Line 5 Straits of Mackinac (West Leg)
Enbridge Energy Limited Partnership
20 inch Crude Oil Pipeline

Executive Summary

A full survey of the Enbridge Energy Limited Partnership Line 5 Straits of Mackinac (West Leg) pipeline was successfully completed by GE Oil & Gas, PII Pipeline Solutions on the 8th of May 2008.

A total of 317 metal loss features have been detected on the inspection survey of which the deepest was 40%. These are distributed throughout the pipeline. Approximately 19% of the total number of spools have metal loss reported within them.

The majority of these are external and have the appearance of mill/manufacturing.

A CaliPPer inspection of the pipeline was completed by GE Oil & Gas, PII Pipeline Solutions on the 8th of May 2008. The CaliPPer survey information is included in this report and details of the dents identified in both inspection surveys can be found in the dent report section.

Note: The girth welds for this inspection have been matched to the previous survey performed in June of 2003 under contract number 101211_20G. Girth welds approved by Collin Taylor on the 9th of July 2008.

Analyst	Certification Level	Date Certified
Anna-Marie Lutz	L1	March 2008
Jason Fisk	L2	April 2008

We should hereby like to express our appreciation for the assistance and co-operation which we received from Enbridge Energy Limited Partnership in the course of this project.

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Central File		GE Oil & Gas, PII Pipeline Solutions	1

ENBDNR0000899

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ENBDNR0000900

Inspection Summary

This section presents a summary of inspection operation 109170_20A which was conducted for Enbridge Energy Limited Partnership in the Line 5 Straits of Mackinac (West Leg), 20 inch nominal diameter, 4.153 miles, crude oil pipeline.

The pipeline was inspected by the GE Oil & Gas, PII Pipeline Solutions magnetic inspection vehicle on the 8th of May 2008.

This is a reinspection of the pipeline with the previous inspection having been carried out by GE Oil & Gas, PII Pipeline Solutions on the 12th of June 2003.

1.1. Metal Loss

A total of 317 metal loss features have been detected on the inspection survey of which the deepest was 40%. These are distributed throughout the pipeline. Approximately 19% of the total number of spools have metal loss reported within them.

The majority of these are external and have the appearance of mill/manufacturing.

Mill/manufacturing faults will have been present in the pipeline since it was commissioned. It can be difficult to achieve the normal sizing accuracy for mill/manufacturing faults depending on whether these metal loss features are the result of hot working or cold working of the pipe steel. Consequently, it should be noted that the sizing accuracy specified for corrosion in the Inspection System Performance Specification (Appendix G) contained in the contract may not be applicable to mill/manufacturing faults.

Detailed inspection sheets for 15 of these metal loss features are provided in Section 2. Summaries of all the metal loss features are presented in Section 3.1.

1.2. Pipeline Anomalies

The following is a summary of any pipeline anomalies which have been detected on the inspection survey:

ferrous metal objects:	1
eccentric pipeline casings:	0
dents:	4
girth weld anomalies:	0
shell repairs:	0
patch repaired spools:	0

ENBDNR0000901

More information on pipeline anomalies is given in the anomaly reports presented in Sections 3.2.2 to 3.2.6.

1.3. Inspection Quality

Inspection data was obtained for the full length (4.153 miles) of the pipeline.

The quality of the inspection data is satisfactory and this has enabled a comprehensive assessment of the pipeline to be carried out.

The following is a summary of any pipeline anomalies, which have been detected on the inspection survey:

PIPELINE ANOMALIES	DATA FROM 2003	DATA FROM 2008	COMMENT
External Metal Loss	0	0	No change from previous inspection.
Internal Metal Loss	2	4	Slight change from previous inspection.
External Manufacturing Faults	186	205	Increase in the number of features reported from previous inspection.
Internal Manufacturing Faults	93	108	Increase in the number of features reported from previous inspection.
Ferrous Metal Objects	0	0	No change from previous inspection.
Eccentric Pipeline Casings	0	0	No change from previous inspection.
Dents	5	4	Minor Dent from previous inspection in GW 8290 has not been reported.
Girth Weld Anomalies	0	0	No change from previous inspection.
Shell Repairs	0	0	No change from previous inspection.
Patch Repaired Spools	0	0	No change from previous inspection.

ENBDNR0000902

Metal Loss Feature Report

The Metal Loss Feature Report provides detailed inspection sheets for selected metal loss features.

The metal loss features are selected for detailed analysis and reporting according to the selection rules given in the Specification for the Pipeline Inspection Report (Appendix F).

Those metal loss features that are reported on inspection sheets have predicted axial lengths, predicted peak depths and location details to the accuracy described in the Inspection System Performance Specification (Appendix G).

The Rupture Pressure Ratio (RPR) is calculated using the formula given in the "Reporting" section of the contract (Appendix F).

2.1. Summary Tables

This section provides a summary of the metal loss features reported on the inspection sheets.

Tables summarising the inspection sheets are provided in the following sub-sections:

2.1.1. Summary of Inspection Sheets in Distance Order

This table presents a summary of the inspection sheets with the metal loss features sorted in order of their absolute distance from the launch.

2.1.2. Summary of Inspection Sheets in Feature Selection Order

This table presents a summary of the inspection sheets with the metal loss features sorted in order of their selection rule.

2.1.1 Summary of Inspection Sheets in Distance Order

Insp. Sheet Number	Absolute Distance (feet)	Ext. or Int.	Predicted Dimensions				Pressure Ratio (RPR)	Feature Selection Rule
			Axial (in)	Circ. (in)	Depth % WT			
					Ave.	Peak		
1	51.991	Int	1.3	0.9	21	21	1.325	8
2	52.575	Int	6.6	8.6	13	20	1.235	8
3	53.645	Int	3.4	2.2	21	26	1.273	8
4	385.922	Ext	2.0	1.3	19	27	MFG	8
5	434.892	Ext	1.1	5.9	30	40	MFG	8
6	455.210	Int	1.0	0.7	32	32	MFG	8
7	1844.003	Ext	0.7	1.0	32	32	MFG	8
8	7342.247	Ext	0.7	1.0	30	30	MFG	8
9	11011.037	Ext	2.0	3.9	19	30	MFG	8
10	11223.166	Ext	5.7	2.9	18	30	MFG	8
11	13073.084	Ext	7.2	8.0	18	38	MFG	8
12	14544.846	Ext	0.6	1.0	33	33	MFG	8
13	15033.294	Ext	0.7	1.0	34	34	MFG	8
14	15118.179	Ext	0.5	1.0	33	33	MFG	8
15	15199.892	Ext	3.4	2.3	17	35	MFG	8

2.1.2 Summary of Inspection Sheets in Feature Selection Order

Insp. Sheet Number	Absolute Distance (feet)	Ext. or Int.	Predicted Dimensions				Pressure Ratio (RPR)	Feature Selection Rule
			Axial (in)	Circ. (in)	Depth % WT			
					Ave.	Peak		
3	53.645	Int	3.4	2.2	21	26	1.273	8
1	51.991	Int	1.3	0.9	21	21	1.325	8
2	52.575	Int	6.6	8.6	13	20	1.235	8
5	434.892	Ext	1.1	5.9	30	40	MFG	8
11	13073.084	Ext	7.2	8.0	18	38	MFG	8
15	15199.892	Ext	3.4	2.3	17	35	MFG	8
13	15033.294	Ext	0.7	1.0	34	34	MFG	8
12	14544.846	Ext	0.6	1.0	33	33	MFG	8
14	15118.179	Ext	0.5	1.0	33	33	MFG	8
6	455.210	Int	1.0	0.7	32	32	MFG	8
7	1844.003	Ext	0.7	1.0	32	32	MFG	8
8	7342.247	Ext	0.7	1.0	30	30	MFG	8
9	11011.037	Ext	2.0	3.9	19	30	MFG	8
10	11223.166	Ext	5.7	2.9	18	30	MFG	8
4	385.922	Ext	2.0	1.3	19	27	MFG	8

2.2. Inspection Sheets

This section provides detailed inspection sheets for selected metal loss features.

The metal loss features are selected for detailed analysis and reporting according to the selection rules specified in the Specification for the Pipeline Inspection Report (Appendix F).

Those metal loss features that are reported on inspection sheets have predicted axial lengths, predicted peak depths and location details to the accuracy described in the Inspection System Performance Specification (Appendix G).

2.2.1. Structure of the Inspection Sheet

Each inspection sheet provides information on the location and predicted dimensions of one metal loss feature.

The inspection sheet consists of three areas:

Feature Description

This section of the inspection sheet provides specific details about the metal loss feature.

Feature Location

This section of the inspection sheet provides information that will enable the metal loss feature to be located for excavation. Wherever possible, the position of the metal loss feature is related to reference points that can easily be identified and located from the surface.

Schematic Location Summary

This provides a schematic diagram of the pipeline within the vicinity of the metal loss feature.

The diagram represents five pipe spools, the spool containing the metal loss feature and two spools either side. The girth weld numbers, spool lengths and seam weld orientations, as viewed in the direction of flow, are also given on the diagram. For spiral welded pipe the seam weld orientation at each girth weld will be provided.

2.2.2. Pictorial Representation

Accompanying each inspection sheet are two pictorial representations of the magnetic response derived from the reported metal loss feature.

In both cases the metal loss feature is as viewed from outside the pipe with the upstream end being on the left. The vertical (y) axis is annotated with o'clock orientation as viewed in the

direction of flow (at the time of the inspection). The horizontal (x) axis is annotated with the absolute distance measured from the launch.

The monochrome plot (the Overview Plot) shows the magnetic response in the context of the full circumference of the pipe. In order to assist the Client in identifying the areas of metal loss, it is shaded as if illuminated from the left hand side of the plot.

The colour plot (the Detail Contour Plot) is approximately centred on the area of the pipeline in which the reported metal loss feature is located, and identifies the relative magnitudes of the magnetic responses in this area. The magnitude of change in the magnetic responses is represented by designated colours, with like magnitudes having common colours. Due to the behaviour of this magnetic response, the colour plot will not normally provide a true representation of the physical profile of the reported metal loss feature.

2.2.3. Inspection Sheets 1 to 15

Inspection sheets 1 to 15 are presented on the following pages.

Inspection Sheet Number 1 — 109170_20A

Feature Description

Type:	Internal Metal Loss
Orientation:	06:45 (o'clock)
Axial length:	1.3 in
Circumferential width:	0.9 in
Depth - Peak:	21% WT
- Average:	21% WT
Pressure Ratio (RPR):	1.325
Feature Selection Rule:	8
Nominal Pipe wall thickness for spool:	0.812 in
Absolute Distance from Launch:	51.991 feet

Comments:

This metal loss feature has the appearance of corrosion.

There are other metal loss features within this spool.
More information on these features is given in the Pipeline Listing.

Feature Location

Primary Reference/s:

1. VALVE MP 1475.6
   (Girth Weld 30 + 1.755ft)

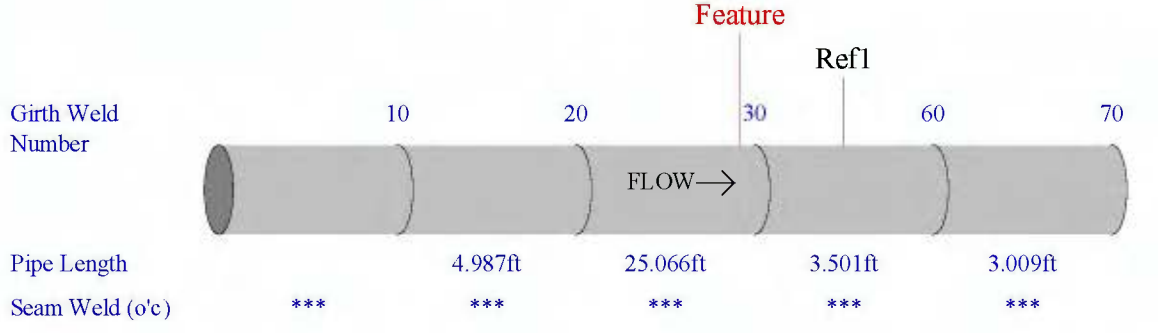
Reference Girth Weld:

The upstream reference girth weld of the feature spool is number 20.
The location of this weld is 26.821 feet upstream from reference 1.

Feature:

The feature is located 22.923 feet downstream from the reference girth weld.

Schematic Location Summary:

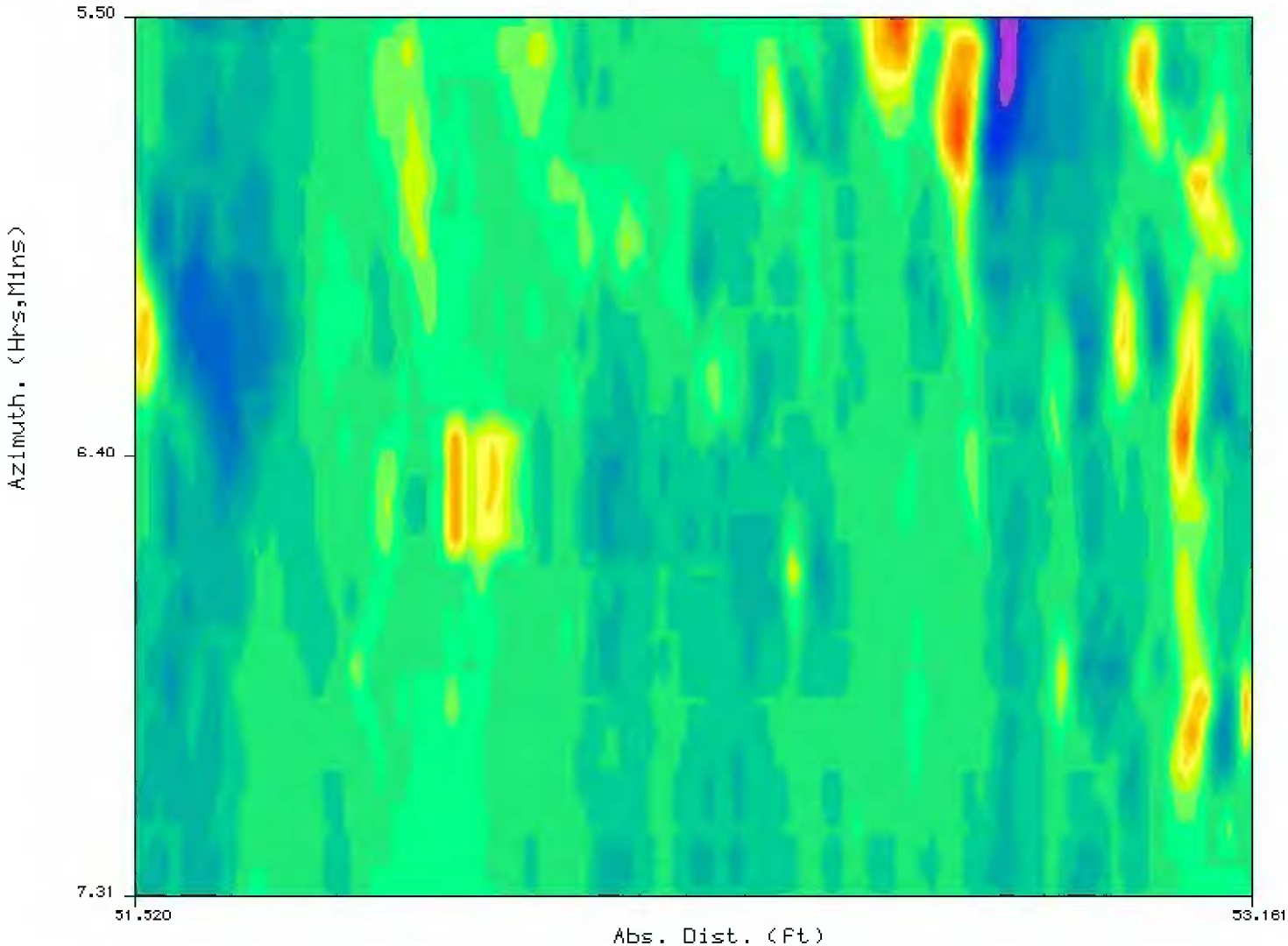


← **Straits of Mackinac (West Leg)** →

*** - seam weld not clearly identifiable in the data


Feature 1 Overview Plot 109170_20A
1.05
7.06
1.12
Azimuth (Hrs,Mins)
.113
Abs. Dist. (Ft)

Feature 1 Detail Contour Plot 109170_20A



Inspection Sheet Number 2 — 109170_20A

Feature Description

Type:	Internal Metal Loss
Orientation:	06:15 (o'clock)
Axial length:	6.6 in
Circumferential width:	8.6 in
Depth - Peak:	20% WT
- Average:	13% WT
Pressure Ratio (RPR):	1.235
Feature Selection Rule:	8
Nominal Pipe wall thickness for spool:	0.812 in
Absolute Distance from Launch:	52.575 feet

Comments:

This metal loss feature has the appearance of corrosion.
This feature has the lowest calculated RPR value of all the metal loss features detected along the pipeline.
There are other metal loss features within this spool.
More information on these features is given in the Pipeline Listing.

Feature Location

Primary Reference/s:

1. VALVE MP 1475.6
   (Girth Weld 30 + 1.755ft)

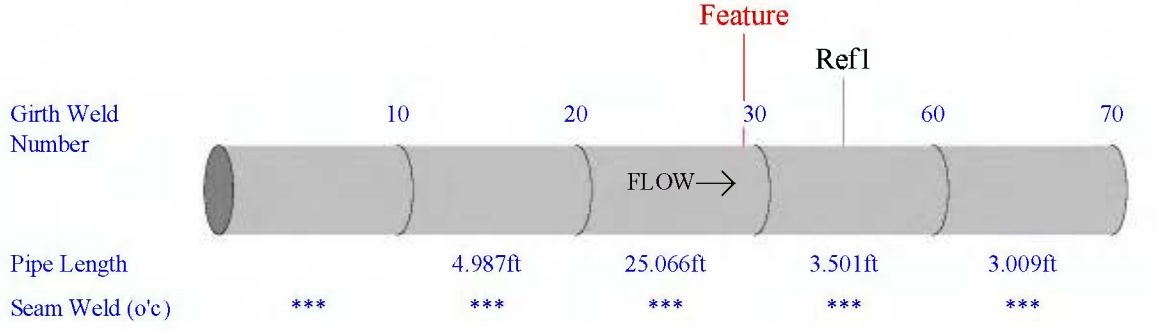
Reference Girth Weld:

The upstream reference girth weld of the feature spool is number 20.
The location of this weld is 26.821 feet upstream from reference 1.

Feature:

The feature is located 23.507 feet downstream from the reference girth weld.

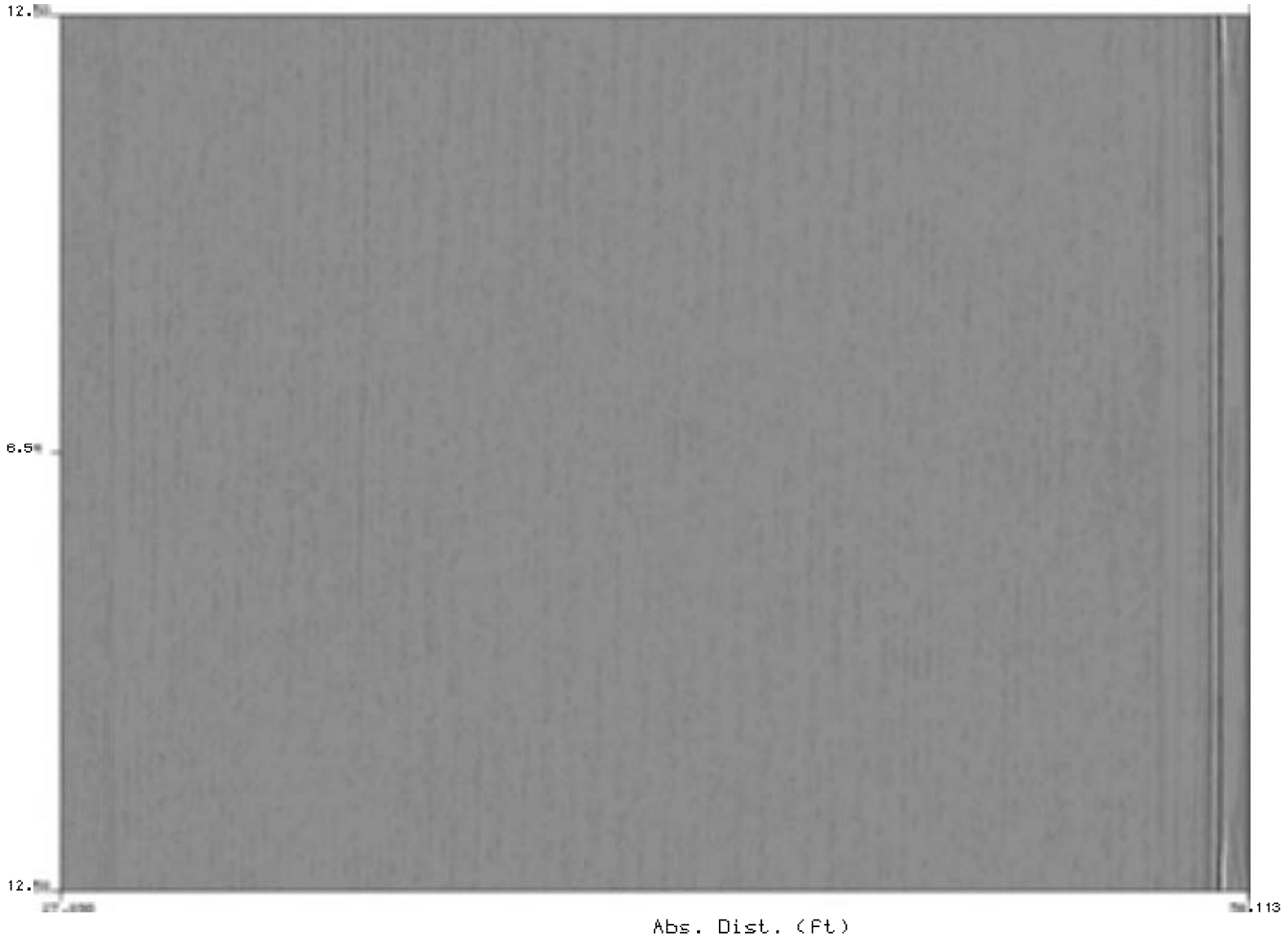
Schematic Location Summary:



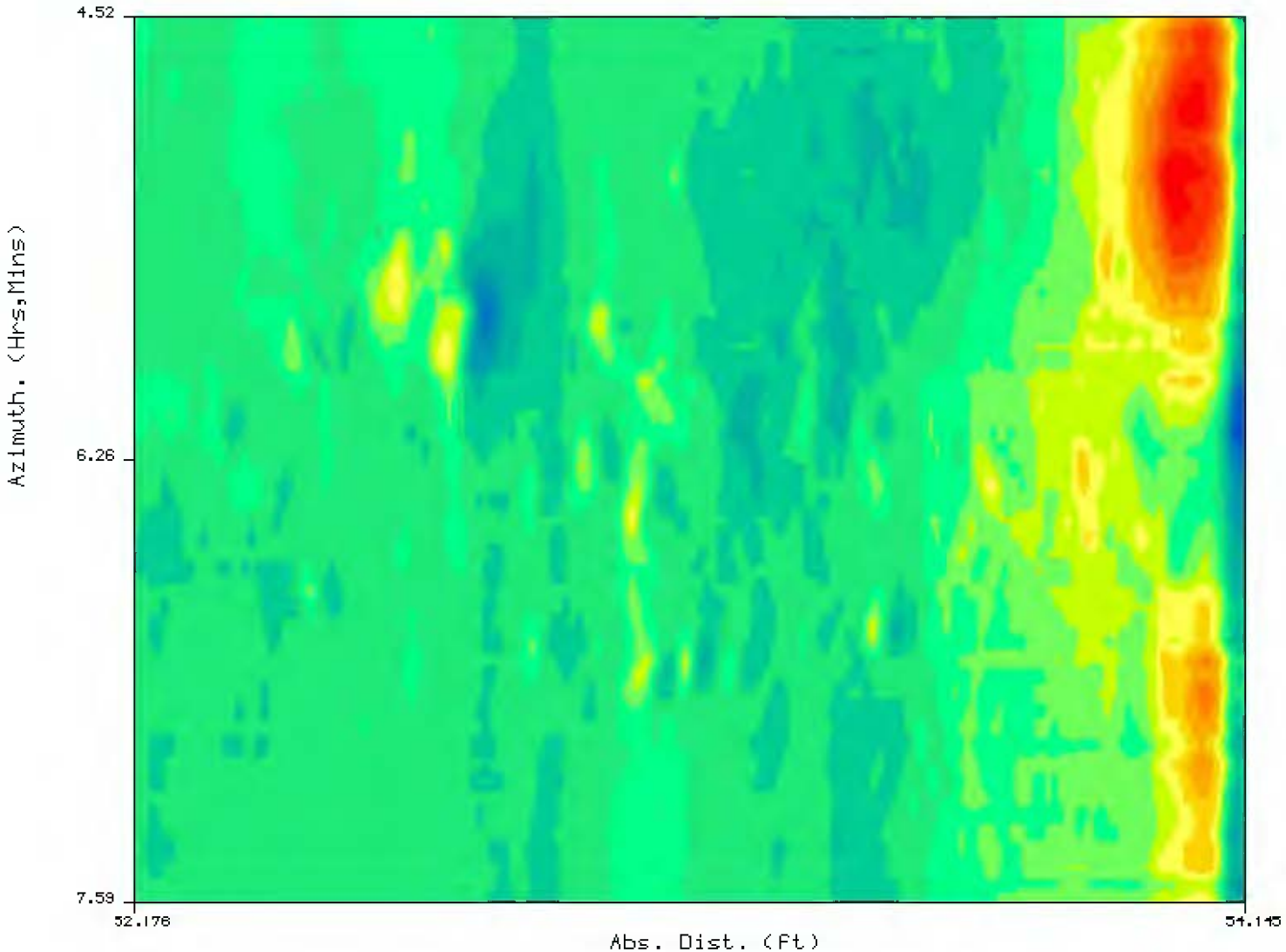
← **Straits of Mackinac (West Leg)** →

*** - seam weld not clearly identifiable in the data

Feature 2 Overview Plot 109170_20A



Feature 2 Detail Contour Plot 109170_20A



Inspection Sheet Number 3 — 109170_20A

Feature Description

Type:	Internal Metal Loss
Orientation:	06:15 (o'clock)
Axial length:	3.4 in
Circumferential width:	2.2 in
Depth - Peak:	26% WT
- Average:	21% WT
Pressure Ratio (RPR):	1.273
Feature Selection Rule:	8
Nominal Pipe wall thickness for spool:	0.812 in
Absolute Distance from Launch:	53.645 feet

Comments:

This metal loss feature has the appearance of corrosion.

There are other metal loss features within this spool.
More information on these features is given in the Pipeline Listing.

Feature Location

Primary Reference/s:

1. VALVE MP 1475.6
   (Girth Weld 30 + 1.755ft)

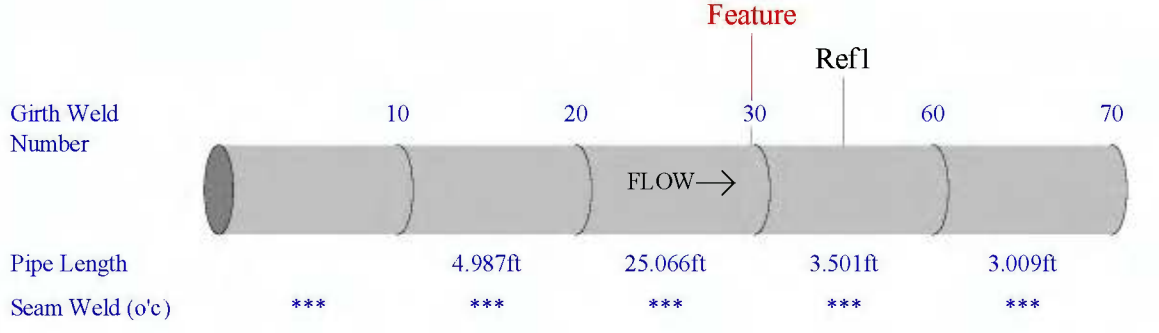
Reference Girth Weld:

The upstream reference girth weld of the feature spool is number 20.
The location of this weld is 26.821 feet upstream from reference 1.

Feature:

The feature is located 24.577 feet downstream from the reference girth weld.

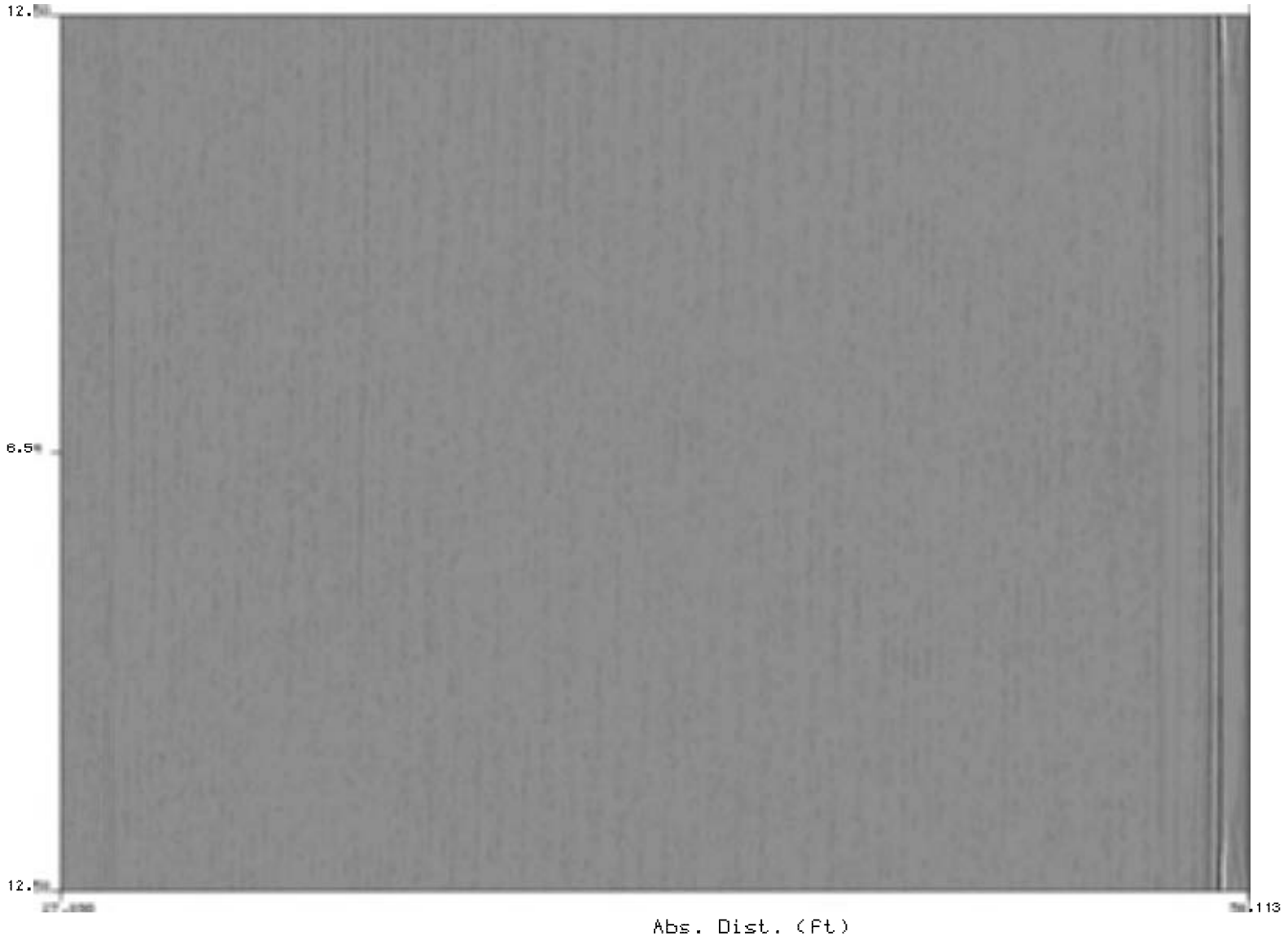
Schematic Location Summary:

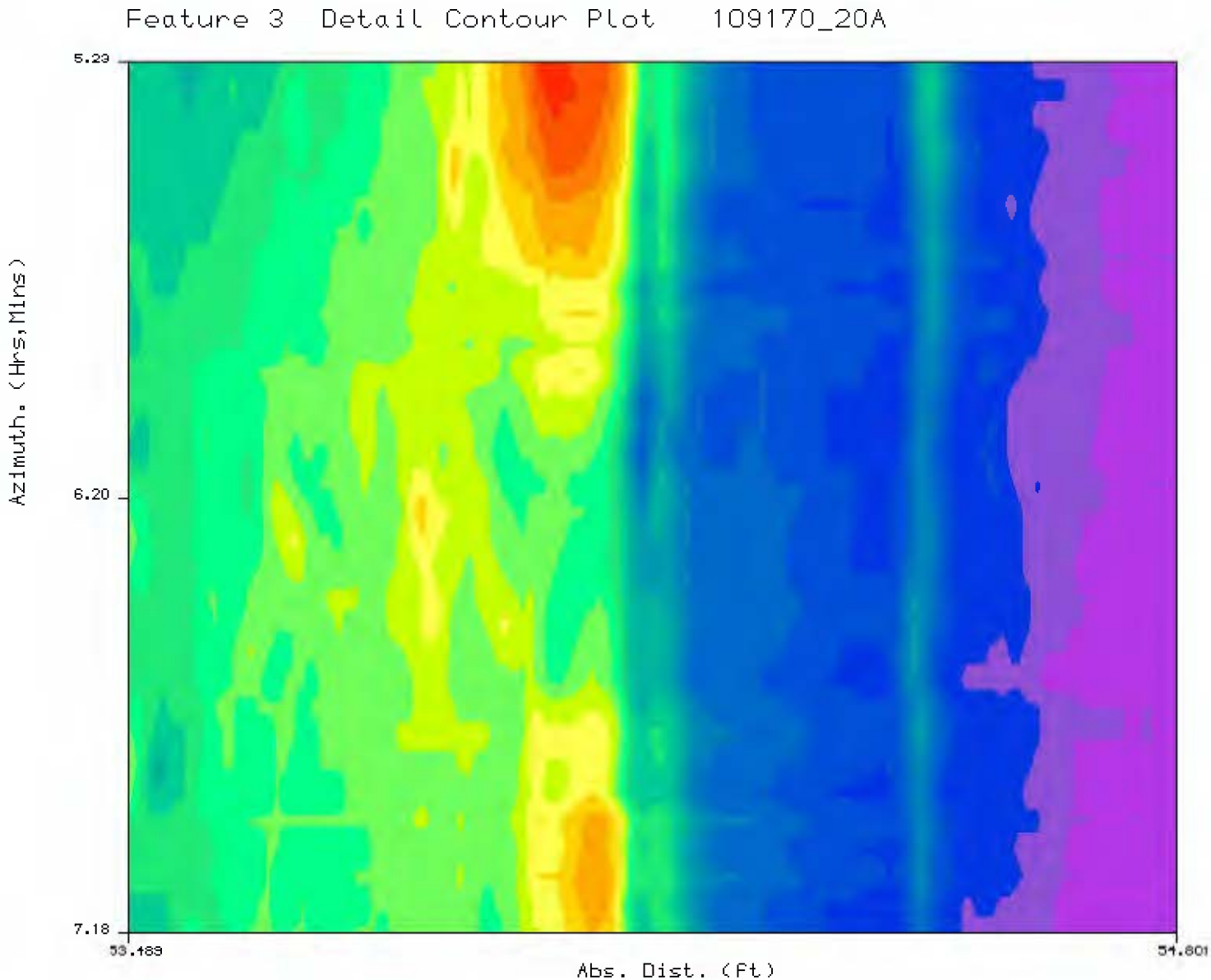


← **Straits of Mackinac (West Leg)** →

*** - seam weld not clearly identifiable in the data

Feature 3 Overview Plot 109170_20A




Feature 3 Detail Contour Plot 109170_20A
5.29
6.20
7.18
Azimuth. (Hrs,Mins)
53.469
54.801
Abs. Dist. (Ft)

Inspection Sheet Number 4 — 109170_20A

Feature Description

Type:	External Mill/Manufacturing Fault
Orientation:	05:45 (o'clock)
Axial length:	2.0 in
Circumferential width:	1.3 in
Depth - Peak:	27% WT
- Average:	19% WT
Feature Selection Rule:	8
Nominal Pipe wall thickness for spool:	0.812 in
Absolute Distance from Launch:	385.922 feet

Comments:

This metal loss feature has the appearance of a mill/manufacturing fault.

Feature Location

Primary Reference/s:

1. VALVE MP 1475.6
   (Girth Weld 30 + 1.755ft)

2. VALVE MP 1479.5
   (Girth Weld 8590 + 1.742ft)

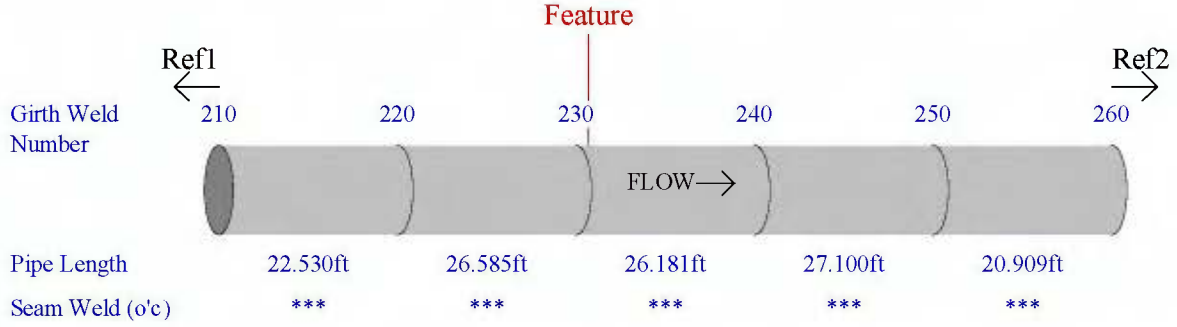
Reference Girth Weld:

The upstream reference girth weld of the feature spool is number 230.
The location of this weld is 328.317 feet downstream from reference 1 and 21485.886 feet upstream from reference 2.

Feature:

The feature is located 1.716 feet downstream from the reference girth weld.

