EL PASO LINE 2000 CONVERSION

Test Section Number 10

Sta. 24635+[redacted] to Sta. 25522+[redacted]

8 August 2002

The purpose of this report is to summarize the results from Test Section #10 of the Line 2000 Conversion Project for EL Paso Natural Gas. This section was primarily comprised of 30" O.D. x 0.281" W.T. x Grade X-70. The section is located in Pinal County, Arizona, and begins at Station# 24635+[redacted] and ends at Station# 25522+[redacted] for a total length of 88 694 ft.

The test began at 4:00 pm on 7 August 02, and ended at 12:00 am on 8 August 02. The initial test pressure at the test-site was 1280 psi and after the full eight hours the final test pressure was 1273 psi. The ambient temperature at the test-site was a maximum of 101°F at the beginning of the test and decreased to a minimum of 84°F at the end of the test. The test-site pipe temperature at the beginning of the test was 93°F and increased to a maximum of 94°F at the end of the test. The minimum test pressure at the highest point in the test section was 1221 psi yielding 93.1% SMYS. The maximum test pressure at the lowest point was 1289 psi yielding 98.3% SMYS. The test pressure was maintained throughout the duration of the test and was subsequently accepted as valid.

EL PASO LINE 2000 CONVERSION

Test Section Number 10A

Sta. 25521+[redacted] to Sta. 25694+[redacted]

5 August 2002

Milbar Hydro-Test, Inc.
651 Aero Drive
Shreveport LA 71107-6943

[redacted] phone
fax

Facsimile transmittal

To: [redacted] **Fax:** [redacted]

Company: El Paso Natural Gas **Date:** December 18, 2002

From: [redacted] **Pages:** 2, Including this one.

Re: Test summary revision-test section 10A

☐ Urgent ☐ For Review ☐ Please Comment ☐ Please Reply ☐ Please Recycle

Notes: This is the revision you and I discussed this morning. Please look it over and let me know if any changes need to be made.

MILBAR

[redacted]
Project Engineer

MILBAR HYDRO-TEST, INC.
P.O. BOX 7701
SHREVEPORT, LA 71137-7701
[redacted]@milbarhydro-test.com

OFFICE: (318) 227-8210
FAX: (318) 222-2558
CEL [redacted]

The purpose of this report is to summarize the results from Test Section #10A of the Line 2000 Conversion Project for EL Paso Natural Gas. This section was primarily comprised of 30" O.D. x 0.438" W.T. x Grade X-70. The section is located in Pinal County, Arizona, and begins at Station# 25521+[redacted] and ends at Station# 25694+[redacted] for a total length of 17 314 ft.

The test began at 1:00 pm on 5 August 02, and ended at 9:00 pm on 5 August 02. The initial test pressure at the test-site was 2033 psi and after the full eight hours the final test pressure was 2033 psi. However, both pressure recorders, test-site and far end, indicate a pressure loss that the test-site dead weights did not register. This most likely was caused by not filling the oil reserve in the dead weight's canister causing the weights to reach a maximum and then maintain that value. According to the test-site pressure chart, the minimum test pressure at the highest point in the test section was 2005 psi yielding 98.1% SMYS. The maximum test pressure at the lowest point was 2044 psi yielding 100% SMYS. The ambient temperature at the test-site was 101°F at the beginning of the test and increased to a maximum of 106°F before decreasing to 81°F at the end of the test. The test-site pipe temperature at the beginning of the test was 92°F and increased to a maximum of 94°F at the end of the test. The test was maintained throughout the duration of the time period and was subsequently accepted as valid.

The purpose of this report is to summarize the results from Test Section #10A of the Line 2000 Conversion Project for EL Paso Natural Gas. This section was primarily comprised of 30" O.D. x 0.438" W.T. x Grade X-70. The section is located in Pinal County, Arizona and begins at Station# 25521+[redacted] and ends at Station# 25694+[redacted] for a total length of 17 314 ft.

The test began at 1:00 pm on 5 August 02, and ended at 9:00 pm on 5 August 02. The initial test pressure at the test-site was 2033 psi and after the full eight hours the final test pressure was 2033 psi. The ambient temperature at the test-site was 101°F at the beginning of the test and increased to a maximum of 106°F before decreasing to 81°F at the end of the test. The test-site pipe temperature at the beginning of the test was 92°F and increased to a maximum of 94°F at the end of the test. The minimum test pressure at the highest point in the test section was 2033 psi yielding 99.5% SMYS. The maximum test pressure at the lowest point was 2044 psi yielding 100% SMYS. The test-site pressure chart was adjusted at 12:50 pm to represent a more accurate depiction of the pressure at the test-site. The test pressure was maintained throughout the duration of the test and was subsequently accepted as valid.

EL PASO LINE 2000 CONVERSION

Test Section Number 12

Sta. 27262+[redacted] to Sta. 27525+[redacted]

22 September 2002

The purpose of this report is to summarize the results from Test Section #12 of the Line 2000 Conversion Project for EL Paso Natural Gas. This section was primarily comprised of 30" O.D. x 0.281" W.T. x Grade X-70. The section is located in Pinal County, Arizona, and begins at Station# 27262+[redacted] and ends at Station# 27525+[redacted] for a total length of 26 277 ft.

The test began at 3:30 pm on 22 September 02, and ended at 11:30 pm on 22 September 02. The initial test pressure at the test-site was 1342 psi and after the full eight hours the final test pressure was 1333 psi. The ambient temperature at the test-site was 96°F at the beginning of the test and decreased to a minimum of 75°F at the end of the test. The test-site pipe temperature at the beginning of the test was 92°F and increased to a maximum of 95°F at the end of the test. The minimum test pressure at the highest point in the test section was 1183 psi yielding 90.2% SMYS. The maximum test pressure at the lowest point was 1342 psi yielding 102.4% SMYS. The test pressure was maintained throughout the duration of the test and was subsequently accepted as valid.

EL PASO LINE 2000 CONVERSION

Test Section Number 13

Sta. 27525+[redacted] to Sta. 27839+[redacted]

22 September 2002

The purpose of this report is to summarize the results from Test Section #13 of the Line 2000 Conversion Project for EL Paso Natural Gas. This section was primarily comprised of 30" O.D. x 0.281" W.T. x Grade X-70. The section is located in Pinal County, Arizona, and begins at Station# 27525+[redacted] and ends at Station# 27839+[redacted] for a total length of 31 362 ft.

The test began at 9:30 am on 22 September 02, and ended at 5:30 pm on 22 September 02. The initial test pressure at the test-site was 1360 psi and after the full eight hours the final test pressure was 1356 psi. The ambient temperature at the test-site was 86°F at the beginning of the test and increased to a maximum of 99°F before decreasing to 97°F at the end of the test. The test-site pipe temperature at the beginning of the test was 82°F and increased to a maximum of 84°F at the end of the test. The minimum test pressure at the highest point in the test section was 1185 psi yielding 90.4% SMYS. The maximum test pressure at the lowest point was 1360 psi yielding 103.7% SMYS. The test pressure was maintained throughout the duration of the test and was subsequently accepted as valid.

EL PASO LINE 2000 CONVERSION

Test Section Number 14

Sta. 27839+[redacted] to Sta. 27980+[redacted]

22 September 2002

The purpose of this report is to summarize the results from Test Section #14 of the Line 2000 Conversion Project for EL Paso Natural Gas. This section was primarily comprised of 30" O.D. x 0.281" W.T. x Grade X-70. The section is located in Pinal County, Arizona, and begins at Station# 27839+[redacted] and ends at Station# 27980+[redacted] for a total length of 14 067 ft.

The test began at 12:15 am on 22 September 02, and ended at 8:15 am on 22 September 02. The initial test pressure at the test-site was 1193 psi and after the full eight hours the final test pressure was 1184 psi. The ambient temperature at the test-site was 73°F at the beginning of the test and increased to a maximum of 84°F at the end of the test. The test-site pipe temperature at the beginning of the test was 86°F and increased to a maximum of 88°F at the end of the test. The minimum test pressure at the highest point in the test section was 1184 psi yielding 90.3% SMYS. The maximum test pressure at the lowest point was 1300 psi yielding 99.2% SMYS. The test pressure was maintained throughout the duration of the test and was subsequently accepted as valid.

EL PASO LINE 2000 CONVERSION

Test Section Number 15

Sta. 27980+[redacted] to Sta. 28104+[redacted]

21 September 2002

The purpose of this report is to summarize the results from Test Section #15 of the Line 2000 Conversion Project for EL Paso Natural Gas. This section was primarily comprised of 30" O.D. x 0.281" W.T. x Grade X-70. The section is located in Pinal County, Arizona, and begins at Station# 27980+[redacted] and ends at Station# 28104+[redacted] for a total length of 12 428 ft.

