi .2%	Yield, ksi .5%	Elong., % in 2"
T1	1.500"	0.392"	79.0	48.3	47.7	33
T2	1.501"	0.392"	79.0	49.0	49.1	34
T3	1.500"	0.392"	79.0	48.7	47.9	34
T4	1.501"	0.392"	79.0	48.9	48.3	34
T5	1.500"	0.392"	79.0	46.7	48.4	35

Width at Ends = Center Width + .002"
Test Method: ASTM A370-09a, Transverse

Item	Charpy, ft-lbs	Lateral Exp. Mils	% Shear
1-1	13.0	15.0	0
-2	10.0	11.0	0
-3	12.0	13.0	0
2-1	11.0	12.0	0
-2	11.0	13.0	0
-3	14.0	16.0	0

Test Method: ASTM E23-07ae1, Transverse

(R) [redacted]
Authorized Agent

TTML TENSILE TESTING
METALLURGICAL LABORATORY

A DIVISION OF J.T. ADAMS CO., INC.
4520 WILLOW PARKWAY
CLEVELAND, OHIO 44125
PHONE (216) 641-3290
FAX (216) 641-1223
www.tensile.com

CERTIFIED TEST REPORT

National Transportation Safety
490 L'enfant Plaza Sw
Washington DC 20594

Job No.: B0-350-359
Date: 1-10-11
Cust. PO#: NTSBP110006

Description: 1 sample 18.5" x 12" Steel Plate ID: P3

Temp: Charpy Test Temperature@ +32°F
2/3 Size

TEST RESULTS

Location	Center Width	Center Thickness	Tensile, ksi	Yield, ksi .2%	Yield, ksi .5%	Elong., % in 2"
T1	1.501"	0.376"	60.5	33.8	35.3	42
T2	1.499"	0.376"	60.5	34.1	34.9	43
T3	1.501"	0.377"	60.0	32.8	34.1	43
T4	1.501"	0.378"	60.0	33.7	34.9	43
T5	1.500"	0.377"	60.5	33.5	35.3	43

Width at Ends = Center Width + .002"
Test Method: ASTM A370-09a, Transverse

Item	Charpy, ft-lbs	Lateral Exp. Mils	% Shear
1-1	8.0	9.0	0
-2	8.0	10.0	0
-3	8.0	9.0	0
2-1	9.0	9.0	0
-2	9.0	11.0	0
-3	8.0	7.0	0

Test Method: ASTM E23-07ae1, Transverse

(R) [redacted]
Authorized Agent

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METALLURGICAL LABORATORY

A DIVISION OF J.T. ADAMS CO., INC.
4520 WILLOW PARKWAY
CLEVELAND, OHIO 44125
PHONE (216) 641-3290
FAX (216) 641-1223
www.tensile.com

CERTIFIED TEST REPORT

National Transportation Safety
490 L'enfant Plaza Sw
Washington DC 20594

Job No.: B0-350-361
Date: 1-10-11
Cust. PO#: NTSBP110006

Description: 1 sample 18.5" x 12" Steel Plate ID: P5

Temp: Charpy Test Temperature@ +32°F
2/3 Size

TEST RESULTS

Location	Center Width	Center Thickness	Tensile, ksi	Yield, ksi .2%	Yield, ksi .5%	Elong., % in 2"
T1	1.501"	0.379"	72.0	37.2	38.9	34
T2	1.501"	0.379"	72.0	37.5	38.4	36
T3	1.501"	0.379"	72.0	37.8	38.6	36
T4	1.501"	0.379"	71.5	37.3	38.6	37
T5	1.501"	0.379"	71.5	37.1	38.2	36

Width at Ends = Center Width + .002"
Test Method: ASTM A370-09a, Transverse

Item	Charpy, ft-lbs	Lateral Exp. Mils	% Shear
1-1	14.0	15.0	0
-2	7.0	7.0	0
-3	7.0	5.0	0
2-1	6.0	6.0	0
-2	7.0	6.0	0
-3	9.0	11.0	0