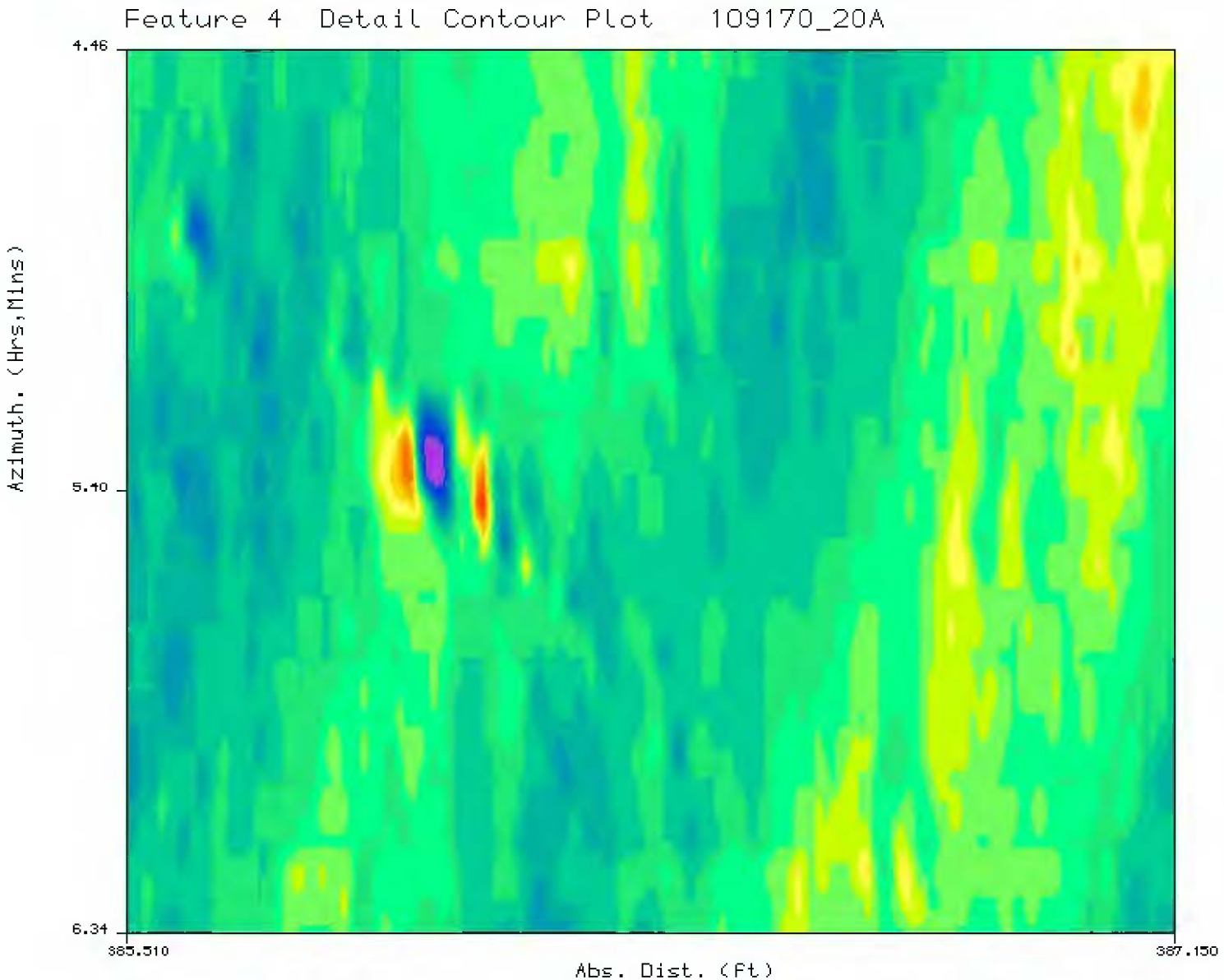
Schematic Location Summary:



← **Straits of Mackinac (West Leg)** →

*** - seam weld not clearly identifiable in the data


Feature 4 Overview Plot 109170_20A
Azimuth (Hrs,Mins)
Abs. Dist. (Ft)


Feature 4 Detail Contour Plot 109170_20A
4.46
5.40
6.34
Azimuth. (Hrs,Mins)
385.510
387.150
Abs. Dist. (Ft)

Inspection Sheet Number 5 — 109170_20A

Feature Description

Type:	External Mill/Manufacturing Fault
Orientation:	11:00 (o'clock)
Axial length:	1.1 in
Circumferential width:	5.9 in
Depth - Peak:	40% WT
- Average:	30% WT
Feature Selection Rule:	8
Nominal Pipe wall thickness for spool:	0.812 in
Absolute Distance from Launch:	434.892 feet

Comments:

This metal loss feature has the appearance of a mill/manufacturing fault.
This is the deepest feature within the pipeline.

Feature Location

Primary Reference/s:

1. VALVE MP 1475.6
   (Girth Weld 30 + 1.755ft)

2. VALVE MP 1479.5
   (Girth Weld 8590 + 1.742ft)

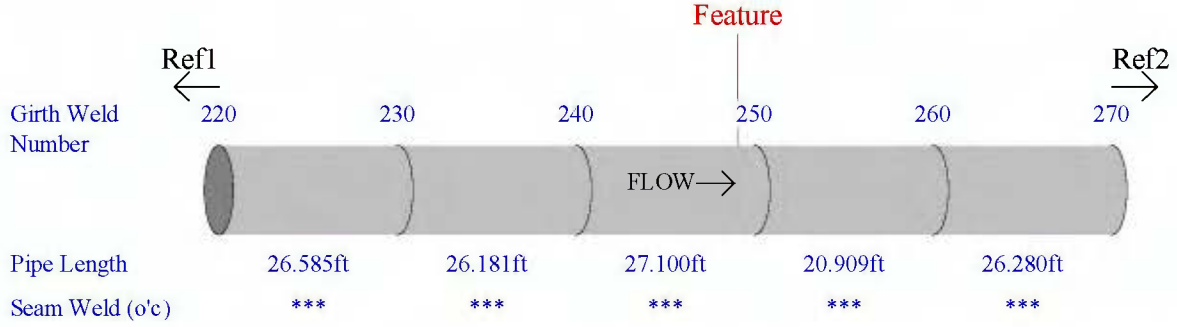
Reference Girth Weld:

The upstream reference girth weld of the feature spool is number 240.
The location of this weld is 354.501 feet downstream from reference 1 and 21459.701 feet upstream from reference 2.

Feature:

The feature is located 24.501 feet downstream from the reference girth weld.

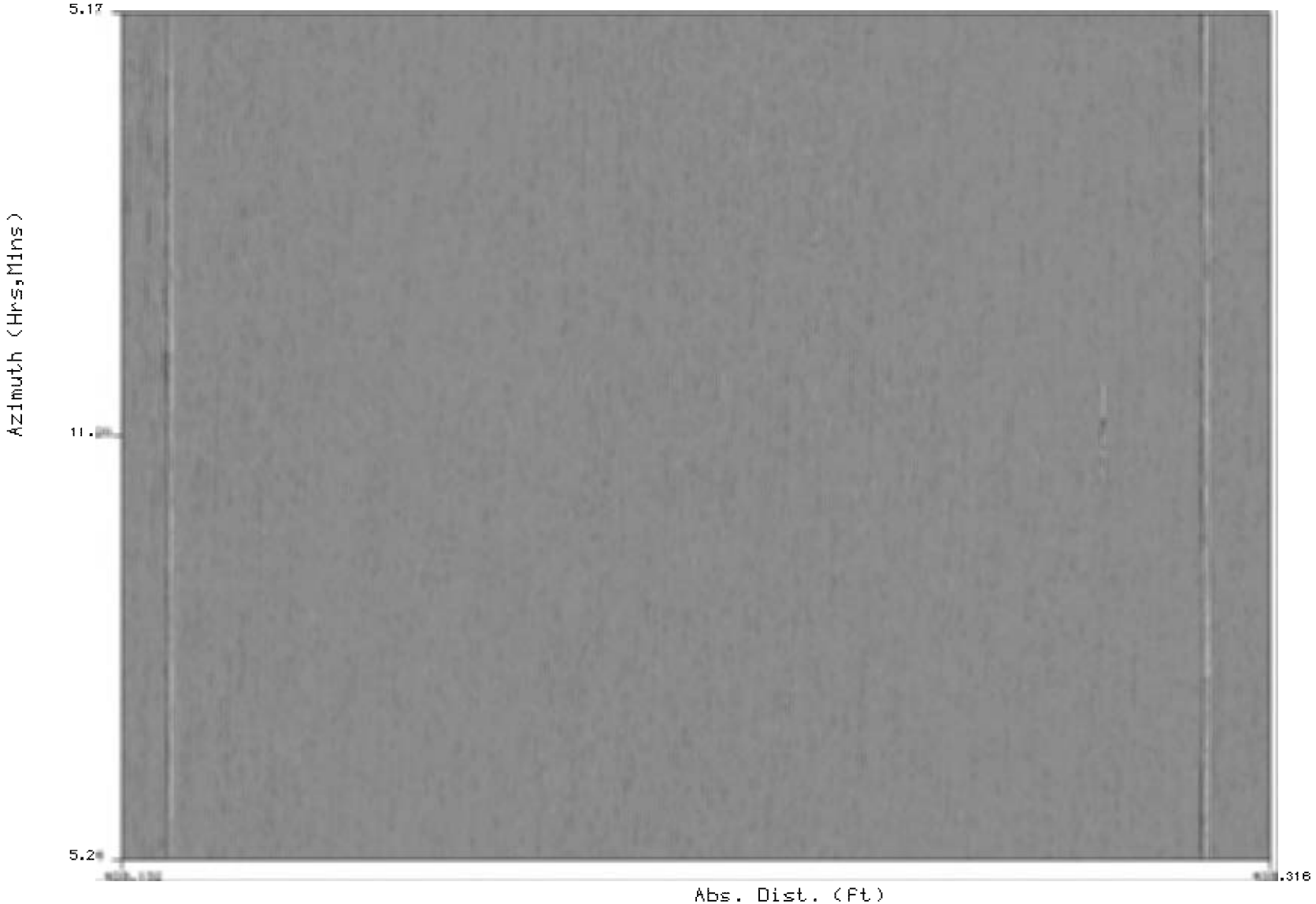
Schematic Location Summary:

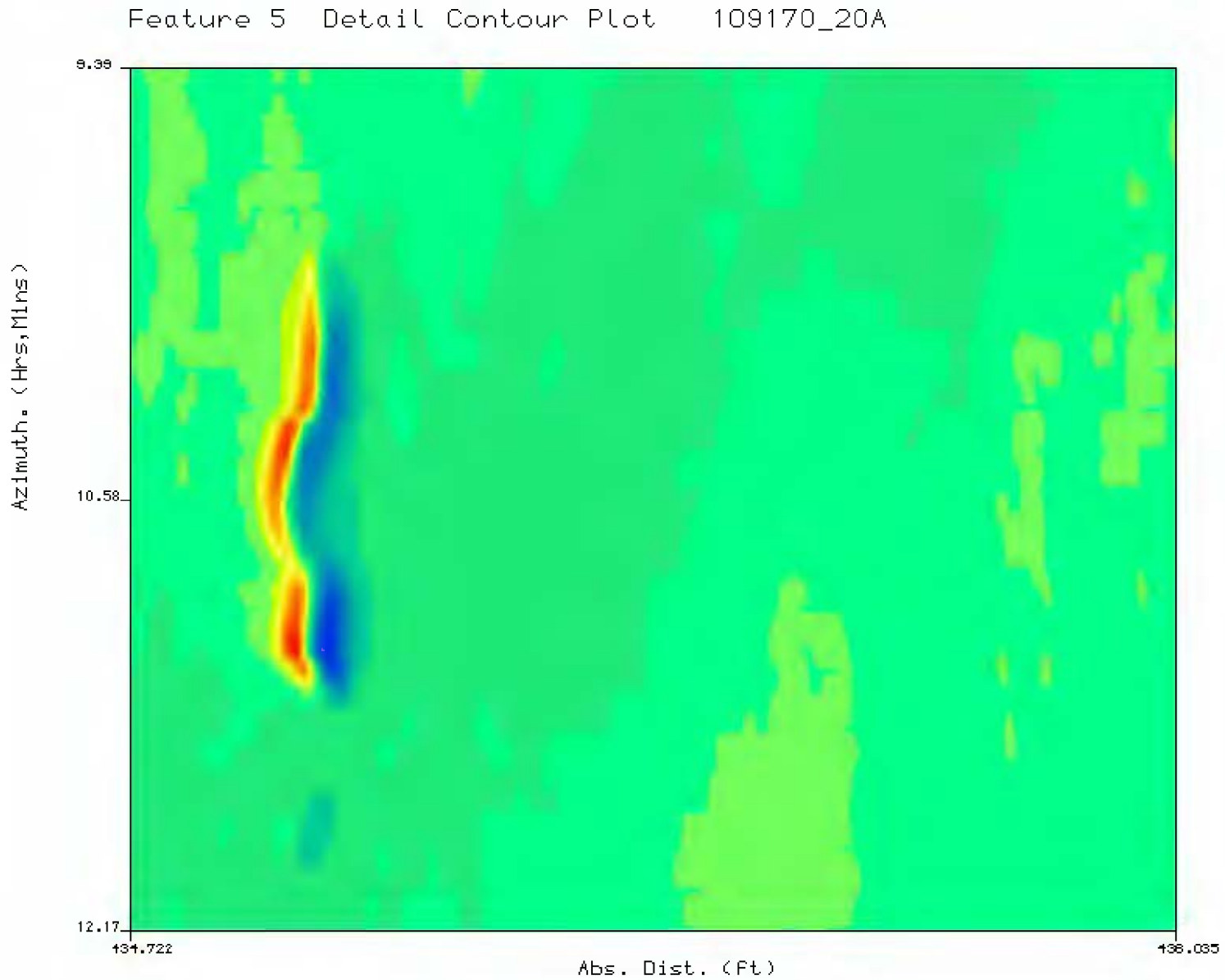


← **Straits of Mackinac (West Leg)** →

*** - seam weld not clearly identifiable in the data

Feature 5 Overview Plot 109170_20A




Feature 5 Detail Contour Plot 109170_20A
9.39
10.58
12.17
Azimuth. (Hrs,Mins)
434.722
436.035
Abs. Dist. (Ft)

Inspection Sheet Number 6 — 109170_20A

Feature Description

Type:	Internal Mill/Manufacturing Fault
Orientation:	10:45 (o'clock)
Axial length:	1.0 in
Circumferential width:	0.7 in
Depth - Peak:	32% WT
- Average:	32% WT
Feature Selection Rule:	8
Nominal Pipe wall thickness for spool:	0.812 in
Absolute Distance from Launch:	455.210 feet

Comments:

This metal loss feature has the appearance of a mill/manufacturing fault.

Feature Location

Primary Reference/s:

1. VALVE MP 1475.6
   (Girth Weld 30 + 1.755ft)

2. VALVE MP 1479.5
   (Girth Weld 8590 + 1.742ft)

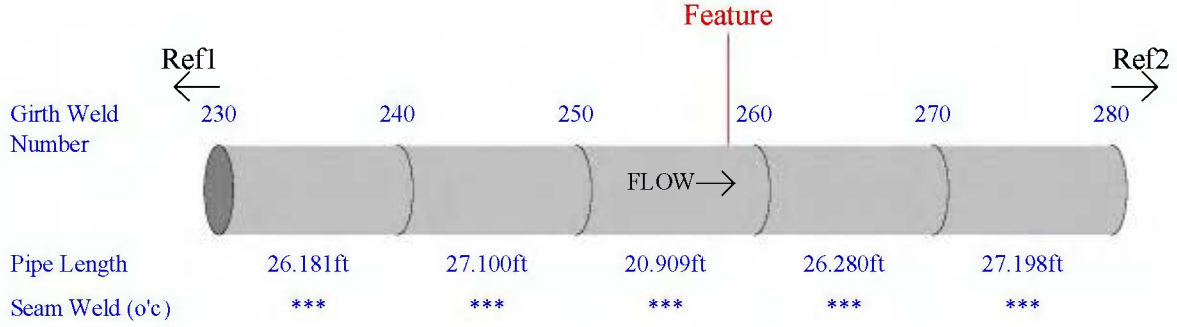
Reference Girth Weld:

The upstream reference girth weld of the feature spool is number 250.
The location of this weld is 381.601 feet downstream from reference 1 and 21432.602 feet upstream from reference 2.

Feature:

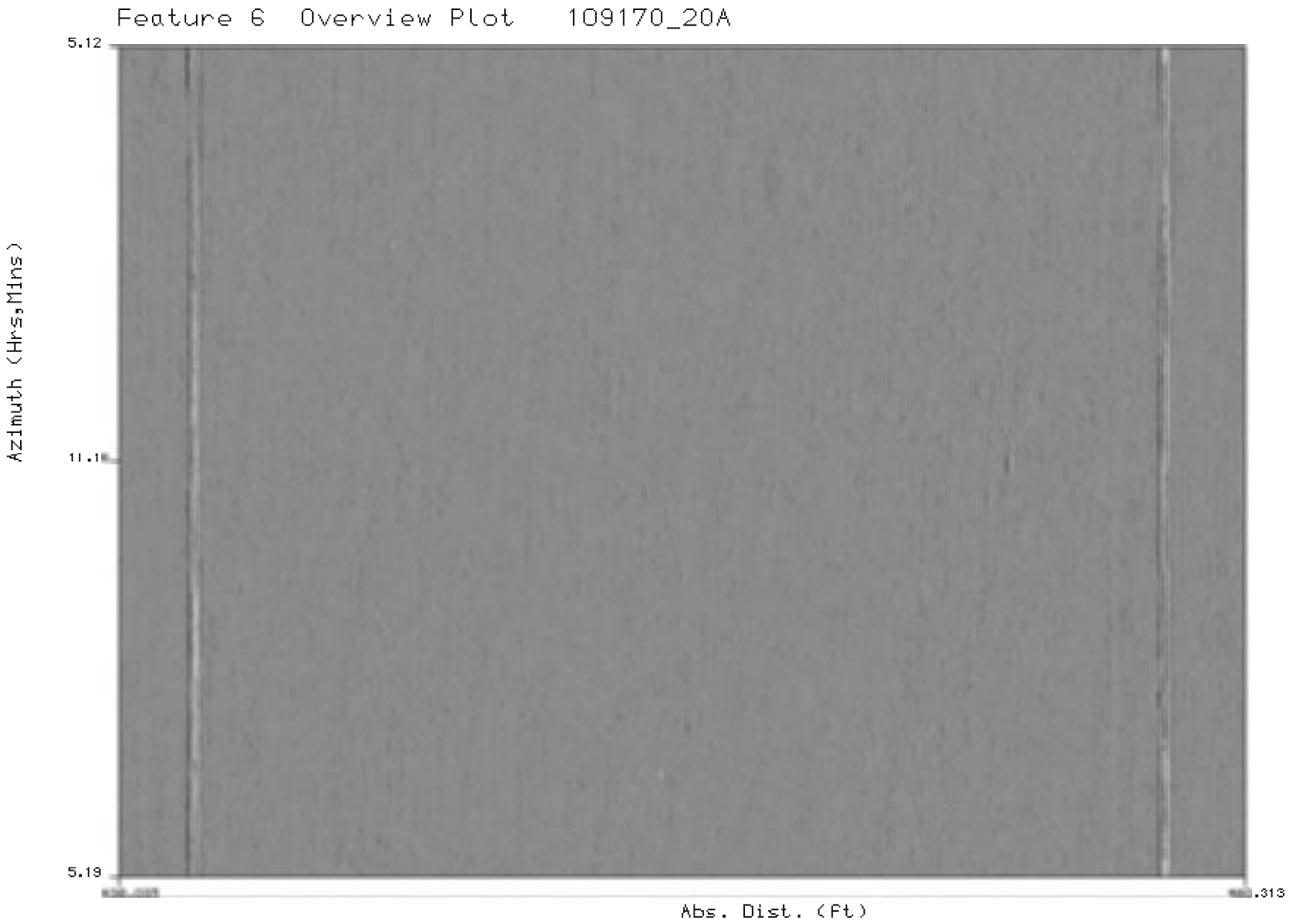
The feature is located 17.720 feet downstream from the reference girth weld.

Schematic Location Summary:

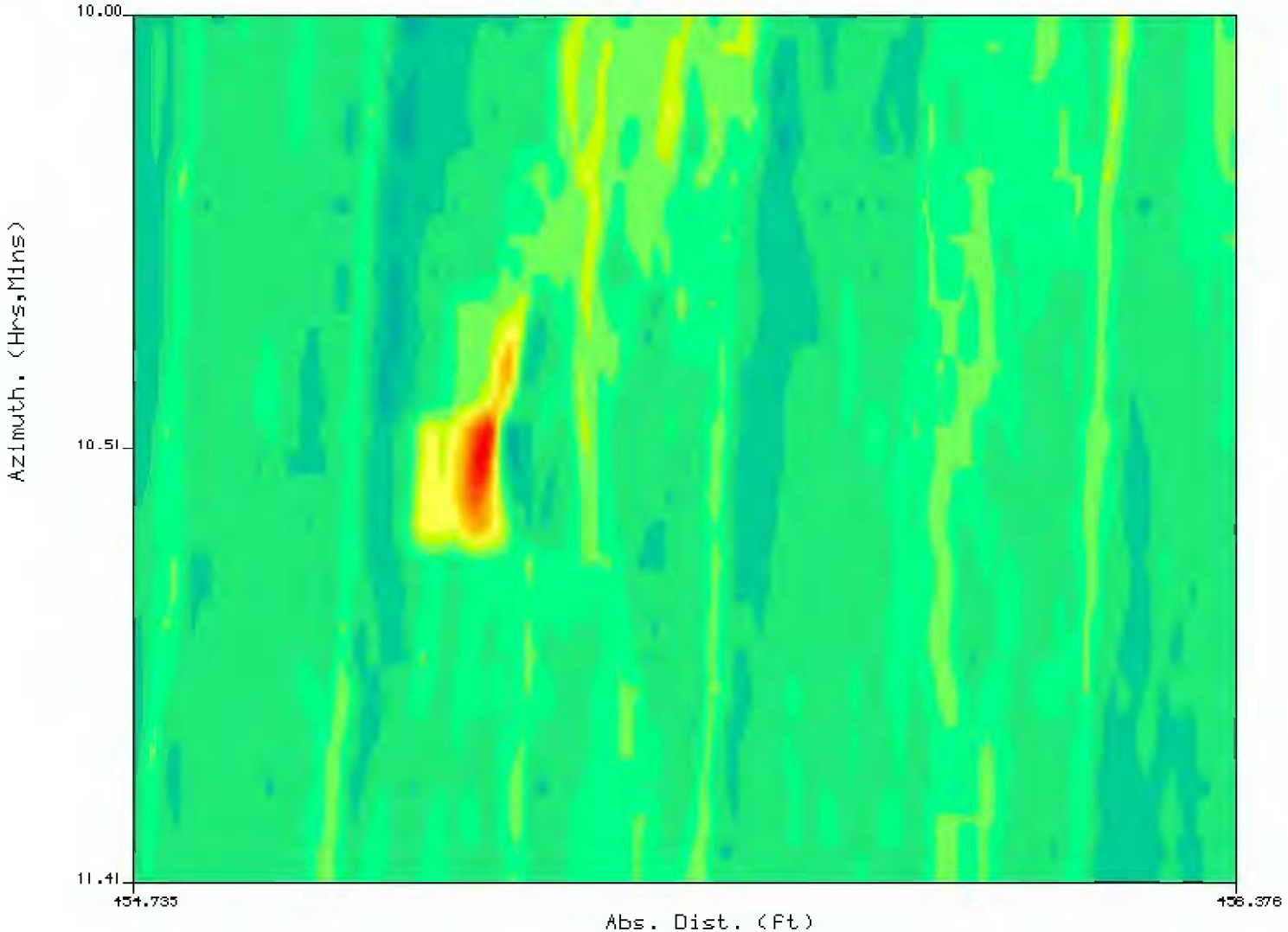


← **Straits of Mackinac (West Leg)** →

*** - seam weld not clearly identifiable in the data


Feature 6 Overview Plot 109170_20A
5.12
11.1
5.19
Azimuth (Hrs,Mins)
.313
Abs. Dist. (Ft)

Feature 6 Detail Contour Plot 109170_20A



Inspection Sheet Number 7 — 109170_20A

Feature Description

Type:	External Mill/Manufacturing Fault
Orientation:	07:45 (o'clock)
Axial length:	0.7 in
Circumferential width:	1.0 in
Depth - Peak:	32% WT
- Average:	32% WT
Feature Selection Rule:	8
Nominal Pipe wall thickness for spool:	0.812 in
Absolute Distance from Launch:	1844.003 feet

Comments:

This metal loss feature has the appearance of a mill/manufacturing fault.

Feature Location

Primary Reference/s:

1. VALVE MP 1475.6
   (Girth Weld 30 + 1.755ft)

2. VALVE MP 1479.5
   (Girth Weld 8590 + 1.742ft)

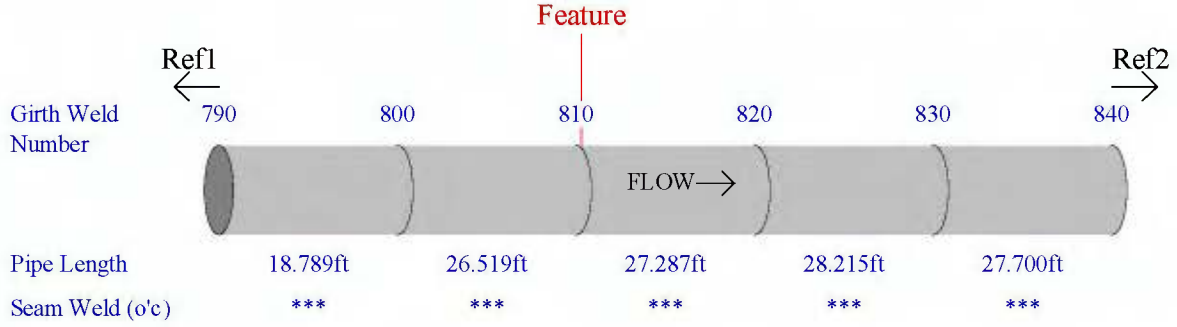
Reference Girth Weld:

The upstream reference girth weld of the feature spool is number 810.
The location of this weld is 1787.267 feet downstream from reference 1 and 20026.936 feet upstream from reference 2.

Feature:

The feature is located 0.846 feet downstream from the reference girth weld.

Schematic Location Summary:

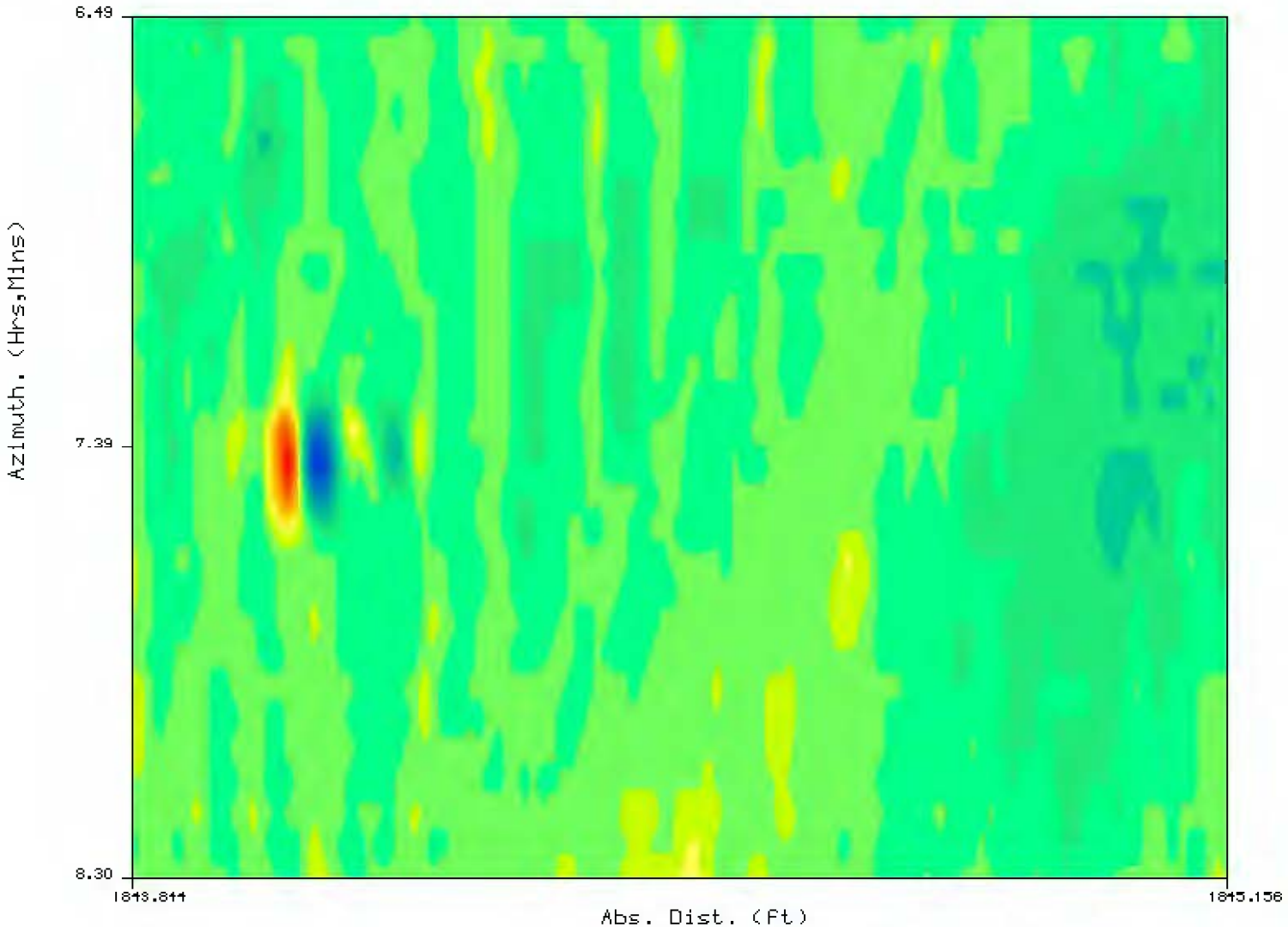


← **Straits of Mackinac (West Leg)** →

*** - seam weld not clearly identifiable in the data


Feature 7 Overview Plot 109170_20A
1.41
7.45
1.49
Azimuth (Hrs,Mins)
.388
Abs. Dist. (Ft)

Feature 7 Detail Contour Plot 109170_20A



Inspection Sheet Number 8 — 109170_20A

Feature Description

Type:	External Mill/Manufacturing Fault
Orientation:	02:15 (o'clock)
Axial length:	0.7 in
Circumferential width:	1.0 in
Depth - Peak:	30% WT
- Average:	30% WT
Feature Selection Rule:	8
Nominal Pipe wall thickness for spool:	0.812 in
Absolute Distance from Launch:	7342.247 feet

Comments:

This metal loss feature has the appearance of a mill/manufacturing fault.

Feature Location

Primary Reference/s:

1. VALVE MP 1475.6
   (Girth Weld 30 + 1.755ft)

2. VALVE MP 1479.5
   (Girth Weld 8590 + 1.742ft)

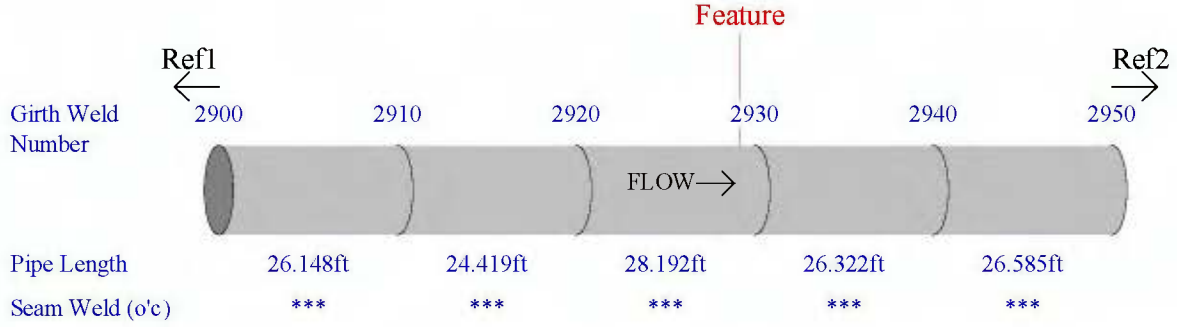
Reference Girth Weld:

The upstream reference girth weld of the feature spool is number 2920.
The location of this weld is 7260.538 feet downstream from reference 1 and 14553.665 feet upstream from reference 2.

Feature:

The feature is located 25.820 feet downstream from the reference girth weld.

Schematic Location Summary:

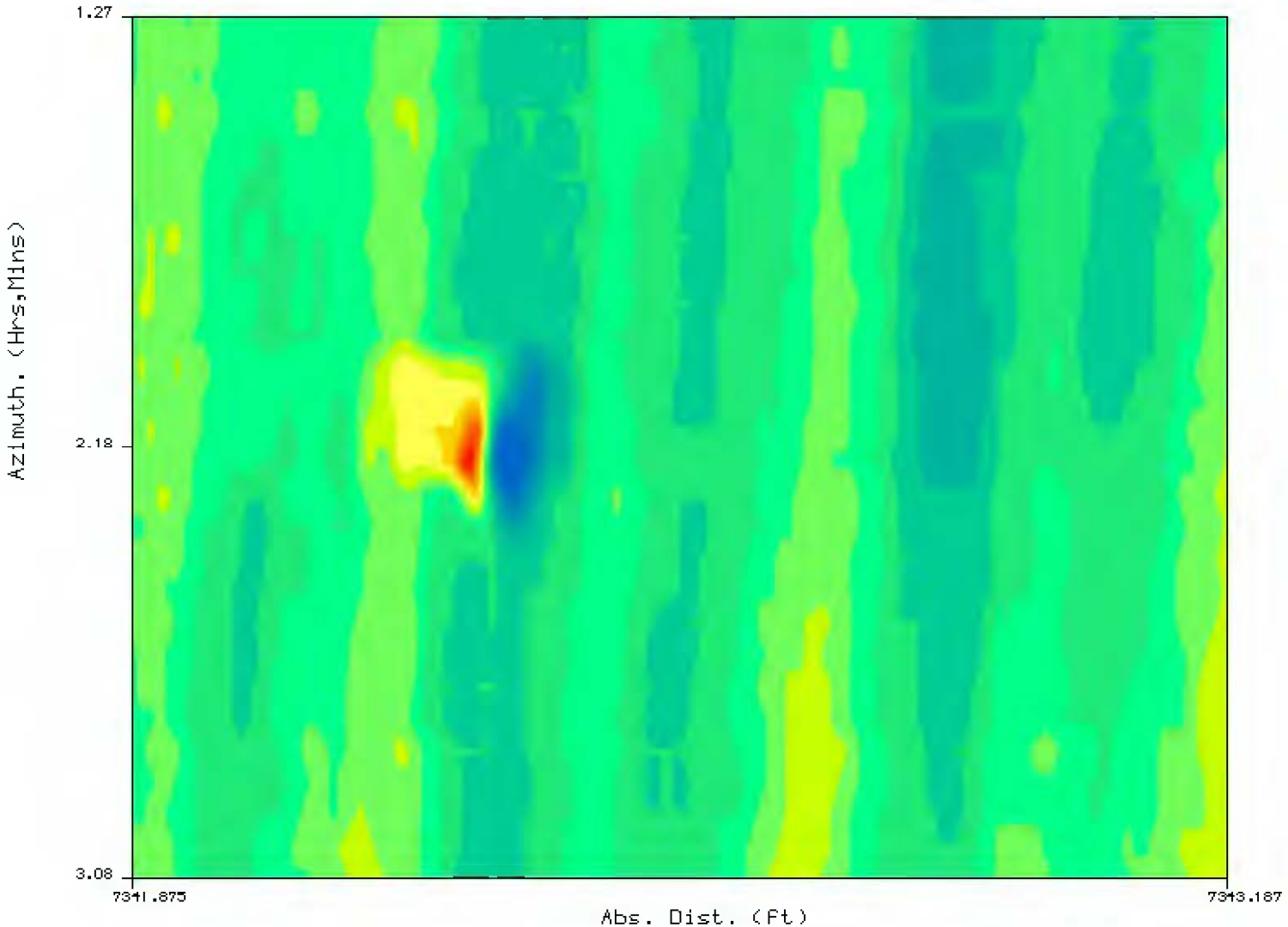


← **Straits of Mackinac (West Leg)** →

*** - seam weld not clearly identifiable in the data


Feature 8 Overview Plot 109170_20A
8.51
2.54
8.58
Azimuth (Hrs,Mins)
Abs. Dist. (Ft)

Feature 8 Detail Contour Plot 109170_20A



Inspection Sheet Number 9 — 109170_20A

Feature Description

Type:	External Mill/Manufacturing Fault
Orientation:	09:45 (o'clock)
Axial length:	2.0 in
Circumferential width:	3.9 in
Depth - Peak:	30% WT
- Average:	19% WT
Feature Selection Rule:	8
Nominal Pipe wall thickness for spool:	0.812 in
Absolute Distance from Launch:	11011.037 feet

Comments:

This metal loss feature has the appearance of a mill/manufacturing fault.

Feature Location

Primary Reference/s:

1. VALVE MP 1475.6
   (Girth Weld 30 + 1.755ft)

2. VALVE MP 1479.5
   (Girth Weld 8590 + 1.742ft)

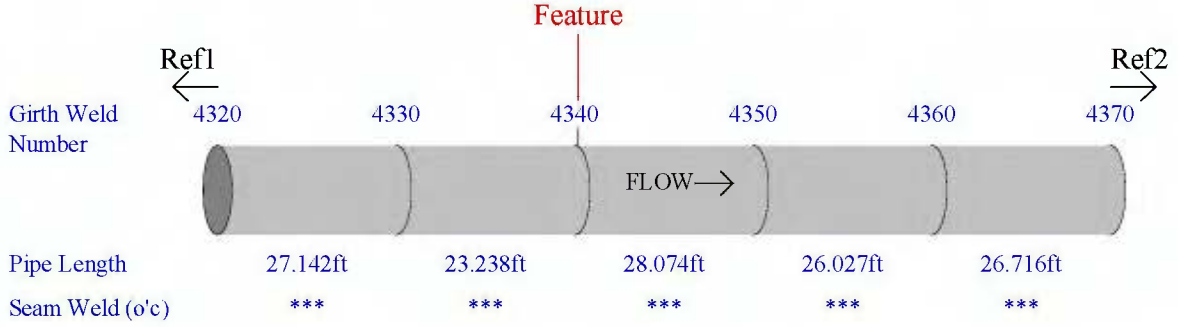
Reference Girth Weld:

The upstream reference girth weld of the feature spool is number 4340.
The location of this weld is 10954.600 feet downstream from reference 1 and 10859.603 feet upstream from reference 2.

Feature:

The feature is located 0.548 feet downstream from the reference girth weld.