The test began at 11:00 am on 21 September 02, and ended at 7:00 pm on 21 September 02. The initial test pressure at the test-site was 1314 psi and after the full eight hours the final test pressure was 1314 psi. The ambient temperature at the test-site was 84°F at the beginning of the test and increased to a maximum of 90°F before decreasing to 84°F at the end of the test. The test-site pipe temperature at the beginning of the test was 87°F and increased to a maximum of 89°F before decreasing to 88°F at the end of the test. The minimum test pressure at the highest point in the test section was 1189 psi yielding 90.7% SMYS. The maximum test pressure at the lowest point was 1314 psi yielding 100.2% SMYS. The test pressure was maintained throughout the duration of the test and was subsequently accepted as valid.

12/10/2002 13:16 [redacted] [redacted] PAGE 01

FAX
Page #1 of 14

To: [redacted]

From: [redacted]

Ref.: Hydrostatic Test #1-2 for Tom Mix Comp. Sta.

Sent To FAX # [redacted]

Date Sent: 10/07/03

Sir;

This is the second of two Hydrostatic tests for the launcher/receiver here at Tom Mix Compressor Station. The tie-in on Line 2000 is set for this Wednesday Oct. 8th.

Please E-mail acceptance to:

[redacted]@ElPaso.com

[redacted]

[redacted]@ElPaso.com

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TEST SPECIFICATIONS

ANR ☐ CIG ☐ EPNG ☑ TGP ☐ SNG ☐

Date:	Select Routing:
21-Sep-2003	1

Test Number: 2 of 2

Project Name:	Project I.D. / AFE Number	Facility Name or Number
Tom Mix L2000 M.P. 530+[redacted]	074609	Tom Mix Compressor Station

Installation Location (M.P. or S.S.):		State:	County/Parish:	Class Location Designation		Selected Design Pressure		Planned MAOP	
From: 530+[redacted]	To: 530+[redacted]	Arizona	Pinal		1		970		944

Project Description:
Suction & discharge piping launcher & receiver piping (Line 2000) Power Gas , fuel gas, vent line piping. Inlet scrubber.
DWG # TM-2-P13, 2000-530+[redacted] 2000-530+[redacted] 2000-530+[redacted] 2000-530+[redacted]

LEAK ONLY TEST ☐ STRENGTH TEST ☑ FABRICATION ☑ NEW CONSTRUCTION ☑ REPLACEMENT ☐ RETEST ☐ REFERENCE DRAWINGS ATTACHED ☐

POST-INSTALLATION TEST ☑ PRE-INSTALLATION TEST ☐

Test Design Criteria

Minimum Component Characteristics

Pipe Information

O.D.	34
Wall Thickness	0.562
SMYS	70,000

Valve/Flange ANSI Class Rating
600# Valves/Fittings

Test Pressure Calculations

☐ Input minimum and maximum pressure of test
☐ Input minimum and maximum %SMYS of test

	Pressure (psig)	% PIPE SMYS
Max. Test Pressure (Pipe)	1600.0	69.0%
Max. Test Pressure (Valves and Fittings)	1600.0	71.9%
Min.	1505.0	62.9%

Test Section - Reference Data

Test Medium	Water	
Test Duration	8	Hours (min)
Section Length	0	Ft.
Section Fill Volume	0	Gal
Max. Elevation Change	0	Ft.

Station Equations:	1	2	3
Back			
Ahead			

Test Pressures

Location	Station	Elevation (feet)	Max. psig.	% SMYS @ Max.	Min. psig.	% SMYS @ Min.	Variance psig.	Target psig.	% SMYS @Target
BEGIN	0+00	0	1,600	69.0%	1,505	64.9%	95	1,552	66.9%
HIGH ELEVATION	0+00	0	1,600	69.0%	1,505	64.9%	95	1,552	66.9%
LOW ELEVATION	0+00	0	1,600	69.0%	1,505	64.9%	95	1,552	66.9%
END	0+00	0	1,600	69.0%	1,505	64.9%	95	1,552	66.9%
Dead Weight Location (Test Point)	**0+00**	**0**	**1,600**	**69.0%**	**1,505**	**64.9%**	**95**	**1,552**	**66.9%**

REMARKS:
Test consist of all station suction piping and inlet scrubber. All discharge piping including fin fan leads, pig receiver and launcher piping power gas, fuel gas and vent line piping.

PRE-TEST SPECIFIED / REVIEWED BY:		TEST PERFORMED / ACCEPTED BY:		POST-TEST REVIEWED BY:	
Originator (Signature) [redacted]	Date:	Test Performed by (Signature):	Date:	Compliance (signature)	Date:
Designed Reviewed if applicable (Signature)	Date:	Company Name (for Contractor or for Employee):	Date:	Engineering or Operations (Signature)	Date:
Compliance (Signature)	Date:	Witnessed & Accepted by El Paso Representative: (Signature)	Date:	Actual MAOP	

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TEST DESIGN INFORMATION

Date:	Select Routing:
21-Sep-2003	1

Project Name:	Project I.D. / AFE Number	Facility Name or Number
Tom Mix L2000 M.P. 530+[redacted]	074509	Tom Mix Compressor Station

Item Number	P = calculated Design Pres. (psig)	D = Outside dia. (inches)	t = Wall Thick. (inches)	S = SMYS (psi)	F = Design Factor	Begin Station	End Station	Elevation	Calculated Stress Levels: Stress Level (% SMYS) @ Select. Design Pres.	@ min. test pres.	@ max. test pres.
1	8654	1.315	0.250	35,000	0.50				7.3	11.3	12.0
2	3855	2.375	0.218	42,000	0.50				12.6	19.5	20.8
3	2739	4.500	0.237	52,000	0.50				17.7	27.5	29.2
4	2198	6.625	0.280	52,000	0.50				22.1	34.2	36.4
5	1941	8.625	0.322	52,000	0.50				25.0	38.8	41.2
6	1426	10.750	0.365	42,000	0.50				34.0	52.6	56.1
7	1235	12.750	0.375	42,000	0.50				39.9	60.9	64.8
8	1167	30.000	0.500	70,000	0.50				41.6	64.5	68.6
9	1157	34.000	0.562	70,000	0.50				41.9	65.0	69.1
10											
11											
12											
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REMARKS:

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TEST LOG

Test Date:	Select Routing:
10-06-03	1

Project Name:	Project I.D. / AFE Number	Facility Name or Number
Tom Mix L2000 M.P. 530+[redacted]	074509	Tom Mix Compressor Station

Actual Installation Location: Begin 530+[redacted] End 530+[redacted]

Test # 1-2

Measured pressure (psig)	Time AM PM	Ambient Temp. (F°)	Test Medium Temp. (F°)	Ground Temp (F°) (If Applicable)	Remarks (see instructions on page 1)
0	6:?? AM	67.5	73		Began pumping up
253 PSI	7:00 AM	67.7	73		
738 PSI	730 AM	70.0	80		Still check for leaks – working on pipes
753 PSI	8:00 AM	89.0	89.0		Still check for leaks working on 'empty' pipes
0 PSI	?:45 AM	88.0	88.0		Bled down for leak @ 34" Enclosure
0 PSI	12:00	87.3	94.5		Begin pressurizing
500 PSI	12:25 PM	87.5	91.5		Stop for leak check
500 PSI	12:26 PM	88.7	91.5		Begin pressurizing
1085 PSI	12:35 PM	87.7	90.0		Stop for leak check
1041 PSI	12:45 PM	88.6	90.0		Took pressure down to replace plug on launcher door
0 PSI	1:10 PM	86.9	90.0		Begin pressurizing
320 PSI	1:25 PM	87.1	91.0		
455 PSI	1:40 PM	85.9	91.0		Stop for leak - check
455 PSI	1:45 PM	86.2	91.0		Begin pressurizing
1075 PSI	2:00 PM	86.2	91.0		Stop for leak check
1075 PSI	2:05 PM	86.8	91.0		Begin pressurizing
1530 PSI	2:15 P.M.	85.9	91.0		Stop pump - check for leaks.
1535 PSI	2:45 P.M.	84.8	91.5		Begin test.
1535 PST	2:55 P.M.	85.9	91.5		Running test - sun just came through clouds
1537 PSI	3:05 P.M.	85.9	91.5		Running test - sun warming up pipe
1541 PSI	3:15 P.M.	85.0	91.5		Running test - Bled off some pressure to hold level edge.
1543 PST	3:25 P.M.	83.9	92		Running test - sun in & out of clouds - windy (cloudy overcast)
1545 PSI	3:35 P.M.	83.0	92		Running test - wind picking up - sun in & out of clouds (cloudy)
1546 PSI	3:45 P.M.	83.0	92		Running test - windy - cloudy
1546 PSI	4:00 P.M.	82.3	92		Running Test - cloudy overcast - windy
15?6 PSI	4:15 P.M.	81.5	91.5		Test doing great - same type of weather - windy & cloudy
1545 PSI	4:30 P.M.	80.8	90.5		Sun in & out of clouds - Holding
1543 PSI	4:45 P.M.	80.1	90.5		Sun behind clouds - cloudy overcast
1541 PSI	5:00 P.M.	80.1	90.0		No sun - cloudy - thundering
1538 PSI	5:15 P.M.	79.4	90.0		Very cloudy - windy - & thundering
1536 PSI	5:30 P.M.	79.0	89.0		Temp. getting cooler - slight winds - still cloudy
1533 PSI	5:45 P.M.	78.7	88.0		Sun going down - getting cooler - cloudy overcast
1530 PSI	6:00 P.M.	78.3	88.0		getting dark - cool - windy - pipe cooling down
1537 PSI	6:10 P.M.	77.9	88.0		Raised pressure to stay on line. O.K.
1532 PSI	6:30 P.M.	77.2	87.5		nightfall - Temp. cooling off pipe - light winds
1530 PSI	6:40 P.M.	77.2	87.5		Temp. cooling down - need to raise pressure.
1539 PSI	6:45 P.M.	77.2	8?.5		Raised pressure to hold test on line - getting cool temp.
1538 PSI	7:00 P.M.	76.7	87.5		Cool night - test doing good. -
1534 PSI	7:30 P.M.	75.8	8?.0		Temp. dropping - cooling pipe test doing ok.
1?21 PSI	8:00 PM	75.6	8?.?		Temp [illegible] some light breeze pipe cooling.
1510 PSI	805 PM	75.6	8?.?		Pressurizing up to target PSI
1542 PSI	810 PM	75.?	83.5		Pressured up to 1542 Holding steady - Spikes due to pump vibration