Test Method: ASTM E23-07ae1, Transverse

(R) [redacted]
Authorized Agent

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METALLURGICAL LABORATORY

A DIVISION OF J.T. ADAMS CO., INC.
4520 WILLOW PARKWAY
CLEVELAND, OHIO 44125
PHONE (216) 641-3290
FAX (216) 641-1223
www.tensile.com

CERTIFIED TEST REPORT

National Transportation Safety
490 L'enfant Plaza Sw
Washington DC 20594

Job No.: B0-350-362
Date: 1-10-11
Cust. PO#: NTSBP110006

Description: 1 sample 18.5" x 12" Steel Plate ID: P6

Temp: Charpy Test Temperature@ +32°F
2/3 Size

TEST RESULTS

Location	Center Width	Center Thickness	Tensile, ksi	Yield, ksi .2%	Yield, ksi .5%	Elong., % in 2"
T1	1.499"	0.370"	78.5	49.9	48.5	31
T2	1.500"	0.371"	78.5	52.0	51.5	31
T3	1.501"	0.370"	79.0	52.0	50.5	30
T4	1.500"	0.371"	79.0	51.5	50.0	30
T5	1.499"	0.372"	78.5	52.5	52.0	32

Width at Ends = Center Width + .002"
Test Method: ASTM A370-09a, Transverse

Item	Charpy, ft-lbs	Lateral Exp. Mils	% Shear
1-1	10.0	12.0	0
-2	11.8	12.0	0
-3	8.0	8.0	0
2-1	8.0	8.0	0
-2	10.0	10.0	0
-3	10.0	11.0	0

Test Method: ASTM E23-07ae1, Transverse

(R) [redacted]
Authorized Agent

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METALLURGICAL LABORATORY

A DIVISION OF J.T. ADAMS CO., INC.
4520 WILLOW PARKWAY
CLEVELAND, OHIO 44125
PHONE (216) 641-3290
FAX (216) 641-1223
www.tensile.com

CERTIFIED TEST REPORT

National Transportation Safety
490 L'enfant Plaza Sw
Washington DC 20594

Job No.: B0-350-363
Date: 1-10-11
Cust. PO#: NTSBP110006

Description: 1 sample 18.5" x 12" Steel Plate ID: LN

Temp: Charpy Test Temperature@ +32°F
2/3 Size

TEST RESULTS

Location	Center Width	Center Thickness	Tensile, ksi	Yield, ksi .2%	Yield, ksi .5%	Elong., % in 2"
T1	1.500"	0.315"	76.5	51.5	54.0	31
T2	1.498"	0.313"	77.0	51.5	54.5	31
T3	1.500"	0.313"	77.0	50.5	53.5	30
T4	1.500"	0.313"	77.0	51.5	54.0	30
T5	1.500"	0.313"	77.0	52.5	54.0	30

Width at Ends = Center Width + .002"
Test Method: ASTM A370-09a, Transverse

Item	Charpy, ft-lbs	Lateral Exp. Mils	% Shear
1-1	16.0	22.0	50
-2	14.0	19.0	50
-3	15.0	17.0	50
2-1	11.0	11.0	40
-2	11.0	13.0	30
-3	9.0	13.5	20

Test Method: ASTM E23-07ae1, Transverse

(R) [redacted]
Authorized Agent

IMR TEST LABS
A Division of Ithaca Materials Research & Testing Incorporated

131 Woodsedge Drive
Lansing Business & Technology Park
Lansing, NY 14882

Phone 607.533.7000 • Fax 607.533.9210
www.imrtest.com • E-mail imr@imrtest.com
Toll Free 888.464.8422

December 15, 2010

Don Kramer
National Transportation
Safety Board
490 L'Enfant Plaza
Washington, DC 20594

PO Number
Credit Card

Date Received
December 8, 2010

Material
Low Carbon Steel

Description
30" OD 0.375 inch wall thickness pipe

Sample ID
LS

TEST REPORT

IMR Report Number 201010412B

SUMMARY

One sample was received for chemical analysis.

The results are on the following page(s).