Schematic Location Summary:

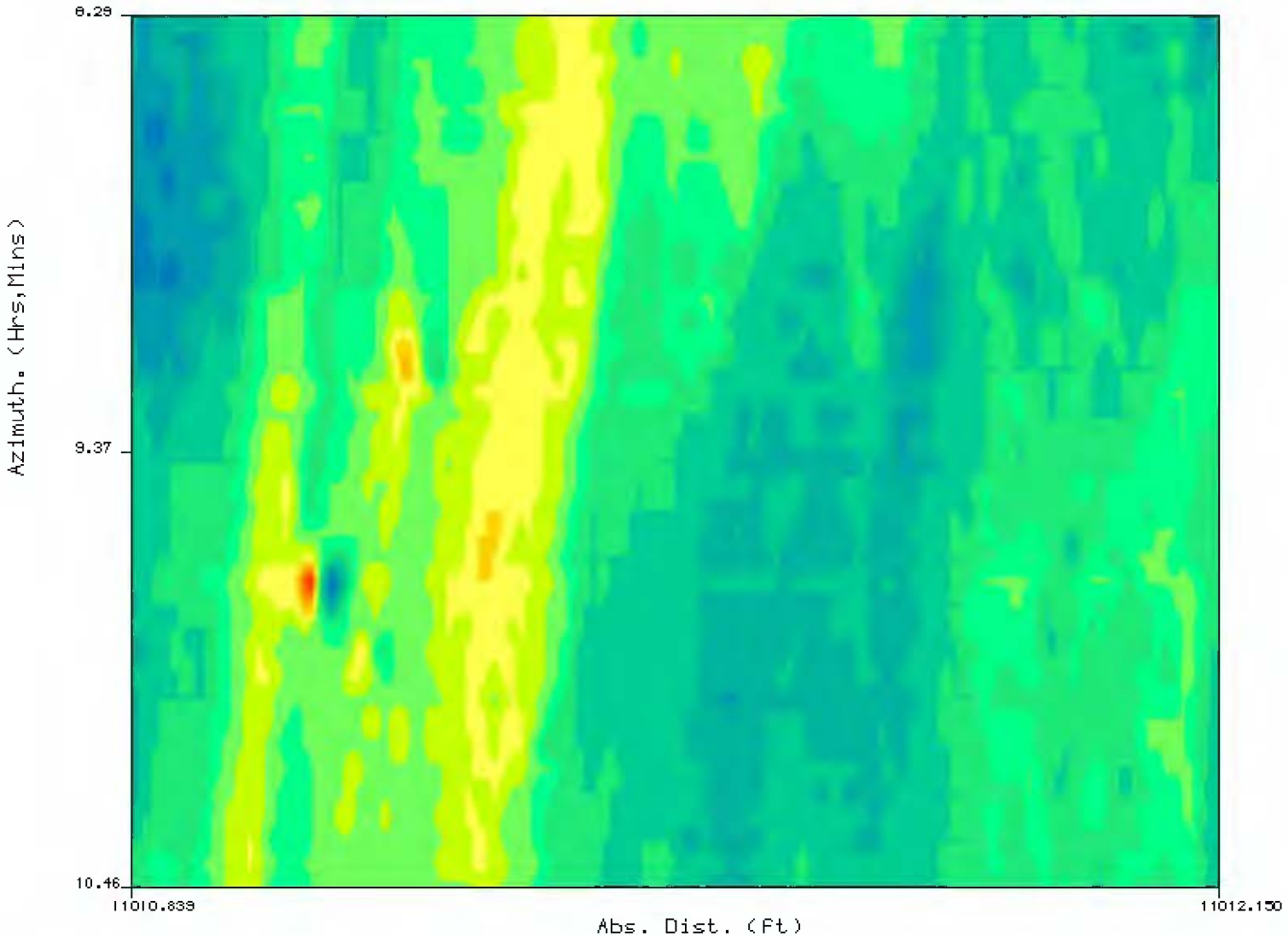


← **Straits of Mackinac (West Leg)** →

*** - seam weld not clearly identifiable in the data


Feature 9 Overview Plot 109170_20A
3.37
9.40
3.44
Azimuth (Hrs,Mins)
Abs. Dist. (Ft)

Feature 9 Detail Contour Plot 109170_20A



Inspection Sheet Number 10 109170_20A

Feature Description

Type:	External Mill/Manufacturing Fault
Orientation:	12:00 (o'clock)
Axial length:	5.7 in
Circumferential width:	2.9 in
Depth - Peak:	30% WT
- Average:	18% WT
Feature Selection Rule:	8
Nominal Pipe wall thickness for spool:	0.812 in
Absolute Distance from Launch:	11223.166 feet

Comments:

This metal loss feature has the appearance of a mill/manufacturing fault.

There is another mill/manufacturing feature within this spool.
More information on this feature is given in the Pipeline Listing.

Feature Location

Primary Reference/s:

1. VALVE MP 1475.6
   (Girth Weld 30 + 1.755ft)

2. VALVE MP 1479.5
   (Girth Weld 8590 + 1.742ft)

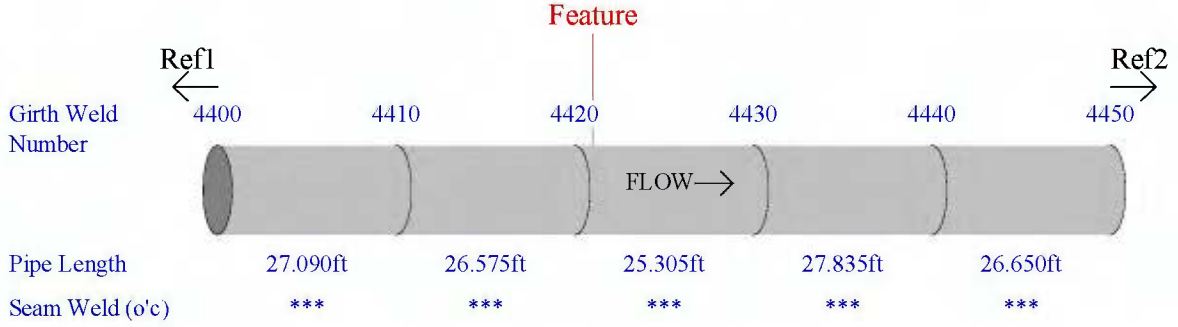
Reference Girth Weld:

The upstream reference girth weld of the feature spool is number 4420.
The location of this weld is 11164.715 feet downstream from reference 1 and 10649.488 feet upstream from reference 2.

Feature:

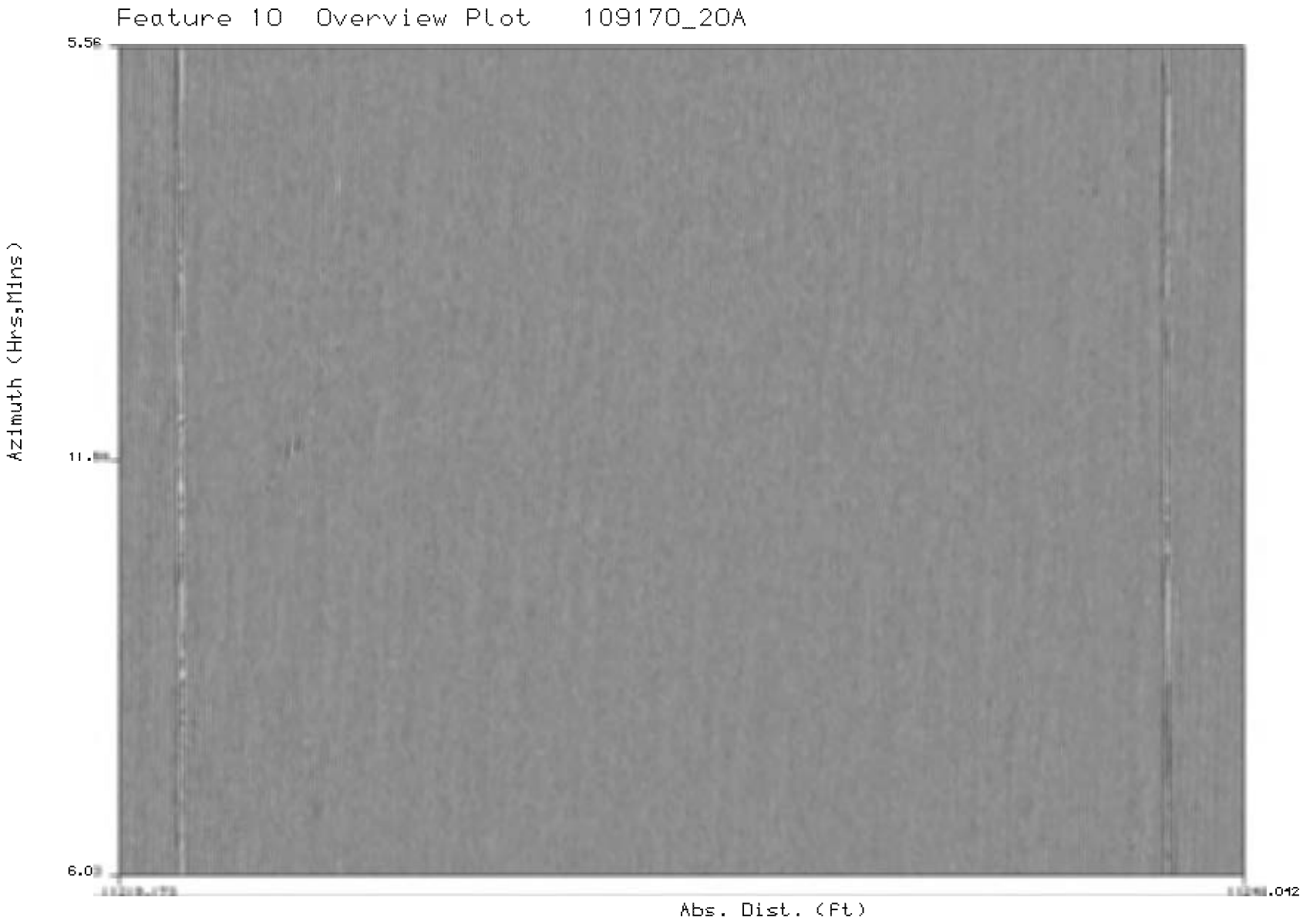
The feature is located 2.562 feet downstream from the reference girth weld.

Schematic Location Summary:

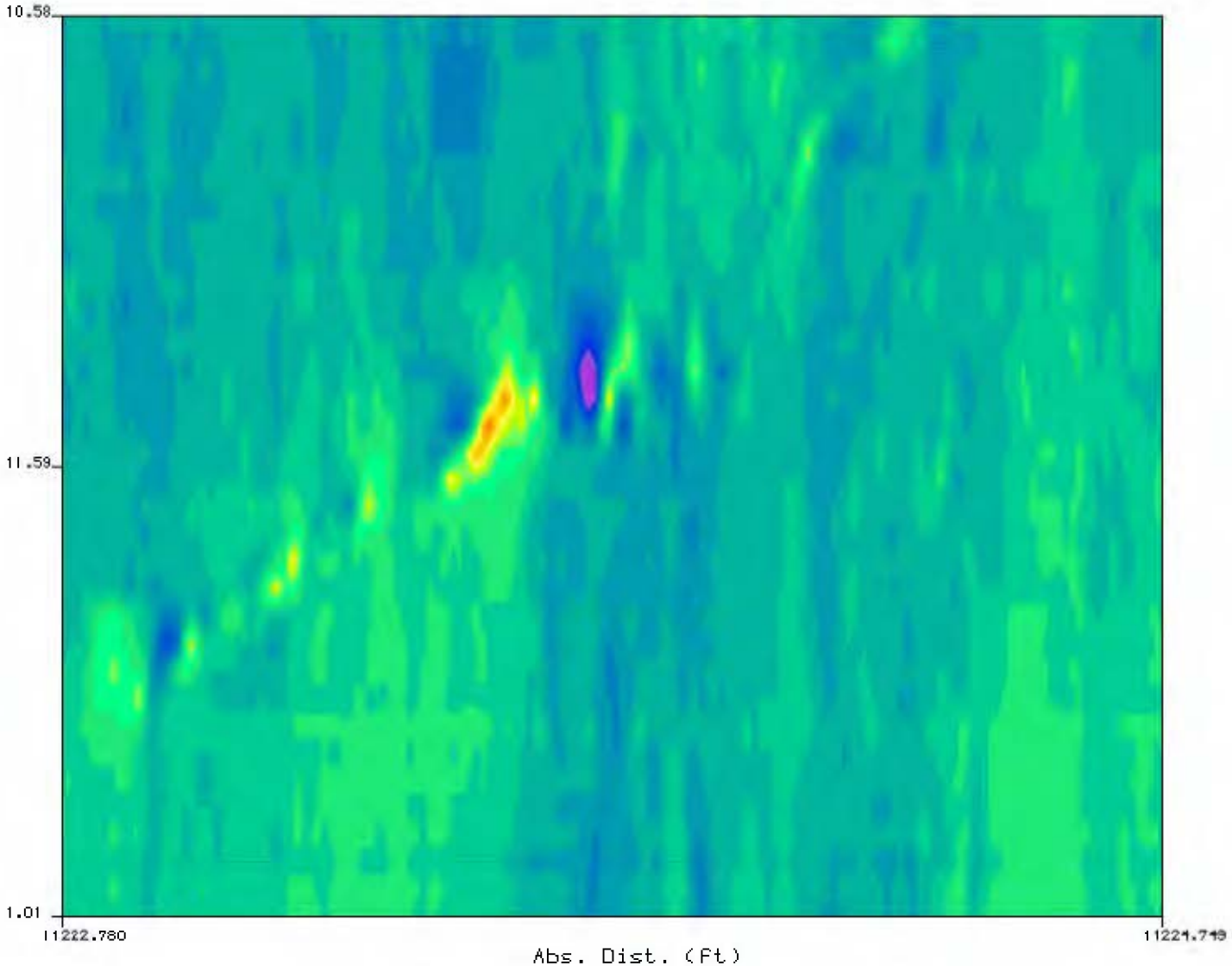


← **Straits of Mackinac (West Leg)** →

*** - seam weld not clearly identifiable in the data


Feature 10 Overview Plot 109170_20A
5.56
11.
6.0
Azimuth (Hrs,Mins)
.042
Abs. Dist. (Ft)

Feature 10 Detail Contour Plot 109170_20A



Inspection Sheet Number 11 — 109170_20A

Feature Description

Type:	External Mill/Manufacturing Fault
Orientation:	09:15 (o'clock)
Axial length:	7.2 in
Circumferential width:	8.0 in
Depth - Peak:	38% WT
- Average:	18% WT
Feature Selection Rule:	8
Nominal Pipe wall thickness for spool:	0.812 in
Absolute Distance from Launch:	13073.084 feet

Comments:

This metal loss feature has the appearance of a mill/manufacturing fault.

Feature Location

Primary Reference/s:

1. VALVE MP 1475.6
   (Girth Weld 30 + 1.755ft)

2. VALVE MP 1479.5
   (Girth Weld 8590 + 1.742ft)

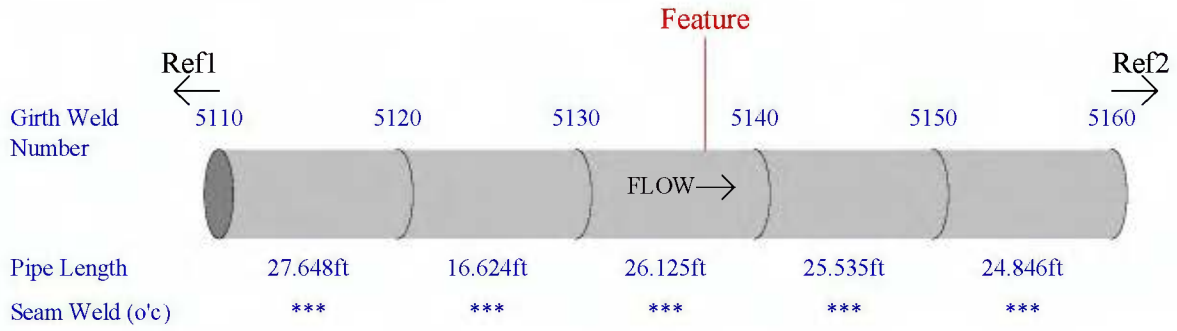
Reference Girth Weld:

The upstream reference girth weld of the feature spool is number 5130.
The location of this weld is 12998.445 feet downstream from reference 1 and 8815.758 feet upstream from reference 2.

Feature:

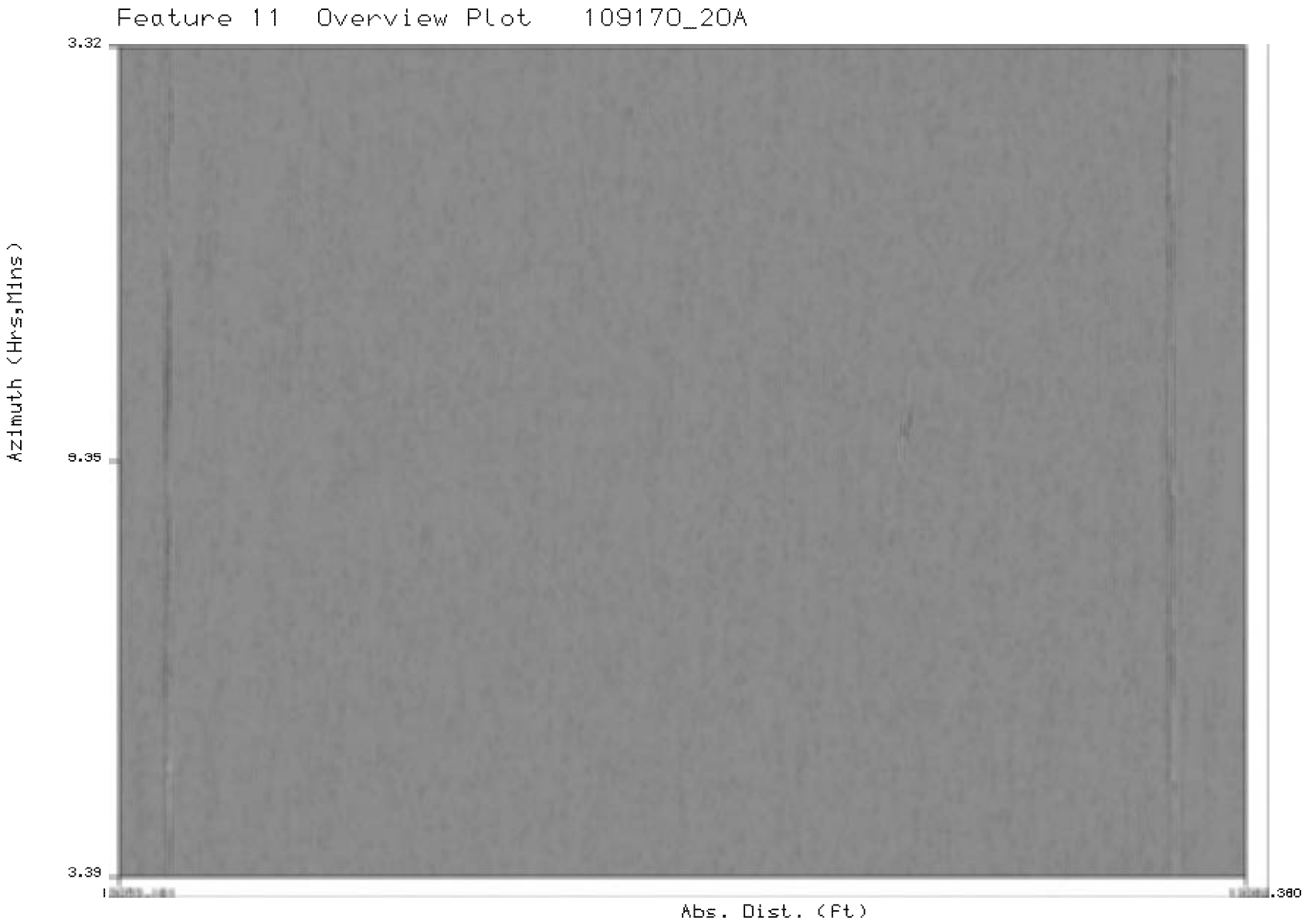
The feature is located 18.750 feet downstream from the reference girth weld.

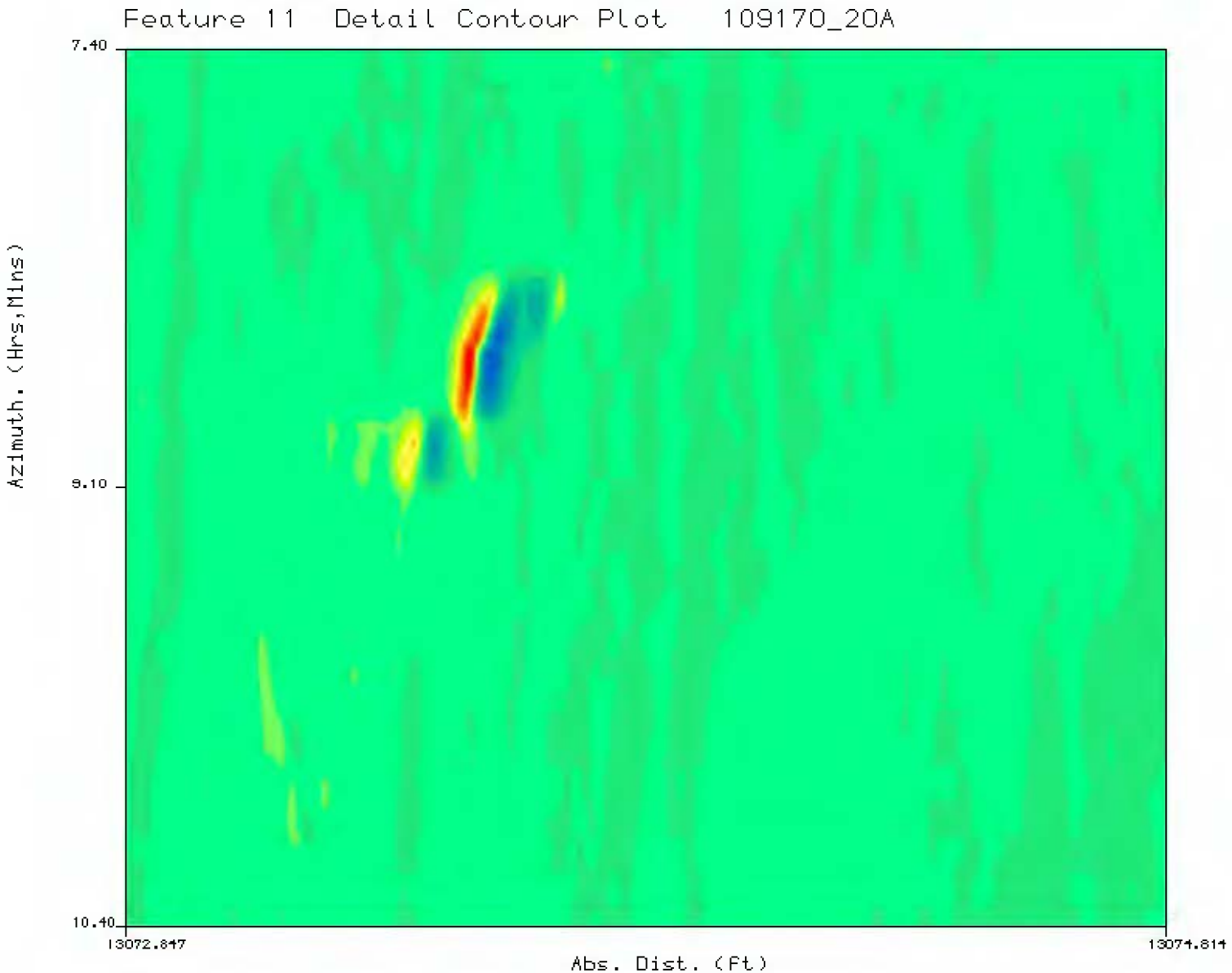
Schematic Location Summary:



← **Straits of Mackinac (West Leg)** →

*** - seam weld not clearly identifiable in the data


Feature 11 Overview Plot 109170_20A
3.32
9.35
3.39
Azimuth (Hrs,Mins)
Abs. Dist. (Ft)


Feature 11 Detail Contour Plot 109170_20A
7.40
9.10
10.40
Azimuth. (Hrs,Mins)
13072.847
13074.814
Abs. Dist. (Ft)

Inspection Sheet Number 12 — 109170_20A

Feature Description

Type:	External Mill/Manufacturing Fault
Orientation:	12:30 (o'clock)
Axial length:	0.6 in
Circumferential width:	1.0 in
Depth - Peak:	33% WT
- Average:	33% WT
Feature Selection Rule:	8
Nominal Pipe wall thickness for spool:	0.812 in
Absolute Distance from Launch:	14544.846 feet

Comments:

This metal loss feature has the appearance of a mill/manufacturing fault.

Feature Location

Primary Reference/s:

1. VALVE MP 1475.6
   (Girth Weld 30 + 1.755ft)

2. VALVE MP 1479.5
   (Girth Weld 8590 + 1.742ft)

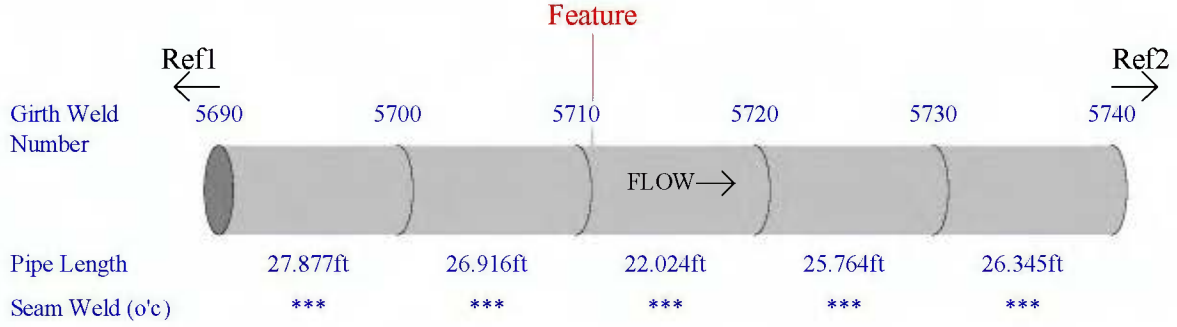
Reference Girth Weld:

The upstream reference girth weld of the feature spool is number 5710.
The location of this weld is 14487.014 feet downstream from reference 1 and 7327.188 feet upstream from reference 2.

Feature:

The feature is located 1.942 feet downstream from the reference girth weld.

Schematic Location Summary:

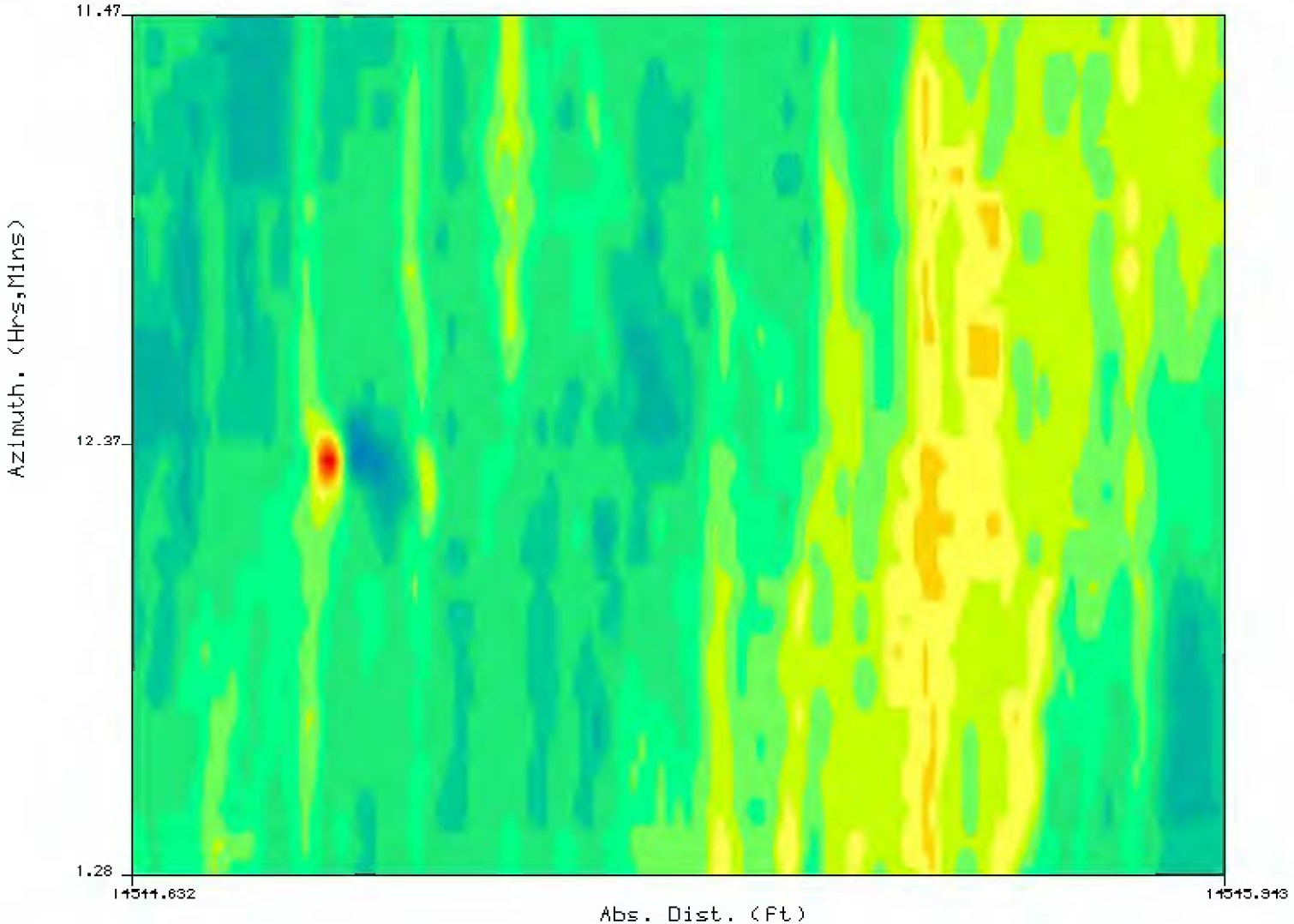


← **Straits of Mackinac (West Leg)** →

*** - seam weld not clearly identifiable in the data


Feature 12 Overview Plot 109170_20A
6.39
12.
6.4
Azimuth (Hrs,Mins)
Abs. Dist. (Ft)

Feature 12 Detail Contour Plot 109170_20A



Inspection Sheet Number 13 — 109170_20A

Feature Description

Type:	External Mill/Manufacturing Fault
Orientation:	04:15 (o'clock)
Axial length:	0.7 in
Circumferential width:	1.0 in
Depth - Peak:	34% WT
- Average:	34% WT
Feature Selection Rule:	8
Nominal Pipe wall thickness for spool:	0.812 in
Absolute Distance from Launch:	15033.294 feet

Comments:

This metal loss feature has the appearance of a mill/manufacturing fault.

Feature Location

Primary Reference/s:

1. VALVE MP 1475.6
   (Girth Weld 30 + 1.755ft)

2. VALVE MP 1479.5
   (Girth Weld 8590 + 1.742ft)

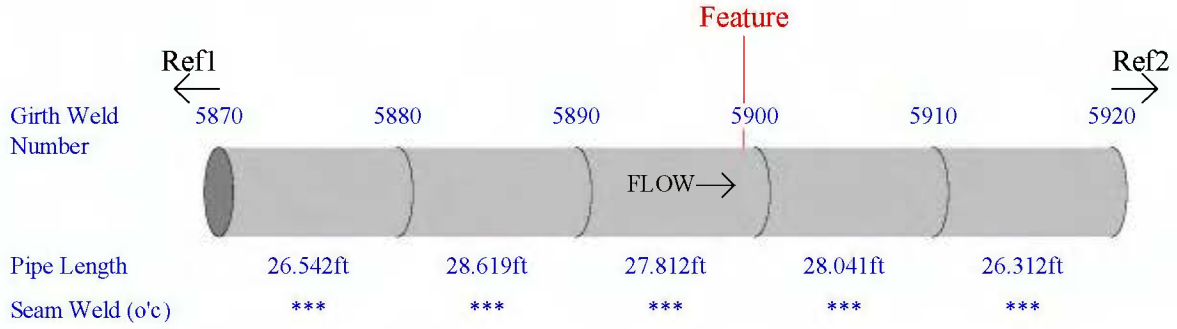
Reference Girth Weld:

The upstream reference girth weld of the feature spool is number 5890.
The location of this weld is 14951.329 feet downstream from reference 1 and 6862.874 feet upstream from reference 2.

Feature:

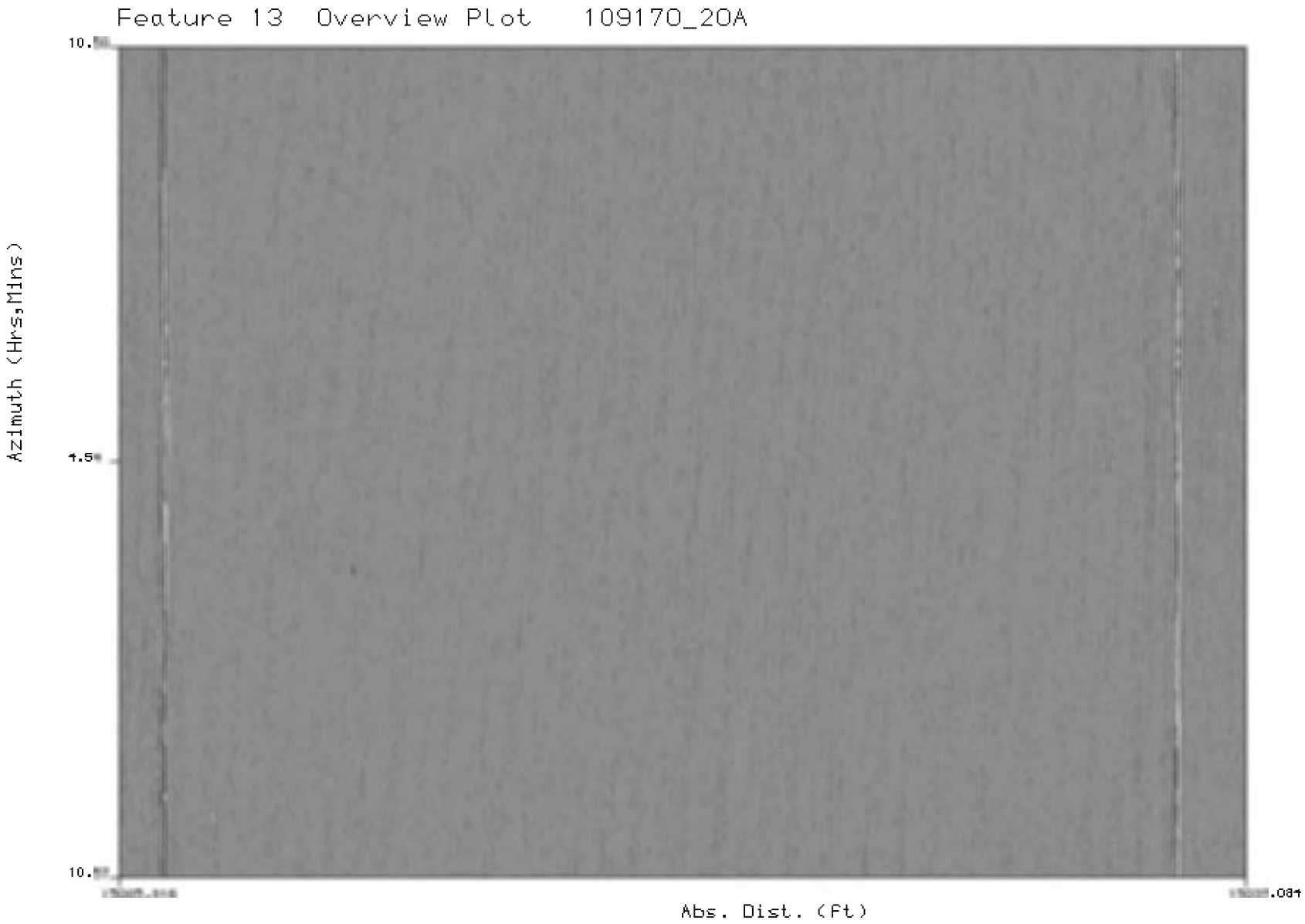
The feature is located 26.076 feet downstream from the reference girth weld.

Schematic Location Summary:

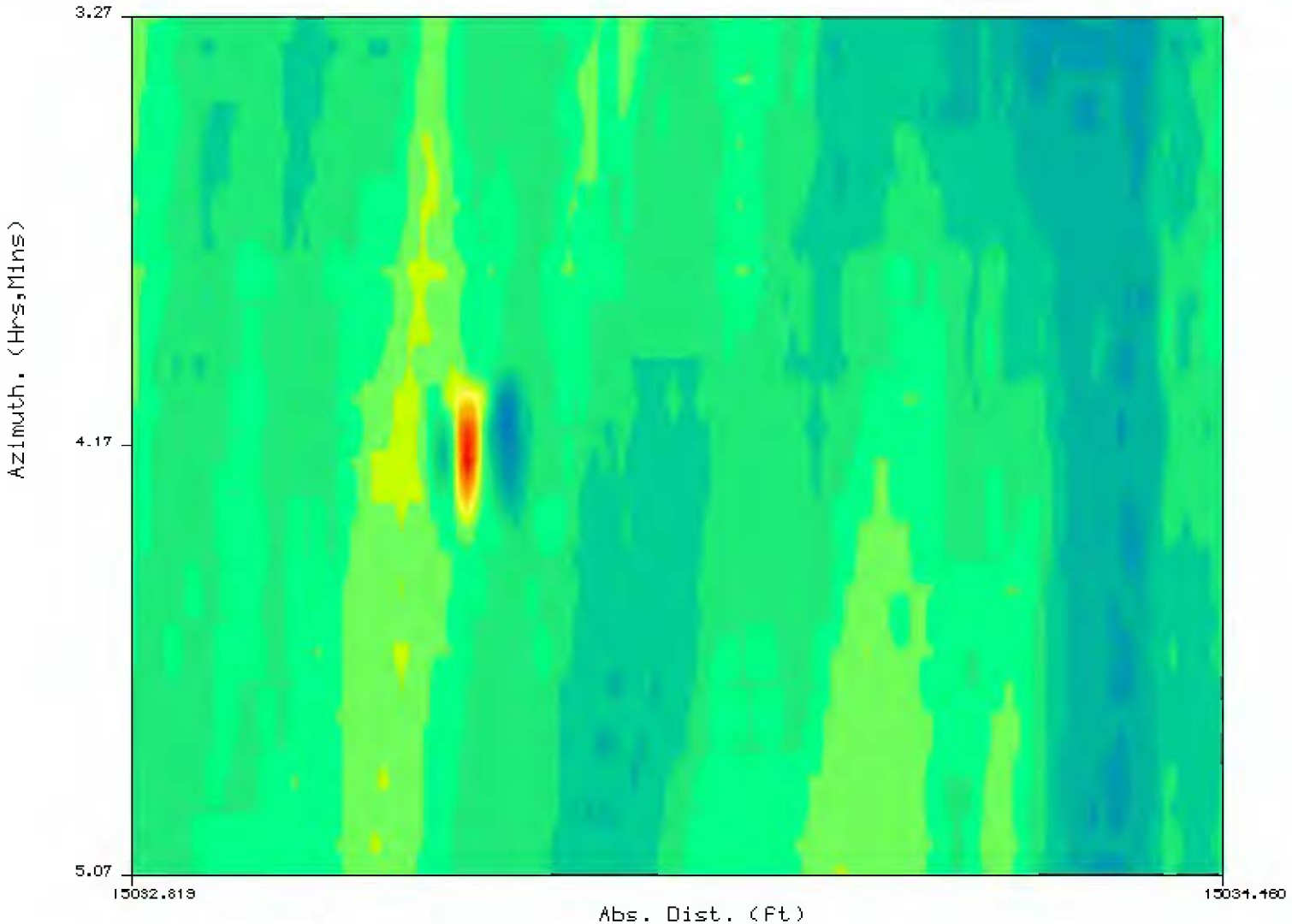


← **Straits of Mackinac (West Leg)** →

*** - seam weld not clearly identifiable in the data


Feature 13 Overview Plot 109170_20A
Azimuth (Hrs,Mins)
Abs. Dist. (Ft)

Feature 13 Detail Contour Plot 109170_20A



Inspection Sheet Number 14 — 109170_20A

Feature Description

Type:	External Mill/Manufacturing Fault
Orientation:	08:00 (o'clock)
Axial length:	0.5 in
Circumferential width:	1.0 in
Depth - Peak:	33% WT
- Average:	33% WT
Feature Selection Rule:	8
Nominal Pipe wall thickness for spool:	0.812 in
Absolute Distance from Launch:	15118.179 feet

Comments:

This metal loss feature has the appearance of a mill/manufacturing fault.