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TEST LOG

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Project Name:	Project I.D. / AFE Number	Test Date:	Select Routing:
Tom Mix L2000 M.P. 530[redacted]	074509	10-06-03	1
		Facility Name or Number: Tom Mix Compressor Station	

Actual Installation Location: Begin End

Test # 1-2

Measured pressure (psig)	Time AM PM	Ambient Temp. (F°)	Test Medium Temp. (F°)	Ground Temp (F°) (If Applicable)	Remarks (see instructions on page 1)
1537 PSI	830 PM	75.1	82°		Pressure Dropping Slowly As Pipe Cools
1530 PSI	9:00 Pm.	74.8	81		Pressure Holding Slowly Pipe Cooling.
1527 PSI	9:15 Pm.	74.0	83.5		Temp Probe Partially detached From Pipe Retaped Probe To Pipe
4. 1523 PSI	9:30 PM.	74.0			And Temp Rose Slightly
1523 PSI	9:30 Pm.	74.0	88°		Pressure Dropping Slowly.
1520 PSI	9:45 PM.	74.1	88.5		Pressuring [illegible] Back to Target
1540 PSI	9:50 PM.	74.2	86.5		Pumped back up to 1540 Pressure Holding Spiking From Pump Vibration
1537 PSI	10:00 PM.	74.2	86.5		Pressure dropping Slowly Test still OK
1532 PSI	10:30 Pm.	73.6	83		Pressure Still dropping Slowly Test ok
1524 PSI	11:00 Pm.	73.6	83"		Pressure Dropping Slightly Slight Cool Breeze
1520 PSI	11:15 PM	73.3	82.5		Test Complete. / [illegible] Test

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TEST SPECIFICATIONS

Date:	Select Routing:
26-Sep-2003	1

ANR ☐ CIG ☐ EPNG ☑ TGP ☐ SNG ☐

Test Number: 1 of 1

Project Name:	Project I.D. / AFE Number	Facility Name or Number
INSTALL VALVE 39-1/2 2000 LINE	086005	CASA GRANDE L6775

Installation Location (M.P. or S.S.):	State:	County/Parish:	Class Location Designation		Selected Design Pressure		MAOP	
From: ES 2547+[redacted] To:	AZ	PINAL COUNTY		1		944		944

Project Description:

INSALL NEW LINE 2000 BURIED MAIN LINE VALVE 39 1/2 WITH 30" FULL OPENING BLOCK VALVE WITH BLOWOFFS. BYPASS AND SHAFER OPERATOR LOCATION IS SECTION 2, T-6
A GROUND DISTURBANCE OF LESS THAN 5 ACRES IS REQUIRED. PROJECT IS UNFORSEEN AND IS REQUIRED TO COMPLY WITH DOT 192. 179, LINE VALVE SPACING. MAX 20 MILES
BETWEEN VALVES IN CLASS 1 LOCATIONS.
THIS VALVE ASSEMBLY WAS TESTED HERE IN EL PASO STATION# 3 BY AN EL PASO EMPLOYEE WILLIE Q. GARCIA.

LEAK ONLY TEST ☐ STRENGTH TEST ☐ FABRICATION ☐ NEW CONSTRUCTION ☑ REPLACEMENT ☐ RETEST ☐ REFERENCE DRAWINGS ATTACHED ☐

POST-INSTALLATION TEST ☐ PRE-INSTALLATION TEST ☐

Test Design Criteria

Minimum Component Characteristics

Pipe Information

O.D.	30
Wall Thickness	0.500
SMYS	60,000

Valve/Flange ANSI Class Rating
N/A

Test Pressure Calculations

☐ Input minimum and maximum pressure of test
☐ Input minimum and maximum %SMYS of test

	Pressure (psig)	% PIPE SMYS
Max. Test Pressure (Pipe)	1900.0	95.0%
Max. Test Pressure (Valves and Fittings)	N/A	N/A
Min.	1800.0	90.0%

Test Section - Reference Data

Test Medium	Water	
Test Duration	8	Hours (min)
Section Length	0	Ft.
Section Fill Volume	0	Gal
Max. Elevation Change	0	Ft.

Station Equations:

	1	2	3
Back			
Ahead			

Test Pressures

Location	Station	Elevation (feet)	Max. psig.	% SMYS @ Max.	Min. psig.	% SMYS @ Min.	Variance psig.	Target psig.	% SMYS @Target
BEGIN	0+00	0	1,900	95.0%	1,800	90.0%	100	1,850	92.5%
HIGH ELEVATION	0+00	0	1,900	95.0%	1,800	90.0%	100	1,850	92.5%
LOW ELEVATION	0+00	0	1,900	95.0%	1,800	90.0%	100	1,850	92.5%
END	0+00	0	1,900	95.0%	1,800	90.0%	100	1,850	92.5%
Dead Weight Location (Test Point)	**0+00**	**0**	**1,900**	**95.0%**	**1,800**	**90.0%**	**100**	**1,850**	**92.5%**

REMARKS:
RECOREDER SERIAL# 5144-DS DEADWEIGHT SERIAL# 7683
THE FABRICATION WILL BE HYDROSTATICALLY TESTED IN THE SHOP. IT IS NOT PRACTICAL TO TEST THE FABRICATION AFTER INSTALLATION IN THE MAINLINE BECAUSE
THIS IS AN EXISTING, IN-SERVICE LINE
THE ADDITION OF THIS VALVE IS BEING EXPEDITED TO MEET DOT COMPLIANCE REQUIREMENTS FOR VALVE SPACING AND TAKE ADVANTGE OF A PLANNED OUTAGE
UPSTREAM ON THE LINE.

PRE-TEST SPECIFIED / REVIEWED BY:	TEST PERFORMED / ACCEPTED BY:	POST-TEST REVIEWED BY:
Originator (Signature) Date:	Test Performed by (Signature): [redacted] Date: 9/27/03	Compliance (signature) [redacted] Date: 10/03/03
Designed Reviewed if applicable (Signature) Date:	Company Name (for Contractor or for Employee): [redacted] Date: 9/27/03	Engineering or Operations (Signature) Date:
Compliance (Signature) Date: 03/27/2003	Witnessed & Accepted by EPNG Representative (Signature) Date:	Actual MAOP

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TEST DESIGN INFORMATION

Date: 26-Sep-2003

Select Routing: 1

Project Name: INSTALL VALVE 39-1/2 2000 LINE

Project I.D. / AFE Number: 076328

Facility Name or Number: CASA GRANDE L6775

Item Number	P = calculated Design Pres.(psig)	D = Outside dia. (inches)	t = Wall Thick. (inches)	S = SMYS (psi)	F = Design Factor	Begin Station	End Station	Elevation	Calculated Stress Levels Stress Level (% SMYS) @ Select.Design Pres.	@ min. test pres.	@ max. test pres.
1	1022	30.000	0.438	70,000	0.50	sraight pipe			46.2	88.1	93.0
2	1000	30.000	0.500	60,000	0.50	tees			47.2	90.0	95.0
3	1875	16.000	0.500	60,000	0.50	reducing tee			25.2	48.0	50.7
4	1188	10.750	0.365	35,000	0.50	sraight tee			39.7	75.7	79.9
5	4764	1.315	0.179	35,000	0.50	sraight pipe			9.9	18.9	19.9
6	6125	0.840	0.147	35,000	0.50	nipple			7.7	14.7	15.5
7	1260	30.000	0.375	70,000	0.72	transition piece	(0/s fab. Assy		53.9	102.9	108.6
8											
9											
10											
11											
12											
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REMARKS:

(Rev. 8/02)-Draft

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elpaso

TEST LOG

Test Date:	Select Routing:
23-Sep-2003	1

Project Name:	Project I.D. / AFE Number	Facility Name or Number
INSTALL VALVE 39-1/2 2000 LINE	086005	CASA GRANDE L6775

Actual Installation Location: Begin ES 2547+03.1 End

Measured pressure (psig)	Time AM PM	Ambient Temp. (F°)	Test Medium Temp. (F°)	Ground Temp (F°) (If Applicable)	Remarks (see instructions on page 1)
1856	9:30 AM	80			ON TEST
1854	9:40	80			
1853	9:50	80			
1855	10:00	80			
1850	10:10	82			
1850	10:20	82			
1850	10:30	82			
1848	10:45	84			
1848	11:00	84			
1847	11:15	84			
1848	11:30	84			
1850	12:00	84			
1852	12:30	85			
1856	1:00	86			
1858	1:30	87			
1861	2:00	88			
1864	2:30	89			
1870	3:00	90			
1872	3:30	90			
1877	4:00	90			
1882	4:30	90			
1887	5:00	90			5:10 BLED TO 1848 WAS 1900
1850	5:30	90			OFF TEST

Request

Additional information on 4 leaks near MP 484 during 2002 hydrotest – documentation shows these were caused by manufacturing defects. Does KM know what type of manufacturing defects (hard spots, seam issues, etc.)?

Response

The four pressure test failures requested were in Test Section 11 during the 2002 conversion of service (details of the conversion tests are noted in DR-11B_Conversion of service listing_CONF).

Pressure Test Failure table

Date	Segment	Location	Cause
8/6/2002	CASA GRANDE TO TOM MIX	MP 487 Station [redacted]	Manufacturing
8/12/2002	CASA GRANDE TO TOM MIX	MP 493 Station [redacted]	Manufacturing
8/23/2002	CASA GRANDE TO TOM MIX	MP 496 Station [redacted]	Manufacturing
9/2/2002	CASA GRANDE TO TOM MIX	MP 498 Station [redacted]	Manufacturing

Note: the stationing has been updated in this table to match the original metallurgical report to allow for easy comparison.

A metallurgical analysis of these four failures was completed on April 17, 2003 and is attached (DR-101_Att01_TSIMS 5-2003-0510 Line 2000 Hydrotest 4-03_CONF.pdf). Excerpts from the conclusion are:

- All four of the hydrotest failures initiated at sites of original manufacturing defects in the forms of part-wall defects, narrow laminations, center-line segregation, and inclusion clusters within the pipe body. One of the sites also demonstrated external corrosion damage with approximately 59% wall loss.
- Visual inspection indicated that the lamination defects observed were less than one-inch wide. Ultrasonic inspection was unable to confirm any additional dimensional aspects of these defects other than near mid-wall positioning.
- Although certain aspects of the microstructural state of Bergrohr pipe steel have presented problems with the original manufacturing defects noted, the benefit of the finegrained microstructural state is manifested in the propensity of this material for a higher fracture toughness response.
- The chemical and mechanical test results for Line 2000 pipe material meet or exceed the minimum requirements stipulated in API5L for Grade X70.
- Fracture mechanics modeling formulated conservative stress intensity factors (KI) for the defect condition at MP 496.9 and confirmed that the rupture initiated at the lamination defect progressing in a radial direction toward the OD surface of the pipe. *(Note: This was the location with external corrosion found)*
- Since the hydrotests exposed the original manufacturing defect conditions, and recognizing that all remaining defects should be sub-critical in size, additional work on this line is not anticipated at this time.

As related to the external corrosion found at hydrotest failure at MP 496, the in-line inspection for this piggable segment occurred in December 2002 after the pressure testing was completed. So the external corrosion threat was addressed through the pressure test and the in-line inspection.

elpaso

Metallurgy Laboratory

8645 Railroad Drive, El Paso, Texas 79904 Ph: (915)587-3784 FAX: (915)587-3714

TO: Distribution DATE: April 17, 2003

FROM: [redacted]

SUBJECT: Line 2000 Hydrotest Ruptures

INTRODUCTION

Hydrotesting Line 2000 during the months of August and September produced four ruptures at MPs 487.5, 493.1, 496.9, and 498.6. All of the ruptured pipe sections were submitted to the Metallurgy Lab for analysis. Although operational background information on this line is unavailable, the pipe is nominally a 30 inch OD, 0.303 inch wall thickness, X70, manufactured by Bergrohr.

CONCLUSIONS AND RECOMMENDATIONS

- All four of the hydrotest failures initiated at sites of original manufacturing defects in the forms of part-wall defects, narrow laminations, center-line segregation, and inclusion clusters within the pipe body. One of the sites also demonstrated external corrosion damage with approximately 59% wall loss.

- Hydrotest failures caused by manufacturing defects on this line trace back to as early as 1986, as referenced in a metallurgical report prepared by J. P. Kenny & Partners for the All-American Line Company. One of these failures was within two miles of the rupture experienced at MP 487.5.

- Visual inspection indicated that the lamination defects observed were less than one-inch wide. Ultrasonic inspection was unable to confirm any additional dimensional aspects of these defects other than near mid-wall positioning.

- Although certain aspects of the microstructural state of Bergrohr pipe steel have presented problems with the original manufacturing defects noted, the benefit of the fine-grained microstructural state is manifested in the propensity of this material for a higher fracture toughness response.

- The chemical and mechanical test results for Line 2000 pipe material meet or exceed the minimum requirements stipulated in API5L for Grade X70.

- Fracture mechanics modeling formulated conservative stress intensity factors (K_I) for the defect condition at MP 496.9 and confirmed that the rupture initiated at the lamination defect progressing in a radial direction toward the OD surface of the pipe.

- RSTRENG analysis showed that the external corrosion damage observed at MP 496.9 had reduced the safe maximum operating pressure to 917 psig and projected a burst pressure of 1273 psig. The actual rupture pressure was slightly higher at 1303 psi.

- Since the hydrotests exposed the original manufacturing defect conditions, and recognizing that all remaining defects should be sub-critical in size, additional work on this line is not anticipated at this time.

- Due to the extent of OD corrosion observed at the MP 496.9 location, historical documentation of the CP history and related information should be examined for all piping downstream of former heating stations. The coating at this site may have been particularly effective in shielding the pipe, since it consisted of an inner tape coating, a polyurethane foam insulation layer, plus a heavy tape outer layer, possibly Polyken 956-30.

LABORATORY PROCEDURE

As-received and close-up photographs were taken of each of the ruptures submitted for analysis. NDE inspection utilizing ultrasonics was performed to determine the extent of the apparent lamination defects intersecting all of the rupture surfaces and to evaluate the extent of wall loss due to OD corrosion. Representative pipe sections from each rupture were torch cut from the general initiation site and submitted to the Lab for metallographic preparation and microhardness testing. Additional pipe material was removed from the hydrotest rupture at MP 496.9 and submitted to METL (Phoenix) for chemical and mechanical property assessment. Fracture mechanics modeling was also performed.

DISCUSSION

Table I summarizes some of the basic information assigned to each of the four hydrotest ruptures.

Table I. Summary Data on the Hydrotest Ruptures

MP	Engr. Station	Wall Thickness, inches	Rupture Pressure, psi	Date	Time
487.5	[redacted]	0.299	1290	8/6/02	1:27am
493.1		0.297	1293	8/12/02	3:39pm
496.9		0.297	1303	8/23/02	3:10pm
498.6		0.303	1294	9/02/02	1:20pm

All four ruptures are primarily oriented axially with a significant portion of the rupture planes demonstrating shear fracture conditions. Photograph 1, showing the rupture at MP 493.1, is generally represent of the macroscopic fracture evidence observed at each of the other rupture sites. The predominance of the shear fracture zones confirms high fracture toughness of the pipe material, while the axial portions of the rupture interfaces signify coincidentally the presence of the rupture initiation sites in association with at least two conditional states: 1). The presence of pre-existing (original manufacturing) defects and 2). Corrosion enhanced wall thickness reduction. Details of the axial portions of each of these ruptures are shown in Photographs 2-6. The rupture at MP 487.5 is revealed in Photographs 2 and 3, which document a pre-existing defect condition in the form of an unbounded interface or part-wall defect and at least some portion of a lamination (see arrow locations in Photographs 2 and 3). The defect conditions representative of the MP 493.1 rupture are revealed in Photograph 4. These linear features are associated with inclusion chains and possibly center-line segregation,

which have promoted internal separations. These defect conditions were sufficiently narrow to evade ultrasonic detection along the rupture interface.