A2LA ACCREDITED Testing Cert # 1140.01 & 1140.02
Accredited Nadcap Materials Testing Laboratory

Reviewed by
(R)
Andrew Waldron, Supervisor
Chemistry Department

Reviewed by
(R)
Brian Wackowicz, Supervisor
Chemistry Department

CHEMISTRY

Element	Sample
Al	<0.01
As	0.01
C[1]	0.29
Co	0.03
Cr	0.02
Cu	0.06
Mn	1.02
Mo	<0.01
N[2]	0.01
Ni	0.07
P	0.020
S[1]	0.025
Si	0.09
Sn	<0.01

[1]Determined by combustion-infrared absorbance.
[2]Determined by inert gas fusion-thermal conductivity.
Results in weight percent unless otherwise indicated.
Method(s): ASTM E 415-08 and ASTM E 1019-08

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A Division of Ithaca Materials Research & Testing Incorporated

131 Woodsedge Drive
Lansing Business & Technology Park
Lansing, NY 14882

Phone 607.533.7000 • Fax 607.533.9210
www.imrtest.com • E-mail imr@imrtest.com
Toll Free 888.464.8422

December 15, 2010

Don Kramer
National Transportation
Safety Board
490 L'Enfant Plaza
Washington, DC 20594

PO Number
Credit Card

Date Received
December 8, 2010

Material
Low Carbon Steel

Description
30" OD 0.375 inch wall thickness pipe

Sample ID
P1

TEST REPORT

IMR Report Number 201010412D

SUMMARY

One sample was received for chemical analysis.

The results are on the following page(s).

A2LA ACCREDITED Testing Cert # 1140.01 & 1140.02
Accredited Nadcap Materials Testing Laboratory

Reviewed by
(R)
Andrew Waldron, Supervisor
Chemistry Department

Reviewed by
(R)
Brian Wackowicz, Supervisor
Chemistry Department

CHEMISTRY

Element	Sample
Al	<0.01
As	0.01
C[1]	0.24
Co	0.01
Cr	0.05
Cu	0.12
Mn	0.34
Mo	0.01
N[2]	<0.01
Ni	0.06
P	0.012
S[1]	0.023
Si	0.01
Sn	0.01

[1]Determined by combustion-infrared absorbance.
[2]Determined by inert gas fusion-thermal conductivity.
Results in weight percent unless otherwise indicated.
Method(s): ASTM E 415-08 and ASTM E 1019-08

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131 Woodsedge Drive
Lansing Business & Technology Park
Lansing, NY 14882

Phone 607.533.7000 • Fax 607.533.9210
www.imrtest.com • E-mail imr@imrtest.com
Toll Free 888.464.8422

December 15, 2010

Don Kramer
National Transportation
Safety Board
490 L'Enfant Plaza
Washington, DC 20594

TEST REPORT

IMR Report Number 201010412E

PO Number
Credit Card

Date Received
December 8, 2010

Material
Low Carbon Steel

Description
30" OD 0.375 inch wall thickness pipe

Sample ID
P2

SUMMARY

One sample was received for chemical analysis.

The results are on the following page(s).

A2LA ACCREDITED Testing Cert # 1140.01 & 1140.02
Accredited Nadcap Materials Testing Laboratory

Reviewed by
(R) [redacted]
Andrew Waldron, Supervisor
Chemistry Department

Reviewed by
(R) [redacted]
Brian Wackowicz, Supervisor
Chemistry Department

CHEMISTRY

Element	Sample
Al	<0.01
As	0.01
C[1]	0.12
Co	0.01
Cr	0.05
Cu	0.08
Mn	0.35
Mo	0.01
N[2]	<0.01
Ni	0.05
P	0.008
S[1]	0.022
Si	0.01
Sn	0.01

[1]Determined by combustion-infrared absorbance.
[2]Determined by inert gas fusion-thermal conductivity.
Results in weight percent unless otherwise indicated.
Method(s): ASTM E 415-08 and ASTM E 1019-08

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131 Woodsedge Drive
Lansing Business & Technology Park
Lansing, NY 14882

Phone 607.533.7000 • Fax 607.533.9210
www.imrtest.com • E-mail imr@imrtest.com
Toll Free 888.464.8422

December 15, 2010

Don Kramer
National Transportation
Safety Board
490 L'Enfant Plaza
Washington, DC 20594

PO Number
Credit Card

Date Received
December 8, 2010

Material
Low Carbon Steel

Description
30" OD 0.375 inch wall thickness pipe

Sample ID
P3

TEST REPORT

IMR Report Number 201010412F

SUMMARY

One sample was received for chemical analysis.