There are other mill/manufacturing features within this spool.
More information on these features is given in the Pipeline Listing.

Feature Location

Primary Reference/s:

1. VALVE MP 1475.6
   (Girth Weld 30 + 1.755ft)

2. VALVE MP 1479.5
   (Girth Weld 8590 + 1.742ft)

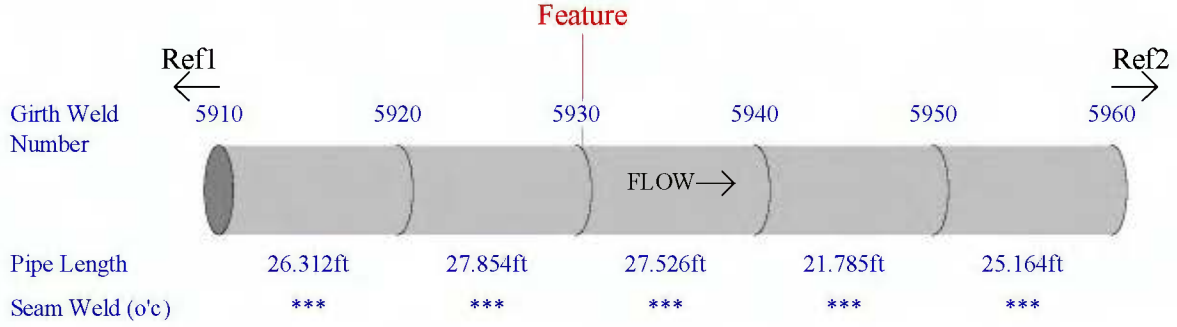
Reference Girth Weld:

The upstream reference girth weld of the feature spool is number 5930.
The location of this weld is 15061.345 feet downstream from reference 1 and 6752.858 feet upstream from reference 2.

Feature:

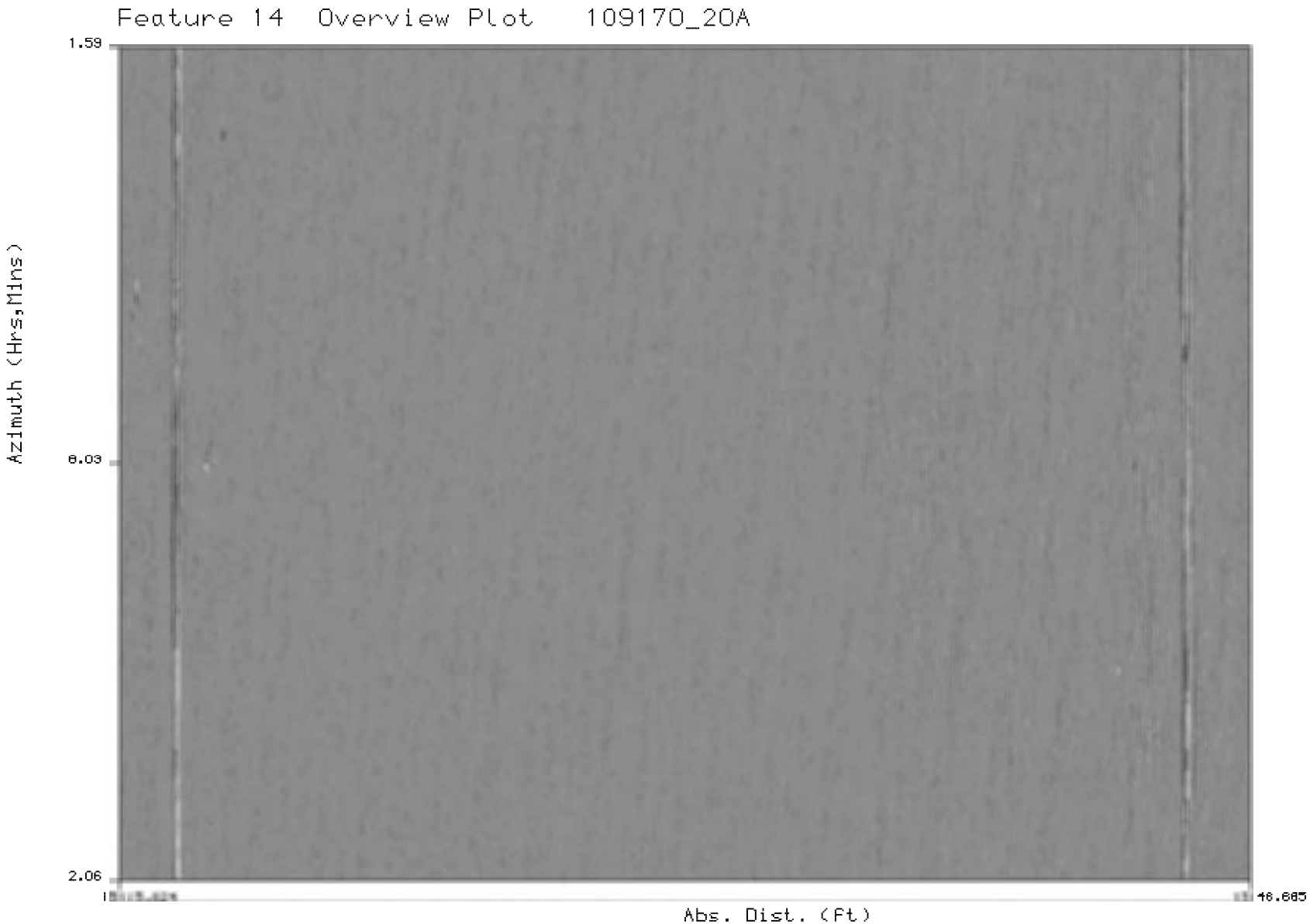
The feature is located 0.945 feet downstream from the reference girth weld.

Schematic Location Summary:

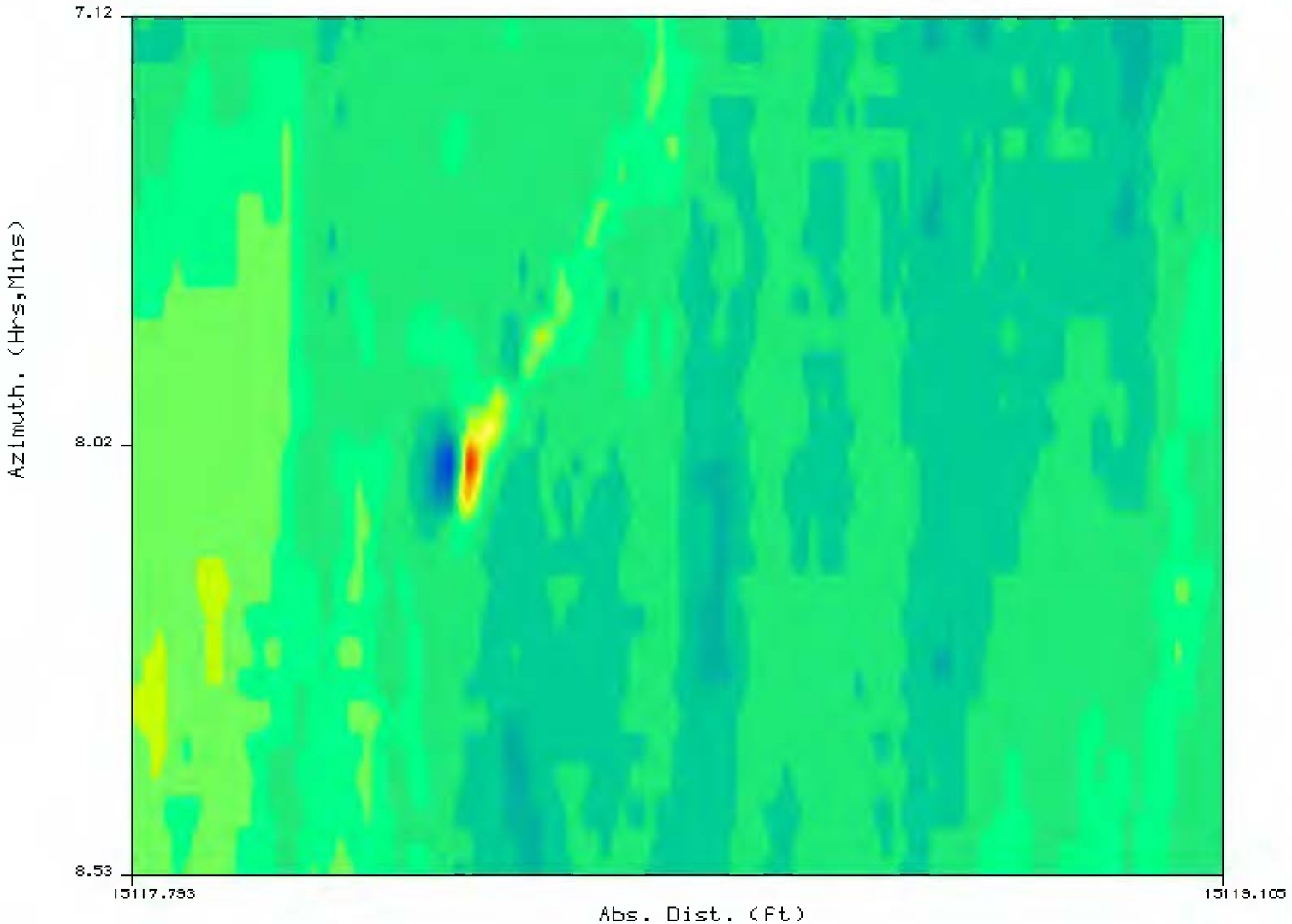


← **Straits of Mackinac (West Leg)** →

*** - seam weld not clearly identifiable in the data


Feature 14 Overview Plot 109170_20A
1.59
6.03
2.06
Azimuth (Hrs,Mins)
48.685
Abs. Dist. (Ft)

Feature 14 Detail Contour Plot 109170_20A



Inspection Sheet Number 15 — 109170_20A

Feature Description

Type:	External Mill/Manufacturing Fault
Orientation:	01:30 (o'clock)
Axial length:	3.4 in
Circumferential width:	2.3 in
Depth - Peak:	35% WT
- Average:	17% WT
Feature Selection Rule:	8
Nominal Pipe wall thickness for spool:	0.812 in
Absolute Distance from Launch:	15199.892 feet

Comments:

This metal loss feature has the appearance of a mill/manufacturing fault.

There is another mill/manufacturing feature within this spool.

Feature Location

Primary Reference/s:

1. VALVE MP 1475.6
   (Girth Weld 30 + 1.755ft)

2. VALVE MP 1479.5
   (Girth Weld 8590 + 1.742ft)

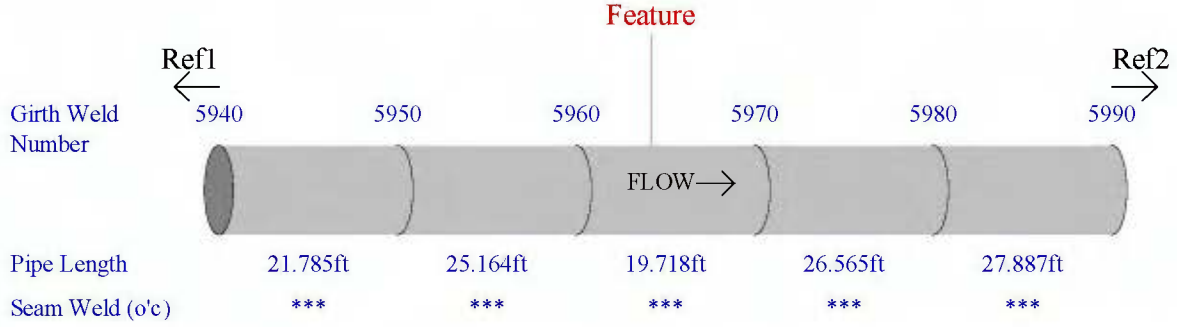
Reference Girth Weld:

The upstream reference girth weld of the feature spool is number 5960.
The location of this weld is 15135.823 feet downstream from reference 1 and 6678.379 feet upstream from reference 2.

Feature:

The feature is located 8.179 feet downstream from the reference girth weld.

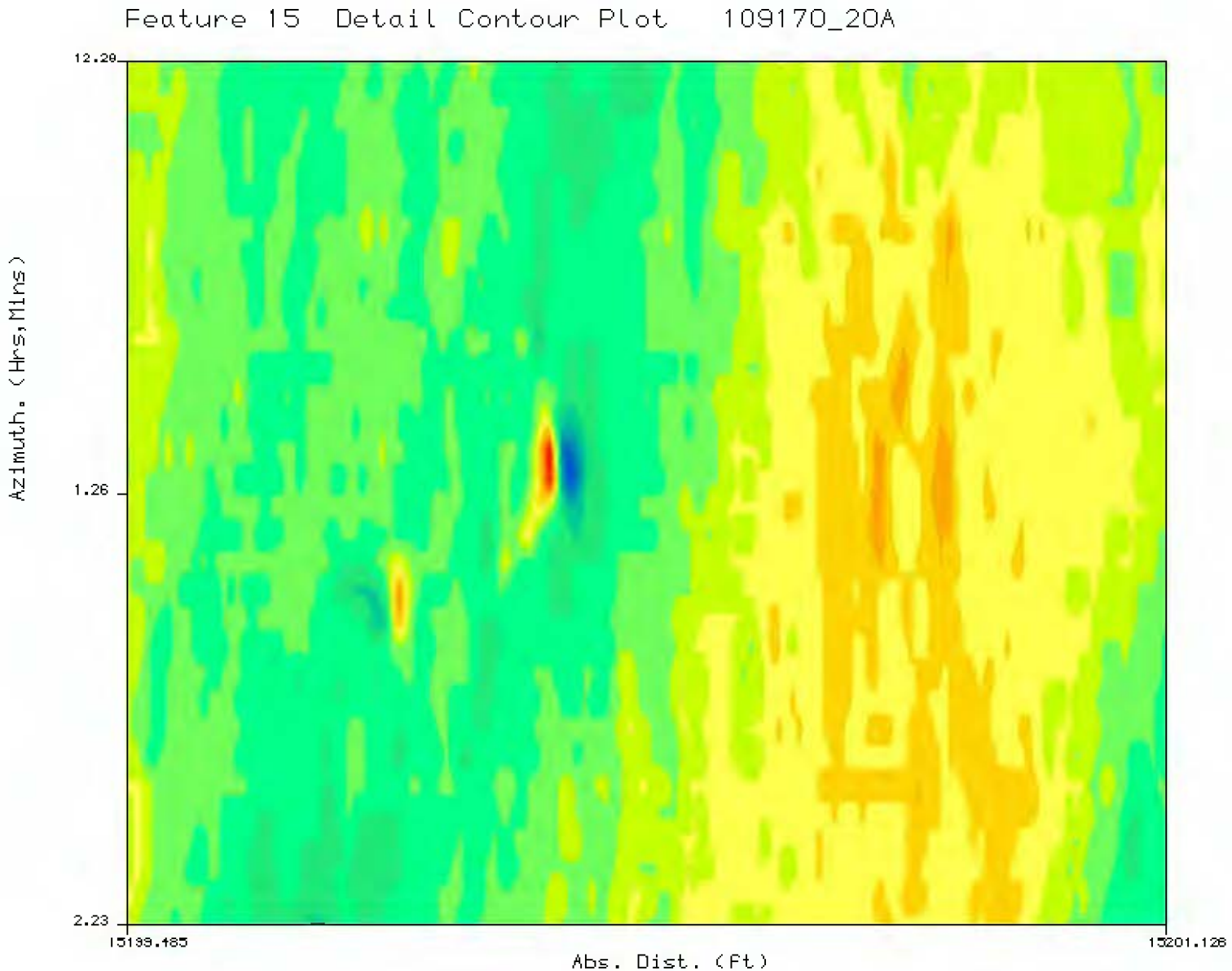
Schematic Location Summary:



← **Straits of Mackinac (West Leg)** →

*** - seam weld not clearly identifiable in the data


Feature 15 Overview Plot 109170_20A
7.31
1.34
7.38
Azimuth (Hrs,Mins)
13.206
Abs. Dist. (Ft)


Feature 15 Detail Contour Plot 109170_20A
12.20
1.26
2.23
Azimuth. (Hrs,Mins)
15199.485
15201.128
Abs. Dist. (Ft)

Pressure Based Pipeline Summary Report

The Pressure Based Pipeline Summary Report provides an overview of the pipeline condition.

3.1. Metal Loss Information

This section provides summaries of all the metal loss features detected along the pipeline in the following formats:

- Pressure Sentenced Plot
- Pressure Based Histograms
- Depth Based Histograms
- Orientation Plot
- Severity Table

ENBDNR0000953

3.1.1. Pressure Sentenced Plot

The pressure sentenced plot shows the relative significance of each detected metal loss feature.

Metal loss features that have been identified as manufacturing faults are not included on the pressure sentenced plot.

The significance of each metal loss feature has been assessed using the pressure sentencing formulae as supplied by the client and defined in the Appendix to the Specification for the Pipeline Inspection Report (Appendix F).

These formulae depend on the following five variables;

two measured by the GE Oil & Gas, PII Pipeline Solutions inspection system:

- the predicted peak depth of the metal loss feature, or the area ratio if the metal loss feature consists of two or more metal losses that have been clustered together;
- the predicted axial length of the metal loss feature, or the overall predicted axial length if the metal loss feature consists of two or more metal losses that have been clustered together;

and three specified by the pipeline operator:

- the external pipe radius (r);
- the nominal pipe wall thickness (nwt); and,
- the Specified Minimum Yield Strength (SMYS).

The pressure sentenced plot shows the relative significance of each metal loss feature by plotting the sentenced depth of the metal loss feature against its predicted axial length and by indicating on the graph the appropriate curve that represents an RPR of 1. The curve representing an RPR of 1 will move if any of the values for r, nwt, or SMYS change.

Those metal loss features with RPR values <1 will be plotted above the curve. The lower the value, the higher the significance and the further away from the curve the metal loss feature will be plotted.

The report contains one pressure sentenced plot for each major pipeline segment defined by the pipeline operator. Only those metal loss features within the major segment, and any minor segments within the major segment, are shown on the respective pressure sentenced plot. The RPR unity curve is calculated using the values of r, nwt, and SMYS that have been specified for the major segment by the pipeline operator; these values are also given on each plot.

A pressure sentenced plot will not be provided if the major segment does not contain any metal loss features.

ENBDNR0000954

A list of the major segments and the values of nwt and SMYS that apply within each segment are provided in the nominal wall thickness listing presented in Section 3.2.8. The value for r is assumed to be constant throughout the pipeline.

There are four symbols used on the pressure sentenced plot to represent metal loss features. These are:

+	The metal loss feature is within the major segment. That is the spool containing the metal loss feature has pipeline parameters equal to those used to calculate the RPR unity curve.
⊕	The metal loss feature is reported on an inspection sheet and is within the major segment.
Δ	The metal loss feature is within a minor segment. That is the spool containing the metal loss feature has pipeline parameters different to those used to calculate the RPR unity curve.
⊚	The metal loss feature is reported on an inspection sheet and is within a minor segment.

Each pressure sentenced plot is presented overleaf.

ENBDNR0000955

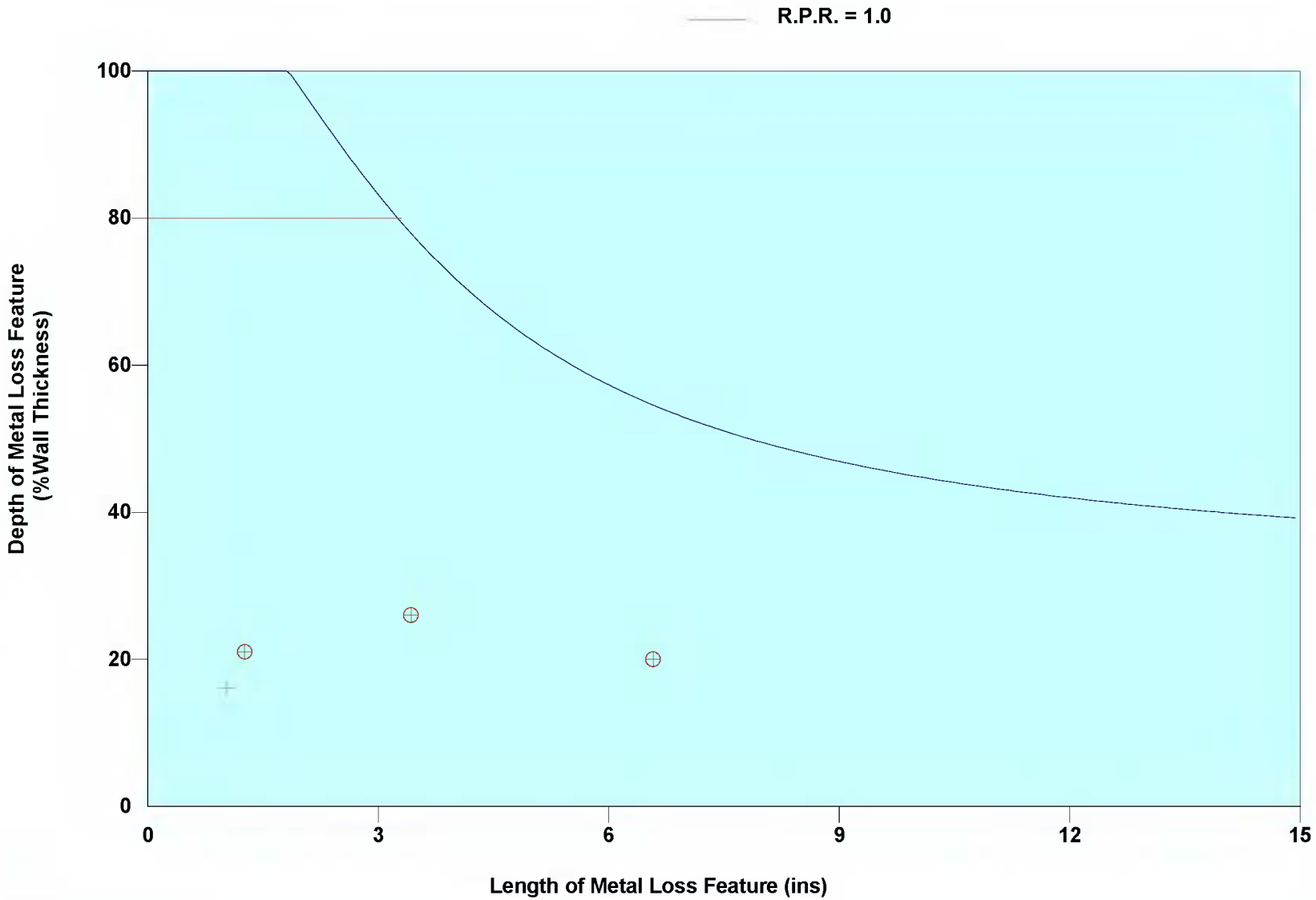
SENTENCED PLOT

Straits of Mackinac (West Leg)

Major Segment 1

External Diameter 20 ins
Wall Thickness 0.812 ins
SMYS 30000.0 PSI

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3.1.2. Pressure Based Histograms

The pressure based histograms show the distribution of the most significant metal loss features along the pipeline.

Metal loss features that have been identified as manufacturing faults are not included in the pressure based histograms.

The significance of each metal loss feature has been assessed using the pressure sentencing formulae supplied by the client and defined in the Appendix to the Specification for the Pipeline Inspection Report (Appendix F).

Each pressure based histogram shows the distribution along the pipeline of those metal loss features with RPR values below a chosen pressure sentenced threshold.

Each bar on the histogram represents the number of occurrences within a 50 ft section of the pipeline.

The pressure sentenced thresholds chosen to highlight the most significant metal loss features are as follows:

- all metal loss features with RPR values <1.000
- all metal loss features with RPR values <1.100
- all metal loss features with RPR values <1.350

Summarising from the histograms:

0 metal loss features with RPR values <1.000

0 metal loss features with RPR values <1.100

4 metal loss features with RPR values <1.350

In addition, a single three-dimensional summary histogram is included which shows the distribution along the pipeline of those metal loss features with RPR values below each of the chosen pressure sentenced thresholds.

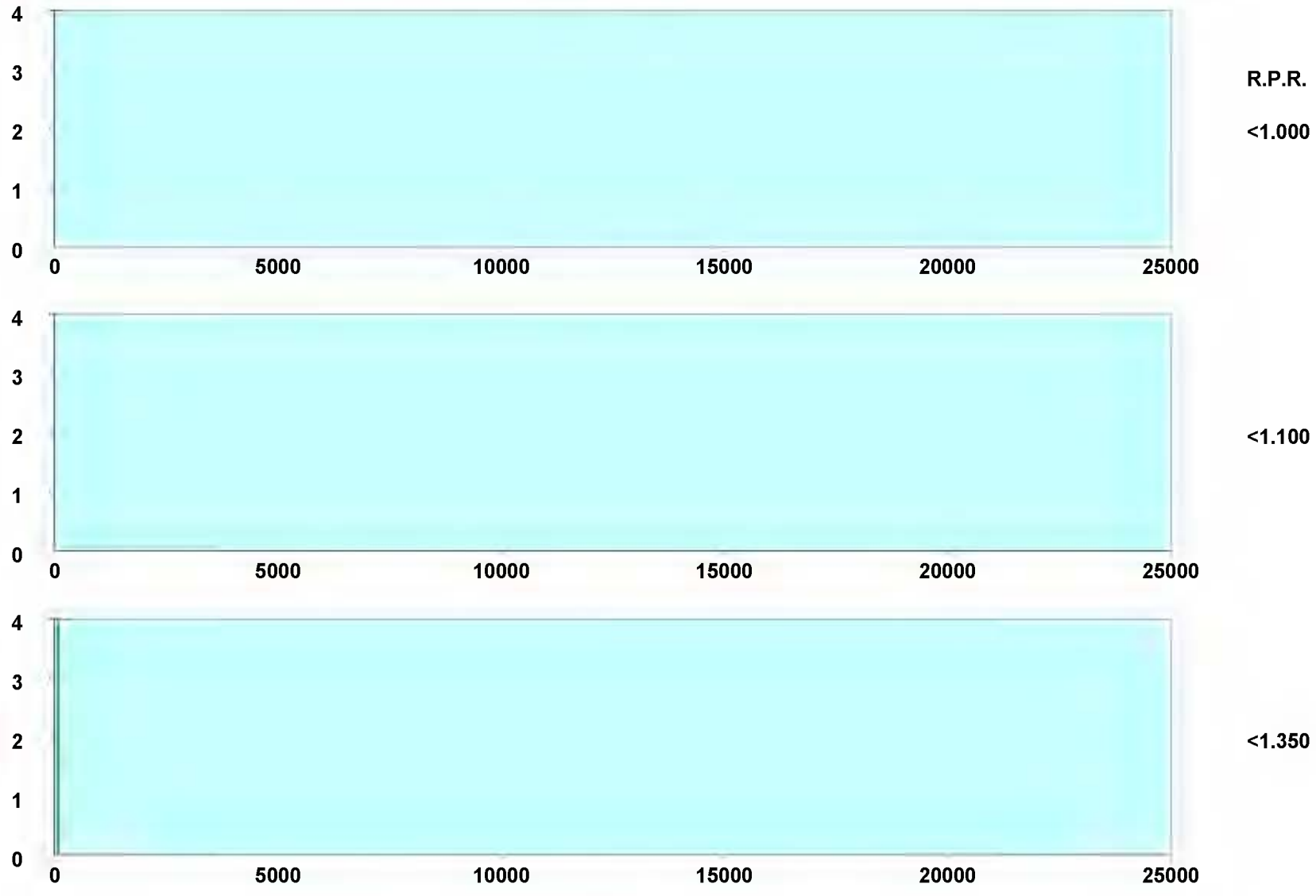
The pressure based histograms are presented overleaf.

Number of Metal Loss Features

PRESSURE BASED HISTOGRAM

Straits of Mackinac (West Leg)

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PRESSURE BASED HISTOGRAM

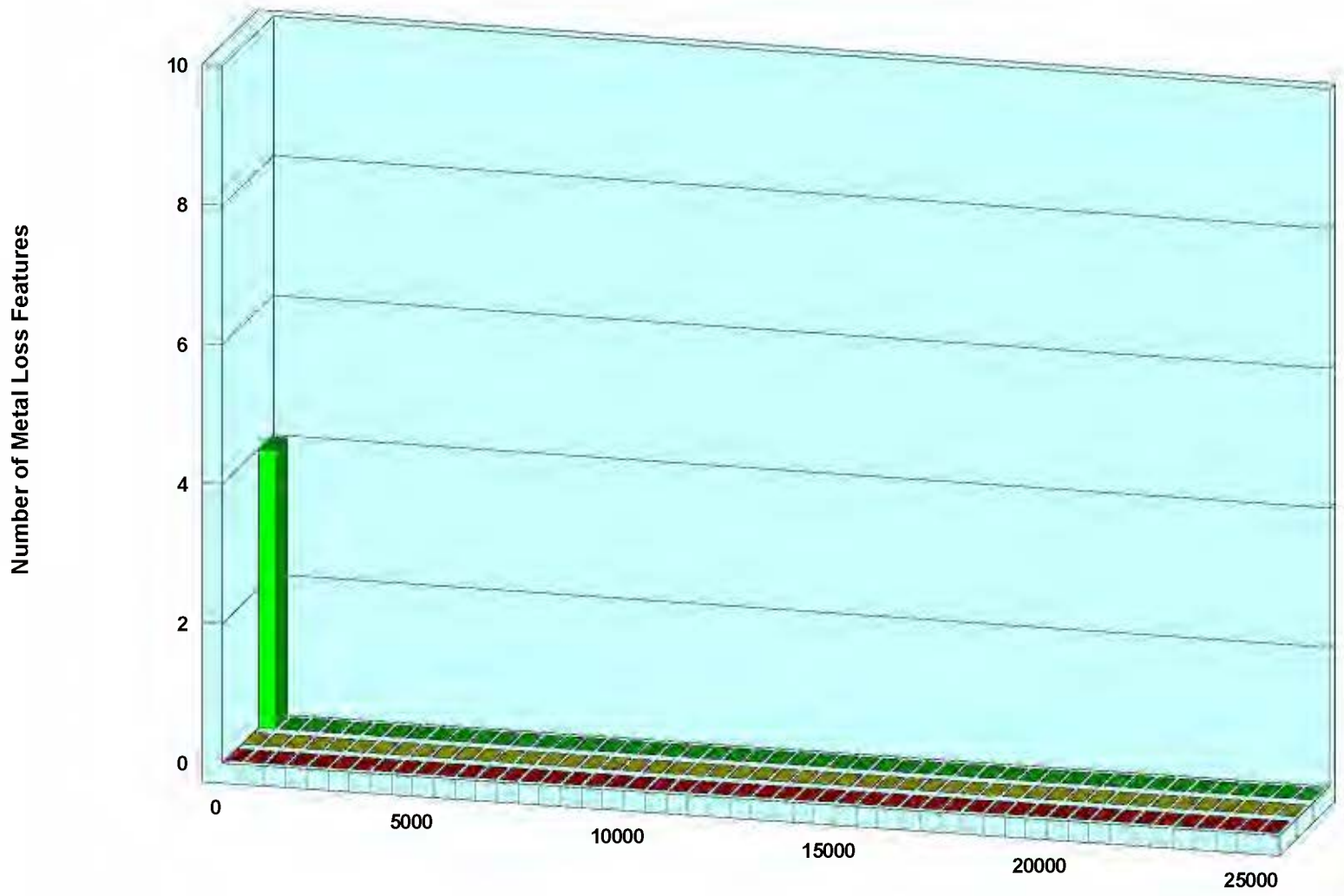
Straits of Mackinac (West Leg)

R.P.R. < 1.350

R.P.R. < 1.100

R.P.R. < 1.000

109170_20A
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3.1.3. Depth Based Histograms

The depth based histograms show the distribution of all detected metal loss features along the pipeline.

Twelve histograms are presented in this section:

- three ungraded metal loss histograms
- eight graded metal loss histograms
- one three-dimensional summary histogram

Ungraded Metal Loss Histograms

The total metal loss histogram shows the distribution of all metal loss features along the pipeline. Each bar on the histogram represents the number of occurrences within a 50 ft section of the pipeline.

The area metal loss histogram shows how much of the pipe surface has been affected by metal loss. Each bar on the histogram represents the total surface area of the metal loss within a 50 ft section of the pipeline. This is expressed as a percentage of the surface area of an undamaged pipe section.

The volume metal loss histogram shows how the volume of metal in the pipeline has been affected by metal loss. Each bar on the histogram represents the total volume of the metal loss features within a 50 ft section of the pipeline. This is expressed as a percentage of the volume of metal in an undamaged pipe section.

ENBDNR0000960

Graded Metal Loss Histograms

The metal loss features are graded into eight categories, which are derived from combinations of two length and four predicted peak depth categories.

There is one graded metal loss histogram for each category. Each bar on the histogram represents the number of occurrences within a 50 ft section of the pipeline.

Summarising from the histograms, a total of **317** metal loss features have been identified within the pipeline. These have been graded as follows:

237 metal loss features with predicted axial lengths ≤ 3t.
Of these:

84	have a predicted peak depth of ≤ 20%t.
153	have a predicted peak depth of > 20%t and ≤ 40%t.
0	have a predicted peak depth of > 40%t and ≤ 60%t.
0	have a predicted peak depth of > 60%t.

80 metal loss features with a predicted length > 3t.
Of these:

32	have a predicted peak depth of ≤ 20%t.
48	have a predicted peak depth of > 20%t and ≤ 40%t.
0	have a predicted peak depth of > 40%t and ≤ 60%t.
0	have a predicted peak depth of > 60%t.

Three-Dimensional Summary Histogram

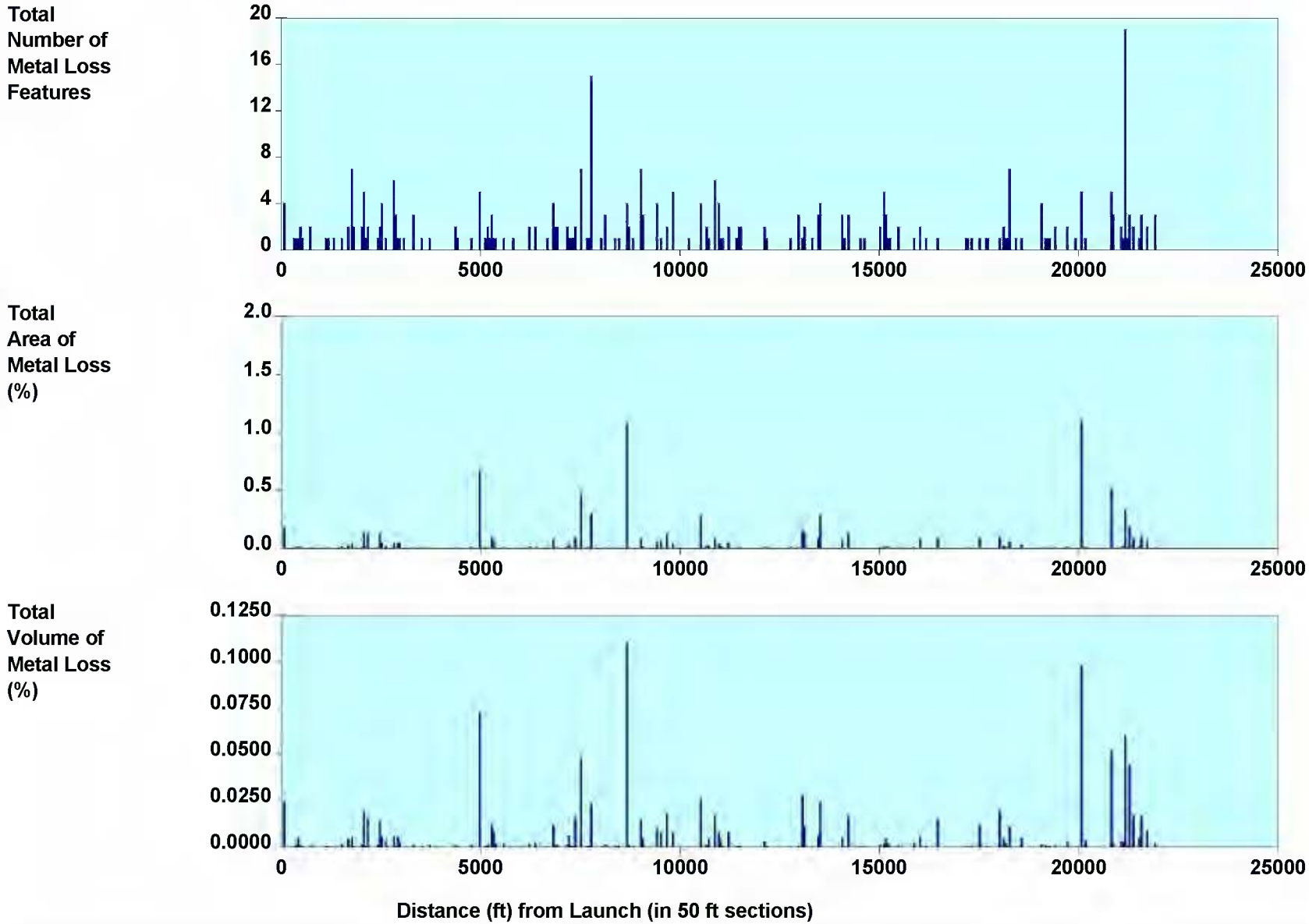
The metal loss features are graded into nine depth categories and displayed on a single three-dimensional histogram. Each bar on the summary histogram represents the number of metal loss occurrences within the appropriate depth category for a specific section of the pipeline.