Photograph 5 shows a portion of the rupture interface for MP 496.9, which reveals significant wall loss (58.8%) due to external corrosion damage. The external coating system used on this portion of the piping was a multi-layer tape system with urethane foam insulation. Small lamination defects can also be observed in Photograph 5.

The rupture at MP 498.6 is shown in Photograph 6. The scalloped contour of this rupture interface is due to a lamination, which was approximately 0.7 inches wide. Since the dimensions of this lamination were measurable, fracture mechanics was utilized for this defect condition.

Transverse metallographic sections were prepared for three of the four failures, with each intersecting the approximate hydrotest rupture origins. Photographs 7 and 8 provide details of the general microstructural features representative of pipe comprising this Bergrohr production. The pipe material represents fine-grained steel, generally banded and alternating in very thin layers of ferrite (light) and carbides (dark). Fibering of small inclusion clusters in linear arrays was also observed. The ASTM grain size equivalent for the ferritic grains is 10+, which serves to optimize strength and fracture toughness (see mechanical test results). The sectioning on the rupture at MP 487.5 documents the size and distribution of the inclusion clusters found intersecting this portion of the rupture interface. Photographs 9-11 show the inclusions in close proximity to the rupture interface. Since the original slabs that were rolled into plate as a precursor for pipe manufacturing were continuously cast, some portion of the inclusions are probably representative of center-line segregation. However, the general microstructural state is the same that was shown in Photographs 7 and 8.

The remaining transverse metallographic section is shown in Photograph 12. As shown in this photograph, the corrosion is in the form of overlapping pits with some demonstration of preferential microstructural corrosion. This rupture site was the only site which demonstrated significant corrosion damage. UT wall thickness readings were performed from the ID-side of the pipe along an axial distance of six-feet adjacent to the rupture. The maximum pit depth was 0.055 inches, while the average pit depth was less at 0.034 inches. RSTRENG analysis for the B31G (Case 3) criterion demonstrated that the safe maximum pressure for this line would have been 917 psig.

Nondestructive testing utilizing ultrasonic instrumentation indicated that the internal separations were extremely narrow and virtually undetectable, which is typical for inclusion chains and accompanying center-line segregation. However, the rupture at MP 498.6 exposed the entire width of a lamination that measured approximately 0.7 inches.

The tensile test results provided by METL (Phoenix) substantiated the API5L X70 Grade for this pipe with a 0.2% offset (per ASTM A370) and 0.5% gage length intercept (per API5L) yield strength in excess of 77,000 psi in the circumferential orientation. The tensile strength averaged 98,500 psi with 21% elongation.

Figure 1 portrays the Charpy V-Notch test results for test temperatures up to 212^{o}F. These results satisfy the API5L Supplementary Requirement 5 (SR5) for minimum shear area, while the absorbed energy values at 32^{o}F averaged 75 ft-lb for a full size equivalent sample size. The chemical analysis results are listed under Table II.

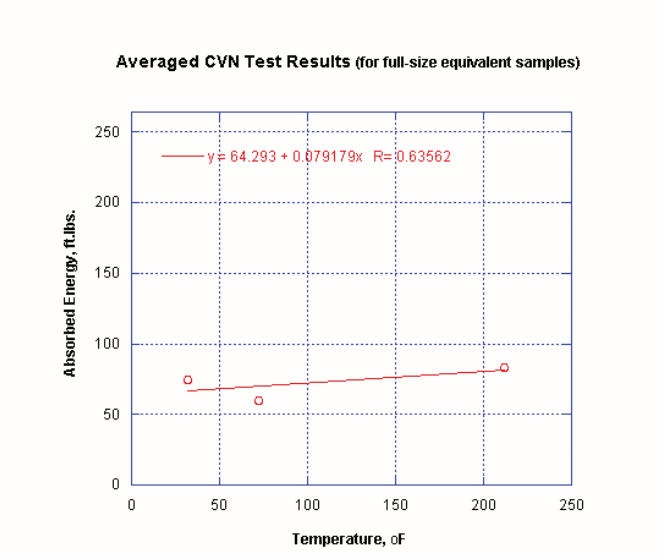


Figure 1. CVN test results for Line 2000 pipe material.

Using the fracture mechanics approach used in the hydrotest failure investigation on this same line at MP 945.1 (report dated June 13, 2002), a circumferential lamination of width (2a) is used to model the pipe defect and its influence on rupture behavior during hydrotesting (see Figure 2). The membrane stress represents the hoop stress and the parameters, G_m and G_b, can be computed based on the flaw size width (2a), pipe radius (R), and pipe wall thickness (t). Utilizing the actual hydrotest rupture pressure of 1294 psi for MP 498.6, K_I, and the stress intensity factor for the outer and inner membrane surfaces can be calculated. Although the boundary conditions for plane strain conditions are not satisfied for these pipe dimensions, conservative predictions of the critical stress intensity factor can be determined. For this case, K_I for the inner pipe surface was 58.8 ksi $(in.)^{1/2}$, while the outer pipe surface was 75.6 ksi $(in.)^{1/2}$. The difference in stress intensity magnitude suggests that the rupture initiated in the outer membrane first along the lamination interface and progressed to the inner membrane as the longitudinal interface grew radially and axially.

In a metallurgical report prepared by J. P. Kenny & Partners for the All-American Line Company, dated June 1986 and entitled “Metallurgical Report on Field Hydrotest Failures in Bergrohr/Herne Line Pipe,” two hydrotest failures were investigated from MPs 485.25 and 471.9. The J. P. Kenny report actually contained a metallurgical analysis by the original plate manufacturer, Peine-Salzgitter, based on their production records and analysis of the hydrotest failures submitted. The rupture pressures for both of these locations were 1129 psi (86%SMYS) and 1179 psi (89.9% SMYS), respectively. Peine-Salzgitter formulated that the first failure was due to an original manufacturer defect referred to as a part-wall defect and the latter due to a high volume fraction of Al_2O_3 and CaO inclusions. The chemical analysis quoted for the aforementioned pipe sections is listed in Table II.

Table II. Chemical analysis results for the pipe at MP 496.9 compared to two former hydrotest failure sites referenced in the Kenny report (weight percentages)

MP	C	Mn	P	S	Si	Cu	Ni	Cr	V	Nb	Al
496.9	0.09	1.60	0.012	0.001	0.43	0.01	0.09	0.04	0.05	0.06	0.030
*485.2[redacted]	0.10	1.49	0.015	0.003	0.46	0.02	0.02	0.02	0.06	0.03	0.036
*471.9	0.08	1.49	0.014	0.005	0.43	0.1	0.06	0.02	0.06	0.03	0.032
API5LX70 (max.)	0.23	1.60	0.030	0.030							

*Information provided in the Kenny Report

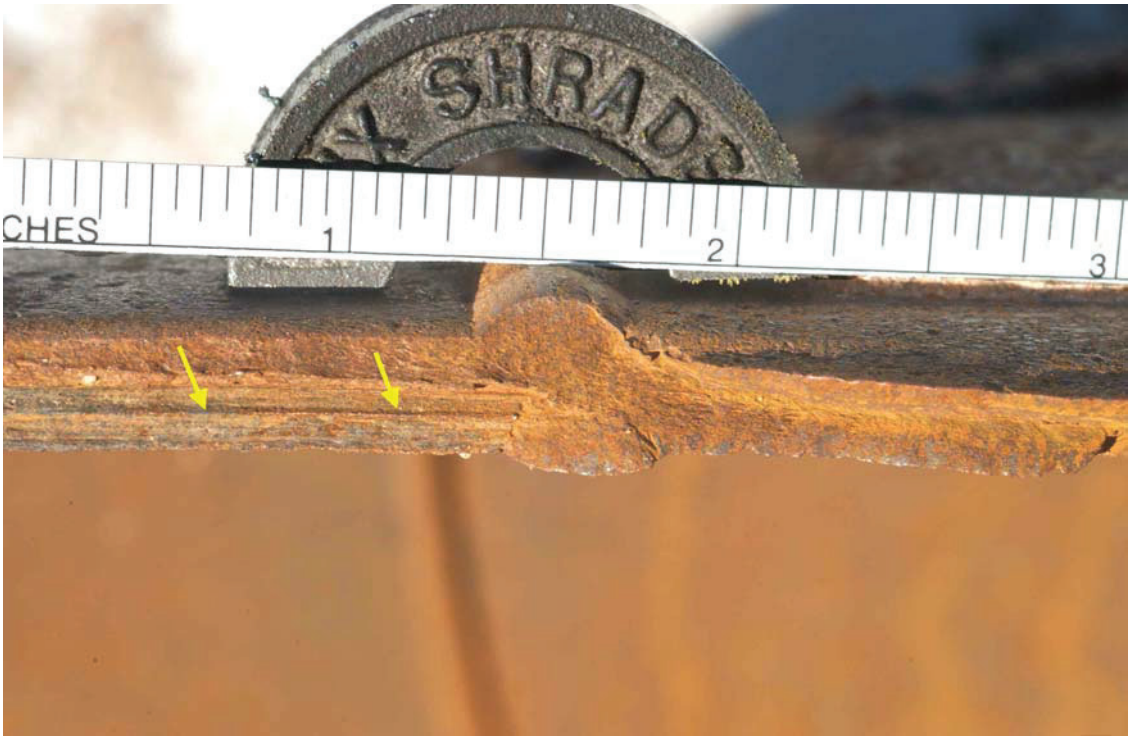
These chemistries appear well designed and appropriate for the X70 Grade. Although the Peine-Salzgitter ultrasonic slab inspection reports did not reveal any problems with the steel prior to plate rolling in the case of the first failure, the second failure indicated that ultrasonic inspection did pick up minor readings of "chain-like inclusions." The source of these inclusion defects was hypothesized to be due to a build-up of de-oxidation products in the continuously cast steel slab tundish, which for some unknown reason dropped into the slab caster and rolled out in the plate product. Peine-Salzgitter admitted that the cause for both hydrotest failures was their original manufacturing defects.