The results are on the following page(s).

A2LA ACCREDITED Testing Cert # 1140.01 & 1140.02

Accredited Nadcap Materials Testing Laboratory

R----------
(R) [redacted]
Andrew Waldron, Supervisor
Chemistry Department

Reviewed by
(R) [redacted]
Brian Wackowicz, Supervisor
Chemistry Department

CHEMISTRY

Element	Sample
Al	<0.01
As	0.01
C[1]	0.21
Co	0.01
Cr	0.05
Cu	0.12
Mn	0.32
Mo	0.01
N[2]	<0.01
Ni	0.06
P	0.012
S[1]	0.026
Si	0.01
Sn	0.01
W	0.01

[1]Determined by combustion-infrared absorbance.
[2]Determined by inert gas fusion-thermal conductivity.
Results in weight percent unless otherwise indicated.
Method(s): ASTM E 415-08 and ASTM E 1019-08

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Lansing Business & Technology Park
Lansing, NY 14882

Phone 607.533.7000 • Fax 607.533.9210
www.imrtest.com • E-mail imr@imrtest.com
Toll Free 888.464.8422

December 15, 2010

Don Kramer
National Transportation
Safety Board
490 L'Enfant Plaza
Washington, DC 20594

PO Number
Credit Card

Date Received
December 8, 2010

Material
Low Carbon Steel

Description
30" OD 0.375 inch wall thickness pipe

Sample ID
P4

TEST REPORT

IMR Report Number 201010412G

SUMMARY

One sample was received for chemical analysis.

The results are on the following page(s).

A2LA ACCREDITED Testing Cert # 1140.01 & 1140.02
Accredited Nadcap Materials Testing Laboratory

Reviewed by
(R) [redacted]
Andrew Waldron, Supervisor
Chemistry Department

Reviewed by
(R) [redacted]
Brian Wackowicz, Supervisor
Chemistry Department

CHEMISTRY

Element	Sample
Al	0.01
As	0.01
C[1]	0.18
Co	0.01
Cr	0.04
Cu	0.42
Mn	0.81
Mo	0.01
N[2]	0.01
Ni	0.10
P	0.073
S[1]	0.026
Si	0.19
Sn	0.05
Ti	0.01
W	0.01

[1]Determined by combustion-infrared absorbance.
[2]Determined by inert gas fusion-thermal conductivity.
Results in weight percent unless otherwise indicated.
Method(s): ASTM E 415-08 and ASTM E 1019-08

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131 Woodsedge Drive
Lansing Business & Technology Park
Lansing, NY 14882

Phone 607.533.7000 • Fax 607.533.9210
www.imrtest.com • E-mail imr@imrtest.com
Toll Free 888.464.8422

December 15, 2010

Don Kramer
National Transportation
Safety Board
490 L'Enfant Plaza
Washington, DC 20594

PO Number
Credit Card

Date Received
December 8, 2010

Material
Low Carbon Steel

Description
30" OD 0.375 inch wall thickness pipe

Sample ID
P5

TEST REPORT

IMR Report Number 201010412H

SUMMARY

One sample was received for chemical analysis.

The results are on the following page(s).

A2LA ACCREDITED Testing Cert # 1140.01 & 1140.02
Accredited Nadcap Materials Testing Laboratory

Reviewed by
(R)
Andrew Waldron, Supervisor
Chemistry Department

Reviewed by
(R)
Brian Wackowicz, Supervisor
Chemistry Department

CHEMISTRY

Element	Sample
Al	<0.01
As	0.01
C[1]	0.28
Co	<0.01
Cr	0.04
Cu	0.05
Mn	0.62
Mo	0.01
N[2]	<0.01
Ni	0.03
P	0.017
S[1]	0.036
Si	0.03
Sn	0.01

[1]Determined by combustion-infrared absorbance.
[2]Determined by inert gas fusion-thermal conductivity.
Results in weight percent unless otherwise indicated.
Method(s): ASTM E 415-08 and ASTM E 1019-08