The histograms are presented on four pages overleaf.

DEPTH BASED HISTOGRAM - ALL METAL LOSS

Straits of Mackinac (West Leg)

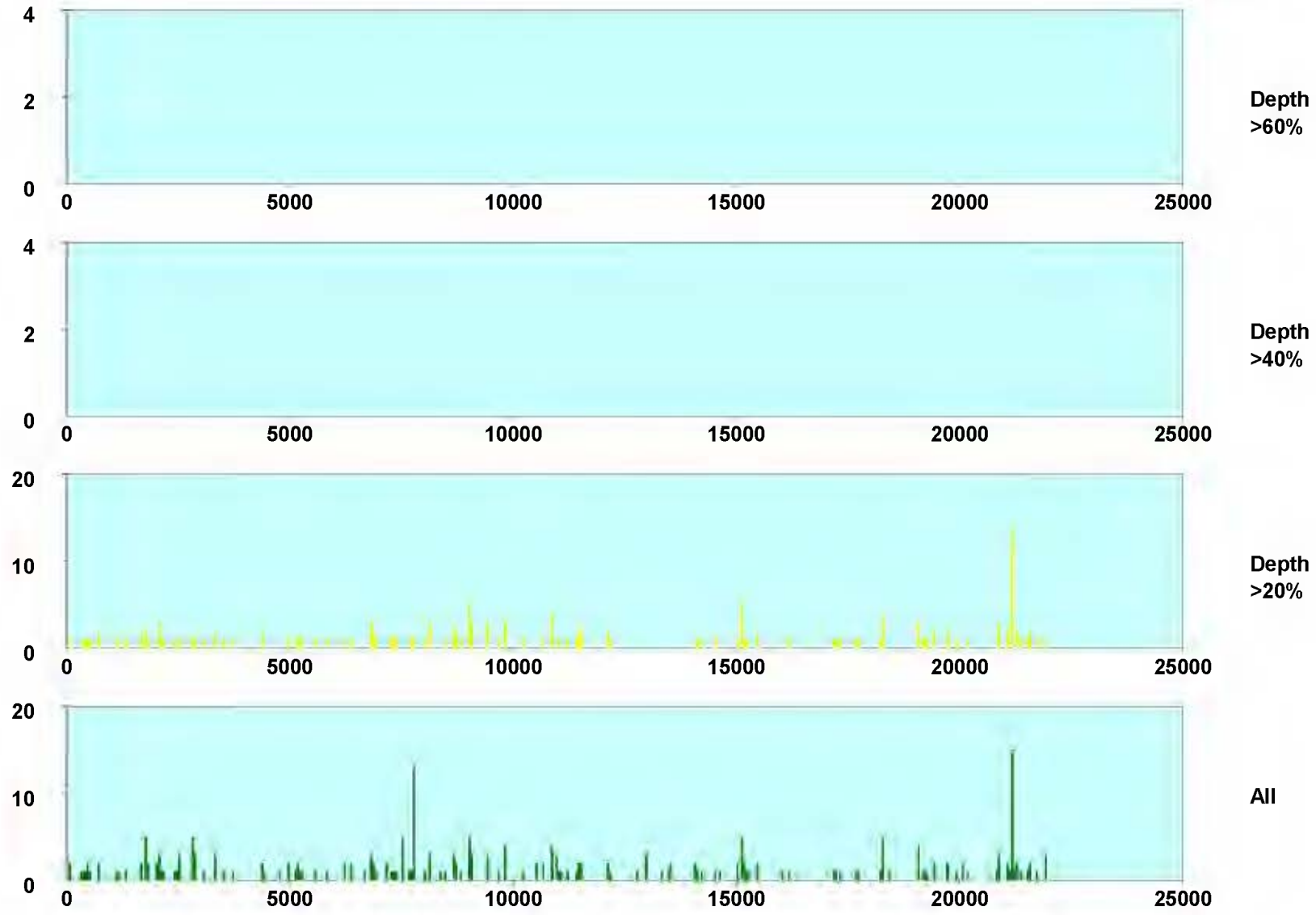
109170_20A
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Number of
Metal Loss
Features

DEPTH BASED HISTOGRAM
Axial Length ≤ 3t
Straits of Mackinac (West Leg)

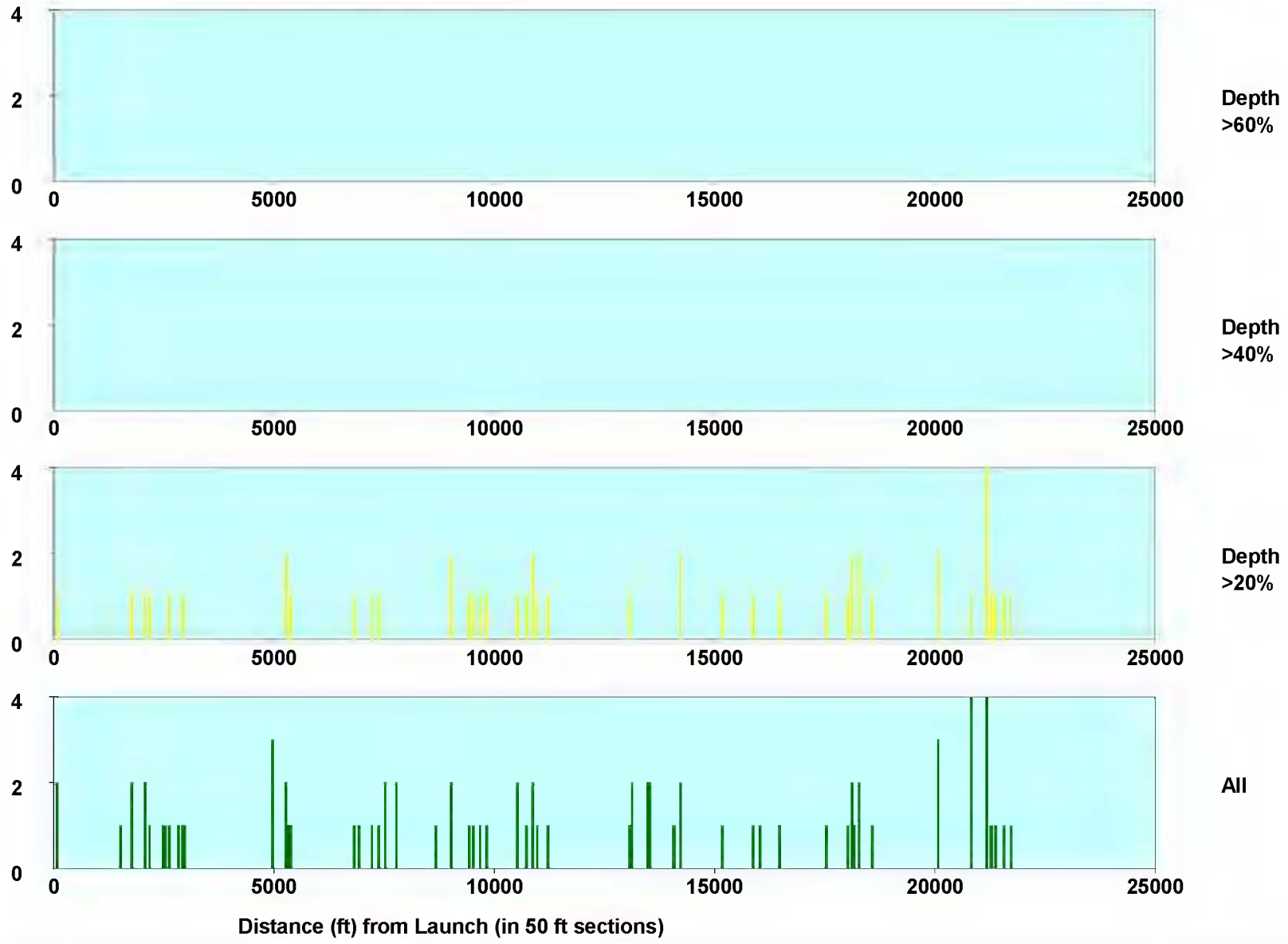
109170_20A
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Number of
Metal Loss
Features

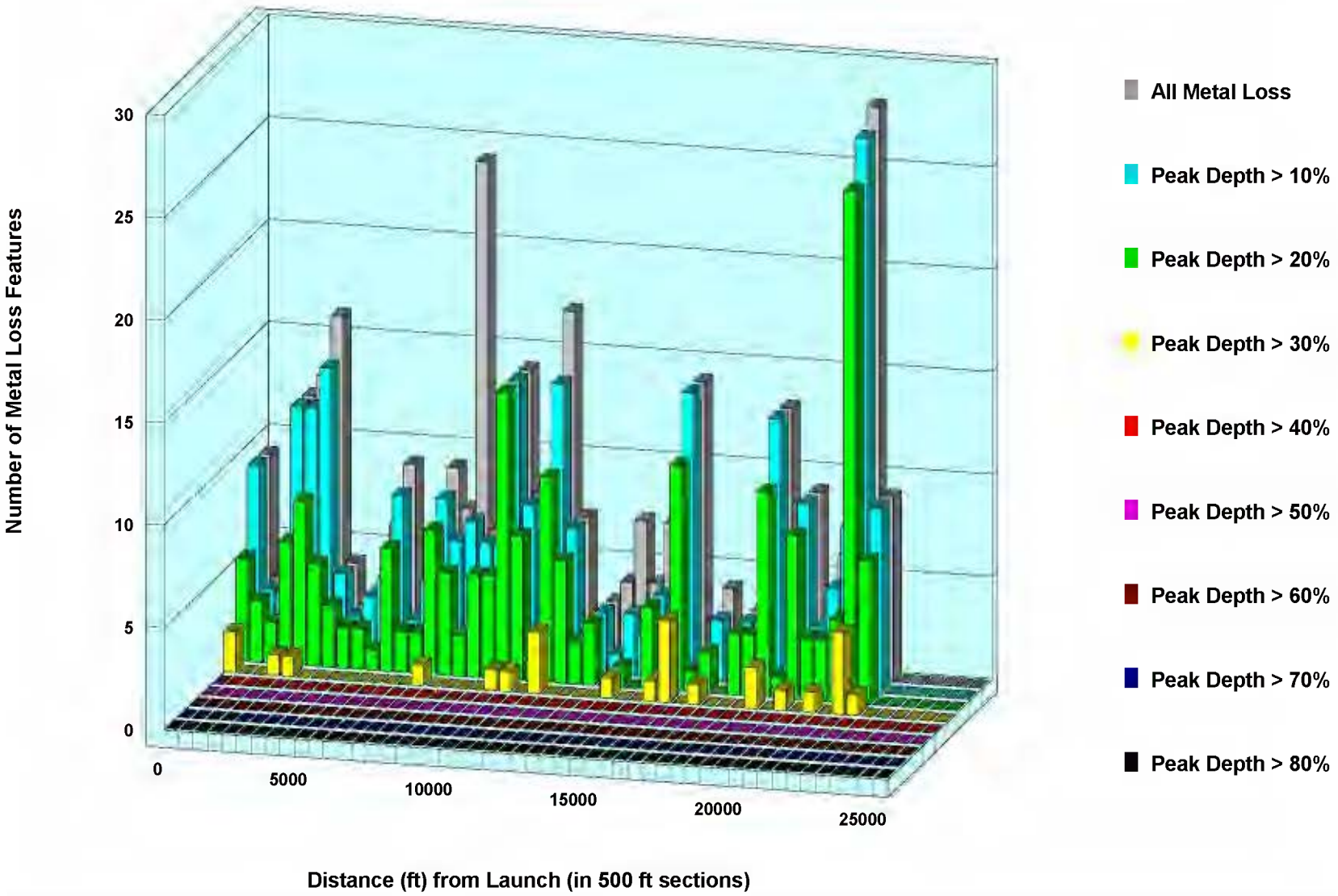
DEPTH BASED HISTOGRAM
Axial Length > 3t
Straits of Mackinac (West Leg)

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DEPTH BASED HISTOGRAM

Straits of Mackinac (West Leg)



3.1.4. Orientation Plot

The orientation plot shows the location and extent of each metal loss feature around the pipe's circumference.

The absolute distance from the launch is plotted against the orientation of the metal loss. The orientation is based on a 12 hour clock as viewed in the direction of product flow; for example, twelve indicates the top of the pipe and six indicates the bottom.

For each metal loss feature a box is drawn on the plot showing the predicted circumferential and axial extent of the metal loss feature. Due to the scale along the distance axis, each metal loss feature appears as a solid vertical line on the plot.

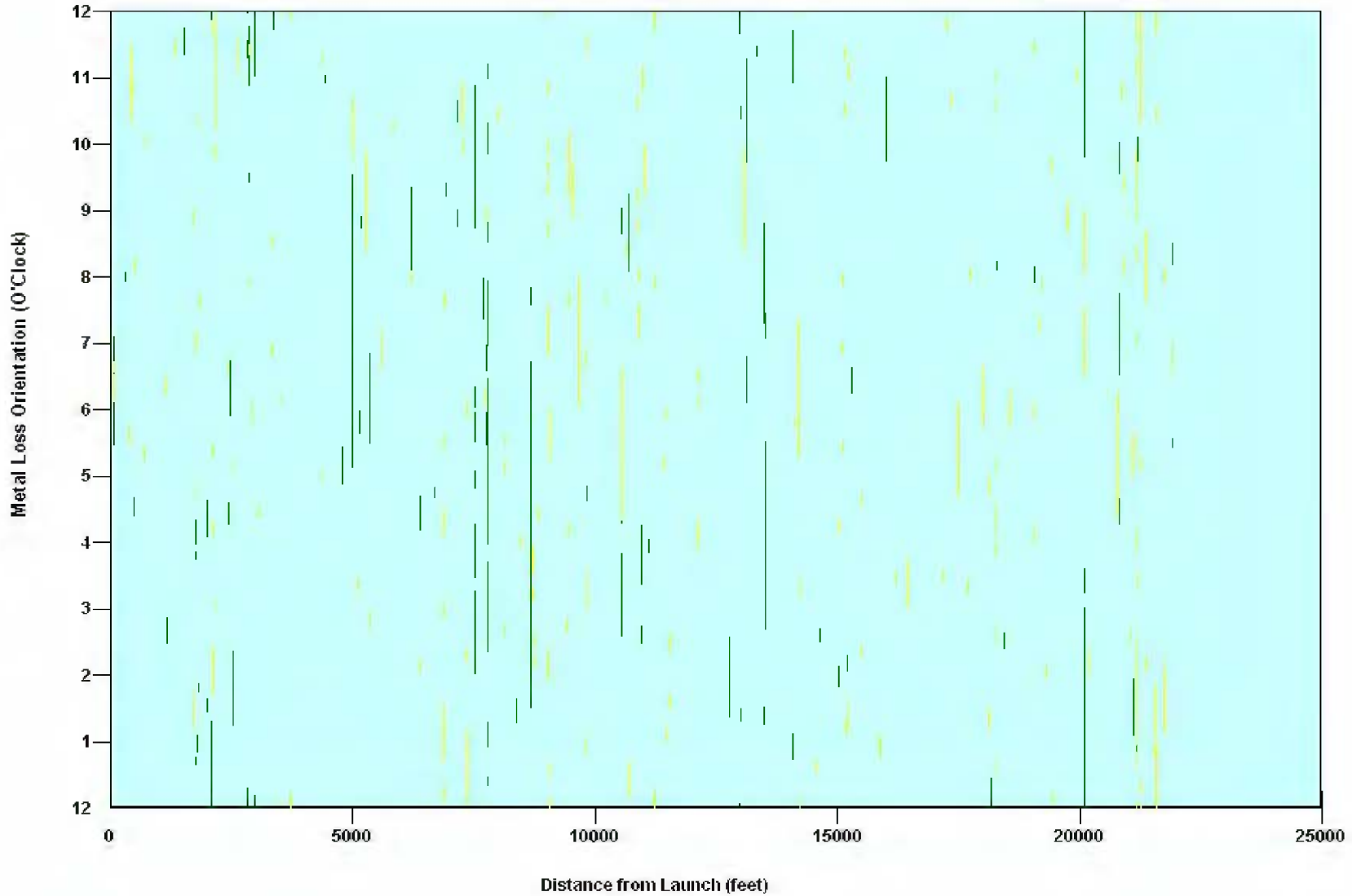
The orientation plot is presented overleaf.

ORIENTATION PLOT

Straits of Mackinac (West Leg) to

Peak Depth ≤ 20%
20% < Peak Depth ≤ 40%
40% < Peak Depth ≤ 60%
Peak Depth > 60%

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3.1.5. Severity Table

The severity table identifies those pipe spools which contain the most severe metal loss features.

Metal loss features that have been identified as manufacturing faults are not included in the severity table.

Only the worst metal loss feature in each spool is considered and these are listed in severity order as defined by the selection rules specified in the Specification for the Pipeline Inspection Report contained in the contract (Appendix F).

The severity table lists the twenty-five pipe spools which contain the most severe metal loss features. Metal loss features that have been identified as manufacturing faults are included in the severity table.

The RPR value for undamaged pipe is 1.333.

The severity table is presented overleaf.

Severity Table

Straits of Mackinac (West Leg)

Feature Selection Rule	RPR	Peak Depth (%)	Axial Length (in)	Circ. Width (in)	Upstream Girth Weld Number	Absolute Distance (feet)	Orientation (hrs:mins)
8	1.273	26	3.43	2.17	20	53.65	06:15
8	-	40	1.06	5.95	240	434.89	11:00
8	-	38	0.91	1.02	4290	10886.83	08:00
8	-	38	7.24	8.03	5130	13073.08	09:15
8	-	38	7.56	9.21	8310	21269.73	11:15
8	-	36	5.12	4.45	2730	6847.49	01:15
8	-	35	3.39	2.32	5960	15199.89	01:30
8	-	34	0.67	1.02	5890	15033.29	04:15
8	-	34	2.24	2.32	7890	20178.39	02:15
8	-	33	1.18	4.17	3580	9055.85	05:45
8	-	33	4.76	6.02	3810	9655.69	06:30
8	-	33	0.63	1.02	5710	14544.85	12:30
8	-	33	0.47	1.02	5930	15118.18	08:00
8	-	33	2.36	1.30	5980	15240.20	11:00
8	-	32	0.98	0.71	250	455.21	10:45
8	-	32	0.67	1.02	810	1844.00	07:45
8	-	32	8.47	3.82	6450	16460.33	03:30
8	-	32	3.19	1.61	7090	18116.15	01:15
8	-	32	0.67	1.02	7540	19290.20	02:00
8	-	32	2.28	1.02	8270	21182.12	11:30
8	-	31	4.45	3.82	900	2098.91	02:00
8	-	31	2.84	1.97	4320	10974.79	11:00
8	-	31	8.15	4.76	7040	18014.73	06:15
8	-	31	0.59	1.02	8430	21597.62	10:30
8	-	30	0.83	1.02	930	2184.23	03:00

3.2. Pipeline Information

The Pipeline Information section presents summaries of any pipeline anomalies, repairs, location reference points and changes in the nominal pipe wall thickness along the pipeline. The following summaries are provided:

- Velocity Plot
- Metal Object Report
- Eccentric Casing Report
- Dent Report
- Girth Weld Anomaly Report
- Repair Listing
- Location Reference Point Listing
- Nominal Wall Thickness Listing

3.2.1. Velocity Plot

The velocity plot shows the speed of the inspection vehicle during the inspection run.

The red line on the velocity plot indicates the specified maximum velocity for the inspection vehicle. If the vehicle exceeds the specified maximum velocity then the performance of the inspection vehicle may be degraded.

The inspection vehicle did not exceed the specified maximum velocity during the inspection survey.

The inspection vehicle's average velocity during the inspection run was 9.2 ft/s.

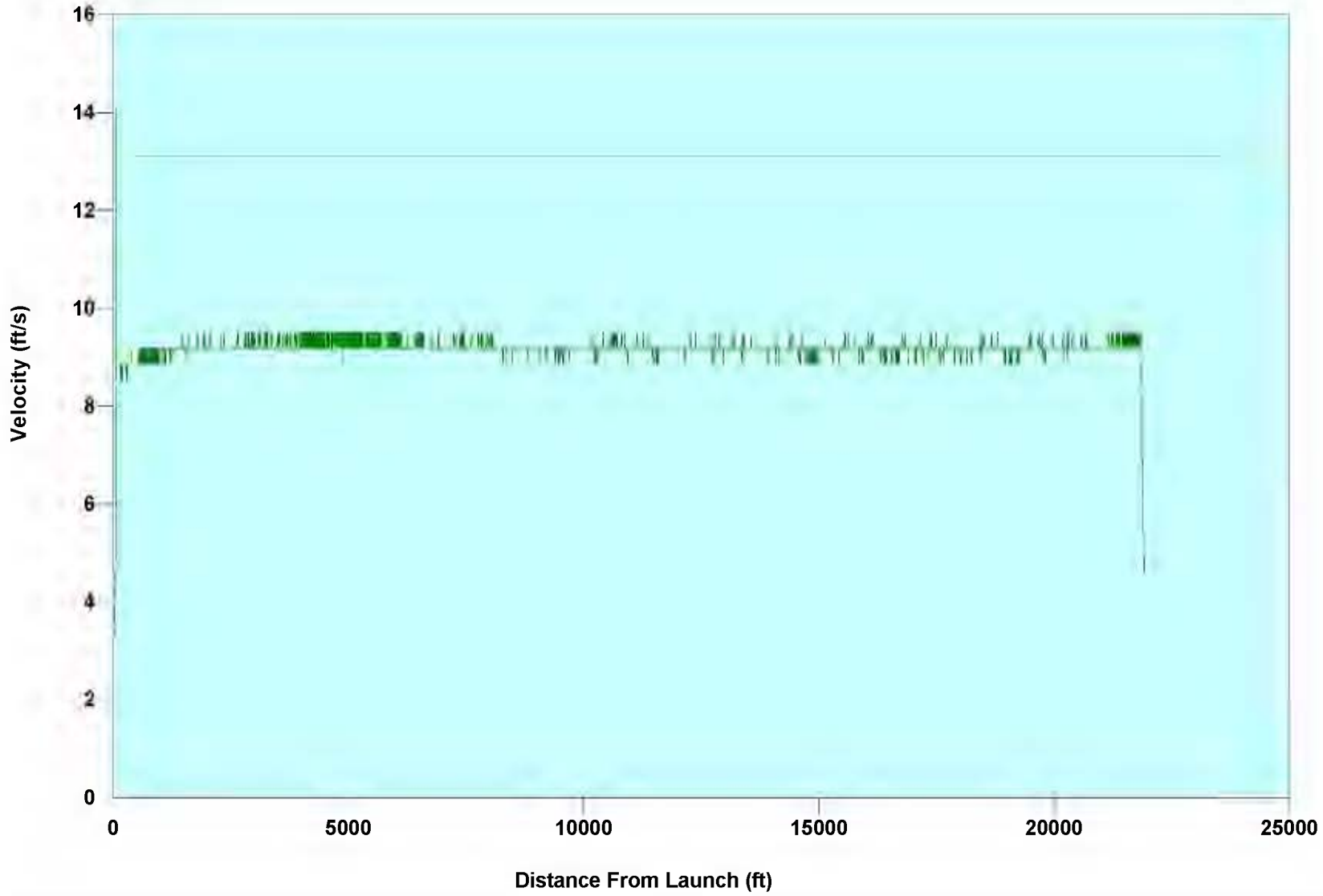
The velocity profile plot is presented overleaf.

VELOCITY PLOT

Straits of Mackinac (West Leg)

Contractual Maximum Velocity

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3.2.2. Metal Object Report

The metal object report provides a list of all ferrous metal objects that have been detected along the pipeline.

Metal objects can be potentially hazardous to the pipeline. They can impair the pipeline's protective coating or the cathodic protection system, and over time they can also dent or damage the pipe itself.

Metal objects are classified as close to or touching the pipeline. Those metal objects classified as touching are considered to have damaged the pipeline's protective coating or impaired the cathodic protection system. Metal objects that are considered to be part of the pipeline build, such as supports but excluding attachments, will only be reported if they are touching the pipeline. Pipeline casings that are touching the pipe will be reported in the eccentric pipeline casing report presented in Section 3.2.3.

One metal object has been detected during this pipeline inspection.

A table listing the metal object is presented overleaf.

ENBDNR0000973

Metal Object Report

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Proximity	Orientation (hrs:mins)	Upstream Reference	Distance U/S Ref. to Girth Weld (feet)	Downstream Reference	Distance D/S Ref. to Girth Weld (feet)
4710	3.068	11972.612	CLOSE	09:30	VALVE MP 1475.6	11913.655	VALVE MP 1479.5	9900.548

3.2.3. Eccentric Casing Report

The eccentric casing report provides a list of all casings detected along the pipeline which appear to be eccentric to the pipe and may, therefore, have damaged the pipeline's protective coating or impaired the cathodic protection system.

No eccentric casings have been detected during this pipeline inspection.

3.2.4. Dent Report

The dent report provides a list of all dents that have been detected along the pipeline.

The proximity of dents to metal losses, girth welds and seam welds is indicated in the report. If the orientation of a seam weld is unclear in the data then the dent proximity will be marked '***'.

Dents will affect the integrity of the pipeline and are potentially dangerous. It should be noted that a dent associated with metal loss is potentially more significant than a dent alone.

A CaliPPer inspection of the pipeline was completed by GE Oil & Gas, PII Pipeline Solutions on the 8th of May 2008. The Calipper survey detected no dents with an Internal Diameter (ID) reduction in excess of 2%OD.

4 dents have been detected during this pipeline inspection.

A table listing the dents is presented overleaf.

Dent Report

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Metal Loss	Girth Weld	Associated Seam Weld	% ID Reduction	Orientation (hrs:mins)	Upstream Reference	Distance U/S Ref. to Girth Weld (feet)	Downstream Reference	Distance D/S Ref. to Girth Weld (feet)
1290	1.67	3086.54	NO	NO	NO	<2% ID REDUCTION	08:30	VALVE MP 1475.6	3028.98	VALVE MP 1479.5	18785.23
3930	25.14	9990.88	NO	NO	NO	<2% ID REDUCTION	08:00	VALVE MP 1475.6	9909.86	VALVE MP 1479.5	11904.34
5420	2.76	13792.33	NO	NO	NO	<2% ID REDUCTION	05:15	VALVE MP 1475.6	13733.68	VALVE MP 1479.5	8080.53
6040	4.84	15402.81	NO	NO	NO	<2% ID REDUCTION	03:45	VALVE MP 1475.6	15342.08	VALVE MP 1479.5	6472.13

3.2.5. Girth Weld Anomaly Report

The girth weld anomaly report provides a list of all significant girth weld anomalies that have been detected along the pipeline.

Incomplete welds and circumferential cracks within the weld are examples of girth weld anomalies.

No girth weld anomalies have been detected during this pipeline inspection.

ENBDNR0000978

3.2.6. Repair Listing

The repair listing provides a list of all fully circumferential repair shells and patch repaired spools that have been detected along the pipeline.

It should be noted that any metal loss detected beneath a repair shell or repair patch will not be included in the inspection analysis.

If a patch repair is detected within the spool then the spool will be reported on this listing as a patch repaired spool. Details of the individual patch repairs within the patch repaired spool will not normally be provided.

The inspection system has detected **no repair shells** and **no patch repaired spools** during this pipeline inspection.

3.2.7. Location Reference Point Listing

This is a list of the line markers (timer boxes), magnets, mainline valves, offtakes and anodes, as appropriate, that have been detected by the inspection system and that can be used to locate features along the pipeline.

Line markers were not used on the inspection survey.

A table listing the location reference points along the pipeline is presented overleaf.

Location Reference Point Listing

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Identification
30	1.76	55.89	VALVE	MP 1475.6
8590	1.74	21870.09	VALVE	MP 1479.5

3.2.8. Nominal Wall Thickness Listing

The nominal wall thickness listing provides a list of the locations along the pipeline where a change in the nominal pipe wall thickness, or other parameter of the pipeline, has been detected by the inspection system. This listing identifies the major and minor pipeline segments used during the analysis of the inspection data.

A pipeline segment is a section of the pipeline where the nominal wall thickness (nwt) and the SMYS are constant.

Pipeline segments can be categorised as either major or minor segments.

A major segment is a pipeline segment that has been defined by the pipeline operator in the table provided in the Company Defined Operating Parameters section of the contract. In this table the pipeline operator specifies the locations of the start and end of the segment and the values of nwt and SMYS that apply within it.

A minor segment is a pipeline segment identified by the inspection system. The minor segment is a section within the major segment where the nominal wall thickness is distinctly different from that detected for the major segment.

In the absence of information from the pipeline operator, the SMYS value for the minor segment will be assumed to be the same as that specified for the major segment in which it is located.

The nominal wall thickness within the minor segment will be estimated from readings obtained from the inspection survey. The estimated nominal wall thickness will be either a wall thickness stated by the pipeline operator as being present in the pipeline, or the nearest American Petroleum Institute (API) nominal wall thickness.

The values of nwt and SMYS specified for each segment are used to calculate the RPR value of each metal loss feature detected within the segment.

A table listing the pipeline segments is presented overleaf.

ENBDNR0000982

Nominal Wall Thickness Listing

Straits of Mackinac (West Leg)

Upstream Girth Weld	Absolute Distance (feet)	Length of Segment (feet)	NWT (in)	Segment Number	SMYS (PSI)
10	24.081	21903.599	0.812	1	30000.0

3.3. Pipeline Listing

The pipeline listing presents the sequence of girth welds, metal loss features, metal objects, eccentric pipeline casings, dents, girth weld anomalies and repairs detected along the pipeline. Location reference points and changes in the nominal pipe wall thickness are also included in the pipeline listing.

The listing also contains all other pipeline tally information.

There are four types of entry in the pipeline listing. These are:

Girth Welds

Each girth weld entry consists of:

- a girth weld number;
- the relative distance along the pipeline to the girth weld from the previous (upstream) girth weld; and,
- the absolute distance from the start of the pipeline.

Metal Loss Features

Each entry for a metal loss feature consists of:

- the relative distance along the pipeline to the upstream edge of the metal loss feature from the previous (upstream) girth weld;
- the absolute distance along the pipeline to the upstream edge of the metal loss feature;
- ML to denote that the entry refers to a metal loss feature;
- EXT or INT to denote whether the metal loss feature is on the external or internal surface of the pipe. It should be noted that mid-wall metal loss features would be classified as external;
- the predicted peak depth of the metal loss feature;
- the predicted axial length of the metal loss feature;
- the predicted circumferential width of the metal loss feature;
- the local wall thickness;
- the orientation of the metal loss feature, as viewed in the direction of flow;
- the calculated RPR value for the metal loss feature;
- the calculated LAPA Pressure value for the metal loss feature;

ENBDNR0000984

- the calculated RPR LAPA value for the metal loss feature;
- a unique Cluster Identifier for the metal loss feature; and,
- those metal loss features which have undergone detailed processing and analysis are indicated by a *. This includes all features reported on inspection sheets.

Please be aware that the RPR values in the Pipeline Listing are allocated to individual features. In the case of future corrosion, increasing depth of individual corrosion features is not the only consideration. Individual features in close proximity may link together through low level corrosion leading to lower net RPR values.

Identified Manufacturing Faults

The entry for an identified manufacturing fault is the same as that for a metal loss feature with the following differences:

- MFG (in place of ML) to denote that the entry refers to an identified manufacturing fault; and,
- there is no calculated RPR value for an identified manufacturing fault.

Pipeline Anomalies and Fittings

Other entries in the pipeline listing relate to pipeline fittings and pipeline anomalies. These entries consist of:

- the relative distance along the pipeline to the fitting or anomaly from the previous (upstream) girth weld;
- the absolute distance along the pipeline to the fitting or anomaly; and,
- a comment describing the fitting or anomaly.

It should be noted that where the orientation of a pipeline fitting has not been specified then the fitting is centred on the 12-00 position.

The pipeline listing is presented overleaf.

ENBDNR0000985

Pipeline Listing

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
10	0.00	24.08										
	0.00	24.08	SEAMLESS START									
20	4.99	29.07										
	14.02	43.09	15 DEG BEND-COLD UNDER									
	22.42	51.49	*INT ML	16%	1.02	1.06	0.812	1.329	06:30	3235	1.328	1
	22.92	51.99	*INT ML	21%	1.26	0.87	0.812	1.325	06:45	3223	1.323	2
	23.51	52.58	*INT ML	20%	6.58	8.58	0.812	1.235	06:15	3051	1.253	3
	24.58	53.65	*INT ML	26%	3.43	2.17	0.812	1.273	06:15	3105	1.275	4
30	25.07	54.13										
	1.76	55.89	VALVE MP 1475.6									
60	3.50	57.64										
70	3.01	60.64										
	1.26	61.90	16 IN OFFTAKE-FORGED						03:00			
80	2.56	63.20										
	13.61	76.81	2 IN OFFTAKE-WELDOLET						03:00			
	18.42	81.62	2 IN OFFTAKE-WELDOLET						12:00			
90	24.06	87.26										
95	1.54	88.80										
	0.56	89.36	JOINT-INSULATED									
105	1.18	89.98										
110	1.33	91.31										
120	6.96	98.26										
130	27.10	125.36										
140	26.84	152.20										
150	23.43	175.62										
160	27.09	202.71										
170	27.64	230.35										
180	27.78	258.13										
190	22.69	280.82										
	25.68	306.50	INT MFG	18%	0.55	0.75	0.812		08:00			5
200	27.17	307.98										
210	27.11	335.10										
220	22.53	357.62										
230	26.59	384.21										
	1.72	385.92	*EXT MFG	27%	2.01	1.30	0.812		05:45			6
240	26.18	410.39										
	24.50	434.89	*EXT MFG	40%	1.06	5.95	0.812		11:00			7
250	27.10	437.49										
	17.72	455.21	*INT MFG	32%	0.98	0.71	0.812		10:45			8
260	20.91	458.40										
270	26.28	484.68										
	2.03	486.71	EXT MFG	19%	0.87	1.50	0.812		04:30			9

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
280	27.20	511.88										
	1.07	512.95	EXT MFG	25%	0.51	1.02	0.812		08:15			10
290	23.10	534.97										
300	26.71	561.68										
	12.89	574.57	20 DEG BEND-COLD LEFT									
310	25.01	586.69										
	12.04	598.73	20 DEG BEND-COLD LEFT									
320	25.52	612.21										
	13.10	625.31	25 DEG BEND-COLD LEFT									
330	25.76	637.97										
	11.49	649.47	25 DEG BEND-COLD LEFT									
340	26.17	664.14										
350	7.56	671.70										
360	26.89	698.59										
	1.89	700.48	EXT MFG	27%	0.59	1.02	0.812		05:15			11
	26.37	724.96	EXT MFG	26%	0.71	1.06	0.812		10:00			12
370	27.63	726.21										
380	27.69	753.90										
390	28.42	782.33										
400	26.66	808.99										
410	25.16	834.15										
420	25.63	859.79										
430	23.93	883.72										
440	27.84	911.56										
450	23.70	935.26										
460	23.87	959.12										
470	28.09	987.22										
480	19.89	1007.11										
490	27.02	1034.13										
500	24.30	1058.43										
510	27.73	1086.17										
520	26.68	1112.85										
530	25.67	1138.52										
	0.39	1138.90	EXT MFG	21%	0.91	1.34	0.812		06:15			13
540	21.05	1159.57										
	0.25	1159.82	INT MFG	14%	0.91	2.13	0.812		02:45			14
550	26.87	1186.44										
560	27.14	1213.58										
570	26.98	1240.56										
580	23.17	1263.74										
590	24.98	1288.71										
600	26.37	1315.08										

Pipeline Listing

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
	17.65	1332.73	EXT MFG	24%	0.47	1.02	0.812		11:30			15
610	20.97	1336.06										
620	27.99	1364.04										
630	24.67	1388.71										
640	24.29	1413.00										
650	20.00	1433.01										
660	27.08	1460.08										
670	21.27	1481.36										
680	27.79	1509.14										
	0.82	1509.96	INT MFG	12%	3.35	2.17	0.812		11:30			16
690	24.42	1533.56										
700	27.32	1560.88										
710	24.84	1585.72										
720	26.84	1612.56										
730	27.48	1640.04										
740	27.35	1667.39										
750	25.72	1693.11										
	0.81	1693.92	EXT MFG	24%	0.59	1.30	0.812		09:00			17
	5.36	1698.47	EXT MFG	23%	2.44	3.07	0.812		01:30			18
760	23.05	1716.17										
770	26.90	1743.07										
	15.73	1758.79	INT MFG	21%	0.28	0.71	0.812		04:45			19
	16.35	1759.42	INT MFG	19%	4.06	1.97	0.812		04:15			20
	17.14	1760.20	INT MFG	12%	0.28	0.71	0.812		03:45			21
	20.88	1763.94	INT MFG	21%	2.68	1.65	0.812		07:00			22
	24.79	1767.85	INT MFG	20%	0.39	0.71	0.812		12:45			23
	27.64	1770.71	INT MFG	13%	1.38	1.46	0.812		01:00			24
780	27.98	1771.04										
	21.80	1792.85	INT MFG	28%	0.28	0.71	0.812		10:15			25
790	26.80	1797.84										
800	18.79	1816.63										
	2.40	1819.03	INT MFG	20%	0.28	0.75	0.812		01:45			26
810	26.52	1843.15										
	0.85	1844.00	*EXT MFG	32%	0.67	1.02	0.812		07:45			27
820	27.29	1870.44										
830	28.22	1898.66										
840	27.70	1926.36										
850	21.28	1947.64										
860	26.37	1974.01										
	27.20	2001.21	INT MFG	17%	1.81	1.02	0.812		01:30			28
	27.88	2001.89	INT MFG	11%	1.10	2.99	0.812		04:30			29
870	28.04	2002.05										