With the impact samples returned from METL, one of the samples was chosen at random and examined using the SEM/EDS system. All of the impact samples demonstrated high proportions of shear fracture evidence as well as mid-span delaminations. In order to understand the fracture characteristics of this pipe steel and the relevance of the fibering or inclusion clusters observed in the microstructural state, a SEM study of one of the fractured impact samples located numerous residual inclusions. One of the inclusions observed is referenced in Photograph 13, which was confirmed by EDS to be mostly a particle composed of calcium sulfide. Since CaO or burnt lime is added during steel production operations to aid in desulfurization, residual CaS dispersed within the steel indicates that the slag-off process was not fully effective. The linear morphology of these inclusion particles is further illustrated in Photograph 13 by noting the two "tracks" of former sites of inclusion particles. The balance of the fracture evidence confirms dimple rupture and shear fracture predominance.

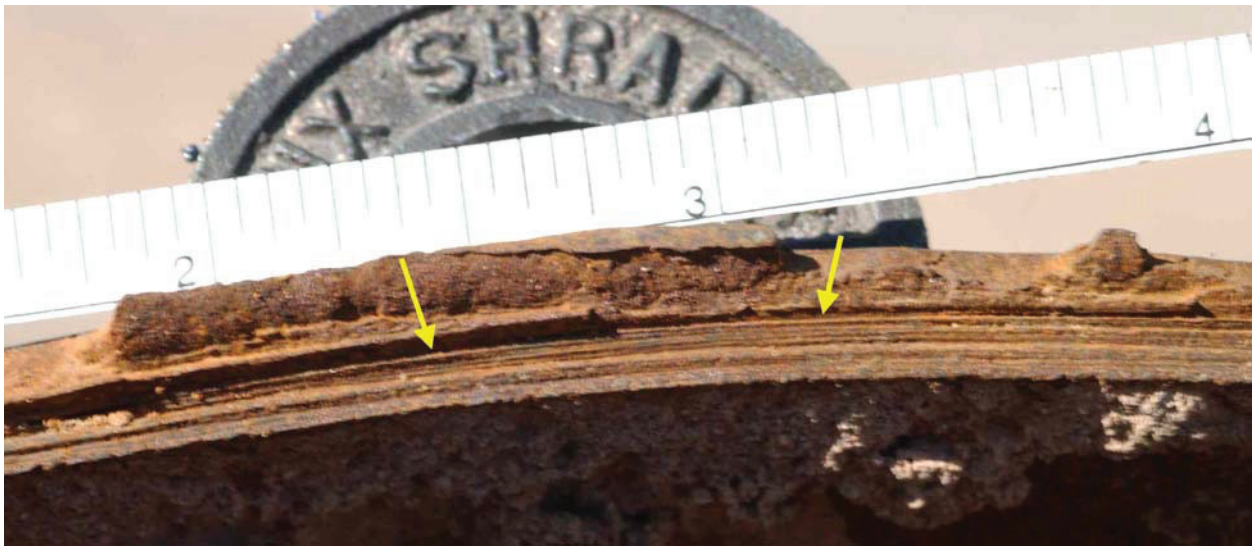
DISTRIBUTION

[redacted]

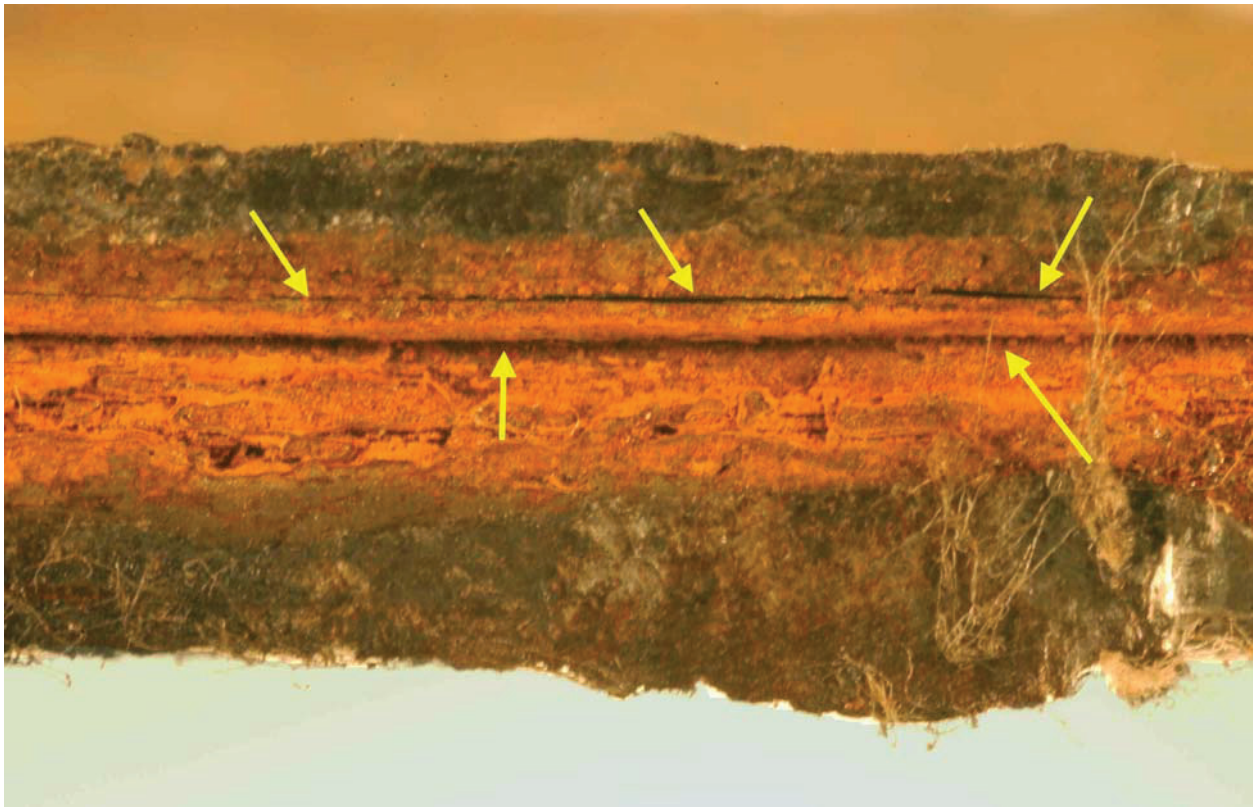
Photograph 1. Representative documentation of the hydrotest rupture at MP 493.1.



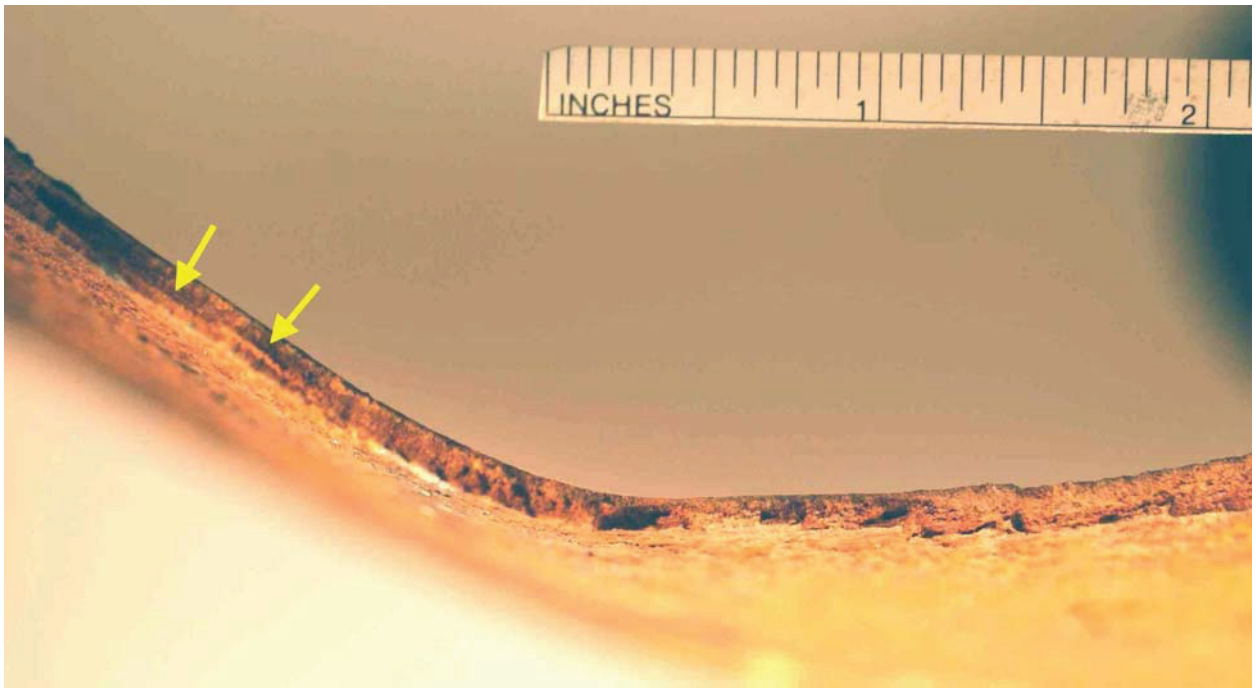
Photograph 2. A portion of the hydrotest rupture surface at MP 487.5 showing the part-wall defect (arrows).