IMR TEST LABS
A Division of Ithaca Materials Research & Testing Incorporated

131 Woodsedge Drive
Lansing Business & Technology Park
Lansing, NY 14882

Phone 607.533.7000 • Fax 607.533.9210
www.imrtest.com • E-mail imr@imrtest.com
Toll Free 888.464.8422

December 15, 2010

Don Kramer
National Transportation
Safety Board
490 L'Enfant Plaza
Washington, DC 20594

PO Number
Credit Card

Date Received
December 8, 2010

Material
Low Carbon Steel

Description
30" OD 0.375 inch wall thickness pipe

Sample ID
P6

TEST REPORT

IMR Report Number 201010412I

SUMMARY

One sample was received for chemical analysis.

The results are on the following page(s).

A2LA ACCREDITED Testing Cert # 1140.01 & 1140.02
Accredited Nadcap Materials Testing Laboratory

(R)

Andrew Waldron, Supervisor
Chemistry Department

Reviewed by

(R)

Brian Wackowicz, Supervisor
Chemistry Department

CHEMISTRY

Element	Sample
Al	<0.01
As	0.01
C[1]	0.27
Co	0.03
Cr	0.01
Cu	0.04
Mn	0.95
Mo	<0.01
N[2]	<0.01
Ni	0.07
P	0.016
S[1]	0.035
Si	0.05
Sn	<0.01

[1]Determined by combustion-infrared absorbance.
[2]Determined by inert gas fusion-thermal conductivity.
Results in weight percent unless otherwise indicated.
Method(s): ASTM E 415-08 and ASTM E 1019-08

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December 15, 2010

Don Kramer
National Transportation
Safety Board
490 L'Enfant Plaza
Washington, DC 20594

PO Number
Credit Card

Date Received
December 8, 2010

Material
Low Carbon Steel

Description
30" OD 0.375 inch wall thickness pipe

Sample ID
LN

TEST REPORT

IMR Report Number 201010412C

SUMMARY

One sample was received for chemical analysis.

The results are on the following page(s).

A2LA ACCREDITED Testing Cert # 1140.01 & 1140.02
Accredited Nadcap Materials Testing Laboratory

Reviewed by
[redacted]
Andrew Waldron, Supervisor
Chemistry Department

Reviewed by
[redacted]
Brian Wackowicz, Supervisor
Chemistry Department

CHEMISTRY

Element	Sample
Al	<0.01
As	0.01
C[1]	0.20
Co	0.03
Cr	0.03
Cu	0.04
Mn	1.02
Mo	0.02
N[2]	0.01
Ni	0.13
P	0.011
S[1]	0.025
Si	0.07
Sn	<0.01
W	0.01

[1]Determined by combustion-infrared absorbance.
[2]Determined by inert gas fusion-thermal conductivity.
Results in weight percent unless otherwise indicated.
Method(s): ASTM E 415-08 and ASTM E 1019-08

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TEST REPORT

IMR Report Number 201010412A

SUMMARY

One sample was received for chemical analysis.

The results are below.

December 15, 2010

Don Kramer
National Transportation
Safety Board
490 L'Enfant Plaza
Washington, DC 20594

PO Number
Credit Card

Date Received
December 8, 2010

Material
Low Carbon Steel

Sample ID
Welding Rod

CHEMISTRY

Element	Sample
Al	<0.01
C[1]	0.10
Cr	0.02
Cu	0.13
Mn	0.49
Mo	0.01
Ni	0.03
P	<0.005
S[1]	0.018
Si	0.01
Sn	0.06

[1]Determined by combustion-infrared absorbance.
Results in weight percent unless otherwise indicated.
Method(s): CAP-017K (ICP-AES) and ASTM E 1019-08

Reviewed by
(R) [redacted]
Andrew Waldron, Supervisor
Chemistry Department

Reviewed by
(R) [redacted]
Brian Wackowicz, Supervisor
Chemistry Department

A2LA ACCREDITED Testing Cert # 1140.01 & 1140.02
Accredited Nadcap Materials Testing Laboratory