Pipeline Listing

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
880	27.79	2029.83										
890	23.79	2053.62										
	22.55	2076.17	INT MFG	10%	4.33	7.60	0.812		12:30			30
900	25.60	2079.22										
	19.46	2098.68	EXT MFG	22%	0.75	1.02	0.812		04:15			31
	19.62	2098.84	EXT MFG	26%	0.55	1.02	0.812		05:30			32
	19.69	2098.91	*EXT MFG	31%	4.45	3.82	0.812		02:00			33
	20.40	2099.62	EXT MFG	23%	0.67	1.02	0.812		11:45			34
910	26.76	2105.98										
	20.14	2126.12	EXT MFG	25%	0.95	0.98	0.812		10:00			35
920	25.30	2131.28										
930	26.29	2157.57										
	26.55	2184.12	EXT MFG	25%	5.24	9.33	0.812		11:00			36
	26.66	2184.23	EXT MFG	30%	0.83	1.02	0.812		03:00			37
940	27.88	2185.44										
950	25.10	2210.54										
960	27.95	2238.49										
970	28.17	2266.67										
980	27.90	2294.56										
990	20.36	2314.93										
1000	27.47	2342.40										
1010	27.84	2370.23										
1020	27.92	2398.15										
	27.54	2425.70	INT MFG	22%	1.69	1.34	0.812		06:45			38
1030	27.89	2426.04										
1040	27.55	2453.59										
	0.38	2453.97	INT MFG	16%	2.13	1.85	0.812		04:30			39
1050	26.67	2480.26										
	0.16	2480.42	INT MFG	17%	10.28	4.45	0.812		06:15			40
1060	27.20	2507.46										
	25.92	2533.37	INT MFG	18%	1.14	1.14	0.812		01:15			41
	26.46	2533.92	INT MFG	15%	2.60	5.55	0.812		01:45			42
	26.62	2534.08	INT MFG	23%	0.28	0.71	0.812		05:15			43
	27.12	2534.57	INT MFG	15%	0.91	0.91	0.812		02:15			44
1070	27.73	2535.19										
1080	23.51	2558.70										
1090	25.23	2583.93										
1100	26.37	2610.30										
	26.99	2637.29	EXT MFG	21%	3.07	2.87	0.812		11:30			45
1110	27.43	2637.73										
1120	27.21	2664.94										
1130	27.08	2692.02										

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
1140	22.37	2714.38										
1150	24.08	2738.46										
1160	22.76	2761.22										
1170	25.22	2786.44										
1180	25.16	2811.60										
1190	24.38	2835.98										
	2.40	2838.38	INT MFG	9%	0.71	1.61	0.812		12:15			46
	3.03	2839.01	INT MFG	18%	0.43	0.71	0.812		12:00			47
	4.04	2840.02	INT MFG	19%	0.75	1.38	0.812		11:30			48
	4.58	2840.56	INT MFG	13%	0.28	0.71	0.812		12:15			49
	8.35	2844.33	INT MFG	19%	3.62	4.09	0.812		11:30			50
	11.57	2847.55	INT MFG	28%	0.28	0.71	0.812		08:00			51
	19.70	2855.67	INT MFG	14%	0.59	0.83	0.812		09:30			52
	22.76	2858.74	INT MFG	24%	0.47	0.91	0.812		11:30			53
	23.31	2859.29	INT MFG	16%	0.71	0.71	0.812		11:00			54
1200	23.59	2859.57										
1210	26.91	2886.48										
1220	26.72	2913.20										
	0.87	2914.07	INT MFG	21%	6.58	2.52	0.812		06:00			55
1230	19.46	2932.65										
1240	22.98	2955.63										
	0.38	2956.01	INT MFG	5%	3.31	6.10	0.812		11:45			56
1250	26.93	2982.56										
1260	22.61	3005.16										
1270	25.91	3031.07										
1280	27.30	3058.37										
	11.47	3069.84	INT MFG	26%	0.47	0.71	0.812		04:30			57
1290	26.50	3084.87										
	1.67	3086.54	DENT <2% ID REDUCTION						08:30			
1300	21.60	3106.46										
1310	26.03	3132.49										
1320	27.16	3159.65										
1330	25.88	3185.52										
1340	27.75	3213.26										
1350	27.00	3240.27										
1360	25.85	3266.12										
1370	28.12	3294.24										
	25.74	3319.98	EXT MFG	25%	0.59	1.02	0.812		08:30			58
1380	26.83	3321.06										
	23.25	3344.31	EXT MFG	24%	0.47	1.02	0.812		07:00			59
1390	24.45	3345.52										
	3.01	3348.53	EXT MFG	17%	0.63	1.46	0.812		11:45			60

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
1400	24.71	3370.22										
1410	27.02	3397.24										
1420	26.73	3423.97										
1430	25.35	3449.32										
1440	28.44	3477.76										
	24.49	3502.25	INT MFG	25%	1.22	0.83	0.812		06:15			61
1450	24.71	3502.46										
1460	26.75	3529.21										
1470	22.14	3551.35										
1480	24.40	3575.75										
1490	25.92	3601.66										
1500	28.00	3629.66										
1510	24.34	3654.00										
1520	26.96	3680.96										
1530	19.74	3700.70										
1540	24.96	3725.66										
	1.56	3727.21	EXT MFG	28%	1.14	1.97	0.812		12:00			62
1550	27.81	3753.47										
1560	27.45	3780.92										
1570	27.87	3808.78										
1580	26.99	3835.77										
1590	26.36	3862.13										
1600	25.41	3887.53										
1610	22.78	3910.31										
1620	22.35	3932.67										
1630	28.44	3961.10										
1640	25.77	3986.88										
1650	22.89	4009.77										
1660	26.13	4035.89										
1670	23.76	4059.66										
1680	26.87	4086.53										
1690	26.67	4113.20										
1700	26.88	4140.08										
1710	19.60	4159.68										
1720	25.63	4185.31										
1730	26.48	4211.79										
1740	27.78	4239.57										
1750	28.49	4268.05										
1760	26.60	4294.65										
1770	26.90	4321.56										
1780	27.24	4348.80										
1790	25.39	4374.19										

Pipeline Listing

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
	0.66	4374.85	EXT MFG	23%	0.47	1.02	0.812		11:15			63
	1.97	4376.16	EXT MFG	24%	1.14	1.02	0.812		05:00			64
1800	26.74	4400.93										
	20.99	4421.93	INT MFG	18%	0.32	0.71	0.812		11:00			65
1810	27.67	4428.60										
1820	25.15	4453.75										
1830	25.93	4479.68										
1840	25.54	4505.22										
1850	20.70	4525.92										
1860	24.62	4550.54										
1870	26.57	4577.10										
1880	26.73	4603.83										
1890	27.30	4631.12										
1900	21.74	4652.87										
1910	27.53	4680.39										
1920	27.41	4707.80										
1930	27.55	4735.34										
1940	27.38	4762.73										
1950	27.97	4790.69										
	3.02	4793.71	INT MFG	10%	1.50	2.99	0.812		05:15			66
1960	26.39	4817.08										
1970	26.42	4843.50										
1980	25.59	4869.09										
1990	26.99	4896.09										
2000	21.74	4917.83										
2010	26.41	4944.24										
2020	27.12	4971.36										
	22.10	4993.46	INT MFG	11%	8.90	6.10	0.812		07:30			67
	23.67	4995.03	INT MFG	8%	0.43	1.54	0.812		07:45			68
	24.81	4996.17	INT MFG	20%	6.69	23.19	0.812		07:15			69
	25.58	4996.94	INT MFG	12%	9.13	4.41	0.812		08:15			70
	25.84	4997.20	INT MFG	23%	0.87	4.80	0.812		10:15			71
2030	26.74	4998.10										
2040	22.78	5020.88										
2050	27.62	5048.49										
2060	26.25	5074.74										
2070	27.69	5102.43										
	8.12	5110.55	EXT MFG	24%	0.95	1.02	0.812		03:30			72
2080	27.47	5129.90										
	24.27	5154.17	INT MFG	15%	1.22	1.89	0.812		05:45			73
2090	26.96	5156.86										
2100	20.67	5177.53										

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
	4.22	5181.75	INT MFG	10%	0.83	1.02	0.812		08:45			74
2110	27.61	5205.13										
2120	25.82	5230.95										
	19.05	5250.00	EXT MFG	23%	0.59	1.02	0.812		09:00			75
	19.67	5250.61	EXT MFG	26%	4.41	6.81	0.812		09:15			76
	22.42	5253.37	EXT MFG	29%	0.47	1.02	0.812		08:30			77
	23.28	5254.23	EXT MFG	23%	2.56	1.54	0.812		09:00			78
2130	25.39	5256.34										
2140	26.07	5282.42										
2150	24.18	5306.59										
	24.72	5331.32	EXT MFG	17%	3.62	7.13	0.812		06:15			79
2160	27.70	5334.30										
	20.40	5354.70	EXT MFG	23%	2.91	1.42	0.812		02:45			80
2170	26.95	5361.24										
2180	25.97	5387.22										
2190	25.27	5412.49										
2200	25.54	5438.03										
2210	27.21	5465.23										
2220	27.50	5492.74										
2230	27.12	5519.86										
2240	23.81	5543.67										
2250	27.08	5570.75										
	26.38	5597.12	EXT MFG	25%	1.38	3.19	0.812		07:00			81
2260	27.13	5597.88										
2270	21.69	5619.57										
2280	26.16	5645.73										
2290	27.60	5673.33										
2300	25.82	5699.15										
2310	27.31	5726.45										
2320	26.06	5752.52										
2330	27.25	5779.77										
2340	27.63	5807.39										
	13.96	5821.36	EXT MFG	28%	0.59	1.02	0.812		10:15			82
2350	26.81	5834.21										
2360	25.73	5859.94										
2370	27.29	5887.23										
2380	24.53	5911.76										
2390	26.87	5938.63										
2400	20.51	5959.13										
2410	24.69	5983.82										
2420	25.76	6009.58										
2430	25.37	6034.95										

Pipeline Listing

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
2440	21.84	6056.79										
2450	27.04	6083.84										
2460	26.67	6110.51										
2470	27.56	6138.07										
2480	26.26	6164.33										
2490	27.85	6192.18										
	21.14	6213.32	EXT MFG	25%	0.59	1.02	0.812		08:00			83
	25.71	6217.89	INT MFG	12%	0.95	6.61	0.812		08:45			84
2500	26.37	6218.55										
2510	25.34	6243.89										
2520	22.51	6266.39										
2530	27.53	6293.92										
2540	26.44	6320.36										
2550	27.44	6347.80										
2560	27.53	6375.33										
	21.97	6397.29	EXT MFG	25%	0.95	1.02	0.812		02:15			85
	22.84	6398.16	EXT MFG	15%	1.58	2.76	0.812		04:30			86
2570	26.06	6401.39										
2580	28.27	6429.66										
2590	27.97	6457.64										
2600	20.97	6478.60										
2610	26.63	6505.23										
2620	26.70	6531.92										
2630	23.40	6555.33										
2640	27.12	6582.45										
2650	26.21	6608.66										
2660	26.76	6635.42										
2670	27.21	6662.63										
2680	27.55	6690.18										
	0.27	6690.45	INT MFG	9%	0.79	0.95	0.812		04:45			87
2690	26.45	6716.63										
2700	27.35	6743.99										
2710	27.98	6771.96										
2720	27.85	6799.81										
2730	25.63	6825.45										
	21.50	6846.95	EXT MFG	26%	2.17	1.02	0.812		04:30			88
	22.05	6847.49	*EXT MFG	36%	5.12	4.45	0.812		01:15			89
	22.17	6847.62	EXT MFG	26%	0.75	1.10	0.812		03:00			90
	22.91	6848.36	*EXT MFG	23%	0.47	1.02	0.812		12:15			91
	24.71	6850.15	EXT MFG	24%	1.02	1.34	0.812		04:15			92
2740	26.08	6851.53										
2750	20.70	6872.23										

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
	1.29	6873.53	EXT MFG	23%	0.47	1.02	0.812		05:30			93
2760	28.28	6900.52										
	1.38	6901.89	EXT MFG	26%	0.51	1.42	0.812		07:45			94
2770	28.00	6928.51										
	1.80	6930.31	INT MFG	12%	2.60	1.02	0.812		09:15			95
2780	26.58	6955.09										
2790	25.32	6980.40										
2800	26.19	7006.59										
2810	23.51	7030.11										
2820	24.96	7055.06										
2830	27.22	7082.28										
2840	27.36	7109.65										
2850	24.63	7134.28										
	25.04	7159.31	INT MFG	12%	2.21	1.73	0.812		10:30			96
	25.31	7159.58	INT MFG	7%	0.51	1.38	0.812		09:00			97
2860	27.24	7161.52										
2870	25.49	7187.01										
2880	26.02	7213.03										
2890	26.41	7239.44										
	4.86	7244.29	EXT MFG	30%	3.39	3.66	0.812		10:30			98
	25.81	7265.25	EXT MFG	21%	0.71	1.34	0.812		10:00			99
2900	26.42	7265.86										
2910	26.15	7292.01										
2920	24.42	7316.43										
	25.82	7342.25	*EXT MFG	30%	0.75	1.02	0.812		02:15			100
2930	28.19	7344.62										
	24.25	7368.87	EXT MFG	28%	6.22	5.71	0.812		12:45			101
	24.78	7369.40	EXT MFG	25%	0.47	1.02	0.812		06:00			102
2940	26.32	7370.94										
2950	26.59	7397.53										
2960	28.00	7425.53										
2970	27.46	7452.99										
2980	26.91	7479.90										
2990	27.71	7507.61										
	4.02	7511.63	INT MFG	10%	1.18	1.65	0.812		06:15			103
	4.08	7511.69	INT MFG	8%	1.61	1.42	0.812		05:00			104
	4.70	7512.31	INT MFG	3%	1.69	3.11	0.812		02:15			105
	5.39	7513.00	INT MFG	16%	13.15	11.38	0.812		09:45			106
	6.57	7514.18	INT MFG	8%	1.34	4.29	0.812		04:00			107
	7.01	7514.62	INT MFG	5%	1.10	2.36	0.812		05:45			108
	7.61	7515.22	INT MFG	7%	2.99	3.82	0.812		03:00			109
3000	27.19	7534.80										

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
3010	22.82	7557.62										
3020	26.18	7583.81										
3030	26.43	7610.24										
3040	20.55	7630.78										
3050	25.30	7656.08										
3060	26.31	7682.39										
	2.50	7684.90	EXT MFG	6%	1.06	3.31	0.812		07:45			110
3070	24.44	7706.83										
3080	26.68	7733.52										
	0.43	7733.95	EXT MFG	26%	0.71	1.18	0.812		06:15			111
3090	26.82	7760.34										
	3.98	7764.31	INT MFG	4%	0.59	2.60	0.812		05:45			112
	4.85	7765.18	INT MFG	21%	0.51	0.71	0.812		09:00			113
	5.81	7766.14	INT MFG	6%	1.89	2.13	0.812		06:45			114
	6.28	7766.61	INT MFG	10%	0.75	1.69	0.812		08:45			115
	6.39	7766.73	INT MFG	14%	6.46	10.00	0.812		05:00			116
	7.54	7767.87	INT MFG	17%	0.71	0.71	0.812		12:30			117
	8.61	7768.94	INT MFG	10%	0.47	1.22	0.812		11:00			118
	9.14	7769.48	INT MFG	14%	2.44	3.07	0.812		06:15			119
	9.78	7770.12	INT MFG	6%	2.13	7.17	0.812		03:00			120
	9.91	7770.25	INT MFG	5%	0.71	1.54	0.812		01:15			121
	11.04	7771.38	INT MFG	9%	1.46	2.48	0.812		10:00			122
	11.66	7771.99	INT MFG	2%	1.06	5.16	0.812		07:30			123
	12.18	7772.51	INT MFG	10%	1.69	4.57	0.812		05:30			124
	12.68	7773.02	INT MFG	10%	0.43	0.87	0.812		07:00			125
3100	27.51	7787.84										
	5.99	7793.83	INT MFG	13%	0.55	0.71	0.812		01:00			126
3110	27.03	7814.87										
3120	25.68	7840.55										
3130	25.56	7866.11										
3140	27.82	7893.93										
3150	26.72	7920.65										
3160	27.01	7947.66										
3170	27.57	7975.23										
3180	11.40	7986.63										
	18.96	8005.59	EXT MFG	27%	0.47	1.02	0.812		10:30			127
3190	27.35	8013.98										
3200	28.55	8042.53										
3210	26.31	8068.84										
3220	26.15	8094.99										
3230	25.08	8120.07										
	16.90	8136.97	EXT MFG	24%	0.59	1.02	0.812		05:30			128

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
	17.83	8137.89	EXT MFG	23%	1.10	1.18	0.812		02:45			129
	18.01	8138.08	EXT MFG	25%	0.59	1.02	0.812		05:15			130
3240	27.18	8147.24										
3250	21.84	8169.09										
3260	24.68	8193.77										
3270	24.67	8218.44										
3280	25.29	8243.72										
3290	25.35	8269.07										
3300	26.72	8295.79										
3310	26.06	8321.85										
3320	28.03	8349.88										
3330	25.74	8375.62										
	0.68	8376.31	EXT MFG	13%	1.22	1.97	0.812		01:30			131
3340	28.06	8403.68										
3350	26.34	8430.02										
3360	26.96	8456.98										
	20.47	8477.44	EXT MFG	29%	0.63	1.02	0.812		04:00			132
3370	27.19	8484.16										
3380	28.05	8512.22										
3390	26.74	8538.95										
3400	23.12	8562.07										
3410	26.86	8588.93										
3420	26.64	8615.57										
3430	26.45	8642.03										
	25.16	8667.19	INT MFG	10%	0.39	1.46	0.812		07:45			133
	25.69	8667.72	INT MFG	16%	14.84	27.36	0.812		04:15			134
3440	27.89	8669.92										
	17.79	8687.71	EXT MFG	25%	1.38	2.24	0.812		03:45			135
	18.45	8688.37	EXT MFG	25%	0.51	1.02	0.812		03:15			136
3450	27.73	8697.65										
3460	23.66	8721.31										
	20.75	8742.05	EXT MFG	28%	1.06	1.02	0.812		02:15			137
	22.02	8743.32	EXT MFG	23%	0.47	1.02	0.812		02:30			138
3470	24.33	8745.64										
3480	25.29	8770.92										
3490	24.81	8795.74										
3500	26.76	8822.50										
	4.19	8826.69	EXT MFG	29%	0.47	1.02	0.812		04:30			139
3510	26.06	8848.56										
3520	24.75	8873.30										
3530	26.69	8899.99										
3540	28.08	8928.07										

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
3550	24.61	8952.68										
3560	28.07	8980.75										
3570	27.15	9007.90										
3580	26.04	9033.93										
	1.70	9035.63	EXT MFG	25%	0.51	1.02	0.812		10:00			140
	1.71	9035.64	EXT MFG	30%	3.90	3.94	0.812		07:15			141
	2.56	9036.49	EXT MFG	24%	0.55	1.02	0.812		09:45			142
	3.07	9037.00	EXT MFG	27%	0.71	1.02	0.812		09:15			143
	3.96	9037.90	EXT MFG	29%	5.83	2.28	0.812		02:15			144
	5.63	9039.57	EXT MFG	25%	0.47	1.02	0.812		08:45			145
	11.21	9045.14	EXT MFG	24%	0.59	1.02	0.812		10:45			146
	21.92	9055.85	*EXT MFG	33%	1.18	4.17	0.812		05:45			147
	26.46	9060.39	EXT MFG	26%	0.47	1.02	0.812		12:00			148
3590	27.69	9061.62										
	1.83	9063.46	EXT MFG	24%	0.59	1.02	0.812		12:30			149
3600	25.99	9087.62										
3610	25.92	9113.54										
3620	27.40	9140.94										
3630	27.58	9168.51										
3640	27.69	9196.20										
3650	27.68	9223.89										
3660	27.47	9251.36										
3670	21.98	9273.34										
3680	26.88	9300.22										
3690	27.06	9327.28										
3700	25.33	9352.60										
3710	27.25	9379.86										
3720	27.82	9407.68										
	21.11	9428.79	EXT MFG	26%	0.51	1.02	0.812		02:45			150
	24.88	9432.56	EXT MFG	28%	4.37	5.08	0.812		09:45			151
	24.99	9432.67	EXT MFG	24%	0.47	1.02	0.812		04:15			152
	25.53	9433.21	EXT MFG	30%	0.47	1.02	0.812		07:45			153
3730	27.69	9435.37										
3740	26.29	9461.66										
3750	27.78	9489.44										
3760	27.07	9516.50										
3770	28.26	9544.76										
	2.22	9546.98	EXT MFG	24%	5.95	4.13	0.812		09:15			154
3780	27.61	9572.37										
3790	26.58	9598.94										
3800	27.90	9626.84										
3810	27.25	9654.09										

Pipeline Listing

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
	0.76	9654.85	EXT MFG	25%	2.32	8.27	0.812		07:15			155
	1.59	9655.69	*EXT MFG	33%	4.76	6.02	0.812		06:30			156
3820	26.65	9680.74										
3830	25.17	9705.92										
3840	24.72	9730.63										
3850	26.89	9757.52										
3860	27.34	9784.87										
3870	28.06	9812.93										
	0.67	9813.60	EXT MFG	27%	0.47	1.02	0.812		06:45			157
	1.14	9814.06	EXT MFG	25%	0.83	1.02	0.812		01:00			158
	5.73	9818.65	EXT MFG	24%	4.29	1.69	0.812		11:30			159
	6.72	9819.64	EXT MFG	19%	0.79	1.26	0.812		04:45			160
	20.84	9833.76	*EXT MFG	25%	1.58	3.31	0.812		03:15			161
3880	22.84	9835.76										
3890	26.59	9862.35										
3900	27.55	9889.90										
3910	20.57	9910.47										
3920	27.85	9938.32										
3930	27.43	9965.75										
	25.14	9990.88	DENT <2% ID REDUCTION						08:00			
3940	27.60	9993.35										
3950	28.14	10021.49										
3960	24.72	10046.20										
3970	27.38	10073.59										
3980	26.38	10099.97										
3990	27.90	10127.86										
4000	22.50	10150.36										
4010	27.65	10178.01										
4020	24.88	10202.89										
	25.76	10228.65	EXT MFG	29%	0.47	1.02	0.812		07:45			162
4030	26.12	10229.00										
4040	23.63	10252.64										
4050	24.95	10277.58										
4060	22.68	10300.26										
4070	24.66	10324.93										
4080	27.09	10352.01										
4090	23.65	10375.66										
4100	26.97	10402.63										
4110	27.48	10430.11										
4120	27.58	10457.69										
4130	27.52	10485.20										
4140	26.96	10512.16										

Pipeline Listing

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
	19.95	10532.11	INT MFG	22%	6.97	12.21	0.812		05:30			163
	20.57	10532.73	INT MFG	17%	0.28	0.71	0.812		04:15			164
	21.86	10534.02	INT MFG	5%	0.83	2.09	0.812		08:45			165
	22.42	10534.58	INT MFG	12%	2.76	6.65	0.812		03:15			166
4150	26.43	10538.59										
4160	12.49	10551.08										
4170	19.96	10571.04										
4180	24.88	10595.92										
4190	26.88	10622.80										
4200	27.76	10650.56										
	3.07	10653.63	EXT MFG	23%	0.71	1.02	0.812		08:30			167
4210	25.92	10676.48										
	0.73	10677.21	INT MFG	6%	1.30	6.10	0.812		08:45			168
4220	26.75	10703.23										
	9.53	10712.75	EXT MFG	29%	4.21	2.56	0.812		12:30			169
4230	27.24	10730.47										
4240	21.14	10751.61										
4250	27.52	10779.12										
4260	20.15	10799.28										
4270	25.19	10824.47										
4280	27.50	10851.97										
4290	26.12	10878.08										
	4.51	10882.59	EXT MFG	26%	1.38	1.02	0.812		10:30			170
	7.11	10885.19	EXT MFG	29%	1.34	1.14	0.812		09:15			171
	7.69	10885.77	EXT MFG	22%	1.02	1.02	0.812		08:45			172
	8.74	10886.83	*EXT MFG	38%	0.91	1.02	0.812		08:00			173
	9.60	10887.68	EXT MFG	34%	6.93	1.65	0.812		07:30			174
	10.64	10888.72	EXT MFG	30%	8.15	2.21	0.812		07:15			175
4300	28.05	10906.14										
4310	27.83	10933.97										
4320	26.14	10960.11										
	8.17	10968.27	EXT MFG	20%	1.81	2.52	0.812		04:00			176
	8.28	10968.38	EXT MFG	18%	1.38	1.42	0.812		02:45			177
	10.25	10970.35	EXT MFG	9%	1.61	2.95	0.812		03:45			178
	14.69	10974.79	*EXT MFG	31%	2.84	1.97	0.812		11:00			179
4330	27.14	10987.25										
4340	23.24	11010.49										
	0.55	11011.04	*EXT MFG	30%	1.97	3.94	0.812		09:45			180
4350	28.07	11038.56										
4360	26.03	11064.59										
4370	26.72	11091.31										
	2.66	11093.97	EXT MFG	19%	1.14	1.02	0.812		04:00			181

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
4380	27.78	11119.09										
4390	24.11	11143.20										
4400	23.74	11166.94										
4410	27.09	11194.03										
4420	26.58	11220.60										
	2.56	11223.17	*EXT MFG	30%	5.75	2.87	0.812		12:00			182
	4.15	11224.75	EXT MFG	26%	0.71	1.02	0.812		08:00			183
4430	25.31	11245.91										
4440	27.84	11273.74										
4450	26.65	11300.39										
4460	27.46	11327.85										
4470	26.58	11354.43										
4480	24.13	11378.56										
4490	25.78	11404.33										
	13.93	11418.26	EXT MFG	24%	0.47	1.02	0.812		05:15			184
4500	23.84	11428.17										
4510	27.94	11456.12										
	16.18	11472.30	INT MFG	21%	0.32	0.71	0.812		06:00			185
	19.22	11475.34	EXT MFG	23%	0.55	1.02	0.812		01:15			186
4520	19.51	11475.62										
4530	27.50	11503.13										
	5.44	11508.57	EXT MFG	21%	0.59	1.22	0.812		02:30			187
	23.61	11526.74	EXT MFG	24%	0.47	1.02	0.812		01:30			188
4540	26.13	11529.26										
4550	26.96	11556.21										
4560	26.82	11583.04										
4570	23.12	11606.16										
4580	26.11	11632.26										
4590	24.98	11657.24										
4600	27.27	11684.51										
4610	27.59	11712.11										
4620	25.37	11737.48										
4630	27.53	11765.00										
4640	26.32	11791.33										
4650	27.14	11818.47										
4660	24.94	11843.42										
4670	23.43	11866.84										
4680	23.29	11890.14										
4690	25.93	11916.07										
4700	27.84	11943.91										
4710	25.63	11969.54										
	3.07	11972.61	CLOSE METAL OBJECT						09:30			

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
4720	27.83	11997.38										
4730	23.37	12020.75										
4740	26.48	12047.22										
4750	26.67	12073.89										
4760	27.37	12101.27										
	25.61	12126.88	EXT MFG	30%	1.97	1.02	0.812		06:30			189
	25.82	12127.09	EXT MFG	24%	1.18	2.48	0.812		04:15			190
4770	26.49	12127.76										
4780	27.81	12155.57										
	0.23	12155.79	EXT MFG	29%	0.83	1.02	0.812		06:15			191
4790	26.87	12182.44										
4800	26.34	12208.77										
4810	27.36	12236.13										
4820	26.89	12263.03										
4830	26.65	12289.68										
4840	27.86	12317.54										
4850	26.42	12343.96										
4860	26.24	12370.20										
4870	23.71	12393.91										
4880	21.13	12415.04										
4890	26.77	12441.81										
4900	27.65	12469.46										
4910	23.03	12492.49										
4920	26.98	12519.47										
4930	26.47	12545.93										
4940	27.54	12573.47										
4950	27.44	12600.91										
4960	27.30	12628.21										
4970	23.73	12651.94										
4980	27.00	12678.94										
4990	25.82	12704.76										
5000	27.59	12732.35										
5010	22.07	12754.42										
5020	24.79	12779.21										
	5.33	12784.54	EXT MFG	3%	0.79	6.34	0.812		02:00			192
5030	26.35	12805.55										
5040	25.65	12831.20										
5050	24.42	12855.62										
5060	25.31	12880.93										
5070	25.41	12906.33										
5080	26.36	12932.69										
5090	26.60	12959.29										

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
5100	24.77	12984.06										
	2.64	12986.69	INT MFG	5%	0.83	2.13	0.812		12:00			193
	11.23	12995.29	INT MFG	16%	0.71	1.10	0.812		10:30			194
	11.59	12995.65	INT MFG	6%	0.51	1.14	0.812		01:30			195
5110	26.01	13010.06										
5120	27.65	13037.71										
5130	16.62	13054.33										
	18.75	13073.08	*EXT MFG	38%	7.24	8.03	0.812		09:15			196
5140	26.13	13080.46										
5150	25.54	13105.99										
	23.86	13129.86	INT MFG	11%	2.68	3.70	0.812		06:30			197
	24.30	13130.29	INT MFG	6%	5.04	8.27	0.812		10:30			198
5160	24.85	13130.84										
5170	27.88	13158.72										
5180	26.66	13185.38										
5190	20.10	13205.48										
5200	26.80	13232.27										
5210	24.36	13256.63										
5220	26.64	13283.27										
5230	28.12	13311.39										
	26.24	13337.62	INT MFG	14%	0.28	0.83	0.812		11:30			199
5240	27.21	13338.59										
5250	24.86	13363.45										
5260	26.28	13389.73										
5270	21.73	13411.46										
5280	25.19	13436.65										
5290	25.09	13461.74										
	5.65	13467.39	INT MFG	5%	1.10	1.10	0.812		08:45			200
	6.36	13468.10	INT MFG	8%	3.23	7.56	0.812		08:00			201
	19.68	13481.41	INT MFG	7%	2.68	1.46	0.812		01:30			202
5300	24.00	13485.74										
	25.90	13511.64	EXT MFG	11%	1.30	2.13	0.812		07:15			203
5310	26.05	13511.79										
	8.07	13519.86	INT MFG	12%	7.05	11.34	0.812		03:45			204
	9.58	13521.37	INT MFG	9%	2.95	7.56	0.812		04:45			205
	13.43	13525.22	INT MFG	7%	1.06	2.68	0.812		05:00			206
5320	27.18	13538.97										
5330	25.42	13564.38										
5340	27.11	13591.49										
5350	28.62	13620.11										
5360	25.48	13645.59										
5370	26.48	13672.07										

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
5380	27.41	13699.48										
5390	19.09	13718.56										
5400	21.66	13740.22										
5410	23.20	13763.42										
5420	26.15	13789.57										
	2.76	13792.33	DENT <2% ID REDUCTION						05:15			
5430	27.79	13817.36										
5440	24.14	13841.49										
5450	25.11	13866.60										
5460	27.19	13893.79										
5470	23.53	13917.32										
5480	22.74	13940.06										
5490	26.53	13966.59										
5500	27.91	13994.50										
5510	27.03	14021.53										
5520	26.73	14048.26										
5530	24.60	14072.86										
	4.93	14077.79	INT MFG	9%	0.95	1.22	0.812		11:15			207
	5.67	14078.53	INT MFG	7%	5.32	4.13	0.812		11:15			208
	5.71	14078.57	INT MFG	6%	0.47	2.13	0.812		01:00			209
5540	28.13	14100.98										
	0.99	14101.98	EXT MFG	24%	0.51	1.02	0.812		05:45			210
5550	27.48	14128.47										
5560	20.93	14149.40										
5570	25.95	14175.35										
5580	25.73	14201.08										
	3.08	14204.16	EXT MFG	29%	3.50	11.14	0.812		06:15			211
	18.99	14220.08	EXT MFG	23%	4.45	1.38	0.812		03:15			212
	20.54	14221.62	EXT MFG	26%	1.38	1.02	0.812		12:00			213
5590	25.55	14226.63										
5600	26.36	14252.99										
5610	21.34	14274.32										
5620	27.16	14301.48										
5630	24.95	14326.42										
5640	27.62	14354.04										
5650	25.74	14379.78										
5660	27.33	14407.11										
5670	26.52	14433.63										
5680	27.31	14460.94										
5690	27.18	14488.11										
5700	27.88	14515.99										
5710	26.92	14542.90										

Pipeline Listing

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
	1.94	14544.85	*EXT MFG	33%	0.63	1.02	0.812		12:30			214
5720	22.02	14564.93										
5730	25.76	14590.69										
5740	26.35	14617.04										
	18.97	14636.01	EXT MFG	20%	0.55	1.02	0.812		02:30			215
5750	25.85	14642.89										
5760	22.54	14665.43										
5770	26.87	14692.30										
5780	21.41	14713.71										
5790	27.37	14741.09										
5800	26.25	14767.33										
5810	25.22	14792.55										
5820	28.35	14820.90										
5830	24.90	14845.80										
5840	25.49	14871.29										
5850	26.32	14897.62										
5860	26.99	14924.61										
5870	27.45	14952.06										
5880	26.54	14978.60										
5890	28.62	15007.22										
	26.08	15033.29	*EXT MFG	34%	0.67	1.02	0.812		04:15			216
5900	27.81	15035.03										
	3.61	15038.64	INT MFG	19%	1.26	1.58	0.812		02:00			217
5910	28.04	15063.07										
5920	26.31	15089.38										
	26.22	15115.60	EXT MFG	26%	0.59	1.02	0.812		07:00			218
	26.92	15116.30	EXT MFG	26%	0.47	1.02	0.812		05:30			219
5930	27.85	15117.23										
	0.95	15118.18	*EXT MFG	33%	0.47	1.02	0.812		08:00			220
	25.83	15143.07	EXT MFG	24%	0.47	1.02	0.812		10:30			221
	26.80	15144.03	EXT MFG	30%	0.47	1.02	0.812		11:30			222
5940	27.53	15144.76										
5950	21.79	15166.55										
	0.47	15167.02	EXT MFG	30%	0.75	1.02	0.812		01:15			223
5960	25.16	15191.71										
	7.42	15199.12	EXT MFG	18%	0.55	1.38	0.812		02:15			224
	8.18	15199.89	*EXT MFG	35%	3.39	2.32	0.812		01:30			225
5970	19.72	15211.43										
5980	26.57	15237.99										
	2.21	15240.20	*EXT MFG	33%	2.36	1.30	0.812		11:00			226
5990	27.89	15265.88										
6000	27.16	15293.04										

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
	2.52	15295.55	EXT MFG	11%	0.51	2.13	0.812		06:30			227
6010	22.78	15315.81										
6020	27.58	15343.40										
6030	27.11	15370.51										
6040	27.46	15397.97										
	4.84	15402.81	DENT <2% ID REDUCTION						03:45			
6050	27.61	15425.57										
6060	26.63	15452.20										
6070	22.61	15474.80										
	20.45	15495.26	EXT MFG	23%	0.75	1.02	0.812		04:45			228
6080	22.20	15497.01										
	0.89	15497.89	EXT MFG	24%	0.71	1.02	0.812		02:30			229
	15.13	15512.13	10 DEG BEND-COLD UNDER									
6090	21.21	15518.22										
6100	26.22	15544.44										
	16.89	15561.33	5 DEG BEND-COLD OVER									
6110	20.56	15565.01										
6120	19.55	15584.56										
6130	26.17	15610.73										
6140	26.40	15637.13										
6150	25.11	15662.24										
6160	27.02	15689.26										
6170	26.62	15715.88										
6180	26.67	15742.55										
6190	26.43	15768.99										
6200	26.13	15795.11										
6210	25.52	15820.63										
6220	27.81	15848.44										
	25.19	15873.63	EXT MFG	25%	3.43	1.65	0.812		01:00			230
6230	28.01	15876.44										
6240	26.07	15902.52										
6250	27.18	15929.69										
6260	28.40	15958.09										
6270	28.05	15986.15										
6280	26.29	16012.43										
	0.51	16012.94	INT MFG	3%	0.91	2.13	0.812		10:30			231
	1.02	16013.46	INT MFG	12%	4.41	6.69	0.812		10:30			232
6290	26.94	16039.37										
6300	24.35	16063.72										
6310	27.03	16090.76										
6320	28.44	16119.19										
6330	26.80	16146.00										

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
6340	26.31	16172.31										
6350	26.25	16198.56										
	0.51	16199.07	EXT MFG	29%	0.59	1.02	0.812		03:30			233
6360	27.23	16225.79										
6370	26.26	16252.04										
6380	19.61	16271.65										
6390	26.17	16297.83										
6400	25.45	16323.27										
6410	26.97	16350.24										
6420	26.13	16376.37										
6430	27.79	16404.16										
6440	27.70	16431.86										
6450	27.33	16459.19										
	1.15	16460.33	*EXT MFG	32%	8.47	3.82	0.812		03:30			234
6460	27.78	16486.97										
6470	23.78	16510.74										
6480	24.42	16535.16										
6490	27.42	16562.58										
6500	21.72	16584.30										
6510	24.44	16608.74										
6520	25.26	16634.00										
6530	19.47	16653.47										
6540	26.54	16680.01										
6550	24.99	16705.00										
6560	24.81	16729.81										
6570	28.12	16757.93										
6580	24.44	16782.37										
6590	26.53	16808.90										
6600	27.18	16836.08										
6610	26.16	16862.24										
6620	24.65	16886.89										
6630	27.82	16914.71										
6640	26.09	16940.80										
6650	23.96	16964.76										
6660	21.42	16986.19										
6670	22.52	17008.70										
6680	22.57	17031.28										
6690	24.11	17055.39										
6700	27.64	17083.03										
6710	26.60	17109.63										
6720	24.07	17133.69										
6730	21.32	17155.01										

Pipeline Listing

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
6740	27.12	17182.13										
	1.45	17183.58	EXT MFG	23%	0.47	1.02	0.812		03:30			235
6750	27.92	17210.05										
6760	25.99	17236.05										
	5.58	17241.63	EXT MFG	23%	0.91	1.02	0.812		11:45			236
6770	27.93	17263.98										
6780	27.67	17291.64										
6790	26.68	17318.33										
6800	26.17	17344.50										
	0.44	17344.94	EXT MFG	26%	0.51	1.02	0.812		10:45			237
6810	27.20	17371.70										
6820	27.62	17399.31										
6830	26.19	17425.51										
6840	26.16	17451.66										
6850	27.19	17478.85										
6860	25.77	17504.62										
	0.41	17505.03	EXT MFG	26%	4.88	7.24	0.812		05:30			238
6870	26.62	17531.23										
6880	27.11	17558.34										
6890	28.09	17586.44										
6900	27.32	17613.76										
6910	26.67	17640.43										
6920	27.12	17667.55										
6930	26.65	17694.21										
	1.31	17695.51	EXT MFG	28%	0.67	1.02	0.812		03:15			239
6940	27.25	17721.46										
	6.97	17728.43	EXT MFG	27%	0.63	1.02	0.812		08:00			240
6950	26.86	17748.32										
6960	26.44	17774.76										
6970	26.93	17801.68										
6980	27.65	17829.33										
6990	26.75	17856.08										
7000	27.44	17883.52										
7010	26.41	17909.93										
7020	26.04	17935.97										
7030	27.68	17963.65										
7040	25.35	17989.00										
	25.74	18014.73	*EXT MFG	31%	8.15	4.76	0.812		06:15			241
7050	26.52	18015.52										
7060	24.57	18040.09										
7070	26.37	18066.46										
7080	23.14	18089.60										