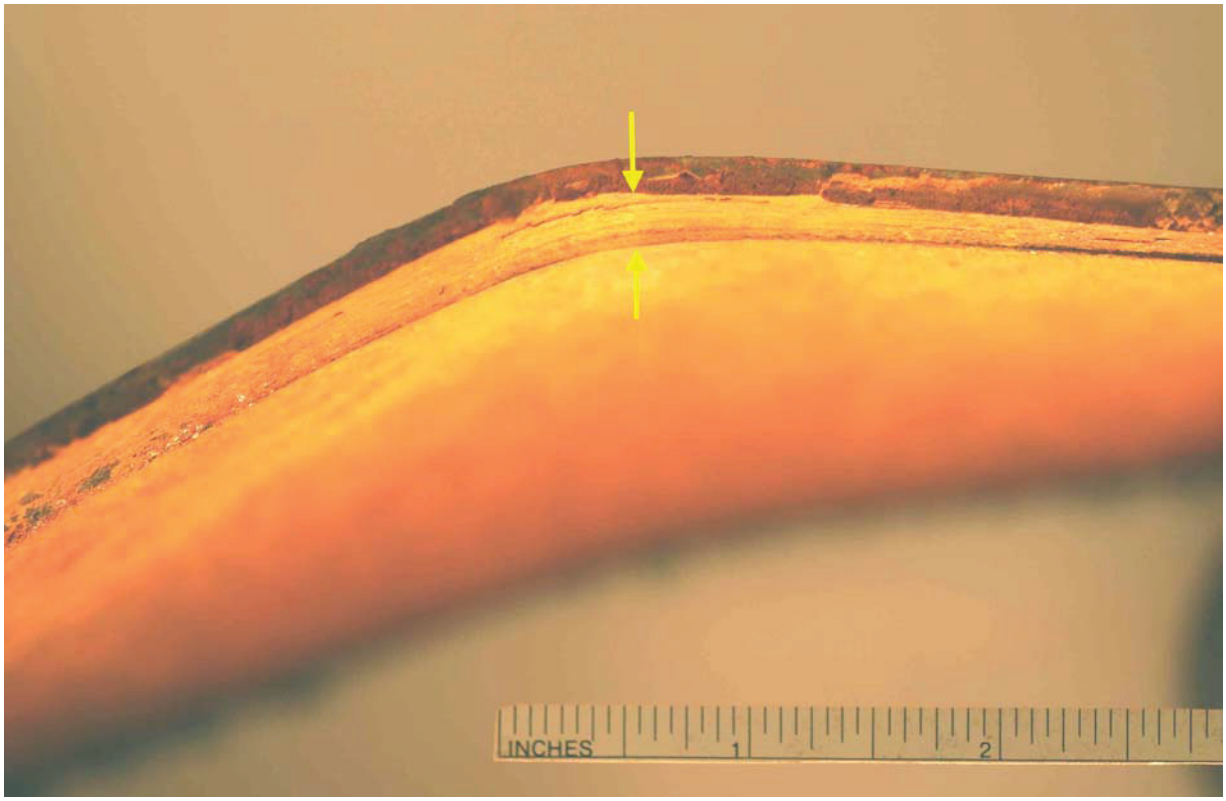
Photograph 3. Another portion of the hydrotest rupture surface at MP 487.5 showing more of the part-wall defect (arrows).



Photograph 4. A portion of the rupture surface at MP 493.1 showing the intersection of two laminations. Approximately 6X.

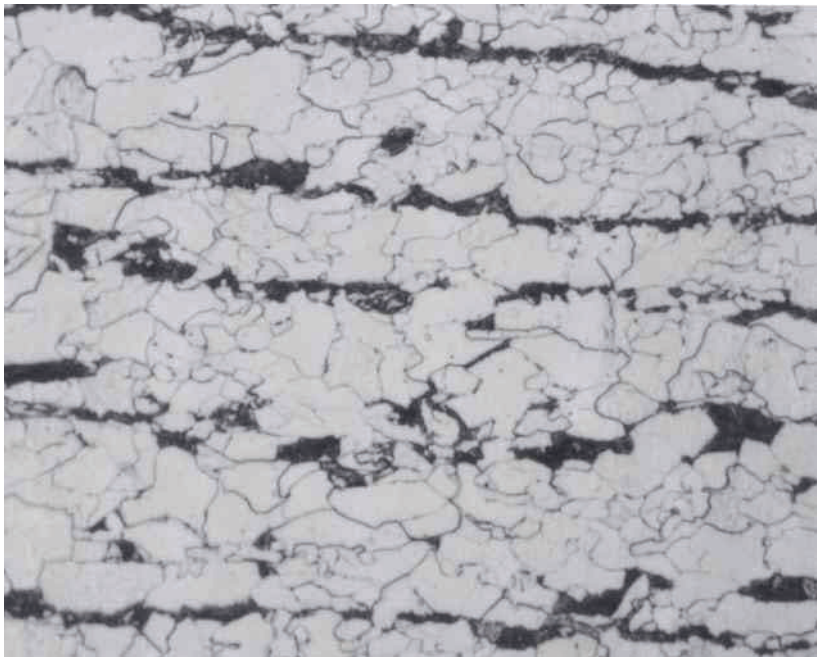


Photograph 5. A portion of the rupture surface at MP 496.9 showing significant wall loss due to external corrosion and a shallow lamination (see arrows).

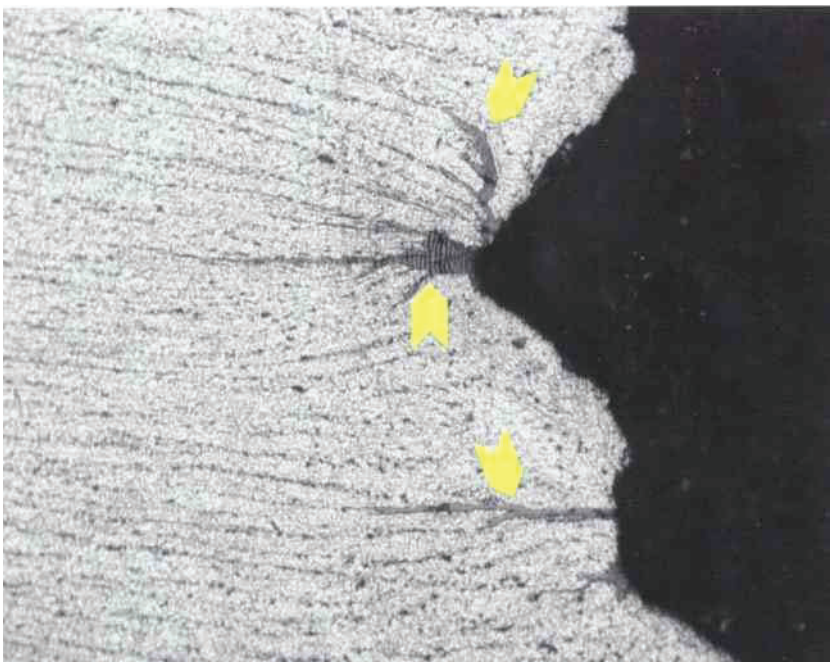


Photograph 6. A portion of the rupture surface at MP 498.6 showing exposure of the contained lamination (arrows).