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
7090	26.20	18115.80										
	0.35	18116.15	*EXT MFG	32%	3.19	1.61	0.812		01:15			242
	0.86	18116.66	*EXT MFG	25%	2.80	1.38	0.812		04:45			243
7100	27.11	18142.91										
	24.02	18166.93	EXT MFG	14%	2.64	2.21	0.812		12:15			244
7110	24.94	18167.85										
7120	27.14	18194.99										
7130	27.98	18222.97										
7140	25.09	18248.05										
	1.38	18249.44	EXT MFG	26%	0.47	1.02	0.812		12:45			245
	21.79	18269.84	EXT MFG	27%	0.67	1.02	0.812		05:15			246
	26.35	18274.40	EXT MFG	22%	0.47	1.02	0.812		11:00			247
7150	26.61	18274.66										
	0.80	18275.46	EXT MFG	30%	4.92	2.48	0.812		04:15			248
	1.07	18275.74	EXT MFG	21%	0.47	1.14	0.812		10:30			249
	1.56	18276.22	EXT MFG	27%	0.91	1.02	0.812		02:30			250
	2.04	18276.70	EXT MFG	26%	5.32	1.34	0.812		04:00			251
	22.23	18296.89	INT MFG	16%	0.87	0.79	0.812		08:15			252
7160	26.78	18301.44										
7170	26.92	18328.36										
7180	21.56	18349.91										
7190	25.49	18375.40										
7200	23.42	18398.82										
7210	27.11	18425.93										
	3.27	18429.20	INT MFG	12%	0.32	1.26	0.812		02:30			253
7220	25.39	18451.33										
7230	27.71	18479.04										
7240	26.17	18505.21										
7250	27.41	18532.61										
7260	25.83	18558.45										
	1.15	18559.59	EXT MFG	25%	4.13	2.87	0.812		06:00			254
7270	26.61	18585.05										
7280	28.25	18613.30										
7290	27.59	18640.89										
7300	27.79	18668.68										
7310	24.07	18692.75										
7320	27.86	18720.61										
7330	24.92	18745.53										
7340	26.66	18772.19										
7350	27.59	18799.78										
7360	24.71	18824.49										
7370	24.96	18849.44										

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
7380	25.10	18874.54										
7390	25.23	18899.77										
7400	26.41	18926.18										
7410	22.50	18948.68										
7420	27.56	18976.24										
7430	26.19	19002.43										
7440	26.80	19029.22										
7450	24.08	19053.30										
	0.46	19053.76	EXT MFG	27%	0.47	1.02	0.812		11:30			255
	0.64	19053.94	EXT MFG	25%	0.47	1.02	0.812		04:15			256
	0.71	19054.01	EXT MFG	18%	0.55	1.30	0.812		08:00			257
	1.40	19054.71	EXT MFG	22%	0.51	1.06	0.812		06:00			258
7460	27.28	19080.59										
7470	25.37	19105.96										
7480	26.32	19132.28										
7490	25.80	19158.08										
	27.27	19185.35	*EXT MFG	30%	1.14	1.02	0.812		07:15			259
7500	27.57	19185.65										
7510	20.17	19205.82										
	18.98	19224.80	EXT MFG	23%	0.63	1.02	0.812		08:00			260
7520	26.76	19232.58										
7530	26.06	19258.64										
7540	26.94	19285.57										
	4.62	19290.20	*EXT MFG	32%	0.67	1.02	0.812		02:00			261
7550	20.20	19305.77										
7560	27.47	19333.25										
7570	26.66	19359.91										
7580	25.12	19385.03										
7590	26.84	19411.86										
	23.76	19435.62	EXT MFG	27%	0.67	1.02	0.812		09:45			262
7600	24.55	19436.42										
	8.57	19444.98	EXT MFG	24%	0.71	1.02	0.812		12:15			263
7610	26.33	19462.74										
7620	22.70	19485.45										
7630	28.63	19514.08										
7640	26.31	19540.39										
7650	27.89	19568.27										
7660	23.26	19591.54										
7670	23.95	19615.49										
7680	26.74	19642.22										
7690	20.67	19662.89										
7700	22.71	19685.61										

Pipeline Listing

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
7710	23.33	19708.93										
	24.68	19733.61	EXT MFG	25%	2.40	2.36	0.812		09:00			264
	25.76	19734.69	EXT MFG	24%	0.47	1.02	0.812		09:00			265
7720	26.61	19735.54										
7730	27.24	19762.79										
7740	22.70	19785.49										
7750	27.56	19813.05										
7760	27.93	19840.98										
7770	25.51	19866.49										
7780	26.59	19893.09										
7790	24.54	19917.63										
	13.63	19931.25	EXT MFG	26%	0.55	1.02	0.812		11:00			266
7800	26.52	19944.15										
7810	26.28	19970.43										
7820	28.01	19998.44										
7830	24.90	20023.34										
7840	26.92	20050.25										
7850	25.34	20075.59										
	14.65	20090.25	EXT MFG	25%	3.27	5.16	0.812		07:00			267
	16.24	20091.83	EXT MFG	13%	1.34	1.97	0.812		03:30			268
	16.33	20091.92	EXT MFG	10%	1.85	2.76	0.812		10:15			269
	16.54	20092.13	EXT MFG	24%	7.24	4.76	0.812		08:30			270
	18.90	20094.49	INT MFG	18%	13.03	27.28	0.812		12:30			271
7860	23.79	20099.38										
7870	26.95	20126.33										
7880	23.17	20149.50										
7890	21.63	20171.13										
	7.26	20178.39	*EXT MFG	34%	2.24	2.32	0.812		02:15			272
7900	26.55	20197.68										
7910	23.29	20220.97										
7920	26.74	20247.72										
7930	26.98	20274.70										
7940	25.34	20300.03										
7950	27.46	20327.49										
7960	26.39	20353.88										
7970	27.14	20381.03										
7980	27.35	20408.38										
7990	28.02	20436.39										
8000	24.91	20461.31										
8010	27.47	20488.78										
8020	26.61	20515.39										
8030	27.77	20543.15										

Pipeline Listing

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
8040	27.45	20570.60										
8050	26.98	20597.59										
8060	25.57	20623.15										
8070	25.78	20648.94										
8080	26.18	20675.12										
8090	27.63	20702.75										
8100	26.42	20729.17										
8110	27.71	20756.88										
8120	26.87	20783.75										
	18.09	20801.83	INT MFG	24%	13.11	9.72	0.812		05:15			273
	19.85	20803.59	INT MFG	17%	4.69	2.17	0.812		04:30			274
	21.09	20804.83	INT MFG	11%	6.38	2.52	0.812		09:45			275
	21.73	20805.48	INT MFG	14%	0.47	0.98	0.812		07:30			276
	22.79	20806.54	INT MFG	17%	6.30	6.46	0.812		07:15			277
8130	26.63	20810.38										
8140	20.55	20830.93										
8150	23.46	20854.39										
	26.18	20880.56	EXT MFG	23%	0.87	1.34	0.812		10:45			278
8160	27.11	20881.50										
	15.54	20897.03	EXT MFG	28%	0.87	1.14	0.812		09:30			279
	16.31	20897.81	EXT MFG	25%	0.47	1.02	0.812		08:15			280
8170	21.38	20902.88										
8180	27.80	20930.68										
8190	26.26	20956.93										
	14.40	20971.34	10 DEG BEND-COLD OVER									
8200	26.78	20983.71										
8210	27.04	21010.75										
8220	27.41	21038.16										
	17.64	21055.80	EXT MFG	23%	0.67	1.02	0.812		02:30			281
8230	23.70	21061.85										
	24.28	21086.13	EXT MFG	24%	1.50	3.43	0.812		05:15			282
8240	24.48	21086.33										
	25.77	21112.10	INT MFG	15%	1.89	4.61	0.812		01:30			283
8250	26.63	21112.96										
8260	22.28	21135.24										
8270	26.61	21161.84										
	1.27	21163.12	EXT MFG	26%	3.58	8.27	0.812		01:45			284
	1.95	21163.79	EXT MFG	24%	0.47	1.14	0.812		09:15			285
	2.40	21164.24	EXT MFG	25%	0.71	1.02	0.812		04:15			286
	3.00	21164.84	EXT MFG	26%	0.51	1.02	0.812		05:30			287
	6.16	21168.00	*EXT MFG	28%	1.77	2.95	0.812		11:45			288
	6.64	21168.48	EXT MFG	28%	5.55	4.69	0.812		01:45			289

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
	7.56	21169.41	EXT MFG	26%	1.58	6.14	0.812		02:00			290
	14.76	21176.61	EXT MFG	25%	0.55	1.02	0.812		07:00			291
	16.05	21177.89	EXT MFG	22%	0.75	1.02	0.812		12:45			292
	17.62	21179.46	EXT MFG	30%	0.55	1.02	0.812		11:30			293
	18.37	21180.22	EXT MFG	30%	1.97	1.97	0.812		11:15			294
	19.04	21180.88	EXT MFG	25%	0.63	1.06	0.812		11:45			295
	19.35	21181.19	EXT MFG	24%	6.65	5.67	0.812		09:15			296
	19.81	21181.65	EXT MFG	28%	0.67	1.02	0.812		11:45			297
	20.28	21182.12	*EXT MFG	32%	2.28	1.02	0.812		11:30			298
	20.50	21182.35	EXT MFG	31%	2.80	1.65	0.812		08:30			299
	24.66	21186.51	EXT MFG	24%	0.47	1.02	0.812		04:00			300
	25.51	21187.35	EXT MFG	20%	0.91	1.26	0.812		12:45			301
	26.30	21188.15	EXT MFG	27%	0.55	1.02	0.812		03:30			302
8280	27.54	21189.38										
	25.12	21214.50	INT MFG	7%	0.59	1.93	0.812		10:00			303
8290	27.82	21217.21										
	5.57	21222.77	5 DEG BEND-COLD UNDER									
8300	24.35	21241.56										
	11.76	21253.31	10 DEG BEND-COLD LEFT									
8310	26.53	21268.09										
	1.12	21269.20	EXT MFG	23%	1.06	1.02	0.812		12:15			304
	1.64	21269.73	*EXT MFG	38%	7.56	9.21	0.812		11:15			305
	2.07	21270.16	EXT MFG	31%	1.14	1.02	0.812		05:15			306
	15.52	21283.61	20 DEG BEND-COLD LEFT									
8320	29.01	21297.10										
	11.02	21308.13	20 DEG BEND-COLD LEFT									
8330	24.60	21321.70										
	13.58	21335.28	25 DEG BEND-COLD LEFT									
8340	27.83	21349.53										
	10.95	21360.48	15 DEG BEND-COLD LEFT									
	11.14	21360.67	EXT MFG	29%	5.39	5.71	0.812		08:15			307
	15.73	21365.26	EXT MFG	23%	1.06	1.02	0.812		02:15			308
8350	24.74	21374.27										
8360	27.57	21401.84										
8370	26.41	21428.25										
8380	24.08	21452.33										
8390	18.90	21471.23										
8400	27.98	21499.20										
8410	24.06	21523.26										
	23.90	21547.17	EXT MFG	29%	2.21	4.13	0.812		01:30			309
8420	25.34	21548.60										
	20.23	21568.84	EXT MFG	29%	0.47	1.02	0.812		01:00			310

Pipeline Listing

Straits of Mackinac (West Leg)

Upstream Girth Weld	Relative Distance (feet)	Absolute Distance (feet)	Comment	Peak Depth (%wt)	Length (in)	Width (in)	Local Wall Thickness (in)	RPR	Orientation (hrs:mins)	LAPA Burst Pressure (PSI)	LAPA RPR	Cluster Identifier
8430	26.81	21575.42										
	22.20	21597.62	*EXT MFG	31%	0.59	1.02	0.812		10:30			311
	22.28	21597.70	EXT MFG	26%	6.02	6.69	0.812		12:15			312
8440	23.05	21598.47										
8450	23.28	21621.75										
8460	27.46	21649.21										
8470	25.25	21674.47										
8480	24.97	21699.43										
8490	27.53	21726.96										
	0.99	21727.95	EXT MFG	24%	4.92	5.20	0.812		01:45			313
	2.02	21728.98	EXT MFG	28%	0.59	1.02	0.812		08:00			314
8500	26.83	21753.78										
8510	26.29	21780.08										
8520	28.30	21808.38										
8530	26.04	21834.42										
8540	3.02	21837.43										
8545	1.57	21839.00										
	0.56	21839.56	JOINT-INSULATED									
8555	1.19	21840.19										
8560	1.39	21841.58										
8570	21.27	21862.85										
	1.22	21864.07	16 IN OFFTAKE-FORGED						03:00			
8580	2.44	21865.29										
8590	3.06	21868.35										
	1.74	21870.09	VALVE MP 1479.5									
8620	3.52	21871.87										
	6.31	21878.18	15 DEG BEND-COLD UNDER									
8630	22.59	21894.47										
	9.57	21904.03	INT MFG	19%	0.35	0.71	0.812		05:30			315
8640	10.28	21904.75										
	2.27	21907.02	2 IN OFFTAKE-WELDOLET						12:00			
	11.91	21916.66	10 DEG BEND-COLD OVER									
	17.96	21922.70	EXT MFG	11%	0.55	1.85	0.812		08:15			316
	17.97	21922.72	EXT MFG	21%	0.98	2.80	0.812		06:45			317
8650	19.21	21923.95										
	0.00	21923.95	JOINT-FLANGED									
	1.76	21925.71	2 IN OFFTAKE-WELDOLET						12:00			
8660	3.73	21927.68										

Glossary of Terms

Absolute Distance	The distance from the start of the pipeline to the upstream edge of the metal loss feature.
Axial Length	The predicted axial length of the metal loss feature.
Relative Distance	The distance between the upstream girth weld and the feature under consideration.
ERF	The calculated Estimated Repair Factor value of the metal loss feature.
Ext or Int	Denotes whether the metal loss feature is on the external or internal surface of the pipe. It should be noted that mid-wall metal loss features would be classified as external.
Feature Selection Rule	The number of the selection rule under which the metal loss feature was chosen. The selection rules are specified in the Specification for a Pipeline Inspection Report (Appendix F)
FPR	The calculated Failure Pressure Ratio value of the metal loss feature.
Girth Weld Number	The number of the girth weld at which the pipeline segment begins, as used in the pipeline listing.
Identification	The identification number of the line marker, magnet or anode.
Inspection Sheet Number	The number of the inspection sheet which is summarised by each line in the Summary tables.
Major Segment	A pipeline segment that has been defined by the pipeline operator in the table provided in the Company Defined Operating Parameters section of the contract. In this table the pipeline operator specifies the locations of the start and end of the segment and the values of nwt and SMYS that apply within it.
MAOP	The maximum allowable operating pressure for the pipeline segment, as specified by the pipeline operator.
Minor Segment	A pipeline segment identified by the inspection system. The minor segment is a section within the major segment where the nominal wall thickness is distinctly different from that detected for the major segment.
Nominal Wall Thickness	The pipe wall thickness of the spool containing the metal loss feature.

ENBDNR0001015

Orientation	The location of the metal loss feature around the circumference of the pipe, as viewed in the direction of flow.
Peak Depth	The predicted peak depth of the metal loss feature, expressed as a percentage of nominal wall thickness.
Pi	The internal design pressure for the pipeline segment, as specified by the pipeline operator.
Predicted Dimensions	The predicted dimensions of a metal loss feature are: **Axial length:** The dimension along the pipe and parallel to the pipe axis; **Circumferential width:** The dimension around the pipe and perpendicular to the pipe axis; **Peak depth:** The depth of the metal loss feature expressed as a percentage of nominal wall thickness.
Pressure Ratio	The Estimated Repair Factor (ERF), Failure Pressure Ratio (FPR) or Rupture Pressure Ratio (RPR) calculated for the metal loss feature. This value was calculated using the formulae defined in the Specification for a Pipeline Inspection Report contained in the contract; a copy of which is given in Appendix F.
Primary Reference	A pipeline fitting or marker from which the metal loss feature can be easily located. More than one reference point may be provided on an inspection sheet.
Reference Girth Weld	The girth weld located at the upstream end of the spool containing the metal loss feature.
RPR	The calculated Rupture Pressure Ratio value of the metal loss feature.
Segment Number	Denotes whether the segment is a major or minor segment. A number (n) indicates that the segment is part of the nth major segment defined by the pipeline operator. A number (n/m) indicates that the segment is the mth minor segment within the nth major segment.
Selection Rule	The selection rule under which the most severe metal loss feature within the pipe spool is rated.
Strip Map Number	The drawing number, where available, of the pipeline strip map on which the metal loss feature is located.
Type	Denotes whether the metal loss feature is on the internal or external surface of the pipe. It should be noted that mid-wall metal loss features would be classified as external.

Upstream Girth Weld Number	The girth weld number of the girth weld located at the upstream end of the pipe spool.

ENBDNR0001017

Appendix A. Locating Metal Loss Features And Pipeline Anomalies

Locating metal loss features or pipeline anomalies is a difficult task, which can cost the pipeline operator valuable time and resources. Therefore, it is important that appropriate techniques are used at each stage in locating these features.

This appendix gives guidelines for locating pipeline features efficiently and effectively.

A1. Reference Points

Wherever possible, the position of metal loss features and pipeline anomalies is related to reference points that can be easily identified and located from the surface.

Reference points are either pipeline fittings, such as mainline valves, offtakes, anodes or side bends, or artificial reference points, such as magnets or line markers; these will have been placed on or near the pipeline at the time of the inspection.

At least one reference point is provided for each metal loss feature reported on the inspection sheets. If the reference point is more than 1600 feet from the metal loss feature then a second reference point will usually be provided.

Two reference points are provided for each pipeline anomaly. These reference points are extracted automatically from the pipeline listing and are limited to mainline valves and line markers.

A2. Location of Features

The location of the feature can be carried out in two stages; locating the spool that contains the metal loss feature or pipeline anomaly; then locating the feature within that spool.

To locate the spool containing the feature, the distance from the reference point to the girth weld at the upstream end of the spool is provided.

To locate the feature within the spool, the distance from the upstream girth weld to the feature and the location of the feature around the circumference of the pipe, as viewed in the direction of flow, are provided. Girth weld anomalies will be located within the upstream girth weld.

These distances are given to an accuracy of ±1%. It is recommended that electronic distance measuring equipment (EDM) is used to measure out these distances accurately.

ENBDNR0001018

A3. Identification of Features

Metal objects should be easily identified. Metal loss, dents and girth weld anomalies will require an area of the protective wrap to be removed.

A minimum area of approximately 2 ft along the pipe axis by 45° of the circumference, centred on the reported feature position, should be cleaned back to bare metal.

Once this has been done, any external metal loss, dents or the girth weld that contains an anomaly should be easily identified. The position of internal metal loss should be marked on the outside of the pipe in preparation for further examination.

Shallow dents can usually be identified by running one's hand along the pipe surface, or by placing a straight edge along the pipe.

NOTE: Features that are wholly contained within the pipe wall, such as voids, slag inclusions, or non-magnetic alloys, may have been classified as external metal loss, however these anomalies are quite rare.

A4. Contacting GE Oil & Gas, PII Pipeline Solutions

GE Oil & Gas, PII Pipeline Solutions aims to provide its clients with a quality service. If you cannot locate a metal loss feature from the information provided on the inspection sheet or if the metal loss is very different from the description given on the inspection sheet, then please do not hesitate to contact the project manager at GE Oil & Gas, PII Pipeline Solutions.

GE Oil & Gas, PII Pipeline Solutions Telephone Numbers:

Telephone:	+1-403-262-7447	(CANADA)
Facsimile:	+1-403-237-9693	(CANADA)
Address:	GE Oil & Gas, PII Pipeline Solutions 1003, 11th Street. S.W. Calgary, Alberta T2R 1G2 CANADA	

ENBDNR0001019

Appendix B. Guidance Notes for Recording Excavation of Metal Loss Features

Contents

B1. Introduction

B2. Preparing pipe surface for inspection and recording

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B3. External metal loss area mapping

B3.1 Rubbing and Photographic Methods

B4. External metal loss depth recording

B5. Wall thickness and remaining ligament thickness recording

B6. Locating and quantifying internal metal loss in gas pipelines using x-radiography

B6.1 Introduction
B6.2 Technique for Quantifying Internal Metal Loss

Illustrations

Figure 1 Example of rubbing

Figure 2 Typical micrometer and bridging bar arrangement

Figure 3 Typical arrangement for X-ray technique

Figure 4 Procedure for inspecting and recording reported metal loss features - simplified flow diagram

Figure 5 Example of completed Pipeline Damage Record form

Blank 7097A for Client use

ENBDNR0001020

B1. Introduction

To help maintain and improve the defect sizing accuracy from these high resolution inspection systems it is extremely valuable to have feedback from defect excavations.

Reliable and accurate information from site investigations can be used to monitor actual defect dimensions against the dimensions reported from the inspection survey. This site data can then be used to improve defect sizing methods which brings benefit to all users of the inspection service.

We would ask pipeline operators wherever possible to feed any available comparison data from excavations back to us to help improve our service even more. For guidance, the most useful format for this data is as shown in the sample Damage Record Form in figure 5. This shows feature dimensions and location information.

We would like to express our appreciation to those who have provided this data in the past.

B2. Preparing Pipe Surface For Inspection And Recording

B2.1 Surface Preparation

To achieve satisfactory recording and measurement of the feature it is essential that the specified area of pipe surface is cleaned back to bare bright metal.

There are a number of methods for removing pipe wrap primer including:

(a) Solvent cleaning.

(b) Chemical cleaning.

(c) Wire brushing.

(d) Grit blasting.

For certain types of corrosion product it is possible to produce a finish resembling bright metal when cleaned using a wire brush. In this instance grit blasting is the preferred method in order to remove all the corrosion product.

B3. External Metal Loss Area Mapping

B3.1 Rubbing and Photographic Methods

The preferred method of mapping is by taking a simple rubbing. This is achieved by placing a sheet of paper over the feature, holding the paper firmly in place with, for example, small magnets and rubbing the long edge of a wax crayon over the surface of the paper. The edges of the feature will be delineated and if required, can be highlighted by careful manipulation of the crayon.

ENBDNR0001021

The following parameters should be annotated on the paper:

(a) Feature identity (e.g. PII Report Number and Feature Number).

(b) Direction of flow.

(c) Orientation of the feature.

(d) Distance of the feature from the nearest girth weld.

Refer to Figure 1 for an example of a mapped area using the rubbing technique.

The rubbing technique has a definite advantage over photographic recording methods in that it is possible to record all subsequent measurements directly on the rubbing in the appropriate location e.g. each individual pit depth in multiple pitting. Refer to Figure 1 for the example.

Photographic recording can be used but unless a 'polaroid' type film is used it can be a lengthy process before a result is obtained.

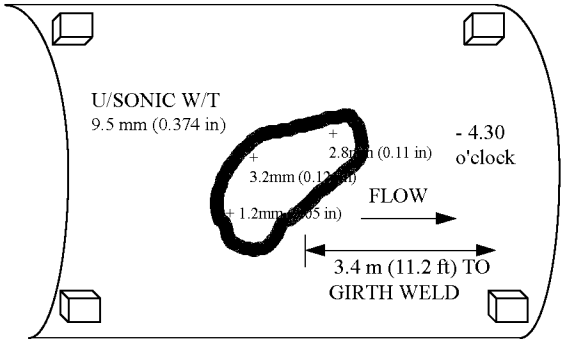


Figure 1: Example of Rubbing

B4. External Metal Loss Depth Recording

The most effective method for recording external metal loss depth is by using a depth micrometer in conjunction with a large bridging bar. Refer to Figure 2 for a typical arrangement.

ENBDNR0001022

It is recommended that the micrometer anvil be ground to a taper with a tip diameter of approximately 0.04 inches. This will enable entry into the small diameter pitting and concave surfaces found at the bottom of most metal loss features.

A pit gauge is not recommended because of its potential inaccuracy of up to 0.08 inches. A depth micrometer has a resolution of better than 0.002 inches.

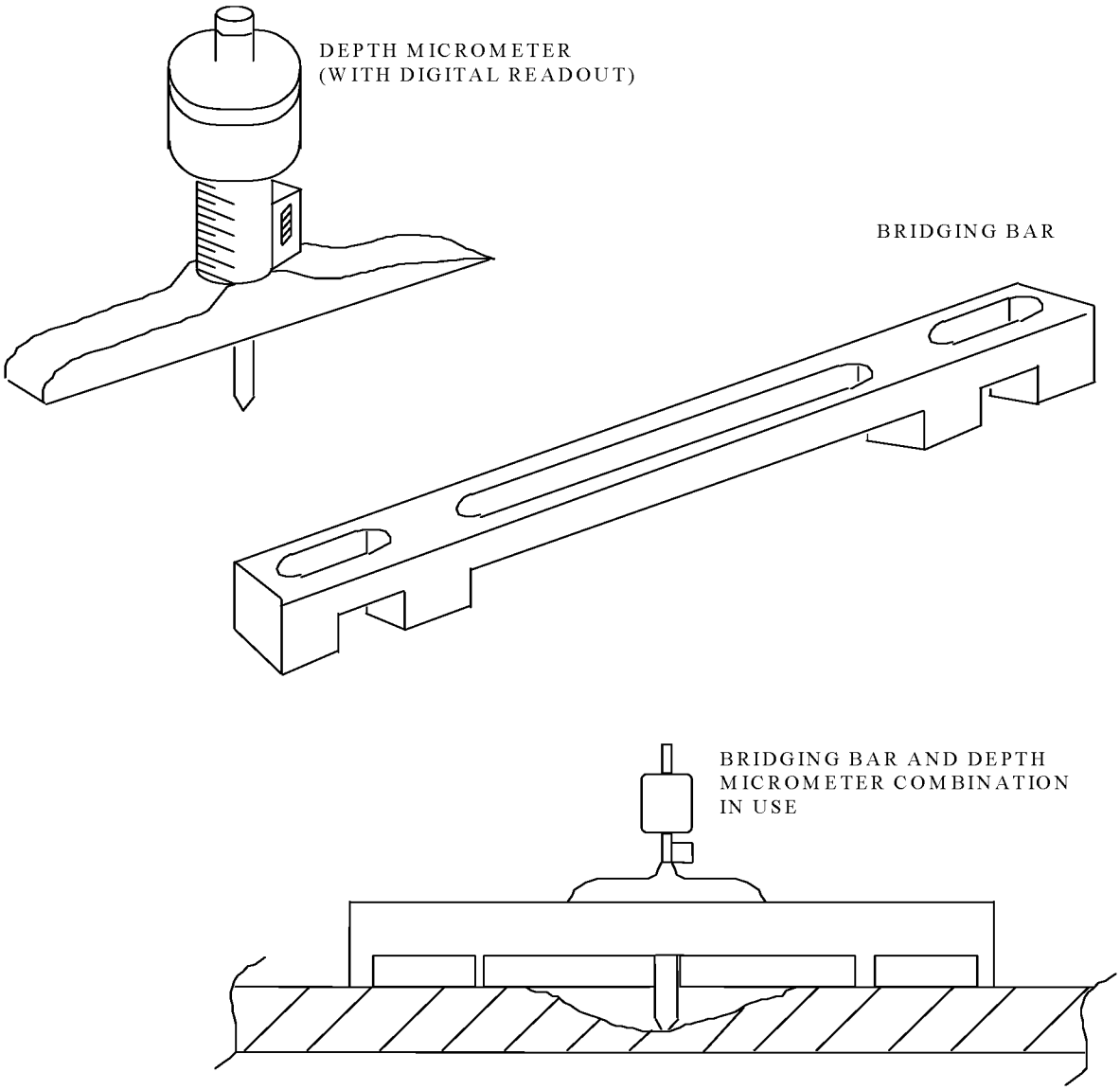


Figure 2: Typical Micrometer and Bridging Bar Arrangement

ENBDNR0001024

B5. Wall Thickness And Remaining Ligament Thickness Recording

Pipe wall thicknesses and remaining ligament thicknesses of internal damage can be measured to an accuracy of ±0.002 inches using standard ultrasonic wall thicknesses meters and suitable couplant.

Extreme care should be exercised when attempting to measure remaining ligament thicknesses directly within an area of external damage because there is extra couplant under the transducer when mounted on concave surfaces which results in an overestimated reading.

Decisions on assessing the significance of the damage are primarily based on the remaining ligament thickness. It is therefore important to obtain a reliable reading. This is best accomplished by obtaining the minimum ultrasonic thickness reading immediately surrounding the damage and subtracting the mechanical depth measurement.

B6. Locating And Quantifying Internal Metal Loss In Gas Pipelines Using X-Radiography

B6.1 Introduction

Locating a small area of internal metal loss is occasionally difficult using manual ultrasonic techniques. In these instances it is usually preferable to obtain an X-ray of the suspect area to locate the feature. Although time consuming the X-ray technique does have the advantage of providing a permanent record of the feature, and obtaining full inspection coverage.

Gamma radiography is not recommended since this technique is relatively insensitive to metal loss. Depending on wall thickness and the diameter of the pipe a sensitivity of approximately 10% of wall thickness can be achieved using gamma-ray techniques whereas X-ray techniques can achieve a sensitivity of better than 2% of wall thickness.

B6.2 Technique for Quantifying Internal Metal Loss

The following procedure for quantifying metal loss using X-radiograph has been devised and proved successful by GE Oil & Gas, PII Pipeline Solutions. Refer to Figure 3.

(1) Locate area of metal loss using ultrasonic or Double Wall Single Image (DWSI) X-ray techniques.

(2) Place plate of known thickness over the metal loss area or deepest part of the metal loss. The plate thickness must be equal to or greater than the damage through-wall thickness.

(3) Place an ultrasonic step wedge on the pipe surface the adjacent to the metal loss but on sound pipe.

(4) Carry out DWSI X-radiography aiming for a density of approximately 3 on the parent plate.

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(5) Using a densitometer on the radiograph compare the density of the darkest part in the metal loss plus plate with that on the step wedge and note the step thickness.

(6) Subtract the step thickness from the plate thickness to give the through-wall depth of the metal loss.

NOTE: It has been shown that slag or air are equally transparent to X-ray when using the energies applied to steel pipelines where the density is equal to that of the metal loss.

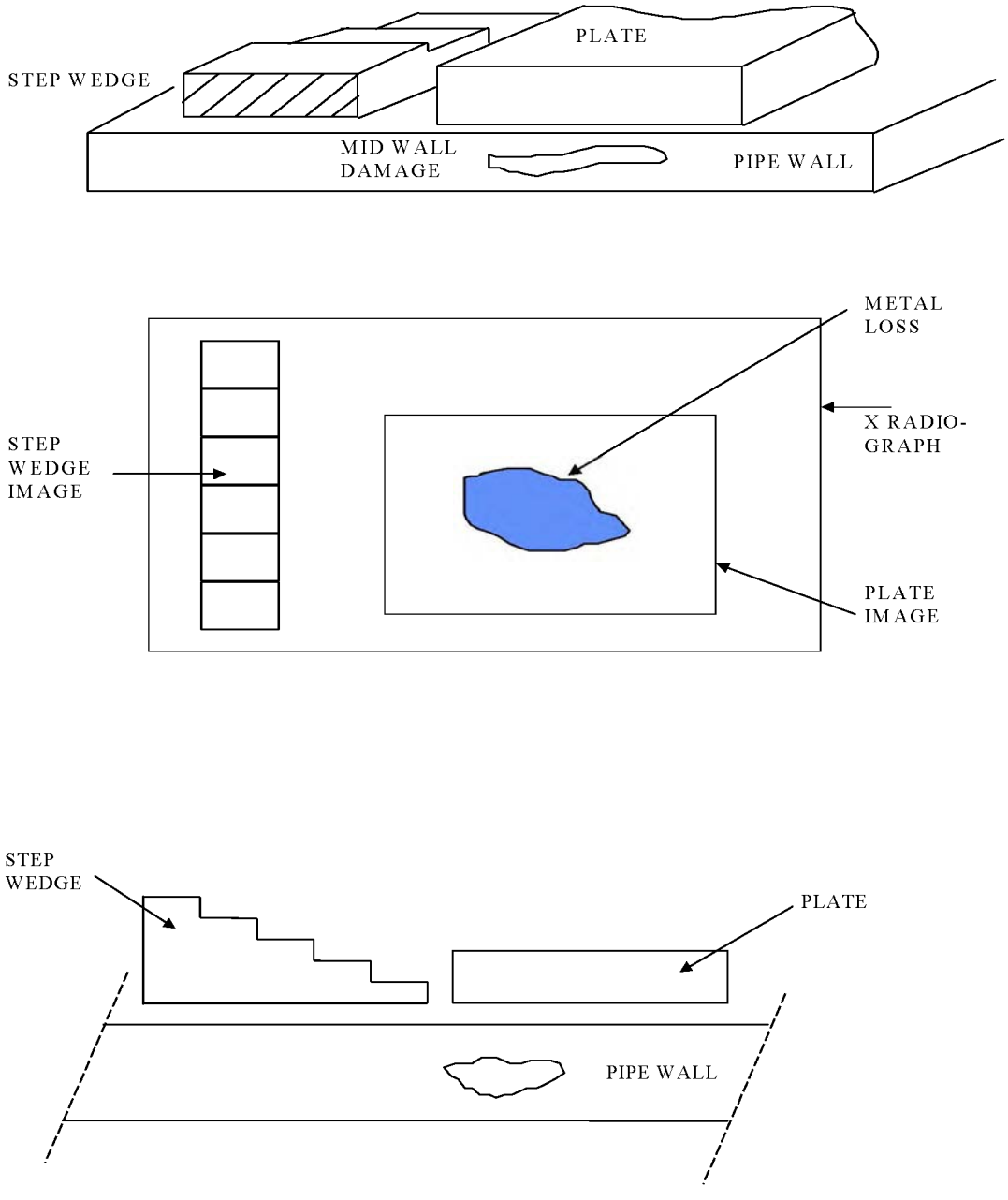


Figure 3: Typical Arrangement for X-ray Technique

ENBDNR0001027

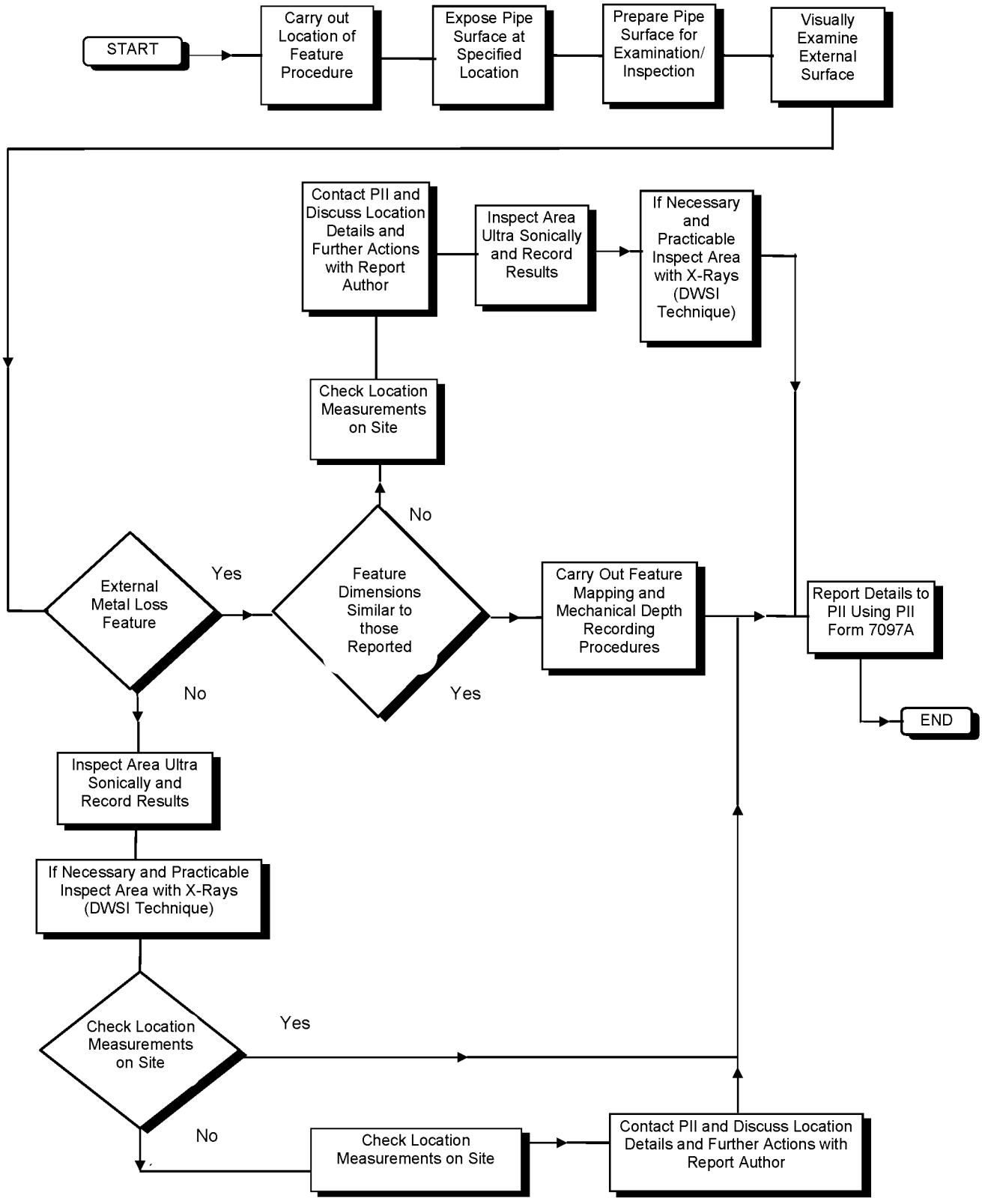


Figure 4: Procedure for Inspecting and Recording Reported Metal Loss Features - Simplified Flow Diagram

ENBDNR0001028

PIPELINE DAMAGE RECORD

7097A
Oct 18/93

1. LOCATION OF DAMAGE

PIPELINE START: .....Somewhere Launch..... END: .....Somewhere Receive.....

FEATURE IDENTITY (PII) - REPORT NUMBER: ..SR 192..... INSP SHEET NO: ....3.....

FEATURE TYPE: General Corrosion ☒ Isolated Pit ☐ Gouge ☐ Manufacturing (Mill) ☐

Other: .....

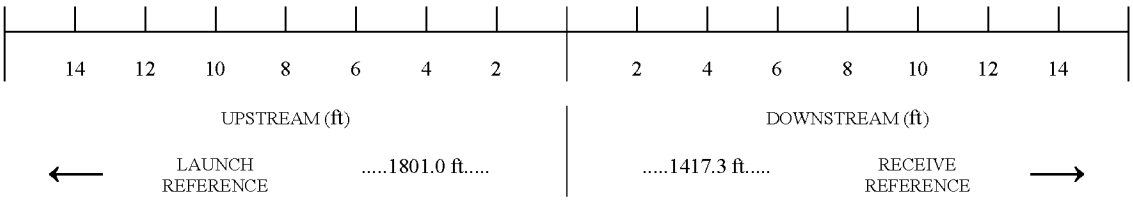
MEASURED WALL THICKNESS: .....0.361in.....

2. FEATURE DIMENSIONS

PII FEATURE NO.	EXACT POSITION UPSTREAM OR DOWNSTREAM OF REF. GIRTH WELD (ft)	ORIENTATION (o'clock)	AXIAL LENGTH (in)	CIRC'L WIDTH (in)	DEPTH	
					AVERAGE in% WT	PEAK in% WT
3/1	4.25 ft down	4.45	2.6	3.2		0.13
3/2	5.10 ft down	4.45	4.1	5.0		0.15
3/3	7.5 ft down	2.45	0.8	0.9		0.28

3. PLAN DIAGRAM OF SPOOL

CLOCK POSITION		REF GIRTH WELD
6	BOTTOM	.....
7	.....	.....
8	.....	.....
9	.....	.....
10	.....	.....
11	.....	.....
12	TOP	.....
1	.....	.....
2	.....	.....3/3.....
3	.....	.....+.....
4	.....	.....3/1.....3/2.....
5	.....	.....+.....+.....
6	BOTTOM	.....



NOTE: FOR COMPLEX FEATURES PLEASE ATTACH A 'RUBBING' OR SKETCH WITH DIMENSIONS AND DEPTHS IDENTIFIED.

RUBBING ATTACHED ☐ SKETCH ATTACHED ☐

DATA OF SITE INSPECTION: ..... SIGNATURE: .....

Figure 5: Example of completed Pipeline Damage Record Form (7097A)

ENBDNR0001029

PIPELINE DAMAGE RECORD

7097A
Oct 18/93

1. LOCATION OF DAMAGE

PIPELINE START: ..... END: .....

FEATURE IDENTITY (PII) - REPORT NUMBER: ..... INSP SHEET NO: .....

FEATURE TYPE: General Corrosion ☐ Isolated Pit ☐ Gauge ☐ Manufacturing (Mill) ☐

Other: .....

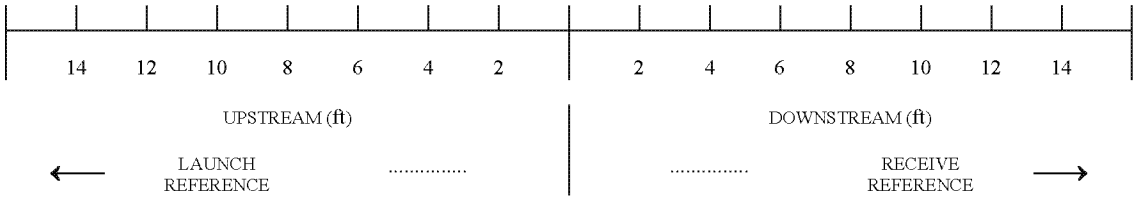
MEASURED WALL THICKNESS: .....

2. FEATURE DIMENSIONS

PII FEATURE NO.	EXACT POSITION UPSTREAM OR DOWNSTREAM OF REF. GIRTH WELD (ft)	ORIENTATION (o'clock)	AXIAL LENGTH (in)	CIRC'L WIDTH (in)	DEPTH	
					AVERAGE in% WT	PEAK in% WT

3. PLAN DIAGRAM OF SPOOL

CLOCK POSITION	REF GIRTH WELD
6 BOTTOM	.....
7	.....
8	.....
9	.....
10	.....
11	.....
12 TOP	.....
1	.....
2	.....
3	.....
4	.....
5	.....
6 BOTTOM	.....



NOTE: FOR COMPLEX FEATURES PLEASE ATTACH A 'RUBBING' OR SKETCH WITH DIMENSIONS AND DEPTHS IDENTIFIED.

RUBBING ATTACHED ☐ SKETCH ATTACHED ☐

DATA OF SITE INSPECTION: ..... SIGNATURE: .....

Appendix C. Operational Details

Contract Number	109170_20A
Operator	Enbridge Energy Limited Partnership
Launch Site	Straits of Mackinac (West Leg)
Receive Site	
Inspection Run	
Date of Operation	08 May 2008
Duration of Run	0 hours 40 minutes
Data Recorded	0.000 miles to 4.153 miles
Inspection Modules	MTV: 1290 IV1: 975 BV: 1292 BATT: 124 REC: 2/006
Processor Pack	036

Appendix D. Pipeline Details

Contract Number	109170_20A
Date of Pipeline Commission	1950
Pipeline Outside Diameter	20 inches nominal
Product	Crude Oil
Pipeline Length (Client Data)	4.153 miles
Pipeline Length (PII Data)	4.101 miles
API Grade	A
Predominant Pipe Type	Seamless
Previous PII Inspection	June 2003 (101211_20G)

The nominal wall thickness listing, presented in Section 3.2.8, provides a list of the major and minor pipeline segments.

The listing identifies the locations of the start and end of each segment and the values of the nominal wall thickness (nwt) and the SMYS that apply within it.

ENBDNR0001032

Appendix E. Additional Services

As a complement to the inspection service GE Oil & Gas, PII Pipeline Solutions can offer the following:

- Assessment

  This involves an Integrity Assessment which relates the severity of any defects reported by the inspection to the required future operating conditions of the pipeline. At GE Oil & Gas, PII Pipeline Solutions we have a dedicated team of engineers who have:

  - successfully conducted over 60 commercial consultancies for major oil and gas companies world-wide;
  - pioneered new integrity assessment methods now accepted by Regulatory Authorities (which have been included in pipeline codes); and
  - initiated and conducted extensive pipeline research.

- Repair

  Specialist repair services can be provided based on proven technologies established to support British Gas' 11000 miles pipeline transmission system. The repair team have extensive experience of operating a pipeline repair service, including work for many clients in Europe and the Middle East.

ENBDNR0001033

Appendix F. Pipeline Inspection Report Specification

The contents of the pipeline inspection report and the selection rules for selecting individual metal loss features for detailed analysis and reporting are specified in the Specification for the Pipeline Inspection Report, a copy of which is provided overleaf.

ENBDNR0001034

SCHEDULE 5 (Enbridge Version)

PIPELINE INSPECTION REPORT

MAGNESCAN™

For the Pipeline the subject of this Contract the Pipeline Inspection Report shall comprise:

1. **Preliminary Assessment Report**

2. **Metal Loss Feature Report**

    2.1 Inspection Sheets
    2.2 Colour Plots of data
    For a number of the worst metal loss features; manually analyzed and selected against pre-defined selection rules.

3. **Pipeline Summary Report**

    (a) Metal Loss Information

    3.1 Sentenced Plots
    3.2 Pressure Based Histograms
    3.3 Depth Based Histograms
    3.4 Orientation Plot
    3.5 Severity Table

    (b) Pipeline Information

    3.6 Velocity Plot
    3.7 Metal Object Report
    3.8 Eccentric Casing Report
    3.9 Dent Report
    3.10 Girth Weld Anomaly Report
    3.11 Repair Listing
    3.12 Location Reference Points Listing
    3.13 Nominal Wall Thickness Listing

    (c) Summary

    3.14 Pipeline Listing

4. **PipeImage™ Inspection Data Software**

In addition to detailing the Report, this Schedule also contains:

APPENDIX 1 – Definition of Terms

APPENDIX 2 – Interaction Rules

APPENDIX 3 – Software Licensing

1. Preliminary Assessment Report

At the Company's request, a Preliminary Assessment Report will not be provided. Instead, during the course of data analysis, the Contractor will notify the Company of any feature assessed to be greater than 80% on an as discovered basis.

The Contractor will ensure that accurate feature location information is supplied when informing the Company of any feature of concern.

2. Metal Loss Feature Report

The Contractor will provide for each Component Line, a Metal Loss Feature Report comprising up to a maximum of fifteen (15) Inspection Sheets describing the severity, type, size and location of individual Metal Loss Features, all in accordance with those parameters set out in the Inspection Performance Specification.

If due to high levels of metal loss in the Pipeline the Company requires Inspection Sheets in excess of said maximum the Company may select additional Metal Loss Features and the Contractor shall report on such Metal Loss Features at additional charge.

2.1 Inspection Sheets

(a) Inspection Sheets will be prepared employing detailed examination and analysis techniques, for those sentenced metal loss features (or identified Manufacturing Faults) selected for detailed reporting using the Selection Rules listed below. The information contained within a typical Inspection Sheet is as follows:

(i) **Metal Loss Feature Description**

1. Internal/external characterization
2. Orientation of Metal Loss Feature viewed in the direction of the flow
3. Axial length, circumferential width, peak and where appropriate, average depth of the Metal Loss Feature, to the accuracy specified in the Inspection Performance Specification
4. Indication of Pressure Sentenced Ratio
5. Selection Rule Number
6. Nominal wall thickness of the pipe spool as advised by the Company
7. Distance from start of the Component Line to the Metal Loss Feature (absolute distance)
8. Comment of the general nature of the Metal Loss Feature and the existence of any nearby metal loss

(ii) **Metal Loss Feature Location**

1. Relevant strip map number, if available
2. Definition of at least one primary reference point on the Component Line which can be used to locate the Metal Loss Feature
3. Definition of the reference girth weld as the nearest upstream girth weld to the Metal Loss Feature
4. Distance between the reference girth weld and the primary reference points to the accuracy specified in the Inspection Performance Specification
5. Distance between the Metal Loss Feature and the reference girth weld (relative distance) to the accuracy specified in the Inspection Performance Specification
6. Length of the spool containing the Metal Loss Feature, the length of the two adjacent spools both upstream and downstream from the Metal Loss Feature spool and if visible, the orientation of the seam welds in each of the spools

(b) Selection Rules, for detailed reporting of Metal Loss Features on Inspection Sheets, will be selected according to the following:

Rule 1 - The 3 (three) most significant Metal Loss Features with Pressure Sentenced Ratio less than 1.0
Rule 2 - Metal Loss Features with peak depth greater than 80% wall penetration (0.8t)
Rule 3 - Metal Loss Features with a Pressure Sentenced Ratio less than 0.8
Rule 4 - Metal Loss Features with a Pressure Sentenced Ratio between 0.8 and 1.0
Rule 5 - Metal Loss Features with a Pressure Sentenced Ratio less than 1.1 (providing always that such Metal Loss Features are above the Inspection reporting parameters set out in the Inspection Performance Specification)
Rule 6 - Metal Loss Features with a peak depth greater than 60% wall penetration (0.6t)
Rule 7 - Metal Loss Features with a peak depth greater than 40% wall penetration (0.4t)
Rule 8 - Metal Loss Features with a peak depth greater than 20% wall penetration (0.2t)
Rule 9 - Metal Loss Features with a peak depth greater than 10% wall penetration (0.1t) and whose length is greater than 3 times the wall thickness

Some of the Metal Loss Features reported may fall below the Inspection Performance Specification and therefore the Inspection Performance Specification may not apply to the sizing of such Metal Loss Features.

(c) Initially reporting of Metal Loss Features will be limited to not more than 1 (one) per pipe spool. If due to low numbers of corroded pipe spools, the specified maximum number of Metal Loss Features to be separately reported upon has not been achieved for each Component Line then the one Metal Loss Feature per pipe per spool rule will be relaxed. The Selection Rules will then be reactivated such that so far as is possible, the balance of the Metal Loss Features up to the maximum specified are selected for inclusion on Individual Inspection Sheets.

(d) If due to low levels of detected metal loss within the Pipeline, the maximum number of Metal Loss Features to be separately reported upon for each Component Line has not been achieved subsequent to the reporting of Rule 9 Features, then those Manufacturing Faults identified in the Pipeline Listing shall be selected for reporting. This shall be on a one per pipe spool basis. The Inspection Performance Specification may not apply to the sizing of such Manufacturing Faults.

(e) In the event that subsequent to (b), (c) and (d) above, the maximum number of Inspection Sheets to be provided for each Component Line has not been achieved, the Contractor shall have no obligation to report further save that where no Metal Loss Features or Manufacturing Faults are selected under the Selection Rules, the Contractor shall select one (1) low level metal loss instance for reporting. The Inspection Performance Specification may not apply to the sizing of such low level metal losses.

2.2 Colour Plots

Accompanying each Inspection Sheet are two pictorial representations of the magnetic response derived from the Metal Loss Feature.

In both cases the pictorial representations of Metal Loss Feature are as viewed from outside the pipe with the upstream end being on the left. The vertical (y) axis is annotated with o'clock orientation as viewed in the direction of flow (at the time of the inspection). The horizontal (x) axis is annotated with the absolute distance measured from the launch.

The Overview Plot (monochrome) shows the magnetic response of the full circumference of the pipe for a length of approximately one spool to give the context of the Metal Loss Feature reported on the Inspection Sheet. To assist the Company in identifying the areas of metal loss it is shaded as if illuminated from the left side of the plot.

The Detailed Contour Plot (colour) is approximately centered on the Metal Loss and identifies the relative magnitudes of the magnetic responses in this area. The magnitude of the magnetic responses is represented by designated colours, with common magnitudes having common colours. Due to the behaviour of this magnetic response, the plot will not normally, provide a true representation of the physical profile of the Metal Loss Feature. The aspect ratio and zoom will be chosen to produce an appropriate image with the Metal Loss Feature being displayed to a higher magnification than in the Overview Plot.

3. Pipeline Summary Report

The Pipeline Summary Report provides an overview of the detected metal loss and other pipeline anomalies within each Component Line. Metal Loss Features, which during the process of selection have undergone detailed processing and analysis will be highlighted on the Pipeline Listing and the sizing accuracy specified in the Inspection Performance Specification will apply to all such Metal Loss Features (excluding identified Manufacturing Faults).

Otherwise than aforesaid, the processes used to size the Metal Loss Features in the Pipeline Summary Report do not include the detailed examination and analysis

employed when reporting Metal Loss Features on Inspection Sheets and hence, the sizing accuracy contained in the Inspection Performance Specification does not apply to the Pipeline Summary Report.

The Pipeline Summary Report shall comprise the following:

(A) Metal Loss Information:

3.1 Sentenced Plots
3.2 Pressure Based Histograms
3.3 Depth Based Histograms
3.4 Orientation Plot
3.5 Severity Table

(B) Pipeline Information:

3.6 Velocity Plot
3.7 Metal Object Report
3.8 Eccentric Casing Report
3.9 Dent Report
3.10 Girth Weld Anomaly Report
3.11 Repair Listing
3.12 Location Reference Points Listing
3.13 Nominal Wall Thickness Listing

(C) Summary

3.14 Pipeline Listing

3.1 Sentenced Plots

A Sentenced Plot will be produced for each Major Segment of each Component Line (as detailed by the Company). This will show sentenced depth versus length for all detected Metal Loss Features (excluding identified Manufacturing Faults) and includes the curve for a Pressure Sentenced Ratio of unity also defined in the Appendix. Metal Loss Features detected in Minor Segments identified within the Major Segment of any Component Line will be represented separately on the Sentenced Plot.

3.2 Pressure Based Histograms

A histogram will be provided indicating the number of occurrences of Pressure Sentenced Metal Loss Features (excluding identified Manufacturing Faults) per unit distance against absolute distance along each Component Line. Such Pressure Sentenced Metal Loss Features will be graded into bands according to severity. Additionally, a three-dimensional histogram will be provided showing the metal loss distribution for each of the pre-selected graded bands along each Component Line

3.3 Depth Based Histograms

The Depth Based Histograms show the number of occurrences of detected Metal Loss Features and identified Manufacturing Faults against absolute distance along each Component Line, presented in the following formats:

(i) All detected Metal Loss Features against absolute distance along each Component Line.

(ii) Total area of metal loss expressed as a percentage of surface area of Component Line against absolute distance.

(iii) Total volume of metal loss expressed as a percentage of pipe wall volume, against absolute distance.

(iv) Short Metal Loss Features i.e. Metal Loss Features with axial length < 3t graded into bands according to peak depth.

(v) Long Metal Loss Features i.e. Metal Loss Features with axial length > 3t graded into bands according to peak depth.

(vi) The distribution of detected metal loss graded into bands according to peak depth. This will be provided on a three dimensional histogram.

3.4 Orientation Plot

This plot shows all the instances of Metal Loss Features and identified Manufacturing Faults detected over the total length of each Component Line and indicates the orientation of the metal loss viewed in the direction of flow, against the absolute distance along the Component Line. The Orientation Plot is colour coded to show the depth grading of the Metal Loss Feature as reported in the Depth Based Histogram. Internal/external distribution can be viewed on the Orientation Plot contained in PipeImage™ Inspection Data Software.

3.5 Severity Table

The Severity Table comprises a list of pipe spools indicating the Pressure Sentenced Ratio, peak depth and axial length of the most severe Metal Loss Feature (excluding identified Manufacturing Faults) within each spool. These Metal Loss Features are selected in accordance with the Selection Rules detailed in Paragraph 2.1.(b) and listed in descending order of severity.

The Severity Table includes all pipe spools containing a Metal Loss Feature with Pressure Sentenced Ratio less than or equal to unity.

In the event that there are less than 25 (twenty five) pipe spools containing a Metal Loss Feature with Pressure Sentenced Ratio equal to or less than unity, the balance up to 25 shall be made up of the most severe of the remaining pipe spools.

The Severity Table shall contain the following:

(a) Pressure Sentenced Ratio of the Metal Loss Feature calculated in accordance with the Appendix

(b) Peak Depth and axial length of the Metal Loss Feature

(c) Weld number of nearest upstream girth weld

(d) Distance from the start of the Component Line (absolute distance)

(e) Orientation of the Metal Loss Feature viewed in the direction of the flow

3.6 Velocity Plot

This plot indicates the Inspection Vehicle velocity against absolute distance along the Component Line

3.7 Metal Object Report

The following information will be provided for all ferrous metal objects detected in proximity to a Component Line:

(a) Number of nearest upstream girth weld from the metal object

(b) Distance of metal object from the nearest upstream girth weld (relative distance) to the accuracy set out in the Inspection Performance Specification

(c) Distance of metal object from the start of the Component Line (absolute distance)

(d) Proximity classification (i.e. close or touching). Those metal objects classified as 'touching' may in the Contractor's opinion, have interfered with the coating or cathodic protection of the Component Line

(e) Orientation of detected metal object viewed in the direction of the flow

(f) Identification of nearest upstream location reference point

(g) Distance of upstream location reference point from nearest upstream girth weld to the accuracy set out in the Inspection Performance Specification

(h) Identification of nearest downstream location reference point

(i) Distance of downstream location reference point from nearest upstream girth weld to the accuracy set out in the Inspection Performance Specification

3.8 Eccentric Casing Report

Where a casing is considered by the Contractor to be so eccentric as to affect the carrier protective coating or the cathodic protection system the following information will be provided:

(a) Number of nearest upstream girth weld from the start of the casing

(b) Distance from nearest upstream girth weld to upstream end of casing (relative distance) to the accuracy set out in the Inspection Performance Specification

(c) Distance from the start of the Component Line to the upstream end of the casing (absolute distance)

(d) Category of position (i.e. start, end or intermediate)

- upstream end
- downstream end
- ends of unconnected spools making up the casing, if appropriate

(e) Comment as to whether the point of minimum separation of the casing so affected is 'close' or 'touching'

(f) Comment as to whether corrosion has been detected within the casing

(g) Length of casing (relative distance from start of casing)

(h) Comment on the identity of the casing and a statement as to whether the affected casing is associated with a road/railway crossing.

(i) Orientation of the point of minimum separation between the casing and the carrier pipe

3.9 Dent Report

All dents detected by the Inspection System will be reported upon in the following format:

(a) Number of nearest upstream girth weld from dent

(b) Distance of dent from nearest upstream girth weld (relative distance) to the accuracy set out in the Inspection Performance Specification

(c) Distance of dent from the start of the Component Line (absolute distance)

(d) Indication of presence of associated metal loss

(e) Indication of presence of associated girth weld

(f) Indication of presence of associated seam weld

(g) Orientation of dent viewed in the direction of the flow

(h) Identification of nearest upstream location reference point

(i) Distance of upstream location reference point from nearest upstream girth weld to the accuracy set out in the Inspection Performance Specification

(j) Identification of nearest downstream location reference point

(k) Distance of downstream location reference point from nearest upstream girth weld to the accuracy specified in the Inspection Performance Specification

3.10 Girth weld Anomaly Report

The following information shall be provided for all girth weld anomalies detected by the Inspection System:

(a) The number of the girth weld in which the anomaly occurs

(b) Distance of girth weld from the start of the Component Line (absolute distance)

(c) Indication of the type of girth weld anomaly (e.g. crack, incomplete weld, dressing repairs etc.

(d) Estimated circumferential extent of the girth weld anomaly

(e) Orientation of detected girth weld anomaly viewed in the direction of the flow

(f) Identification of nearest upstream location reference point

(g) Distance of upstream location reference point from the nearest upstream girth weld to the accuracy specified in the Inspection Performance Specification

(h) Identification of nearest downstream location reference point

(i) Distance of downstream location reference point from nearest upstream girth weld to the accuracy specified in the Inspection Performance Specification

3.11 Repair Listing

The following information shall be provided for all repair shells (i.e. full circumferential, snug fitting, welded or epoxy filled, or repair clamps) or spools containing repair patches detected by the Inspection System:-

(a) Number of nearest upstream girth weld from the start of the repair shell or the spool containing the repair patch(es)

(b) Distance from nearest upstream girth weld to upstream end of repair shell (relative distance) to the accuracy specified in the Inspection Performance Specification

(c) Distance from the start of the Component Line to the upstream end of the repair shell or the spool containing the repair patch(es) (absolute distance)

(d) Comment as to whether the repair is a shell or a patch-repair spool

(e) Length of repair shell

NB: Metal loss detected under repair shells and repair patches shall not be included in the reports, which comprise the Pipeline Summary Report.

3.12 Location Reference Point Listing

To assist in the location of features the Contractor shall detail the location of reference points such as timer boxes, magnets and/or anodes, valves and major offtakes (i.e. offtakes >50% of Component Line nominal bore), and shall provide the following information:

(a) Number of nearest upstream girth weld from reference point

(b) Distance of reference point from nearest upstream girth weld (relative distance)

(c) Distance of reference point from the start of the Component Line (absolute distance)

(d) Indication of the presence of a reference point

(e) Magnet/timerbox/anode identification number

(f) Mile Post value for location points as supplied by the Company

Additionally, the Contractor shall provide a separate listing containing the reference point identification number from the above listing against which a description of the above ground geographical location of each such reference point shall be provided, when available.

3.13 Nominal Wall Thickness Listing

All pipe spool nominal wall thickness changes detected by the Inspection System will be reported in the following format:

(a) The number of the girth weld at which the change in the pipe spool nominal wall thickness occurs

(b) Distance of the girth weld from the start of the Component Line (absolute distance)

(c) Distance from the girth weld to the next identified pipe spool nominal wall thickness change (length)

(d) Nominal wall thickness of the spools downstream from the girth weld

(e) Segment Number which also gives an indication as to whether the spools are in Major or Minor Segments

(f) SMYS value as supplied by the Company

3.14 Pipeline Listing

The Pipeline Listing will provide a comprehensive overview of all detected features along the length of the pipeline, including girth welds, fittings, metal loss features, identified manufacturing faults, metal objects, casings, dents, girth weld anomalies, repair shells, location reference points, and nominal wall thickness changes. This will include the following information:

(a) Girth weld number

(b) Distance from the nearest upstream girth weld (relative distance) to the current listing item (provided such information can be reliably identified)

(c) Distance from the start of the Component Line to the current listing item (absolute distance)

(d) Description of the current listing item

(e) Peak depth of Metal Loss Feature or Manufacturing Fault

(f) Axial length of Metal Loss Feature or Manufacturing Fault

(g) Pressure sentenced ratio of the Metal Loss Feature calculated in accordance with the Appendix

(h) Orientation of detected Metal Loss Feature, Manufacturing Fault, metal object, dent, girth weld anomaly or major offtake viewed in the direction of the flow. For welds this will show orientation of seam weld (when visible) or start and end orientation of spiral weld on the downstream spool.

4. PipeImage™ Inspection Data Software

4.1 The PipeImage™ Inspection Data Software will be supplied on CD-ROM and will include all the information contained within the Pipeline Inspection Report.

4.2 PipeImage™ Inspection Data Software provides the following user features:

(i) Data Display
- Menu driven command interface in Windows environment
- Icon driven pipeline data navigation and report generation
- Graphical Mainview report window
- Graphical display of inspection data in multiple formats including "Grey Scale"
- Pipeline overview window
- Pipeline zoom and pan
- Graphical representation of feature boxes and clusters
- User defined annotation of areas of features and other interest

(ii) Pipeline Listing
- User defined reports
- Pipeline feature search and go to
- Data filtering and sorting
- Interactive listings and graphical reports

(iii) Reporting
- Sentenced Plots
- Re-sentencing with variable pipeline and pressure parameters
- Pressure and Depth Based Histogram
- Metal Loss Plot
- Velocity Plot
- Inspection/Dig sheet generation
- Report Browser Utility

(iv) Utilities
- PipeImage™ Inspection Data Software -set up program
- Data export tool
- Online Help
- Suitable for installation on a network

4.3 The Contractor hereby grants to the Company the perpetual right to use the PipeImage™ Inspection Data Software save that all patent, copyright and other intellectual property rights embodied in the PipeImage™ Inspection Data Software shall remain vested in the Contractor. The Company hereby agrees that it shall not cause or permit the reverse engineering, disassembly or de-compilation of the PipeImage™ Inspection Data Software and shall keep confidential information relating to the processes and/or programs employed in the aforementioned software

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APPENDIX 1

MAGNESCAN™ - PIPELINE INSPECTION REPORT

1. Definition of Terms

1.1 Metal Loss Feature

The term Metal Loss Feature is used to describe an occurrence of metal loss detected by the Inspection System. Where an occurrence of metal loss has been recognized to be "distinct", a box will be drawn around the Metal Loss Feature, which will be used to describe the boundary of the metal loss by its axial length and circumferential width. For isolated Metal Loss Features "distinct" means that the metal loss levels surrounding the box are below the reporting levels set out in the Inspection Performance Specification. For more complex areas of metal loss where pitting occurs within an area of general metal loss "distinct" shall mean that the metal loss level surrounding the box is significantly lower than that of the box.

Within areas of Pipeline where general corrosion has been detected, background metal loss below the reporting threshold of the Inspection System is commonly found to surround the boxed Metal Loss Feature. To ensure that the Company is made aware of all Metal Loss Features, which could pose a threat to the integrity of the Pipeline, the Contractor adopts a conservative approach to such areas of general corrosion by the application of signal clustering rules. Where the Contractor considers two or more boxed Metal Loss Features in close proximity may reasonably be joined by background metal loss, these will be combined and classified as a "cluster". The dimensions of the resulting cluster will be described by the peak depth, axial length and circumferential width.

1.2 Manufacturing Fault

A Manufacturing Fault is an occurrence of metal loss detected by the Inspection System, which has been assessed as having been caused during the manufacture of the line pipe/Component Line prior to commissioning/hydrostatic testing. It will be either,

(a) a single isolated box, or
(b) a cluster

The profile and surface texture of some Manufacturing Faults may make it difficult during analysis of the inspection data, to distinguish between a Manufacturing Fault and metal loss caused for example by corrosion. However, such faults should have been subject to the hydrostatic test during commissioning of the Pipeline and therefore should pose no threat to the integrity of the Pipeline.

1.3 Interaction Rules

The Interaction Rules are intended to represent the physical interaction between areas of metal loss (boxes). The Interaction Rules to be used in the compilation of the Pipeline Inspection Report are as follows;

Feature boxes, regardless of reported depth, will "interact" if they are separated by no more than 6 wall-thicknesses (6t) both axially and circumferentially. Each set of interacting boxes will be "clustered".

1.4 Pressure Sentenced Ratio

The Pressure Sentenced Ratio expresses the severity of the Metal Loss Feature. This is calculated below as RPR085. The more severe the Metal Loss Feature, the lower the Pressure Sentenced Ratio.

$S =$ Hoop stress level at failure

$$A = \frac{L^2}{Dt}$$

If the value of A is greater than 50

$$M_{085} = 3.3 + 0.032A$$

If the value of A is less than or equal to 50

$$M_{085} = \sqrt{1 + 0.6275A - 0.003375A^2}$$

$$T = \frac{1 - \frac{0.85d_{\%}}{100}}{1 - \frac{0.85d_{\%}}{100M_{085}}}$$

$$S = F_{stress}T$$

$$\text{RPR085} = \frac{S}{SMYS}$$

d	=	Sentenced Depth = Peak depth of the cluster.
t	=	Nominal wall thickness of pipe for each Component Line Major segment as defined in Paragraph 1.5 (page 4 of 4).
L	=	Axial length of the Cluster. Note the individual metal loss boxes will have been clustered according to the specified Interaction Rules of Appendix 2.
D	=	Nominal outside diameter of the pipe.

1.5 Company Defined Operating Parameters

Pressure Sentenced calculations may be varied for each identifiable segment of a Component Line to suit different operating parameters as required. The Company shall define such Major Segments and the appropriate operating parameters in the table below prior to Contract signature or as soon as possible thereafter.

In the event that the operating parameters have not been so defined by the Company, the Contractor shall perform Pressure Sentenced calculations using the following default parameters:

(a) The design pressure and MAOP will be assumed to be the same pressure and the same pressure will apply to all Major Segments. This provides for a conservative evaluation of any Metal Loss Feature in relation to Pipeline safety.

(b) The wall thickness in Major and Minor Segments (t and t' respectively) will be derived from the inspection data and where appropriate cross checked against previous inspection data or other data provided by the Company.

Component Line

Major Segment	START	FINISH	P_i kpa/psi	t mm/ins	SMYS Kpa/psi	MAOP kpa/psi	Minor Segment t' mm/ins
1	Launch to						
2							
3							
4							
5		Receive to					

P_i = Internal Design Pressure
t = Nominal Wall Thickness of Pipe (Major Segment)
MAOP = Maximum Allowable Operating Pressure or Company chosen Operating Pressure
SMYS = Specified Minimum Yield Stress
t' = Nominal Wall Thickness of Pipe within a Minor Segment where it is known to vary from t (e.g. road, river crossings etc.)

Those Major Segments of the Component Line listed by the Company above will be subdivided into Minor Segments in the event that the Contractor identifies areas of the Major Segment containing line pipe with Nominal Wall Thickness which varies significantly to that stated by the Company (e.g. road or river crossings, repair sections etc.).

For Minor Segments, the Contractor shall use either the appropriate Minor Segment wall thickness (t') supplied in the table above or the appropriate API wall thickness that is most consistent with the inspection data.

In the absence of any other information from the Company (strip maps, pipe listings etc.), the Contractor shall assume the Major Segment pressure parameters (P_i, MAOP) for the Minor Segments.

Pressure Sentenced Calculations shall be produced for each Metal Loss Feature in such Minor Segments on this basis.

This additional information relating to the wall thickness in Minor Segments shall be provided in the Nominal Wall Thickness Listing. Detailed sentenced plot data for Minor segments will be presented in the PipeImage™ Inspection Data Software report only.

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APPENDIX 2

MAGNESCAN™ - PIPELINE INSPECTION REPORT

Interaction Rules

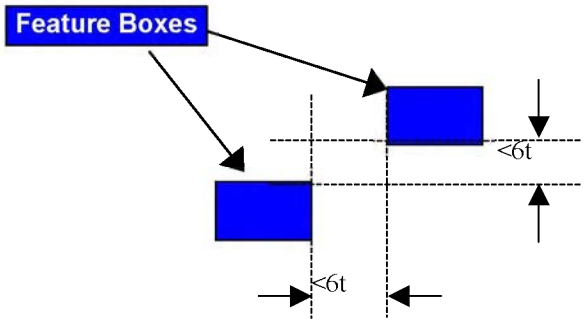
The Interaction Rules are intended to represent the physical interaction between areas of metal loss (boxes). The Interaction Rules to be used in the compilation of the Pipeline Inspection Report are as follows:

(i) Feature boxes will "interact" if their axial separation and their circumferential separation are both no more than 6 wall-thicknesses (6t).

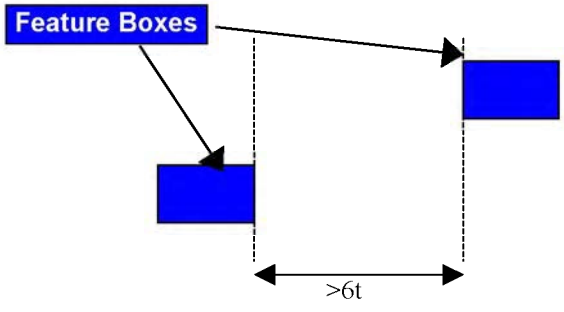
(ii) A set of interacting boxes will form a "cluster"

An example is as follows:

Example of Feature Boxes that Interact



Example of Feature Boxes that Do Not Interact



Feature Boxes must be within 6 Wall Thicknesses (6t) in both directions.

A cluster of pits situated across a girth weld shall be considered to be continuous (i.e. girth welds do not prevent interaction).

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APPENDIX 3

MAGNESCAN™ - PIPELINE INSPECTION REPORT

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- physically transfer the program from one computer to another, provided that the program is used on only one computer at a time.

You must not:

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Appendix G Inspection System Performance Specification

The pipeline inspection system employed by GE Oil & Gas, PII Pipeline Solutions has been designed to carry out a genuine high resolution pipeline inspection.

The performance capabilities of the inspection system are defined in the Inspection System Performance Specification, a copy of which is provided overleaf:

ENBDNR0001054

SCHEDULE 5

THE INSPECTION PERFORMANCE SPECIFICATION

1. Introduction

The Contractor's Inspection Vehicles have been specifically designed to ensure high resolution inspection of the full circumferential extent of the Pipeline and the detection of metal loss occurrences therein.

Inspection data obtained during the Inspection Vehicle run(s) in the Pipeline is subjected to a two stage processing and analysis procedure.

During Stage 1, preliminary processing and analysis is performed using the Contractor's automatic data analysis facilities. All Metal Loss Features detected by the Inspection System irrespective of depth or surface dimension are automatically sized and are reported together with Pipeline Anomalies and Pipeline Fittings, in the Pipeline Summary Report detailed in Schedule 5. The analysis systems employed during this stage are specifically designed such that all Metal Loss Features which may be of concern to the integrity of the Pipeline are highlighted and are selected for more detailed processing and analysis, subject to the maximum number of Features specified in Schedule 5.

During Stage 2, the most significant Metal Loss Features identified in Stage 1 are selected using the priority rules detailed in Schedule 5, for more detailed processing and analysis and reported on Individual Inspection Sheets. Those Metal Loss Features that have undergone such detailed processing and analysis shall be sized to the accuracy detailed in section 4 below.

The Contractor's Inspection Vehicles together with the aforementioned data processing and analysis comprise the Contractor's Inspection System.

2. Detection Capability

The capability of the Contractor's Inspection System, which applies irrespective of the type of pipeline construction (i.e. seamless, seamwelded, spiral etc.), is such that the following types of feature present in the pipeline can be detected:

(a) Metal loss

(i) associated with corrosion, including
- such metal loss in the vicinity of girth welds
- such metal loss associated with dents
- such metal loss situated beneath casings

(ii) associated with gouging

All such metal loss of depth and surface dimension greater than the minimum required for accurate sizing as detailed in Table 1 shall be detected. Metal loss below such depth and surface dimension can be detected. However, the probability of detection is reduced as the depth and surface dimension of the feature is reduced.

(b) Metal loss situated beneath repair clamps

(c) Metal loss associated with manufacturing faults

(d) Welds - girth, seam and spiral

(e) Girth weld anomalies including circumferential cracks within girth welds

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(f) Dents

(g) Manufacturing/mill type defects

(h) Construction damage

(i) Changes in nominal pipe wall thickness

(j) Pipeline fixtures and fittings including:
- (i) Tees
- (ii) Offtakes
- (iii) Valves
- (iv) Bends
- (v) Anodes
- (vi) Buckle Arrestors
- (vii) External Supports
- (viii) Ground Anchors
- (ix) Repair Shells
- (x) CP Connections - ferro-magnetic type

(k) Ferrous metal objects in close proximity to the pipeline considered likely to affect the carrier protective coating or cathodic protection system.

(l) Casings, including eccentric casings where the degree of eccentricity is considered likely to affect the carrier protective coating or cathodic protection system.

(m) Reference marker magnets

3. Location Accuracy

3.1 All those features detailed in section 2 detected by the Inspection System shall be located to the accuracy detailed in Table 1.

4. Sizing Accuracy

4.1 Those Metal Loss Features as detailed in section 2.(a) detected by the Inspection System and which have been selected for reporting on Individual Inspection Sheets shall subject to section 4.2, be sized to the accuracy detailed in Table 1 attached hereto.

4.2 It should be noted that the sizing accuracy is dependent upon several factors such as pipeline cleanliness, pipe construction methods, product flow conditions etc. These factors have been taken into account by the Contractor when designing the Inspection System. However it has been found impractical to compensate fully for the extremes which have been noticed in practice and as a result the accuracy with which Metal Loss Features can be detected and sized can vary from point to point along a pipeline. The Contractor's experience of operating on-line Inspection Systems show that the sizing accuracy detailed in Table 1 is attained for greater than 80% of Metal Loss Features reported.

ENBDNR0001056

TABLE 1 DETECTION, SIZING AND LOCATION ACCURACY (10/20)

	METAL LOSS CATEGORY		
	PITTING <(3t X 3t)*	**GENERAL >(3t x 3t)***	**GOUGING**
Minimum Depth for Accurate Sizing	If surface dimension is > 0.275" x 0.275" or 0.4t x 0.4t (whichever greater): 0.2t	0.1t	If width > 0.5t or 0.275" (whichever greater): 0.2t If width > 3t: 0.lt
Sizing Accuracy (Depth)	±0.1t	±0.1t	±0.1t
Sizing Accuracy (Length)	±0.4"	±0.8"	±0.8"
Sizing Accuracy (Width)	±0.8"	±0.8"	±0.8"
Location Accuracy (Axial)	±8" between the feature and the reference girth weld and ±1% of stated distance between reference girth weld and identified location reference		
Location Accuracy (Circumferential)	±7.5 degrees which for ease of reference is stated to the nearest half hour clock position		

t = nominal wall thickness

* Metal loss is characterized by the minimum rectangle of dimensions, circumferential width (W) and axial length (L) that contains the surface area of pipe affected by metal loss.

Pipeline Anomalies (i.e. Dents, Weld Anomalies, Eccentric Casings, and Metal Objects) and Pipeline Fittings (i.e. Valves, Offtakes, etc.) shall also be located to the accuracy stated above.

ENBDNR0001057