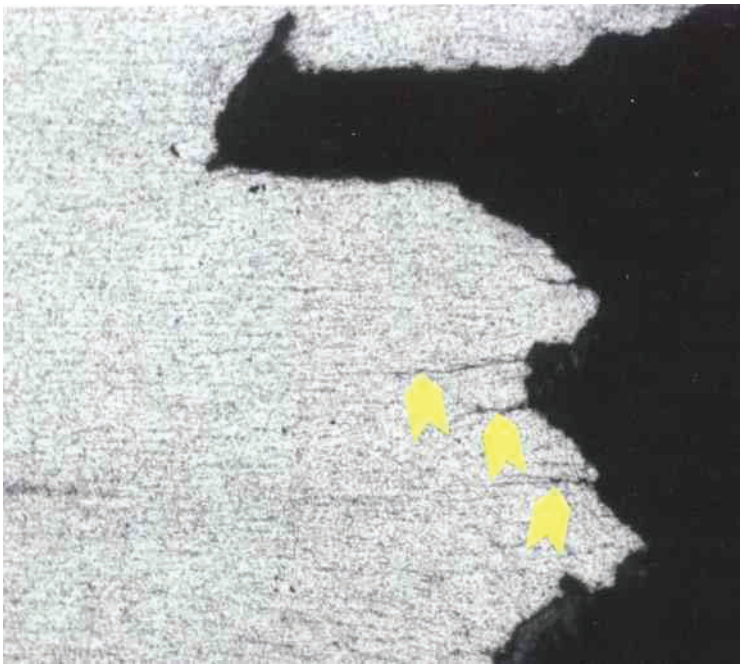
Photograph 7. Representative microstructural features of the pipe steel at MP 487.5 with fine-grained, banded ferrite and pearlite. 100X. Nital reagent.



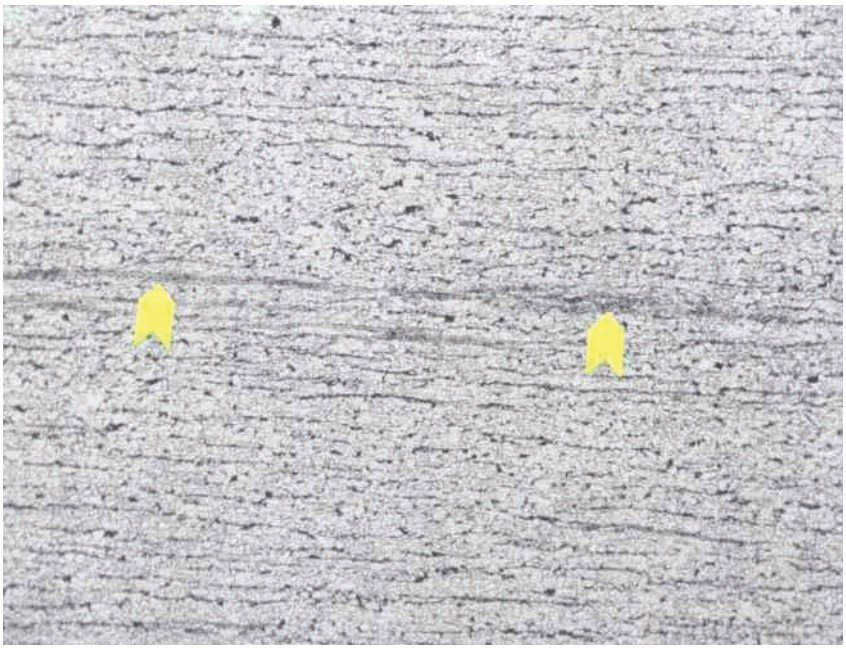
Photograph 8. A close-up of the microstructural features of the pipe steel with alternating layers of ferrite (light) and pearlite (dark). 800X. Nital reagent.



Photograph 9. Representative microstructural features of the pipe steel along the rupture interface at MP 487.5 showing the inclusion enrichment (arrows). 100X. Nital reagent.

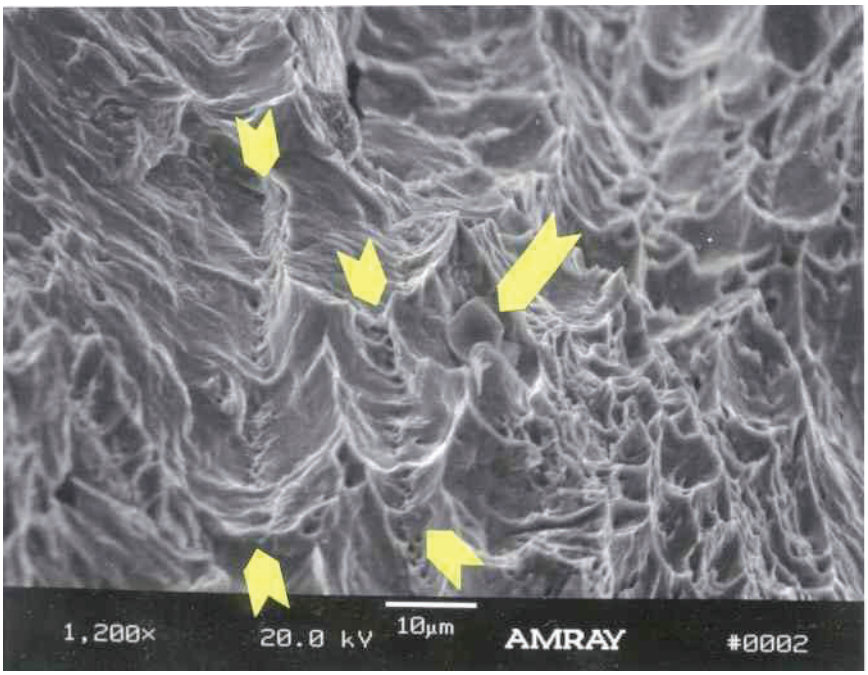


Photograph 10. More general view of the microstructural features of the pipe steel along the rupture interface at MP 487.5 showing the inclusion enrichment (arrows). 50X. Nital reagent.



Photograph 11. Representative microstructural features of the pipe steel along the rupture interface at MP 487.5 showing some minor inclusion clusters (arrows). 100X. Nital reagent.

Photograph 12. Representative microstructural features of the pipe steel at MP 496.9 OD surface corrosion in the form overlapping pits. 100X. Nital reagent.



Photograph 13. SEM fractograph showing a CaS particle (large arrow), two linear arrays of former inclusion sites (see smaller arrows), and shear fracture evidence. 1200X.

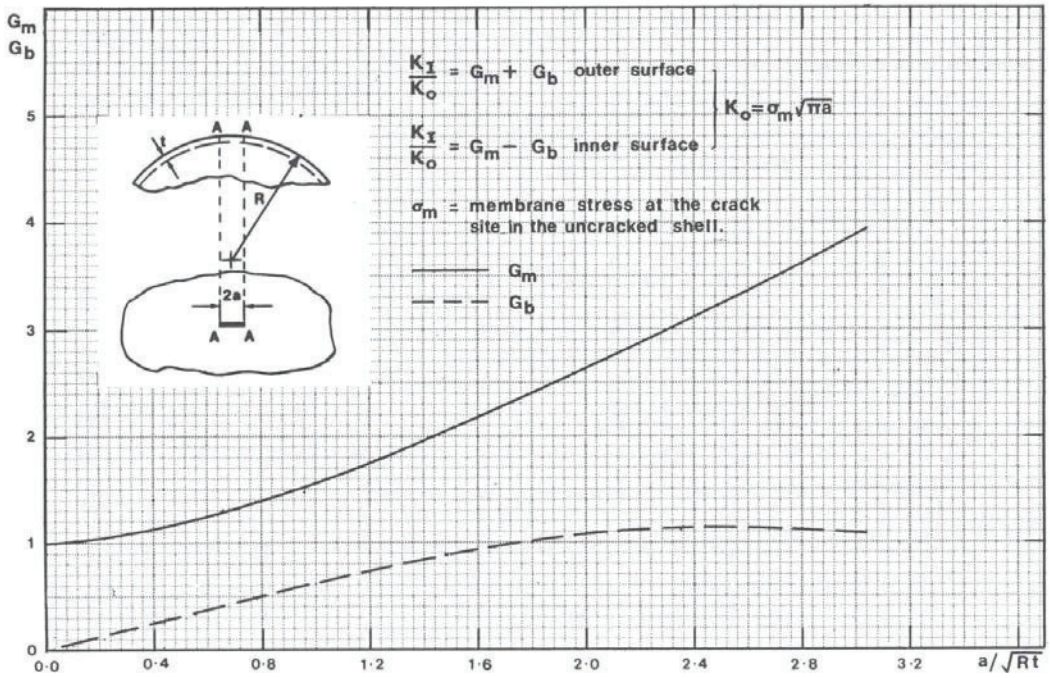


Figure 2. The stress intensity relationship for a crack in a spherical shell subjected to a uniform membrane stress. Ref: D. P. Rooke and D. J. Cartwright, Compendium of Stress Intensity Factors, Hillingdon Press, Uxbridge, 1974, p. 328.